F650 Digital Bay Controller

Instruction Manual

Firmware version: 9.1x
EnerVista F650 Setup version: 9.1x
GE publication code: 1601-0800-A5

WORLDWIDE 10 YEAR WARRANTY

LISTED

REGISTERED ISO 9001 GE MULTILIN

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F650 Digital Bay Controller

Table of Contents

1 GETTING STARTED

1.1 Important procedures 1-1
1.1.1 Cautions and warnings 1-2
1.1.1.1 General cautions and warnings 1-3
1.1.1.2 Communication board withdrawal/insertion 1-5
1.1.1.3 Magnetic module terminals 1-6
1.1.2 Inspection checklist 1-7
1.1.3 Safety instructions 1-9
1.1.3.1 General safety instructions 1-10
1.1.3.2 Warning symbols 1-11
1.2 Overview 1-11
1.2.1 Introduction to the 650 family of relays 1-12
1.2.2 Hardware architecture 1-13
1.2.2.1 F650 basic design 1-14
1.2.2.2 F650 signal type 1-15
1.2.3 Communications architecture 1-16
1.3 EnerVista 650 Setup software 1-18
1.3.1 System requirements 1-19
1.3.2 Installation 1-20
1.3.3 Connecting EnerVista 650 Setup to the F650 1-24
1.3.3.1 Configuring an Ethernet connection 1-25
1.3.3.2 Configuring the RS232 connection 1-26
1.4 650 hardware 1-26
1.4.1 Mounting & wiring 1-27
1.4.2 650 communications 1-28
1.4.3 Faceplate display 1-30
1.4.4 Maintenance 1-31
1.4.4.1 General maintenance 1-32
1.4.4.2 In-service maintenance 1-33
1.4.4.3 Out-of-service maintenance 1-34
1.4.4.4 Unscheduled maintenance 1-35
1.4.5 Storage 1-36
1.4.6 Repairs 1-37
1.4.7 Disposal 1-38

2 PRODUCT DESCRIPTION

2.1 F650 Overview 2-1
2.2 ANSI device numbers and functions 2-2

2.3 Other device functions 2-3
2.4 Order codes 2-4
2.5 Technical specifications 2-7
2.5.1 Protection 2-7
2.5.2 Control 2-16
2.5.3 Monitoring 2-19
2.5.4 User-programmable 2-21
2.5.5 Metering 2-22
2.5.6 Inputs 2-22
2.5.7 Real time clock 2-24
2.5.8 Outputs 2-24
2.5.9 Control power supply 2-24
2.5.10 Communications 2-25
2.5.11 Optical 2-27
2.5.12 Environmental 2-28
2.5.13 Packaging and weight 2-28
2.5.14 Type tests 2-28
2.5.15 Approvals 2-29
2.6 External connections 2-30

3 HARDWARE
3.1 Module description 3-1
3.2 Power supply 3-2
3.3 Mechanical description 3-3
3.3.1 Mounting 3-3
3.3.2 Rear description 3-6
3.4 Wiring 3-9
3.4.1 External connections 3-9
3.4.2 Digital inputs with trip circuit supervision 3-9
3.4.3 Cable/fiber Ethernet board 3-11
3.5 Transceiver optical power budget vs. link length 3-11

4 INTERFACES, SETTINGS & ACTUAL VALUES
4.1 EnerVista 650 Setup software 4-1
4.1.1 Introduction 4-1
4.1.1.1 Using settings files 4-2
4.1.1.2 Viewing actual values 4-3
4.1.1.3 Viewing triggered events 4-4
4.1.1.4 Firmware upgrades 4-5
4.1.1.5 One line diagrams 4-6
4.1.2 Main screen 4-7
4.1.3 Connect to the relay 4-8
4.1.3.1 Computer Settings: 4-9
4.1.3.2 Communication Control: 4-10
4.1.3.3 Communication Optimization: 4-11
4.1.4 File management menu 4-12
4.1.4.1 File Management menu for firmware below v7.70 4-13
4.1.4.2 File Management menu for firmware v7.70 and above 4-18
4.1.5 EnerVista 650 Setup menu 4-22
4.1.6 File menu 4-23
4.1.6.1 New 4-24
4.1.6.2 Open 4-26
4.1.6.3 Save/Save as 4-30
4.1.6.4 Close 4-31
4.1.6.5 Configuration file converter 4-32
4.1.6.6 Properties 4-36
4.1.6.7 Print options 4-37

4.1.6.8 Compare to settings file 4-38
4.1.6.9 PLC checksum calculation 4-39
4.1.6.10 Setting checksum calculation 4-40
4.1.7 Setpoint menu 4-40
4.1.7.1 Product setup menu 4-41
4.1.7.2 Communication settings menu 4-42
4.1.7.3 System setup menu 4-43
4.1.7.4 Breaker menu 4-44
4.1.7.5 Protection elements menu 4-45
4.1.7.6 Control elements menu 4-48
4.1.7.7 Inputs/Outputs menu 4-50
4.1.7.8 Quick settings menu 4-51
4.1.7.9 Relay configuration menu 4-52
4.1.7.10 Logic Configuration menu 4-54
4.1.7.11 IEC 103 Configuration menu 4-55
4.1.7.12 Clock menu 4-56
4.1.8 Actual values menu 4-56
4.1.8.1 Front panel 4-57
4.1.8.2 Status 4-58
4.1.8.3 Metering 4-61
4.1.8.4 Inputs/Outputs menu 4-62
4.1.8.5 Records menu 4-63
4.1.9 Operations menu 4-64
4.1.10 Communications menu 4-64
4.1.11 Security menu 4-66
4.1.12 View menu 4-67
4.1.13 Help menu 4-67
4.2 Human-machine interface (HMI) 4-68
4.2.1 Display 4-69
4.2.2 LED indicators 4-70
4.2.3 Pushbuttons 4-70
4.2.3.1 Keypad and shuttle key 4-71
4.2.3.2 Command push button 4-73
4.2.4 Front port and cover sealing system 4-74
4.2.5 Screen contrast 4-74
4.2.6 Text menus 4-74
4.2.6.1 Navigation 4-75
4.2.6.2 Text menu hierarchy 4-76
4.2.6.3 Actual Values 4-77
4.2.6.4 Snapshot events 4-79
4.2.6.5 Fault report 4-80
4.2.6.6 View settings menu 4-83
4.2.6.7 Change Settings 4-87
4.2.6.8 Date & time 4-88
4.2.6.9 Commands 4-90
4.2.6.10 Passwords 4-91
4.2.6.11 Select main screen 4-93
4.2.6.12 Select language 4-94
4.2.7 Graphic display 4-94
4.2.7.1 One-line diagram 4-95
4.2.7.2 Metering screen 4-96
4.2.7.3 All events screen 4-97
4.2.7.4 New events screen 4-100
4.2.7.5 Alarms panel 4-101
4.2.7.6 Input/output monitoring screen 4-103
4.3 Web server 4-105
4.3.1 Home 4-105
4.3.2 Snapshot events 4-106
4.3.3 Control events 4-108

4.3.4 Alarms 4-109
4.3.5 Oscillography 4-110
4.3.6 Fault report 4-111
4.3.7 Data logger 4-112

5 SETPOINTS

5.1 Overview 5-1
5.1.1 Setpoint main menu 5-1
5.2 Product setup 5-3
5.2.1 Communication settings 5-3
5.2.1.1 Serial ports 5-3
5.2.1.2 Network (Ethernet) 5-3
5.2.1.3 MODBUS protocol 5-7
5.2.1.4 DNP3 slave 5-7
5.2.1.5 IEC 60870-5-104 5-9
5.2.1.6 SNTP 5-10
5.2.1.7 Procome protocol settings 5-11
5.2.1.8 IEC 870-5-103 protocol settings 5-11
5.2.1.9 PTP IEEE 1588 protocol settings 5-12
5.2.1.10 Routing 5-14
5.2.2 MODBUS user map settings 5-16
5.2.3 Fault report settings 5-17
5.2.3.1 Fault report settings 5-17
5.2.3.2 Fault report retrieval 5-19
5.2.4 Oscillography settings 5-20
5.2.4.1 Oscillography settings 5-20
5.2.4.2 Oscillography states 5-21
5.2.4.3 Oscillography file retrieval 5-22
5.2.5 Data logger settings 5-22
5.2.5.1 Data logger SETTINGS 5-22
5.2.5.2 Data logger associated states 5-23
5.2.5.3 Data logger file format and retrieval 5-23
5.2.6 Demand settings 5-25
5.2.6.1 Metering values and settings 5-25
5.2.6.2 Demand calculation methods 5-26
5.2.6.3 Demand function measurements and states 5-29
5.2.7 Time Settings 5-30
5.3 System setup 5-32
5.3.1 General settings 5-32
5.3.2 Miscellaneous settings 5-33
5.3.2.1 Out of service setting 5-33
5.3.2.2 Local - remote block setting 5-35
5.3.3 FlexCurve settings 5-36
5.3.4 Breaker settings 5-38
5.3.4.1 Breaker maintenance 5-39
5.3.5 Switchgear settings 5-40
5.4 Protection elements 5-40
5.4.1 Available settings and setting groups 5-40
5.4.1.1 Firmware 7.2x and below 5-40
5.4.1.2 Firmware 7.50 or above 5-44
5.4.2 Inverse time curve characteristics 5-49
5.4.2.1 IEEE curves 5-50
5.4.2.2 IEC curves 5-51
5.4.2.3 IAC curves 5-53
5.4.2.4 ANSI curves 5-54
5.4.2.5 I2t curves 5-56
5.4.2.6 Definite time curves 5-56
5.4.2.7 Rectifier time curves 5-56
5.4.2.8 User curves - FlexCurves A/B/C/D 5-57

5.4.3 Phase current 5-58
5.4.3.1 Phase time delayed overcurrent elements – phase high/low (51Ph/51pl) 5-58
5.4.3.2 Phase instantaneous overcurrent element- phase high/low (50PH/ 50PL) 5-62
5.4.3.3 Phase directional element (67P) 5-64
5.4.3.4 Thermal model element (49) 5-69
5.4.4 Neutral current 5-70
5.4.4.1 Neutral time-delayed overcurrent element (51N) 5-70
5.4.4.2 Neutral instantaneous overcurrent element (50N) 5-70
5.4.4.3 Neutral directional element (67N) 5-72
5.4.4.4 Voltage polarization operation principles 5-73
5.4.4.5 Current polarization operation principles: 5-74
5.4.5 Ground current 5-76
5.4.5.1 Ground time-delayed overcurrent element (51G) 5-76
5.4.5.2 Ground instantaneous overcurrent element (50G) 5-77
5.4.5.3 Ground directional element (67G) 5-77
5.4.6 Sensitive ground current 5-79
5.4.6.1 Sensitive ground time-delayed overcurrent element (51SG) 5-79
5.4.6.2 Sensitive ground instantaneous overcurrent element (50SG) 5-80
5.4.6.3 Instantaneous overcurrent element for ungrounded systems (50IG) 5-80
5.4.6.4 Sensitive ground directional element (67SG) 5-82
5.4.7 Negative sequence current 5-84
5.4.7.1 Negative sequence overcurrent element (46P) 5-84
5.4.8 Voltage elements 5-85
5.4.8.1 Phase undervoltage element (27P) 5-86
5.4.8.2 Phase overvoltage element (59P) 5-87
5.4.8.3 Neutral overvoltage element high/low (59NH/59nl) 5-87
5.4.8.4 Negative sequence overvoltage element (47) 5-88
5.4.8.5 Auxiliary overvoltage element (59X) 5-88
5.4.8.6 Auxiliary undervoltage element (27X) 5-89
5.4.9 Power elements 5-89
5.4.9.1 Forward power element (32FP) 5-89
5.4.9.2 Directional power element (32) 5-90
5.4.9.3 Wattmetric ground fault (32N) 5-95
5.4.10 Frequency elements 5-99
5.4.10.1 Underfrequency element (81U) 5-99
5.4.10.2 Overfrequency element (81O) 5-100
5.4.10.3 Frequency rate of change 5-100
5.4.11 Miscellaneous elements 5-102
5.4.11.1 Broken conductor 5-102
5.4.11.2 Locker rotor 5-102
5.4.12 Load encroachment 5-104
5.5 Control elements 5-105
5.5.1 Setting group 5-106
5.5.2 Synchronism check element - synchrocheck (25) 5-107
5.5.2.1 Voltage inputs 5-108
5.5.2.2 Application 5-108
5.5.2.3 Settings 5-109
5.5.2.4 Synchrocheck states 5-110
5.5.2.5 Algorithm 5-111
5.5.3 Autoreclose (79) 5-115
5.5.3.1 Main autoreclose settings 5-115
5.5.3.2 Autoreclose inputs 5-116
5.5.3.3 Autoreclose internal status 5-117
5.5.3.4 General autoreclose status diagram 5-118
5.5.3.5 Logic for blocking protection functions during reclose cycle 5-119
5.5.4 Breaker failure element (50BF) 5-121
5.5.5 VT fuse failure element (VTFF) 5-125
5.5.5.1 Fuse failure algorithm 5-125
5.5.6 Pulse counters 5-126
5.5.7 Analog comparators 5-128

5.5.8 Maximum number of starts (66) ... 5-129
5.5.9 Digital counters ... 5-131
5.5.10 Cold load pickup ... 5-133
5.5.11 60 CTS failure ... 5-134
5.5.12 Second harmonic inhibit ... 5-136
5.6 Inputs/outputs ... 5-139
5.6.1 Input/output placement ... 5-139
5.6.2 Control settings for input/output ... 5-140
5.6.3 Inputs ... 5-142
5.6.4 Outputs ... 5-144
5.6.4.1 Output status signals ... 5-144
5.6.5 Circuit supervision and contact seal-in circuits ... 5-146
5.6.5.1 Digital inputs ... 5-146
5.6.5.2 With trip circuit supervision ... 5-146
5.6.5.3 Without supervision ... 5-148
5.6.5.4 With current supervision (with SEAL-IN) ... 5-148
5.6.5.5 With simple voltage supervision ... 5-150
5.6.5.6 With double voltage supervision ... 5-153
5.6.5.7 With double voltage supervision and serial resistor in voltage monitors ... 5-154
5.6.6 Analog board specific settings ... 5-156
5.6.7 Virtual inputs ... 5-156
5.6.7.1 Virtual inputs writing ... 5-156
5.6.7.2 Virtual inputs status monitoring: ... 5-156
5.6.8 Virtual outputs ... 5-157
5.6.9 Virtual outputs latched ... 5-157
5.7 Remote comms ... 5-158
5.8 Testing ... 5-158
5.8.1 Force IO–input testing ... 5-158
5.8.2 Force IO–output testing ... 5-158
5.9 Relay configuration ... 5-159
5.9.1 Outputs ... 5-159
5.9.2 LEDs ... 5-161
5.9.3 Operations ... 5-162
5.9.3.1 Programming an operation ... 5-164
5.9.4 Protection elements ... 5-166
5.9.5 Control elements tab ... 5-167
5.9.6 Oscillography ... 5-168
5.9.7 Control events ... 5-169
5.9.8 Switchgear ... 5-171
5.9.9 HMI (human-machine interface) ... 5-173
5.9.10 Device display selection ... 5-177
5.9.10.1 Type of graphical display ... 5-177
5.10 Logic configuration (PLC editor) ... 5-178
5.10.1 Theory of operation ... 5-179
5.10.1.1 Description ... 5-179
5.10.1.2 Logic compilation ... 5-182
5.10.2 Main menu ... 5-183
5.10.3 Configuration generation ... 5-184
5.10.3.1 Create new project ... 5-184
5.10.3.2 Create equation ... 5-185
5.10.3.3 Add input to automation ... 5-185
5.10.3.4 Add output to automation ... 5-185
5.10.3.5 Add digital operation ... 5-185
5.10.3.6 Link inputs, outputs, and operations ... 5-185
5.10.3.7 Add library ... 5-185
5.10.4 Library generation ... 5-185
5.10.4.1 Library example ... 5-186
5.10.5 Application example ... 5-187

5.11 IEC 61850 configuration 5-188
5.12 Procome configuration 5-190
5.13 IEC 60870-5-103 configuration 5-195

6 ACTUAL VALUES
6.1 Front panel 6-1
6.1.1 LEDs 6-1
6.2 Status 6-2
6.2.1 Operation bits status 6-2
6.2.2 Breaker status 6-2
6.2.3 Protection status 6-3
6.2.3.1 Protection blocks 6-3
6.2.3.2 Phase current 6-4
6.2.3.3 Neutral current 6-4
6.2.3.4 Ground current 6-5
6.2.3.5 Sensitive ground current 6-5
6.2.3.6 Negative sequence current 6-6
6.2.3.7 Thermal model 6-6
6.2.3.8 Voltage 6-7
6.2.3.9 Power 6-8
6.2.4 Control element status 6-9
6.2.4.1 Frequency 6-9
6.2.4.2 Synchrocheck 6-10
6.2.4.3 Autoreclose 6-11
6.2.4.4 Breaker failure 6-12
6.2.4.5 VT fuse failure 6-13
6.2.4.6 Broken conductor 6-13
6.2.4.7 Setting groups 6-13
6.2.4.8 Locked rotor 6-14
6.2.4.9 Pulse counters 6-14
6.2.4.10 Analog comparators 6-14
6.2.4.11 Load encroachment 6-15
6.2.4.12 Maximum number of starts 6-16
6.2.4.13 Digital counters 6-16
6.2.4.14 Cold load pickup 6-17
6.2.4.15 60CTS failure 6-18
6.2.4.16 2nd HRMC Inhibit 6-18
6.2.5 Protection & control status summary 6-18
6.2.6 Snapshot event summary 6-18
6.2.7 MODBUS user map 6-18
6.2.8 Switchgear status 6-19
6.2.9 Calibration status 6-20
6.2.10 FlexCurves 6-21
6.2.11 System info 6-21
6.2.12 Record status 6-24
6.2.12.1 Fault reports 6-24
6.2.12.2 Control events 6-26
6.2.12.3 Oscillography 6-26
6.2.12.4 Data logger 6-27
6.2.12.5 Demand 6-27
6.2.12.6 Energy 6-27
6.2.12.7 Breaker maintenance 6-28
6.2.13 IEEE 1588 precision time protocol (PTP) 6-29
6.2.14 Versions 6-29
6.2.15 Redundancy 6-31
6.3 Metering 6-31
6.3.1 Primary values 6-31
6.3.1.1 Current 6-31
6.3.1.2 Voltage 6-32

6.3.1.3 Power 6-32
6.3.1.4 Energy 6-34
6.3.1.5 Demand 6-34
6.3.2 Secondary values 6-35
6.3.2.1 Current 6-35
6.3.2.2 Voltage 6-35
6.3.2.3 Power 6-36
6.3.3 Phasor diagram 6-37
6.3.4 Frequency 6-38
6.4 Inputs / outputs 6-38
6.4.1 Contact inputs 6-38
6.4.2 Contact output status 6-38
6.4.3 Contact output operates 6-39
6.4.4 Contact output resets 6-41
6.4.5 I/O board status 6-41
6.4.6 Virtual inputs 6-42
6.4.7 Virtual outputs 6-42
6.4.8 Remote outputs 6-42
6.4.9 Remote inputs 6-44
6.4.10 Analog inputs 6-45
6.4.11 Virtual output latched 6-45
6.4.12 RIOs 6-45
6.5 Records 6-45
6.5.1 Event recorder 6-45
6.5.1.1 All snapshot events 6-45
6.5.1.2 New snapshot events 6-46
6.5.1.3 Control events 6-47
6.5.1.4 Alarm panel 6-47
6.5.2 Waveform capture 6-48
6.5.3 Fault report 6-49
6.5.4 Data logger 6-50

7 IEC 61850 PROTOCOL
7.1 IEC 61850 Overview 7-1
7.2 IEC 61850 generic substation state event (GSSE) 7-2
7.2.1 Overview 7-2
7.2.2 Remote communication 7-2
7.2.3 GSSE configuration 7-2
7.2.4 Remote inputs 7-4
7.2.5 Remote outputs 7-5
7.2.5.1 DNA bit pairs 7-5
7.2.5.2 UserSt bit pairs 7-6
7.3 IEC 61850 profile for F650 7-6
7.3.1 Overview 7-6
7.3.1.1 Scope and outline of IEC 61850 7-8
7.3.2 Communication profiles 7-9
7.3.3 TCP connection timing 7-9
7.3.4 MMS protocol 7-9
7.3.5 Peer-to-peer communication 7-9
7.3.6 File services 7-9
7.3.7 IEC 61850 conformance statements 7-10
7.3.7.1 Abbreviations and acronyms 7-10
7.3.7.2 Definitions of the ISO/OSI reference model 7-10
7.3.7.3 Conformance statements for F650 devices 7-11
7.4 IEC 61850 FUNCTIONALITY 7-209
7.4.1 Client Connections 7-209
7.4.2 GOOSES 7-210

7.4.2.1 TRANSMISSION GOOSES 7-210
7.4.2.2 RECEPTION GOOSES 7-210
7.4.3 IEC 61850 Server 7-210
7.4.3.1 LOGICAL DEVICES AND REPORTS 7-210
7.5 IEC 61850 Status 7-211
7.5.1 GOOSES Status 7-211
7.5.2 IEC 61850 CID Status 7-212
7.6 IEC 61850 Configurator 7-214
7.6.1 Overview 7-214
7.6.2 Online/Offline operation modes 7-214
7.6.3 IEC 61850 configurator details 7-215
7.6.3.1 IEC 61850 configurator interface. 7-216
7.6.3.2 Configuration of setting groups 7-248

8 SECURITY
8.1 Security level for firmware versions prior to 9.00 8-1
8.1.1 Adding users 8-1
8.1.2 Changing passwords 8-2
8.1.3 Enabling security 8-2
8.1.4 Logging into EnerVista 650 Setup 8-3
8.2 Security level for firmware versions 9.00 and higher 8-4
8.2.1 Cybersecurity Overview 8-4
8.2.2 Settings 8-5
8.2.4 Authentication Methods 8-15
8.2.5 Secure communication 8-17
8.2.6 Other Features 8-19
8.2.7 Product Hardening 8-22
8.2.8 Security Logging - Syslog 8-25
8.2.9 LOST PASSWORD 8-26

9 BOOTCODE AND FIRMWARE UPGRADE
9.1 Firmware upgrade versions below 7.00. 9-1
9.1.1 Communication parameters 9-3
9.1.2 Bootware version upgrade 9-4
9.1.2.1 Bootware upgrade 9-4
9.1.3 Firmware version upgrade 9-12
9.1.3.1 Introduction 9-12
9.1.3.2 Firmware upgrade 9-12
9.1.4 Summary of main steps 9-21
9.1.4.1 Boot code upgrade (*) 9-21
9.1.4.2 Firmware upgrade(*) 9-21
9.2 Firmware upgrade version 7.00 or above 9-21
9.2.1 Communication parameters 9-23
9.2.2 Firmware version upgrade 9-24
9.2.2.1 Introduction 9-24
9.2.2.2 Firmware upgrade 9-24
9.2.2.3 Order code upgrade process 9-27
9.2.3 Summary of main firmware upgrade steps 9-30

10 COMMISSIONING
10.1 Visual inspection 10-1
10.2 Out of service setting 10-1
10.3 General considerations, power supply network 10-2
10.4 Isolation tests 10-3
10.5 Indicators 10-4
10.6 Power supply testing 10-4
10.7 Communications 10-4

10.8 Verification of measurement 10-4
10.8.1 Voltages 10-5
10.8.2 Phase currents 10-5
10.8.3 Active, reactive power, and COSJ metering 10-6
10.8.4 Frequency 10-7
10.9 Inputs and outputs 10-7
10.9.1 Digital inputs 10-7
10.9.2 Contact outputs 10-8
10.9.3 Circuit continuity supervision inputs 10-8
10.9.4 Latching circuits 10-8
10.10 Connections for testing protection elements 10-9
10.11 Instantaneous overcurrent (50PH, 50PL, 50N, 50G, 50SG) 10-9
10.12 Time overcurrent (51PH, 51PL, 51N, 51G, 46) 10-10
10.13 Directional elements (67P, 67N, 67G, 67SG) 10-11
10.13.1 67P element 10-11
10.13.2 67N element 10-12
10.13.3 67G element 10-12
10.13.4 67SG element 10-13
10.14 Undervoltage elements (27P, 27X) 10-13
10.14.1 27P element 10-13
10.14.2 27X element 10-14
10.15 Overvoltage elements (59P, 59X, 59NH, 59NL, 47) 10-14
10.15.1 59P element 10-14
10.15.2 59X element 10-15
10.15.3 59NH and 59NL elements 10-15
10.15.4 47 element - Neg Seq OV 10-16
10.16 Frequency elements (81O/81U) 10-17
10.17 Recloser (79) 10-17
10.17.1 Reclosing cycle 10-18
10.17.2 Recloser status 10-18
10.17.3 External reclose initiation 10-19
10.18 Thermal image element (49) 10-19

11 APPLICATION EXAMPLES
11.1 Example 1: Communication & protection settings 11-1
11.1.1 Description 11-1
11.1.2 Communicate with the relay 11-1
11.1.3 Set the protection function 11-3
11.1.4 Test 11-4
11.2 Example 2: TOC protection & reclosing settings 11-5
11.2.1 Description 11-5
11.2.2 Communicate with the relay 11-5
11.2.3 Set the protection function 11-5
11.2.4 Set the recloser 11-6
11.2.5 Set the synchrocheck 11-6
11.3 Example 3: Set an operation 11-8
11.3.1 Description 11-8
11.3.2 Procedure 11-8
11.3.3 Test 11-10

12 FREQUENTLY ASKED QUESTIONS
12.1 Communications 12-1
12.2 Protection 12-3
12.3 Control & HMI 12-3
12.4 Relay configuration 12-5

13 F650 TROUBLESHOOTING GUIDE

13.1 Symptoms and recommended actions 13-1

A LOGIC OPERANDS

A.1 Operands - F650 - model FX - GX A-1

B MODBUS PROTOCOL

B.1 Introduction B-1
B.2 MODBUS F650 ..... B-1
B.2.1 Implemented MODBUS functionality B-1
B.2.2 Physical layer B-2
B.2.2.1 Serial layer B-2
B.2.2.2 B.2.2.2 TCP/IP layer B-2
B.2.3 Data link layer B-2
B.2.4 Generic reading B-3
B.2.5 Generic writing B-4
B.2.6 Function codes B-5
B.2.7 Exception and error responses B-6
B.3 Data type B-6
B.4 MODBUS data B-7
B.4.1 Data management B-7
B.4.2 Writing settings B-7
B.4.3 Snapshot events B-7
B.4.4 Operations B-10
B.4.5 Force outputs of IO boards B-11
B.4.6 Control events B-12
B.4.6.1 Event structure B-12
B.4.6.2 Event collection process B-13
B.4.6.3 Control events from the command line B-14
B.4.6.4 Event status request (alarms) B-15
B.4.6.5 Acknowledging alarms B-15
B.4.7 Write virtual inputs B-15
B.4.8 User map B-15
B.4.9 Retrieve oscillography B-16
B.4.10 Time synchronization B-16
B.4.11 Queuing messages B-17
B.4.12 Traces and troubleshooting B-17
B.4.13 MODBUS CRC generation function B-18
B.5 Memory map B-20

C DNP 3.0 PROTOCOL FOR F650

C.1 DNP 3.0 protocol settings C-1
C.2 DNP 3.0 device profile document C-4
C.3 Implementation table C-7
C.4 Binary input points C-11
C.5 DNP configuration examples C-12
C.5.1 Configuring DNP user map C-12
C.5.2 Example of custom binary input points map C-14
C.5.3 Multiple DNP 3.0 masters communication with F650 ..... C-15
C.6 Binary output and control relay output C-16
C.7 Binary counters C-17
C.8 Analog inputs C-18

D IEC 60870-5-104 PROTOCOL

D.1 Introduction D-1
D.2 Technical description D-1
D.3 Basic application functions D-1
D.4 IEC 104 settings D-2
D.5 IEC 60870-5-104 point list D-8
D.6 IEC 60870-5-104 Interoperability D-9

E PROCOME PROTOCOL

E.1 PROCOME protocol E-1

F IEC 60870-5-103 PROTOCOL

F.1 IEC 60870-5-103 protocol F-1
F.1.1 Interoperability document F-1
F.1.2 Application level F-6

G REDUNDANCY PROTOCOL

G.1 PRP and HSR Ethernet protocols G-1
G.1.1 PRP G-4
G.1.2 HSR G-5
G.2 RSTP (IEEE 802.1D-2004) and daisy chain G-6
G.2.1 RSTP description G-6
G.2.2 RSTP concepts G-6
G.2.3 Use in meshed networks G-7
G.2.4 Daisy chain G-7
G.3 Link loss alert (LLA) G-8
G.3.1 LLA G-8
G.3.2 LLA priority G-8
G.3.3 LLA timeout G-8

H FACTORY DEFAULT LOGIC

H.1 Factory default logic H-2

I FACTORY DEFAULT CONFIGURATION

I.1 Factory default settings I-1

J MISCELLANEOUS

J.1 Warranty J-1
J.1.1 Major Updates J-2

F650 Digital Bay Controller

Chapter 1: Getting Started

1.1 Important procedures

Use this chapter for initial setup of your new F650 Digital Bay Controller.

1.1.1 Cautions and warnings

To help ensure years of trouble free operation, please read through the following chapter for information to help guide you through the initial installation procedures of your new relay.

Before attempting to install or use the relay, it is imperative that all warnings and cautions in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.

The following safety and equipment symbols are used in this document.

DANGER **Indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

WARNING **Indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

CAUTION **Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.**

NOTICE Indicates practices not related to personal injury.

1.1.1.1 General cautions and warnings

The following general safety precautions and warnings apply.

⚠WARNING Ensure that all connections to the product are correct so as to avoid accidental risk of shock and/or fire, for example such as can arise from high voltage connected to low voltage terminals.

Follow the requirements of this manual, including adequate wiring size and type, terminal torque settings, voltage, current magnitudes applied, and adequate isolation/clearance in external wiring from high to low voltage circuits.

Use the device only for its intended purpose and application.

Ensure that all ground paths are uncompromised for safety purposes during device operation and service.

Ensure that the control power applied to the device, the AC current, and voltage input match the ratings specified on the relay nameplate. Do not apply current or voltage in excess of the specified limits.

Only qualified personnel are to operate the device. Such personnel must be thoroughly familiar with all safety cautions and warnings in this manual and with applicable country, regional, utility, and plant safety regulations.

Hazardous voltages can exist in the power supply and at the device connection to current transformers, voltage transformers, control, and test circuit terminals. Make sure all sources of such voltages are isolated prior to attempting work on the device.

Hazardous voltages can exist when opening the secondary circuits of live current transformers. Make sure that current transformer secondary circuits are shorted out before making or removing any connection to the current transformer (CT) input terminals of the device.

For tests with secondary test equipment, ensure that no other sources of voltages or currents are connected to such equipment and that trip and close commands to the circuit breakers or other switching apparatus are isolated, unless this is required by the test procedure and is specified by appropriate utility/ plant procedure.

When the device is used to control primary equipment, such as circuit breakers, isolators, and other switching apparatus, all control circuits from the device to the primary equipment must be isolated while personnel are working on or around this primary equipment to prevent any inadvertent command from this device.

Uses an external disconnect to isolate the mains voltage supply.

⚠WARNING LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered safe to the unaided eye. Do not view directly with optical instruments.

NOTICE This product is rated to Class A emissions levels and is to be used in Utility, Substation Industrial environments. Not to be used near electronic devices rated for Class B levels.

Figure 1-1: Front view of F650 unit

1.1.1.2 Communication board withdrawal/insertion

WARNING **MODULE WITHDRAWAL AND INSERTION SHALL ONLY BE PERFORMED BY DULY QUALIFIED SERVICE PERSONNEL. FOR PERSONAL SECURITY PURPOSES, BEFORE ACCOMPLISHING ANY WITHDRAWAL OR INSERTION OPERATION, THE RELAY MUST BE POWERED OFF AND ALL THE REAR TERMINALS MUST BE POTENTIAL FREE. THE RELAY MUST BE GROUNDED USING THE REAR GROUNDING SCREW.**

The modular design of the relay allows for the withdrawal and insertion of the communication module.

Figure 1-2: Module withdrawal/insertion shows the location of communication modules on the rear part of the relay. Qualified personnel must carry out the insertion or extraction of the communication boards only after disconnecting the relay auxiliary voltage and ensuring that all the rear terminals are potential free.

Communication boards are installed on the rear of the unit, with upper port reserved for the asynchronous communications board and CAN bus, and the lower port for the ETHERNET board. (The Ethernet module can be withdrawn or inserted only in models with Rear Ethernet Communication Board 2: "B", "C", "D" or "E". For the remaining options, Ethernet communications are included in the main CPU).

Before performing any of these actions, control power must be removed from the relay and all the rear terminals must be potential free. A grounded anti static wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components.

WITHDRAWAL: Loosen the small screws that keep the faceplate in place and extract the module.

INSERTION: Insert the module and press it firmly in the case, until it is completely fixed. After this, bolt the faceplate screws and replace the control power. Check that the relay is fully operative.

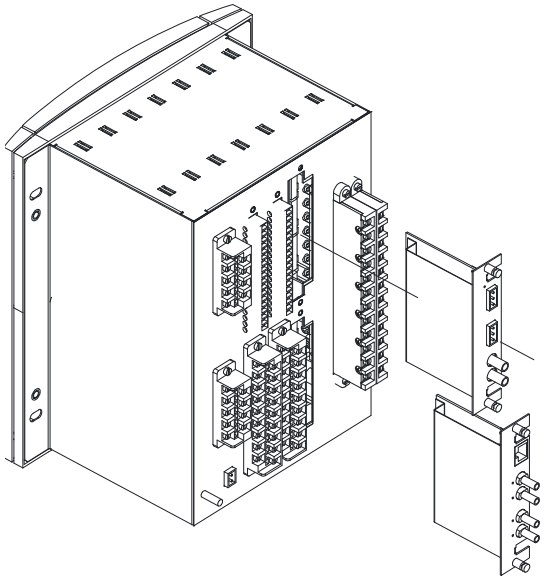


Figure 1-2: Module withdrawal/insertion

GE VERNOVA Multilin will not be responsible for any damage to the relay, connected equipment or personnel whenever these safety rules are not followed.

1.1.1.3 Magnetic module terminals

The transformer module for the VTs and CTs is already connected to a female connector screwed to the case. The current inputs incorporate shorting bars, so that the module can be extracted without the need to short-circuit the currents externally. It is very important, for safety reasons, not to change or switch the terminals for CTs and VTs.

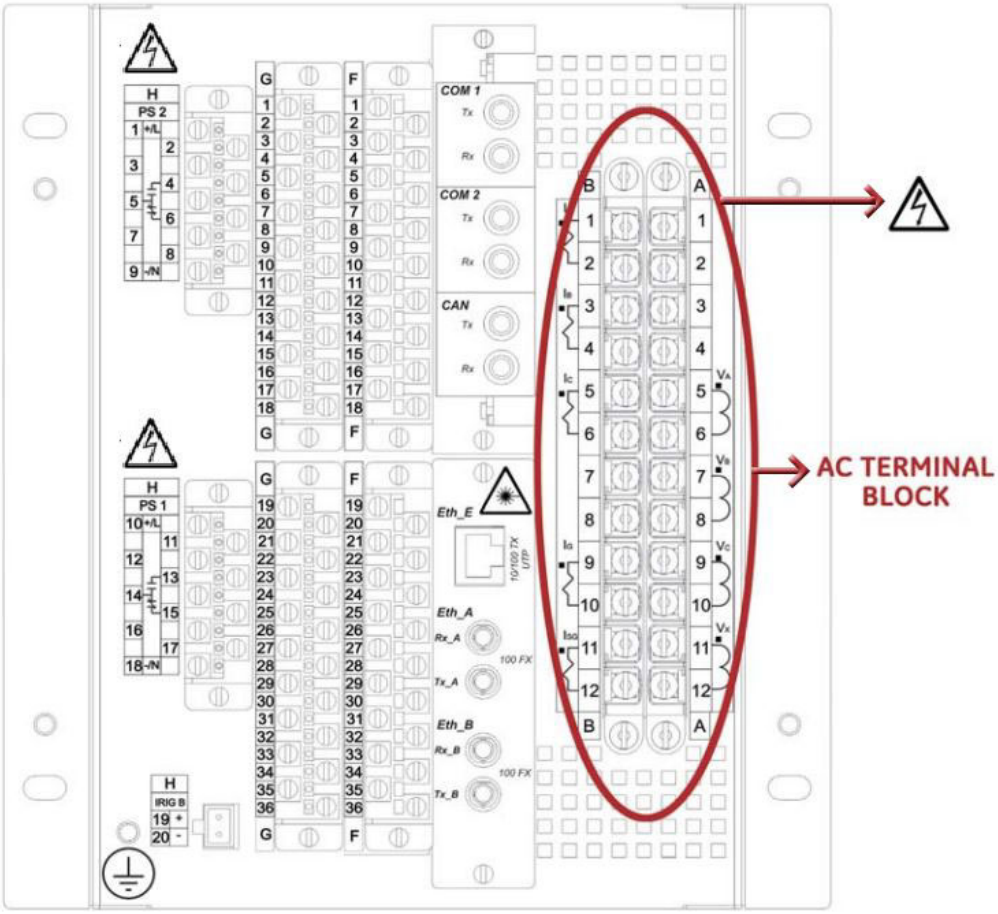


Figure 1-3: Rear view of F650 unit

GE VERNOVA Multilin will not be responsible for any damage of the relay, connected equipment or personnel whenever these safety rules are not followed.

1.1.2 Inspection checklist

1. Unwrap the relay and inspect the relay for physical damage.
2. View the nameplate and verify that the correct model has been ordered and delivered. The model number is at the top.

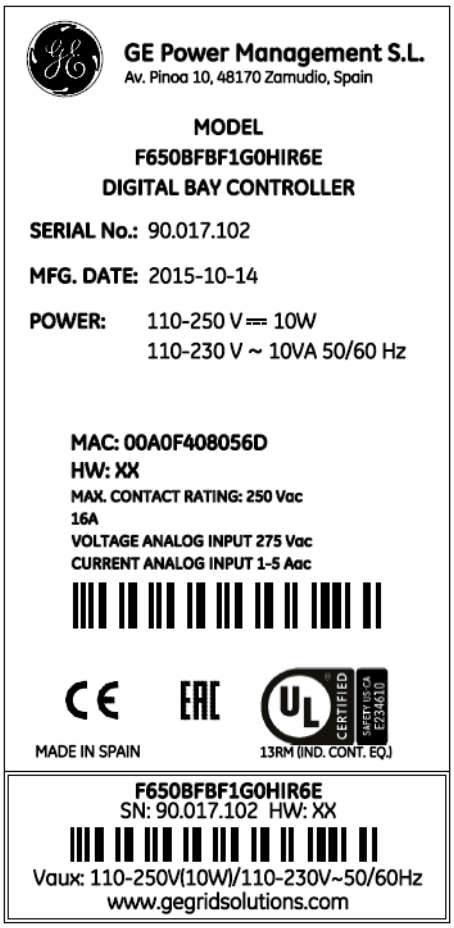


Figure 1-4: Identification label (A4454P6)

Please ensure that you received the following items with your relay:

- **Mounting screws for fixing the relay to a cabinet**
- **GE EnerVista™ DVD (includes the EnerVista 650 Setup software and manuals in PDF format)**
- **Wiring diagram.**
- **Certificate of Compliance**

For product information, instruction manual updates, and the latest software updates, please visit the GE VERNOVA Multilin Home Page: https://www.gevernova.com/grid-solutions/multilin

Note: If there is any physical damage detected on the relay, or any of the contents listed are missing, please contact GE VERNOVA Grid Solutions immediately:

EUROPE, MIDDLE EAST AND AFRICA:

GE VERNOVA Grid Solutions
Av. Pinoa, 10
48170 Zamudio, Vizcaya (SPAIN)
Tel.: (34) 94-485 88 54
Fax: (34) 94-485 88 38
E-mail: multilin.tech.euro@gevernova.com

AMERICA, ASIA AND AUSTRALIA:

GE VERNOVA Grid Solutions
650 Markland Street
Markham, Ontario
Canada L6C 0M1
North America toll-free: +1 800 547 8629
Tel.: +1 905 927 7070
Fax: +1 905 927 5098
E-mail: multilin.tech@gevernova.com

⚠CAUTION **The information provided herein is not intended to cover all the details of the variations of the equipment, nor does it take into account the circumstances that may be present in your installation, operating or maintenance activities.**

Should you wish to receive additional information, or for any particular problem that cannot be solved by referring to the information contained herein, please contact GE VERNOVA, Grid Solutions.

1.1.3 Safety instructions

The F650 ground screw shown in Figure 1-5: Location of grounding screw must be correctly grounded.

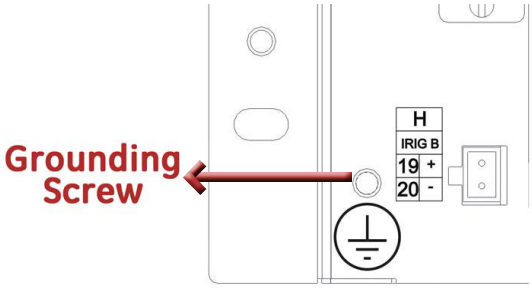


Figure 1-5: Location of grounding screw

Before communicating with the F650 through the front USB port, ensure that the computer's power supply is grounded. When using a laptop, it is recommended that the power supply be disconnected. In many cases the laptop may not be correctly grounded either due to the power supply or to the connector cables used.

GE VERNOVA Multilin will not be responsible for any damage to the relay or connected equipment when this basic safety rule is not followed.

1.1.3.1 General safety instructions

⚠CAUTION

- **Failure to practice safe working procedures is likely to damage the equipment, cause severe injury and/ or death.**
- **The use of appropriate safety gloves, safety glasses and protective clothing are recommended during equipment installation, maintenance and service of the equipment.**
- **All procedures must be strictly adhered to.**
- **Failure to observe and follow the instructions provided in the equipment manual(s) could cause irreversible damage to the equipment and could lead to property damage, personal injury and/or death.**
- **Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.**
- **If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in Impaired operation and injury.**
- **Beware of potential hazards, wear personal protective equipment and carefully inspect the work area for tools and objects that may have been left inside the equipment.**
- **Caution: Hazardous voltages can cause shock, burns or death.**
- **Test/Installation/Service personnel must be familiar with general device test practices, safety precautions and follow standard ESD precautions to avoid personal injury or equipment damage.**
- **Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.**
- **Failure to shut equipment power off prior to removing the power connections could expose you to dangerous voltages causing injury or death.**
- **All recommended equipment that should be grounded must have a reliable and uncompromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.**
- **Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.**
- **Keep all ground leads as short as possible.**
- **At all times, equipment ground terminal must be grounded during device operation.**
- **While the equipment manual may suggest several safety and reliability steps, safety precautions must be used in conjunction with the safety codes in force at your location.**
- **LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered safe to the unaided eye. Do not view directly with optical instruments.**
- **It is the responsibility of the user to check the equipment ratings and installation instructions prior to commissioning, service.**
- **Use a lift system with side rails/bucket to reduce a fall hazard as opposed to other means when installing or servicing.**
- **In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.**
- **Before working on CTs, they must be short circuited.**
- **Do not remove the voltage terminal blocks or disconnect the voltage input wires when the voltage phases are live. The voltage inputs must be de-energized prior to any servicing.**

1.1.3.2 Warning symbols

The following table explains the meaning of warning symbols that may appear on the device or in this manual.

	The relevant circuit is direct current. Le circuit principal est à courant continu.
	The relevant circuit is alternating current. Le circuit principal est à courant alternatif.
	CAUTION: Refer to the documentation for important operating and maintenance instructions. Failure to take or avoid a specified action can result in loss of data or physical damage. **AVERTISSEMENT**: Se réferer à la documentation pour l'entretien et l'utilisation. L'absence ou èviter de prender des mesures spècifiques peut entraîner des pertes de données ou même causer des dommages physiques.
	WARNING! Dangerous voltage constituting a risk of electric shock is present within the unit. Failure to take or avoid a specified action can result in physical harm to the user. **AVERTISSEMENT**! Tensions dangereuses comportant un risque de choc électrique sont presents dans l'equipement. L'absence ou èviter de prender des mesures spècifiques peut causer des dommages physiques à l'utilisateur.
	CAUTION: Class 1M Laser (IEC 60825-1 Safety of laser products) DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS. **AVERTISSEMENT**: Laser de classe 1M (IEC60825-1) ÉVITER DE REGARDER DIRECTEMENT LE DISPOSITIF QUI ÉMET LE LASER OPTIQUE.
	CAUTION: Hot surface. **AVERTISSEMENT**: Surface chaude.
	Earth (Ground) Terminal. Terminal de terre (masse).
	Protective Earth Terminal. Terminal de terre de protection.

Note: Read all instructions included in package before using your product. Additional safety information

Product Safety Supplement document available at : https://www.gevernova.com/grid-solutions/productsafety/

1.2 Overview

1.2.1 Introduction to the 650 family of relays

The GE 650 family relay is a new generation of digital and multifunction equipment that is easily incorporated into automation systems, at both the station and enterprise levels.

1.2.2 Hardware architecture

1.2.2.1 F650 basic design

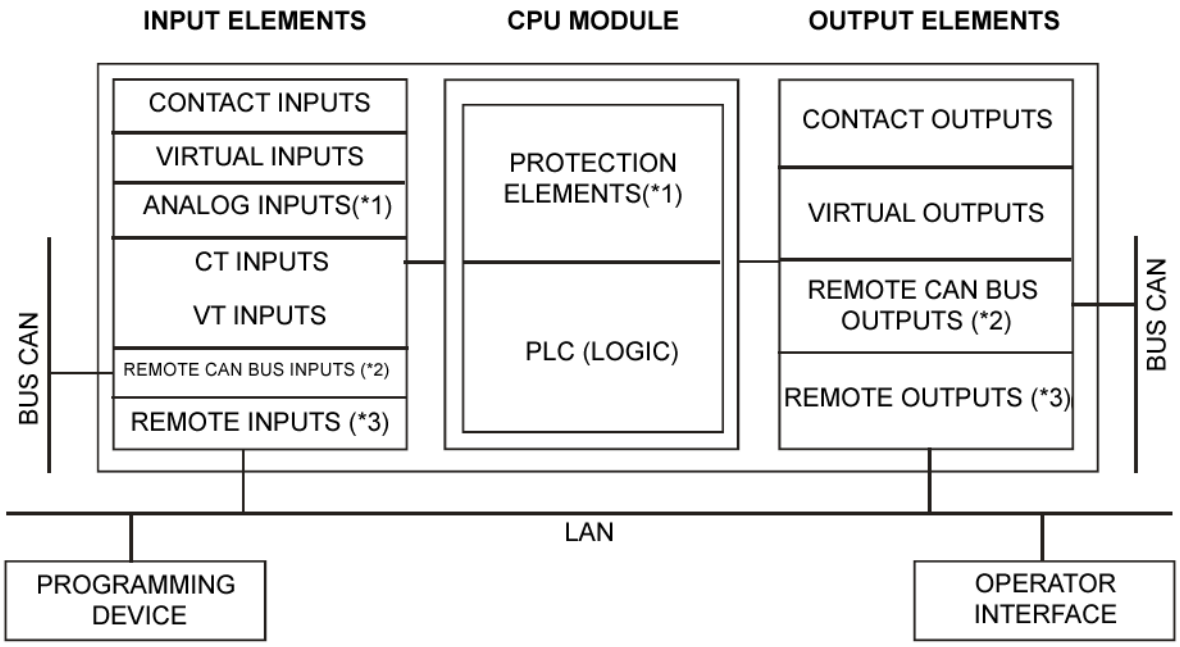
The 650 is a digital-based device containing a central processing unit (CPU) that handles multiple types of input and output signals. The 650 family can communicate over a local area network (LAN) with an operator interface, a programming device, or another 650 device.

The **CPU module** contains firmware that provides protection elements in the form of logic algorithms, as well as programming logic gates, timers, and latches for control features.

Input Elements accept a variety of analog or digital signals from the field. The 650 isolates and converts these signals into logic signals used by the relay.

Output Elements convert and isolate the logic signals generated by the relay into digital signals that can be used to control field devices.

Figure 1-6: 650 concept block diagram



(*1) Analog CT and VT Inputs and Protection Elements are not available in C650 models
(*2) Can Bus Inputs/Outputs are not available in W650 models
(*3) Remote Inputs and Outputs are not available in G650 and C650 models

1.2.2.2 F650 signal type

Contact Inputs/Outputs: Digital signals.

CT and VT inputs: Signals coming from the inputs of current and voltage transformers, used for monitoring the power system signals.

Remote CAN Bus Inputs/Outputs: Signals associated with physical input/output contacts from a Remote Digital Input/Output Module (CIO) connected to the 650 unit via the CAN Bus existing in options X, Y, Z, C and M for rear serial communication board 1.

PLC: Programmable Logic Controller. Control module that enables the unit configuration (assignment of inputs/outputs) and the implementation of logic circuits.

Protection Elements: Relay protection elements, for example: Overcurrent, overvoltage, etc.

Remote inputs and outputs: Provide a means of sharing digital point state information between remote devices using IEC 61850 GSSE and GOOSE messages.

Analog Inputs: Signals associated with transducers.

1.2.3 Communications architecture

A dedicated serial port is used for communication between the main processor and the human-machine interface. The serial connection provides immunity against electromagnetic disturbances, thus increasing system safety.

All 650 units incorporate one RS232 (USB or DB9)serial port on the front of the relay. They can also incorporate up to two additional communication modules on the rear.

One of the modules provides asynchronous serial communications, using different physical media (RS485 + cable remote CAN bus I/O, plastic or glass fiber optic) depending on the selected model. The module incorporates two identical ports, COM1 and COM2. The COM2 port is multiplexed with the front port. Additionally, this module may incorporate a port for CAN bus communications, used for the connection to the remote CAN Bus I/O module. This feature increases the I/O capability by up to 100% if the maximum number of I/Os available inside the relay is not enough for a specific application. Available options are:

Table 1-1: Rear serial communications board 1

Board Code	Functionality
F	Without additional communication ports
A	Two RS485 ports
P	Two Plastic F.O. ports
G	Two Glass F.O. ports
X	Two RS485 ports and a CAN port for remote CAN bus Inputs/Outputs
Y	Two Plastic F.O. ports and a CAN port for remote CAN bus Inputs/Outputs (fiber)
Z	Two Glass F.O. ports and a CAN port for remote CAN bus Inputs/Outputs (fiber)
C	CAN port for remote CAN Bus I/O (cable)
M	RS485 + RS485 port and a CAN port for remote CAN Bus I/O (cable)

The other module provides Ethernet communications (ETH Port), using 10/100BaseTX (self-negotiable speed) or 100BaseFX connectors, depending on the selected model. The most complete models include a double redundant 100BaseFX fiber optic port. Redundancy is provided at the physical level, for options D and E; the unit incorporates internally duplicated and independent controllers for extended system reliability and accessibility.

Available Options are:

Table 1-2: REAR ETHERNET COMMUNICATIONS BOARD 2

Board Code	Functionality
B	One 10/100BaseTX port (self-negotiable speed)
C	One 10/100BaseTX port and one 100BaseFX port.
D	One 10/100BaseTX port and redundant 100BaseFX ports
E	Redundant 10/100BaseTX ports

For options C and D you must select the active physical media, by means of an internal selector inside the module. The factory configuration for this selection is the 10/100BaseTX port. For firmware versions 7.00 and above, the following options are available:

G	1588, 10/100 Base TX* + 100 Base TX
H	1588, 10/100 Base TX* + 100 Base FX
J	PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
K	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
L	PRP, 1588, 10/100 Base TX + Redundant 100 Base TX
M	PRP, HSR, RSTP, 1588, 10/100 Base TX + Redundant 100 Base TX

Finally, internal communication with input and output modules is performed via an internal CAN Bus, independent of the one used for remote CAN Bus I/Os. This provides increased communication speed, and acknowledgment of modules, abnormalities, etc. As this is a serial port supporting a communications protocol, it provides immunity against external or internal disturbances.

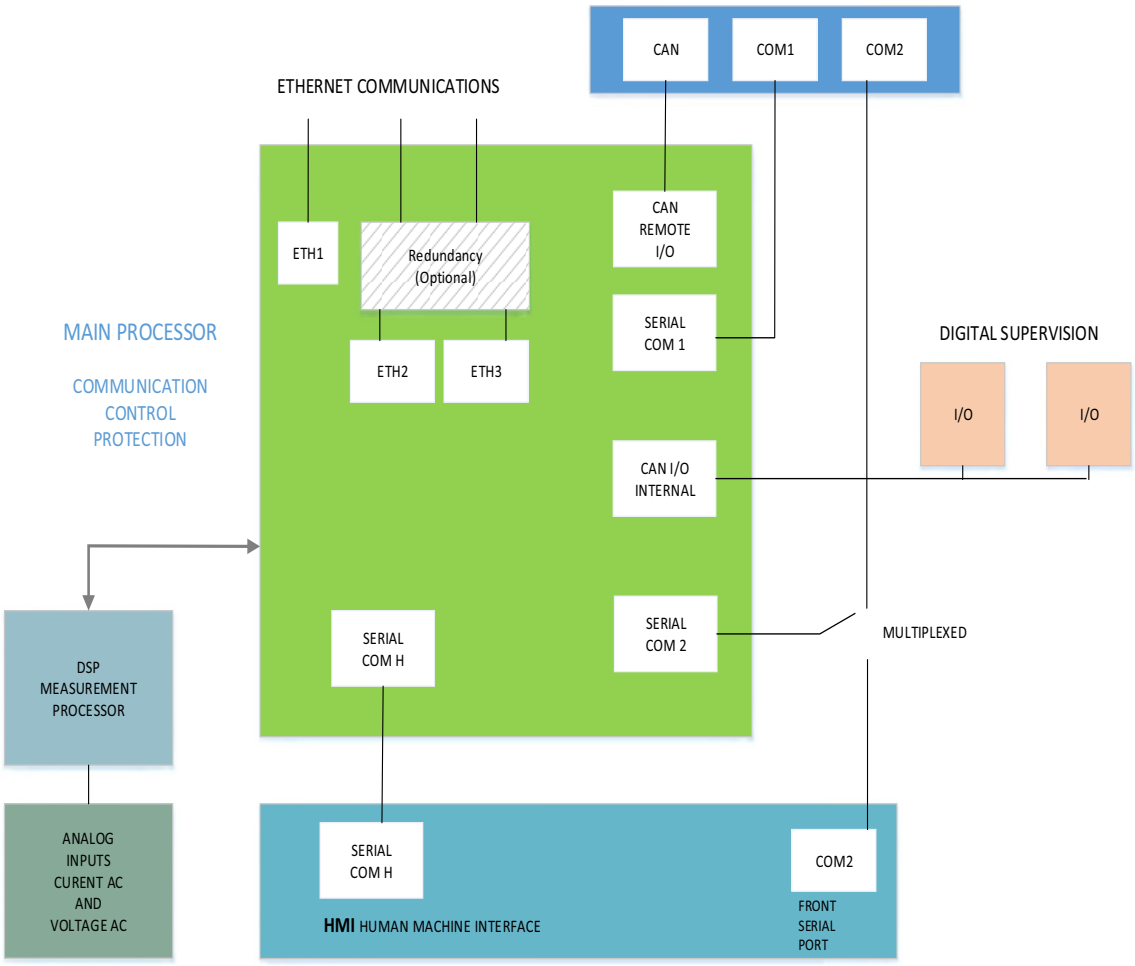


Figure 1-7: Communications architecture (B6816F2)

1.3 EnerVista 650 Setup software

1.3.1 System requirements

The relay front panel or the EnerVista 650 Setup software can be used to communicate with the relay. The software interface is the preferred method to edit settings and view actual values because the computer monitor can display more information.

The minimum system requirements for the EnerVista 650 Setup software are as follows:

- **Pentium® 4 (Core Duo recommended).**
- **Windows® XP with Service Pack 2 (Service Pack 3 recommended), Windows 7, Windows 8 or Windows 10**
- **1 GB of RAM (2 GB recommended).**
- **500 MB free hard drive space (1 GB recommended).**
- **1024 x 768 display (1280 x 800 recommended).**
- **RS232 and USB serial and/or Ethernet port for communications with the relay.**

1.3.2 Installation

After ensuring the minimum requirements for using EnerVista 650 Setup are met (see previous section), obtain the software from the GE EnerVista DVD, or download from: https://www.gevernova.com/grid-solutions/multilin/ as follows:

1. Insert the GE EnerVista DVD into the DVD drive of your computer.
2. Click **Install Now** and follow the installation instructions to install the complimentary EnerVista software.
3. When installation is complete, start the EnerVista Launchpad application.
4. Click **IED Setup** in the **Launch Pad** window.

Figure 1-8: Launchpad window

5. Click **Add Product** and select the "F650 Bay Controller" relay from the Install Software window as shown below. Select the "Web" option to ensure the most recent software release, or select "CD" if you do not have a web connection, then click **Add Now** to list software items for the F650.

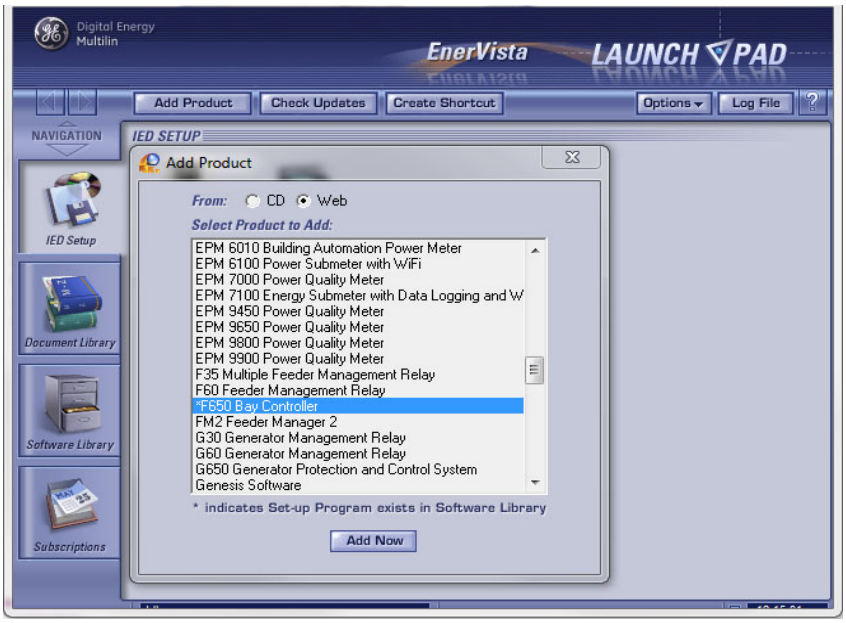


Figure 1-9: Add Product window

6. EnerVista Launchpad obtains the installation program from the Web or CD. Once the download is complete, double-click the installation program to install the EnerVista 650 Setup software.
7. Follow the on-screen instructions to install the EnerVista 650 Setup software. When the **Welcome** window appears, click **Next** to continue with the installation.

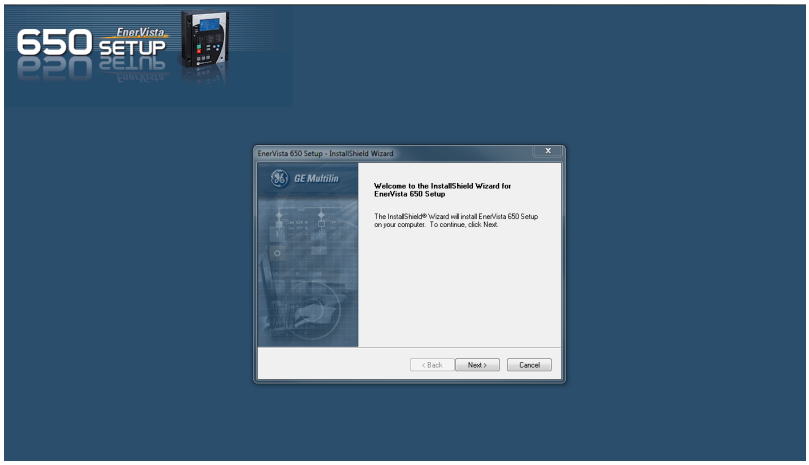


Figure 1-10: EnerVista 650 Setup installation

8. When the **Choose Destination Location** window is displayed, change the installation directory id needed by clicking **Change...** and typing in the complete path name including the new directory name. Click **Next** to continue with the installation.

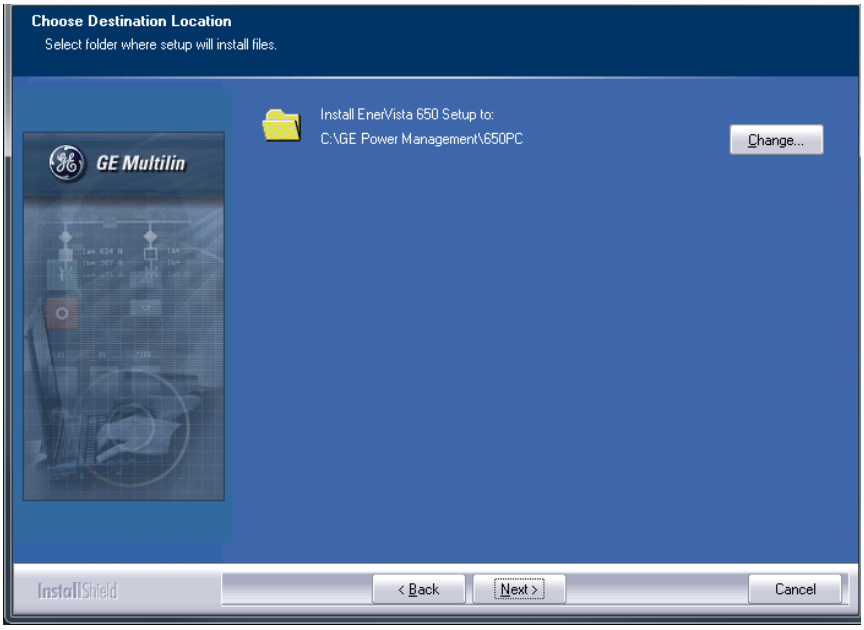


Figure 1-11: EnerVista 650 Setup installation cont.

9. The default program group containing the application is added to as shown in the **Selected Program Folder** window. Click **Next** to begin the installation process, and all the necessary program files are copied into the selected directory.

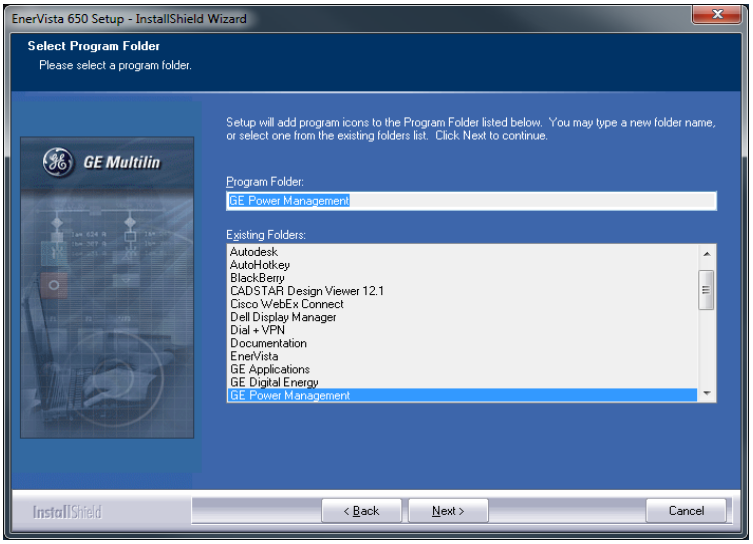


Figure 1-12: Select program folder

10. To complete the installation, select the desired language for startup.

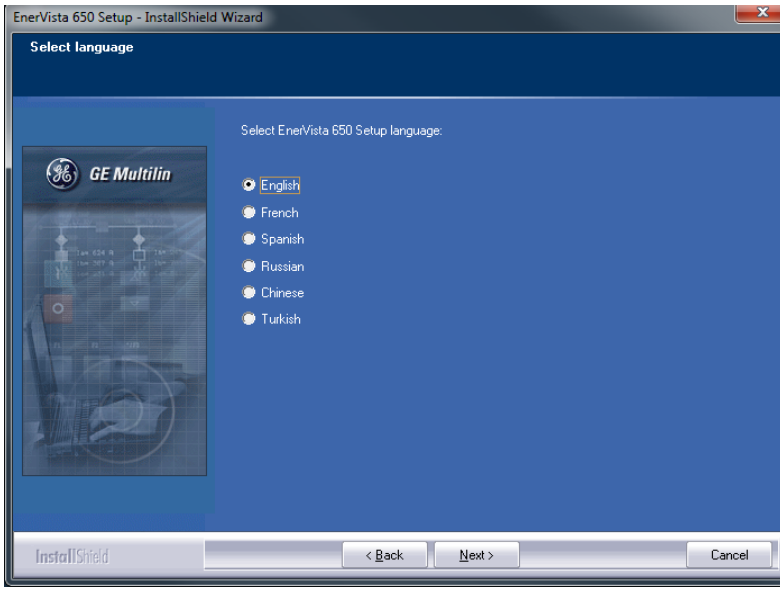


Figure 1-13: Language window

11. Click **Finish** to end the installation. The F650 device has been added to the list of installed IEDs in the EnerVista Launchpad window, as shown below.

Figure 1-14: EnerVista Launchpad

1.3.3 Connecting EnerVista 650 Setup to the F650

This section is intended as a quick start guide to using the EnerVista 650 Setup software. Refer to section 4.1 in this manual for more information about the EnerVista 650 Setup software interface.

1.3.3.1 Configuring an Ethernet connection

Before starting, verify that the Ethernet network cable is properly connected to the Ethernet port on the back of the relay.

1. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista DVD or online from https://www.gevernova.com/grid-solutions/multilin (see previous section for installation instructions).
2. Go to **Communication > Computer**.
3. Select **Control Type** as **MODBUS TCP/IP** from the drop-down list. This option displays a number of interface parameters that must be entered for proper Ethernet communications.
4. Enter the relay IP address (from **Setpoint > Product Setup > Communication Settings > Network > IP Address**) in the **IP Address** field in **MODBUS TCP/IP SETUP**.
5. Enter the relay ModBus address (from **Setpoint > Product Setup > Communication Settings > ModBus Protocol > ModBus Address COM1/COM2 setting**) in the Unit Identifier (Slave Address) field.
6. Enter the ModBus port address (from **Setpoint > Product Setup > Communication Settings > ModBus Protocol > ModBus Port Number** setting) in the ModBus Port field.
7. The Device has now been configured for Ethernet communications. Click **ON** to begin communicating.

1.3.3.2 Configuring the RS232 connection

Before starting, verify that the RS232 serial cable, or the USB Cable, is properly connected to the RS232port or the USB port on the front panel of the relay.

1. Install and start the latest version of the EnerVista 650 Setup software (available from the GE EnerVista DVD or online from https://www.gevernova.com/grid-solutions (see previous section for installation instructions).
2. Go to **Communication > Computer** and enter the following data referred to communications:
3. Under **Control Type** select **No Control Type** from the drop-down list.
4. Enter the relay Slave Address (**Setpoint > Product Setup > Communication Settings > ModBus Protocol**) in the Slave Address field. The default value is 254.
5. Enter the physical communications parameters (Baud rate and parity settings) from the **Setpoint > Product Setup > Communication Settings > Serial Ports** menu. Default values are 19200 for baud rate and none for parity.
6. The unit has now been configured for RS232 communications. Click **ON** to begin communicating.

1.4 650 hardware

1.4.1 Mounting & wiring

Refer to Chapter 3. Hardware for detailed mounting and wiring instructions.

1.4.2 650 communications

The EnerVista 650 Setup software communicates with the relay via the faceplate USB port in hardware 04 (E in order code) or RS232 port or the rear RS485/Ethernet ports. To communicate via the faceplate RS232 port, a standard “straight-through” serial cable is used. The DB-9 male end is connected to the relay and the DB-9 or DB-25 female end is connected to the PC COM1 or COM2 port as described in Figure 1-15: Relay- PC connection for RS232 front port. To communicate via USB port a male A / male B USB shielded wire is needed

To communicate via the F650 rear RS485 port from a PC RS232 port, the GE Multilin RS232/RS485 converter box is required. This device (catalog number F485) connects to the computer using a “straight-through” serial cable. A shielded twisted-pair (20, 22 or 24 AWG according to American standards; 0.25, 0.34 or 0.5 mm^2 according to European standards) connects the F485 converter to the F650 rear communication port.

To minimize communication errors that can be caused by external noise, a shielded twisted pair is recommended. In order to avoid loops where external currents can flow, the cable shield must be grounded at one end only.

The converter box (-, +, GND) terminals are connected to the relay (SDA, SDB, GND) terminals respectively. For long communications cables (longer than 1 km), the RS485 circuit must be terminated in an RC network (i.e. 120 ohm, 1 nF). This circuit is shown in Figure 1-16: RS485 connection for 650 units, associated with the text Zt(*).

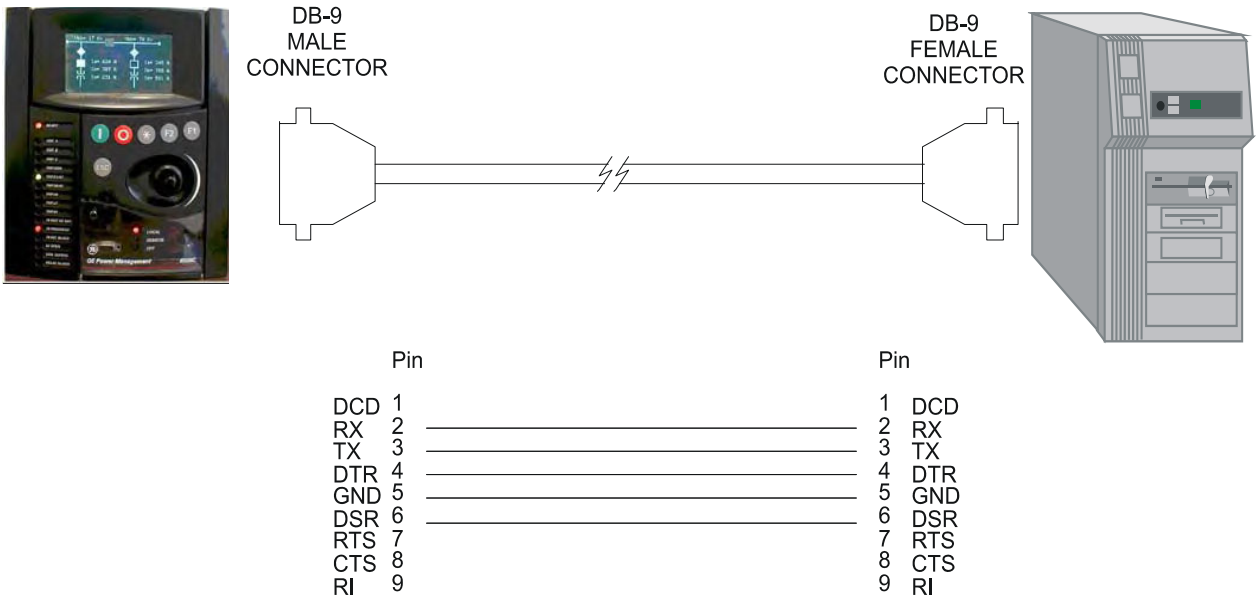


Figure 1-15: Relay- PC connection for RS232 front port

To minimize errors from noise, the use of shielded twisted pair wire is recommended. For correct operation, polarity must be respected, although a different polarity will not damage the unit. For instance, the relays must be connected with all RS485 SDA terminals connected together, and all SDB terminals connected together. This may result in confusion, as the RS485 standard refers to terminals “A” and “B”, although many devices use terminals labeled “+” and “-“.

As a general rule, terminals labeled “A” should be connected to terminals “-“, and terminals “B” to “+”. The GND terminal should be connected to the common wire inside the shield, when provided. Otherwise, it should be connected to the shield. Each relay should also be daisy chained to the next relay in the system. A maximum of 32 relays can be connected in this manner without exceeding driver capability; for larger systems, additional serial channels must be added. It is also possible to use commercially available repeaters to increase the number of relays on a single channel. Do not use other connection configurations.

Lightening strikes and ground surge currents can cause large momentary voltage differences between remote ends of the communication link. For this reason, surge protection devices are provided internally. To ensure maximum reliability, all equipment should have similar transient protection devices installed.

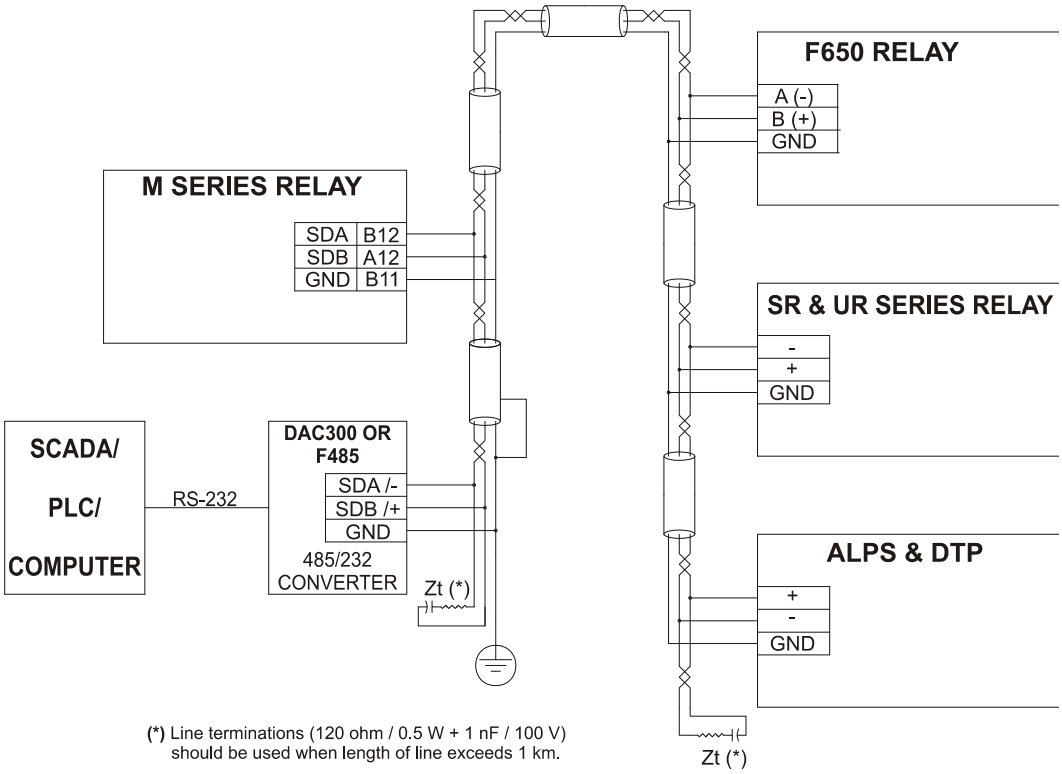


Figure 1-16: RS485 connection for 650 units

To communicate through the F650 rear Ethernet port from a PC, a crossover cable is required. If the connection is performed through a hub or a switch, a direct Ethernet cable is required.

1.4.3 Faceplate display

All messages are displayed on a 20x4 character LCD display. An optional graphic display is also available. Messages are displayed in different languages depending on the model and configuration settings.

1.4.4 Maintenance

1.4.4.1 General maintenance

The F650 requires minimum maintenance once it is commissioned into service. F650 is a microprocessor based relay and its characteristics do not change over time; as such no further functional tests are required. While the F650 performs continual self-tests, it is recommended that maintenance be scheduled with other system maintenance. This maintenance can involve in-service, out-of-service, or unscheduled maintenance.

If it is concluded that the relay or one of its modules is of concern, contact GE Multilin or one of its representative for prompt service.

1.4.4.2 In-service maintenance

1. Visual verification of the analog value integrity such as voltage and current (in comparison to other devices in the system).
2. Visual verification of active alarms, relay display messages and LED indications.
3. Visual inspection for any damage, corrosion, dust or loose wires.
4. Event recorder file download with further event analysis.

1.4.4.3 Out-of-service maintenance

1. Check wiring connections for firmness.
2. Analog value (current, voltages, analog inputs) injection test and metering accuracy verification. Calibrated test equipment is required.
3. Protection element setpoint verification (analog values injection or visual verification of setting file entries against relay settings).
4. Contact inputs and outputs verification. This test can be conducted by direct change of state forcing or as part of the system functional testing.
5. Visual inspection for any damage, corrosion or dust.
6. Event recorder file download with further events analysis.

NOTICE To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energized state once per year, for one hour continuously.

1.4.4.4 Unscheduled maintenance

Unscheduled maintenance such as during a disturbance causing system interruption:

- **View the event recorder and oscillography or fault report for correct operation of inputs, outputs and elements.**

1.4.5 Storage

Store the unit indoors in a cool, dry place. If possible, store in the original packaging. Follow the storage temperature range outlined in the Specifications.

NOTICE To avoid deterioration of electrolytic capacitors, power up units that are stored in a de-energized state once per year, for one hour continuously.

1.4.6 Repairs

The firmware and software can be upgraded without return of the device to the factory.

For issues not solved by troubleshooting, the process to return the device to the factory for repair is as follows:

- **Contact a GE Grid Solutions Technical Support Center. Contact information is found in the first chapter.**
- **Obtain a Return Materials Authorization (RMA) number from the Technical Support Center.**
- **Verify that the RMA and Commercial Invoice received have the correct information.**
- **Tightly pack the unit in a box with bubble wrap, foam material, or Styrofoam inserts or packaging peanuts to cushion the item(s). You may also use double boxing whereby you place the box in a larger box that contains at least 5 cm of cushioning material.**
- **Ship the unit by courier or freight forwarder, along with the Commercial Invoice and RMA, to the factory.**
- **Fax a copy of the shipping information to the GE Grid Solutions service department. Customers are responsible for shipping costs to the factory, regardless of whether the unit is under warranty.**

Use the detailed return procedure outlined at

https://www.gevernova.com/grid-solutions/multilin/support/ret_proc.htm

The current warranty and return information are outlined at

https://www.gevernova.com/grid-solutions/multilin/warranty.htm

1.4.7 Disposal

The F650 is intended to be part of defective large-scale stationary industrial tools and large-scale fixed installations. This product cannot be disposed of as unsorted municipal waste in the European Union. For proper recycling return this product to your supplier or a designated collection point. For more information go to www.recyclethis.info.

F650 Digital Bay Controller

Chapter 2: Product Description

2.1 F650 Overview

F650 is a protection, control, monitoring, metering and registering unit, suitable for many different applications, such as main protection for distribution feeders and transmission lines, as well as backup protection for transformers, busbars, capacitor banks, etc.

Overvoltage and undervoltage protection, overfrequency and underfrequency protection, breaker failure protection, directional current supervision fault diagnostics and programmable logic functions are provided.

This relay also provides phase, neutral, ground and sensitive ground, instantaneous and time overcurrent protection. The time overcurrent function provides multiple curve shapes or FlexCurves™ for optimum co-ordination. Automatic reclosing, synchrocheck, and line fault locator features are also provided.

Voltage, current, power, and energy metering is built into the relay as a standard feature. Current parameters are available as true RMS magnitude, or as RMS magnitude of fundamental frequency and angle (phasor).

Diagnostic features include a sequence of records. The internal clock used for time-tagging can be synchronized with an IRIG-B signal or via SNTP, DNP or Modbus protocol over the Ethernet port. From firmware version 7.00 and above, IEEE 1588 time protocol is also available. Precise time stamping allows the sequence of events to be determined throughout the system. Oscillography data capture may be set to record the measured parameters before and after the event for viewing on a personal computer (PC). These tools significantly reduce troubleshooting time and simplify report generation in the event of a system fault.

A faceplate RS232 or USB port may be used to connect to a PC for programming settings and monitoring actual values.

A variety of communications modules are available. Two rear RS485 ports allow independent access by operating and engineering personnel. All serial ports use the Modbus® RTU protocol. Optional communications modules include a 100BaseFX Ethernet interface which can be used to provide fast, reliable communications in noisy environments.

Another option provides two 100BaseFX fiber optic ports for redundancy. The Ethernet port supports IEC 61850, Modbus®/TCP, DNP 3.0 and TFTP protocols, and allows access to the relay via any standard web browser. The IEC 60870-5-104 protocol is supported on the Ethernet port. The Ethernet port also supports the Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR) of IEC 62439-3 (clause 4 (PRP) and clause 5 (HSR)) for firmware version 7.00 and so on.

Rear port COM1 can be set to support IEC60870-5-103 protocol

The F650 IEDs use flash memory technology which allows field upgrading as new features are added:

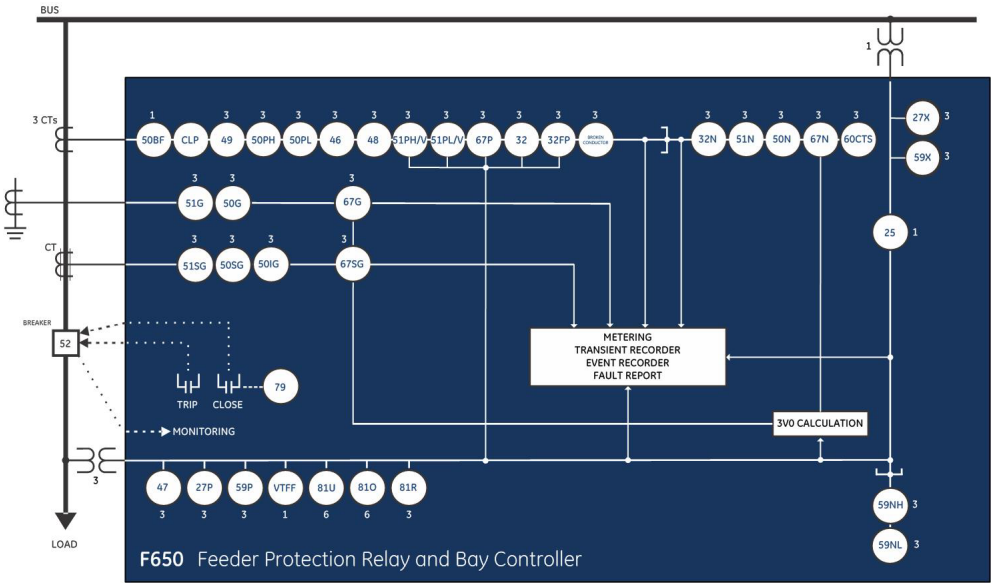


Figure 2-1: FUNCTIONAL BLOCK DIAGRAM

2.2 ANSI device numbers and functions

Main features available in the relay are gathered in tables below

DEVICE NUMBER	PROTECTION & CONTROL FUNCTIONS
25	Synchronism Check
27/27X	Bus/Line Undervoltage
32	Sensitive Directional Power
32FP	Forward Power
32N	Wattmetric Zero-Sequence Directional
46	Negative Sequence Time Overcurrent
47	Negative Sequence Voltage
48	Locked Rotor
49	Thermal Image - overload protection
50 BF	Breaker Failure
50PH/PL	Phase Instantaneous Overcurrent (High/Low)
50N	Neutral Instantaneous Overcurrent
50G	Ground Instantaneous Overcurrent
50SG	Ground Instantaneous Overcurrent for sensitive ground systems (measured from 5th current transformer input)
50IG	Isolated Ground Instantaneous Overcurrent (measured from 5th current transformer input)

51N	Neutral Time Overcurrent
51G	Ground Time Overcurrent
51SG	Sensitive Ground Time Overcurrent
51PH/V	Voltage Restraint Phase Time Overcurrent
51PL/V	Voltage Restraint Phase Time Overcurrent
59/59X	Bus/Line Overvoltage
59NH/NL	Neutral Overvoltage - High/Low
67P	Phase Directional Overcurrent
67N	Neutral Directional Overcurrent
67SG	Sensitive Ground Directional Overcurrent
79	Autoreclose (Four shot recloser)
81 U/O	Under/Over Frequency Broken Conductor Detection
N/A	Load Encroachment
N/A	Broken Conductor
81df/dt	Frequency Rate of Change
VTFF	VT Fuse Failure Detection
60CTS Failure	Current Transformer Failure **
2nd Harmonic Inhibit	Second Harmonic Inhibit **

** These functions are available for firmware version 7.50 or above

2.3 Other device functions

INPUTS/OUTPUTS
9 Analog Inputs: 5 current inputs (3 for phases, 1 for ground, 1 for sensitive ground), 4 voltage inputs (3 for phases, 1 for busbar or auxiliary voltage)
Digital Programmable Contact Inputs (up to 64)
Digital Programmable Contact Outputs (up to 16)
32 Latched Virtual Inputs 32 Self-Reset Virtual Inputs
Virtual Outputs (up to 512)
Tripping and closing circuit supervision
Remote Inputs/Outputs (GSSE and GOOSE messages)
Analog Inputs (dCmA)

METERING
Metering Current for phases, ground and sensitive ground inputs
Voltages phase to phase and phase to ground
Real, Reactive and Apparent Power and Power Factor
Three Phase Energy
Frequency
Sequence components of currents and voltages
Pulse Counters
Analog Comparators
*Digital Counters

COMMUNICATIONS
Front RS232 port, USB port in HMI option E, Two rear RS485/fibre optic ports, 10/100 TX and 100 FX Mbps Ethernet port
ModBus Communications RTU and over TCP/IP
DNP Multimaster (3.0 Level 2)
IEC 870-5-104
ModBus User Map
IEC 61850 protocol
IEC 870-5-103 protocol

*This functionality is available from firmware version 7.00

USER INTERFACE
Alphanumerical display (4x20)
Graphic display (16 x 40)
User Programmable LEDs (15)

RECORDS
Data Logger
Demand
Event Recorder (up to 128 configurable events)

OTHERS
Breaking Arcing Current (I^2t)
Breaker Control
IRIG-B synchronization/SNTP/ IEEE 1588

User Programmable Keys (up to 5)	Fault Locator and Fault report (up to 10 records)	Logic Equations (PLC Editor)
Easy menu management	Oscillography (up to 20 records)	Operations (up to 24)
Configurable One-Line Diagram (Graphic model only)	Snapshot Events (up to 1023)**	Web Server Application
Phasor Diagram (available in EnerVista 650 Setup)		

** Maximum number of events can vary depend on firmware version. See details in section 2.5.3.3

2.4 Order codes

F650 units are supplied as ½ 19” rack, 6 units high, containing the following modules: power supply, CPU, I/O modules, communication modules. The required information to completely define an F650 model is shown on Table 2–1:

Table 2-1: Order codes

F650	-	-	-	F	-	G	-	-	-	-	-		DESCRIPTION
	B												Basic Display (See Note 2)
	M												Graphic Display with Standard Symbols (See Note 2)
	N												Graphic Display with IEC symbols (See Note 2)
													REAR SERIAL COMMUNICATIONS BOARD 1
		F											None
		A											Redundant RS485
		P											Redundant plastic fiber optic
		G											Redundant glass fiber optic
		X											Redundant RS485 + fiber remote CAN bus I/O
		Y											Redundant plastic fiber optic + fiber remote CAN bus I/O
		Z											Redundant glass fiber optic + fiber remote CAN bus I/O
		C											Cable Remote CAN bus I/O
		M											RS485 + cable Remote CAN bus I/O
													REAR ETHERNET COMMUNICATIONS BOARD 2 (FW version 6.xx or below. See Note 11.)
			B										10/100 Base TX
			C										10/100 Base TX + 100 Base FX
			D										10/100 Base TX + Redundant 100 Base FX
			E										Redundant 10/100 Base TX
													REAR ETHERNET COMMUNICATIONS BOARD 2 (FW version 7.xx or above)
			G										1588, 10/100 Base TX* + 100 Base TX (See Note 3)
			H										1588, 10/100 Base TX* + 100 Base FX (See Note 3)
			J										PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX (See Note 4)
			K										PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX (See note4)
			L										PRP, 1588, 10/100 Base TX*+ Redundant 100 Base TX (See Note 4)
			M										PRP, HSR, RSTP, 1588, 10/100 Base TX*+ Redundant 100 Base TX (See Note 4)
													I/O BOARD IN SLOT F
					1								16 Digital Inputs + 8 Outputs
					2								8 Digital Inputs + 8 Outputs + 2 trip/close circuit supervision circuits
					4								32 Digital Inputs

					5								16 Digital Inputs + 8 Analog Inputs
													I/O BOARD IN SLOT G
							0						None
							1						16 Digital Inputs + 8 Outputs
							4						32 Digital Inputs (see Note 1)
							5						16 Digital Inputs + 8 Analog Inputs (See Note 1)
													AUXILIARY VOLTAGE
								LO					24-48 Vdc (range 19.2 – 57.6)
								HI					110-250 Vdc (range 88 – 300). 120-230 Vac (range 96 – 250)
								LO R					Redundant LO
								HIR					Redundant HI
													LANGUAGE
									-				English/English
									C				Chinese/English (See Note 2 and Note 7)
									F				French/English
									P				Russian/English (See Note 2)
									S				Spanish/English
									T				Turkish/English
													PROTOCOL & Cybersecurity
										-			Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104, Basic Cybersecurity level
										3			IEC 60870-5-103, Modbus® RTU,TCP/IP, Basic Cybersecurity level
										6			IEC 61850 (See Note 10), Modbus® RTU and TCP/IP,DNP 3.0 Level 2, IEC 60870-5-104, Basic Cybersecurity level
										A			Modbus® RTU, TCP/IP, DNP 3.0 Level 2, IEC 60870-5-104, Advanced Cybersecurity level
										B			IEC 60870-5-103, Modbus® RTU,TCP/IP, Advanced Cybersecurity level
										D			IEC 61850 (See Note 10), Modbus® RTU and TCP/IP,DNP 3.0 Level 2, IEC 60870-5-104, Advanced Cybersecurity level
													ENVIRONMENTAL PROTECTION
											-		Without Harsh (Chemical) Environment Conformal Coating
											H		Harsh (Chemical) Environment Conformal Coating
											M		Marine range: (See Note 9)
													ENHANCED DISPLAY
												-	Display with RS232 (See Note 8)
												E	Enhanced Display with USB

SPECIAL MODELS MOD001 (Abbreviation "+M1"): have 6A output contacts instead of 16A.

Notes:

(*) For firmware version 7.00 or above, Port E is only intended for maintenance purposes.

(1) Order code option F4 requires option G4 or G5. Order code option F5 requires option G5.
For example: F1G5 is a valid selection and F5G1 is an invalid selection.

(2) **Display options with language selection:**

Graphic display: available for English, French, Spanish and Chinese languages. For Chinese and Russian only IEC symbols option is available (N in order code).

Basic display: available for all languages

(3) **Advance functionalities Level I:**

G, H: IEEE1588 Precision Time Protocol (PTP), 61850 Edition 2.0. Digital counters. Max numbers of starts and Cold Load Pick-up functionalities.

(4) **Advance functionalities Level II:**

J, L: Parallel Redundancy Port (PRP,) IEEE1588 Precision Time Protocol (PTP), 61850 Edition 2.0. Digital counters, DFT, 16 Switchgear mapped in IEC61850, 16 nodes CILO, mapping of BlkOpn and BlkCls leafs of XSWI nodes, Max numbers of starts and Cold Load Pick-up functionalities.

K, M: High-Availability Seamless Redundancy (HSR), Rapid Spanning Tree Protocol (RSTP), Parallel Redundancy Port (PRP,) IEEE1588 Precision Time Protocol (PTC), 61850 Edition 2.0. Digital counters, DFT, 16 Switchgear mapped in IEC61850, 16 nodes CILO, mapping of BlkOpn and BlkCls leafs of XSWI nodes, Max numbers of starts and Cold Load Pick-up functionalities.

(5) For special models requested, relay order code shall be codified as a standard model (Table 2-1) following by Abbreviation + MX where X indicates the number of special model selected.

(6) For non-last released firmware version models requested, relay order code shall be codified as standard model (Table 2-1), following by Abbreviation +VXXXXXBYYYYY where XXXXX is the firmware version requested and YYYYY is the corresponding bootcode version.

(7) **Chinese Language:** This language is not supported for Rear Ethernet Communication Board options: G, H, J, K, L or M

(8) Display option with RS232 is not available for F650 Models with Rear Ethernet Communication Board 2 options from G to M or with Environmental Protection option M

(9) Marine Range option M in the Environmental Protection section is obsolete and the alternative is H Harsh Environmental Conformal Coating.

(10) For F650 order codes with Communication Option 6, Rear Ethernet Communication Board 2, and firmware version 7.52 or above, IEC 61850 Edition 1.0 is also available. The relay will work with IEC 61850 Edition 1.0 or Edition 2.0, depending on which ICD file has been sent to the device. See section7.6.3.1.2: Quick Menu Toolbar on page 7–222.

(11) Models with REAR ETHERNET COMMUNICATION BOARD 2 option B, C, D or E do not work with FW version 7.xx or above. If you want to take advantage of the 650 family evolution with extended functionality (FW 7.xx or above), please order models with REAR ETHERNET COMMUNICATION BOARD 2 option: G, H, J, K, L or M

(12) Cybersecurity functionality available in Order Code is only applicable to firmware versions 9.00 and onwards. For further information, see chapter 8-Security.

For applications requiring a high number of inputs and outputs, F650 units can be connected to a CIO module (Remote CAN bus I/O module) for using up to 2 additional boards.

F650 units allow monitoring and configuring these I/O boards as if they were internal boards, located on slots F and G. In this case, slots are labeled as H and J.

The required information to completely define a CIO Module is shown on Table 2–2:.

Table 2-2: Order code for CIO module

CIO	H	-	J	-	-		DESCRIPTION
							I/O BOARD IN SLOT H
		1					16 Digital inputs + 8 outputs
		2					8 Digital Inputs + 8 Outputs + 2 trip/close circuit supervision circuits
		4					32 Digital Inputs
		5					16 Digital Inputs + 8 Analog Inputs
							I/O BOARD IN SLOT J
				0			None
				1			16 Digital inputs + 8 outputs
				4			32 Digital Inputs (See Note 1)
				5			16 Digital Inputs + 8 Analog Inputs (See Note 1)
							AUXILIARY VOLTAGE
					LO		24-48 Vdc (range 19.2 – 57.6)
					HI		110-250 Vdc (range 88 – 300) 120-230 Vac (range 96 – 250)
							ENVIRONMENTAL PROTECTION
						H	Harsh (Chemical) Environment Conformal Coating

(1) The digit selected for option J must be equal or higher than the digit selected for option H for models including boards 4 and 5.
CIOH1J5**: is a valid selection
CIOH5J1**: is an invalid selection

2.5 Technical specifications

NOTICE **TECHNICAL SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE**

2.5.1 Protection

Phase and Ground protection functions use currents measured through CT inputs for performing internal calculations, while the Neutral protection functions use the current calculated from three phase currents.

The sensitive ground protection functions are usually used for applications where the neutral is completely isolated. These functions use current measured though the sensitive ground current input. This CT has a sensitivity 10 time higher than standard CT inputs (Connected to 1A and 5A CT) and its current withstand is lower.

PHASE TIME OVERCURRENT (51PH/51PL)

Current Input: ..... phasor (without harmonics) or RMS
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ..... IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve

Curve Multiplier (Time Dial): ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Type: ..... instantaneous or time delayed, according to IEEE
Timing Accuracy: ..... Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Voltage Restraint: ..... selectable by setting
Saturation Level: ..... 48 times the pickup level
Snapshot Events: ..... selectable by setting

GROUND TIME OVERCURRENT (51G)

Current Input: ..... phasor (without harmonics) or RMS
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ..... IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Type: ..... instantaneous or time delayed, according to IEEE
Timing Accuracy: ..... Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Saturation Level: ..... 48 times the pickup level
Snapshot Events: ..... selectable by setting

NEUTRAL TIME OVERCURRENT (51N)

Current Input: ..... fundamental phasor (without harmonics) or RMS
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ..... IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Type: ..... instantaneous or time delayed, according to IEEE
Timing Accuracy: ..... Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Saturation Level: ..... 48 times the pickup level
Snapshot Events: ..... selectable by setting

SENSITIVE GROUND TIME OVERCURRENT (51SG)

Current Input: ..... phasor (without harmonics) or RMS
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level: ..... 0.005 to 16.000 A in steps of 0.001 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Curve Shape: ..... IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Type: ..... instantaneous or time delayed, according to IEEE
Timing Accuracy: ..... Operate at > 1.03 times the pickup ±3% of operate time or 50 ms (whichever is greater)
Saturation Level: ..... 48 times the pickup level
Snapshot Events: ..... selectable by setting

PHASE AND GROUND INSTANTANEOUS OVERCURRENT (50PH/50PL/50G)

Current Input: ..... phasor (without harmonics) or RMS
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Overreach: ..... < 2%
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Operate Time: ..... < 50 ms at 3 x pickup at 50 Hz, typically
Timing Accuracy: ..... at 0 ms time delay (no intentional delay): 50 ms
at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events: ..... selectable by setting

NEUTRAL INSTANTANEOUS OVERCURRENT (50N)

Current Input: ..... fundamental phasor (without harmonics)
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Overreach: ..... < 2%
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Operate Time: ..... < 50 ms at 3 x pickup at 50 Hz, typically
Timing Accuracy: ..... at 0 ms time delay (no intentional delay): 50 ms
at non-zero time delay: ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events: ..... selectable by setting

SENSITIVE GROUND INSTANTANEOUS OVERCURRENT (50SG)

Current Input: ..... phasor (without harmonics) or RMS
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level: ..... 0.005 to 16.000 A in steps of 0.001 A
Level Accuracy: ..... values at nominal frequency:
±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Overreach: ..... < 2%
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Operate Time: ..... < 50 ms at 3 x pickup at 50 Hz, typically
Timing Accuracy: ..... at 0 ms time delay (no intentional delay): 50 ms
at non-zero time delay: ±3% of operate time or 50 ms
(whichever is greater)
Snapshot Events: ..... selectable by setting

ISOLATED GROUND INSTANTANEOUS OVERCURRENT (50IG)

Current Input: ..... fundamental phasor (without harmonics)
Voltage Input: ..... fundamental phasor (without harmonics)
Current Pickup Level: ..... 0.005 to 0.400 A in steps of 0.001 A
Voltage Pickup Level: ..... 2 to 70 V in steps of 1 V
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... ±1.5% of the reading ± 1 mA from 0.005 to 16.000 A
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Time to Instantaneous: ..... 0.00 to 900.00 s in steps of 0.01 s
Operate Time: ..... < 50 ms at 3 x pickup at 50 Hz, typically
Timing Accuracy: ..... at 0 ms time delay (no intentional delay): 50 ms
at non-zero time delay: ±3% of operate time or 50 ms
(whichever is greater)
Snapshot Events: ..... selectable by setting

NEGATIVE SEQUENCE CURRENT (46)

Current Input: ..... fundamental phasor (without harmonics)
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ±10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Curve Shape: ..... IEEE extremely/very/moderately inverse
IEC A/B/C/long-time inverse/short time inverse curve
IAC extremely/very/moderately inverse
ANSI extremely/very/normally/moderately inverse
I^2t
Definite time
Rectifier curve
FlexCurve™ A/B/C/D user curve
Curve Multiplier (Time Dial): ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Type: ..... instantaneous or time delayed, according to IEEE
Timing Accuracy: ..... Operate at > 1.03 times the pickup ±3% of operate time or 50 ms
(whichever is greater)
Saturation Level: ..... 48 times the pickup level
Snapshot Events: ..... selectable by setting

PHASE DIRECTIONAL (67P)

Directionality: .....forward and reverse selectable by setting
Polarizing:.....quadrature voltage:
ABC seq: Phase A (VBC), Phase B (VCA), Phase C (VAB)
ACB seq: Phase A (VCB), Phase B (VAC), Phase C (VBA)
Polarizing Voltage Threshold: .....0 to 300 Vac in steps of 1 V
Current Sensitivity Threshold:.....50 mA
Characteristic Angle:.....-90º to +90º in steps of 1º
Block Logic: .....permission or block selectable by setting
Angle Accuracy: .....±3º for I > 0.1 A and V > 5 Vac
Voltage Memory Time: .....0.00 to 3.00 s in steps of 0.01 s
Operate Time:.....< 30 ms, typically

GROUND DIRECTIONAL (67G)

Directionality: .....forward and reverse selectable by setting
Polarizing:.....voltage, current, dual
Polarizing Voltage: .....V_N (measured or calculated, selected by setting)
Polarizing Current: .....I_{sg} (measured from 5th current transformer)
Operating Current:.....I_g (measured from 4th current transformer)
Polarizing Voltage Threshold: .....0 to 300 Vac in steps of 1 V
Polarizing Current Threshold: .....0.005 A
Characteristic Angle:.....-90º to +90º in steps of 1º
Block Logic: .....permission or block selectable by setting
Angle Accuracy: .....±3º for I > 0.1 A and V > 5 Vac
Operate Time:.....< 30 ms, typically

NEUTRAL DIRECTIONAL (67N)

Directionality: .....forward and reverse selectable by setting
Polarizing:.....voltage, current, dual
Polarizing Voltage: .....V_N (measured or calculated, selected by setting)
Polarizing Current: .....I_{sg} (measured from 5th current transformer)
Operating Current:.....I_N
Polarizing Voltage Threshold: .....0 to 300 Vac in steps of 1 V
Polarizing Current Threshold: .....0.005 A
Characteristic Angle:.....-90º to +90º in steps of 1º
Block Logic: .....permission or block selectable by setting
Angle Accuracy: .....±3º for I > 0.1 A and V > 5 Vac
Operate Time:.....< 30 ms, typically

SENSITIVE GROUND DIRECTIONAL (67SG)

Directionality: .....forward and reverse selectable by setting
Polarizing:.....voltage
Polarizing Voltage: .....V_N (measured or calculated, selected by setting)
Operating Current:.....I_{sg} (measured from 5th current transformer)
Polarizing Voltage Threshold: .....0 to 300 Vac in steps of 1 V
Characteristic Angle:.....-90º to +90º in steps of 1º
Block Logic: .....permission or block selectable by setting
Angle Accuracy: .....±2º for I > 0.1 A and V > 5 Vac
Operate Time:.....< 30 ms, typically

THERMAL MODEL (49)

Current Input: ..... fundamental phasor (without harmonics)
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Timing Accuracy: ..... ±3.5% of operating time or 50 ms (whichever is greater)
Heating Constant: ..... 3.0 to 600.0 minutes in steps of 0.1 minutes
Cooling Constant: ..... 1.00 to 6.00 times the heating constant, in steps of 0.01
Snapshot Events: ..... selectable by setting

PHASE OVERVOLTAGE (59P)

Voltage Input: ..... fundamental phasor (without harmonics) of phase-to-phase voltages
Pickup Level: ..... 2 to 30 V in steps of 1 V
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... ±1% of the reading from 10 to 208 V at nominal frequency
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ..... ±3.5% of operating time or 50 ms (whichever is greater)
Logic: ..... Any/Two/All phases logic, selectable by setting
Snapshot Events: ..... selectable by setting

PHASE UNDERVOLTAGE (27P)

Voltage Input: ..... fundamental phasor of phase-to-ground or phase-to-phase voltages (selectable by setting)
Pickup Level: ..... 3 to 300 V in steps of 1 V
Dropout Level: ..... 102% to 103% of the pickup level
Level Accuracy: ..... ±1% of the reading from 10 to 208 V at nominal frequency
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Curve Shapes: ..... fixed time or inverse curves
Reset Type: ..... instantaneous
Curve Multiplier (Time Dial): ..... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ..... ±3.5% of operating time or 50 ms (whichever is greater)
Minimum Voltage Threshold: ..... 0 to 300 V in steps of 1 V
Logic: ..... Any/Two/All phases logic, selectable by setting
Supervised by Breaker: ..... selectable by setting
Snapshot Events: ..... selectable by setting

NEUTRAL OVERVOLTAGE (59NH/59NL)

Voltage Input: ..... fundamental phasor of the neutral voltage
Pickup Level: ..... 3 to 300 V in steps of 1 V
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... ±1% of the reading from 10 to 208 V at nominal frequency
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ..... ±3.5% of operating time or 50 ms (whichever is greater)
Snapshot Events: ..... selectable by setting

NEGATIVE SEQUENCE OVERVOLTAGE (47)

Voltage Input: fundamental phasor
Pickup Level: 3 to 300 V in steps of 1 V
Dropout Level: 97% to 98% of the pickup level
Level Accuracy: ±1% of the reading from 10 to 208 V
Trip Delay: 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ±3.5% of operating time or 50 ms (whichever is greater)
Snapshot Events: selectable by setting

AUXILIARY OVERVOLTAGE (59X)

Voltage Input: fundamental phasor of the auxiliary voltage
Pickup Level: 3 to 300 V in steps of 1 V
Dropout Level: 97% to 98% of the pickup level
Level Accuracy: ±1% of the reading from 10 to 208 V at nominal frequency
Trip Delay: 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ±3.5% of operating time or 50 ms (whichever is greater)
Snapshot Events: selectable by setting

AUXILIARY UNDERVOLTAGE (27X)

Voltage Input: fundamental phasor of the auxiliary voltage
Pickup Level: 3 to 300 V in steps of 1 V
Dropout Level: 102% to 103% of the pickup level
Level Accuracy: ±1% of the reading from 10 to 208 V at nominal frequency
Curve Shapes: fixed time or inverse curves
Reset Type: instantaneous
Curve Multiplier (Time Dial): 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ±3.5% of operating time or 50 ms (whichever is greater)
Snapshot Events: selectable by setting

UNDERFREQUENCY (81U)

Pickup Level: 20.00 to 65.00 Hz in steps of 0.01 Hz
Dropout Level: pickup + 0.03 Hz
Level Accuracy: ±0.05 Hz of the reading from 30 to 80 Hz
Trip Delay: 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: 0.00 to 900.00 s in steps of 0.01 s
Minimum Voltage Threshold: 10 to 300 V in steps of 1 V
Time Delay Accuracy: 0 to 7 cycles
Operate Time: typically 10 cycles at 0.1 Hz/s change
Snapshot Events: selectable by setting

OVERFREQUENCY (81O)

Pickup Level: 20.00 to 65.00 Hz in steps of 0.01 Hz
Dropout Level: pickup - 0.03 Hz
Level Accuracy: ±0.05 Hz of the reading from 30.00 to 80.00 Hz
Trip Delay: 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: 0.00 to 900.00 s in steps of 0.01 s
Minimum Voltage Threshold: 10 to 300 V in steps of 1 V
Time Delay Accuracy: 0 to 7 cycles
Operate Time: typically 10 cycles at 0.1 Hz/s change
Snapshot Events: selectable by setting

FORWARD POWER (32FP)

Current, Voltage: ..... fundamental phasor (primary values)
Number of Stages: 2
Pickup Level: ..... 0.00 to 10000.00 MW in steps of 0.01 MW
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy for Primary Magnitudes: ..... ±3% of complete range
Trip Delay (Two Stages): ..... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ..... ±3.5% of operate time or 50 ms (whichever is greater)
Block Time After Close: ..... 0.00 to 900.00 s in steps of 0.01 s
Snapshot Events: ..... selectable by setting

DIRECTIONAL POWER (32)

Current, Voltage: ..... fundamental phasor (primary values)
Number of Stages: 2
Pickup Level: ..... -10000.00 to 10000.00 MW (primary values) in steps of 0.01 MW
Characteristic Angle (Two Stages): ..... 0.00° to 359.99° in steps of 0.01°
Accuracy for Primary Magnitudes: ..... ±3% of complete range
Trip Delay (Two Stages): ..... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ..... ±3.5% of operate time or 50 ms (whichever is greater)
Block Time After Close: ..... 0.00 to 900.00 s in steps of 0.01 s
Snapshot Events: ..... selectable by setting
Operate Time: ..... < 45 ms at 50 Hz, typically

WATTMETRIC ZERO-SEQUENCE DIRECTIONAL (32N)

Measured Power: ..... zero sequence
Number of Elements: ..... 6 (3 high level, 3 low level)
Voltage Pickup Level V_N: ..... 2.00 to 70.00 V in steps of 0.01 V
voltage calculated from phases if auxiliary voltage is set to V_x
voltage measured from the 4th voltage transformer if auxiliary voltage is set to V_N
Level Accuracy for Voltage: ..... ±1% of reading from 10 to 208
Current Selection: ..... I_N (calculated from phases)
I_G (measured from the 4th current transformer)
OC Pickup Level: ..... 0.005 to 0.400 A in steps of 0.001
Level Accuracy for Current: ..... ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
OC Pickup Delay: ..... 0.00 to 600.00 s in steps of 0.01 s
Power Pickup Level: ..... 0.01 to 4.50 W in steps of 0.01 W
Characteristic Angle (MTA): ..... 0° to 360° in steps of 1°
Power Pickup Delay: ..... 0.00 to 600.00 s in steps of 0.01 s
Level Accuracy for Power: ..... ±2.5% of the reading at -0.8 ≤ PF ≤ -1 and 0.8 < PF ≤ 1
Curve Shapes: ..... Inverse Curve
Definite Time
FlexCurve™ A/B/C/D user curves
Curve Multiplier (Time Dial): ..... 0.02 to 2.00 s in steps of 0.01 s
Tripping Time Accuracy: ..... ±3.5% of operate time or 50 ms whichever is greater
Snapshot Events: ..... selectable by setting
Operate Time: ..... < 45 ms at 50 Hz, typically

2.5.2 Control

AUTORECLOSE (79)

Schemes: ..... three-pole tripping schemes
Number of Shots: ..... up to 4 reclose attempts before lockout
Dead Time: ..... independent dead time setting before each shot
adjustable between 0.00 and 900.00 s in steps of 0.01 s.
Reclaim Time: ..... 0.00 and 900.00 s in steps of 0.01 s
Condition Permission: ..... selectable by setting
Hold Time: ..... 0.00 and 900.00 s in steps of 0.01 s
Reset Time: ..... 0.00 and 900.00 s in steps of 0.01 s
Snapshot Events: ..... selectable by setting
Protection settings can be modified after each shot through PLC programming (block signals are available after each shot).

SYNCHROCHECK (25)

Dead/live Level for Line and Bus: ..... 0.00 to 300.00 in steps of 0.01 V
Maximum Voltage Difference: ..... 2.00 to 300.00 V in steps of 0.01 V
Maximum Angle Difference: ..... 2.0º to 80.0º in steps of 0.1º
Maximum Frequency Slip: ..... 10 to 5000 mHz in steps of 10 mHz
Synchronism Time: ..... 0.01 to 1.00 s in steps of 0.01 s
Angle Accuracy: 3º
Dead Source Function: ..... None
(DL-DB) Dead Line - Dead Bus
(LL-DB) Live Line-Dead Bus
(DL-LB) Dead Line – Live Bus
Snapshot Events: ..... selectable by setting

FUSE FAILURE

Algorithm based on positive sequence of voltage and current
Activation by V_2/V_1 ratio

BREAKER FAILURE (50BF)

Current Input: ..... phasor (without harmonics)
Rated Current: ..... for connection to 1 or 5 A CTs
Pickup Level for Supervision: ..... 0.05 to 160.00 A in steps of 0.01 A
Pickup Level for High Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Pickup Level for Low Level: ..... 0.05 to 160.00 A in steps of 0.01 A
Pickup Level for Internal Arcing: ..... 0.05 to 160.00 A in steps of 0.01 A
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy: ..... values at nominal frequency:
±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
±1.5% of the reading for higher values
Timing Accuracy: ..... ±3.5% of operate time or 50 ms (whichever is greater)
Snapshot Events: ..... selectable by setting

CT SUPERVISION FAILURE (60CTS)

Inputs: ..... Neutral Current I_N
Neutral Voltage V_N (from three-phase VTs)
Ground Current I_g
Sensitive Ground Current I_{sg}
Time Delay: ..... 0.00 to 600.00 s in steps of 0.01 s
3IO Level Accuracy: ..... ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A (for ground)
±1.5% of the reading ± 1 mA from 0.005 to 5.000 A (for sensitive ground
3VO Level Accuracy: ..... ±1% of reading from 10 to 208 V
Ground Current Accuracy: ..... ±0.5% of the reading ± 10 mA from 0.05 to 10.00 A
Sensitive Ground Current Accuracy: ..... ±1.5% of the reading ± 1 mA from 0.005 to 5.000 A
Operate Time: ..... < 20 ms at 60 Hz
< 25 ms at 50 Hz
Snapshot Events: ..... selectable by setting

SECOND HARMONIC INHIBIT

Operating Parameter: ..... current 2nd harmonic per phase or average
Pickup Level: ..... 0.1 to 40.0% in steps of 0.1%
Dropout Level: ..... 98% of the pickup level
Level Accuracy: ..... 2% or 10 mA
Minimum Current: ..... 0.05 to 15.00 A in steps of 0.01 A
Time Delay: ..... 0.00 to 600.00 s in steps of 0.01 s
Time Delay Accuracy: ..... ±3% of expected time or 1.5 cycles (whichever is greater)
Time Accuracy: ..... 3% or 1.5 cycles
Snapshot Events: ..... selectable by setting

BROKEN CONDUCTOR (I2/I1)

Pickup Level: ..... 20.0-100.0% (I2/I1 ratio) in steps of 0.1%
Dropout Level: ..... 97% to 98% of the pickup level
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Timing Accuracy: ..... ±3.5% of operate time or 50 ms (whichever is greater)
Snapshot Events: ..... selectable by setting
Operation Threshold: ..... 0.000 to 1.000 A in steps of 0.001 A
Current Inhibition Level: ..... selectable by setting from 0.000 to 1.000 A in steps of 0.001 A

LOCKED ROTOR (48)

Current Input: ..... phasor (without harmonics) or RMS
Rated Current: ..... for connection to 1 or 5 A CTs
Full Load Current: ..... 0.10 to 10.00 kA in steps of 0.01 kA
Pickup Level: ..... .1.01 to 109.00 in steps of 0.01 x FLC
Dropout Level: ..... 97% to 98% of the pickup level
Level Accuracy for Primary Magnitudes: ..... ±3% complete range
Trip Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Reset Delay: ..... 0.00 to 900.00 s in steps of 0.01 s
Operate Time: ..... 20 ms at 3 x pickup at 50 Hz, typically
Timing Accuracy: ..... ±3% of operate time or 50 ms (whichever is greater)
Snapshot Events: ..... selectable by setting

PULSE COUNTERS

Number of Pulse Counters Available: ..... up to 8
Multiplier Factor: ..... 0.000 to 65000.000 in steps of 0.001
Overload Factor: ..... 0 to 10000000 in steps of 1
Board Origin: ..... all available input/output boards in the device. See order code (F, G, H, J)
Input Origin: ..... up to 32 (depending on board selection type)

ANALOG COMPARATORS

Analog Input: ..... any analog value in the device
Analog Maximum Threshold Value: ..... -100000.000 to 100000.000 in steps of 0.001
Analog Minimum Threshold Value: ..... -100000.000 to 100000.000 in steps of 0.001
Analog Delay: ..... 0.00 to 900.00 in steps of 0.01
Analog Hysteresis: ..... 0.0 to 50.0 in steps of 0.1
Analog Direction (for activation inside or outside the deadband: ..... IN or OUT

FREQUENCY RATE OF CHANGE

df/dt Trend: ..... increasing, decreasing, bidirectional
df/dt Pickup Level: ..... 0.10 to 10.00 Hz/s in steps of 0.01 Hz/s
df/dt Level Accuracy: ..... 80 mHz/s or 3.5% (whichever is greater)
Overvoltage Supv. ..... 0.00 to 110.00% in steps of 0.01%
95% Settling Time for df/dt: ..... < 24 cycles
Operate Time: ..... at 2 x pickup: 12 cycles
at 3 x pickup: 8 cycles
at 5 x pickup: 6 cycles
Frequency Rate Min. ..... 20.00 to 80.00 Hz in steps of 0.01 Hz
Frequency Rate Max. ..... 20.00 to 80.00 Hz in steps of 0.01 Hz
Frequency Rate Delay: ..... 0.00 to 60.00 s in steps of 0.01 s
Snapshot Events: ..... selectable by setting

LOAD ENCROACHMENT

Responds to: ..... positive sequence quantities
Minimum Voltage: ..... 0.00 to 300.00 V in steps of 0.01 V
Reach (sec.Ω): ..... 0.02 to 250.00 Ω in steps of 0.01 Ω
Impedance Accuracy: ..... ±3%
Angle: ..... 5 to 50º in steps of 1º
Angle Accuracy: ..... ±3%
Pickup Delay: ..... 0.000 to 65.535 s in steps of 0.001
Reset Delay: ..... 0.000 to 65.535 s in steps of 0.001
Time Accuracy: ..... ±3.5% or ±60 ms, whichever is greater
Operate Time: ..... < 60 ms at 50 Hz, typically
Snapshot Events: ..... selectable by setting

BREAKER SETTINGS

Number of Switchgear: ..... 1 to 16 (selection of switchgear for breaker control)
Maximum KI^2t: ..... 0.00 to 9999.99 $(kA)^2s$ in steps of 0.01 $(kA)^2s$
KI^2t Integration Time: ..... 0.03 to 0.25 s in steps of 0.01
Maximum Openings: ..... 0 to 9999 in steps of 1
Maximum Openings in One Hour: ..... 1 to 60 in steps of 1
Snapshot Events: ..... selectable by setting

BREAKER MAINTENANCE

KI^2t Breaker Counters for Phases A, B, C: ..... 0.00 to 9999.99 $(kA)^2s$ in steps of 0.01 $(kA)^2s$
Breaker Opening Counters: ..... 0 to 9999 in steps of 1
Breaker Closing Counters: ..... 0 to 9999 in steps of 1

SWITCHGEAR

Switchgear: ..... 1 to 16 (configurable in **Relay Configuration**)
Snapshot Events: ..... selectable by setting (for each switchgear, in **System Setup**)

MAXIMUM NUMBER OF STARTS

Metering Algorithm: ..... fundamental
Tripping Time Accuracy: ..... ±250 ms or 5% (whichever is greater)
Full Load Amps: ..... 0.5 to 10.0 A in steps of 0.1 A
Breaker Supervision: ..... selectable by setting
Min. Stop Time: ..... 0.0 to 900.0 s in steps of 0.1 s

Number of Starts: ..... 0 to 10 in steps of 1
Time to Restart: ..... 0 to 100 minutes in steps of 1 minute
Reset Counter: ..... selectable by setting
Snapshot Events: ..... selectable by setting
Operate Time: ..... < 45 ms at 50 Hz, typically

DIGITAL COUNTERS

Function: ..... Disabled, Enabled
Name: ..... any 12 alphanumeric characters
Preset: ..... -2147483648, 0, +2147483647
Compare: ..... -2147483648, 0, +2147483647

COLD LOAD PICKUP

Cold Outage Time: ..... 1 to 1000 minutes in steps of 1 minute
Cold Blocking Time: ..... 1 to 1000 s in steps of 1 s

2.5.3 Monitoring

OSCILLOGRAPHY

Maximum Records: ..... up to 20 oscillography records
Sampling Rate: ..... programmable to 4, 8, 16, 32, or 64 samples per power cycle
Capacity per record: ..... (27592 samples)/(number of oscillos x number of samples/cycle)
Maximum Records: ..... up to 20 oscillography records
Trigger Position: ..... 5% to 95% of total length
Trigger: ..... programmable via PLC
Data: ..... 5 current channels and 4 voltage channels up to 16 digital channels programmable through PLC
Data Storage: ..... non-volatile (flash) memory without battery
Format: ..... International Standard COMTRADE ASCII - IEEE C37.111-1999
Automatic Overwrite: ..... selectable by setting (oscillography records can be concatenated)
Snapshot Events: ..... selectable by setting

FAULT LOCATOR

Method: ..... single-ended
Positive Sequence Module: ..... 0.01 to 250.00 Ohm in steps of 0.01 Ohms
Positive Sequence Angle: ..... 25 to 90º in steps of 1º
Zero Sequence Module: ..... 0.01 to 750.00 Ω in steps of 0.01 Ω
Zero Sequence Angle: ..... 25 to 90º in steps of 1º
Line Length: ..... 0.0 to 2000.0 in steps of 0.1 miles or km (as per line length setting)
Accuracy: ..... 5% (typically)
Show Fault on HMI: ..... selectable by setting
Snapshot Events: ..... selectable by setting
Maximum Records: ..... up to 10 fault report records
Data: ..... Fault date and time, pre-fault currents and voltages, fault currents and voltages, fault type, distance to the fault (fault location), line parameters, recloser and breaker status information.
Data Storage: ..... In non-volatile (flash) memory without battery available through communications In volatile (RAM) memory available through HMI (if selectable by setting)
Format: ..... text in ASCII format

SNAPSHOT EVENTS

Capacity*: 1023 scrolling events
Time-tag: 1 ms using an internal clock of 100 µs
Timing Accuracy: 1 ms (using IRIG-B synchronization)
Triggers: any element pickup, dropout, or operation
digital input/output change of state
virtual inputs and control events
Data Storage: non-volatile (flash) memory without battery
*Note: For firmware 7.20, up to 511 snapshot events are available. For firmware below 7.20, up to 479 snapshot events are available.

CONTROL EVENTS

Capacity: 128 events programmable through PLC
Time-tag: 1 ms plus one PLC cycle using an internal clock of 100 µs. For digital inputs, the debounce time of these digital inputs must be added.
Timing Accuracy: 1 ms (with IRIG-B synchronization input)
Trigger: Any digital signal programmable through the PLC
Alarm: Control events can be displayed as an alarm on the alarms panel. Information is always available through **Communications** for all models and in the HMI for models with a graphical display (M in order code).
Data Storage: non-volatile (flash) memory without battery
Control events are also displayed in the snapshot events recording

DEMAND

Channels: 9
Parameters: Ia (kA RMS), Ib (kA RMS), Ic (kA RMS), Ig (kA RMS), Isg (kA RMS), I2 (kA), P (MW), Q (MVAr) and S (MVA)
Current and Power Method: Thermal Exponential, Block Interval, Rolling Demand
Measurements: Each channel shows the present and maximum measured value, with date and time for the maximum recorded value.
Samples: 5, 10, 15, 20, 30, 60 minutes
Accuracy: ±2%
Trigger Input: selectable by setting (operation mode selection for the block interval calculation method)
Snapshot Events: selectable by setting

DATA LOGGER

Number of Channels: 1 to 16
Parameters: any available analog actual value
Samples: 1 second, 1, 5, 10, 15, 20, 30, 60 minutes
Storage Capacity: fixed, 32768 measurements

2.5.4 User-programmable

PLC LOGIC

Programming language: The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.

Lines of code*: 640 lines of code or 15360 bytes, whichever is greater (for versions < 7.00)
1000 total equations or 15360 bytes, whichever is greater (for versions >= 7.00)

(*) Note: Reserved Modbus memory space of PLC equations in text format is up to 15360 bytes. This space is shared with information configured in EnerVista at **Setpoint > Relay Configuration**. According to this, the number of PLC equations can be limited by values configured on that section.

Supported operations: NOT, XOR, OR (2 to 8 inputs), AND (2 to 8 inputs), NOR (2 to 8 inputs), NAND (2 to 8 inputs), Latch (Reset Dominant), Edge Detectors, Timers.
2 inputs default gates, from 3 to 8 inputs provided in library format.
Starting in version 7.20, analog operators are also available.

Libraries: Logical gates fully programmable by user. Used to create user-programmable logic to be distributed as a single object.

Inputs: any logical variable, contact or virtual input

Number of Timers: 8 maximum in each logic scheme (provided in library format)

FLEXCURVES

Number: 4 (A through D)

Reset Points: 40 (0 through 1 of pickup)

Operate Point: 80 (0 through 20 of pickup)

Time Delay: 0 to 65535 ms in steps of 1 ms

Saturation Level: 20 x the pickup level

USER-PROGRAMMABLE LEDS

Number: 15 configurable LEDs plus the Ready non-configurable LED

Programmability: any logical variable, contact, or virtual input

Reset Mode: self-reset or latched.
The first 5 LEDs (red) are latched by hardware, usually configured for trip signals.
The following 10 LEDs (yellow and green) are self-reset but can be latched through PLC configuration.

Reset Signal: The LEDs can be reset by hardware, pressing the front “esc” key for more than 3 seconds or using the LED reset signal through PLC configuration.

USER-DEFINABLE DISPLAYS

Number of Configurable Displays: 1: one line diagram fully configurable. In graphical displays only

Number of Fixed Displays: 6: Metering (selectable between Primary and Secondary values), Snapshot Events (all and new), Alarms, Inputs and Outputs screen with test functionality for inputs and outputs. (In graphical displays only.)

Number of Selectable Displays: 2: Logotype, Metering, or both in scrolling mode can be selected as the default screen in text display for all models (basic and mimic). The metering screen contains current and voltages for phases and ground in primary or secondary values.

USER-PROGRAMMABLE FRONT KEYS

Number of Configurable Keys: 5

Operation: Drive PLC operands

2.5.5 Metering

CURRENT

Accuracy (at nominal frequency):.....±0.5% of the reading ± 10 mA from 0.05 to 10.00 A (for phases and ground)
±1.5% of the reading ± 1 mA from 0.005 to 5 A (for sensitive ground)
±1.5% of the reading for higher values

% of Load-to-trip Accuracy:.....±0.5% of full-scale

VOLTAGE

Accuracy:.....±1% of reading from 10 to 208 V

REAL POWER (WATTS)

Accuracy:.....±2.0% of the reading at -0.8 ≤ PF ≤ -1.0 and 0.8 < PF ≤ 1.0

REACTIVE POWER (VARS)

Accuracy:.....±2.0% of the reading at -0.2 ≤ PF ≤ 0.2

APPARENT POWER (VA)

Accuracy:.....±2.0% of the reading

WATT-HOURS (POSITIVE AND NEGATIVE)

Accuracy:.....±2.0% of the reading
Range:.....-2147483 to +2147483 MWh
Parameters:.....3-phase only
Update Rate:.....100 ms

WAR-HOURS (POSITIVE AND NEGATIVE)

Accuracy:.....±2.0% of the reading
Range:.....-2147483 to +2147483 MVArh
Parameters:.....3-phase only
Update Rate:.....100 ms

FREQUENCY

Accuracy:.....+/- 0.03Hz
From 30 to 80 Hz

Note: Voltage input must be above 10 V to start measuring frequency

ANGLE

Accuracy:.....±3º

2.5.6 Inputs

AC CURRENT INPUTS

CT Ratio:.....1.0 to 6000.0 in steps of 0.1
Rated Currents:.....Appropriate for 1 or 5 A. F650 has universal range for CT (valid for 1 or 5 A to only one terminal).
Relay Burden: .....< 8 mVA at 1 A
< 200 mVA at 5 A VA
Input Impedance: .....< 8 mOhm
Current Withstand: .....Continuous at 20 A
1 s at 500 A for phases and ground
1 s at 50 A for sensitive ground

AC VOLTAGE INPUTS

VT Ratio: ..... 1.0 to 6000.0 in steps of 0.1
Rated Voltage: ..... 275 Vac
Metering Range: ..... From 2 to 275 Vac
Relay Burden: ..... 0.05 VA at 120 Vac (50 or 60 Hz)
Voltage Withstand: ..... Continuous at 275 V to neutral
1 min/hr at 420 to neutral

VAC inputs do not need varistors, as the impulse test is applied to 100% of the transformers

CONTACT INPUTS

Input Activation Threshold: ..... 10 to 230 Vdc in steps of 1 V (selectable by setting)
Impedance: ..... > 100 kΩ
Maximum Error: ..... ±10% setting or ± 5 V
Load for Voltage Supervision Inputs: ..... 2 mA + V/100 kΩ
Voltage Threshold for Voltage Supervision Inputs: .. < 10 V (fixed)
Debounce Time: ..... 1 to 50 ms in steps of 1 ms
Recognition Time: ..... 2 ms (typical)
Timing Resolution: ..... 1 ms

For Activation Voltage Threshold and Debounce Time there is a single setting for all inputs in the same group (all inputs sharing the same common).

Input Type and Delay Input Time are not grouped; there is a different setting for each input.

Input Type: ..... positive-edge/negative-edge/positive/negative
Delay Input Time: ..... 0 to 60000 ms in steps of 1 ms (input signal time delay)

REMOTE INPUTS (IEC61850 GSSE/GOOSE)

Number of Input Devices: ..... 32, configured from 64 incoming bit pairs
Number f Remote Devices: ..... 16 (24 for relay version 7.00 and above)
Default States on Loss of Comms: ..... On, Off, Latest/on, Latest/off

ANALOG INPUTS

Input Impedance: 116Ω
Current Input (mADC): ..... 0 to -1; 0 to +1; -1 to +1; 0 to 5; 0 to 10; 0 to 20; 4 to 20 (programmable)
Conversion Range: ..... -1 to +20 mA
Accuracy: ..... ±0.2% of full scale
Type: ..... passive

IRIG-B INPUT

Amplitude Modulation: ..... DC SHIFT = demodulated input (no carrier)
Input Voltage: ..... TTL
Input Burden: ..... 1.5 mA
Input Impedance: ..... 3.3 kΩ
Minimum Input Voltage: ..... 2.4 V
Maximum Input Voltage: ..... ± 24 V
Formats: ..... B000 (*) B001, B002 and B003 (*
(*) Signal combinations recognized in accordance with IRIG Standard 200-95
Isolation: ..... 2 kV

2.5.7 Real time clock

Accuracy:.....typical ±20 ppm
Backup Energy:.....more than 1 week

Note: For relay versions before 7.00, when the relay date and time is changed using any documented methods (Modbus, IRIG-B, SNTP, Front Panel...) the relay acknowledges and updates the time instantly but it takes nearly 3 minutes for the new time to be permanently stored in the Real Time Clock's NVRAM.

2.5.8 Outputs

OUTPUTS

Single Contact Carry continuous:.....16 A
Make and Carry for 1 s:.....60 A
Break at L/R of 40 ms:.....0.3 A DC max. at 125 Vdc
0.25 A DC max. at 250 Vdc
Operate Time:.....< 8 ms
Contact Material:.....silver alloy

Output Logic Type, Output Type and Pulse Output Time are selectable by setting for each output

Output Logic Type:.....positive/negative
Output Type:.....normal/pulse/latch (selectable by setting for each output)
Pulse Output Time:.....0 to 60000 ms in steps of 1 ms (applicable only to signals sent as pulse type)

Separate operate and reset signals can be configured by any digital signal programmable through the PLC

Contact Outputs (F31-F33, F34-F36) for board type 2 (supervision) in slot F:.....The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 500 mA, the function is sealed independently of the status of the function that caused the trip.

REMOTE OUTPUTS (IEC61850 GSSE/GOOSE)

Standard Output Points:.....32
User Output Points:.....32

2.5.9 Control power supply

LOW RANGE (LO)

Nominal DC Voltage:	24 to 48 V
Min/Max DC Voltage	19.2 / 57.6 V
Note:	Low range is DC only
Voltage Loss hold-up time:(*)	24 Vdc 30 ms 48 Vdc 100 ms

ALL RANGES

Power Consumption:	Typical =25 VA, Maximum =45 VA
Display back-light auto power-off mode after 15 minutes without touching any key, in order to ensure long life and minimum consumption	

(*) These figures have been calculated for models with the following characteristic:
- IEC Symbols Graphic display
- Rear Ethernet Communication Board 2: PRP, 1588, 10/100 Base TX+ Redundant 100 Base FX
- F and G I/O Board:
  Slot F: 8 Digital Inputs + 8 Outputs + 2 Trip / Close circuit supervision circuits
  Slot G: 16 Digital Inputs + 8 Outputs

HIGH RANGE (HI)

Nominal DC Voltage:	110 to 250 V
Min/Max DC Voltage	88 / 300 V
Nominal AC Voltage:	120 to 230 V
Min/Max AC Voltage:	102 / 250 V
Voltage Loss Hold-up Time:	200 ms typical 100 ms worst case

INTERNAL FUSE

V:	250 VAC
I:	2.5A
Size:	5 x 20 mm
Type:	Quick acting (F)
UL listed miniature Fuse	

2.5.10 Communications

FRONT PORT:	
Front port:	**COM2**
Type:	RS232/USB
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 baud
Default Baud Rate:	19200 baud
Protocols:	ModBus® RTU/DNP 3.0
Typical Distance:	3 m
Isolation:	2 kV
ASYNCHRONOUS REAR PORTS:	
None or two rear ports (depending on model):	COM1, COM2 (rear COM2 multiplexed with front port)
Type (depending on model):	
Model F	None
Model A	Redundant RS485
Model X	Redundant RS485 + fiber CAN for inputs/outputs module
Model P	Redundant 1mm-plastic F.O.
Model Y	Redundant 1mm-plastic F.O. + fiber CAN for inputs/outputs module
Model G	Redundant multimode glass F.O.
Model Z	Redundant multimode glass F.O. + fiber CAN for inputs/outputs module
Model C	Cable CAN port for I/O module
Model M	Cable CAN port for I/O module (cable) + RS485 (ModBus RTU)
Optic Features for ST Connector Devices:	Wave length: 1300nm
	Fiber type: multimode 62.5/125 µm or 50/125 µm
Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 baud
Default Baud Rate:	19200 baud
Protocols:	ModBus® RTU/DNP 3.0/IEC103
Typical Distance:	1200 m for cooper cable, 1000 m for glass fiber and 50 m for plastic fiber
Isolation:	2 kV
CAN PORT:	
Rear Port:	CAN port in models C, M, X, Y, Z for asynchronous rear ports
Type:	Multimode glass F.O. port with ST connectors
Fiber Wavelength:	820 nm
Fiber Type:	multimode 62.5/125 µm or 50/125 µm
Maximum Recommended Length:	300 m for cooper cable and glass fiber
Isolation:	2 kV
ETHERNET PORT:	
Rear port:	
For models B, C, D, E:	ETH_1/ ETH_2
For models G, H, J, K, L, M:	ETH_E/ ETH_A/ ETH_B
Type (depending on model):	
Model B:	10/100BaseTX self-negotiable
Model C:	10/100BaseTX + 100Base FX
Model D:	10/100BaseTX + redundant 100BaseFX (Physical media redundancy)
Model E:	Redundant 10/100BaseTX self-negotiable ports
Model G:	1588, 10/100 Base TX* + 100 Base TX
Model H:	1588, 10/100 Base TX* + 100 Base FX
Model J:	PRP, 1588, 10/100 Base TX* + Redundant 100 Base FX
Model K:	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base FX
Model L:	PRP, 1588, 10/100 Base TX* + Redundant 100 Base TX
Model M:	PRP, HSR, RSTP, 1588, 10/100 Base TX* + Redundant 100 Base TX

(*) Note: This Ethernet port (ETH_E) is intended only for maintenance purposes.

10/100BaseTX:	RJ45 connector
100BaseFX:	ST connectors
Wavelength:	1300 nm
Fiber Type:	multimode 62.5/125 µm or 50/125 µm
Protocols:	ModBus® TCP/IP
	DNP over TCP/IP and UDP/IP
	IEC 61850
	http, ftp, tftp (allow the use of a standard Internet browser)
Typical Distance:	1000 m for glass fiber and 150 m for RJ45 cable
Response Time to ModBus Commands:	10 ms typical
Isolation:	2 kV

In Models C and D, the 10/100BaseTX port is selected by an internal switch (see 3.3.3)

Two witness LEDs for transmission and reception are included: green LED indicates the link is activive and red LED indicates the link is unstable.

SIMPLE NETWORK TIME PROTOCOL (SNTP)

Clock Synchronization error:	<10 ms (typical)

PRECISION TIME PROTOCOL (PTP)

PTP IEEE Std 1588 2008 (version 2)

Power Profile (PP) per IEEE Standard PC37.238TM2011

Slave-only ordinary clock

Peer delay measurement mechanism

PARALLEL REDUNDANCY PROTOCOL (PRP) (IEC 62439-3 CLAUSE 4, 2012)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

PARALLEL REDUNDANCY PROTOCOL (HSR) (IEC 62439-3 CLAUSE 5, 2012)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

RAPID SPANNING TREE PROTOCOL (RSTP) (IEC 62439-1, IEEE 801.2D)

Ethernet ports:	A and B
Networks:	10/100 MB Ethernet

2.5.11 Optical

Wave length: 1300 nm

Connector types: ST package style

Fiber type: multimode 62.5/125 µm or 50/125 µm

Transmitter characteristics						
Parameter		Min.	Typ.	Max.	Unit	Reference
Output Optical Power 62.5/125 µm, NA = 0.275 Fiber	BOL EOL	-19 -20		-14	dBm avg.	Note 1
Output Optical Power 50/125 µm, NA = 0.275 Fiber	BOL EOL	-22.5 -23.5		-14	dBm avg.	Note 1
Output Optical Power at Logic “0” State				-45	dBm avg.	Note 2

Receiver characteristics					
Parameter	Min.	Typ.	Max.	Unit	Reference
Input Optical Power Minimum at Window Edge		-33.9	-31	dBm avg.	Note 3
Input Optical Power Minimum at Eye Center		-35.2	-31.8	dBm avg.	Note 4
Input Optical Power Maximum	-14			dBm avg.	Note 3

Notes:

1. These optical power values are measured with the following conditions:

   The Beginning of Live (BOL) to the End of Life (EOL) optical power degradation is typically 1.5 dB per industry convention for long wavelength LEDs. The actual degradation observed in Agilent’s 1300nm LED products is <1 dB, as specified in this data sheet.

   Over the specified operating voltage and temperature ranges.

   With HALT Line State, (12.5 MHz square-wave), input signal.

   At the end of one meter of noted optical fiber with cladding modes removed.

   The average power value can be converted to a peak power value by adding 3 dB. Higher output optical power transmitters are available on special request.

2. The transmitter provides compliance with the need for Transmit_Disable commands from the FDDI SMT layer by providing an Output Optical Power level of <-45 dBm average in response to a logic “0” input. This specification applies to either 62.5/125 µm or 50/125 µm fiber cables.

3. This specification is intended to indicate the performance of the receiver section of the transceiver when Input Optical Power signal characteristics are present per the following definitions. The Input Optical Power dynamic range from the minimum level (with a window time-width) to the maximum level is the range over which the receiver is guaranteed to provide output data with a Bit Error Ratio (BER) better than or equal to 2.5e-10.

   At the Beginning of Life (BOL).

   Over the specified operating temperature and voltage ranges.

4. All conditions for Note 3 apply except that the measurement is made at the center of the symbol with no window time-width.

CAUTION: LED transmitters are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1M. Class 1M devices are considered eye safe to the unaided eye. **Do not view directly with optical instruments.**

2.5.12 Environmental

Operating Temperature: ..... - 10°C to + 60°C
Storage Temperature: ..... - 40°C to + 85°C
Humidity (non-condensing): 95%
Altitude: ..... up to 2000 m
Class of Equipment: I
Equipment Mobility: ..... fixed
Overvoltage Category: III
Pollution Degree: 2

2.5.13 Packaging and weight

Net Weight: ..... 5 kg
Packaged Weight: ..... 6 kg
Package Dimensions: ..... 30 x 40 x 40 cm (D x W x H)

2.5.14 Type tests

CATEGORY	STANDARD	CLASS	TEST
SAFETY	Dielectric voltage withstand	IEC60255-27	2 KV / 2.3 KV
	Impulse voltage withstand	IEC60255-27	5 KV
	Insulation resistance	IEC60255-27	500 V (test level)
EMC	Electrostatic Discharge Immunity	IEC60255-26/IEC61000-4-2	Level 4
	Radiated RF Electromagnetic Field Immunity	IEC60255-26/IEC61000-4-3	Level 3
	Electrical Fast Transient Immunity	IEC60255-26/IEC61000-4-4	Zone A
	Surge Immunity	IEC60255-26/IEC61000-4-5	Zone A
	Conducted RF Immunity	IEC60255-26/IEC61000-4-6	Level 3
	Power magnetic Immunity	IEC60255-26/IEC61000-4-8	Level 5
	Power Frequency Immunity	IEC60255-26/IEC61000-4-16	Zone A
	Damped Oscillatory Wave Immunity	IEC60255-26/IEC61000-4-18	2.5 KV Common Mode 1 KV Diff. Mode
	Voltage Dips & Interruptions	IEC60255-26/IEC61000-4-11/IEC61000-4-29	Levels based on IEC61000-4-11 & IEC61000-4-29
	Ripple on DC	IEC60255-26/IEC61000-4-17	15% Rated DC value
	Radiated & Conducted Emissions	IEC60255-26/CISPR11/ CISPR22	Class A
MECHANICAL	Sinusoidal Vibration	IEC60255-21-1	Class 1
	Shock & Bump	IEC60255-21-2	Class 1
	Seismic	IEC60255-21-3	Class 2
	Enclosure Protection	IEC60255-27/IEC60529	IP52
CLIMATIC	Cold test (storage)	IEC60068-2-1	-40˚C 16 hrs
	Cold test (operational)	IEC60068-2-1	-20˚C 16 hrs
	Dry heat test (storage)	IEC60068-2-2	85˚C 16 hrs
	Dry heat test (operational)	IEC60068-2-2	60˚C 16 hrs
	Change of Temperature	IEC60068-2-14	5 cycles (3+3) -20˚C/60˚C
	Damp Heat Humidity Cyclic	IEC60068-2-30	6 cycles (12+12) 55˚C @ 93% R.H.
	Damp Heat steady state	IEC60068-2-78	40˚C @ 93% R.H.

Type test report available upon request.

F650 has been designed to comply with the highest existing requirements. More specifically, UNIPEDE recommendations for high voltage substations are followed, even if for most applications such high classes are not required.

The relay complies with ANSI C37.90 standards, and has been designed to comply with international standards.

2.5.15 Approvals

	APPLICABLE COUNCIL DIRECTIVE	ACCORDING TO
CE COMPLIANCE	Low voltage directive	IEC60255-27
	EMC Directive	IEC60255-26
NORTH AMERICA	UL	UL508
EAC	Machines and Equipment	TR CU 010/2011
ISO	Manufactured under a registered quality program	ISO9001

EAC

The EAC Technical Regulations (TR) for Machines and Equipment apply to the Customs Union (CU) of the Russian Federation, Belarus, and Kazakhstan

Item	Description
Country of origin	Spain
Date of manufacture	See label on the F650 unit
Declaration of Conformity and/or Certificate of Conformity	Available on request

2.6 External connections

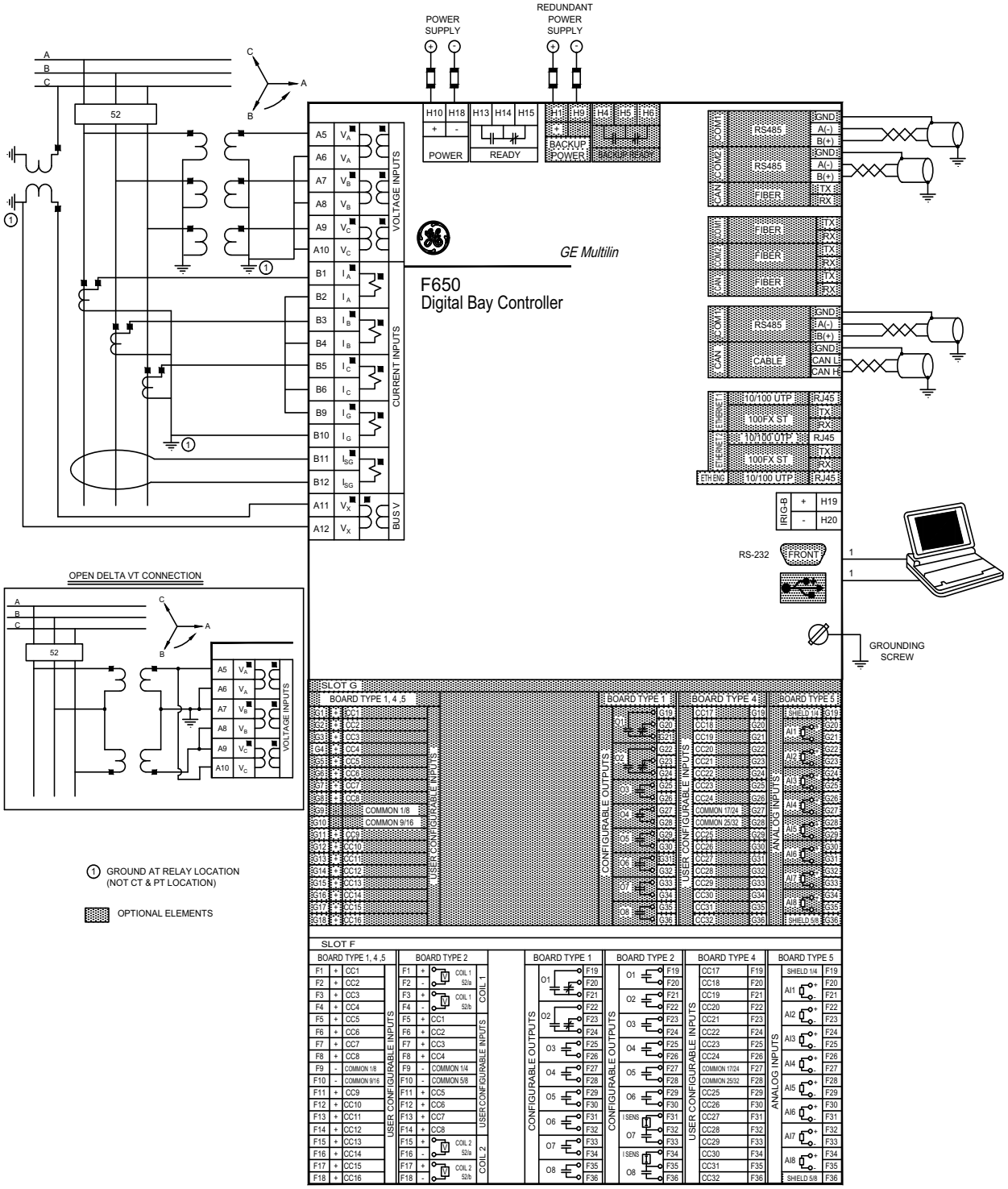


Figure 2-2: F650 wiring diagram (189C4216H2)

INPUTS / OUTPUTS CONFIGURATION FOR BOARDS F1 AND F2

SLOT F CONFIGURATION (BOARD TYPE 1)

INPUTS F1

F1	+	CC1	52b	USER CONFIGURABLE INPUTS
F2	+	CC2	50P BLOCK	
F3	+	CC3	51P BLOCK	
F4	+	CC4	67P BLOCK	
F5	+	CC5	50G BLOCK	
F6	+	CC6	51G BLOCK	
F7	+	CC7	79 INITIATE	
F8	+	CC8	79 BLOCK	
F9	-	COMMON 1/8	COMMON 1/8	
F10	-	COMMON 9/16	COMMON 9/16	
F11	+	CC9	NOT USED	
F12	+	CC10	NOT USED	
F13	+	CC11	NOT USED	
F14	+	CC12	NOT USED	
F15	+	CC13	NOT USED	
F16	+	CC14	NOT USED	
F17	+	CC15	NOT USED	
F18	+	CC16	NOT USED	

OUTPUTS F1

USER CONFIGURABLE OUTPUTS	O1	F19, F20, F21	79 BLOCK
	O2	F22, F23, F24	27/59 PICKUP
	O3	F25, F26	50/67G PICKUP
	O4	F27, F28	51/67G PICKUP
	O5	F29, F30	50/67P PICKUP
	O6	F31, F32	51/67P PICKUP
	O7	F33, F34	RECLOSE
	O8	F35, F36	TRIP

SLOT F CONFIGURATION (BOARD TYPE 2)

INPUTS F2

F1	+	COIL 1 52/a	52/a SUPERVISION	COIL 1
F2	-			
F3	+	COIL 1 52/b	52/b SUPERVISION	
F4	-			
F5	+	CC1	52b	USER CONFIGURABLE INPUTS
F6	+	CC2	50P BLOCK	
F7	+	CC3	51P BLOCK	
F8	+	CC4	67P BLOCK	
F9	-	COMMON 1/4	COMMON 1/4	
F10	-	COMMON 5/8	COMMON 5/8	
F11	+	CC5	50G BLOCK	
F12	+	CC6	51G BLOCK	
F13	+	CC7	79 INITIATE	
F14	+	CC8	79 BLOCK	
F15	+	COIL 2 52/a	52/a SUPERVISION	COIL 2
F16	-			
F17	+	COIL 2 52/b	52/b SUPERVISION	
F18	-			

OUTPUTS F2

USER CONFIGURABLE OUTPUTS	O1	F19, F20	79 BLOCK
	O2	F21, F22	27/59 PICKUP
	O3	F23, F24	50/67G PICKUP
	O4	F25, F26	51/67G PICKUP
	O5	F27, F28	50/67P PICKUP
	O6	F29, F30	51/67P PICKUP
	I SENS, O7	F31, F32, F33	RECLOSE
	I SENS, O8	F34, F35, F36	TRIP

Figure 2-3: Input/output configurations for boards F1 and F2 (189C4216H1)

NOTE: For detailed information about different I/O boards types configuration, see section 5.6.1: Input/output placement on page 5–139.

F650 Digital Bay Controller

Chapter 3: Hardware

3.1 Module description

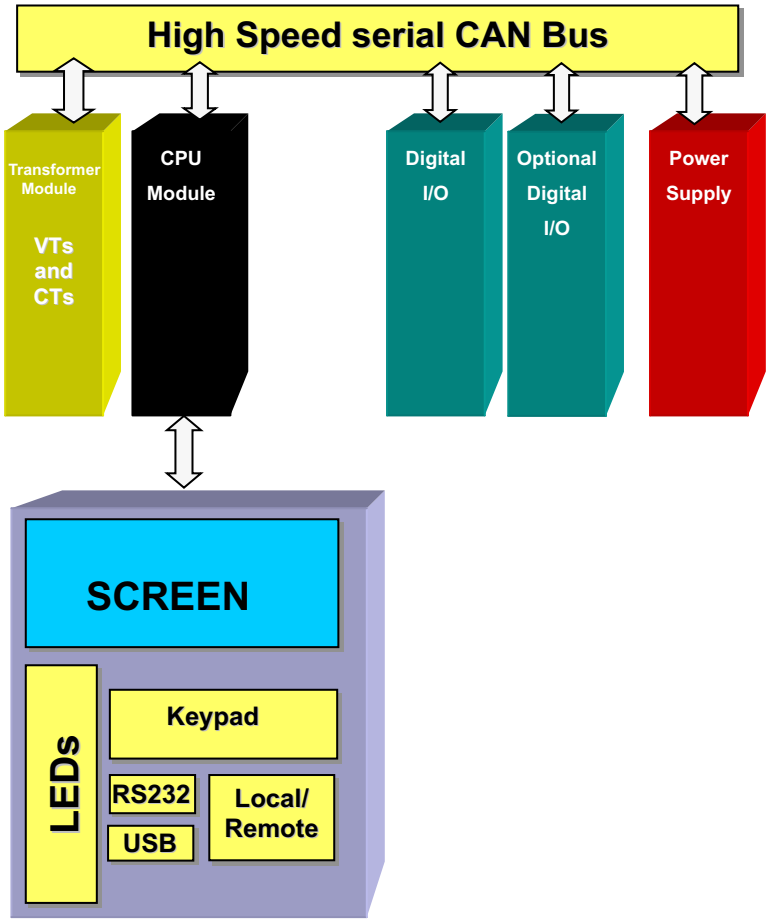


Figure 3-1: Block diagram

F650 units incorporate the following modules:

- **Power supply**, which can be simple or redundant, depending on the selected model
- **Front module with alphanumerical (4 x 20) or optional graphical (16 x 40 characters) display.** It includes the bus on its rear, which communicates with the rest of modules via a high speed CAN bus.
- **Transformer module** with 5 current transformers and 4 voltage transformers
- **CPU** including a powerful DSP for measure processing as well as synchronous and asynchronous communication accessories.
- **Input/Output module** included in basic unit
- Optionally, a **second I/O module** can be added.

3.2 Power supply

F650 can incorporate a simple or redundant power supply. The main and backup modules are identical.

NOTICE **Control power supplied to the relay must be connected to the matching power supply range of the relay. If the voltage is applied to the wrong terminals, damage can occur.**

NOTICE **The F650 relay contains electrolytic capacitors. These capacitors are well known to be subject to deterioration over time if voltage is not applied periodically. Deterioration can be avoided by powering the relays up once a year.**

In the case of a redundant power supply the two modules work in parallel continuously, distributing 50% of the load on each, thus ensuring greater reliability and an instantaneous load transfer from a failed power supply to the backup, without loss of time or module reset.

A contact relay connected to the low voltage side of the power supply monitors this voltage. The three contact terminals, normally open, common, and normally closed, are available at the external connector terminals. The contact monitors the power supply integrity and it is not controlled by the main microprocessor. In order to monitor whether the unit is ready to protect (READY), an auxiliary output contacts in the unit should be programmed. This “fly-back” type power supply provides high efficiency, stability and reliability and is available in two ranges, Hi and Low, in order to optimize efficiency and general performance, including the capability to tolerate auxiliary voltage interruptions (dips).

Oversized components highly resistant to temperature are used. For example, all capacitors are specified to stand up to 105ºC, transformer components are specially designed to stand up to 180ºC, the MOSFET transistor has very low resistance, supports high voltage and is refrigerated by an oversized heat sink. This allows temperatures over the 60ºC shown in the Technical Characteristics section, and prolonged overloads such as those occurring at batteries in deep charge mode (much higher than +15% voltage shown in the Technical Characteristics section).

High capacitance capacitors are also used, providing high tolerance to prolonged dips, 100ms, even in the most unfavorable consumption conditions. This allows the relay to continue operating normally without undesired resets leaving protection features offline.

⚠CAUTION **In the case of a blown fuse, replacement should be conducted by authorized/trained personnel only. Use replacement fuses with the same characteristics.**

Fuse Requirements:

V:	250 VAC
I:	2.5A
Size:	5 x 20 mm
Type:	Quick acting (F)

UL listed miniature fuse

Note: Contact technical support for further guidance.

3.3 Mechanical description

The model number and electrical characteristics of the unit are indicated on the label located on the right side of the relay case.

The metallic case of the unit is highly resistant to corrosion. It is made of stainless steel (AISI 430), coated with an epoxy layer. The rest of the metallic pieces are covered with a high quality resistive coating that has successfully passed at least 96 hours in the salt spray chamber (S/N ASTM B-117).

The front of the relay is made of a thermoplastic, flame retardant (V0, UL94), highly resistive material, which guarantees the unit's immunity to all kinds of EMI/RFI/ESD interferences. There is also an IP52 (IEC 529) protection rating against dust and water through the front and with the relay mounted in the panel.

3.3.1 Mounting

The unit is designed for semi-flush mounting. The relay is secured to the panel with the 4 M6 screws provided with the unit. The front keypad, display, and communications port are easily access on the front of the unit. The wiring is at the rear of the unit. Drilling dimensions are shown on Figure 3-3: Cutout and drilling dimensions

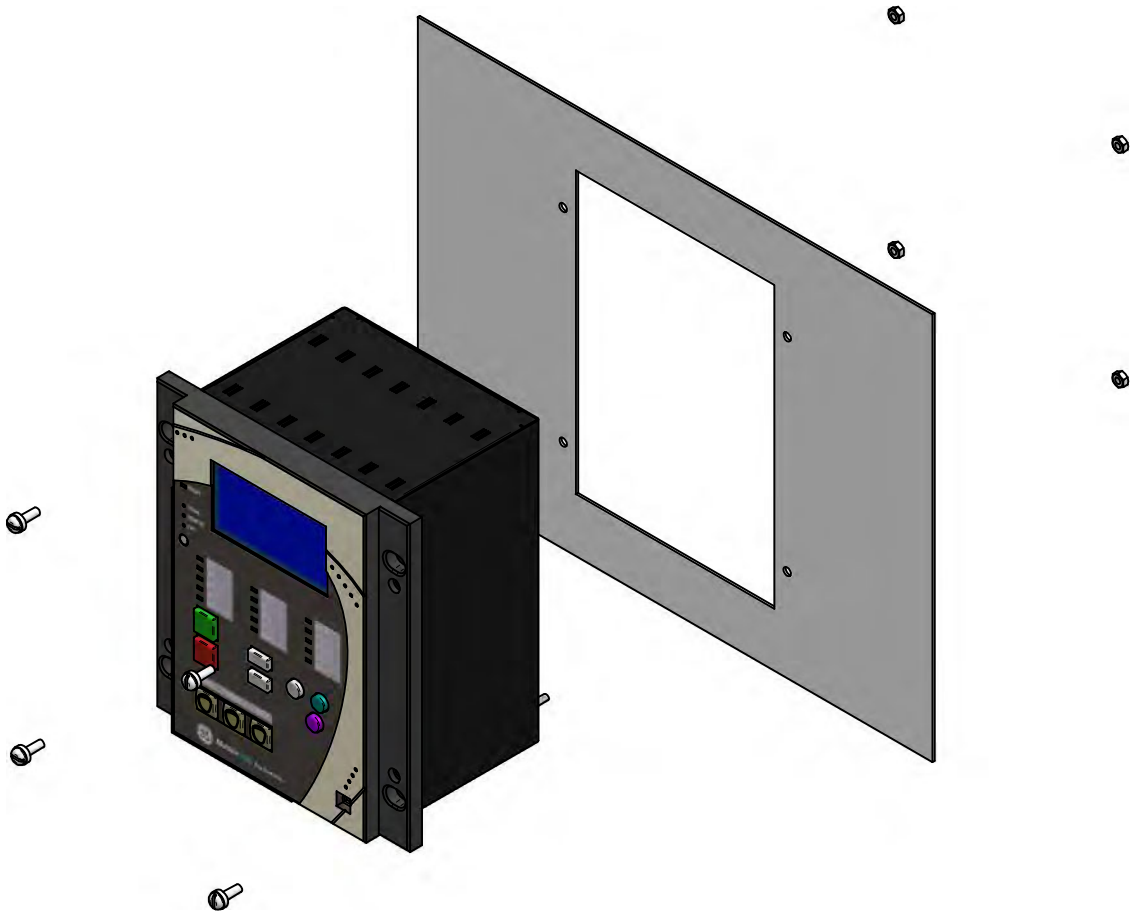


Figure 3-2: Panel mount

The relay width allows the mounting of two units on a standard 19'' panel, 8 units high.

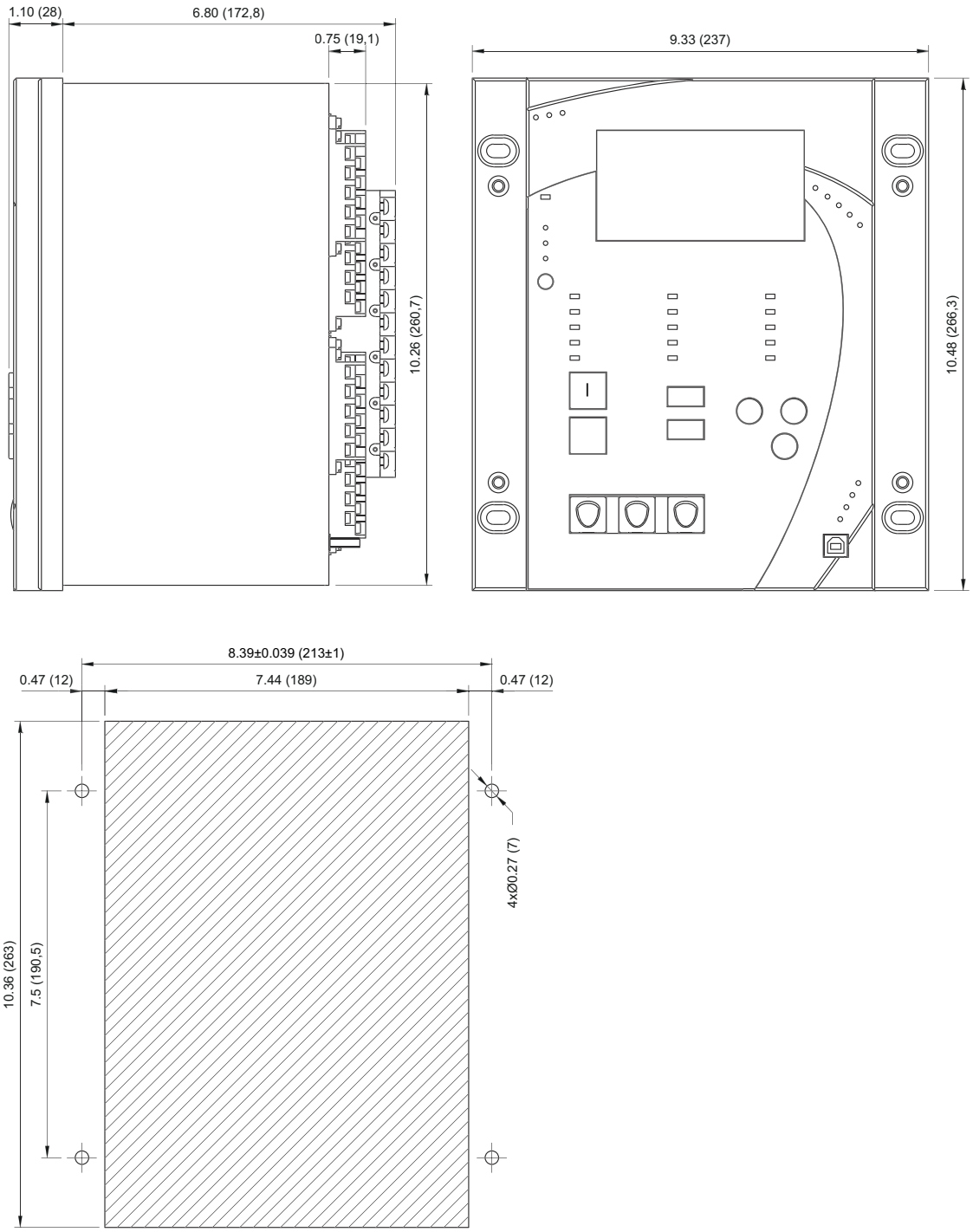


Figure 3-3: Cutout and drilling dimensions

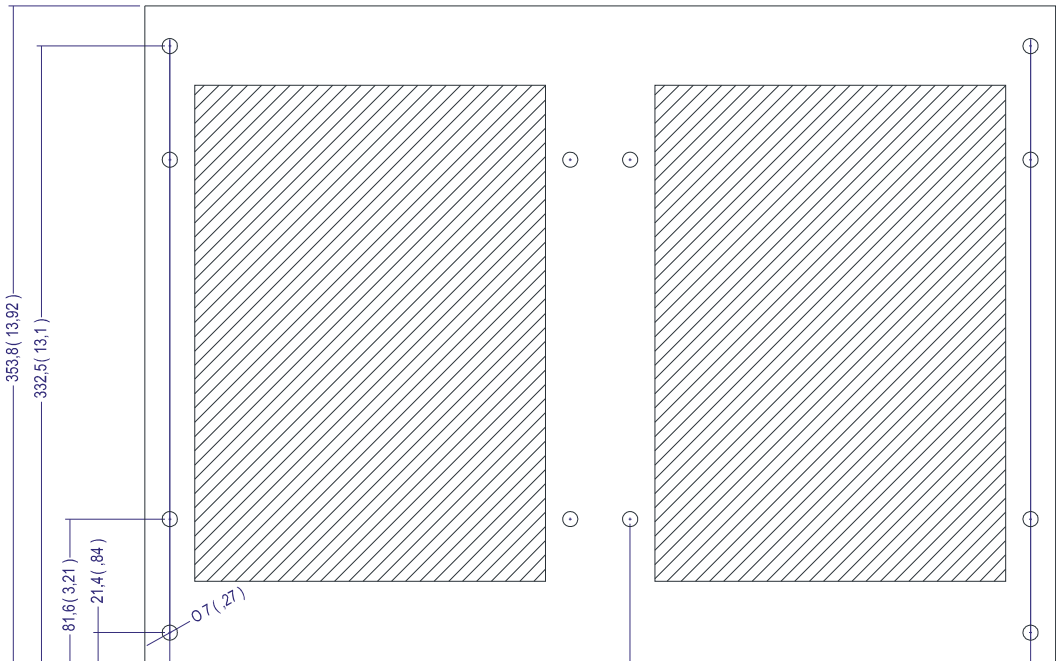


Figure 3-4: 19” rack dimensions 8U high for two relays

3.3.2 Rear description

WARNING **Module withdrawal and insertion may only be performed when control power has been removed from the unit.**

Proper electrostatic discharge protection (i.e. a static wrap) must be used when coming in contact with products while the relay is energized.

The relay is wired through the terminal blocks located at the rear of the unit.

The magnetic module, which receives the CT secondary currents and the metering voltages, incorporates a very robust terminal board (columns A and B) The maximum tightening torque for the screws on terminal boards A and B is 1.2 Nm. Current inputs provide automatic shorting of external CT circuits. The maximum recommended cable section for this terminal board, with the appropriate terminal, is 6 mm^2 (AWG 10).

The use of twisted pair wire and/or shielded is recommended for the CT secondary current Isg.

The rest of the terminal blocks, including the digital I/O and auxiliary power supply, incorporate high quality connectors with the capacity to withstand a rated current of 17 A at 300 V. These terminal blocks changed from old ring terminal to the pin terminal in the new hardware, admit a cable section of up to 2.54 mm^2 (AWG 12).

The relay should be connected directly to the ground bus, using the shortest practical path. A tinned copper, braided, shielding and bonding cable should be used. As a minimum, 96 strands of number 34 AWG should be used.

The communication boards have different types of connector depending on the selected media: RS485, glass or plastic fiber optic.

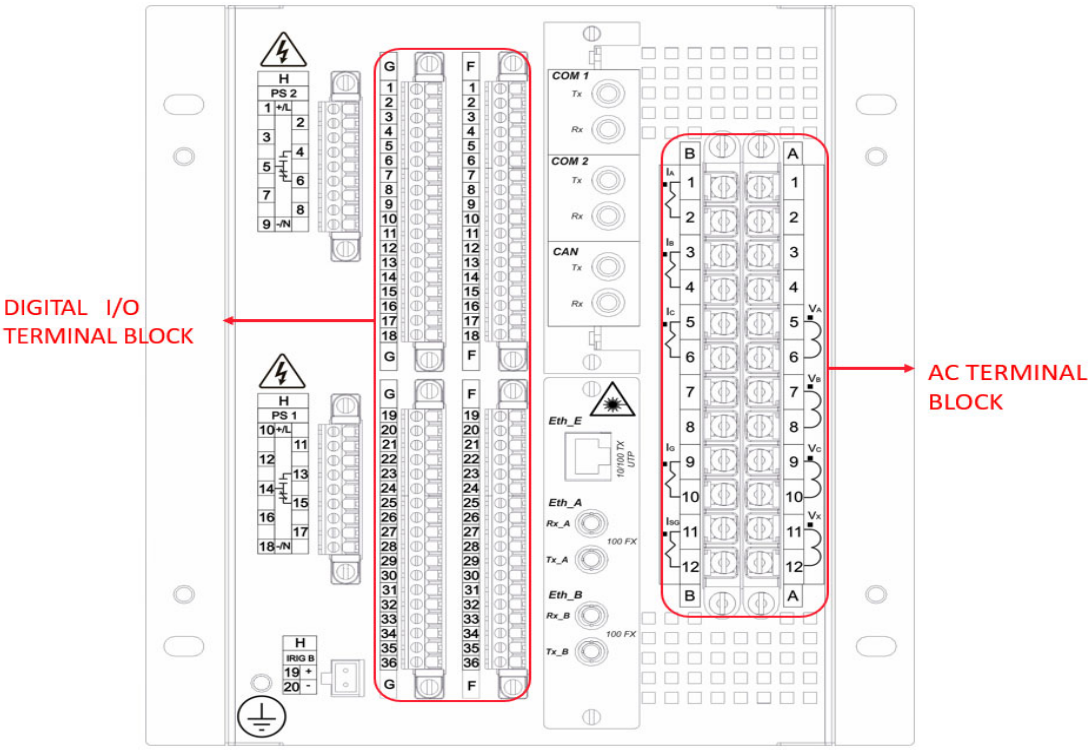


Figure 3-5: Connector locations for 1/2 rack model

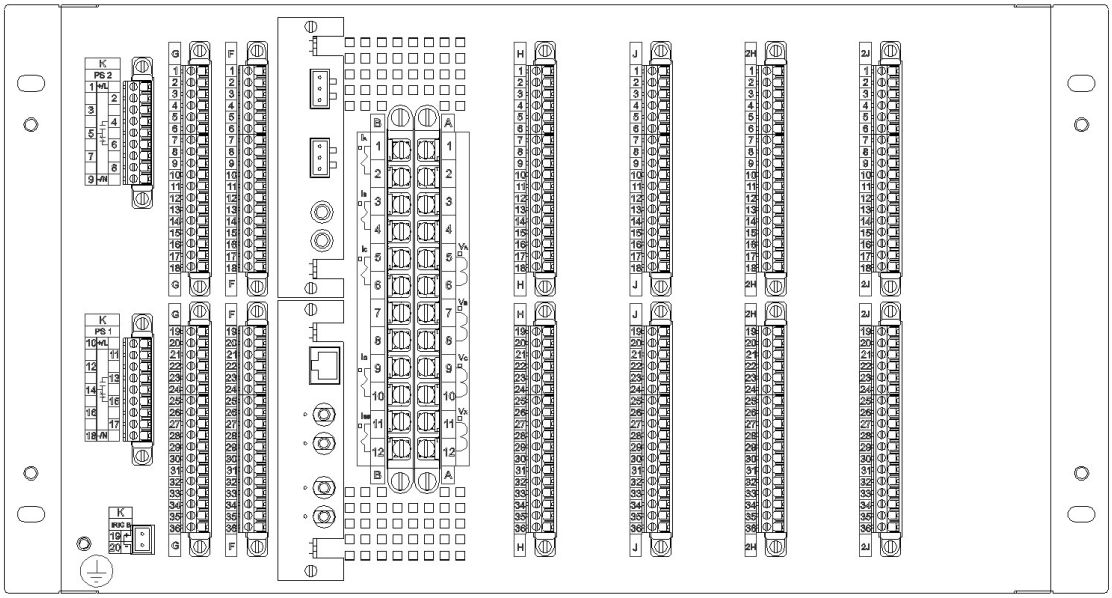


Figure 3-6: Connector locations for form factor 19" model

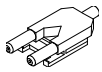
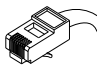
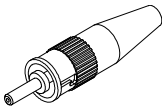
TYPE OF COMMUNICATION	CONNECTOR	
RS485 / CAN cable	Plug-in, 3 poles.	
IRIG B	Plug-in, 2 poles.	
Plastic fiber optic	Versatile Link	
Ethernet 10/100 UTP (10/100BaseTX)	RJ45, Class 5.	
Glass fiber optic (100BaseFX)	ST	
Ethernet 100 FX (100BaseFX)	ST	
CAN Fiber	ST	

Figure 3-7: Communications media selector guide

Communication boards are installed at the rear part of the unit, the upper port being reserved for the asynchronous communications board and CAN, and the lower port for the Ethernet board in any of its configurations.

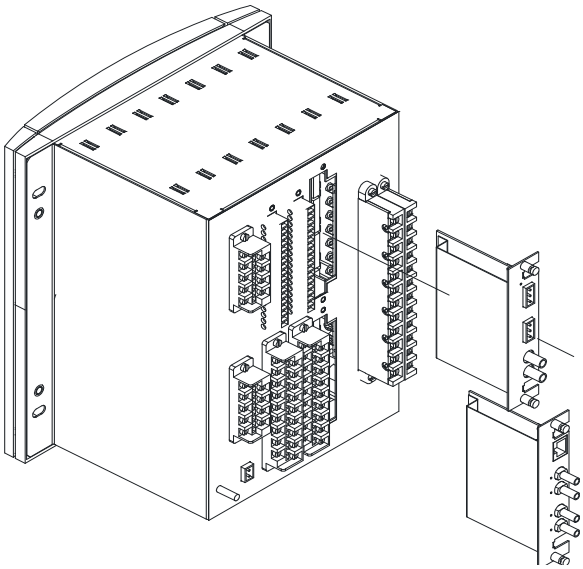


Figure 3-8: Detail of insertion/extraction of communication modules

Note: For version 7.00 and above, only the serial card can be removed

⚠WARNING **The transformer module housing the VTs and CTs is already connected to a female connector screwed to the case that incorporates shorting bars in the current inputs, so that it can be extracted without the need to short-circuit the currents externally. It is very important, for safety reasons, not to change or switch the terminals for CTs and VTs.**

A grounded antistatic wristband must be used when manipulating the module in order to avoid electrostatic discharges that may cause damage to the electronic components

⚠WARNING **Special care is required when disconnecting CT wire leads from the terminal block. A high voltage potential can occur if a wire is disconnected while a CT is energized. CT isolation or de-energization is required prior to CT terminal wire removal.**

3.4 Wiring

3.4.1 External connections

F650 units can have different options for the F module:

Option 1: Board with 16 digital inputs and 8 outputs.

Option 2: Board with 8 digital inputs, 4 circuit supervision inputs, 6 conventional outputs, and two current sensing outputs

Option 4: Board with 32 digital inputs.

Option 5: Board with 16 digital inputs and 8 analog inputs.

For slot G there are five different options:

Option 0: No board

Option 1: Board with 16 digital inputs and 8 outputs.

Option 2: Board with 8 digital inputs, 4 circuit supervision inputs, 6 conventional outputs, and two current sensing outputs

Option 4: Board with 32 digital inputs.

Option 5: Board with 16 digital inputs and 8 analog inputs.

The number selected for slot G must be equal or higher than the number selected for option F for models including boards 4 and 5.

3.4.2 Digital inputs with trip circuit supervision

The Option 2 I/O board includes two groups of 4 inputs with one common, in terminals F9 to F10. It also includes 6 auxiliary outputs, in terminals F19 to F30 with normally open contacts and two current sensing (latching) outputs (F31-F33 and F34-F36).

Besides, there are 2 groups of inputs for trip circuit supervision. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the unit output contact.

NOTICE **In order to implement these schemes, it is not necessary to perform any setting in the unit. Internal functions are always operative. A detailed description of trip circuit supervision is included in chapter 5 in this manual.**

3.4.3 Cable/fiber Ethernet board

The Ethernet board for versions prior to 7.00 is an independent module located in the bottom at the rear part of the relay.

In models C and D (options for versions prior to 7.00), the 10/100BaseTx port is selected by an internal switch. This switch must be configured as shown in the figure 3-8 in order to select between fiber or cable.

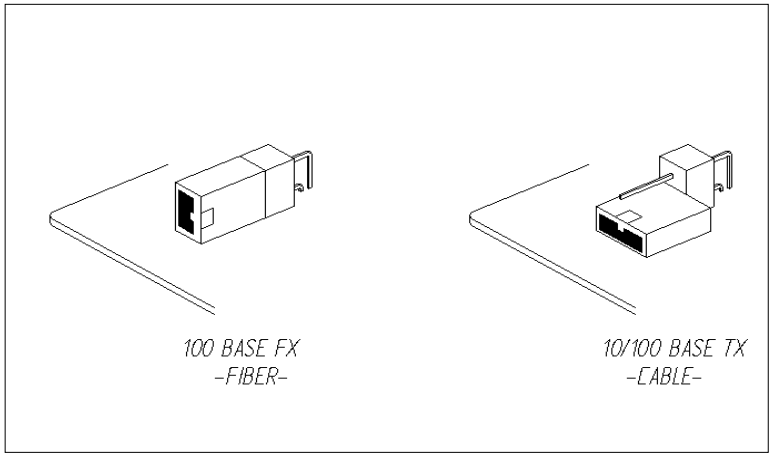


Figure 3-9: Fiber/cable selection

3.5 Transceiver optical power budget vs. link length

Optical Power Budget (OPB) is the available optical power for a fiber optic link to accommodate fiber cable losses plus losses due to in-line connectors, splices, and optical switches. OPB also provides a margin for link aging and unplanned losses due to cable plant reconfiguration and repair.

OPB (dB)		Fiber optic Cable length (km)
62.5/125 µm	**50/125 µm**	
11.4	8	0
10.9	7.4	0.3
10.5	7.1	0.5
9.6	6.2	1.0
8.5	5.3	1.5
7.3	4.3	2.0
6	3.3	2.5

F650 Digital Bay Controller

Chapter 4: Interfaces, Settings & Actual Values

4.1 EnerVista 650 Setup software

4.1.1 Introduction

The EnerVista 650 Setup software provides a graphical user interface (GUI) as one of two direct interfaces with a 650 device. The alternate interface is implemented via the device faceplate keypad and display (see the Human Machine Interface (HMI) section in this chapter).

The EnerVista 650 Setup software interface provides access to configure, monitor, maintain, and trouble-shoot the operation of relay functions, connected over local or wide area communication networks. It can be used while disconnected (offline) or connected (online) with a 650 device. In offline mode, settings files can be created for eventual download to the device. In online mode, real-time communication with the device is supported.

The EnerVista 650 Setup software, provided with every F650 relay, can be run from a computer supporting Microsoft Windows XP (SP 2 or 3), Windows 7 or Windows 8. This chapter provides a summary of the basic EnerVista 650 Setup software interface features. The EnerVista 650 Setup Help File provides details for getting started and using the EnerVista 650 Setup software interface.

The EnerVista 650 Setup software package uses ModBus protocol, and is designed to communicate with a single relay at a time. GE offers different communication software packages, such as GE-POWER, which can be used to communicate simultaneously with several relays.

EnerVista 650 Setup software provides an easy way to configure, monitor and manage all F650 features.

4.1.1.1 Using settings files

The EnerVista 650 Setup software interface supports three ways of handling changes to relay settings:

1. In offline mode (relay disconnected), create or edit relay settings files for later download to communicating relays.
2. In online mode (relay connected), modify any relay settings via relay data view windows, and then save the settings to the relay.
3. Combining online and offline modes, create/edit settings files and then write them to the relay while the interface is connected to the relay.

Settings files are organized on the basis of file names assigned by the user. A settings file contains data pertaining to the following types of relay settings:

- Product Setup
- System Setup
- Protection Elements
- Control Elements
- Inputs/Outputs
- Quick Settings
- Relay Configuration
- Logic Configuration

4.1.1.2 Viewing actual values

You can view real-time relay data such as input/output status and measurements while connected to a relay.

4.1.1.3 Viewing triggered events

In online mode, you can view and analyze data generated by triggered specified parameters, via one of the following:

- **Event Recorder:** The event recorder captures contextual data associated with the last 479 events, listed in chronological order from most recent to oldest. For firmware version 7.20 or higher, 511 events are available.
- **Oscillography:** The oscillography waveform traces and digital states are used to provide a visual display of power system and relay operation data captured during specific triggered events.

4.1.1.4 Firmware upgrades

The firmware of a F650 device can be upgraded, locally or remotely, via the EnerVista 650 Setup software. Instructions are provided in Chapter 9: Bootcode and firmware upgrade.

Modbus addresses assigned to firmware modules, features, settings, and corresponding data items (i.e. default values, minimum/maximum values, data type, and item size) may change slightly from version to version of firmware.

The addresses are rearranged when new features are added or existing features are enhanced or modified.

4.1.1.5 One line diagrams

You can configure a one line diagram (bay mimic) to be used in relays with a graphical display.

4.1.2 Main screen

The EnerVista 650 Setup software main window includes the following components:

- Title bar
- Main menu bar
- Main icon bar
- Working area
- Status bar

Figure 4-1: EnerVista 650 Setup main screen

4.1.3 Connect to the relay

To start communicating with the relay go to **Communication > Computer** in the main EnerVista 650 Setup menu.

NOTICE Safety instructions must be followed before connecting the computer to the relay. Safety instructions are detailed in section 1.1.3 Safety instructions. Connect the relay ground terminal and the communicating computer to a good grounding. Otherwise, communication may not be viable, or even, in worst cases, the relay and/or the computer can result damaged by overvoltages.

When working online, ensure that all relay communication parameters, such as baud rate, slave ModBus address, etc., match the computer settings before connected to the relay.

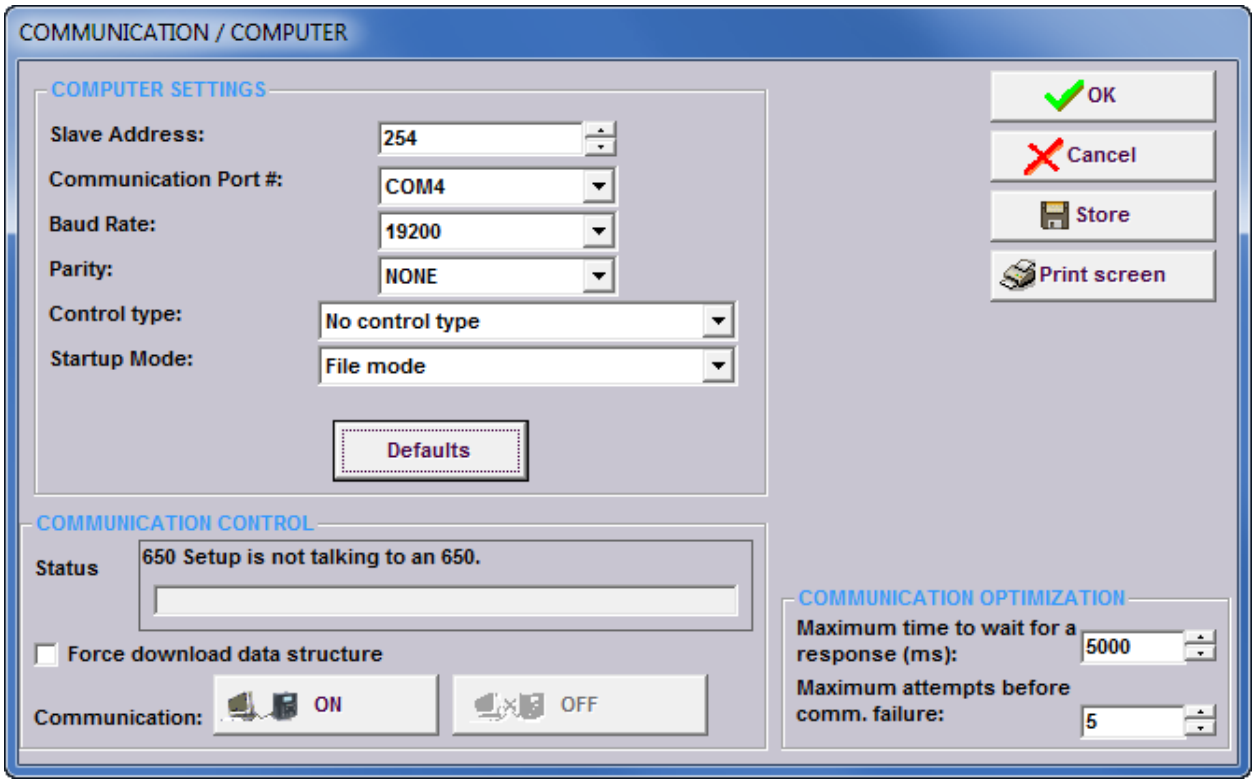


Figure 4-2: Communication parameters menu

The **Communication > Computer** screen is divided in several subsections:

- **Computer settings**: Main communication parameters for serial communication and control type selection.
- **Modbus/TCP Setup** (if ModBus /TCP is selected as control type): Communication parameters for ModBus TCP communication.
- **Communication control**: Device communication status (communicating or not communicating).
- **Communication optimization**: allows optimizing the communication time outs and failure establishing.

4.1.3.1 Computer Settings:

This section shows the communication parameters needed to establish communication with the unit, such as slave address, communication port, baud rate, parity, control type and startup mode.

Baud rate, parity, data bits, stop bits and ModBus slave address for Com2 (RS232 front port and second serial port in the rear communication board) are displayed in the default text on the relay main screen.

ModBus Slave Address: ModBus address used for serial and Ethernet communication; default 254.

Communication ports: Ports used in the computer for serial communication.

Baud Rate: Baud rate for serial communication (from 1200 to 115200 baud in EnerVista 650 Setup, from 300 to 115200 baud in relay).

Parity: Parity for serial communication. None, odd or even can be selected.

Control Type: The available control modes are:

- **No Control Type**, this option selects the serial communication mode, for use with serial communication ports (front port, RS485, or plastic or glass fiber optic).
- **MODBUS/TCP**, this option selects ModBus TCP/IP communication mode, for communication through the Ethernet port. In this case, the top right window shows the typical parameters to be programmed; IP address, port address and unit identifier in the MODBUS TCP SETUP section.
- **MODEM**, this option displays the parameter to set in case of using a modem for the communication, such as Phone number, Time out (sec.), init. command, type of dialing (tones or pulses).

4.1.3.2 Communication Control:

Located at the bottom of the screen, this section shows the status of communication with the relay. When the relay is not communicating, the message "*650 Setup is not talking to an 650*" is shown and the **ON** button is enabled. Click **ON** to start the EnerVista 650 Setup software communicating with the relay.

When the relay is communicating, the message "*650 Setup is now talking to an 650*" is shown and **OFF** is enabled. Click **OFF** to disconnect communications between the relay and PC.

4.1.3.3 Communication Optimization:

Adjusting the parameters in the Communication optimization section can improve communication, although using the default values is recommended in most cases. These parameters are the maximum time to wait for a response in the relay (in ms) and the maximum number of connection attempts to perform before assuming communications failure.

4.1.4 File management menu

File management with EnerVista 650 Setup software differs for firmware below version 7.70. and for firmware version 7.70 and above.

4.1.4.1 File Management menu for firmware below v7.70

4.1.4.1.1 Offline mode (firmware below v7.70)

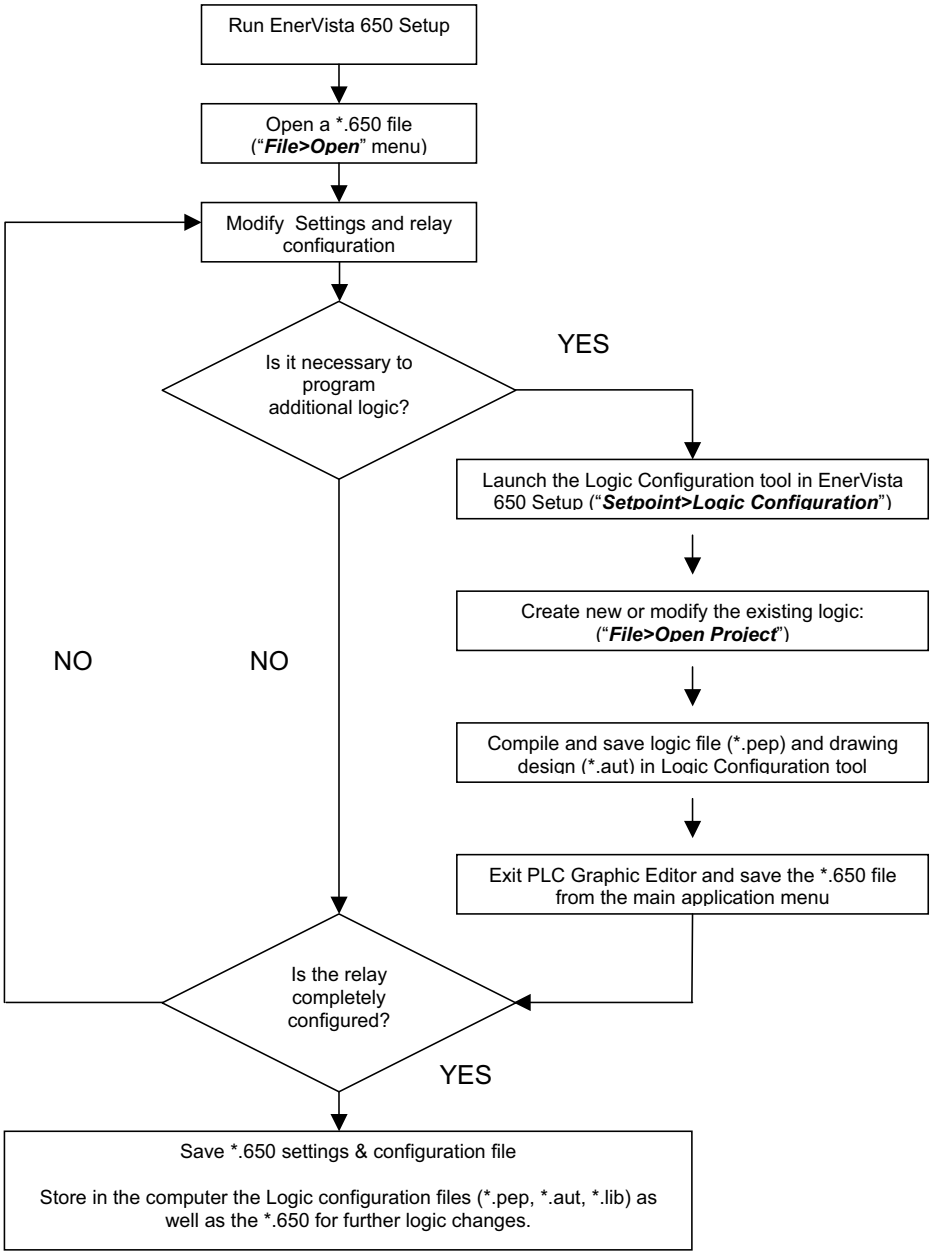


Figure 4-3: Offline mode file management (firmware below v7.70)[1]

1. "Relay and logic configuration" and "Protection and Control Settings" must be uploaded to the F650 relay or the device to operate properly

Table 4-1: Types of files generated by EnerVista 650 Setup software, offline:

	Settings & Configuration File *.650	Logic Configuration Files (*.pep, *aut, *.lib)		
		*.pep	*.aut	*.lib

Description	Settings and Configuration Section	Header for Logic project	Graphical edition container. Logic equations (Virtual Outputs) in FDB format.	User programmable logic objects
Created by	EnerVista 650 Setup	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Contents	Relay configuration file containing all elements Settings, input/output and LEDs configuration, graphic display configuration, etc. Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).	Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.
How to save	EnerVista 650 Setup: File > Save *	PLC Editor: File > Save Project	PLC Editor: File > Save Project	PLC Editor: File > Save Library
How to open	EnerVista 650 Setup: File>Open *	PLC Editor: File > Open Project	PLC Editor: File > Open Project	PLC Editor: File > Library > New Library
How to transfer to relay	Connect with the relay (**Communications > Computer**) Open the created file (**File > Open** *) Send to relay from the menu: **File > Send info to relay** Note that texts used in the configuration of inputs, outputs, etc. are not sent to the relay. The only texts sent to relay are operations, events, and LEDs.	Connect with the relay (**Communications > Computer**) Launch Logic equations Editor (**Setpoint > Logic Configuration**) Open the created PLC project (**File > Open Project**) Compile the project (**Run > Compile**) Now the logic (virtual outputs) can be sent directly to relay (**Run > Send Equations to Relay**). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		

When using element libraries (both pre-existing in **File Library > Open Library** or created by the user in **File Library > New Library**), the program creates and manages the corresponding files (*.lib) in a folder named FDB (Functional Block Diagram). These files are used for PLC project compilation. The element library files must be stored with the other logic configuration files that build the PLC project (*.pep, *.aut, *.lib).

Besides sending configuration information to the relay (Settings & configuration in *.650 format), storing the complete set of *.650, *.pep, *.aut and *.lib files inside the relay is recommended (**Communication > Upload info files to relay**). This ensures that logic configuration files are available in future for logic modifications. Even if these files are not used by the relay, they are required to connect to the relay and analyze its configuration. The EnerVista 650 Setup software program manages the logic configuration files globally, so that when the *.pep file is uploaded to the relay, the associated *.aut and *.lib files are also stored.

File storage inside the relay (RECOMMENDED)	**Communication > Upload info files to relay** through Ethernet
Retrieval of files stored in the relay (RECOMMENDED)	**Communication > Download info files from relay** through Ethernet

4.1.4.1.2 Online mode (firmware below v7.70)

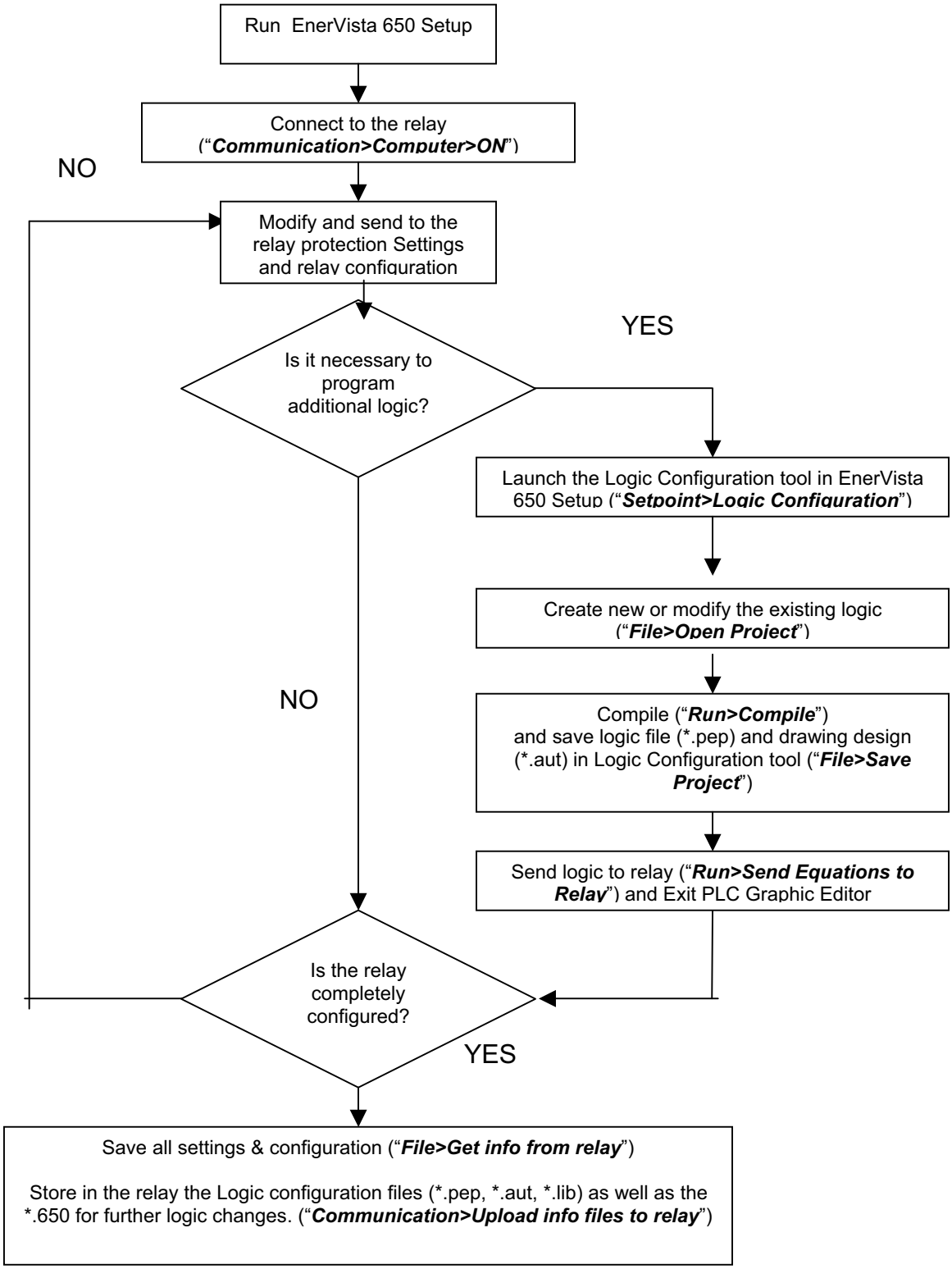


Figure 4-4: Online mode file management (firmware below v7.70)

Table 4-2: Types of files generated by EnerVista 650 Setup software, online

	Settings & Configuration File *.650	Logic Configuration Files (*.pep, *.aut, *.lib)		
		*.pep	*.aut	*.lib
Description	Settings and Configuration Section	Header for Logic project	Graphical edition container. Logic equations (Virtual Outputs) in FDB format.	User programmable logic objects
Created by	EnerVista 650 Setup	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)	Logic configuration graphic editor (PLC Editor)
Contents	Relay configuration file containing all elements, settings, input/output and LEDs configuration, graphic display configuration, etc. Equations corresponding to the logic created and compiled in the PLC Editor	PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (*.lib), graphic file name (*.aut), etc.	PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).	Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.
How to transfer to relay	Connect with the relay (**Communications > Computer**)	Connect with the relay (**Communications > Computer**)		
	Send settings and configuration from file	Launch 650 Logic equations editor (**Setpoint > Logic Configuration**)		
		Open the created PLC project (**File > Open Project**)		
		Compile the project (**Run > Compile**)		
		Now the logic (virtual outputs) can be sent directly to relay (**Run > Send Equations to Relay**). Texts of virtual outputs are not stored in the relay, only in the logic configuration files to be edited.		
	Modify settings and configuration directly in the relay:			
How to save	EnerVista 650 Setup: **File > Get info from relay**. User definable texts retrieved are operations, events, and LEDs.	PLC Editor:		
		File > Save Project		File > Save Library
		The relay does not provide this information unless the *.pep file is stored in the relay	The relay does not provide this information unless the *.pep file is stored in the relay.	The relay does not provide this information unless the *.pep file is stored in the relay.
		To store the logic configuration files in the relay use the **Communication > Upload info files to relay** option		
How to store in the relay	**Communication > Upload info files to relay** through Ethernet	**Communication > Upload info files to relay** through Ethernet		
How to retrieve from the relay	**Communication > Download info files *from relay*** through Ethernet	**Communication > Download info files from relay** through Ethernet		

REMINDER:
Logic programming support files (*.pep, *.aut, *.lib) CANNOT be retrieved directly from the relay.

It is necessary to do one of the following to store support files:

* Store in the PC

* Upload to the relay (**Communication > Upload info files to relay**), after which they can be retrieved from the relay

4.1.4.2 File Management menu for firmware v7.70 and above

Firmware versions 7.70 and above work with EnerVista 650 Setup software version 8.10 and above (see corresponding release notes).

EnerVista 650 Setup software 8.10 and above uses a new *.650 file format, combining previous settings and configuration files (*.650) along with Logic configuration files (*.pep, *.aut,*.lib) into a single *.650 file.

4.1.4.2.1 Offline mode (firmware v7.70 and above)

This mode will allow to create, open and/or modify only one file (*.650) instead of multiple files that are managed for firmware versions below 7.70 (setting and configuration file (*.650) and Logic configuration files (*.pep, *.aut,*.lib)).

Existing *.650 files for firmware below 7.70 must be converted to files supported by firmware version 7.70 or above using Enervista 650 Setup version 8.10 or above. During the update process, a PLC project file (*.aut,*.pep,*.lib) must be selected.

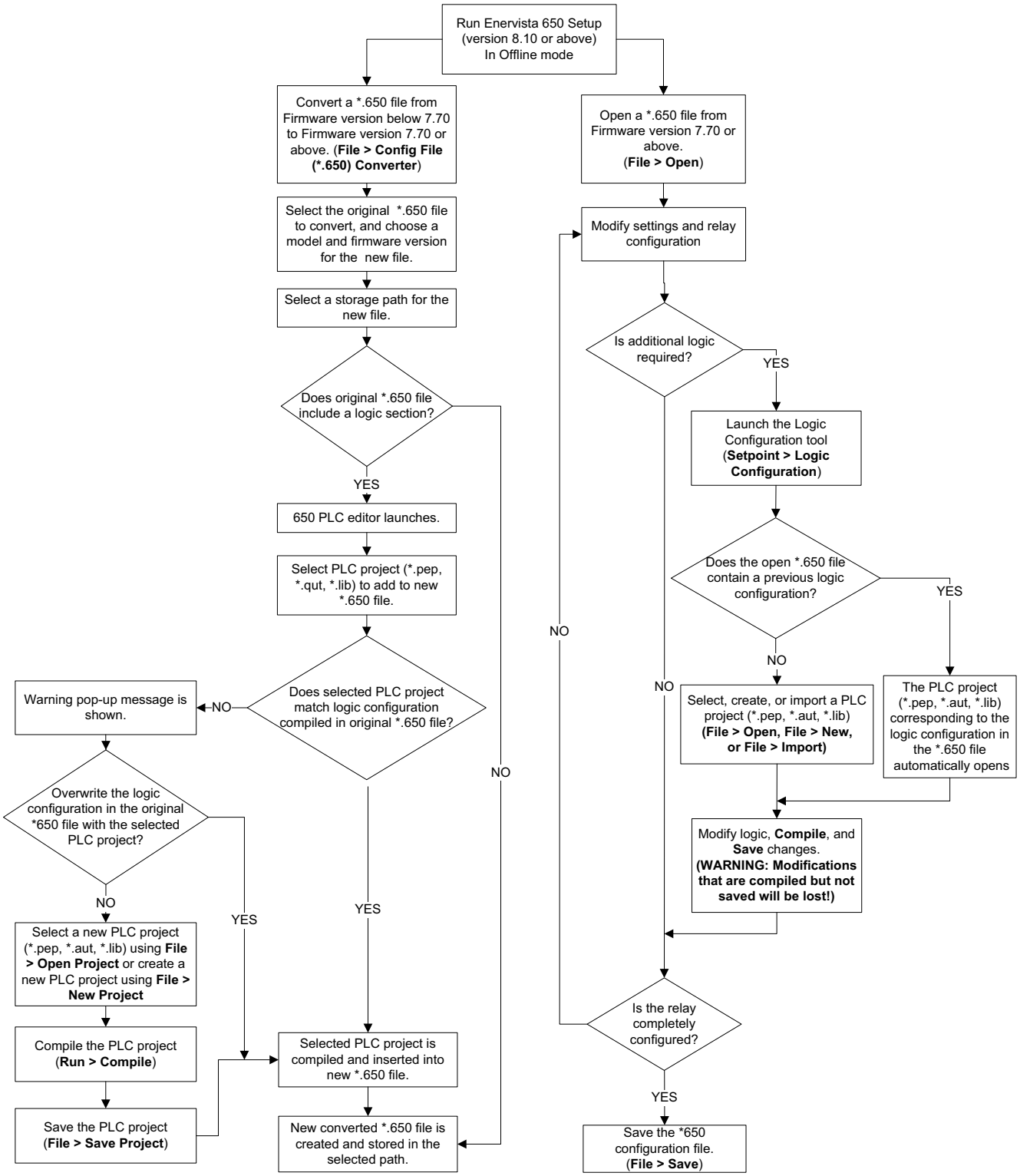


Figure 4-5: Offline mode file management (firmware v7.70 and above))

4.1.4.2.2 Online mode (firmware v7.70 and above)

This mode allows the modification of Logic Configuration that is running in the relay without having to store a backup of the PLC project (*.pep,*.aut,*.lib) on the local computer or by running **Communication > Upload info files to relay** as was done previously.

NOTE: Storing a local PC back-up of the following 650 relay configuration files before changing settings or logic is highly recommended:

- *.650 configuration file
- Logic programming support files (*.pep, *.aut, *.lib) inserted into *.650 (PLC Editor> File> Export)

WARNING **Do not try to communicate with the relay during the start-up process. Doing so may cause loss of the configuration file (*.650), leading to unexpected behavior.**

Communication can be established safely once relay has fully started-up. The relay has completed its start-up process when Menus are accessible from the HMI.

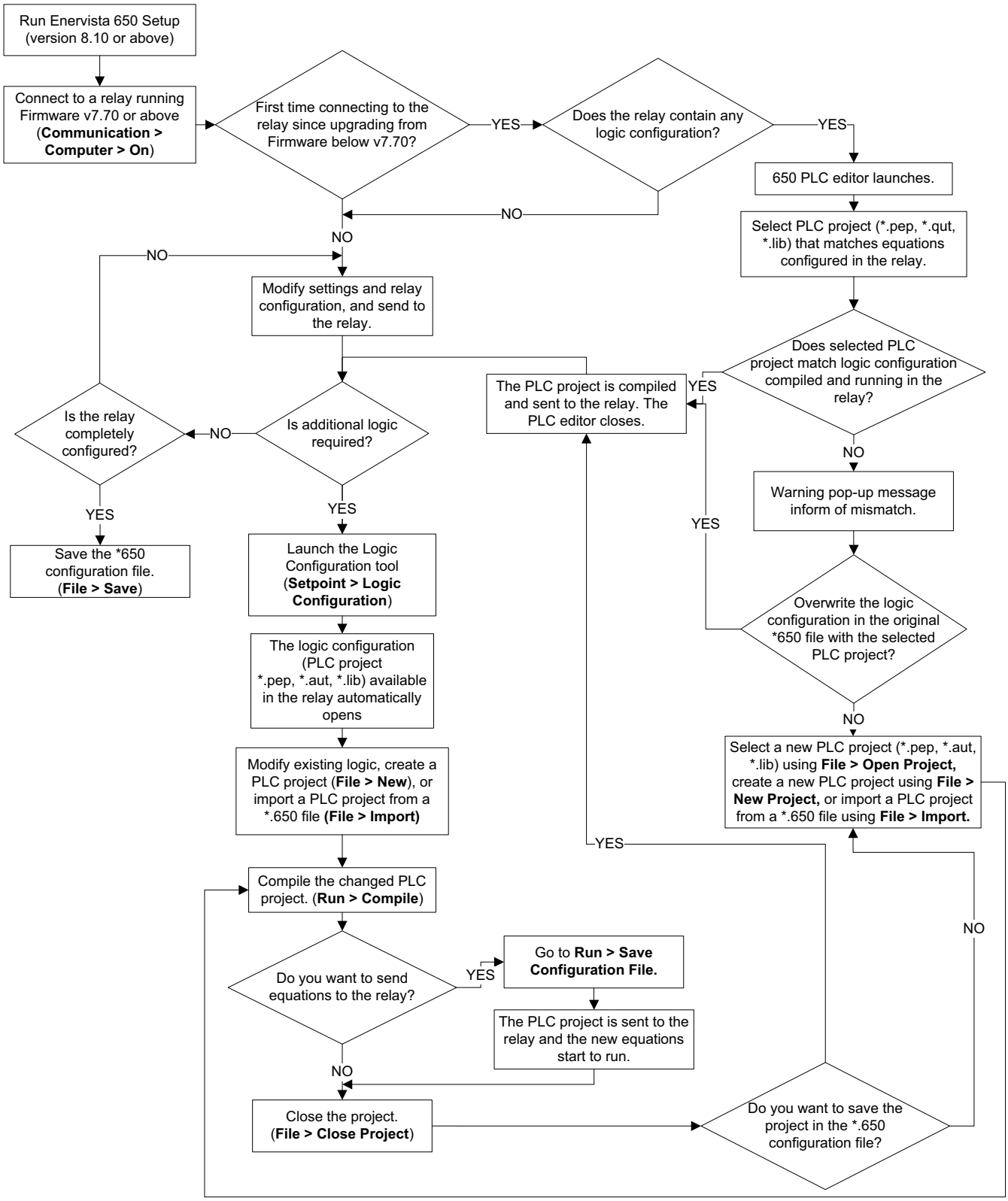


Figure 4-6: Online mode file management (firmware v7.70 and above)

4.1.5 EnerVista 650 Setup menu

The EnerVista 650 Setup menu structure is shown in Table 4-3: EnerVista 650 Setup menu structure.

Unless specified, options are available in both online and offline mode.

(*) indicates options enabled only in online mode. (**) indicates options enabled only in offline mode.

NOTICE The **View > Language** submenu allows the user to change the default language for the EnerVista 650 Setup program. This feature is only enabled when the relay is not communicating and no file has been opened.

Table 4-3: EnerVista 650 Setup menu structure

File	Setpoint	Actual	Operations(*)	Communication	IEC 61850 CONFIGURATOR	Security	View	Help
New (**)	Product Setup	Front Panel	Fixed commands	Computer		Login user	Traces	Instruction Manual
Open (**)	System Setup	Status		Modem (*)		Change Password	ModBus Memory Map	GE Multilin on the web
Save (**)	Protection Elements	Metering		Troubleshooting (*)		User Management	Languages (**)	About EnerVista 650 Setup
Save As (**)	Control Elements	Inputs/ Outputs		Calibration (*)				
Close (**)	Inputs/ Outputs Quick Settings	Records (*)		Upgrade Relay (*)				
Config File (* 650) Converter	Relay Configuration							
Compare to settings file								
Properties (**)	Logic Configuration			Upgrade 650 Web Server				
	Procome Configuration			Update Magnetic Module				
	IEC103 Configuration							
Get info from relay (*)	Clock (*)			Upload info files to relay				
Send info to relay (*)				Download info files from relay				
Print Setup (**)								
Print Preview (**)								
Print (**)								
Print to file								
PLC Checksum Calculation								
Settings Checksum Calculation								
Order Code								
Exit								

4.1.6 File menu

File

New (**)	Create a new settings and configuration file, with the default relay settings and no configuration
Open (**)	Open a settings and configuration file for offline working.
Save (**)	Save *.650 settings and configuration file
Save As (**)	Save as *.650 settings and configuration file.
Close (**)	Close the opened *.650 file in EnerVista 650 Setup.
Config File (*.650)	Converter Tool to convert the *.650 files from one version to another
Compare to settings file	Compare online unit or opened settings file to another settings file
Properties (**)	File properties for *.650.
Get info from relay (*)	Retrieve the *.650 settings and relay configuration compiled equations from the relay.
Send info to relay (*)	Send and write the *.650 settings and configuration to the relay.
Print Setup (**)	To configure printer settings.
Print Preview (**)	Preview of settings and configuration file printing format.
Print (**)	Launch the *.650 file to be printed.
Print to file (*.xls) (**)	*.650 printed to file in excel format.
PLC Checksum Calculation	Calculate the CRC of PLC equations of the .650 file (When a .650 is uploaded to the relay, the calculate PLC CRC and the actual value of the PLC CRC read from the relay must match).
Settings Checksum Calculation	Calculate the CRC of settings of the .650 file (When a .650 is uploaded to the relay, the calculate Setting CRC and the actual value of the Setting CRC read from the relay must match).
Order code(*)	Option available for F650 with firmware version 7.00 or above. This allows a model to have special functionality (see model selection) with password requirements. For detailed information go to section "9.6.3.3 ORDER CODE UPGRADE PROCESS" in chapter 9.
Exit	Quit the application closing all the open windows.

(*) indicates online only, (**) indicates offline only

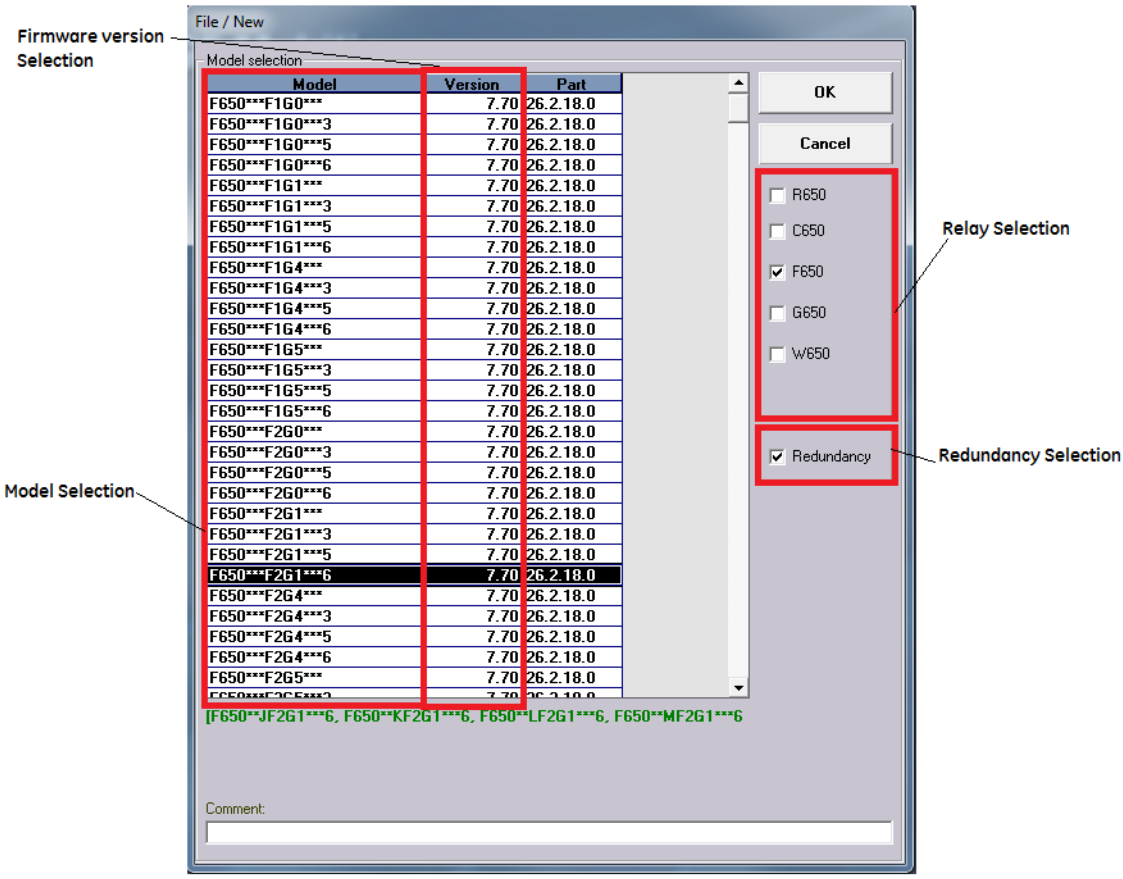
4.1.6.1 New

Use the **File > New** menu option to create a new default settings file while working offline.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

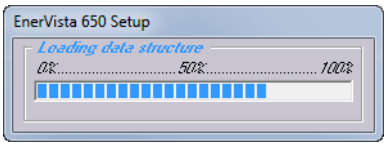
1. Select **File > New**.

   EnerVista 650 Setup opens a pop-up window with a list of all files available for different models/firmware versions.

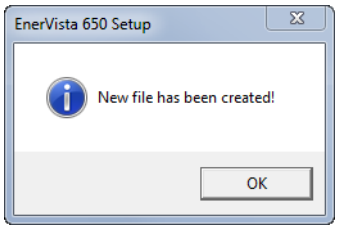


   - Relay Selection: Select a 650 family relay (F650, R650, C650, W650 or G650).
   - Redundancy Selection (firmware v7.00 and above only): Select to include files for F650/C650 relays with Rear Ethernet Communications 2 Board options J, K, L and M.
   - Models and Firmware Selection: Click to select one of the different models and firmware versions available.

2. Once you have selected a file, click **OK** and wait until the file has finished loading.



3. A message indicates when the new *650 file has been created. Click **OK** to access the new file in offline mode.



4.1.6.2 Open

Use the **File > Open** menu option to open an existing settings file while working offline.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

Open a *.650 configuration file for firmware versions below 7.70:

- Navigate to **File > Open** and select a file to open.

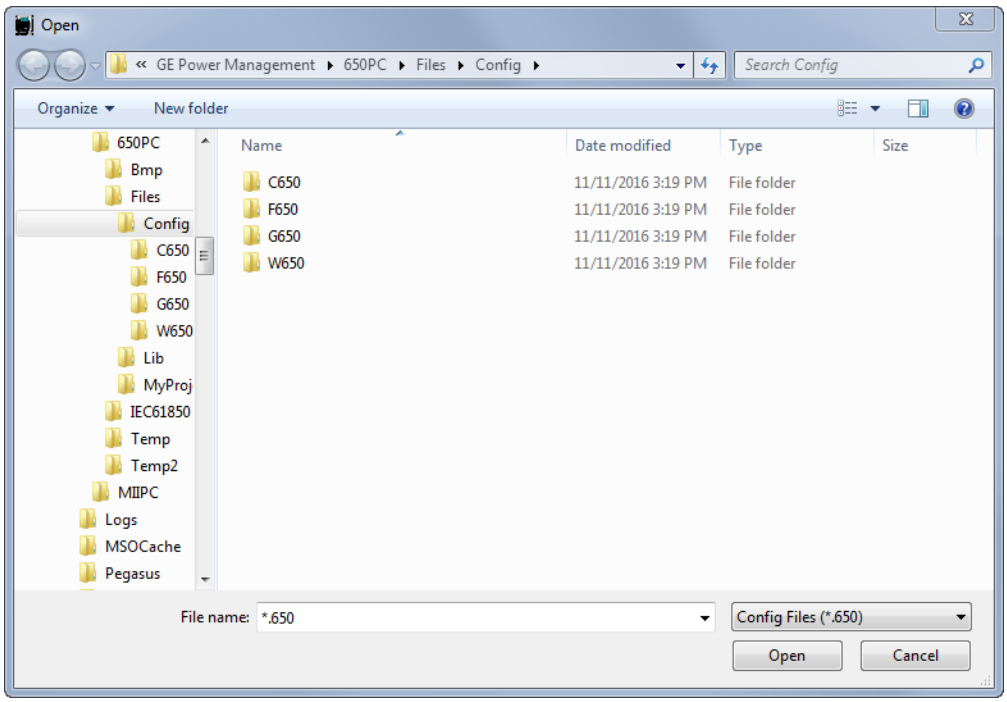
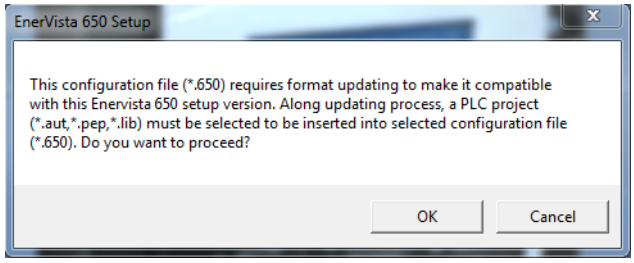


Figure 4-7: Open file menu

Open a *.650 configuration file for firmware versions 7.70 and above:

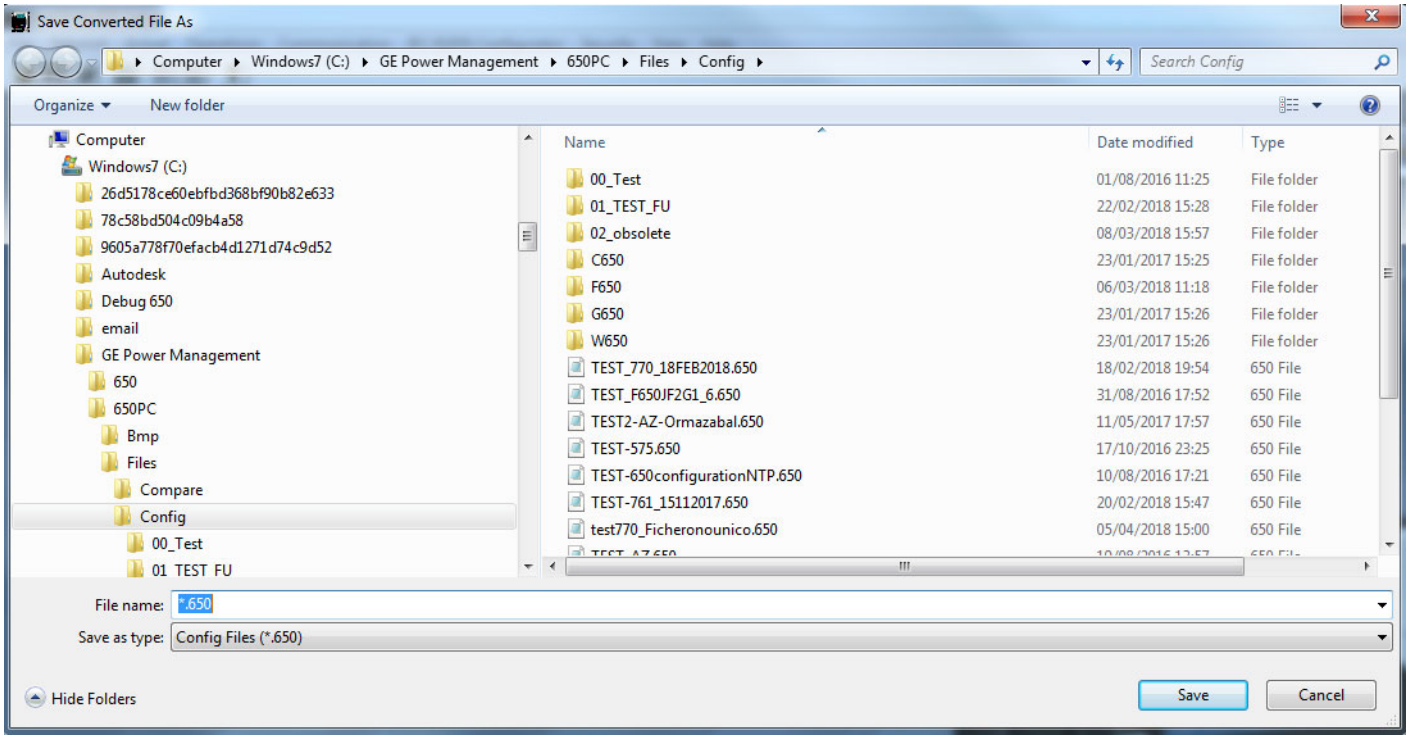
Enervista 650 Setup version 8.10 or above is required.

1. Navigate to **File > Open** and select a file to open.
   - If the file is a firmware v7.70 or higher file, or has already been converted, proceed to edit the settings and configuration.
   - If the file has logic configuration that has not yet been updated for firmware v 7.70 and higher, continue to follow these steps.
2. The following message is shown:

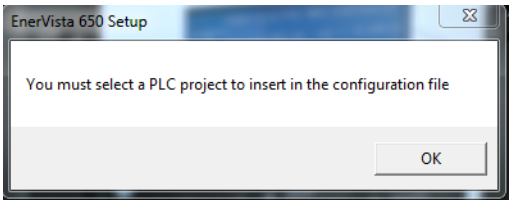


Click **OK** to continue with the update process.

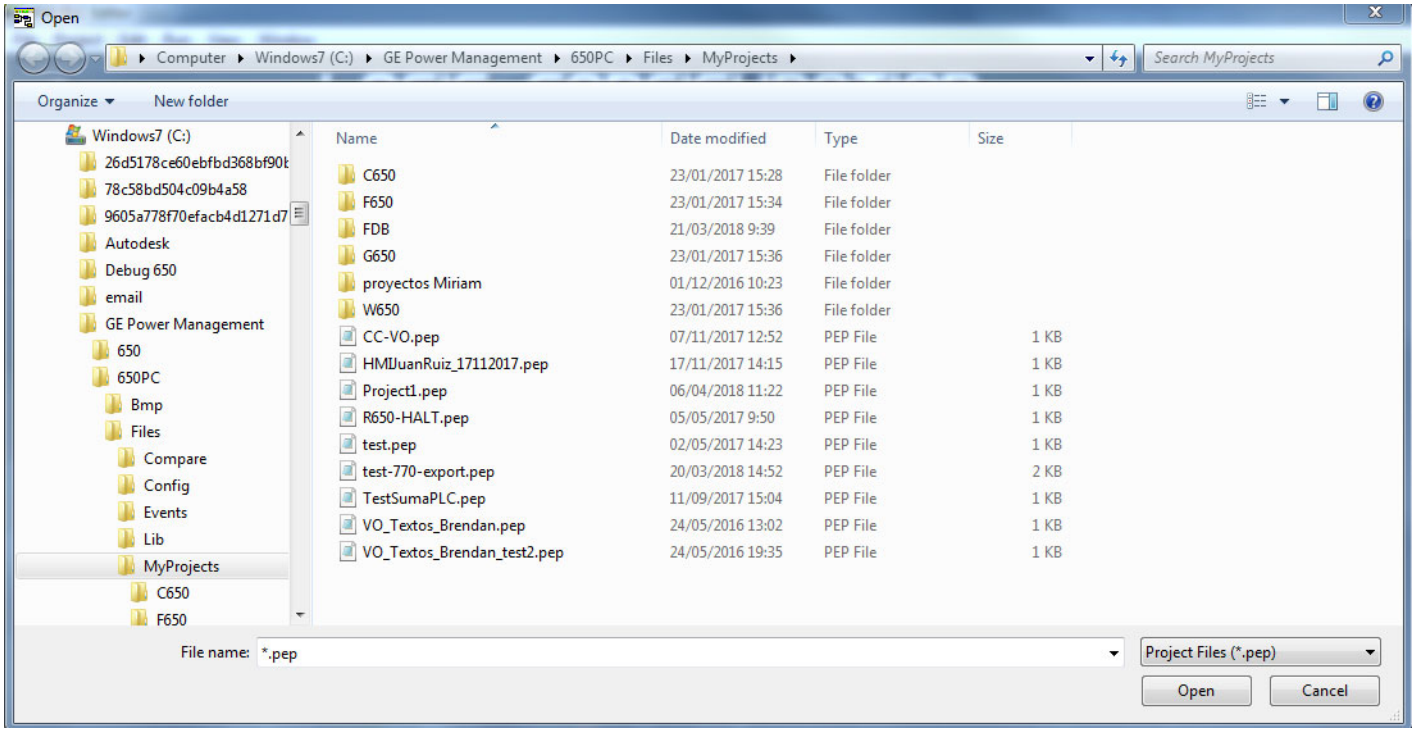
3. Select a name and path for the new, updated *650 file being created.



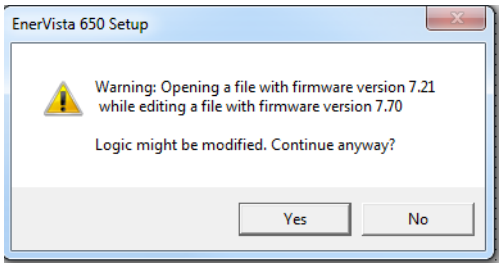
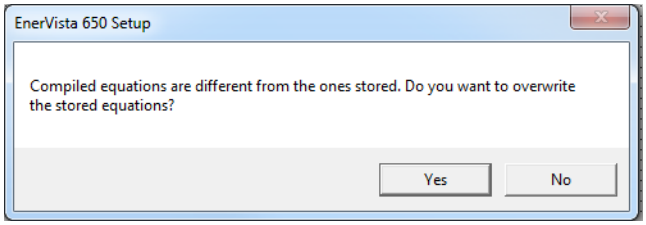
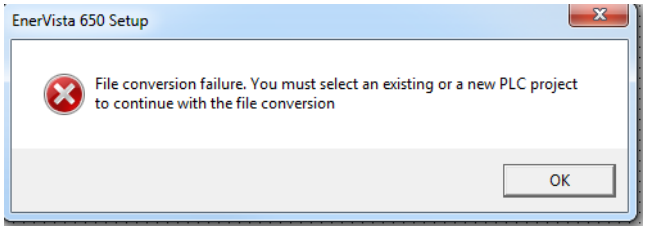
A message explains that the *.650 file needs a PLC project



4. Select PLC files (*.pep, *.aut, *.lib) as prompted.



Depending on the *.650 file and selected PLC project files, one of the following messages may be displayed:

Message	Meaning
Warning: Opening a file with firmware version x.xx while editing a file with firmware version y.yy Logic might be modified. Continue anyway?  	The version of the *.650 configuration file and version of the PLC project (*.pep, *.aut,*.lib) do not match. Some PLC project variables may not be supported by the *.650 configuration file.
Compiled equations are different from the ones stored. Do you want to overwrite the stored equations?  	Logic equations compiled in the *.650 configuration file do not match equations in the selected PLC project (*.pep, *.aut,*.lib). Select **Yes**, and logic configuration from the selected PLC project (*.pep, *.aut,*.lib) will be compiled and saved into *.650 configuration file. Select **No**, and the original logic will remain in the *.650 configuration file.
File conversion failure. You must select an existing or a new PLC project to continue with file conversion.  	This message indicates that the conversion process is unsuccessful because a PLC project has not been selected. A PLC project (*.pep, *.aut,*.lib) must be selected for insertion into the *.650 configuration file, and the conversion process restarts.

5. Upon successful file conversion, the newly converted *.650 file is saved.

4.1.6.3 Save/Save as

The **Save as** and **Close** file options are used to save the *.650 file into the computer and to close the current file. To work in offline mode for settings and configuration editing, a new *.650 file can be opened without closing the previous file.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

During settings and configuration edits, saving your file regularly is recommended. Unsaved changes will be lost when the file is closed.

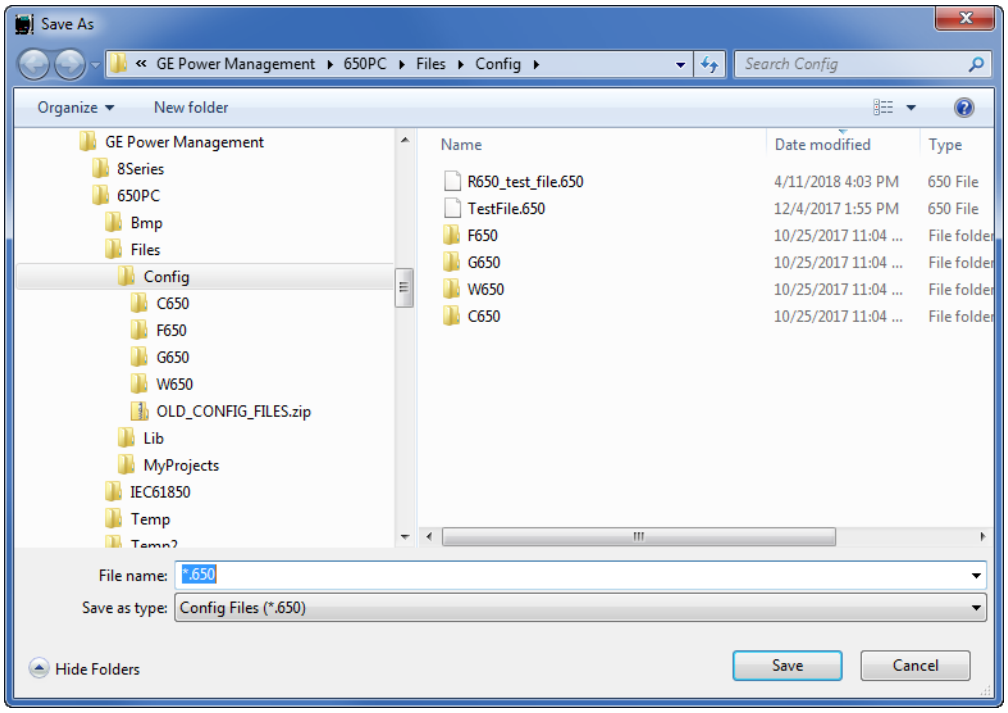


Figure 4-8: Save/Save as file menu

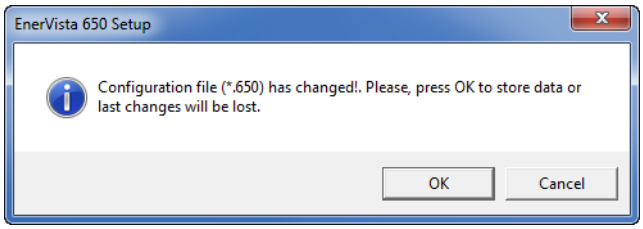
4.1.6.4 Close

In addition to closing the working file, the **File > Close** option is used to clear all data in the EnerVista 650 Setup program, enabling the Language, Upgrade firmware version, and Upgrade Operating system menu options.

Use the **File > Close** menu option to close a settings file while working offline.

To access this menu, there must be no communication between the Enervista 650 Setup program and the relay (offline mode).

If **File > Close** is selected during *.650 configuration process, without first saving the file (**File > Save**), the following warning message is shown:



Click **OK** to open the **File > Save/Save as** window, or **Cancel** to close without saving.

4.1.6.5 Configuration file converter

The configuration file converter tool provides automatic conversion of configuration files from and older firmware version to a newer version. In order to convert a configuration file, follow these steps:

1. Working in offline mode, go to **File > Config File (*.650) Converter**
2. Select the file to be converted.
3. After source file selection is complete, select conversion settings. Make the following selections:

Source Model:	Indicates source F650 model and original version of selected file.
Destination model:	Drop-down list of available F650 models and firmware versions. Select a destination model and firmware version. In the bottom part of this section, a brief description of all models affected is displayed in green after selecting one model in the list.
Source file path	Indicates the path where source model file is located.

Source Model

Destination Model

Source file path

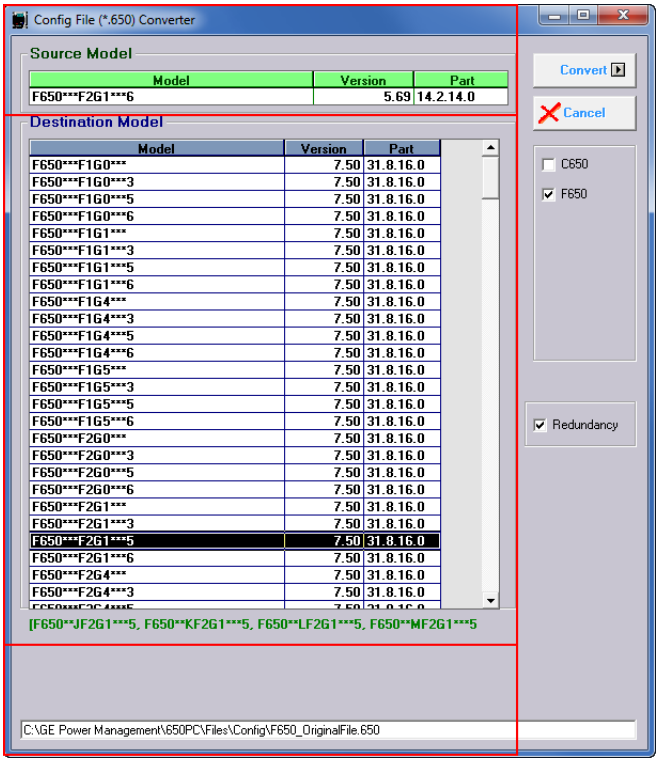


Figure 4-9: Config file (*650) converter menu

It is possible to change the model type (FXGX) using the conversion tool. It must be taken into account that part of the logic can be readjusted to fit the new input and output board selection. Notice also that the external wiring of input and output boards is different for type 1, 2, 4 and 5.

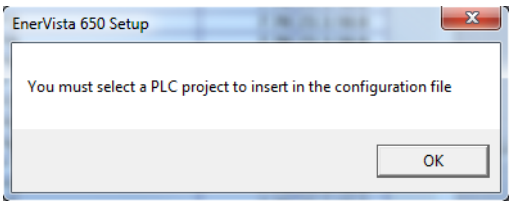
File conversion to firmware version 7.70 or above

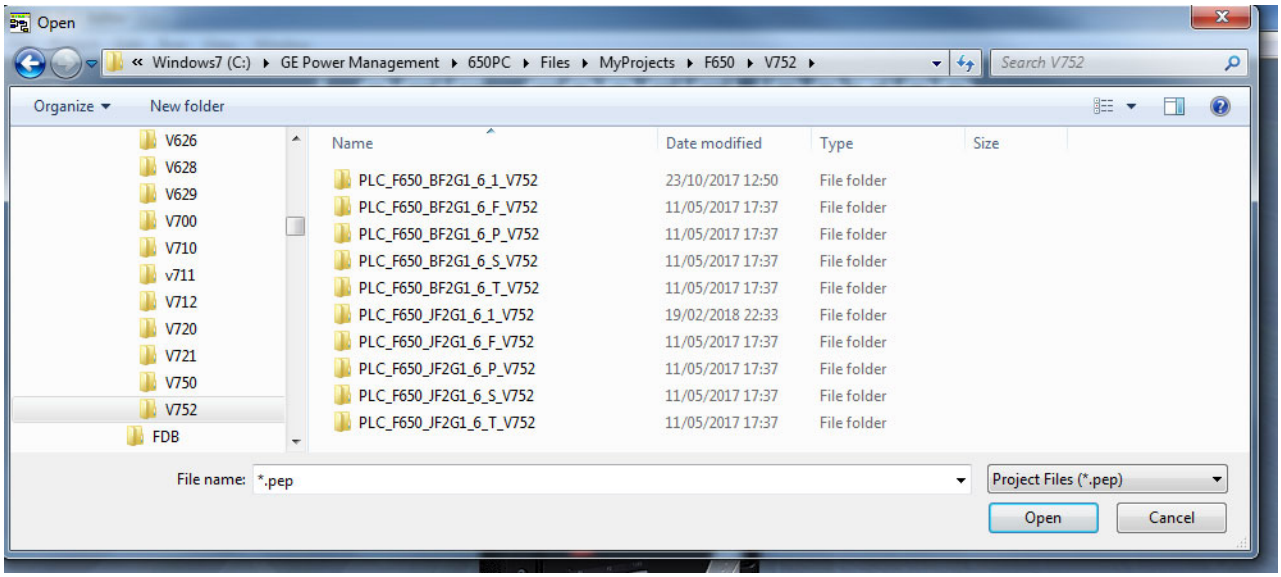
The *.650 configuration files for firmware v7.70 and above include the logic configuration and don't require separate PLC project files (*.pep, *.aut, *.lib), some extra actions are required when converting configuration files from below firmware v7.70 to firmware v 7.70 or above.

After selecting the *.650 source file and conversion settings:

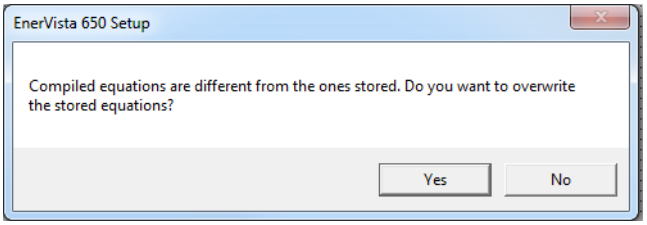
- If the source (*.650) configuration file does not contain Logic configuration, file conversion is completed automatically.

- If the source (*.650) configuration file contains Logic configuration, a PLC project (*.pep, *.aut, *.lib) must be selected for insertion into the converted (*.650) configuration file.:



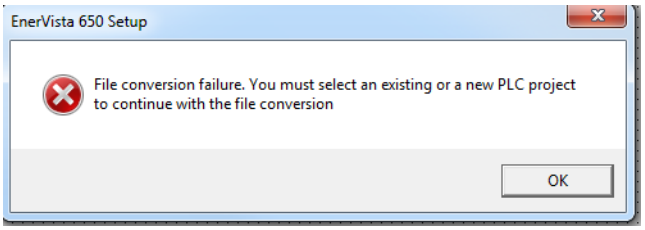


The selected PLC project file is checked against the (*.650) configuration file to ensure they match. If the files do not match, the following message pops-up:



Select **Yes**, and the equations available on selected PLC project (*.pep, *.aut, *.lib) will be compiled and stored into (*.650) configuration file. New equations will overwrite the equations existing in (*.650) configuration file

Select **No**, and the following message will display to indicate that file conversion process has failed.



To convert the *,650 file, a new PLC project (*.pep, *.aut, *.lib) must be selected for insertion into the converted (*.650) configuration file.

Note: If the PLC editor is closed before selecting, compiling and storing a PLC project, the file conversion process will not be successful.

File conversion to firmware 7.50 or above (including firmware 7.70 or above)

The file conversion tool has been modified to include the increased number of setting groups available in firmware version 7.50 and above. In firmware version 7.50, the maximum number of setting groups (SG) available increased from 3 to 6.

Some considerations must be taken into account previous to convert (*.650) files from firmware version below 7.50 to firmware version 7.50 or above. In these cases, the tool internally checks if setting groups functionality is enabled or disable at **Setpoint > Control Elements > Setting group** in the source file and depend on its value, different conversions are performed in elements affected by setting groups.

For example, if the Phase TOC High element is configured in the source *.650 file as described below:

Phase TOC High	Phase TOC High 1 (G1)	Phase TOC High 2 (G2)	Phase TOC High 3(G3)
Function	ENABLED	ENABLED	ENABLED
Input	PHASOR(DFT)	PHASOR(DFT)	PHASOR(DFT)
Pickup Level	0.10	1.50	2.00
Curve	Definite time	Definite time	Definite time
TD Multiplier	0.02	0.05	0.1
Reset	INSTANTANEOUS	INSTANTANEOUS	INSTANTANEOUS
Voltage Restraint	DISABLED	DISABLED	DISABLED
Snapshot Events	ENABLED	ENABLED	ENABLED

1. Note that fields in blue contain default values

CASE 1: If the setting groups option is disabled (**Setpoint > Control Elements > Setting group**) in the source file, conversion is performed in the destination file as follows:

- Settings of different elements (Phase TOC High 1, 2 and 3) that belong to Setting group 1(SG1) in the source file are copied into elements that belong to Setting Group 1 in the destination file.
- Elements in the other setting groups are configured with default values in the configuration file.

	SG1			SG2			SG3			SG4			SG5			SG6		
Phase TOC High	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
Function	ENABLED			DISABLED														
Input	PHASOR(DFT)																	
Pickup Level	0.10	1.50	2.00	1.00														
Curve	Definite time			IEEE Ext Inv														
TD Multiplier	0.02	0.05	0.10	1.00														
Reset	INSTANTANEOUS																	
Voltage Restraint	DISABLED																	
Snapshot Events	ENABLED																	

CASE 2: If the setting groups option is enabled (**Setpoint > Control Elements > Setting group**) in the source file, conversion to the destination file is as follows:

- Settings of different elements (Phase TOC High 1, 2 and 3) that belong to different setting groups in the source file are copied into elements that belong to first group of first three setting groups in the destination file
- Protection elements in the other groups/setting groups are configured with default values in the destination file.

	SG1			SG2			SG3			SG4			SG5			SG6		
Phase TOC High	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
Function	ENABLED	DISABLED		ENABLED	DISABLED		ENABLED	DISABLED										
Input	PHASOR(DFT)																	
Pickup Level	0.10	1.00		1.50	1,00		2.00	1.00										
Curve	Definite time	IEEE Ext Inv		Definite time	IEEE Ext Inv		Definite time	IEEE Ext Inv										
TD Multiplier	0.02	1.00		0.05	1,00		0.10	1.00										
Reset	INSTANTANEOUS																	
Voltage Restraint	DISABLED																	
Snapshot Events	ENABLED																	

4.1.6.6 Properties

When this option is selected, the program displays the relay model information, firmware version, etc. of the file being edited, as shown:

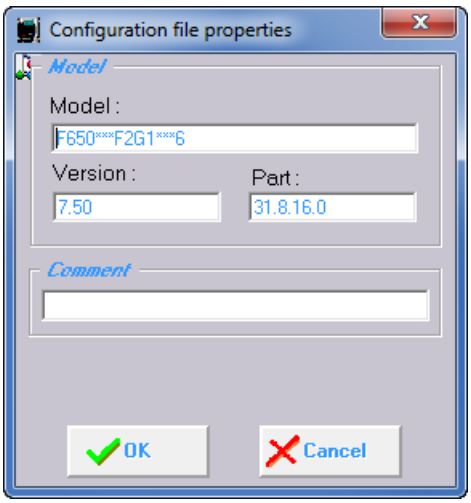


Figure 4-10: File properties menu

4.1.6.7 Print options

The printing options are active only in offline mode with a file open, and not in online mode, connected with the relay.

Print setup

Option to configure the printer options and settings.

Print preview

Option to preview the whole settings and configuration file (*.650) in paper format to be printed as shown:

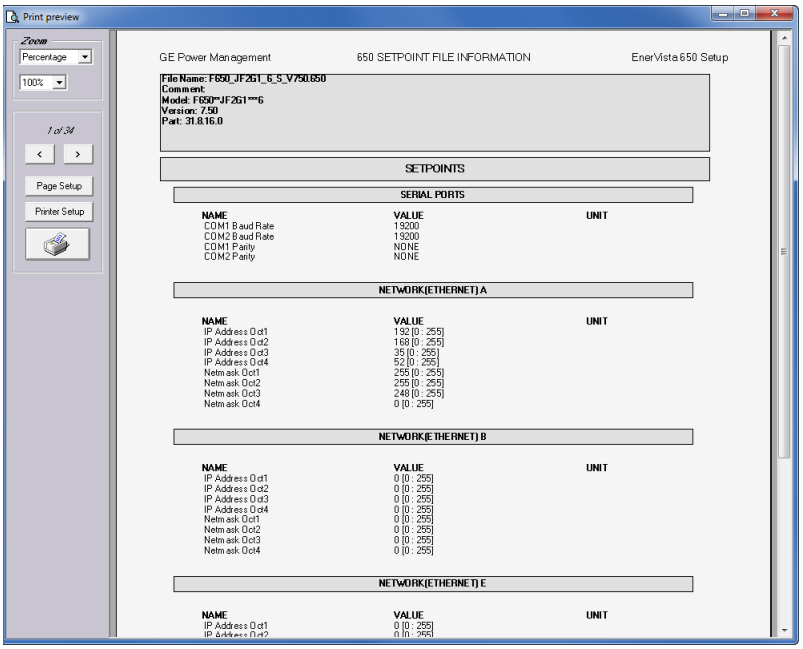


Figure 4-11: Print preview of settings file

Print

Option to print the relay configuration using the PC default (active) printer on port COMx or LPT. This option is active only in offline mode and in file edition (not in online mode while connected to the relay).

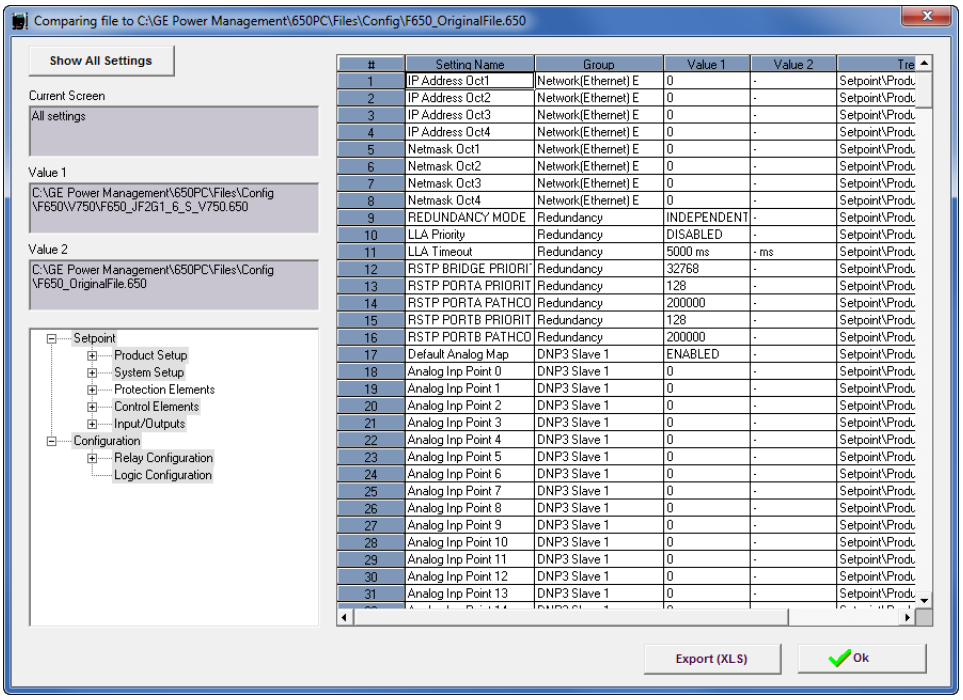
Print to file (*xls)

Option to export the configuration file to an Excel file.

4.1.6.8 Compare to settings file

This tool provides an automatic comparison of two different configuration files, or of an online unit to one settings file.

Open the source *.650 file and select the version and model to compare against. The results of the comparison are displayed as shown:



#	Setting Name	Group	Value 1	Value 2	Tre
1	IP Address Oct1	Network(Ethernet) E	0	-	Setpoint\Produ
2	IP Address Oct2	Network(Ethernet) E	0	-	Setpoint\Produ
3	IP Address Oct3	Network(Ethernet) E	0	-	Setpoint\Produ
4	IP Address Oct4	Network(Ethernet) E	0	-	Setpoint\Produ
5	Netmask Oct1	Network(Ethernet) E	0	-	Setpoint\Produ
6	Netmask Oct2	Network(Ethernet) E	0	-	Setpoint\Produ
7	Netmask Oct3	Network(Ethernet) E	0	-	Setpoint\Produ
8	Netmask Oct4	Network(Ethernet) E	0	-	Setpoint\Produ
9	REDUNDANCY MODE	Redundancy	INDEPENDENT	-	Setpoint\Produ
10	LLA Priority	Redundancy	DISABLED	-	Setpoint\Produ
11	LLA Timeout	Redundancy	5000 ms	- ms	Setpoint\Produ
12	RSTP BRIDGE PRIORI	Redundancy	32768	-	Setpoint\Produ
13	RSTP PORTA PRIORIT	Redundancy	128	-	Setpoint\Produ
14	RSTP PORTA PATHCO	Redundancy	200000	-	Setpoint\Produ
15	RSTP PORTB PRIORIT	Redundancy	128	-	Setpoint\Produ
16	RSTP PORTB PATHCO	Redundancy	200000	-	Setpoint\Produ
17	Default Analog Map	DNP3 Slave 1	ENABLED	-	Setpoint\Produ
18	Analog Inp Point 0	DNP3 Slave 1	0	-	Setpoint\Produ
19	Analog Inp Point 1	DNP3 Slave 1	0	-	Setpoint\Produ
20	Analog Inp Point 2	DNP3 Slave 1	0	-	Setpoint\Produ
21	Analog Inp Point 3	DNP3 Slave 1	0	-	Setpoint\Produ
22	Analog Inp Point 4	DNP3 Slave 1	0	-	Setpoint\Produ
23	Analog Inp Point 5	DNP3 Slave 1	0	-	Setpoint\Produ
24	Analog Inp Point 6	DNP3 Slave 1	0	-	Setpoint\Produ
25	Analog Inp Point 7	DNP3 Slave 1	0	-	Setpoint\Produ
26	Analog Inp Point 8	DNP3 Slave 1	0	-	Setpoint\Produ
27	Analog Inp Point 9	DNP3 Slave 1	0	-	Setpoint\Produ
28	Analog Inp Point 10	DNP3 Slave 1	0	-	Setpoint\Produ
29	Analog Inp Point 11	DNP3 Slave 1	0	-	Setpoint\Produ
30	Analog Inp Point 12	DNP3 Slave 1	0	-	Setpoint\Produ
31	Analog Inp Point 13	DNP3 Slave 1	0	-	Setpoint\Produ

Figure 4-12: Compare to settings file

4.1.6.9 PLC checksum calculation

When working in offline mode, the PLC Checksum calculation option calculates the CRC of the PLC equations and Relay configuration section for the open *.650 file. When a *.650 file is uploaded to the relay, the calculated PLC Checksum and the actual value of the PLC Checksum read from the relay (**Actual values > Status > System Info**) must match.

In order to calculate this checksum, the following sections of the * .650 file are considered:

- All equations compiled in the file and located in EnerVista 650 Setup **Setpoint > Logic configuration**
- Configuration available in the file and located in EnerVista 650 Setup **Setpoint > Relay configuration**, excluding:
  - HMI tab configuration
  - All configured text
  - Opening and closing time in the Switchgear section

4.1.6.10 Setting checksum calculation

When working in offline mode, the Settings Checksum calculation option calculates the CRC of different configured settings for the open *.650 file. When a *.650 file is uploaded to the relay, the calculated Settings Checksum and the actual value of the Settings Checksum read from the relay (**Actual values > Status > System Info**) must match.

In order to calculate this checksum, the following sections of the * .650 file are considered:

- All settings in the relay configuration section (**Setpoint > Relay configuration**) excluding:
  - Those communication settings: **Setpoint > Product Setup > Communication settings > SerialPorts** or **Network (Ethernet)** or **Modbus Protocol** or **Routing**
  - Relay calibration factors
  - Opening and closing time in the Switchgear section

4.1.7 Setpoint menu

Setpoint	
Product Setup	Communications settings for all protocols and physical mediums. ModBus user map definition, fault report, oscillography, data logger demand settings and Time Settings.
System Setup	General Settings, Flex Curves Definition, Breaker settings, maintenance, switchgear snapshot events management and Miscellaneous Settings.
Protection Elements	Phase, Neutral, Ground, Sensitive Ground and Negative Sequence Current Settings. Voltage Elements settings and Power Settings management.
Control Elements	Setting groups, under- and over-frequency settings, synchrocheck, autoreclose, breaker failure, VT fuse failure, broken conductor, locked rotor settings management, Pulse Counters, Analog comparators, Frequency Rate of Change, Load encroachment, max number of starts, Digital Counters, Cold Load Pickup and PLC Timer Masks
Inputs/Outputs	Contact I/O settings for all boards available in device, Remote Comms Force Outputs and Virtual inputs.
Quick Settings	Menu that encompass the most important settings to configure the device such as; Current and Voltage sensing or current protection element.
Relay Configuration	Configuration of Outputs, LEDs, Operations, Protection Elements, Oscillography, Control Events, Control Elements, Switchgear, Inputs, Virtual Inputs, Operations and HMI. Whole relay configuration with internal relay signals or user-definable ones as logic (virtual outputs).
Logic Configuration	Logic configuration graphic editor (PLC Editor). It is a PLC Project file editor that contains all the internal drawings used to make the logic (virtual outputs) based on IEC 61131-3 standard. Functional block diagram (FDB).
Procome Configuration	Procome Configuration tool. Only available for Procome models (5) when communicating through Ethernet with EnerVista 650 Setup
IEC103 Configuration	IEC103 settings for available IEC103 models (3) when communicating through Ethernet with Enervista 650 Setup
Clock (*)	Relay synchronization to computer clock or to user-definable date and time. Online mode only.

(*) indicates online only, (**) indicates offline only

4.1.7.1 Product setup menu

Product Setup	
Communication Settings	Serial Ports, Network (Ethernet), ModBus Protocol, DNP Slave, IEC 870-5-104, SNTP settings and procome (if available on model selection), PTP1588 and Routing (for firmware version 7.00 and higher)
ModBus User Map	ModBus user map definition. The ModBus user map is formed by 256 records, selectable from the complete relay ModBus map.
Fault Report	Fault report settings. Possibility to show fault reports on HMI screen.
Oscillography	Oscillography settings (trigger position, samples per cycle, etc.). The trigger and digital channels (up to 16) must be configured in **Setpoint > Relay configuration**.
Data Logger	Data logger configuration
Demand	Demand settings. The demand trigger and demand reset signals must be configured in **Setpoint > Relay configuration**
Time Settings	Time settings.

(*) indicates online only, (**) indicates offline only

4.1.7.2 Communication settings menu

This section details the settings related to communication parameters for the different protocols available in the F650.

Communication Settings		
	Serial Ports	Baud rate and parity for COM1 and COM2 serial communication ports.
	Network (Ethernet)	Ethernet communication parameters for ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model) (IP Address, Netmask, Gateway IP) NOTE: The ModBus Slave address used by Ethernet ports is the one set for COM2.EnerVista 650 Setup software allows programming two different Ethernet addresses, but the first IP has always to be set as the second IP Address is an Alias.
	ModBus Protocol	ModBus Slave Addresses for serial and Ethernet communication and the ModBus port number used for ModBus TCP/IP
	DNP3 Slave	Physical port, Slave Address for DNP, IP Addresses for Masters, TCP/UDP Port, Unsolicited Response parameters, Analog scale factors and deadbands, message fragment size, Binary input block.Available for standard and IEC61850 models.
	IEC 870-5-104	TCP Port, Common Addr of ASDU, Cyclic Meter Period and, Synchronization Event settings.Available for standard and IEC61850 models.
	SNTP (*)	Synchronization over Ethernet settings
	PROCOME	Comm port and slave number for procome protocol. Only available for procome models (5).
	PTP 1588	Precision Time Protocol 1588 settings. (Available on fw version 7.00 or higher)
	Routing	A default route and a maximum number of 6 static routes may be configured. The default route is used as the last choice, if no other route towards a given destination is found.This option is only available for version 7.00 and higher.

(*) indicates online only, (**) indicates offline only

4.1.7.3 System setup menu

System Setup		
	General Settings	This screen describes and enables the settings of the power system where the relay operates. Some of these settings are used only for metering values presentation purposes; however, some of them apply directly to the sampling and analog-digital conversion process (rated frequency setting). Therefore, these settings need to be adjusted to fit the system settings.
	Flex Curves	Flex Curves ‚Äì Programmable user curves: The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in **Setpoint > System Setup > Flex Curves > Edit Curve** menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.
	Breaker	Breaker Configuration
	Switchgear	Configuration of snapshot events for each switchgear (enable or disable)
	Miscellaneous Settings	This screen contains settings related with relay working mode. Out of service setting, Local/Remote mode and Active language mode are options listed below.

(*) indicates online only, (**) indicates offline only

4.1.7.4 Breaker menu

Breaker settings	Breaker settings, maintenance and switchgear selection of the device configured as breaker in the F650. The selected switchgear is used in recloser, breaker failure and synchronism functions. The settings are Number of Switchgear, Maximum KI2t, KI2t Integ. Time, Maximum Openings, Max.Openings 1 hour and Snapshot Events.
Breaker maintenance	These settings correspond to the initialization of $(KI)^2t$ counters, and the counting of number of openings and closings of the switchgear configured as breaker. These Counters allow the breaker Maintenance. They are used to cumulate the breaker aging produced by a trip or a breaker opening. In order to incorporate the breaker historic, in case of existing breakers, the system allows assigning an initial value to accumulated amperes, and to the number of opening and closing operations.

4.1.7.5 Protection elements menu

This option shows all protection elements available in the relay as shown in the following two tables (exact menu depends on firmware version).

For firmware versions below 7.50, each group of protection elements includes the specific protection units of the same type. For example phase currents group includes TOC, IOC, directional units, etc. There are three groups available, so there are three protection units of each function that can work in grouped mode or ungrouped (altogether).

Table 4-4: Protection elements menu, firmware version below 7.50

Protection Elements		
	Phase Current	All overcurrent functions for phase current.
	Neutral Current	All overcurrent functions for neutral current. (Calculated from phases, not measured)
	Ground Current	All overcurrent functions for ground current. (Measured from 4th current input)
	Sensitive Ground Current	All overcurrent functions for sensitive ground current. (Measured from 5th current input)
	Negative Sequence Current	All Negative sequence overcurrent functions.
	Voltage Elements	All voltage functions for phases, neutral, ground and auxiliary voltage
	Power	Forward power, directional power and wattmetric ground fault (High and Low) protection functions.

(*) indicates online only, (**) indicates offline only

For firmware version 7.50 and above, there are six setting groups of protection elements. Protection element groups are within each setting group.

Table 4-5: Protection elements menu, firmware version 7.50 or above

Protection Elements		
	Setting Group 1	All protection functions available when setting group 1 is the active group
	Setting Group 2	All protection functions available when setting group 2 is the active group
	Setting Group 3	All protection functions available when setting group 3 is the active group
	Setting Group 4	All protection functions available when setting group 4 is the active group
	Setting Group 5	All protection functions available when setting group 5 is the active group
	Setting Group 6	All protection functions available when setting group 6 is the active group

(*) indicates online only, (**) indicates offline only

For firmware version 7.5 and above, the specific protection element menus shown are available under each setting group. For firmware versions below 7.5, these menus are located directly under the **Protection Element** menu.

Table 4-6: Protection elements in each setting group

Phase Current		
	Phase TOC High	Phase time overcurrent, high level (51PH)
	Phase TOC Low	Phase time overcurrent, low level (51PL)
	Phase IOC High	Phase instantaneous overcurrent, high level (50PH)
	Phase IOC Low	Phase instantaneous overcurrent, low level (50PL)
	Phase Directional	Phase directional unit (67P). Quadrature Voltage for polarization
	Thermal Model	Thermal model or Thermal image unit for phases (49)
Neutral Current		
	Neutral TOC	Neutral time overcurrent (51N)

	Neutral IOC	Neutral instantaneous overcurrent (50N)
	Neutral Directional	Neutral directional unit (67N). Voltage, current and dual polarization.
Ground Current		
	Ground TOC	Ground time overcurrent (51G)
	Ground IOC	Ground instantaneous overcurrent (50G)
	Ground Directional	Ground directional unit (67G). Voltage, current and dual polarization.
Sensitive Ground Current		
	Sensitive Ground TOC	Sensitive ground time overcurrent (51SG).
	Sensitive Ground IOC	Sensitive ground instantaneous overcurrent (50SG).
	Isolated Ground IOC	Isolated ground overcurrent (50IG)
	Sensitive Ground Directional	Sensitive ground directional unit (67SG)
Negative Sequence Current		
	Negative Sequence TOC	Negative sequence time overcurrent (46P)
Voltage Elements		
	Phase UV	Phase undervoltage (27P)
	Phase OV	Phase overvoltage (59P)
	Neutral OV High	Neutral overvoltage, high level (59NH)
	Neutral OV Low	Neutral overvoltage, low level (59NL)
	Negative Sequence OV	Negative sequence overvoltage (47)
	Auxiliary OV	Auxiliary overvoltage (59X)
	Auxiliary UV	Auxiliary undervoltage (27X)
Power		
	Forward Power	Forward power (32FP), in primary values.
	Directional Power	Directional power (32), in primary values.
	Watt Gnd Flt High	Wattmetric ground fault high (32N High), in secondary values
	Watt Gnd Flt Low	Wattmetric ground fault low (32N Low), in secondary values

Firmware version 7.50 and above also include **Frequency** and **Miscellaneous** menus in the **Protection Element** section.

Frequency		
	Underfrequency	Underfrequency unit (81U).
	Overfrequency	Overfrequency unit (81O).
	Frequency Rate of Change	Frequency rate of change function (81R).
Miscellaneous		

Broken Conductor	Broken or fallen conductor detection function (I2/I1). Grouped element. Ratio between the negative sequence current, I2, and the positive sequence current I1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio is increased.
Locked Rotor	Locked rotor detection function (48).
Load Encroachment	Load Encroachment function.

4.1.7.6 Control elements menu

This option shows all protection elements available in the relay as shown in the following two tables (exact menu depends on firmware version).

Table 4-7: Control elements menu, firmware version below 7.50

Control Elements	
Setting Group	Control elements can be used in either a single setting group (default mode-all units can operate simultaneously) or three setting groups (elements are grouped in three independent tables, with only one active at a given time).
Underfrequency	Underfrequency unit (81U). Grouped element.
Overfrequency	Overfrequency unit (81O). Grouped element.
Synchrocheck	Synchronism check unit (25). Single element.
Autoreclose	Recloser (79). Single element.
Breaker Failure	Breaker failure (50BF). Single element
VT Fuse Failure	Fuse Failure (VTFF). Single element.
Broken Conductor	Broken or fallen conductor detection function (I2/I1). Grouped element. Ratio between the negative sequence current, I2, and the positive sequence current I1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio is increased.
Locked Rotor	Locked rotor detection function (48). Grouped element.
Pulse Counters	Pulse counters function. 8 counters provided.
Analog Comparators	Analog comparator function. 20 analog comparators provided.
Frequency Rate of Change	Frequency rate of change function (81R). Grouped element.
Load Encroachment	Load Encroachment function. Grouped element.
Max. Number of Starts	Maximum Number of Starts (66). Single element.
Digital Counters	Up to 8 Digital Counters
Cold Load Pickup	Cold Load Pickup Function. Not grouped, a single unit provided (Available starting on firmware version 7.00).
PLC Timer Masks	Configuration of masks that can be assigned to PLC timers

Table 4-8: Control elements menu, firmware version 7.50 and above

Control Elements		
	Setting Group	F650 incorporate a flexible grouping capability for protection units can be used in either single setting group (default mode- All units that belong to Active group, configured in Setpoint > Control > Setting Group, can operate simultaneously) or up to six setting groups (in this mode, all protection elements, that are available when setting group function is disabled, will be available in each individual setting group (Up to maximum of 6). Only one of setting group will be active at a given time). Units grouped under Protection elements section will be the units affected by changing of setting group.
	Synchrocheck	Synchronism check unit (25). Single element.
	Autoreclose	Recloser (79). Single element.
	Breaker Failure	Breaker failure (50BF). Single element.
	VT Fuse Failure	Fuse Failure (VTFF). Single element.
	Pulse Counters	Pulse counters function. 8 counters provided.
	Analog Comparators	Analog comparator function. 20 analog comparators provided.
	Max. Number of Starts	Maximum Number of Starts (66). Single element.
	Digital Counters	Up to 8 Digital Counters
	Cold Load Pickup	Cold Load Pickup Function. Single element. Available for firmware version 7.00 and above.
	PLC Timer Masks	Configuration of masks that can be assigned to PLC timers
	60 CTS Failure	Current transformer failure function
	2nd HRMC Inhibit	Second harmonic inhibit

4.1.7.7 Inputs/Outputs menu

Section that contains the settings for all input and output boards and the Force Outputs and Virtual inputs activation tools.

Inputs/Outputs

Contact I/O	Inputs and outputs settings for all boards in F650. The I/O settings configuration can only be performed through EnerVista 650 Setup, not available through the HMI.
Force Outputs (*)	This menu allows activating each contact output in the relay, to facilitate maintenance testing. Online mode only.
Virtual Inputs (*)	This menu allows operating virtual inputs. These variables are used as inputs to logic schemes configured in the relay. Virtual inputs can be operated in a latched mode (32 latched virtual inputs) or in Self-reset mode (32 self reset virtual inputs).
Remote Comms.	This menu allows configuring remote inputs coming from other devices and allow enabling None, GSSE or GOOSE messages. Available for IEC61850 (6) models only.

(*) indicates online only, (**) indicates offline only

This section shows the settings related to inputs and outputs for the different boards available in F650 (F, G, H, J)

Contact I/O

Board F	Board located in first slot, always connected.
Board G	Board located in second slot, depending on model definition. If model is type G0 there is no board in second slot.
Board H	Board located in first slot of CIO Module (external inputs/outputs module)
Board J	Board located in second slot of CIO Module (external inputs/outputs module)

4.1.7.8 Quick settings menu

This menu allows quick access to the main Setpoints of the relay.

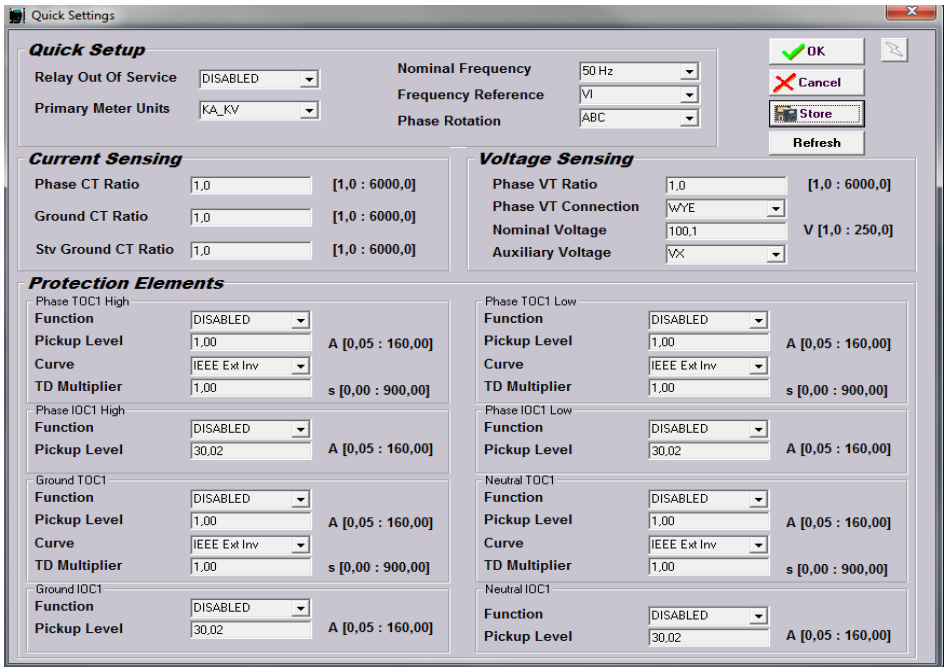


Figure 4-13: Quick Settings

4.1.7.9 Relay configuration menu

This is the relay configuration section in which the relay can be configured using internal states or already compiled equation on PLC Editor.

Relay Configuration	
Outputs	Configuration of contact output operate and reset signals for all boards.
LEDs	15 LEDs fully configurable from any logical variable, contact or virtual input. First 5 LEDs are latched by hardware, the rest are self-reset but can be latched through PLC configuration. For firmware version 7.20 and higher, all 15 LEDs can be latched by setting. From the LED configuration screen, it is possible to print the vertical LED label for the relay.
Operations	Configurable operations up to 24. Operation texts, interlocks, final states, frontal keys, time outs and masters.
Protection Elements	This tab allows assigning operands (logic signals) as inputs to different protection elements. To block, reset, initiate the different protection elements inputs.
Control Elements	This tab allows assigning operands (logic signals) as inputs to different control elements.
Oscillography	Trigger and up to 16 digital channels to be included in oscillography records, are programmable from any logical variable, contact or virtual input. Text configuration is only for offline mode. **NOTE:** This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/disabling, sampling rate, number of oscillography files, etc. must be set on the **Setpoint > Product Setup > Oscillography** menu.
Control Events	Up to 128 user programmable events from any logical variable, contact or virtual input. Possibility to display the event as an alarm on the alarms panel. Control events are also displayed in the snapshot events recording. 1 ms time tagging. A control event is a logic signal associated with an operand or combination of operands, that allows following the status of that signal.
Switchgear	Up to 16 configurable switchgear elements. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. This screen allows configuration of type of contacts, opening and closing time, contact assignation and text for events related to switchgear. There are 64 pre-established events for switchgear, which correspond to opening, closing, Error01 and Error11 of the 16 programmable switchgear elements.
Remote outputs	Up to 32 DNA bits and 64 user St bits to be transmitted to remote devices over CAN using GSSE messages
Inputs	Text configuration for offline mode file management for all the contact inputs available in device.
Virtual Inputs	Text configuration for offline mode file management. 32 latched and 32 self reset virtual inputs.
MMI (HMI-Human Machine Interface)	Screen one line diagram configuration. This menu shows a canvas to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings. See an example on the next page.

The following figures show an example of the default factory configuration for F650:

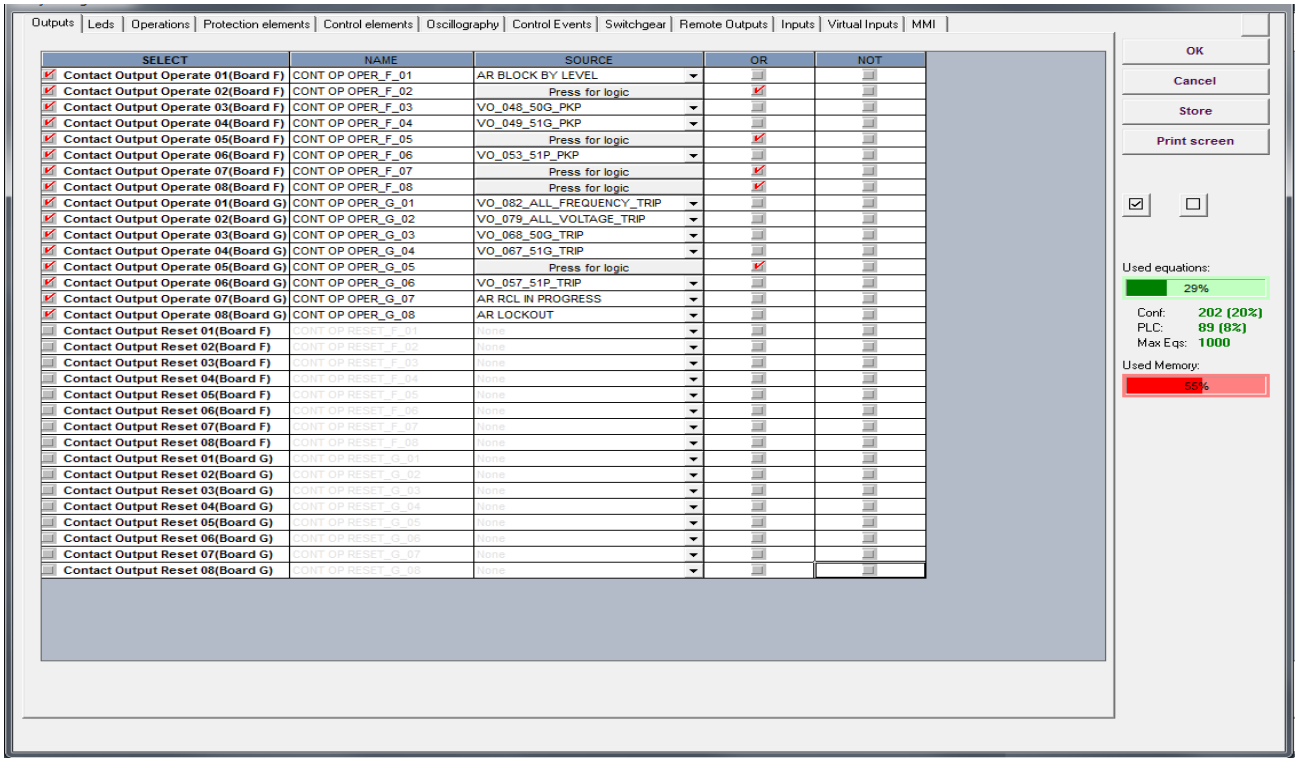


Figure 4-14: Relay configuration

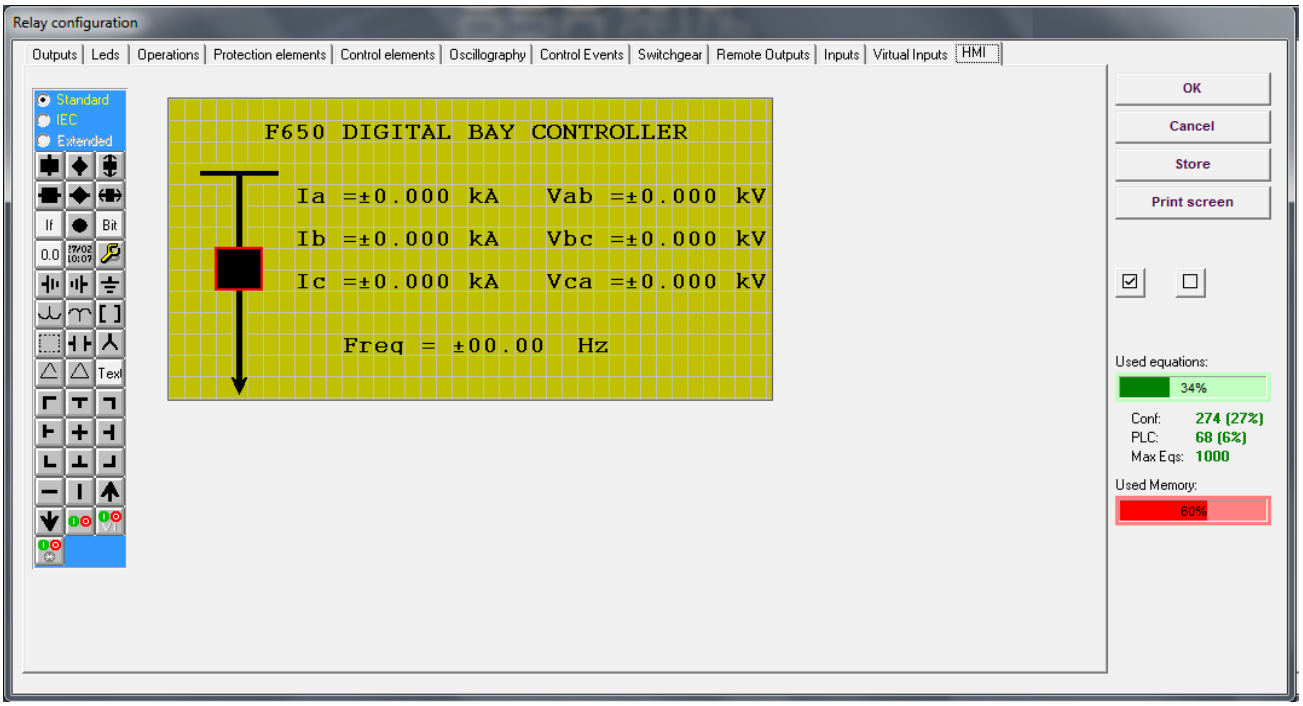


Figure 4-15: HMI configuration

4.1.7.10 Logic Configuration menu

This logic configuration allows creating more complex configurations, using the graphical PLC, than using the tables from Relay Configuration. For file management detailed information go to section 4.1.4 File management menu.

File description:

.pep:Header for Logic project: PLC project file containing the necessary information relative to the relay model, logic libraries included in the project (.lib), graphic file name (*.aut), etc.

*.aut:PLC Project file containing all the drawings used by the logic, required by 650 relay based on IEC 61131-3 standard. Functional block diagram (FDB).

*.lib:User programmable logic objects: Library file to be included as an object in a PLC project. Logic packages that can be stored into libraries and be distributed in different PLC projects.

4.1.7.11 IEC 103 Configuration menu

This menu allows to update the IEC 103 configuration of the unit.

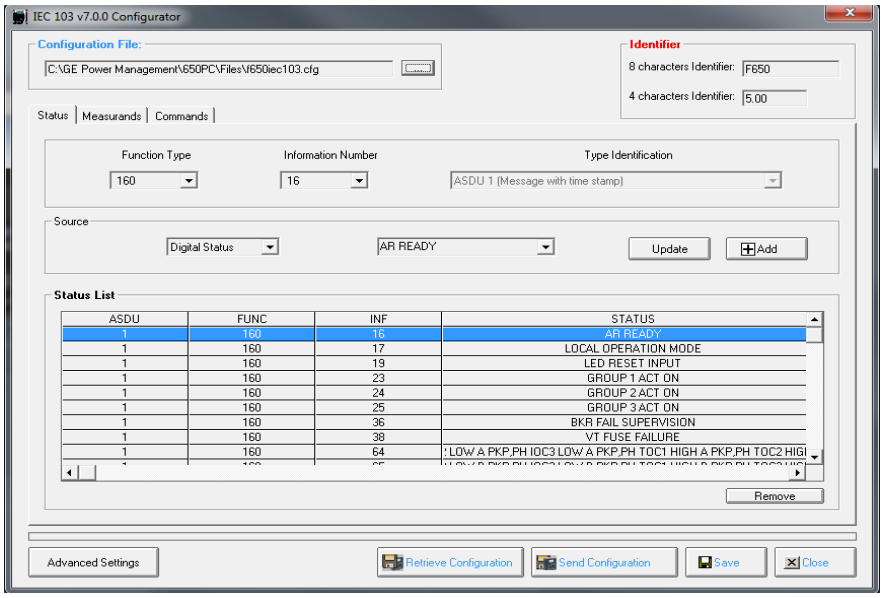


Figure 4-16: IEC 103 Configurator

See chapter 5.13

4.1.7.12 Clock menu

This menu allows updates to the date and time of the relay, either synchronizing them with the PC clock, or entering the information manually.

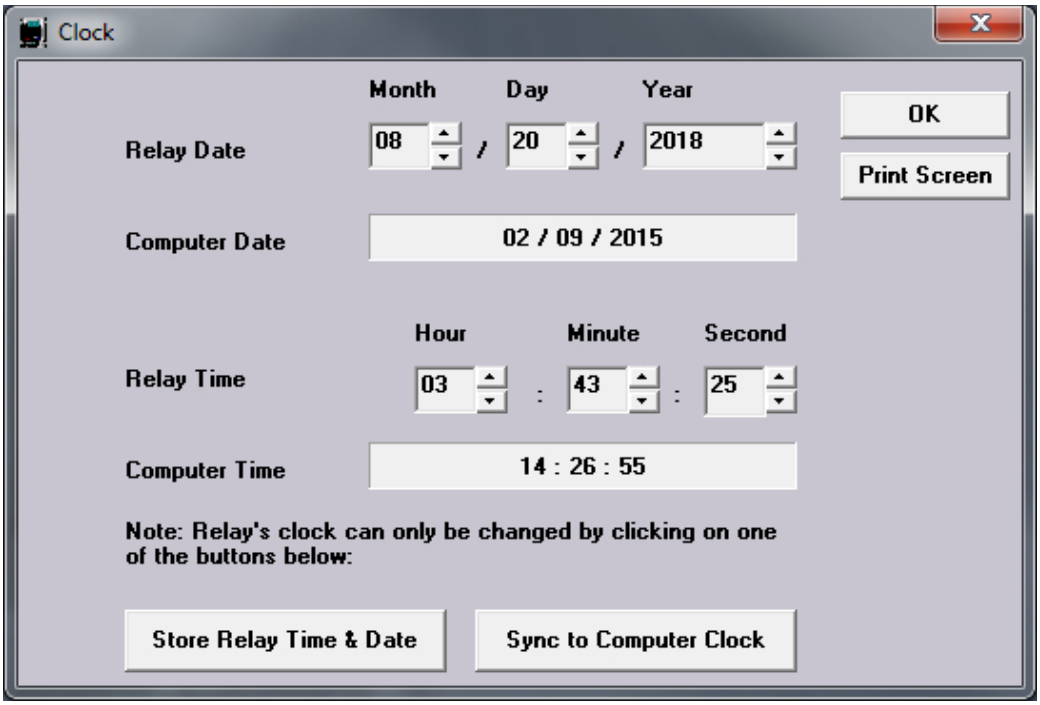


Figure 4-17: Clock

4.1.8 Actual values menu

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This section shows only the structure of menus in EnerVista 650 Setup.

Actual		
	Front Panel	The relay front LED status is shown on this menu.
	Status	Protection and control status signals for all available protection functions in device.
	Metering	All metering values available in device. Primary and secondary values, frequency and phasor diagram provided.
	Inputs/Outputs	All input and output status provided. For contact inputs and contact outputs as well as virtual input and virtual output signals.
	Records	Only enabled in online mode, retrieval of all the available records in device. Snapshot events, control events, oscillography and fault reports.

4.1.8.1 Front panel

The front panel menu shows the LEDs submenu where all the front LEDs can be monitored.

4.1.8.2 Status

The following menu includes all the available protection status in the device. Location of different menus can vary depending firmware version.

status	
Operation Bits	Up to 24 elements. OPERATION BIT XX is (0) when the configured time out for the operation XX expires or when success conditions are met. And it is (1) if operation XX is executed and interlocks are fulfilled.
Breaker	Breaker status (open, closed or undefined). The rest of the status signals corresponding to the switchgear XX configured as breaker are in the **Status > Switchgear Status > Switchgear XX** menu.
Protection	Status of all the protection units in the device.
Control Elements	Status of all the control units available in the device.
Protection Summary	This screen shows a complete list of all protection and control elements in the relay, showing their status (enabled or not).
Snapshots Events summary	Summary of the snapshot events status (enabled or disabled) for protection, control, inputs and outputs boards and switchgear.
ModBus User Map	Up to 256 elements. Value in SIGNED INT 16 BIT format of the reading for the selected address configured in **Setpoint > Product Setup > ModBus User Map**
Switchgear Status	Up to 16 blocks of switchgear status signals for the 16 configurable devices. Status signals such as inputs for A and B contacts, status for A and B, open and close status, error 00 and error 11, open init and close init, fail to open and fail to close signals.
Calibration	Internal states for calibration. Factory calibration and calibration error signals.
FlexCurves	Flex curve status for A, B, C and D user curves. (0) if it is not configured, (1) if it is configured. To configure a flex curve go to **Setpoint > System Setup > Flex Curves** menu.
System Info	This screen can monitor the system parameters and the internal status of the Relay operating system. Not enabled by default, password required
Records Status	Information related to the different records stored in the Relay, such as: Fault reports, control events, oscillography, data logger, demand, energy, and breaker maintenance.
SNTP-IRIG_B & PTP 1588	Information related to synchronization via IRIG_B, SNTP or PTP1588.
Versions	Information related to the different firmware versions and hardware revisions.
Redundancy	Information related to the status of the frames sent through PRP and HSR. Also information related to the status of RSTP port.

Table 4-9: Protection elements, actual values menu

Protection	
Protection Blocks	This screen shows all the protection element blocks available. Protection elements block signals can be configured at **Setpoint > Relay Configuration > Protection Elements**.
Phase Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for phase current.
Neutral Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for neutral current (calculated from phases).
Ground Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent and directional protection functions for ground current (measured from 4th current input).
Sensitive Ground Current	Protection status signals (pickups and operations) for time overcurrent, instantaneous overcurrent, isolated and directional protection functions for ground current (measured from 5th current input).
Negative Sequence Current	Protection status signals (pickups and operations) for negative sequence time overcurrent function.

Thermal Model	Protection status signals for thermal model. Reset, alarm and operation signals for phases and for unit, besides the thermal image values in percentage for all phases and units.
Voltage	Protection status signals (pickups and operations) for all voltage functions, undervoltage, overvoltage, neutral overvoltage, negative sequence overvoltage and auxiliary under and over voltage.
Power	Protection status signals (pickups and operations) for forward, directional and wattmetric ground fault (high and low) power units, and power factor status. Power values for 32N High and Low functions (in watts).

Table 4-10: Control elements, actual values menu, firmware versions below 7.50

Control Elements	
Frequency	Status signals (pickups and operations) for under, overfrequency and frequency rate of change units.
Synchrocheck	Status signals for synchrocheck function (25).
Autoreclose	Status signals for autoreclose function (79). Close signal, recloser status (ready, lockout, etc.), block signals after each shot.
Breaker Failure	Status signals for breaker failure function (50BF).
VT Fuse Failure	Fuse failure detection signal.
Broken Conductor	Status signals (pickups and operations) for broken conductor (I2/I1).
Setting Groups	Status signals (activations and blocks) for the relay setting group change. By default the "setting group" setting is disabled and all the grouped elements can be enabled at the same time.
Locked Rotor	Status signals (pickups and operations) for locked rotor units.
Pulse Counters	Status signals for pulse counters units.
Analog Comparator	Status signals for analog comparator units.
Load Encroachment	Status signals (pickups and operations) for load encroachment units.
Max. Number of Starts	Status signal for number of starts operations
Digital Counters	Status signals for the Digital Counter units.
Cold Load Pickup	Status signals for the Cold Load Pickup Function.

Table 4-11: Control elements, actual values menu, firmware version 7.50 and above

Control Elements	
Frequency	Status signals (pickups and operations) for under, overfrequency and frequency rate of change units.
Synchrocheck	Status signals for synchrocheck function (25).
Autoreclose	Status signals for autoreclose function (79). Close signal, recloser status (ready, lockout, etc.), block signals after each shot.
Breaker Failure	Status signals for breaker failure function (50BF).
VT Fuse Failure	Fuse failure detection signal.
Broken Conductor	Status signals (pickups and operations) for broken conductor (I2/I1).
Setting Groups	Status signals (activations and blocks) for the relay setting group change. By default the **Setting Groups** setting is disabled and all the grouped elements can be enabled at the same time.
Locked Rotor	Status signals (pickups and operations) for locked rotor units.
Pulse Counters	Status signals for pulse counters units.
Analog Comparator	Status signals for analog comparator units.
Load Encroachment	Status signals (pickups and operations) for load encroachment units.
Max. Number of Starts	Status signal for number of starts operations
Digital Counters	Status signals for the Digital Counter units.
Cold Load Pickup	Status signals for the Cold Load Pickup Function.
60CTS Failure	Status signals of Current transformer failure Function
2nd HRMC Inhibit	Status signals of Second Harmonic Inhibit Function

Table 4-12: Records status, actual values menu

Record Status	
Fault Reports	This menu shows the fault report status signals, as fault report trigger, fault date, fault type and location, besides the fault report number.
Control Events	Status of the control events (if the signal configured to launch the control event is active or not).
Oscillography	Status of signals related to oscillography recording, such as status or digital channels, oscillography trigger, number of records available, etc.
Data Logger	Data logger information about oldest and newest sample time stamp, and number of channels and days configured in data logger settings.
Demand	Demand trigger and reset inputs status.
Energy	Freeze, unfreeze and reset input signals for energy counters.
Breaker Maintenance	All signals related to breaker maintenance, such as number of openings, closings, $(KI)^2t$ counters, alarm signal for $(KI)^2t$, etc.

4.1.8.3 Metering

The Metering menu includes all the measurements available in the device. Primary and secondary values, and also the data related to the recording functions in the relay

metering	
Primary Values	Primary values measurements for currents, voltages, power, energy and demand
Secondary Values	Secondary values measurements for currents, voltages and power.
Phasor Diagram	Current, voltage and sequence components.
Frequency	Line and Bus frequencies.

4.1.8.4 Inputs/Outputs menu

The Inputs/Outputs menu includes all the inputs and outputs signals available in the device. Contact and virtual type.

inputs/outputs

Contact Inputs	Status of digital inputs in the Relay for each board according to the relay model.
Contact Output Status	Status of digital outputs in the Relay for each board according to the relay model.
Contact Outputs Operates	Status (activated or not) of the variables used to operate a contact output. To configure these signals go to **Setpoint > Relay Configuration > Outputs** menu.
Contact Outputs Resets	Status (activated or not) of the variables used to reset a contact output. To configure these signals go to **Setpoint > Relay Configuration > Outputs** menu. This output reset Command is only effective if **latch** is selected for **Output Type** setting on the I/O board, thus the contact output has been configured to emulate function 86 (latching relay).
IO Board Status	Status of I/O boards. This status provides if the hardware it is OK (boards matching relay model, correctly inserted in their tracks, in good state and communicating through the internal CAN bus).
Virtual Inputs	Status of Virtual inputs latched (32) and self-reset (32).
Virtual Outputs	Status of virtual outputs (configured in PLC Editor). Up to 512.
Remote Outputs	States of remote outputs for IEC61850 models.
Remote Inputs	Status of remote device and remote inputs for IEC61850 models.
Analog Inputs (*)	Measurements coming from analog inputs (DCMA)
Virtual Output Latched	Status of Virtual Output Latched (configured in PLC Editor). Up to 16.
Virtual output Analogue	Status of Virtual Output Analogues configured in PLC Editor). Up to 49 float values and 49 integer values can be used.

(*) indicates online only, (**) indicates offline only

4.1.8.5 Records menu

The Records menu is only available in online mode and includes the possibility to retrieve all the records available in the device. By serial or Ethernet.

Records (*)	
Event recorder (*)	Retrieval and visualization of snapshot event (all and new), control events and alarm panel. By serial or Ethernet (ModBus RTU or TCP/IP)
Waveform capture (*)	Retrieval of oscillography files, by Ethernet.
Fault Report (*)	Retrieval and visualization of fault report files, by Ethernet.
Data logger (*)	Retrieval and visualization of data logger files. Only by Ethernet.

(*) indicates online only, (**) indicates offline only

4.1.9 Operations menu

Option only available in online mode, showing all the operations previously configured in the relay with their corresponding texts, which must be different from the default text (Op_X not configured).

operations	
Operation 1 (*)	Entry to first operation (with its corresponding text)
...	...
Operation 24 (*)	Entry to 24th operation (with its corresponding text)

(*) indicates online only, (**) indicates offline only

4.1.10 Communications menu

The communication menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operating system, web server and other file storing capabilities (upload and download info files to/from relay).

For more detail information go to section 4.1.3 Connect to the relay for communication menus description and to section 5 for flash memory update procedures.

Communication	
Computer	Menu to start communication with the relay.
Modem (**)	Configure the unit for remote communications via modem, using a telephone line. This is only available if the relay is not communicating and if modem has been selected under **Communication > Computer** control type.
Troubleshooting (*)	Read/write to ModBus addresses, for verifying communications and access to different positions in the ModBus memory map. Only available if the communication has already been established.
Calibration (*)	Retrieve the unit calibration settings and storing them in a file (with extension *.cal). For reading or storing the calibration settings in the relay go to **Communications > Calibration > Get** or **Set** calibration settings and select the intended calibration file. The calibration retrieval process must be performed before updating the operating system. When the firmware and bootcode are updated, all the data in the relay is deleted, including the factory calibration settings. When only the firmware is updated (for versions higher than 1.50), the calibration settings are automatically saved in the relay.
Upgrade relay (**)	Upgrade firmware version (Ethernet connection): Update the relay firmware through Ethernet communication. Firmware is related to the relay internal program, designed by GE Multilin, which performs the protection and control functions, and which is run by the relay main microprocessor.
Upgrade 650 web server	Upgrade 650 web server (Ethernet connection): Go to Communications > Upgrade 650 web server. The relay web server application can be updated to further versions (if available) using this menu without modifying the relay operating system.
Upload info files to relay	Upload info files to relay (Ethernet connection): This functionality is used to store setting files (*.650) inside the relay, as well as auxiliary files used by the programmable logic graphical editor (*.pep, *.aut, *.lib).
Download info files from relay	Download info files from relay (Ethernet connection): This functionality is used for retrieving the files (*.650 and *.pep, *.aut, *.lib) that have been previously stored in the relay flash memory.

(*) indicates online only, (**) indicates offline only

⚠CAUTION **CAREFULLY READ THE FLASH MEMORY UPDATE PROCEDURE DESCRIBED IN SECTION "BOOT CODE AND FIRMWARE" AND CLOSE ALL RUNNING APPLICATIONS BEFORE PERFORMING FIRMWARE AND OPERATING SYSTEM UPDATES.**

NOTICE For firmware versions below 7.00, check that the firmware version that is going to be updated matches the operating system version of the relay before updating firmware. If not, update the operating system before proceeding to update the firmware. Other combinations of firmware and operating system different from the listed in section 5 will not be operative.

For previous version than 7.00 the operating system version is available in the logotype main screen in HMI; it is the number between brackets in the first line, e.g. F650 1.70 (2.35). The operating system version is 2.35

NOTICE *.650 files contain protection, control settings, relay configuration and compiled logic equations. This file can be retrieved from the relay, using the **File > Get info from relay** option in EnerVista 650 Setup (through serial or Ethernet communication). **File > Send info to relay** option stores this *.650 file in the relay.

*.pep, *.aut and *.lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the **Communication > Upload info files to relay** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using **Communication > Download info files to relay** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the *.pep, *.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the **Communication > Upload info files to relay** option to store these logic configuration files into the relay.

*.pep, *.aut and *.lib files contain the logic configuration projects necessary to modify the logic (virtual outputs) in the relay. These files can be stored in the relay, using the **Communication > Upload info files to relay** option in EnerVista 650 Setup (through Ethernet communication). They can be retrieved using **Communication > Download info files to relay** option in EnerVista 650 Setup program (Ethernet communication). Take into account that the *.pep, *.aut and library files are necessary to modify the PLC logic (virtual outputs). Without these files setting and configuration can be modified but not logic equations (virtual outputs). It is advisable to use the **Communication > Upload info files to relay** option to store these logic configuration files into the relay.

An example of **Communication > Troubleshooting follows**:

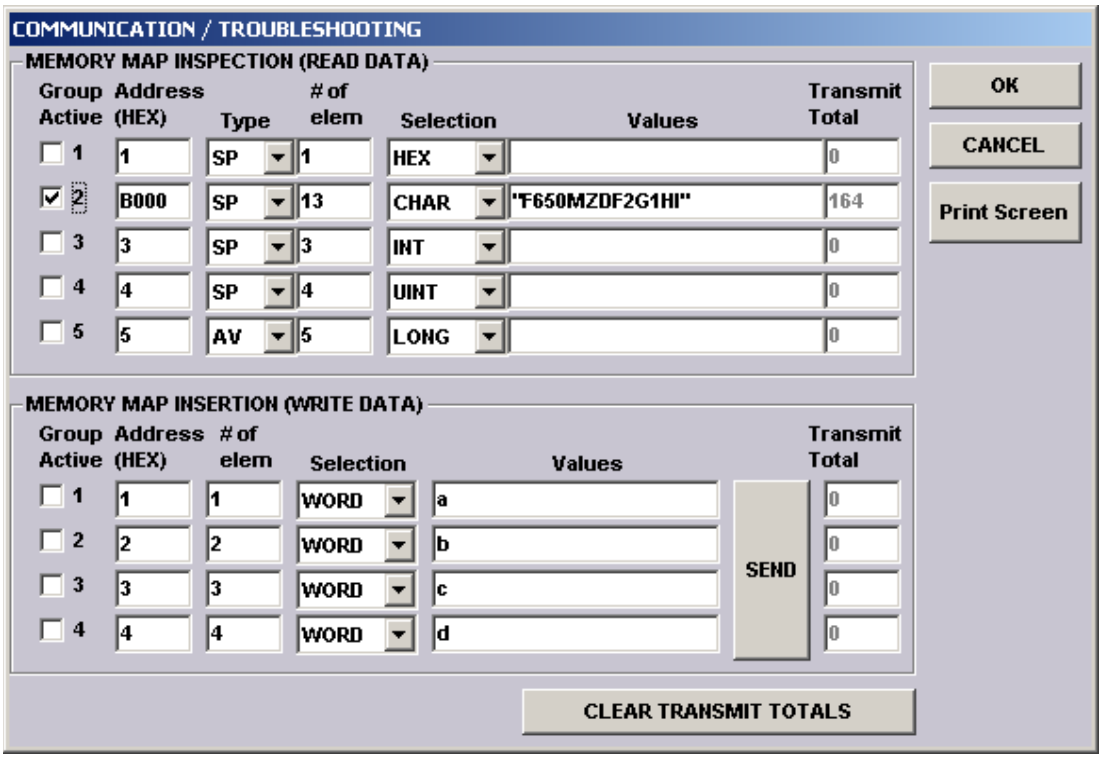


Figure 4-18: Communication troubleshooting example

4.1.11 Security menu

The security menu includes all the menus related to security control in EnerVista 650 Setup. EnerVista 650 Setup security users and passwords are not related to passwords in HMI. Each security level has its own access for HMI management and EnerVista 650 Setup management.

security		
	Login User (*)	Log on menu for EnerVista 650 Setup. Enabled after security control has been enabled in user management menu.
	Change Password (*)	Menu to change passwords and establish password recovering questions.
	User Management (*)	User management dialog box.

(*) indicates online only, (**) indicates offline only

4.1.12 View menu

The view menu includes the computer screen to start communicating with the relay, the different update procedures available in device: firmware, operating system, web server and other file storing capabilities (upload and download info files to/from relay).

The ModBus memory map is detailed in the complete instruction manual (English only) and can be obtained from EnerVista 650 Setup program.

View

Traces (*)	ModBus communication traces between the EnerVista 650 Setup and the relay.
ModBus Memory map	Complete ModBus memory map description.
Languages (**)	Option to change the EnerVista 650 Setup default language. Only available if the relay is not communicating and no file (*650) is open.

(*) indicates online only, (**) indicates offline only

4.1.13 Help menu

Complete instructions manual and data about EnerVista 650 Setup release.

Help

Instruction Manual	Instructions manual in the language selected in **View > Languages**.
GE Mulitlin on the Web	GE Multilin web page link.
About EnerVista 650 Setup	Release version and date of the EnerVista 650 Setup program.

4.2 Human-machine interface (HMI)

The HMI interface consists of several functional panels. The faceplate can be unscrewed to allow easy access to the removable modules. There is also a removable dust cover that fits over the display and other cover that protects the front RS232 Communications port and the commands buttons that can be sealed. The following figure shows the HMI in F650

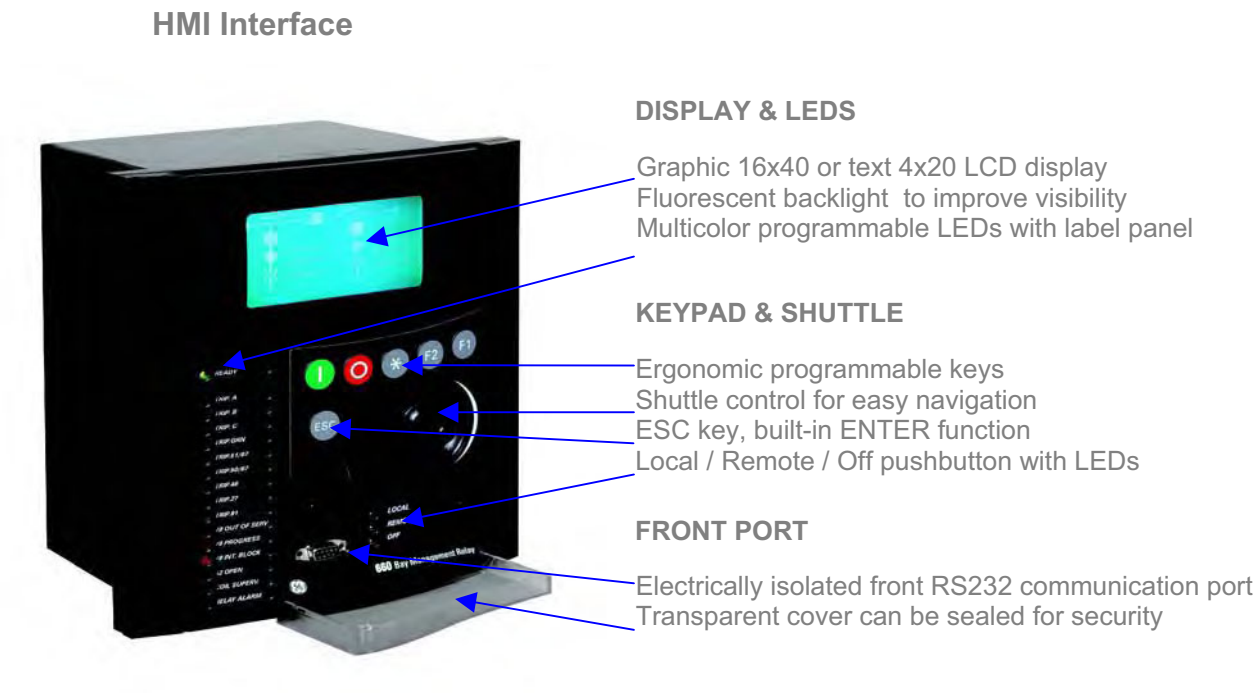


Figure 4-19: HMI interface, available for firmware versions 7.00 and below

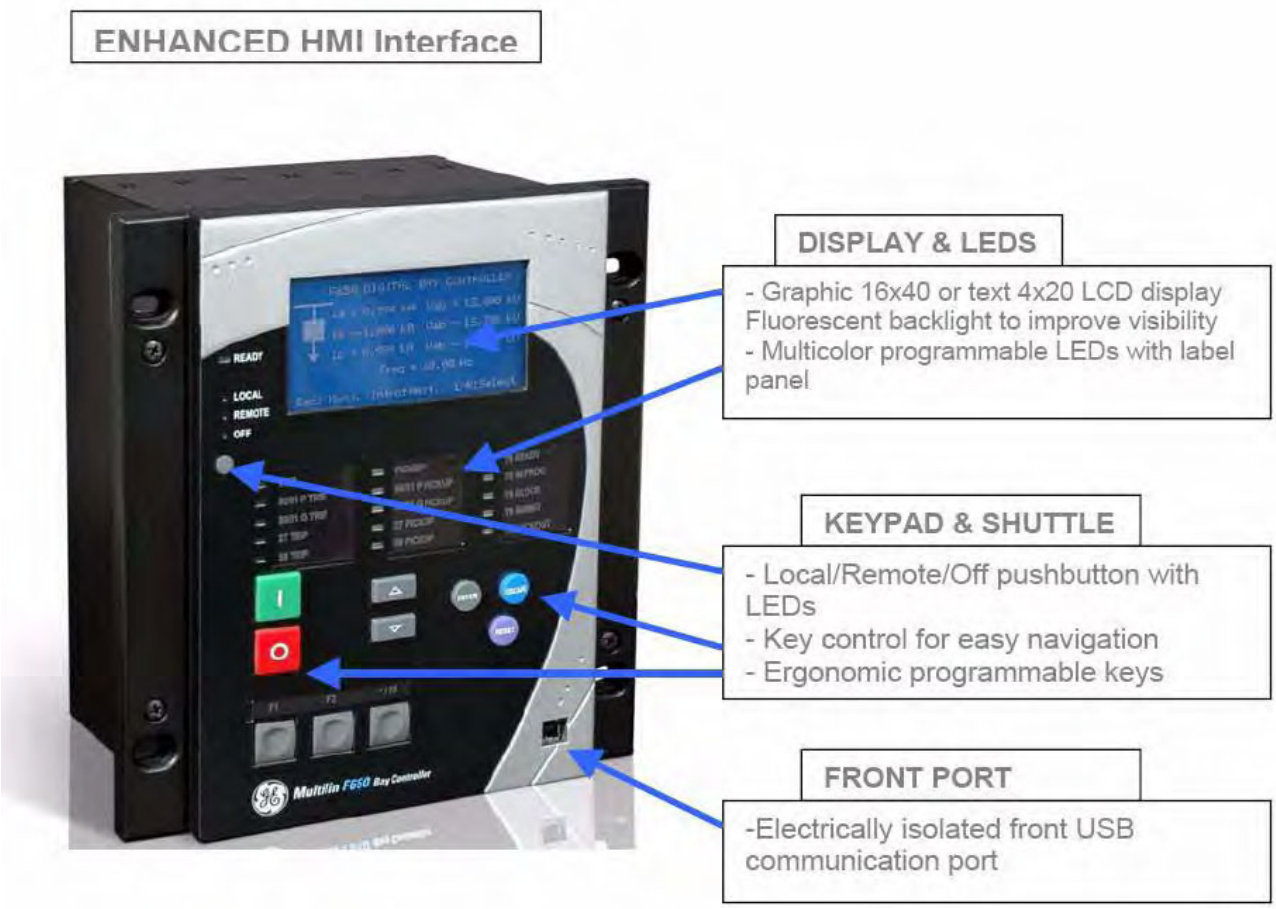


Figure 4-20: Enhanced HMI interface

4.2.1 Display

F650 units are available with two different options for the front display. The first option is an alphanumerical display of 4 lines with 20 characters each, and the second option is a graphical display of 16 lines with 40 characters each (128x240 pixels).

The boot code and firmware versions can be seen in the relay text main screen, this screen is the default screen in the text menu for all models: After the text “F650“, appears the relay firmware version (7.00 in the example), and between brackets the boot program version (7.00 in the example), followed by “General Electric”, the relay model and the default front port (COM2) communication parameters.

F650 7.00 (7.00)
General Electric
F650MZKF2G1HI6E
19200N81: MODBUS: 254

Figure 4-21: Text main screen

4.2.2 LED indicators

The relay provides 16 LED indicators, 15 user programmable plus one non-configurable LED (READY) that shows if the relay is in service.

Programmable LEDs are divided into groups of 5 LEDs, each of the groups having a different color. The first group of LED indicators is latched by hardware (red), usually configured for trip signals. The second group (yellow) and third group (green) of LED indicators are self-reset and will reset once the condition has been cleared. These LEDs can also be latched using logic through PLC configuration. For firmware version 7.20 and above, all 15 LEDs are latched through relay settings.

The ESC key is used to reset any latched LED indicator, once the condition has been cleared. Keep the ESC button pressed for more than 3 seconds; all LEDs light up, verifying their correct operation. When releasing the ESC key, all indicators programmed with memory, such as tripping LEDs, are reset. For models with enhanced display, there is a reset LEDs button dedicated for this purpose.

The latched conditions can also be reset via communications using the LED reset input (to configure this signal go to **Setpoint > Relay Configuration > Control Elements > LED RESET INPUT**). By default this LED reset input signal is set to LEDS RESET operation.

4.2.3 Pushbuttons

The front panel provides:

Push buttons: keypad (5 user programmable plus ESC/ESCAPE non configurable), shuttle key or keypad for easy navigation, command pushbutton to select operations mode.

RS232/USB port: intended for connection to a portable PC.

4.2.3.1 Keypad and shuttle key

I	This button can be used for closing the user-programmable switchgear. It is fully programmable by the user.
O	This button can be used for closing the user-programmable switchgear. It is fully programmable by the user.
*	User programmable.
F1	User programmable.
F2	User programmable.
ESC	(ESC) Escape key. When pressed for more than 3 seconds, it tests all LEDs and resets the trip LEDs.
	Rotary knob or Shuttle Key (it can be both rotated and pressed): Used for selecting menus, sub menus, settings and for confirmation. Press or rotate the shuttle key to enter the text main menu from the text standby screen.

Figure 4-22: Keypad and shuttle key description, basic display models (not enhanced)

Used for closing the user programmable switchgear. It is fully programmable.

Used for closing the user programmable switchgear. It is fully programmable.

F1. User programmable.

F2. User programmable.

F3 / *. User programmable.

Up Key. Used for selecting menus, submenus, and settings.

Down Key. Used for selecting menus, submenus, and changing values of settings.

Enter Key. Press to enter to submenus or to change values.

Escape key. Press key to exit from menus

Reset key. Press to test all LEDs and reset the trip LEDs.

Figure 4-23: Enhanced keypad description

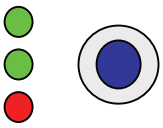
4.2.3.2 Command push button

The unit incorporates a command pushbutton located at the bottom right side of the HMI interface and at the top left for Enhanced interface, with three options: local, remote, and off. The first option (LOCAL) allows executing operations in local mode (HMI, front port, and rear COM2 port). The second option (REMOTE) allows operation execution only through remote communications (COM1 and ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model)). The third option (OFF) blocks the execution of operations. Each position is identified with an LED indicator, as follows:

LOCAL operations (green)

REMOTE operations (green)

OFF (red)



Press the command button to switch from local to remote operations mode and vice versa. OFF status (operation inhibited for maintenance and safety) can be reach pressing the commands pushbutton during several seconds (local-remote-off sequence).

The local-remote-off sequence can be also available through communications (see chapter 5.8), with a configurable signal that can be set in the **Setpoint > Relay Configuration > Control Elements** screen.

4.2.4 Front port and cover sealing system

The following Figure 4-24: Detail of front port and cover sealing system shows a detail of the front RS232 communication port and local/remote button access cover sealing system in basic (not enhanced) displays. The sealing system is similar to the one used in energy meters, using wire and plumb seal. High quality plastic have been used in the design to withstand extreme environmental conditions, both mechanical and electrical, sun radiation, humidity, etc. in order to guarantee a long life for the unit.

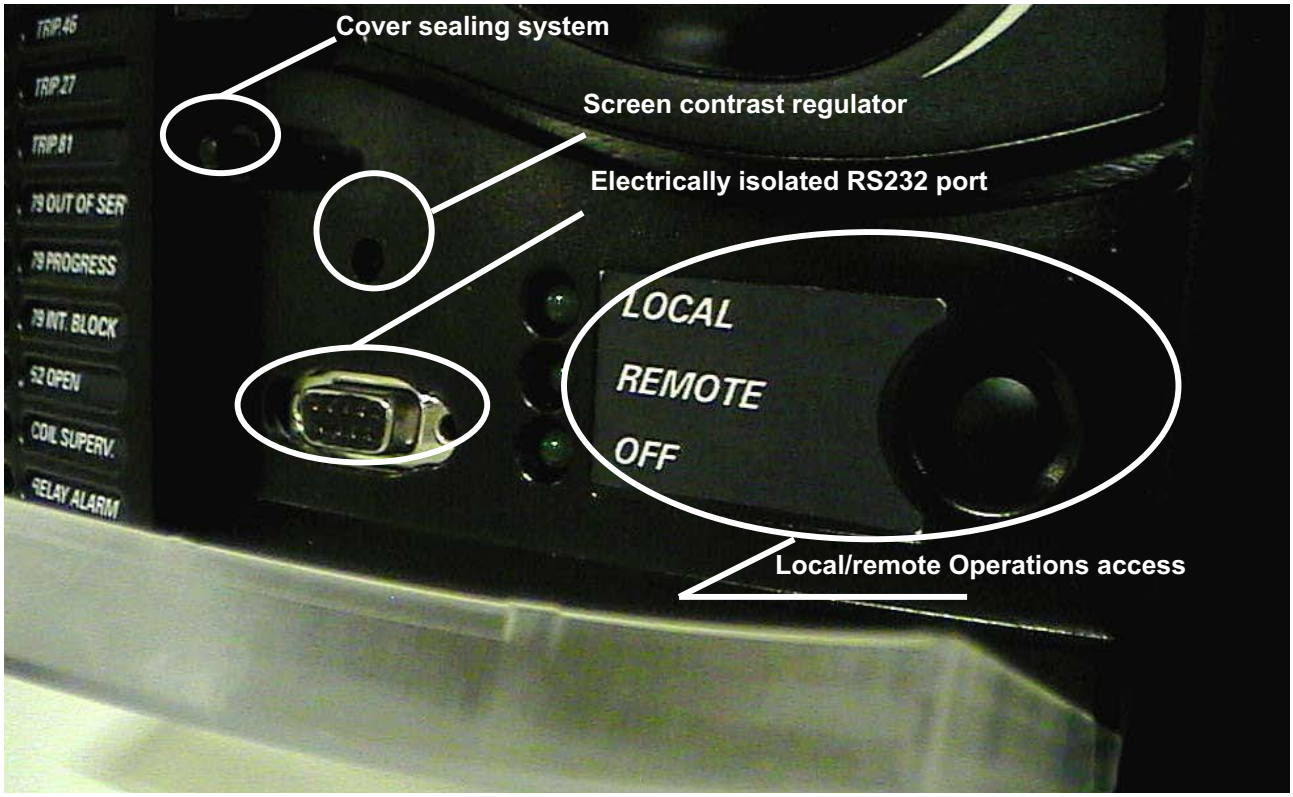


Figure 4-24: Detail of front port and cover sealing system

4.2.5 Screen contrast

Regulation of screen contrast should be performed as described below depend on display model selected:

Basic HMI: Dedicated screen contrast regulator is located below cover sealing system. See Figure 4-24: Detail of front port and cover sealing system.

Enhanced HMI: Back light level regulation can be performed by using enhanced keypad. Reset button must be pressed at the same time that the up or down key is pressed to increase or decrease the contrast.

4.2.6 Text menus

4.2.6.1 Navigation

Text menu is available for all models, this is the main menu for visualizing actual values, metering, changing settings, etc. through the HMI. In models with graphical display besides this text main menu there are several screens providing more performance for control purposes.

Press (or rotate left or right) the enter/shuttle key to enter the main menu, starting from the standby screen (default main screen). The default main screen can be accessed pressing ESC key until it appears. In all the navigation press the enter/shuttle key to select the desired header display (top-level menu). Each press of the enter/shuttle key advances through the main heading pages as illustrated below. To return to previous menus press the ESC key. To move inside the top-level menu without changing to other low levels, rotate the shuttle key left to move up and right to move down (or use up/down keys).

When rotating the shuttle key (or up/down keys) the selected menu is marked by a single scroll bar character. The mark (**>**) in the right part of any menu means that contains more than one level.

Symbol	Action Performed	Navigation in menu
ENTER	Press Shuttle Key	Enter next level
ESCAPE	Press Esc Key	Exit to previous level
⇧/⇩	Up-down keys	Move up and down in the same level
■	Menu selection	Menu selection
>	More menus to display	More menus to display

Figure 4-25: Text menu navigation Shows an example of main menu navigation:

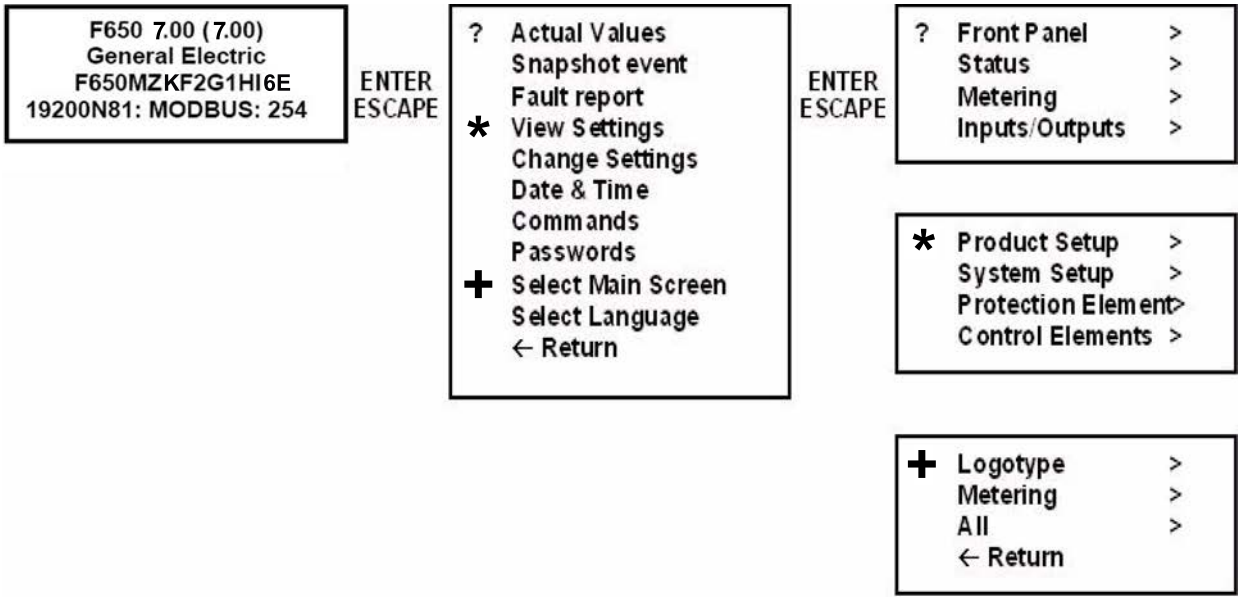


Figure 4-25: Text menu navigation

4.2.6.2 Text menu hierarchy

The structure of HMI text menu is similar to the EnerVista 650 Setup menu in the actual values and settings (view and change) menus. The main menu shows the following options:

Name	Description	Navigation in menu
Actual Values	Actual values of all the signals available in device. Status of protection and control elements, measurements, inputs and outputs, etc.	Press shuttle key or enter key to enter next level. Press ESC to return to default main screen.
Snapshot events	Visualization of all snapshot events in text mode (two screens for each snapshot event). In graphical displays there can be seen in a dedicated screen.	Press shuttle key or enter key to visualize snapshot events in text menu. Press ESC to return to default main screen.
Fault Report	Fault reports information available in HMI (two screens for each fault report)	Press shuttle key or enter key to enter next level. Move Up/Down to see all the available fault reports in device. Press shuttle key or enter key to enter particular information for fault report selected.
View Settings	Visualization of all protection and control settings available in device.	Press shuttle key or enter key to enter next level. Move Up/Down to select sub menu. Press ESC to return to previous level.
Change Settings	Menu that allows changing all protection and control settings available in device. Inputs and outputs settings, relay configuration and logic configuration are not available in HMI, only via EnerVista 650 Setup software.	Press shuttle key or enter key to enter next level. Move Up/Down to select sub menu. Press esc to return to previous level.
Date & Time	Date and time visualization and modification by user.	First mode is visualization. Press again shuttle key or enter key to start modification in date and time. Press ESC to return to previous level.
Commands	Operations execution in local mode.	Move Up/Down to preselect operation. Press shuttle key or enter key to select and confirm. Press ESC to return to previous level.
Password	Password menu for settings and commands	Move Up/Down to select submenu. Press shuttle key or enter key to enter next level. Press ESC to return to previous level.
Select Main Screen	Selection of default main screen in text menu.	Move Up/Down to select the default main screen type. Press shuttle key or enter key to confirm.
Select Language	Language selection. Between default language (see order code) and English.	Move Up/Down to select the default language. Press shuttle key or enter key to confirm selection. Switch the relay off and on.
< - return	Return to previous level	Press shuttle key or enter key to return to previous level.

4.2.6.3 Actual Values

The Actual Values menu option in HMI concentrates and displays all the status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc.

Front Panel >		
	LEDs	
Status >		
	Operation Bits	
	Breaker	
	Protection >	Protection Blocks Phase Current Neutral Current Ground Current Sens. Ground Current Neg. Seq. Current Thermal Model Voltage Power Voltage Power
	Control Elements >	Frequency Synchrocheck Autoreclose Breaker Failure VT Fuse Failure Broken Conductor Setting Groups Locked Rotor Pulse Counters Analog Comparators Load Encroachment Max. Number of starts Digital Counters Cold Load Pickup
	Switchgear Status >	Switchgear 1 Switchgear... Switchgear 16
	Calibration	
	FlexCurves	
	System Info	
	Records Status >	Fault Reports Control Events Oscillography Data logger Demand Energy Breaker Maintenance
	SNTP-IRIG_B-PTP	
	Versions	
	Redundancy	
Metering >		
	Primary Values >	Current Voltage Power Energy Demand

	Secondary Values >	Current Voltage Power
	Frequency	
Inputs/Outputs >		
	Contact Inputs >	Board F/ Board G/ Board H/ Board J
	Cont. Output St. >	Board F/ Board G/ Board H/ Board J
	Cont. Output Op. >	Board F/ Board G/ Board H/ Board J
	Cont. Output Rs. >	Board F/ Board G/ Board H/ Board J
	IO Board Status	
	Virtual Inputs >	Virtual Inp.Latched Virtual Inp.SR
	Virtual Outputs	
	Remote Outputs (for IEC61850 models only) >	DNA User St GOOSE Dig Outputs
	Remote Inputs for IEC61850 models only)>	Remote Input Remote Devices GOOSE Dig Inputs GOOSE Analog Inputs
	Analog Inputs >	Board F/ Board G/ Board H/ Board J
	Virtual out. Latched	
	Virtual out. Analogue	

To enter this menu press the shuttle key or enter key when the option Actual Values is selected in main menu. A secondary level is displayed with different sub levels as shown on . Pressing Up/down keys or rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the enter/shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation is performed the same for all the menus in Actual Values. Once the last sub level is reached, move up and down to visualize the actual values selected.

One example of data screen for actual values is shown in Figure 4-26: Actual values screen data.

First Line: Header of last level in actual values (Phase Current in the example)

Second Line: Data identifier (in the example PH IOC1 HIGH A, is the pickup signal for the first instantaneous overcurrent function level high for phase A).

Third line: Status of the displayed actual value.

Fourth Line:Relative position in the menu (it is the first value of 114)

Phase Current
PH IOC1 HIGH A PKP
OFF
(1/114)

Figure 4-26: Actual values screen data

In the Actual Values menus are different types of data; each type of data displays its particular status type (on and off, 0 or 1, OK or fail, analog values, etc.)

4.2.6.4 Snapshot events

To enter this menu press the enter/shuttle key when the option Snapshot events is selected in main menu (). In this menu all the snapshot events stored can be displayed.

Snapshot events are changes in the relay internal status.

One snapshot event is displayed in two text screens:

The first screen display the status, date and time of the snapshot event: the snapshot event identifier, its status, event number and the date and time of the occurrence. If the snapshot event identifier does not fit the first line, the whole text is shown using as well the second line alternating with the status and event number.

The second screen displays currents and voltages in primary values for that particular snapshot event. Ia, Ib, Ic and Ig for currents and Vab, Vbc, Vca and V0 for voltages. To access the metering screen in snapshot events menu, press shuttle key from the snapshot event first screen. To exit from the metering screen press ESC.

To select different snapshot events to be displayed, press the up-down keys or rotate the shuttle key to select the snapshot event and then press the enter/shuttle key to enter the metering screen. Press esc to exit the metering screen and return to snapshot events menu.

Figure 4-27: Snapshot event navigation HMI shows an example of snapshot events navigation:

Press enter/shuttle key from the default main screen and enter in the main text menu.

Move the shuttle key or press up-down keys until a single scroll bar character (o) appears in the left part of Snapshot event header.

Press enter/shuttle key to enter in the snapshot events menu)

Select the snapshot event to display using the up/down keys or shuttle key (left and right to move up and down inside the recorded snapshot events).

Once selected the snapshot event, identifier, status, date and time are displayed.

In the second line St: is showing the status and the relative snapshot index from the whole recorded number. Third and fourth lines are used to display the time and date of the snapshot event.

Pressing the enter/shuttle key the metering screen for the snapshot event is displayed.

To exit from this screen press the ESC key and return to the snapshot events menu.

Figure 4-27: Snapshot event navigation HMI

4.2.6.5 Fault report

To enter the **Fault Report** menu, press the enter/shuttle key when the option Fault report is selected in main menu (). This menu displays information about the last ten faults recorded in the relay.

The relay HMI can handle fault reports stored in the relay in two different ways:

1. Show fault warning messages on the HMI display when the fault is produced. This option is disabled by default. To enable the display of warning messages from the HMI go to the menu **Change Settings > Product Setup > Fault Report > Show Fault On HMI** and select **Enable**.
2. Save information from the last ten faults in the relay. View in the **HMI Fault Report** menu

In the first option, when a fault occurs a warning message is displayed including information about the fault in two screens, one with general fault information, and a second with the measured values at the time the fault occurred.

The fault-warning message must be acknowledged by the user before performing any other operation. In the event of several consecutive faults, the HMI shows the most recent fault, however the user needs to acknowledge all faults (up to a maximum of ten faults).

In the second option, fault reports can be viewed through the HMI Fault Report menu accessed by pressing the enter/shuttle key. The display shows information from the last ten faults, including both general information and metering screens for each fault. Displayed information starts with the most recent fault, and previous faults can be viewed by rotating the enter/shuttle key.

Displayed information is stored in the relay volatile memory, so if the relay is turned off this information is lost, as also happens if a **Clear Fault Report** command is executed. However, saved fault reports stored in the relay non-volatile memory remain after the Fault reset, and can be obtained from the relay using the EnerVista 650 Setup software, **Actual > Records > Fault report**.

If there is no fault report available through the display, the relay shows a **Fault report not available** message.

The format of the displayed screens is as follows:

```
Actual Values
Snapshot event
□ Fault report
View settings
```

Select the Fault report menu in text menu

```
ENTER
ESCAPE
```

```
Fault Report #1
 NAF   dist:    0.00
 Time: 09:21:40.545
 Date: 07/Nov/2004
```

If there is more than one fault record press the up-down keys or rotate the shuttle key and select the desired record to be displayed.

```
↑–↓
```

```
Fault Report #2
 NAF   dist:    0.00
 Time: 09:22:03.047
 Date: 07/Nov/2004
```

First screen with general fault information: Fault report #number, fault type, distance and date and time.

```
ENTER
ESCAPE
```

```
Fault Report #2
Ia    0.00    Vab    0.00
Ib    0.00    Vbc    0.00
Ic    0.00    Vca    0.00
```

Second screen with metering data for that fault record. All this data is a summary from the fault report file that can be retrieved via EnerVista 650 Setup software.

Figure 4-28: Fault report navigation in HMI

Possible fault types are as follows:

GROUND	Ground faults
	AG phase A to ground ABG phase AB to ground BG phase BG to ground BCG phase BCG to ground CG phase CG to ground CAG phase CAG to ground
PHASE	Phase to phase faults
	AB phase A to phase B BC phase B to phase C CA phase C to phase A
3PHASE	Three-phase faults (shown on the display as 3PH)
NAF	Fault type not calculated

4.2.6.6 View settings menu

To enter this menu press the enter/shuttle key when the option **View Settings** is selected in main menu (o). A secondary level is displayed with different sub levels. Pressing up-down keys or rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed (o), press the enter/shuttle key again to enter in next level and press esc key to return to previous level if desired. This navigation is performed the same for all the menus in "View Settings". Once the last sub level is reached, move up and down to see the available settings.

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
Product Setup >			
	Communication >		
		Serial Ports	
		Ethernet >	Ethernet A Ethernet B Ethernet E Redundancy
		ModBus Protocol	
		DNP3 Slave (Available for standard and IEC61850 models) >	DNP3 Slave 1..3
		IEC 870-5-104(Available for standard and IEC61850 models) >	
		SNTP	
		PROCOME (Available for procome models only).	
		PTP 1588	
		Routing	
	Fault Report		
	Oscillography		
	Demand		
	Time Settings		
System Setup >			
	General Settings		
	Breaker >	Breaker Settings Breaker Maintenance	
	Misc. settings		
Protection Element > (*) See note			
	Phase Current >		
		Phase TOC High >	Phase TOC High 1..3
		Phase TOC Low >	Phase TOC Low 1..3
		Phase IOC High >	Phase IOC High 1..3
		Phase IOC Low >	Phase IOC Low 1..3
		Phase Directional >	Phase Directional 1..3
		Thermal Model >	Thermal Model 1..3
	Neutral Current >		
		Neutral TOC >	Neutral TOC 1..3
		Neutral IOC >	Neutral IOC 1..3
		Neutral Dir >	Neutral Dir 1..3
	Ground Current >		
		Ground TOC >	Ground TOC 1..3
		Ground IOC >	Ground IOC 1..3
		Ground Dir >	Ground Dir 1..3
	Sens. Ground Curr >		
		Sens. Ground TOC >	Sens. Ground TOC 1..3

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL
		Sens. Ground IOC >	Sens. Ground IOC 1..3
		Isolated Gnd IOC >	Isolated Gnd IOC 1..3
		Sens. Ground Dir >	Sens. Ground Dir. 1..3
	Neg. Seq. Current >		
		Neg. Seq. TOC >	Neg. Seq. TOC 1..3
	Voltage Elements >		
		Phase UV >	Phase UV 1..3
		Phase OV >	Phase OV 1..3
		Neutral OV High >	Neutral OV High 1..3
		Neutral OV Low >	Neutral OV Low 1..3
		Neg. Seq. OV >	Neg. Seq. OV 1..3
		Auxiliary OV >	Auxiliary OV 1..3
		Auxiliary UV >	Auxiliary UV 1..3
	Power >		
		Forward Power >	Forward Power 1..3
		Directional Power >	Directional Power 1..3
		Watt Gnd Flt High >	Watt Gnd Flt High 1..3
		Watt Gnd Flt Low >	Watt Gnd Flt Low 1..3
Control elements > (*) See note			
	Setting Group		
	Underfrequency >	Underfrequency 1..6	
	Overfrequency >	Overfrequency 1..6	
	Synchrocheck		
	Autoreclose		
	Breaker Failure		
	VT Fuse Failure.		
	Broken Conductor >	Broken Conductor 1..3	
	Locked Rotor >	Locked Rotor 1..3	
	Fq Rate of Change	Fq Rate of Change 1..3	
	Load Encroachment	Load Encroachment 1..3	
	Max. Num of starts		
	Cold Load Pickup		
	PLC Timer Masks		

(*) This menu changes as indicated in table 4.35 for firmware version 7.50 or above.

Table 4-13: Protection Element and control element menu for firmware version 7.50 or above

MAIN SETTINGS MENU	FIRST LEVEL	SECOND LEVEL	THIRD LEVEL	MAIN SETTINGS MENU
Protection Element >				
	Setting Group X >			
		Phase Current >		
			Phase TOC High >	Phase TOC High 1..3
			Phase TOC Low >	Phase TOC Low 1..3
			Phase IOC High >	Phase IOC High 1..3
			Phase IOC Low >	Phase IOC Low 1..3
			Phase Directional >	Phase Directional 1..3
			Thermal Model >	Thermal Model 1..3
		Neutral Current >		

			Neutral TOC >	Neutral TOC 1..3
			Neutral IOC >	Neutral IOC 1..3
			Neutral Dir >	Neutral Dir 1..3
		Ground Current >		
			Ground TOC >	Ground TOC 1..3
			Ground IOC >	Ground IOC 1..3
			Ground Dir >	Ground Dir 1..3
		Sens. Ground Curr >		
			Sens. Ground TOC >	Sens. Ground TOC 1..3
			Sens. Ground IOC >	Sens. Ground IOC 1..3
			Isolated Gnd IOC >	Isolated Gnd IOC 1..3
			Sens. Ground Dir. >	Sens. Ground Dir. 1..3
		Neg. Seq. Current >		
			Neg. Seq. TOC >	Neg. Seq. TOC 1..3
		Voltage Elements >		
			Phase UV >	Phase UV 1..3
			Phase OV >	Phase OV 1
			Neutral OV High >	Neutral OV High 1..3
			Neutral OV Low >	Neutral OV Low 1
			Neg. Seq. OV >	Neg. Seq. OV 1..3
			Auxiliary OV >	Auxiliary OV 1..3
			Auxiliary UV >	Auxiliary UV 1
		Power >		
			Forward Power >	Forward Power 1..3
			Directional Power >	Directional Power 1..3
			Watt Gnd Flt High >	Watt Gnd Flt High 1
			Watt Gnd Flt Low >	Watt Gnd Flt Low 1..3
		Frequency >		
			Underfrequency >	Underfrequency 1..6
			Overfrequency >	Overfrequency 1..6
			Fq Rate of Change >	Fq Rate of Change 1..3
		Miscellaneous >		
			Broken Conductor >	Broken Conductor 1..3
			Locked Rotor >	Locked Rotor 1..3
			Load Encroachment >	Load Encroachment 1..3
Control Elements >				
	Setting Group			
	Synchrocheck			
	Autoreclose			
	Breaker Failure			
	VT Fuse Failure.			
	Max. Num of starts			

Cold Load Pickup			
PLC Timer Masks			
60 CTS Failure			
2nd HRMC Inhibit			

4.2.6.7 Change Settings

To enter this menu press the enter/shuttle key when **Change Settings** is selected in main menu. A secondary level is displayed with different sublevels. Press up-down key or rotating the shuttle key, (left for moving up and right for moving down) select the next level to be displayed, press the enter/shuttle key again to enter in next level and press ESC key to return to previous level if desired. This navigation is performed the same for all the menus in **Change Settings**. Once the last sub levels is reached, move up and down to visualize the settings selected.

To change a particular setting, press the enter/shuttle key on the setting to be modified. After selecting the setting, the value for that setting appears between brackets. Choose the new value moving up and down. After selecting the appropriate value press again the enter/shuttle key to fix that value. To save the new settings, go to the end of the menu pressing down key or rotating the shuttle key right, and select **Press Enter to save settings**. When pressing the shuttle key inside this menu the new settings is saved.

```
  Snapshot event
  Fault report
  View settings
□ Change settings
```

Select the menu Change settings and press the enter/shuttle key to enter in the next sub levels.

```
  Product Setup        >
□ System Setup         >
  Protection Elements  >
  Control Elements     >
```

If there is more than one sub levels, select the next sub level by pressing the up-down keys or rotating and pressing the enter/shuttle key until the last level is reached.

```
□ General Settings
  Breaker              >
  <- return
```

Press the enter/shuttle key in the function to be modified

```
Phase CT Ratio
1
--
[ 1:6000:1]
```

-> Group of settings

-> Setting to be modified

-> Value

-> Range and step

```
Phase CT Ratio
1
20
[ 1:6000:1]
```

Pressing the enter/shuttle key, value appears between brackets and can be modified pressing the up-down keys or rotating the shuttle key. Pressing again the enter/shuttle key, the new value is accepted.

```
Press Intro
to save settings
```

Once all settings inside the group have been modified, go to the last screen pressing the down key or rotating the shuttle key and press Enter. At this moment of time, the new settings is active in the relay.

Figure 4-29: Change settings in HMI

4.2.6.8 Date & time

The “Date & Time” menu shows the relay date and time information in the following format:

DST: Daylight Saving Time information

Date:Day/Month/Year

Time:Hour:Minutes:Seconds

To modify date and time, press the enter/shuttle key. The relay shows the year between brackets at the top of the screen. By pressing the up-down keys or rotating the shuttle key, reach the desired value for the year, and press the enter/shuttle key to select and store that value. After the year, the relay shows the month. Proceed as in the case of the year. The date & time modification sequence is as follows:

```
Fault report
View settings
Change settings
□ Date & Time
```

Press the up-down key or rotate the shuttle key to select the “Date and Time” menu and press to enter in it

The date and time data appear in the format described above.

```
Date:  07/Nov/2004
Time: 14:39:54
Sunday
```

Pressing the enter/shuttle key the year can be modified pressing up-down key or rotating the shuttle key, after selecting the desired value, press again the enter/shuttle key to store the value.

```
'Year'
Date:  07/Nov/<2004>
Time: 14:39:54
```

“Year”

Date:Day/Month/**<Year>**

Time:Hour:Minutes:Seconds

After storing the value for Year, Month appears between brackets and can be modified

```
'Month'
Date:  07/<Nov>/2004
Time: 14:39:54
```

“Month”

Date:Day/<**Month>**/Year

Time:Hour:Minutes:Seconds

After storing the value for Month, Day appears between brackets and can be modified

```
'Day'
Date:  <07>/Nov/2004
Time: 14:39:54
```

“Day”

Date:<**Day**>/Month/Year

Time:Hour:Minutes:Seconds

After storing the value for Day, Hour appears between brackets and can be modified

```
'Hour'
Date:  07/Nov/2004
Time: <14>:39:54
```

“Hour”

Date:Day/Month/Year

Time:<**Hour**>:Minutes:Seconds

After storing the value for Hour, Minutes appears between brackets and can be modified

```
'Minute'
Date:  07/Nov/2004
Time: 14:<39>:54
```

“Minute”

Date:Day/Month/Year

Time:Hour:<**Minute**>:Seconds

After storing the value for Minutes, Seconds appears between brackets and can be modified

```
'Second'
Date:  07/Nov/2004
Time: 14:39: <54>
```

“Second”

Date:Day/Month/Year

Time:Hour: Minute:<**Seconds**>

Once this sequence is completed, these values remain stored in the relay, and the display once again shows the date at the bottom of the text screen.

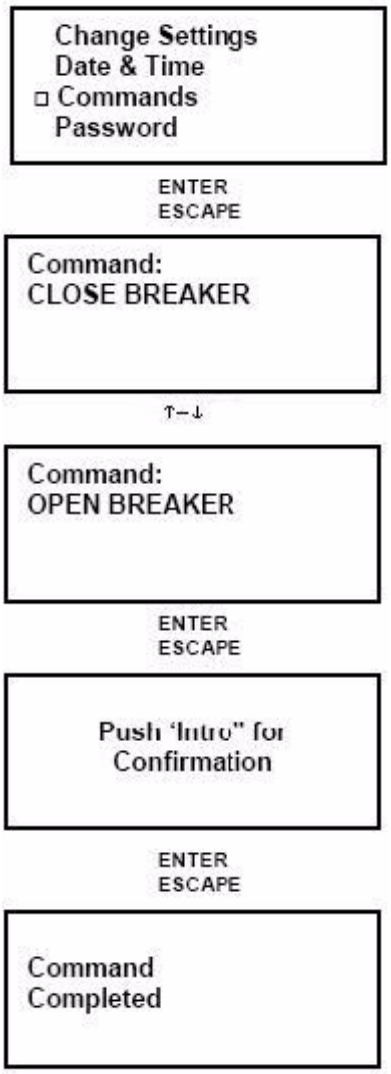
Figure 4-30: Change date & time in HMI

4.2.6.9 Commands

Commands are configured using EnerVista 650 Setup, and they can be executed using the pushbuttons on the relay front.

Use the EnerVista 650 Setup software to configure up to 24 commands with a descriptive text. When executing the operations from the relay front panel, the operation description is displayed.

Example of commands (operations) executions via HMI



Press the enter/shuttle key when **Commands** is selected in the display (o).

All the previously configured commands are displayed. Press up-down keys or rotate the shuttle key to move through the available commands. Press ESC to return to previous level.

Press the enter/shuttle key to pre-select the operation to execute.

When the message **Push Enter for Confirmation** appears, press the enter/shuttle key to confirm.

Once the command has been performed or the time out has expired the **Command completed** message is shown on the display.

Figure 4-31: Commands in HMI

4.2.6.10 Passwords

The F650 units incorporate independent passwords for protection and control, in order to prevent unauthorized keypad and display access to the relay.

Settings Password:

This password restricts access to settings changes in the relay protection elements.

Commands Password:

This password restricts access to executing operation commands through the keypad and display.

If the Commands Password is activated, when the user tries to execute an operation, the relay requests this password. When using single-line diagrams for graphical display models, all objects are not operational until the password is entered, either by logging in to **Login Pwd Commands**, or by entering the password in the **Commands** menu.

Relay settings view, measures, and other monitored information are not password-protected, and can be accessed by all users.

The password menu is located at the **Password** option in the relay text menu. This menu includes the following options:

"Login Pwd Settings"

"Logout Pwd Settings"

"Change Pwd Settings"

"Login Pwd Commands"

"Logout Pwd Commands"

"Change Pwd Commands"

"Forgot Password?"

Among the available options in this menu, there are three types of functionality:

Login:	For entering the password, either for settings or commands, and enable access to settings or commands. Once entering the password the relay is no longer password protected, and access is enabled to settings modification or commands execution.
Logout:	Once the necessary setting changes or operation commands have been executed, the user can log out, so that the relay is password protected again.
Change:	Setting or modifying the desired password.
Forgot Password:	Retrieves the encrypted password, so that it can be recovered if the user loses or forgets it.

Passwords are restricted for Settings change and Commands execution. To password-protect the relay, it is first necessary to set the desired password, using the corresponding **Change Pwd...** menu. The default password is **0000**. This password provides access to the whole relay functionality.

Once a new password has been set, the user must log in to access the protected functionality; otherwise, the relay requests the password when trying to change settings or execute commands. Once the password is entered the relay is unprotected (as if the user had logged in), and remains so for 15 minutes of inactivity or until the user logs out.

Password range

The valid range for F650 passwords is a number from 0000 to 9999.

The default password is 0000, which provides access to the whole relay functionality. This is the default option for enabling relay use without using passwords.

Entering passwords (Login PWD)

This operation is the same for both the settings and commands passwords. The only difference is the access menu. For entering the password, the user must access the **Login** menus inside the **Password** menu.

Login Pwd Settings or *Login Pwd Commands:*

The relay requests the password with the following message on the screen:

Setting passwd.

Login: < 1000 >

For entering the desired password, the user must press up-down key or rotate the shuttle key to the left (decrease) or to the right (increase), and establish the desired number. Once entered, the selected password between brackets has been entered, the relay shows the message **"Processing passwd. Wait..."**. If the password is correct, the relay allows access to the settings change or command execution. It is not necessary to enter the password every time a change is to be performed. The relay requests the password again after 15 minutes of inactivity. This period of time is the same that takes the relay to turn off the display back-lighting.

Logging out (Logout PWD)

To disable access to settings and commands, the user must logout.

Logout Pwd Settings or *Logout Pwd Commands:*

For safety reasons, the relay automatically logs out the active user 15 minutes after the last keypad action.

Changing the password (Change PWD commands)

To set a password in the relay, both for settings and commands, the corresponding menu must be accessed inside the **Password** menu:

Change Pwd Settings or *Change Pwd Commands:*

To change the password, the user must first log in with the existing password; if the relay has the default factory password, this would be 0000.

The relay requests the existing password with the following message:

(Setting or Command) passwd.

Login: < 0000 >

Once the existing password has been acknowledged, the new password must be entered:

(Setting or Command) passwd.

New passwd: < 1000 >

Once the new password has been entered, the relay returns to the general Passwords menu.

Service Command for password recovery

In the event of losing all passwords, the Service Command allows the customer to reset both Settings and Commands HMI Passwords.

1. Customer must call the customer support service.
2. A secret key will be provided by customer support to facilitate the reset
3. At the moment, the HMI has no passwords for Settings and Commands. The customer can reintroduce new passwords.

4.2.6.11 Select main screen

The relay display offers the possibility to select the default main screen. For this purpose, the user must access **Select Main Screen** through the HMI. This menu includes the following options:

Logotype

This option selects as main screen the relay logotype including the firmware and boot code versions, the relay model and the communication parameters for local port COM2.

```
F650 7.00 (7.00)
General Electric
F650MZKF2G1HI6E
19200N81: MODBUS: 254
```

Figure 4-32: Default logotype screen

Metering

This option shows a Metering screen including the phase and ground currents as well as phase-to-phase voltage, and zero sequence voltage values, all of them in primary values.

```
Ia  0.000     Vab  0.000
Ib  0.000     Vbc  0.000
Ic  0.000     Vca  0.000
Ig  0.000     V0   0.000
```

Figure 4-33: Default metering screen

All

This option alternates in time the two previous options.

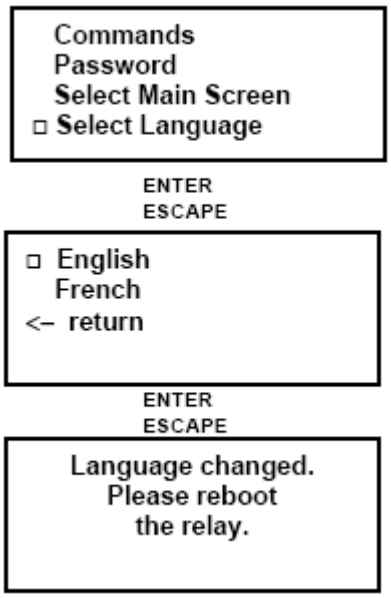
4.2.6.12 Select language

Option only available for versions 1.70 or higher than 5.20.

The relay display offers the possibility to select the default language for the relay. For this purpose, the user must access the "***Select language***" menu located at the end of the main menu through the HMI. This menu allows the user to set the default language of the relay between English (always available) and second language selected in the relay model.

For example one relay in French language (e.g. FC650MZDF2G1HIR**F**) can be displayed in French or in English only by changing the language setting in HMI. It is necessary to switch off and on the relay to start working with the new language configuration in the relay. In EnerVista 650 Setup it is possible to select the language for the software (**View > Languages**).

Example of language selection in HMI



Press the enter/shuttle key to enter the select language menu.

Depending on the relay model there are different language selections available: English/French, English/ Russian, etc.

Press up-down keys or rotate the shuttle key to select the desired language and press enter to store the selection in the relay

Once the new language has been selected it is necessary to reboot the relay in order to start working with the new language in the device.

Figure 4-34: Language selection in HMI

4.2.7 Graphic display

4.2.7.1 One-line diagram

In models with graphic display default main screen is the single-line diagram. This single-line diagram can be configured using EnerVista 650 Setup software by choosing the **HMI** menu inside **Relay Configuration** (**Setpoint > Relay Configuration > HMI**).

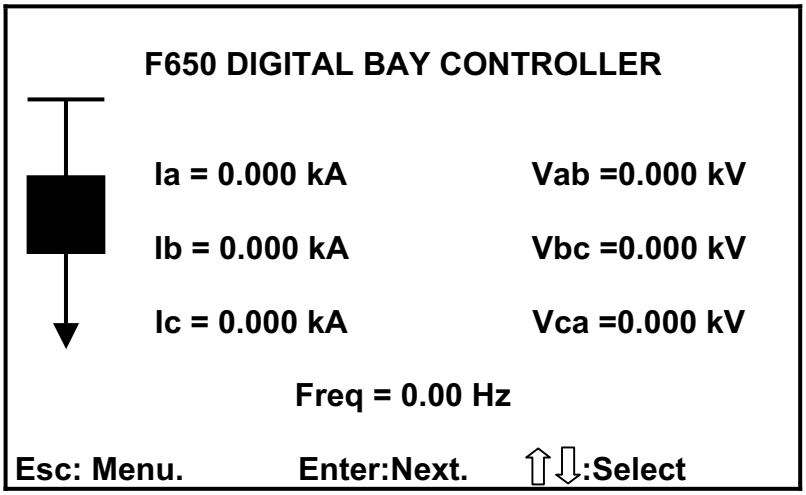


Figure 4-35: One-line diagram

The bottom of the display shows a legend that indicates the possible selections that can be made from this screen.

Esc: Menu. **Enter: Next.** **⇧⇩ : Select.**

The meaning of these options is as follows:

Esc: Menu.

Press the ESC key to access the relay main menu, similar to the one displayed by the text-display model (F650B).

Press the ESC key again and the menu selection screen (Actual Values, Snapshot events, etc.) is displayed. This main menu screen is identical to the one described for the text display, with functionality described in section 4.2.6 Text menus.

Intro: Next.

Press the enter/shuttle key to access the next graphical screen, which in this case corresponds to the primary metering values screen.

⇧⇩ : Select

Once the different switchgear elements have been configured using EnerVista 650 Setup, they can be operated from the graphic display.

If a single-line diagram has been configured in the EnerVista 650 Setup software, in the HMI option inside the ***Relay Configuration*** menu, the different switchgear elements configured for the display are operative from the graphic display. By pressing the up-down key or rotating the shuttle key to the left and right, the cursor moves among the elements and blinks on each of them. When an element is selected by pressing the enter/shuttle key, the relay indicates the command to be executed, and the user needs to confirm by pressing the enter/shuttle key.

The following sections describe only the operation of screens that are specific for the graphic display models.

4.2.7.2 Metering screen

The Metering screen displays relay analog measures in their primary values. Available metering values are as follows:

Metering Screen.	Total metering 53
Phasor Ia Primary	0.000 KA
Phasor Ib Primary	0.000 KA
Phasor Ic Primary	0.000 KA
Phasor Ig Primary	0.000 KA
Phasor Isg Primary	0.000 KA
RMS Ia Primary	0.000 KA
RMS Ib Primary	0.000 KA
RMS Ic Primary	0.000 KA
RMS Ig Primary	0.000 KA
RMS Isg Primary	0.000 KA
I0 Primary	0.000 KA
Enter: Next. ESC: Prev	⇧⇩:Scroll.

Figure 4-36: METERING SCREEN

As in the rest of graphical display screens, the bottom part shows a legend that indicates the possible options for the user. In this case, the options are:

Enter: Next.Esc: Prev. ⇧⇩ : Scroll.

Intro: Next.

Pressing the enter shuttle key the user accesses the next screen, in this case the ALL EVENTS screen.

Esc: Prev.

Pressing the ESC key the user returns to the previous screen (One-line diagram)

⇧⇩ : Scroll.

Pressing the up-down key or rotating the shuttle key to the left (L) or right (R) the user can access all the Metering values in the screen.

METERING SCREEN ANALOG MEASURES IN PRIMARY VALUES			
Phasor Ia Primary	V0 Primary	Phase A Real Pwr	Line Frequency Primary
Phasor Ib Primary	V1 Primary	Phase B Reactive Pwr	Bus Frequency Primary
Phasor Ic Primary	V2 Primary	Phase B Apparent Pwr	Vx Primary
Phasor Ig Primary	Vab Primary	Phase B Real Pwr	Pos MVarhour Freeze
Phasor Isg Primary	Vbc Primary	Phase C Reactive Pwr	NegMVarhour Freeze
Phasor In Primary	Vca Primary	Phase C Apparent Pwr	PosMWatthour Freeze
RMS Ia Primary	Vn Primary	Phase C Real Pwr	Neg MWatthour Freeze
RMS Ib Primary	Va Primary	3 Phase Reactive Pwr	Positive MVarhour
RMS Ic Primary	Vb Primary	3 Phase Apparent Pwr	Negative MVarhour
RMS Ig Primary	Vc Primary	3 Phase Real Pwr	Positive MWatthour
RMS Isg Primary	VL Primary	Phase A Power Factor	Negative MWatthour
I0 Primary	VBB Primary	Phase B Power Factor	% of Load-to-trip
I1 Primary	Phase A Reactive Pwr	Phase C Power Factor	
I2 Primary	Phase A Apparent Pwr	3 Phase Power Factor	

4.2.7.3 All events screen

This screen shows all events that have been produced in the relay. The top of the screen shows its name (All Events), and the relative and total number of events contained in the screen.

All Events (1/479) or (1/511 for Firmware version 7.20 or higher)

This legend means that there are a total of events stored in the relay, and that the cursor is located on event number 1. The information shown on this screen for each event is as follows:

"Hour:Minute:Second:Millisecond" "Event text" "Event status (ON/OFF)"

```
All Events (1/479).
                    - [ Ready LED ON ] -
16:11:08.035  Ready LED ON                  ON
16:11:08.017  Breaker Closed ON             ON
16:11:08.005  Isolated Gnd3 Block OFF       OFF
16:11:08.005  Isolated Gnd2 Block OFF       OFF
16:11:08.005  Isolated Gnd1 Block OFF       OFF
16:11:08.005  Sens Gnd TOC3 Block OFF       OFF
16:11:08.005  Sens Gnd TOC2 Block OFF       OFF
16:11:08.005  Sens Gnd TOC1 Block OFF       OFF
16:11:08.005  Ground TOC3 Block OFF         OFF
16:11:08.005  Ground TOC2 Block OFF         OFF
16:11:08.005  Ground TOC1 Block OFF         OFF
Esc: Prev.          Enter: Menu.          ⇧⇩: Scroll.
```

Figure 4-37: All events screen

The screen legend options are:

Esc: Prev. Enter: Menu. ⇧⇩ : Scroll.

Esc: Prev.

Pressing the ESC key, the user returns to the previous screen (Metering screen)

Intro: Menu.

Pressing the enter/shuttle key, the user accesses the Events menu that offers the following options at the bottom of the screen:

nextprevreloaddetailsAt

To access the different options in the snapshot events graphic menu the user must move the cursor from up to down or from left to right. The selected option is displayed in upper case and between brackets. To access the selected option, the user must press again the enter/shuttle key.

<NEXT>

The user accesses the next available graphic screen (Events ,Äì New)

<PREV>

This option returns to the general events graphic menu (All Events)

<RELOAD>

This option updates all events stored in the relay and returns to the general events screen.

<DETAILS>

The Details screen provides access to metering values, and date and time related with the event.

The top of the screen displays a legend with the event text, followed by the date and time, the event status (ON or OFF), and the event index number related to the complete list of events in the relay, for example (1/479). The rest of information provided by the Details screen corresponds to the relay measures in the moment of the event. Metering values provided in the events are secondary, and voltage values correspond to phase-to-ground voltage.

```
                    Ready LED ON
Date:   07/Nov/2004                 St:ON
Time:   16:11:08.035                (1/479)

Phasor Ia Primary                   0.000
Phasor Ib Primary                   0.000
Phasor Ic Primary                   0.000
Line Frequency                      0.000
Phasor Ig Primary                   0.000
Phasor Isg Primary                  0.000
I0 Primary                          0.000
I1 Primary                          0.000

Enter: Meters.      ESC: Prev       ⇧⇩: Scroll.
```

Figure 4-38: Snapshot events details screen

To navigate this screen the user must follow the legend at the bottom of the screen:

Enter: Meters. **ESC: Prev.** ⇧⇩ **: Scroll.**

Intro: Meters.

To access the metering values in the moment of the event, the user must press the enter/shuttle key. A new metering screen is displayed, containing the primary metering values in the snapshot event, such as:

Phasor Ia Primary	I2 Primary
Phasor Ib Primary	Vab Primary
Phasor Ic Primary	Vbc Primary
Line Frequency Primary	Vca Primary
Phasor Ig Primary	V1 Primary
Phasor Isg Primary	V2 Primary
I0 Primary	V0 Primary
I1 Primary	3 Phase Power Factor

Once inside the Metering screen, a new legend is shown for each event (Intro or ESC: Prev. U-D (L-R: Scroll); press ESC or the shuttle key to return to the Event Details screen, and press the up-down key or rotate the shuttle key to access all the metering values contained in the metering screen of the selected event.

ESC: Prev.

If the user presses the ESC key from the event detail screen, the system returns to the all events screen.

⇧⇩: Scroll.

Pressing the up-down key or rotating the shuttle key left (L) or right (R) moves among all the events contained in the all events screen, allowing a preview of the details for each of them.

<AT>

When this option is selected, the system marks the event where the cursor is located. A relative time stamp is performed, in such a way that the selected event, marked with an asterisk (*) between the time and the event name is set with a relative time of 00:00:00:000 on the top line of the event screen, together with its relative index, and the rest of events in the screen shows a date/time that relates to the marked event. This operation mode allows a quick inspection of the relative time passed between several events, which is very useful for analyzing events in the field. The corresponding legend to this relative event-marking screen is as follows:

Esc: Out At.Enter: Tag event.

Esc: Out At.

The relative event marking is eliminated and the system returns to the general events screen.

Enter: Tag event.

If the user places the cursor on a different event by pressing the up-down key or rotating the shuttle key left or right, pressing the enter/shuttle key changes the relative mark to that new event.

4.2.7.4 New events screen

This screen shows the new events that have been produced in the relay since the last time the New Events screen was read. The top of the screen shows a "**New Events**" legend, and the relative and total number of events contained.

Navigation through the different menus in this New Events screen is similar to the one described in the previous section for All Events. The main difference is that in the case of new events it is necessary to select the ***RELOAD*** submenu to update the screen with new events that have been produced, while in the All Events screen, this refreshment is automatic.

After the new events have been read, if the user selects again the ***Reload*** menu, the system shows a ***<No new events available.>*** message, indicating that there are no more new events available since the last reading.

4.2.7.5 Alarms panel

Alarms panel can be viewed in all F650 models using communication software EnerVista 650 Setup, however, only models with graphic display allow access to the alarms panel from the HMI.

First line shows the relative and total number of alarms existing in that screen. The relative number refers to the alarm on which the cursor is located, and the total number refers to the total amount of alarms available. The second line on this screen shows an index that indicates the number of the configured control event that corresponds to the displayed alarm, followed by the alarm text configured in the **Control Events** menu inside the **Relay Configuration** option (***Setpoint > Relay Configuration > Control Events***).

```
                    Alarm Panel    (1/3).
#1        OPERATIONS IN LOCAL MODE

7/11/04 16:54:16      OPERATIONS IN LO.        ON
7/11/04 16:54:16      GENERAL PICKUP           ON
7/11/04 16:54:16      GENERAL TRIP             ON

              Esc: Prev.          Enter: Next
```

Figure 4-39: Alarms panel in HMI

The rest of the screen shows the different alarms produced in the relay with the date and time when the corresponding event was produced, followed by the alarm identification text, and its status, active (ON) or inactive (OFF).

In the previous example, the produced alarm is the change to local of the execution of operations (OPERATIONS IN LOCAL MODE), the date and time when this event has been produced, and its status (ON):

The bottom of the screen shows the legend that indicates how to navigate through the different options available in the screen.

ESC: Prev.Enter: Next.

ESC: Prev.

Pressing the ESC key, the system returns to the previous New Events screen.

Enter: Next.

Pressing the enter/shuttle key, the user accessed the available alarms menu, which includes the following options.

nextprevackack all

To access the different options provided by the alarms graphic menu, the user must press the up-down key or move the shuttle key left to right. The selected option is displayed in upper case and between brackets. To access the selected option, the enter/shuttle key must be pressed.

<NEXT>

This option provides access to the next available graphic screen (I/O boards)

<PREV>

The system returns to the previous New Events screen.

<ACK>

This option acknowledges the alarm on which the cursor is located.

<ACK ALL>

This option acknowledges all alarms. Alarm acknowledgment through the graphic HMI is considered as through communication port COM2, as it is considered to be Local in both cases.

When an alarm has been acknowledged, a selection mark appears to the right of its status. Inactive alarms disappear from the screen once they are acknowledged.

4.2.7.6 Input/output monitoring screen

This is the last screen available in the graphic display. This screen allows viewing the status of the relay inputs and outputs, as well as emulate inputs (for verification of the logic, or related functions), and contact outputs (to verify wiring).

The format of this screen is shown on the figure below.

The first line shows the name of the screen "I/O Cards", followed by the type and description of the board where the cursor is located, which appears between selection marks **> <** and blinking.

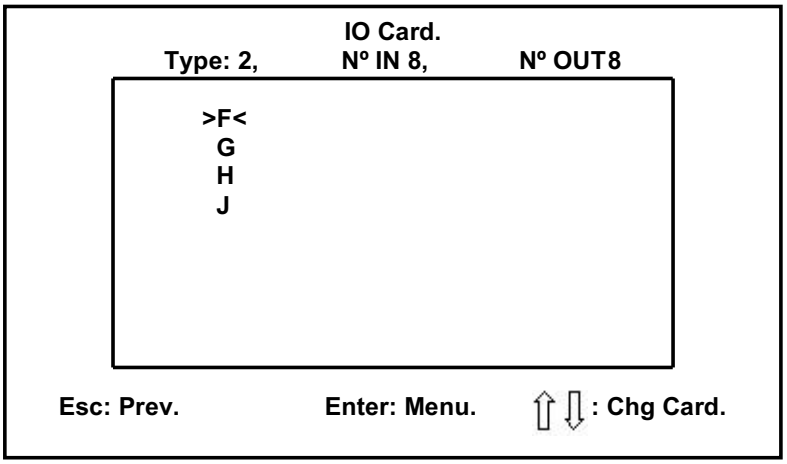


Figure 4-40: INPUTS/OUTPUTS GENERAL SCREEN

The navigation legend on this screen is as follows:

Esc: Prev. Enter: Menu. : ⇧⇩ Chg Card

Esc: Prev.

This option returns to the previous screen (Alarms Panel).

Enter: Menu.

This option provides access to the selected I/O board menu:

This menu includes the following options.

nextviewtest inputtest output

As in previous screens, to access the different options provided by the inputs/outputs graphic menu, the user must press the up-down key or move the shuttle key left to right. The selected option is displayed in upper case and between brackets. To access the selected option, the enter/shuttle key must be pressed.

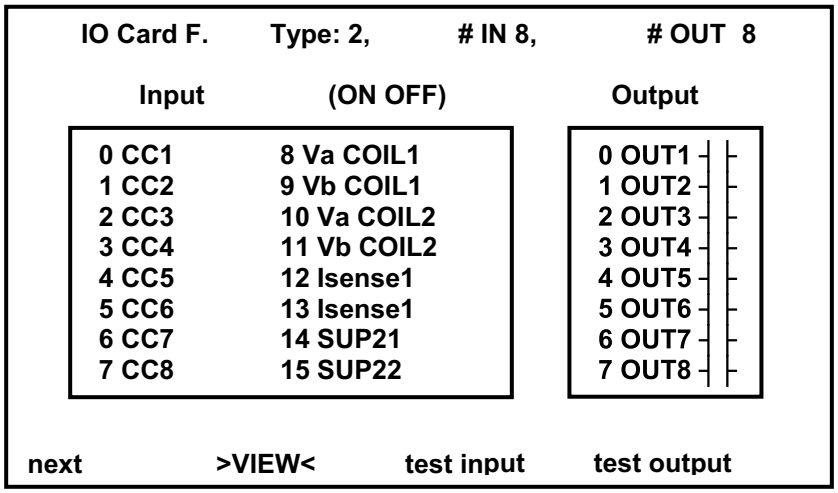


Figure 4-41: Input/output viewing screen

<NEXT>

This option brings the system back to the one-line diagram.

<VIEW>

This option shows the real status of all inputs and outputs in the selected board. Depending on the type of board, with or without supervision, the screen varies depending on the board characteristics.

The first line of this screen shows the slot where the board is located, **F**, **G**, **H** or **J**, and the type of board. The view menu differentiates inputs and outputs; the active status (ON) is represented by the lighting of the corresponding input or output.

The legend at the bottom of the screen indicates how to navigate:

Esc: Prev. **Enter: Menu.** ⇧⇩ **: Chg Card**

Esc: Prev.

Returns to the general I/O screen

Enter: Menu.

Provides access to the I/O menu (next, view, test input, test output).

⇧⇩ **: Chg Card**

Pressing the up-down key or Moving the shuttle key to the left or right provides access to the status of inputs/ outputs for the different boards available in the relay.

<TEST INPUT>

This option allows testing the input activation (in emulation mode). The displayed screen is similar to the viewing screen, but in this case the user can operate the different relay inputs.

This screen shows the **Input** name lit up, showing that this is an Input emulation mode.

The first relay input appears blinking and between brackets; the user can select a different input by pressing up-down key or rotating the enter/shuttle key. When the shuttle key is pressed, the selected input is activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Enter: Chg Input.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Enter: Chg Input.

Pressing the enter/shuttle key on the blinking input, this input is activated in emulation mode.

Note: input emulation can only be executed through the TEST INPUT tool on the graphic display.

<TEST OUTPUT>

This option allows testing the output activation in emulation mode. The displayed screen is similar to the viewing screen, but in this case the user can operate the different relay contact outputs to test the wiring.

This screen shows the **Output** name lit up, showing that this is an output emulation mode.

The first relay output appears blinking and between brackets; the user can select a different output by pressing the up-down key or rotating the shuttle key. When the enter/shuttle key is pressed, the selected output is activated. Navigation through this screen is indicated by the following legend:

Esc: Exit Text. **Enter: Chg Output.**

Esc: Exit Text.

The ESC option returns to the general I/O board menu.

Enter: Chg Output.

Pressing the enter/shuttle key on the blinking output, this output is activated in emulation mode.

Note: Output emulation can be executed through the TEST OUTPUT tool on the graphic display, and also through communications using EnerVista 650 Setup software for all F650 models.

⇧⇩ : Chg Card

Pressing the up-down key or rotating the shuttle key allows to change the selected I/O board in the main I/O screen.

4.3 Web server

4.3.1 Home

The web server in the F650 can be accessed running the Windows explorer, and typing http://xxx.xxx.xx.xxx, where xxx.xxx.xxx.xxx is the relay IP address, which must be configured in **Setpoint > Product Setup > Communication Settings > Ethernet**.

The main screen of the F650 web server shows the different monitoring possibilities for snapshot events, events, alarms, oscillography, fault reports, data logger and metering values provided by the relay through the web.

In order to access the different functions provided by the web server, the user must simply click the list name on the left side of the screen.

The web server (for version 1.70 and higher ones) allows the user to visualize the different web server screen languages: English, French, Spanish, Russian and Chinese by pressing the language button on the top right corner of the main window. Take into account that this selection only changes the language in the web server screen, all the relay texts, such as snapshot events, control events, etc. are in the language selected in the relay (see section 4.2.6.12 Select language in this manual).

Figure 4-42: Web server main screen

4.3.2 Snapshot events

The Snapshot events screen shows all Snapshot events produced in the relay. This screen is refreshed automatically every minute.

The information provided in this screen includes: first, the relative event index, the lowest index corresponding to the most recent event; next, the event text that shows the reason for the event, its status, active (ON) or inactive (OFF), and finally the date and time when the event was produced.

The bottom of the screen shows a Metering screen; clicking on one of the events, the associated metering values are shown on that screen.

Figure 4-43: Snapshot events screen

4.3.3 Control events

The control events screen provides access to all events that have been configured in the Control Events screen inside the **Relay Configuration** menu of EnerVista 650 Setup.

Figure 4-44: Control events screen

Unlike the case of Snapshot events, in this screen the highest index corresponds to the most recent event. The information provided is the control event index, the text that has been associated with the event when configured, its status, active (ON) or inactive (OFF), and its date and time.

4.3.4 Alarms

The alarms screen provides access to alarms configured in the relay. As in the case of snapshot events and control events, this screen allows only to view the alarms, but not to acknowledge them.

Figure 4-45: Alarms screen

4.3.5 Oscillography

The oscillography screen allows obtaining from the relay available oscillography records in that moment.

This screen includes two windows. The first window shows oscillography records available in the relay, identified by an index, being the highest index the most recent record (oscillography record No 6 in the example below).

Figure 4-46: Oscillography screen

If the user clicks on the oscillography record he wants to retrieve, the window on the right shows a description of the record header, indicating its date, time, and the most relevant parameters of the record. Once a record is selected, it is required to press the ***Download*** button. The system then opens a window to allow saving the files in Comtrade format on the PC hard drive. Once the records have been saved, the system asks if the user wants to open GE-OSC tool (Comtrade record viewer) to view the downloaded files.

Figure 4-47: GE-osc launch screen

4.3.6 Fault report

The fault report screen provides access to the last 10 fault reports obtained by the relay. These records are stored according to an index that marks their position among all records produced in the relay, with a range from 1 to 999, returning to 1 in case of exceeding the limit of 999. As in the case of oscillography records, the highest index corresponds to the most recent record.

In the fault report, oscillography and data logger screens, the system requests acceptance of a safety-warning message.

Figure 4-48: Fault report screen

The information provided in this screen includes the date and time when the fault was registered, fault calculations such as distance to the fault, type of fault, date and time, and the line parameters, as well as the recloser and breaker status during the fault.

This screen shows also pre-fault and fault voltage and current primary values. At the top of the screen, associated with the trigger event number there is a button labeled as **INFO**. This button displays at the bottom of the screen the events produced before and after the fault report trigger, so that the user has very useful information about the moment when the fault was produced.

To obtain a text file with all the fault report information, press the ***Download*** option and save the file in the computer.

4.3.7 Data logger

The data logger screen allows viewing the data logger first and last value retrieval date and allows downloading the data record files in Comtrade format, by pressing the ***Download*** option. Stored files can be viewed later using any Comtrade format viewer.

Figure 4-49: Data logger screen

F650 Digital Bay Controller

Chapter 5: Setpoints

5.1 Overview

5.1.1 Setpoint main menu

Table 5-1: Setpoint main menu in EnerVista 650 Setup software:

Product Setup		
	Communication settings	
		Serial Ports
		Network (Ethernet)
		ModBus Protocol
		DNP3 Slave (Available for standard and IEC61850 models, not available for IEC 870-5-103 models)
		IEC 870-5-104 (Available for standard and IEC61850 models, not available for IEC 870-5-103 models)
		SNTP
		Procome (Available for Procome models only)
		IEC 870-5-103 (Available for IEC 870-5-103 models only)
		PTP 1588 (Available from V7.00)
		Routing (Available from V7.00)
	ModBus User Map	
	Fault Report	
	Oscillography	
	Data Logger	
	Demand	
	Time Settings	
System Setup		
	General settings	

	Flex Curves	
	Breaker	
		Breaker Settings
		Breaker Maintenance
	Switchgear	
	Miscellaneous Settings	
Protection Elements		
	Phase Current	
		Phase TOC High
		Phase TOC Low
		Phase IOC High
		Phase IOC Low
		Phase Directional
		Thermal Model
	Neutral Current	
		Neutral TOC
		Neutral IOC
		Neutral Directional
	Ground Current	
		Ground TOC
		Ground IOC
		Ground Directional
	Sensitive Ground Current.	
		Sensitive Ground TOC
		Sensitive Ground IOC
		Isolated Ground IOC
		Sensitive Ground Directional
	Negative Sequence Current	
		Negative Sequence TOC
	voltage Elements	
		Phase UV
		Phase OV
		Neutral OV High
		Neutral OV Low
		Negative Sequence OV
		Auxiliary OV
		Auxiliary UV
	Power	
		Forward Power
		Directional Power
		Watt Gnd Flt High
		Watt Gnd Flt Low
Control Elements		
	Setting Group	
	Underfrequency	
	Overfrequency	
	Synchrocheck	
	Autoreclose	
	Breaker Failure.	
	VT Fuse Failure.	
	Broken Conductor	

	Locked Rotor	
	Pulse Counters	
	Analog Comparator	
	Frequency rate of change	
	Load Encroachment	
	Max. Number of Starts	
	Digital Counters	
	Cold Load Pickup	
Input/Outputs		
	Contact I/O	
		Board F
		Board G
		Board H
		Board J
	Force Outputs.	
	Remote Comms (Available for IEC61850 models only).	
	Virtual Inputs	

5.2 Product setup

5.2.1 Communication settings

5.2.1.1 Serial ports

Baud rate and parity for COM1 and COM2 serial communication ports.

Product Setup > Communication settings >Serial Ports			
Name	Default Value	Step	Range
COM1 Baud Rate	19200	N/A	[300: 115200]
COM2 Baud Rate	19200	N/A	[300: 115200]
COM1Parity	NONE	N/A	[NONE:ODD:EVEN]
COM2Parity	NONE	N/A	[NONE:ODD:EVEN]

5.2.1.2 Network (Ethernet)

Depending on the firmware version the Network (Ethernet) setting window vary.

For versions previous to 7.00 of firmware; the network Ethernet window settings are for configure Ethernet communication parameters for ETH_1/ETH2 (Depending on model). Two different Ethernet addresses can be used, but the first IP always has to be set as the second IP Address is an Alias. The ModBus Slave address used by Ethernet ports is the one set for COM2.

Table 5-2: NETWORK settings for firmware versions previous to 7.00

Product Setup > Communication settings >Network (Ethernet) Network (Ethernet)1 > NETWORK (ETHERNET)2			
Name	Default Value	Step	Range
IP Address Oct1	0	N/A	[0: 255]
IP Address Oct2	0	N/A	[0: 255]
IP Address Oct3	0	N/A	[0: 255]

IP Address Oct4	0	N/A	[0: 255]
Netmask Oct1	0	N/A	[0: 255]
Netmask Oct2	0	N/A	[0: 255]
Netmask Oct3	0	N/A	[0: 255]
Netmask Oct4	0	N/A	[0: 255]
Gateway IP Oct1	0	N/A	[0: 255]
Gateway IP Oct2	0	N/A	[0: 255]
Gateway IP Oct3	0	N/A	[0: 255]
Gateway IP Oct4	0	N/A	[0: 255]

For firmware versions 7.00 or higher; the Network settings are the Ethernet communication parameters for Port A, Port B and Port E. Depending on the order code, up to three different Ethernet addresses can be used, The ModBus Slave address used by Ethernet ports is the one set for COM2.

Table 5-3: Network settings for firmware version 7.00 and above

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET) NETWORK (ETHERNET)A > NETWORK (ETHERNET)B > NETWORK (ETHERNET) E > REDUNDANCY				
Name	Default Value	Step	Range	User Value
IP Address Oct1	0	N/A	[0 : 255]	
IP Address Oct2	0	N/A	[0 : 255]	
IP Address Oct3	0	N/A	[0 : 255]	
IP Address Oct4	0	N/A	[0 : 255]	
Netmask Oct1	0	N/A	[0 : 255]	
Netmask Oct2	0	N/A	[0 : 255]	
Netmask Oct3	0	N/A	[0 : 255]	
Netmask Oct4	0	N/A	[0 : 255]	

IP ADDRESS: This setting sets the ports IPv4 address in standard IPV4 format. Note that this setting is only valid on port B if port A's REDUNDANCY is set to INDEPENDENT.

NETMASK: This setting sets the ports IPv4 subnet mask in standard IPV4 format. Note that this setting is only valid on port B if port A's REDUNDANCY is set to INDEPENDENT.

Table 5-4: Redundancy settings

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET) > REDUNDANCY			
Name	Default Value	Step	Range
REDUNDANCY MODE	INDEPENDENT	N/A	[INDEPENDENT; LLA; PRP; HSR; RSTP; DAISY_CHAIN]
LLA Priority	DISABLED	N/A	[ENABLED; DISABLED]
LLA Timeout	5000	N/A	[0 : 600000]
RSTP BRIDGE PRIORITY	32768	N/A	[0 : 61440]
RSTP PORT A PRIORITY	128	N/A	[0 : 240]
RSTP PORT A PATHCOST	200000	N/A	[0 : 2000000]
RSTP PORT B PRIORITY	128	N/A	[0 : 240]
RSTP PORT B PATHCOST	200000	N/A	[0 : 2000000]

REDUNDANCY MODE: This setting is available only if the hardware has multiple ports. The setting determines if ports A and B operate in redundant or independent mode. Different options are listed below:

-**Independent**: In non-redundant mode, port A and B operate independently with their own MAC, IP address, mask and gateway.

NOTE: When using more than one Ethernet port, each port must be configured to belong to a different network, otherwise communications becomes unpredictable.

NOTE 2: When non-redundant mode is selected, MAC address assigned to port A is the same as MAC address assigned to port E but increased in one unit and MAC address assigned to port B is the same as MAC address assigned to port A but increased in one unit.

E.g (MAC_portE: 00AFF40A24DA, MAC_portA:00AFF40A24DB, MAC_portB: 00AFF40A24DC)

-LLA (Link Loss) operation: The operation of ports A and B are as follows:

Ports A and B use port A's MAC and IP address settings while port B is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link.

-**PRP (Parallel Redundancy Protocol):** ports A and B use the same MAC (physical device) address and combine information at the link layer. It is intended to only be used if the two ports are connected to separate parallel LAN's. In this mode of operation both ports cannot be connected to the same LAN. The receiving

devices process the first frame received and discard the duplicate through a link redundancy entity (LRE) or similar service that operates below layer 2. Aside from LRE, PRP uses conventional Ethernet hardware but both ports must know they are in PRP. Both ports of PRP devices operate with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP).

-**HSR (High-availability Seamless Redundancy):** ports A and B use the same MAC (physical device) address and combine information at the link layer. It is intended to work in a ring topology. In this mode of operation port A is connected to the other device's port B, and port B is connected to other device´s port A provided that ring topology is respected. The receiving devices process the first frame received and discard the duplicate through a link redundancy entity (LRE) or similar service that operates below layer 2. Aside from LRE, HSR uses conventional Ethernet hardware but both ports must know they are in HSR. Both ports of HSR devices operate with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP).

-**RSTP (Rapid Spanning Tree Protocol):** ports A and B use the same MAC (physical device) address and can operate with different network topologies. The device operates only with one IP address through these 2 ports

-**Daisy Chain:** ports A and B use the same MAC (physical device) address and operate by chaining one device with the next one. Note that it is important not to create a loop in this topology. Both ends of the chain can be connected to different networks. The device operates only with one IP address through these 2 ports.

NOTE 3: When LLA/PRP/HSR or PRR mode is selected, MAC addresses assigned to port A and B are the same between them and a consecutive value of MAC address assigned to port E.

E.g (MAC_portE: 00AFF40A24DA, MAC_portA:00AFF40A24DB, MAC_portB: 00AFF40A24DB)

NOTE 4: When LLA/PRP/HSP/RSTP or DAISY CHAIN mode is selected, the IP configured at **Product Setup > Communication Settings > Network (Ethernet) > Network (Ethernet) A** is the one used by both ports (A and B) to communicate in these modes.

LLA PRIORITY: If this setting is set to enabled, the port A has the priority. If PORTA's LLA detects a problem with the link, communications is switched to Port B. Port B is, in effect, acting as a redundant or backup link to the network for port A.

LLA TIMEOUT: This setting is active only when the LLA PRIORITY is set to ENABLED. When the link on primary port is detected again after it fails, there is LLA TIMEOUT (ms) monitoring time for the health of the network. During this time, the secondary port remains active. If primary network is healthy for more than LLA TIMEOUT value, the switch over to primary port is automatic.

RSTP BRIDGE PRIORITY: Specifies the switch (bridge) priority value. This value is used along with the switch MAC address to determine which switch in the network is the root device. Lower values mean higher priority. The value ranges from 0 to 65535, with a default of 32768.

RSTP PORTA PRIORITY: This is to determine which ports are used for forwarding. Lower the number means higher priority. Value ranges from 0 to 255. Default is 128**.**

RSTP PORTA PATHCOST: This is the assigned port cost value used for the switch to determine the forwarding points. Values range from 1 to 2000000. The lower the value, the lower the cost and hence the preferred route.

RSTP PORTB PRIORITY: This is to determine which ports are used for forwarding. Lower the number means higher priority. Value ranges from 0 to 255. Default is 128**.**

RSTP PORTB PATHCOST: This is the assigned port cost value used for the switch to determine the forwarding points. Values range from 1 to 2000000. The lower the value, the lower the cost and hence the preferred route.

For this setting change to take effect, a reboot is required.

5.2.1.3 MODBUS protocol

ModBus Slave Addresses for serial and Ethernet communication and the ModBus port number used for ModBus TCP/IP. For more detailed information go to appendix B in this manual.

Product Setup > Communication settings > ModBus Protocol			
Name	Default Value	Step	Range
ModBus Address COM1	254	1	[1 : 255]
ModBus Address COM2	254	1	[1 : 255]
ModBus Port Number	502	1	[0 : 65535]

5.2.1.4 DNP3 slave

Physical port, Slave Address for DNP, IP Addresses for Masters, TCP/UDP Port, Unsolicited Response parameters, Analog scale factors and deadbands, message fragment size, Binary input block. For more detailed information go to appendix C in this manual. DNP protocol is available for standard and IEC61850 models but it is not available Procome models.

Table 5-5: DNP protocol settings

Product Setup > Communication settings >DNP3 Slave DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3			
Name	Default Value	Step	Range
Physical Port	NONE	N/A	[COM1:COM2:NETWORK]
Address	255	1	[0 : 65534]
IP Addr Client1 Oct1	0	1	[0 : 255]
IP Addr Client1 Oct2	0	1	[0 : 255]
IP Addr Client1 Oct3	0	1	[0 : 255]
IP Addr Client1 Oct4	0	1	[0 : 255]
IP Addr Client2 Oct1	0	1	[0 : 255]
IP Addr Client2 Oct2	0	1	[0 : 255]
IP Addr Client2 Oct3	0	1	[0 : 255]
IP Addr Client2 Oct4	0	1	[0 : 255]
IP Addr Client3 Oct1	0	1	[0 : 255]
IP Addr Client3 Oct2	0	1	[0 : 255]
IP Addr Client3 Oct3	0	1	[0 : 255]
IP Addr Client3 Oct4	0	1	[0 : 255]
IP Addr Client4 Oct1	0	1	[0 : 255]
IP Addr Client4 Oct2	0	1	[0 : 255]
IP Addr Client4 Oct3	0	1	[0 : 255]
IP Addr Client4 Oct4	0	1	[0 : 255]
IP Addr Client5 Oct1	0	1	[0 : 255]
IP Addr Client5 Oct2	0	1	[0 : 255]
IP Addr Client5 Oct3	0	1	[0 : 255]
IP Addr Client5 Oct4	0	1	[0 : 255]
TCP/UDP Port	20000	1	[0 : 65535]
Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]
Unsol Resp TimeOut	5	1	[0 : 60]
Unsol Resp Max Ret	10	1	[0 : 255]
Unsol Resp Dest Adr	200	1	[0 : 65535]
Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]

Product Setup > Communication settings > DNP3 Slave DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3			
Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
PF Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000-10000]
Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]
Current Deadband	30000	1	[0 : 65535]
Voltage Deadband	30000	1	[0 : 65535]
Power Deadband	30000	1	[0 : 65535]
Energy Deadband	30000	1	[0 : 65535]
PF Deadband	30000	1	[0 : 32767]
Other Deadband	30000	1	[0 : 65535]
Msg Fragment Size	240	1	[30 : 2048]
Binary Input Block 1	CTL EVENTS 1-16	N/A	
Binary Input Block 2	CTL EVENTS 17-32	N/A	
Binary Input Block 3	CTL EVENTS 33-48	N/A	
Binary Input Block 4	CTL EVENTS 49-64	N/A	
Binary Input Block 5	CTL EVENTS 65-80	N/A	
Binary Input Block 6	CTL EVENTS 81-96	N/A	
Binary Input Block 7	CTL EVENTS 97-112	N/A	
Binary Input Block 8	CTL EVENTS 113-128	N/A	
Binary Input Block 9	SWITCHGEAR 1-8	N/A	
Binary Input Block 10	SWITCHGEAR 9-16	N/A	
Default Analog Map	ENABLED	N/A	
Analog Input Point 0	End of list	N/A	
Analog Input Point 1	End of list	N/A	
Analog Input Point 2	End of list	N/A	
Analog Input Point 3	End of list	N/A	
Analog Input Point 4	End of list	N/A	
Analog Input Point 5	End of list	N/A	
Analog Input Point 6	End of list	N/A	
Analog Input Point 7	End of list	N/A	
Analog Input Point 8	End of list	N/A	
Analog Input Point 9	End of list	N/A	
Analog Input Point 10	End of list	N/A	
Analog Input Point 11	End of list	N/A	
Analog Input Point 12	End of list	N/A	
Analog Input Point 13	End of list	N/A	
Analog Input Point 14	End of list	N/A	
Analog Input Point 15	End of list	N/A	
Analog Input Point 16	End of list	N/A	
Analog Input Point 17	End of list	N/A	
Analog Input Point 18	End of list	N/A	
Analog Input Point 19	End of list	N/A	
Analog Input Point 20	End of list	N/A	
Analog Input Point 21	End of list	N/A	
Analog Input Point 22	End of list	N/A	

Analog Input Point 23	End of list	N/A	
Analog Input Point 24	End of list	N/A	
Analog Input Point 25	End of list	N/A	
Analog Input Point 26	End of list	N/A	
Analog Input Point 27	End of list	N/A	
Analog Input Point 28	End of list	N/A	
Analog Input Point 29	End of list	N/A	
Analog Input Point 30	End of list	N/A	
Analog Input Point 31	End of list	N/A	

5.2.1.5 IEC 60870-5-104

Communication settings for IEC 60870-5-104 protocol. For more detailed information go to appendix D in this manual. DNP protocol is available for standard and IEC61850 models but it is not available Procome models.

Table 5-6: IEC 60870-5-104 protocol settings

Product Setup > Communication settings >IEC 870-5-104			
Name	**Default Value**	**Step**	**Range**
Function	DISABLED	N/A	[DISABLED-ENABLED]
TCP Port	2404	1	[1 : 65535]
Common Addr of ASDU	255	1	[0 : 65535]
Cyclic Meter Period	0	1	[0 : 3600]
Synchronization Event	0	1	[0 : 3600]
IEC104 NET1 CLI1 OCTET1	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET2	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET3	0	N/A	[0 : 255]
IEC104 NET1 CLI1 OCTET4	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET1	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET2	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET3	0	N/A	[0 : 255]
IEC104 NET1 CLI2 OCTET4	0	N/A	[0 : 255]
Function 2	DISABLED	N/A	
TCP Port 2	2404	N/A	[0 : 65535]
Common Addr of ASDU 2	255	N/A	[0 : 65535]
IEC104 NET2 CLI1 OCTET1	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET2	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET3	0	N/A	[0 : 255]
IEC104 NET2 CLI1 OCTET4	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET1	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET2	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET3	0	N/A	[0 : 255]
IEC104 NET2 CLI2 OCTET4	0	N/A	[0 : 255]
IEC104 SCALE CURRENT	1		[0,00001; 0,0001; 0,001; 0,01; 0,1; 1; 10; 100; 1000; 10000]
IEC104 SCALE VOLTAGE	1		
IEC104 SCALE POWER	1		[0 : 65535]
IEC104 SCALE ENERGY	1		[0 : 65535]
IEC104 SCALE OTHER	1		[0 : 65535]
IEC104 DEADBAND CURRENT	30000		[0 : 65535]
IEC104 DEADBAND VOLTAGE	30000		[0 : 65535]

IEC104 DEADBAND POWER	30000		[0 : 65535]
IEC104 DEADBAND ENERGY	30000		[0 : 65535]
IEC104 DEADBAND OTHER	30000		[0 : 65535]
IEC104 IOA BINARIES	1000		[0 : 65535]
IEC104 IOA DOUBLE POINTS	1500		[0 : 65535]
IEC104 IOA ANALOGS	2000		[0 : 65535]
IEC104 IOA COUNTERS	4000		[0 : 65535]
IEC104 IOA COMMANDS	3000		[0 : 65535]
IEC104 IOA ANALOG PARAMETERS	5000		[0 : 65535]

5.2.1.6 SNTP

Product Setup > Communication settings > SNTP > SNTP1/SNTP2			
Name	**Default Value**	**Step**	**Range**
Function	DISABLED	N/A	[DISABLED – ENABLED]
UDP Port	123	1	[1 : 65535]
Server Ip Oct1	0	1	[0 : 255]
Server Ip Oct2	0	1	[0 : 255]
Server Ip Oct3	0	1	[0 : 255]
Server Ip Oct4	0	1	[0 : 255]

The F650 supports the Simple Network Time Protocol specified in RFC-2030. With SNTP, the F650 can obtain the clock time over an Ethernet network. The F650 acts as an SNTP client to receive time values from an SNTP/NTP server, usually a dedicated product using a GPS receiver to provide an accurate time. Three different modes of SNTP operation are supported. These modes are unicast, broadcast and anycast.

If SNTP functionality is enabled at the same time as an IRIG-B source is connected to the F650, the IRIG-B signal provides the time value to the F650 clock for as long as a valid signal is present. If the IRIG-B signal is removed, the time obtained from the SNTP server is used.

To use SNTP in unicast mode, **Server IP Oct1...4** must be set to the SNTP/NTP server IP address. Once this address is set and the **Function** setting is “UNICAST”, the F650 attempts to obtain time values from the SNTP/NTP server. Since many time values are obtained and averaged, it generally takes forty seconds until the F650 clock is synchronized with the SNTP/NTP server. It may take up to one minute for the F650 to signal an SNTP FAIL state if the server is offline.

To use SNTP in broadcast mode, set the **Function** setting to “BROADCAST”. The F650 then listens to SNTP messages sent to the “all ones” broadcast address for the subnet. The F650 waits up to eighteen minutes (>1024 seconds) without receiving an SNTP broadcast message before signalling an SNTP FAIL state.

To use SNTP in anycast mode, set the **Function** setting to “ANYCAST”. Anycast mode is designed for use with a set of cooperating servers whose addresses are not known beforehand by the client. The F650 sends a request to a multicast group address assigned by IANA for NTP protocol. This address is 224.0.1.1 and a group of SNTP/NTP servers listens to it. Upon receiving a request each server sends a unicast response to the SNTP/NTP client. The F650 relay binds to the first unicast message received from any server. Then it continues operating with SNTP/NTP server in unicast mode. Any further responses from other SNTP/NTP servers are ignored. In unicast mode of operation the chosen time server can go offline, in that case it takes about one minute for the F650 to signal an SNTP FAIL state and to switch again to anycast mode to try to find another time server. In anycast mode the F650 tries to send multicast messages up to five minutes before signalling an SNTP FAIL state.

The F650 relay does not support the multicast mode of SNTP functionality.

For firmware version 7.20 or above, F650 shall accept time synchronization from up to two different SNTP servers. In order to define number of SNTP servers to be used, different settings for each SNTP server must be configured in the F650. SNTP1 or/and SNTP2 tab settings shall be configured.

If only one SNTP server is used to synchronize the relay, SNTP1 tab settings shall be filled with its corresponding settings. If two SNTP servers are used, SNTP1 and SNTP2 tab shall be filled as follow:

"SNTP1 tab shall contain settings of main SNTP server.

"SNTP2 tab shall contain settings of back-up SNTP server.

If two SNTP servers are configured, F650 operation mode is described as follows:

Scenario	Expected behaviour
SNTP1 server= Available SNTP2 server= Available	F650 shall be synchronized by SNTP1 server. No alarm
SNTP1 server= Available SNTP2 server= Not Available	F650 shall continue to be synchronized by SNTP1 server No alarm
SNTP1 server= Not Available SNTP2 server= Available	If SNTP1 server fails, F650 shall get synchronization from SNTP2 server. When SNTP1 server recovers, F650 shall switch to be synchronized by SNTP1 server. No alarm
SNTP1 server= Not Available SNTP2 server= Not Available	"Not Syncronized" Alarm shall appear in local mimic

NOTE: SNTP settings take effect after rebooting the device.

5.2.1.7 Procome protocol settings

Communication settings for Procome protocol. For more detail information go to APPENDIX E in this manual.

Product Setup > Communication settings > PROCOME			
Name	Default Value	Step	Range
COMM Port	NONE	N/A	[NONE - COM1]
Slave Number	0	1	[0 : 254]

When NONE is selected in the comm port setting the protocol is not enabled. The com1 selection enables Procome for the com1 (remote) serial port.

Slave Number:is the Procome slave number.

Baud rate and parity for COM1 must be set in the **Setpoint > Communications > Serial Ports** menu.

5.2.1.8 IEC 870-5-103 protocol settings

Communication settings for IEC 60870-5-103 protocol. For more detailed information go to 5.13 Section in this manual.

Product Setup > Communication settings > IEC 870-5-103			
Name	Default Value	Step	Range
COMM Port	NONE	N/A	[NONE - COM1]
Slave Number	1	1	[0 : 254]
Synchronization Timeout	30 min	1	[0 : 1440]

DNP protocol is available for standard and IEC61850 models but it is not available IEC 60870-5-103 models.

If COMM Port is set to NONE, IEC 870-5-103 communication protocol is not available.

If the user sets a value different from 0 in the Synchronization Timeout setting, when this timer expires without receiving a synchronization message, the Invalid bit is set in the time stamp of a time-tagged message.

5.2.1.9 PTP IEEE 1588 protocol settings

PRODUCT SETUP > COMMUNICATION SETTINGS > PTP 1588		
Name	**Default Value**	**Step**
PTP FUNCTION	DISABLE	[DISABLE; ENABLE]
PORTA DELAY ADDER	0	ns [0 : 60000]
PORTA DELAY ASYM	0	ns [-1000 : 1000]
PORTB DELAY ADDER	0	ns [0 : 60000]
PORTB DELAY ASYM	0	ns [-1000 : 1000]
STRICT POWER PROFILE	DISABLED	DISABLED/ENABLED
PTP DOMAIN NUMBER	0	[0 : 255]
PTP VLAN PRIORITY	4	[0 : 7]
PTP VLAN ID	0	[0 : 4095]
PTP EPOCH	UTC SINCE 2000	UTC SINCE 2000; UTC SINCE 1970; UTC SINCE 1900

F650 relay supports IEEE 1588 version 2.

The relay meets the time accuracy requirements of IEC 61850-5-Ed2 clause 11.1.3.3 time synchronization class T5 (± 1 µs) and of the IEEE Std. PC37.118.1 Draft 1.6 clause 4.3 (± 1 µs), given an error-free PP input and stable temperature

The relay resynchronizes to a grandmaster slewing at ±2 µs/s when the rate of change of frequency stabilizes. It may become unsynchronized when the ramp starts or stops.

The relay only supports Peer-To-Peer delay mechanism.

PTP FUNCTION

While this port setting is selected to disabled, PTP is disabled on this port. The relay does not generate or listen to PTP messages on this port.

PORT A, B PATH DELAY ADDER

The time delivered by PTP is advanced by the time value in this setting prior to the time being used to synchronize the relay's real time clock. This is to compensate to the extent practical for time delivery delays not compensated for in the network. In a fully compliant PP network, the peer delay and the processing delay mechanisms compensate for all the delays between the grandmaster and the relay. In such networks, this setting should be zero.

In networks containing one or more switches and/or clocks that do not implement both of these mechanisms, not all delays are compensated, so the time of message arrival at the relay is later than the time indicated in the message. This setting can be used to approximately compensate for this delay. However, as the relay is not aware of network switching that dynamically changes the amount of uncompensated delay, there is no setting that is always completely correct for uncompensated delay. A setting can be chosen to reduce the worst-case error to half of the range between minimum and maximum uncompensated delay, if these values are known.

PORT A, B PATH DELAY ASYMMETRY

Range: -1 000 … +1 000 ns

Default: 0

This setting corresponds to "delayAsymmetry" in PTP, which is used by the peer delay mechanism to compensate for any difference in the propagation delay between the two directions of a link. Except in unusual cases, the two fibers are of essentially identical length and composition, so this setting should be set to zero.

In unusual cases where the length of the link is different in different directions, this setting should be set to the number of nanoseconds the Ethernet propagation delay to the relay is longer than the mean of path propagation delays to and from the relay. For instance, if it is known say from the physical length of the fibers and the propagation speed in the fibers that the delay from the relay to the Ethernet switch it is connected to is 9 000 ns and the that the delay from the switch to the relay is 11 000 ns, then the mean delay is 10 000 ns, and the path delay asymmetry is +1 000 ns.

STRICT POWER PROFILE

Power profile (IEEE Std C37.238™-2011) requires that the relay only select as a grandmaster power profile compliant clocks, that the delivered time have worst-case error of ±1 µs, and that the peer delay mechanism be implemented. With the strict power profile setting enabled, the relay only selects master clocks displaying the IEEE_C37_238 identification codes. It uses a port only when the peer delay mechanism is operational. With the strict power profile setting disabled, the relay uses clocks without the power profile identification when no power profile clocks are present, and uses ports even if the peer delay mechanism is non-operational.

This setting applies to all of the relay's PTP capable ports.

PTP DOMAIN NUMBER

This setting should be set to the domain number of the grandmaster-capable clock(s) to be synchronized to. A network may support multiple time distribution domains, each distinguished with a unique domain number. More commonly, there is a single domain using the default domain number zero.

This setting applies to all of the relay's PTP capable ports.

PTP VLAN PRIORITY

This setting selects the value of the priority field in the 802.1Q VLAN tag in request messages issued by the relay's peer delay mechanism. In compliance with PP the default VLAN priority is 4, but it is recommended that in accordance with PTP it be set to 7.

Depending on the characteristics of the device to which the relay is directly linked, VLAN Priority may have no effect.

This setting applies to all of the relay's PTP capable ports.

PTP VLAN ID

This setting selects the value of the ID field in the 802.1Q VLAN tag in request messages issued by the relay's peer delay mechanism. It is provided in compliance with PP. As these messages have a destination address that indicates they are not to be bridged, their VLAN ID serves no function, and so may be left at its default value.

Depending on the characteristics of the device to which the relay is directly linked, VLAN ID may have no effect.

This setting applies to all of the relay's PTP capable ports.

PTP EPOCH

This setting sets the reference point from which time is measured.

NOTE: PTP settings take effect after rebooting the device.

5.2.1.10 Routing

A default route and a maximum number of 6 static routes may be configured. The default route is used as the last choice, if no other route towards a given destination is found.

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING		
Name	**Default Value**	**Step**
Default RT GWY Oct1	10	[0 : 255]
Default RT GWY Oct2	3	[0 : 255]
Default RT GWY Oct3	32	[0 : 255]
Default RT GWY Oct4	1	[0 : 255]
Static RT1 IP Oct1	0	[0 : 255]
Static RT1 IP Oct2	0	[0 : 255]
Static RT1 IP Oct3	0	[0 : 255]
Static RT1 IP Oct4	0	[0 : 255]
Static RT1 Mask Oct1	0	[0 : 255]
Static RT1 Mask Oct2	0	[0 : 255]
Static RT1 Mask Oct3	0	[0 : 255]
Static RT1 Mask Oct4	0	[0 : 255]
Static RT1 GWY Oct1	0	[0 : 255]
Static RT1 GWY Oct2	0	[0 : 255]
Static RT1 GWY Oct3	0	[0 : 255]
Static RT1 GWY Oct4	0	[0 : 255]
Static RT2 IP Oct1	0	[0 : 255]
Static RT2 IP Oct2	0	[0 : 255]
Static RT2 IP Oct3	0	[0 : 255]
Static RT2 IP Oct4	0	[0 : 255]
Static RT2 Mask Oct1	0	[0 : 255]
Static RT2 Mask Oct2	0	[0 : 255]
Static RT2 Mask Oct3	0	[0 : 255]
Static RT2 Mask Oct4	0	[0 : 255]
Static RT2 GWY Oct1	0	[0 : 255]
Static RT2 GWY Oct2	0	[0 : 255]
Static RT2 GWY Oct3	0	[0 : 255]
Static RT2 GWY Oct4	0	[0 : 255]
Static RT3 IP Oct1	0	[0 : 255]
Static RT3 IP Oct2	0	[0 : 255]
Static RT3 IP Oct3	0	[0 : 255]
Static RT3 IP Oct4	0	[0 : 255]
Static RT3 Mask Oct1	0	[0 : 255]
Static RT3 Mask Oct2	0	[0 : 255]
Static RT3 Mask Oct3	0	[0 : 255]
Static RT3 Mask Oct4	0	[0 : 255]
Static RT3 GWY Oct1	0	[0 : 255]
Static RT3 GWY Oct2	0	[0 : 255]
Static RT3 GWY Oct3	0	[0 : 255]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING		
Name	**Default Value**	**Step**
Static RT3 GWY Oct4	0	[0 : 255]
Static RT4 IP Oct1	0	[0 : 255]
Static RT4 IP Oct2	0	[0 : 255]
Static RT4 IP Oct3	0	[0 : 255]
Static RT4 IP Oct4	0	[0 : 255]
Static RT4 Mask Oct1	0	[0 : 255]
Static RT4 Mask Oct2	0	[0 : 255]
Static RT4 Mask Oct3	0	[0 : 255]
Static RT4 Mask Oct4	0	[0 : 255]
Static RT4 GWY Oct1	0	[0 : 255]
Static RT4 GWY Oct2	0	[0 : 255]
Static RT4 GWY Oct3	0	[0 : 255]
Static RT4 GWY Oct4	0	[0 : 255]
Static RT5 IP Oct1	0	[0 : 255]
Static RT5 IP Oct2	0	[0 : 255]
Static RT5 IP Oct3	0	[0 : 255]
Static RT5 IP Oct4	0	[0 : 255]
Static RT5 Mask Oct1	0	[0 : 255]
Static RT5 Mask Oct2	0	[0 : 255]
Static RT5 Mask Oct3	0	[0 : 255]
Static RT5 Mask Oct4	0	[0 : 255]
Static RT5 GWY Oct1	0	[0 : 255]
Static RT5 GWY Oct2	0	[0 : 255]
Static RT5 GWY Oct3	0	[0 : 255]
Static RT5 GWY Oct4	0	[0 : 255]
Static RT6 IP Oct1	0	[0 : 255]
Static RT6 IP Oct2	0	[0 : 255]
Static RT6 IP Oct3	0	[0 : 255]
Static RT6 IP Oct4	0	[0 : 255]
Static RT6 Mask Oct1	0	[0 : 255]
Static RT6 Mask Oct2	0	[0 : 255]
Static RT6 Mask Oct3	0	[0 : 255]
Static RT6 Mask Oct4	0	[0 : 255]
Static RT6 GWY Oct1	0	[0 : 255]
Static RT6 GWY Oct2	0	[0 : 255]
Static RT6 GWY Oct3	0	[0 : 255]
Static RT6 GWY Oct4	0	[0 : 255]

The redundancy communications comes with the capability of setting a number of static routes and one default route, which is used instead of default gateway.

Default RT GWY:

This setting sets the gateway of the default route to be used by IP traffic sent from the relay, if no other route towards a given IP destination is found.

Note that this setting is only valid on port B if port REDUNDANCY is set to INDEPENDENT.

Static RTX IP: This setting sets the destination IPv4 route.

Static RTX MASK: This setting sets the IP mask associated with the route.

Static RTX GWY: This setting sets the gateway to reach the destination IP route.

Important Notes:

1. Host routes are not supported at present.
2. The route mask has IPv4 mask format. In binary this should be a set of contiguous bits of 1 from left to right, followed by one or more contiguous bits of 0.
3. The route destination and mask must match.
   - This can be verified by checking that RtDestination & RtMask == RtDestination
   - Example of good configuration: RtDestination= 10.1.1.0; Rt Mask= 255.255.255.0
   - Example of bad configuration: RtDestination = 10.1.1.1; Rt Mask= 255.255.255.0

4) The route destination must not be a connected network.

5) The route gateway must be on a connected network. This rule applies to the gateway address of the default route as well.

5.2.2 MODBUS user map settings

The ModBus user map definition. 256 records, selectable from the complete relay ModBus map, from the ModBus user map. For more detailed information go to appendix B in this manual.

Product Setup > ModBus User Map			
Name	Default Value	Step	Range
Address 00	0000		[0000 : FFFF]
Address 01	0000		[0000 : FFFF]
...			...
Address 254	0000		[0000 : FFFF]
Address 255	0000		[0000 : FFFF]

5.2.3 Fault report settings

The fault report module defines the type of fault (three-phase, phase-to-phase, phase-to-ground), and the distance to the fault. The fault activation signal (FAULT REPORT TRIGG) is programmed at **Setpoint > Relay Configuration > Protection Elements**.

The fault report provides fault date, fault type and fault location information.

Information referred to the last ten faults is stored as fault report and available to the user through the EnerVista 650 Setup software or the web server application. Each fault report includes the following information:

- Fault date and time
- Pre-fault current and voltage in primary values
- Fault current and voltages in primary values
- Fault type
- Distance to the fault (fault location)
- Line parameters
- Recloser and breaker status information

As an option, the Relay offers the possibility to display a fault-warning message on the relay HMI (selectable by setting).

5.2.3.1 Fault report settings

Setpoint > Product Setup > Fault Report				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
CT Direction	CT Direction	REVERSE	N/A	REVERSE-FORWARD
CT Connections	CT Connections	CTA+CTB+CTC	N/A	[CTA+CTB+CTC-CTA+CTB-CTA+CTC-CTB+CTC]

Function permission (Function): Enabling this setting allows to create a fault report when the FAULT REPORT TRIGG is activated.

Positive sequence impedance module (Pos Seq Module): Value, in ohms, of the line positive sequence impedance module.

Positive sequence impedance Angle (Pos Seq Angle): Value, in degrees, of the line positive sequence angle.

Zero sequence impedance module (Zero Seq Module): Value, in ohms, of the line zero sequence impedance module.

Zero sequence impedance Angle (Zero Seq Angle): Value, in degrees, of the line zero sequence angle.

Line Length: The metering element can be kilometers or miles.

Show Fault On HMI: This setting enables or disables the option to display faults on the Relay HMI.

Snapshot Events: This setting enables or disables the snapshot event generation for the fault report element.

CT Direction: Direction of the phase current transformers.

Forward: The polarity of he current transformers is as the F650 wiring diagram.

Reverse: The polarity of the current transformers is inverted. Voltage and current are 180º out of phase.

CT Connections: This setting allows fault locator function to work with different CTs configurations. Based on this selection, fault locator function can work with two different configurations:

-With three phase current inputs measured through phase CT inputs

-With two phase current inputs and ground current inputs measured through corresponding CT inputs. Third phase current inputs is calculated using measured values of current inputs previously described.

Settings available:

CTA+CTB+CTC- All three currents used during fault location are the ones that are measured directly from Ia, Ib, Ic current inputs.

CTA+CTB- Ia and Ib used by fault locator are the ones measured and Ic is calculated based on Ia, Ib and Ig.

CTA+CTC- Ia and Ic used by fault locator are the ones measured and Ib is calculated based on Ia, Ic and Ig.

CTB+CTC- Ib and Ic used by fault locator are the ones measured and Ib is calculated based on Ia, Ic and Ig.

WARNING

If only two phase CTs are connected to the relay, several protection elements are affected and could experience unexpected behaviors. Also several measurements are affected and accuracy will not be met.

Proper behavior of all protection elements and measurements accuracy cannot be guaranteed if any of these settings is selected: CTA+CTB, CTA+CTC, CTB+CTC.

States associated with the fault report (**Actual > Status > fRecords Status > Fault Reports**), are shown on Table 5-7: Fault report states

Table 5-7: Fault report states

FAULT REPORT STATES
FAULT REPORT TRIGG
CLEAR FAULT REPORTS
FAULT DATE
FAULT TYPE
FAULT LOCATION

FAULT REPORT NUMBER

FAULT REPORT TRIGG: The activation of this state initiates the calculation of the fault location and the generation of the corresponding report.

CLEAR FAULT REPORTS: The activation of this state produces the removal of all faults stored in the relay. Additionally, all active faults on the HMI display are acknowledged. This signal is programmed at "***Setpoint > Relay Configuration > Protection Elements***".

FAULT DATE: Date and time of the last fault.

FAULT TYPE: Type of the last fault produced (3PHASE, AG, BG, CG, AB, ABG, BC, BCG, CA, CAG, NAF). NAF indicates that the type of fault has not been calculated.

FAULT LOCATION: Calculated distance to the last fault (the metering element is the same used for setting the line length).

FAULT REPORT NUMBER: Number of the fault report file saved in the relay's non-volatile memory, associated with the last fault produced.

5.2.3.2 Fault report retrieval

Fault report files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

To obtain fault reports using the EnerVista 650 Setup software, go to **Actual > Records > Fault report**. The top of the window shows the number of the last fault report stored by the device (Fault Record Number). Click **View header** to see the header of the record selected under **Select Record**.

Click **Download** to retrieve the file and save in a selected folder. The file name is "FLTxxx.TXT", where xxx is the corresponding record number.

- For firmware versions below 7.XX, oscillography record retrieval uses serial (ModBus RTU) or Ethernet (ftp, tftp) communication ports.
- For firmware versions below 7.70, oscillography record retrieval uses Ethernet communications ports (ftp, tftp).
- For firmware versions 7.70 and above, oscillography record retrieval uses serial (ModBus RTU) or Ethernet (ftp, tftp) communication ports.

Fault reports are stored in the relay's non-volatile memory, so they are accessible from the EnerVista 650 Setup software or the relay's web server. The fault report is a text file named FLTxxx.txt where xxx is the record number, with a range of 001 to 999. Only files from the 10 last faults are stored. If there are already ten files stored and a new fault occurs, the new fault overwrites the oldest one. If **Show Fault on HMI** is enabled, real-time fault information is also displayed on the HMI.

When a fault is produced and a warning message is displayed on the HMI, fault information alternates between two separate screens: one with general information, and a second with the fault metering values. This screen needs to be acknowledged by the user to exit the fault report screen. If several consecutive faults are produced, the HMI displays the most recent one. Each stored fault needs to be acknowledged (up to a maximum of 10 faults). The HMI menu offers an option to view the last 10 faults produced, with both the general information screen and the metering screen available for each fault.

5.2.4 Oscillography settings

Oscillography records contain waveforms captured at the sampling rate as well as other relay data at the point of trigger. This trigger can be configured with a programmable logic operand.

Oscillography records are stored in COMTRADE ASCII - IEEE C37.111-1999 standard format.

The oscillography module is in charge of storing the instantaneous values of the 9 analog signals and the 16 programmable digital signals at ***Setpoint > Relay Configuration > Oscillography*** in fault conditions (OSCILLO TRIGGER signal activation).

All oscillography records store all analog signals (fixed) plus 16 digital signals (programmable). The order of storage in the case of analog signals is as follows:

Analog 1 IA channel.

Analog 2 IB channel.

Analog 3 IC channel.

Analog 4 IG channel.

Analog 5 ISG channel.

Analog 6 VA or VAB channel, depending on the selected configuration (Wye or Delta, at "***Setpoint > System Setup > General Settings > Serial VT Connection***").

Analog 7 VB or VBC channel, depending on the selected configuration (Wye or Delta, at "***Setpoint > System Setup > General settings > Phase VT Connection***").

Analog 8 VC or VCA channel, depending on the selected configuration (Wye or Delta, at "***Setpoint > System Setup > General settings > Phase VT Connection***").

Analog 9 VN or VX channel, depending on the selected configuration (zero sequence measured, or busbar voltage, at "***Setpoint > System Setup > General settings > Auxiliary Voltage***").

The 16 digital channels and the oscillography trigger signal are programmable using the EnerVista 650 Setup software at ***Setpoint > Relay configuration > Oscillography***. Each digital channel can be associated with a single status or to a logic status. In this last case, the logic must be configured using the PLC Editor tool, at ***Setpoint > Logic Configuration*** inside EnerVista 650 Setup. The oscillography trigger signal can be a single status or a configured logic. The relay's default configuration associates the oscillography trigger to Virtual Output 83, which corresponds to the logic associated with the general trip of protection elements.

5.2.4.1 Oscillography settings

Setpoint > Product Setup > Oscillography				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]
Prefault	Trigger Position	30	1%	[5 : 95]
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Function Permission (Function): Enabling this setting allows to create an oscillography record when the "**TRIGGER OSCILLO**" signal is activated.

Trigger Position: This setting defines the prefault data (in percentage) stored every time a new oscillo is produced.

Samples/Cycle: This setting defines the number of samples per cycle stored in each oscillography record.

Maximum Number of Oscillos (Max. Number Osc.):

1 to 20 oscillography records can be selected.

Automatic Overwrite: This setting allows chained oscillographies during the fault (TRIGGER OSCILLO signal activated). The oscillography module is reset once the data has been completely stored in Flash memory and the TRIGGER OSCILLO state is deactivated.

Snapshot Events: This setting enables or disables snapshot event generation for the oscillography element.

Oscillography files calculations

The overall maximum samples capacity is allocated for 27594 samples. The size of each oscillography file depends on the configured number of oscillographies and is evenly distributed based on the maximum samples value using these formulas:

Number of samples per oscillography = (27594 samples)/(Max. Number Osc. setpoint)

Number of cycles per oscillography = (Number of samples per oscillography)/(Samples / Cycle setpoint).

NOTICE After a change in oscillography settings all oscillography files stored on the flash memory are erased.

EXAMPLE

For a Max. Number Osc. of 4, each record stores 27594 / 4 = 6898 samples per stored oscillo.

If we set the Samples /Cycle setpoint to 64 samples per cycle, each record stores up to 6898 / 64 = 107.78 signal cycles. This value expressed in terms of time is:

For 50 Hz: 204.79 cycles x 20 ms/cycle = 4095.8 ms.

For 60 Hz: 204.79 cycles x 16.67 ms/cycle = 3413 ms.

5.2.4.2 Oscillography states

OSCILLOGRAPHY STATES
OSC DIG CHANNEL 1
OSC DIG CHANNEL 2
OSC DIG CHANNEL 3
OSC DIG CHANNEL 4
OSC DIG CHANNEL 5
OSC DIG CHANNEL 6
OSC DIG CHANNEL 7
OSC DIG CHANNEL 8
OSC DIG CHANNEL 9
OSC DIG CHANNEL 10
OSC DIG CHANNEL 11
OSC DIG CHANNEL 12
OSC DIG CHANNEL 13
OSC DIG CHANNEL 14
OSC DIG CHANNEL 15
OSC DIG CHANNEL 16
OSCILLO TRIGGER
NUMBER OF TRIGGERS
CYCLES PER RECORD

AVAILABLE RECORDS

OSC DIGITAL CHANNEL XX: These states are configured at "***Setpoint > Relay configuration > Oscillography***". Each of these states can be associated with a protection state or to a virtual output. Each oscillography record reflects the changes experienced by this state during the record.

OSCILLO TRIGGER: The activation of this state produces the oscillography record capture. Each record uses a percentage of its capacity to store prefault information. This percentage is selected in the Trigger Position setting, and the rest of the record's capacity stores post-fault information.

NUMBER OF TRIGGERS: This is the number of the most recent oscillography record stored in the relay. The record is stored in COMTRADE format. The range is 0 to 999.

CYCLES PER RECORD: This state displays the number of cycles that are stored in each oscillography record. Although the number of cycles can be a decimal number, the record represents only the integer part.

AVAILABLE RECORDS: The range is 0 to 20.

5.2.4.3 Oscillography file retrieval

Oscillography files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

To obtain the oscillography records using the EnerVista 650 Setup software, go to "***Actual > Records > Waveform capture***". The top of the window shows the number of the last oscillography record stored by the device (Newest Record Number), followed by the maximum number of oscillos available (Available Records in Device). Click **View header** to show the header of the record selected at **Select Record**.

Click **Download** and the three files (*.DAT, *.HDR, *.CFG) that form the oscillography record in the COMTRADE standard are retrieved and viewed automatically if the GE-OSC software is installed in the computer. Retrieved oscillography records can be viewed using any Comtrade viewer. The EnerVista 650 Setup software stores oscillography records in the folder ".\EnerVista 650 Setup\files\osc" by default, in the same directory where the program is installed. The file names are "OSCxxx.DAT", "OSCxxx.CFG", "OSCxxx.HDR", where xxx is the corresponding record number.

- For firmware versions below 7.XX, oscillography record retrieval uses serial (ModBus RTU) or Ethernet (ftp, tftp) communication ports.
- For firmware versions above 7.00 and below 7.70, oscillography record retrieval uses Ethernet communications ports (tftp).
- For firmware versions 7.70 and above, oscillography record retrieval uses serial (ModBus RTU) or Ethernet (tftp) communication ports.

5.2.5 Data logger settings

The F650 data logger can store information from up to 16 analog channels, among all channels available in the relay, with a selectable sampling rate. The memory of the data logger is fixed at 64 Kilobytes with two bytes needed per channel. The selected channels take all available memory space, therefore, the number of days of storage depends on the selected number of channels and sampling rate.

5.2.5.1 Data logger SETTINGS

Setpoint > Product Setup > Data Logger				
Setting Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min., 10 min., 15 min., 20 min., 30 min., 60 min.]

Data Logger analog channels X	Data Logger Chnl X	None	N/A	[1 to 16]

Function permission (Function): This must be enabled to start storing information.

Data Logger Rate: the data logger can be configured in rates of 1 second, and 5, 10, 15, 20, 30 and 60 minutes

Data Logger Analog Channel X (Data Logger Chnl X): Analog Channels programmable in the data logger. The **X** value has a range from 0 to 16.

Any setting change in the Data Logger erases all stored information.

5.2.5.2 Data logger associated states

States associated with the data logger module ("***Actual > Status > Records Status > Data logger***) are shown on the table below:

DATA LOGGER STATES
OLDEST SAMPLE TIME
NEWEST SAMPLE TIME
DATA LOGGER CHANNELS
DATA LOGGER DAYS

OLDEST SAMPLE TIME: The Date/time of the oldest state with 6 characters. This is the time that corresponds to the oldest sample. This value remains constant until the available memory capacity is exceeded. Afterwards, this value changes according to the sampling rate (Data Logger Rate).

NEWEST SAMPLE TIME: The Date/time of the newest state with 6 characters. This is the time when the most recent sample was taken. This value is updated according to the sample rate selected.

If no channel has been selected, these settings do not change.

DATA LOGGER CHANNELS: This state shows the number of channels selected.

DATA LOGGER DAYS: This state shows the number of days that can be stored. It depends on the Data Logger Rate setting, and on the number of channels selected.

5.2.5.3 Data logger file format and retrieval

File Retrieval

Data logger files can be retrieved using the EnerVista 650 Setup software, or the web server at "http:\\relay IP address".

For obtaining the data logger files using the EnerVista 650 Setup software, the user must access "***Actual > Records > Data Logger***". The top of the window shows the date when the oldest sample was taken, and then the date when the newest sample was taken.

This screen shows the measurements stored for the different channels through the time.

Clicking on the "Download" button, all the information contained in the file can be read.

Clicking on the "Save" button, the data logger files (*.DAT, *.CFG) are retrieved in COMTRADE format, and saved by default in the folder "...\EnerVista 650 Setup\files\osc", using "DLGxxx.DAT", "DLGxxx.CFG" names, where xxx is the corresponding record number.

For firmware versions below 7.70, datalogger record retrieval uses Ethernet communications ports (ftp, tftp). For firmware versions 7.70 or above, datalogger record retrieval uses serial (ModBus RTU) or Ethernet (tftp) communication ports

File Format

Data logger information is made of two text files: configuration file (datalogger.cfg), and data file (datalogger.dat).

5.2.6 Demand settings

5.2.6.1 Metering values and settings

The demand calculation is made according to the following primary parameters:

Table 5-8: Primary demand values

PRIMARY DEMAND VALUES	STEP
IA (RMS)	KA
IB (RMS)	KA
IC (RMS)	KA
IG (RMS)	KA
ISG (RMS)	KA
I2	KA
Three phase active power (W)	MW
Three phase reactive power (VAR)	MVAr
Apparent power (VA)	MVA

*Note: The step depends on the selected “Primary Meter Units” in System Setup > General Settings (A_V; KA_KV)

Different integration methods can be selected to calculate current and power values.

Calculated demand values are as follows:

Table 5-9: Demand calculated values

DEMAND CALCULATED VALUES		
DEMAND IA	DEMAND IG	DEMAND W
DEMAND IA MAX	DEMAND IG MAX	DEMAND W MAX
DEMAND IA DATE	DEMAND IG DATE	DEMAND W DATE
DEMAND IB	DEMAND ISG	DEMAND VAR PWR
DEMAND IB MAX	DEMAND ISG MAX	DEMAND VAR MAX
DEMAND IB DATE	DEMAND ISG DATE	DEMAND VAR DATE
DEMAND IC	DEMAND I2	DEMAND VA PWR
DEMAND IC MAX	DEMAND I2 MAX	DEMAND VA MAX
DEMAND IC DATE	DEMAND I2 DATE	DEMAND VA DATE
DEMAND W MIN	DEMAND VAR MIN	DEMAND VA MIN

The relay measures current demanded on each phase, ground and sensitive ground, negative sequence and three-phase demand for real, reactive and apparent power. Current and Power methods can be chosen separately. Settings are provided to disable certain measuring techniques. These techniques are used by many utilities for statistical or control purposes.

Demand module settings are as follows:

Table 5-10: Demand settings

Setpoint > Product Setup > Demand				
Setting Description	Name	Default Value	Step	Range
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL - ROLLING DEMAND - THERMAL EXPONENTIAL]
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL - ROLLING DEMAND - THERMAL EXPONENTIAL]
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Function permission (Function): This setting enables the demand function.

Demand Method for Current values (CRNT Demand Method): Selection of the demand calculation method for current values. Available methods are Thermal Exponential, Block interval, and Rolling Demand.

Demand Method for Power values (POWER Demand Method): Selection of the demand calculation method for power values. Available methods are Thermal Exponential, Block interval, and Rolling Demand.

Demand Interval: Integration interval. Available intervals are 5, 10, 15, 20, 30, 60 minutes. Measurement integration is performed in the period adjusted in the Demand Interval setting.

Demand Trigger: Operation mode selection for the Block Interval calculation method. This operation mode depends on the “Trigger Enabled” setting. If trigger enabled is set as disabled, measurement integration is made in the Demand Interval period. If trigger enabled is enabled, measurement integration is made during the time interval between two consecutive pulses of the input assigned as DEMAND TRIGGER INP,. This input is set at ***Setpoint > Relay configuration > Protection Elements***

Snapshot Events: This setting enables or disables the snapshot event generation for the demand element.

5.2.6.2 Demand calculation methods

Calculation Method 1: Thermal Exponential

This method simulates the action of an analog peak recording thermal demand meter. The relay measures the magnitude for each phase (or three-phase, depending on the case) every second, and it assumes that the magnitude remains the same until the next update. It calculates the equivalent thermal demand using the following equation:

$$d(t) = D(1 - e^{-Kt})$$

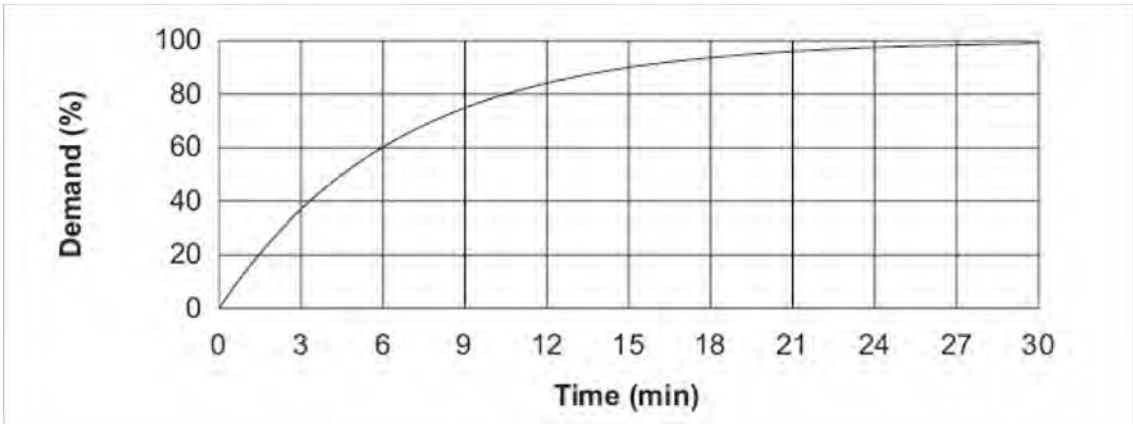
Where:

D Input signal (constant).

d(t) Demand value after applying the input value during time t (in minutes)

K 2.3 / thermal 90% response time

Illustrated bellow is the curve with a 90% characteristic time of 15 minutes. A setting establishes the time to reach 90% of a steady-state value, just as the response time of an analog instrument. A steady-state valve applied for twice the response time indicates 99% of the value.



Calculation Method 2: Rolling Demand.

This method calculates the linear average of the quantity over the set demand time interval. The calculation is made every second. The value is updated every minute and indicates the demand over the time interval just preceding the time of update.

Calculation Method 3: Block Interval

The Block Interval operation mode depends on the “Trigger Enabled” setting.

Calculation Method 3a: Block Interval – With trigger setting DISABLED.

This method consists on integrating the measurements during the time period specified in the DEMAND INTERVAL setting. The calculation is made every second and the demand value is the average of all values produced during the time interval. The time interval is chosen in the DEMAND INTERVAL setting. The interval demand value is shown once this time has expired.

If, for example, the setting indicates 15 minutes for integration, the demand value update is made every 15 minutes (although the calculation is made every second). This method calculates a linear average of the magnitude.

Calculation Method 3b: Block Interval – With trigger setting ENABLED.

The demand value is given by integration of the measurement during the time between two consecutive pulses in the input assigned. The input is assigned to DEMAND TRIGGER in Relay Configuration. The integration is made every second with each new measure.

In case the interval between two consecutive pulses exceeds 60 minutes, the relay calculates the demand after 60 minutes from the last pulse, this measure is updated in the status and a new demand count starts. This method calculates a linear average of the magnitude.

Figure 5-1: Response to different demand methods shows the behavior of the demand, depending on the Selected setting for demand calculation.

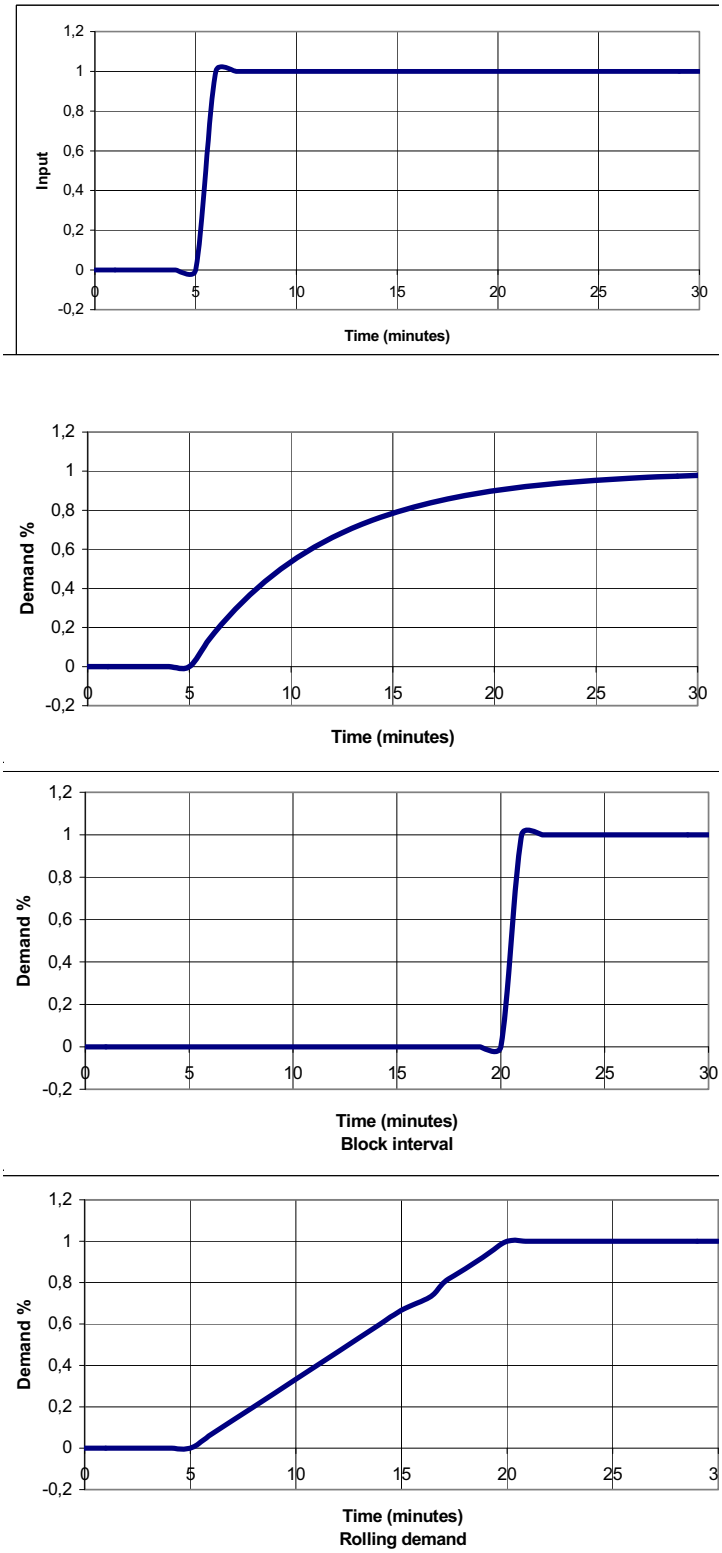


Figure 5-1: Response to different demand methods

5.2.6.3 Demand function measurements and states

Demand values are available at ***Actual > Metering > Primary Values > Demand***.

Table 5-11: Demand measurements

Name	Default Value	Step
DEMAND IA	0.000	KA
DEMAND IA MAX	0.000	KA
DEMAND IA DATE	01-Jan-2000 00:00:00.000	
DEMAND IB	0.000	KA
DEMAND IB MAX	0.000	KA
DEMAND IB DATE	01-Jan-2000 00:00:00.000	
DEMAND IC	0.000	KA
DEMAND IC MAX	0.000	KA
DEMAND IC DATE	01-Jan-2000 00:00:00.000	
DEMAND IG	0.000	KA
DEMAND IG MAX	0.000	KA
DEMAND IG DATE	01-Jan-2000 00:00:00.000	
DEMAND ISG	0.000	KA
DEMAND ISG MAX	0.000	KA
DEMAND ISG DATE	01-Jan-2000 00:00:00.000	
DEMAND I2	0.000	KA
DEMAND I2 MAX	0.000	KA
DEMAND I2 DATE	01-Jan-2000 00:00:00.000	
DEMAND W	0.000	MW
DEMAND W MAX	0.000	MW
DEMAND W MIN	0.000	MW
DEMAND W DATE	01-Jan-2000 00:00:00.000	
DEMAND VAR PWR	0.000	MVAr
DEMAND VAR MAX	0.000	MVAr
DEMAND VAR MIN	0.000	MVAr
DEMAND VAR DATE	01-Jan-2000 00:00:00.000	
DEMAND VA PWR	0.000	MVA
DEMAND VA MAX	0.000	MVA
DEMAND VA MIN	0.000	MVA
DEMAND VA DATE	01-Jan-2000 00:00:00.000	

*Note: The step depends on the selected “Primary Meter Units” in System Setup > General Settings (A_V; KA_KV)

Demand measurements for **current values** are as follows:

DEMAND I**X** — This is the demanded value every minute or every integration period, depending on the selected settings.

DEMAND I**X** MAX — Demanded maximeter; it stores the Maximum demand value until a demand reset is issued.

DEMAND I**X** DATE — Date of the Maximum demand value

Being **X** the phase considered in each case.

Demand measurements for **power values** are as follows (**Y** being the power considered in each case):

DEMAND **Y** — This is the demanded value every minute or every integration period, depending on the selected settings

DEMAND **Y** MAX	Demand maximeter; it stores the maximum demand value until a demand reset is issued.
DEMAND **Y** MIN	Demand minimeter; it stores the minimum demand value until a demand reset is issued.
DEMAND **Y** DATE	Date of the maximum demand value.
W	Three-phase active power
VAR	Three-phase reactive power
VA	Three-phase apparent power

The maximum or minimum demanded values are stored in non-volatile memory. These are not cleared when the relay is turned off. When the relay is turned on again, the values are updated.

States associated with the demand ("***Actual > Status > Records Status > Demand***") are the following:

Table 5-12: Demand associated values

DEMAND ASOCIATED STATES
DEMAND TRIGGER INP
DEMAND RESET INP

Besides the previously considered demand measures, two states are used for demand control:

DEMAND TRIGGER INP Bit type state, Programmable at "***Setpoint > Relay Configuration > Protection Elements"*** in the EnerVista 650 Setup software. This signal is used by the Block Interval demand method.

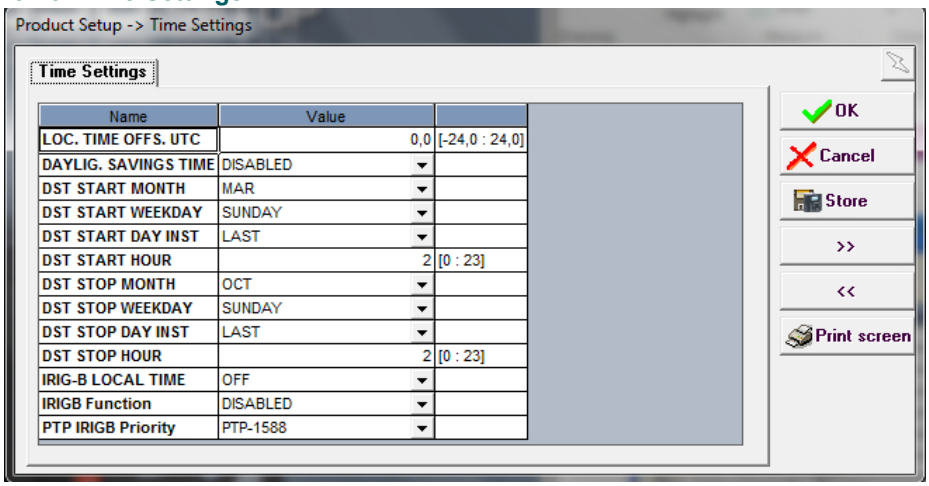
DEMAND RESET INP Bit type state, programmable at "***Setpoint > Relay Configuration > Protection Elements"*** in the EnerVista 650 Setup software. When this bit is activated, the demand measures are reset. All stored values are reset to zero (for demand dates, this value represents January 1st, 2000).

5.2.7 Time Settings

The date and time can be synchronized to a known time using the SNTP protocol, IRIG-B protocol (when it provides UTC Time) or IEEE1588 (Available starting from version V7.00) and the TIME SETTINGS allow setting the date and time provided by these protocols to the proper local time on the Real Time Clock.

When there is no SNTP protocol enabled, IRIG-B protocol is not set to UTC Time or IEEE1588 synchronization, the TIME SETTINGS are not used in the Real Time Clock but are still used to calculate the UTC Time (i.e., for the IEC61850 protocol), but its behavior is not assumed correct in several critical hour changes because of Daylight Savings Time getting effective. In these configuration cases, it is recommended to disable Daylight Savings Time.

Table 5-13: Time Settings



Name	Value	
LOC. TIME OFFS. UTC	0,0	[-24,0 : 24,0]
DAYLIG. SAVINGS TIME	DISABLED	
DST START MONTH	MAR	
DST START WEEKDAY	SUNDAY	
DST START DAY INST	LAST	
DST START HOUR	2	[0 : 23]
DST STOP MONTH	OCT	
DST STOP WEEKDAY	SUNDAY	
DST STOP DAY INST	LAST	
DST STOP HOUR	2	[0 : 23]
IRIG-B LOCAL TIME	OFF	
IRIGB Function	DISABLED	
PTP IRIGB Priority	PTP-1588	

The TIME SETTINGS settings are as follows:

LOC. TIME OFFS. UTC:

Is used to specify the local time zone offset from Universal Coordinated Time (Greenwich Mean Time) in hours.

DAYLIG. SAVINGS TIME:

Allow the unit clock to follow DST rules of the local time zone.

DST START MONTH:

Allow to set the start month of the DST from January to December

DST START WEEKDAY

Allow to set the start weekday of the DST from Monday to Sunday

DST START DAY INST:

Allow to set the start day instance from First, Second, Third, Fourth or Last

DST START HOUR

Allow to set the starting hour of the DST (in local time)

DST STOP MONTH

Allow to set the stop month of the DST from January to December

DST STOP WEEKDAY

Allow to set the stop weekday of the DST from Monday to Sunday

DST STOP DAY INST

Allow to set the stop day instance from First, Second, Third, Fourth or Last

DST STOP HOUR

Allow to set the stop hour of the DST (in local time)

IRIG-B LOCAL TIME:

Determines, in case of being enabled, if the IRIG-B protocol would carry the date in local time or else in UTC Time.

IRIG-B FUNCTION:

Setting for enable or disable the IRIG-B protocol

PTP IRIG-B PRIORITY:

If two or more time sources are setup the time source with the higher priority shown in the table below is used where 1 is considered to be the highest priority. Note that the time source priority of PTP and IRIG-B can be swapped. Setting changes become active after reboot.

The F650 is capable of receiving a time reference from several time sources in addition to its own internal clock for the purpose of time stamping events, transient recorders and other occurrences within the relay. The accuracy of the time stamp is based on the time reference that is used. The F650 supports an internal clock, SNTP, IRIG-B and 1588 as potential time references.

Regarding the PTP, F650 acts as an ordinary clock, with only Sync and Pdelay_Req messages.

Table 5-14: Synchronization priority table

Time source	Accuracy	Priority
PTP		1*
IRIG-B		2*
SNTP		3
Internal Clock		4

The priority of IRIG B and PTP can be swapped

Note:
Synchronization by IEC103, DNP, Modbus and IEC104 is not going to be issued if there is a synch source from IRIG-B, SNTP or PTP.

5.3 System setup

This section shows the settings related to the system setup definition.

5.3.1 General settings

This section determines the settings of the element configuration regarding its connection to the power system.

Setpoint > System Setup > General settings				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Phase CT ratio	Phase CT Ratio	1.0	0.1	[1.0 : 6000.0]
Ground CT ratio	Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]
Sensitive ground CT ratio	Stv Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]
Phase VT ratio	Phase VT Ratio	1.0	0.1	[1.0 : 6000.0]
Phase VT connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]
Rated voltage	Nominal Voltage	100.0	0.1	[1.0 : 250.0]
Rated Frequency	Nominal Frequency	50 Hz	N/A	[50-60]
Phase rotation	Phase Rotation	ABC	N/A	[ABC – ACB]
Frequency reference	Frequency Reference	VI	N/A	[VI-VII-VIII]
Auxiliary Voltage	Auxiliary Voltage	VX	N/A	[VX – VN]
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]
Primary Meter Units	Primary Meter Units	KA_KV	N/A	[KA_KV; A_V]
Device Name	Device Name		N/A	

The system rated voltage is used as reference by the voltage restraint in the phase timed overcurrent element.

The Frequency reference marks the voltage channel to which the system Frequency is measured.

The auxiliary voltage setting can be selected between VN and VX.

VN means that all elements using neutral voltage take the value directly from the fourth voltage input.

VX means that all elements using neutral voltage take the value calculated from phase voltages.

5.3.2 Miscellaneous settings

This section determines the relays status configuration regarding the service and local or remote modes.

Setpoint > System Setup > MISCELLANEOUS settings				
setting Description	**Name**	**Default Value**	**Step**	**Range**
Relay Out of Service	Relay Out of Service	ENABLED	N/A	[DISABLED – ENABLED]
Local/Remote Blocked	Local/Remote Blocked	OFF	N/A	[ON -OFF]
Active Language	Active Language	0	N/A	[0;1]

5.3.2.1 Out of service setting

The unit **Relay Out of Service** setting is configured in **Setpoint > System Setup > Miscellaneous**. The unit also has an **Out of Service** status that is configured in **Relay configuration > Protection elements**. When active, these states stop all changes to PLC equations and functions, including changes in the input/output boards, so if there is a change in any input or output the unit will not show this change until has returned to ready mode. For example, if an output is closed and the unit goes to the **Out of Service** state, the output is kept closed even if the state that closed it changes and would otherwise open the output. When the unit goes out of the **Out of Service** state, the output is then opened.

Functions affected by Out of service State

- IO Boards.

- Protection functions

o Current:

- Phase IOC Low (50PL)
- Phase IOC High (50PH)
- Phase TOC High (51PH)
- Phase TOC Low (51PL)
- Phase Dir (67P)
- Thermal Model (49)
- Ground TOC (51G)
- Ground IOC (50G)
- Ground Dir (67G)
- Neutral TOC (51N)
- Neutral IOC (50N)
- Neutral Dir (67N)
- Senstv Gnd TOC (51SG)
- Senstv Gnd IOC (50SG)
- Sensitive Gnd Dir (67SG)

- IS Ground IOC (50IG)
- Neg Seq TOC (46)
- Neg Seq Dir (67I2)

o Voltage:
- Auxiliary OV (59X)
- Voltage Unbalance (60V)
- Phase UV (27)
- Neutral OV High (59NH)
- Neutral OV Low (59NL)
- Neg Seq OV (47)
- Auxiliary UV (27X)
- Phase OV (59)

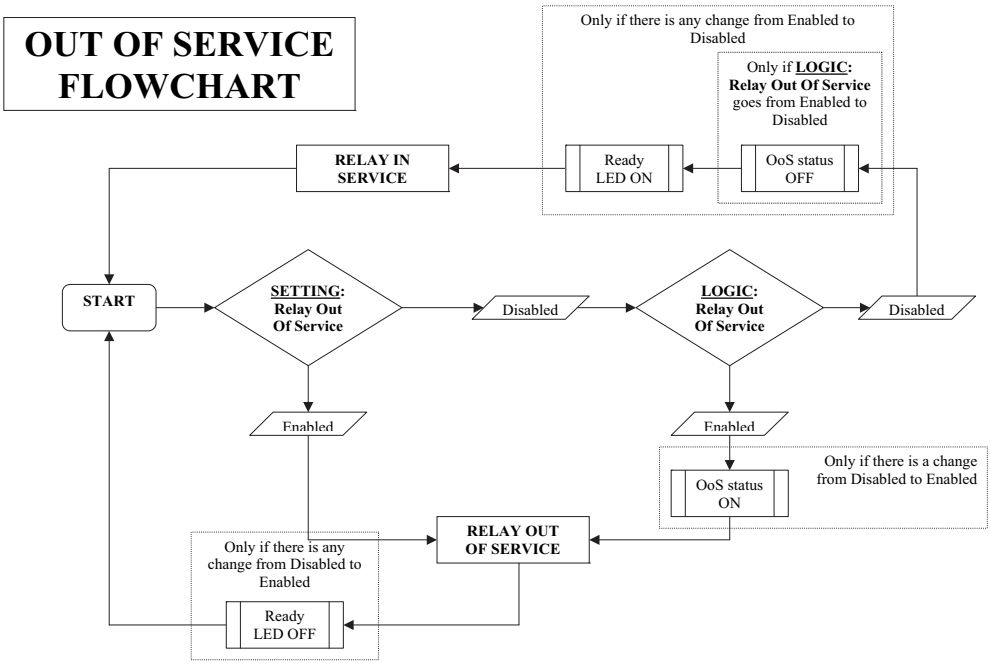
o Power:
- Forward Power (32FP)
- Directional Power (32DIR)
- Watt Gnd Flt Low (32NL)
- Watt Gnd Flt High (32NH)

o Frequency:
- Underfrequency (81U)
- Overfrequency (81O)
- Frequency Rate of Change (81df/dt)

o Misc:
- Broken Conductor (I1I2)
- Load Encroachment
- Rotor Blocked (48)
- Setting Groups
- Recloser (79)
- Oscillography
- Synchrocheck (25)
- Fault Locator
- Max. number of starts (66)
- Fuse Failure (VTFF)
- Data Logger
- Comparator
- Switchgear
- Breaker

When the Out of Service status goes to ON, or the setting has been changed to Enabled, the ready LED changes to red. Be careful if the ready LED is linked to an output, because the output will not change its state. To set an output to the ready state, see the factory default Logic & Configuration. Take notice that VO_000 is set to the output instead of VO_099

The following figure shows the flow chart of these states



5.3.2.2 Local - remote block setting

In the enhanced HMI with USB port new setting has been released in order to be able to lock the Local/Remote front key. This setting is available via COMS or frontal HMI menu. The settings can be locked by password, so the operator wouldn't be able to change the local-remote without inserting the password.

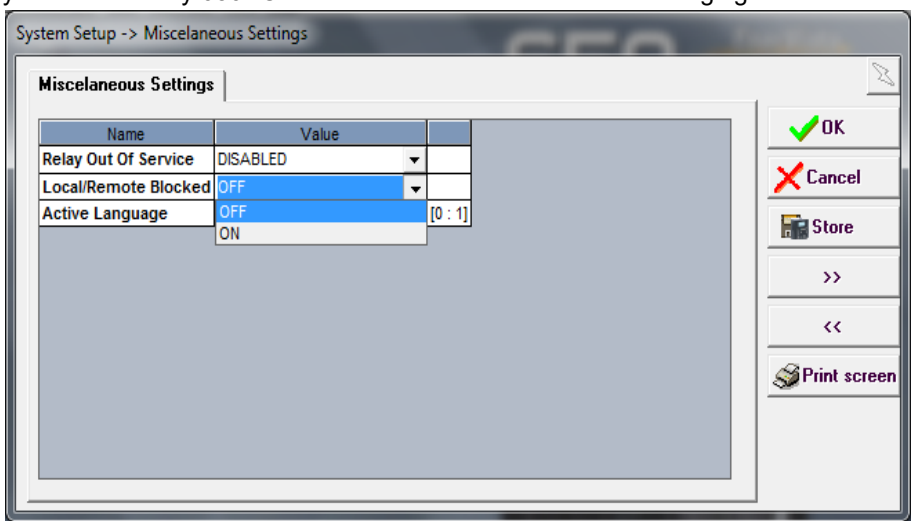
Definitions

The value is defined as:

- OFF: The operator is able to change the operations from local to remote or OFF.
- ON: The operator is not able to change the operations from local to remote or OFF.

Settings

The unit is set by the HMI and by 650PC software as it is shown in the following figure.



5.3.3 FlexCurve settings

The relay incorporates 4 user curves called Flex Curve A, B, C and D. The points for these curves are defined by the user in ***"Setpoint > System Setup > Flex Curves"*** menu in EnerVista 650 Setup. User defined flex curves can be selected as an operation curve in all the time overcurrent functions in the relay.

In the flex curves menu there are 120 points to define a user curve. 40 points for reset (from 0 to 0.98 times the pickup value) and 80 for operate (from 1.03 to 20 times the pickup).

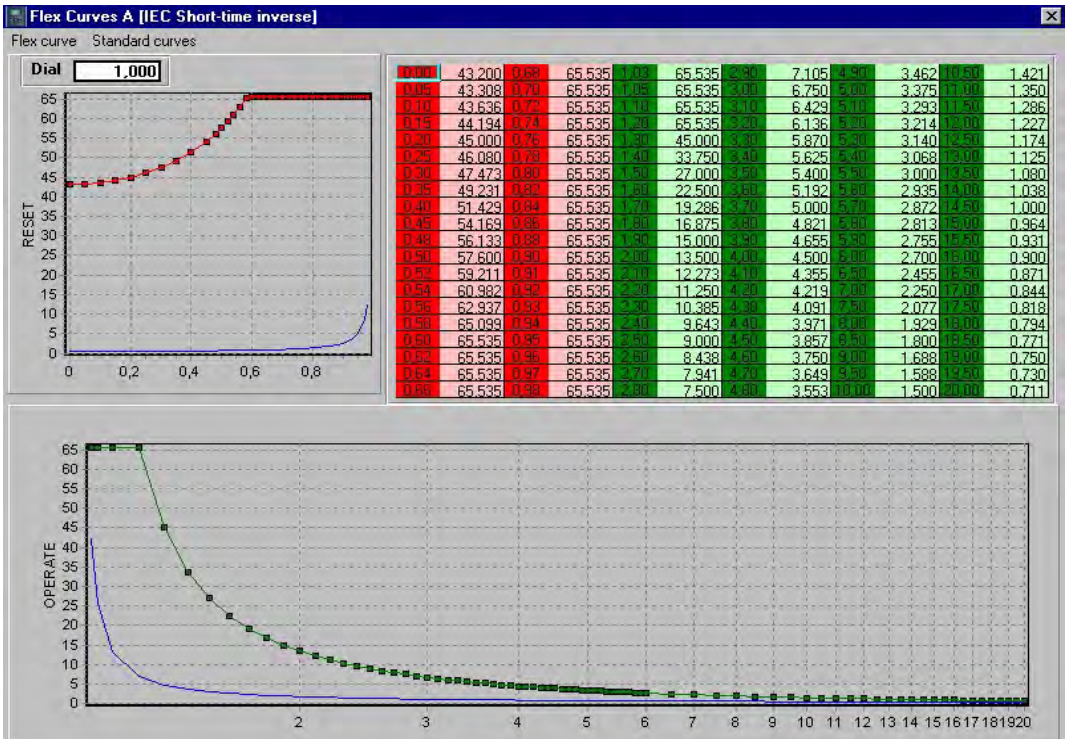
Table 5-15: FlexCurve settings

Setpoint > System Setup > Flex Curves Flex Curves A > Flex Curves B > Flex Curves C > Flex Curves D				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
…	…	…	…	…
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
…	…	…	…	…
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]

The definition of the curve points can be introduced directly in the Flex Curve settings menu. Alternatively they can be created using the graphical tool provided by clicking **Edit Curve** in the Flex curves menu in EnerVista 650 Setup.

In the user curve edit screen (see Figure 5-2: FlexCurves edition), a base curve can be selected, from the Standard Curves menu. This curve is used as a template to create the user curve. Once the standard curve is viewed, it is possible to make the user curve (operate, reset or both) reconcile the standard curve, using the **Flex curve > set flex curve from the standard curve**, and then modifying any of the points by editing in the table the corresponding value.

The user can also view a different curve model to the one the FlexCurve has been adapted to, and compare both models to adopt the most appropriate values in each case. If once the user curve has been configured, the user wants to store the information, the "***Flex Curve > Exit with Data***" menu must be selected. If the results are not to be saved, the ***Exit without Data*** option must be selected. Now, calculated points must be saved in the Flex Curve using the "Store" option.



0.00	43.200	0.68	65.535	1.03	65.535	2.90	7.105	4.90	3.462	10.50	1.421
0.05	43.308	0.70	65.535	1.05	65.535	3.00	6.750	5.00	3.375	11.00	1.350
0.10	43.636	0.72	65.535	1.10	65.535	3.10	6.429	5.10	3.293	11.50	1.286
0.15	44.194	0.74	65.535	1.20	65.535	3.20	6.136	5.20	3.214	12.00	1.227
0.20	45.000	0.76	65.535	1.30	45.000	3.30	5.870	5.30	3.140	12.50	1.174
0.25	46.080	0.78	65.535	1.40	33.750	3.40	5.625	5.40	3.068	13.00	1.125
0.30	47.473	0.80	65.535	1.50	27.000	3.50	5.400	5.50	3.000	13.50	1.080
0.35	49.231	0.82	65.535	1.60	22.500	3.60	5.192	5.60	2.935	14.00	1.038
0.40	51.429	0.84	65.535	1.70	19.286	3.70	5.000	5.70	2.872	14.50	1.000
0.45	54.169	0.86	65.535	1.80	16.875	3.80	4.821	5.80	2.813	15.00	0.964
0.48	56.133	0.88	65.535	1.90	15.000	3.90	4.655	5.90	2.755	15.50	0.931
0.50	57.600	0.90	65.535	2.00	13.500	4.00	4.500	6.00	2.700	16.00	0.900
0.52	59.211	0.91	65.535	2.10	12.273	4.10	4.355	6.50	2.455	16.50	0.871
0.54	60.982	0.92	65.535	2.20	11.250	4.20	4.219	7.00	2.250	17.00	0.844
0.56	62.937	0.93	65.535	2.30	10.385	4.30	4.091	7.50	2.077	17.50	0.818
0.58	65.099	0.94	65.535	2.40	9.643	4.40	3.971	8.00	1.929	18.00	0.794
0.60	65.535	0.95	65.535	2.50	9.000	4.50	3.857	8.50	1.800	18.50	0.771
0.62	65.535	0.96	65.535	2.60	8.438	4.60	3.750	9.00	1.688	19.00	0.750
0.64	65.535	0.97	65.535	2.70	7.941	4.70	3.649	9.50	1.588	19.50	0.730
0.66	65.535	0.98	65.535	2.80	7.500	4.80	3.553	10.00	1.500	20.00	0.711

Figure 5-2: FlexCurves edition

5.3.4 Breaker settings

There are two types of breaker settings:

Breaker settings: These settings correspond to the switchgear configured as a breaker in the F650; this switchgear is used in the recloser functions, breaker failure and synchronism.

Breaker Maintenance: These settings correspond to the initialization of the $(KI)^2t$ counters, and the counting of the number of openings and closings of the switchgear configured as a breaker.

Setpoint > System Setup > Breaker > Breaker settings				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Number of Switchgear selected as breaker	Number of Switchgear	1	1	[1 : 16]
Maximum value of $(KI)^2t$	Maximum $(KI)^2t$	9999.99	$0.01(KA)^2$ s	[0.00 : 9999.99]
$(KI)^2t$ integration time	$(KI)^2t$ Integ. Time	0.03	0.01s	[0.03 : 0.25]
Maximum number of openings	Maximum Openings	9999	1	[0 : 9999]
Maximum Openings in one hour	Max.Openings 1 hour	40	1	[1 : 60]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Breaker settings are as follows:

Number of switchgear: This is the Number of the Switchgear that is configured as a breaker. It is the reference for breaker failure (50BF), recloser (79) and synchronism (25) elements. The selected switchgear in the breaker settings must be previously configured at ***Setpoint > Relay Configuration > Switchgear***. The relay allows to configure up to 16 switchgear elements, but the one configured as a breaker is the reference for $(KI)^2t$, openings and closings counters.

Maximum $(KI)^2t$: This is the maximum set value for the square of the current multiplied by the breaker opening time. There is a separate counter for each phase, but the value stored as the maximum is a single value for the three phases.

$(KI)^2t$ Integration Time: This is the integration time taken as the base (fixed opening time) for the calculation of $(KI)^2t$.

Maximum Openings: This is the maximum number of openings allowed in the relay, with a limit of 9999; once this value is exceeded, the relay produces an alarm. When the limit 9999 is reached the maximum openings counter starts from zero.

Maximum Openings in 1 hour: This is the maximum number of openings allowed in the relay during one hour; once this value is reached, the corresponding alarm signal is activated; this value is updated and reset after one hour.

Snapshot Events: This setting enables or disables the snapshot event generation for the breaker signals.

The interrupted current limit setting, fixes the Maximum breaker capacity (this value is set depending on the information provided by the breaker manufacturer); the relay incorporates a $(KI)^2t$ counter for each phase, when a breaker opening occurs, the counter increases its value (in primary values). If the flowing current is lower than the rated current, the relay takes the rated current value for its calculations. When the accumulated counter for each phase reaches or exceeds the set value, the corresponding alarm signal is activated.

The purpose of this function is to provide closer information of the current status of the breaker's internal contacts. This is, in order to ensure appropriate breaker maintenance, and to decrease the risk of damage when the breaker has suffered severe operations during a long time. Once the breaker has been operated, and the preventive maintenance is in place, the accumulated I^2t values and the number of operations are reset to zero.

5.3.4.1 Breaker maintenance

To consider used breakers, the relay allows to set initial I^2t values as well as an initial number of operations, in order to take into account previous breaker operations, as well as operations produced during testing. Breaker maintenance parameters can be set in the breaker maintenance menu.

Setpoint > System Setup > Breaker > Breaker Maintenance				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
$(KI)^2t$ Counter Phase A	$(KI)^2t$ BKR Ph A Cnt	0.00	0.01 $(KA)^2$ s	[0.00 : 9999.99]
$(KI)^2t$ Counter Phase B	$(KI)^2t$ BKR Ph B Cnt	0.00	0.01 $(KA)^2$ s	[0.00 : 9999.99]
$(KI)^2t$ Counter Phase C	$(KI)^2t$ BKR Ph C Cnt	0.00	0.01 $(KA)^2$ s	[0.00 : 9999.99]
Openings counter	BKR Openings Cnt	0	1	[0 : 9999]
Closings counter	BKR Closings Cnt	0	1	[0 : 9999]

In this group of settings, the start values of the breaker Counters can be set.

These Counters allow the breaker Maintenance. They are used to accumulate the breaker aging produced by a trip or a breaker opening. In order to incorporate the breaker's history, in case of used breakers, the system allows assigning an initial value to accumulated amperes, and to the number of opening and closing operations.

To supervise breaker aging, $S(KI)^2t$ accumulated values are calculated and stored for each phase in each opening. If the rated current is not exceeded, as in the case of a manual opening command, without fault current, the relay uses the rated current instead of the measured value.

$(KI)^2t$ value is accumulated and maintained in independent Counters for each phase. Counters can be accessed through the local HMI as well as through the EnerVista 650 Setup software. The element incorporates a setting to select the integration time ($(KI)^2t$ Integ. Time).

The signals associated with the opened or closed status of the breaker can be monitored at **Actual > Status > Breaker**

Table 5-16: Breaker status

BREAKER STATUS	DESCRIPTION
BREAKER OPEN	Breaker in open position.
BREAKER CLOSED	Breaker in close position
BREAKER UNDEFINED	Breaker undefined

The signals associated with breaker maintenance can be monitored at **Actual > Status > Records Status > Breaker Maintenance**, and they are as follows:

Table 5-17: Breaker maintenance status

BREAKER MAINTENANCE	DESCRIPTION
$(KI)^2t$ PHASE A ALARM	This signal activates when the set value for phase A is exceeded.
$(KI)^2t$ PHASE B ALARM	This signal activates when the set value for phase B is exceeded.
$(KI)^2t$ PHASE C ALARM	This signal activates when the set value for phase C is exceeded.
BKR OPENINGS ALARM	Relay total Number of Openings alarm
BKR OPEN 1 HOUR ALRM	Relay total Number of Openings in one hour alarm
RESET $(KI)^2t$ COUNTERS	$(KI)^2t$ Counters reset signal. This signal is configured at ***Setpoint > Relay Configuration > Protection Elements***, and it is used for resetting the $(KI)^2t$ counter through the corresponding signal, command, digital input, etc.
RESET BKR COUNTERS	Reset signal for the Opening and Closing Counters. This signal is configured at ***Setpoint > Relay Configuration > Protection Elements***, and it is used for resetting the breaker Opening and closing counters.
BREAKER OPENINGS	Number of Breaker openings
BREAKER CLOSINGS	Number of Breaker closings

$(KI)^2t$ PHASE A	Accumulated $(KI)^2t$ value for phase A ($(KI)^2t$ Counter for Phase A)
$(KI)^2t$ PHASE B	Accumulated $(KI)^2t$ value for phase B ($(KI)^2t$ Counter for Phase B)
$(KI)^2t$ PHASE C	Accumulated $(KI)^2t$ value for phase C ($(KI)^2t$ Counter for Phase C)
BKR OPENING TIME	Maximum breaker Opening time. This signal is configured at ***Setpoint > Relay Configuration > Switchgear*** in the number of switchgear corresponding to the breaker selection
BKR CLOSING TIME	Maximum breaker Closing time. This signal is configured at ***Setpoint > Relay Configuration > Switchgear*** in the number of switchgear corresponding to the breaker selection
BKR OPEN TIMING	Exact time in opening the breaker
BKR CLOSE TIMING	Exact time in closing the breaker

5.3.5 Switchgear settings

There is the possibility to enable or disable the generation of internal signals for the different elements (protection, control, inputs and outputs, switchgear) available in the device.

Setpoint > System Setup > Switchgear				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Snapshot Event generation for switchgear #1	Snapshot Events SWGR 1	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #2	Snapshot Events SWGR 2	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #3	Snapshot Events SWGR 3	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #4	Snapshot Events SWGR 4	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #5	Snapshot Events SWGR 5	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #6	Snapshot Events SWGR 6	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #7	Snapshot Events SWGR 7	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #8	Snapshot Events SWGR 8	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #9	Snapshot Events SWGR 9	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #10	Snapshot Events SWGR 10	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #11	Snapshot Events SWGR 11	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #12	Snapshot Events SWGR 12	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #13	Snapshot Events SWGR 13	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #14	Snapshot Events SWGR 14	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #15	Snapshot Events SWGR 15	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation for switchgear #16	Snapshot Events SWGR 16	DISABLED	N/A	[DISABLED – ENABLED]

5.4 Protection elements

NOTE: Unless otherwise specified, menu references to EnerVista 650 Setup software are related to version 7.5X or above in this section. To obtain menu information for older firmware version, refer to the corresponding manual.

5.4.1 Available settings and setting groups

Available protection elements and setting groups are described for different firmware versions, along with configuration examples. Ensure you are looking at the correct firmware version for your relay: 5.4.1.1 Firmware 7.2x and below or 5.4.1.2 Firmware 7.50 or above.

5.4.1.1 Firmware 7.2x and below

This section only affects F650 units with firmware version 7.2x or below.

F650 relays incorporate the following **protection elements**:

CURRENT ELEMENTS

Instantaneous overcurrent:

3 x PHASE IOC HIGH (50PH)

3 x PHASE IOC LOW (50PL)

3 x NEUTRAL IOC (50N)

3 x GROUND IOC (50G)

3 x SENSITIVE GROUND IOC (50SG)

3 x ISOLATED GROUND IOC (50IG)

Time delayed overcurrent:

3 x PHASE TOC HIGH (51PH)

3 x PHASE TOC LOW (51PL)

3 x NEUTRAL TOC (51N)

3 x GROUND TOC (51G)

3 x SENSITIVE GROUND TOC (51SG)

Negative sequence overcurrent:

3 x NEGATIVE SEQUENCE TOC (46P)

Thermal image:

3 x THERMAL MODEL (49P)

DIRECTIONAL ELEMENTS

3 x PHASE DIR (67P)

3 x NEUTRAL DIR (67N)

3 x GROUND DIR (67G)

3 x SENSITIVE GROUND DIR (67SG)

VOLTAGE ELEMENTS

Phase under/overvoltage

3 x PHASE UV (27P)

3 x PHASE OV (59P)

Zero sequence overvoltage

3 x NEUTRAL OV HIGH (59NH)

3 x NEUTRAL OV LOW (59NL)

Additional auxiliary under/overvoltage (for VX selection in auxiliary voltage)

3 x AUXILIARY OV (59X)

3 x AUXILIARY UV (27X)

Negative sequence overvoltage:

3 x NEGATIVE SEQUENCE OV (47P)

POWER

3 x FORWARD POWER (32FP)

3 x DIRECTIONAL POWER (32)

3 x WATT GND FLT HIGH (32NH)

3 x WATT GND FLT LOW (32NL)

The F650 elements incorporate also the following **control elements**:

1 x SETTINGS GROUP

3 x OVERFREQUENCY (81O)*1

3 x UNDERFREQUENCY (81U)*1

1 x SYNCHROCHECK(25)

1 x AUTORECLOSE (79)

1 x BREAKER FAILURE (50BF)

1 x FUSE FAILURE (VTFF)

3 x BROKEN CONDUCTOR

1 x BREAKER SETTINGS

3 x LOCKED ROTOR

8 x PULSE COUNTERS (No group concept)

20 x ANALOG COMPARATORS (No group concept)

3 x FREQUENCY RATE OF CHANGE (81 df/dt)

3 x LOAD ENCROACHMENT

Note *1: For firmware version 7.20 or above, three extra underfrequency and overfrequency elements have been added which gives a total of 6 underfrequency and 6 overfrequency elements.

F650 elements incorporate a flexible grouping capability for protection ELEMENTS. This means that protection elements can be used in either one of the following modes:

5.4.1.1.1 Single setting groups

In this operation mode, all protection elements can be activated and operated simultaneously.

5.4.1.1.2 Three setting groups

In this mode, protection elements are grouped in three independent tables. Only one of them is active at a given time. A logic signal, e.g. a digital input, selects which table is active at each time, providing adaptive protection to each network condition.

Protection element grouping involves only Protection elements together with broken conductor detection and active and directional power, which are usually considered as control elements. The rest of the control elements such as recloser, fuse failure, breaker failure, synchronism, and breaker settings are not involved in the tabled groups concept.

The distribution of protection elements in tabled groups is described in Table 5-18: Distribution of protection and control elements

Table 5-18: Distribution of protection and control elements

TABLE 1	TABLE 2	TABLE 3
1x50PH	1x50PH	1x50PH
1x50PL	1x50PL	1x50PL
1x50N	1x50N	1x50N
1x50G	1x50G	1x50G
1x50SG	1x50SG	1x50SG
1x50IG	1x50IG	1x50IG

1x51PH	1x51PH	1x51PH
1x51PL	1x51PL	1x51PL
1x51N	1x51N	1x51N
1x51G	1x51G	1x51G
1x51SG	1x51SG	1x51SG
1x46P	1x46P	1x46P
1x49P	1x49P	1x49P
1x67P	1x67P	1x67P
1x67N	1x67N	1x67N
1x67G	1x67G	1x67G
1x67SG	1x67SG	1x67SG
1x27P	1x27P	1x27P
1x59P	1x59P	1x59P
1x47P	1x47P	1x47P
1x59NH	1x59NH	1x59NH
1x59NL	1x59NL	1x59NL
1x59X	1x59X	1x59X
1x27X	1x27X	1x27X
1x32FP	1x32FP	1x32FP
1x32	1x32	1x32
1x32N High	1x32N High	1x32N High
1x32N Low	1x32N Low	1x32N Low
1x81U	1x81U	1x81U
1x81O	1x81O	1x81O
1 x Broken conductor	1 x Broken conductor	1 x Broken conductor
1 x Locked Rotor	1 x Locked Rotor	1 x Locked Rotor
1 x Freq. Rate of Change	1 x Fq. Rate of Change	1 x Fq. Rate of Change
1 x Load Encroachment	1 x Load Encroachment	1 x Load Encroachment

The settings used for setting table management are located in **Setpoint > Control Elements > Setting Group**:

Setpoint > Control Elements > Setting Group				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Setting Group settings are as follows:

Function: Possible values are: [DISABLED – ENABLED]

When this setting is disabled, the relay is working in single setting group mode, with all the available protection elements working at the same time. If this function is enabled, the setting groups are enabled, and only the setting group indicated by the Active Group setting is active.

Active group: Possible values are 1, 2 or 3.

The setting group selected by default is setting Group 1. This setting indicates which setting group is active (for this purpose, the previous setting must be set as ENABLED)

The Relay incorporates several signals associated with the Protection elements grouping in tables. First, signals that indicate the group activation:

GROUP 1 ACT ON This signal produces the activation of setting group 1

GROUP 2 ACT ON This signal produces the activation of setting group 2

GROUP 3 ACT ON This signal produces the activation of setting group 3

These activation signals for the different setting groups are configured using EnerVista 650 Setup at **Setpoint > Relay Configuration > Control Elements** as shown in the figure. For firmware prior to 7.00, these signal are located at **Setpoint > Relay Configuration > Protection Elements**

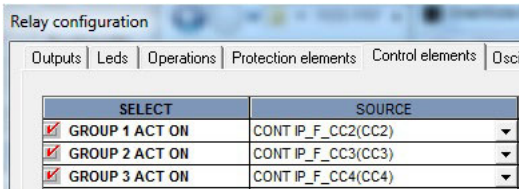


Figure 5-3: Table change signals configuration example

The example above uses three digital inputs to perform the table selection, but it is possible to use any other logic signal in the relay.

In case of using digital inputs, the user can select the setting table activating these digital inputs (which can come from the PLC, or from a different relay, or from an auxiliary switch, for adaptive protection). This selection of the active group has priority over the setting. If several signals are active at the same time, the highest one is taken as valid. For example, if selection signals for both groups 1 and 2 are active, the active table is number 2.

The time used in the table change is one PLC logic scan cycle (5 ms typical), allowing a fast adaptation to system changes.

Another type of signals are block signals. These are internal relay signals that indicate which groups are active, and which are blocked. For example, if the setting group function is enabled and setting group 1 has been set as active, block signals from setting groups 2 and 3 are active, and the block signal that corresponds to group 1 is inactive because that group is enabled.

Block signals are as follows:

GROUP 1 BLOCKED

GROUP 2 BLOCKED

GROUP 3 BLOCKED

All signals corresponding to setting Groups, both the activation and the block signals, are located in the ***Actual > Status > Control Elements > Setting Groups*** menu.

5.4.1.2 Firmware 7.50 or above

This section only affects to F650s which work with firmware version 7.5X or above.

All F650 functions that are affected by setting groups are located in EnerVista 650 Setup under **Protection (Setpoints > Protection Elements > Setting Group X**). All these functions are grouped into every different setting group available (up to 6)**.**

CURRENT ELEMENTS

Instantaneous overcurrent:

3 x PHASE IOC HIGH (50PH)

3 x PHASE IOC LOW (50PL)

3 x NEUTRAL IOC (50N)

3 x GROUND IOC (50G)

3 x SENSITIVE GROUND IOC (50SG)

3 x ISOLATED GROUND IOC (50IG)

Time delayed overcurrent:

3 x PHASE TOC HIGH (51PH)

3 x PHASE TOC LOW (51PL)

3 x NEUTRAL TOC (51N)

3 x GROUND TOC (51G)

3 x SENSITIVE GROUND TOC (51SG)

Negative sequence overcurrent:

3 x NEGATIVE SEQUENCE TOC (46P)

Thermal image:

3 x THERMAL MODEL (49P)

DIRECTIONAL ELEMENTS

3 x PHASE DIR (67P)

3 x NEUTRAL DIR (67N)

3 x GROUND DIR (67G)

3 x SENSITIVE GROUND DIR (67SG)

VOLTAGE ELEMENTS

Phase under/overvoltage

3 x PHASE UV (27P)

3 x PHASE OV (59P)

Zero sequence overvoltage

3 x NEUTRAL OV HIGH (59NH)

3 x NEUTRAL OV LOW (59NL)

Additional auxiliary under/overvoltage (for VX selection in auxiliary voltage)

3 x AUXILIARY OV (59X)

3 x AUXILIARY UV (27X)

Negative sequence overvoltage:

3 x NEGATIVE SEQUENCE OV (47P)

POWER

3 x FORWARD POWER (32FP)

3 x DIRECTIONAL POWER (32)

3 x WATT GND FLT HIGH (32NH)

3 x WATT GND FLT LOW (32NL)

FREQUENCY ELEMENTS

6 x OVERFREQUENCY (81O)

6 x UNDERFREQUENCY (81U)

3 x FREQUENCY RATE OF CHANGE (81 df/dt)

MISCELLANEOUS

3 x BROKEN CONDUCTOR

3 x LOCKED ROTOR

3 x LOAD ENCROACHMENT

The F650 elements incorporate also the following **control elements**. These control elements are not affected by setting groups and they are available in EnerVista 650 Setup at **Setpoints > Control Elements**

1 x SETTINGS GROUP

1 x SYNCHROCHECK(25)

1 x AUTORECLOSE (79)

1 x BREAKER FAILURE (50BF)

1 x VT FUSE FAILURE (VTFF)

8 x PULSE COUNTERS

8 x DIGITAL COUNTERS

20 x ANALOG COMPARATORS

1x MAX. NUMBERS OF STARTS

1 x COLD LOAD PICKUP

16 x PLC TIMER MASK

1x 60 CTS FAILURE

1x 2ND HRMC INHIBIT

As in previous firmware versions, F650 elements incorporate a flexible grouping capability for elements grouped in **protection elements** section. However, two different working modes have been implemented for firmware version 7.5X and above

This means that protection elements can be used in either one of the following modes:

5.4.1.2.1 Single setting group

In this operation mode, all protection elements under one particular Setting Group can be activated and operated simultaneously. When the Setting Group Function is disabled at **Setpoint > Control Elements > Setting Group**, protection elements of the group selected as the Active Group become available.

5.4.1.2.2 Multiple setting groups

In this mode, all protection elements are available in each individual setting group (up to maximum of 6). Only one configured setting groups is active at a given time. A logic signal, e.g. a digital input, selects which table is active at each time, providing adaptive protection to each network condition.

The distribution of protection elements in groups is described in Table 5–33:

Table 5-19: DISTRIBUTION OF PROTECTION ELEMENTS

SETTING GROUP 1	SETTING GROUP 2	SETTING GROUP 3	SETTING GROUP 4	SETTING GROUP 5	SETTING GROUP 6
3x50PH	3x50PH	3x50PH	3x50PH	3x50PH	3x50PH
3x50PL	3x50PL	3x50PL	3x50PL	3x50PL	3x50PL
3x50N	3x50N	3x50N	3x50N	3x50N	3x50N
3x50G	3x50G	3x50G	3x50G	3x50G	3x50G
3x50SG	3x50SG	3x50SG	3x50SG	3x50SG	3x50SG

3x50IG	3x50IG	3x50IG	3x50IG	3x50IG	3x50IG
3x51PH	3x51PH	3x51PH	3x51PH	3x51PH	3x51PH
3x51PL	3x51PL	3x51PL	3x51PL	3x51PL	3x51PL
3x51N	3x51N	3x51N	3x51N	3x51N	3x51N
3x51G	3x51G	3x51G	3x51G	3x51G	3x51G
3x51SG	3x51SG	3x51SG	3x51SG	3x51SG	3x51SG
3x46P	3x46P	3x46P	3x46P	3x46P	3x46P
3x49P	3x49P	3x49P	3x49P	3x49P	3x49P
3x67P	3x67P	3x67P	3x67P	3x67P	3x67P
3x67N	3x67N	3x67N	3x67N	3x67N	3x67N
3x67G	3x67G	3x67G	3x67G	3x67G	3x67G
3x67SG	3x67SG	3x67SG	3x67SG	3x67SG	3x67SG
3x27P	3x27P	3x27P	3x27P	3x27P	3x27P
3x59P	3x59P	3x59P	3x59P	3x59P	3x59P
3x47P	3x47P	3x47P	3x47P	3x47P	3x47P
3x59NH	3x59NH	3x59NH	3x59NH	3x59NH	3x59NH
3x59NL	3x59NL	3x59NL	3x59NL	3x59NL	3x59NL
3x59X	3x59X	3x59X	3x59X	3x59X	3x59X
3x27X	3x27X	3x27X	3x27X	3x27X	3x27X
3x32FP	3x32FP	3x32FP	3x32FP	3x32FP	3x32FP
3x32	3x32	3x32	3x32	3x32	3x32
3x32N High	3x32N High	3x32N High	3x32N High	3x32N High	3x32N High
3x32N Low	3x32N Low	3x32N Low	3x32N Low	3x32N Low	3x32N Low
6x81U	6x81U	6x81U	6x81U	6x81U	6x81U
6x81O	6x81O	6x81O	6x81O	6x81O	6x81O
3 x Broken conductor	3 x Broken conductor	3 x Broken conductor	3 x Broken conductor	3 x Broken conductor	3 x Broken conductor
3 x Locked Rotor	3 x Locked Rotor	3 x Locked Rotor	3 x Locked Rotor	3 x Locked Rotor	3 x Locked Rotor
3 x Freq. Rate of Change	3 x Freq. Rate of Change	3 x Freq. Rate of Change	3 x Freq. Rate of Change	3 x Freq. Rate of Change	3 x Freq. Rate of Change
3 x Load Encroachment	3 x Load Encroachment	3 x Load Encroachment	3 x Load Encroachment	3 x Load Encroachment	3 x Load Encroachment

The settings used for setting group management are located in **Setpoint > Control Elements > Setting Group**

Table 5-20: Setting group settings

Setpoint > Control Elements > Setting Group				
Setting Description	Name	Default Value	Step	Range
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3- GROUP 4-GROUP 5-GROUP 6]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Setting Group settings are as follows:

Function: Possible values are: [DISABLED – ENABLED]

When this setting is DISABLED, the relay is working in single setting group mode. All protection elements that belong to the group selected in the active groups setting are available and working at the same time if required.

If this setting is ENABLED, the relay is working in multiple setting groups mode. In this mode, all protection elements of different setting groups are available to be activated. However, only protection elements of the Active Group selected are real active ones. In this case, selection of active setting group can be modified through logic signals.

Active group: Possible values are 1, 2, 3, 4, 5 or 6.

This setting indicates which setting group is active by default. Default configuration value is 1.

- When this function is disabled, the Active Group value indicates which setting group of protection elements is available, e.g if Active Group is GROUP 1, all protection elements under setting group 1 in **SetPoint > Protection Elements** are available.
- When this function is enabled, the Active Group value indicates the active setting group when no group is selected as the active one.

Snapshot events: Possible values are: [DISABLED – ENABLED]

If this setting is ENABLED, Snapshot events related to change of setting groups are reported.

Regarding changing between setting groups when working in multiple setting groups mode, the Relay incorporates several signals associated with the Protection elements grouping in tables.

First, signals that indicate the group activation:

GROUP 1 ACT ON: This signal produces the activation of setting group 1

GROUP 2 ACT ON: This signal produces the activation of setting group 2

GROUP 3 ACT ON: This signal produces the activation of setting group 3

GROUP 4 ACT ON: This signal produces the activation of setting group 4

GROUP 5 ACT ON: This signal produces the activation of setting group 5

GROUP 6 ACT ON: This signal produces the activation of setting group 6

Priority of activation signals is indicated as follow:

GROUP 6 > GROUP 5 > GROUP 4 > GROUP 3 > GROUP 2 > GROUP 1

E.g: If group 4 and group 1 are selected at the same time, setting group 4 is the active one due to the higher priority level.

As previously mentioned, when no activation signal is selected, the default group set in EnerVista 650 Setup under **Setpoint > Control Elements > Setting Group > Active group** is the active group.

These activation signals for the different setting groups can be configured using EnerVista 650 Setup at **Setpoint > Relay Configuration > Control Elements** as shown. Different inputs can be linked to different activation signals.

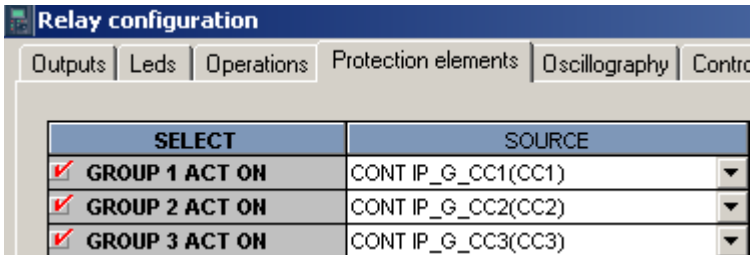


Figure 5-4: Table change signals configuration example

The example above uses six digital inputs to perform the table selection, but it is possible to use any other logic signal in the relay.

In case of using digital inputs, the user can select the setting table activating these digital inputs (which can come from the PLC, or from a different relay, or from an auxiliary switch, for adaptive protection). This selection of the active group has priority over default setting.

The time used in the table change is one PLC logic scan cycle (5 ms typical), allowing a fast adaptation to system changes.

Another type of signal is PROT ACTIVE GROUP, which indicates the active setting group. Protection element settings in the active group are the values being used by different protection functions.

All actual values signals corresponding to setting groups are located in the ***Actual > Status > Control Elements > Setting Groups*** menu.

5.4.2 Inverse time curve characteristics

Inverse time curves available in time overcurrent elements are as follows:

IEEE extremely/very/moderately inverse

IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse

IAC extremely/very/normally/moderately inverse

ANSI extremely/very/normally/moderately inverse

I2t

Definite time curves

Rectifier time curves

User Curve - FlexCurve A/B/C/D

Recloser Curves

The saturation level for the user curve is 20 times the pickup value, for the rest of time overcurrent elements the saturation level is 48 times the pickup.

All these curves follow the standards defined for each of them, allowing an efficient coordination with other devices located downstream. A dial or curve setting allows selection of a tripping time X times the set time in the selected curve. Fixing this value to 0 would produce an instantaneous response for any selected curve.

Tripping time calculations are performed on the base of an internal variable called “energy”. This energy represents the system dissipation capability, that is, when 100% of energy is reached, this means that the tripping time associated with the curve for a certain current value has expired.

Therefore, once the current value has exceeded the pickup value, the relay starts increasing the energy variable value. If it reaches 100%, a trip is produced. When the current value falls below 97% of the pickup value, the element is reset. There are two reset types: Instantaneous and Timed (IEEE) or Linear.

The instantaneous mode provides that, when the current value falls below the reset level, energy is immediately reset to 0. This mode is used for coordinating with static devices, which behave in a similar way. In the Linear mode, energy is reduced at a speed associated with the reset times curve (showed in the curve tables), trying to simulate the behavior of electromechanical relays.

5.4.2.1 IEEE curves

This family of curves follows the standard IEEE C37.112-1996 for extremely inverse, very inverse, and inverse curves. The following formulas define this type of curve:

$$t = dial * \left[\frac{A}{\left(\frac{I}{Itap}\right)^{p} - 1} + B \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^{2} - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

A, B, p = constants defined by the standard

T_{RESET} = reset time in seconds

t_r = characteristic constant.

Table 5-21: Constants for IEEE curves

IEEE Curve Shape	Name	A	B	p	tr
IEEE Extremely Inverse	IEEE Ext Inv	28.2	0.1217	2.0000	29.1
IEEE Very Inverse	IEEE Very Inv	19.61	0.491	2.0000	21.6
IEEE Inverse	IEEE Mod Inv	0.0515	0.1140	0.0200	4.85

Table 5-22: Tripping time in seconds for IEEE curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEEE Extremely Inverse										
0.5	11.341	4.761	1.823	1.001	0.648	0.464	0.355	0.285	0.237	0.203
1.0	22.682	9.522	3.647	2.002	1.297	0.927	0.709	0.569	0.474	0.407
2.0	45.363	19.043	7.293	4.003	2.593	1.855	1.418	1.139	0.948	0.813
4.0	90.727	38.087	14.587	8.007	5.187	3.710	2.837	2.277	1.897	1.626
6.0	136.090	57.130	21.880	12.010	7.780	5.564	4.255	3.416	2.845	2.439
8.0	181.454	76.174	29.174	16.014	10.374	7.419	5.674	4.555	3.794	3.252
10.0	226.817	95.217	36.467	20.017	12.967	9.274	7.092	5.693	4.742	4.065
IEEE Very Inverse										
0.5	8.090	3.514	1.471	0.899	0.654	0.526	0.450	0.401	0.368	0.345
1.0	16.179	7.028	2.942	1.798	1.308	1.051	0.900	0.802	0.736	0.689
2.0	32.358	14.055	5.885	3.597	2.616	2.103	1.799	1.605	1.472	1.378
4.0	64.716	28.111	11.769	7.193	5.232	4.205	3.598	3.209	2.945	2.756
6.0	97.074	42.166	17.654	10.790	7.849	6.308	5.397	4.814	4.417	4.134

8.0	129.432	56.221	23.538	14.387	10.465	8.410	7.196	6.418	5.889	5.513
10.0	161.790	70.277	29.423	17.983	13.081	10.513	8.995	8.023	7.361	6.891
IEEE Inverse										
0.5	3.220	1.902	1.216	0.973	0.844	0.763	0.706	0.663	0.630	0.603
1.0	6.439	3.803	2.432	1.946	1.688	1.526	1.412	1.327	1.260	1.207
2.0	12.878	7.606	4.864	3.892	3.377	3.051	2.823	2.653	2.521	2.414
4.0	25.756	15.213	9.729	7.783	6.753	6.102	5.647	5.307	5.041	4.827
6.0	38.634	22.819	14.593	11.675	10.130	9.153	8.470	7.960	7.562	7.241
8.0	51.512	30.426	19.458	15.567	13.507	12.204	11.294	10.614	10.083	9.654
10.0	64.390	38.032	24.322	19.458	16.883	15.255	14.117	13.267	12.604	12.068

5.4.2.2 IEC curves

This family of curves follows the European standard IEC 255-4, and the British standard BF142 for IEC Curves A, B and C, IEC Long-Time Inverse and IEC Short-Time Inverse. The formulas that define these curves are as follows:

$$t = dial * \left[\frac{K}{\left(\frac{I}{Itap}\right)^{E} - 1} \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^{2} - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplying factor

I = Input current

Itap = Current pickup value

K, E = constants defined by the standard

T_{RESET} = reset time in seconds (assuming 100% of power capacity and that the reset is activated)

t_r = characteristic constant.

Table 5-23: Constants for IEC curves

IEC Curve Shape	Name	K	E	tr
IEC Curve A	IEC Curve A	0.140	0.020	9.7
IEC Curve B	IEC Curve B	13.500	1.000	43.2
IEC Curve C	IEC Curve C	80.000	2.000	58.2
IEC Long-Time Inverse	IEC Long-Time Inv	120.000	1.000	120.0
IEC Short-Time Inverse	IEC Short-Time Inv	0.050	0.040	0.5

Table 5-24: Tripping time in seconds for IEC curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEC Curve A										
0.05	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149
0.10	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297
0.20	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594
0.40	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188
0.60	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782
0.80	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376
1.00	17.194	10.029	6.302	4.980	4.280	3.837	3.528	3.297	3.116	2.971
IEC Curve B										
0.05	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075
0.10	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150
0.20	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300
0.40	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600
0.60	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900
0.80	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200
1.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500
IEC Curve C										
0.05	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040
0.10	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081
0.20	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162
0.40	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323
0.60	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485
0.80	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646
1.00	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808
IEC Long-Time Inverse										
0.05	12.000	6.000	3.000	2.000	1.500	1.200	1.000	0.857	0.750	0.667
0.10	24.000	12.000	6.000	4.000	3.000	2.400	2.000	1.714	1.500	1.333
0.20	48.000	24.000	12.000	8.000	6.000	4.800	4.000	3.429	3.000	2.667
0.40	96.000	48.000	24.000	16.000	12.000	9.600	8.000	6.857	6.000	5.333
0.60	144.000	72.000	36.000	24.000	18.000	14.400	12.000	10.286	9.000	8.000
0.80	192.000	96.000	48.000	32.000	24.000	19.200	16.000	13.714	12.000	10.667
1.00	240.000	120.000	60.000	40.000	30.000	24.000	20.000	17.143	15.000	13.333
IEC Short-Time Inverse										
0.05	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026
0.10	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052
0.20	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104
0.40	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207
0.60	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311
0.80	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415
1.00	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518

5.4.2.3 IAC curves

This family of curves follows the time response of the General Electric IAC electromechanical relays. The following formulas define these curves:

$$t = dial * \left[A + \frac{B}{\left(\frac{I}{Itap} - C\right)} + \frac{D}{\left(\frac{I}{Itap} - C\right)^2} + \frac{E}{\left(\frac{I}{Itap} - C\right)^3} \right] \qquad T_{RESET} = dial * \left[\frac{t_r}{\left(\frac{I}{Itap}\right)^2 - 1} \right]$$

Where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

A, B, C, D, E = predefined constants

T_{RESET} = reset time in seconds

t_r = characteristic constant.

Table 5-25: Constants for IAC curves

IAC Curve Shape	Name	A	B	C	D	E	tr
IAC Extremely Inverse	IAC Ext Inv	0.0040	0.6379	0.6200	1.7872	0.2461	6.008
IAC Very Inverse	IAC Very Inv	0.0900	0.7955	0.1000	-1.2885	7.9586	4.678
IAC Inverse	IAC Mod Inv	0.2078	0.8630	0.8000	-0.4180	0.1947	0.990

Table 5-26: Tripping time in seconds for IAC curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC Extremely Inverse										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC Very Inverse										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC Inverse										

0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.168	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969

5.4.2.4 ANSI curves

This family of curves complies with the American Standard ANSI C37.90 for Extremely inverse, Very inverse, Normally inverse and Moderately inverse curves. The formulas that define these curves are as follows:

$$T = Dial\left[A + \frac{B}{\left(\frac{I}{Ipickup} - C\right)} + \frac{D}{\left(\frac{I}{Ipickup} - C\right)^2} + \frac{E}{\left(\frac{I}{Ipickup} - C\right)^3}\right] \qquad T_{reset} = TDM \times \left[\frac{T_r}{\left(\frac{I}{I_{pickup}}\right)^2 - 1}\right]$$

where:

T = Operation time (in seconds).

Dial = Multiplying factor

I = Input current

I_{pickup} = Current pickup setting

A, B, C, D, E = Constants

T_{reset} = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

T_r = Characteristic constant

The different constants that define the above-mentioned curves are:

Table 5-27: Constants for ANSI curves

ANSI Curve Shape	A	B	C	D	E	Tr
ANSI Extremely Inverse	0.0399	0.2294	0.5	3.0094	0.7222	5.67
ANSI Very Inverse	0.0615	0.7989	0.34	-0.284	4.0505	3.88
ANSI Normally Inverse	0.0274	2.2614	0.3	-4.1899	9.1272	5.95
ANSI Moderately Inverse	0.1735	0.6791	0.8	-0.08	0.1271	1.08

Table 5-28: Tripping time in seconds for ANSI curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
ANSI Extremely inverse										
0.50	2.000	0.872	0.330	0.184	0.124	0.093	0.075	0.063	0.055	0.049
1.00	4.001	1.744	0.659	0.368	0.247	0.185	0.149	0.126	0.110	0.098
2.00	8.002	3.489	1.319	0.736	0.495	0.371	0.298	0.251	0.219	0.196
4.00	16.004	6.977	2.638	1.472	0.990	0.742	0.596	0.503	0.439	0.393
6.00	24.005	10.466	3.956	2.208	1.484	1.113	0.894	0.754	0.658	0.589
8.00	32.007	13.955	5.275	2.944	1.979	1.483	1.192	1.006	0.878	0.786
10.00	40.009	17.443	6.594	3.680	2.474	1.854	1.491	1.257	1.097	0.982
ANSI Very Inverse										
0.50	1.567	0.663	0.268	0.171	0.130	0.108	0.094	0.085	0.078	0.073
1.00	3.134	1.325	0.537	0.341	0.260	0.216	0.189	0.170	0.156	0.146
2.00	6.268	2.650	1.074	0.682	0.520	0.432	0.378	0.340	0.312	0.291
4.00	12.537	5.301	2.148	1.365	1.040	0.864	0.755	0.680	0.625	0.583
6.00	18.805	7.951	3.221	2.047	1.559	1.297	1.133	1.020	0.937	0.874
8.00	25.073	10.602	4.295	2.730	2.079	1.729	1.510	1.360	1.250	1.165
10.00	31.341	13.252	5.369	3.412	2.599	2.161	1.888	1.700	1.562	1.457
ANSI Normally inverse										
0.50	2.142	0.883	0.377	0.256	0.203	0.172	0.151	0.135	0.123	0.113
1.00	4.284	1.766	0.754	0.513	0.407	0.344	0.302	0.270	0.246	0.226
2.00	8.568	3.531	1.508	1.025	0.814	0.689	0.604	0.541	0.492	0.452
4.00	17.137	7.062	3.016	2.051	1.627	1.378	1.208	1.082	0.983	0.904
6.00	25.705	10.594	4.524	3.076	2.441	2.067	1.812	1.622	1.475	1.356
8.00	34.274	14.125	6.031	4.102	3.254	2.756	2.415	2.163	1.967	1.808
10.00	42.842	17.656	7.539	5.127	4.068	3.445	3.019	2.704	2.458	2.260
ANSI Moderately inverse										
0.50	0.675	0.379	0.239	0.191	0.166	0.151	0.141	0.133	0.128	0.123
1.00	1.351	0.757	0.478	0.382	0.332	0.302	0.281	0.267	0.255	0.247
2.00	2.702	1.515	0.955	0.764	0.665	0.604	0.563	0.533	0.511	0.493
4.00	5.404	3.030	1.910	1.527	1.329	1.208	1.126	1.066	1.021	0.986
6.00	8.106	4.544	2.866	2.291	1.994	1.812	1.689	1.600	1.532	1.479
8.00	10.807	6.059	3.821	3.054	2.659	2.416	2.252	2.133	2.043	1.972
10.00	13.509	7.574	4.776	3.818	3.324	3.020	2.815	2.666	2.554	2.465

5.4.2.5 I2t curves

The following formulas define this type of curves:

$$t = dial * \left[\frac{100}{\left(\frac{I}{Itap} \right)^{2}} \right] \qquad T_{RESET} = dial * \left[\frac{100}{\left(\frac{I}{Itap} \right)^{-2}} \right]$$

where:

t = Operation time in seconds

Dial = multiplier setting

I = Input current

Itap = Current pickup value

T_{RESET} = reset time in seconds

Table 5-29: Tripping time in seconds for I2t curves

Dial	Current (I/Itap)									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.01	0.444	0.250	0.111	0.063	0.040	0.028	0.020	0.016	0.012	0.010
0.10	4.444	2.500	1.111	0.625	0.400	0.278	0.204	0.156	0.123	0.100
1.00	44.444	25.000	11.111	6.250	4.000	2.778	2.041	1.563	1.235	1.000
10.00	444.444	250.000	111.111	62.500	40.000	27.778	20.408	15.625	12.346	10.000
100.00	4444.444	2500.000	1111.111	625.000	400.000	277.778	204.082	156.250	123.457	100.000
600.00	26666.667	15000.000	6666.667	3750.000	2400.000	1666.667	1224.490	937.500	740.741	600.000

5.4.2.6 Definite time curves

The definite time makes the element trip when the current value is maintained beyond the pickup value during a longer time period than the set value. The Dial setting allows modifying this time frame from instantaneous to 900 seconds in steps of 10 ms.

5.4.2.7 Rectifier time curves

Rectifier curves are generated from the following formulas:

$$T = TDM \times \left(\frac{45900}{\left(\frac{I}{I_{pickup}} \right)^{5,6} - 1} \right) \qquad T_{reset} = TDM \times \left(\frac{45900}{\left(\frac{I}{I_{pickup}} \right)^{2} - 1} \right)$$

where:

T = Operation time (in seconds).

TDM = Multiplying factor

I = Input current

I_{pickup} = Pickup current

T_{reset} = Reset time (in seconds) assuming a 100% of power capacity and that the reset is activated

5.4.2.8 User curves - FlexCurves A/B/C/D

The relay incorporates 4 user curves called User Curve A, B, C and D. The points for these curves are defined by the user. Each of the four curves has an operation characteristic (operate), defined by 80 points, and a reset characteristic, defined by 40 points. Each point is defined as a time value for each I/I_{pickup} value (number of times the pickup current) given on the table. The user can assign values between 0 and 65.535 seconds in steps of 1 ms.

The following table details the 120 points as well as the characteristic for each of them, and a blank cell where the user can write the time value when the operation (for $I > I_{pickup}$) or the reset (for $I < I_{pickup}$) is required,

Table 5-30: User curve characteristics

RESET (xPKP)	Time (s)	RESET (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)	OPERATE (xPKP)	Time (s)
0.00		0.68		1.03		2.9		4.9		10.5	
0.05		0.70		1.05		3.0		5.0		11.0	
0.10		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12.0	
0.20		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13.0	
0.30		0.80		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14.0	
0.40		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15.0	
0.48		0.88		1.9		3.9		5.9		15.5	
0.50		0.90		2.0		4.0		6.0		16.0	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7.0		17.0	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8.0		18.0	
0.60		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9.0		19.0	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10.0		20.0	

The two first columns (40 points) correspond to the RESET curve. The other 4 columns, with 80 points in total, correspond to the OPERATE curve. The reset characteristic values are between 0 and 0.98, and the operation values are between 1.03 and 20.

The final curve is created by means of a linear interpolation from the points defined by the user. This is a separate process for the RESET and the OPERATE curve.

The definition of these points is performed in a separate module from the relay, using a configuration program included in the EnerVista 650 Setup, which incorporates a graphical environment for viewing the curve, thus making it easy for the user to create it. This module can be accessed from the “Edit Curve” option in the FlexCurve menu, at ***Setpoint > System Setup > Flex Curves***.

5.4.3 Phase current

The F650 Phase current menu incorporates the following overcurrent elements:

Phase time overcurrent (51PH/51PL)

Phase instantaneous overcurrent (50PH/50PL)

Phase directional overcurrent (67P)

Thermal Model (49)

5.4.3.1 Phase time delayed overcurrent elements – phase high/low (51Ph/51pl)

The phase overcurrent element (51P) can be configured in EnerVista 650 Setup at **Setpoint > Protection Element > Setting Group X > Phase Current**.

Table 5-31: Phase time overcurrent settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Phase Current > > Phase TOC High > Phase TOC High 1 > Phase TOC High 2 > Phase TOC High 3 > Phase TOC Low > Phase TOC Low 1 > Phase TOC Low 2 > Phase TOC Low 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The phase overcurrent element (51P) operates in a time period that depends on the applied current and on the set curve. Possible outputs for the protection element logic are the pickup and tripping signals independent for each phase, and the general element pickup and tripping signals.

Function: This setting allows enabling or disabling the corresponding directional element.

Input: The phase current input may be selected as fundamental phasor magnitude or total waveform RMS magnitude as required by the application.

Pickup Level: This setting allows selecting the current level for the Phase Time Overcurrent element to operate. The PICKUP setting of the element can be dynamically reduced by a VOLTAGE RESTRAINT feature. In order to avoid undesired trips, pickup will occur at 1.03 times the set value.

Curve: This setting allows to select the curve that want to be use to operate this element. If the element Curve is set as Definite Time, then the TD Multiplier setting is used to define both the Operation time and, in case of selecting Linear reset, the Reset time of the element.

TD Multiplier: This setting allows the curve to be shifted up or down on the time-current characteristic curve. This allows configuration of the relay depending on network selectivity

Reset: The element reset can be selected between Instantaneous and Linear (timed according to the corresponding equation).

Voltage Restraint: As mention above, the pickup current magnitude can be dynamically reduced depending on the existing voltage value. This is done using the Voltage Restraint setting. The pickup current level is proportional to the phase-to-phase voltage measured according to a coefficient shown on Figure 5–5:.This is accomplished via the multipliers (Mvr) corresponding to the phase-phase voltages of the voltage restraint characteristic curve; the

pickup level is calculated as 'Mvr' times the 'Pickup' setting. In the figure, Vpp is the phase-to-phase voltage, and VT Nominal is the rated voltage set under General settings (refer to section 5.3.1)

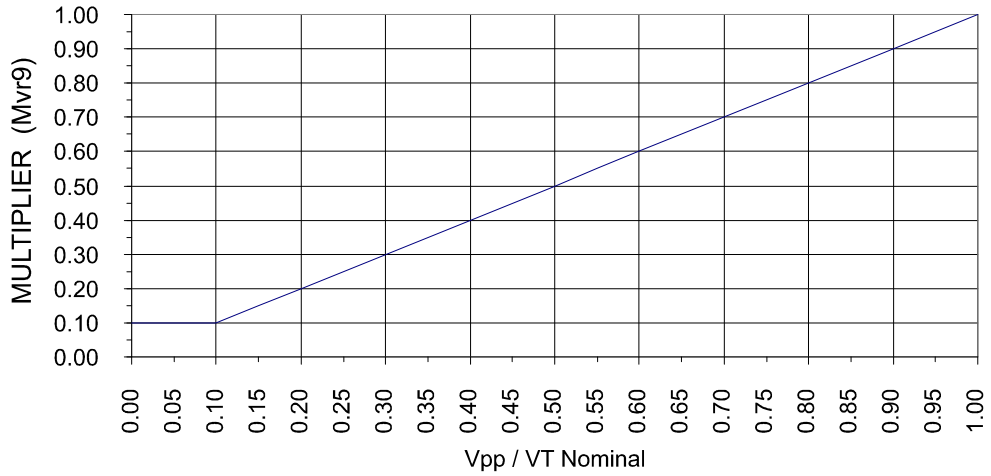


Figure 5-5: Voltage restraint characteristics

If the voltage restraint feature is disabled, the pickup level always remains at the value set in the Pickup Level setting.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for the phase directional elements.

Phase time delayed overcurrent element is an independent Protection element that provides block and Operation signals for each phase. Block signal status can be monitored through the relay HMI or using EnerVista 650 Setup at ***Actual > Status > Protection > Protection*** Block and Operation Signal status at ***Actual > Status > Protection > Phase Current***

The element incorporates independent block inputs for each phase. Block signals indicate blocked elements by an external block input. When a particular signal is activated, the element is blocked. These inputs can be configured using EnerVista 650 setup at ***Setpoint > Relay Configuration > Protection elements***

Table 5-32: Block signal for the phase time delayed overcurrent element

BLOCK SIGNALS FOR 51P
PH TOC1 HIGH A BLK
PH TOC1 HIGH B BLK
PH TOC1 HIGH C BLK
PH TOC2 HIGH A BLK
PH TOC2 HIGH B BLK
PH TOC2 HIGH C BLK
PH TOC3 HIGH A BLK
PH TOC3 HIGH B BLK
PH TOC3 HIGH C BLK

When the element is blocked, the tripping time counter is reset to 0. This feature allows the use of this input to instantaneously reset the protection element timing

The following diagram shows the logic scheme followed by high range and low range time overcurrent elements (51PH and 51PL) in the following figure.

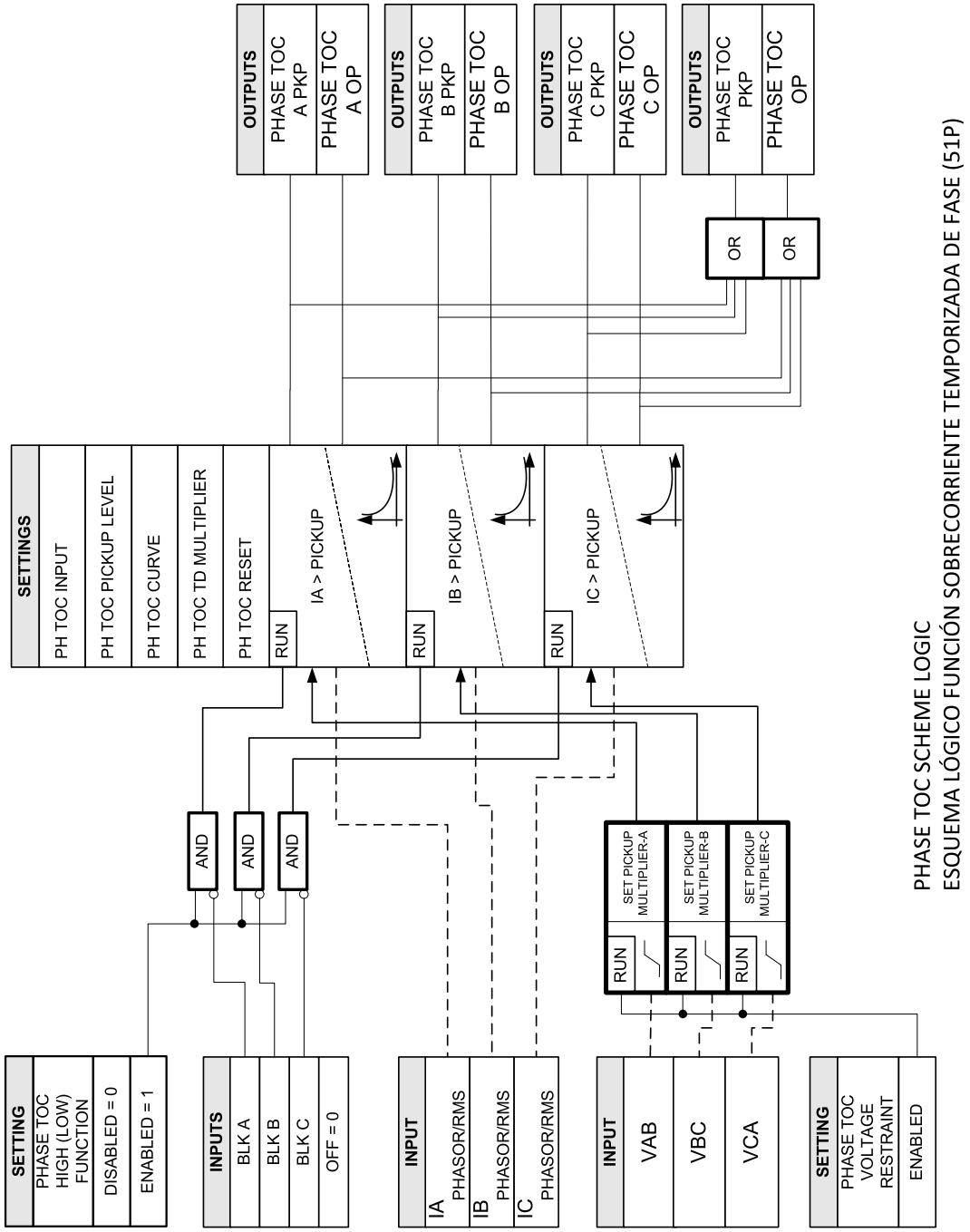


Figure 5-6: TOC element logic scheme (A6632F2)

5.4.3.2 Phase instantaneous overcurrent element- phase high/low (50PH/ 50PL)

The Phase instantaneous overcurrent element has a setting range from 0.05 A to 160 A. It can be set as instantaneous or timed, with the timer selectable between 0.00 and 900 seconds. The input quantities may be chosen as Fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds.

This element also incorporates a block input for disabling the pickup and trip signals. The logic outputs for the element are the pickup and trip flags, independent for each phase, and general pickup and trip flags.

SETPOINT > PROTECTION ELEMENTS > SETPOINT GROUP X > Phase Current > > Phase IOC High > Phase IOC High 1 > Phase IOC High 2 > Phase IOC High 3 > Phase IOC Low > Phase IOC Low 1 > Phase IOC Low 2 > Phase IOC Low 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for these elements.

The following figure shows the logic scheme diagram for high range and low range Instantaneous overcurrent elements (50PH, 50PL).

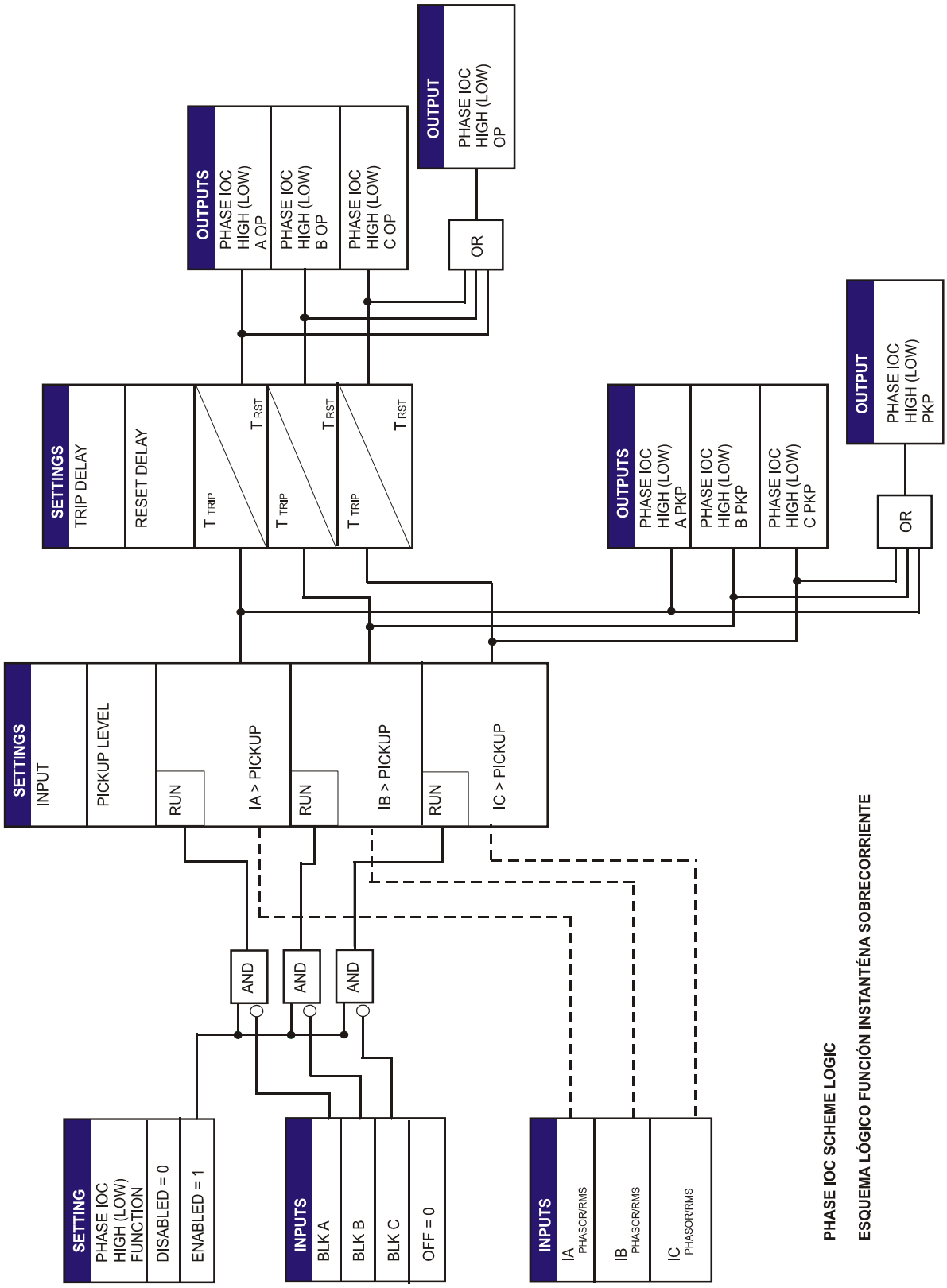


Figure 5-7: Phase IOC elements logic scheme (A6632F1)

5.4.3.3 Phase directional element (67P)

The Phase directional element (67P) provides independent elements for each phase, and determines the direction of the current both in permanence and in fault condition.

Its main function is to apply a blocking signal to the overcurrent elements to prevent their operation when the current is flowing in a certain direction. In order to determine the direction of the current, the element uses phase current values as operation magnitude, and phase-to-phase voltage values as polarization magnitude. This means that in order to polarize a phase, we use the phase-to-phase voltage of the other two phases, known as crossed polarization. To increase security for three phase faults very close to the VTs used to measure the polarizing voltage, a voltage memory feature is incorporated. This feature remembers the measurement of the polarizing voltage 3 cycles back from the moment when the voltage has collapsed below the “polarizing voltage threshold”, and uses it to determine direction. The voltage memory remains valid for a maximum of 3 seconds after the voltage has collapsed. This time is configurable.

The following table describes the phase directional element settings.

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > SETPOINT GROUP X > Phase Current > Phase Directional > Phase Directional 1 > Phase Directional 2 > Phase Directional 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	45º	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	40	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Voltage Memory Time	Voltage Memory time	0,00	s	[0,00: 3,00]

Function: This setting allows enabling or disabling the corresponding directional element.

MTA: The MTA setting corresponds to the Torque angle, which is the rotation applied to phase-to-phase crossed voltage.

Direction: This setting allows selecting the area for the directional element to operate, either forward or reverse.

Block Logic: This setting allows selecting either permission or block, depending on the logic to be applied upon expiration of voltage memory.

Polarization Voltage Threshold: This is the minimum voltage considered for the direction calculation. Under this setting, memory voltage is used.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for the phase directional elements.

Voltage Memory Time: This is the time voltage memory is considered as valid and used for direction calculation when polarization voltage collapses.

Phase directional element is an independent Protection element that provides block and Operation signals for each phase. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at “***Actual > Status > Protection > Phase Current***”

Table 5-33: Block and operation signals for the phase directional element

BLOCK AND OPERATION FOR 67P
PHASE DIR1 BLOCK A
PHASE DIR1 A OP
PHASE DIR1 BLOCK B
PHASE DIR1 B OP
PHASE DIR1 BLOCK C
PHASE DIR1 C OP
PHASE DIR2 BLOCK A
PHASE DIR2 A OP
PHASE DIR2 BLOCK B
PHASE DIR2 B OP
PHASE DIR2 BLOCK C
PHASE DIR2 C OP
PHASE DIR3 BLOCK A
PHASE DIR3 A OP
PHASE DIR3 BLOCK B
PHASE DIR3 B OP
PHASE DIR3 BLOCK C
PHASE DIR3 C OP

Signals provided by the directional element are, block and operation signals. Signals used to block overcurrent elements are configured at ***Setpoint > Relay Configuration > Protection Elements.***

Operation signals are active when operation and polarization magnitudes meet conditions given by the settings.

Block signals indicate blocked elements by an external block input or by polarization voltage loss after voltage memorize time elapses. Using the “Block logic” setting, the user can select how the directional element responds in case of a block. When the “Block” option is selected, the operational signal is not activated in a block condition. When the “Permission” option is selected, the operation signal is activated in a block condition.

Figure 5-8: Overcurrent elements block configuration by the directional element shows the default configuration for the phase overcurrent block input. When the “Block logic” setting is set as “Block”, this input is active in case of a block in the directional element, avoiding any phase overcurrent trip.

When the “Block logic” setting is set as “Permission”, the phase overcurrent element is enabled to trip as the block input is not active in case of polarization voltage memory expiration.

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The polarization diagram is as follows:

Vpol: VBCx1∠ECA

MAGNITUD DE OPERACION/OPERATION MAGNITUDE

MTA/ECA:(ANGULO CARACTERISTICO/ELEMENT CHARACTERISTIC ANGLE)

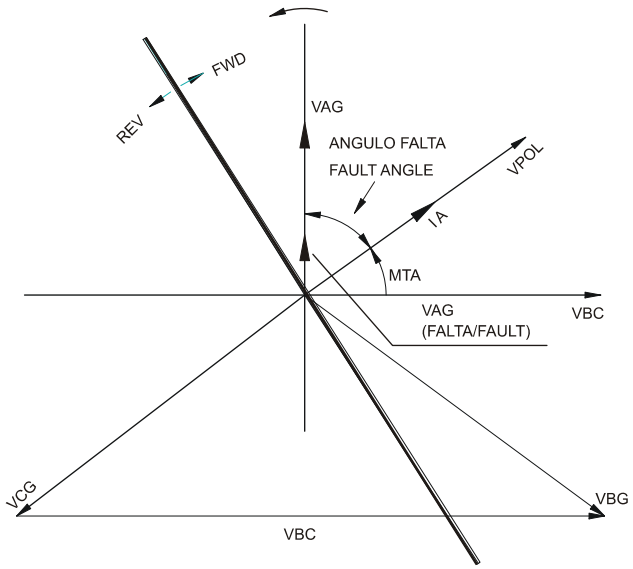


Figure 5-10: Polarization diagram

The diagram shows a fault in phase A, therefore the Operation magnitude is IA, the polarization magnitude is VBC, which has been rotated the torque angle set as ***MTA***. Positive angles are considered as counter clockwise rotations, and negative angles clockwise rotations. Direction is considered to be forward when the fault current is inside an arc of ±90º to both sides of the polarization voltage. In the directional element settings there is a ***Direction*** setting that allows to select in which area the element operation is allowed, either forward or reverse. Operation areas include a safety zone of 5º to each side of the cone. This safety cone is applied when the operation direction calculation is performed from initial block conditions. When we go from a non-trip area to a trip area, the safety cone is considered.When going from a trip area to a non-trip area, this cone is not considered, and the whole area is operative. This safety cone is always located in the operation area, both in forward and reverse cases.

NOTE: In situations where a current inversion is produced during a fault, the phase directional element requires a period of time to establish the blocking signal. This time is approximately 20 ms. Certain instantaneous overcurrent elements can be activated before receiving the blocking signal from the directional element. In cases where these situations can be expected, we recommend to add a 50ms delay to IOC elements.

The following figure shows the logic scheme for the phase directional element.

Figure 5-11: Directional element logic scheme (A6632F4)

5.4.3.4 Thermal model element (49)

Thermal model is a protection element that calculates the thermal heating generated as a result of the flowing current, and prevents this heating from causing damage to the protected equipment. In order to calculate the tripping time, the following equation is used:

$$t = \tau * Ln \frac{I'^2}{I'^2 - 1}$$

Where,

t is the heating/cooling time constant.

I' is the ratio current/pickup

Table 5-35: Thermal model element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X Phase Current > Thermal Model > Thermal Model 1 > Thermal Model 2 > Thermal Model 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Heating time constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]
Cooling time constant	Cool Time Constant	2.00	0.01 times Heat Time	[1.00 : 6.00]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Alarm level	Alarm Level	80.0	0.1 %	[1.0 : 110.0]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The cooling constant is given in times the heating constant.

The snapshot event setting enables or disables the snapshot event generation for the thermal model elements.

5.4.4 Neutral current

The Neutral Current menu incorporates the following overcurrent elements:

- Neutral time overcurrent (51N)
- Neutral instantaneous overcurrent (50N)
- Neutral directional element (67N)

5.4.4.1 Neutral time-delayed overcurrent element (51N)

Neutral TOC is a neutral time delayed overcurrent protection element. This element uses as the input quantity the **neutral current, calculated from the phase currents**. The trip can be timed by a curve selectable by setting. The reset can be instantaneous or linear.

Table 5-36: Neutral toc element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Neutral Current > Neutral TOC Neutral TOC 1 > Neutral TOC 2 > Neutral TOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.4.2 Neutral instantaneous overcurrent element (50N)

This function can be used as an instantaneous element or as a definite time element. The element responds to the neutral current, calculated from phase currents.

Table 5-37: Neutral IOC element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Neutral Current > Neutral IOC Neutral IOC 1 > Neutral IOC 2 > Neutral IOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

The following figure shows the logic scheme for the neutral Instantaneous overcurrent element.

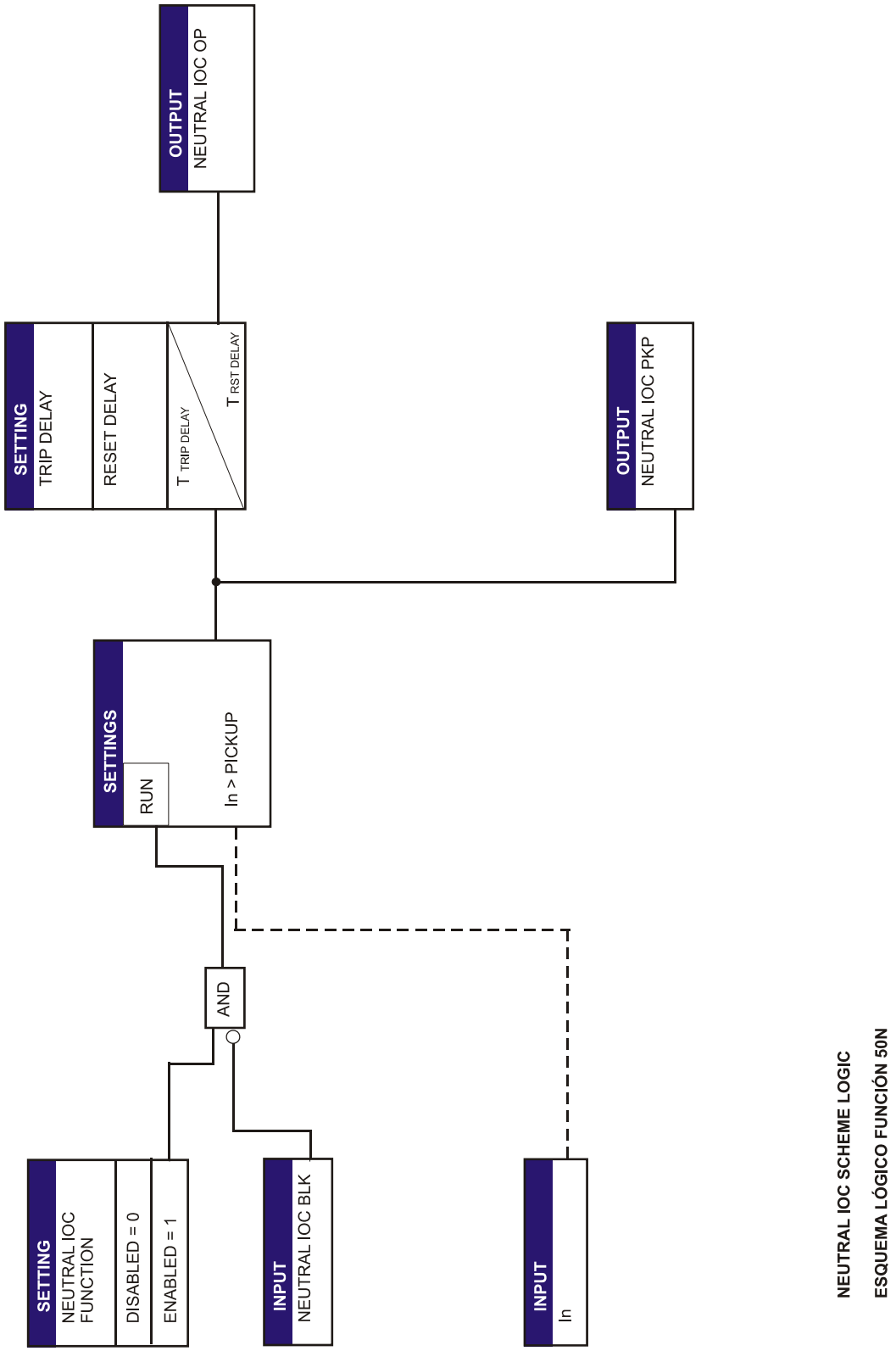


Figure 5-12: LOGIC SCHEME FOR NEUTRAL IOC element

5.4.4.3 Neutral directional element (67N)

The Neutral directional element is used for supervising the neutral (3I0) overcurrent elements. This element can be set to use either the neutral voltage, or the polarization current measured by the 5th current input (Ip), or both as polarization magnitude.

Table 5-38: 67N element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Neutral Current > Neutral Directional > Neutral Directional 1 > Neutral Directional 2 > Neutral Directional 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Settings for this element are:

Maximum Torque Angle (MTA): Angle used to rotate the polarization voltage. Positive angles are counter clockwise rotations, and negative angles are clockwise rotations. The polarization magnitude, once rotated, defines the MTA line. Vn rotated by this angle points to the semi plane that corresponds to a Reverse fault. -Vn rotated this angle points to the semi plane that corresponds to a Forward fault. A typical setting can be –45º.

Directional element direction (Direction): This setting indicates the Direction for which the element allows a trip. Depending on this setting, the element is activated for faults in the forward direction, or ion the reverse direction, allowing its use in tripping or blocking schemes. Possible options for this setting are FORWARD and REVERSE.

Polarization type (Polarization): This setting indicates the type of Polarization to be used. The relay can use voltage polarization (V0), and/or current polarization (Ip). Possible setting values are:

- **V0** Voltage polarization
- **Ip** Current polarization
- **V0 + Ip** Voltage or current polarization. This allows the element to operate when any of the polarization magnitudes allow operation.
- **V0 * Ip** Voltage and current polarization. This allows the element to operate when both polarization magnitudes allow operation.

If the selected polarization type is V0+Ip, then the relay operates when any of the polarization magnitudes indicate the selected direction in the Direction setting.

If the selected polarization type is V0*Ip, then the relay only operates when both polarization magnitudes indicate the selected direction in the Direction setting.

Polarization Voltage Threshold This is the minimum voltage considered for the direction calculation. Under this setting, the element is blocked.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this elements.

The Neutral directional element is an independent Protection element that provides Block and Operation signals. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at "***Actual > Status > Protection > Neutral Current***"

67N Block (NEUTRAL DIR BLOCK): It indicates that the element is blocked by digital input or because the Operation magnitude (In current), or the Polarization magnitude (Vn voltage and/or Ip current) level is too low.

67N Operation (NEUTRAL DIR OP): It indicates that the directional element is giving permission, that the angle relations between the operation magnitude and the polarization magnitude are met, according to the set conditions, or in case of having selected Permission in the Block Logic setting, it indicates that the element allows operation under block conditions.

Table 5-39: Signals for the neutral directional element

NEUTRAL DIRECTIONAL
NEUTRAL DIR1 BLOCK
NEUTRAL DIR1 OP
NEUTRAL DIR2 BLOCK
NEUTRAL DIR2 OP
NEUTRAL DIR3 BLOCK
NEUTRAL DIR3 OP

5.4.4.4 Voltage polarization operation principles

Operation Magnitude: In = 3·Io, calculated from the phase currents.

Polarization Magnitude: $-3V_0$. Calculated from the phase voltages or measured at the input terminals (A11, A12).The relay measures $3V_0$ and rotates 180º internally to obtain $-3V_0$.

shows the operation of the zero sequence polarization, $3V_0$, in case of an AG fault. In this case, the polarization magnitude $3V_0$ can be calculated from the three phase voltage values, or measured through the fourth voltage input (Vx). In this last case, the voltage transformer must be wye connected, and the ***Auxiliary Voltage*** setting in ***General settings*** must be configured as VX. The operation magnitude I_n, is calculated from the phase currents.

When Ip Polarization is selected, the Polarization magnitude is Ip, this current value measured at the fifth current input (terminals B11-B12). This polarization current usually comes from a CT measuring the current flow from the ground to the neutral of the neutral fault current source, which is usually a transformer. The direction is considered to be ***Forward*** when the neutral current I_n is inside a ±90º arc at both sides of the polarization current. In any other case, the direction is ***Reverse***. If the polarization current is lower than 5 mA, the element output takes the value of the ***Block Logic*** setting. See Figure 5-13: Voltage polarization.

Figure 5-13: Voltage polarization shows the Operation of the directional element for a Phase A to Ground fault, where the Phase A current grows in magnitude and is delayed with respect to its voltage by an angle similar to the protected line. Va voltage decreases or can even disappear if the fault is close and the fault resistance is very low.

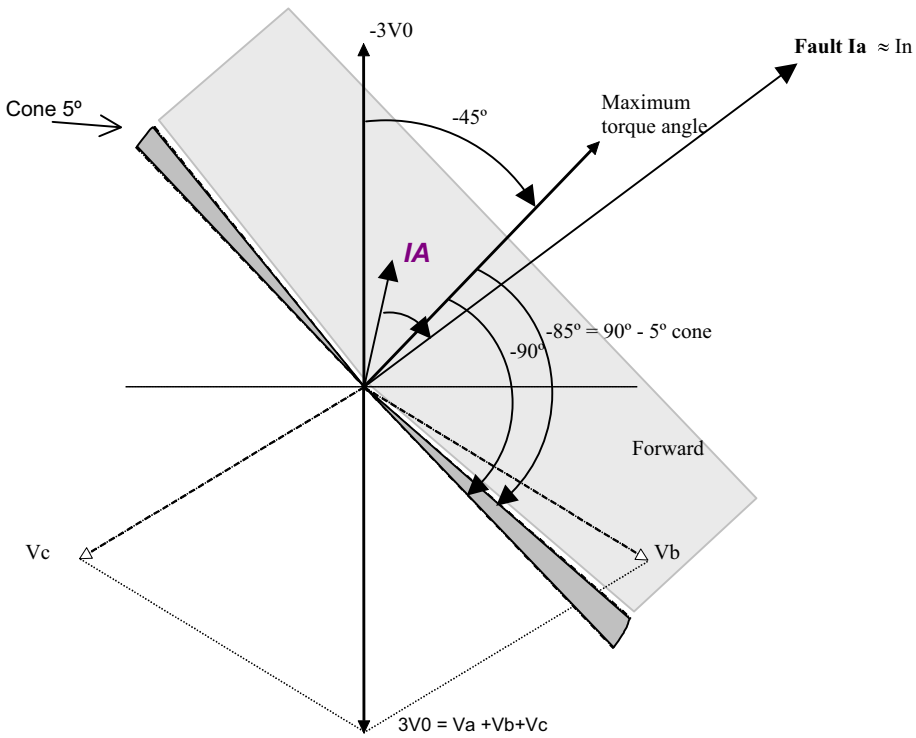


Figure 5-13: Voltage polarization

The voltage polarization algorithm uses –Vn, -(Va+Vb+Vc) = $-3 \cdot V_0$, as a substitute for the faulted phase voltage. This magnitude can be rotated by the desired angle to fix the MTA line and to define the operative semi plane of the relay, following the rule that positive angles are in counter clockwise direction. A typical setting is –45º, as shown on the figure. The operative semi plane is delimited to ± 85º of the MTA line. Every time the operation magnitude, In, is inside this semi plane, the element considers the direction to be forward. If the ***Direction*** setting is set as ***Forward***, the operation signal of the neutral directional element (NEUTRAL DIR OP) is activated.

Minimum acceptable values, both for the polarization magnitude and the operation magnitude are as follows: minimum In current for the element to operate is 50 mA. Minimum polarization voltage for the element to operate is set in the ***Polarization Voltage Threshold*** setting. Minimum polarization current (Ip) is 5 mA.

The voltage polarized directional element needs a typical time of 1 cycle (20ms @ 50Hz) to polarize. This time must be considered when setting the overcurrent elements with the ***Block Logic*** setting as ***Permission***. This may cause, especially in testing processes, the relay to trip with counter direction faults when voltage and current are applied at the same time starting from zero. As there is no previous polarization voltage, the overcurrent element is ready to trip under any overcurrent (as set in the ***Block Logic*** setting), while the directional element needs a complete cycle to polarize and give the correct direction. If the current is high enough to pickup the overcurrent element and there is no set time delay, the element trips before the directional element blocks the trip. In cases where this situation is foreseen, it is recommended to program the ***Block Logic*** setting as ***Block***, or else to add a small time delay to the overcurrent element to allow the directional element to polarize and block the trip.

5.4.4.5 Current polarization operation principles:

Operation Magnitude: In = calculated from phase currents.

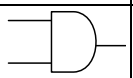
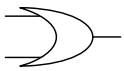
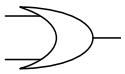
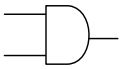
Polarization Magnitude: Ip, measured at input terminals B11-B12.

To perform a directional comparison by current, the polarization magnitude used is the current measured at the relay Ip input, terminals B11-B12, with input or “positive” in B11. This current is taken from the source (transformer or generator) neutral grounding.

Direction is considered to be forward when the phase shift between both magnitudes is lower than 85º. If the angle is higher than 85º, the fault is considered to be reverse.

The following table shows the element’s output signals management (block and permission) depending on the polarization type setting.

Table 5-40: Output signals management according to polarization type setting

POLARIZATION setting	NEUTRAL DIR BLOCK SIGNAL	NEUTRAL DIR OP SIGNAL
Vo	Vo < POL V THRESHOLD setting	Permission Vo
Ip	Ip < 5 mA	Permission Ip
Vo + Ip	Vo < POL V THRESHOLD Ip < 5 mA 	Permission Vo Permission Ip 
Vo * Ip	Vo < POL V THRESHOLD Ip < 5 mA 	Permission Vo Permission Ip 

Configuration of the required signals for blocking the neutral overcurrent elements from the signals provided by the neutral directional elements is performed at ***Setpoint > Relay Configuration > Protection Elements*** using the inverted operation signals to block the trip, as shown in the following example:

How to block neutral time overcurrent elements with neutral directional functions:

NEUTRAL TOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL TOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL TOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

To block neutral instantaneous elements:

NEUTRAL IOC1 BLOCK = NOT (NEUTRAL DIR1 OP)

NEUTRAL IOC2 BLOCK = NOT (NEUTRAL DIR2 OP)

NEUTRAL IOC3 BLOCK = NOT (NEUTRAL DIR3 OP)

Table 5-41: Quantities

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE (Vo)	FORWARD	-Vo	Io x 1 MTA
	REVERSE	-Vo	-Io x 1 MTA
CURRENT (Ip)	FORWARD	Isg	Io
	REVERSE	Isg	-Io
Vo + Ip	FORWARD	- Vo	Io
		or	
		Isg	Io
	REVERSE	- Vo	-Io
		or	
		Isg	-Io
Vo * Ip	FORWARD	- Vo	Io
		and	
		Isg	Io
	REVERSE	- Vo	-Io
		and	
		Isg	-Io

5.4.5 Ground current

The Ground Current menu incorporates the following overcurrent elements:

Ground time overcurrent (51G)

Ground instantaneous overcurrent (50G)

Ground directional element (67G)

5.4.5.1 Ground time-delayed overcurrent element (51G)

Ground TOC is a ground time delayed overcurrent protection element. The ground current is measured from the ground input, terminals B9-B10, and it may be programmed as Fundamental phasor magnitude or RMS magnitude as required by the application. The element trip can be time delayed using a selectable curve. It incorporates a reset time that is selectable between instantaneous or linear.

Table 5-42: 51G element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Ground Current > Ground TOC Ground TOC 1 > Ground TOC 2 > Ground TOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.5.2 Ground instantaneous overcurrent element (50G)

Ground IOC is a ground instantaneous overcurrent protection element, with a setting range from 0.05 A to 160 A, which can also be time delayed. The delay is selectable between 0.00 and 900 seconds. The ground current input quantity is measured from the ground input, and it may be programmed as Fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The element outputs are the general pickup and trip signals of the element.

Table 5-43: 50G element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Ground Current > Ground IOC Ground IOC 1> Ground IOC 2 > Ground IOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.5.3 Ground directional element (67G)

Ground directional is a directional protection element, used for monitoring the ground overcurrent elements. The operation magnitude is the ground current measured directly from the corresponding input (B9-B10), while the polarization magnitude is the neutral voltage (V_n). The neutral voltage is calculated from the three phase voltages or measured from the dedicated voltage input (A11-A12).

In case of using the voltage measured from the dedicated voltage input terminals, the ***Auxiliary Voltage*** setting in ***General settings*** must be ***VN***.

If the F650 is set to have synchronism check protection, then this input is adjusted as busbar voltage and it will not be the 3V0 voltage (*AUXILIARY VOLTAGE *setting as VX)

If the F650 does not have a synchronism check element, then this input can be set as I_n neutral voltage, and it can be used as polarization magnitude for the 67G element (*AUXILIARY VOLTAGE *setting as VN).

As in the case of a phase directional element, this element incorporates a voltage loss logic that allows blocking or permitting the trip by means of a setting.

Table 5-44: 67G element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Ground Current > Ground Directional > Ground Directional 1 > Ground Directional 2 > Ground Directional 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Operation of the Ground directional element 67G is similar to the operation of the neutral directional element 67N (refer to section 5.4.4.3 Neutral directional element (67N)), with the exception that the operation magnitude here is the ground current Ig (67G), measured from the input terminals B9-B10 instead of the Neutral current, In (67N), calculated from the phase currents.

Polarization magnitudes can be, as in the case of 67N, Polarization voltage (3Vo), either calculated from the phase voltages or measured from terminals A11-A12, or polarization current (Ip), measured from the fifth input transformer terminals, Isg, terminals B11-B12.

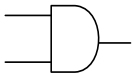
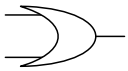
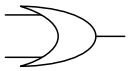
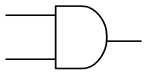
The following table shows the used magnitudes in each of the Polarization possibilities:

Table 5-45: Magnitudes according to polarization setting

POLARIZATION setting	OPERATION MAG.	POLARIZATION MAG.
Vo	Ig	3V0
Ip	Ig	Isg
Vo + Ip	Ig	3V0 or Isg
Vo * Ip	Ig	3V0 and Isg

The following table shows the management of the element output signals (block and permission) depending on the **Polarization Type** setting.

Table 5-46: Output signal management according to polarization type setting

POLARIZATION setting	GROUND DIR BLOCK SIGNAL	GROUND DIR OP SIGNAL
Vo	V_0 < Ajs. POL V THRESHOLD	Permission V_0
Ip	I_P < 5 mA	Permission I_P
Vo + Ip	V_0 < POL V THRESHOLD I_P < 5 mA 	Permission V_0 Permission I_P 
Vo * Ip	V_0 < POL V THRESHOLD I_P < 5 mA 	Permission V_0 Permission I_P 

The configuration of the signals required for blocking the Ground overcurrent elements from the signals provided by the Ground directional element is made at ***Setpoint > Relay Configuration > Protection Elements*** using inverted operation signals to block the trip.

For example, to block the ground time delayed elements:

GROUND TOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND TOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND TOC3 BLOCK = NOT (GROUND DIR3 OP)

To block the Ground Instantaneous elements:

GROUND IOC1 BLOCK = NOT (GROUND DIR1 OP)

GROUND IOC2 BLOCK = NOT (GROUND DIR2 OP)

GROUND IOC3 BLOCK = NOT (GROUND DIR3 OP)

Table 5-47: Quantities

POLARIZING MODE	DIRECTION	COMPARED PHASORS	
VOLTAGE (Vo)	FORWARD	-Vo	Io x 1 MTA
	REVERSE	-Vo	-Io x 1 MTA
CURRENT (Ip)	FORWARD	Isg	Io
	REVERSE	Isg	-Io
Vo + Ip	FORWARD	- Vo	Io
		or	
		Isg	Io
	REVERSE	- Vo	-Io
		or	
		Isg	-Io
Vo * Ip	FORWARD	- Vo	Io
		and	
		Isg	Io
	REVERSE	- Vo	-Io
		and	
		Isg	-Io

5.4.6 Sensitive ground current

The F650 Sensitive ground Current menu incorporates the following overcurrent elements:

- Sensitive ground time overcurrent (51SG)
- Sensitive ground instantaneous overcurrent (50SG)
- Isolated ground overcurrent (50IG)
- Sensitive ground directional overcurrent (67SG)

5.4.6.1 Sensitive ground time-delayed overcurrent element (51SG)

Sensitive Ground TOC is a sensitive ground time delayed overcurrent protection element with a setting range 0.005A to 16A. The sensitive ground current input quantity is measured from the sensitive ground input, terminals B11-B12, and it may be programmed as fundamental phasor magnitude or RMS magnitude as required by the application. The element trip can be time delayed using a selectable curve. And it incorporates a reset time selectable between instantaneous or linear.

Table 5-48: 51SG element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Sensitive Ground TOC Sensitive Ground TOC 1> Sensitive Ground TOC 2 > Sensitive Ground TOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.6.2 Sensitive ground instantaneous overcurrent element (50SG)

50SG is a sensitive ground instantaneous overcurrent protection element, with a setting range from 0.005 A to 16.00 A, which can also be time delayed, with a delay selectable between 0 and 900 seconds. The ground current input quantity is measured from the sensitive ground input, and it may be programmed as fundamental phasor magnitude or RMS magnitude as required by the application. The element incorporates a reset time selectable between 0 and 900 seconds, and a block input that resets the pickup and trip signals to 0. The element outputs are the general pickup and trip signals of the element.

Table 5-49: 50SG element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Sensitive Ground IOC Sensitive Ground IOC 1> Sensitive Ground IOC 2 > Sensitive Ground IOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.6.3 Instantaneous overcurrent element for ungrounded systems (50IG)

The operation of this element is similar to sensitive ground overcurrent elements; the difference is that in this case, 3I0 current is capacitive, and uses very reduced magnitudes (0.5-10.0 A primary values).

The operation characteristic is shown on figure Figure 5-14: Operations characteristics, element 50IG, where Vh, Vl, Ih and Il are element settings.

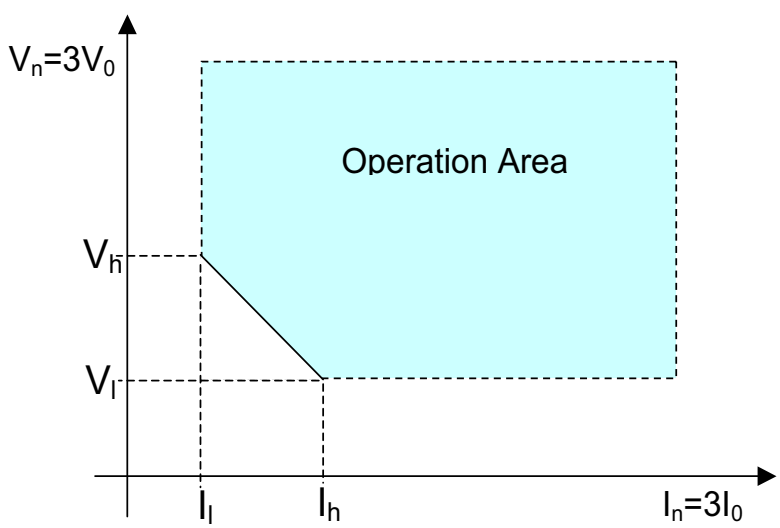


Figure 5-14: Operations characteristics, element 50IG

Table 5-50: Isolated ground IOC element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Isolated Ground IOC Isolated Ground IOC 1 > Isolated Ground IOC 2 > Isolated Ground IOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
High Voltage	Vh Level	20	1 V	[2 : 70]
Low Current	Il LEVEL	0.005	0.001 A	[0.005 : 0.400]
Low Voltage	Vl LEVEL	2	1 V	[2 : 70]
High Current	Ih LEVEL	0.025	0.001 A	[0.005 : 0.400]
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The relay settings for the Isolated Ground IOC elements are as follows:

Function: This setting determines whether the element is operative and can generate pickup and trip events, which can be configured to close outputs, light up LEDs or trigger oscillography.

Vh, VL, Ih, IL: Vn and In values that define the points in the operative area.

Operation time (Delay): This is the selectable period between the element pickup and trip, with a range from 0 to 900 seconds in steps of 0,01 seconds.

Deviation time to Instantaneous (Time to inst): Time after the trip during which the elements become instantaneous. It must be set to zero if the functionality is not required.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

OPERATION PRINCIPLES:

Operation of the isolated Ground element is based on the detection of a current that exceeds the setting, with neutral voltage supervision (3V0). This allows very sensitive setting of the element, with a very low current level, ensuring that small angle or ratio errors in the current transformers do not cause the relay to operate, as the neutral voltage verified is higher than the one set.

Values for Ih, IL, Vh and VL, which define the relay operation area, are configurable. H magnitudes must be higher than L magnitudes. The 50IG element can be supervised by directional element 67SG.

Using the relay input magnitudes In and Vn, if the point defined by (In, Vn) is inside the operation area and if the directional element (if directional supervision is set) allows it, the element picks up and the set delay time starts counting down. If a directional block appears during the countdown, the element is reset. After the set time the element trips. Once tripped, the relay cannot be blocked by the directional element, and the trip remains while the fault exists.

After the trip, the deviation time to instantaneous starts to run, so that all pickups produced during this time produce an Instantaneous trip. This means that, if after a trip the breaker is reclosed and the fault persists or reappears, the trip is instantaneous. If the user doesn't want to use this function, then the ***Deviation Time to Instantaneous (Time to inst)*** setting must be set to zero seconds. Once the time has expired, the element returns to its normal operation.

5.4.6.4 Sensitive ground directional element (67SG)

Sensitive Ground directional is a directional element used for supervising sensitive ground overcurrent functions. The operation magnitude is the ground current measured directly from the corresponding input (terminals B11-B12), while the polarization magnitude is the neutral voltage (3Vo). The neutral voltage is either calculated from three phase voltages or measured from the dedicated voltage input (A11-A12)

In case of using the voltage measured at the dedicated voltage input terminals, the ***Auxiliary Voltage*** setting in ***Setpoint > System Setup > General settings*** must be VN.

*If the F650 is set to have synchronism check protection, then this input is adjusted as busbar voltage and it will not be the 3V0 voltage (*AUXILIARY VOLTAGE *setting as VX)*

*If the F650 does not have a synchronism check element, then this input can be set as 3V0 neutral voltage, and it can be used as polarization magnitude for the 67SG element (*AUXILIARY VOLTAGE *setting as VN).*

The same way as the directional element for phases, it has a polarization voltage loss logic that allows blocking or producing trip depending on the setting.

Table 5-51: Sensitive ground directional element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Sensitive Ground Current > Sensitive Ground Directional > Sensitive Ground Directional 1> Sensitive Ground Directional 2 > Sensitive Ground Directional 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Available settings are:

Function permission (Function):This setting determines whether the sensitive Ground directional element is enabled or Disabled.

Maximum Torque Angle (MTA):This angle is used to rotate the Polarization voltage. Positive angles mean counter clockwise rotation, and negative angles mean clockwise. The polarization magnitude, once rotated, defines the MTA line. Vn rotated by this angle points to the semi plane that corresponds to a Reverse fault. (-Vn) rotated this angle points to the semi plane that corresponds to a Forward fault.

Operation Direction (Direction):This setting indicates the Direction for which the element allows a trip. Depending on this setting, the element is activated for faults in a direction or in the opposite direction. Possible setting values are FORWARD or REVERSE.

Polarization Voltage Threshold (Pol. V Threshold):This is the minimum polarization voltage threshold. For a voltage value lower than this setting the directional element is blocked.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

Sensitive ground directional element is an independent Protection element that provides block and Operation signals. These signals can be monitored both through the relay HMI or using EnerVista 650 Setup at **Actual > Status > Protection > Sensitive Ground Current**

67SG Block (SENS GND DIR1 BLOCK): It indicates that the element is blocked by digital input or because the Operation magnitude (In current), or the Polarization magnitude (Vn voltage and/or Ip current) level is too low.

67SG Operation (SENS GND DIR1 OP): It indicates that the directional element is giving permission, the operation magnitude and the polarization magnitude conditions are met, or in case of having selected Permission in the Block Logic setting, it indicates that the element allows operation under block conditions.

Table 5-52: Sensitive ground directional signals

SENS GND DIRECTIONAL
SENS GND DIR1 BLOCK
SENS GND DIR1 OP
SENS GND DIR2 BLOCK
SENS GND DIR2 OP
SENS GND DIR3 BLOCK
SENS GND DIR3 OP

Configuration of the required signals for blocking the sensitive ground overcurrent elements from the signals provided by the sensitive ground directional elements is performed at ***Setpoint > Relay Configuration > Protection Elements.*** This is done using the inverted operation signals to block the trip, as shown in the following example:

For example, to block sensitive Ground time overcurrent elements, use the following signals:

SENS GND TOC1 BLOCK = NOT (SENS GND DIR1 OP)

SENS GND TOC2 BLOCK = NOT (SENS GND DIR2 OP)

SENS GND TOC3 BLOCK = NOT (SENS GND DIR3 OP)

To block Ground instantaneous elements:

SENS GND IOC1 BLOCK = NOT (SENS GND DIR1 OP)

SENS GND IOC2 BLOCK = NOT (SENS GND DIR2 OP)

SENS GND IOC3 BLOCK = NOT (SENS GND DIR3 OP)

To block isolated Ground elements:

ISOLATED GND1 BLK = NOT (SENS GND DIR1 OP)

ISOLATED GND2 BLK = NOT (SENS GND DIR2 OP)

ISOLATED GND3 BLK = NOT (SENS GND DIR3 OP)

5.4.7 Negative sequence current

The Negative sequence menu incorporates the Negative sequence time overcurrent (46P) element:

5.4.7.1 Negative sequence overcurrent element (46P)

Negative Sequence TOC is an overcurrent protection element that uses the fundamental phasor of the negative sequence current as input magnitude, calculated from the phase currents. This element can be used for detecting load unbalance in the system, and for open phase conditions (fallen or broken conductor). The trip can be time delayed by a curve selectable by setting. The reset can be instantaneous or linear.

Table 5-53: Negative sequence toc element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Negative Sequence Current > Negative Sequence TOC > Negative Sequence TOC 1> Negative Sequence TOC 2 > Negative Sequence TOC 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8 Voltage elements

The F650 incorporates the following voltage elements:

- Phase undervoltage (27P)
- Phase overvoltage (59P)
- Neutral overvoltage (59NH/59NL)
- Negative sequence overvoltage (47)
- Auxiliary overvoltage (59X)
- Auxiliary undervoltage (27X)

These protection elements can be used in multiple applications, such as:

Undervoltage protection: for induction motor load types, where a voltage dip can cause an increase of the consumed current. Element 27P (phase undervoltage) can be used to issue a trip or an alarm.

Transfer Schemes: in the event of an undervoltage condition, we can use the 27P element (phase undervoltage) to send a signal that transfers load to another power source.

Undervoltage elements can be set to operate with definite time or with an inverse time curve. If the element is set as definite time, it operates when voltage remains under the set value during the set period of time. This period can be set from 0s to 900.00 s in steps of 10ms.

These elements can also be set as inverse time curves. This family of curves is defined by the following formula:

$$T = \frac{D}{1 - \frac{V}{Vpickup}}$$

Where:

T = operation time

D = operation time setting (delay)

V = voltage applied to the relay

Vpickup = pickup setting (Pickup level)

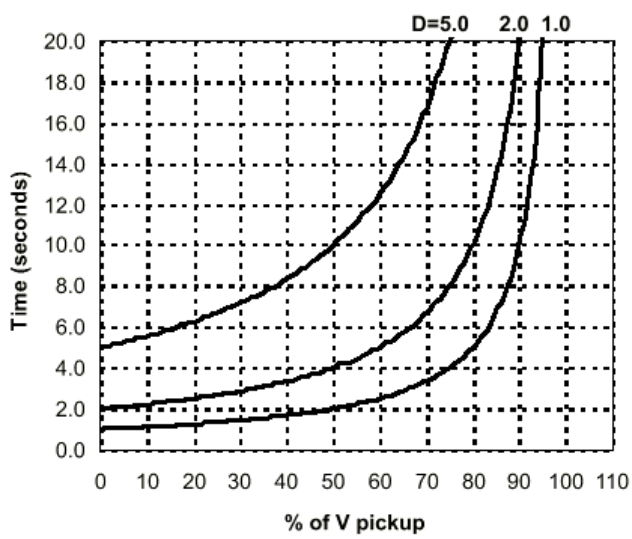


Figure 5-15: Inverse time undervoltage curves

5.4.8.1 Phase undervoltage element (27P)

This element may be used to give a desired time-delayed operating characteristic versus the applied fundamental voltage (phase-to-ground or phase-to-phase for wye VT connection, or phase-to phase- for Delta VT connection) or as a Definite time element. The element resets instantaneously if the applied voltage exceeds the dropout voltage.

The delay setting selects the minimum operating time of the phase undervoltage. The minimum voltage setting selects the operating voltage below which the element is blocked (a setting of “0” allows a dead source to be considered a fault condition.

This element generates independent pickup and trip signals per phase, and general pickup and trip signals for the element. These last signals can be selected, by means of the operation logic setting, to be an OR (any phase signal) or an AND (all phase signals).

Table 5-54: 27P element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Voltage Elements > Phase UV > Phase UV 1 > Phase UV 2 > Phase UV 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]
Minimum Voltage Threshold	Minimum Voltage	0	1 V	[0 : 300]
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Phase undervoltage element settings are:

Function Permission (Function): This setting indicates whether the phase undervoltage element is enabled or disabled.

Input mode (Mode): This setting allows selecting operation for phase-to-phase or phase-to-ground voltage, depending on the selected setting.

Pickup Level: This is the voltage threshold below which the undervoltage element operates.

Curve Shape (Curve): Undervoltage elements can be set to operate with definite time or with an inverse time curve. Elements set as definite time operate when the voltage value remains under the pickup setting during the set time. If inverse time is selected, the element operates according to the previously described inverse time curve.

Time Dial (Delay): Setting of the Protection element operation time.

Minimum voltage Threshold (Minimum Voltage): Voltage setting under which the undervoltage element is inhibited, in order not to operate in dead line cases.

Operation logic (Logic): This setting allows the element operation logic selection:

ANY PHASE The element operates under an undervoltage condition in any of the three phases.

TWO PHASES The element operates under an undervoltage condition in at least two phases.

ALL PHASES The element operates under an undervoltage condition in three phases.

Supervision by breaker status (Supervised by 52): This setting allows inhibiting the undervoltage element if the breaker is open breaker. In case this setting is enabled, the undervoltage element is supervised by the breaker status. Otherwise, the element operates independently of the breaker status.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.2 Phase overvoltage element (59P)

The Phase overvoltage element may be used as an instantaneous element with no intentional time delay or as a Definite Time element. The input voltage is the phase-to-phase voltage, either measured directly from Delta-connected VTs or as calculated from phase-to-ground (wye) connected VTs. The time delay can be set from instantaneous to 900 seconds. The element reset can be delayed up to 900 seconds.

As in the case of the undervoltage element, this element generates independent pickup and trip signals for each phase. The general signal is selectable by setting to be an OR or an AND of the phase signals.

Table 5-55: 59P element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Voltage Elements > Phase OV > Phase OV 1 > Phase OV 2 > Phase OV 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Phase overvoltage element settings are:

Function Permission (Function): This setting indicates whether the phase overvoltage element is enabled or disabled.

Pickup Level: This is the voltage threshold over which the overvoltage element operates.

Trip time (Trip Delay): setting of the Protection element operation time.

Reset time (Reset Delay): Reset time of the Protection element.

Operation logic (Logic): This setting allows the element operation logic selection:

- ANY PHASE — The element operates under an overvoltage condition in any of the three phases.
- TWO PHASES — The element operates under an overvoltage condition in at least two phases.
- ALL PHASES — The element operates under an overvoltage condition in three phases.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.3 Neutral overvoltage element high/low (59NH/59nl)

The Neutral Overvoltage element can be used to detect an asymmetrical system voltage condition due to a ground fault or to the loss of one or two phases of the source.

The element responds to the system neutral voltage (3V0), calculated from the phase voltages or measured by the 4th voltage transformer.

VT errors and normal voltage unbalance must be considered when setting this element.

The element time delay is selectable between 0 and 900 seconds and incorporates a reset with a selectable delay between 0 and 900 seconds.

Notice that the neutral overvoltage element is not be available if a ***DELTA*** Connection is set in the ***Phase VT Connection*** setting in General settings, and the fourth voltage transformer input is set to the busbar voltage for the synchronism element (Vx in ***Auxiliary Voltage*** setting). This is because with this combination of settings it is not possible to calculate the zero sequence component from the phase-to-phase voltage magnitudes.

Table 5-56: 59NH/59NL element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Voltage Elements > >Neutral OV High > Neutral OV High 1> Neutral OV High 2 > Neutral OV High 3 >Neutral OV Low > Neutral OV Low 1> Neutral OV Low 2 > Neutral OV Low 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.4 Negative sequence overvoltage element (47)

The Negative sequence phase overvoltage element uses as its input magnitude the negative sequence component calculated from the phase voltage values. This element can be used to detect the loss of one or two phases, unbalance voltage conditions, etc.

Table 5-57: 47 element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > VOLTAGE ELEMENTS > Negative Sequence OV > Negative Sequence OV 1 > Negative Sequence OV 2 > Negative Sequence OV 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.5 Auxiliary overvoltage element (59X)

This is an Auxiliary overvoltage element for general use that uses as its input magnitude the voltage measured by the 4th VT (when VX is selected as Auxiliary Voltage in General Settings). The time delay for element 59X can be set from 0 to 900 seconds. The element has a reset than can be programmed from 0 to 900 seconds.

Table 5-58: 59X element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > VOLTAGE ELEMENTS > Auxiliary OV > Auxiliary OV 1 > Auxiliary OV 2 > Auxiliary OV 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.8.6 Auxiliary undervoltage element (27X)

This is an Auxiliary undervoltage element for general use that uses as its input magnitude the voltage measured by the 4th VT, terminals A11-A12 (when VX is selected as Auxiliary Voltage in General Settings).

Table 5-59: 27X element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > VOLTAGE ELEMENTS > Auxiliary UV > Auxiliary UV 1 > Auxiliary UV 2 > Auxiliary UV 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup Level	Pickup Level	10	1 V	[3 : 300]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

5.4.9 Power elements

5.4.9.1 Forward power element (32FP)

The 32FP element produces a trip when exported power exceeds the setting value. Monitored power is active power, calculated by the three phase voltages and currents, and it is considered to be exported, positive active power, the one given in the direction of the line protected by the relay; in this situation, the angle between secondary voltage and current is lower than 90º, according to the relay wiring diagram.

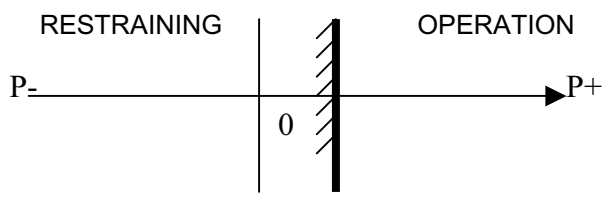


Figure 5-16: Forward power characteristics

Table 5-60: 2FP element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Power > Forward Power Forward Power 1 > Forward Power 2 > Forward Power 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

The F650 includes three 32FP elements. Each elements incorporates two stages, the first stage, less critical, is intended to produce an alarm, the second stage is used for trip. Both **levels are set in primary values**, for instance: if in general settings we set CT_RATIO to a value of 100, and the same value for PT_RATIO, the base power is: 100 x 100 = 10000 W

The block time allows blocking the element operation during a set time after the coupling breaker closure. For this purpose it is necessary to connect the breaker bay using a 52B type contact. The purpose of this setting is to avoid spurious trips caused by overloads after the breaker closure.

Power calculations depending on the VT connection:

1- **WYE** VT connection, or only one transformer in phase-to-ground connection:

$$P = V_a * I_a * \cos\varphi_a + V_b * I_b * \cos\varphi_b + V_c * I_c * \cos\varphi_c$$

2- **DELTA** VT connection, or only one voltage transformer in phase-to-ground connection:

$$P = \frac{V_{ab}}{\sqrt{3}} * I_a * \cos(\varphi_a - 30) + \frac{V_{bc}}{\sqrt{3}} * I_b * \cos(\varphi_b - 30) + \frac{V_{ca}}{\sqrt{3}} * I_c * \cos(\varphi_c - 30)$$

5.4.9.2 Directional power element (32)

Element description

The Directional Power element responds to three-phase active power measured from the feeder associated with the F650. This element can be selected to operate according to the power threshold adjusted in the corresponding setting. This element is ideal for reverse power applications (F32 REV) or forward power (F32 FWD), depending on the selected setting. The relay measures the three-phase power for wye or delta connections.

The element has an adjustable characteristic angle and minimum operating power as shown in the Directional Power Characteristic diagram. The element responds to the following condition:

P cos(j) + Q sin (j) > SMIN

where: P and Q are active and reactive powers as measured per the F650 convention, j is the angle set at the 32 setting (DIR POWER ANGLE) in degrees in steps of 0.01º, and SMIN is the minimum operating power.

The element has two independent (as to the pickup and delay settings) elements. Both elements can be used for alarm and trip, and they can be set separately to provide a mixed power protection.

The Directional Power Characteristic is shown in the following diagram.

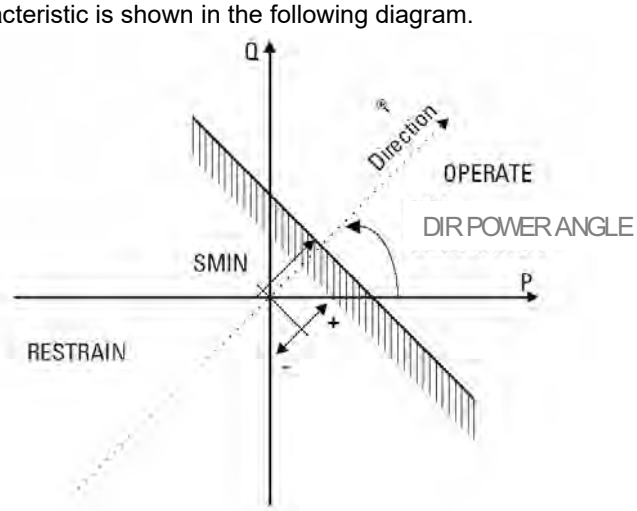


Figure 5-17: Power directional characteristics

By making the characteristic angle adjustable from 0º to 360º in steps of 0.01º, a variety of operating characteristics can be achieved as presented in the figures below. For example, for an angle of 0º, the element would operate as a 32 Forward Power element, while if setting an RCA angle of 180º, the element would operate as a 32 Reverse Power element. For angles of 90º and 270º, the case would be similar but with reactive power.

Figures (a, b, c, d, e, f) below shows settings for different power applications.

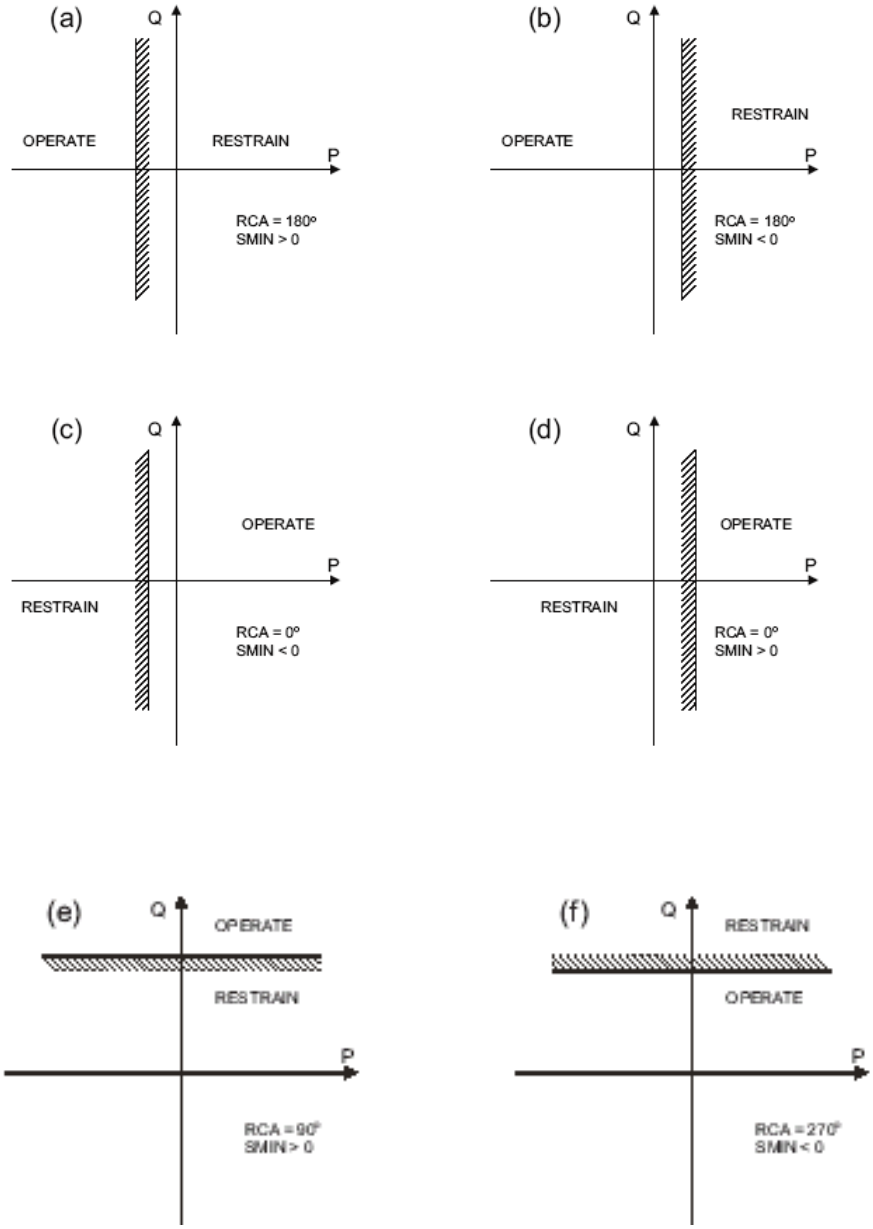


Figure 5-18: Directional power element sample applications

The following table shows the SMIN and angle values that must be used for some typical applications:

Table 5-61: Directional power element

SMIN (Stage Tap)	ANGLE (RCA)	ELEMENT
>0	0º	Forward Active Power
<0	0º	Reverse Low Forward Active Power
>0	180º	Reverse Forward Active Power
<0	180º	Low Forward Active Power

By adding 90º to the angles shown on figures a, b, c and d, the represented elements would be similar but with ***Reactive Power*** instead of Active Power.

Any other angle would provide a mixed Protection Between Active and Reactive power.

A different angle selection for Stage 1 and Stage 2 can provide in a single element, a Reactive and Active power limitation. For example, using the following values:

Dir Power Angle 1(RCA)	0º
Stage 1 Tap	0
Dir Power Angle 2(RCA)	90º
Stage 2 Tap	0

We would obtain a mixed Protection Between figure (d) and figure (e).

Settings

Table 5-62: 32 element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Power > Directional Power > Directional Power 1 > Directional Power 2 > Directional Power 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]
Directional Angle for stage 1 (RCA1)	Dir Power Angle 1	0.00	1 Deg	[0.00 : 359.99]
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]
Directional Angle for stage 2 (RCA2)	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

Function: Enables or disables the directional element.

Blk Time After Close: In seconds. This settings allow to block the element 32 during the time specified in the setting after the breaker switches from OPEN to CLOSED.

Dir Power Angle (1-2) (RCA): This setting specifies the relay characteristic angle (RCA) for the directional power element. This setting provides ability to respond to the function in any direction defined (active forward power, active low forward power, etc.)

The following figure illustrates the conventions established:

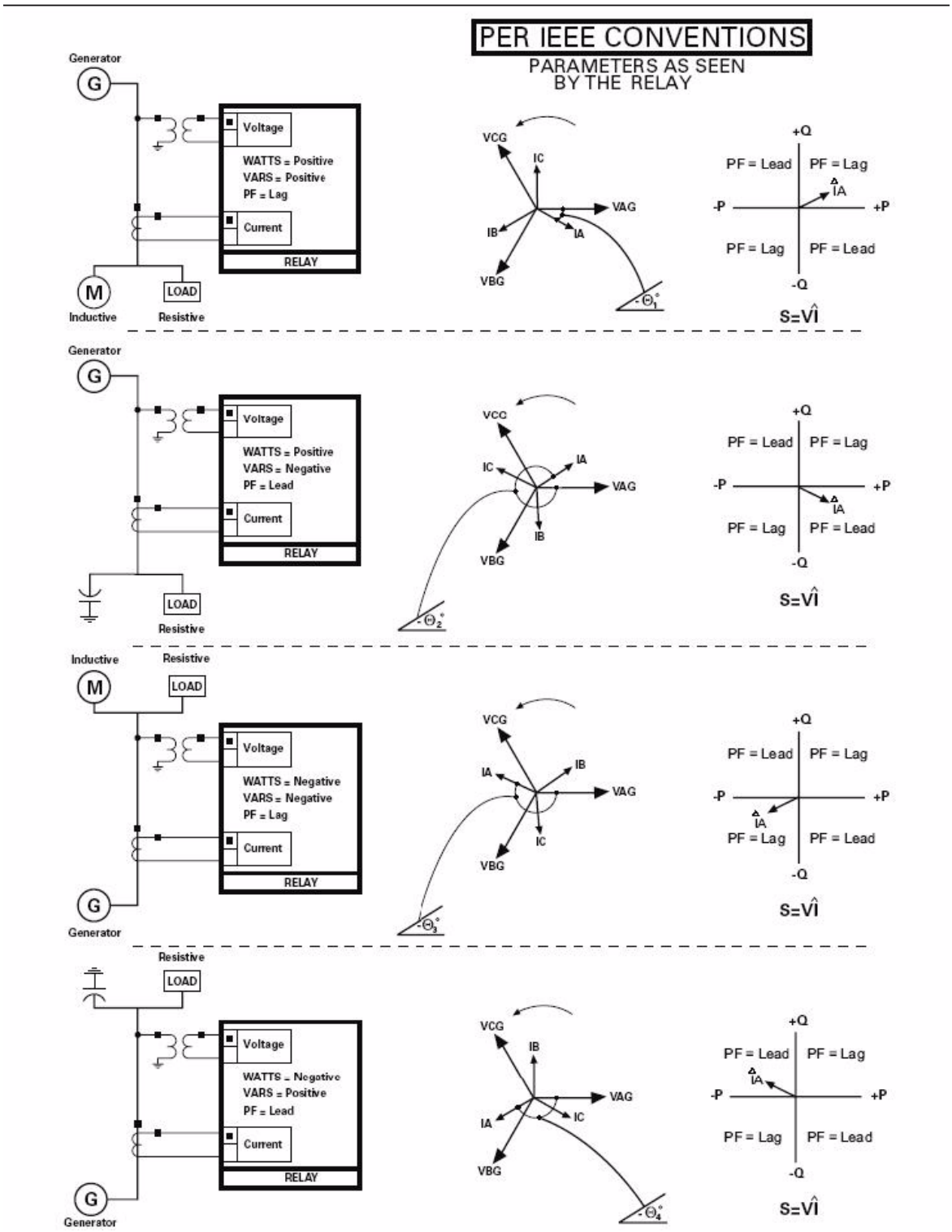


Figure 5-19: Angles

Stage (1 - 2) Tap: This setting specifies the minimum Operation three-phase power for the Stage 1 (2) element. The power value defined in this setting is the minimum distance between the source and the directional power characteristic. This value can be positive or negative. The value of this setting is defined in total MW (primary) – the CT and VT value is considered in the calculations.

NOTE:

Even if the element defined in this setting is MW, this does not necessarily mean that the resulting value and the RCA setting are in MW. For example:

***RCA**: 30 ° **SMIN**: 100 MW.*

If we assume that there is only active power. The element operation would be produced for a value of:

P = 100 / cos (30) = 115,7 MW.

If there was only reactive power:

Q = 100/sin (30) = 200,0 MVar.

(In this case the real Operation elements are Mvar, even if SMIN is expressed in MW.)

Stage 1 (2)Time: This setting specifies the delay for Stage 1 of the element. For reverse power or direct power applications, usually Stage 1 is used for alarm functions, while Stage 2 is used for tripping functions.

Snapshot Events: This setting enables or disables the generation of events. All states in this function are affected by this setting.

Status

Statuses defined for this Function are as follows:

DIR PWR1 (2, 3) BLOCK: Writing status, operates by level. When this status is activated externally (via PLC), the directional power element is blocked. This status affects both elements in the protection element (stage 1 and 2).

Activation of this status produces the event: **DIR PWR1 (2, 3) BLK ON.**

Deactivation produces the event: **DIR PWR1 (2, 3) BLK OFF.**

DIR PWR1 (2, 3) STG1 (2) OP: This is activated when the element that corresponds to stage 1/2 is activated. Events generated by this element are:

DIR PWR1 (2, 3) STG1 (2) OP ON

DIR PWR1 (2, 3) STG1 (2) OP OFF

DIR PWR1 (2, 3) STG1 (2) PKP: Activation of this status indicates that the power value has exceeded the threshold indicated by the Stage 1/2 element. Events generated by this element are:

DIR PWR1 (2, 3) STG1 (2) PKP ON

DIR PWR1 (2, 3) STG1 (2) PKP OFF

DIR PWR1 (2, 3) STG PKP: This status is a logic OR between the DIR PWR STG1 PKP and DIR PWR STG2 PKP statuses. Activation of this status indicates that the power value has exceeded the threshold indicated by any of the Stage 1/2 elements. Events generated by this element are:

DIR PWR1 (2, 3) STG PKP ON

DIR PWR1 (2, 3) STG PKP OFF

DIR PWR1 (2, 3) STG OP: This status is a logic OR between the DIR PWR STG1 OP and DIR PWR STG2 OP statuses. This is activated when the element that corresponds to stage 1/2 is activated. Events generated by this element are:

DIR PWR1 (2, 3) STG OP ON

DIR PWR1 (2, 3) STG OP OFF

5.4.9.3 Wattmetric ground fault (32N)

This document specifies wattmetric zero-sequence directional function, which can be used on solidly grounded, low-resistance grounded, isolated or resonant (Petersen coil) grounded systems. The function determines presence and direction of ground faults by measuring value and direction of zero-sequence power.

The element responds to power derived from zero-sequence voltage and current in a direction specified by the element characteristic angle. The angle can be set within all four quadrants, the power can be selected to be either active or reactive. Therefore, the element may be used to sense either forward or reverse ground faults in either inductive, capacitive or resistive networks. Inverse time characteristic allows time coordination of the elements across the network.

Typical applications include ground fault protection in solidly grounded transmission networks, grounded/ungrounded/resistor-grounded/resonant-grounded distribution networks, or for directionalizing other non-directional ground elements.

Element settings

SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > POWER > WATT GND FLT HIGH 1 > WATT GND FLT HIGH 2 > WATT GND FLT HIGH 3 WATT GND FLT LOW 1 > WATT GND FLT LOW 2 > WATT GND FLT LOW 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED-ENABLED]
Supervision minimum voltage	Voltage Pickup Level	2.00	0.01 V	[2.00 : 70.00]
Source of operating current.	Current selection	IN	N/A	[IN-IG]
Pickup Level for Overcurrent	OC Pickup Level	0.005	0.001A	[0.005 : 0.400]
Pickup Delay for Overcurrent	OC Pickup Delay	0.20	0.01 s	[0.00 : 600.00]
Pickup Level for operating Power	Power Pickup	0.01	0.01 W	[0.01 : 4.50]
Max torque angle	MTA	0	1 Deg	[0 : 360]
Pickup Delay for Operating Power	Power Pickup Delay	0.20	0.01 s	[0.00 : 600.00]
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME - INVERSE TIME - USER CURVE A - USER CURVE B - USER CURVE C - USER CURVE D]
Multiplier	Multiplier	1.00	0.01 s	[0.02 : 2.00]
Snapshot event generation	Snapshot Event	DISABLED	N/A	[DISABLED-ENABLED]

Function: Enables or disables the directional element.

Voltage Pickup Level: The element uses neutral, i.e. 3 times zero-sequence, voltage. This setting specifies the minimum neutral voltage supervising the directional power measurement. This threshold should be higher than possible unbalance during normal operation of the system.

Current selection: The element responds to the neutral (3 times zero-sequence) current, either calculated internally (IN) from the phase currents, or supplied externally (IG) via the ground CT input. This setting allows selecting the source of the operating current.

OC Pickup Level: This setting specifies the current supervision level for the measurement of the zero-sequence power.

OC Pickup Delay: This setting specifies delay for the overcurrent portion of this element. The delay applies to the 32N1(2 3) HIGH(LOW) OC PKP operand driven from the overcurrent condition.

Power Pickup: This setting specifies the operating point of the element.

MTA: This setting adjusts the maximum torque angle of the element.

Power Pickup Delay: This setting defines a definite time delay before the inverse time characteristic is activated. If the curve selection is set as “Definite Time”, the element would operate after this security time delay.

Curve: This setting allows choosing one of three methods to delay operate signal once all conditions are met to discriminate fault direction:

Definite time: Fixed time delay defined by the POWER PICKUP DELAY setting

Inverse time: Inverse time characteristics delay defined by**:**

$$t = m \bullet \frac{S_{PKP}}{S_{OP}}$$

where m is a multiplier defined by the MULTIPLIER setting, S_{PKP} is the pickup setting and S_{OP} is the operating power at the time.

FlexCurve A,B,C,D: any time characteristics programmed by the user with FlexCurves.

Multiplier: Time dial multiplier

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for the wattmetric ground fault elements.

Element description

The operating power is calculated as:

S_op= real(Vn(In 1ÐMTA))*

where: * stands for complex conjugate. By varying the MTA angle one can make the element to respond to forward or reverse direction in inductive, resistive, or capacitive networks as shown in the figure below.

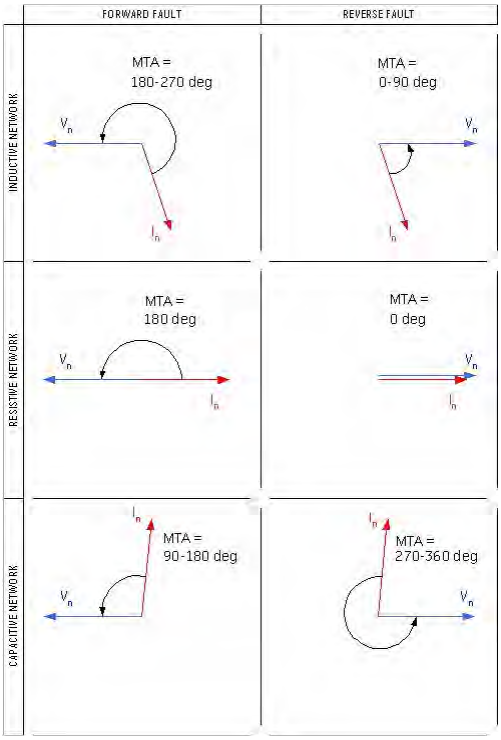


Figure 5-20: Angles

Operating power

V_n – neutral voltage (3 times V_0): either calculated (VX as auxiliary voltage setting) or supplied from the Auxiliary voltage channel (VN as auxiliary voltage setting)

I_n – neutral current (3 times I_0): either calculated (IN as current selection setting) or supplied from the ground current channel (IG as current selection setting)

The following figure shows the logic scheme diagram for high range and low range wattmetric ground fault elements (32NH, 32NL).

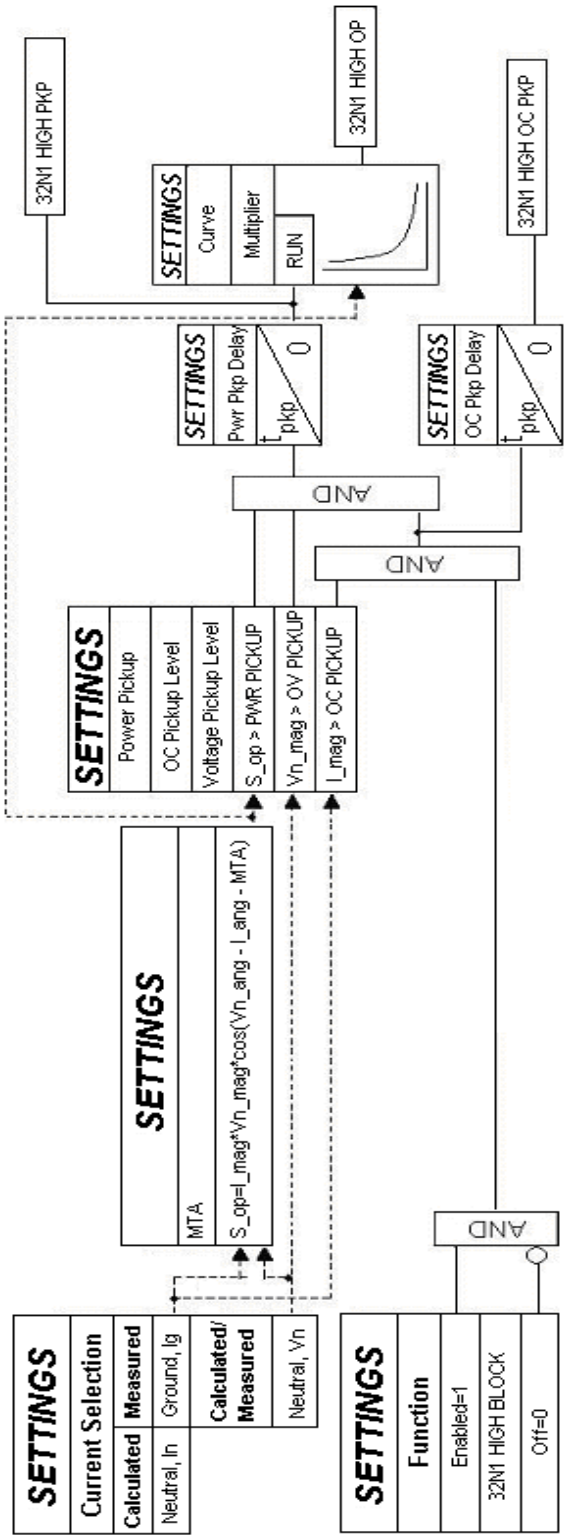


Figure 5-21: Wattmetric ground fault elements logic scheme

Status

Statuses defined for this Function are as follows:

32N1 (2, 3) HIGH (LOW) BLOCK: Writing status, operates by level. When this status is activated externally (via PLC), the wattmetric ground fault element is blocked.

The activation produces the event: **32N1 (2, 3) HIGH (LOW) BLOCK ON**.

Deactivation produces the event: **32N1 (2, 3) HIGH (LOW) BLOCK OFF**.

32N1 (2, 3) HIGH (LOW) OC PKP: The activation of this status indicates that the current value has exceeded the threshold indicated and pickup delay has expired. Events generated by this element are:

32N1 (2, 3) HIGH (LOW) OC PKP ON

32N1 (2, 3) HIGH (LOW) OC PKP OFF

32N1 (2, 3) HIGH (LOW) PKP: Activation of this status indicates that the current, voltage and power value has exceeded the threshold indicated and power pickup delay has expired.

Events generated by this element are:

32N1 (2, 3) HIGH (LOW) PKP ON

32N1 (2, 3) HIGH (LOW) PKP OFF

32N1 (2, 3) HIGH (LOW) OP: This is activated when the element is activated. Events generated by this element are:

32N1 (2, 3) HIGH (LOW) OP ON

32N1 (2, 3) HIGH (LOW) OP OFF

5.4.10 Frequency elements

5.4.10.1 Underfrequency element (81U)

The steady-state frequency of a power system is a certain indicator of the existing balance between the generated power and the load. Whenever this balance is disrupted through the loss of an important generating unit, the effect is a reduction in frequency. A reliable method to quickly restore the balance between load and generation is to automatically disconnect the selected loads, based on the actual system frequency. This technique called “load-shedding” maintains system integrity and minimizes widespread outages.

The 81U element is an underfrequency control element. The pickup setting can be selected from 20.00 to 65.00 Hz. The element reset time delayed is selectable between 0.00 and 900 seconds, and for the element to operate it is necessary that the voltage value is over the value set for minimum voltage threshold. This way undesired trips are prevented when the signal for metering the frequency is not available or has a very low value.

Underfrequency elements (81U) can be configured by using EnerVista 650 Setup at **Setpoint>Protection Elements>Setting Group X**

Table 5-63: 81U element settings

Setpoint > Control Elements > Underfrequency UNDERFREQUENCY 1 > UNDERFREQUENCY 2 > UNDERFREQUENCY 3 > UNDERFREQUENCY 4 > UNDERFREQUENCY 5 > UNDEFREQUENCY 6 **				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]

Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Minimum voltage threshold	Minimum Voltage	30	1 V	[10 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Frequency Source	Frequency Source	LINE FRQ	N/A	[LINE FRQ - BUS FRQ]

** For firmware below 7.20 version, only the first three underfrequency elements is available.

The snapshot event setting enables or disables the snapshot event generation for this element.

Frequency elements operate with the system frequency, this frequency is measured in the voltage channel set for the frequency reference, in the ***Frequency Reference*** setting inside ***Setpoint > System Setup >General Settings.***

5.4.10.2 Overfrequency element (81O)

81O is an overfrequency protection element. The pickup setting can be selected from 20.00 to 65.00 Hz, with a time delay selectable between 0 and 900 seconds. The element-reset delay is from 0.00 to 900.00 seconds.

Underfrequency elements (81U) can be configured by using EnerVista 650 Setup at **Setpoint>Protection Elements>Setting Group X**

Table 5-64: 81O element settings

Setpoint > Control Elements > Overfrequency OVERFREQUENCY 1 > OVERFREQUENCY 2 > OVERFREQUENCY 3 > OVERFREQUENCY 4 > OVERFREQUENCY 5 > OVERFREQUENCY 6				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]
Minimum voltage threshold	Minimum Voltage	30	1 V	[10 : 300]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Frequency Source	Frequency Source	LINE FRQ	N/A	[LINE FRQ - BUS FRQ]

** For firmware below 7.20 version, only the first three overfrequency elements is available.

The snapshot event setting enables or disables the snapshot event generation for this element.

Frequency elements operate with the system frequency, this frequency is measured in the voltage channel set for the frequency reference, in the ***Frequency Reference*** setting inside ***Setpoint > System Setup >General Settings***.

5.4.10.3 Frequency rate of change

F650 uses a defined signal as frequency reference. This signal is analyzed by the Digital Signal Processor and time between two consecutive zero-crossing is measured. Reference signal is set in ***Setpoint > System Setup > General Settings > Frequency Reference***.

SETPOINT > Protection Elements > Setting Group X > FREQUENCY RATE OF CHANGE				
FREQUENCY RATE OF CHANGE 1 > FREQUENCY RATE OF CHANGE 2 > FREQUENCY RATE OF CHANGE 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Direction of the frequency change	Freq. rate trend	INCREASING	N/A	[INCREASING - DECREASING - BI-DIRECTIONAL]
Operation Value in Hz/s	Freq. rate pickup	0.50	0.01 Hz/s	[0.10 : 10.00]
Minimum required voltage in % nominal voltage	Freq. rate OV supv	40.00	0.01%	[0.00 : 110.00]
Minimum Frequency Threshold	Freq. rate min	45.00	0.01 Hz	[20.00 : 80.00]
Maximum Frequency Threshold	Freq. rate max	65.00	0.01 Hz	[20.00 : 80.00]
Frequency rate Trip Delay	Freq. rate delay	0.00	0.01 s	[0.00 : 60.00]

Snapshot Events Generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Rate of Change Function: This setting allows enabling or disabling the frequency rate of change element.

Freq rate trend: This setting allows to configure the element in order to answer to increasing, decreasing or both directions frequency changes.

Freq. Rate Pickup: This setting defines the value to operate the element. If Direction is set as "Increasing", element operates when df/dt > Pickup Level, if set as "Decreasing" when -df/dt > Pickup Level, if set as both when |df/dt| > Pickup Level.

Freq. Rate OV supv: This setting defines the minimum required voltage. Under this level, the frequency rate of change element is blocked. This is the percentage of the nominal voltage (adjust in general settings). Voltage used as reference is line voltage (see frequency reference setting in general settings).

Freq rate Min: This setting defines the minimum frequency required in this unit to be enabled. For any value under this level the element is disabled.

Freq rate Max: This setting defines the maximum frequency allowed in this unit to be enabled. For any value above this level the element is disabled.

Freq rate Delay: Time that the element must remain picked up before it operates.

Snapshot events: The snapshot event setting enables or disables the snapshot event generation for this element.

The frequency rate of change actual values can be viewed at ***Actual> Status > Control Elements > Frequency:***

Table 5-65: Frequency rate of change status

FREQUENCY RATE OF CHANGE STATUS
FREQ RATE1 PKP
FREQ RATE1 OP
FREQ RATE2 PKP
FREQ RATE2 OP
FREQ RATE3 PKP
FREQ RATE3 OP

The block signals for the frequency rate of change element can be viewed at: ***Actual> Status > Protection > Protection Blocks***:

Table 5-66: Frequency rate of change blocks

FREQUENCY RATE OF CHANGE BLOCKS
FREQ RATE1 BLOCK
FREQ RATE2 BLOCK
FREQ RATE3 BLOCK

5.4.11 Miscellaneous elements

5.4.11.1 Broken conductor

F650 incorporates a broken or fallen conductor detection function. The relay uses the ratio between the negative sequence current, I_2, and the positive sequence current I_1. In normal and balanced load situations, this ratio is zero, while in severe load fault conditions, an unbalance is produced and this ratio increases.

SETPOINT > PROTECTION ELEMENTS > SETTING GROUP X > MISCELLANEOUS > BROKEN CONDUCTOR				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Tap Level in percentage of I2/I1	Tap	20.0	0.1%	[20.0 : 100.0]
Trip Time	Trip Delay	60.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]
Current Inhibition Level setting	Operation Threshold	0.005	0.001 A	[0.000 : 1.000]

This way, when the function is enabled and the unbalance is produced over the set percentage, the element picks up. If unbalance conditions are maintained during a period longer than the set time delay, the element trips.

In order to avoid trips or pickups with very weak loads there is a **current level threshold to inhibit the operation of the element** when the three phase currents are below a fixed level.

Note: The I2/I1 current inhibition level for the different firmware versions is as follows:

Firmware Version	Current Inhibition Level
1.50 or Lower	10 mA
1.60 or Higher	50 mA
1.80 or Higher	Selectable by setting from 0.000 to 1.000 in steps of 0.001 A

The Operation Threshold level has been included to allow the user selecting the current inhibition level suitable for a particular application, in order to avoid operation of the element when the relay is not connected to the line or in case the relay has previously operated correctly and has been disconnected from the line, as in this case the operation condition is met but the relay should not trip.

The operation threshold operation is as follows:

The Broken conductor element is fully operational if at least one of the phase currents is higher than the setting. This condition assumes that the relay is connected to the line.

If the element is on trip or pickup condition, the element is reset if the three phase currents are below the operation threshold level. This condition assumes that the relay is not connected to the line and therefore the relay should not trip.

Due to the response time of this function, if the set time delay is 0s, a trip can occur in situations where, for example, one of the currents is stopped before the rest, as these currents would produce a negative sequence current calculation. Therefore, to avoid this kind of undesired trips, it is strongly recommended to establish a minimum time delay setting, such as 100 ms, or higher depending on the expected normal unbalances in the network. This is to differentiate these situations from broken conductor situations.

5.4.11.2 Locker rotor

F650 incorporates a locked rotor element (48) with three elements. Protection element produces a trip when current **(primary values)** exceeds the set value. This current setting value is the product of the set Full load current by the pickup setting.

Settings can be configured by using EnerVista 650 setup at Setpoint> Protection Elements> Setting Group X> Miscellaneous>Locked Rotor

Table 5-67: Locker rotor element settings

SETPOINT > PROTECTION ELEMENTS > SETTING GROUP X > MISCELLANEOUS > LOCKED ROTOR 1 > LOCKED ROTOR 2 > LOCKED ROTOR 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Input type	Input	PHASOR (DFT)	N/A	[PHASOR – RMS]
Full load current	Full Load Current	0.50	KA	[0.10 : 10.00]
Pickup level	Pickup Level	1.01	N/A	[1.01 : 109.00]
Trip time	Trip Delay	0.00	s	[0.00 : 900.00]
Reset time	Reset Delay	0.00	s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Locked rotor element settings are:

Function Permission (Function): This setting indicates whether the locked rotor element is enabled or disabled.

Input (Phasor(DFT)-RMS): Selection between fundamental phasor magnitude (DFT) or total waveform RMS magnitude.

Full Load Current (FLC): This is the average maximum expected operating phase current for the motor.

Pickup Level: This is the current threshold over the full load current setting with which the element operates. The operating current for this element is calculated as follows:

$$I_{tap} = FLC \times Pickup_Level$$

Trip time (Trip Delay): Setting of the Protection element operation time.

Reset time (Reset Delay): Reset time of the Protection element.

Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

The signals related to the locked rotor pickups and operations for the three locked rotor elements can be viewed at ***Actual > Status > Control Elements > Locked Rotor*** and they are as follows:

Table 5-68: Locked rotor status

LOCKED ROTOR STATUS
LOCKED ROTOR1 PKP
LOCKED ROTOR1 OP
LOCKED ROTOR2 PKP
LOCKED ROTOR2 OP
LOCKED ROTOR3 PKP
LOCKED ROTOR3 OP

The block signals for the locked rotor element can be configured at: ***Setpoint > Relay Configuration > Protection Elements***

Table 5-69: Locked rotor blocks

LOCKED ROTOR BLOCKS
LOCKED ROTOR1 BLK
LOCKED ROTOR2 BLK
LOCKED ROTOR3 BLK

Note:

The element works with primary values.

The element picks up if at least one of the three phase currents is above the adjusted level. The operation value is the higher of the three.

The reset level is 97% to 98% of the pickup level.

5.4.12 Load encroachment

SETPOINT > CONTROL ELEMENTS > LOAD ENCROACHMENT				
LOAD ENCROACHMENT 1 > LOAD ENCROACHMENT 2 > LOAD ENCROACHMENT 3				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Minimum positive-sequence voltage required	Min. Voltage	25.00	0.01 V	[0.00 : 300.00]
Impedance reach of the element	Reach	1.00	0.01 Ohm	[0.02 : 250.00]
Angle (Size of the blocking region)	Angle	5	1 Deg	[5 : 50]
Trip Time	Pickup Delay	0.000	0.001 s	[0.000 : 65.535]
Reset Time	Reset Delay	0.000	0.001 s	[0.000 : 65.535]
Snapshot Events Generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The load encroachment element responds to the positive-sequence voltage and current and applies a characteristic shown in the figure below.

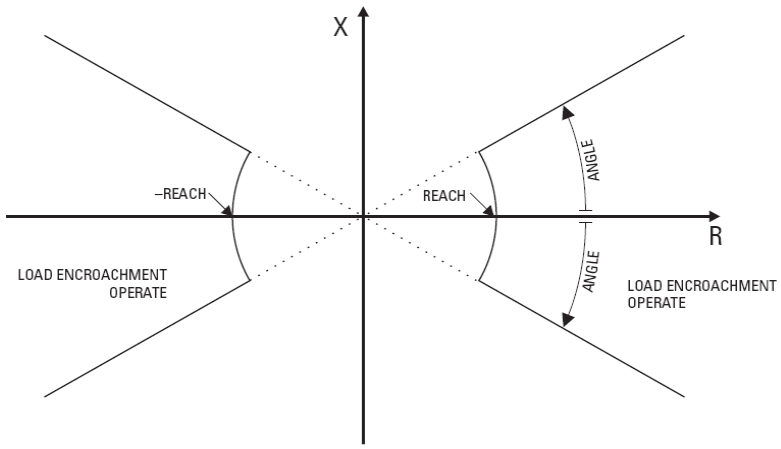


Figure 5-22: Load encroachment characteristics

The element operates if the positive-sequence voltage is above a selectable level and asserts its output signal that can be used to block selected protection elements such as distance or phase overcurrent.

Take into account that the time programmed in the overcurrent element must be higher than the time programmed in the load encroachment function to avoid false tripping.

Load encroachment settings description:

Load Encroachment function: enable/disable the Load Encroachment function.

Min Voltage: This setting specifies the minimum positive-sequence voltage required for operation of the element. If the voltage is below this threshold a blocking signal is not asserted by the element.

Reach: This setting specifies the impedance reach of the element as shown in the load encroachment characteristic diagram. This settings should be entered in secondary ohms and be calculated as the positive-sequence impedance seen by the relay under maximum load conditions.

Angle: This setting specifies the size of the blocking region as shown on the Load Encroachment Characteristic diagram and applies to the positive sequence impedance.

Pickup Delay: This setting specifies the delay for the trip of Load Encroachment element. After this time expires the signal Load Encroachment Operate is asserted.

Reset Delay: This setting specifies the time that the signal Pickup and operate are asserted after trip conditions have been removed.

Snapshot events: The snapshot event setting enables or disables the snapshot event generation for this element.

The Load Encroachment actual values can be viewed at ***Actual> Status > Control Elements > Load Encroachment***

Table 5-70: Load encroachment status

LOAD ENCROACHMENT STATUS
LOAD ENCR1 PKP
LOAD ENCR1 OP
LOAD ENCR2 PKP
LOAD ENCR2 OP
LOAD ENCR3 PKP
LOAD ENCR3 OP

The block signals for the Load Encroachment element can be viewed at: ***Actual> Status > Protection > Protection Blocks***:

Table 5-71: Load encroachment blocks

LOAD ENCROACHMENT BLOCKS
LOAD ENCR1 BLOCK
LOAD ENCR2 BLOCK
LOAD ENCR3 BLOCK

There are three load encroachment type of signals:

Load Encroachment Block: Writing status. When this signal is asserted the Load Encroachment function is blocked until this signal is eliminated and the positive sequence voltage is above the settable level programmed in the Min. Voltage setting.

Load Encroachment pickup: Reading state. This state is asserted when the conditions for the operate are fulfilled.

Load Encroachment operate: Reading state. This state is asserted after the conditions for the operate are fulfilled at least during the period of time programmed in the pickup delay setting.

5.5 Control elements

The F650 incorporates the following control elements:

Setting Group

Synchrocheck (25)

Autoreclose (79)

Breaker Failure (50BF)

VT Fuse Failure

Pulse Counters

Digital Counters

Analog Comparators

Max Number of starts

Cold Load Pickup

PLC Timer mask

60 CTS Failure

2nd Harmonic Inhibit

Note: for all control elements related to the breaker, it must be considered that all operations are performed considering the status of the switchgear configured as breaker. In ***Setpoint > Relay Configuration > Switchgear*** up to 16 switchgear elements can be configured to operate and be monitored, but only one of them can be configured as a breaker, for monitoring, number of openings and closings counters, $(KI)^2t$.

5.5.1 Setting group

The settings used for setting table management are located in ***Setpoint > Control Elements > Setting Group***:

Table 5-72: Setting group settings

Setpoint > Control Elements > setting Group				
setting Description	Name	Default Value	Step	Range
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3 - GROUP 4 – GROUP 5 – GROUP 6]
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The snapshot event setting enables or disables the snapshot event generation for this element.

For more detailed information go to section 5.4.1 Available settings and setting groups

5.5.2 Synchronism check element - synchrocheck (25)

Note: The Switchgear element used in the F650 synchronism element is the one configured in the ***Number of Switchgear*** setting inside ***Breaker settings***, at "***Setpoint > System Setup > Breaker > Breaker Settings***".

WARNING

When testing this function do not forget that the relay must detect an open breaker to operate.

The synchronism element is used for monitoring the connection of two parts of the circuit by the close of a breaker. This element verifies that voltages (V1 and V2) at both sides of the breaker are within the magnitude, angle and frequency limits set by the user. V1 and V2 are the line and busbar voltage values measured by the relay.

Synchronism check (25) is defined as the comparison of the voltage difference of two circuits with different sources to be either linked through an impedance element (transmission line, feeder, etc.), or connected through parallel circuits of defined impedance (Figure 5-23: Synchronism check element) The voltage comparison between both sides of a breaker is performed before closing the breaker, in order to minimize internal damage that can occur due to the voltage difference, both in magnitude and angle. This is extremely important in steam generating plants, where reclosing output lines with angle differences can lead to severe damage to the turbine axis.

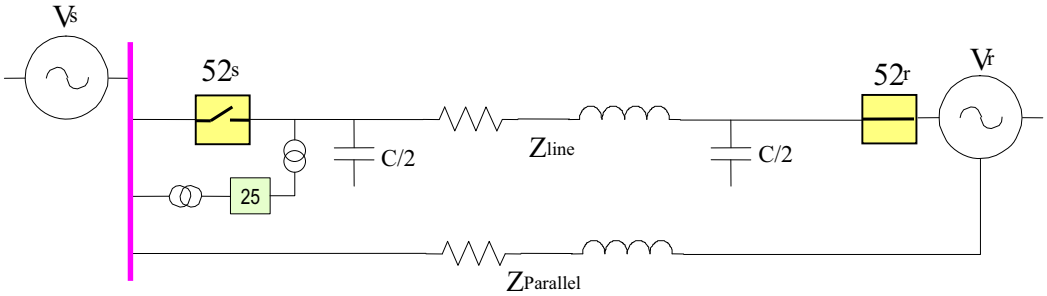


Figure 5-23: Synchronism check element

The difference in voltage level and phase angle in a given moment is the result of the existing load between remote sources connected through parallel circuits (load flux), as well as a consequence of the impedance of those elements connecting them (even if there is no load flux in parallel circuits, or because sources to be connected are completely independent and isolated from one another).

In interconnected systems, the angle difference between both ends of an open breaker is usually negligible, as its sources are remotely connected through other elements (equivalent or parallel circuits). However, in isolated circuits as in the case of an independent generator, the difference in angle, voltage levels and relative slip of voltage phasors can be very important. It may happen that the relative slip of voltage values is very low or null so that they are rarely in phase. Luckily, due to the changing conditions of a power system (connection-disconnection of loads, sources, and new inductive-capacitive elements) the relative slip between phasors is not null and they can be synchronized.

In the first case, even if we must take into consideration the length of the line whose ends (sources) are connected for determining the angle difference between them, this is not enough to fix the synchronism conditions before closing the breaker. Experience tells us that the window of angle difference between voltage phasors must be fixed to a value of 15º-20º.

5.5.2.1 Voltage inputs

In order to perform the synchronism check function, the F650 uses only one voltage from each end of the breaker. Voltage values to be compared must be on the same basis, either phase-to-phase or phase-to-ground voltage; they must be the same at both ends of the breaker; it is not possible to compare a phase-to-ground voltage at one end with a phase-to-phase voltage at the other end.

Additionally, if on one end, three voltages have been connected, the necessary voltage on the other end for Function 25 is only single-phase voltage. If there is only one voltage (either phase-to-phase or phase-to-ground) at both ends of the breaker, this must be from the same phase in both cases.

The selection of voltage values to be used by the synchronism element is made in the relay General settings:

V1 is the line voltage, selectable from the relay voltage channels, using the "***Frequency Reference***" setting at ***Setpoint > System Setup > General settings > Frequency Reference***. (refer to the voltage correspondence Table 5-73: Voltage correspondence element 25)

V2 is the busbar voltage measured at the auxiliary voltage input (terminals A11-A12). To enable the busbar voltage metering in the relay, it is required to select VX in the ***Auxiliary Voltage*** setting at ***Setpoint > System Setup > General settings > Auxiliary Voltage***.

The voltage correspondence is detailed in the following table:

Table 5-73: Voltage correspondence element 25

	Voltage Correspondence		
Setpoint>System Setup>General settings>Frequency Reference Voltage selection for element 25 of F650	V_I	V_{II}	V_{III}
Setpoint>System Setup>General settings>Phase VT Connection=WYE Phase-to-ground voltage connection.(Wye connection**)**	V_{a-g}	V_{b-g}	V_{c-g}
Setpoint>*System Setup>General settings>Phase VT Connection=DELTA* Phase-to-phase voltage connection.(Delta connection).	V_{a-b}	V_{b-c}	V_{c-a}
Setpoint>System Setup>General settings> Auxiliary Voltage=Vx	V_x		

Setpoint > System Setup > General settings > Auxiliary Voltage setting must be set to Vx, in order to monitor auxiliary voltage instead of Vn (neutral voltage, coming from an open delta connection).

5.5.2.2 Application

Even if the application range of the F650 is quite wide and the element can be used in distribution lines at any voltage level, it must be taken into account that it is a **three-pole tripping** relay, designed for managing a **single breaker**. This is why F650 is not suitable for one and a half breaker configurations, or ring configurations where a transmission line or feeder has two breakers.

5.5.2.3 Settings

There is only one synchrocheck element in the F650.

Setpoint > Control Elements > Synchrocheck				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 300.00]
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 1.00]
Dead Line – Dead Bus Function permission	DL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]
Live Line – Dead Bus Function permission	LL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]
Dead Line – Live Bus Function permission	DL-LB Function	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Settings description for element 25:

Function permission (Function): This setting allows enabling and disabling the synchrocheck element.

Voltage Level determination settings for busbar and line:

This setting group allows determining the voltage levels considered as dead and live for line and busbar voltage.

Dead Bus voltage level (Dead Bus Level): Voltage level considered as dead bus

Live Bus voltage level (Live Bus Level): Voltage level considered as live bus

Dead Line voltage level (Dead Line Level): Voltage level considered as dead line

Live Line voltage level (Live Line Level): Voltage level considered as live line

Synchrocheck settings (live bus, live line):

F650 relays verify synchronism by establishing and comparing three basic parameters: the difference in module and angle of voltage phasors, and the frequency slip of a phasor related to the other one. synchrocheck settings include a fourth time setting, that allows using an anticipative algorithm to issue a closing signal.

Voltage Difference (Max Volt Difference): Maximum Difference in module between the line and busbar voltage to allow a closing in the synchrocheck element.

Angle Difference (Max Angle Difference): Maximum Difference in angle between the line and busbar voltage to allow a closing in the synchrocheck element.

Frequency Slip (Max Freq Difference): Maximum difference in frequency (slip) between both voltage values to be compared in the synchrocheck element.

Breaker Closing time (Time): Estimated breaker Closing time, used for establishing the Closing order in a moment that allows the busbar and line voltages to be in phase.

This time is considered if the relative slip is higher than 20 mHz; in this case, an anticipative algorithm is executed to calculate the closing signal with the necessary advance for the breaker effective Closing to be produced when voltages are in phase. The limit for the anticipative algorithm is two times

the maximum angle difference. This means that if the product of the frequency slip multiplied by the breaker closing time covers an angle greater than two times the maximum angle, closing is not allowed. For further information see 5.5.4.5.

Closing permission logic settings:

In case that the voltage at one or both ends of the breaker is null, the synchronism element cannot establish the necessary parameters to give closing conditions, and therefore it does not issue synchronism permission. For those situations where the user wants to enable the closing permission in a condition of loss of one or both voltages at both ends of the breaker, F650 elements incorporate closing permission logics for the cases of: dead line-dead bus, live line-dead bus and dead line-live bus.

Dead line- Dead Bus Function permission (DL-DB Function): Enabling this Function allows issuing a Closing permission signal in dead line and dead bus Condition (without voltage at both sides of the breaker).

Live line- Dead Bus Function permission (LL-DB Function): Enabling this Function allows to issue a Closing permission signal in live line and dead bus Condition (without voltage at the sides of the breaker that corresponds to the busbar voltage)

Dead line- Live Bus Function permission (DL-LB Function): Enabling this Function allows issuing a Closing permission signal in live line and dead bus Condition (without voltage at the sides of the breaker that corresponds to the line voltage).

Snapshot event: The snapshot event setting enables or disables the snapshot event generation for this element.

5.5.2.4 Synchrocheck states

Internal signals provided by the F650 (***Actual> Status > Control Elements > Synchrocheck***) for the synchronism element are as follows:

Table 5-74: Synchrocheck internal states

SYNCHROCHECK ACTUAL VALUES
SYNCROCHECK BLK INP
SYNCROCHECK OP
SYNCHK CLOSE PERM
SYNCROCHECK COND OP
DL-DB OPERATION
DL-LB OPERATION
LL-DB OPERATION
SLIP CONDITION
BUS FREQ > LINE FREQ
BUS FREQ < LINE FREQ
VOLTAGE DIFFERENCE
FREQUENCY DIFFERENCE

SYNCROCHECK BLK INP: Block signal for the synchrocheck element, configurable at ***Setpoint > Relay Configuration > Control Elements***

SYNCROCHECK OP: Closing permission signal in live line-live bus conditions with open breaker.

SYNCHK CLOSE PERM: General Closing permission of the Synchronism element. It contemplates all possible situations, live line-live bus conditions, and the closing permission logics (dead line-dead bus, live line- dead bus, dead line-live bus). **Note**: in case the Function is disabled, the Closing permission signal is activated in order not to interfere with possible logics where it is included. If the synchronism element is enabled, this signal is only activated in the closing conditions established by setting.

SYNCROCHECK COND OP: Closing permission according to permission logics (DL-DB, LL-DB, DL-LB).

	DL-DB OPERATION: Closing permission in dead line – dead bus condition.
	DL-LB OPERATION: Closing permission in dead line – live bus condition.
	LL-DB OPERATION: Closing permission in live line – dead bus condition.
SLIP CONDITION:	Internal signal indicating frequency slip between the line voltage and bus voltage phasors.
BUS FREQ > LINE FREQ:	Busbar Frequency higher than line frequency
BUS FREQ < LINE FREQ:	Busbar Frequency lower than line frequency
VOLTAGE DIFFERENCE:	Voltage difference in Volts between line and busbar
FREQ. DIFFERENCE:	Frequency difference in Hz between line and busbar

Voltage and frequency values for the line and busbar can be obtained, both in primary and secondary values at:

Actual> Metering > Primary Values > Voltage

VBB Primary (KV)	Busbar voltage in primary values
VL Primary (KV)	Line voltage in primary values

Actual> Metering > Secondary Values > Voltage

Line Voltage (V)	Line voltage in secondary values
Bus Voltage (V)	Busbar voltage in secondary values

Actual> Metering > Frequency

Line Frequency (Hz)	Line frequency in Hz
Bus Frequency (Hz)	Bus frequency in Hz

The voltage angles can be obtained in primary metering values *(Actual> Metering > Primary Values > Voltage)*, being the line voltage angle, the one that corresponds to the voltage set in the frequency reference in General settings (refer to the voltage correspondence table (Table 5-73: Voltage correspondence element 25), and the angle of the busbar voltage the one that corresponds to Vx Angle, when the Auxiliary Voltage setting as been selected as Vx.

5.5.2.5 Algorithm

F650 elements perform the synchronism check by basically establishing and comparing three parameters:

Module difference of voltage phasors DV (V)

Phase angle of voltage phasors Dj (º)

Frequency slip between two phasors S (Hz)

These parameters are continuously determined and managed once that element 25 has been enabled by setting, and in open breaker conditions. It is necessary to consider that all calculations are made once the open breaker condition is detected; if the breaker is closed or undefined, the synchronism element does not issue a closing permission signal, even when closing conditions are met.

If voltage on one side of the breaker to be closed is null, the synchronism element cannot establish the synchronism check, and therefore it does not issue synchronism permission. For these cases, usual in breaker maintenance situations, or in new installations where voltage might not be present, but the breaker operation needs to be verified, F650 elements incorporate closing permission logics for situations of:

Dead Line – Dead Bus (DL-DB)

Live Line – Dead Bus (LL-DB)

Dead Line – Live Bus (DL-LB)

In order to establish the closing permission signal, the first parameter used by the algorithm is the difference in magnitude between line and bus voltages, and afterwards, the angle difference and frequency slip are verified.

Voltage Difference DV

Comparing the voltage values for line voltage (V1) and busbar voltage (V2) at both sides of the breaker, the relay can determine the synchronism situation of the element (see Table 5-75: Synchronism conditions).

Being:

V_1 line voltage

V_2 bus voltage

V_L Minimum acceptable voltage by setting to establish synchronism conditions (dead line and bus levels).

V_H Appropriate voltage to establish synchronism conditions, configured by setting (live line and bus levels).

Table 5-75: Synchronism conditions

Synchronism Situation	Synchronism check	Closing logic	Line voltage levels	Busbar voltage levels
(1) $V_L < (V_1 \& V_2) < V_H$	Not permitted	Not permitted	V1 > dead line level V1 < live line level	V2 > dead bus level V2 < live bus level
(2) $(V_1 \& V_2) > V_H$	Permitted	Live Line – Live Bus	V1 > live line level	V2 > live bus level
(3) $(V_1 \& V_2) < V_L$	Not permitted	Dead Line – Dead Bus	V1 < dead line level	V2 < dead bus level
(4) $(V_1 < V_L) \& (V_L < V_2 < V_H)$	Not permitted	Not permitted	V1 < dead line level	V2 > dead bus level V2 < live bus level
(5) $(V_2 < V_L) \& (V_L < V_1 < V_H)$	Not permitted	Not permitted	V1 > dead line level V1 < live line level	V2 < dead bus level
(6) $(V_1 < V_L) \& (V_2 > V_H)$	Not permitted	Dead Line – Live Bus	V1 < dead line level	V2 > live bus level
(7) $(V_2 < V_L) \& (V_1 > V_H)$	Not permitted	Live Line – Dead Bus	V1 > live line level	V2 < dead bus level

Table 5-75: Synchronism conditions shows the different synchrocheck and closing logic situations, that can be produced depending on the line and busbar voltage levels.

Live Line – Live Bus (Synchronism check): Only in case number (2), with live line and live bus, the element starts evaluating the line and busbar voltage comparison with respect to the setting $\mathbf{DV}_{set}$ established by setting (Max Volt Difference). In this case, if the voltage difference is lower than $\mathbf{DV}_{set}$, the synchronism check element (25) verifies the angle difference **Dj** adjusted by setting (Max Angle Difference).

Dead Line – Dead Bus (DL - DB): Case number (3) does not allow the synchronism function, but it does allow DL-DB operation logic, if this logic is enabled by setting (DL-DB Function).

Dead Line – Live Bus (DL - LB): Case number (6) does not allow the synchronism function, but it does allow DL-LB Operation logic, if this logic is enabled by setting (DL-LB Function)

Live Line – Dead Bus (LL - DB): Case number (7) does not allow the synchronism function, but it does allow LL-DB operation logic, if this logic is enabled by setting (LL-DB Function)

Case numbers (1), (4) and (5) are not considered neither for synchronism check purposes, nor for closing logic.

Phase Angle Difference Dj

In the live line-live bus Condition, once the voltage difference has been successfully verified in magnitude, the system establishes the angle difference between both voltage phasors. If the angle difference is lower than the **Dj_{set}** (Max Angle Difference) setting, then the system verifies the frequency slip **S** (Max Freq Difference).

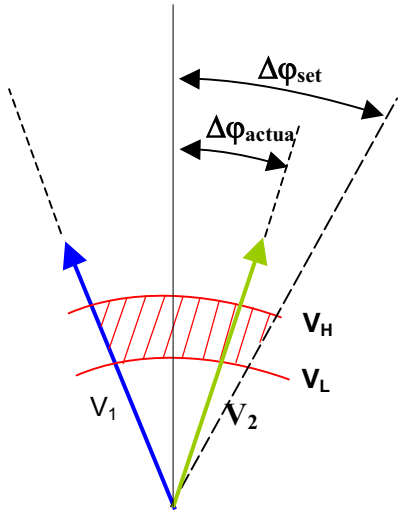


Figure 5-24: Voltage angle difference

In the live-live bus condition, once the voltage difference has been successfully verified in magnitude, the relative frequency slip between phasors is calculated. From the information obtained from the relay, the algorithm knows the slip (mHz) of both phasors, and it takes as reference (VRef) the lowest frequency phasor. The behaviour of the algorithm depends on the slip frequency and the breaker close time as follows:

1. If the relative slip, Δf, is equal or lower than 20 mHz, the algorithm gives permission to close as soon as the angle difference is slower than the Δϕset (Max Angle Difference), because at such a low speed, the hold time for getting an “in-phase” closing permission would be too long.
2. If the relative slip is higher than 20 mHz, the element performs an anticipative algorithm, determining the right moment to give the closing command to the breaker, so that the breaker closes when the line and busbar voltages are in phase. When the difference between voltage values equals “two times” the set angle as maximum angle difference (ΔV = ΔVset), the anticipative algorithm starts running and uses the set breaker closing time to establish the initiation of permission, so that it is executed in the moment when both voltage phasors are completely in phase, thus minimizing the voltage difference in the breaker chamber to negligible values. The main benefit is that after a considerable number of breaker operations, damage to internal connection elements, as well as to the chamber isolating element is drastically reduced, ensuring a longer life for the breaker, and reducing costly maintenance operations.
3. If the product of frequency slip and breaker closing time is higher than Max Angle difference and lower than two times this setting, as an in phase close is not possible, the algorithm ensures that the difference between voltages in the real closing moment is not higher than the set value (Max Volt Difference).
4. If this product is beyond two times Max Angle difference, closing operation is not allowed.

The Closing process using anticipative algorithm is described on the following figure:

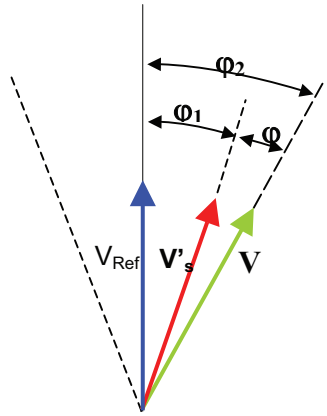


Figure 5-25: Anticipative algorithm

Where:

V_{ref}	Referenced phasor (the one with lower frequency)
V_s	Actual voltage phasor (the one with lower frequency)
V'_s	Calculated voltage phasor, depending on the set breaker closing time (anticipative algorithm)
j	360º *TCB *Df = Calculated angle for phasor V'_s
TCB	Breaker Closing time defined by setting
Df	Frequency slip (mHz) between phasors
j_1	Angle difference set as maximum angle difference (**Dj_{set}** , Max Angle Difference)
j_2 =	Angle difference between V_{ref} and V_s. The algorithm starts operating when **j_2** equals two times the angle set as maximum angle difference.

Closing permission is given when **V'_s** is over **V_{ref}**, which means that line and busbar voltages are in phase.

If the frequency slip is high, it is possible that as soon as the window defined by two times the maximum angle difference (**j_2**) is entered, the relay produces a closing permission output, if it is guaranteed that the projected phasor is within the limit marked by the setting, as shown in the following figure. Besides, when the product of frequency slip and breaker close time goes beyond this window, closing is not allowed.

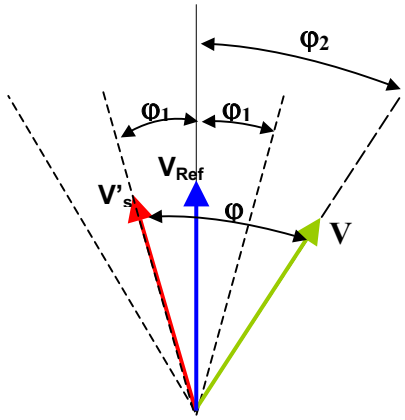


Figure 5-26: High slip closing permission signal

5.5.3 Autoreclose (79)

Note: The Switchgear element used in the F650 autoreclose element is the one configured in the ***Number of Switchgear*** setting inside ***Breaker settings***, at "***Setpoint > System Setup > Breaker > Breaker settings***". Configuration of these Switchgear parameters is performed at ***Setpoint > Relay Configuration > Switchgear*** using the EnerVista 650 Setup software.

The F650 autoreclose element produces up to four breaker "shots" prior to lockout. Thanks to the great flexibility of F650 configurable logic, the conditions to produce the autoreclose initiation and the selection of protection elements is enabled after each shot can be programmed. This flexibility allows implementing protection schemes that used to require wiring and special functions in conventional equipment. One application is, for instance, programming as instantaneous the first protection trip while the second one is time delayed, in order to give time for output fuses to burning of a feeder branch. This can be as simple as disabling the instantaneous elements after the first shot using programmable logic. (see example in section 5.5.3.5 Logic for blocking protection functions during reclose cycle)

5.5.3.1 Main autoreclose settings

Setpoint > Control Elements > Autoreclose				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Autoreclose settings description:

Function: This setting allows enabling or disabling the autoreclose operation. If this setting is adjusted as DISABLED, the recloser is out of service.

Max Number Shots: This setting specifies the number of autoreclose shots allowed in the element. If this number is exceeded, the autoreclose goes to LOCKOUT status, and the fault is considered to be permanent.

Dead Time 1 ... 4: These times correspond to the first, second, third and fourth breaker reclosings configured in the element.

Reclaim Time (also known as **safety time** or **reset lockout delay**)**:** This is the time required to go from LOCKOUT to READY status once the breaker is closed.

Cond. Permission: This setting enables the verification of the relay reclose conditions. If this setting is enabled, before the breaker closing command execution the system verifies the possible reclose conditions. If this setting is disabled, the closing command is executed after the reclose time without verifying these conditions. The reclose conditions input is configured as AR CONDS INPUT at ***Setpoint > Relay Configuration > Protection Elements***

Hold Time: This setting indicates the waiting time for the reclose conditions to be present. This setting is only operative if the *Cond. Permission* setting is enabled.

Reset Time: This is the time that the autoreclose takes to return to READY status after a successful reclose. Once this time has expired, the shot counter resets and the autoreclose goes to READY.

5.5.3.2 Autoreclose inputs

For the correct operation of the autoreclose element, it is required to configure several input signals in the Relay. These signals can be configured using the EnerVista 650 Setup software, at **Setpoint > Relay Configuration > Protection Elements**. The **Protection Elements** screen allows to select simple signals provided directly by the relay (***states***), or to use more complex logics using **virtual outputs**, configured at **Setpoint > Logic Configuration** using the PLC Editor tool inside EnerVista 650 Setup.

Actual> Status > Control Elements > Autoreclose

Table 5-76: 79 configurable inputs

AUTORECLOSE INPUTS
AR LEVEL BLOCK
AR PULSE BLOCK
AR PULSE UNBLOCK
AR INITIATE
AR CONDS INPUT

AR LEVEL BLOCK: This signal is configured to block the autoreclose by level; when the block signal disappears, the recloser goes to Lockout status before returning to either the READY status, or the corresponding status in the reclosing cycle.

AR PULSE BLOCK: This signal is configured to block the autoreclose by pulse; a pulse moves the autoreclose to BLOCK status. The autoreclose block is active until an unblock signal is received.

AR PULSE UNBLOCK: This signal is configured as autoreclose unblock by pulse; this pulse is required to bring the recloser out of the block status. The autoreclose goes to Lockout after a block situation.

AR INITIATE: This signal indicates the autoreclose initiation. Usually, the factory default configuration sets this signal as a combination of the general trip signal (Virtual Output 83), and an external input configured as AR Initiate.

AR CONDS INPUT: This signal configures the conditions that are to be met before executing a breaker close command. These conditions are verified once the configured ***Dead Time*** has expired, and they are only considered if the ***Cond. Permission*** setting is enabled. Otherwise, these conditions wouldn't have any effect. In the default factory configuration, the conditions input is associated with the synchronism check element close permission.

5.5.3.3 Autoreclose internal status

Actual> Status > Control Elements > Autoreclose. These signals can be used as conditions for executing logics in the relay; they are also useful to know the autoreclose behavior.

Table 5-77: 79 internal status

AUTORECLOSE SINGLE STATUS
AR CLOSE BREAKER
AR OUT OF SERVICE
AR READY
AR LOCKOUT
AR BLOCK
AR RCL IN PROGRESS
AR LCK BY ANOMALY
AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE
AR LCK BY USER
AR LCK BY CONDS
AR LCK BY TRIPS
AR LCK BY SHOTS
AR BLK AFTER 1 SHOT
AR BLK AFTER 2 SHOT
AR BLK AFTER 3 SHOT
AR BLK AFTER 4 SHOT
AR BLOCK BY LEVEL
AR BLOCK BY PULSE

AUTORECLOSE ENUMERATED STATUS
AR STATUS
AR READY
AR LOCKOUT
AR BLOCK
AR RCL IN PROGRESS
AR LOCKOUT MODE
AR LCK BY ANOMALY
AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE
AR LCK BY USER
AR LCK BY CONDS
AR LCK BY TRIPS
AR LCK BY SHOTS
AR BLOCK MODE
AR BLOCK BY LEVEL
AR BLOCK BY PULSE

Description of autoreclose internal status:

AR CLOSE BREAKER Breaker close command given by the autoreclose

AR OUT OF SERVICE Autoreclose out of service (Disabled)

AR READY Autoreclose in service

AR LOCKOUT Autoreclose in lockout status (finished cycled-definite trip)

AR BLOCK Autoreclose blocked (by input, logic, others, etc.).

AR RCL IN PROGRESS Cycle in course (autoreclose in progress).

AR LCK BY ANOMALY Autoreclose in “Lockout” by anomaly.

AR LCK BY FAIL OPEN Autoreclose in “Lockout” by failure to open

AR LCK BY FAIL CLOSE Autoreclose in “Lockout” by failure to close

AR LCK BY USER Autoreclose in “Lockout” by user Command; manual breaker close during the autoreclose cycle

AR LCK BY CONDS Autoreclose in lockout by non-compliance of the autoreclose conditions

AR LCK BY TRIPS Autoreclose in “Lockout” by maximum number of trips (Lockout status not available)

AR LCK BY SHOTS Autoreclose in “Lockout” at the end of cycle – Definite trip (due to Maximum Number of shots reached).

AR BLK AFTER 1 SHOT Block signal sent by the autoreclose after the first shot

AR BLK AFTER 2 SHOT Block signal sent by the autoreclose after the second shot

AR BLK AFTER 3 SHOT Block signal sent by the autoreclose after the third shot

AR BLK AFTER 4 SHOT Block signal sent by the autoreclose after the fourth shot

AR BLOCK BY LEVEL Autoreclose blocked by level. See AR block signals configuration (AR LEVEL BLOCK)

AR BLOCK BY PULSE Autoreclose blocked by pulse. See AR block signals configuration (AR PULSE BLOCK)

AR STATUS Autoreclose status (see Table 5-77: 79 internal status)

AR LOCKOUT MODE Autoreclose lockout mode (see Table 5-77: 79 internal status)

AR BLOCK MODE Autoreclose block mode (see Table 5-77: 79 internal status)

5.5.3.4 General autoreclose status diagram

The following diagram describes the different autoreclose states, as well as the transitions between states.

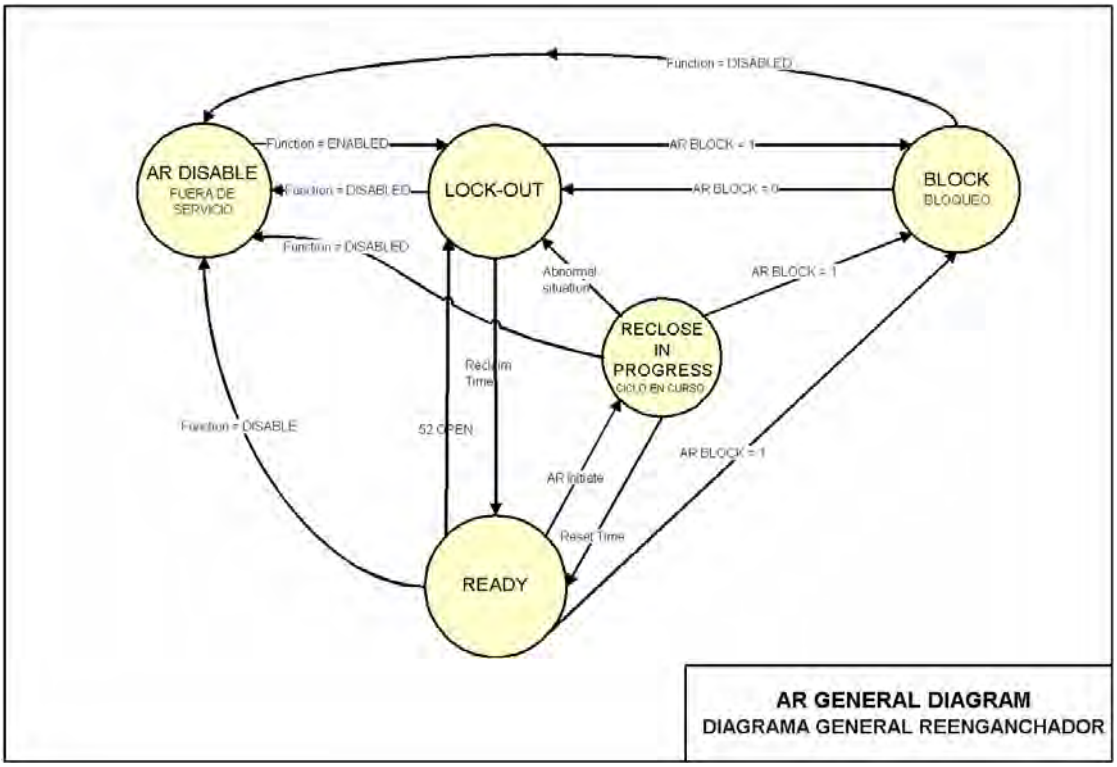


Figure 5-27: General autoreclose status diagram

Description of the general autoreclose status:

OUT OF SERVICE / AR DISABLE

In this status, the autoreclose is disabled. From any state, if the *Function* setting is set as DISABLED, the autoreclose moves to OUT OF SERVICE status, where it is not operative.

AR READY

This is the initiation and normality situation status: closed breaker. There are neither faults producing a autoreclose initiation nor Block signal.

If the autoreclose was in LOCKOUT, if the breaker is closed and the time set in *Reclaim Time* setting expires, the autoreclose goes to the initial status of READY.

From RECLOSE IN PROGRESS, the recloser moves to READY, if the *Reset Time* setting expires without any autoreclose initiation condition.

AR RECLOSE IN PROGRESS

From READY status, a reclose initiation sets the cycle counter to 1 and a reclosing sequence is initiated which produce breaker close commands, unless any abnormality is produced that makes the autoreclose go to LOCKOUT status.

The reclosing sequence consists on the following steps:

Wait until the breaker is open, if the waiting exceeds the ***Fail to Open Time*** setting, the autoreclose goes to LOCKOUT by failure of opening status (AR LCK BY FAIL OPEN).

Once the breaker is open, it waits for the time set in the ***Dead Time N*** setting, *N* being the number of the cycles in progress. If during this waiting the breaker is closed or reclose initiation conditions are given, the recloser goes to LOCKOUT status by anomaly (AR LCK BY ANOMALY).

Once the Dead Time has expired, in case the ***Conditions Permission*** setting is disabled, a closing command would be produced. If the conditions permission setting is enabled, the system waits for the conditions fixed in the conditions input (AR CONDS INPUT) configured at ***Setpoint > Relay Configuration > Protection Elements***; if the waiting period for the reclosing conditions signal activation exceeds the ***Hold Time***, the autoreclose goes to Lockout status by conditions (AR LCK BY CONDS).

The autoreclose gives a Closing command and waits for the breaker to close. If the ***Fail to Close Time*** setting is exceeded, the autoreclose goes to lockout by failure to close (AR LCK BY FAIL CLOSE).

At this point, the diagram indicates that a reclosing cycle has been reached, and so the cycle counter is increased. In this time, the period set in ***Reset Time*** starts to count. If during the set element reset time there is no autoreclose initiation, the cycle counter resets to its initial value (1), and the autoreclose returns to the standby status (READY). If during the ***Reset Time*** setting period, there is a new autoreclose initiation, the ***Reclose In Progress*** sequence starts again. If this reclose is produced after the last configured cycle in the ***Maximum Number of Shots*** setting, the autorecloser goes to Lockout by maximum number of shots (AR LCK BY SHOTS).

AR LOCKOUT

This is a safety status, scheme lockout blocks all phases of the reclosing cycle, preventing automatic reclosure.

From the out of service (AR DISABLE) and BLOCK statuses, the autoreclose stays in LOCKOUT prior to going to READY.

From the RECLOSE IN PROGRESS status, the recloser goes to LOCKOUT status if any of the anomalies described above occur.

To go from the LOCKOUT status to READY it is necessary that the breaker is closed and stays closed for preset time in ***Reclaim Time*** setting.

AR BLOCK

The BLOCK status is similar to the LOCKOUT status, as it guarantees that if the autoreclose is in Block, no breaker close command is produced, but the difference between them is that this Block status is reached by an external action. The autoreclose block can be configured by pulse or level signals. This configuration must be selected at ***Setpoint > Relay Configuration > Protection Elements***

When the autoreclose block signal is deactivated, either by a level change in the set signal (in case of block by level) or by an Unblock pulse (in case of block by pulse), the block status is abandoned and the autoreclose returns to the Lockout status.

Configurable signals to block the autorecloser are described in section 5.5.3.2 Autoreclose inputs.

5.5.3.5 Logic for blocking protection functions during reclose cycle

The F650 autoreclose generates a series of internal signals that allow performing block logics for Protection elements during the reclosing cycle. These signals are blocks after autoreclose shots (***BLK AFTER SHOT***). For example, if the user wants to block a protection element during the complete reclosing cycle, it is necessary to configure a signal as an OR of the four blocking signals provided after each reclosing cycle in the logic configuration tool ***Setpoint > Logic Configuration***, and then use it to block the desired protection elements at ***Setpoint > Relay Configuration > Protection Elements***.

Figure 5-28: clock signal during reclose cycleshows an example of the logic configuration for the block signal during the reclosing cycle.

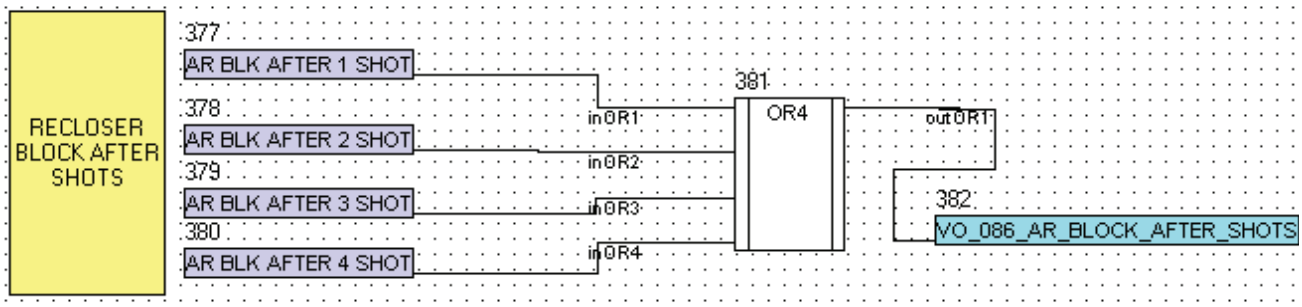


Figure 5-28: clock signal during reclose cycle

Figure 5-29: Reclose initiation and block signals configuration example shows an example of the autoreclose initiation and protection element block signals after the different trips. The autoreclose initiate signal is configured to the relay general trip that corresponds to virtual output 83 configured in the logic configuration tool, and a physical contact to generate an external autoreclose initiation.

In the example shown on the figure, the 50PH element block signal is configured as a combination of block by digital input, block by non-trip permission of the directional element, and finally the element remains blocked during the reclosing cycle. This means that only the first trip can be executed by the phase instantaneous overcurrent element; after the first reclose trip, the element remains blocked until the end of the cycle.

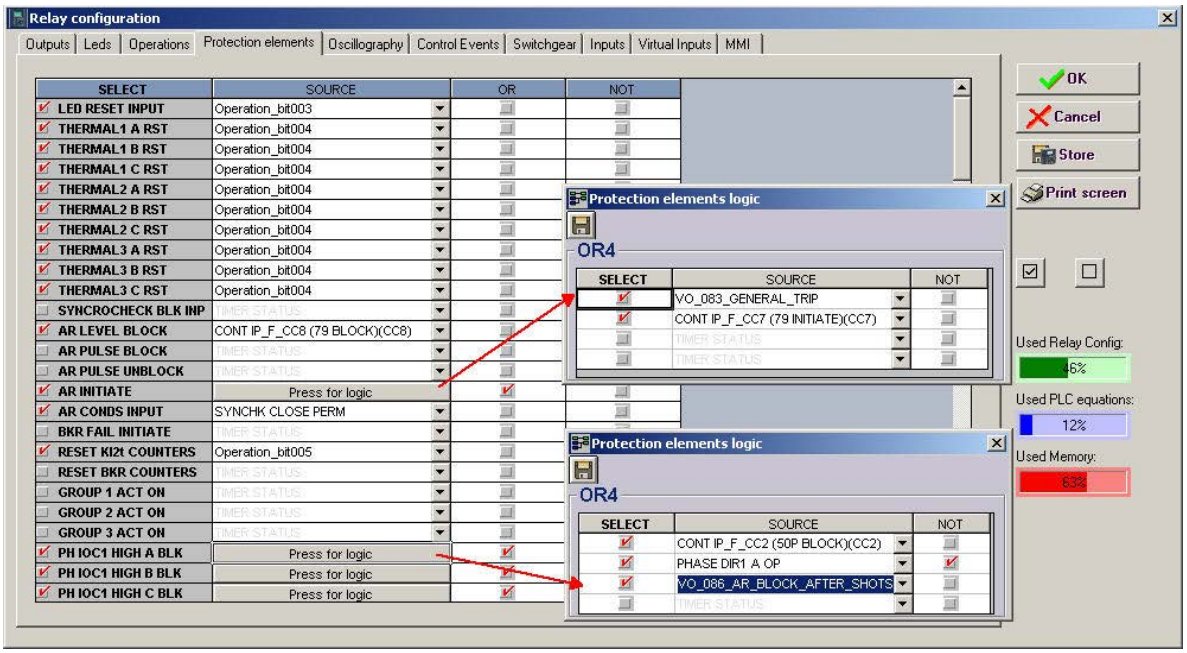


Figure 5-29: Reclose initiation and block signals configuration example

5.5.4 Breaker failure element (50BF)

Note: The Switchgear element used in the **Breaker Failure** element is the one configured in the **Number of Switchgear** setting, inside **Breaker settings** at ***SETPOINT > PROTECTION ELEMENT > SETTING GROUP X > Breaker > Breaker settings***

The breaker failure element is used to determine when a trip command sent to a breaker has not been executed within a selectable delay. Most commonly it is a failure to open from the tripped breaker. In the event of a breaker failure, the 50BF element must issue a signal that trips the rest of breakers connected at that time to the same busbar, and that can provide fault current.

Comparing the current measured by the Relay with a setting level makes breaker failure detection. If after receiving a breaker initiate signal, the current level is maintained over the set level for a time period longer than the set time, this indicates that the breaker that has received the opening command has not been able to open and clear the fault. The relay would issue the corresponding breaker failure signal.

F650 elements incorporate 2 levels of current and time, together with a trip without current element, and an internal arc detection element.

The breaker failure Initiate signal is configured at ***Setpoint > Relay Configuration > Protection Elements***. In the BRK FAILURE INITIATE input, the user must select the desired signal for the breaker failure initiation.

The following table describes the breaker failure element settings: ***Setpoint > Control Elements > Breaker Failure***

Table 5-78: 50BF element settings

Setpoint > Control Elements > Breaker Failure				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Supervision (retrip) pickup level	Supervision Pickup	1.00	0.01 A	[0.05 : 160.00]
Hiset pickup level	Hiset Pickup	5.00	0.01 A	[0.05 : 160.00]
Lowset pickup level	Lowset Pickup	2.00	0.01 A	[0.05 : 160.00]
Internal arc pickup level	Internal Arc Pickup	0.10	0.01 A	[0.05 : 160.00]
Internal arc time delay	Internal Arc Delay	10.00	0.01 s	[0.00 : 900.00]
Retrip time delay	Supervision Delay	10.00	0.01 s	[0.00 : 900.00]
Hiset time delay	HiSet Delay	10.00	0.01 s	[0.00 : 900.00]
Lowset time delay	LowSet Delay	10.00	0.01 s	[0.00 : 900.00]
Second stage time delay	2nd Step Delay	10.00	0.01 s	[0.00 : 900.00]
WITHOUT current element time delay	No Current Delay	10.00	0.01 s	[0.00 : 900.00]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Settings description for breaker failure element:

Function permission (Function): This setting allows enabling and disabling the 50BF element

Supervision or retrip pickup level (Supervision Pickup): Supervision level pickup current threshold

Hiset pickup level (Hiset Pickup): High-level pickup current threshold.

Lowset pickup level (Loset Pickup): Low level pickup current threshold.

Internal arc pickup level (Internal Arc Pickup): Internal arc element pickup current threshold.

Internal arc time delay (Internal Arc Delay): Time delay applied to the internal arc element

Supervision or Retrip time delay (Supervision Delay): Time delay applied to the supervision or retrip element.

High-level time delay (Hiset Delay): Time delay applied to the high level element.

Low-level time delay (Loset Delay): Time delay applied to the low level element.

2nd step time delay (2nd Step Delay): Time delay applied to the breaker failure second step.

No current element time delay (No Current Delay): Time delay applied to the trip without current element.

Signals relative to breaker failure provided by the relay can be viewed at ***Actual> Status > Control Elements > Breaker Failure***, and they are as follows:

Table 5-79: Breaker failure status

BREAKER FAILURE STATUS
BKR FAIL INITIATE
BKR FAIL NO CURRENT
BKR FAIL SUPERVISION
BKR FAIL HISET
BKR FAIL LOWSET
INTERNAL ARC
BKR FAIL 2nd STEP

BKR FAIL INITIATE External signal for breaker failure initiation. (Configurable at ***settings> Relay Configuration > Protection Elements***).

BKR FAIL NO CURRENT Signal for breaker failure without current

BKR FAIL SUPERVISION Signal for supervision level breaker failure (retrip)

BKR FAIL HISET Signal for high-level breaker failure

BKR FAIL LOWSET Signal for low-level breaker failure

INTERNAL ARC Signal for internal arc

BKR FAIL 2nd STEP Signal for Second level breaker failure (high and low)

The following figure shows the logic scheme for the breaker failure element:

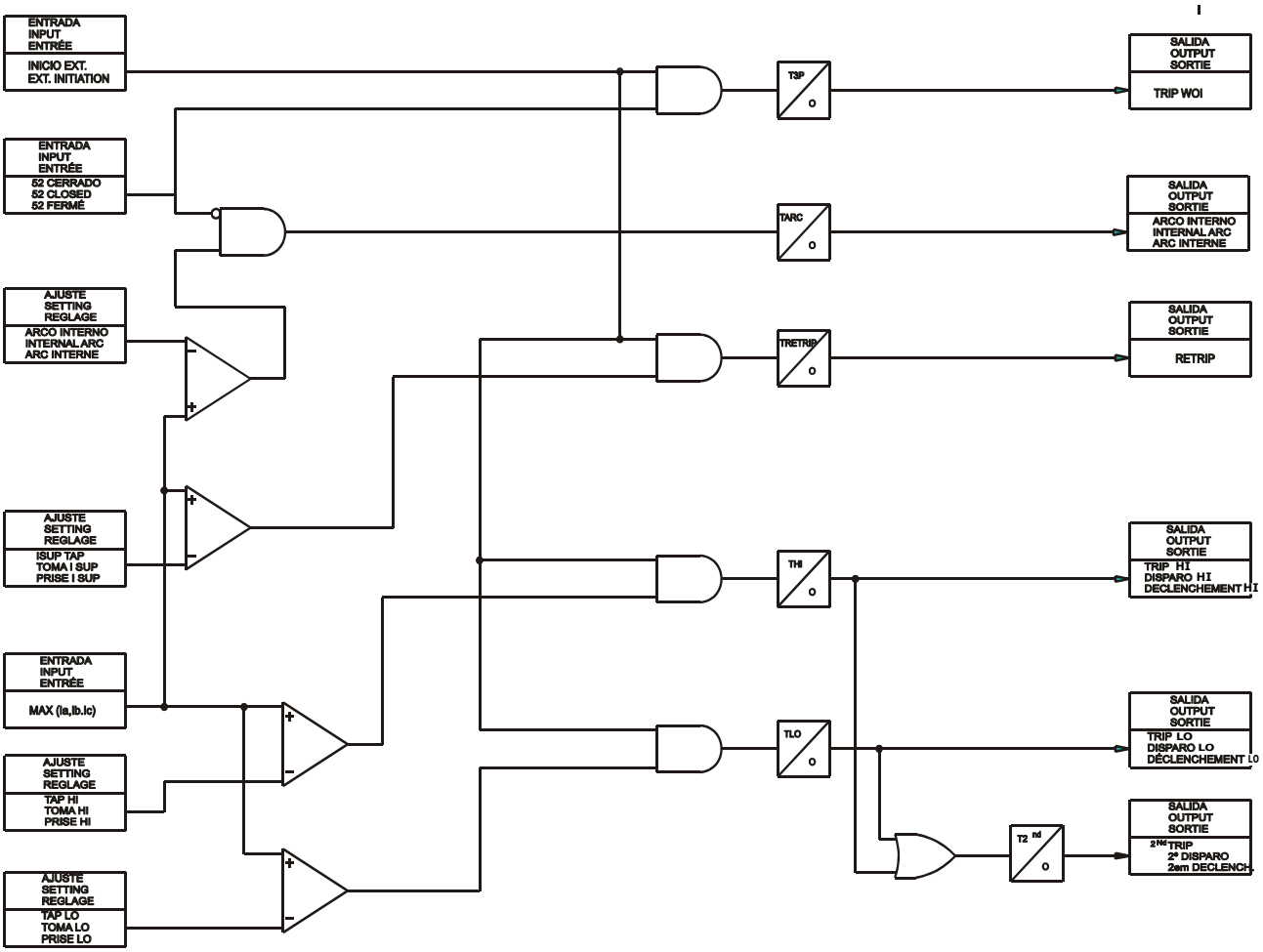


Figure 5-30: Logic scheme for 50BF

The breaker failure element has three levels. The first one is called “Retrip” or “Supervision”. This operation level can be used to give a signal to the breaker on which the initial opening has been executed. This is sometimes a usual practice; 50 milliseconds after the trip signal, a retrip signal is sent to the breaker.

Besides the supervision or retrip level, there are two additional levels, known as “Hiset” and “Lowset”. These two levels, together with their time delays, allow executing complex protection schemes. Additionally to these two supervision levels, there is a second time stage called “second step”.

Operation of breaker failure elements by level (supervision, hi set and lo set) is produced when the current level is higher than the set current for the pickup of each level during the time set in the corresponding delay setting.

High and low levels constitute a second step level; for the pickup of this second level, only the pickup of any of the two levels (hiset and loset) is required. For the element pickup to dropout it is required that the current is under the pickup levels of both hiset and loset settings. Once the second level time delay has expired, a “Second Step” trip signal is issued.

50BF element incorporates also a no current tripping element, and an internal arc element. The no-current trip element is governed only by the status of the breaker auxiliary contact; once the external breaker failure initiation signal is received, if the breaker status does not change to open during the set time in the element (No Current Delay), the corresponding breaker failure signal is issued (BKR FAIL NO CURRENT),

The internal arc element inside the breaker failure element is independent from the external breaker failure signal; this element is used to detect arcing produced with an open breaker; if a higher current that the set level is detected during a period that is longer than the set delay for the element (Internal Arc Delay), and the breaker is open, the corresponding internal arc signal is issued (INTERNAL ARC).

5.5.5 VT fuse failure element (VTFF)

Note: The Switchgear element used in the **VT Fuse Failure** element is the one configured in the **Number of Switchgear** setting, inside **Breaker settings** at **Setpoint > Protection Element > Setting Group X > Breaker > Breaker Settings.** This switchgear must have previously been configured at **Setpoint > Relay Configuration > Switchgear**

The fuse failure detector is used to block protection elements that can operate incorrectly due to a partial or total voltage loss. This loss can be caused by the voltage transformers secondary circuit protection fuse failure.

Setpoint > Control Elements > VT Fuse Failure				
setting Description	Name	Default Value	Step	Range
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

The fuse failure element has only two settings, one to enable or disable the element and the other to enable or disable the snapshot event generation.

The fuse failure signal provided by the element (VT FUSE FAILURE) can be monitored at **Actual> Status > Control Elements >VT Fuse Failure**

5.5.5.1 Fuse failure algorithm

To detect different types of fuses failures, it is necessary to use different detection methods. In example, a fuse failure indication with loss of one or two voltage phases provides a significant level of negative sequence voltage, instead of a loss of all voltage phases which causes a very low positive sequence voltage, but any negative sequence voltage.

F650 elements detect fuse failure under three possible situations:

(1)Breaker closed and positive sequence voltage (V1) under an established value (V1<0.5 p.u.).

(2)Positive sequence voltage lower than 0.5 p.u (V1<0.5 p.u.) and positive sequence current higher than 0.075 p.u. (I1>0.075 p.u.).

(3)Ratio between the negative and positive voltage components (V2/V1) higher than 0.25.

With the activation of any of the three previous signals during a period longer than 80 ms, the fuse failure signal (VT FUSE FAILURE) is activated. Once this signal is activated, it is latched until whatever caused it disappears; for this purpose the following condition must be met:

(4)Positive sequence voltage higher than 0.75 p.u and positive sequence current lower than 0.05 p.u.

The fuse failure signal can be used to issue an alarm and/or to block elements that may operate incorrectly due to a partial or total loss of voltage. Protection elements that are usually blocked by the fuse failure signal are voltage restraint overcurrent elements, and directional elements. To configure the block of these elements it is necessary to enter the ***Setpoint > Relay Configuration > Protection Elements***" menu and select as block input for protection elements, the fuse failure operation signal.

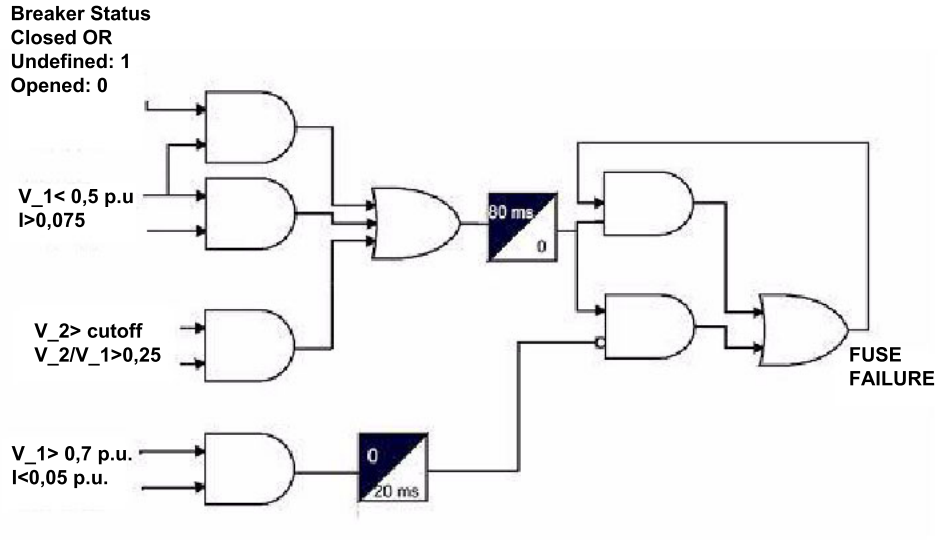


Figure 5-31: Fuse failure element block diagram

5.5.6 Pulse counters

The F650 includes eight pulse counters, each pulse counter stores the activation number to that pulse counter. This value can be multiplied for a factor selectable by setting.

The inputs used in this pulse counter function can be selected from all the available in the F650 device. Take into account that the input/output settings are both set for the generic input as well as for the pulse counter input, e.g. Debounce time.

SETPOINT > CONTROL ELEMENTS > PULSE COUNTERS				
Setting Description	Name	Default Value	Step	Range
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]
Name of the pulse counter	CntPulses Name X	Pulse Counter X	N/A	N/A
Multiplier factor for the pulse counter	CntPulses Factor X	1.000	0.001	[0.000 : 65000.000]
Overflow value for the pulse counter	CntPulses Overflow X	65535	1	[0 : 1000000]
Board selection for the pulse counter	CntPulses Board Origin X	F	N/A	[F,G,H,I]
Input index inside the selected board	CntPulses Input Origin X	1	1	[1 : 32]
Note: X is the pulse counter index, up to 8.				

Pulse Counters settings are:

CntPulses Enabled: Enable/disable each pulse counter.

CntPulses Name: Each pulse counter can have a configurable user name.

CntPulses Factor: This is the factor multiplier applied to the input activations number stored in the pulse counter, providing possibilities to adjust the obtained value to any scale. It the "CntPulses Factor X" is set to zero it takes no effect.

CntPulses Overflow: It is the maximum value set as result of the CntPulses Factor plus the number of inputs activation. This means that after reaching that value, the pulse counter value starts counting from zero.

CntPulses Board Origin: Board selection for the pulse counter input.

CntPulses Input Origin: Index of the input select in the board origin.

The signals related to the 8 pulse counters can be viewed at **Actual> Status > Control Elements > Pulse Counters** and they are as follows:

Table 5-80: Pulse counters status

PULSE COUNTERS STATUS
CntPulses Value 1
CntPulses Value 2
CntPulses Value 3
CntPulses Value 4
CntPulses Value 5
CntPulses Value 6
CntPulses Value 7
CntPulses Value 8
CntPulses Freeze 1
CntPulses Freeze 2
CntPulses Freeze 3
CntPulses Freeze 4
CntPulses Freeze 5
CntPulses Freeze 6
CntPulses Freeze 7
CntPulses Freeze 8

The F650 includes eight different pulse counters in which the value shown is the result of the number of activation of the input configured for that counter multiplied plus the CntPulses Factor set for that pulse. For each pulse counter there are two magnitudes available, the actual value and the frozen value.

The freeze and unfreeze and reset operations are similar to the energy management, the signals used for that purpose are the same for both energy and pulse counters.

By default, all the values are unfreeze, updating the values in a continuous mode. After a freeze operation the freeze value stops updating and the actual value is being updated. If a freeze operation is set again, the actual value is copied to the freeze one, which remains frozen again.

To unfreeze all the values it is necessary to perform an unfreeze operation.

If a reset operation is set, all the values, actual and frozen ones goes to zero.

All the operations (freeze, unfreeze and reset) are performed over all the energy counters (both energy and pulse counters). It is not possible to set them to a particular counter.

5.5.7 Analog comparators

The F650 provides 20 different analog comparators in an analog comparator module located in the control elements part of the device. Each analog comparator gives indication when the analog variable selected is inside or outside some minimum and maximum threshold values.

SETPOINT > CONTROL ELEMENTS > ANALOG COMPARATORS				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Generic Analog Function Permission	Analog Function	DISABLED	N/A	[DISABLED – ENABLED]
Generic Snapshot Events Generation	Analog Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]
Analog Input Value Selection	Analog Input X	None	N/A	[All available analog values]
Analog Maximum Threshold Value	Analog Maximum X	1.000	0.001	[-100000.000 : 100000.000]
Analog Minimum Threshold Value	Analog Minimum X	1.000	0.001	[-100000.000 : 100000.000]
Analog Delay for Activation Signal	Analog Delay X	0.00	0.01 s	[0.00 : 900.00]
Analog Hysteresis for the Deadband	Analog Hysteresis X	1.0	0.1	[0.0 : 50.0]
Analog Direction for Activation Inside or Outside the Deadband	Analog Direction X	Out	N/A	[IN-OUT]
Note: X is the analog comparator index, up to 20				

The analog comparator settings includes two global settings such as

Analog Function: This setting allows enabling or disabling the analog comparators module. Each analog comparator can not be enabled/disabled individually.

Analog Snapshot Events: The snapshot event setting enables or disables the snapshot event generation for this element.

Besides the main settings there are some settings for each analog comparator (up to 20) as follows:

Analog Input: Analog value selected by the user from the available analog variables in the device. This is used to make the comparison inside a set band for that magnitude.

Analog Maximum: Maximum threshold value for the comparison band.

Analog Minimum: Minimum threshold value for the comparison band.

Analog Delay: Time value for the analog signal to be active inside the comparison band before setting the Analog Level signal to 1.

Analog Hysteresis: It establishes the deadband at each extreme when going out of operation band.

Direction IN: min value = min - hysteresis (in %)
max value = max + hysteresis (in %)

Direction OUT: min value = min + hysteresis (in %)
max value = max - hysteresis (in %)

Analog Direction: Analog direction for the activation signal to be set Inside or Outside the Deadband.

OUT: The "Analog Level X" gives an activation signal when the analog value is located outside the comparison band.

IN: The "Analog Level X" gives an activation signal when the analog value is located inside the comparison band.

The F650 provides 20 different analog comparators. Their status values can be viewed at ***Actual> Status > Control Elements > Analog Comparators:***

Table 5-81: Analog comparator status

ANALOG COMPARATORS STATUS
Analog Level 01
Analog Level 02
Analog Level 03
Analog Level 04
Analog Level 05
Analog Level 06
Analog Level 07
Analog Level 08
Analog Level 09
Analog Level 10
Analog Level 11
Analog Level 12
Analog Level 13
Analog Level 14
Analog Level 15
Analog Level 16
Analog Level 17
Analog Level 18
Analog Level 19
Analog Level 20

The analog level value is by default in a reset state, when the value meets the comparison (inside or outside the comparison band) the "Analog Level X" signal is activated if the analog value remains active the time set in the analog delay setting. When the activation conditions are not met the "Analog Level X" value goes to the reset state.

An analog change must remain active at least 40 ms to be considered, plus the analog time setting. Besides the snapshot event data has a 20 ms accuracy.

5.5.8 Maximum number of starts (66)

technical characteristics	
Metering algorithm	Fundamental
Tripping time accuracy	±250 ms or 5% whichever is greater
Full load Amps	0.5 to 10.0 A in steps of 0.1
Breaker supervision	Selectable by settings
Min. Stop time	0.0 to 900.0s in steps of 0.1
Number of starts	0 to 10 in steps of 1
Time to restart	0 to 100 minutes in steps of 1
Reset Counter	Selectable by settings
Snapshot events	Selectable by settings
Operate time	<45ms at 50Hz, typically

For F650 with firmware version below 7.XX, the special model F650 MOD003 relay incorporates a maximum number of starts function (66) to prevent operators from jogging the motor (multiple starts and stops performed in rapid succession). For F650 with firmware version 7.XX this element is included in standard models (No special model (MOD) is required)

A motor start is assumed to be occurring when the F650 measures the transition of the motor current from below 5% of FLA to some value above 7% of FLA. Breaker status can also be used to detect motor starts. At this point, one of the Starts/Hour timers is loaded with 60 minutes. Even unsuccessful start attempts are logged as starts for this feature. Once the motor is stopped, the number of starts within the past hour is compared to the number of starts allowable. If the two numbers are the same, a block occurs. If a block occurs, the lockout time is equal to the longest time elapsed since a start within the past hour, subtracted from one hour.

The time to Restart feature may be used to ensure that a certain amount of time passes between stopping a motor and restarting that motor. This timer feature may be very useful for some process applications or motor considerations. If a motor is on a down-hole pump, after the motor stops, the liquid may fall back down the pipe and spin the rotor backwards. It would be very undesirable to start the motor at this time. In another scenario, a motor may be driving a very high inertia load. Once the supply to the motor is disconnected, the rotor may continue to turn for a long period of time as it decelerates. The motor has now become a generator and applying supply voltage out of phase may result in catastrophic failure.

The Restart Block feature is strictly a timer. The F650 does not sense rotor rotation.

SETPOINT > CONTROL ELEMENTS > MAX. NUMBERS OF STARTS				
Setting Description	Name	Default Value	Step	Range
Function Permission	Function	DISABLED	N/A	[DISABLED- ENABLED]
Motor Full Load Current	Full Load Amps	5.0	0.1 A	[0.5: 10.0]
Stop condition supervised by breaker	Breaker Supervision	DISABLED	N/A	[DISABLED- ENABLED]
	Min. Stop Time	0.0	0.1s	[0.0: 900.0]
Number of Starts per tour	Number of Starts	5	1	[0: 100]
Reset counter setting	Reset Counter	DISABLED	N/A	[DISABLED- ENABLED]
Snapshot Event Generation	Snapshot Events	ENABLED	N/A	[DISABLED- ENABLED]
NOTE 1: A zero value in the number of starts disables the unit				
NOTE 2: The reset counter setting can be enabled to set the motor starting count to zero				

Maximum number of starts settings description:

Function: This setting allows enabling or disabling the Maximum numbers of starts function.

Full Load Amps.: This setting must be set with the current at full load of the motor in running conditions.

Breaker Supervision: This setting specifies if the element must consider the motor is stopped when the unit detects that the breaker is open. If the Breaker supervision is DISABLED, the motor is considered to be stopped when the average current of the three phases is below 5% of the value set for “Full Load Amps” during at least the period of time programmed in “Min Stop time”. A motor start-up is detected when, being the motor stopped (according to the above consideration), the average current of three phases rises above 7% of FLA. If the Breaker supervision is ENABLED, the motor is considered to be stopped when the unit detects that the breaker is open. A motor start-up is detected when the breaker is closed.

Min Stop Time: As has been related before, this setting must be configured with the time that this units has to detect the average current below 5%of FLA, before considering that the motor is stopped.

Number of starts: Once the motor is stopped, the number of starts within the past hour is compared to the number of starts allowable. If the two values are the same, an inhibit occurs. If an inhibit occurs, the lockout time is equal to one hour less the first start time stored. A zero value in this setting disables this unit. The global counter of Number of starts increases at each start of the motor detected but no action is taken.

Time to Restart: This setting may be used to ensure that a certain amount of time passes between stopping a motor and restarting that motor.

Reset Counter: This settings is always DISABLED by default. When this setting is change or ENABLED the global counters of starts is set to a zero value. It operates like a command to reset the starts counters, after being enabled it goes to its default disabled status.

Snapshot events: The snapshot event setting enables or disables the snapshot event generation for this element.

This unit operates only if the motor is stopped, in order to avoid a new start. The unit never operate while the motor is running.

The maximum number of starts actual values can be viewed at **Actual > Status > Control Elements >Max. Number of Starts:**

MAXIMUM NUMBER OF STARTS STATUS
NUMBER OF STARTS OP
GLOBAL STARTS CNT
BLOCK LOCKOUT TIME

The block signals for the frequency rate of change element can be viewed at: **Actual > Status > Protection > Protection Blocks:**

MAXIMUM NUMBER OF STARTS BLOCKS
BLOCK NUM OF STARTS

Maximum number of starts actual values description:

Number of starts operate: Reading state. This state is activated when maximum number of starts has been reached within one hour or when the time to restart setting has been programmed.

Global Starts Counter: Reading state. Provides the number of starts of the motor detected by the unit. This value can be reset by means of “Reset counter” setting. This counter is increased when the motor goes from motor stopped to motor started. When the “NUMBER OF STARTS OP” is activated indicating a excessive number of starts, changes in the breaker or average current above 7% do not increase this counter.

Starts Hour Block Lockout Time: Reading state. If the unit is enabled, this state shows the lockout time in minutes until a new start of the motor is enabled by this element. If maximum number of starts are below “Number of starts” setting, this state shows 0 min indicating that there is not lockout time.

Block number of starts: Writing state. When this state is set the unit is blocked, meaning that the Lockout time and the number of starts counted within last hour are reset to a zero value allowing starting operations in the motor. The “Number of starts counter” continues with the last value and does not reset because of blocking the unit.

Note: All the counters are stored in a RAM memory, therefore when the relay is powered off and powered, on all timers and counters are set to a zero value.

5.5.9 Digital counters

Digital Counters are functions to count discrete bit logic value changes, for example, it is able to count the number of pickups of a protection element, the number of breaker openings or the contact inputs state changes.

There are 8 identical digital counters and they count the number of state transitions from Logic 0 to Logic 1, of the logic states configured by the user, that trigger the increment or decrement commands of the digital counter value.

Settings

SETPOINT> CONTROL ELEMENTS >DIGITAL COUNTERS				
Setting Description	Name	Default Value	Step	Range
Digital counter enabling setting	DigCnt Function X	DISABLED	N/A	[DISABLED – ENABLED]
Name of the digital counter	DigCnt Name X	Digital Counter X	N/A	N/A

Initial Digital counter value	DigCnt Preset X	0.00	0	[-2,147,483,648 : 2,147,483,647]:
Compare Digital counter value	DigCnt Compare X	0.00	0	[-2,147,483,648 : 2,147,483,647]:
Note: X is the pulse counter index, up to 8.				

For each of the 8 digital counters, there exist independent and identical groups of settings:

DigCnt X Function: This setting allow to Enables or disables the specified counter. If a counter's DigCnt X Function is set to Disabled, then the DIGCNT X HI, DIGCNT X EQ and DIGCNT X LO are set to OFF and the DIGCNT X VALUE, DIGCNT X FROZENVALUE and DIGCNT X FROZENDATE are set unaltered.

DigCnt X Name: Sets a name to identify the specified counter. Note that the name length is cut down to only 12 characters long.

DigCnt X Preset: Indicates the preset value that the specified counter can be set before counting operations begin or after a reset command is accomplished.

DigCnt X Compare: Indicates the comparison value that the specified counter current value is compared to and several logic bits (HI, EQ and LO) are updated accordingly.

Snapshot Events: This is a global setting that affects all of 8 digital counters. Enables or disables the snapshot events for this function. Note that all enabled digital counters are affected by this setting.

Relay configuration

To the correct operation of each counter, there are several PLC status variables in EnerVista 650 Setup at **Setpoint> Relay Configuration>Control Elements** section that should be configured properly. Each one of the 8 digital counters has its own PLC statuses and they are identical:

SETPOINT> RELAY CONFIGURATION >CONTROL ELEMENTS	
Setting Description	**Name**
Digital counter block	DigCnt X Block
Digital counter UP	DigCnt X UP
Digital counter DOWN	DigCnt X DOWN
Digital counter SETPRESET	DigCnt X SetPreset
Digital counter RESET	DigCnt X Reset
Digital counter FREEZERESET	DigCnt X FreezeReset
Digital counter FREEZECOUNT	DigCnt X FreezeCount
Note: X is the pulse counter index, up to 8.	

DIGCNT X BLOCK: Blocks the functionality of the specified counter. If a counter's DIGCNT X BLOCK is set to 1, all the counter's values remain unaltered and no counter commands are processed. When the counter's DigCnt X Function is set to Enabled and the DIGCNT **X** BLOCK is set to 0, then the counter starts running and accepting counter commands.

DIGCNT X UP: Counter command. When this element changes from 0 to 1, the value of the specified counter is incremented by 1. If the current counter value is 2,147,483,647 and is incremented, the updated value is set to -2,147,483,648.

DIGCNT X DOWN: Counter command. When this element changes from 0 to 1, the value of the specified counter is decremented by 1. If the current counter value is -2,147,483,648 and is decremented, the updated value is set to 2,147,483,647.

DIGCNT X SETPRESET: Counter command. This element defines the behavior of the specified counter's Reset and the Freeze/Reset commands or when counter is set from Disabled to Enabled:

- If set to 0, all commands with a Reset involved or when counter is Enabled set the initial counter value to 0
- If set to 1, all commands with a Reset involved or when counter is Enabled set the initial counter value to the one specified in the setting DigCnt # Preset.

DIGCNT X RESET: Counter command. It sends a Reset command to the specified counter.

DIGCNT X FREEZERESET: Counter command. It copies the current counter value to the DIGCNT X FROZENVALUE actual value and the current date to the DIGCNT X FROZENDATE actual value. Then a Reset command is sent to the specified counter.

DIGCNT X FREEZECOUNT: Counter command. It copies the current counter value to the DIGCNT X FROZENVALUE actual value and the current date to the DIGCNT X FROZENDATE actual value. Then the specified counter value DIGCNT X VALUE is set to 0 or to the DigCnt X Preset setting value.

Periodically the counter current Value and Frozen Value and Date are saved to non-volatile memory to keep them safe from an unexpected energy loss.

Note: Digital Counters only appear in the Actual Values menu option in HMI, in the Control Elements level.

5.5.10 Cold load pickup

The F650 can be programmed to detect a Cold Load condition and generate a signal which can be configured to block protection elements.

Under normal operating conditions, the actual load on a feeder is less than the maximum connected load, since not all consumers require maximum load at the same time. A Cold Load condition can be caused by a prolonged outage of the load or by opening of the circuit breaker. Upon the return of the source, the circuit experiences inrush current into connected transformers, accelerating currents into motors, and simultaneous demand from many other loads because the normal load diversity has been lost.

The relay detects Cold Load condition (Cold Load Pickup OP) when the breaker remains opened for a period of time greater than the **Outage Time Before Cold Load** setting.

Once the breaker is closed, Cold Load Pickup OP is maintained asserted for the time programmed in **Cold Load Pickup Block.** This signal can be used as a source for blocking the protection elements to be inhibited during the Cold Load.

Specifications – Control

COLD LOAD PICKUP	
Operating Parameters:	Breaker opened (from AV)
Outage time before cold load:	1 -1000 in steps of 1min
Cold Load Blocking time:	1-1000 in steps of 1s

SETPOINT > CONTROL ELEMENTS > COLD LOAD PICKUP				
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]
Outage Time before ColdLoad	Outage Time before ColdLoad	20 min	1 min	[1-1000]

SETPOINT > CONTROL ELEMENTS > COLD LOAD PICKUP				
ColdLoad Blocking Time	ColdLoad Blocking Time	5 s	1 s	[1-1000]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

Setting description for Cold Load Pickup:

Function permission (Function): This setting allows enabling and disabling the Cold Load Pickup element.

Outage Time before ColdLoad: Time that the breaker must remain opened in order to detect Cold Load condition.

ColdLoad Blocking Time: Time that the Cold Load condition is maintained after the breaker has been closed.

Snapshot event generation: Enables or disables the snapshot event generation for this element.

5.5.11 60 CTS failure

For firmware 7.50 or above, the F650 incorporates, one CT failure element which can be used to detect if any of the current transformers experience abnormal conditions resulting in phase lost.

Phase lost, caused by a current transformer (CT) failure, or CT secondary wiring can lead to undesired operation by some of the enabled protection elements. The most affected protection would be the differential protection - main transformer percent differential, and the restricted ground fault, as well as some overcurrent protection such as the neutral and negative sequence instantaneous, and timed over-current elements.

SETPOINTS > CONTROL ELEMENTS > CURRENT TRANSFORMER FAILURE				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function Permission	Function Permission	DISABLED	N/A	[DISABLED – ENABLED]
Neutral Current PKP	3I0 Current PKP	0.10	0.01	[0.05- 10.00]
Neutral Voltage Inhibit	3V0 Voltage Inhibit	20.0	0.1	[0.0-240.0]
GND Current Inhibit	GND Current Inhibit	0.05	0.01	[0.05-10.00]
SGND Current Inhibit	SGND Current Inhibit	0.005	0.001	[0.005-1.000]
Time Delay	Time Delay	0.00	0.01	[0.00 -600.00]
Snapshot events	Snapshot events	DISABLED	N/A	ENABLED/DISABLED

Function This setting allows enabling and disabling the CTS function.

3I0 Current PKP*:* This setting defines the level of neutral current, above which CT failure would pick up. Refer to the CT Failure logic diagram for more detail.

3V0 Voltage Inhibit This setting defines the level of neutral voltage (3V0) above which the CT failure detection is inhibited.

GND Current Inhibit *This* setting defines the level of ground current above which CT failure detection is inhibited.

SGND Current Inhibit This setting defines the level of sensitive ground current above which CT failure detection is inhibited.

TIME DELAY This setting defines the time for CT failure to operate.

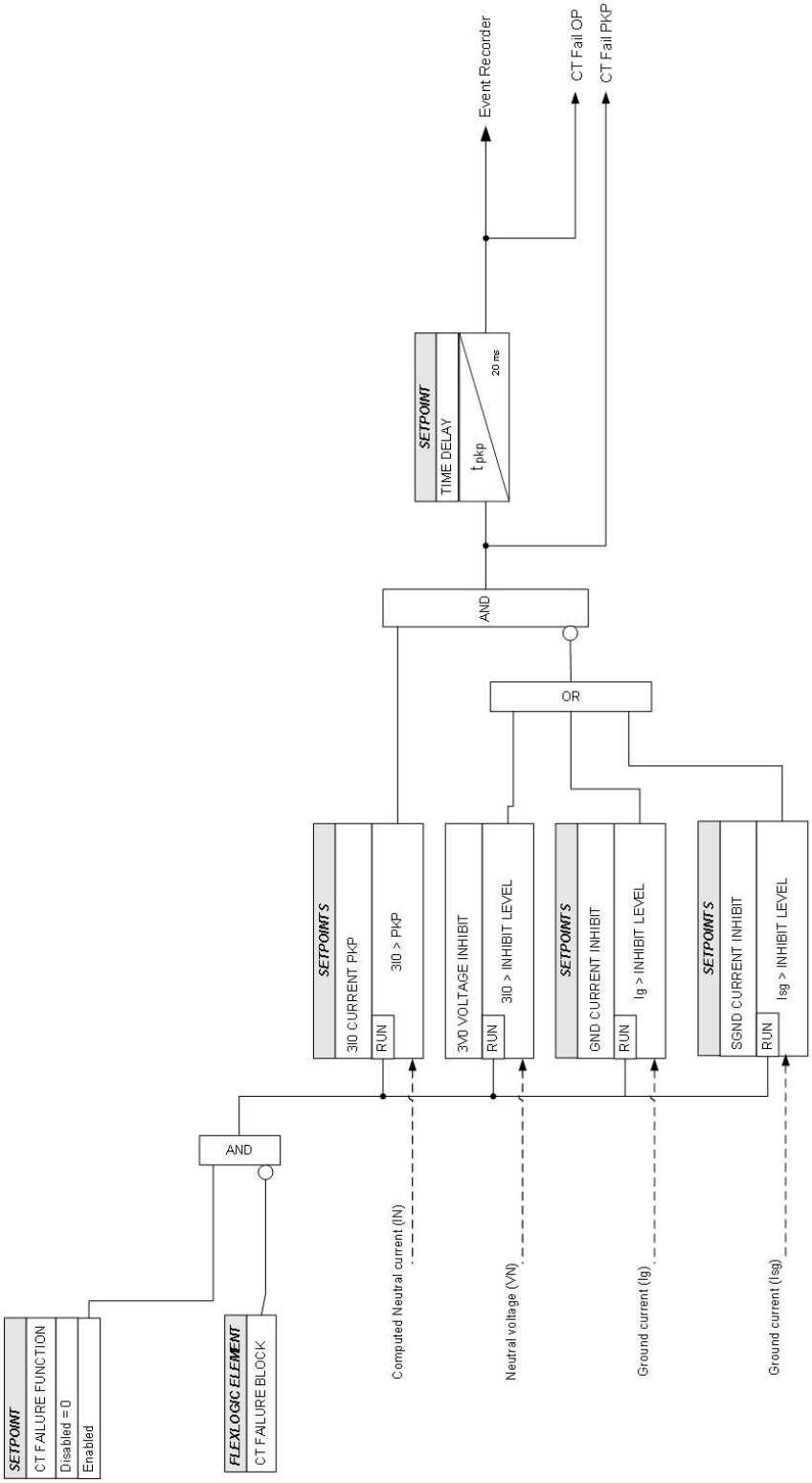


Figure 5-32: Logic scheme for 60 CTS failure function

Care must be taken when configuring the delay for an IOC or TOC element that is being supervised by CT Supervision Failure function. The delay time in the IOC function should be set to a value 10 ms greater than CT Supervision Failure delay timer

5.5.12 Second harmonic inhibit

For firmware 7.50 or above, the F650 incorporates one Second Harmonic Inhibit element which can be used to block sensitive elements when particular level of inrush currents is detected in phase currents.

During transformer energization, the inrush current presenting in phase currents may impact some sensitive elements, such as neutral directional overcurrent. Therefore, the ratio of the second harmonic to the fundamental magnitude per phase is monitored, while exceeding the settable pickup level, an inhibit signal is asserted, which can be used to block such sensitive elements. In order to get proper functionality, 2nd Harmonic Inhibit delay must be minor than delay of IOC or TOC element that is being supervised by 2nd Harmonic inhibit function.

Second harmonic function settings are available in EnerVista 650 setup at **Setpoint > Control Elements > 2nd HRMC Inhibit**

SETPOINTS > CONTROL ELEMENTS > 2nd HRMC Inhibit				
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE
Function	Function	DISABLED	N/A	[DISABLED – ENABLED]
Second harmonic pickup	2ND HRMC PICKUP	1	1%	[1- 40.00]
Second harmonic delay	2ND HRMC DELAY	0.00	0.1s	[0.00-600.00]
Minimum secondary current to operate	MINIMUM. CURRENT	0.05	0.01A	[0.05-15.00]
Phase affected to operate	PHASES FOR OPERATION	ANY ONE	N/A	[ANY ONE- ANY TWO- ALL THREE-AVERAGE]
Snapshot events	Snapshot events	DISABLED	N/A	[DISABLED – ENABLED]

Function This setting allows enabling and disabling the 2nd Harmonic Inhibit function.

2nd HRMC PICKUP This setting sets the Phase Current 2nd Harmonic value required to allow the Second Harmonic Inhibit element to pick up.

2nd HRMC DELAY This setting specifies the pickup time delay for this function to operate after pickup. Note that

MINIMUM CURRENT Sets the minimum value of fundamental secondary current required to allow the Second Harmonic Inhibit element to operate.
If Phase for Operation is set to AVERAGE, the average of three-phase currents is used for supervision. The similar adaptive average algorithm is applied to calculate the average of operation current magnitude.

PHASES FOR OPERATION This setting defines the phases required for operation, and the detail is explained below:

- ANY ONE: At least one phase picked up.
- ANY TWO: Two or more phases picked up.
- ALL THREE: All three phases picked up.
- AVERAGE: The average of three-phase harmonics picked up.

If set to AVERAGE, the relay calculates the average level of the second harmonic and compares this level against the pickup setting. Averaging of the selected harmonic follows an adaptive algorithm depending on the fundamental current magnitude per-phase. Only phases where the fundamental current exceeds the cut-off level are included in the average.

Second harmonic Inhibit actual values are available in EnerVista 650 setup at Actual Values>Control Elements> 2nd HRMC Inhibit

Table 5-82: 2nd HRMC inhibit status

2nd HARMONIC STATUS	DESCRIPTION
2nd HARMONIC PKP	2nd Harmonic function has picked up
2nd HARMONIC OP	2nd Harmonic function has operated
2nd HARMONIC PHASE A	Shows % of 2nd harmonic in phase A
2nd HARMONIC PHASE B	Shows % of 2nd harmonic in phase B
2nd HARMONIC PHASE C	Shows % of 2nd harmonic in phase C

Blocks of 2nd harmonic inhibit can be configured in EnerVista 650 Setup at Setpoint> Relay Configuration> Protection Elements. The status of this signal can be viewed at: ***Actual> Status > Protection > Protection Blocks***.

The following picture shows the logic scheme for the 2nd Harmonic Inhibit function:

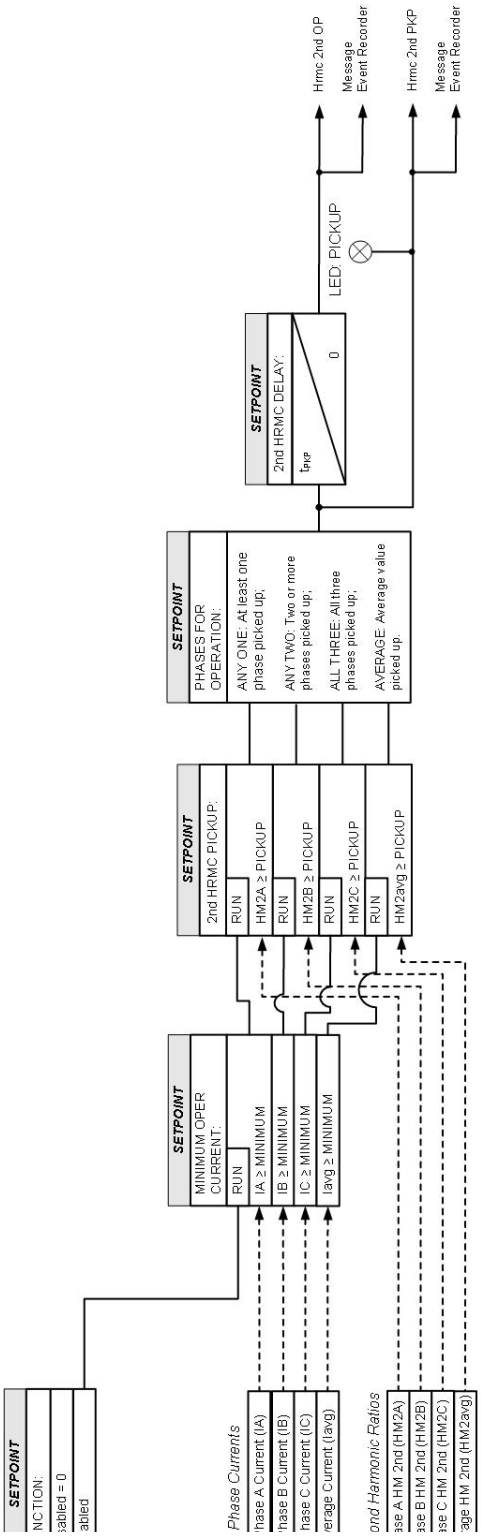


Figure 5-33: 2nd harmonic inhibit logic diagram

5.6 Inputs/outputs

5.6.1 Input/output placement

	MIXED	SUPERVISION	INPUTS	ANALOG
TERMINALS	1	2	4	5
1	CC1	COIL 1	CC1	CC1
2	CC2	52/a	CC2	CC2
3	CC3	COIL 1	CC3	CC3
4	CC4	52/b	CC4	CC4
5	CC5	CC1	CC5	CC5
6	CC6	CC2	CC6	CC6
7	CC7	CC3	CC7	CC7
8	CC8	CC4	CC8	CC8
9	COMMON 1/8	COMMON 1/4	COMMON 1/8	COMMON 1/8
10	COMMON 9/16	COMMON 5/8	COMMON 9/16	COMMON 9/16
11	CC9	CC5	CC9	CC9
12	CC10	CC6	CC10	CC10
13	CC11	CC7	CC11	CC11
14	CC12	CC8	CC12	CC12
15	CC13	COIL 2	CC13	CC13
16	CC14	52/a	CC14	CC14
17	CC15	COIL 2	CC15	CC15
18	CC16	52/b	CC16	CC16
19	O1	O1	CC17	SHIELD 1/4
20			CC18	AI 1
21		O2	CC19	
22	O2		CC20	AI 2
23		O3	CC21	
24			CC22	AI 3
25	O3	O4	CC23	
26			CC24	AI 4
27	O4	O5	COMMON 17/24	
28			COMMON 25/32	AI 5
29	O5	O6	CC25	
30			CC26	AI 6
31	O6	I SENS	CC27	
32		O7	CC28	AI 7
33	O7		CC29	
34		I SENS	CC30	AI 8
35	O8	O8	CC31	
36			CC32	SHIELD 5/8

Figure 5-34: Input/output location and type

5.6.2 Control settings for input/output

Configuration of settings relative to inputs and outputs can only be accessed through the EnerVista 650 Setup software, and not via the HMI. For this purpose, the user must access ***Setpoint > Inputs/Outputs > Contact I/O > Board X***, being X the corresponding I/O board.

settings relative to I/O boards are described in Table 5-83: I/O board settings

Table 5-83: I/O board settings

SETPOINT > INPUTS/OUTPUTS > CONTACT I/O >				
BOARD F > BOARD G > BOARD H > BOARD J				
Setting Description	Name	Default Value	Step	Range
I/O board type (available only for CIO modules)	I/O Board Type_**X**	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV, 32 INP 16 INP + 8 ANA]
Input activation voltage threshold Group A	Voltage Threshold A_**X**	80	1 V	[10 : 230]
Input activation voltage threshold Group B	Voltage Threshold B_**X**	80	1 V	[10 : 230]
Input activation voltage threshold Group C	Voltage Threshold C_**X**	80	1 V	[10 : 230]
Input activation voltage threshold Group D	Voltage Threshold D_**X**	80	1 V	[10 : 230]
Debounce time for Group A	Debounce Time A_**X**	15	1 ms	[1 : 50]
Debounce time for Group B	Debounce Time B_**X**	15	1 ms	[1 : 50]
Debounce time for Group C	Debounce Time C_**X**	15	1 ms	[1 : 50]
Debounce time for Group D	Debounce Time D_**X**	15	1 ms	[1 : 50]
Input type	Input Type_**X**_CC**Y** (CC**Y**)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]
Input signal time delay	Delay Input Time_**X**_CC**Y** (CC**Y**)	0	1 ms	[0 : 60000]
Output logic type	Output Logic_**X**_0**Z**	POSITIVE	N/A	[POSITIVE, NEGATIVE]
Output type	Output Type_**X**_0**Z**	NORMAL	N/A	[NORMAL, PULSE, LATCH]
Output pulse length	Pulse Output Time_**X**_0**Z**	10000	1 ms	[0 : 60000]
Analog Inputs Range	Range_**X**_0**Z**	NONE	N/A	[NONE, -1 to 0mA, 0 to 1 mA, -1 to 1 mA, 0 to 5 mA, 0 to 10 mA]
Minimum Value	Min_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]
Maximum Value	Max_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]

For versions previous to 7.00, the snapshot event setting enables or disables the snapshot event generation for this element. It is mandatory to enable this setting in order the input/output values to be refreshed in IEC61850 protocol.

Being:

X F, G, H or J, the I/O board name, depending on the Relay model.

F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module).

For the I/O board selection in the relay model, associated digits to each board type are as follows:

Table 5-84: I/O board type

Associated Digit	EnerVista 650 Setup Board Settings	Board Type
0	NONE	None
1	16 INP+ 8OUT	Mixed
2	8 INP +8 OUT +SUPV	Supervision
4	32 INP	32 digital inputs
5	16 INP + 8 ANA	8 Analog Inputs + 16 digital inputs

CC**Y** Is the name used for inputs in I/O boards

0**Z** Is the name used for the different outputs in I/O boards

5.6.3 Inputs

Input settings description

Input Activation Voltage Threshold: The range of this value goes from 20 to 230 volts. There is a single setting for all inputs in the same group (inputs sharing the same common). In mixed and supervision boards there are two groups of inputs, called A and B., in 32DI board there are four groups of 8 inputs each.

Debounce Time: This is the debounce time set for inputs (1 to 50 ms). The debounce time is the time window for input filtering. If an input suffers a change of level that lasts less than this set time, the change is not considered. There is a single setting for all inputs in the same group.

Input Type: Type of logic associated with the physical input. Possible settings are, positive and negative.

Positive and Negative settings correspond to signals that are activated or deactivated with the input level, considering the delay setting. Positive-edge, and Negative-edge settings correspond to signals that are activated with the change of the input signal; in this case, the Delay Input Time is not considered, only the Debounce Time; this edge signals are deactivated automatically after one PLC scan cycle. Figure 5-35: INPUT LOGIC TYPES shows the types of signals associated with the different input configuration types.

Delay Input Time: This is the delay applied to the input signal; the default value is zero, meaning no delay; the setting range is 0 to 60000 milliseconds (1 minute). This setting is used in slow switchgear applications.

This is not a grouped setting; there is a different setting for each input. It is important to distinguish between this ***delay input time*** and the ***debounce time*** used for filtering undesired transients in the input signal. The Debounce time is always added to the delay input time.

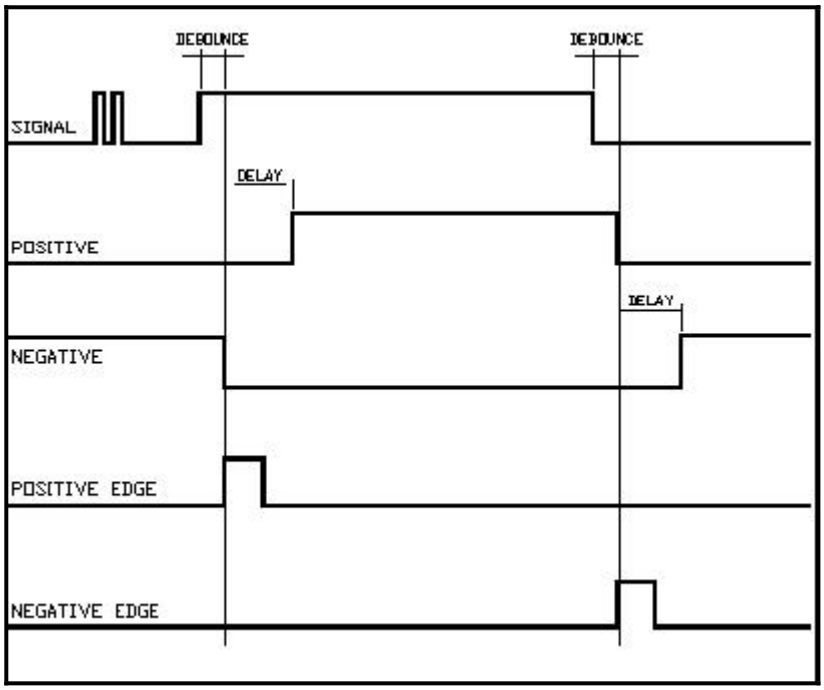


Figure 5-35: INPUT LOGIC TYPES

Input status signals

Actual > Inputs/Outputs > Contact inputs > Board X (being X the corresponding board in each case). Depending on the I/O board, inputs are represented as follows:

Table 5-85: Contact inputs status

Input Status (X: Board F, G, H, J)	Mixed And Analog Board (Types 1 And 5)	Supervision Board (Type 2)	32 di (Type 4)	
CONT IP_X_CC1	CC1	CC1	CC1	CC17
CONT IP_X_CC2	CC2	CC2	CC2	CC18
CONT IP_X_CC3	CC3	CC3	CC3	CC19
CONT IP_X_CC4	CC4	CC4	CC4	CC20
CONT IP_X_CC5	CC5	CC5	CC5	CC21
CONT IP_X_CC6	CC6	CC6	CC6	CC22
CONT IP_X_CC7	CC7	CC7	CC7	CC23
CONT IP_X_CC8	CC8	CC8	CC8	CC24
CONT IP_X_CC9	CC9	Va_COIL1	CC9	CC25
CONT IP_X_CC10	CC10	Vb_COIL1	CC10	CC26
CONT IP_X_CC11	CC11	Va_COIL2	CC11	CC27
CONT IP_X_CC12	CC12	Vb_COIL2	CC12	CC28
CONT IP_X_CC13	CC13	O7_SEAL	CC13	CC29
CONT IP_X_CC14	CC14	O8_SEAL	CC14	CC30
CONT IP_X_CC15	CC15	SUP_COIL1	CC15	CC31
CONT IP_X_CC16	CC16	SUP_COIL2	CC16	CC32

The operation logic for supervision signals (board type 2) is detailed in section 5.6.5 Circuit supervision and contact seal-in circuits in this manual.

5.6.4 Outputs

Output settings description

Output Logic_0X _0Z: Type of logic applied to outputs. Possible values are ***positive*** and ***negative***. The default value is positive. Depending on the type of setting selected, the physical output is in the same direction (positive) or opposite (negative) the output activation command.

Output Type_0X _0Z: Type of output adjusted. Possible values are ***normal***, ***pulse*** *or* ***latched***, the default value is ***Normal***.

Normal: The contact output follows the activation command. Remains active while the operation signal is active.

Pulse: The contact output is active the pulse output time, according to the ***Pulse Output Time*** setting.

Latched: The output remains active after the operation signal has been cleared. The reset signal for the latched outputs is configured at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***".

Pulse Output Time_0X _0Z: This is the length of the output pulse in case the output type is selected as ***pulse***; the default value is 10000 ms.

Figure 5-36: Output logic typesshows the types of signals associated with the different output configuration types.

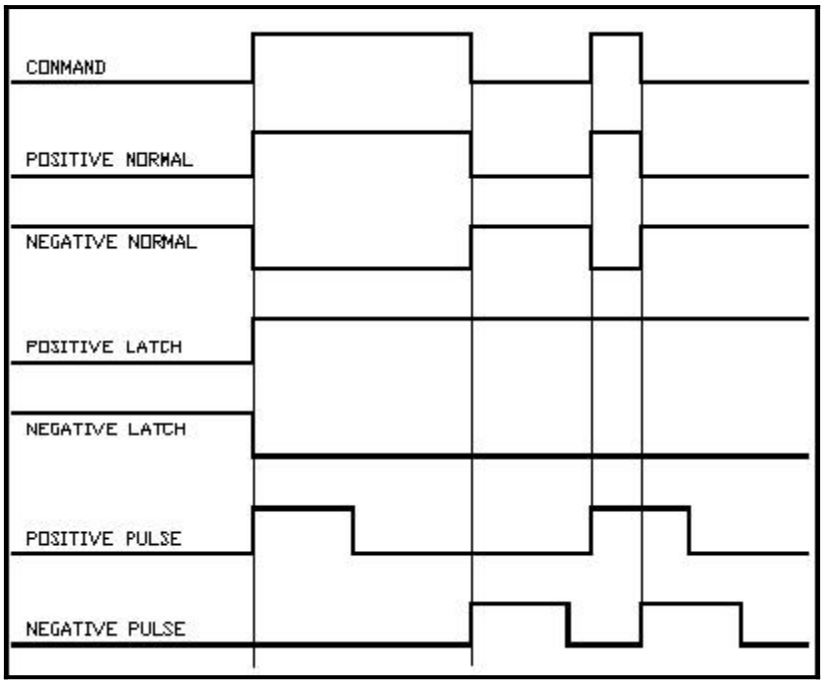


Figure 5-36: Output logic types

5.6.4.1 Output status signals

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in Table 5-86: Contact output signals

Actual > Inputs/Outputs >Contact Output Status

Real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in **Setpoint > Inputs/Outputs >Contact I/O > Board X**

Actual > Inputs/Outputs > Contact Output Operates

Activated or deactivated status of those variables used internally to operate a contact output.

Actual > Inputs/Outputs > Contact Output Resets

These are the logic signals associated with the contact output reset, which produce the reset of those signals previously configured as Latched. Configuration for the contact output reset signal is set at **Setpoint > Relay Configuration > Outputs > Contact Output Reset**.

Actual > Inputs/Outputs >I/O Board Status

These signals are associated with the different I/O boards. There are internal signals that provide information about the status of these boards, indicating whether there is any anomaly in the board, or whether the board is not available in the relay according to the relay model.

Table 5-86: Contact output signals

CONTACT OUTPUT STATUS	CONTACT OUTPUT OPERATES	CONTACT OUTPUT RESETS	IO BOARD STATUS
CONT OP_X_01	CONT OP OPER_X_01	CONT OP RESET_X_01	BOARD F STATUS
CONT OP_X_02	CONT OP OPER_X_02	CONT OP RESET_X_02	BOARD G STATUS
CONT OP_X_03	CONT OP OPER_X_03	CONT OP RESET_X_03	BOARD H STATUS
CONT OP_X_04	CONT OP OPER_X_04	CONT OP RESET_X_04	BOARD J STATUS
CONT OP_X_05	CONT OP OPER_X_05	CONT OP RESET_X_05	
CONT OP_X_06	CONT OP OPER_X_06	CONT OP RESET_X_06	
CONT OP_X_07	CONT OP OPER_X_07	CONT OP RESET_X_07	
CONT OP_X_08	CONT OP OPER_X_08	CONT OP RESET_X_08	

Being X the corresponding board in each case

5.6.5 Circuit supervision and contact seal-in circuits

Circuit Supervision:

F650 elements can include supervision boards (type 2), either in their internal slot F, or in an additional CIO module connected to the element via a CAN bus (slots H and J). This type of board includes 4 voltage detectors for implementing tripping or opening circuit supervision control logics.

Contact Seal-in:

The current seal-in circuit is used for verifying the current condition in a circuit during the time that the tripping contact remains closed. If the current in the tripping circuit is maintained over 500 mA, the function is sealed independently of the status of the function that caused the trip.

This current seal-in function in tripping circuits is mainly used in applications where auxiliary contacts 52/a (in charge of cutting the current in the tripping circuit) are very slow. This may cause that, once the function that produced the trip is reset, the relay contact opens before the breaker auxiliary 52/a, even if the time delay of the first has expired.

By using this function, we prevent the relay contact from cutting the current (basically inductive and high) from the tripping circuit, which can cause damage to the element, as these currents exceed the nominal breaking characteristics.

The circuit and the current threshold of the function are as follows:

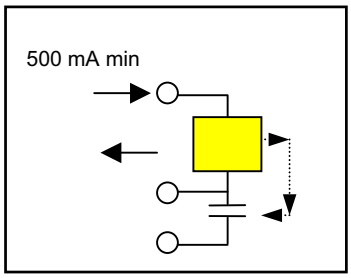


Figure 5-37: Current supervision

5.6.5.1 Digital inputs

5.6.5.2 With trip circuit supervision

The supervision board includes:

8 digital inputs in two groups of 4 inputs with one common, in terminals F9 to F10

8 auxiliary outputs: 6 normally open contacts in terminals F19 to F30 and two current sensing (latching) outputs (F31-F33 and F34-F36).

2 groups of inputs for trip circuit supervision with 4 voltage detectors. The first group includes two isolated digital inputs, terminals F1-F2 and F3-F4. The second group, symmetrical and identical to the first, is formed by isolated voltage inputs F15-F16 and F17-F18.

Using voltage detectors and current sensing, it is possible to implement several trip or close circuit supervision schemes, as well as protection of the element output contact.

In order to implement these schemes, it is not necessary to set any setting in the element. Internal functions are always operative and provide the following logic operands:

Table 5-87: Supervision logic operands

Actual > Inputs/Outputs > Contact inputs > Board X Being X the corresponding board in each case	
OPERAND	DESCRIPTION
CONT IP_X_CC9 (Va_COIL1)	Active when voltage is detected in terminals F1 - F2 (circuit 1)
CONT IP_X_CC10 (Vb_COIL1)	Active when voltage is detected in terminals F3 - F4 (circuit 1)
CONT IP_X_CC11 (Va_COIL2)	Active when voltage is detected in terminals F15 - F16 (circuit 2)
CONT IP_X_CC12 (Vb_COIL2)	Active when voltage is detected in terminals F17 - F18 (circuit 2)
CONT IP_X_CC13 (O7_SEAL)	Active if current is detected by sensor in output O7 (F31-F33)
CONT IP_X_CC14 (O8_SEAL)	Active if current is detected by sensor in output O8 (F34-F36)
CONT IP_X_CC15 (SUP_COIL1)	Active when continuity is detected in circuit 1
CONT IP_X_CC16 (SUP_COIL2)	Active when continuity is detected in circuit 2

A continuity failure is detected in a circuit when both voltage detectors (Va and Vb) detect lack of voltage during more than 500 ms. This function is not influenced by the breaker status.

These operands can be associated with internal signals (virtual outputs), LEDs or element outputs, to issue alarm signals or to block elements, for example for blocking the Breaker close if an anomaly is detected in the trip circuit.

Available schemes are as follows:

1. Without supervision
2. With current supervision (with seal-in)
3. With simple voltage supervision
4. With double voltage supervision
5. With current and simple voltage supervision (with seal-in)
6. With current and double voltage supervision (with seal-in)
7. With current and double voltage supervision (with seal-in) and serial resistor in voltage monitors.

The following subsections describe the different types of connection to create each supervision scheme in an easy way. As the supervision circuits are identical, only the first group connection examples are described, being also applicable to the second group.

In order to assure a high isolation level between groups, the digital inputs for supervision have been located in a symmetrical basis. That is to optimize the isolation between groups that can be connected to different batteries, and therefore requiring a greater distance between circuits.

5.6.5.3 Without supervision

This is a very frequent common case, and we must only wire the tripping circuit to terminals F35 and F36, leaving unused terminals F34, F15, F16, F17, F18.

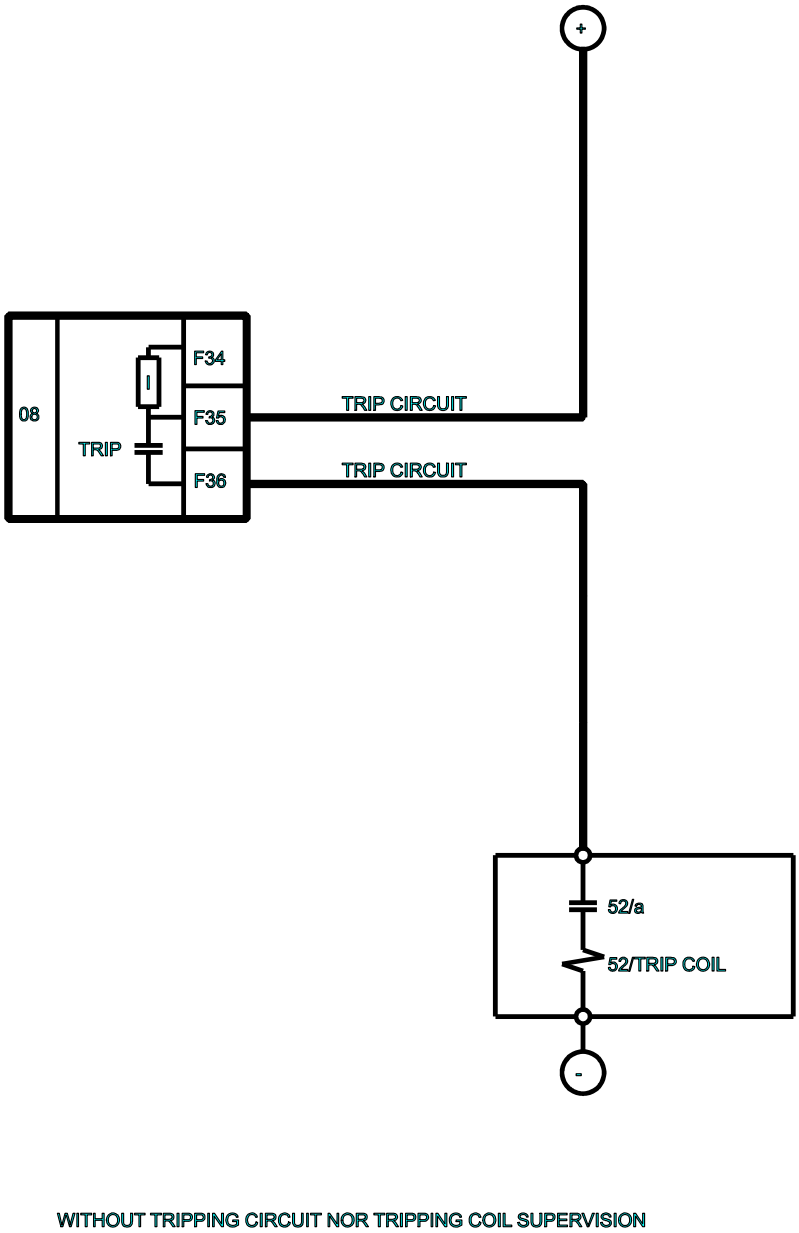


Figure 5-38: Circuit without tripping circuit supervision (A6631F1)

5.6.5.4 With current supervision (with SEAL-IN)

In this case, as shown in Figure 5-39: Current supervision of the tripping contact (A6631F2), the current supervision circuit consists of a circuit connected in series with the output contact, so that the external circuit is wired to terminals F34 and F36. This supervision circuit includes a low impedance reed relay that is activated when the current value exceeds 200 mA, and sends a signal to the main microprocessor. This latches the output relay in such a way that

this indication can be used to produce a latching of the output relay, so that it remains closed while the circulating current is over 200 mA. To use the seal-in feature in the relay it is not necessary to configure any setting. It works, we only must program the corresponding Circuit latching setting wiring the external circuit to terminals F34 and F36.

With this scheme, in the case of a failure to open from the breaker auxiliary contact, the F650 output relay does not open the tripping coil current, as in this case the contact may be damaged, as it is prepared for opening currents around 0.35 A at 125 Vdc. This latching or memory function is only guaranteed while the element is powered.

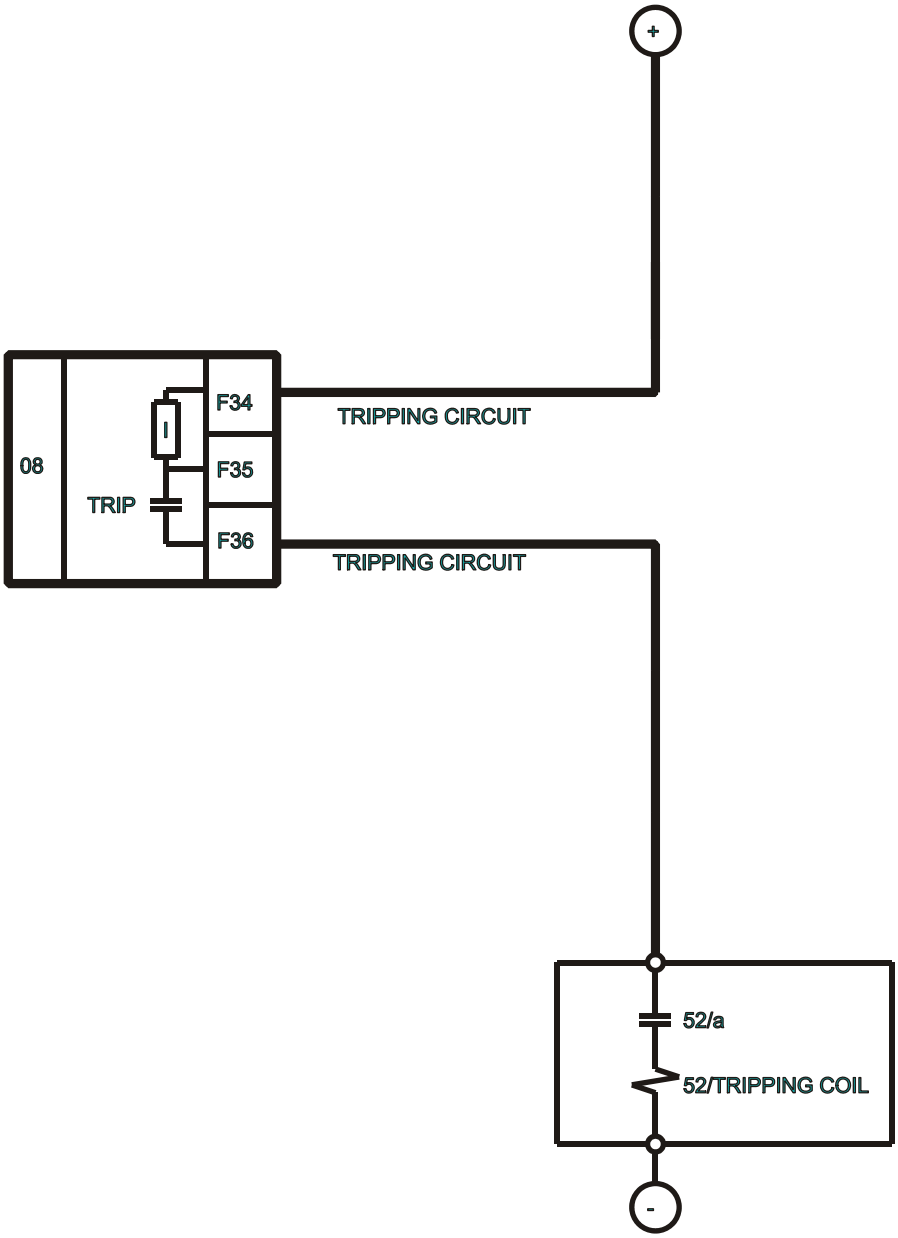


Figure 5-39: Current supervision of the tripping contact (A6631F2)

5.6.5.5 With simple voltage supervision

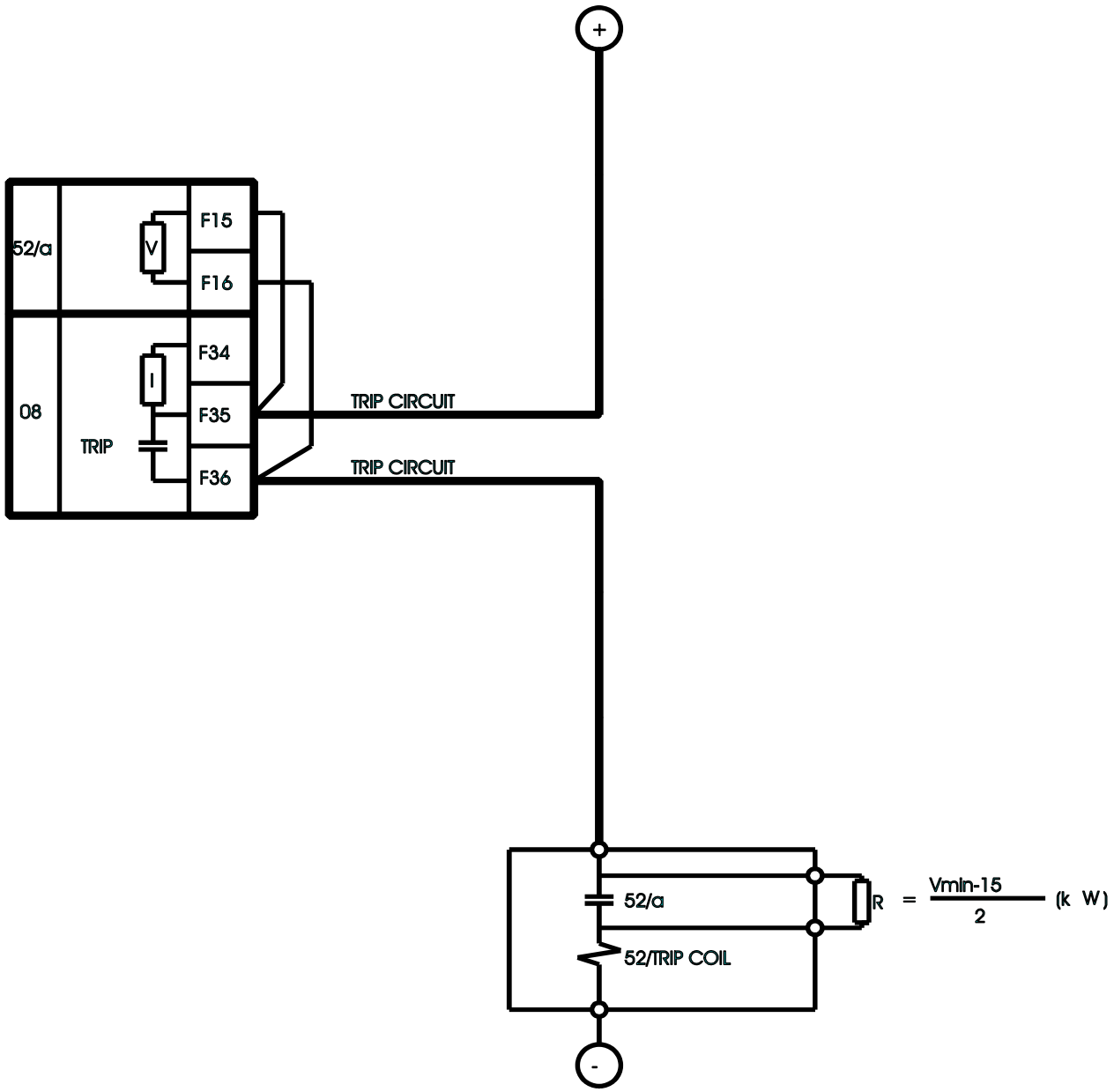


Figure 5-40: Supervision application with auxiliary contact 52a and a resistor (A6631F3)

Table 5-88: Supervision with 52/a

INTERNAL STATE	V 52/a	SUPERVISION
52 open	ON	OK
52 closed	ON	OK
TRIP	OFF	OK if t < 0.5 s
TRIP with 52 open	OFF	OK if t < 0.5 s

There is a possibility to monitor the trip circuit and trip coil continuity. This can be done by monitoring Vdc through the output contact when this is open.

Table 5-89: Supervision algorithm with simple voltage supervision scheme

Status of Involved Elements			Input to F650	Decision
CIRCUIT STATUS	OUTPUT STATUS (F35-F36)	BREAKER STATUS	OPERAND CONT IP_X_CC11 (Va_COIL2) V 52/a (F15-F16)	OPERAND CONT IP_X_CC16 (SUP_COIL2)
Healthy	Open	52 closed	ON	ON
Healthy	Open	52 open	ON	ON
Healthy	Closed	52 closed	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Faulty	Open	52 closed	OFF	OFF (500 ms delay)
Faulty	Open	52 open	OFF	OFF (500 ms delay)
Faulty	Closed	52 closed	OFF	OFF (500 ms delay)
Faulty	Closed	52 open	OFF	OFF (500 ms delay)

In this table, ON means that the voltage detector V52/a is active, detecting a voltage.

In the first case shown on the table, with closed breaker, voltage is detected by V 52/a sensor, and this means that there is continuity in the supervised circuit.

As shown on Figure 5-40: Supervision application with auxiliary contact 52a and a resistor (A6631F3), when the relay is not tripped, trip contact F35-F36 remains open. If the breaker is closed, its auxiliary contact 52a is closed. Therefore, a little current is flowing, about 2 mA, through terminals F15 and F16 through the voltage detector circuit, which flows through 52/a and the tripping coil 52TC (TC = tripping coil). Current only circulates when there is continuity in the whole circuit, so the complete circuit is monitored, and not only the trip coil. This circuit includes auxiliary 52/a as well as the whole wiring between the battery and the relay tripping terminals, and between these and the breaker tripping circuit.

For the second case shown on the table, open breaker, its auxiliary contact 52/a remains open, and current cannot flow through it for detecting continuity. In order to correctly monitor the circuit, a resistor must be used, not included in the protection, connected in parallel. The value of resistance is selected so that the V 52/a input circuit minimum detection current flows, but not as high as to activate the breaker-tripping coil. The figure shows the following equation:

Where:

$$R = \frac{V_{min} - 15}{2}$$

Vmin	Is the minimum voltage, in Volts, expected in the battery (e.g. 80% of Vn)
R	Resistance, in kilo ohms.
2	2 mA of approximate current flowing through input V 52/a

As shown in the second case in the table, with an open breaker, as current flows through R if there is continuity in the WHOLE tripping circuit, voltage is detected in input V 52/a.

This works correctly in steady state. However, if the breaker trips, while it is opening, the V 52/a input signal can be deactivated without this meaning that the circuit is not correct. This is due to the fact that the tripping relay, terminals F35-F36, short circuits input V 52/a temporarily.

Therefore, if there is a trip signal, it is permitted that no signal is detected during a period of 1s to allow the breaker to open, and reopen the tripping relay F35-F36.

Figure 5-41: Trip circuit and trip coil supervision, auxiliary contact 52/a (closed breaker only) (A6631F5) shows the possibility of monitoring the circuit only when the breaker is closed. In this case resistance R is not used, but it must be observed in the element logic that the corresponding signal CONT IP_F_CC16 (SUP_COIL2) is activated showing a failure when the breaker is open. Therefore it is required to supervise the continuity failure signaling by the breaker status information.

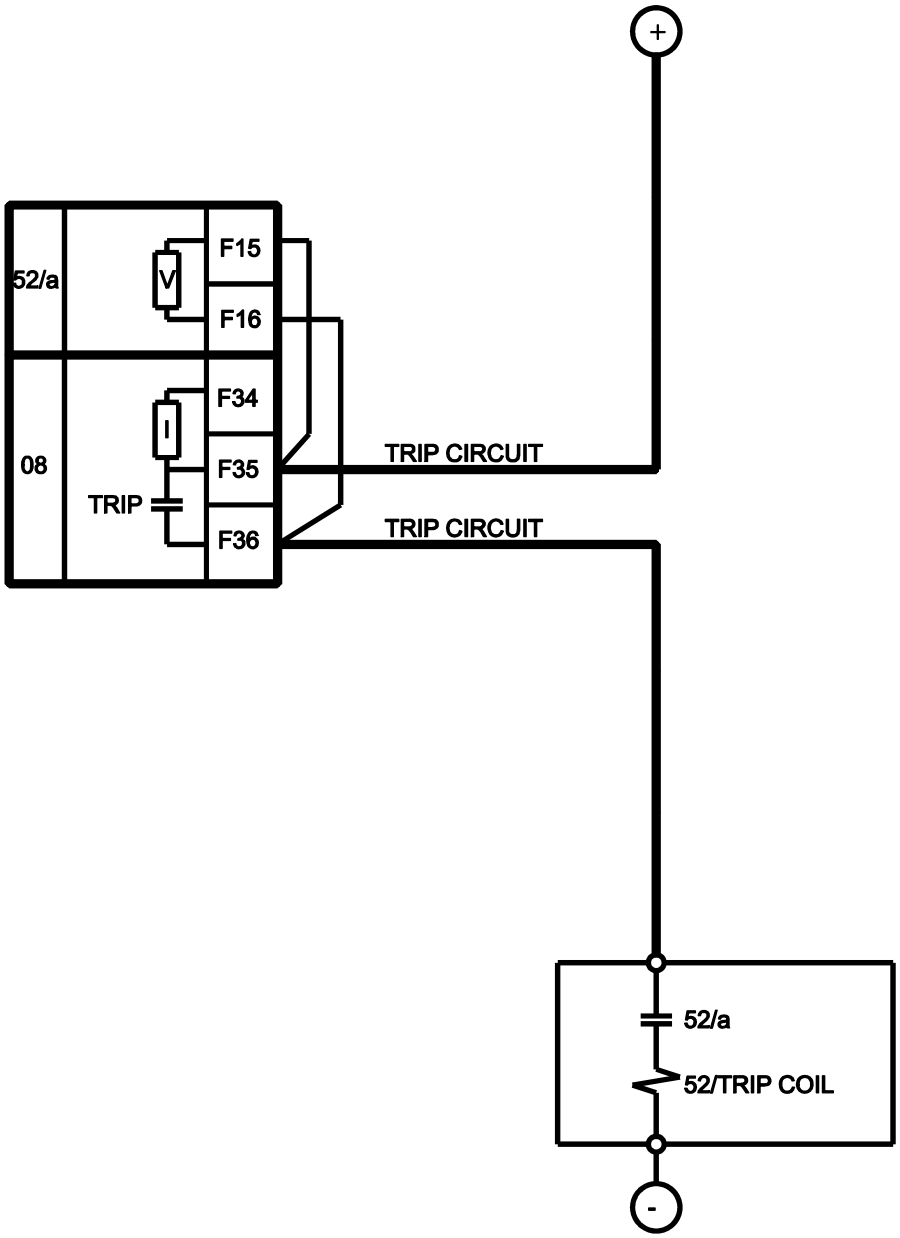


Figure 5-41: Trip circuit and trip coil supervision, auxiliary contact 52/a (closed breaker only) (A6631F5)

5.6.5.6 With double voltage supervision

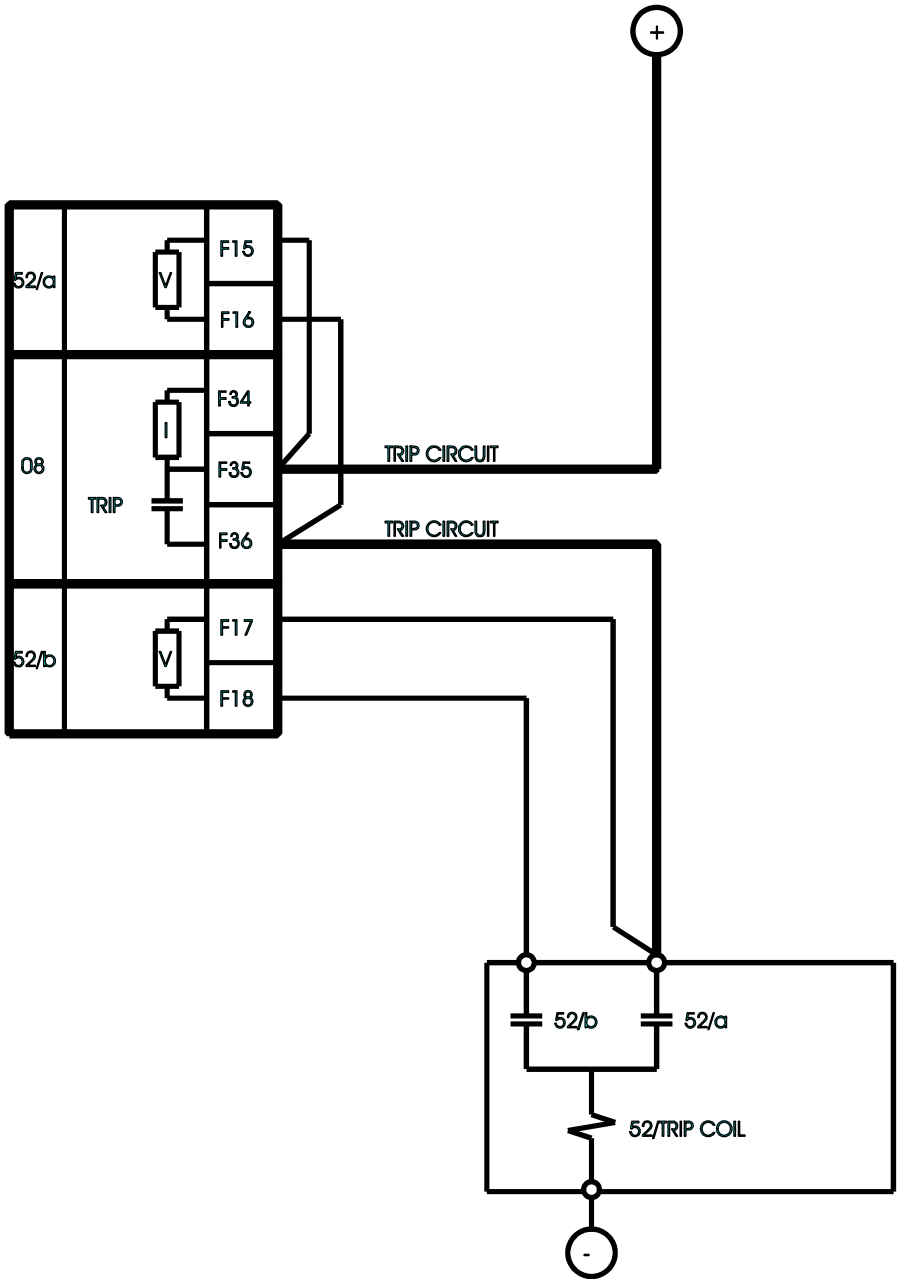


Figure 5-42: Supervision application with auxiliary contacts 52a and 52b (A6631F4)

Table 5-90: Supervision algorithm with double voltage supervision scheme

Status of Involved Elements			Inputs to 650		Decision
CIRCUIT STATUS	OUTPUT STATUS (F35-F36)	BREAKER STATUS	OPERAND CONT IP_X_CC11 (Va_COIL2) V 52/a (F15-F16)	OPERAND CONT IP_X_CC12 (Vb_COIL2) V 52/b (F17-F18)	OPERAND CONT IP_X_CC16 (SUP_COIL2)

Healthy	Open	52 closed	ON	OFF	ON
Healthy	Open	52 open	ON	ON	ON
Healthy	Closed	52 closed	OFF	OFF	ON (if t < 500 ms) OFF (if t > 500 ms)
Healthy	Closed	52 open	OFF	ON	ON (if t < 500 ms) OFF (if t > 500 ms)
Defective	Open	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Open	52 open	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 closed	OFF	OFF	OFF (500 ms delay)
Defective	Closed	52 open	OFF	OFF	OFF (500 ms delay)

There is a possibility to monitor the trip circuit continuity not only via its auxiliary contact 52/a, but also with auxiliary contact 52/b. This avoids the need to install a resistance in parallel with auxiliary 52/a. The correct connection is shown on Figure 5-42: Supervision application with auxiliary contacts 52a and 52b (A6631F4)

The circuit works in a similar way to the one described in the previous section, but it uses both supervision inputs F15-F16 and F17-F18.

The advantage in this case is that circuit supervision with 52 open is more complete, as input V 52/b is used through contact 52/b, (that is closed when the breaker is open).

We must point out that in this scheme, the tripping contact, shown in the example as the F650 trip relay, can be the one in the relay (terminals F35 and F36), or be provided by another protection or by the parallel of several protections. This provides high flexibility in the use of this circuit.

The battery voltage can also be monitored, by using one of the standard digital inputs.

5.6.5.7 With double voltage supervision and serial resistor in voltage monitors

Figure 5-43: Supervision application, auxiliary contacts 52a and 52b and series resistor in F15-F16shows the supervision scheme with an external resistor.

An external series resistor is used with the 52a voltage monitor to prevent CB tripping with a short-circuited voltage monitor. With CB open, 52/a is open and 52/b is closed. A shorted 52/a voltage monitor does not cause a trip because 52/b voltage monitor is current limited to 2mA. With a shorted 52/b voltage monitor, no false trip is performed because 52/a is in series limiting current to 2mA.

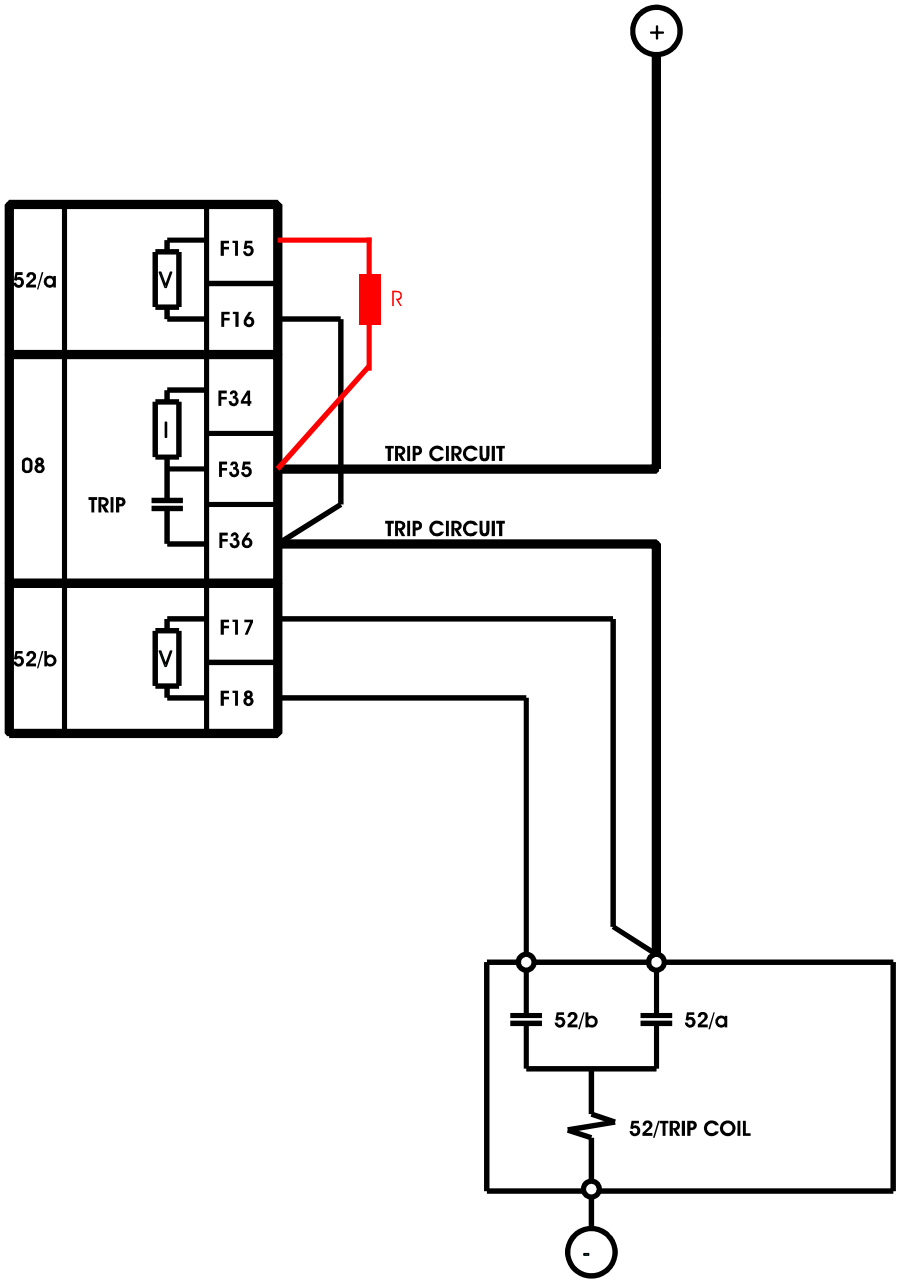


Figure 5-43: Supervision application, auxiliary contacts 52a and 52b and series resistor in F15-F16

5.6.6 Analog board specific settings

Hardware and software is provided to receive signals from external transducers and convert these signals into a digital format for use as required. The relay accepts inputs in the range of –1 to +20 mA DC, suitable for use with the most common transducer output ranges; all inputs are assumed to be linear over the complete range.

The Input Range setting specifies the mA DC range of the transducer connected to the input channel.

- Range: -1 to 0, 0 to 1, -1 to 1, 0 to 5, 0 to 10, 0 to 20, 4 to 20.

The Min and Max Value settings are used to program the span of the transducer in primary units.

- Min Value: -9999.99 to 9999.99
- Max Value: -9999.99 to 9999.99

5.6.7 Virtual inputs

Virtual inputs are signals that can be written directly via communications. Their status can be established as ON (1) and OFF (0), through writing by communications using EnerVista 650 Setup.

The change of state of virtual inputs is made according to their type. Latched virtual inputs remain at the set value until it is changed by communications. Self-reset virtual inputs are activated by writing, and they remain active during one cycle. There are 32 virtual inputs of each type.

5.6.7.1 Virtual inputs writing

Setpoint > Input/Outputs >Virtual Inputs for activating / deactivating signals

To write a virtual input, select the virtual input to activate by clicking on the virtual input checkbox, then click **Store** and the virtual input is written to the relay (see Figure 5-44: Virtual input writing through EnerVista 650 Setup).

For self-reset, the value remains active during one PLC cycle and after that the virtual input value is cleared.

For latched, the value remains active until it is cleared by the user, clicking again in the virtual input checkbox and clicking **Store** to clear the value.

Figure 5-44: Virtual input writing through EnerVista 650 Setup

5.6.7.2 Virtual inputs status monitoring:

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

Table 5-91: Virtual input status

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
…	…
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

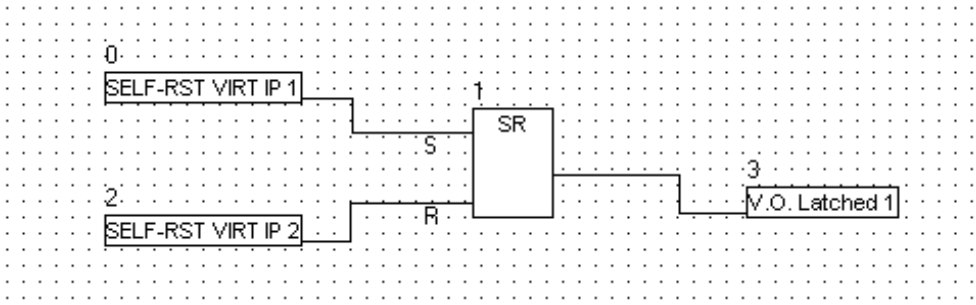
Text assignment for virtual input is made at ***Setpoint > Relay Configuration > Virtual Inputs***. It should be taken into account that the text assigned for virtual inputs in the relay configuration screen are only for file management, they are not sent to the relay.

5.6.8 Virtual outputs

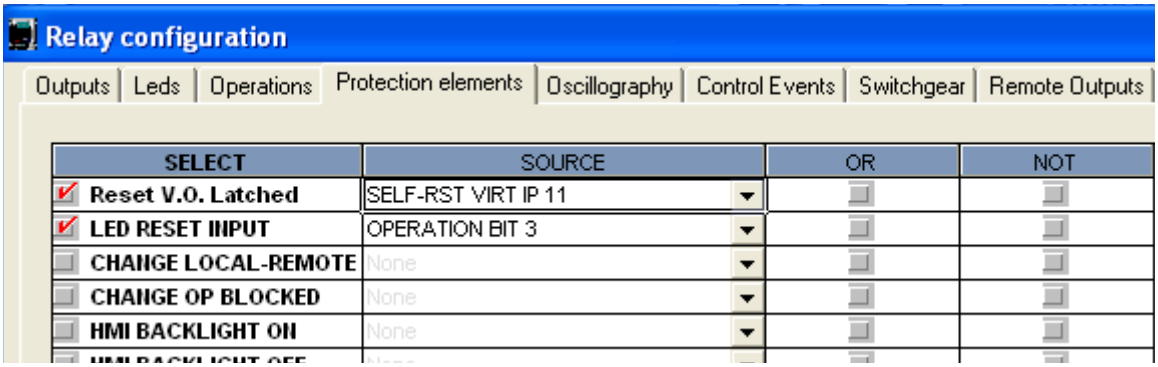
There are 512 virtual outputs that may be assigned via Logic configuration. If not assigned, the output is forced to OFF (Logic 0). An ID may be assigned to each virtual output. Virtual outputs are resolved in each pass through the evaluation of the logic equations. For more detailed information see chapters 5.9 Relay configuration and 5.10 Logic configuration (PLC editor) in this manual.

5.6.9 Virtual outputs latched

There are 16 virtual outputs latched that may be assigned via Logic configuration. If not assigned, the output is forced to OFF (Logic 0). Virtual outputs are resolved in each pass through the evaluation of the logic equations. These latched virtual outputs can only be assigned as an S/R output, they only are linked to a PLC's S/R output and their values remain after switching the unit off and then on.



These virtual output latched may be reset by a PLC setting as it is shown in the following figure



5.7 Remote comms

This settings allow configuring the remote comms settings for the IEC61850 protocol regarding GSSE. For more information see 7.3 IEC 61850 profile for F650.

SETPOINT > INPUTS/OUTPUTS > REMOTE COMMS				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]
Setting Description For Gsse				
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]
Device Identification	650 ID	F650	N/A	
Hold time signal send by the transmitting device	Hold Time	10000	1 ms	[1000 : 60000]
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]
Remote Device Description	Remote Device X	Remote Device X	N/A	
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]
Setting Description For Goose				
Remote comms selection	Remote Comms	GOOSE	N/A	[NONE – GSSE – GOOSE]
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]
Note: X is the Remote Device index, up to 32				

5.8 Testing

5.8.1 Force IO–input testing

The input testing can only be performed in relay with graphical display, see the human interfaces section in this manual for more detailed information.

5.8.2 Force IO–output testing

Output testing can be performed via HMI in models with graphical display and via communications through EnerVista 650 Setup in all models.

Setpoint > Inputs/Outputs > Force Outputs

This menu allows activating each contact output in the relay, to facilitate maintenance testing. In the screen, the user can select the I/O board to be tested, and also select which output is to be forced (operated).

After selecting the desired output, clicking on the checkbox on the left, the user must click **Force Output** to activate the selected output.

In order to refresh the real status of outputs, according to the information received by the relay processor, click **Refresh**.

The following figure shows the output-testing screen:

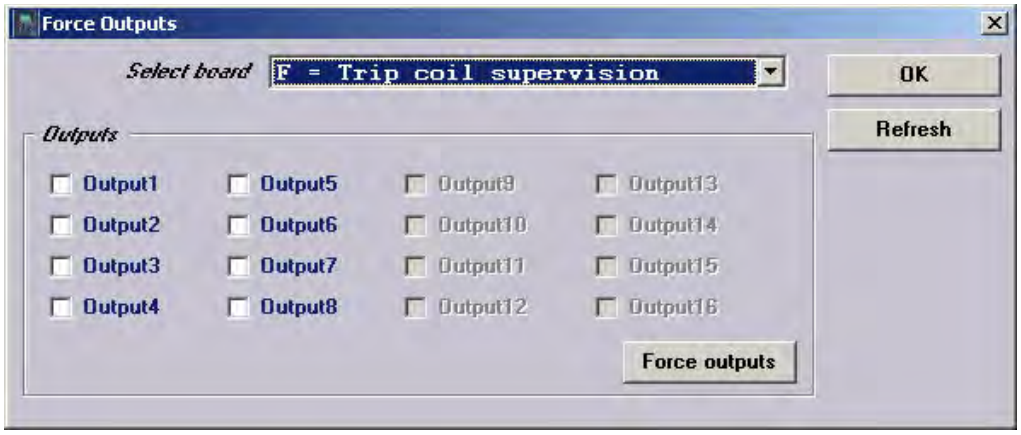


Figure 5-45: Force IO

5.9 Relay configuration

Setpoint > Relay Configuration

This is the relay configuration section in which the relay can be configured (all input/output and LEDs configuration, protection elements signals, graphic display configuration, etc.) using internal states or already compiled equation on PLC Editor (see section 5.10 Logic configuration (PLC editor)).

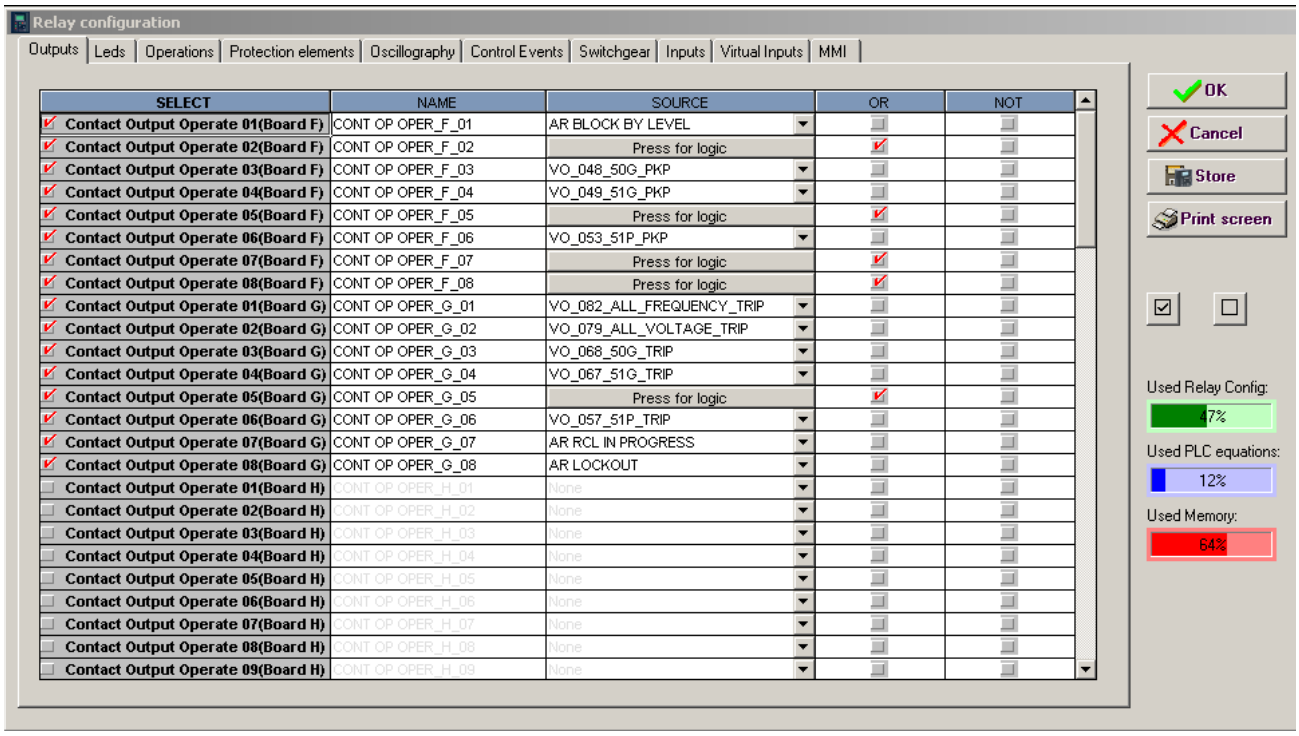
5.9.1 Outputs

Configuration of contact output operates and reset signals for all boards available in the device:

To configure any output it is necessary to select the output to be configured, clicking on the checkbox in the select column and choose the logic operand in the source column. Simple logics can be performed on this screen, using the “or” and “not” columns, for more complex logics go to the logic configuration tool to create the virtual outputs and afterwards select it in the source column.

The different options available in this screen are the following:

- ***Select*** checkbox enables each output. The output must be enabled before modifying any other setting on that output
- ***Name*** setting for defining identification for the output. Note: nor the Output name, nor the Input name, nor the Virtual Input name is recorded into the relay.
- ***Source*** setting for defining a function, logic, remote input, digital input, etc. that activates the contact.
- ***OR*** checkbox for configuring the output operation by activation of any of the indicated signals. The element performs an OR of the signals, and its output produces operation.
- ***NOT*** checkbox for inverting or not the configured logic.



SELECT	NAME	SOURCE	OR	NOT
Contact Output Operate 01(Board F)	CONT OP OPER_F_01	AR BLOCK BY LEVEL		
Contact Output Operate 02(Board F)	CONT OP OPER_F_02	Press for logic	✓	
Contact Output Operate 03(Board F)	CONT OP OPER_F_03	VO_048_50G_PKP		
Contact Output Operate 04(Board F)	CONT OP OPER_F_04	VO_049_51G_PKP		
Contact Output Operate 05(Board F)	CONT OP OPER_F_05	Press for logic	✓	
Contact Output Operate 06(Board F)	CONT OP OPER_F_06	VO_053_51P_PKP		
Contact Output Operate 07(Board F)	CONT OP OPER_F_07	Press for logic	✓	
Contact Output Operate 08(Board F)	CONT OP OPER_F_08	Press for logic	✓	
Contact Output Operate 01(Board G)	CONT OP OPER_G_01	VO_082_ALL_FREQUENCY_TRIP		
Contact Output Operate 02(Board G)	CONT OP OPER_G_02	VO_079_ALL_VOLTAGE_TRIP		
Contact Output Operate 03(Board G)	CONT OP OPER_G_03	VO_068_50G_TRIP		
Contact Output Operate 04(Board G)	CONT OP OPER_G_04	VO_067_51G_TRIP		
Contact Output Operate 05(Board G)	CONT OP OPER_G_05	Press for logic	✓	
Contact Output Operate 06(Board G)	CONT OP OPER_G_06	VO_057_51P_TRIP		
Contact Output Operate 07(Board G)	CONT OP OPER_G_07	AR RCL IN PROGRESS		
Contact Output Operate 08(Board G)	CONT OP OPER_G_08	AR LOCKOUT		
Contact Output Operate 01(Board H)	CONT OP OPER_H_01	None		
Contact Output Operate 02(Board H)	CONT OP OPER_H_02	None		
Contact Output Operate 03(Board H)	CONT OP OPER_H_03	None		
Contact Output Operate 04(Board H)	CONT OP OPER_H_04	None		
Contact Output Operate 05(Board H)	CONT OP OPER_H_05	None		
Contact Output Operate 06(Board H)	CONT OP OPER_H_06	None		
Contact Output Operate 07(Board H)	CONT OP OPER_H_07	None		
Contact Output Operate 08(Board H)	CONT OP OPER_H_08	None		
Contact Output Operate 09(Board H)	CONT OP OPER_H_09	None		

Figure 5-46: Output configuration

5.9.2 LEDs

F650 has 15 LEDs fully configurable from any logical variable, contact or virtual input. For firmware version below 7.20, the first five are latched by hardware, the rest are self reset but can be latched through PLC Configuration. For firmware version 7.20 or higher, all these LEDs can be individually configured as latched or self-reset. This new setting is accessible from **Setpoint > Relay Configuration > LED.**

This window displays all relay LEDs with the following setting options for each one:

- **Select** checkbox enables each LED. The LED must be enabled before modifying any other setting on that LED
- **Name** setting for defining identification for the LED
- **Source** setting defines which function; logic, remote input, digital input, etc. activates the LED.
- **OR** checkbox for configuring the LED operation by activation of any of the indicated signals. The element performs an OR of the signals, and its output produces operation.
- **NOT** checkbox for inverting or not the configured logic.
- For firmware version 7.20 or higher, latched checkboxes are available for configuring the LEDs. If it is selected, LED shall work as latched, if it is deselected, LED shall work as self-reset.

From the LED configuration screen, it is possible to print the vertical LED label for the relay. For this purpose, click the printer icon. The label obtained is similar to the default factory label, with black background and the LED texts in white. This label can replace the original one under the black plastic cover. The label is also provided in word format and can be modified by the user (e.g. different color marking)

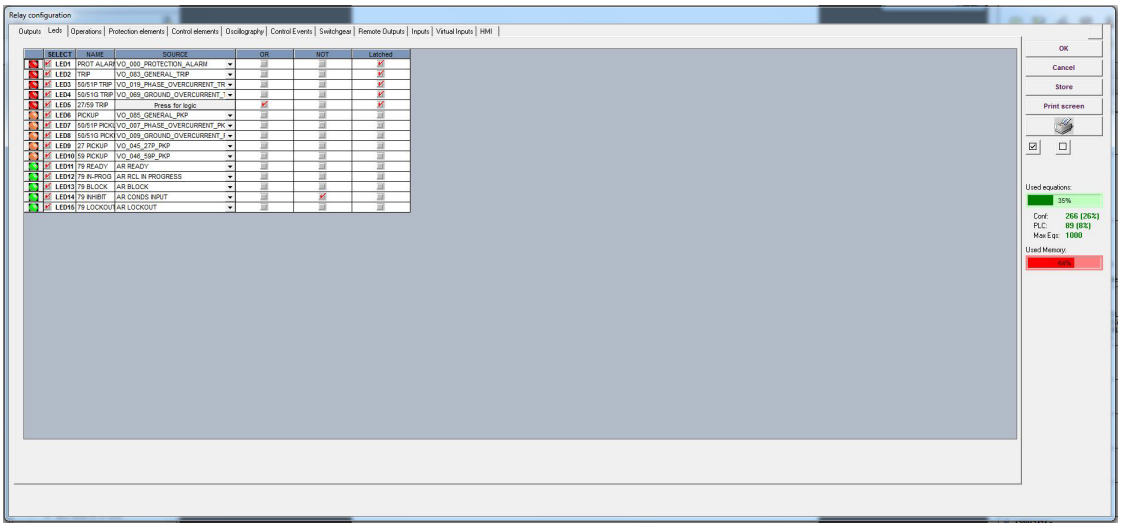


Figure 5-47: LED configuration

5.9.3 Operations

This menu option shows the settings for the 24 control operations that can be programmed, as follows:

- ***Select*** checkbox enables the desired operation.
- ***Command Text*** setting defines the command name.
- ***Interlocks Type*** setting defines the desired interlock type (An interlock is a condition that must be fulfilled for an operation to be performed). The possible options are ***Logic*** or ***None.*** If the **LOGIC** option is selected, the program enables a new window for creating the logic. If the **NONE** option is selected, then the following setting (***Interlocks***) is irrelevant.
- ***Interlocks*** setting define the desired interlocks. This setting is enabled selecting the "***logic***" option in "***Interlock type***". In the "***Interlock logic***" screen we can set the interlock logic, as shown on Figure 5-48: Operations and interlocks

  The settings on this screen allow creating a logic configuration with up to 3 AND gates and 1 OR gate for each of the 24 operations available in the relay. These settings are:

  Select – Enables/disables the selection for the interlock input

  Source – Selects a function, digital input, logic, etc. for defining each input of each AND gate.

  NOT – Logic inverter

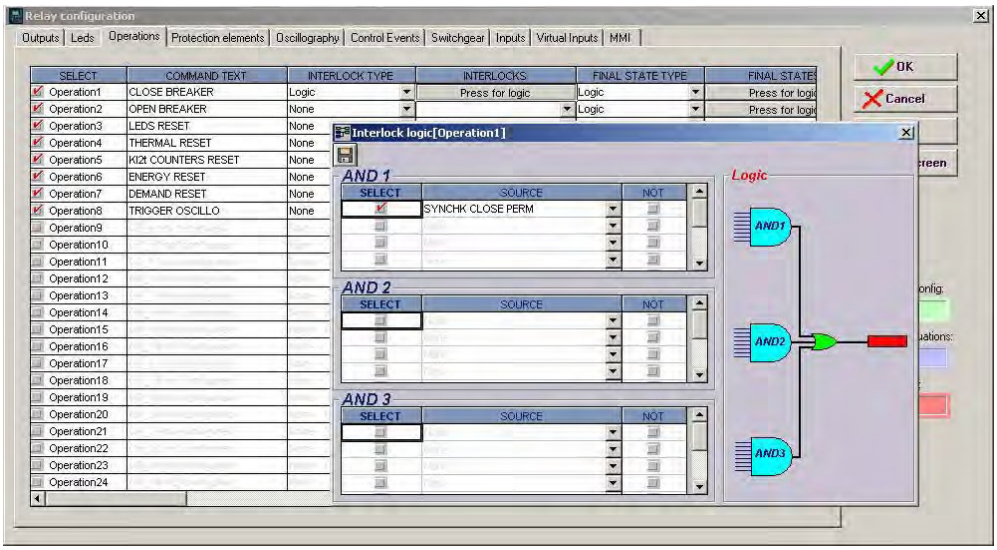


Figure 5-48: Operations and interlocks

- ***Final State Type*** setting: defines whether the operation requires (in addition to the interlock logic) any other conditions to determine a "success condition". If so, we must select LOGIC. Otherwise, we must select NONE.
- ***Final State*** setting: defines the success condition of a programmed operation, if the previous setting (***Final State type***) was set as LOGIC.
- ***Front Key*** setting: defines the front pushbutton from which the operation can be executed.
- ***Contact Input*** setting: defines whether the operation can be executed by digital input. It defines the digital input to be used for this purpose.
- ***Virtual Output*** setting: defines whether the operation can be executed from a virtual output previously defined at the logic configuration tool (PLC logic).
- ***Time Out*** setting: defines the period during which the operation command remains activated waiting for a success condition. If the success signal is received before this period expires, the command signal is removed and the timer reset. If the success condition is not received within this period of time, the operation is considered to be finished.

- **HMI setting:** defines whether the operation can be executed by HMI
- ***COM1 (REMOTE)*** setting: defines whether the operation can be executed by communications through the rear port COM1.
- ***COM2 (LOCAL)*** setting: defines whether the operation can be executed by communications through the rear port COM2. We must note that this local port is the same as the front port (DB-9 connector). We can establish simultaneous communication with the relay through ports COM1 and COM2. However, it is not possible to use rear COM2 and the front port simultaneously.
- ***ETHER-MASTER*** setting: defines whether the operation can be executed by communications through the ETHERNET.

It must be taken into account that besides the master selection in the operations screen inside relay configuration, there is a hardware selection (with the operation pushbutton in the front part of the relay) to switch between local (COM2 and HMI) and remote masters (COM1 and ETHERNET) for operations.The local-remote-off sequence can be also available through communications selecting the signal to switch in "***Setpoint > Relay Configuration > Protection Elements***".

The following diagram shows an example of the operations internal logic.

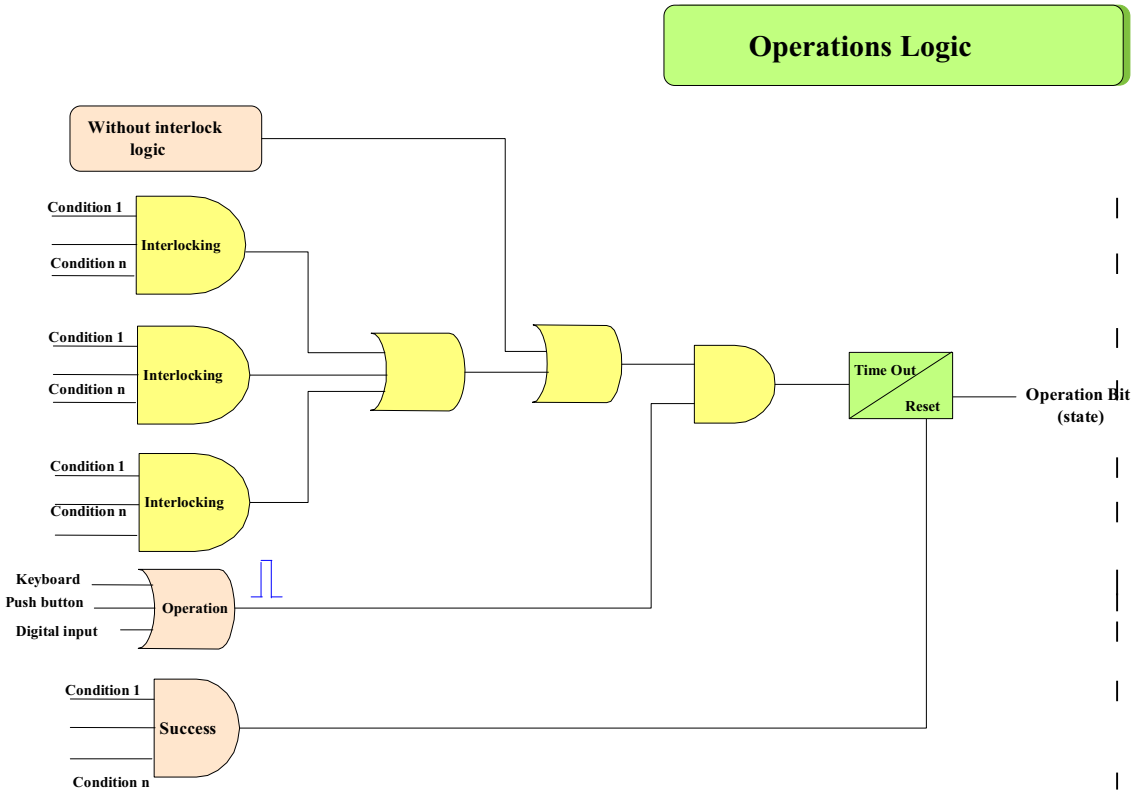


Figure 5-49: Operation logic diagram

5.9.3.1 Programming an operation

Example of how to program an operation to close a breaker with an operating time of 90 ms (closing), incorporating 52/b contacts to indicate the change of position, using an interlock logic to enable the operation if there is synchronism condition, and there is no autoreclose in progress. The operation must be commanded from the relay faceplate using one of the available operation push buttons.

To configure the related operation, go to ***Setpoint > Relay Configuration*** and select ***Operations*** tab.

This screen shows all the fields required for the operations configuration in the F650. In order to select an operation, click the operation name under the **Select** column, and all the related parameters are enabled. The chosen name for the operation is entered in **Command Text**. To configure an interlock logic, select the **Logic** option in **Interlocks Type**. Once this option has been selected, the interlock configuration screen is enabled. To display this screen, click **Press for Logic** for the desired operation on the **Interlocks** column. On this **Interlocks** screen, the two conditions that conform the Interlock that enables the operation have been selected. To save the interlock, click the disk icon on the toolbar. A **Logic Saved** displays.

Once the Interlocks have been defined, the user must define the success conditions for the operation, define **Final State Type** as LOGIC, and a PRESS FOR LOGIC message lights up below **Final States**. When clicking PRESS FOR LOGIC, the success condition screen is displayed, defining there as BREAKER CLOSED.

The front key to be used for executing the Operation can be selected on the Frontal Key column, in this example the **Key I** option is selected on **Frontal Key**. As none of the other contact input or virtual output options are going to be used they are set to **None**. The success condition time **Time out** is set to **500 ms**, and the operation is only enabled through the relay keypad, so only the **MMI** option is selected, thus disabling the rest of options (COM1, COM2, ETHERNET master are not selected).

All the selections previously related are summarized in the following table:

Table 5-92: Operation Settings

OPERATION	COMMAND TEXT	settingS	VALUE/SOURCE
Operation1	CLOSE BREAKER	INTERLOCK (LOGIC)	SYNCHK CLOSE PERM
		FINAL STATES (LOGIC)	BREAKER CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	MMI

Finally, configure a contact output to be activated with the programmed Operation (Operation1).

This is done under **Setpoint > Relay Configuration > Output**, selecting an output and choosing the internal signal OPERATION BIT 1, which corresponds to the bit that is activated when the related operation is executed.

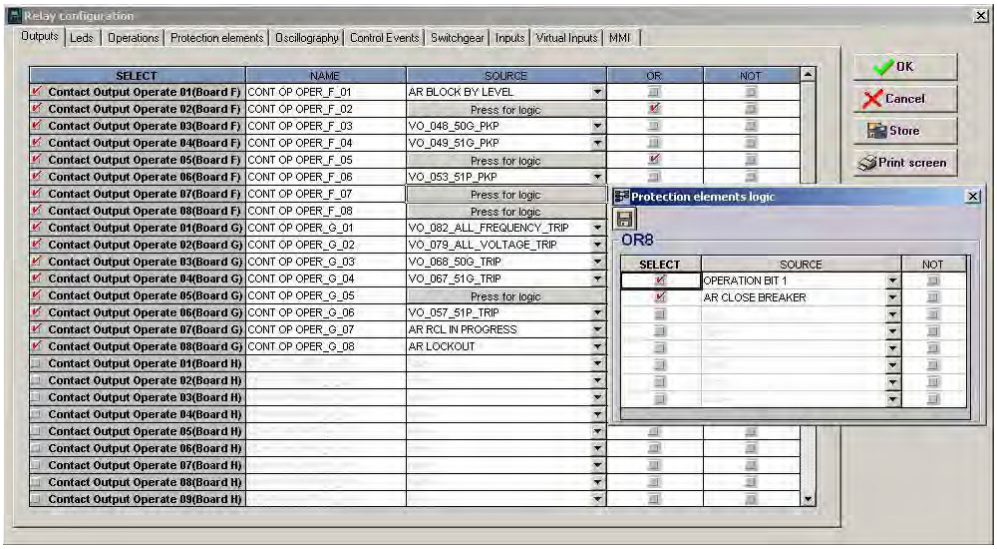


Figure 5-50: Contact output configuration

Note: Operations time out for confirmation

Configurable screen in graphical HMI: In the relay HMI the configurable objects wait one minute for confirmation after operation selection. The object is blinking for one minute. After that time, the object is deselected.

Front Keys: In operations performed by front keys, the time out for confirmation is 10 seconds.

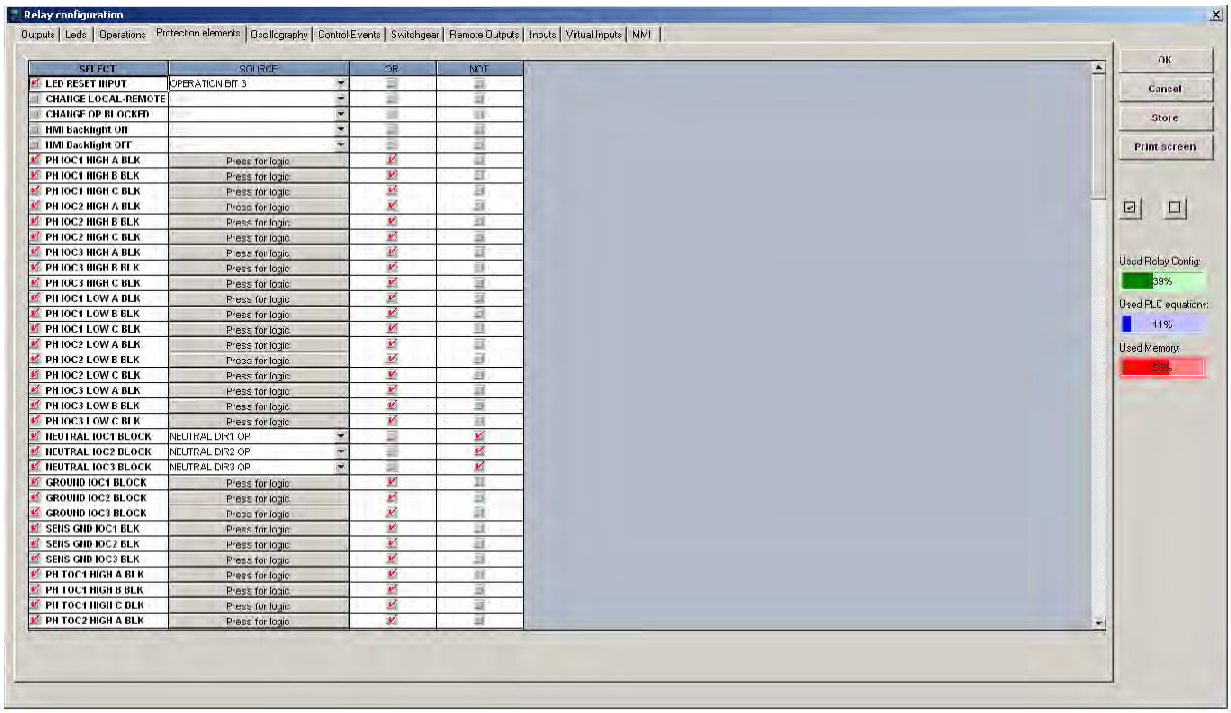
5.9.4 Protection elements

This tab allows assigning operands (logic signals) as inputs to different protection elements. This way, the user assigns which operands can reset the Thermal Image, etc. In this screen we can also configure a logic signal to perform the LED reset by communications.

The settings are as follows:

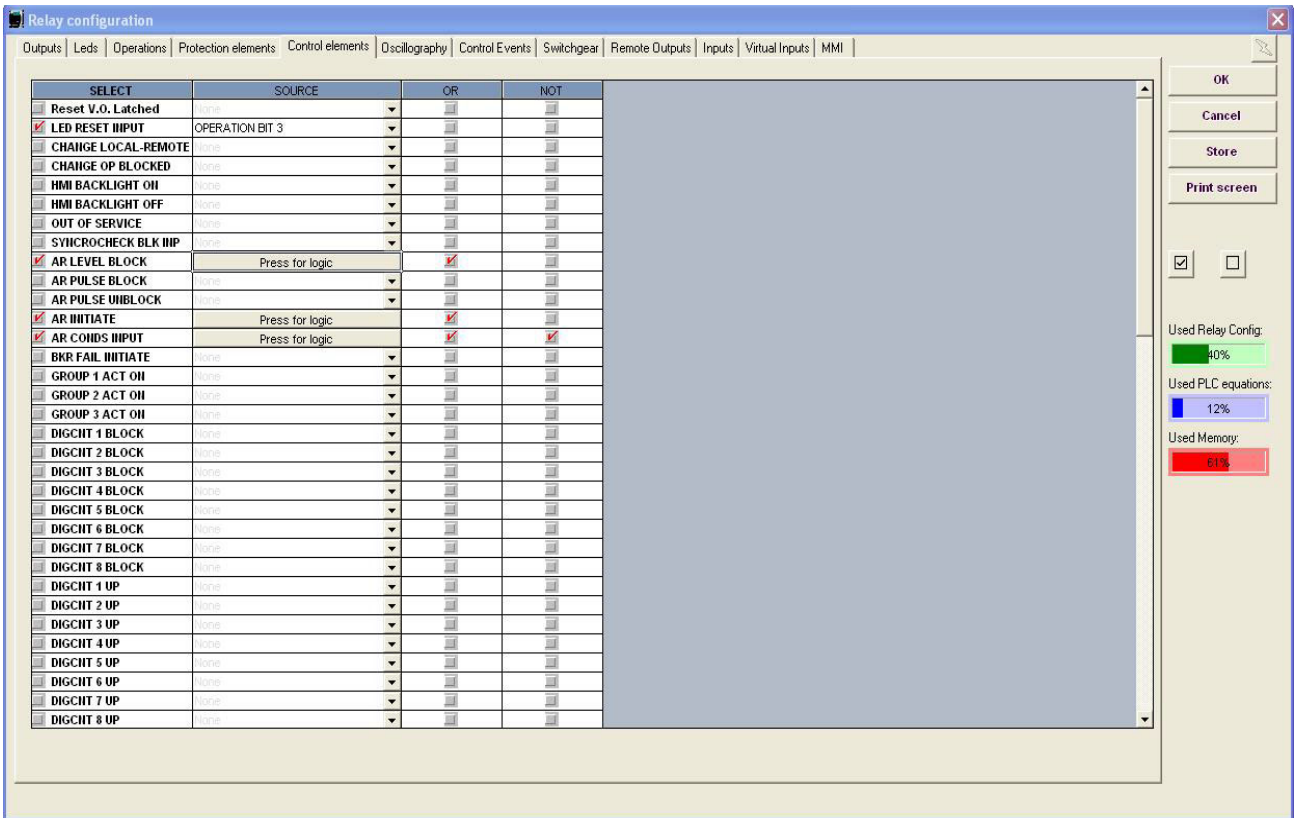
- ***Select*** checkbox enables/disables the selection.
- ***Source*** setting defines the operand that performs the function indicated in the SELECT column. ***NOT*** setting inverts the block signal.
- ***NOT*** setting for inverting the logic signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces the operation.

The following figure shows this screen:



5.9.5 Control elements tab

This tab allows assigning operands (logic signals) as inputs to different control elements. This way, the user assigns which operands configure digital counters, etc. In this screen we can also configure a logic signal to perform the LED reset by communications. The settings are the same as in *Protection Elements* tab.



5.9.6 Oscillography

This menu is used for selecting the digital channels to be included in oscillography records, and the oscillo trigger signal. As for the above-described settings, the trigger selection can be any of the signals provided by the relay or a logic combination of these.

settings are described below:

- ***Select*** checkbox enables or disables a digital channel and the oscillography trigger.
- ***Name*** setting defines the name of the digital channel to be included in oscillography records.
- ***Source*** setting defines the source or signal to be recorded in that specific channel, which can be selected among all the operands available in the signals menu.
- ***NOT*** checkbox inverts the enabled digital channel signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.

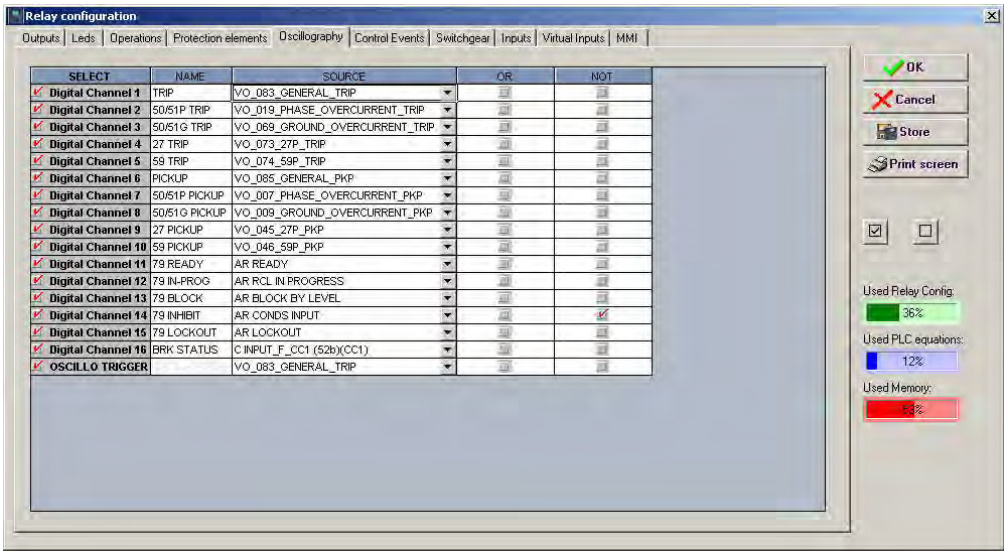


Figure 5-51: Oscillography configuration

NOTE This screen is used for the configuration of digital channels and oscillography trigger. The rest of parameters, such as function enabling/disabling, sampling rate, number of oscillography files, etc. must be set on the **Setpoint > Product Setup > Oscillography** menu.

5.9.7 Control events

This menu is used for defining the **CONTROL EVENTS**, up to 128 user programmable events.

A control event is a logic signal associated with an operand or combination of operands which monitories the change of status of the logic operand. The relay shows which events are active each time, as well as their date and time of activation.

There are 128 user programmable events and 64 pre-established events for switchgear, which correspond to opening, closing, Error00 and Error11 of the 16 programmable switchgear elements. (Refer to section 5.9.9 HMI (human-machine interface) for more detailed information).

As for the rest of previous settings, the source selection can be made between:

- An operand, selecting it directly on this screen.
- An **OR** of several operands, selecting directly the **OR** column in this same menu.
- A logic combination of operands, by selecting a VIRTUAL OUTPUT as trigger source, and using the logic configuration available in the relay, graphical PLC, that allows to design logic circuits and to assign their outputs to internal variables, called VIRTUAL OUTPUT.

Available settings are as follows:

- ***Select*** checkbox: enables or disables the generation of each event.
- ***Name*** setting: defines the text for each control event.
- ***Source*** setting defines the source that triggers the event. The source is chosen from the list that shows all the operands available in the element.
- ***NOT*** checkbox inverts the selected signal.
- ***OR*** checkbox to select a group of operands instead of a single one. The relay performs an OR of the signals, and its output produces operation.
- ***Alarm*** checkbox: allows treating the event as an alarm and making the event activation to be reported on the alarm panel.

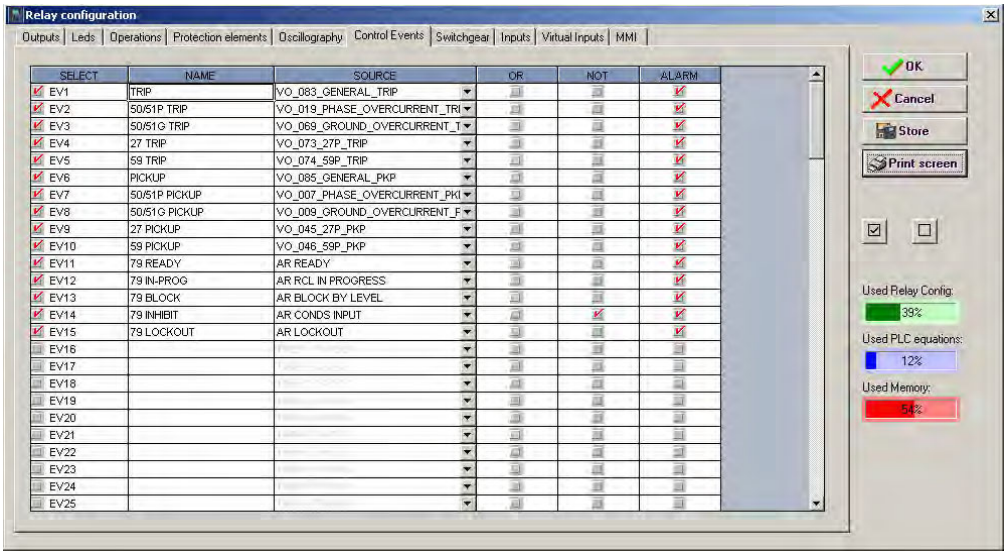


Figure 5-52: Control events configuration

The Alarm panel can be displayed in:

HMI screen for models with graphical display.

EnerVista 650 Setup: ***Actual>Event Recorder>Alarm Panel*** for all models.

Web Server application: ***http://xxx. xxx. xxx. xxx /Alarms.htm*** for all models.

If the event is not selected as an alarm, it can be viewed as an event at:

HMI screen for all models in snapshot event screen (with default text).

EnerVista 650 Setup: ***Actual>Event Recorder> Control Events*** for all models.

Web Server application: ***http://xxx.xxx.xxx.xxx/ControlEvents.htm*** for all models.

Alarm management in F650:

The relay can manage alarms in from three different masters, local, remote COM1, remote Ethernet. The alarms can be active or not active and can be acknowledged or not acknowledged. As shown in the following table:

Table 5-93: Alarm management

ALARM STATUS	MASTER MANAGEMENT		
ACTIVE - NOT ACTIVE	ALL MASTERS		
ACKNOWLEDGED - NOT ACKNOWLEDGED	LOCAL	REMOTE	
	COM2 & HMI	COM1	ETHERNET

ACTIVE status is shown on the display (relay HMI), showing an ON label on the right of the alarm. The PC shows the alarm text in red.

ACKNOWLEDGED: Operation acknowledgment can be performed from three independent channels: MMI-COM2 (local), COM1 (remote) and ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Ethernet). Inactive alarms disappear from the HMI when being acknowledged.

HMI: Acknowledged status is shown on the HMI with a selection mark on the right of the ON label.

EnerVista 650 Setup: the acknowledged status is shown by a check mark to the left of the Operation name.

5.9.8 Switchgear

This menu is used for defining the SWITCHGEAR elements to be controlled by the relay. A switchgear element can be a breaker, a line selector switch, a grounding selector switch, a busbar selector switch, etc. It is possible to define up to 16 switchgear elements. The settings are as follows:

- ***Select*** checkbox: enables or disables the control of a new switchgear element
- ***Contacts*** setting: allows selecting which type of contact is used for monitoring the status (open/closed) of the element. The selection can be: ***52a*** (contact type A, showing the same status as the represented element), ***52b*** (opposite status to the represented element), ***52a+52b*** (both types of contacts are used), ***NONE*** (no status monitoring).
- ***Opening Time*** setting: defines the maximum opening time of an element. It is used for issuing an opening time failure signal if the element opening is not produced within this time.
- ***Closing Time*** setting: defines the maximum closing time of an element. It is used for issuing a closing time failure signal if the element closing is not produced within this time.
- ***Contact A*** checkbox: allows selecting which operand or combination of operands activate the type A contact status. Usually it is an input contact wired to type A contact of the element (Breaker/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is ***52a*** or ***52a+52b***.
- ***OR*** checkbox: selects a group of operands instead of a single one. The relay performs and OR of the signals, and its output produces operation.
- ***NOT*** checkbox inverts the status of the signal selected in column ***Contact A***.
- ***Contact B*** checkbox: allows selecting which operand or combination of operands activates the type B contact status. Usually it is an input contact wired to type B contact of the element (Breaker/selector switch). This column and the next two columns are only active if the selected contact type in the Contacts column is ***52b*** or ***52a+52b***.
  - ***OR*** checkbox selects a group of operands instead of a single one. The relay performs OR of the signals, and its output produces operation.
  - ***NOT*** checkbox inverts the status of the signal selected in column ***Contact B***.
- ***Open text*** setting: allows associating a text to the control event associated with the element opening.
- ***Close text*** setting: allows associating a text to the control event associated with the element closing.
- ***Error 00 text*** setting: in case of using double contact for the switchgear element status (***52a+52b***), this setting allows to associate a text to the Error00 internal status, this means, when both contacts are inactive during a period longer than the associated with the opening or closing Operation, depending on which Operation is being performed.
- ***Error 11 text*** setting: in case of using double contact for the switchgear element status (***52a+52b***), this setting allows to associate a text to the Error11 internal status, this means, when both contacts are active during a period longer than the associated with the opening or closing Operation, depending on which Operation is being performed.
- ***ALARM*** setting: enables the issue of an alarm in the event of a close, open, 00-type, 11-type error. If it is configured as an alarm.
- ***Opening init*** setting: this setting selects which operand or combination of operands indicate the initiation of an opening operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the opening init must be configured in the operations tab inside relay configuration.
- ***Closing init*** setting: this setting selects which operand or combination of operands indicate the initiation of a closing operation, in order to allow the follow up of the operation and generate the corresponding alarms if the operation is not successful. The operation bit signal used to launch the closing init must be configured in the operations tab inside relay configuration.
- **Block Open:** allow selecting which operand or combination of operands activates the opening blocks for the switchgears (XSWISTBlkOpn and XSWISTBlkCls) for operating in 61850.

- **Block Close settings**: allow selecting which operand or combination of operands activates the closing blocks for the switchgears (XSWISTBlkOpn and XSWISTBlkCls) for operating in 61850.

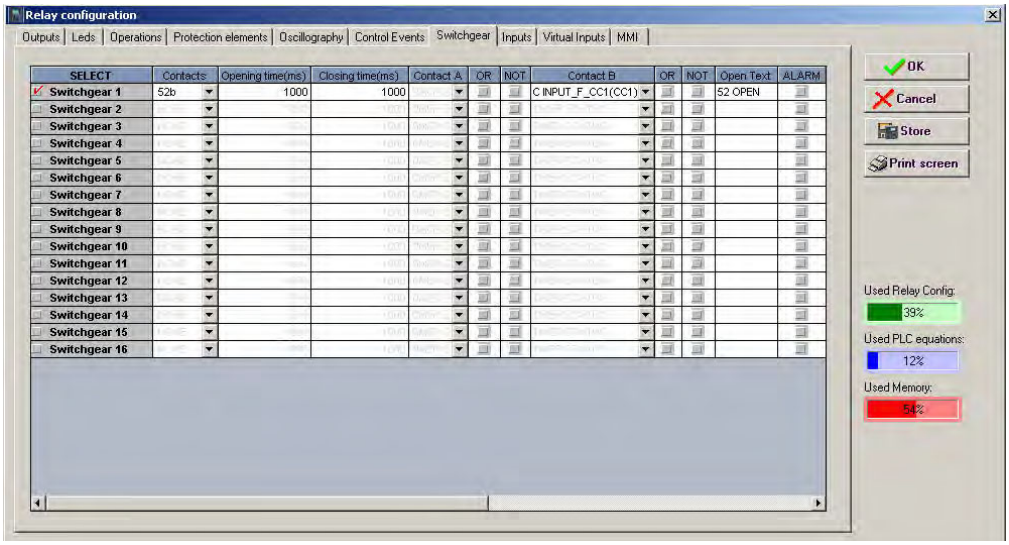


Figure 5-53: Switchgear configuration

Note: when a switchgear device is only monitored (open init and closing init signals are not used), it is not possible to distinguish between the fail to open or fail to close time, the time used to give an error 00 or 11 signal is the maximum of the opening and closing time configured for that switchgear.

5.9.9 HMI (human-machine interface)

This menu shows a scenario to draw a simplified one-line diagram of a bay in a feeder, line, transformer, etc. The menu includes a library for power elements, metering elements, text and drawings.

To use the drawing toolbar elements, select the desired element and then click the yellow area. The selected element is moved to the screen on the selected spot (see Figure 5-54: HMI configuration).

The graphic display can be used to configured switchgear elements, operations, metering values, date and time, etc. The configured values is always updated with the real status of the relay.

This functionality is only applicable to F650 elements with graphical display, and not for elements with alphanumerical display. Depending on the relay model, the graphical display can show IEC 1082-1 symbols (N option in order code).

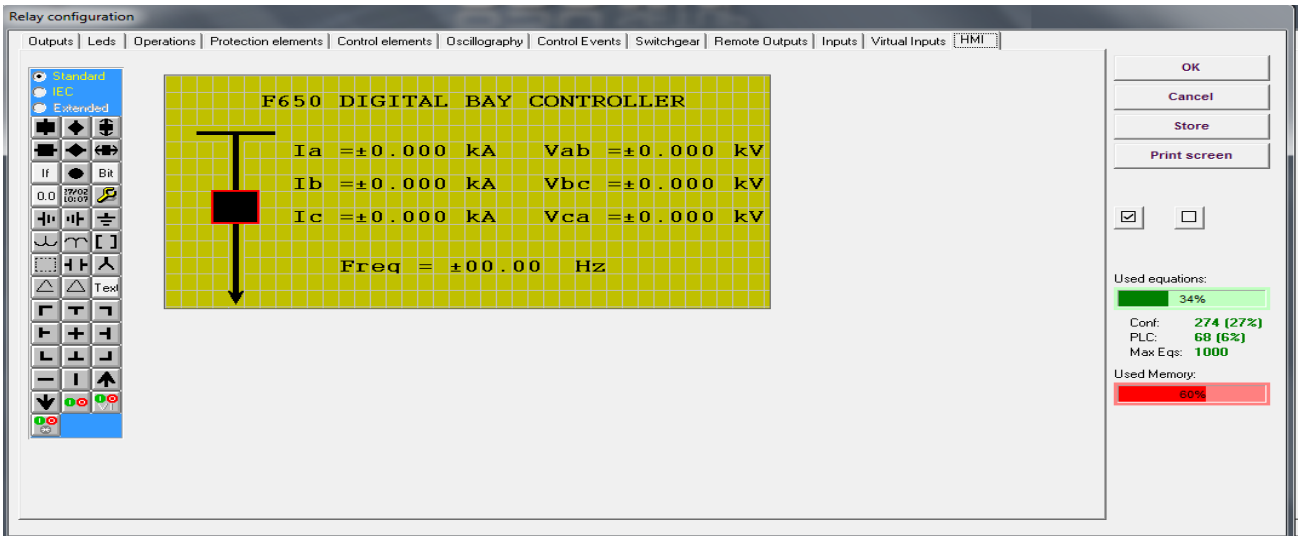
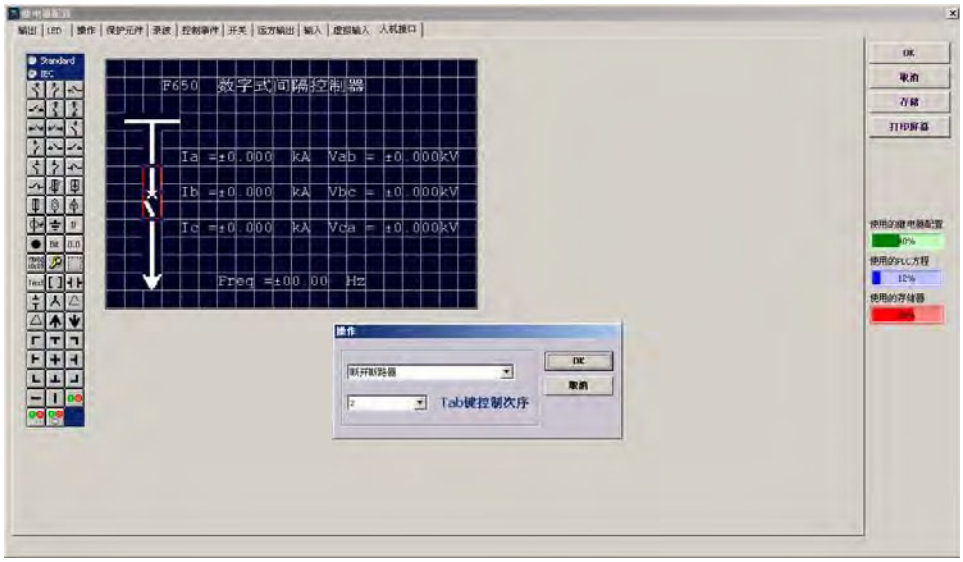


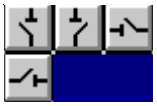
Figure 5-54: HMI configuration

For Chinese graphical displays (only available N option in order code) the configuration screen has the following appearance with full configuration capabilities:



On the left side of the window all the available elements to be programmed on the HMI are displayed. Their meaning is detailed on the right.

Table 5-94: Active configurable symbols in online diagram for graphical HMI

ACTIVE SYMBOLS	
ICONS IN SCREEN	DESCRIPTION
SWITCHGEAR SYMBOLS	STANDARD AND IEC 1082-1 SWITCHGEAR SYMBOLS
STANDARD SWITCHGEAR SYMBOLS	M and C selection for graphic display option in the order code
	Switchgear elements: breaker (square) and selector switch (rhombus), in vertical and horizontal positions. It is necessary to associate the figure to its corresponding switchgear number. The figure is shown filled if the element is closed, and blank if the element is open. The symbol on the right represents an unpluggable breaker. In this case it is necessary to indicate which operands show whether the element is plugged or unplugged. The figure shows also graphically these two statuses.
IEC SWITCHGEAR SYMBOLS	N and D selection for graphic display option in the order code
	Breakers and breaker trucks in vertical and horizontal positions. The first fourth symbols are breakers in vertical and horizontal positions for left and right options. The last fourth symbols are breaker trucks or unpluggable breakers. When the device is connected two arrows can be seen, if the device is not connected only one arrow is displayed. When the device it is inserted the device can be seen and when it is not inserted only a blank space is displayed
	Contactors in vertical and horizontal positions
	Selector switches in vertical and horizontal positions.
OTHER CONFIGURABLE SYMBOLS	Available for both M, N, C and D selection
MULTISTATE VARIABLE SYMBOL	
	Displays a dialog box on screen that is one variable status function (like a switch case) for the following internal states AR STATUS, AR LOCKOUT MODE, AR BLOCK MODE and FAULT TYPE. This type of data allows to visualize the different states of one particular value, for example, AR STATUS has several states such as (0) OUT OF SERVICE, (1) READY, (2) LOCKOUT, (3) BLOCK, (4) RECLOSE IN PROGRESS. Significant texts can be associated with those states.
STATUS SYMBOLS	(TEXT AND GRAPHIC MODES):
	Bit: Represents the state of an operand by means of a configurable text. It allows associating a test to the active status and a different text to the inactive status.
	Led(O) Performs the same function in a graphical mode. This way, it works as a virtual LED. When showing a black circle, it means that the selected operand is active, and if the circle is blank, the operand is inactive
ANALOG MAGNITUDE SYMBOL	
	Used for displaying analog magnitudes (current, voltage, power, etc.) in floating point numbers, such as a current value (123.5 A). Both the number of decimals and the integer characters can be selected, in order to facilitate the reading. Any of the analog magnitudes available in the relay can be configured.

ACTIVE SYMBOLS	
Icons On Screen	Description
DATE AND TIME SYMBOL	
	Display the date and time provided by the device in the HMI.
OPERATIONS SYMBOL	
	Configure and execute operations on the graphic display. This symbol can only be selected once the operations have been configured in the **Operations** screen of the **Relay Configuration** menu. To select an Operation, click the element and then the display. A window opens to select the operation and the tab order. Once selected, a red border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute this operation, the object on which it is located blinks. It is possible to place several operations on the same object, for example to open and close the breaker object.
	Configure and execute operations with the front keys "I" and "O" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required operations "I" and "O" and the tab order. Once selected, a blue border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute these operations, the object on which it is located blinks. Press key "I" or "O" to execute the configured operations.
	Configure and execute operations with the front keys "I", "O" and "*" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required operations "I", "O" and "*" and the tab order. Once selected, a green border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute these operations, the object on which it is located blinks. Press key "I", "O" or "*" to execute the configured operations. After executing this kind of operation, information about the result of the operation is displayed on the HMI.
	Configure and execute virtual inputs with the front keys "I" and "O" on the graphic display over an object selected. To select the object, click the element and then the display. A window opens to select the required virtual operations "I" and "O" and the tab order. Once selected, a white border square is shown. Place this square on the object to operate. When the object is selected on the screen to execute this virtual inputs, the object on which it is located blinks. Press key "I" or "O" to set the configured virtual inputs.

Table 5-95: GRAPHIC AND TEXT EDITION SYMBOLS

GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	DESCRIPTION	AVAILABILITY
	Ground symbols in different positions.	The first two are not available in the N model (IEC selection).
	Voltage Transformers representation	Only for standard model M.
	Two and three winding voltage transformers representation.	Only for N model (IEC selection)

	Current transformer representation	Only for N model (IEC selection).
	Symbols reserved for future uses	Both M and N selection
	Symbol for capacitor banks.	Both M and N selection
	Symbol for vertical capacitor banks.	Only for N model (IEC selection).
	Symbol for wye connection	Both M and N selection
	Symbol for open delta and delta connection	Both M and N selection
Text	Display of a fix text up to 40 ASCII characters	Both M and N selection
	Auxiliary drawing lines	Both M and N selection

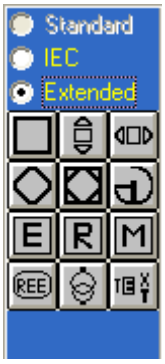
EXTENDED GRAPHIC SYMBOLS

For the extended graphic symbols, extraction device must be set to 52a+52b switchgear device.

Table 5-96: GRAPHIC AND TEXT EDITION SYMBOLS

EXTENDED GRAPHIC AND TEXT EDITION SYMBOLS		
ICONS IN SCREEN	DESCRIPTION	AVAILABILITY
	Breaker	Only for N model (IEC selection)
	Breaker+Extraction device (Vertical)	Only for N model (IEC selection)

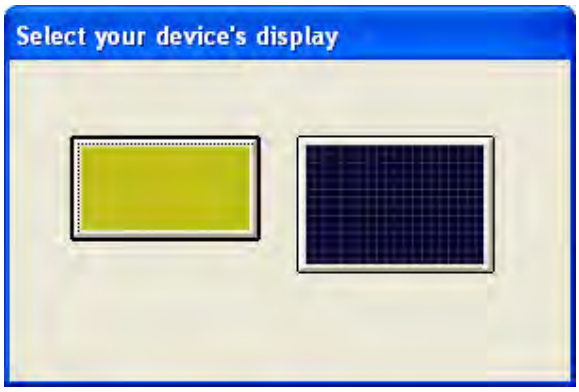
	Breaker+Extraction device (Horizontal)	Only for N model (IEC selection)
	Isolator	Only for N model (IEC selection)
	Isolator Remote controlled	Only for N model (IEC selection)
	Neutral Reactance	Only for N model (IEC selection)
	“Encravado” Interlocked	Only for N model (IEC selection)
	Autorecloser In Service/ Out of Service	Only for N model (IEC selection)
	“M”/”A” Symbol for Manual/Automatic	Only for N model (IEC selection)
	“Regime Especial Exploração”	Only for N model (IEC selection)
	Voltage transformer	Only for N model (IEC selection)
	Different Text properties (Bold/Vertical/Reverse Video)	Only for N model (IEC selection)



5.9.10 Device display selection

5.9.10.1 Type of graphical display

On offline mode, when creating a new setting file (*.650), when entering on SETPOINT > RELAY CONFIGURATION > HMI, it is possible to choose the display type that is wanted to configure from two types of graphical displays depending on the order code. Green one for standard models and the black one for “N” model IEC selection.



5.10 Logic configuration (PLC editor)

Setpoint > Logic Configuration

The logic configuration (or PLC Editor) tool is a graphical design tool that allows the F650 built complex logic diagram in an easy way using different logic functions.

The logical configuration is performed using graphical functions based on the IEC 61131-3 standard.

- This standard defines five basic ways of programming:
  - •Sequential Function Chart (SFC).
  - •Instruction List (IL).
  - •Structured Text (ST).
  - •Ladder Diagram (LD).
  - •Function Block Diagram (FBD).

Out of these five methods, FBD has been chosen because it allows for graphical configurations that are more comprehensive. This method provides the possibility of grouping several basic functions inside a single function (hereon called libraries), achieving higher modularity and clarity in the design.

NOTICE

The first equation entered in the PLC can never be a timer

Analog elements (analog comparators, etc,) are not implemented.

5.10.1 Theory of operation

5.10.1.1 Description

As already mentioned in the introduction, this tool uses FBD mode of IEC 61131-3 standard. For this purpose we have defined a series of basic operations with illustrations below.

The basic operations available in the PLC Editor are located in the tool bar of the application and are as follows:

Table 5-97: PLC editor basic operation in F650

PLC EDITOR BASIC OPERATION	
ICONS IN SCREEN	DESCRIPTION
	INPUT TO LOGIC: Selection of the digital input to the logic. (All available internal status can be used as logic inputs **)
	OUTPUT FROM LOGIC: Virtual output built with internal logic. (Up to 512)
	LIBRARY: Possibility to build blocks of logic in a simple graphic object. OR and AND from 3 to 8 inputs are provided as libraries.
	AND of two digital inputs.
	OR of two digital inputs.
	NOT of a digital input.
	NAND of two digital inputs.
	XOR of two digital inputs.
	SR: Latch (set-reset): reset dominant.
	ONS: signal to pulse an logic input to a signal of one scan cycle length.
	TIMER: timer signal with set, reset and mask for timing.
	TEXT LABEL: text to customize the logic configuration file.
	Flip-Flop D: signal that maintains the actual value frozen during a PLC cycle
	MASK: Time mask to be used in timing operations.

For firmware 7.20 or above, analog operands are available. It is possible to use these operands with analog or digital values.

The basic operations available in PLC Editor are located in the tool bar of the application and are as follows:

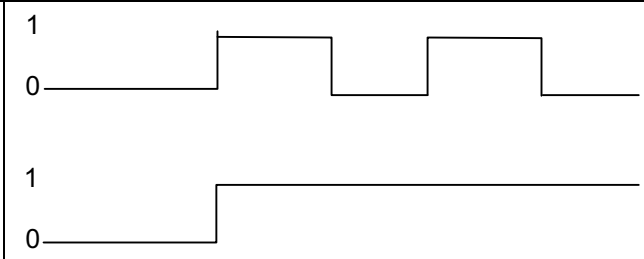
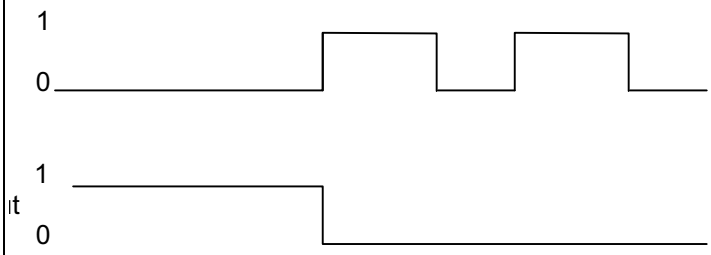
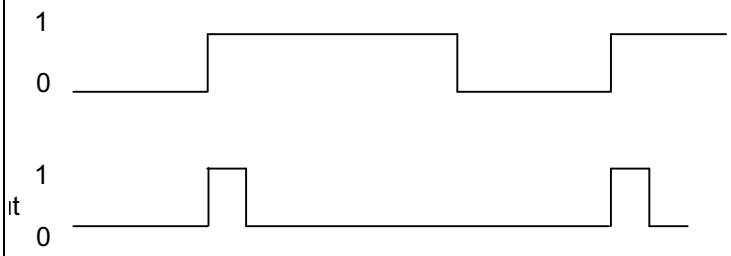
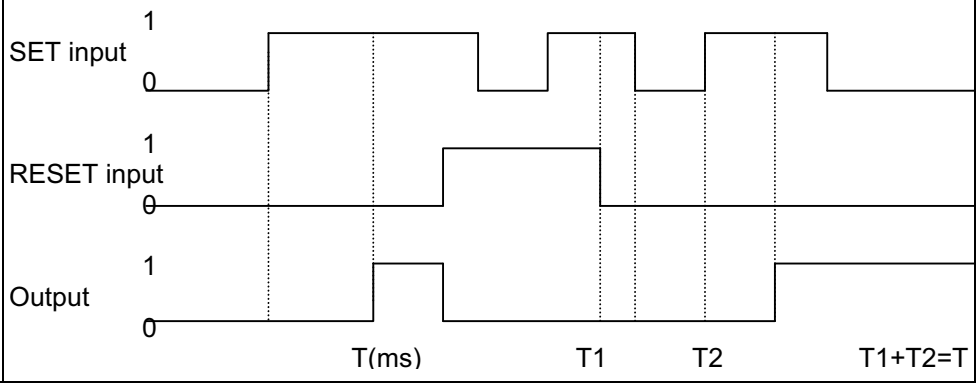
PLC EDITOR ANALOG OPERATION	
ICONS IN SCREEN	DESCRIPTION
	GREATER THAN COMPARATOR of two digital or analog inputs.
	EQUAL TO COMPARATOR of two digital or analog inputs

	MULTIPLIER of two digital or analog inputs
	DIVIDER of two digital or analog inputs
	ADDER of two digital or analog inputs
	SUBTRACTOR of two digital or analog inputs

**NOTE1: For firmware version 7.20 or above, two new inputs have been added; PLC_BOOL_ON and PLC_BOOL_OFF. These two inputs are set always to PLC_BOOL_ON =1 and PLC_BOOL_OFF =0 and their values are not accessible via protocol and cannot be modified.

Example of logic signals in F650 logic configuration:

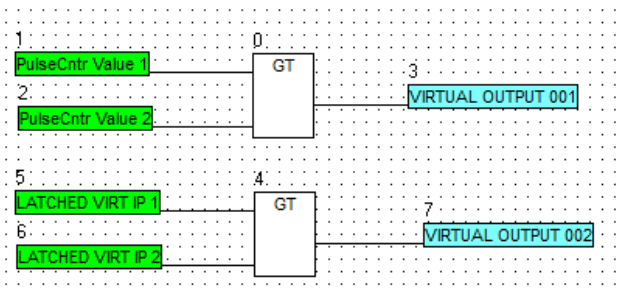
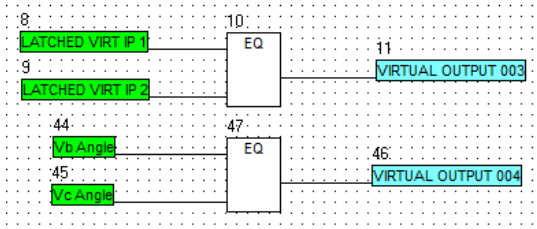
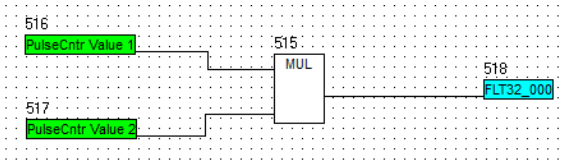
Table 5-98: Logic signals in F650

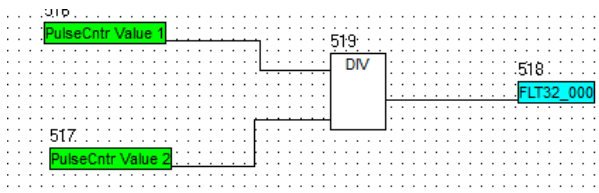
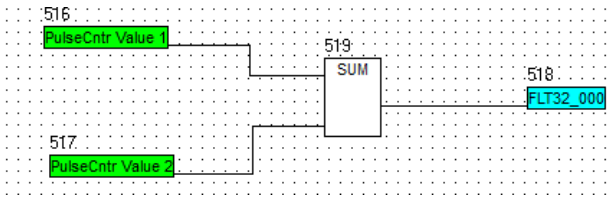
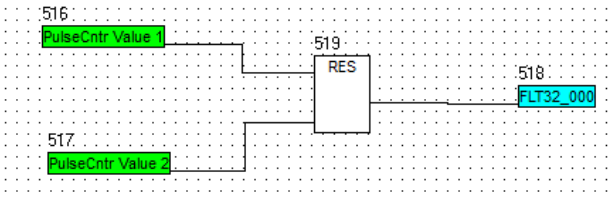
LOGIC SIGNALS EXAMPLES		
SIGNAL	DESCRIPTION	TIME DIAGRAM
SET	When the input signal is set to 1 the output signal remain fixed to 1 until a reset signal is received.	
RESET	When the input signal is reset to 1 the output signal remain fixed to 0.	
ONS	The input signal is pulsed. The width of the output pulse is the same as that of the PLC cycle	
TIMER	With selectable time (MASK), one SET input and one RESET input	

Example of analog operands in F650 logic configuration:

Table 5-99: Analog operands in F650

When this operand is used, Subtraction between two inputs is performed and result is stored into variable assigned to subtraction output.

ANALOG OPERANDS		
Operands	**Example**	**Description**
GREATER THAN		<u>Analog Variables:</u> 1. If Pulse Cntr value 1 > Pulse Cntr value 2 then Virtual output is set to 1 2. If Pulse Cntr value 1 = Pulse Cntr value 2 then Virtual output is set to 0 3. If Pulse Cntr value 1 < Pulse Cntr value 2 then Virtual output is set to 0 <u>Digital Variables:</u> 1. If Latched Virtual input 1 =0 & Latched Virtual input 2 =0 then Virtual output is set to 0 2. If Latched Virtual input 1 =1 & Latched Virtual input 2 =1 then Virtual output is set to 0 3. If Latched Virtual input 1 =1 & Latched Virtual input 2 =0 then Virtual output is set to 1 4 If Latched Virtual input 1 =0 & Latched Virtual input 2 =1 then Virtual output is set to 0
EQUAL TO		<u>Analog Variables:</u> 4. If Vb Angle > Vc Angle then Virtual output is set to 0 5. If Vb Angle = Vc Angle then Virtual output is set to 1 6. If Vb Angle < Vc Angle then Virtual output is set to 0 <u>Digital Variables:</u> 5. If Latched Virtual input 1 =0 & Latched Virtual input 2 =0 then Virtual output is set to 1 6. If Latched Virtual input 1 =1 & Latched Virtual input 2 =1 then Virtual output is set to 1 7. If Latched Virtual input 1 =1 & Latched Virtual input 2 =0 then Virtual output is set to 0 8. If Latched Virtual input 1 =0 & Latched Virtual input 2 =1 then Virtual output is set to 0
MULTIPLIER		Result of multiplication of both inputs is stored into variable assigned to Multiplier output

DIVISION		Result of division of both inputs is stored into variable assigned to Division output. If Input 2=0 Then result of division is stored as 0.
ADDITTION		Result of multiplication of both inputs is stored into variable assigned to addition output
SUBTRACTIO N		When this operand is used, Subtraction between two inputs is performed and result is stored into variable assigned to subtraction output.

5.10.1.2 Logic compilation

The F650 configuration is made using the basic operations related before and more complex operations can be developed inside libraries.

All the graphical configuration performed in the Logic configuration editor must be read and interpreted by the PLC as the F650 engine. The graphical equations must be translated into compiled equations to be understood by the relay. For this purpose the logic configuration editor provides a compilation option to compile the whole configuration, creating a series of equations that forms the logical configuration of the element.

The next diagram shows the way compiled logic equations are built.

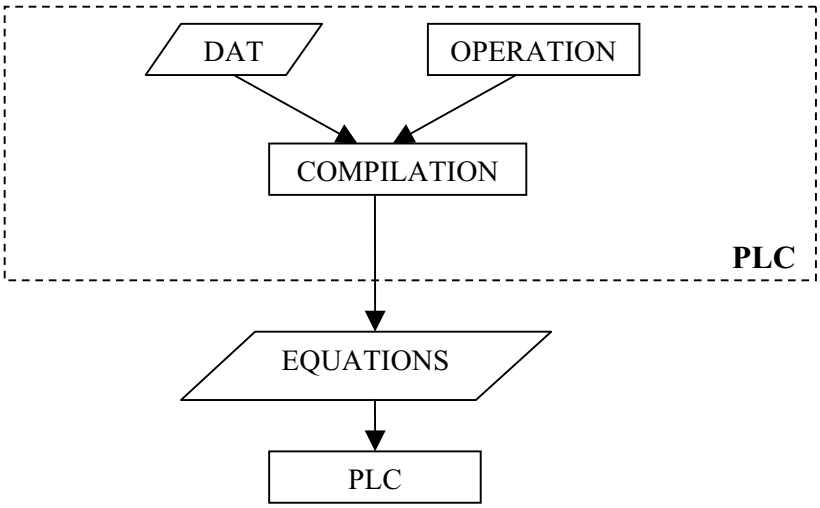


Figure 5-55: Compiled logic equations

A single equation is composed of one or more inputs, one or more operations, and one output. The order of equations is determined by the relative position of their outputs.

In the following example is shown the order of compilation for equations determined by their relative position in the configuration file:

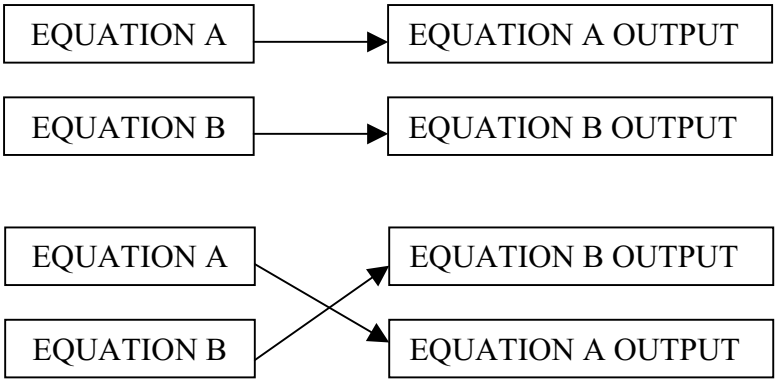


Figure 5-56: Order of equations

In this case, equation A is the first to be executed. However, in the second case, the first equation to be executed would be B, as its output is before the Equation A output.

5.10.2 Main menu

The PLC Editor tool *(***Setpoint > Logic Configuration***)* provides a main menu with different sub menus (File, Project, Edit, Run, View, and Window) that allows the user to built customized logic for the F650 devices.

File menu

The FILE menu includes the following options:

New Project: Create a new project that includes the logic configuration files.

Open Project: Open an existing project.

Close Project: Close the currently open project.

Import***: Obtain the PLC project information (*.pep, *.aut, *.lib files) from another *.650 file (firmware version 7.70 or above) to insert in the open *.650 file.

Export***: Extract the PLC project information (*.pep, *.aut, *.lib files) from the open *.650 configuration file, and save it to the local PC.

Get Project from Relay:** Retrieve a previously saved project from the relay.

Save Project / Save Project as**: Save the open project.

Save Automatic Function &

Save Automatic Function As**: Save the file of the active project.

Library: Give access to the library sub-menus, where new libraries can be created and existing libraries can be modified and saved.

Print: Print the active configuration file.

Preview: Preview of the document before printing.

Exit: Close all open projects and exit the application.

***Option only available for firmware v7.70 or above.

** Option only available for firmware below v7.70.

Project menu

The Project menu includes the following options:

Project Explorer: Display a tree structure showing all files contained in the project.

Insert library: Insert a library in the active automatic function.

Edit menu

The Edit menu includes the following options:

Undo: Undo the last modification in the active function.

Redo: Repeat the last modification.

Cut: Cut one or more logic operations.

Copy: Copy one or more logic operations.

Paste: Paste one or more logic operations.

Find: Search for a logic operation in the project.

Copy as Bitmap: Copy the active automatic function to the clipboard in picture format.

View Clipboard: Launch the clipboard viewer application.

Run menu

The RUN menu includes the following options:

Configuration: Not valid in the current application (for analog operations still not available).

Compile: Compile the configuration functions to generate the equations that are interpreted by the 650 PLC.

Save Configuration file***: Save compiled equations into *.650 configuration file

***Option only available for firmware v7.70 or above.

View menu

The VIEW menu includes the following options:

Log: Display the status name and time stamp of the digital statuses configured in the PLC logic (still not available).

Equations: Display the equations resulting from the compilation.

Grid: Show or hide the form grid where the configuration functions are developed. It also aligns the different objects to the grid.

Zoom: Allow selection of the percentage of zoom in the application.

Rectangle Zoom (Zoom rectangular): Allow zooming the selected rectangle.

5.10.3 Configuration generation

5.10.3.1 Create new project

Click **File > New Project** to open a new PLC project for programming the desired automation. An automation can be formed by one or more equations.

5.10.3.2 Create equation

A single equation can be formed by one or more inputs, one or more operations, and one output. The order of equations is determined by the relative position of their respective outputs, this order being downward. To link the output of an equation with the input of another equation, an internal variable (virtual output) must be used. The virtual output is used as an input to the second equation.

5.10.3.3 Add input to automation

Click the button that represents the inputs in the toolbar at the top of the screen. A logic input can be any of the available digital internal status provided by the relay. Such as protection status, contact inputs, contact outputs, I/O status, other protection status, front keys, LEDs, operation bits, virtual inputs and virtual outputs.

5.10.3.4 Add output to automation

Click the button that represents the outputs in the toolbar at the top of the screen. The logic outputs are virtual outputs (up to 512 configurable signals), virtual metering (up to float 32 signals, up to 50 int 32 signals) or virtual output latched (up to 16 signals).

5.10.3.5 Add digital operation

Click any of the digital operations in the toolbar at the top of the screen, and then click the window background. A box with the selected digital operation is displayed and the inputs and outputs must be connected to the logic box as explained before.

5.10.3.6 Link inputs, outputs, and operations

The user can link the different graphic objects clicking on an object output and dragging to the input of another graphic object. Graphic objects available in the PLC configuration are digital objects.

There is a series of restrictions when performing connections:

It is not possible to auto-link an object; the output of a certain object cannot be linked to its input;

There can only be one input per object input;

RESET and SET outputs must be internal variables or outputs.

We must take into account that as the timer is a digital operation that operates as an analog, there must only be a single internal variable or digital input in the timer input.

5.10.3.7 Add library

Click **LIB** and select the corresponding file.

Users can build their own libraries and distribute them in their projects in an easy way.

The manufacturer provides default libraries such as ORs, ANDs of 3 up to 8 inputs, besides timers (pickup-dropout) and key examples.

5.10.4 Library generation

Libraries can contain a set of operations grouped in a single graphic object being formed by inputs, outputs and operations

Working with libraries follows the same procedure as working in the main project menu, the only difference is that the inputs and outputs to the library must be selected as external inputs and outputs. The rest of variables are internal variables used in the logic compilation.

The name assigned to the inputs and outputs of the library and to the library itself are used to represent the library as an object in the main project.

Internal variables inside the libraries are assigned randomly when compiling.

These libraries are saved in the LIB folder in order to be used in further projects

5.10.4.1 Library example

Go to the main menu **File >Library > Open Library > New Library**

Open a new library or modify an existing one, in this example a timer library is going to be displayed Timer (Pkp-Dpt).lib as shown on Figure 5-57: Timer (PKP-DPT).LIB configuration example

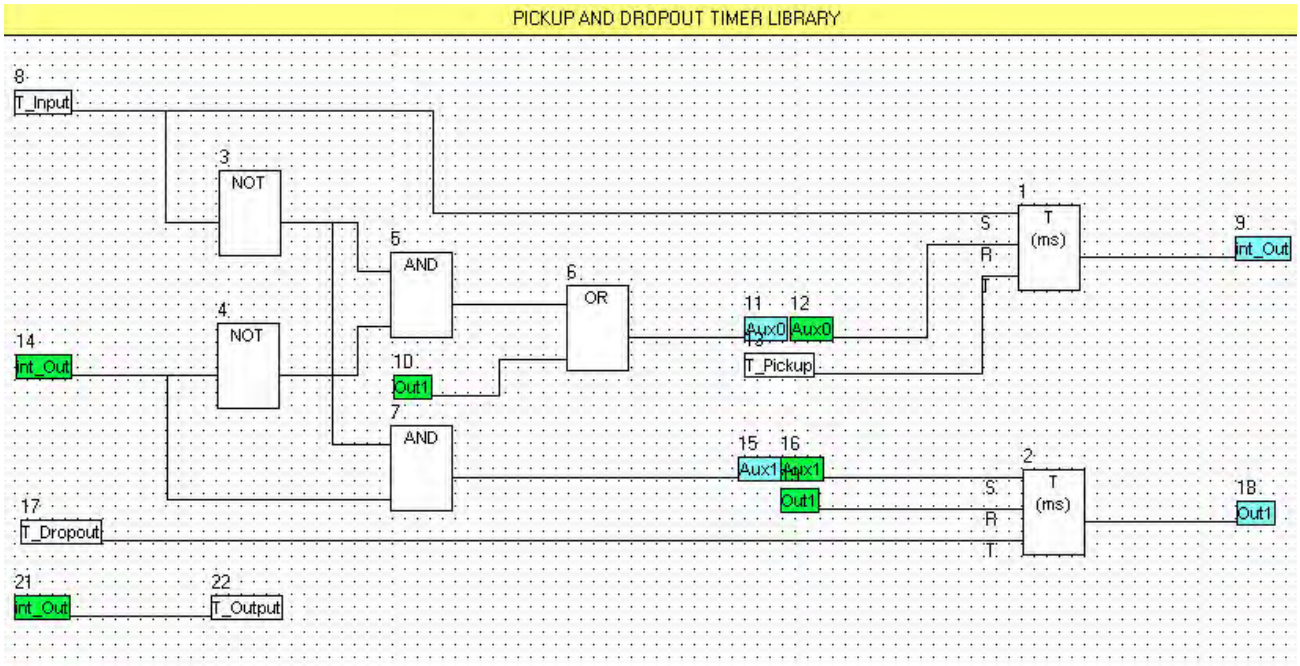


Figure 5-57: Timer (PKP-DPT).LIB configuration example

Green and blue signals are internal inputs and outputs used in the library and are not going to be accessible to the user when working in the main menu outside the library environment. The white boxes (T_Input, T_Pickup, T_Dropout, T_output) are inputs and outputs to the library that are going to be accessible to the user to connect the library in the main application to create virtual outputs to be sent to the relay.

Once the library is created and saved it can be selected in the main application menu in ***Project > Insert Library.*** The library has the following object:

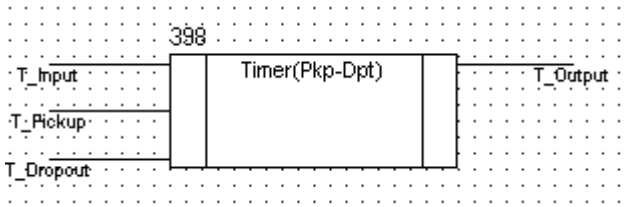


Figure 5-58: Library object

5.10.5 Application example

In this section a simple logic application is described step by step, a logic is such that keeping one digital input activated, several outputs are activated and deactivated in a time window (outputs remain activated for 200 ms and deactivated for 5 ms). See the following figure:

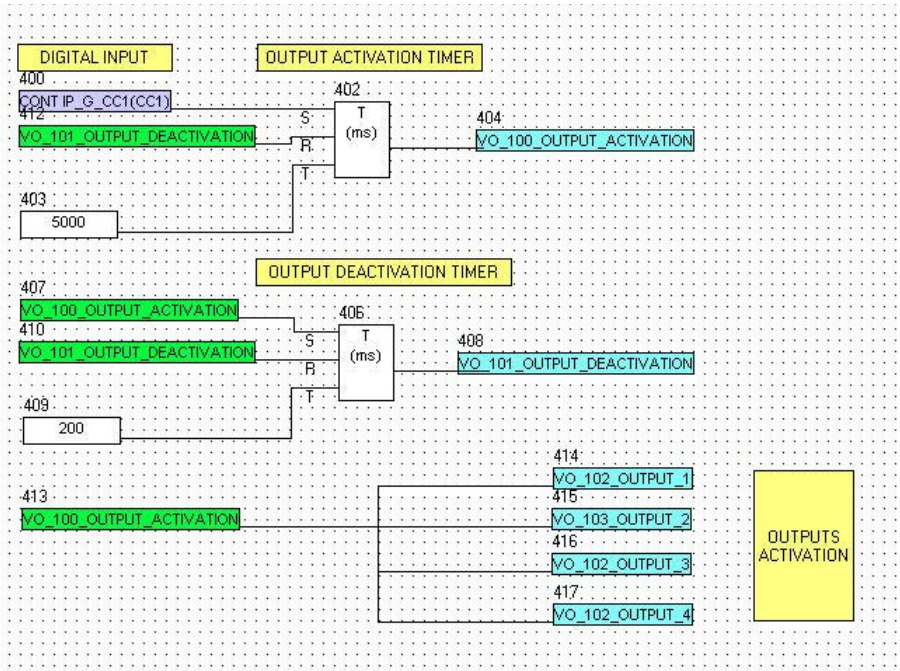


Figure 5-59: Logic example

Go to the main menu and select **File >New project,** create a new project and select an input in the icons toolbar on the top of the window. This input is selected as a digital input among the several options for inputs that can be selected. This input is the SET input for the first timer to launch the output activation signal. Click the icon related to the timer to insert the timer on the project. The timer has three inputs (S=set, R=reset and T=timing input)

The reset signal of the first timer is a virtual output called output_deactivation that has been created as an output of another second timer. This signal is selected as an output

The timing signal for the first timer is a mask provided by the application, in which the time in milliseconds must be entered in order to configure the timer time delay.

After creating the first timer, the second one for output deactivation is made. The set signal is the virtual output created as an output of the first timer (VO_100_OUTPUT_ACTIVATION), the reset signal is the output of the second timer (VO_100_OUTPUT_DEACTIVATION), the time delay is set as 200 ms.

Once the timing logic (timer 1 + timer 2) has been created, the activation signal (VO_100_OUTPUT_ACTIVATION) is linked to several virtual outputs. Therefore, virtual outputs (VO_102_OUTPUT_1, VO_103_OUTPUT_2, VO_104_OUTPUT_3, VO_105_OUTPUT_4) are activated if the CONT IP_G_CC1(CC1) variable is set to 1. Once the VO_100_OUTPUT_ACTIVATION is active, it is deactivated after 200 ms, and remains deactivated for 5 seconds. This process is repeated while the digital input is active.

To finish the process the logic must be compiled (***Run >Compile***) and the equations sent to the relay (***Run >Send Equations to relay***) to start working with the new logic.

5.11 IEC 61850 configuration

The 61850 Configuration option is only available if the F650 supports this protocol (6 in the order code for protocol selection) with firmware versions 3.44 or lower. For firmware versions 3.60 or higher ones, go to section 7.6 IEC 61850 Configurator.

This menu is located in **Setpoint > 61850 Configuration**

The user can configure some 61850 parameters in the F650.icd file, and then send this file to the relay. The parameters that can be configured are:

Domain name parameters:

- IED Name
- LD Name from the Domain Name

Ethernet parameters:

- IP Address
- Subnet Mask
- Gateway

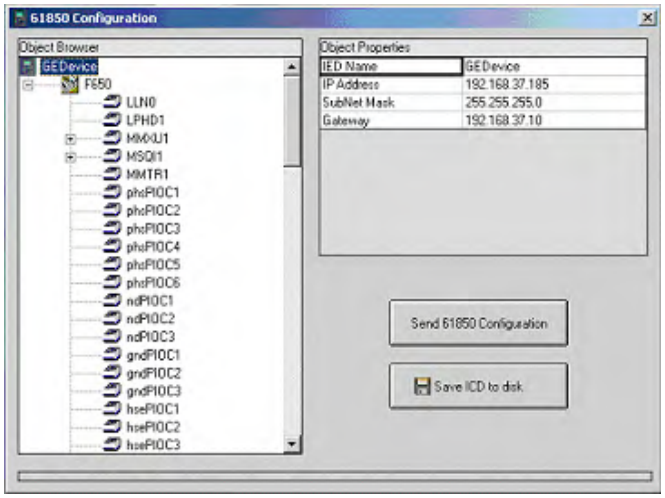


Figure 5-60: IED name and Ethernet parameter configuration

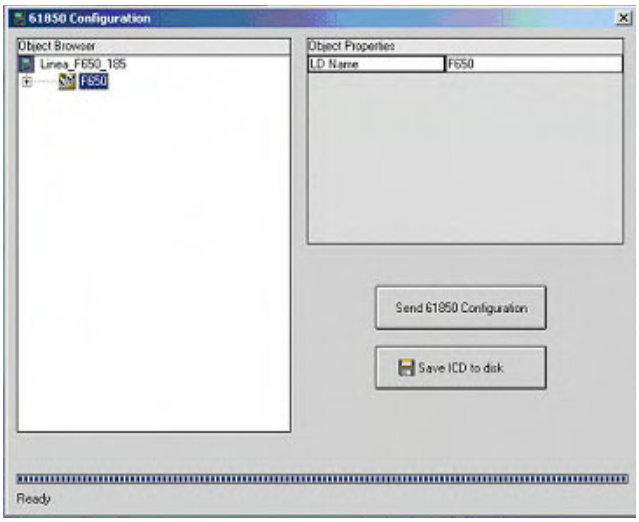


Figure 5-61: LD name configuration

MMXU parameters:

The MMXU deadband settings represent the deadband values used to determine when updating the MMXU.mag. and .cVal. values from the associated .instmag. and .instcVal. values.

The .mag. and .cVal. values are used for the IEC 61850 buffered and unbuffered reports. These settings correspond to the associated .db data items in the CF functional constraint of the MMXU logical node, as per the IEC 61850 standard. According to IEC 61850-7-3, the db values represent the percentage of difference between the maximum and the minimum in units of 0.00%. Thus, it is important to know the maximum value for each MMXU measured quantity, since this represents the 100.00% value for the deadband. The minimum value for all quantities is 0; the maximum values are as follows:

A value of 1000 represent the 1% of the scale.

The minimum and maximum main values (secondary) are:

-For Current 0 to 160 A

-For Voltage 0 to 300 V

-For frequency 0 to 70 Hz

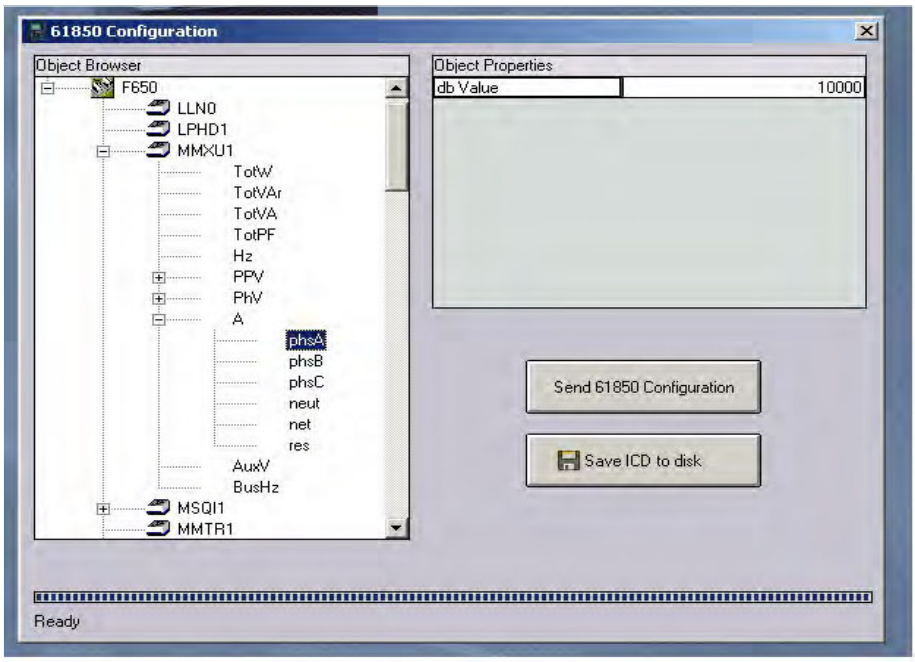


Figure 5-62: MMXU deadband setting configuration

5.12 Procome configuration

The Procome Configuration option is only be available if the F650 supports this protocol (5 in the order code for protocol selection).

This menu is located in ***Setpoint > Procome Configuration***

When opening the Procome configuration tool, either open a "f650procome.cfg" file or continue to the procome configuration tool with no file selected. The procome configuration can be retrieved from the relay by clicking **Retrieve Configuration**. Changes can be saved to the f650procome.cfg configuration file, and then sent to the relay by clicking **Send Configuration**. In order to start working with the new procome configuration, the relay must be switched off and on.

The Procome slave can be identified (besides the slave number) with a long name (8 characters identifier) and with a sort name (4 characters identifier) that can be set in the Procome configuration file.

The control data that can be configured can be classified in digital signals, measurements and operations. The user can configure some Procome parameter in the f650procome.conf file and then send this file to the relay. The parameters that are possible to configure are:

Digital signals:

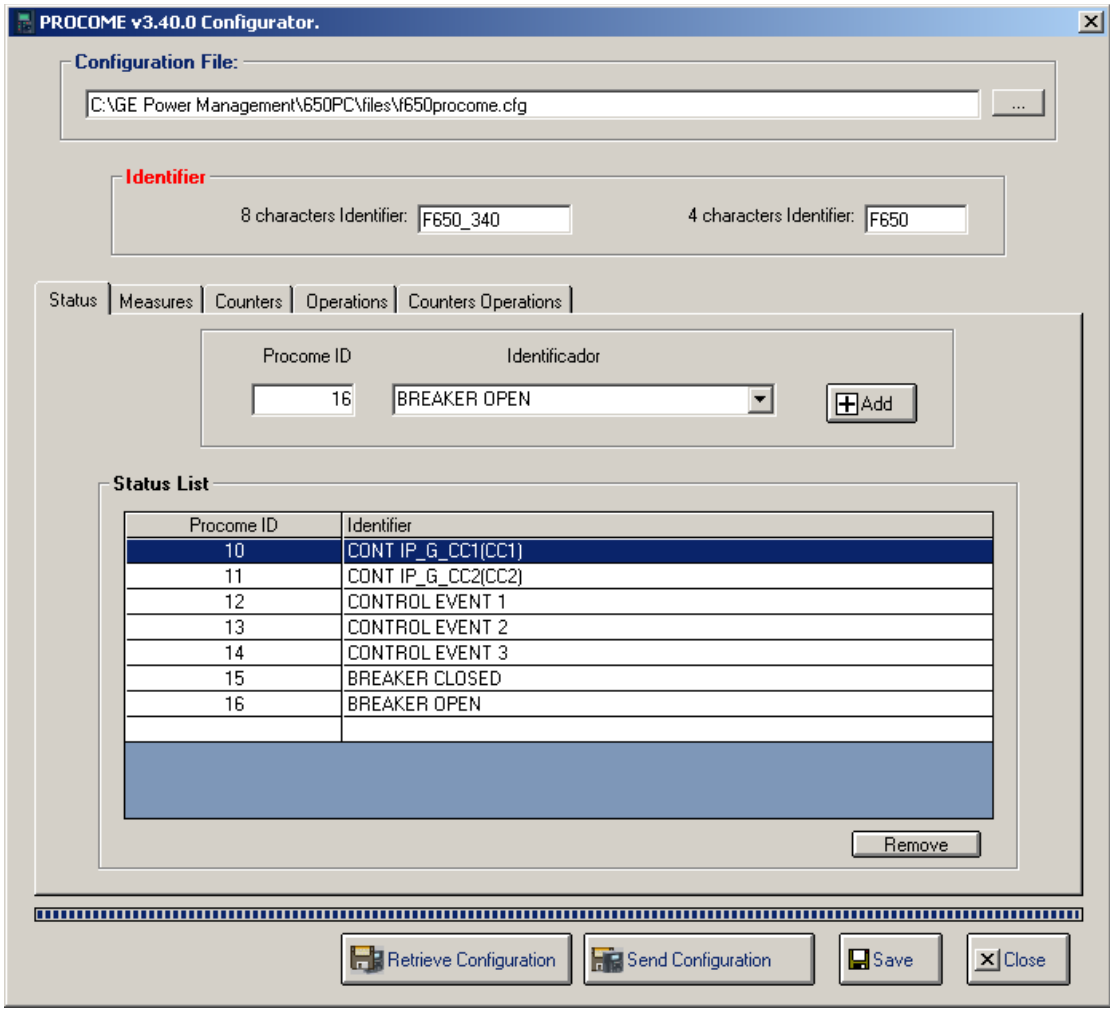


Figure 5-63: Digital signal configuration

The user must select the digital signals to be sent to the Procome master configuring the identifier number (Procome ID) for each of them. Take into account that this Procome ID is the bit in which is set the digital signal configured in that ID, for example, it the contact input 1 from the board G is configured to the Procome ID 10, the signal 10 is located in the byte 1 bit 2 of the answer sent by the Procome slave.

To configure a new signal, set the Procome ID selected for that signal, select the digital signal, and then click **Add** to add the new signal to the status list of signals configured in the Procome configuration file. To remove an existing signal from the status list, select the signal and click **Remove**. To save the data in the configuration file, click **Save**; all data is stored in the "f650procome.cfg" file.

Analog Measurements

In the measurements configuration screen, for each measurement selected the configuration signals are:

- Procome ID: the identification number for each measurement
- Identifier: the measurement selected to be sent in the Procome slave answer
- Factor: the multiplier factor to be applied to the relay measurement to make the final measurement calculation to be sent to the master

- Offset: an offset factor to be applied to the relay measurement to make the final measurement calculation to be sent to the master

The Factor and offset parameters allow the user to perform different scaling in the relay measurements. The final measurement sent to the Procome master is: a*x+b, where x is the relay measurement, a is the multiplier factor and b is the offset.

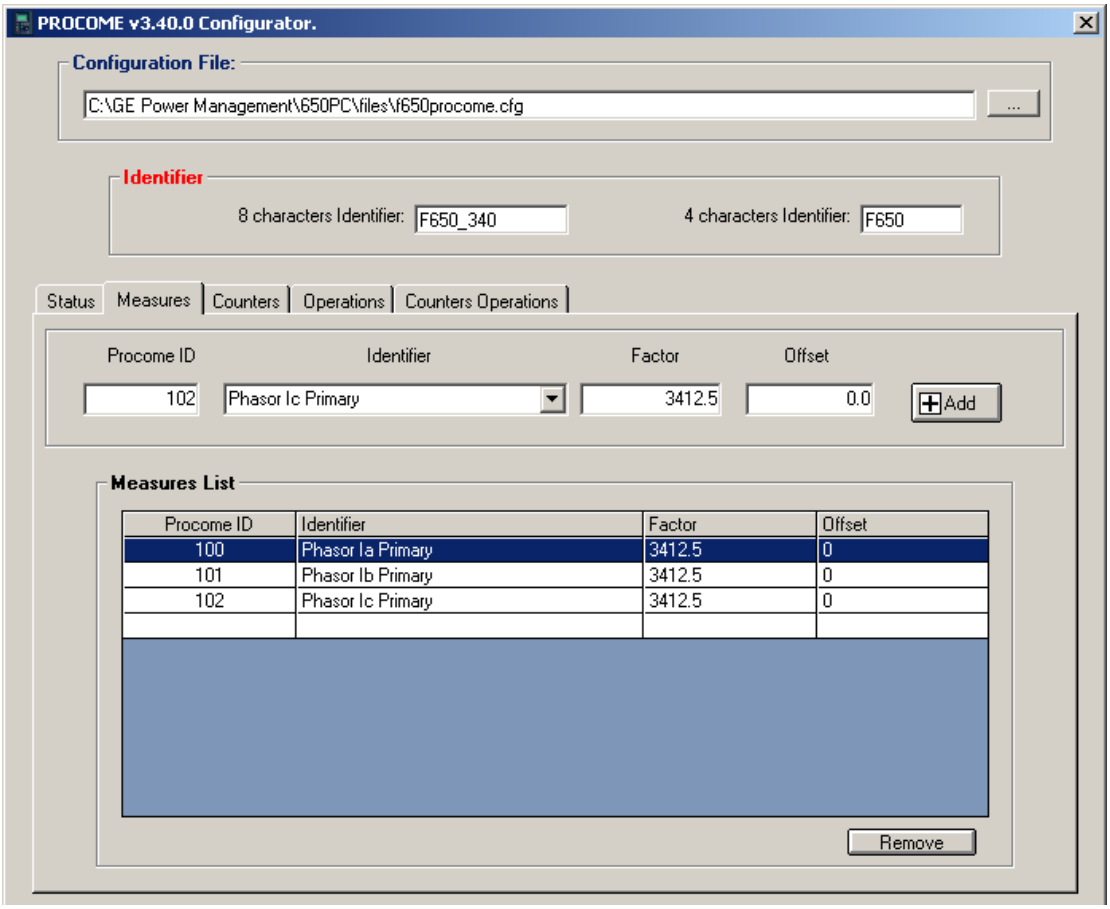


Figure 5-64: Measurement configuration

Counters

The counters (pulse counters and energy counters) have the same management as the measurements, this is Procome ID, Identifier, Factor and offset configuration for each of them.

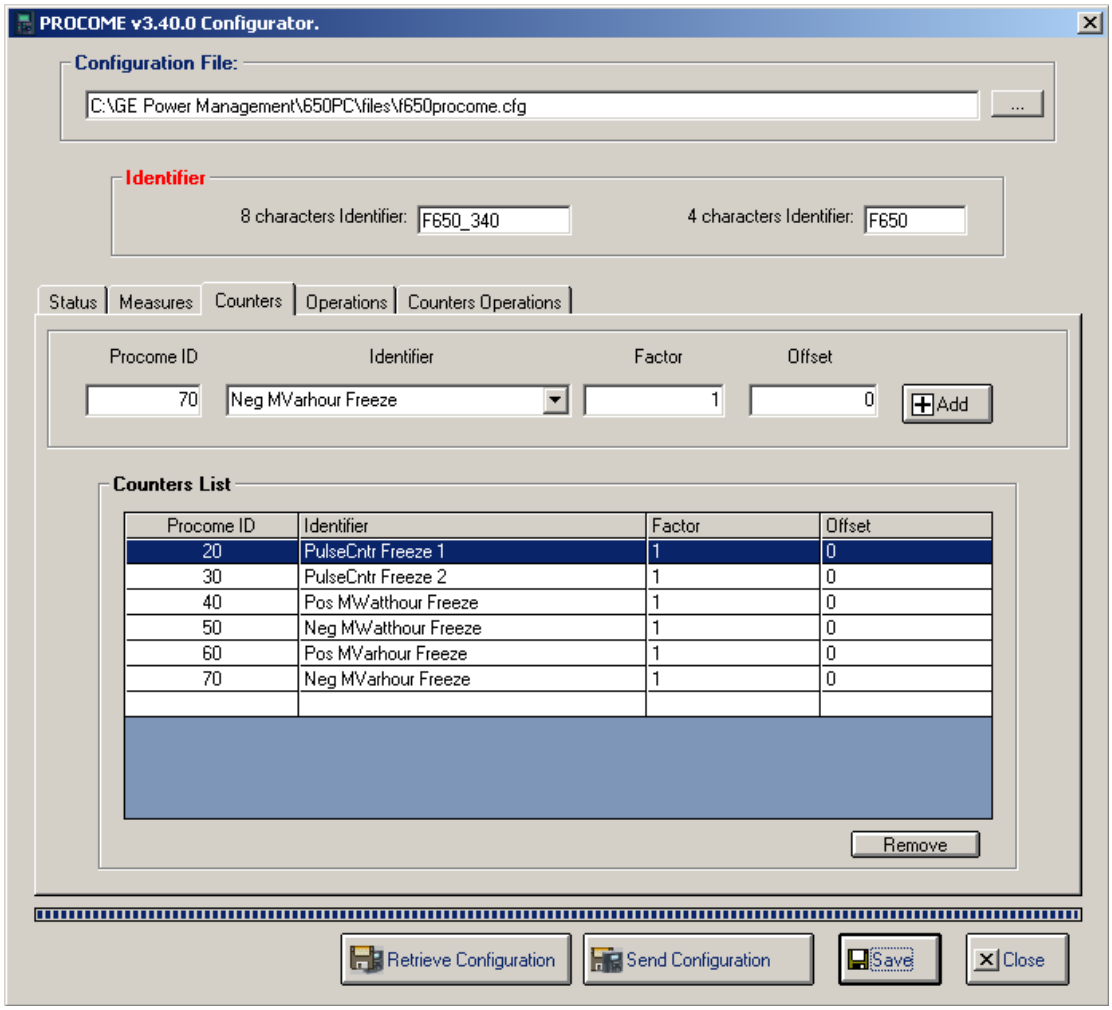


Figure 5-65: Counter configuration

Operations

This operations configuration screen allow the user to configure the Procome number that identifies the command in the Procome protocol and the "operation bit number" that the slave when the command has DCO_ON and the operation to be executed when the command is DCO_OFF. The user can set the same operation for DCO_ON and DCO_OFF or a different one for each status if desired.

The user must select:

- **Procome ID (IEC):** which is the identification number for each operation
- **Type:** type 1 for operation bits.
- **Operation ON:** DCO_ON operation bit selection
- **Operation OFF:** DCO_OFF operation bit selection

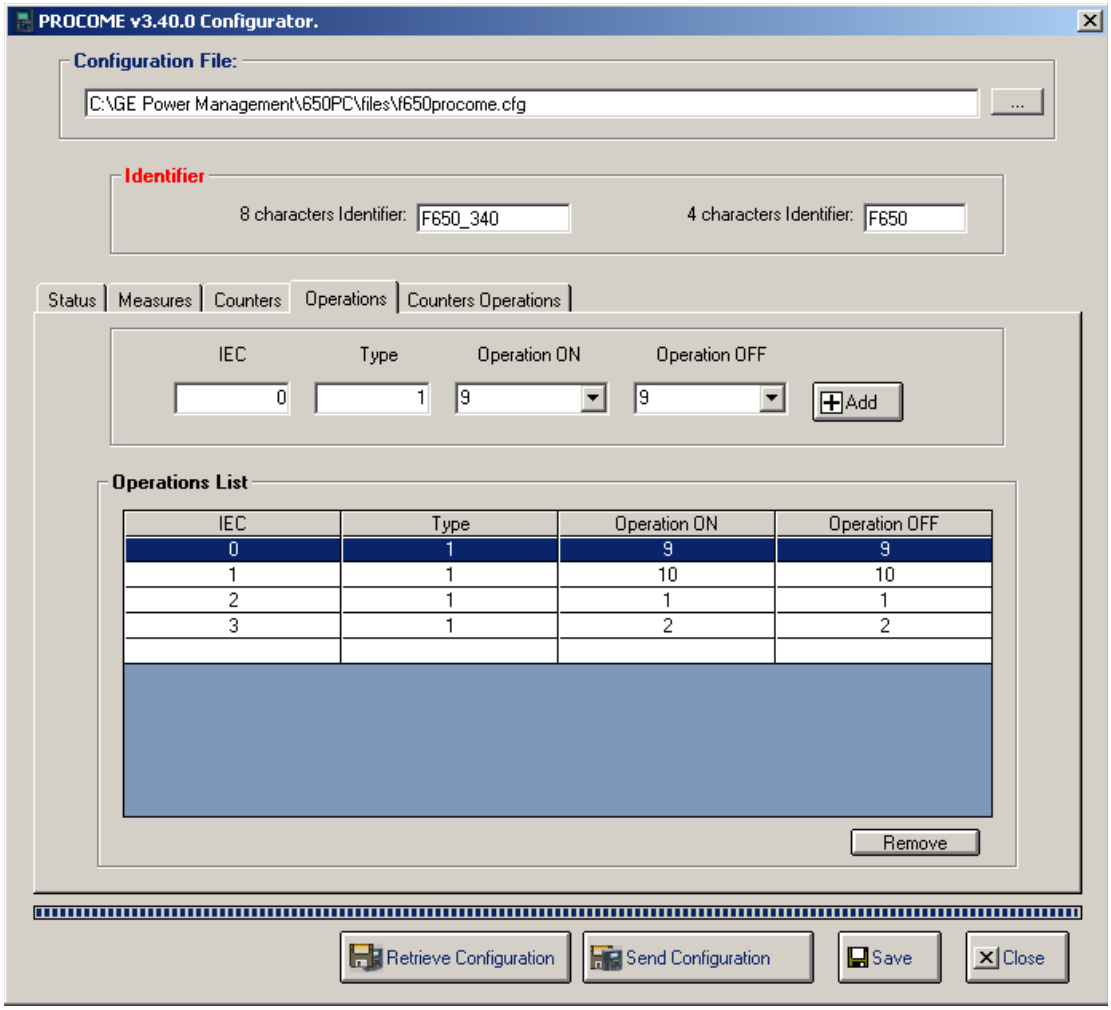


Figure 5-66: Operation configuration

Counters Operations

The counter operations screen is a dedicated configuration screen for the counter (pulse and energy) operations to freeze, unfreeze and reset.

These operations must be set in the "Setpoint > Relay configuration > Operations" and "Setpoint > Relay configuration > Protection Elements" in FREEZE ENERGY CNT, UNFREEZE ENERGY CNT and RESET ENERGY CNT.

For example if the ENERGY RESET operation is the 6th one in the operations screen, it must be configured to the "ENERGY RESET CNT" input in the protection elements screen. To configure this operation to be launched through Procome see the example below. This configuration screen has the same management as the operations one.

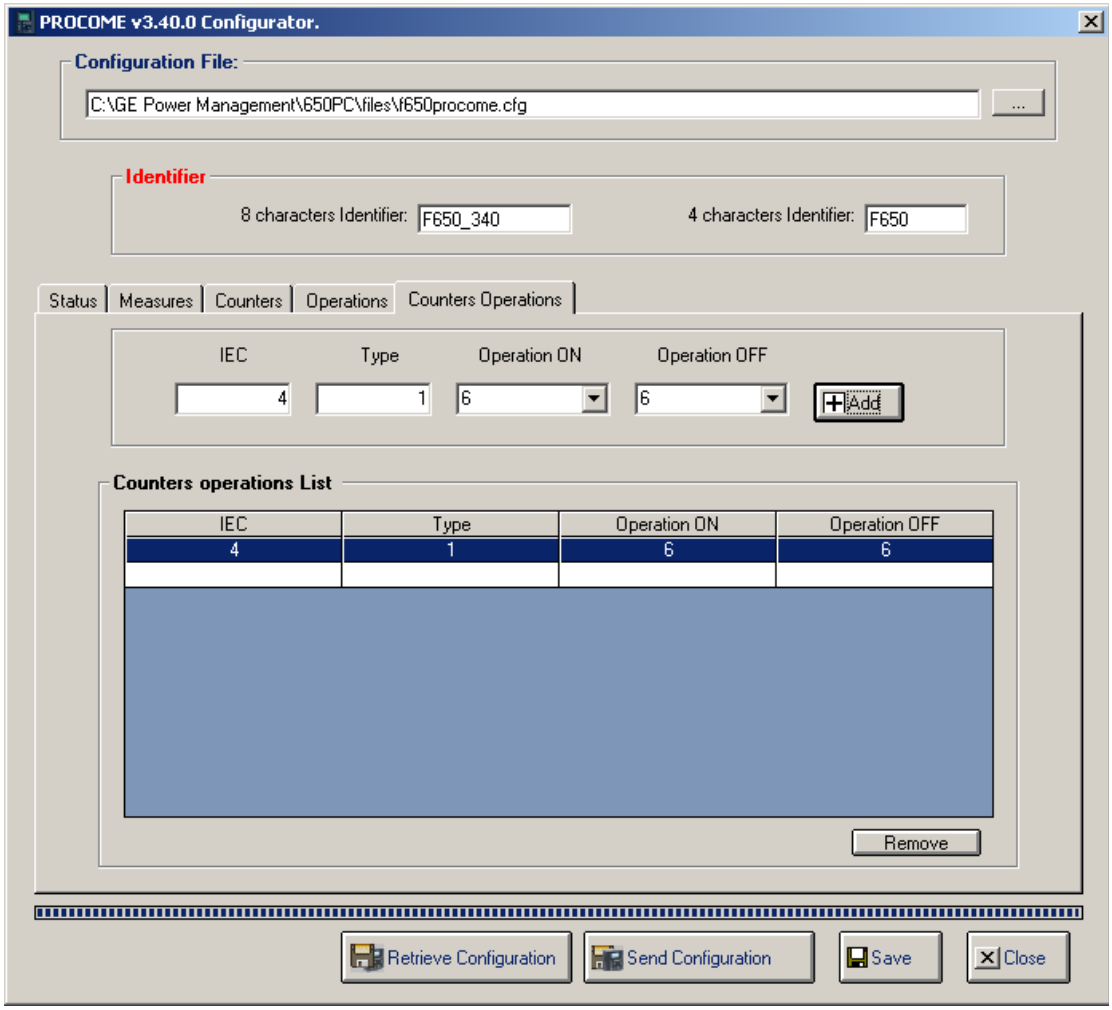


Figure 5-67: Counter operations configuration

5.13 IEC 60870-5-103 configuration

The IEC103 Configuration option is only be available if the F650 that supports this protocol (3 in the order code for protocol selection). The IEC103 protocol for the F650 can be configured using the EnerVista 650 Setup program in the menu **Setpoint > IEC103 Configuration**.

When opening the IEC103 configuration tool, either open a "f650iec103.cfg" configuration file or continue to the IEC103 configuration tool with no file selected. The IEC103 configuration can be retrieved from the relay by clicking **Retrieve Configuration**. Changes can be saved to the configuration file, and then sent to the relay by clicking **Send Configuration**. In order to start working with the new IEC103 configuration, the relay must be switched off and on.

The IEC103 slave can be identified (besides the slave number) with a long name (8 characters identifier) and with a short name (4 characters identifier for the manufacturer's internal software release) that can be set in the IEC103 configuration file.

Control data that can be configured includes: digital states, measurands and commands. Some IEC103 parameters can be set in the configuration file and then sent to the relay

Digital states:

All the digital states that F650 supports are available in order to be mapped using the EnerVista 650 Setup program. All the mapped information is sent as a response to a general interrogation.

In the interoperability table, the states that the standard propose have been selected with the suitable information number. Some of them must be generated in the firmware code as an OR operation. This information is mapped by default, but the user can delete them if desired. For the other states, you can assign the Information Number <1..255> and the Function Type <0..255>, but the Identification Type 1 (Time-tagged message) is fixed.

- To configure a new mapping of a digital state, set the Function Type and the Information number. Then select D**igital Status** from the first combo box in the **Status** frame for mapping a single digital state, and the digital state to be sent to the IEC103 master from the second combo box. You can configure a logic OR operation of digital states selecting **Logic** in the first combo box and clicking **Press for Logic**. In the next screen, choose the digital status combination to be sent to the IEC103 master and click **Save**.

  Finally click **Add** and the configured data is added to the Status List.
- To remove an existing signal from the status list, select the signal then click **Remove**. The signal is removed from the status list.
- In the same way, to change a configured signal from the status list, select the signal, make the changes, and then click **Update**. The signal is updated in the status list
- To save the data in the configuration file, click **Save** and all the data is stored in the corresponding "*.cfg" file.

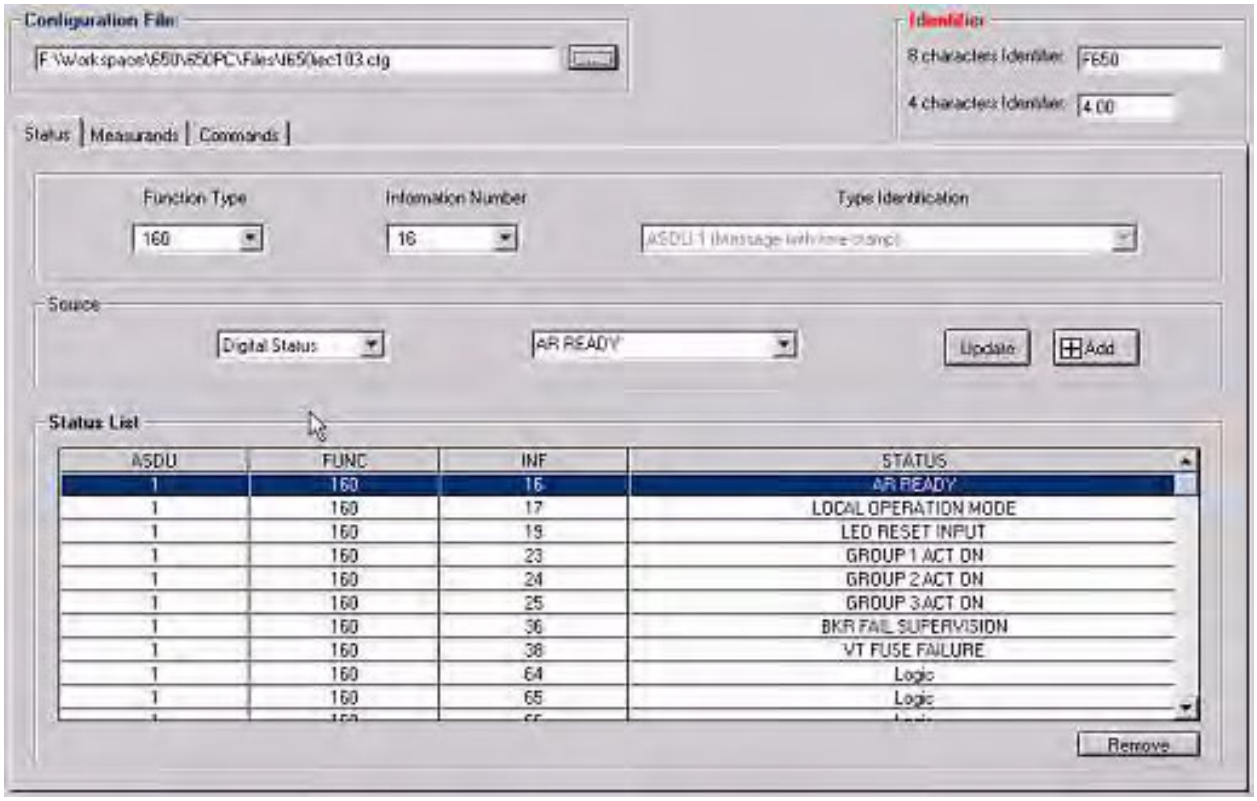


Figure 5-68: Digital signal configuration for IEC 60870-5-103 protocol

Measurands

The standard proposes some analog points supported by the F650 with compatible information number that has been included in the previous profile.

For the other measurands, it would be possible to use the 650 EnerVista Setup to select the desired point and assign the Identification Type (3 or 9), Function Type <0..255>, and Information Number <1..255>.

If the user selects Identification Type 3 (ASDU 3) only four measurands are available for the configuration, but if Identification Type 9 (ASDU 9) is selected, up to nine measurands can be sent in the IEC103 slave answer. For each measurand, all metering values that F650 supports, are available in order to be mapped.

In the measurands configuration screen, with each selected measurement, a Factor and an Offset must be configured. The Factor is a multiplier factor and the Offset is an offset factor to be applied to the relay measurement to make the final measurement calculation to be sent to the master The factor and offset parameters allow the user to perform different scaling in the relay measurements. The final measurement sent to the IEC103 master is: "a*x+b", where "x" is the relay measurement, "a" is the multiplier factor and "b" is the offset.

The measurands are sent to the primary station as a response to a class 2 request. There is a Timeout configurable with increments of 100 ms, between 0 and 60 min, in order to configure the interval desired.

Click **Add** and the configured data is added to the Measurands List. The processes of removing, updating and saving are done in the same way as for digital states.

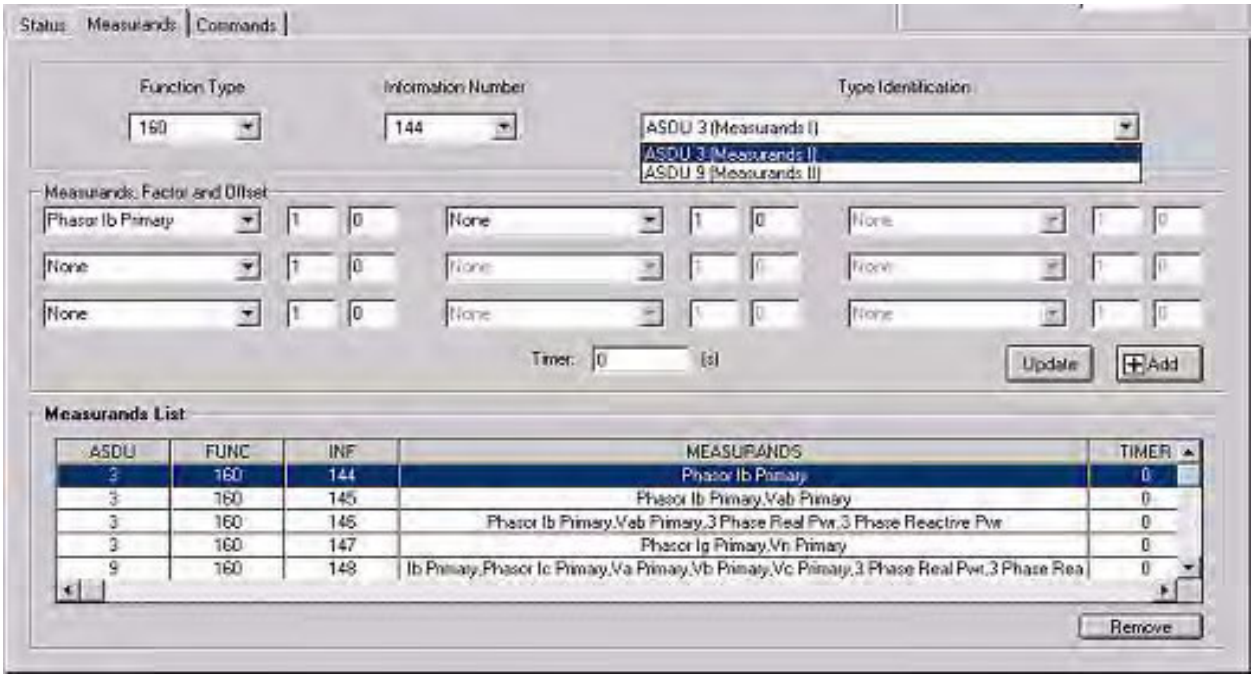


Figure 5-69: Measurand configuration for IEC 60870-5-103 protocol

Commands

All configurable commands and virtual inputs self-reset are available in order to be mapped using the EnerVista 650 Setup program. It would be possible to choose the desired command for the ON state and the same or different command for the OFF state.

You can select the Information Number <1..255> and the Function Type <0..255>, but the Identification Type 20 (General Commands) is fixed and it is used to send a command to the slave station.

Clicking the **Add** button the configured data is added to the Operations List. The processes of removing, updating and saving are done in the same way as for digital states and for measurands.

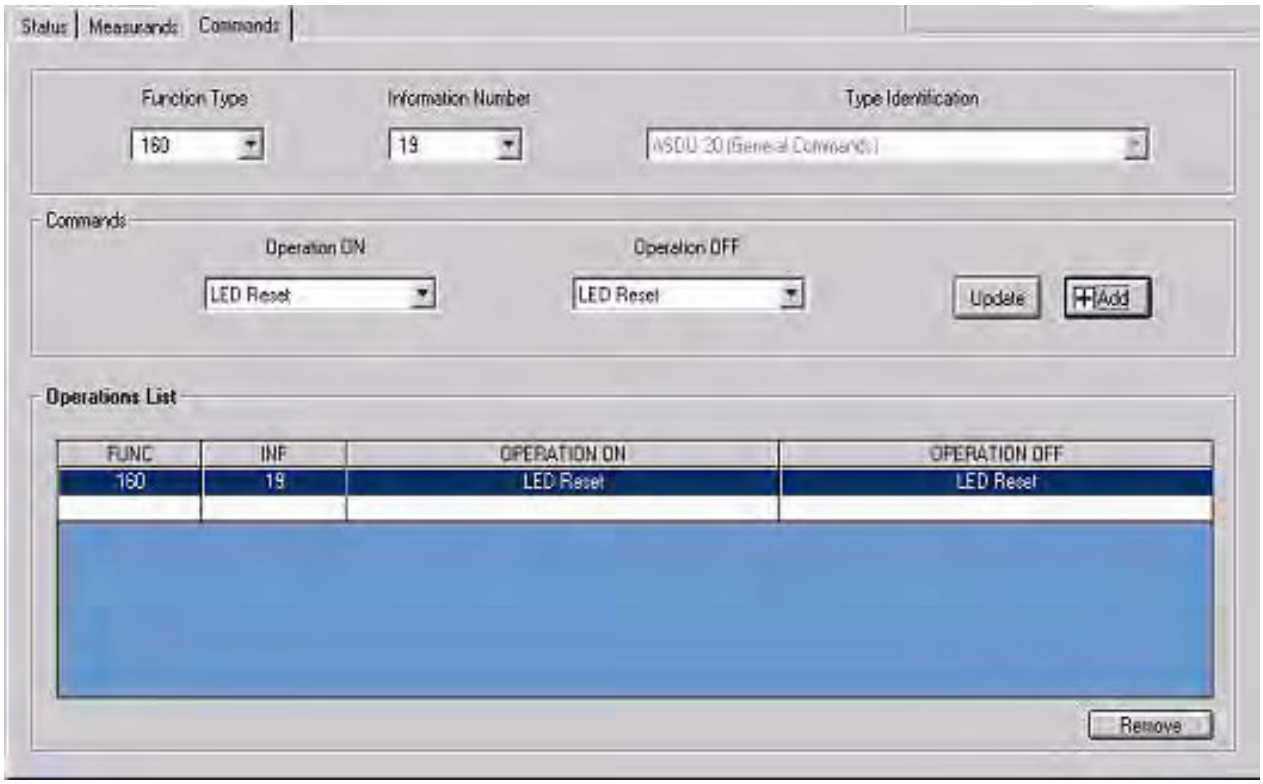


Figure 5-70: Command configuration for IEC 60870-5-103 protocol

F650 Digital Bay Controller

Chapter 6: Actual values

6.1 Front panel

The menu bar in the main screen of EnerVista 650 Setup software shows the ACTUAL menu option. This option concentrates and displays all status of protection, control elements, metering, counters information, oscillography, events, fault locator, etc. This menu is divided in several sub menus that are detailed in the following sections.

6.1.1 LEDs

Operation of the relay front LEDs is shown on the following figure (***Actual > Front Panel > LEDs***) by the lighting of the associated LED in the appropriate color. The Ready LED is green when the relay is in service. LEDs 1 to 5 light up in red when active, LEDs 6 to 10 light up in orange, and the last 5 LEDs light up in green.

The first five LEDs are latched by hardware and can

only be reset by a LEDs RESET Command, either pressing the “esc” key on the Front of the Relay, or by Communications using the appropriate signal. The rest of LEDs are not latched, but can be latched by logic.

Table 6-1: Front panel LEDs

LEDS
READY LED
LED 1
LED 2
LED 3
LED 4
LED 5
LED 6
LED 7
LED 8
LED 9
LED 10
LED 11
LED 12
LED 13

LED 14
LED 15
LOCAL OPERATION MODE
OPERATIONS BLOCKED
ST HMI BACKLIGHT

6.2 Status

6.2.1 Operation bits status

(***Actual* > *Status* > *Operation bits***)

OPERATION BIT 1...24 These 24 bits are the outputs of each possible Operation modules, programmed in menu **Setpoint > Relay Configuration > Operations**. The light up LED indicates their status 1 (activation)

OPERATION BITS
OPERATION BIT 1
OPERATION BIT 2
...
OPERATION BIT 24

6.2.2 Breaker status

The signals associated with the opened or closed status of the breaker can be monitored at **Actual > Status > Breaker**

BREAKER STATUS
BREAKER OPEN
BREAKER CLOSED
BREAKER UNDEFINED

BREAKER OPEN: Open breaker status. In the switchgear selected as breaker, besides providing the usual switchgear contact status, the system provides also the open breaker, closed breaker, and undefined breaker states.

BREAKER CLOSED: Breaker closed.

BREAKER UNDEFINED: If there are two digital inputs configured for breaker contacts 52/a and 52/b, this status is present when both inputs are at 0 or at 1. This status can be caused by a wiring failure, failure of auxiliary elements, etc.

6.2.3 Protection status

6.2.3.1 Protection blocks

(**Actual > Status > Protection > Protection Blocks**)

This screen shows the entire protection element blocks available. If the protection element is blocked, the green LED located on the right side of the text lights up and remains lit as long as the element remains blocked.

Protection elements block signals are configured at ***Setpoint > Relay Configuration > Protection Elements***.

Table 6-2: PROTECTION ELEMENTS BLOCK

IOC BLOCK SIGNALS	TOC BLOCK SIGNALS	DIRECTIONAL BLOCKS	VOLTAGE BLOCKS
PH IOC1 HIGH A /B / C BLK	PH TOC1 HIGH A /B /C BLK	PHASE DIR1 BLK INP	PHASE UV1 BLOCK
PH IOC2 HIGH A /B / C BLK	PH TOC2 HIGH A /B /C BLK	PHASE DIR2 BLK INP	PHASE UV2 BLOCK
PH IOC3 HIGH A /B / C BLK	PH TOC3 HIGH A /B /C BLK	PHASE DIR3 BLK INP	PHASE UV3 BLOCK
PH IOC1 LOW A /B / C BLK	PH TOC1 LOW A /B /C BLK	NEUTRAL DIR1 BLK INP	PHASE OV1 BLOCK
PH IOC2 LOW A /B / C BLK	PH TOC2 LOW A /B /C BLK	NEUTRAL DIR2 BLK INP	PHASE OV2 BLOCK
PH IOC3 LOW A /B / C BLK	PH TOC3 LOW A /B /C BLK	NEUTRAL DIR3 BLK INP	PHASE OV3 BLOCK
NEUTRAL IOC1 BLOCK	NEUTRAL TOC1 BLOCK	GROUND DIR1 BLK INP	NEUTRAL OV1 HIGH BLK
NEUTRAL IOC2 BLOCK	NEUTRAL TOC2 BLOCK	GROUND DIR2 BLK INP	NEUTRAL OV2 HIGH BLK
NEUTRAL IOC3 BLOCK	NEUTRAL TOC3 BLOCK	GROUND DIR3 BLK INP	NEUTRAL OV3 HIGH BLK
GROUND IOC1 BLOCK	GROUND TOC1 BLOCK	SENS GND DIR1 BLK IP	NEUTRAL OV1 LOW BLK
GROUND IOC2 BLOCK	GROUND TOC2 BLOCK	SENS GND DIR2 BLK IP	NEUTRAL OV2 LOW BLK
GROUND IOC3 BLOCK	GROUND TOC3 BLOCK	SENS GND DIR3 BLK IP	NEUTRAL OV3 LOW BLK
SENS GND IOC1 BLK	SENS GND TOC1 BLOCK	**POWER BLOCKS**	AUXILIARY UV1 BLOCK
SENS GND IOC2 BLK	SENS GND TOC2 BLOCK	FWD PWR1 BLOCK	AUXILIARY UV2 BLOCK
SENS GND IOC3 BLK	SENS GND TOC3 BLOCK	FWD PWR2 BLOCK	AUXILIARY UV3 BLOCK
ISOLATED GROUND BLOCKS	NEG SEQ TOC1 BLOCK	FWD PWR3 BLOCK	AUXILIARY OV1 BLOCK
ISOLATED GND1 BLK	NEG SEQ TOC2 BLOCK	DIR PWR1 BLOCK	AUXILIARY OV2 BLOCK
ISOLATED GND2 BLK	NEG SEQ TOC3 BLOCK	DIR PWR2 BLOCK	AUXILIARY OV3 BLOCK
ISOLATED GND3 BLK	THERMAL MODEL BLOCKS	DIR PWR3 BLOCK	NEG SEQ OV1 BLOCK
SETTING GROUPS BLOCK IP	THERMAL1 BLOCK	32N1 HIGH BLOCK	NEG SEQ OV2 BLOCK
SETT GROUPS BLOCK	THERMAL2 BLOCK	32N2 HIGH BLOCK	NEG SEQ OV3 BLOCK
GENERAL TRIP BLOCK	THERMAL3 BLOCK	32N3 HIGH BLOCK	**LOCKED ROTOR BLK**
GENERAL TRIP	**BROKEN CONDUCTOR BLK**	32N1 LOW BLOCK	LOCKED ROTOR1 BLK
	BROKEN CONDUCT1 BLK	32N2 LOW BLOCK	LOCKED ROTOR2 BLK
	BROKEN CONDUCT2 BLK	32N3 LOW BLOCK	LOCKED ROTOR3 BLK
	BROKEN CONDUCT3 BLK	**FREQUENCY BLOCKS**	**LOAD ENCROACHMENT BLKS**
		OVERFREQ1 BLOCK	LOAD ENCR1 BLOCK
		OVERFREQ2 BLOCK	LOAD ENCR2 BLOCK
		OVERFREQ3 BLOCK	LOAD ENCR3 BLOCK
		OVERFREQ Q4 BLOCK	**MOTOR BLK**
		OVERFREQ Q5 BLOCK	NUM OF STARTS BLOCKS
		OVERFREQ Q6 BLOCK	**COLD LOAD BLK**
		UNDERFREQ1 BLOCK	COLD LOAD BLOCK
		UNDERFREQ2 BLOCK	
		UNDERFREQ3 BLOCK	
		UNDERFREQ Q4 BLOCK	
		UNDERFREQ Q5 BLOCK	
		UNDERFREQ Q6 BLOCK	

6.2.3.2 Phase current

This screen shows the pickup and trip for all phase instantaneous and time overcurrent elements in the F650 and block and operation signals provided by the phase directional units. Any of these two events of any phase element lights up the corresponding LED in this screen, and it remains lit as the associated function remains in pickup or operation. All the values are provided for phases and total as shown on the table below.

This screen is accessed in menu: **Actual> Status > Protection > Phase Current**, and includes the following signaling LEDs:

Table 6-3: Phase current actual values

PHASE IOC ACTUAL VALUES	PHASE IOC ACTUAL VALUES	PHASE DIRECTIONAL ACTUAL VALUES
PH IOC1 HIGH A / B / C PKP	PH TOC1 HIGH A / B / C PKP	PHASE DIR1 BLOCK A
PH IOC1 HIGH A / B / C OP	PH TOC1 HIGH A / B / C OP	PHASE DIR1 A OP
PH IOC1 HIGH PKP	PH TOC1 HIGH PKP	PHASE DIR1 BLOCK B
PH IOC1 HIGH OP	PH TOC1 HIGH OP	PHASE DIR1 B OP
PH IOC2 HIGH A / B / C PKP	PH TOC2 HIGH A / B / C PKP	PHASE DIR1 BLOCK C
PH IOC2 HIGH A / B / C OP	PH TOC2 HIGH A / B / C OP	PHASE DIR1 C OP
PH IOC2 HIGH PKP	PH TOC2 HIGH PKP	PHASE DIR2 BLOCK A
PH IOC2 HIGH OP	PH TOC2 HIGH OP	PHASE DIR2 A OP
PH IOC3 HIGH A / B / C PKP	PH TOC3 HIGH A / B / C PKP	PHASE DIR2 BLOCK B
PH IOC3 HIGH A / B / C OP	PH TOC3 HIGH A / B / C OP	PHASE DIR2 B OP
PH IOC3 HIGH PKP	PH TOC3 HIGH PKP	PHASE DIR2 BLOCK C
PH IOC3 HIGH OP	PH TOC3 HIGH OP	PHASE DIR2 C OP
PH IOC1 LOW A / B / C PKP	PH TOC1 LOW A / B / C PKP	PHASE DIR3 BLOCK A
PH IOC1 LOW A / B / C OP	PH TOC1 LOW A / B / C OP	PHASE DIR3 A OP
PH IOC1 LOW PKP	PH TOC1 LOW PKP	PHASE DIR3 BLOCK B
PH IOC1 LOW OP	PH TOC1 LOW OP	PHASE DIR3 B OP
PH IOC2 LOW A / B / C PKP	PH TOC2 LOW A / B / C PKP	PHASE DIR3 BLOCK C
PH IOC2 LOW A / B / C OP	PH TOC2 LOW A / B / C OP	PHASE DIR3 C OP
PH IOC2 LOW PKP	PH TOC2 LOW PKP	
PH IOC2 LOW OP	PH TOC2 LOW OP	
PH IOC3 LOW A / B / C PKP	PH TOC3 LOW A / B / C PKP	
PH IOC3 LOW A / B / C OP	PH TOC3 LOW A / B / C OP	
PH IOC3 LOW PKP	PH TOC3 LOW PKP	
PH IOC3 LOW OP	PH TOC3 LOW OP	

6.2.3.3 Neutral current

This screen shows the pickup and trip for all neutral instantaneous and time overcurrent elements in the F650 and block and operation signals provided by the neutral directional units. Any of these two events of any neutral element lights up the corresponding LED in this screen, and it remains lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Neutral Current**, and includes the following signaling LEDs:

Table 6-4: Neutral current actual values

NEUTRAL IOC ACTUAL VALUES	NEUTRAL TOC ACTUAL VALUES	NEUTRAL DIRECTIONAL ACTUAL VALUES
NEUTRAL IOC1 PKP	NEUTRAL TOC1 PKP	NEUTRAL DIR1 BLOCK
NEUTRAL IOC1 OP	NEUTRAL TOC1 OP	NEUTRAL DIR1 OP
NEUTRAL IOC2 PKP	NEUTRAL TOC2 PKP	NEUTRAL DIR2 BLOCK
NEUTRAL IOC2 OP	NEUTRAL TOC2 OP	NEUTRAL DIR2 OP
NEUTRAL IOC3 PKP	NEUTRAL TOC3 PKP	NEUTRAL DIR3 BLOCK
NEUTRAL IOC3 OP	NEUTRAL TOC3 OP	NEUTRAL DIR3 OP

6.2.3.4 Ground current

This screen shows the pickup and trip for all ground instantaneous and time overcurrent elements in the F650 and block and operation signals provided by the ground directional units. Any of these two events for any ground element light up the corresponding LED in this screen, and it remains lit as the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Ground Current**, and includes the following signaling LEDs:

Table 6-5: Ground current actual values

GROUND IOC ACTUAL VALUES	GROUND TOC ACTUAL VALUES	GROUND DIRECTIONAL ACTUAL VALUES
GROUND IOC1 PKP	GROUND TOC1 PKP	GROUND DIR1 BLOCK
GROUND IOC1 OP	GROUND TOC1 OP	GROUND DIR1 OP
GROUND IOC2 PKP	GROUND TOC2 PKP	GROUND DIR2 BLOCK
GROUND IOC2 OP	GROUND TOC2 OP	GROUND DIR2 OP
GROUND IOC3 PKP	GROUND TOC3 PKP	GROUND DIR3 BLOCK
GROUND IOC3 OP	GROUND TOC3 OP	GROUND DIR3 OP

6.2.3.5 Sensitive ground current

This screen shows the pickup and trip for all sensitive ground instantaneous, time overcurrent and isolated ground elements in the F650 and block and operation signals provided by the sensitive ground directional units. Any of these two events of any ground element lights up the corresponding LED in this screen, and it remains lit while the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection >Sensitive Ground Current**, and includes the following signaling LEDs:

Table 6-6: Sensitive ground current actual values

SENSITIVE GROUND IOC ACTUAL VALUES	SENSITIVE GROUND TOC ACTUAL VALUES	ISOLATED GROUND ACTUAL VALUES	SENSITIVE GROUND DIRECTIONAL ACTUAL VALUES
SENS GND IOC1 PKP	SENS GND TOC1 PKP	ISOLATED GND1 PKP	SENS GND DIR1 BLOCK
SENS GND IOC1 OP	SENS GND TOC1 OP	ISOLATED GND1 OP	SENS GND DIR1 OP
SENS GND IOC2 PKP	SENS GND TOC2 PKP	ISOLATED GND2 PKP	SENS GND DIR2 BLOCK
SENS GND IOC2 OP	SENS GND TOC2 OP	ISOLATED GND2 OP	SENS GND DIR2 OP
SENS GND IOC3 PKP	SENS GND TOC3 PKP	ISOLATED GND3 PKP	SENS GND DIR3 BLOCK
SENS GND IOC3 OP	SENS GND TOC3 OP	ISOLATED GND3 OP	SENS GND DIR3 OP

6.2.3.6 Negative sequence current

This screen shows the pickup and trip for negative sequence elements in the F650. Any of these two events of any ground element lights up the corresponding LED in this screen, and it remains lit while the associated function remains in pickup or operation.

This screen is accessed in menu: **Actual > Status > Protection > Negative Sequence Current**, and includes the following signaling LEDs:

Table 6-7: Negative sequence current actual values

NEGATIVE SEQUENCE TOC ACTUAL VALUES
NEG SEQ TOC1 PKP
NEG SEQ TOC1 OP
NEG SEQ TOC2 PKP
NEG SEQ TOC2 OP
NEG SEQ TOC3 PKP
NEG SEQ TOC3 OP

6.2.3.7 Thermal model

F650 units incorporate up to 3 thermal image elements. For each of them, this screen shows by means of green LEDs, the activation of the reset, alarm, operation and thermal image signals for each phase (A, B, C) and each unit (1, 2, 3). Any of the reset, alarm and operation signals light up the corresponding LED in this screen, and it remains lit as the associated function remains in reset, pickup or operation. This function also provides the thermal image value for all the phases and functions in percentage. All the values are provided individually for phases and for the three thermal elements.

This screen is accessed in menu: **Actual> Status > Protection >Thermal image**, and includes the following signaling LEDs:

Table 6-8: Thermal model actual values

THERMAL IMAGE RESET SIGNALS	THERMAL IMAGE ALARM SIGNALS	THERMAL IMAGE OPERATION SIGNALS	THERMAL IMAGE VALUE IN %
	THERMAL1 ALARM	THERMAL1 OP	
THERMAL1 A RST	THERMAL1 A ALARM	THERMAL1 A OP	THERMAL1 IMAGE A
THERMAL1 B RST	THERMAL1 B ALARM	THERMAL1 B OP	THERMAL1 IMAGE B
THERMAL1 C RST	THERMAL1 C ALARM	THERMAL1 C OP	THERMAL1 IMAGE C
	THERMAL2 ALARM	THERMAL2 OP	
THERMAL2 A RST	THERMAL2 A ALARM	THERMAL2 A OP	THERMAL2 IMAGE A
THERMAL2 B RST	THERMAL2 B ALARM	THERMAL2 B OP	THERMAL2 IMAGE B
THERMAL2 C RST	THERMAL2 C ALARM	THERMAL2 C OP	THERMAL2 IMAGE C
	THERMAL3 ALARM	THERMAL3 OP	
THERMAL3 A RST	THERMAL3 A ALARM	THERMAL3 A OP	THERMAL3 IMAGE A
THERMAL3 B RST	THERMAL3 B ALARM	THERMAL3 B OP	THERMAL3 IMAGE B
THERMAL3 C RST	THERMAL3 C ALARM	THERMAL3 C OP	THERMAL3 IMAGE C

6.2.3.8 Voltage

This screen shows the activation of all voltage elements available in the F650. It can be accessed from the menu: **Actual > Status > Protection > Voltage**, and it includes the following signaling LEDs.

The values shown are:

Pickup and operation signals for phase to ground and phase-to-phase undervoltage elements and the three-phase signal for pickup and operation for the undervoltage element.

Pickup and operation for negative sequence overvoltage element.

Pickup and operation signals for phase-to-phase overvoltage elements and the three-phase signal for pickup and operation for the overvoltage element.

Pickup and operation for neutral overvoltage elements (High and low).

Pickup and operation for auxiliary undervoltage and overvoltage elements.

Table 6-9: Voltage actual values

UNDERVOLTAGE ACTUAL VALUES		OVERVOLTAGE ACTUAL VALUES	NEUTRAL OV (HIGH AND LOW) ACTUAL VALUES
PHASE UV1 A PKP	PHASE UV2 AB OP	PHASE OV1 AB PKP	NEUTRAL OV1 HIGH PKP
PHASE UV1 A OP	PHASE UV2 BC PKP	PHASE OV1 AB OP	NEUTRAL OV1 HIGH OP
PHASE UV1 B PKP	PHASE UV2 BC OP	PHASE OV1 BC PKP	NEUTRAL OV2 HIGH PKP
PHASE UV1 B OP	PHASE UV2 CA PKP	PHASE OV1 BC OP	NEUTRAL OV2 HIGH OP
PHASE UV1 C PKP	PHASE UV2 CA OP	PHASE OV1 CA PKP	NEUTRAL OV3 HIGH PKP
PHASE UV1 C OP	PHASE UV2 PKP	PHASE OV1 CA OP	NEUTRAL OV3 HIGH OP
PHASE UV1 AB PKP	PHASE UV2 OP	PHASE OV1 PKP	NEUTRAL OV1 LOW PKP
PHASE UV1 AB OP	PHASE UV3 A PKP	PHASE OV1 OP	NEUTRAL OV1 LOW OP
PHASE UV1 BC PKP	PHASE UV3 A OP	PHASE OV2 AB PKP	NEUTRAL OV2 LOW PKP
PHASE UV1 BC OP	PHASE UV3 B PKP	PHASE OV2 AB OP	NEUTRAL OV2 LOW OP
PHASE UV1 CA PKP	PHASE UV3 B OP	PHASE OV2 BC PKP	NEUTRAL OV3 LOW PKP
PHASE UV1 CA OP	PHASE UV3 C PKP	PHASE OV2 BC OP	NEUTRAL OV3 LOW OP
PHASE UV1 PKP	PHASE UV3 C OP	PHASE OV2 CA PKP	**AUXILIARY OV**
PHASE UV1 OP	PHASE UV3 AB PKP	PHASE OV2 CA OP	AUXILIARY OV1 PKP
PHASE UV2 A PKP	PHASE UV3 AB OP	PHASE OV2 PKP	AUXILIARY OV1 OP
PHASE UV2 A OP	PHASE UV3 BC PKP	PHASE OV2 OP	AUXILIARY OV2 PKP
PHASE UV2 B PKP	PHASE UV3 BC OP	PHASE OV3 AB PKP	AUXILIARY OV2 OP
PHASE UV2 B OP	PHASE UV3 CA PKP	PHASE OV3 AB OP	AUXILIARY OV3 PKP
PHASE UV2 C PKP	PHASE UV3 CA OP	PHASE OV3 BC PKP	AUXILIARY OV3 OP
PHASE UV2 C OP	PHASE UV3 PKP	PHASE OV3 BC OP	**AUXILIARY UV**
PHASE UV2 AB PKP	PHASE UV3 OP	PHASE OV3 CA PKP	AUXILIARY UV1 PKP
		PHASE OV3 CA OP	AUXILIARY UV1 OP
		PHASE OV3 PKP	AUXILIARY UV2 PKP
		PHASE OV3 OP	AUXILIARY UV2 OP
		NEGATIVE SEQ OV1 PKP	AUXILIARY UV3 PKP
		NEGATIVE SEQ OV1 OP	AUXILIARY UV3 OP
		NEGATIVE SEQ OV2 PKP	
		NEGATIVE SEQ OV2 OP	
		NEGATIVE SEQ OV3 PKP	
		NEGATIVE SEQ OV3 OP	

6.2.3.9 Power

Forward Power and directional power elements

These functions may have several applications, for example, small generating plants connected to the power system, to limit the supplied power and not to exceed its rated capacity.

If programmed conditions for any of the three elements are met, the corresponding LEDs lights up.

This screen shows the activation of all power elements available in the F650. It can be accessed from the menu: ***Actual > Status > Protection > Power***, and it includes the following signaling LEDs.

Table 6-10: Power actual values

Forward Power Actual Values	Directional Power Actual Values	Wattmetric Ground Fault Actual Values
FWD PWR1 STG1 PKP	DIR PWR1 STG1 PKP	**32N1 HIGH PKP**
FWD PWR1 STG1 OP	DIR PWR1 STG1 OP	32N1 HIGH OC PKP
FWD PWR1 STG2 PKP	DIR PWR1 STG2 PKP	32N1 HIGH OP
FWD PWR1 STG2 OP	DIR PWR1 STG2 OP	32N2 HIGH PKP
FWD PWR2 STG1 PKP	DIR PWR1 STG PKP	32N2 HIGH OC PKP
FWD PWR2 STG1 OP	DIR PWR1 STG OP	32N2 HIGH OP
FWD PWR2 STG2 PKP	DIR PWR2 STG1 PKP	32N3 HIGH PKP
FWD PWR2 STG2 OP	DIR PWR2 STG1 OP	32N3 HIGH OC PKP
FWD PWR3 STG1 PKP	DIR PWR2 STG2 PKP	32N3 HIGH OP
FWD PWR3 STG1 OP	DIR PWR2 STG2 OP	32N1 LOW PKP
FWD PWR3 STG2 PKP	DIR PWR2 STG PKP	32N1 LOW OC PKP
FWD PWR3 STG2 OP	DIR PWR2 STG OP	32N1 LOW OP
	DIR PWR3 STG1 PKP	32N2 LOW PKP
	DIR PWR3 STG1 OP	32N2 LOW OC PKP
	DIR PWR3 STG2 PKP	32N2 LOW OP
	DIR PWR3 STG2 OP	32N3 LOW PKP
	DIR PWR3 STG PKP	32N3 LOW OC PKP
	DIR PWR3 STG OP	32N3 LOW OP
		Wattmetric Ground Fault Power Measurement Actual Values
		32N1 HIGH POWER
		32N2 HIGH POWER
		32N3 HIGH POWER
		32N1 LOW POWER
		32N2 LOW POWER
		32N3 LOW POWER

6.2.4 Control element status

6.2.4.1 Frequency

F650 units incorporate three overfrequency and three underfrequency units. For each of them there are two magnitudes pickup and trip (operation).

Frequency elements are often used in generating plants, as well as in the connection of substations to the main system. Frequency monitoring is the base for synchronous machines protection application, with a couple of setting levels, as well as for the development of automatic shedding functions and underfrequency reset.

This screen shows the activation of all frequency elements available in the F650. It can be accessed from the menu: ***Actual> Status > Control Elements >Frequency***, and it includes the following signaling LEDs.

Table 6-11: Frequency actual values

OVERFREQUENCY ACTUAL VALUES	UNDERFREQUENCY ACTUAL VALUES
OVERFREQ1 PKP	UNDERFREQ1 PKP
OVERFREQ1 OP	UNDERFREQ1 OP
OVERFREQ2 PKP	UNDERFREQ2 PKP
OVERFREQ2 OP	UNDERFREQ2 OP
OVERFREQ3 PKP	UNDERFREQ3 PKP
OVERFREQ3 OP	UNDERFREQ3 OP
OVERFREQ4 PKP	UNDERFREQ4 PKP
OVERFREQ4 OP	UNDERFREQ4 OP
OVERFREQ5 PKP	UNDERFREQ5 PKP
OVERFREQ5 OP	UNDERFREQ5 OP
OVERFREQ6 PKP	UNDERFREQ6 PKP
OVERFREQ6 OP	UNDERFREQ6 OP
FREQUENCY RATE OF CHANGE ACTUAL VALUES	
FREQ RATE1 PKP	
FREQ RATE1 OP	
FREQ RATE2 PKP	
FREQ RATE2 OP	
FREQ RATE3 PKP	
FREQ RATE3 OP	

6.2.4.2 Synchrocheck

This screen can be accessed at ***Actual> Status > Control Elements > Synchrocheck***, and it includes the following signaling LEDs for the synchronism check function:

Table 6-12: Synchrocheck actual values

SYNCHROCHECK ACTUAL VALUES
Synchrocheck BLK INP
Synchrocheck OP
SYNCHK CLOSE PERM
Synchrocheck COND OP
DL-DB OPERATION
DL-LB OPERATION
LL-DB OPERATION
SLIP CONDITION
BUS FREQ > LINE FREQ
BUS FREQ < LINE FREQ
VOLTAGE DIFFERENCE
FREQUENCY DIFFERENCE

Synchrocheck BLK INP: Block signal for the synchrocheck unit, configurable at ***Setpoint > Relay Configuration > Protection Elements***

Synchrocheck OP: Closing permission signal in live line-live bus conditions with open breaker.

SYNCHK CLOSE PERM: General Closing permission of the Synchronism unit. It contemplates all possible situations, live line-live bus conditions, and the closing permission logics (dead line-dead bus, live line- dead bus, dead line-live bus). **Note**: in case the Function is disabled, the Closing permission signal is activated in order not to interfere with possible logics where it is included. If the synchronism unit is enabled, this signal only activates under the closing conditions established by setting.

Synchrocheck COND OP: Closing permission according to permission logics (DL-DB, LL-DB, DL-LB).

DL-DB OPERATION: Closing permission in dead line – dead bus condition.

DL-LB OPERATION: Closing permission in dead line – live bus condition.

LL-DB OPERATION: Closing permission in live line – dead bus condition.

SLIP CONDITION: Internal signal indicating frequency slip between the line voltage and bus voltage phasors.

BUS FREQ > LINE FREQ: Busbar Frequency higher than line frequency

BUS FREQ < LINE FREQ: Busbar Frequency lower than line frequency

VOLTAGE DIFFERENCE: Voltage difference between the line and the busbar in volts (secondary values), only available if the Synchrocheck element is enabled.

FREQ. DIFFERENCE: Frequency difference between the line and the busbar in Hz, only available if the Synchrocheck element is enabled.

6.2.4.3 Autoreclose

This screen can be accessed at ***Actual> Status > Control Elements > Autoreclose***, and it includes the following signaling LEDs for the Autoreclose function:

Table 6-13: Autoreclose actual values

AUTORECLOSE INPUTS
AR LEVEL BLOCK
AR PULSE BLOCK
AR PULSE UNBLOCK
AR INITIATE
AR CONDS INPUT
AUTORECLOSE INTERNAL STATUS
AR CLOSE BREAKER
AR OUT OF SERVICE
AR READY
AR LOCKOUT
AR BLOCK
AR RCL IN PROGRESS
AR LCK BY ANOMALY
AR LCK BY FAIL OPEN
AR LCK BY FAIL CLOSE
AR LCK BY USER
AR LCK BY CONDS
AR LCK BY TRIPS
AR LCK BY SHOTS
AR BLK AFTER 1 SHOT
AR BLK AFTER 2 SHOT
AR BLK AFTER 3 SHOT
AR BLK AFTER 4 SHOT
AR BLOCK BY LEVEL
AR BLOCK BY PULSE
AR STATUS
AR LOCKOUT MODE
AR BLOCK MODE
AUTORECST_61850

The AUTORECLOSE INPUTS are signal configurable by the user at ***Setpoint > Relay Configuration > Protection Elements*** to:

AR LEVEL BLOCK: programmable signal to block the autoreclose unit by level

AR PULSE BLOCK: programmable signal to block the autoreclose unit by pulse

AR PULSE UNBLOCK: programmable signal to unblock the autoreclose unit by pulse

AR INITIATE: programmable signal to initiate the autoreclose.

AR CONDS INPUT: programmable signal to set the conditions to be met before executing a breaker close.

The AUTORECLOSE INTERNAL STATUS are internal signals provided by the autoreclose unit:

AR CLOSE BREAKER:	Breaker close command given by the autoreclose
AR OUT OF SERVICE:	Autoreclose out of service (Disabled)
AR READY:	Autoreclose in service
AR LOCKOUT:	Autoreclose in lockout status (finished cycled-definite trip)
AR BLOCK:	Autoreclose blocked (by input, logic, others, etc).
AR RCL IN PROGRESS:	Cycle in course (autoreclose in progress).
AR LCK BY ANOMALY:	Autoreclose in “Lockout” by anomaly.
AR LCK BY FAIL OPEN:	Autoreclose in “Lockout” by a failure in opening the breaker.
AR LCK BY FAIL CLOSE:	Autoreclose in “Lockout” by a failure in closing the breaker.
AR LCK BY USER:	Autoreclose in “Lockout” by manual close.
AR LCK BY CONDS:	Autoreclose in “Lockout” by conditions. See input conditions configuration.
AR LCK BY TRIPS:	Autoreclose in “Lockout” by maximum number of trips.
AR LCK BY SHOTS:	Autoreclose in “Lockout” at the end of cycle – Definite trip.
AR BLK AFTER 1 SHOT:	Signal sent by the autoreclose after the 1st shot.
AR BLK AFTER 2 SHOT:	Signal sent by the autoreclose after the 2nd shot.
AR BLK AFTER 3 SHOT:	Signal sent by the autoreclose after the 3rd shot.
AR BLK AFTER 4 SHOT:	Signal sent by the autoreclose after the 4th shot.
AR BLOCK BY LEVEL:	Autoreclose blocked by level. See AR block signals configuration
AR BLOCK BY PULSE:	Autoreclose blocked by pulse. See AR block signals configuration
AR STATUS:	Autoreclose status (in service – out of service)
AR LOCKOUT MODE:	Relay “Lockout” status.
AR BLOCK MODE:	Relay “Block” status

AutoRecSt_61850: Autorecloser status sent in IEC 61850. This value represent whether or not the auto reclosing is ready, in progress or successful. It is an enumerate type whose values are defined in IEC 61850-7-4 Edition 2.0 standard and it is available

6.2.4.4 Breaker failure

This screen can be accessed at **Actual> Status > Control Elements > Breaker Failure**, and it includes the following signaling LEDs for the breaker failure function:

Table 6-14: Breaker failure actual values

BREAKER FAILURE ACTUAL VALUES
BKR FAIL INITIATE
BKR FAIL NO CURRENT
BKR FAIL SUPERVISION
BKR FAIL HISET
BKR FAIL LOWSET
INTERNAL ARC
BKR FAIL 2nd STEP

BKR FAIL INITIATE External signal for breaker failure initiation. (configurable at **Settings> Relay Configuration > Protection Elements**).

BKR FAIL NO CURRENT Signal for breaker failure without current

BKR FAIL SUPERVISION Signal for supervision level breaker failure (retrip)

BKR FAIL HISET Signal for high-level breaker failure

BKR FAIL LOWSET Signal for low-level breaker failure

INTERNAL ARC Signal for internal arc

BKR FAIL 2nd STEP Signal for Second level breaker failure (high and low)

6.2.4.5 VT fuse failure

This screen can be accessed at **Actual> Status > Control Elements >VT Fuse Failure**, and it includes only one LEDs for the VT fuse failure function, indicating the activation of the unit.

Table 6-15: VT fuse failure actual values

VT FUSE FAILURE ACTUAL VALUES
VT FUSE FAILURE

6.2.4.6 Broken conductor

F650 units incorporate three Broken Conductor elements for special applications that may require different timing steps or levels for alarm or trip purposes.

The green LED lights up when the pickup or trip (operation) of each of the three available functions is activated. The three functions are identical and can be configured separately.

These functions compare the negative and positive sequence current levels per phase. If this magnitude exceeds a programmable threshold and is maintained for a programmable time delay, a tripping output is issued. If a pickup or operation is produced, the corresponding LED in this screen lights up.

This screen can be accessed at **Actual> Status > Control Elements > Broken Conductor**, and it includes the following signaling LEDs for the breaker failure function:

Table 6-16: Broken conductor actual values

BROKEN CONDUCTOR ACTUAL VALUES
BROKEN CONDUCT1 PKP
BROKEN CONDUCT1 OP
BROKEN CONDUCT2 PKP
BROKEN CONDUCT2 OP
BROKEN CONDUCT3 PKP
BROKEN CONDUCT3 OP

6.2.4.7 Setting groups

This screen can be accessed at **Actual> Status > Control Elements > Setting Groups**, and it includes activation and block signals for the relay setting groups change in the following signaling LEDs:

Table 6-17: Setting group actual values for firmware version 7.50 or above

SETTING GROUPS ACTUAL VALUES
GROUP 1 ACT ON
GROUP 2 ACT ON
GROUP 3 ACT ON
GROUP 4 ACT ON
GROUP 5 ACT ON
GROUP 6 ACT ON
ACTIVE GROUP

6.2.4.8 Locked rotor

F650 units incorporate three locked rotor units. For each of them there are two magnitudes pickup and trip (operation).

This screen shows the activation of all locked rotor elements available in the F650. It can be accessed from the menu: ***Actual> Status > Control Elements > Locked Rotor***, and it includes the following signaling LEDs.

Table 6-18: Locked rotor actual values

LOCKED ROTOR ACTUAL VALUES
LOCKED ROTOR1 PKP
LOCKED ROTOR1 OP
LOCKED ROTOR2 PKP
LOCKED ROTOR2 OP
LOCKED ROTOR3 PKP
LOCKED ROTOR3 OP

6.2.4.9 Pulse counters

F650 units incorporate eight pulse counters. For each of them there are two magnitudes: the actual value and the freeze value.

This screen shows the activation of all pulse counters available in the F650. It can be accessed from the menu:

Actual> Status > Control Elements > Pulse counters, and it includes the following values.

Table 6-19: Pulse counter actual values

PULSE COUNTERS ACTUAL VALUES
CntPulses Value 1
CntPulses Value 2
CntPulses Value 3
CntPulses Value 4
CntPulses Value 5
CntPulses Value 6
CntPulses Value 7
CntPulses Value 8
CntPulses Freeze 1
CntPulses Freeze 2
CntPulses Freeze 3
CntPulses Freeze 4
CntPulses Freeze 5
CntPulses Freeze 6
CntPulses Freeze 7
CntPulses Freeze 8
Cnt Pulses Freeze
Cnt Pulses Unfreeze
Cnt Pulses Reset

6.2.4.10 Analog comparators

F650 units incorporate 20 analog comparators. This screen can be accessed from the menu:

Actual > Status > Control Elements > Analog Comparators and it includes the following signalling LEDs showing the ON/OFF status of the analog level.

Table 6-20: Analog comparators actual values

ANALOG COMPARATORS ACTUAL VALUES
Analog Level 01
Analog Level 02
Analog Level 03
Analog Level 04
Analog Level 05
Analog Level 06
Analog Level 07
Analog Level 08
Analog Level 09
Analog Level 10
Analog Level 11
Analog Level 12
Analog Level 13
Analog Level 14
Analog Level 15
Analog Level 16
Analog Level 17
Analog Level 18
Analog Level 19
Analog Level 20

6.2.4.11 Load encroachment

F650 units incorporate three load encroachment units. For each of them there are two magnitudes, pickup and trip (operation).

This screen shows the activation of all load encroachment elements available in the F650. It can be accessed from the menu:

Actual> Status > Control Elements > Load Encroachment, and it includes the following signalling LEDs.

Table 6-21: Load encroachment actual values

LOAD ENCROACHMENT ACTUAL VALUES
LOAD ENCR1 PKP
LOAD ENCR1 OP
LOAD ENCR2 PKP
LOAD ENCR2 OP
LOAD ENCR3 PKP
LOAD ENCR3 OP

6.2.4.12 Maximum number of starts

This screen can be accessed at **Actual > Status > Control Elements > Max. Number of Starts**, and it includes one LEDs for the Maximum Number of Starts function, indicating the activation of the unit. There are also two magnitudes global starts and block lockout time.

Table 6-22: Table 6-24: Maximum number of starts actual values

MAX. NUMBER OF STARTS ACTUAL VALUES
NUMBER OF STARTS OP
GLOBAL STARTS CNT
BLOCK LOCKOUT TIME

6.2.4.13 Digital counters

This screen can be accessed at **Actual > Status > Control Elements > Digital Counters**, and it includes 24 LEDs for the 8 Digital Counters status, indicating which status is activate (HI, LO or EQ).

Table 6-23: Digital counter actual values

DIGITAL COUNTERS ACTUAL VALUES
DIGCNT 1 HI
DIGCNT 2 HI
DIGCNT 3 HI
DIGCNT 4 HI
DIGCNT 5 HI
DIGCNT 6 HI
DIGCNT 7 HI
DIGCNT 8 HI
DIGCNT 1 EQ
DIGCNT 2 EQ
DIGCNT 3 EQ
DIGCNT 4 EQ
DIGCNT 5 EQ
DIGCNT 6 EQ
DIGCNT 7 EQ
DIGCNT 8 EQ
DIGCNT 1 LO
DIGCNT 2 LO
DIGCNT 3 LO
DIGCNT 4 LO
DIGCNT 5 LO
DIGCNT 6 LO
DIGCNT 7 LO
DIGCNT 8 LO
DIGCNT 1 VALUE
DIGCNT 2 VALUE
DIGCNT 3 VALUE
DIGCNT 4 VALUE
DIGCNT 5 VALUE
DIGCNT 6 VALUE
DIGCNT 7 VALUE

DIGCNT 8 VALUE
DIGCNT 1 FROZENVALUE
DIGCNT 2 FROZENVALUE
DIGCNT 3 FROZENVALUE
DIGCNT 4 FROZENVALUE
DIGCNT 5 FROZENVALUE
DIGCNT 6 FROZENVALUE
DIGCNT 7 FROZENVALUE
DIGCNT 8 FROZENVALUE
DIGCNT 1 FROZENDATE
DIGCNT 2 FROZENDATE
DIGCNT 3 FROZENDATE
DIGCNT 4 FROZENDATE
DIGCNT 5 FROZENDATE
DIGCNT 6 FROZENDATE
DIGCNT 7 FROZENDATE
DIGCNT 8 FROZENDATE

For each of the 8 digital counters, there exist independent and identical groups of actual values:

• DIGCNT # HI [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is greater than the setting DigCNt #Compare value.

• DIGCNT # EQ [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is equal than the setting DigCNt #Compare value.

• DIGCNT # LO [OFF: ON]: If this bit is activated, the counter value DIGCNT # VALUE is lower than the setting DigCNt #Compare value.

(These 3 previous states are mutually exclusive: only one can be ON at the same time. If the counter is Disabled, the 3 of them are OFF.)

• DIGCNT # VALUE [-2,147,483,648 : 2,147,483,647]: The specified counter current value.

• DIGCNT # FROZENVALUE [-2,147,483,648 : 2,147,483,647]: The specified counter last captured (frozen) value.

• DIGCNT # FROZENDATE [Valid date]: The specified counter last captured (frozen) date.

6.2.4.14 Cold load pickup

This screen can be accessed at **Actual > Status > Control Elements > Cold Load Pickup**, and it includes two LEDs for the Cold Load Pickup function, indicating two magnitudes; pickup and trip (operation).

Table 6-24: Cold load pickup actual values

COLD LOAD PICKUP
Cold Load PKP
Cold Load OP

6.2.4.15 60CTS failure

This screen can be accessed at **Actual > Status > Control Elements > 60CTS Inhibit**, and it includes two LEDs for the Current Transformer Supervision element, indicating two magnitudes; pickup and trip (operation).

Table 6-25: 60CTS inhibit actual values

60CTS Inhibit
CT Failure PKP
CT Failure OP

6.2.4.16 2nd HRMC Inhibit

This screen can be accessed at **Actual > Status > Control Elements > 2nd HRMC Inhibit**.

Table 6-26: 2nd HRMC inhibit actual values

2nd HRMC Inhibit
2nd Harmonic PKP
2nd Harmonic OP
2nd Harmonic Phase A
2nd Harmonic Phase B
2nd Harmonic Phase C

6.2.5 Protection & control status summary

Actual > Status > Protection Summary . This screen shows a complete listing of all protection and control elements in the relay, showing their status (enabled or not) through the corresponding LED.

6.2.6 Snapshot event summary

Actual > Status > Snapshot Event Summary

The F650 provides via setting the possibility to enable or disable the snapshot event generation in the different functions available in the device.

This screen shows a complete listing of the snapshot event generation for all the protection, control and inputs/ outputs elements in the relay, showing their status (enabled or not) through the corresponding LED.

6.2.7 MODBUS user map

The ModBus User Map consists of a selection of the most important 256 records in the complete ModBus Map regarding the application. By selecting these records and defining the user map appropriately, it is possible to read all the information included by a single ModBus reading operation, optimizing the refresh time.

This screen can be accessed at ***Actual> Status> ModBus User Map***, and it includes all the readings for the previously configured records in the ModBus memory map.

Table 6-27: MODBUS user map actual values

MODBUS USER MAP
Address 00
Address 01
...
Address 255

6.2.8 Switchgear status

Actual > Status > Switchgear Status

For a better understanding of the represented statuses in this screen, figure 6.1 shows the available “Switchgear” modules to be programmed in the F650. Each of them has a series of inputs/outputs that are the statuses represented on this screen. Separate signal for each switchgear device (for 1 to 16).

Each Switchgear module can be programmed at: **Setpoint > Relay Configuration >Switchgear**, and its statuses are as follows:

Table 6-28: Switchgear status

SWITCHGEAR 1 STATUS		SWITCHGEAR X STATUS		SWITCHGEAR 16 STATUS
SWITCH 1 A INPUT	...	SWITCH X A INPUT	...	SWITCH 16 A INPUT
SWITCH 1 B INPUT	...	SWITCH X B INPUT	...	SWITCH 16 B INPUT
SWITCH 1 A STATUS	...	SWITCH X A STATUS	...	SWITCH 16 A STATUS
SWITCH 1 B STATUS	...	SWITCH X B STATUS	...	SWITCH 16 B STATUS
SWITCH 1 OPEN	...	SWITCH X OPEN	...	SWITCH 16 OPEN
SWITCH 1 CLOSED	...	SWITCH X CLOSED	...	SWITCH 16 CLOSED
SWITCH 1 00_ERROR	...	SWITCH X 00_ERROR	...	SWITCH 16 00_ERROR
SWITCH 1 11_ERROR	...	SWITCH X 11_ERROR	...	SWITCH 16 11_ERROR
SWITCH 1 OPEN INIT	...	SWITCH X OPEN INIT	...	SWITCH 16 OPEN INIT
SWITCH 1 CLOSE INIT	...	SWITCH X CLOSE INIT	...	SWITCH 16 CLOSE INIT
SWGR 1 FAIL TO OPEN	...	SWGR X FAIL TO OPEN	...	SWGR 16 FAIL TO OPEN
SWGR 1 FAIL TO CLOSE	...	SWGR X FAIL TO CLOSE	...	SWGR 16 FAIL TO CLOSE

SWITCH **X** A INPUT — The LED lights up when the input associated with switchgear Contact A is activated.

SWITCH **X** B INPUT — The LED lights up when the input associated with switchgear Contact B is activated.

SWITCH **X** A STATUS — Status associated with Switchgear contact A. It is activated once the time required for the Switchgear module to acknowledge contact A has expired.

SWITCH **X** B STATUS — Status associated with Switchgear contact B. It is activated once the time required for the Switchgear module to acknowledge contact B has expired.

SWITCH **X** OPEN — Lights up when the associated switchgear is open

SWITCH **X** CLOSED — Lights up when the associated switchgear is closed

SWITCH **X** 00_ERROR — Output that represents the Switchgear status 00, considered as abnormal.

SWITCH **X** 11_ERROR — Output that represents the Switchgear status 11, considered as abnormal.

SWITCH **X** OPEN INIT — Programmable input that indicates the initiation of the Opening Operation for the considered switchgear.

SWITCH **X** CLOSE INIT — Programmable input that indicates the initiation of the closing Operation for the considered switchgear.

SWGR **X** FAIL TO OPEN — Output that represents a failure to open, from the associated external device (opening time exceeded)

SWGR **X** FAIL TO CLOSE — Output that represents a failure to close from the associated external device (closing time exceeded)

See the following figure:

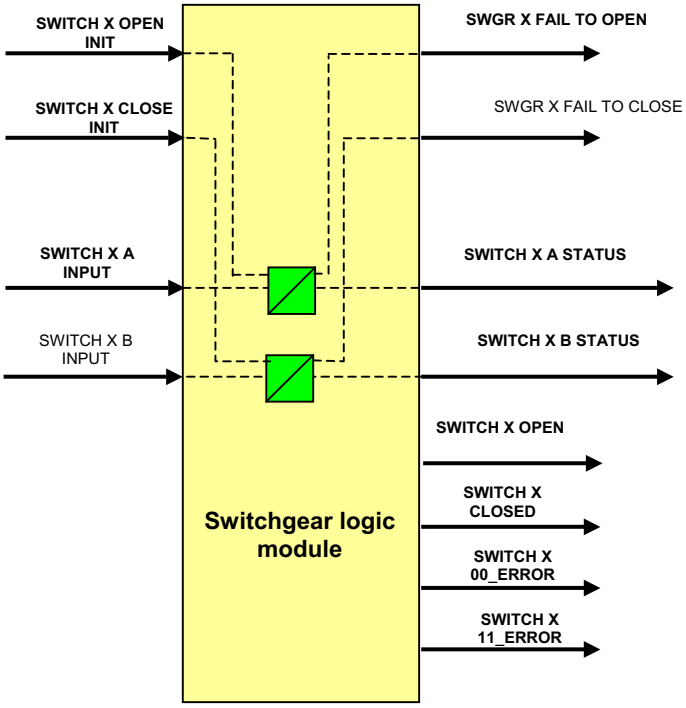


Figure 6-1: Switchgear contacts

6.2.9 Calibration status

This screen can be accessed at ***Actual > Status > Calibration***, and it includes the internal calibration status for the relay.

Table 6-29: Calibration status

CALIBRATION
FACTORY CALIBRATION
CALIBRATION ERROR
CALIBRATION DATE

FACTORY CALIBRATION: This value is active when the relay calibration settings are the default values (no calibration).

CALIBRATION ERROR: Error shown when there is a problem in the calibration settings (wrong values).

CALIBRATION DATE: This value is showing date when relay was calibrated.

6.2.10 FlexCurves

This screen can be accessed at ***Actual> Status > Flex Curves***, and it includes the internal flex curves status.

If the LED associated with the FlexCurve status is lit up, this indicates that the user curve has been configured with new values (not default values).

Table 6-30: FlexCurve status

FLEX CURVES STATUS
FLEXCURVE A STATUS
FLEXCURVE B STATUS
FLEXCURVE C STATUS
FLEXCURVE D STATUS

6.2.11 System info

This screen can be accessed at Actual> Status > System Info. It can monitor the system parameters and the internal status of the Relay operating system.

Form firmware version prior to 7.00, System Info pop-up window shows general system information as described in the table below:

Table 6-31: System info for firmware versions below 7.00

SYSTEM INFO
E2PROM STATUS
DSP COMM ERROR
MAGNETIC MODULE ERROR
Green Zone
Yellow Zone
Orange Zone
Red Zone
Kswapd Time
mtd2 Time
mtd2 Time
CPU Rtai
CPU Linux
Total RAM
Used DRAM
Free RAM
Shared RAM
Buffer RAM
Chached RAM
Green Counter
Yellow Counter
Orange Counter
Red Counter
Up Time

DSP Counter
ICD Status
MAC Address
Serial Number
Manufacturer date

- **E2PROM status:** LED associated lights in green if E2PROM is configured and working properly
- **DSP comm error:** LED associated lights in green if communication error between DSP and main processor.
- **Magnetic module error:** LED associated lights in green if communication error between DSP and magnetic module.
- **Green/Yellow/Orange/Red Zones and Counters:** These 4 counters are referred to the total amount of free RAM available in the device. The usual state should be Green zone and the rest of indicators means that the device can have or stop some task just in case that they would need to prioritize the protection task.
- **Kswapd Time:** It should take value always to 0
- **Mtd2 Time:** Time accessing to this partition with Linux OS
- **Mtd3 Time:** Time accessing to this partition with Application
- **CPU Rtai:** Percentage corresponding to protection tasks execution
- **CPU Linux:** Percentage corresponding to rest of Linux tasks execution
- **Total RAM:** Total RAM in the device
- **Used DRAM:** Used RAM in the device
- **Free RAM:** Available RAM in the device
- **Chached RAM:** Memory reserved for the Linux OS
- **Up Time:** Second from the last power-up
- **DSP Counter:** It shows that DSP is running
- **ICD Status:** Information about status of ICD file stored in the F650. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
- **MAC address:** MAC address assigned to Ethernet ports, Eth_1 and Eth_2.
- **Serial number:** Serial number of the relay that is communicating with EnerVista 650 Setup.
- **Manufacturing date:** Date when the relay, connected to EnerVista 650 Setup, was assembled.

Table 6-32: System info for firmware versions 7.00 and above

SYSTEM INFO
E2PROM STATUS
DSP COMM ERROR
MAGNETIC MODULE ERROR
PLC ERROR
NET CONF ERROR
ORDER CODE ERROR
Total RAM
Used DRAM
Free RAM
Up Time

DSP Counter
CPU Usage
ICD Status
ICD Status NOTVAL
DSP Status
FLASH Usage
KINETICS Usage
CPU Max Usage
Temp Current Value
Temp Max Value
Temp Min Value
Scan Cycle Average
Scan Cycle Rate
PLC Checksum
Settings Checksum
MAC Address
Serial Number
Manufacturer date

- **E2PROM Status:** LED associated lights in green if E2PROM is configured and working properly
- **DSP COMM ERROR:** LED associated lights in green if communication error between DSP and main processor.
- **Magnetic module error:** LED associated lights in green if communication error between DSP and magnetic module.
- **Plc error:** PLC equations sent to the relay have an error or are incorrect.
- **Net conf error:** Network configuration is incorrect
- **Order code error:** Order code and hardware configuration do not match
- **Total RAM:** Total RAM in the device
- **Used DRAM:** Used RAM in the device
- **Free RAM:** Available RAM in the device
- **UpTime:** DSP heartbeat
- **DSP Counter:** Percentage of CPU in use
- **CPU Usage:** Percentage of CPU in use
- **ICD Status:** Information about status of ICD file stored in the F650. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
- **ICD Status NotVal:** Information about validation of new ICD after being sent into the relay. For detailed information go to Chapter 7, section 7.3.2.2 IEC 61850 CONFIGURATOR FEATURES FOR CONFIGURATION
- **Dsp Status:** Internal status of the DSP
- **Flash Usage:** FLASH memory in use
- **KINETIS Status:** Kinetis working mode
- **CPU MAX Usage:** Maximum measured CPU usage
- **Temp Current Value:** Current temperature of CPU. This value is displayed in Celsius units.

- **Temp Max Value:** Maximum temperature reached by CPU during operating mode. This value is reset This value is taken into account from last reboot.
- **Temp Min Value:** Maximum temperature reached by CPU after last reboot.
- **Scan Cycle Average:** Mean time in nanoseconds that takes a Scan cycle to run
- **Scan Cycle Rate:** Every milliseconds a Scan cycle is run
- **PLC Checksum:** Value of CRC of PLC equations. This value is read from the relay.
- **Settings checksum:** Value of CRC of relay settings. This value is read from the relay.
- **MAC address:** MAC address assigned to Ethernet port, Eth_E.
- **Serial number:** Serial number of the relay that is communicating with EnerVista 650 Setup.
- **Manufacturing date:** Date when the relay, connected to EnerVista 650 Setup, was assembled.

6.2.12 Record status

This screen shows part of the information related to the different records stored in the Relay, such as:

6.2.12.1 Fault reports

Actual> Status > Records Status > Fault Reports

Table 6-33: Fault report status

FAULT REPORT STATUS
FAULT REPORT TRIGG
CLEAR FAULT REPORTS
PreFault Ia Mod
PreFault Ia Ang
PreFault Ib Mod
PreFault Ib Ang
PreFault Ic Mod
PreFault Ic Ang
PreFault Vab Mod
PreFault Vab Ang
PreFault Vbc Mod
PreFault Vbc Ang
PreFault Vca Mod
PreFault Vca Ang
PreFault Ig Mod
PreFault Ig Ang
PreFault Isg Mod
PreFault Isg Ang
PostFault Ia Mod
PostFault Ia Ang
PostFault Ib Mod
PostFault Ib Ang
PostFault Ic Mod
PostFault Ic Ang
PostFault Vab Mod
PostFault Vab Ang
PostFault Vbc Mod
PostFault Vbc Ang
PostFault Vca Mod

PostFault Vca Ang
PostFault Ig Mod
PostFault Ig Ang
PostFault Isg Mod
PostFault Isg Ang
FAULT DATE
FAULT TYPE
FAULT LOCATION
FAULT REPORT NUMBER
R Primary
R Secondary
X Primary
X Secondary
FAULT RESISTANCE

- **PreFault values:** Prefault values for all the current and voltage units (Modulus (mod), Angle (deg))
- **PostFault values**: Postfault values for all the current and voltage units (Modulus (mod), Angle (deg))
- **R Primary/R Secondary**: Primary/Secondary Fault Resistance; this value represents the resistance in primary/ secondary values of the portion of the affected line until the defect.
- **Secondary fault resistance**: Resistance of Positive sequence x distance / Line Length;
- **X Primary/X Secondary**: Primary/Secondary Fault Reactance. This value represents the reactance in primary/ secondary values of the portion of the affected line until the defect.
- **Secondary fault reactance**: Reactance of Positive sequence x distance / Line Length;
- **Fault resistance**: This value provides the estimated ground fault resistance in primary values of the fault seen by the F650 by neglecting the resistance of the affected portion of the line.
- **Fault report trigg**: This signal indicates whether the signal that initiates the calculation of the distance to the fault has been activated.
- **Clear fault reports**: This signal indicates the reset of fault reports.
- **Fault date**: Date and time of the last fault produced in the relay. In format (Day/Month/year Hour:minutes:seconds.milliseconds)
- **Fault type**: Type of the last fault produced in the Relay (phase to ground, phase to phase, three-phase, etc).
- **Fault location**: Location of the last fault produced in the relay.
- **Fault report number**: Number of fault reports

6.2.12.2 Control events

Actual> Status > Records Status > Control Events

In this screen ***Actual> Status > Records Status > Control Events***, the status of the signals configured to launch the control events can be seen, activated or not.

The F650 provides the possibility to configure 128 control events (at **Settings > Relay Configuration > Control Events**). In the **Actual > Records > Event Recorder > Control Events** it is possible to see and retrieve the recorded control events to a file, seeing the text and date and time and status of the preconfigured control event.

Table 6-34: Control event status

CONTROL EVENTS
CONTROL EVENT 1
CONTROL EVENT 2
...
CONTROL EVENT 128

6.2.12.3 Oscillography

Actual> Status > Records Status > Oscillography

The following figure shows the status of the different digital channels that can be programmed to be included in oscillography records. When the signal associated with a specific channel is active, its LED lights up on this screen.

This screen also shows the oscillography trigger status, active or inactive, by lighting up that channel.

Table 6-35: Oscillography status

OSCILLOGRAPHY
OSC DIG CHANNEL 1
OSC DIG CHANNEL 2
OSC DIG CHANNEL 3
OSC DIG CHANNEL 4
OSC DIG CHANNEL 5
OSC DIG CHANNEL 6
OSC DIG CHANNEL 7
OSC DIG CHANNEL 8
OSC DIG CHANNEL 9
OSC DIG CHANNEL 10
OSC DIG CHANNEL 11
OSC DIG CHANNEL 12
OSC DIG CHANNEL 13
OSC DIG CHANNEL 14
OSC DIG CHANNEL 15
OSC DIG CHANNEL 16
OSCILLO TRIGGER
NUMBER OF TRIGGERS
CYCLES PER RECORD
AVAILABLE RECORDS

The last three values shown are as follows:

NUMBER OF TRIGGERS: This is the number of the last oscillography record obtained in the relay. This value has a range of 0 to 999.

CYCLES PER RECORD: This is the number of cycles contained in the oscillography record; this value depends on the settings adjusted on the oscillography menu at ***Setpoint > Product Setup > Oscillography***.

AVAILABLE RECORDS: This is the number of available oscillography records in the relay.

Values for these last 3 fields are reset every time the oscillography settings are modified.

6.2.12.4 Data logger

Actual> Status > Records Status > Data Logger

Table 6-36: Data logger status

DATA LOGGER
OLDEST SAMPLE TIME
NEWEST SAMPLE TIME
DATA LOGGER CHANNELS
DATA LOGGER DAYS

OLDEST SAMPLE TIME: Date and time of the oldest value stored in the data logger.

NEWEST SAMPLE TIME: Date and time of the most recent value stored in the data logger

DATA LOGGER CHANNELS: Number of channels configured in the data logger

DATA LOGGER DAYS: Time in days during which, samples are stored without overwriting them.

6.2.12.5 Demand

Actual> Status > Records Status > Demand

Table 6-37: Demand status

DEMAND
DEMAND TRIGGER INP
DEMAND RESET INP

DEMAND TRIGGER INP: Signal used for triggering the demand in the case of Rolling demand.

DEMAND RESET INP: Signal to reset the demand.

These signals can be configured at ***Setpoint > Relay Configuration > Protection Elements***

6.2.12.6 Energy

Freeze/Unfreeze/reset Energy: These signals correspond to the relay energy counters statuses of freeze, unfreeze and reset.

Actual> Status > Records Status > Energy

Table 6-38: Energy status

ENERGY
FREEZE ENERGY CNT
UNFREEZE ENERGY CNT
RESET ENERGY CNT

FREEZE ENERGY CNT: Signal used to freeze the energy counters for measurement purposes.

UNFREEZE ENERGY CNT: Signal used to unfreeze the energy counters.

RESET ENERGY CNT: Signal to reset the energy measurements and set the values to zero.

These signals can be configured at ***Setpoint > Relay Configuration > Protection Elements***

6.2.12.7 Breaker maintenance

Actual> Status > Records Status > Breaker Maintenance

This screen shows the breaker status related to breaker maintenance. Other statuses are provided in the different switchgear or breaker status signals.

Table 6-39: Breaker maintenance status

BREAKER MAINTENANCE INPUTS
RESET KI2t COUNTERS
RESET BKR COUNTERS
BREAKER MAINTENANCE STATUS
KI2t PHASE A ALARM
KI2t PHASE B ALARM
KI2t PHASE C ALARM
BKR OPENINGS ALARM
BKR OPEN 1 HOUR ALARM
BREAKER OPENINGS
BREAKER CLOSINGS
KI2t PHASE A
KI2t PHASE B
KI2t PHASE C
BKR OPENING TIME
BKR CLOSING TIME
BKR OPEN TIMING
BKR CLOSE TIMING

The breaker maintenance inputs are signals that can be configured at Setpoint > Relay Configuration > Protection Elements:

RESET KI2t COUNTERS Signal to reset and set to zero all the KI2t counters (for all phases)

RESET BKR COUNTERS Signal to reset and set to zero all the breaker counters (number of openings and closings and alarms)

KI2t PHASE A ALARM Alarm signal for maximum breaking capacity in phase A exceeded

KI2t PHASE B ALARM Alarm signal for maximum breaking capacity in phase B exceeded

KI2t PHASE C ALARM Alarm signal for maximum breaking capacity in phase C exceeded

BKR OPENINGS ALARM Alarm related to the maximum number of breaker openings

BKR OPEN 1 HOUR ALARM Alarm related to the maximum number of breaker openings in one hour

BREAKER OPENINGS Counter of the total number of openings performed by the breaker

BREAKER CLOSINGS Counter of the total number of closings performed by the breaker

KI2t PHASE A kI^2t phase A counter (total accumulative breaking level – phase A)

KI2t PHASE B kI^2t phase B counter (total accumulative breaking level – phase B)

KI2t PHASE C kI^2t phase C counter (total accumulative breaking level – phase C)

BKR OPENING TIME Time to set a failure in opening the breaker.

BKR CLOSING TIME Time to set a failure in closing the breaker.

BKR OPEN TIMING Exact time in opening the breaker

BKR CLOSE TIMING Exact time in closing the breaker

Breaker opening and closing time signals are configured at ***Setpoint > Relay Configuration > Switchgear*** for the related switchgear device.

6.2.13 IEEE 1588 precision time protocol (PTP)

Actual> Status > IRIG-B PTP 1588

This screen shows the IRIG-B and PRP status. It includes the following signaling LEDs showing the FAILURE of the SNTP and IRIG-B and other statuses are provided.

SNTP - IRIGB - PTP1588 STATUS
SNTP FAILURE
IRIG-B FAILURE
RTC Sync Source
GrandMaster-ID LOW
GrandMaster-ID HIGH
PTP ACCURACY

The **RTC Sync Source** actual value is the time synchronizing source the relay is using at present. Possible sources are: Port A PTP Clock, Port B PTP Clock, IRIG B, SNTP and None.

Grandmaster ID is the grandmaster Identity code being received from the present PTP grandmaster if any. When the relay is not using any PTP grandmaster, this actual value is zero. The grandmaster Identity code is specified by PTP to be globally unique, so one can always know which clock is grandmaster in a system with multiple grandmaster-capable clocks.

PTP Accuracy is the estimated maximum time error at present in the Real Time Clock (RTC), considering the quality information embedded in the received time signal, how long the relay has had to lock to the time source, and in the case of time signal interruptions, the length of the interruption. The value 999,999,999 indicates that the magnitude of the estimated error is one second or more, or that the error cannot be estimated.

Note:

The F650 does not support the end-to-end delay mechanism, so it is not unexpected that changing the device to which the F650 is connected to this mode would cause the (NoPDelay) message. When PTP source clock is having "End to End clock delay” configured, and if F650 is receiving PTP packets from this clock F650 is getting synchronized and status is showing Synch'd (No Pdelay). Note that the relay does not allow manual overwriting of its RTC time if PTP is functional.

6.2.14 Versions

This screen can be accessed at **Actual > Status > Versions**. It shows the current versions and dates of the different applications.

VERSIONS
HMI Version
DISPLAY TYPE
Boot Version
Boot Date
Kinetis Boot Version
Kinetis Boot Date
Kinetis Loader Ver
Kinetis Loader Date
Kinetis App Version
Kinetis App Date
DSP Version
DSP Date
Firmware Date
FPGA Version
RM PRP HSR Version
RM RSTP Version
RM LLA Version
RM Bypass Version
CPU Revision

HMI Version: Relay display version

DISPLAY TYPE: Relay's display model (refers to order code, basic or graphic)

1. Basic display
2. Graphic display
3. Chinese Basic
4. Chinese Graphic (IEC symbols)

Boot Version: Boot version

Boot Date: Boot versions release date

Kinetis Boot Version: Kinetis microprocessor boot version

Kinetis Boot Date: Kinetis boot release date

Kinetis Loader Ver: Kinetis bootloader version

Kinetis Loader Date: Kinetis bootloader release date

Kinetis App Version: Kinetis application version

Kinetis App Date: Kinetis application release date

DSP Version: Digital Signal Processor firmware version

DSP Date: Digital Signal Processor firmware release date

Firmware Date: Firmware application release date

FPGA Version: Current version of the bitstream running in CPU FPGA.

RM PRP HSR Version: Current version of the PRP_HSR bitstream running in the redundancy module FPGA.

RM RSTP Version: Current version of the RSTP-Daisy Chain bitstream running in the redundancy module FPGA.

RM LLA Version: Current version of the LLA bitstream running in the redundancy module FPGA.

RM Bypass Version: Current version of the Bypass bitstream running in the redundancy module FPGA.

CPU Revision: CPU hardware version:

- Redundant Fiber Optic: 0
- Redundant Cooper Cable: 1
- Single Fiber Optic: 2
- Single Cooper Cable: 3

6.2.15 Redundancy

Actual > Status > Redundancy: This screen shows the port A and B statuses related to PRP, HSR and RSTP protocols.

REDUNDANCY
PRP_HSR A tx
PRP_HSR B tx
PRP_HSR A err
PRP_HSR B err
RSTP PortA State
RSTP PortB State

- **PRP_HSR A TX**: This is the number of the transmitted messages over port A when PRP or HSR option is enabled.
- **PRP_HSR B TX**: This is the number of the transmitted messages over port B when PRP or HSR option is enabled.
- **PRP_HSR A ERR**: This value shows the number of messages received over port A with wrong LAN ID.
- **PRP_HSR B ERR**: This value shows the number of messages received over port B with wrong LAN ID.
- **RSTP PortA State**: This is the state of RSTP for port A (Discarding, Learning & Forwarding)
- **RSTP PortB State**: This is the state of RSTP for port B (Discarding, Learning & Forwarding)

6.3 Metering

6.3.1 Primary values

6.3.1.1 Current

Actual> Metering > Primary Values > Current

Description	UNITS
CT Ratio	N/A
CT Ratio Ig	N/A
CT Ratio Isg	N/A
Ia Angle	Deg
Ib Angle	Deg
Ic Angle	Deg
In Angle	Deg
Ig Angle	Deg
Isg Angle	Deg
Phasor Ia Primary	KA
Phasor Ib Primary	KA
Phasor Ic Primary	KA
Phasor Ig Primary	KA
Phasor Isg Primary	KA
Phasor In Primary	KA
RMS Ia Primary	KA
RMS Ib Primary	KA
RMS Ic Primary	KA

RMS Ig Primary	KA
RMS Isg Primary	KA
I0 Primary	KA
I1 Primary	KA
I2 Primary	KA
% Load to trip	N/A

6.3.1.2 Voltage

Actual > Metering > Primary Values > Voltage

DESCRIPTION	UNITS
PT Ratio	N/A
Va Angle	Deg
Vb Angle	Deg
Vc Angle	Deg
Vn Angle	Deg
Vx Angle	Deg
Vab Angle	Deg
Vbc Angle	Deg
Vca Angle	Deg
V0 Primary	KV
V1 Primary	KV
V2 Primary	KV
Vab Primary	KV
Vbc Primary	KV
Vca Primary	KV
Va Primary	KV
Vb Primary	KV
Vc Primary	KV
Vn Primary	KV
Vx Primary	KV
VBB Primary	KV
VL Primary	KV

6.3.1.3 Power

Actual > Metering > Primary Values > Power

DESCRIPTION	UNITS
Phase A Real Pwr	MW
Phase A Reactive Pwr	MVAr
Phase A Apparent Pwr	MVA
Phase B Real Pwr	MW
Phase B Reactive Pwr	MVAr
Phase B Apparent Pwr	MVA
Phase C Real Pwr	MW
Phase C Reactive Pwr	MVAr
Phase C Apparent Pwr	MVA
3 Phase Real Pwr	MW
3 Phase Reactive Pwr	MVAr
3 Phase Apparent Pwr	MVA

Phase A Power Factor	N/A
Phase B Power Factor	N/A
Phase C Power Factor	N/A
3 Phase Power Factor	N/A

NOTE: If voltage inputs are configured in Delta connection and the auxiliary voltage input is set as Vx, measurements of single phase power value cannot be duly calculated, and therefore, its value is zero. For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

NOTE 2: When currents and neither voltages are not available in the F650, default value for power factor will be indicated as zero.

6.3.1.4 Energy

Actual> Metering > Primary Values > Energy

Energy is only given in three phase primary values

DESCRIPTION	UNITS
Positive MWatthour	MWh
Negative MWatthour	MWh
Positive MVarhour	MVArh
Negative MVarhour	MVArh
Pos Mwatthour Cnt	MWh
Neg Mwatthour Cnt	MWh
Pos MVarhour Cnt	MVArh
Neg MVarhour Cnt	MVArh

When the energy counters reach the value (2ˆ 31)/1000 (approximately 2147483 MVArh and MWh) all the values are set to zero and starts counting again.

6.3.1.5 Demand

Actual > Metering > Primary Values > Demand

Demand is only given in primary values

DESCRIPTION	UNITS
DEMAND IA	KA
DEMAND IA MAX	KA
DEMAND IA DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IB	KA
DEMAND IB MAX	KA
DEMAND IB DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IC	KA
DEMAND IC MAX	KA
DEMAND IC DATE	dd/mm/yy hh:mm:ss:ms
DEMAND IG	KA
DEMAND IG MAX	KA
DEMAND IG DATE	dd/mm/yy hh:mm:ss:ms
DEMAND ISG	KA
DEMAND ISG MAX	KA
DEMAND ISG DATE	dd/mm/yy hh:mm:ss:ms

DESCRIPTION	UNITS
DEMAND I2	KA
DEMAND I2 MAX	KA
DEMAND I2 DATE	dd/mm/yy hh:mm:ss:ms
DEMAND W	MW
DEMAND W MAX	MW
DEMAND W MIN	MW
DEMAND W DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VAR PWR	MVAr
DEMAND VAR MAX	MVAr
DEMAND VAR MIN	MVAr
DEMAND VAR DATE	dd/mm/yy hh:mm:ss:ms
DEMAND VA PWR	MVA
DEMAND VA MAX	MVA
DEMAND VA MIN	MVA
DEMAND VA DATE	dd/mm/yy hh:mm:ss:ms

6.3.2 Secondary values

6.3.2.1 Current

Actual> Metering > Secondary Values > Current

DESCRIPTION	UNITS
Phasor Ia	A
RMS Ia	A
Phasor Ib	A
RMS Ib	A
Phasor Ic	A
RMS Ic	A
Phasor In	A
Phasor Ig	A
RMS Ig	A
Phasor Isg	A
RMS Isg	A
Zero seq I0	A
Positive Seq I1	A
Negative Seq I2	A

6.3.2.2 Voltage

Actual > Metering > Secondary Values > Voltage

DESCRIPTION	UNITS
Phasor Vab	V
Phasor Vbc	V
Phasor Vca	V
Phasor Van	V
Phasor Vbn	V
Phasor Vcn	V
Phasor Vn	V
Positive Seq V1	V
Negative Seq V2	V
Zero Seq V0	V
Phasor Vx	V
Nominal Voltage	V
Line Voltage	V
Bus Voltage	V

6.3.2.3 Power

Actual> Metering > Secondary Values > Power

DESCRIPTION	UNITS
Phase A Apparent Pwr	VA
Phase B Apparent Pwr	VA
Phase C Apparent Pwr	VA
Phase A Real Pwr	W
Phase B Real Pwr	W
Phase C Real Pwr	W
Phase A Reactive Pwr	VARS
Phase B Reactive Pwr	VARS
Phase C Reactive Pwr	VARS
3 Phase Apparent Pwr	VA
3 Phase Real Pwr	W
3 Phase Reactive Pwr	VARS
Phase A Power Factor	N/A
Phase B Power Factor	N/A
Phase C Power Factor	N/A
3 Phase Power Factor	N/A

NOTE: If voltage inputs are configured in Delta connection and the auxiliary voltage input is set as Vx, measurements of single phase power value cannot be duly calculated, and therefore, its value is zero. For the three-phase power value, the system uses the ARON method, or two-wattmeters method.

6.3.3 Phasor diagram

Actual> Metering > Phasor Diagram

This window shows the phasors for voltage and current values, phase to phase, phase to ground and sequence values, provided by the unit. The angles provided by the unit are counter clockwise, all the angles are positive values, so for a system Va (0,0°), Vb (0,-120°), Vc (0,120°) the relay provides the following angles Va (0,0°), Vb (0,240°), Vc (0,120°).

The following figure shows the phasor diagram provided by EnerVista 650 Setup:

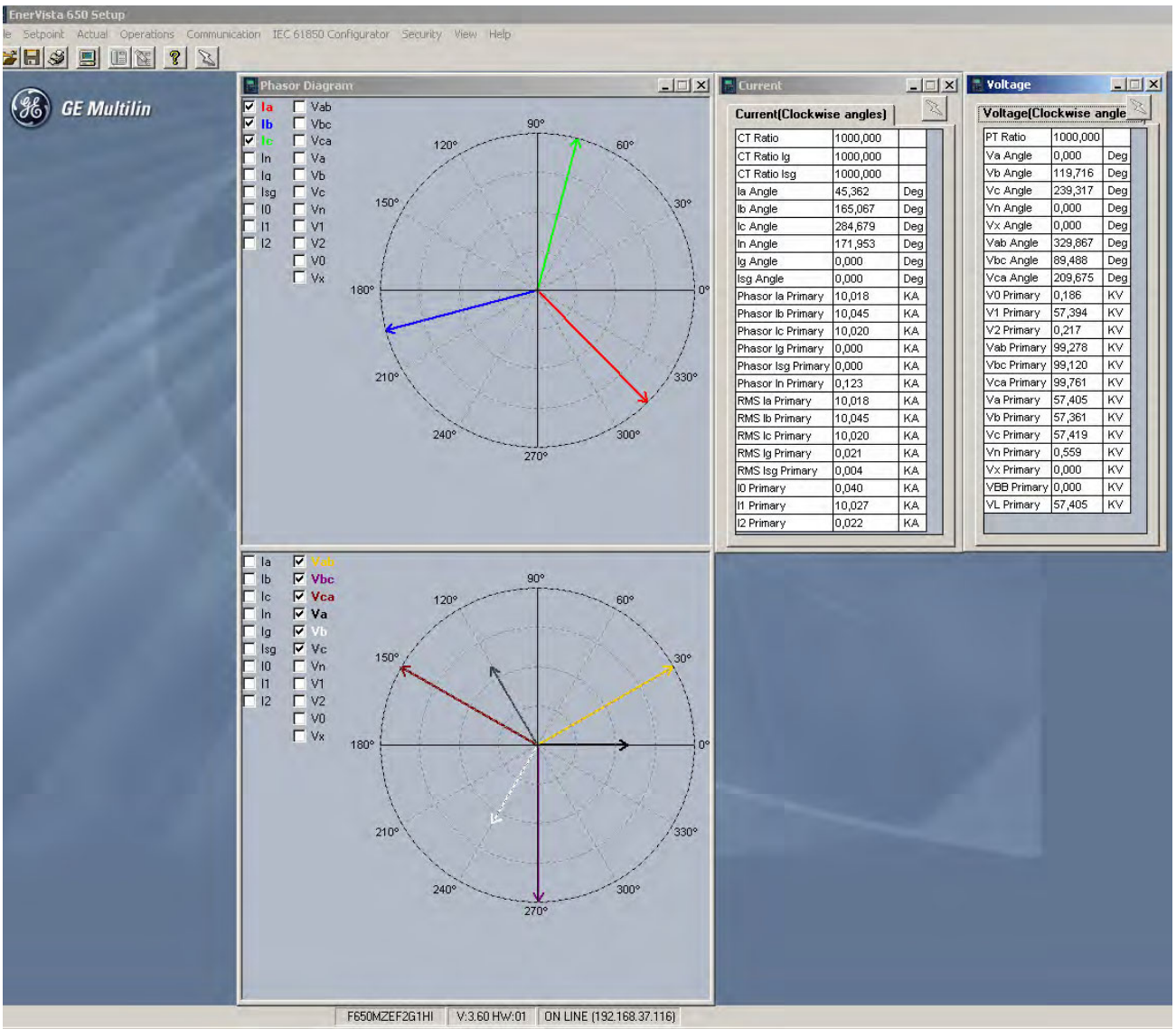


Figure 6-2: Phasor diagram

6.3.4 Frequency

Actual > Metering > Frequency

DESCRIPTION	UNITS
Line Frequency	Hz
Bus Frequency	Hz
df/dt	Hz/s

6.4 Inputs / outputs

Digital inputs and outputs are located in the same board. Depending on the relay model, the number of inputs and outputs varies.

6.4.1 Contact inputs

Actual > Inputs/Outputs > Contact inputs > Board X (being X the corresponding board in each case).

On the inputs screen, the LED associated with the activated input lights in green, if an input is not activated, the LED does not light up. The **Board X Status** LED indicates the status of the board; it is lit up if the board is correct and the communication or the Relay model is appropriate.

Table 6-40: Contact input activation signals

CONTACT INPUTS TYPE 1	CONTACT INPUTS TYPE 2	CONTACT INPUTS TYPE 4		CONTACT INPUTS TYPE 5
CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)	CONT IP_X_CC1 (CC1)	CONT IP_X_CC17 (CC17)	CONT IP_X_CC1 (CC1)
CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)	CONT IP_X_CC2 (CC2)	CONT IP_X_CC18 (CC18)	CONT IP_X_CC2 (CC2)
CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)	CONT IP_X_CC3 (CC3)	CONT IP_X_CC19 (CC19)	CONT IP_X_CC3 (CC3)
CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)	CONT IP_X_CC4 (CC4)	CONT IP_X_CC20 (CC20)	CONT IP_X_CC4 (CC4)
CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)	CONT IP_X_CC5 (CC5)	CONT IP_X_CC21 (CC21)	CONT IP_X_CC5 (CC5)
CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)	CONT IP_X_CC6 (CC6)	CONT IP_X_CC22 (CC22)	CONT IP_X_CC6 (CC6)
CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)	CONT IP_X_CC7 (CC7)	CONT IP_X_CC23 (CC23)	CONT IP_X_CC7 (CC7)
CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)	CONT IP_X_CC8 (CC8)	CONT IP_X_CC24 (CC24)	CONT IP_X_CC8 (CC8)
CONT IP_X_CC9 (Va_COIL1)	CONT IP_X_CC9 (CC9)	CONT IP_X_CC9 (CC9)	CONT IP_X_CC25 (CC25)	CONT IP_X_CC9 (CC9)
CONT IP_X_CC10 (Vb_COIL1)	CONT IP_X_CC10 (CC10)	CONT IP_X_CC10 (CC10)	CONT IP_X_CC26 (CC26)	CONT IP_X_CC10 (CC10)
CONT IP_X_CC11 (Va_COIL2)	CONT IP_X_CC11 (CC11)	CONT IP_X_CC11 (CC11)	CONT IP_X_CC27 (CC27)	CONT IP_X_CC11 (CC11)
CONT IP_X_CC12 (Vb_COIL2)	CONT IP_X_CC12 (CC12)	CONT IP_X_CC12 (CC12)	CONT IP_X_CC28 (CC28)	CONT IP_X_CC12 (CC12)
CONT IP_X_CC13 (O7_SEAL)	CONT IP_X_CC13 (CC13)	CONT IP_X_CC13 (CC13)	CONT IP_X_CC29 (CC29)	CONT IP_X_CC13 (CC13)
CONT IP_X_CC14 (O8_SEAL)	CONT IP_X_CC14 (CC14)	CONT IP_X_CC14 (CC14)	CONT IP_X_CC30 (CC30)	CONT IP_X_CC14 (CC14)
CONT IP_X_CC15 (SUP_COIL1)	CONT IP_X_CC15 (CC15)	CONT IP_X_CC15 (CC15)	CONT IP_X_CC31 (CC31)	CONT IP_X_CC15 (CC15)
CONT IP_X_CC16 (SUP_COIL2)	CONT IP_X_CC16 (CC16)	CONT IP_X_CC16 (CC16)	CONT IP_X_CC32 (CC32)	CONT IP_X_CC16 (CC16)
BOARD X STATUS	BOARD X STATUS		BOARD X STATUS	BOARD X STATUS

6.4.2 Contact output status

Actual > Inputs/Outputs > Contact Output Status > Board X (being X the corresponding board in each case).

The corresponding Outputs screen displays the activation of a contact output by lighting in green the associated LED. Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in the table below.

This screen shows the real status of the contact output, which corresponds to the transformation of the output activation signal (Contact output operate), by the logic applied to this output in **Setpoint > Inputs/Outputs >Contact I/O > Board X**

CONTACT OUTPUT STATUS
CONT OP_X_01

CONT OP_X_02
CONT OP_X_03
CONT OP_X_04
CONT OP_X_05
CONT OP_X_06
CONT OP_X_07
CONT OP_X_08
BOARD X STATUS

NOTE: Both in the outputs menu as in the rest of menus available in "**Actual**", the user can view several screens at the same time to facilitate analysis.

6.4.3 Contact output operates

Actual > Inputs/Outputs > Contact Output Operates > Board X (being X the corresponding board in each case).

CONTACT OUTPUT OPERATES
CONT OP OPER_X_01
CONT OP OPER_X_02
CONT OP OPER_X_03
CONT OP OPER_X_04
CONT OP OPER_X_05
CONT OP OPER_X_06
CONT OP OPER_X_07
CONT OP OPER_X_08
BOARD X STATUS

These screens are available for all boards incorporated in the relay model, which can be F, G, H, and/or J.

This screen shows the activated or deactivated status of those variables used internally to operate a contact output.

Signals shown on this screen are configured in the Outputs screen inside the ***Setpoint > Relay Configuration*** menu, either directly by selecting the signals provided by the relay, or selecting a signal provided by the logic configured at ***Setpoint > Logic Configuration.***

These logic signals (Contact Output Operates), when being transformed by the outputs logic configured at ***Setpoint > Inputs/Outputs >Contact I/O > Board X*** become ***Contact Output*** signals. This output logic can be POSITIVE, NEGATIVE, pulse, latched, etc.

Operation example of output contacts:

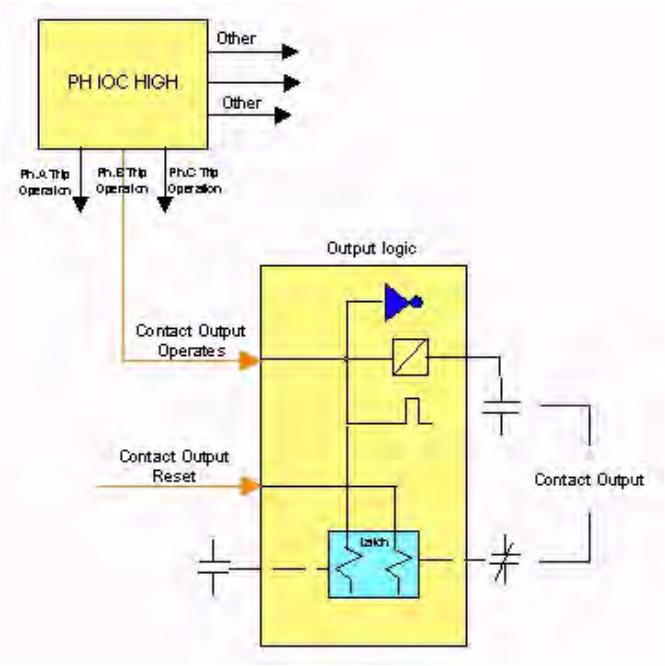


Figure 6-3: Output contact operation

6.4.4 Contact output resets

Actual > Inputs/Outputs > Contact Output Resets > Board X (being X the corresponding board in each case).

Boards types 1 and 2 have both 8 outputs, so the representation is the same for both types as shown in

If the reset signal is active, the green LED lights up. Otherwise, it remains unlit.

CONTACT OUTPUT RESETS
CONT OP RESET_X_01
CONT OP RESET_X_02
CONT OP RESET_X_03
CONT OP RESET_X_04
CONT OP RESET_X_05
CONT OP RESET_X_06
CONT OP RESET_X_07
CONT OP RESET_X_08
BOARD X STATUS

The last LED in this screen, labeled **Board Status**, indicates the general board status.

This output reset Command is only be effective if **latch** has been selected for **Output Type** on the I/O board, thus the contact output has been configured to emulate function 86 (latching relay).

Configuration for the contact output reset signal is set at ***Setpoint > Relay Configuration > Outputs > Contact Output Reset***.

6.4.5 I/O board status

Actual > Inputs/Outputs > I/O Board Status

This screen is used for verifying the status of I/O boards. If all the I/O boards, one (F) or both (F and G) depending on the relay model, are correctly inserted in their tracks and are in good state and communicating through the internal CAN bus, the green LED remains lit.

I/O boards accessible through the external CAN bus are labeled as H and J. In order to start working with the external I/O boards is necessary to select the appropriated I/O board type for each slot (H or J for the CIO module) at **Setpoint > Inputs/Outputs >Contact I/O > Board H and J**. Otherwise the relay will not start communicating through the external CAN bus to the related board.

If one of the boards has been extracted, or the relay model does not match the installed hardware, the corresponding LED remains unlit.

I/O BOARD STATUS
BOARD F STATUS
BOARD G STATUS
BOARD H STATUS
BOARD J STATUS

For all I/O board screens described above, the last LED provides this same information individually.

6.4.6 Virtual inputs

Actual > Inputs/Outputs > Virtual Inputs > Virtual Input Latched > Virtual Input Self-Reset

“Virtual Inputs” are signals transmitted by communications. The EnerVista 650 Setup provides a tool to set virtual inputs through ModBus at **Setpoint > Inputs /Outputs /Virtual inputs** that is only available in online mode (communicating to the relay). There are two available groups of 32 signals each: Latched inputs and Self-reset inputs, and all of them can be used internally to perform operations, new logics in the PLC, etc.

In this actual values screen the status of the assigned virtual inputs can as shown on

VIRTUAL INPUTS LATCHED	VIRTUAL INPUTS SELF-RESET
LATCHED VIRT IP 1	SELF-RST VIRT IP 1
LATCHED VIRT IP 2	SELF-RST VIRT IP 2
...	...
LATCHED VIRT IP 32	SELF-RST VIRT IP 32

6.4.7 Virtual outputs

Actual > Inputs/Outputs > Virtual Outputs

This screen provides the status of the 512 configurable virtual outputs (internal variables) used in the logic scheme. The virtual outputs are set from 000 to 511.

The configuration of the logic associated with the virtual output is in the ***Setpoint > Logic Configuration*** tool provided by EnerVista 650 Setup program.

VIRTUAL OUTPUT STATUS
VIRTUAL OUTPUT 000
VIRTUAL OUTPUT 001
...
VIRTUAL OUTPUT 511

6.4.8 Remote outputs

Actual > Inputs/Outputs > Remote Outputs > DNA

This screen provides the status of the 32 DNA remote outputs.

Table 6-41: DNA STATUS

DNA STATUS
DNA 1
DNA 2
DNA 3
...
DNA 32

Actual > Inputs/Outputs > Remote Outputs > UserSt

This screen provides the status of the 64 UserSt remote outputs.

Table 6-42: USER ST STATUS

USERst STATUS
UserSt 1
UserSt 2
UserSt 3
...
UserSt 64

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Dig Outputs

This screen provides the status of the 32 Remote GOOSE Digital Outputs.

Table 6-43: Remote GOOSE digital output status

REMOTE GOOSE DIG OUTPUTS STATUS
Rem GOOSE Dig Out 1
Rem GOOSE Dig Out 2
Rem GOOSE Dig Out 3
...
Rem GOOSE Dig Out 32

6.4.9 Remote inputs

Actual > Inputs/Outputs > Remote Inputs > Remote Input

This screen provides the status of the 32 remote inputs.

REMOTE INPUTS STATUS
Remote Input 1
Remote Input 2
Remote Input 3
...
Remote Input 32

Actual > Inputs/Outputs > Remote Inputs > Remote Device

This screen provides the status of the 16 remote devices.

REMOTE DEVICE STATUS
Remote Device 1
Remote Device 2
Remote Device 3
...
Remote Device 16

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Digital Inputs

This screen provides the status of the 32 Remote GOOSE Digital Inputs.

REMOTE GOOSE DIG INPUTS STATUS
Rem GOOSE Dig Inp 1
Rem GOOSE Dig Inp 2
Rem GOOSE Dig Inp 3
...
Rem GOOSE Dig Inp 32

Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Analog Inputs

This screen provides the values of the 16 Remote GOOSE Analog Inputs. Eight of them are float type and the other eight are integer type.

REMOTE GOOSE ANALOG INPUTS STATUS
Rem Ana Inp FLOAT 1
Rem Ana Inp FLOAT 2
Rem Ana Inp FLOAT 3
...
Rem Ana Inp FLOAT 8
Rem Ana Inp INT 1
Rem Ana Inp INT 2
Rem Ana Inp INT 3
...
Rem Ana Inp INT 8

6.4.10 Analog inputs

Actual > Inputs/Outputs > Analog Intputs > Board X

This screen provides the values of the analog inputs.

ANALOG INPUTS VALUES
Analog_Inp_X_01
Analog_Inp_X_02
Analog_Inp_X_03
...
Analog_Inp_X_08

6.4.11 Virtual output latched

Actual > Inputs/Outputs > Virtual Output Latched

This screen provides the values of virtual output latched

VIRTUAL OUTPUT LATCHED
V.O. Latched 1
V.O. Latched 2
V.O. Latched 3
....
V.O. Latched 16

6.4.12 RIOs

Actual > Inputs/Outputs > RIOs

This screen provides the values of virtual output analogues, integer and float values

INTEGER VALUES	FLOAT VALUES
INT32_000	FLT32_000
INT32_001	FLT32_001
INT32_002	FLT32_002
....	...
INT32_049	FLT32_049

6.5 Records

6.5.1 Event recorder

6.5.1.1 All snapshot events

Actual > Records > Event Recorder > All Snapshot Events

By selecting this option, the F650 provides a general list of all snapshot events stored in the relay up to the request moment:

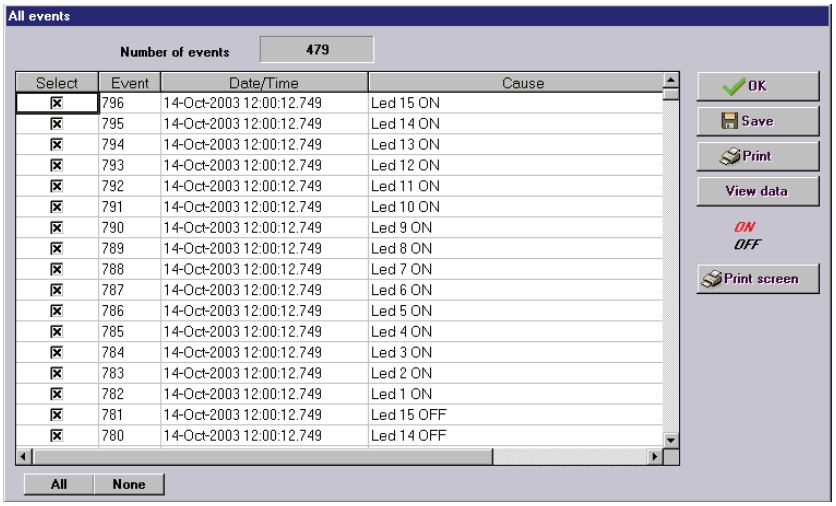


Figure 6-4: Event recorder - all snapshot events

The different options available on this screen are as follows:

Save: It allows saving the Snapshot events information obtained in the relay in a CSV format file.

Print: It allows printing the viewed data.

View data: It allows to view the information contained in the selected event, such as the event number, date and time, cause of the event, as well as the voltage and current values in the moment of the event (see Figure 6-5: Snapshot event details).

There is a "**Select**" option, which is used for selecting the events that are required to appear when the screen information is printed or saved.

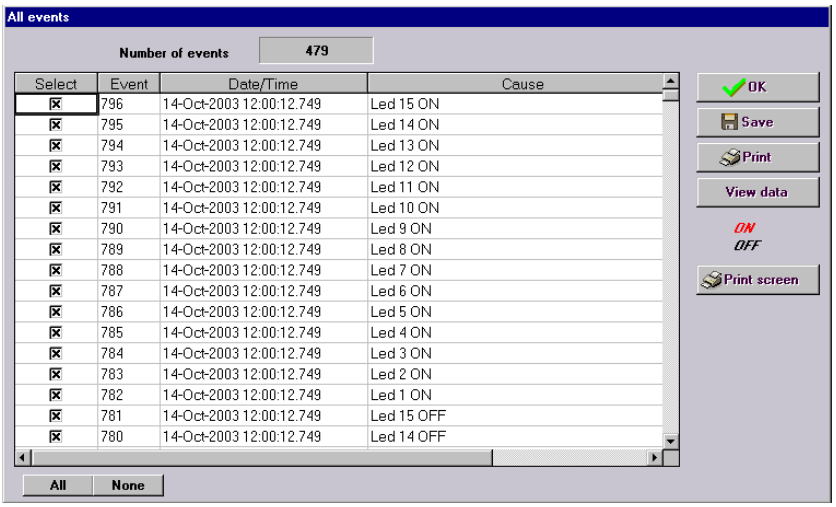


Figure 6-5: Snapshot event details

6.5.1.2 New snapshot events

Actual > Records > Event Recorder > New Snapshot Events

This screen shows new Snapshot events, updated since the last time that this menu was accessed; there are three possible ways to access new events; in local mode (COM2-HMI), remote mode (COM1) and via Ethernet (ETH_1/ ETH2 or ETH_E/ETH_A/ETH_B)

It is the same type of screen as shown on all snapshot event retrieval.

6.5.1.3 Control events

Actual > Records > Event Recorder > Control Events

This screen is identical to the previous ones. The difference is that this screen displays only control events, i.e., those events configured in section **Setpoint > Relay Configuration > Events**. There are a total of 128 configurable events and 64 non-configurable switchgear events.

In this screen, red or black color for a specific event indicates whether it is activated (to 1) or in standby (to 0)

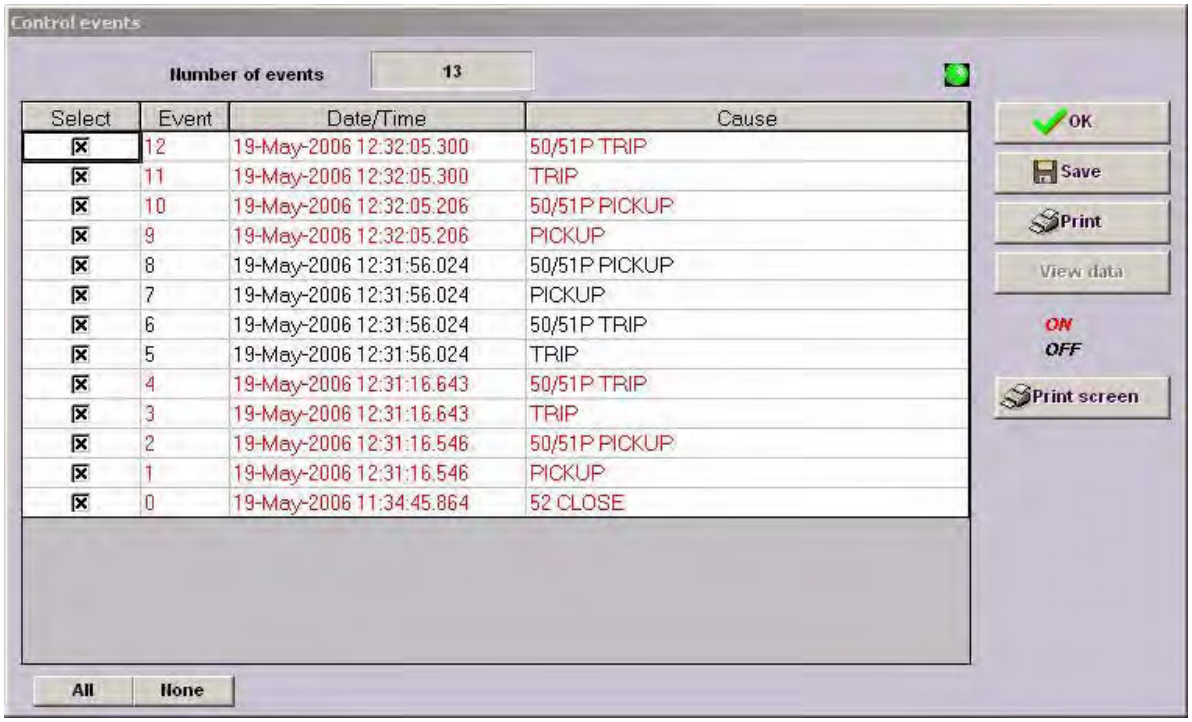


Figure 6-6: Control events

6.5.1.4 Alarm panel

The alarm panel can be accessed at **Actual > Records > Event Recorder > Alarm Panel**.

The following screen provides information about the issued alarms. The screen shows information about their status: active not acknowledged, active acknowledged and not active. The user can either acknowledge all alarms at the same time, or do it partially by selecting the alarms to be acknowledged.

Figure 6-7: Alarm panel

6.5.2 Waveform capture

The ***Actual > Records > Waveform Capture*** screen displays a list of all oscillography records available in the relay. The F650 stores oscillography records from 1 to 999; this is the index of the obtained oscillography record. This screen allows selecting the records to be saved among all records available. Download of these records is done through the selected connection in the "***Communication > Computer***" menu, either serial mode or Ethernet.

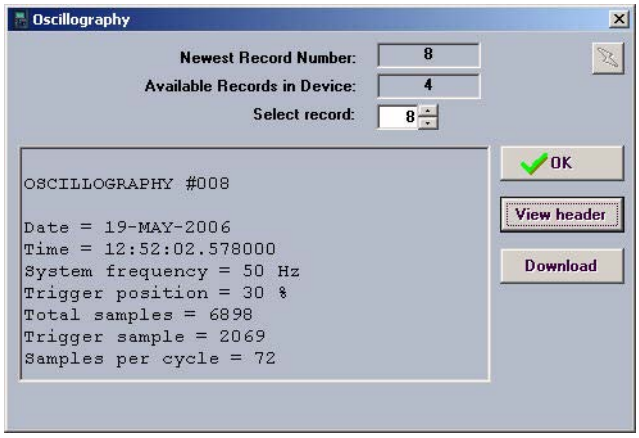


Figure 6-8: Oscillography record retrieval, EnerVista 650 Setup

The screen shows all the available records in the Relay, and by clicking on each of them, the system displays the heading information for that record, allowing downloading the information to a disk. Once the file to be downloaded has been selected, the oscillography record can be opened using GE-OSC software.

GE-OSC is GE proprietary software that is not distributed together with EnerVista 650 Setup. This program is a COMTRADE viewer and analysis software for oscillography files.

If the user does not have the GE-OSC tool, the oscillography record can be stored and viewed using any other analysis tool capable of reproducing COMTRADE.1999 files.

When using GE-OSC software, this program requires the use of a template for each relay. If there is a stored template for F650 relays (as shown in the following figure), select the template and click **Open Selected Template**. The program then prepares to view oscillography and digital records using the options in available menus (Waveforms and Digital Flags). Otherwise, select the **Create New Template** option, and the program helps create a new template. See the GE-OSC software instruction manual for details.

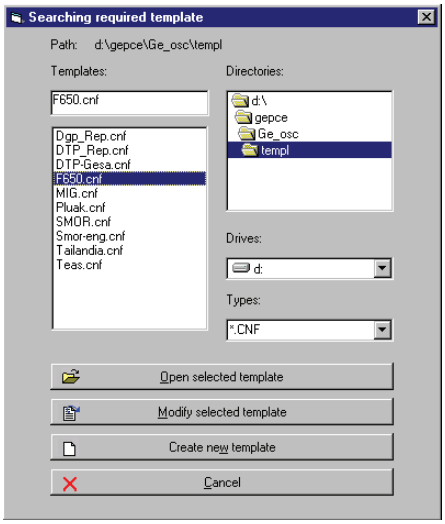


Figure 6-9: GE-OSC oscillography analysis software

Note that any settings change in the oscillography removes all the information stored up to that moment.

6.5.3 Fault report

When selecting the **Actual > Records > Fault Report** menu, EnerVista 650 Setup shows the following screen, indicating the fault reports available in the relay.

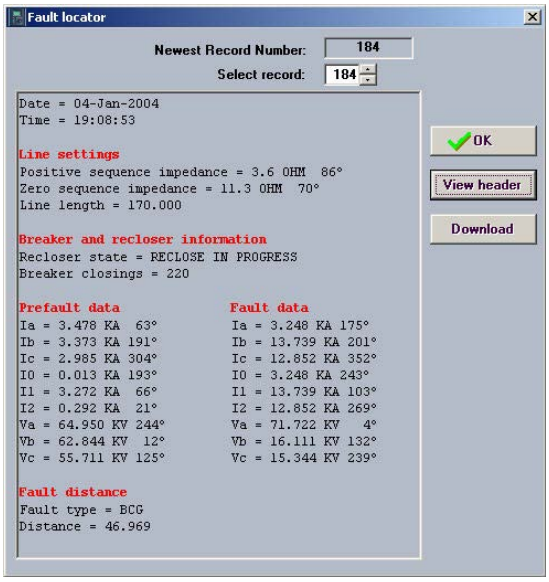


Figure 6-10: Fault report retrieval, EnerVista 650 Setup

When selecting one of the records, a new screen details the following information:

- Date
- Time
- Pre-fault current and voltage in primary values
- Fault current and voltage in primary values
- Fault type
- Distance to the fault

The operation of this screen is similar to that of the previous oscillography screen, being in this case the number of fault reports a fixed number (10), instead of variable and setting-selected like as in the previous case.

Once a fault report is selected, its heading description is displayed, showing pre-fault information, fault information and the distance to the fault. This file can be downloaded to the computer in a CSV format file.

Note that any settings change in the fault report remove all information stored up to that moment. Fault report retrieval is described in section 5.2.3.2 Fault report retrieval.

6.5.4 Data logger

The access menu is **Actual > Records > Data Logger**. Once open, this menu shows a screen containing the information monitored by the relay according to the settings adjusted at **Setpoint > Product Setup > Data Logger**, where the user can select which analog channels are recorded, as well as the sampling rate.

Note that any settings change in the data logger removes all information stored up to that moment.

The data logger screen diagram shows the time during which the displayed values have been obtained.

The upper part of the window shows the time when the oldest sample was taken, as well as the time when the most recent value was taken.

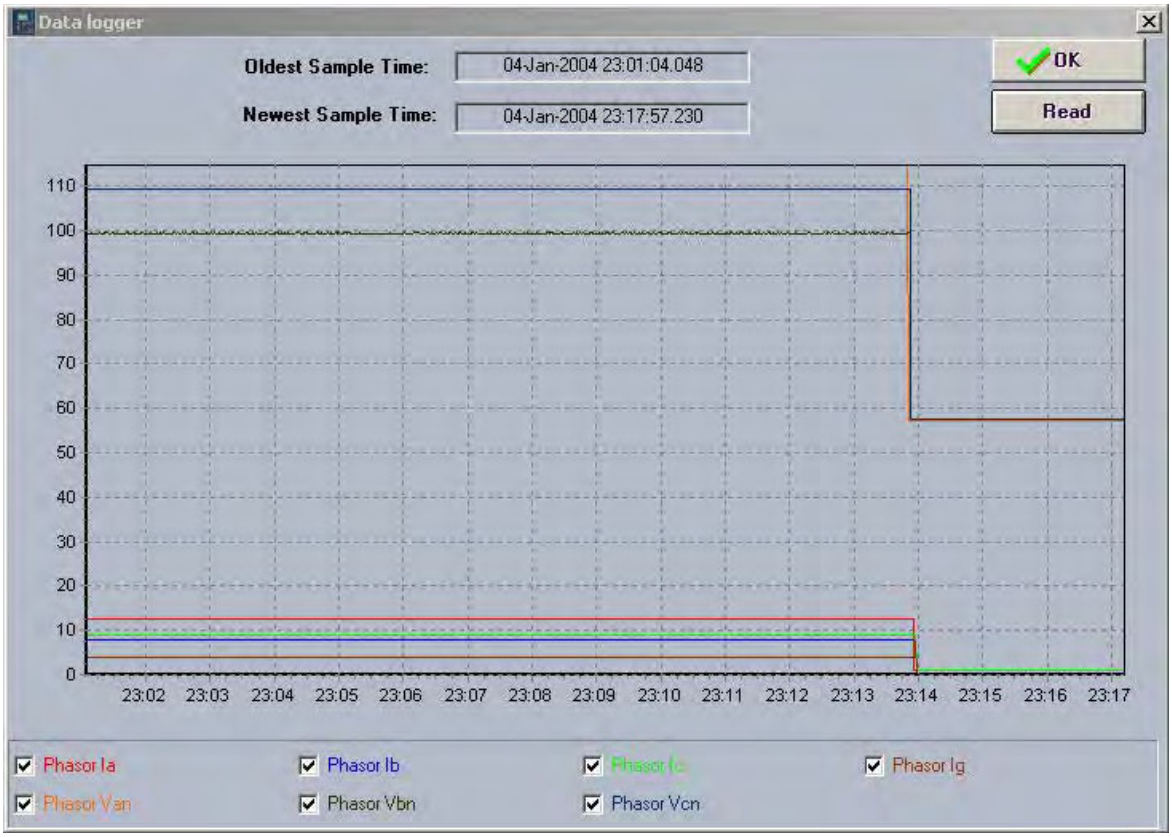


Figure 6-11: Data logger

This screen offers the possibility of storing the data logger record obtained for a further analysis, in COMTRADE format.

Data Logger file retrieval can be performed only via Ethernet communications.

NOTE: Data logger information takes several minutes to be available.

F650 Digital Bay Controller

Chapter 7: IEC 61850 protocol

This chapter outlines the IEC 61850 communications protocol. The IEC 61850 protocol applies when ordered with the product. (Check the order code to determine whether IEC 61850 is included with your product).

7.1 IEC 61850 Overview

This section contains a description of IEC 61850, an International Electrotechnical Commission (IEC) series of documents entitled *Communication Networks and Systems for Power Utility Automation*. IEC 61850 is a series of international standards and technical reports applicable to power utility automation systems (PUAS). It includes semantics, abstract communication services, specific communication services, performance specifications, network engineering guidelines, configuration description methodologies, and engineering processes. The objective of the standard is to provide a framework to achieve interoperability among the intelligent electronic devices (IEDs) from different suppliers, and interoperability among software configuration tools from different suppliers. Interoperability in this case is the ability for IEDs to operate on the same network or communication path sharing information and commands, and for configuration tools to understand each other's configuration files. The standards can be obtained from the IEC (http://www.iec.ch).

650 models with an IEC 61850 option support both the IEC61850 GOOSE and IEC 61850 MMS Server service:

- 650 Family relays with firmware version below 7.00 firmware: As per IEC 61850 standard Edition 1
- 650 Family relays with firmware version from 7.00 to 7.50: As per IEC 61850 standard Edition 2
- F650- Feeder protection relay for firmware version 7.52 or above: As per IEC 61850 standard Edition 1 or 2 (depending on the CID file selected and sent to the relay)
- C650-Digital Bay Controller for firmware version 7.70 or above: As per IEC 61850 standard Edition 1 or 2 (depending on the CID file selected and sent to the relay)

The GOOSE messaging service provides the 650 relay unit the ability to Publish/Subscribe Digital Input Status and its Quality and Timestamp to and from other IEDs which support the GOOSE messaging service, while the server support allows remote a control center, RTU/Gateway, local HMI or other client role devices access to the relay for monitoring and control. The configuration of IEC61850 services is accomplished using the 650 IEC61850 configuration software, EnerVista 650 Setup software. A reboot is required before any changes made in the IEC61850 configuration take effect in the F650 relay.

These models support also Generic Substation State Events (GSSE).

7.2 IEC 61850 generic substation state event (GSSE)

7.2.1 Overview

IEC 61850 specifies two types of peer-to-peer data transfer services: Generic Substation State Events (GSSE) and Generic Object Oriented Substation Events (GOOSE). Both GSSE and GOOSE messages are designed to be short, reliable, and high priority.

GSSE services are compatible with UCA 2.0 GOOSE. IEC 61850 GOOSE services provide virtual LAN (VLAN) support, Ethernet priority tagging, and Ethertype Application ID configuration. The support for VLANs and priority tagging allows for the optimization of Ethernet network traffic. GOOSE messages can be given a higher priority than standard Ethernet traffic, and they can be separated onto specific VLANs. Because of the additional features of GOOSE services versus GSSE services, it is recommended that GOOSE be used wherever backwards compatibility with GSSE (or UCA 2.0 GOOSE) is not required.

Devices that transmit GSSE and/or GOOSE messages also function as servers. Each GSSE publisher contains a "GSSE control block" to configure and control the transmission. Each GOOSE publisher contains a "GOOSE control block" to configure and control the transmission. The transmission is also controlled via device settings. These settings can be seen in the ICD and/or SCD files, or in the device configuration software or files. IEC 61850 recommends a default priority value of 4 for GOOSE. Ethernet traffic that does not contain a priority tag has a default priority of 1. More details are specified in IEC 61850 part 8-1. IEC 61850 recommends that the Ethertype Application ID number be configured according to the GOOSE source. A common number may be used for all GOOSE transmitters in a system. More details are specified in IEC 61850 part 8-1.

GSSE messages contain a fixed set of digital points. IEC 61850 GOOSE messages can, in general, contain any configurable data items. When used by the remote input/output feature, IEC 61850 GOOSE messages contain the same data as GSSE messages. The GSSE message structure contains space for 128 bit pairs representing digital point state information. In addition to digital point states, GSSE/GOOSE messages identify the originator of the message and provide other information required by the communication specification. All devices listen to network messages and capture data only from messages that have originated from selected devices

7.2.2 Remote communication

The IEC 61850 specification includes features that are used to cope with the loss of communication between transmitting and receiving devices. Each transmitting device sends a GSSE/GOOSE message upon a successful power-up, when the state of any included point changes, or after a specified interval, four times the Hold Time setting value, if a change-of-state has not occurred.

Receiving devices are constantly monitoring the communications network for the messages they require, as recognized by the identification of the originating device carried in the message. If the receiving relay has not received another message from the originating device when the specified timeout period elapses, the remote device is declared to be non-communicating, so it uses the programmed default state for all points from that specific remote device.

If a message is received from a remote device before the interval of four times the Hold Time expires, all points for that device are updated to the states contained in the message. The status of a remote device can be displayed.

Remote inputs and outputs provide a means of exchanging digital state information between Ethernet-networked devices. The GSSE facility provides for 32 remote inputs and 64 remote outputs.

7.2.3 GSSE configuration

GSSE messages contain a number of double point status data items. These items are transmitted in two pre-defined data structures named DNA and UserSt. Each DNA and UserSt item is referred to as a 'bit pair'. GSSE messages are transmitted in response to state changes in any of the data points contained in the message. GSSE messages always contain the same number of DNA and UserSt bit pairs. Depending on the configuration, only some of these bit pairs may have values that are of interest to receiving devices.

The relay provides 32 "DNA" bit pairs that represent the state of two pre-defined events and 64 "UserSt" bit pairs, which are status bits representing user-definable events.

GSSE service can be configured using the EnerVista 650 Setup program in the menu **Setpoint > Input/Outputs > Remote Comms**.

Remote Comms must be set to "GSSE" to enable GSSE configuration.

650 ID represents the IEC 61850 GSSE application ID name string sent as part of each GSSE message. This string identifies the GSSE message to the receiving device.

Hold time is used to calculate the interval, if a change-of-state has not occurred, that the device waits to send GSSE message.

Remote Device (1 to 32) is used to select specific remote devices by entering the exact identification (ID) assigned to these devices. A maximum of 32 devices can be configured for receiving GSSE messages.

Bit Pair (1 to 32) is used to assign the data from the GSSE message to remote inputs.

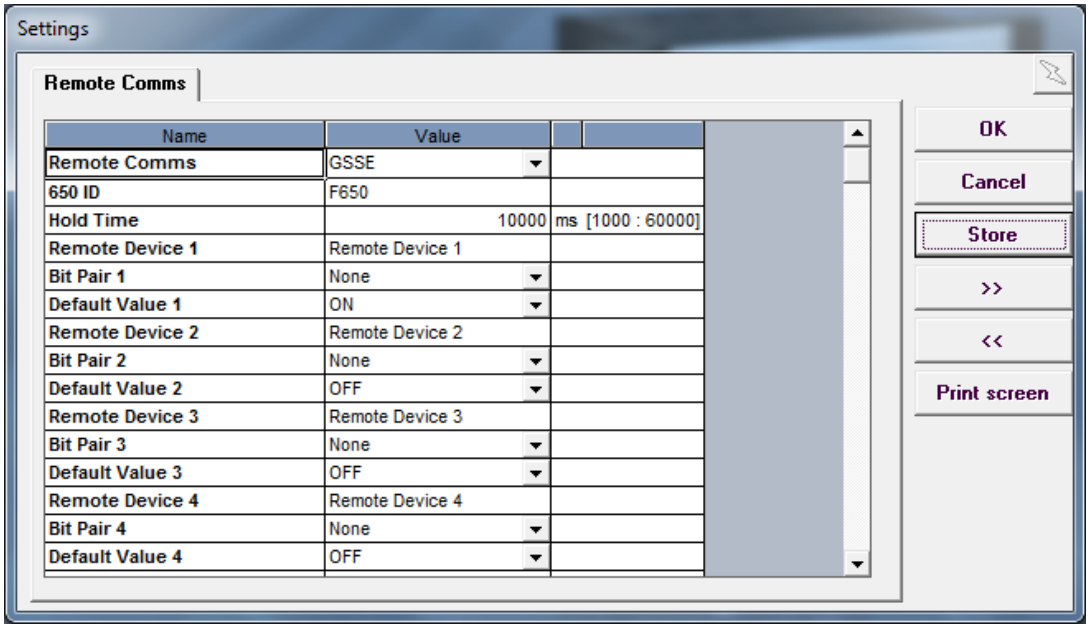


Figure 7-1: Remote communication

Default Value (1 to 32) selects the logic state for this point if the local relay has just completed startup or the remote device sending the point is declared to be non-communicating. The following choices are available:

- ON value defaults the input to Logic 1.
- OFF value defaults the input to Logic 0.
- Latest OFF freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input defaults to Logic 0. When communication resumes, the input becomes fully operational.
- Latest ON freezes the input in case of lost communications. If the latest state is not known, such as after relay power-up but before the first communication exchange, the input defaults to Logic 1. When communication resumes, the input becomes fully operational.

Destination MAC Data (1 to 3): If a valid multicast Ethernet MAC address is entered, this address is used as the destination MAC address for GSSE messages. If a valid multicast Ethernet MAC address is not entered (for example, 00 00 00 00 00 00), the device uses the source Ethernet MAC address as the destination, with the multicast bit set.

GSSE RemDevice (1 to 24) MAC Data (1 to 3) is used to filter receiving messages.

GSSE PORT sets the network port through messaging will be done. Possible values are "Port A", "Port B" or "Both".

7.2.4 Remote inputs

Remote inputs, which create PLC operands at the receiving relay, are extracted from GSSE messages originating in remote devices. The relay provides 32 remote inputs, each of which can be selected from a list consisting of 96 selections: DNA-1 to DNA-32 and UserSt-1 to UserSt-64. The function of DNA and UserSt bits is in both cases the same so user can assign a Remote input either of them through the Bit Pair 1 to 32 field (see figure 1). They can be configured using the EnerVista 650 Setup program in the menu **Setpoint > Input/Outputs > Remote Comms**.

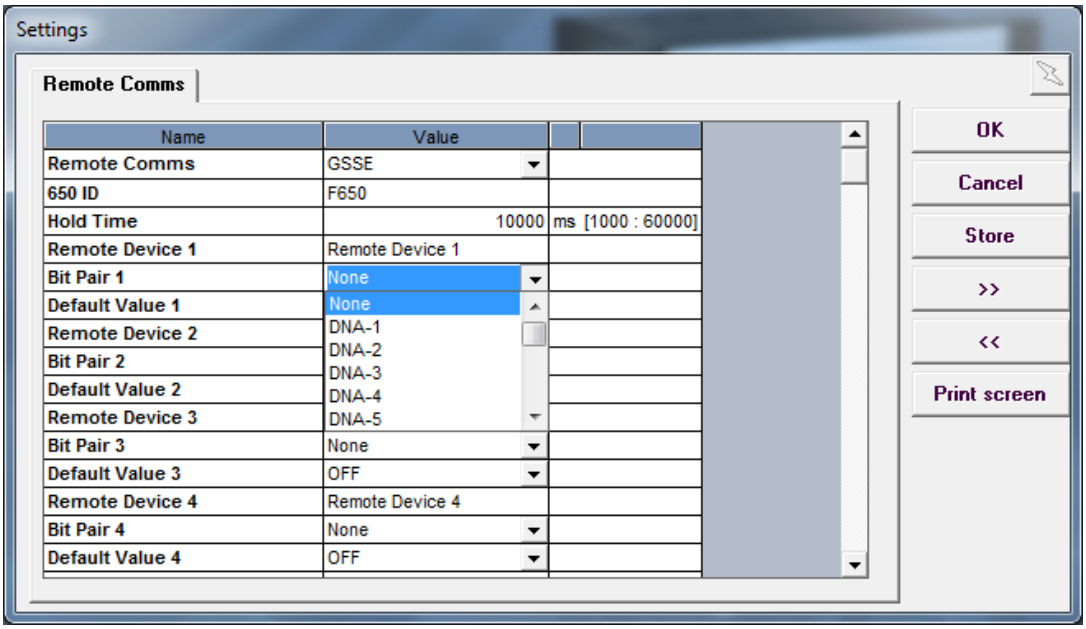


Figure 7-2: Remote communication (remote inputs)

7.2.5 Remote outputs

7.2.5.1 DNA bit pairs

Remote Outputs (1 to 32) are PLC operands inserted into GSSE messages that are transmitted to remote devices on a LAN. Each digital point in the message must be programmed to carry the state of a specific PLC operand, except reserved points DNA1 and DNA2. The complete operand setting represents a specific DNA function to be transmitted. These states are displayed in the F650 relay and in the EnerVista 650 Setup software in the menu **Actual Values > Input/Outputs > Remote Outputs > DNA**.

Each DNA point can only be programmed in the EnerVista 650 Setup software in the menu **Setpoint > Relay Configuration > Remote Outputs**.

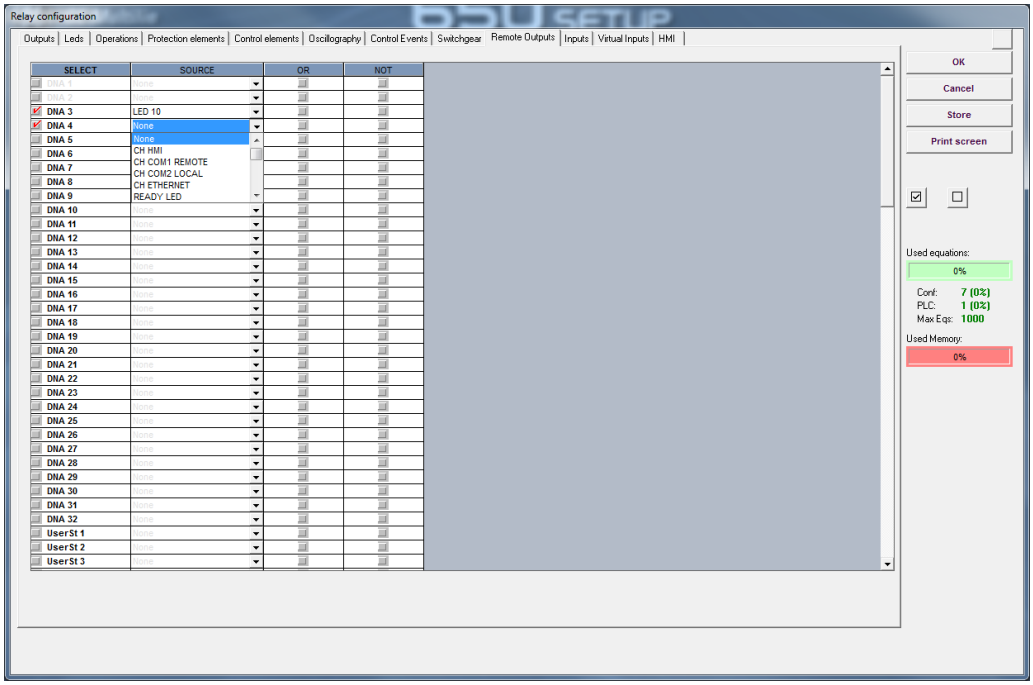


Figure 7-3: Remote outputs (DNA)

7.2.5.2 UserSt bit pairs

Remote Outputs 1 to 64 originates GSSE messages to be transmitted to remote devices. Each digital point in the message must be programmed to carry the state of a specific PLC operand. The UserSt (User Setpoint) setting is used to select the operand which represents a specific UserSt function to be transmitted. These states are displayed in the F650 relay and in the EnerVista 650 Setup software in the menu **Actual Values > Input/Outputs > Remote Outputs > UserSt**.

Each User Set point can only be programmed and displayed in EnerVista 650 Setup in the menu **Setpoint > Relay Configuration > Remote Outputs**.

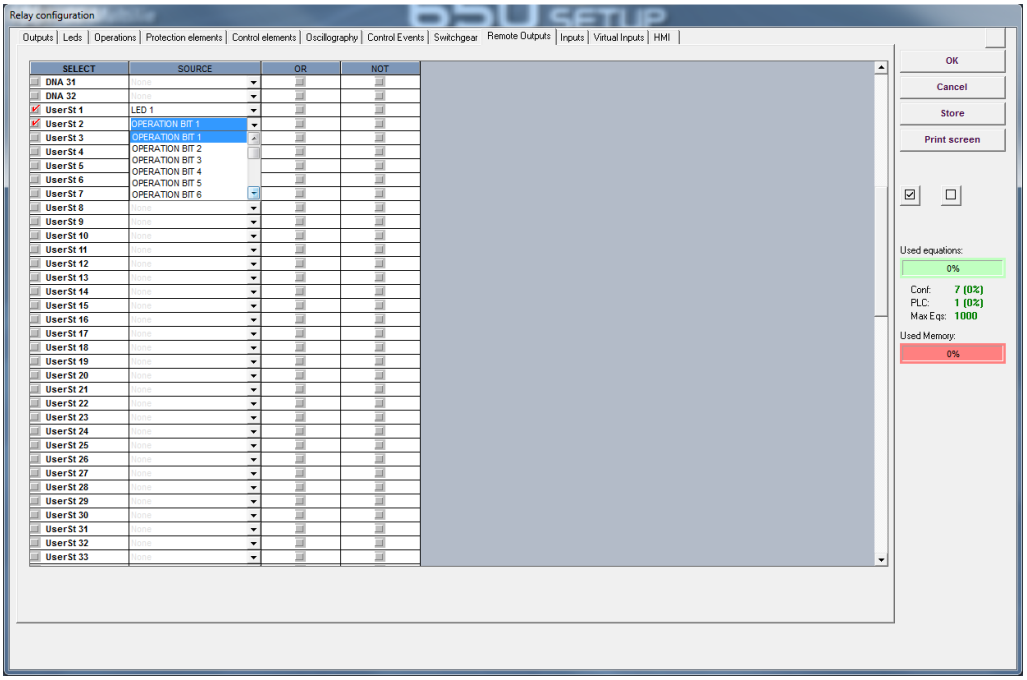


Figure 7-4: Remote outputs (UserSt)

7.3 IEC 61850 profile for F650

7.3.1 Overview

IEC 61850 is a series of standards describing client/server and peer-to-peer communications, substation design and configuration, testing, environmental and project standards.

The 10 parts of the standard IEC 61850 are as listed in the following tables:

1.1.1 System Aspects
Part 1: Introduction and Overview
Part 2: Glossary
Part 3: General Requirements
Part 4: System and Project Management
Part 5: Communication Requirements for Functions and Device Models

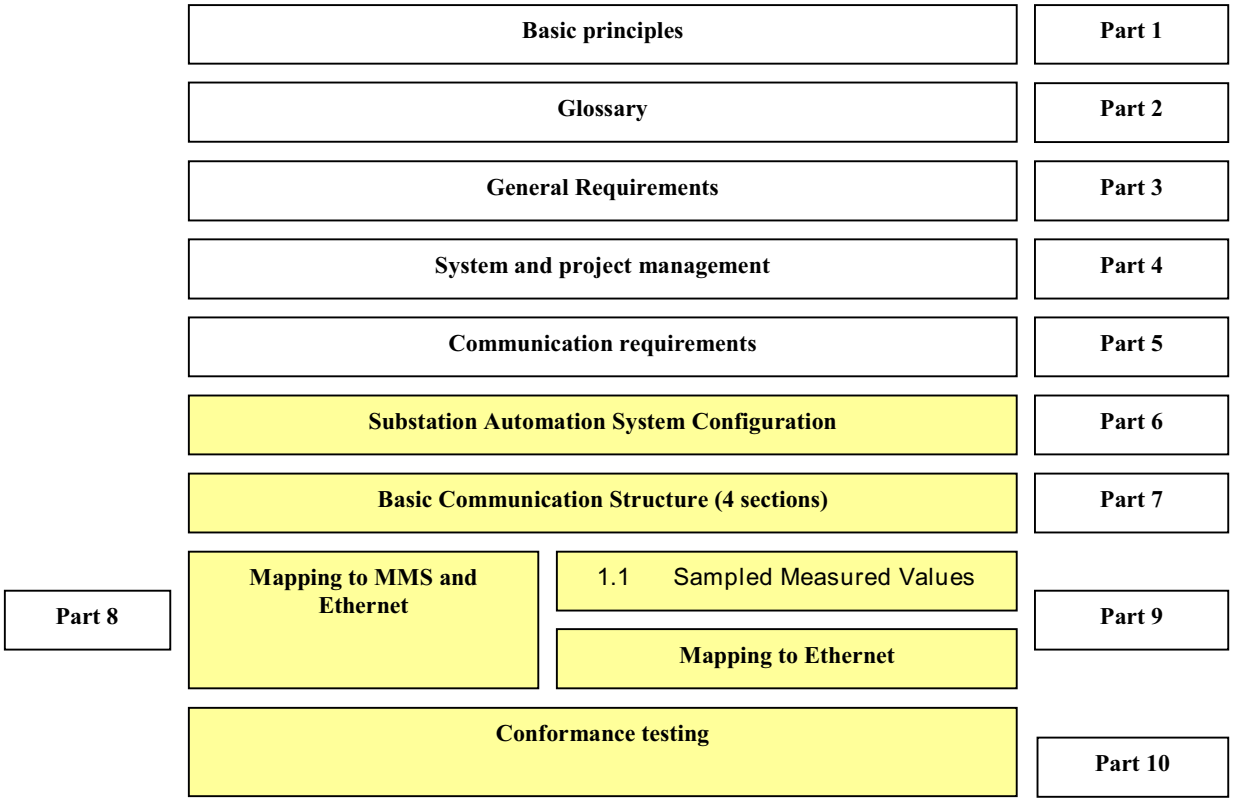
1.1.2 Configuration Part 6: Configuration Description Language For Communication In Electrical Substations Related To IEDs
1.1.3 Testing Part 10: Conformance Testing

The following parts define how the IED behaves:

1.1.4 Data Models Basic Communication Structure for Substations and Feeder Equipment Part 7-4: Compatible Logical Node Classes and Data Classes Part 7-3: Common Data Classes
1.1.5 Abstract Communications Basic Communication Structure for Substations and Feeder Equipment Part 7-2: Abstract Communication Services Interface (ACSI) Part 7-1: Principles and Models
1.1.6 Mapping to real Communication Networks (SCSM) Specific Communication Service Mapping (SCSM) Part 8-1: Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3 Part 9-1: Sampled Values Over Serial Unidirectional Multidrop Point to Point Link Part 9-2: Sampled values over ISO/IEC 8802-3 Mapping on a IEEE 8802-3 based Process Bus

These documents can be obtained from the IEC (http://www.iec.ch). It is strongly recommended that all those involved with any IEC 61850 implementation obtain this document set.

7.3.1.1 Scope and outline of IEC 61850



Parts 3, 4, and 5 of the standard start by identifying the general and specific functional requirements for communications in a substation. These requirements are then used as forcing functions to aid in the identification of the services and data models needed, application protocol required, and the underlying transport, network, data link, and physical layers that meet the overall requirements.

The major architectural construct that 61850 adopts is that of "abstracting" the definition of the data items and the services, that is, creating data items/objects and services that are independent of any underlying protocols. The abstract definitions then allow "mapping" of the data objects and services to any other protocol that can meet the data and service requirements.

The definition of the abstract services is found in part 7.2 of the standard and the abstraction of the data objects (referred to as Logical Nodes) is found in part 7.4.

In as much as many of the data objects are made up of common pieces (such as Status, Control, Measurement, Substitution), the concept of "Common Data Classes" or "CDC" was developed which defined common building blocks for creating the larger data objects. The CDC elements are defined in part 7.3.

Given the data and services abstract definitions, the final step was one of "mapping" the abstract services into an actual protocol. Section 8.1 defines the mapping of the abstract data object and services onto the Manufacturing Messaging Specification - MMS2 and sections 9.1 and 9.2 define the mapping of the Sample Measured Values (unidirectional point-to-point and bi-directional multipoint accordingly) onto an Ethernet data frame. The 9.2 document defines what has become known as the Process Bus.

From a system perspective, there is a significant amount of configuration that is required in order to put all the pieces together and have them work. In order to facilitate this process and to eliminate much of the human error component, an XML based Substation Configuration Language (SCL) was defined in part 6. It allows the formal description of the

relations between the substation automation system and the substation. At the application level, the substation topology itself and the relation of the substation structure to the SAS functions (logical nodes) configured on the IEDs can be described. Each device must provide an SCL file that describes the configuration of itself.

Finally, part 10 defines a testing methodology in order to determine "conformance" with the numerous protocol definitions and constraints defined in the standard.

7.3.2 Communication profiles

The F650 relay supports IEC61850 server services over TCP/IP. This profile requires the F650 to have an IP address to establish communications. It is possible to have up to five simultaneous connections.

7.3.3 TCP connection timing

A built-in TCP/IP connection timeout of 30 seconds is employed by the F650 to detect “dead” connections. If there is no data traffic on a TCP connection for greater than 30 seconds, the connection is aborted by the server. Therefore, when using IEC61850 reporting, clients should configure report control block items such that an integrity report is issued at least every 30 seconds. If other MMS data is being polled on the same connection at least once every 30 seconds, this timeout does not apply.

For firmware version 7.20 or higher, TCP connection timeout is configurable from 120 to 1800 seconds and its default value is 120 seconds

7.3.4 MMS protocol

IEC 61850 specifies the use of the Manufacturing Message Specification (MMS) at the upper (application) layer for transfer of real-time data. This protocol has been in existence for a number of years and provides a set of services suitable for the transfer of data within a substation LAN environment. Actual MMS protocol services are mapped to IEC 61850 abstract services in IEC 61850-8-1.

The exact structure and values of the supported IEC61850 logical nodes can be seen by connecting to a F650 relay with an MMS browser, such as “MMS Object Explorer and AXS4-MMS” DDE/OPC server from Sisco Inc.

7.3.5 Peer-to-peer communication

Peer-to-peer communication of a digital state information (remote inputs/outputs) is supported using the IEC61850 GOOSE/GSE services. This feature allows digital points to be exchanged between IEC 61850 conforming devices.

7.3.6 File services

MMS file services are supported to allow transfer of oscillography, event record, or other files from a F650 relay.

7.3.7 IEC 61850 conformance statements

This section describes conformity with IEC 61850.

7.3.7.1 Abbreviations and acronyms

- ASCI Abstract Communication Service Interface
- SCSM Specific Communication Service Mapping
- SCL Substation Configuration Language
- GSE Generic Substation Events
- GOOSE Generic Object Oriented Substation Events
- GSSE Generic Substation Status Events
- SVC Sampled Value Control
- LCB Log Control Block
- PICS Protocol Implementation Conformance Statement
- MICS Model Implementation Conformance Statement
- PIXIT Protocol Implementation extra Information for Testing
- TICS Technical Issues Conformance Statement

7.3.7.2 Definitions of the ISO/OSI reference model

Communications are based on the OSI Reference Model (OSI/IEC 7498-1) for a multi-layer communication function, to achieve stable data exchange.

The table below shows the ISO Application (A) and Transport (T) profiles.

- An ISO **A profile** is a set of specifications and declarations regarding the top three layers of the ISO/OSI reference model (i.e. the application, presentation, and session layers).
- The **T profile** is a set of specifications and declarations regarding the lower four layers (i.e. transport, network, data link, and physical layers).

Table 7-1: OSI reference model and profiles

Application layer	A Profile
Presentation layer	
Session layer	
Transport layer	T Profile
Network layer	
Data link layer	
Physical layer	

A and T profiles can be combined in various ways to form different types of services and information items that can be exchanged. The services specified in Part 7-2 of the IEC61850 standard are mapped onto four different combinations of the profiles. These four combinations are used for

- Client/server services,
- GOOSE/GSE management services,
- GSSE services,
- Time synchronization,
- Services for measured value sampling.

7.3.7.3 Conformance statements for F650 devices

For F650 relays whose order code contains Rear Ethernet Communication Board 2 "B", "C", "D" or "E" and Communication protocol "6", product protocol and model implementation conformance statements are described in the following sections:

- 7.3.7.3.1 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 "B", "C", "D", "E" on page 7–12 (PICS for 650 family of relays v1_7 firm3_60)
- 7.3.7.3.4 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "B", "C", "D", "E" and IEC 61850 Edition 1 on page 7–42 (MICS for 650 family rev1.4 firm3_60")
- 7.3.7.3.7 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "B", "C", "D", "E" and IEC 61850 Edition 1 on page 7–176 (TICS for 650 family of relays v1_7 firm3_60)
- 7.3.7.3.10 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "B", "C", "D", "E" and IEC 61850 Edition 1 on page 7–185 (PIXIT for 650 family of relays v1_5 firm3_60

For F650 relays whose order code contains Rear Ethernet Communication Board 2 "G", "H", "J", "K", "L" or "M" and Communication protocol "6", product protocol and model implementation conformance statements are described in the following sections:

<u>IEC 61850 Edition 2:</u>

- 7.3.7.3.2 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 "H", "G", "K", "J","L", "M" and IEC 61850 Edition 2 on page 7–25 (PICS for 650 family of relays v1_4 firm7_20)
- 7.3.7.3.5 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2 on page 7–66 MICS for 650 family of relays v1_01 firm7_20
- 7.3.7.3.8 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2 on page 7–180 (TICS for 650 family of relays v1_0 firm7_20)
- 7.3.7.3.11 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2 on page 7–193 (PIXIT for 650 family of relays v1_6 firm7_20)

<u>IEC 61850 Edition 1:</u>

- 7.3.7.3.3 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–37 (PICS For F650 relay V1_6 firm7_52)
- 7.3.7.3.6 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–128 (MICS For F650 relay V1_10 firm7_52)
- 7.3.7.3.9 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–183 (TICS For F650 relay V3_04 firm7_52)
- 7.3.7.3.12 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1 on page 7–202 (PIXIT For F650 relay V1_10 firm7_52)

7.3.7.3.1 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 "B", "C", "D", "E"

Reference documentation: **PICS for 650 family rev1_7 firm3_60.**

This document describes the:

- ACSI Conformance Statement
- PICS ("Protocol Implementation Conformance Statement") for 650 family of relays.

1 ACSI Conformance Statement

The following ACSI conformance statements shall be used to provide an overview and details about a device claiming conformance with ACSI to specify the communication features mapped to an SCSM:

- ACSI **BASIC** conformance statement.
- ACSI **MODELS** conformance statement.
- ACSI **SERVICE** conformance statement.

1.1 Notation

For the following clauses, these definitions apply:

- Y: The item is implemented.
- N: The item is not implemented.
- AA: Application Association.
- TP: Two-party (application association).
- MC: Multicast (application association).

1.2 ACSI BASIC conformance statement

		Client/ subscriber	Server/ publisher	Value/ comments
Client-server roles				
B11	**Server** side (of TWO-PARTY APPLICATION-ASSOCIATION)	-	Y	
B12	**Client** side of (TWO-PARTY APPLICATION-ASSOCIATION)	-	N	
SCSMs supported				
B21	**SCSM**: IEC 6185-8-1 used	-	Y	
B22	**SCSM**: IEC 6185-9-1 used	-	N	
B23	**SCSM**: IEC 6185-9-1 used	-	N	
B24	**SCSM**: other	-	N	
Generic substation event model (GSE)				
B31	**Publisher** side	-	Y	Both GSSE and GOOSE
B32	**Subscriber** side	Y	-	Both GSSE and GOOSE
Transmission of sampled value model (SVC)				
B41	**Publisher** side	-	N	
B42	**Subscriber** side	N	-	

1.3 ACSI MODELS conformance statement

		Client/ subscriber	Server/ publisher	Value/ comments
If **Server** side (B11) supported				
M1	Logical device	-	Y	
M2	Logical node	-	Y	
M3	Data	-	Y	
M4	Data set	-	Y	
M5	Substitution	-	N	
M6	Setting group control	-	Y	
	Reporting			
M7	Buffered report control	-	Y	
M7-1	sequence-number	-	Y	
M7-2	report-time-stamp	-	Y	
M7-3	reason-for-inclusion	-	Y	
M7-4	data-set-name	-	Y	
M7-5	data-reference	-	Y	
M7-6	buffer-overflow	-	Y	
M7-7	entryID	-	Y	
M7-8	BufTm	-	Y	
M7-9	IntgPd	-	Y	
M7-10	GI	-	Y	
M8	Unbuffered report control	-	Y	
M8-1	sequence-number	-	Y	
M8-2	report-time-stamp	-	Y	
M8-3	reason-for-inclusion	-	Y	
M8-4	data-set-name	-	Y	
M8-5	data-reference	-	Y	
M8-6	BufTm	-	Y	

If **Server** side (B11) supported (cont.)				
M8-7	IntgPd	-	Y	
M8-8	GI	-	Y	
	Logging			
M9	Log control	-	N	
M9-1	IntgPd	-	N	
M10	Log	-	N	
M11	Control	-	Y	
f **GSE** (B31/B32) supported				
	GOOSE	Y	Y	
M12-1	entryID	N	N	
M12-2	DataRefInc	N	N	
M13	GSSE	Y	Y	
If **SVC** (B41/B42) supported				
M14	Multicast SVC	-	N	
M15	Unicast SVC	-	N	
M16	Time	-	Y	Time source with required accuracy shall be available
M17	File Transfer	-	Y	

1.4 ACSI SERVICE conformance statement

The ACSI service conformance statement shall be defined depending on the statements in previous tables.

	Services	AA: TP / MC	Client/ subscriber	Server/ publisher	Comments
Server (Clause 6)					
S1	ServerDirectory	TP	-	Y	

Application association (Clause 7)					
S2	Associate		-	Y	
S3	Abort		-	Y	
S4	Release		-	Y	

Logical device (Clause 8)					
S5	LogicalDeviceDirectory	TP	-	Y	

Logical node (Clause 9)					
S6	LogicalNodeDirectory	TP	-	Y	
S7	GetAllDataValues	TP	-	Y	

Data (Clause 10)					
S8	GetDataValues	TP	-	Y	
S9	SetDataValues	TP	-	Y	
S10	GetDataDirectory	TP	-	Y	
S11	GetDataDefinition	TP	-	Y	

Data set (Clause 11)					
S12	GetDataSetValues	TP	-	Y	
S13	SetDataSetValues	TP	-	N	

S14	CreateDataSet	TP	-	N	
S15	DeleteDataSet	TP	-	N	
S16	GetDataSetDirectory	TP	-	Y	

Substitution (Clause 12)					
S17	SetDataValues	TP	-	N	

Setting group control (Clause 13)					
S18	SelectActiveSG	TP	-	Y	
S19	SelectEditSG	TP	-	Y	
S20	SetSGValues	TP	-	Y	
S21	ConfirmEditSGValues	TP	-	Y	
S22	GetSGValues	TP	-	Y	
S23	GetSGCBValues	TP	-	Y	

Reporting (Clause 14)					
Buffered report control block (BRCB)					
S24	Report	TP	-	Y	
S24-1	data-change (dchg)		-	Y	
S24-2	qchg-change (qchg)		-	N	
S24-3	data-update (dupd)		-	N	
S25	GetBRCBValues	TP	-	Y	
S26	SetBRCBValues	TP	-	Y	
Unbuffered report control block (URCB)					
S27	Report	TP	-	Y	
S27-1	data-change (dchg)		-	Y	
S27-2	qchg-change (qchg)		-	N	
S27-3	data-update (dupd)		-	N	
S28	GetURCBValues	TP	-	Y	
S29	SetURCBValues	TP	-	Y	

Logging (Clause 14)					
Log control block					
S30	GetLCBValues	TP	-	N	
S31	SetLCBValues	TP	-	N	
Log					
S32	QueryLogByTime	TP	-	N	
S33	QueryLogAfter	TP	-	N	
S34	GetLogStatusValues	TP	-	N	

Generic substation event model (GSE) (Clause 14.3.5.3.4)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	MC	-	Y	
S36	GetGoReference	TP	-	N	
S37	GetGOOSEElementNumber	TP	-	N	
S38	GetGoCBValues	TP	-	Y	
S39	SetGoCBValues	TP	-	Y	Only GoEna is writable, the rest of attributes are read-only

GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	MC	-	Y	
S41	GetGsReference	TP	-	N	
S42	GetGSSEElementNumber	TP	-	N	
S43	GetGsCBValues	TP	-	Y	
S44	SetGsCBValues	TP	-	Y	

Transmission of sampled value model (SVC) (Clause 16)					
Multicast SVC					
S45	SendMSVMessage	MC	-	N	
S46	GetMSVCBValues	TP	-	N	
S47	SetMSVCBValues	TP	-	N	
Unicast SVC					
S48	SendUSVMessage	TP	-	N	
S49	GetUSVCBValues	TP	-	N	
S50	SetUSVCBValues	TP	-	N	

Control (Clause 17.5.1)					
S51	Select		-	Y	
S52	SelectWithValue	TP	-	Y	
S53	Cancel	TP	-	Y	
S54	Operate	TP	-	Y	
S55	Command- Termination	TP	-	Y	
S56	TimeActivated-Operate	TP	-	N	

File transfer (Clause 20)					
S57	GetFile	TP	-	Y	
S58	SetFile	TP	-	N	
S59	DeleteFile	TP	-	N	
S60	GetFileAttributeValues	TP	-	Y	

Time (Clause 5.5)					
T1	Time resolution of internal clock			10	Nearest negative power of 2 in seconds
T2	Time accuracy of internal clock				T0
					T1
				Y	T2
					T3
					T4
					T5
T3	Supported TimeStamp resolution			10	Nearest value of 2**-n in seconds according to 5.5.3.7.3.3 of Part 7-2

2 PICS (“Protocol Implementation Conformance Statement”)

The tables in sections below appear in the same sequence as in standard IEC 61850-8-1, section 24.

The tables refer to part 7 of the standard and the corresponding information must be contained in the PICS.

2.1 Notation

For the following clauses, these definitions apply:

- Y: The item is implemented.
- N: The item is not implemented.
- x: excluded. The implementation shall not implement this item.
- i: out-of-scope. The implementation of the item is not within the scope of this standard.
- F/S: Functional Standard. Should be applied.
- Base: Shall be applied in any application claiming conformance to this standard.

2.2 Profile conformance

The following tables define the basic conformance statement.

2.2.1 PICS for A-Profile support

A-Profile shortcut	Profile description	Client	Server	Value/comment
		realized	realized	
A1	Client/server A-profile	N	Y	
A2	GOOSE/GSE Management A-profile	Y	Y	Only GOOSE not GSE management
A3	GSSE A-profile	Y	Y	
A4	Time sync A-profile	Y	N	

2.2.2 PICS for T-Profile support

A-Profile shortcut	Profile description	Client	Server	Value/comment
		realized	realized	
T1	TCP/IP T-profile	N	Y	
T2	OSI T-profile	N	N	
T3	GOOSE/GSE T-profile	Y	Y	Only GOOSE not GSE management
T4	GSSE T-profile	Y	Y	
T5	TimeSync T-profile	Y	N	

Refer to the services of Part 7 to see whether these profiles are supported. No distinction is made between A- and T-Profiles there because the definition only refers to the application.

2.3 MMS conformance

The following conformance statements are conditional upon the support of the client/server A-Profile (e.g. A1 see profile description in Clause 6) being declared.

Except where present, MMS conformance shall be in accordance with ISO/ISP 14226-2.

2.3.1 MMS Initiate conformance

2.3.1.1 MMS InitiateRequest general parameters

InitiateRequest	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
InitiateRequest				
localDetailCalling			Y	
proposedMaxServOutstandingCalling			Y	
ProposedMaxServOustandingCalled			Y	

InitRequestDetail			Y	
InitiateRequestDetail				
proposedVersionNumber			Y	
proposedParameterCBB			Y	
servicesSupportedCalling			Y	
additionalSupportedCalling			N	
additionalCbbSupportedCalling			N	
privilegeClassIdentityCalling			N	

2.3.1.2 MMS InitiateResponse general parameters

InitiateRequest	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
InitiateResponse				
localDetailCalled			Y	
negotiatedMaxServOutstandingCalling			Y	1
negotiatedMaxServOustandingCalled			Y	3
initResponseDetail			Y	
InitiateResponseDetail			Y	
negotiatedVersionNumber			Y	
negotiatedParameterCBB			Y	
servicesSupportedCalled			Y	
additionalSupportedCalled			N	
additionalCbbSupportedCalled			N	
privilegeClassIdentityCalled			N	

2.3.2 MMS services supported conformance statement

This table defines the service support requirement, and restrictions, for this standard. Relationship to ACSI services can be found in Table 1 of Part 8-1.

MMS service supported CBB	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
status			Y	
getNameList			Y	
identify			Y	
rename			N	
read			Y	
write			Y	
getVariableAccessAttributes			Y	
defineNamedVariable			N	
defineScatteredAccess			N	
getScatteredAccessAttributes			N	
deleteVariableAccess			N	
defineNamedVariableList			N	
getNamedVariableListAttributes			Y	
deleteNamedVariableList			N	
defineNamedType			N	
getNamedTypeAttributes			N	
deleteNamedType			N	
Input			N	
Output			N	
takeControl			N	

relinquishControl			N	
defineSemaphore			N	
deleteSemaphore			N	
reportPoolSemaphoreStatus			N	
reportSemaphoreStatus			N	
initiateDownloadSequence			N	
downloadSegment			N	
terminateDownloadSequence			N	
initiateUploadSequence			N	
uploadSegment			N	
terminateUploadSequence			N	
requestDomainDownload			N	
requestDomainUpload			N	
loadDomainContent			N	
storeDomainContent			N	
deleteDomain			N	
getDomainAttributes			Y	
createProgramInvocation			N	
deleteProgramInvocation			N	
Start			N	
Stop			N	
Resume			N	
Reset			N	
Kill			N	
getProgramInvocationAttributes			N	
obtainFile			N	
defineEventCondition			N	
MMS service supported CBB (cont.)	**Client-CR**		**Server-CR**	
	Realized	**Value/range**	**Realized**	**Value/range**
deleteEventCondition			N	
getEventConditionAttributes			N	
reportEventConditionStatus			N	
alterEventConditionMonitoring			N	
triggerEvent			N	
defineEventAction			N	
deleteEventAction			N	
alterEventEnrollment			N	
reportEventEnrollmentStatus			N	
getEventEnrollmentAttributes			N	
acknowledgeEventNotification			N	
getAlarmSummary			N	
getAlarmEnrollmentSummary			N	
readJournal			N	
writeJournal			N	
initializeJournal			N	
reportJournalStatus			N	
createJournal			N	
deleteJournal			N	
FileOpen			Y	
FileRead			Y	
FileClose			Y	

fileRename			N	
fileDelete			N	
fileDirectory			Y	
unsolicitedStatus			N	
informationReport			Y	
eventNotification			N	
attachToEventCondition			N	
attachToSemaphore			N	
Conclude			Y	
Cancel			Y	
getDataExchangeAttributes			N	
exchangeData			N	
defineAccessControlList			N	
getAccessControlListAttributes			N	
reportAccessControlledObjects			N	
deleteAccessControlList			N	
alterAccessControl			N	
reconfigureProgramInvocation			N	

2.3.3 MMS parameter Conformance Building Block (CBB)

MMS parameter CBB	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
STR1			Y	
STR2			Y	
VNAM			Y	
VALT			Y	
VADR			N	
VSCA			N	
TPY			N	
VLIS			Y	
REAL			N	
CEI			N	
NEST			Y	7
ACO			N	
SEM			N	
CSR			N	
CSNC			N	
CSPLC			N	
CSPI			N	

2.3.4 GetNameList conformance statement

GetNameList	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
ObjectClass			Y	
ObjectScope			Y	
DomainName			Y	
ContinueAfter			Y	
Response+				

List Of Identifier			Y	
MoreFollows			Y	
Response–				
Error Type			Y	
NOTE Object class 'vmd' (formerly VMDSpecific in MMS V1.0) shall not appear. If a request contains this ObjectClass, an MMS Reject shall be issued.				

2.3.5 Variable access conformance statement

2.3.5.1 Supporting productions

2.3.5.1.1 AlternateAccessSelection conformance statement

AlternateAccessSelection	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
accessSelection			Y	
component			Y	
index			N	
indexRange			N	
allElements			N	
alternateAccess			Y	
selectAccess			Y	
component			Y	
index			N	
indexRange			N	
allElements			N	

2.3.5.1.2 VariableAccessSpecification conformance statement

VariableAccessSpecification	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
listOfVariable			Y	
variableSpecification			Y	
alternateAccess			Y	
variableListName			Y	

2.3.5.1.3 VariableSpecification conformance statement

VariableSpecification	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
name			Y	
address			N	
variableDescription			N	
scatteredAccessDescription			N	
invalidated			N	

2.3.5.2 Read conformance statement

Read	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
specificationWithResult			Y	
variableAccessSpecification			Y	
Response				
variableAccessSpecification			Y	
listOfAccessResult			Y	

2.3.5.3 Write conformance statement

Write	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
variableAccessSpecification			Y	
listOfData			Y	
Response				
failure			Y	
success			Y	

2.3.5.4 InformationReport conformance statement

InformationReport	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
variableAccessSpecification			Y	
listOfAccessResult			Y	

2.3.5.5 GetVariableAccessAttributes conformance statement

GetVariableAccessAttributes	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
name			Y	
address			N	
Response				
mmsDeletable			Y	
address			N	
typeSpecification			Y	

2.3.5.6 GetNamedVariableListAttributes conformance statement

GetNamedVariableListAttributes	Client-CR		Server-CR	
	realized	Value/range	realized	Value/range
Request				
ObjectName			Y	
Response				
mmsDeletable			Y	
listOfVariable			Y	
variableSpecification			Y	
alternateAccess			Y	

2.3.6 File management services

2.3.6.1 FileDirectory conformance statement

FileDirectory	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
filespecification			Y	
continueAfter			Y	
Response+				
listOfDirectoryEntry			Y	
MoreFollows			Y	

2.3.6.2 FileOpen conformance statement

FileOpen	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
filename			Y	
initialPosition			Y	
Response+				
frsmID			Y	
fileAttributes			Y	

2.3.6.3 FileRead conformance statement

FileRead	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
FrsmID			Y	
Response+				
FileData			Y	
moreFollows			Y	

2.3.6.4 FileClose conformance statement

FileClose	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
FrsmID			Y	
Response+			Y	

7.3.7.3.2 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 "H", "G", "K", "J","L", "M" and IEC 61850 Edition 2

Reference documentation: **PICS for 650 family of relays v1_4 firm7_20**.

This document describes the:

- ACSI Conformance Statement
- PICS ("Protocol Implementation Conformance Statement") for 650 family of relays.

1 ACSI Conformance Statement

The following ACSI conformance statements shall be used to provide an overview and details about a device claiming conformance with ACSI to specify the communication features mapped to an SCSM:

- ACSI BASIC conformance statement.
- ACSI MODELS conformance statement.
- ACSI SERVICE conformance statement.

The statements specify the communication features mapped to IEC 61850-8-1 First Edition and/or Edition 2.

1.1 Notation

For the following clauses, these definitions apply:

- Y: The item is implemented.
- N: The item is not implemented.
- AA: Application Association.
- TP: Two-party (application association).
- MC: Multicast (application association).

1.2 ASCI basic conformance statement

The basic conformance statement is defined in Table 7-2: Basic conformance statement

Table 7-2: Basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	-	N	
SCSMs supported				
B21	SCSM: IEC 6185-8-1 used	-	Y	
B22	SCSM: IEC 6185-9-1 used	-	N	Ed2:Deprecated
B23	SCSM: IEC 6185-9-2 used	-	N	
B24	SCSM: other	-	N	

Generic substation event model (GSE)				
B31	**Publisher** side	-	Y	
B32	**Subscriber** side	Y	-	
Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			
– Y = supported N or empty = not supported				

1.3 ACSI models conformance statement

The ACSI models conformance statement is defined in Table 7-3: ACSI models conformance statement.

Table 7-3: ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
If Server or Client side (B11/12) supported				
M1	Logical device	-	Y	
M2	Logical node	-	Y	
M3	Data	-	Y	
M4	Data set	-	Y	
M5	Substitution			
M6	Setting group control	-	Y	
	Reporting			
M7	Buffered report control	-	Y	
M7-1	sequence-number	-	Y	
M7-2	report-time-stamp	-	Y	
M7-3	reason-for-inclusion	-	Y	
M7-4	data-set-name	-	Y	
M7-5	data-reference	-	Y	
M7-6	buffer-overflow	-	Y	
M7-7	entryID	-	Y	
M7-8	BufTm	-	Y	
M7-9	IntgPd	-	Y	
M7-10	GI	-	Y	
M7-11	conf-revision	-	Y	
M8	Unbuffered report control	-	Y	
M8-1	sequence-number	-	Y	
M8-2	report-time-stamp	-	Y	
M8-3	reason-for-inclusion	-	Y	
M8-4	data-set-name	-	Y	
M8-5	data-reference	-	Y	
M8-6	BufTm	-	Y	
M8-7	IntgPd	-	Y	
M8-8	GI	-	Y	
M8-9	conf-revision	-	Y	
	Logging			
M9	Log control	-		
M9-1	IntgPd	-		
M10	Log	-		
M11	Control	-	Y	
M17	File Transfer		Y	

M18	Application association		Y	
M19	GOOSE Control Block		Y	
M20	Sampled Value Control Block			
If GSE (B31/32) is supported				
M12	GOOSE		Y	
M13	GSSE			Deprecated
If SVC (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
For all IEDs				
M16	Time	Y	Y	
Y = service is supported N or empty = service is not supported				

1.4 ACSI service conformance statement

The ACSI service conformance statement is defined in Table 7-4: ACSI service conformance statement.

Table 7-4: ACSI service conformance statement

	Ed	ACSI Service	AA: TP/MC	Client Sub(C)	Server Pub(S)	Comments
Server						
S1	1,2	GetServerDirectory(LOGICAL-DEVICE)	TP		Y	
Application association						
S2	1,2	Associate	TP		Y	
S3	1,2	Abort	TP		Y	
S4	1,2	Release	TP		Y	
Logical device						
S5	1,2	GetLogicalDeviceDirectory	TP		Y	
Logical node						
S6	1,2	GetLogicalNodeDirectory	TP		Y	
S7	1,2	GetAllDataValues	TP		Y	
Data						
S8	1,2	GetDataValues	TP		Y	
S9	1,2	SetDataValues	TP		Y	
S10	1,2	GetDataDirectory	TP		Y	
S11	1,2	GetDataDefinition	TP		Y	
Data set						
S12	1,2	GetDataSetValues	TP		Y	
S13	1,2	SetDataSetValues	TP		N	
S14	1,2	CreateDataSet	TP		N	
S15	1,2	DeleteDataSet	TP		N	
S16	1,2	GetDataSetDirectory	TP		Y	
Substitution						
S17	1	SetDataValues	TP		N	Ed1 only
Setting group control						
S18	1,2	SelectActiveSG	TP		Y	
S19	1,2	SelectEditSG	TP		Y	
S20	1,2	SetEditSGValues	TP		Y	

S21	1,2	ConfirmEditSGValues	TP		Y	
S22	1,2	GetEditSGValues	TP		Y	
S23	1,2	GetSGCBValues	TP		Y	

Reporting						
Buffered report control block (BRCB)						
S24	1,2	Report	TP		Y	
S24-1	1,2	data-change (dchg)			Y	
S24-2	1,2	quality-change (qchg)			Y	
S24-3	1,2	data-update (dupd)			N	
S25	1,2	GetBRCBValues	TP		Y	
S26	1,2	SetBRCBValues	TP		Y	
Unbuffered report control block (URCB)						
S27	1,2	Report	TP		Y	
S27-1	1,2	data-change (dchg)			Y	
S27-2	1,2	quality-change (qchg)			Y	
S27-3	1,2	data-update (dupd)			N	
S28	1,2	GetURCBValues	TP		Y	
S29	1,2	SetURCBValues	TP		Y	

Logging						
Log control						
S30	1,2	GetLCBValues	TP		N	
S31	1,2	SetLCBValues	TP		N	
Log						
S32	1,2	QueryLogByTime	TP		N	
S33	1,2	QueryLogAfter	TP		N	
S34	1,2	GetLogStatusValues	TP		N	

Generic substation event model (GSE)						
GOOSE						
S35	1,2	SendGOOSEMessage	MC		Y	
GOOSE Control Block						
S36	1,2	GetGoReference	TP			
S37	1,2	GetGOOSEElementNumber	TP			
S38	1,2	GetGoCBValues	TP		Y	
S39	1,2	SetGoCBValues	TP		Y	
GSSE (Ed2:61850-7-2 Annex C)						
S40	1,2	SendGSSEMessage	MC		N	Deprecated
GSSE Control Block (Ed2:61850-7-2 Annex C)						
S41	1,2	GetGsReference	TP		N	Deprecated
S42	1,2	GetGSSEDataOffset	TP		N	Deprecated
S43	1,2	GetGsCBValues	TP		N	Deprecated
S44	1,2	SetGsCBValues	TP		N	Deprecated

Transmission of sampled value model (SVC)						
Multicast SV						
S45	1,2	SendMSVMessage	MC		N	Use for 9-2LE or IEC 61869-9
Multicast Sampled Value Control Block						
S46	1,2	GetMSVCBValues	TP		N	
S47	1,2	SetMSVCBValues	TP		N	
Unicast SV						
S48	1,2	SendUSVMessage	TP		N	
Unicast Sampled Value Control Block						
S49	1,2	GetUSVCBValues	TP		N	
S50	1,2	SetUSVCBValues	TP		N	

Control						
S51	1,2	Select	TP		Y	SBO Normal Security
S52	1,2	SelectWithValue	TP		Y	SBO Enhanced Security
S53	1,2	Cancel	TP		Y	

S54	1,2	Operate	TP		Y	
S55	1,2	CommandTermination	TP		Y	
S56	1,2	TimeActivatedOperate	TP		N	

File transfer						
S57	1,2	GetFile	TP		Y	
S58	1,2	SetFile	TP		N	
S59	1,2	DeleteFile	TP		N	
S60	1,2	GetFileAttributeValues	TP		Y	
S61	1,2	GetServerDirectory (FILE)	TP		Y	

Time						
T1	1,2	Time resolution of internal clock	-		2ms	nearest negative power of 2 in seconds
T2	2	Time accuracy of internal clock	-			TL (ms) (low accuracy), T3 < 7) (only Ed2)
	1,2		-			T0 (ms) (<= 10 ms), 7 <= T3 < 9)
	1,2		-			T1 (µs) (<= 1 ms), 10 <= T3 < 13
	1,2		-			T2 (µs) (<= 100 µS), 13 <= T3 < 15
	1,2		-			T3 (µs) (<= 25 µS), 15 <= T3 < 18
	1,2		-			T4 (µs) (<= 4 µS), 18 <= T3 < 20
	1,2		-		Y	T5 (µs) (<= 1 µS), T3 >= 20)
T3	1,2	Supported TimeStamp resolution	-		1ms	nearest negative power of 2 in seconds

2 PICS (“Protocol Implementation Conformance Statement”)

The tables in sections below appear in the same sequence as in standard IEC 61850-8-1, section 24.

The tables refer to part 7 of the standard and the corresponding information must be contained in the PICS.

2.1 Notation

For the following clauses, these definitions apply:

- Y: The item is implemented.
- N: The item is not implemented.
- x: excluded. The implementation shall not implement this item.
- i: out-of-scope. The implementation of the item is not within the scope of this standard.
- F/S: Functional Standard. Should be applied.
- Base: Shall be applied in any application claiming conformance to this standard.

2.2 Profile conformance

The following tables define the basic conformance statement.

2.2.1 PICS for A-Profile support

A-Profile shortcut	Profile description	Client	Server	Value/comment
		Realized	Realized	
A1	Client/server A-profile	N	Y	
A2	GOOSE/GSE Management A-profile	Y	Y	Only GOOSE not GSE management
A3	GSSE A-profile	Y	Y	
A4	Time sync A-profile	Y	N	

2.2.2 PICS for T-Profile support

A-Profile shortcut	Profile description	Client	Server	Value/comment
		Realized	Realized	
T1	TCP/IP T-profile	N	Y	
T2	OSI T-profile	N	N	
T3	GOOSE/GSE T-profile	Y	Y	Only GOOSE not GSE management
T4	GSSE T-profile	Y	Y	
T5	TimeSync T-profile	Y	N	

Refer to the services of Part 7 to see whether these profiles are supported. No distinction is made between A- and T-Profiles there because the definition only refers to the application.

2.3 MMS conformance

The following conformance statements are conditional upon the support of the client/server A-Profile (e.g. A1 see profile description in Clause 6) being declared.

Except where present, MMS conformance shall be in accordance with ISO/ISP 14226-2.

2.3.1 MMS Initiate conformance

2.3.1.1 MMS InitiateRequest general parameters

InitiateRequest	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
InitiateRequest				
localDetailCalling			Y	
proposedMaxServOutstandingCalling			Y	
ProposedMaxServOustandingCalled			Y	
InitRequestDetail			Y	
InitiateRequestDetail				
proposedVersionNumber			Y	
proposedParameterCBB			Y	
servicesSupportedCalling			Y	
additionalSupportedCalling			N	
additionalCbbSupportedCalling			N	
privilegeClassIdentityCalling			N	

2.3.1.2 MMS InitiateResponse general parameters

InitiateRequest	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
InitiateResponse				
localDetailCalled			Y	
negotiatedMaxServOutstandingCalling			Y	1
negotiatedMaxServOustandingCalled			Y	3
initResponseDetail			Y	
InitiateResponseDetail			Y	
negotiatedVersionNumber			Y	
negotiatedParameterCBB			Y	
servicesSupportedCalled			Y	
additionalSupportedCalled			N	
additionalCbbSupportedCalled			N	
privilegeClassIdentityCalled			N	

2.3.2 MMS services supported conformance statement

This table defines the service support requirement, and restrictions, for this standard. Relationship to ACSI services can be found in Table 1 of Part 8-1.

MMS service supported CBB	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
status			Y	
getNameList			Y	
identify			Y	
rename			N	
read			Y	
write			Y	
getVariableAccessAttributes			Y	
defineNamedVariable			N	
defineScatteredAccess			N	
getScatteredAccessAttributes			N	
deleteVariableAccess			N	
defineNamedVariableList			N	
getNamedVariableListAttributes			Y	
deleteNamedVariableList			N	
defineNamedType			N	
getNamedTypeAttributes			N	
deleteNamedType			N	
Input			N	
Output			N	
takeControl			N	
relinquishControl			N	
defineSemaphore			N	
deleteSemaphore			N	
reportPoolSemaphoreStatus			N	
reportSemaphoreStatus			N	
initiateDownloadSequence			N	
downloadSegment			N	
terminateDownloadSequence			N	
initiateUploadSequence			N	
uploadSegment			N	
terminateUploadSequence			N	
requestDomainDownload			N	
requestDomainUpload			N	
loadDomainContent			N	
storeDomainContent			N	
deleteDomain			N	
getDomainAttributes			Y	
createProgramInvocation			N	
deleteProgramInvocation			N	
Start			N	
Stop			N	
Resume			N	
Reset			N	
Kill			N	
getProgramInvocationAttributes			N	

obtainFile			N	
defineEventCondition			N	
deleteEventCondition			N	
getEventConditionAttributes			N	
reportEventConditionStatus			N	
alterEventConditionMonitoring			N	
triggerEvent			N	
defineEventAction			N	
deleteEventAction			N	
alterEventEnrollment			N	
reportEventEnrollmentStatus			N	
getEventEnrollmentAttributes			N	
acknowledgeEventNotification			N	
getAlarmSummary			N	
getAlarmEnrollmentSummary			N	
readJournal			N	
writeJournal			N	
initializeJournal			N	
reportJournalStatus			N	
createJournal			N	
deleteJournal			N	
FileOpen			Y	
FileRead			Y	
FileClose			Y	
fileRename			N	
fileDelete			N	
fileDirectory			Y	
unsolicitedStatus			N	
informationReport			Y	
eventNotification			N	
attachToEventCondition			N	
attachToSemaphore			N	
Conclude			Y	
Cancel			Y	
getDataExchangeAttributes			N	
exchangeData			N	
defineAccessControlList			N	
getAccessControlListAttributes			N	
reportAccessControlledObjects			N	
deleteAccessControlList			N	
alterAccessControl			N	
reconfigureProgramInvocation			N	

2.3.3 MMS parameter Conformance Building Block (CBB)

MMS parameter CBB	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
STR1			Y	
STR2			Y	
VNAM			Y	
VALT			Y	

VADR			N	
VSCA			N	
TPY			N	
VLIS			Y	
REAL			N	
CEI			N	
NEST			Y	7
ACO			N	
SEM			N	
CSR			N	
CSNC			N	
CSPLC			N	
CSPI			N	

2.3.4 GetNameList conformance statement

GetNameList	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
ObjectClass			Y	
ObjectScope			Y	
DomainName			Y	
ContinueAfter			Y	
Response+				
List Of Identifier			Y	
MoreFollows			Y	
Response–				
Error Type			Y	
NOTE Object class 'vmd' (formerly VMDSpecific in MMS V1.0) shall not appear. If a request contains this ObjectClass, an MMS Reject shall be issued.				

2.3.5 Variable access conformance statement

2.3.5.1 Supporting productions

2.3.5.1.1 AlternateAccessSelection conformance statement

AlternateAccessSelection	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
accessSelection			Y	
component			Y	
index			N	
indexRange			N	
allElements			N	
alternateAccess			Y	
selectAccess			Y	
component			Y	
index			N	
indexRange			N	
allElements			N	

2.3.5.1.2 VariableAccessSpecification conformance statement

VariableAccessSpecification	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
listOfVariable			Y	
variableSpecification			Y	
alternateAccess			Y	
variableListName			Y	

2.3.5.1.3 VariableSpecification conformance statement

VariableSpecification	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
name			Y	
address			N	
variableDescription			N	
scatteredAccessDescription			N	
invalidated			N	

2.3.5.2 Read conformance statement

Read	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
specificationWithResult			Y	
variableAccessSpecification			Y	
Response				
variableAccessSpecification			Y	
listOfAccessResult			Y	

2.3.5.3 Write conformance statement

Write	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
variableAccessSpecification			Y	
listOfData			Y	
Response				
failure			Y	
success			Y	

2.3.5.4 InformationReport conformance statement

InformationReport	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
variableAccessSpecification			Y	
listOfAccessResult			Y	

2.3.5.5 GetVariableAccessAttributes conformance statement

GetVariableAccessAttributes	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
name			Y	
address			N	
Response				
mmsDeletable			Y	
address			N	
typeSpecification			Y	

2.3.5.6 GetNamedVariableListAttributes conformance statement

GetNamedVariableListAttributes	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
ObjectName			Y	
Response				
mmsDeletable			Y	
listOfVariable			Y	
variableSpecification			Y	
alternateAccess			Y	

2.3.6 File management services

2.3.6.1 FileDirectory conformance statement

FileDirectory	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
filespecification			Y	
continueAfter			Y	
Response+				
listOfDirectoryEntry			Y	
MoreFollows			Y	

2.3.6.2 FileOpen conformance statement

FileOpen	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
filename			Y	
initialPosition			Y	
Response+				
frsmID			Y	
fileAttributes			Y	

2.3.6.3 FileRead conformance statement

FileRead	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
FrsmID			Y	
Response+				
FileData			Y	
moreFollows			Y	

2.3.6.4 FileClose conformance statement

FileClose	Client-CR		Server-CR	
	Realized	Value/range	Realized	Value/range
Request				
FrsmID			Y	
Response+			Y	

7.3.7.3.3 PICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **PICS For F650 relay V1_6 firm7_52**.

This document describes the:

- ACSI Conformance Statement
- PICS ("Protocol Implementation Conformance Statement") for 650 family of relays.

1 General

The following ACSI conformance statements are used to provide an overview and details about F650 bay controller, with firmware 7.52:

- ACSI BASIC conformance statement.
- ACSI MODELS conformance statement.
- ACSI SERVICE conformance statement.

The statements specify the communication features mapped to IEC 61850-8-1 First Edition and/or Edition 2.

2 ASCI basic conformance statement

The basic conformance statement is defined in Table 7-5: Basic conformance statement

Table 7-5: Basic conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)		Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)			
SCSMs supported				
B21	**SCSM**: IEC 6185-8-1 used		Y	
B22	**SCSM**: IEC 6185-9-1 used			Ed2:Deprecated
B23	**SCSM**: IEC 6185-9-2 used			
B24	**SCSM**: other			
Generic substation event model (GSE)				
B31	**Publisher** side		Y	
B32	**Subscriber** side	Y		
Transmission of sampled value model (SVC)				
B41	**Publisher** side			
B42	**Subscriber** side			
– Y = supported N or empty = not supported				

3 ACSI models conformance statement

The ACSI models conformance statement is defined in Table 7-6: ACSI models conformance statement.

Table 7-6: ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
If Server or Client side (B11/12) supported				
M1	Logical device		Y	
M2	Logical node		Y	
M3	Data		Y	
M4	Data set		Y	
M5	Substitution			
M6	Setting group control		Y	
	Reporting			
M7	Buffered report control		Y	
M7-1	sequence-number		Y	
M7-2	report-time-stamp		Y	
M7-3	reason-for-inclusion		Y	
M7-4	data-set-name		Y	
M7-5	data-reference		Y	
M7-6	buffer-overflow		Y	
M7-7	entryID		Y	
M7-8	BufTm		Y	
M7-9	IntgPd		Y	
M7-10	GI		Y	
M7-11	conf-revision		Y	
M8	Unbuffered report control		Y	
M8-1	sequence-number		Y	
M8-2	report-time-stamp		Y	
M8-3	reason-for-inclusion		Y	
M8-4	data-set-name		Y	
M8-5	data-reference		Y	
M8-6	BufTm		Y	
M8-7	IntgPd		Y	
M8-8	GI		Y	
M8-9	conf-revision		Y	
	Logging			
M9	Log control			
M9-1	IntgPd			
M10	Log			
M11	Control		Y	
M17	File Transfer		Y	
M18	Application association		Y	
M19	GOOSE Control Block		Y	
M20	Sampled Value Control Block			
If GSE (B31/32) is supported				
M12	GOOSE		Y	
M13	GSSE			Deprecated
If SVC (B41/B42) is supported				
M14	Multicast SVC			
M15	Unicast SVC			
For all IEDs				
M16	Time	Y	Y	
Y = service is supported N or empty = service is not supported				

4 ACSI service conformance statement

The ACSI service conformance statement is defined in Table 7-7: ACSI service conformance statement.

Table 7-7: ACSI service conformance statement

	Ed	ACSI Service	AA: TP/MC	Client Sub(C)	Server Pub(S)	Comments
Server						
S1	1,2	GetServerDirectory(LOGICAL-DEVICE)	TP		Y	
Application association						
S2	1,2	Associate	TP		Y	
S3	1,2	Abort	TP		Y	
S4	1,2	Release	TP		Y	
Logical device						
S5	1,2	GetLogicalDeviceDirectory	TP		Y	
Logical node						
S6	1,2	GetLogicalNodeDirectory	TP		Y	
S7	1,2	GetAllDataValues	TP		Y	
Data						
S8	1,2	GetDataValues	TP		Y	
S9	1,2	SetDataValues	TP		Y	
S10	1,2	GetDataDirectory	TP		Y	
S11	1,2	GetDataDefinition	TP		Y	
Data set						
S12	1,2	GetDataSetValues	TP		Y	
S13	1,2	SetDataSetValues	TP		N	
S14	1,2	CreateDataSet	TP		N	
S15	1,2	DeleteDataSet	TP		N	
S16	1,2	GetDataSetDirectory	TP		Y	
Substitution						
S17	1	SetDataValues	TP		N	Ed1 only
Setting group control						
S18	1,2	SelectActiveSG	TP		Y	
S19	1,2	SelectEditSG	TP		Y	
S20	1,2	SetEditSGValues	TP		Y	
S21	1,2	ConfirmEditSGValues	TP		Y	
S22	1,2	GetEditSGValues	TP		Y	
S23	1,2	GetSGCBValues	TP		Y	
Reporting						
Buffered report control block (BRCB)						
S24	1,2	Report	TP		Y	
S24-1	1,2	data-change (dchg)			Y	
S24-2	1,2	quality-change (qchg)			Y	
S24-3	1,2	data-update (dupd)			N	
S25	1,2	GetBRCBValues	TP		Y	
S26	1,2	SetBRCBValues	TP		Y	
Unbuffered report control block (URCB)						
S27	1,2	Report	TP		Y	
S27-1	1,2	data-change (dchg)			Y	
S27-2	1,2	quality-change (qchg)			Y	

S27-3	1,2	data-update (dupd)			N	
S28	1,2	GetURCBValues	TP		Y	
S29	1,2	SetURCBValues	TP		Y	

Logging						
Log control						
S30	1,2	GetLCBValues	TP		N	
S31	1,2	SetLCBValues	TP		N	
Log						
S32	1,2	QueryLogByTime	TP		N	
S33	1,2	QueryLogAfter	TP		N	
S34	1,2	GetLogStatusValues	TP		N	

Generic substation event model (GSE)						
GOOSE						
S35	1,2	SendGOOSEMessage	MC		Y	
GOOSE Control Block						
S36	1,2	GetGoReference	TP			
S37	1,2	GetGOOSEElementNumber	TP			
S38	1,2	GetGoCBValues	TP		Y	
S39	1,2	SetGoCBValues	TP		Y	
GSSE (Ed2:61850-7-2 Annex C)						
S40	1,2	SendGSSEMessage	MC		N	Deprecated
GSSE Control Block (Ed2:61850-7-2 Annex C)						
S41	1,2	GetGsReference	TP		N	Deprecated
S42	1,2	GetGSSEDataOffset	TP		N	Deprecated
S43	1,2	GetGsCBValues	TP		N	Deprecated
S44	1,2	SetGsCBValues	TP		N	Deprecated

Transmission of sampled value model (SVC)						
Multicast SV						
S45	1,2	SendMSVMessage	MC		N	Use for 9-2LE or IEC 61869-9
Multicast Sampled Value Control Block						
S46	1,2	GetMSVCBValues	TP		N	
S47	1,2	SetMSVCBValues	TP		N	
Unicast SV						
S48	1,2	SendUSVMessage	TP		N	
Unicast Sampled Value Control Block						
S49	1,2	GetUSVCBValues	TP		N	
S50	1,2	SetUSVCBValues	TP		N	

Control						
S51	1,2	Select	TP		Y	SBO Normal Security
S52	1,2	SelectWithValue	TP		Y	SBO Enhanced Security
S53	1,2	Cancel	TP		Y	
S54	1,2	Operate	TP		Y	
S55	1,2	CommandTermination	TP		Y	
S56	1,2	TimeActivatedOperate	TP		N	

File transfer						
S57	1,2	GetFile	TP		Y	
S58	1,2	SetFile	TP		N	
S59	1,2	DeleteFile	TP		N	
S60	1,2	GetFileAttributeValues	TP		Y	
S61	1,2	GetServerDirectory (FILE)	TP		Y	

Time						
T1	1,2	Time resolution of internal clock	-		2ms	nearest negative power of 2 in seconds
T2	2	Time accuracy of internal clock	-			TL (ms) (low accuracy), T3 < 7) (only Ed2)
	1,2		-			T0 (ms) (<= 10 ms), 7 <= T3 < 10)

	1,2		-			T1 (µs) (<= 1 ms), 10 <= T3 < 13
	1,2		-			T2 (µs) (<= 100 µS), 13 <= T3 < 15
	1,2		-			T3 (µs) (<= 25 µS), 15 <= T3 < 18
	1,2		-			T4 (µs) (<= 4 µS), 18 <= T3 < 20
	1,2		-		Y	T5 (µs) (<= 1 µS), T3 >= 20)
T3	1,2	Supported TimeStamp resolution	-		1ms	nearest negative power of 2 in seconds

7.3.7.3.4 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "B", "C", "D", "E" and IEC 61850 Edition 1

Reference documentation: **MICS for 650 family rev1.4 firm3_60**.

This document describes the:

- Logical Nodes List
- Logical Nodes and Extensions
- Enum types implementation

1 Logical Nodes List

The following table contains the list of logical nodes implemented in the device with firmware version lower than 7.00:

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
P: Logical Nodes for protection functions
PIOC (Instantaneous overcurrent)
PTOC (Time overcurrent)
PTOF (Overfrequency)
PTOV (Overvoltage)
PTUV (Undervoltage)
PTUF (Underfrequency)
R: Logical nodes for protection related functions
RDIR (Directional element)
RREC (Autoreclosing)
C: Logical Nodes for control
CSWI (Switch controller)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMTR (Metering)
MMXU (Measurement)
MSQI (Sequence and imbalance)
X: Logical Nodes for switchgear
XCBR (Circuit breaker)
XSWI (Circuit switch)

2 Logical Nodes and Extensions

Some of the following logical nodes have been extended with extra data. All extra data has been highlighted in the tables and marked as “E” (Extended), these data contains “dataNs” attribute with the NameSpace “GE MICS for 650 family rev1.3”.

Comments:

ØM: Data is mandatory in the IEC-61850-7-4.

ØO: Data is optional in the IEC-61850-7-4 and is used in the device.

ØE: Data is an extension to the IEC-61850-7-4.

2.1 System Logical Nodes. LN Group: L

2.1.1 LPHD (Physical device information)

LPHD class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
LPHD		Physical device information	M	
Data				
Common Logical Node Information				
PhyNam	DPL	Physical device name plate	M	
PhyHealth	INS	Physical device health	M	
Proxy	SPS	Indicates if this LN is a proxy	M	

2.1.2 LLN0 (Logical node zero)

LLN0 class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Loc	SPS	Local operation for complete logical device	O	
Optmh	INS	Operation time	M	
GsCB (ACSI class GSSE control block)				
GsCB	GsCB			
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			
SGCB (ACSI class Setting Group control block)				
SGCB	SGCB			

2.1.2.1 GsCB (GSSE control block class definition)

GsCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
GsEna	BOOLEAN	GS	Enable (TRUE), disable (FALSE)
GsID	VISIBLE STRING65	GS	
DNALabels[1..n]	VISIBLE STRING65	GS	Labels of DNA bit pairs
UserSTLabels[1..n]	VISIBLE STRING65	GS	Label of ST bit pairs
LSentData [1..n]	GSSEData	GS	Derived from GSSE message

2.1.2.2 GoCB (GOOSE control block class definition)

GoCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
GoEna	BOOLEAN	GO	Enable (TRUE), disable (FALSE)

GoID		VISIBLE STRING65	GO	
DatSet		VISIBLE STRING65	GO	
ConfRev		INT32U	GO	
NdsCom		BOOLEAN	GO	
DstAddress				
	Addr	OCTET-STRING	GO	
	PRIORITY	UNSIGNED8	GO	
	VID	UNSIGNED16	GO	
	APPID	UNSIGNED16	GO	

2.1.2.3 SGCB (Setting Group control block class definition)

SGCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
NumOfSG	INT8U	SP	Total number of settings group available in the logical device. Fixed as 3
ActSG	INT8U	SP	Setting group whose values are used by a logical node to performing its function. Values: 1, 2 or 3
EditSG	INT8U	SP	Setting group whose values can be set. Values: 1, 2 or 3
CnfEdit	BOOLEAN	SP	
LActTm	Timestamp	SP	

2.2 Logical Nodes for protection functions. LN Group: P

2.2.1 PIOC (Instantaneous overcurrent)

2.2.1.1 phsPIOC

This logical node class is used for phase instantaneous overcurrent and has 6 instances inside the device.

PIOC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	O	IOC PKP
Op	ACT	Operate	M	IOC OP
Blk	ACT	Blk	E	IOC BLK
Settings				
StrVal	ASG	Start value	M	Pickup Level (0,05 – 160)
OpDlTmms	ING	Operate Delay Time	E	Trip Delay (0-900000) Units in milliseconds
InMagTyp	ING	Input Type	E	(Phasor or RMS)
RsDlTmms	ING	Reset Delay	E	Reset Delay (0-900000) Units in milliseconds
PIOCEna	SPG	Function IOC enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.1.2 ndPIOC

This logical node class is used for neutral instantaneous overcurrent and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	O	IOC PKP
Op	ACT	Operate	M	IOC OP
Blk	ACT	Blk	E	IOC BLK
Settings				
StrVal	ASG	Start value	M	Pickup Level (0,05 – 160)
OpDlTmms	ING	Operate Delay Time	E	Trip Delay (0-900000) Units in milliseconds
RsDlTmms	ING	Reset Delay	E	Reset Delay (0-900000) Units in milliseconds
PIOCEna	SPG	Function IOC enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.1.3 gndPIOC/hsePIOC

This logical node class is used for ground instantaneous and sensitive ground instantaneous overcurrent. There are 6 instances of this logical node inside the device.

PIOC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	O	IOC PKP
Op	ACT	Operate	M	IOC OP
Blk	ACT	Blk	E	IOC BLK
Settings				
StrVal	ASG	Start value	M	Pickup Level (0,05 – 160)*
OpDlTmms	ING	Operate Delay Time	E	Trip Delay (0-900000) Units in milliseconds
InMagTyp	ING	Input Type	E	(Phasor or RMS)
RsDlTmms	ING	Reset Delay	E	Reset Delay (0-900000) Units in milliseconds
PIOCEna	SPG	Function IOC enable	E	Function

*For sensitive ground pickup level (0,005 - 16)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.2 PTOC (Time overcurrent)

2.2.2.1 phsPTOC

This logical node class is used for phase time overcurrent and has 6 instances inside the device.

PTOC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TOC PKP
Op	ACT	Operate	M	TOC OP
Blk	ACT	Block	E	TOC BLK
Settings				
TmACrv	CURVE	Operating curve type	M	Curve
StrVal	ASG	Start value	O	Pickup Level (0,05 - 160)
TmMult	ASG	Time dial multiplier	O	TD Multiplier (0 – 900)
RsMod	ING	Reset Mode	E	Reset (instantaneous, lineal)
InMagTyp	ING	Input Type	E	Input (Phasor, RMS)
VolRst	SPG	Voltage Restraint	E	(enable, Disable)
PTOCEna	SPG	Function TOC enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.2.2 ndPTOC

This logical node class is used for neutral time overcurrent and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TOC PKP
Op	ACT	Operate	M	TOC OP
Blk	ACT	Block	E	TOC BLK
Settings				
TmACrv	CURVE	Operating curve type	M	Curve
StrVal	ASG	Start value	O	Pickup Level (0,05 - 160)
TmMult	ASG	Time dial multiplier	O	TD Multiplier (0 – 900)
RsMod	ING	Reset Mode	E	Reset (instantaneous, lineal)

PTOCEna	SPG	Function TOC enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.2.3 gndPTOC

This logical node class is used for ground time overcurrent and sensitive ground time overcurrent. There are 6 instances inside of this logical node inside the device, three of them are used for ground time overcurrent a and three for sensitive ground time overcurrent.

PTOC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	O	TOC PKP
Op	ACT	Operate	M	TOC OP
Blk	ACT	Block	O	TOC BLK
Settings				
TmACrv	CURVE	Operating curve type	O	Curve
StrVal	ASG	Start value	O	Pickup Level (0,05 – 160)
TmMult	ASG	Time dial multiplier	O	TD Multiplier (0 – 900)
RsMod	ING	Reset Mode	O	Reset (instantaneous, lineal)
InMagTyp	ING	Input Type	O	Input (Phasor, RMS)
PTOCEna	SPG	Function TOC enable	O	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.3 PTOF (OverFrequency)

This logical node class is used for overfrequency and has 3 instances inside the device.

PTOF class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOF		OverFrequency		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TOF PKP
Op	ACD	Operate	M	TOF OP
Blk	ACT	Block	E	TOF BLK
Settings				
StrVal	ASG	Start value (frequency)	O	Pickup Level (20-65)
BlkVal	ASG	Voltage Block Value	O	Minimum Voltage (10-300)

OpDlTmms	ING	Operate Delay Time	O	Trip Delay (0-900000) Units in milliseconds
RsDlTmms	ING	Reset Delay Time	O	Reset Delay (0-900000) Units in milliseconds
PTOFEna	SPG	Function TOF enable	E	Function (Enable, Disable)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.4 PTOV (Overvoltage)

2.2.4.1 phsPTOV

This logical node class is used for phase overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TOV PKP
Op	ACT	Operate	O	TOV OP
Blk	ACT	Block	E	TOV BLK
Settings				
StrVal	ASG	Start Value	O	Pickup Level (3 – 300)
OpDlTmms	ING	Operate Delay Time	O	Trip Delay (0 – 900000) Units in milliseconds
RsDlTmms	ING	Reset Delay Time	O	Reset Delay (0 – 900000) Units in milliseconds
PhLogic	ING	Logic Mode	E	Logic (Any, two, all phases)
PTOVEna	SPG	Function TOV enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.4.2 auxPTOV

This logical node class is used for auxiliary overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TOV PKP
Op	ACT	Operate	O	TOV OP

Blk	ACT	Block	E	TOV BLK
Settings				
StrVal	ASG	Start Value	O	Pickup Level (3 – 300)
OpDlTmms	ING	Operate Delay Time	O	Trip Delay (0 – 900000) Units in milliseconds
RsDlTmms	ING	Reset Delay Time	O	Reset Delay (0 – 900000) Units in milliseconds
PTOVEna	SPG	Function TOV enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.4.3 neuPTOV

This logical node class is used for neutral overvoltage and has 6 instances inside the device.

PTOV class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TOV PKP
Op	ACT	Operate	O	TOV OP
Blk	ACT	Block	E	TOV BLK
Settings				
StrVal	ASG	Start Value	O	Pickup Level (3 – 300)
OpDlTmms	ING	Operate Delay Time	O	Trip Delay (0 – 900000) Units in milliseconds
RsDlTmms	ING	Reset Delay Time	O	Reset Delay (0 – 900000) Units in milliseconds
PTOVEna	SPG	Function TOV enable	E	Function

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.5 PTUV (Undervoltage)

2.2.5.1 phsPTUV

This logical node class is used for phase undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				

Str	ACD	Start	M	TUV PKP
Op	ACT	Operate	M	TUV OP
Blk	ACT	Block	E	TUV BLK
StrPhGn	ACD	Start	E	TUV Phase-Gnd PKP
OpPhGn	ACT	Operate	E	TUV Phase-Gnd OP
StrPhPh	ACD	Start	E	TUV Phase-Phase PKP
OpPhPh	ACT	Operate	E	TUV Phase-Phase OP
Settings				
TmVCrv	CURVE_2	Operating curve type	O	Curve (definitive, inverse)
StrVal	ASG	Start value	O	Pickup Level (3 – 300)
TmMult	ASG	Time dial multiplier	O	Delay (0 – 900)
DeaLinVal	ASG	Minimum Voltage	E	Minimum Voltage (0 – 300)
PhLogic	ING	Logic	E	Logic (Any, Two, All phases)
InMod	ING	Mode	E	Phase-Phase, Phase-Ground
BkrMon	SPG	Supervised by 52	E	Enable, Disable
PTUVEna	SPG	Function TUV enable	E	Function

Notes:

TmVCrv object uses Enum type setCharact_2 (See the Enum types implementation section).

ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.5.2 AuxPTUV

This logical node class is used for auxiliary undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TUV PKP
Op	ACT	Operate	M	TUV OP
Blk	ACT	Block	E	TUV BLK
Settings				
TmVCrv	CURVE_2	Operating curve type	O	Curve (definitive, inverse)
StrVal	ASG	Start value	O	Pickup Level (3 – 300)
TmMult	ASG	Time dial multiplier	O	Delay (0 – 900)
PTUVEna	SPG	Function TUV enable	E	Function

Notes:

TmVCrv object uses Enum type setCharact_2 (See the Enum types implementation section).

ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.2.6 PTUF (UnderFrequency)

This logical node class is used for phase underfrequency and has 3 instances inside the device.

PTUF class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
PTUF		UnderFrequency		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	ACD	Start	M	TUF PKP
Op	ACD	Operate	M	TUF OP
Blk	ACT	Block	E	TUF BLK
Settings				
StrVal	ASG	Start value (frequency)	O	Pickup Level (20-65)
BlkVal	ASG	Voltage Block Value	O	Minimum Voltage (10-300)
OpDlTmms	ING	Operate Delay Time	O	Trip Delay (0-900000) Units in milliseconds
RsDlTmms	ING	Reset Delay Time	O	Reset Delay (0-900000) Units in milliseconds
PTUFEna	SPG	Function TUF enable	E	Function (Enable, Disable)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.3 Logical Nodes for protection related functions. LN Group: R

2.3.1 RDIR (Directional element)

2.3.1.1 phsRDIR

This logical node class is used for phase directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	ACD	Direction	M	Fixed to unknown value
Op	ACT	Operate	O	Phase Dir OP
Blk	ACT	Block	O	Phase Dir Block
BlkIn	ACT	Phase Dir Blk Inp	O	Phase Dir Blk Inp
Settings				
ChrAng	ASG	Characteristic Angle	O	(-90, 90) MTA
BlkValV	ASG	Minimum operating current	O	(0, 300) Pol V Threshold

PolOpMod	ING	Direction	E	(Reverse, Forward)
BlkMod	ING	Block Logical	E	(Permission, Blocked)
RDIREna	SPG	Function Permission	E	(Enable, Disable)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.3.1.2 ndRDIR

This logical node class is used for neutral directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	ACD	Direction	M	Fixed to unknown value
Op	ACT	Operate	E	Neutral Dir OP
Blk	ACT	Block	E	Neutral Dir Block
BlkIn	ACT	Neutral Dir Blk Inp	E	Neutral Dir Blk Inp
Settings				
ChrAng	ASG	Characteristic Angle	O	(-90, 90) MTA
BlkValV	ASG	Minimum operating current	O	(0, 300) Pol V Threshold
PolOpMod	ING	Direction	E	(Reverse, Forward)
BlkMod	ING	Block Logical	E	(Permission, Blocked)
RDIREna	SPG	Function Permission	E	(Enable, Disable)
PolQty	ING	Polarization	O	(VO,IP,VO+IP,VO*IP)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.3.1.3 gndRDIR

This logical node class is used for ground directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	ACD	Direction	M	Fixed to unknown value
Op	ACT	Operate	E	Ground Dir OP
Blk	ACT	Block	E	Ground Dir Block
BlkIn	ACT	Ground Dir Blk Inp	E	Ground Dir Blk Inp
Settings				

ChrAng	ASG	Characteristic Angle	O	(-90, 90) MTA
BlkValV	ASG	Minimum operating current	O	(0, 300) Pol V Threshold
PolOpMod	ING	Direction	E	(Reverse, Forward)
BlkMod	ING	Block Logical	E	(Permission, Blocked)
RDIREna	SPG	Function Permission	E	(Enable, Disable)
PolQty	ING	Polarization	O	(VO,IP,VO+IP,VO*IP)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.3.1.4 hseRDIR

This logical node class is used for sensitive ground directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	ACD	Direction	M	Fixed to unknown value
Op	ACT	Operate	E	Sens Gnd Dir OP
Blk	ACT	Block	E	Sens Gnd Dir Block
BlkIn	ACT	Sens Gnd Dir Blk Inp	E	Sens Gnd Dir Blk Inp
Settings				
ChrAng	ASG	Characteristic Angle	O	(-90, 90) MTA
BlkValV	ASG	Minimum operating current	O	(0, 300) Pol V Threshold
PolOpMod	ING	Direction	E	(Reverse, Forward)
BlkMod	ING	Block Logical	E	(Permission, Blocked)
RDIREna	SPG	Function Permission	E	(Enable, Disable)

Note: ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.3.2 RREC (Autoreclosing)

This logical node class is used for autorecloser and has 1 instance inside the device.

RREC class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
RREC		Autoreclosing		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
Status Information				
Op	ACT	Operate	M	AR Close Breaker
AutoRecSt	INS	Auto Reclosing status	M	AR Status

AutoRecLo	INS	Auto Reclosing Lockout Status	E	AR Lockout Mode
AutoRecBlk	INS	Auto Reclosing Block Status	E	AR Block Mode
Settings				
Rec1Tmms	ING	First Reclose Time	O	Dead Time 1 Units in milliseconds
Rec2Tmms	ING	Second Reclose Time	O	Dead Time 2 Units in milliseconds
Rec3Tmms	ING	Third Reclose Time	O	Dead Time 3 Units in milliseconds
Rec4Tmms	ING	Fourth Reclose Time	E	Dead Time 4 Units in milliseconds
RclTmms	ING	Reclaim Time	O	Reclaim Time Units in milliseconds
MaxNumShot	ING	Max number of Shots	E	Max number Shots
RsTmms	ASG	Reclosing --> Ready	E	Reset Time
HoldTmms	ASG	Cond Check Time	E	Hold Time
CondEna	SPG	Check Cond (Enable, Disable)	E	Cond Permission
RRECEna	SPG	Function Enable, Disable	E	Function Permission

Notes:

AutoRecSt object includes extra enum values specified by Tissue 3 and Tissue 133 (See the Enum types implementation section).

ACT includes origin attribute in ST, this is implemented according to Tissue 68.

2.4 Logical Nodes for control. LN Group: C

2.4.1 CSWI (Switch controller)

CSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CSWI		Switch controller		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Controls				
Pos	DPC	Switch position	M	Switch open, close, undefined

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to the first sixteen switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN.

In CSWI LN for "Pos" controllable attribute all possible control models are applicable:

- “direct-control-with-normal-security”
- “SBO-control-with-normal-security”
- “direct-control-with-enhanced-security”
- “SBO-control-with-enhanced-security”

The sboTimeout attribute for Pos is configurable in a range from 500 ms to 60 seconds.

The sboClass attribute for Pos can only have value "0" (operate-once).

2.5 Logical Nodes for generic references. LN Group: G

2.5.1 GGIO (Generic process I/O)

2.5.1.1 GGIO

This logical node class is used is used to map digital and analogue inputs of I/O boards F, G, H and J.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
BoardSt	SPS	Board Status	E	Board Status. True: ▪ board present and working correctly False: ▪ board not present ▪ board present and board model mismatch ▪ board present and hardware failure
Ind1	SPS	General Indication (binary input)	O	Contact Input 1
Ind2	SPS	General Indication (binary input)	O	Contact Input 2
Ind32	SPS	General Indication (binary input)	O	Contact Input 32
Ind33	SPS	General Indication (binary input)	O	Contact Output 1
..	..	..	..	..
Ind48	SPS	General Indication (binary input)	O	Contact Output 16
Measured Values				
AnIn1	MV	Analogue input	O	Analog Input 1
AnIn2	MV	Analogue input	O	Analog Input 2
AnIn8	MV	Analogue input	O	Analog Input 8

2.5.1.2 vinGGIO

This logical node class is used is used to map the latched and self reset virtual Inputs.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Controls				
DPCSO1	geDPC	Double point controllable status output	O	Latched Virtual Input 1, 2
DPCSO2	geDPC	Double point controllable status output	O	Latched Virtual Input 3, 4
..	..	..	..	..
DPCSO16	geDPC	Double point controllable status output	O	Latched Virtual Input 31, 32
SPCSO1	SPC	Single point controllable status output	O	Latched Virtual Input 1
SPCSO2	SPC	Single point controllable status output	O	Latched Virtual Input 2
..	..	..	..	..
SPCSO32	SPC	Single point controllable status output	O	Latched Virtual Input 32
SPCSO33	SPC	Single point controllable status output	O	Self reset Virtual Input 1
SPCSO34	SPC	Single point controllable status output	O	Self reset Virtual Input 2
..	..	..	..	..
SPCSO64	SPC	Single point controllable status output	O	Self reset Virtual Input 32

Note:

Double control points operate on pairs of Virtual Inputs in a manner that one Virtual Input of the pair is set to “1” and the other Virtual Input of the pair is set to "0".

For all controllable attributes in this logical node only "direct-control-with-normal-security" model of control is applicable.

2.5.1.3 eveGGIO

This logical node class is used to map data from the list of any all internal digital states (PLC control events).

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
Ind1	SPS	General Indication (binary input)	O	Control Event 1
Ind2	SPS	General Indication (binary input)	O	Control Event 2
.....	.....	.....	.....	.....
Ind128	SPS	General Indication (binary input)	O	Control Event 128
Ind129	SPS	General Indication (binary input)	O	Switchgear 1 event 1
Ind130	SPS	General Indication (binary input)	O	Switchgear 1 event 2
Ind131	SPS	General Indication (binary input)	O	Switchgear 1 event 3
Ind132	SPS	General Indication (binary input)	O	Switchgear 1 event 4
Ind133	SPS	General Indication (binary input)	O	Switchgear 2 event 1
.....	.....	.....	.....	.....
Ind192	SPS	General Indication (binary input)	O	Switchgear 16 event 4

2.5.1.4 geRemoteInputsGGIO

This logical node class is used to map data from incoming GOOSE messages.

GGIO class				
Attribute Name	**Attribute Type**	Explanation	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
Ind1	SPS	General Indication (binary input)	O	Remote Digital Input 1
Ind2	SPS	General Indication (binary input)	O	Remote Digital Input 2
.....	.....	.....	.....	.....

Ind32	SPS	General Indication (binary input)	O	Remote Digital Input 32
AnIn1	SPS	Analogue input	O	Remote Analogue Input 1
AnIn2	SPS	Analogue input	O	Remote Analogue Input 2
.....	.....	.....	.....	.....
AnIn16	SPS	Analogue input	O	Remote Analogue Input 16

2.5.1.5 geRemoteOutputsGGIO

This logical node class is used to map PLC digital states for outgoing GOOSE messages.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
Ind1	SPS	General Indication (binary input)	O	Remote Digital Output 1
Ind2	SPS	General Indication (binary input)	O	Remote Digital Output 2
.....	.....	.....	.....	.....
Ind31	SPS	General Indication (binary input)	O	Remote Digital Output 31
Ind32	SPS	General Indication (binary input)	O	Remote Digital Output 32

Note: In 650 relays data from all logical nodes can be sent through outgoing GOOSE messages. Apart from that, logical node rouGGIO gives the ability to send through GOOSE digital states that are results of PLC logic equations. Mapping and configuration of rouGGIO states should be done with EnerVista 650 software.

2.6 Logical Nodes for metering and measurement. LN Group: M

2.6.1 MMTR (Metering)

MMTR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
MMTR		Metering		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Measured values				
SupWh	BCR	Mapped to generic pulse counter	O	Pulse Counter 1
SupVArh	BCR	Mapped to generic pulse counter	O	Pulse Counter 2
DmdWh	BCR	Mapped to generic pulse counter	O	Pulse Counter 3
DmdVArh	BCR	Mapped to generic pulse counter	O	Pulse Counter 4
CntPsWh	MV	Positive Wat Counter	O	
CntNgWh	MV	Negative Wat Counter	O	
CntPsVArh	MV	Positive VAR Counter	O	
CntNgVArh	MV	Negative VAR Counter	O	

Note: actVal in BCR is implemented as INT32.

2.6.2 MMXU (Measurement)

MMXU class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
MMXU		Measurement		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Measured values				
TotW	MV	Total active power (P)	O	Phase Real Pwr
TotVAr	MV	Total reactive power (Q)	O	Ph Reactive Pwr
TotVA	MV	Total apparent power (S)	O	Ph Apparent Pwr
TotPF	MV	Average power factor (PF)	O	3 Ph Power Factor
Hz	MV	Frequency	O	Frequency
PPV	DEL	Phase to phase voltages (VL1L2,...)	O	Phase-to-Phase Primary Voltages
PhV	WYE	Phase to ground voltages (VL1ER, ...)	O	Phase Primary Voltages
A	WYE	Phase currents (IL1, ...)	O	Phasor Primary
AuxV	CMV	Auxiliary Voltage	E	Vx Primary
BusHz	MV	Bus Frequency	E	Bus Frequency

2.6.3 MSQI (Sequence and imbalance)

MSQI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
MSQI		Sequence and imbalance		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Measured values				
SeqA	SEQ	Positive, Negative and Zero Sequence Current	C	
SeqV	SEQ	Positive, Negative and Zero Sequence Voltage	C	

Condition C: At least one of either data shall be used.

2.7 Logical Nodes for switchgear. LN Group: X

2.7.1 XCBR (Circuit Breaker)

XCBR class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	Number of Switchgear
Loc	SPS	Local operation	M	Local / Remote
OpCnt	INS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC	Switch position	M	Breaker open, close, und
BlkOpn	SPC	Block opening	M	Status-only
BlkCls	SPC	Block closing	M	Status-only
Metered Values				
SumSwARs	BCR	Sum of Switched Amperes	O	Maximum KI2t value of any of the phases
Status information				
CBOpCap	INS	Circuit breaker operating capability	M	Fixed value = 5
Settings				
ThAlSwA	ASG	Threshold Alarm of Switched Amps	E	Maximum KI2t
SumSwATmms	ASG	Sum of sw. Amps integration time	E	KI2t Integ. Time
ExNumTr	ASG	Excessive number of trips	E	Maximum Openings
ExNumTr1hr	ASG	Excessive number of trips in 1 hour	E	Max. Openings 1 hour

Note: actVal in BCR is implemented as INT32.

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to first sixteen switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN.

In F650 relay the Circuit Breaker (XCBR1 Logical Node) by default is mapped to first switchgear (exactly like XSWI1 and CSWI1 LNs). However it is possible to map the Circuit Breaker to any of the 16 switchgears of F650 relay. It can be done by modification of the following setting: **Setpoint > System Setup > Breaker Settings > Number of Switchgear**.

In XCBR LN for "Pos" controllable attribute all possible control models are applicable:

- "direct-control-with-normal-security"
- "SBO-control-with-normal-security"
- "direct-control-with-enhanced-security"
- "SBO-control-with-enhanced-security"

The sboTimeout attribute for Pos is configurable in a range from 500 ms to 60 seconds.

The sboClass attribute for Pos can only have value "0" (operate-once).

2.7.2 XSWI (Circuit switch)

XSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	INC	Mode	M	Status-only
Beh	INS	Behavior	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Loc	SPS	Local operation	M	Local / Remote
EEHealth	INS	External equipment health	O	
OpCnt	INS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC	Switch position	M	Status-only
BlkOpn	SPC	Block opening	M	Status-only
BlkCls	SPC	Block closing	M	Status-only
Status information				
SwTyp	INS	Switch Type	M	Fixed value = 2 (Disconnecter)
SwOpCap	INS	Switch operating capability	M	Fixed value = 5

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to the first sixteen switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN.

"Pos" attribute is not controllable in XSWI it has ctlModel = Status-only. In order to control the switch mapped to given XSWI the corresponding CSWI LN should be used.

3 Enum types implementation

3.1 setCharact

Enum type : setCharact					
Value	**Description**	**supported**	**new enum value added**	**650 setting internal value**	**650 Relay curve**
0	-	N	-	-	-
1	ANSI Extremely Inverse	Y	-	11	ANSI Ext Inv
2	ANSI Very Inverse	Y	-	12	ANSI Very Inv
3	ANSI Normal Inverse	Y	-	13	ANSI Norm Inv
4	ANSI Moderately Inverse	Y	-	14	ANSI Mod Inv
5	ANSI Definite Time	N	-	-	-
6	Long-Time Extremely Inverse	N	-	-	-
7	Long-Time Very Inverse	N	-	-	-
8	Long-Time Inverse	N	-	-	-
9	IEC Normal Inverse	Y	-	3	IEC Curve A
10	IEC Very Inverse	Y	-	4	IEC Curve B
11	IEC Inverse	N	-	-	-
12	IEC Extremely Inverse	Y	-	5	IEC Curve C
13	IEC Short-Time Inverse	Y	-	7	IEC Short-Time Inv
14	IEC Long-Time Inverse	Y	-	6	IEC Long-Time Inv
15	IEC Definite Time	Y	-	16	Definite Time
16	Reserved	N	-	-	-
17	Definable curve 1 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	0	IEEE Ext Inv
18	Definable curve 2 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	1	IEEE Very Inv
19	Definable curve 3 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	2	IEEE Mod Inv
20	Definable curve 4 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	8	IAC Ext Inv
21	Definable curve 5 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	9	IAC Very Inv
22	Definable curve 6 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	10	IAC Mod Inv
23	Definable curve 7 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	15	I2t
24	Definable curve 8 based on formula [x=f(y,A,B,C,D,E,F)]	Y	-	17	Rectifier Curve
25	Definable curve 9 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
26	Definable curve 10 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
27	Definable curve 11 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
28	Definable curve 12 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
29	Definable curve 13 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-

30	Definable curve 14 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
Enum type : setCharact (cont.)					
Value	**Description**	**supported**	**new enum value added**	**650 setting internal value**	**650 Relay curve**
31	Definable curve 15 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
32	Definable curve 16 based on formula [x=f(y,A,B,C,D,E,F)]	N	-	-	-
33	Vendor specific curve 1 defined by n pairs (x,y)	Y	-	11	User Curve A
34	Vendor specific curve 2 defined by n pairs (x,y)	Y	-	12	User Curve B
35	Vendor specific curve 3 defined by n pairs (x,y)	Y	-	13	User Curve C
36	Vendor specific curve 4 defined by n pairs (x,y)	Y	-	14	User Curve D
37	Vendor specific curve 5 defined by n pairs (x,y)	N	-	-	-
38	Vendor specific curve 6 defined by n pairs (x,y)	N	-	-	-
39	Vendor specific curve 7 defined by n pairs (x,y)	N	-	-	-
40	Vendor specific curve 8 defined by n pairs (x,y)	N	-	-	-
41	Vendor specific curve 9 defined by n pairs (x,y)	N	-	-	-
42	Vendor specific curve 10 defined by n pairs (x,y)	N	-	-	-
43	Vendor specific curve 11 defined by n pairs (x,y)	N	-	-	-
44	Vendor specific curve 12 defined by n pairs (x,y)	N	-	-	-
45	Vendor specific curve 13 defined by n pairs (x,y)	N	-	-	-
46	Vendor specific curve 14 defined by n pairs (x,y)	N	-	-	-
47	Vendor specific curve 15 defined by n pairs (x,y)	N	-	-	-
48	Vendor specific curve 16 defined by n pairs (x,y)	N	-	-	-

3.2 setCharact_2

Enum type : setCharact_2					
Value	**Description**	**supported**	**new enum value added**	**650 setting internal value**	**650 Relay curve**
0	Definite Time	Y	Y	0	Definite Time
1	Inverse Time	Y	Y	1	Definite Time

3.3 PolQty

Enum type : PolQty					
Value	**Description**	**supported**	**new enum value added**	**650 setting internal value**	**650 Relay Polarization**
-2	Vendor specific quantity 2	Y	Y	3	V0*IP
-1	Vendor specific quantity 1	Y	Y	2	V0+IP
1	None	N	-	-	-
2	Zero Sequence Current	Y	-	1	IP
3	Zero Sequence Voltage	Y	-	0	V0
4	Negative Sequence Voltage	N	-	-	-
5	Phase to Phase Voltages	N	-	-	-
6	Phase to Ground Voltages	N	-	-	-

3.4 AutoRecSt

Enum type : AutoRecSt				
Value	**Description**	**supported**	**new enum value added**	**Comments**
-1	Definite Trip	Y	-	Specified by Tissue 133
1	Ready	Y	-	
2	In Progress	Y	-	
3	Successful	Y	-	
4	Unsuccessful	Y	-	Specified by Tissue 3

3.5 InMagTyp

Enum type : InMagTyp				
Value	**Description**	**supported**	**new enum value added**	**Value of 650 Relay setting**
0	phasor	Y	Y	PHASOR(DFT)
1	rms	Y	Y	RMS

3.6 RsMod

Enum type : RsMod				
Value	**Description**	**supported**	**new enum value added**	**Value of 650 Relay setting**
0	instantaneous	Y	Y	INSTANTANEOUS
1	lineal	Y	Y	LINEAL

3.7 PolOpMod

Enum type : PolOpMod				
Value	Description	supported	new enum value added	Value of 650 Relay setting
0	reverse	Y	Y	REVERSE
1	forward	Y	Y	FORWARD

3.8 InMod

Enum type : InMod				
Value	Description	supported	new enum value added	Value of 650 Relay setting
0	phase-phase	Y	Y	PHASE-PHASE
1	phase-ground	Y	Y	PHASE-GROUND

3.9 PhLogic

Enum type : PhLogic				
Value	Description	supported	new enum value added	Value of 650 Relay setting
0	any phase	Y	Y	ANY PHASE
1	two phases	Y	Y	TWO PHASES
2	all phases	Y	Y	ALL PHASES

3.10 MaxNumShot

Enum type : MaxNumShot				
Value	Description	supported	new enum value added	Value of 650 Relay setting
0	1 Shot	Y	Y	1
1	2 Shots	Y	Y	2
2	3 Shots	Y	Y	3
3	4 Shots	Y	Y	4

7.3.7.3.5 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2

Reference documentation: **MICS for 650 family rev 1.05 firm 7_72**.

This document describes the:

- Logical Nodes List
- Logical Nodes and Extensions
- Enum types implementation

1 Logical Node List

IEC61850 profile has been updated for F650 firmware version 7.00. The Firmware version 7.00 and above supports IEC 61850 Edition 2. Several Logical Nodes have been added and they have been distributed according its functionality in two different Logical Devices, one for protection functions and the other for control and measure functions. LGOS (24 instances), PTRC, RBRF, RFLO and CILO (16 instances) have been included. Other Logical Nodes like XSWI and CSWI have increased their instances to 16 for each one. GGIO nodes and the Logical Nodes for protection functions have suffered some extensions.

For firmware 7.20 new logical nodes have been included in the data model such as RDRE, RBDR and PTTR. Other logical nodes like PTOF and PTUF have increased their instances to 6 for each one and suffered some extensions, and CSWI logical node has also extended its data model.

For firmware 7.72 new logical nodes have been included in the data model such as LCCH, LTMS, SGCB, SCBR and vouGGIO.

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
LCCH (Physical communication channel supervision)
LGOS (GOOSE subscription)
LTMS (Time master supervision)
SGCB (Setting Group Control Block class definition)
GoCB (GOOSE Control Block class definition)
P: Logical Nodes for protection functions
PIOC (Instantaneous overcurrent)
PTOC (Time overcurrent)
PTOF (Overfrequency)
PTOV (Overvoltage)
PTRC (Protection trip conditioning)
PTTR (Thermal overload)
PTUV (Undervoltage)
PTUF (Underfrequency)
PDOP (Power)**
PFRC (Frequency Rate of Change)**
PDIS (Load Encroachment)**
PRTR (Locked Rotor)**
R: Logical nodes for protection related functions
RBDR (Disturbance recorder channel binary)
RBRF (Breaker failure)
RDIR (Directional element)
RDRE (Disturbance recorder function)
RFLO (Fault Locator)
RREC (Autoreclosing)

RSYN (Synchrocheck)**
C: Logical Nodes for control
CILO (Interlocking)
CSWI (Switch controller)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMTR (Metering)
MMXU (Measurement)
MSQI (Sequence and imbalance)
X: Logical Nodes for switchgear
XCBR (Circuit breaker)
XSWI (Circuit switch)
S: Logical Nodes for supervision and monitoring
SCBR (Circuit breaker supervision)

Nodes with ** in the table above have been included from firmware version 7.50

2 Logical Nodes and Extensions

Notation:

ØM: Data is mandatory in the IEC-61850-7-4.

ØO: Data is optional in the IEC-61850-7-4 and is used in the device.

ØE: Data is an extension to the IEC-61850-7-4.

2.1 System Logical Nodes. LN Group: L

2.1.1 LPHD (Physical device information)

LPHD class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LPHD		Physical device information	M	
Data				
Common Logical Node Information				
PhyNam	geDPL	Physical device name plate	M	
PhyHealth	geHealthENS	Physical device health	M	
Proxy	geSPS	Indicates if this LN is a proxy	M	

2.1.2.1 LLN0 (geLLN0) Logical node zero --> one instance in Protection LDevice

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	

OpTmh	geINS	Operation time	O	
SGCB (ACSI class Setting Group Control Block)				
SGCB	SGCB			

2.1.2.2 LLN0 (geLLN0_LocSta) Logical node zero --> one instance in Control LDevice

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	
OpTmh	geINS	Operation time	O	
lLocSta	geSPC_2	Switching authority at station level	O	
GoCB (ACSI class Goose Control Block)				
GoCB	GoCB			

2.1.3 LCCH (geLCCH) --> physical channel status: one instance in Control LDevice

LCCH class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LCCH		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
ChLiv	geSPS	Physical channel status	M	
RedChLiv	geSPS	Physical channel status of redundant channel	O	

2.1.4 GoCB (GOOSE control block class definition)

GoCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
GoEna	BOOLEAN	GO	Enable (TRUE), disable (FALSE)
GoID	VISIBLE STRING65	GO	
DatSet	Object Reference	GO	
ConfRev	INT32U	GO	
NdsCom	BOOLEAN	GO	
DstAddress	PHYCOMADDR	GO	

2.1.5 LGOS (LGOS) --> GOOSE subscription information: 24 instances in Control LDevice

For firmware version 7.00 or higher, this LN Logical is used for monitoring GOOSE messages, diagnosing the subscription state of a GOOSE message and has 24 instances inside the device

LGOS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LGOS		GOOSE subscription		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
St	geSPS	Status of the subscription	M	
LastStNum	geINS	Last state number received	O	
ConfRevNum	geINS	Expected conf. revision num.	O	
Settings				
GoCBRef	geORG	Ref. to the subscribed GOOSE control block	O	

2.1.6 LTMS (geLTMS) --> Time synchronization: one instance in Control LDevice

LTMS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LTMS		Time master supervision		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
TmSrc	geVSS	Current time source	M	

2.1.7 SGCB (Setting Group Control Block class definition)

SGCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
NumOfSG	INT8U	SE/SG	Total number of settings groups available in the LDevice. Fixed at 6.
ActSG	NT8U	SE/SG	Setting group whose values are used by a logical node to perform its function.
EditSG	NT8U	SE/SG	Setting group whose values can be set.
CnfEdit	BOOLEAN	SE/SG	
LactTm	TimeStamp	SE/SG	

2.2 Logical Nodes for protection functions. LN Group: P

2.2.1 PIOC (Instantaneous overcurrent)

2.2.1.1 phsPIOC

This logical node class is used for phase instantaneous overcurrent and has 6 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.1.2 phsPIOC_2

This logical node class is used for phase instantaneous overcurrent when setting group option is enabled and has 2 instances inside the device. This logical node class is available only for firmware version below 7.50.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	PhsACD	Start	O	IOC PKP
Op	PhsACT	Operate	M	IOC OP
Blk	SPS	Block	O	
Settings				
PIOCEna	SPG_2	Function	O	
InMagTyp	ING_0_2	Input	O	
StrVal	FloatASG_2	Pickup level	O	
OpDlTmms	ING_8_2	Trip delay	O	
RsDlTmms	ING_8_2	Reset delay	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.1.3 ndPIOC

This logical node class is used for neutral instantaneous overcurrent and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	NeutACD	Start	O	IOC PKP
Op	NeutACT	Operate	M	IOC OP
Blk	SPS	Block	O	
Settings				
PIOCEna	SPG	Function	O	
StrVal	FloatASG	Pickup level	O	
OpDlTmms	ING_8	Trip delay	O	
RsDlTmms	ING_8	Reset delay	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.2.1.4 ndPIOC_2

This logical node class is used for neutral instantaneous overcurrent if setting group option is enable and has 1 instance inside the device. This logical node class is available only for firmware version below 7.50

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	NeutACD	Start	O	IOC PKP
Op	NeutACT	Operate	M	IOC OP
Blk	SPS	Block	O	
Settings				
PIOCEna	SPG_2	Function	O	
StrVal	FloatASG_2	Pickup level	O	
OpDlTmms	ING_8_2	Trip delay	O	
RsDlTmms	ING_8_2	Reset delay	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.1.5 gndPIOC/hsePIOC

This logical node class is used for ground instantaneous and sensitive ground instantaneous overcurrent. There are 6

instances (3 for ground and 3 for sensitive ground instantaneous overcurrent) of this logical node inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	IOC PKP
Op	geNeutACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG	Function	O	
InMagTyp	geING_0	Input	O	
StrVal	geFloatASG	Pickup level	O	
OpDlTmms	geING_8	Trip delay	O	
RsDlTmms	geING_8	Reset delay	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.2.1.5 gndPIOC_2

This logical node class is used for ground instantaneous and sensitive ground instantaneous overcurrent when setting group option is enable. There are 2 instances (1 for ground and 1 for sensitive ground instantaneous overcurrent) of this logical node inside the device. This logical node class is available only for firmware version below 7.50.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	

SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.1.6 IsoGndPIOC

This logical node class is used for isolated ground overcurrent and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
VhStr	geIntASG_2	Vh level	O	
VlStr	geIntASG_2	Vl level	O	
IhStr	geFloatASG_1_2	Ih level	O	
IlStr	geFloatASG_1_2	Il level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.1.7 BknCndPIOC

This logical node class is used for broken conductor function and has 3 instances inside the device. This node have been included for firmware versions 7.50 or above.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
BlkCurrent	geFloatASG_1_2	Operation Threshold	O	

SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.2 PTOC (Time overcurrent)

2.2.2.1 phsPTOC

This logical node class is used for phase time overcurrent and has 6 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG	Function	O	
InMagTyp	geING_0	Input	O	
StrVal	geFloatASG	Pickup level	O	
TmACrv	geCURVE	Curve	O	
VolRst	geSPG	Voltage Restraint	O	
TmMult	geFloatASG	TD Multiplier	O	
RsMod	geING_0	Reset	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.2.2.2 phsPTOC_2

This logical node class is used for phase time overcurrent when setting group option is enabled and has 2 instances inside the device. This logical node class is available only for firmware version below 7.50

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	

VolRst	geSPG_2	Voltage Restraint	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.2.3 ndPTOC

This logical node class is used for neutral time overcurrent and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	TOC PKP
Op	geNeutACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG	Function	O	
StrVal	geFloatASG	Pickup level	O	
TmACrv	geCURVE	Curve	O	
TmMult	geFloatASG	TD Multiplier	O	
RsMod	geING_0	Reset	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.2.2.4 ndPTOC_2

This logical node class is used for neutral time overcurrent when setting group option is enable and has 1 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	TOC PKP
Op	geNeutACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.2.5 gndPTOC

This logical node class is used for ground time overcurrent and sensitive ground time overcurrent. There are 6 instances inside of this logical node inside the device. 3 for ground and 3 for sensitive ground time overcurrent.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	PhsACD	Start	M	TOC PKP
Op	PhsACT	Operate	M	TOC OP
Blk	SPS	Block	O	TOC BLK
Settings				
PTOCEna	SPG	Function	O	
InMagTyp	ING_0	Input	O	
StrVal	FloatASG	Pickup level	O	
TmACrv	CURVE	Curve	O	
TmMult	geFloatASG	TD Multiplier	O	
RsMod	geING_0	Reset	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.2.2.6 gndPTOC_2

This logical node class is used for ground time overcurrent and sensitive ground time overcurrent when setting group option is enable. There are 2 instances inside of this logical node inside the device, 1 for ground and 1 for sensitive ground time overcurrent. This logical node class is available only for firmware version below 7.50

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	PhsACD	Start	M	TOC PKP
Op	PhsACT	Operate	M	TOC OP
Blk	SPS	Block	O	TOC BLK
Settings				
PTOCEna	SPG_2	Function	O	
InMagTyp	ING_0_2	Input	O	
StrVal	FloatASG_2	Pickup level	O	
TmACrv	CURVE_3	Curve	O	
TmMult	FloatASG_2	TD Multiplier	O	
RsMod	ING_0_2	Reset	O	

SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.2.7 hsePTOC

This logical node class is used for sensitive ground time overcurrent function and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.2.8 NgSeqPTOC

This logical node class is used for negative sequence time overcurrent function and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.3 PTOF (OverFrequency)

2.2.3.1 PTOF

This logical node class is used for overfrequency and has 3 instances for firmware version below 7.20 and 6 instances for firmware version 7.20 or above inside the device.

PTOF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTOF		Overfrequency		
Data				
Common Logical Node Information				
Mod	ENC	Mode	M	Status-only
Beh	ENS	Behavior	M	
Health	ENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
Str	ACD	Start	M	TOF PKP
Op	ACT	Operate	M	TOF OP
Blk	SPS	Block	O	TOF BLK
BlkV	SPS	Blocked because of voltage	O	
Settings				
StrVal	ASG	Start value (frequency)	O	
BlkVal	ASG	Voltage block value	O	
OpDlTmms	ING	Operate delay time	O	
RsDlTmms	ING	Reset delay time	O	
PTOFEna	SPG	Function TOF enable	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	
FreqSource	SPG	Frequency source	O	Firmware version 7.20 or above

2.2.3.2 PTOF_2

This logical node class is used for overfrequency when setting group option is anable and has 1 instances inside the device.

PTOF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTOF		Overfrequency		
Data				
Common Logical Node Information				
Mod	ENC	Mode	M	Status-only
Beh	ENS	Behavior	M	
Health	ENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
Str	ACD	Start	M	TOF PKP
Op	ACT	Operate	M	TOF OP
Blk	SPS	Block	O	TOF BLK
BlkV	SPS	Blocked because of voltage	O	
Settings				
StrVal	ASG	Start value (frequency)	O	
BlkVal	ASG	Voltage block value	O	
OpDlTmms	ING	Operate delay time	O	
RsDlTmms	ING	Reset delay time	O	
PTOFEna	SPG	Function TOF enable	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	
FreqSource	SPG	Frequency source	O	Firmware version 7.20 or above

2.2.4 PTOV (Overvoltage)

2.2.4.1 phsPTOV

This logical node class is used for phase overvoltage and has 3 instances inside the device

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	PhsACD	Start	M	TOV PKP
Op	PhsACT	Operate	M	TOV OP
Blk	SPS	Block	O	TOV BLK
Settings				
PTOVEna	SPG	Function	O	
StrVal	IntASG	Start value	O	
OpDlTmms	ING_8	Operate delay time	O	
RsDlTmms	ING_8	Reset delay time	O	
PhLogic	ING_0	Logic	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.2.4.2 phsPTOV_2

This logical node class is used for phase overvoltage when setting group option is enabled and has 1 instance inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	PhsACD	Start	M	TOV PKP
Op	PhsACT	Operate	M	TOV OP
Blk	SPS	Block	O	TOV BLK
Settings				
PTOVEna	SPG_2	Function	O	
StrVal	IntASG_3	Start value	O	
OpDlTmms	ING_8_2	Operate delay time	O	
RsDlTmms	ING_8_2	Reset delay time	O	
PhLogic	ING_0_2	Logic	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.4.3 auxPTOV

This logical node class is used for auxiliary overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TOV PKP
Op	GeneralACT	Operate	M	TOV OP
Blk	SPS	Block	O	TOV BLK
Settings				
PTOVEna	SPG_2	Function	O	
StrVal	IntASG_3	Start value	O	
OpDlTmms	ING_8_2	Operate delay time	O	
RsDlTmms	ING_8_2	Reset delay time	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.4.4 auxPTOV_2

This logical node class is used for auxiliary overvoltage when setting group option is enabled and has 1 instance inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TOV PKP
Op	GeneralACT	Operate	M	TOV OP
Blk	SPS	Block	O	TOV BLK
Settings				
PTOVEna	SPG_2	Function	O	
StrVal	IntASG_3	Start value	O	
OpDlTmms	ING_8_2	Operate delay time	O	
RsDlTmms	ING_8_2	Reset delay time	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.4.5 neuPTOV

This logical node class is used for neutral overvoltage and has 6 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TOV PKP
Op	GeneralACT	Operate	M	TOV OP
Blk	SPS	Block	O	TOV BLK
Settings				
PTOVEna	SPG	Function	O	
StrVal	IntASG	Start value	O	
OpDlTmms	ING_8	Operate delay time	O	
RsDlTmms	ING_8	Reset delay time	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.2.4.6 neuPTOV_2

This logical node class is used for neutral overvoltage when setting group option is enabled and has 2 instances inside the device. This logical node class is available only for firmware version below 7.50.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TOV PKP
Op	GeneralACT	Operate	M	TOV OP
Blk	SPS	Block	O	TOV BLK
Settings				
PTOVEna	SPG_2	Function	O	
StrVal	IntASG_3	Start value	O	
OpDlTmms	ING_8_2	Operate delay time	O	
RsDlTmms	ING_8_2	Reset delay time	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.4.7 NgSeqPTOV

This logical node class is used for neutral sequence overvoltage and has 3 instances inside the device. This logical node class has been included from firmware version 7.50.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TOV PKP
Op	geGeneralACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_3	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.5 PTRC (Protection trip conditioning)

For firmware version 7.00 or higher, this logical node shall be used to connect the operate outputs of one or more protection functions to a common trip to be transmitted to XCBR logical node and has 1 instance inside the device.

PTRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTRC		Trip bus		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Op	geGeneralACT	Operate	M	

2.2.6 PTUV (Undervoltage)

2.2.6.1 phsPTUV

This logical node class is used for phase undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUV		Undervoltage		
Data				

Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TUV PKP
Op	GeneralACT	Operate	M	TUV OP
Blk	SPS	Block	O	TUV BLK
StrPhGn	PhsACD_1	Pickup Phase-Ground	O	
OpPhGn	PhsACT_1	Operate Phase-Ground	O	
StrPhPh	PhsACD_1	Pickup Phase-Phase	O	
OpPhPh	PhsACT_1	Operate Phase-Phase	O	
Settings				
PTUVEna	SPG	Function	O	
InMod	ING_0	Mode	O	
StrVal	IntASG	Start value	O	
TmVCrv	CURVE_2	Operating curve type	O	
TmMult	FloatASG	Time dial multiplier	O	
DeaLinVal	IntASG	Minimum Voltage	O	
PhLogic	ING_0	Logic	O	
BkrMon	SPG	Supervised by 52	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.2.6.2 phsPTUV_2

This logical node class is used for phase undervoltage when setting group option is enabled and has 1 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TUV PKP
Op	GeneralACT	Operate	M	TUV OP
Blk	SPS	Block	O	TUV BLK
StrPhGn	PhsACD_1	Pickup Phase-Ground	O	
OpPhGn	PhsACT_1	Operate Phase-Ground	O	
StrPhPh	PhsACD_1	Pickup Phase-Phase	O	
OpPhPh	PhsACT_1	Operate Phase-Phase	O	
Settings				
PTUVEna	SPG_2	Function	O	
InMod	ING_0_2	Mode	O	
StrVal	IntASG_3	Start value	O	
TmVCrv	CURVE_4	Operating curve type	O	
TmMult	FloatASG_2	Time dial multiplier	O	
DeaLinVal	IntASG_3	Minimum Voltage	O	
PhLogic	ING_0_2	Logic	O	
BkrMon	SPG_2	Supervised by 52	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.6.3 AuxPTUV

This logical node class is used for auxiliary undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Str	GeneralACD	Start	M	TUV PKP
Op	GeneralACT	Operate	M	TUV OP
Blk	SPS	Block	O	TUV BLK
Settings				
PTUVEna	SPG	Function	O	
StrVal	IntASG	Start value	O	
TmVCrv	CURVE_2	Operating curve type	O	
TmMult	FloatASG	Time dial multiplier	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.2.6.3 AuxPTUV_2

This logical node class is used for auxiliary undervoltage when setting group is enabled and has 1 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TUV PKP
Op	geGeneralACT	Operate	M	TUV OP
Blk	geSPS	Block	O	TUV BLK
Settings				
PTUVEna	geSPG_2	Function	O	
StrVal	geIntASG_3	Start value	O	
TmVCrv	geCURVE_4	Operating curve type	O	
TmMult	geFloatASG_2	Time dial multiplier	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.7 PTUF (UnderFrequency)

2.2.7.1 PTUF

This logical node class is used for phase underfrequency and has 6 instances inside the device.

PTUF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTUF		Underfrequency		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	Status-only
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
Str	GeneralACD	Start	M	TUF PKP
Op	GeneralACT	Operate	M	TUF OP
Blk	SPS	Block	O	TUF BLK
BlkV	SPS	Blocked because of voltage	O	
Settings				
StrVal	FloatASG_2	Start value (frequency)	O	
BlkVal	IntASG_3	Voltage block value	O	
OpDlTmms	ING_8_2	Operate delay time	O	
RsDlTmms	ING_8_2	Reset delay time	O	
PTUFEna	SPG_2	Function TUF enable	E	
SnpshtEvEna	SPG_2	Snapshot events enabled	E	
FreqSource	SPG_2	Frequency source	E	

2.2.7.2 PTUF_2

This logical node class is used for phase underfrequency when setting group option is enabled and has 1 instance inside the device.

PTUF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTUF		Underfrequency		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	Status-only
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
Str	GeneralACD	Start	M	TUF PKP
Op	GeneralACT	Operate	M	TUF OP
Blk	SPS	Block	O	TUF BLK
BlkV	SPS	Blocked because of voltage	O	
Settings				
StrVal	FloatASG_2	Start value (frequency)	O	
BlkVal	IntASG_3	Voltage block value	O	
OpDlTmms	ING_8_2	Operate delay time	O	
RsDlTmms	ING_8_2	Reset delay time	O	
PTUFEna	SPG_2	Function TUF enable	E	
SnpshtEvEna	SPG_2	Snapshot events enabled	E	
FreqSource	SPG_2	Frequency source	E	

2.2.8. PTTR (Thermal overload)

This logical node shall be used to model the thermal overload functions and has three instances inside the device. This node has been implemented in firmware version 7.20 or above.

PTTR class				
Attribute Name	Attribute type	Explanation	M/O/C/E	Notes
PTTR		Thermal overload		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	Status-only
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
Str	ACD	Start	M	Thermal PKP
Op	PhsACT	Operate	M	Thermal OP
Blk	SPS	Block	O	Thermal BLK
AlmThm	SPS	Thermal alarm	O	
AlmThmPhA	SPS_1	Thermal alarm phase A	O	
AlmThmPhB	SPS_1	Thermal alarm phase B	O	
AlmThmPhC	SPS_1	Thermal alarm phase C	O	
Settings				
PTTREna	SPG_2	Thermal overload enable	O	
ConsTmmHeat	FloatASG_1_2	Heat time constant	O	
ConsTmmCool	FloatASG_1_2	Cool time constant	O	
StrVal	FloatASG_2	Pickup level	O	
AlmVal	FloatASG_2	Alarm level	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.2.9 PDOP (Directional Overpower)

All logical node classes described in this section have been included from firmware version 7.50.

2.2.9.1 FwdPDOP

This logical node class shall be used to model the forward overpower function and has three instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	Stage 1 PKP
Op	gePhsACT	Operate	M	Stage 1 OP
Blk	geSPS	Block	O	
S2Str	gePhsACD_2	Start	O	Stage 2 PKP
S2Op	gePhsACT_1	Operate	O	Stage 2 OP
Settings				
PDOPEna	geSPG_2	Function	O	
BlkCloseTmms	geING_0_2	Blk time after close	O	
StrVal	geFloatASG_2	Stage 1 Tap	O	
OpDlTmms	geING_8_2	Stage 1 Time	O	
S2StrVal	geFloatASG_2	Stage 2 Tap	O	
S2OpDlTmms	geING_8_2	Stage 2 Time	O	

SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.9.2 DirPDOP

This logical node class shall be used to model the directional overpower function and has three instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS	Block	O	
S1Str	gePhsACD_2	Start	O	Stage 1 PKP
S1Op	gePhsACT_1	Operate	O	Stage 1 OP
S2Str	gePhsACD_2	Start	O	Stage 2 PKP
S2Op	gePhsACT_1	Operate	O	Stage 2 OP
Settings				
PDOPEna	geSPG_2	Function	O	
BlkCloseTmms	geING_0_2	Blk time after close	O	
S1DirPwrAng	geFloatASG_1_2	Dir Power Angle 1	O	
S1StrVal	geFloatASG_1_2	Stage 1 Tap	O	
S1OpDlTmms	geING_0_2	Stage 1 Time	O	
S2DirPwrAng	geFloatASG_1_2	Dir Power Angle 2	O	
S2StrVal	geFloatASG_1_2	Stage 2 Tap	O	
S2OpDlTmms	geING_0_2	Stage 2 Time	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.9.3 WattPDOP

This logical node class shall be used to model the wattmeter ground overpower function and has six instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS	Block	O	
SupStr	gePhsACD_2	Start	O	
Settings				
PDOPEna	geSPG_2	Function	O	
OVStrVal	geFloatASG_1_2	Voltage Pickup Level	O	
InMagTyp	geING_0_2	Current Selection	O	

OCStrVal	geFloatASG_1_2	OC Pickup level	O	
OCStrDlTmms	geING_0_2	OC Pickup Delay	O	
PWStrVal	geFloatASG_1_2	Power Pickup	O	
ChrAng	geFloatASG_1_2	MTA	O	
PWStrDlTmms	geING_0_2	Power Pickup Delay	O	
Curve	geING_0_2	Curve	O	
MltTmms	geING_0_2	Multiplier	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.2.10 PFRC (Frequency Rate of Change)

All logical node classes described in this section have been included from firmware version 7.50.

2.2.10.1 PFRC

This logical node class shall be used to model the frequency rate of change function and has three instances inside the device.

PFRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PFRC		Frequency Rate of Change		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS	Block	O	
Settings				
PFRCEna	geSPG_2	Function	O	
Trend	geING_0_2	Freq Rate Trend	O	
StrVal	geFloatASG_2	Freq Rate Pickup	O	
BlkVal	geFloatASG_2	Freq Rate Min Volt	O	
BlkMinFreq	geFloatASG_1_2	Freq Rate Min Freq	O	
BlkMaxFreq	geFloatASG_1_2	Freq Rate Max Freq	O	
OpDlTmms	geING_8_2	Freq Rate Delay	O	
SnpshtEvEna	geSPG_2	Snapshot events	O	

2.2.11 PDIS (Distance)

All logical node classes described in this section have been included from firmware version 7.50.

2.2.11.1 LodEncPDIS

This logical node class shall be used to model the load encroachment function and has three instances inside the device.

PDIS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDIS		Distance		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS	Block	O	
Settings				
PDISEna	geSPG_2	Function	O	
MinVoltage	geFloatASG_1_2	Freq Rate Trend	O	
RisLod	geFloatASG_2	Freq Rate Pickup	O	
AngLod	geFloatASG_2	Freq Rate Min Volt	O	
OpDlTmms	geING_8_2	Operation Delay	O	
RsDlTmms	geING_8_2	Reset Delay	O	
SnpshtEvEna	geSPG_2	Snapshot events	O	

2.2.12 PRTR (Rotor Protection)

All logical node classes described in this section have been included from firmware version 7.50.

2.2.12.1 LockedPRTR

This logical node class shall be used to model the locked rotor function and has three instances inside the device.

PRTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PRTR		Rotor Protection		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	
Op	geGeneralACT	Operate	M	
Blk	geSPS	Block	O	
Settings				
PRTREna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
LodCurrent	geFloatASG_1_2	Full Load Current	O	
strVal	geFloatASG_2	Pickup Level	O	
OpDlTmms	geING_8_2	Operation Delay	O	
RsDlTmms	geING_8_2	Reset Delay	O	

SnpshtEvEna	geSPG_2	Snapshot events	O	

2.3 Logical Nodes for protection related functions. LN Group: R

2.3.1 RDIR (Directional element)

2.3.1.1 phsRDIR

This logical node class is used for phase directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	PhsACD	Direction	M	
Op	PhsACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	GeneralACT_1	Block Input	O	
Settings				
RDIREna	SPG	Function	O	
ChrAng	FloatASG	Characteristic angle	O	
PolOpMod	ING_0	Direction	O	
BlkMod	ING_0	Block Logic	O	
BlkValV	IntASG	Minimum operating current	O	
VMemTms	FloatASG	Voltage Memory Time	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.3.1.2 phsRDIR_2

This logical node class is used for phase directional elements when setting group option is enabled and has 1 instance inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	PhsACD	Direction	M	
Op	PhsACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	GeneralACT_1	Block Input	O	
Settings				
RDIREna	SPG_2	Function	O	
ChrAng	FloatASG_2	Characteristic angle	O	
PolOpMod	ING_0_2	Direction	O	
BlkMod	ING_0_2	Block Logic	O	
BlkValV	IntASG_3	Minimum operating current	O	

VMemTms	FloatASG_1_2	Voltage Memory Time	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.3.1.3 ndRDIR

This logical node class is used for neutral directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	NeutACD	Direction	M	
Op	NeutACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	NeutACT_1	Block Input	O	
Settings				
RDIREna	SPG	Function	O	
ChrAng	FloatASG	Characteristic angle	O	
PolOpMod	ING_0	Direction	O	
PolQty	ENG	Polarizing quantity	O	
BlkMod	ING_0	Block Logic	O	
BlkValV	IntASG	Minimum operating current	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.3.1.4 ndRDIR_2

This logical node class is used for neutral directional elements when setting group option is enable and has 1 instance inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	NeutACD	Direction	M	
Op	NeutACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	NeutACT_1	Block Input	O	
Settings				
RDIREna	SPG_2	Function	O	
ChrAng	FloatASG_2	Characteristic angle	O	
PolOpMod	ING_0_2	Direction	O	
PolQty	ENG_2	Polarizing quantity	O	
BlkMod	ING_0_2	Block Logic	O	
BlkValV	IntASG_3	Minimum operating current	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.3.1.5 gndRDIR

This logical node class is used for ground directional elements and has 3 instances inside the device

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	NeutACD	Direction	M	
Op	NeutACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	NeutACT_1	Block Input	O	
Settings				
RDIREna	SPG	Function	O	
ChrAng	FloatASG	Characteristic angle	O	
PolOpMod	ING_0	Direction	O	
PolQty	ENG	Polarizing quantity	O	
BlkMod	ING_0	Block Logic	O	
BlkValV	IntASG	Minimum operating current	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.3.1.6 gndRDIR_2

This logical node class is used for ground directional elements when setting group option is enabled and has 1 instance inside the device

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	NeutACD	Direction	M	
Op	NeutACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	NeutACT_1	Block Input	O	
Settings				
RDIREna	SPG_2	Function	O	
ChrAng	FloatASG_2	Characteristic angle	O	
PolOpMod	ING_0_2	Direction	O	
PolQty	ENG_2	Polarizing quantity	O	
BlkMod	ING_0_2	Block Logic	O	
BlkValV	IntASG_3	Minimum operating current	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.1.7 hseRDIR

This logical node class is used for sensitive ground directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	GeneralACD	Direction	M	
Op	GeneralACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	GeneralACT_1	Block Input	O	
Settings				
RDIREna	SPG	Function	O	
ChrAng	FloatASG	Characteristic angle	O	
PolOpMod	ING_0	Direction	O	
BlkMod	ING_0	Block Logic	O	
BlkValV	IntASG	Minimum operating current	O	
SnpshtEvEna	SPG	Snapshot events enabled	O	

2.3.1.8 hseRDIR_2

This logical node class is used for sensitive ground directional elements when setting group option is enabled and has 1 instance inside the device. This logical node class is available only for firmware version below 7.50.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Dir	GeneralACD	Direction	M	
Op	GeneralACT	Operate	O	
Blk	SPS	Block	O	
BlkIn	GeneralACT_1	Block Input	O	
Settings				
RDIREna	SPG_2	Function	O	
ChrAng	FloatASG_2	Characteristic angle	O	
PolOpMod	ING_0_2	Direction	O	
BlkMod	ING_0_2	Block Logic	O	
BlkValV	IntASG_3	Minimum operating current	O	
SnpshtEvEna	SPG_2	Snapshot events enabled	O	

2.3.2 RREC (Autoreclosing)

This logical node class is used for autorecloser and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RREC		Autoreclosing Element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
OpCls	GeneralACT	Direction	M	
AutoRecSt	AutoRecStENS	Operate	M	
AutoRecLo	INS_1	Block	O	
AutoRecBlk	INS_1	Block Input	O	
RecCyc	INS	Actual Reclose Cycle	O	
Settings				
RRECEna	SPG	Function	O	
MaxNumShot	ING_0	Max. Number Shots	O	
Rec1Tmms1	ING_8	Dead Time 1	O	
Rec1Tmms2	ING_8	Dead Time 2	O	
Rec1Tmms3	ING_8	Dead Time 3	O	
Rec1Tmms4	ING_8	Dead Time 4	O	
RclTmms	ING_8	Reclaim time		
CondEna	SPG	Cond. Permission		
HoldTmms	FloatASG_1	Hold Time		
RsTmms	FloatASG_1	Reset Time		

2.3.3 RBRF (Breaker failure):

For firmware versions 7.00 or higher, this logical node class is used for breaker failure and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RBRF		Breaker failure element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
OpEx	GeneralACT	Direction	M	

2.3.4 RFLO (Fault Locator):

For firmware version 7.00 or higher, this logical node class is used for fault locator and has 1 instance inside the device.

RFLO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RFLO		Fault locator element		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
FltRprtTrg	SPS_1	Fault Report Trigger	O	
ClrFltRprts	SPS_1	Clear fault reports	O	
FltZ	FloatCMV	Fault impedance	M	
FltDiskm	FloatMV_3	Fault distance in km	O	
RPriFlt	FloatMV_2	Primary Fault Resistance	O	
XPriFlt	FloatMV_2	Primary Fault Reactance	O	
RSeFlt	FloatMV_2	Secondary Fault Resistance	O	
XSeFlt	FloatMV_2	Secondary Fault Reactance	O	
RFault	FloatMV_2	Fault Resistance	O	
FltTyp	INS_1	Fault type	O	
FltRprtNum	INS_1	Fault report number	O	
PreFltIaMod	FloatMV_2	Prefault Ia module	O	
PreFltIaAng	FloatMV_2	Prefault Ia angle	O	
PreFltIbMod	FloatMV_2		O	
PreFltIbAng	FloatMV_2		O	
PreFltIcMod	FloatMV_2		O	
PreFltIcAng	FloatMV_2		O	
PreFltIgMod	FloatMV_2		O	
PreFltIgAng	FloatMV_2		O	
PreFltIsgMod	FloatMV_2		O	
PreFltIsgAng	FloatMV_2		O	
PreFltVabMod	FloatMV_2		O	
PreFltVabAng	FloatMV_2		O	
PreFltVbcMod	FloatMV_2		O	
PreFltVbcAng	FloatMV_2		O	
PreFltVcaMod	FloatMV_2		O	
PreFltVcaAng	FloatMV_2		O	
PstFltIaMod	FloatMV_2	Postfault Ia module	O	
PstFltIaAng	FloatMV_2	Postfault Ia angle	O	
PstFltIbMod	FloatMV_2		O	
PstFltIbAng	FloatMV_2		O	
PstFltIcMod	FloatMV_2		O	
PstFltIcAng	FloatMV_2		O	
PstFltIgMod	FloatMV_2		O	
PstFltIgAng	FloatMV_2		O	
PstFltIsgMod	FloatMV_2		O	
PstFltIsgAng	FloatMV_2		O	
PstFltVabMod	FloatMV_2		O	
PstFltVabAng	FloatMV_2		O	
PstFltVbcMod	FloatMV_2		O	
PstFltVbcAng	FloatMV_2		O	
PstFltVcaMod	FloatMV_2		O	
PstFltVcaAng	FloatMV_2		O	
Settings				

RFLOEna	SPG	Function		
Z1Mod	FloatASG_1	Pos.Seq. Module		
Z1Ang	IntASG_1	Pos.Seq. Angle		
Z0Mod	FloatASG_1	Zero Seq. Module		
Z0Ang	IntASG_1	Zero Seq. Angle		
LinLenkm	FloatASG	Line length		
ShwFltHMI	SPG	Show fault in HMI		
SnpshtEvEna	SPG	Snapshot Events enabled		
PhCtPol	SPG	Phase CT Polarity		
PhCtCon	ENG_5	Phase CT Connections	O	

2.3.5 RBDR (Disturbance recorder channel binary):

This node has been implemented in firmware version 7.20. This logical node class is used for providing the circuit component and phase identification and has 1 instance inside the device. RBDR and RDRE logical nodes make available all attributes needed for the COMTRADE file.

RBDR class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
RBDR		Disturbance recorder channel binary		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	Status-only
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
ChTrg	SPS	Channel triggered	M	
DigCh01	SPS_1		O	
...	...	...	...	
DigChn16	SPS_1		O	

2.3.6 RDRE (Disturbance recorder function)

This logical node has been developed in firmware 7.20. This logical node class is used modeling the disturbance recording function and has 1 instance inside the device. RBDR and RDRE logical nodes make available all attributes needed for the COMTRADE file.

RDRE class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
RDRE		Disturbance recorder channel binary		
Data				
Common Logical Node Information				
Mod	ENC	Mode	M	Status-only
Beh	ENS	Behavior	M	
Health	ENS	Health	M	
NamPlt	LPL	Name Plate	M	
Status information				
RcdMade	SPS	Recording made	M	
FltNum	INS	Fault number	M	
OscTrg	SPS	Oscillo trigger	E	
CycRcd	INS	Cycles per record	E	
RcdNum	INS	Available records	E	
Controls				
RcdTrg	geSPC_1	Trigger Recorder	M	
Settings				
RDREEna	SPG	Oscillography function enable	E	

TrgPos	ING	Trigger position	E	
SmpCyc	ENG	Samples per cycle	E	
MaxNumRcd	ING	Maximum number of records	O	
RcdMod	ENG	Recorder operation mode	O	
SnpshtEvEna	SPG	Snapshot events enabled	E	

2.3.7 RSYN (Synchronism-check)

This logical node has been included from firmware 7.50. This logical node class is used modeling the synchrocheck function and has 1 instance inside the device

RSYN class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RSYN		Synchronism-check		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Blk	geSPS	Block signal	O	
SynOp	geSPS_1	Closing permission signal	O	
Rel	geSPS	Release	M	
SynCondOp	geSPS_1	Closing perm. according to logic	O	
DLDBOp	geSPS_1	Closing perm. in DLDB condition	O	
DLLBOp	geSPS_1	Closing perm. in DLLB condition	O	
LLDBOp	geSPS_1	Closing perm. in LLDB condition	O	
HzInd	geSPS	Frequency difference indicator	O	
BusHzHiLinHz	geSPS_1	Busbar frequency > line frequency	O	
BusHzLoLinHz	geSPS_1	Busbar frequency < line frequency	O	
Measured values				
DifVClc	geFloatMV	Calculated difference in voltage	O	
DifHzClc	geFloatMV	Calculated difference in frequency	O	
DifAngClc	geFloatMV	Calculated difference in angle	O	
Settings				
RSYNEna	geSPG	Function	O	
DeaBusVal	geFloatASG	Dead bus value	O	
LivBusVal	geFloatASG	Live bus value	O	
DeaLinVal	geFloatASG	Dead line value	O	
LivLinVal	geFloatASG	Live line value	O	
DifV	geFloatASG	Difference voltage	O	
DifAng	geFloatASG	Difference angle	O	
DifHz	geIntASG	Difference frequency	O	
TotTmms	geING_8	Total time of synch. process	O	
DLDBEna	geSPG	Dead line - dead bus permission	O	
LLDBEna	geSPG	Live line - dead bus permission	O	
DLLBEna	geSPG	Dead line - live bus permission	O	
SnpshtEvEna	geSPG	Snapshot events enabled	O	

2.4 Logical Nodes for control. LN Group: C

2.4.1 CILO (Interlocking):

For firmware version 7.00 or higher, this logical node class is used for interlocking the operations performed over the switchgears and has 16 instances inside the device.

CILO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
CILO		Switch controller		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
EnaOpn	SPS	Enable Open	M	
EnaCls	SPS	Enable Close	M	

2.4.2 CSWI (Switch controller)

This logical node class is used for switchgears status and has 16 instances inside the device.

CSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CSWI		Switch controller		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	Status-only
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Controls				
Pos	DPC_3	Switch position	M	Switch open, close, undefined
Status Information				
Loc	SPS	Local control behavior	O	Local/Remote For firmware version 7.20 or above

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to all switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN.

- In CSWI LN for "Pos" controllable attribute all possible control models are applicable:
- "direct-control-with-normal-security"
- "SBO-control-with-normal-security"
- "direct-control-with-enhanced-security"
- "SBO-control-with-enhanced-security"

The sboTimeout attribute for Pos is configurable in a range from 500 ms to 60 seconds.

The sboClass attribute for Pos can only have value "0" (operate-once).

2.5 Logical Nodes for generic references. LN Group: G

2.5.1 GGIO (Generic process I/O)

2.5.1.1 GGIO

This logical node class is used to map digital and analogue inputs of I/O boards F, G, H and J: 4 instances in Control LDevice.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
BoardSt	SPS_1	Board status	O	
Ind1	SPS	Status contact input 1	O	
Ind2	SPS	Status contact input 2	O	
..	..	..	..	
Ind32	SPS	Status contact input 32	O	
Ind33	SPS	Status contact output 1	O	
..	..		..	
Ind48	SPS	Status contact output 16	O	
Measured and metered values				
AnIn1	FloatMV	Analog input 1	O	
AnIn2	FloatMV	Analog input 2	O	
..	..		..	
AnIn8	FloatMV	Analog input 8	O	
Settings				
VThrldA	IntASG_1	Voltage threshold A	O	
VThrldB	IntASG_1	Voltage threshold B	O	
VThrldC	IntASG_1	Voltage threshold C	O	
VThrldD	IntASG_1	Voltage threshold D	O	
DbceTmmsA	ING_0	Debounce time A	O	
DbceTmmsB	ING_0	Debounce time B	O	
DbceTmmsC	ING_0	Debounce time C	O	
DbceTmmsD	ING_0	Debounce time D	O	
InTyp01	ING_0	Type input 1	O	
InTyp02	ING_0	Type input 2	O	
..	..	..	..	
InTyp32	ING_0	Type input 32	O	
DlInTmms01	ING_0	Delay time input 1	O	
DlInTmms02	ING_0	Delay time input 2	O	
..	..	..	..	
DlInTmms32	ING_0	Delay time input 32	O	
OutLogic01	ING_0	Logic output 1	O	
OutLogic02	ING_0	Logic output 2	O	
..	..	..	..	
OutLogic16	ING_0	Logic output 16	O	
OutTyp01	ING_0	Type output 1	O	
OutTyp02	ING_0	Type output 2	O	
..		..	..	
OutTyp16	ING_0	Type output 16	O	
PlsOutTmms01	ING_0	Pulse time output 1	O	
PlsOutTmms02	ING_0	Pulse time output 2	O	
..	..		..	
PlsOutTmms16	ING_0	Pulse time output 16	O	

Rng01	ING_0	Range analog input 1	O	
Rng02	ING_0	Range analog input 2	O	
..	..	..	..	
Rng08	ING_0	Range analog input 8	O	
OscTmmsA	ING_0	Oscillation time A	O	
OscTmmsB	ING_0	Oscillation time B	O	
OscTmmsC	ING_0	Oscillation time C	O	
OscTmmsD	ING_0	Oscillation time D	O	
NumChgs	ING_0	Number of transient changes	O	
SnpshtEvEna	SPG	Snapshot Events enabled	O	

2.5.1.2 vinGGIO

This logical node class is used is used to map the latched and self reset virtual Inputs.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	Status-only
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
DPCSO01	geDPC	Double point controllable status output	O	Latched Virtual Input 1, 2
DPCSO02	geDPC	Double point controllable status output	O	Latched Virtual Input 3, 4
..	..	..	..	..
DPCSO16	geDPC	Double point controllable status output	O	Latched Virtual Input 31, 32
SPCSO01	SPC	Single point controllable status output	O	Latched Virtual Input 1
SPCSO02	SPC	Single point controllable status output	O	Latched Virtual Input 2
..	..	..	..	..
SPCSO32	SPC	Single point controllable status output	O	Latched Virtual Input 32
SPCSO33	SPC	Single point controllable status output	O	Self reset Virtual Input 1
SPCSO34	SPC	Single point controllable status output	O	Self reset Virtual Input 2
..	..	..	..	..
SPCSO64	SPC	Single point controllable status output	O	Self reset Virtual Input 32

Note:

Double control points operate on pairs of Virtual Inputs in a manner that one Virtual Input of the pair is set to "1" and the other Virtual Input of the pair is set to "0".

For all controllable attributes in this logical node only "direct-control-with-normal-security" model of control is applicable

2.5.1.3 eveGGIO

This logical node class is used to map data from the list of any all internal digital states (PLC control events).

GGIO class				
Attribute Name	**Attribute Type**	Explanation	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	Status-only
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
Ind1	SPS	General Indication (binary input)	O	Control Event 1
Ind2	SPS	General Indication (binary input)	O	Control Event 2
.....	.....	.....	.....	.....
Ind128	SPS	General Indication (binary input)	O	Control Event 128
Ind129	SPS	General Indication (binary input)	O	Switchgear 1 event 1
Ind130	SPS	General Indication (binary input)	O	Switchgear 1 event 2
Ind131	SPS	General Indication (binary input)	O	Switchgear 1 event 3
Ind132	SPS	General Indication (binary input)	O	Switchgear 1 event 4
Ind133	SPS	General Indication (binary input)	O	Switchgear 2 event 1
.....	.....	.....	.....	.....
Ind192	SPS	General Indication (binary input)	O	Switchgear 16 event 4

2.5.1.4 geRemoteInputsGGIO

This logical node class is used to map data from incoming GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
Ind1	SPS	Remote digital input 1	O	
Ind2	SPS	Remote digital input 2	O	
..	..	..	..	
Ind64	SPS	Remote digital input 32	O	

AnIn1	FloatMV	Remote float input 1	O	
AnIn2	FloatMV	Remote float input 2	O	
..	..	..	..	
AnIn8	FloatMV	Remote float input 8	O	
AnIn9	IntMV_1	Remote integer input 1	O	
AnIn10	IntMV_1	Remote integer input 2	O	
..	..	..	..	
AnIn16	IntMV_1	Remote integer input 8	O	
Settings				
OscTmms	ING_0	Oscillation time remote inputs	O	
NumChgs	ING_0	Number of transient changes	O	
InRef1	ORG_1	Remote digital input 1	O	
InRef64	ORG_1	Remote digital input 64	O	
InRef65	ORG_1	Remote analog input 1	O	
InRef80	ORG_1	Remote analog input 16	O	

2.5.1.5 geRemoteOutputsGGIO

This logical node class is used to map PLC digital states for outgoing GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
Ind1	SPS	Remote digital output 1	O	
Ind2	SPS	Remote digital output 2	O	
..	..	..	..	
Ind32	SPS	Remote digital output 32	O	

Note: In 650 relays data from all logical nodes can be sent through outgoing GOOSE messages. Apart from that, logical node rouGGIO gives the ability to send through GOOSE digital states that are results of PLC logic equations. Mapping and configuration of rouGGIO states should be done with EnerVista 650 software.

2.5.1.6 dcntGGIO:

For versions 7.00 or higher, this logical node is used for modeling the eight digital counters of F650 relay.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	

NamPlt	LPL	Name plate	M	
Status information				
Cnt1	BCR_2	Digital counter 1	O	
..	..	..	..	
Cnt8	BCR_2	Digital counter 8	O	
CntBlk1	SPS_1	Digital counter 1 block	O	
..	..	..		
CntBlk8	SPS_1	Digital counter 8 block	O	
CntHi1	SPS_1	Digital counter 1 high	O	
..	..	..		
CntHi8	SPS_1	Digital counter 8 high	O	
CntEq1	SPS_1	Digital counter 1 equal	O	
..	..	..		
CntEq8	SPS_1	Digital counter 8 equal	O	
CntLo1	SPS_1	Digital counter 1 low	O	
..	..	..		
CntLo8	SPS_1	Digital counter 8 low	O	
CntUp1	SPS_1	Digital counter 1 up	O	
..	..	..		
CntUp8	SPS_1	Digital counter 8 up	O	
CntDwn1	SPS_1	Digital counter 1 down	O	
..	..	..		
CntDwn8	SPS_1	Digital counter 8 down	O	
CntSetPre1	SPS_1	Digital counter 1 set preset	O	
..	..	..		
CntSetPre8	SPS_1	Digital counter 8 set preset	O	
CntRst1	SPS_1	Digital counter 1 reset	O	
..	..	..		
CntRst8	SPS_1	Digital counter 8 reset	O	
CntFrzRst1	SPS_1	Digital counter 1 FreezeReset	O	
..	..	..		
CntFrzRst8	SPS_1	Digital counter 8 FreezeReset	O	
CntFrzCnt1	SPS_1	Digital counter 1 FreezeCount	O	
..	..	..		
CntFrzCnt8	SPS_1	Digital counter 8 FreezeCount	O	

2.5.1.7 vouGGIO (gevouGGIO) --> virtual outputs: 1 instance in Control LDevice

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
AnOutInt1	geIntMV_2	Virtual Output Analogue Int32 1	O	
..	..	..	..	
AnOutInt50	geIntMV_2	Virtual Output Analogue Int32 50	O	
AnOutF1	geFloatMV_5	Virtual Output Analogue Flt32 1	O	

..	..	..		
AnOutF50	geFloatMV_5	Virtual Output Analogue Flt32 50	O	

2.6 Logical Nodes for metering and measurement. LN Group: M

2.6.1 MMTR (Metering) MMTR (geMMTR) --> pulse counters (MMTR1) and energy calculation (MMTR2): 2 instances in Control LDevice

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR		Measurement		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Measured values				
SupWh	BCR	Pulse Counter 1/Real energy supply	O	
SupVArh	BCR	Pulse Counter 2/Reactive energy supply	O	
DmdWh	BCR	Pulse Counter 3/Real energy demand	O	
DmdVArh	BCR	Pulse Counter 4/Reactive energy demand	O	
CntPsWh	FloatMV_1	Positive Wat Counter	O	
CntNgWh	FloatMV_1	Negative Wat Counter	O	
CntPsVArh	FloatMV_1	Positive VAR Counter	O	
CntNgVArh	FloatMV_1	Negative VAR Counter	O	

2.6.2 MMXU (Measurement) measurement analogue values: 1 instance in Control LDevice

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU		Measurement		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Measured values				
TotW	FloatMV	Total active power (P)	O	
TotVAr	FloatMV	Total reactive power (Q)	O	
TotVA	FloatMV	Total apparent power (S)	O	
TotPF	FloatMV	Average power factor (PF)	O	
Hz	FloatMV	Line Frequency	O	
PPV	FloatDEL	Phase to phase voltages (VL1L2,...)	O	
PhV	FloatPhsWYE	Phase to ground voltages (VL1ER, ...)	O	
A	FloatWYE	Phase currents (IL1, ...)	O	
AuxV	FloatCMV_1	Auxiliary Phase Voltage	O	
BusHz	FloatMV_1	Bus Frequency	O	
MaxDmdTotW	geFloatMV_1	Demand W Max	O	
MinDmdTotW	geFloatMV_1	Demand W Min	O	
MaxDmdTotVAr	geFloatMV_1	Demand VAr Max	O	
MinDmdTotVAr	geFloatMV_1	Demand VAr Min	O	
MaxDmdTotVA	geFloatMV_1	Demand VA Max	O	
MinDmdTotVA	geFloatMV_1	Demand VA Min	O	

2.6.3 MSQI (Sequence and imbalance) - MSQI (geMSQI) --> sequence and imbalance analogues values: 1 instance in Control LDevice

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MSQI		Measurement		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Measured values				
SeqA	FloatSEQ		O	
SeqV	FloatSEQ		O	

2.7 Logical Nodes for switchgear. LN Group: X

2.7.1 XCBR (Circuit Breaker) - XCBR (geXCBR) --> circuit breaker: 1 instance in Control LDevice

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Descriptions				
EEName	geDPL	External equipment name plate	M	
Status information				
Loc	SPS	Local operation	M	Local / Remote
OpCnt	INS	Operation counter	M	Breaker openings
SumSwARs			O	
CBOpCap	CBOpCapENS	Circuit breaker operating capability	O	
Controls				
Pos	DPC_1	Switch position	M	Breaker open, close
BlkOpn	SPC_1	Block opening	M	Virtual output
BlkClr	SPC_1	Block closing	M	Virtual output
Settings				
ThAlSwA	FloatASG_1	Maximum KI2t	O	
SumSwATmms	FloatASG_1	KI2t Integ. Time	O	
ExNumTr	IntASG_1	Maximum Openings	O	
ExNumTr1hr	IntASG_1	Max.Openings 1 hour	O	

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to all switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN.

In F650 relay the Circuit Breaker (XCBR1 Logical Node) by default is mapped to first switchgear (exactly like XSWI1 and CSWI1 LNs). However it is possible to map the Circuit Breaker to any of the 16 switchgears of F650 relay. It can be done by modification of the following setting: **Setpoint > System Setup > Breaker Settings > Number of Switchgear**.

In XCBR LN for "Pos" controllable attribute all possible control models are applicable:

- "direct-control-with-normal-security"
- "SBO-control-with-normal-security"
- "direct-control-with-enhanced-security"
- "SBO-control-with-enhanced-security"

The sboTimeout attribute for Pos is configurable in a range from 500 ms to 60 seconds.

The sboClass attribute for Pos can only have value "0" (operate-once).

2.7.2 XSWI (Circuit switch)

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to all switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN. "Pos" attribute is not controllable in XSWI it has ctlModel = Status-only. In order to control the switch mapped to given XSWI the corresponding CSWI LN should be used.

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Descriptions				
EEName	geDPL	External equipment name plate	M	
Status information				
Loc	SPS	Local operation	M	Local / Remote
EEHealth	EEHealthENS	Ext. equipment health	O	
OpCnt	INS	Operation counter	M	Breaker openings
Controls				
Pos	DPC_3	Switch position	M	Breaker open, close
BlkOpn	SPC_1	Block opening	M	Virtual output
BlkCls	SPC_1	Block closing	M	Virtual output
SwTyp	SwTypENS	Switch type	M	
SwOpCap	SwOpCapENS	Switch operating capability		

2.8 Logical Nodes for supervision and monitoring. LN Group: S

2.8.1 SCBR (Circuit breaker supervision)

SCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**

SCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	ModENC	Mode	M	
Beh	BehENS	Behavior	M	
Health	HealthENS	Health	M	
NamPlt	LPL	Name plate	M	
Status information				
ColOpn	geSPS	Open command of trip coil	M	
AbrAlm	geSPS	Contact abrasion alarm	O	
OpTmOpnAlm	geSPS_1	Opening time exceed	O	
OpTmClsAlm	geSPS_1	Closing time exceed	O	
Measured values				
AccAbr	geFloatMV_4	Cumulated abrasion	O	
OpTmOpn	geFloatMV_4	Operation time open	O	
OpTmCls	geFloatMV_4	Operation time close	O	

3. Common Data Class

3.1 Common Data Class for status information

3.1.1 Single Point Status (SPS)

SPS class (Single point status)					
gsSPS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geSPS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.2 Integer Status (INS)

INS class (Integer status)					
geINS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	INT32	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					

d	Vstring255	DC			O
geINS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.3 Enumerated Status (ENS)

ENS class (Enumerated status)					
geAutoRecStENS (AutoRecSt)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dchg	Ready,InProgress,Successful,..	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geBehENS (Beh)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dchg	On,blocked,test,test/blocked,Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geHealthENS (Health)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geEEHealthENS (EEHealth)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	INT32	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geCBOpCapENS (CBOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enumerated	ST	dchg	None,Open,Close-Open,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geSwOpCapENS (SwOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enumerated	ST	dchg	None,Open,Close,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M

Configuration, Description And Extension					
d	Vstring255	DC			O
geSwTypENS (SwTyp)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enumerated	ST	dchg	Load Break,Disconnector,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.1.4 Protection activation information (ACT)

ACT class (Protection activation information)					
gePhsACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
gePhsACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
geNeutACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**

DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
geGeneralACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.5 Directional protection activation information (ACD)

ACD class (Directional protection activation information)					
gePhsACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
gePhsACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geNeutACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O

dataNs	Vstring255	EX			AC_DLN_M
geGeneralACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.1.6 Binary counter reading (BCR)

BCR class (Binary counter reading)					
geBCR					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
control and status					
actVal	Int64	ST	Dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
units	Unit	CF			O
pulsQty	Float32	CF			M
d	Vstring255	DC			O
geBCR_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
geBCR_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1

frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2 Common data class specifications for measured information

3.2.1 Measured Value (MV)

MV class (Measured value)					
geFloatMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	FloatAnalogueValue				
	FLOAT32				GC_1
	INT32U				
d	Vstring255	DC			O
geFloatMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O

zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	FloatAnalogueValue				
	FLOAT32				GC_1
	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
geIntMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
d	Vstring255	DC			O

geIntMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	IntAnalogueValue				
i	INT32U				GC_1
hlim	IntAnalogueValue				
i	UINT32				GC_1
lLim	IntAnalogueValue				
i	INT32U				GC_1
llLim	IntAnalogueValue				
i	INT32U				GC_1
min	IntAnalogueValue				
i	INT32U				GC_1
max	IntAnalogueValue				
i	INT32U				GC_1
limDb	IntAnalogueValue				
	INT32U				GC_1
	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2.2 Complex Measured Value (CMV)

CMV class (Complex measured value)					
geFloatCMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O

zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
geFloatCMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

3.2.3 Phase to ground related measured values of a three phase system (WYE)

WYE class					
geFloatPhsWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
Configuration, Description And Extension					
d	Vstring255	DC			O
geFloatWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
net	CMV_0				GC_1
res	CMV_0				GC_1
Configuration, Description And Extension					
d	Vstring255	DC			O

3.2.4 Phase to phase related measured values of a three phase system (DEL)

DEL class (Phase to phase related measured values of a three phase system)					
geFloatDEL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsAB	CMV_0				GC_1
phsBC	CMV_0				GC_1
phsCA	CMV_0				GC_1
Configuration, Description And Extension					
d	Vstring255	DC			O

3.2.5 Sequence (SEQ)

SEQ class (Sequence)					
geFloatSEQ					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
c1	CMV_0				GC_1
c2	CMV_0				GC_1
c3	CMV_0				GC_1
Measured Attributes					
seqT	enumerated	MX		Pos-neg-zero | dir-quad-zero	O
Configuration, Description And Extension					
d	Vstring255	DC			O

3.3 Common data class specifications for controllable status information

3.3.1 Controlable single point (SPC).

SPC class						
geSPC						
Attribute Name		Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute						
Control And Status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF		ctlModel	M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geSPC_1						
Attribute Name		Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute						
Control And Status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
Q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF		ctlModel_1	M
d		Vstring255	DC			O

3.3.2 Controllable double point (DPC)

DPC class (Controllable double point)						
geDPC						
Attribute Name		Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute						
Control And Status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
Configuration, Description And Extension						

ctlModel		ENUMERATED	CF			M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geDPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
Control And Status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Cancel						
SBO						
SBOw						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF			M
sboTimeout		INT32U	CF			AC_CO_O
sboClass		ENUMERATED	CF			AC_CO_O
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
geDPC_2						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
Control And Status						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF			M
d		Vstring255	DC			O

3.3.3 Controllable enumerated status (ENC).

ENC class (Controllable integer status)					
geModENC (type Mod)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dcgh		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.4 Common data class specifications for status settings

3.4.1 Single point setting (SPG)

SPG class					
geSPG					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Setting					
setVal	Boolean	SP			AC_NSG_M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geSPG_1					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.4.2 Integer status setting (ING)

ING class					
geING_0					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Setting					
setVal	Boolean	SP			AC_NSG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_0_2					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_8					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Setting					
setVal	Boolean	SP			AC_NSG_M
Configuration, Description And Extension					

minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_8_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O

3.4.3 Enumerated status setting (ENG)

ENG class					
geENG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Enumerated	SP		PolQty	AC_NSG_M
Configuration, Description And Extension					
d	Vstring255	DC			O
geENG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.4.4 Object reference setting

ORG class					
geORG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setSrcRef	ObjectReference	SP		Object reference	M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.5 Common data class specifications for analogue settings

3.5.1 Analogue setting (ASG)

ASG class					
geIntASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geIntASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SG			AC_SG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geFloatASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1

Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
geFloatASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geFloatASG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SG			AC_SG_M
f	FLOAT32				GC_1
Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O

3.6 Common data class specifications for description information

3.6.1 Device name plate (DPL)

DPL class (Device name plate)					
geDPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
vendor	Vstring255	DC			M
hwRev	Vstring255	DC			O
swRev	Vstring255	DC			O
serNum	Vstring255	DC			O
model	Vstring255	DC			O

3.6.2 Logical node name plate (LPL)

LPL class (Logical node name plate)					
geLPL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
geLPL_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
ldNs	Vstring255	EX			O

7.3.7.3.6 MICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **MICS For F650 relay V1_4 firm7_52**.

This model implementation conformance statement is applicable for F650 Bay Controller, with firmware 7.52.

This MICS document specifies the modeling extensions compared to IEC 61850 edition 1. For the exact details on the standardized model please compare the ICD substation configuration file: “<F650_6SG_v752_Ed1.icd>”, version <1.0>.

This document describes the:

- Logical Nodes List
- Logical Nodes and Extensions
- Enum types implementation

1 Logical Node List

The following table contains the list of logical nodes implemented in the device:

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
LGOS (GOOSE subscription)
GoCB (GOOSE Control Block Class definition)
P: Logical Nodes for protection functions
PIOC (Instantaneous overcurrent)
PTOC (Time overcurrent)
PTOF (Overfrequency)
PTOV (Overvoltage)
PTRC (Protection trip conditioning)
PTTR (Thermal overload)
PTUV (Undervoltage)
PTUF (Underfrequency)
PDOP (Power)
PFRC (Frequency Rate of Change)
PDIS (Load Encroachment)
R: Logical nodes for protection related functions
RBDR (Disturbance recorder channel binary)
RBRF (Breaker failure)
RDIR (Directional element)
RDRE (Disturbance recorder function)
RFLO (Fault Locator)
RREC (Autoreclosing)
RSYN (Synchrocheck)
C: Logical Nodes for control
CILO (Interlocking)
CSWI (Switch controller)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMTR (Metering)
MMXU (Measurement)
MSQI (Sequence and imbalance)

X: Logical Nodes for switchgear
XCBR (Circuit breaker)
XSWI (Circuit switch)

2 Logical Nodes and Extensions

Notation:

- M: Data is mandatory in the IEC-61850-7-4.
- O: Data is optional in the IEC-61850-7-4 and is used in the device.
- E: Data is an extension to the IEC-61850-7-4.

2.1 System Logical Nodes. LN Group: L

2.1.1 LPHD (Physical device information)

LPHD class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LPHD		Physical device information	M	
Data				
Common Logical Node Information				
PhyNam	geDPL	Physical device name plate	M	
PhyHealth	geHealthINS	Physical device health	M	
Proxy	geSPS	Indicates if this LN is a proxy	M	

2.1.2 LLN0 (Logical node zero)

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL_1	Name plate	M	
Loc	geSPS	Local control behavior	O	
OpTmh	geINS	Operation time	O	
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			

2.1.3 LGOS (GOOSE subscription)

This LN Logical is used for monitoring GOOSE messages, diagnosing the subscription state of a GOOSE message and has 24 instances inside the device

LLN0 class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LLN0		Logical node zero		
Data				
Common Logical Node Information				

Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
St	geSPS	Status of the subscription	M	
LastStNum	geINS	Last state number received	O	
ConfRevNum	geINS	Expected conf. revision num.	O	
GoCBRef	geORG	Ref. to the subscribed GOOSE control block	O	

2.1.4 GoCB (GOOSE control block class definition)

GoCB class			
Attribute Name	**Attribute Type**	**FC**	**Notes**
GoEna	BOOLEAN	GO	Enable (TRUE), disable (FALSE)
GoID	VISIBLE STRINGS	GO	
DatSet	Object Reference	GO	
ConfRev	INT32U	GO	
NdsCom	BOOLEAN	GO	
DstAddress	PHYCOMADDR	GO	

2.2 Logical Nodes for protection functions. LN Group: P

2.2.1 PIOC (Instantaneous overcurrent)

2.2.1.1 gePhsPIOC_2

This logical node class is used for phase instantaneous overcurrent and has 6 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS_1	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.1.2 geNdPIOC_2

This logical node class is used for neutral instantaneous overcurrent and has 3 instances inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	IOC PKP
Op	geNeutACT	Operate	M	IOC OP
Blk	geSPS_1	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.1.3 geGndPIOC_2

This logical node class is used for ground instantaneous overcurrent (3 instances) and sensitive ground instantaneous overcurrent (3 instances). There are 6 instances this logical node inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS_1	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.1.4 IsoGndPIOC_2

This logical node class is used for Isolated sensitive ground instantaneous overcurrent. There are 3 instances this logical node inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS_1	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
VhStr	geIntASG_2	Vh level	O	
VlStr	geIntASG_2	Vl level	O	
IhStr	geFloatASG_1_2	Ih level	O	
IlStr	geFloatASG_1_2	Il level	O	
OpDlTmms	geING_8_2	Trip delay	O	
RsDlTmms	geING_8_2	Reset delay	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.1.5 geBknCndPIOC_2

This logical node class is used for broken conductor instantaneous overcurrent. There are 3 instances this logical node inside the device.

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	IOC PKP
Op	gePhsACT	Operate	M	IOC OP
Blk	geSPS	Block	O	
Settings				
PIOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
OpDlTmms	geING_8_2	Trip delay	O	
BlkCurrent	geFloatASG_1_2	Operation Threshold	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.2 PTOC (Time overcurrent)

2.2.2.1 gePhsPTOC_2

This logical node class is used for phase time overcurrent and has 6 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS_1	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
TmACrv	geCURVE_3	Curve	O	
StrVal	geFloatASG_2	Pickup level	O	
VolRst	geSPG_2	Voltage Restraint	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.2.2 geNdPTOC_2

This logical node class is used for neutral time overcurrent and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geNeutACD	Start	O	TOC PKP
Op	geNeutACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
TmACrv	geCURVE_3	Curve	O	
StrVal	geFloatASG_2	Pickup level	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.2.3 geGndPTOC_2

This logical node class is used for ground time overcurrent (3 instances) and for sensitive ground time overcurrent (3 instances). There are 6 instances inside of this logical node inside the device

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
InMagTyp	geING_0_2	Input	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.2.4 geNgSeqPTOC_2

This logical node class is used for negative sequence time overcurrent function and has 3 instances inside the device.

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PIOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	O	TOC PKP
Op	gePhsACT	Operate	M	TOC OP
Blk	geSPS	Block	O	TOC BLK
Settings				
PTOCEna	geSPG_2	Function	O	
StrVal	geFloatASG_2	Pickup level	O	
TmACrv	geCURVE_3	Curve	O	
TmMult	geFloatASG_2	TD Multiplier	O	
RsMod	geING_0_2	Reset	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.3 PTOF (OverFrequency)

2.2.3.1 gePTOF

This logical node class is used for overfrequency and has 6 instances inside the device.

PTOF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTOF		Overfrequency		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
Str	geGeneralACD	Start	M	TOF PKP
Op	geGeneralACT	Operate	M	TOF OP
Blk	geSPS_1	Block	O	TOF BLK
Settings				
PTOFEna	geSPG_2	Function	E	
StrVal	geFloatASG_2	Start value (frequency)	O	
BlkVal	geIntASG_3	Voltage block value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
FreqSource	geSPG_2	Frequency source	E	
EventEna	geSPG_2	Snapshot events enabled	E	

2.2.4 PTUF (UnderFrequency)

2.2.4.1 gePTUF

This logical node class is used for underfrequency and has 6 instances inside the device.

PTOF class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTUF		Underfrequency		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
Str	geGeneralACD	Start	M	TU PKP
Op	geGeneralACT	Operate	M	TUF OP
Blk	geSPS_1	Block	O	TUF BLK
Settings				
PTUFEna	geSPG_2	Function	E	
StrVal	geFloatASG_2	Start value (frequency)	O	
BlkVal	geIntASG_3	Voltage block value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
FreqSource	geSPG_2	Frequency source	E	
EventEna	geSPG_2	Snapshot events enabled	E	

2.2.5 PTUV

2.2.5.1 gePhsPTUV_2

This logical node class is used for phase undervoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TUV PKP
Op	geGeneralACT	Operate	M	TUV OP
Blk	geSPS_1	Block	O	TUV BLK
StrPhGn	gePhsACD_1	Pickup Phase-Ground	O	
OpPhGn	gePhsACT_1	Operate Phase-Ground	O	
StrPhPh	gePhsACD_1	Pickup Phase-Phase	O	
OpPhPh	gePhsACT_1	Operate Phase-Phase	O	
Settings				
PTUVEna	geSPG_2	Function	O	
InMod	geING_0_2	Mode	O	
TmVCrv	geCURVE_4	Operating Curve Type	O	
StrVal	geIntASG_3	Start value	O	
TmMult	geFloatASG_2	Time dial multiplier	O	
DeaLinVal	geIntASG_3	Minimum Voltage	O	
PhLogic	geING_0_2	Logic	O	
BkrMon	geSPG_2	Supervised by 52	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.5.2 geAuxPTUV_2

This logical node class is used for auxiliary undervoltage and has 3 instances inside the device.

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TUV PKP
Op	geGeneralACT	Operate	M	TUV OP
Blk	geSPS_1	Block	O	TUV BLK
Settings				
PTUVEna	geSPG_2	Function	O	
TmVCrv	geCURVE_4	Operating Curve Type	O	
StrVal	geIntASG_3	Start value	O	
TmMult	geFloatASG_2	Time dial multiplier	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.6 PTOV (Overvoltage)

2.2.6.1 gePhsPTOV_2

This logical node class is used for phase overvoltage and has 3 instances inside the device

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	TOV PKP
Op	gePhsACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_3	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
PhLogic	geING_0_2	Logic	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.6.2 geAuxPTOV_2

This logical node class is used for auxiliary overvoltage and has 3 instances inside the device

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TOV PKP
Op	geGeneralACT	Operate	M	TOV OP
Blk	geSPS_1	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_3	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.6.3 geNeutPTOV_2

This logical node class is used for neutral overvoltage and has 6 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TOV PKP
Op	geGeneralACT	Operate	M	TOV OP
Blk	geSPS_1	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_3	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.6.4 geNgSeqPTOV_2

This logical node class is used for negative sequence overvoltage and has 3 instances inside the device.

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	geGeneralACD	Start	M	TOV PKP
Op	geGeneralACT	Operate	M	TOV OP
Blk	geSPS	Block	O	TOV BLK
Settings				
PTOVEna	geSPG_2	Function	O	
StrVal	geIntASG_3	Start value	O	
OpDlTmms	geING_8_2	Operate delay time	O	
RsDlTmms	geING_8_2	Reset delay time	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.7 PDOP (Directional Overpower)

All logical node classes described in this section have been included from firmware version 7.50.

2.2.7.1 geFwdPDOP_2

This logical node class shall be used to model the forward overpower function and has 3 instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	Stage 1 PKP
Op	gePhsACT	Operate	M	Stage 1 OP
Blk	geSPS_1	Block	O	
S2Str	gePhsACD_2	Start	O	Stage 2 PKP
S2Op	gePhsACT_1	Operate	O	Stage 2 OP
Settings				
PDOPEna	geSPG_2	Function	O	
BlkClsTms	geING_0_2	Blk time after close	O	
StrVal	geFloatASG_2	Stage 1 Tap	O	
OpDlTmms	geING_8_2	Stage 1 Time	O	
S2StrVal	geFloatASG_2	Stage 2 Tap	O	
S2OpDlTmms	geING_8_2	Stage 2 Time	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.7.2 geDirPDOP_2

This logical node class shall be used to model the directional overpower function and has 3 instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
S1Str	gePhsACD_2	Start	O	Stage 1 PKP
S1Op	gePhsACT_1	Operate	O	Stage 1 OP
S2Str	gePhsACD_2	Start	O	Stage 2 PKP
S2Op	gePhsACT_1	Operate	O	Stage 2 OP
Settings				
PDOPEna	geSPG_2	Function	O	
BlkClsTms	geING_0_2	Blk time after close	O	
S1DirPwAng	geFloatASG_1_2	Dir Power Angle 1	O	
S1StrVal	geFloatASG_1_2	Stage 1 Tap	O	
S1OpDlTmms	geING_0_2	Stage 1 Time	O	
S2DirPwAng	geFloatASG_1_2	Dir Power Angle 2	O	

S2StrVal	geFloatASG_1_2	Stage 2 Tap	O	
S2OpDlTmms	geING_0_2	Stage 2 Time	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.7.3 geWattPDOP_2

This logical node class shall be used to model the wattmeter ground overpower function and has 6 instances inside the device.

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Overpower		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
SupStr	gePhsACD_2	Start	O	
Settings				
PDOPEna	geSPG_2	Function	O	
OVStrVal	geFloatASG_1_2	Voltage Pickup Level	O	
InMagTyp	geING_0_2	Current Selection	O	
OCStrVal	geFloatASG_1_2	OC Pickup level	O	
OCStrDlTms	geING_0_2	OC Pickup Delay	O	
PWStrVal	geFloatASG_1_2	Power Pickup	O	
ChrAng	geFloatASG_2	MTA	O	
PWStrDlTms	geING_0_2	Power Pickup Delay	O	
Curve	geING_0_2	Curve	O	
MltTmms	geING_0_2	Multiplier	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.2.8 PFRC (Frequency Rate of Change)

2.2.8.1 gePFRC_2

This logical node class shall be used to model the frequency rate of change function and has three instances inside the device.

PFRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PFRC		Frequency Rate of Change		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
Settings				
PFRCEna	geSPG_2	Function	O	
Trend	geING_0_2	Freq Rate Trend	O	
StrVal	geFloatASG_2	Freq Rate Pickup	O	

BlkVal	geFloatASG_2	Freq Rate Min Volt	O	
BlkMinFreq	geFloatASG_1_2	Freq Rate Min Freq	O	
BlkMaxFreq	geFloatASG_1_2	Freq Rate Max Freq	O	
OpDlTmms	geING_8_2	Freq Rate Delay	O	
EventEna	geSPG_2	Snapshot events	O	

2.2.9 PDIS (Distance)

2.2.9.1 gePDIS_2

This logical node class shall be used to model the load encroachment function and has three instances inside the device.

PDIS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDIS		Distance		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Str	gePhsACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
Settings				
PDISEna	geSPG_2	Function	O	
MinVoltage	geFloatASG_1_2	Freq Rate Trend	O	
RisLod	geFloatASG_2	Freq Rate Pickup	O	
AngLod	geFloatASG_2	Freq Rate Min Volt	O	
OpDlTmms	geING_8_2	Operation Delay	O	
RsDlTmms	geING_8_2	Reset Delay	O	
EventEna	geSPG_2	Snapshot events	O	

2.2.10 PTTR (Thermal overload)

2.2.10.1 gePTTR_2

This logical node shall be used to model the thermal overload functions and has three instances inside the device.

PTTR class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
PTTR		Thermal overload		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
Str	geGeneralACD	Start	M	
Op	gePhsACT	Operate	M	
Blk	geSPS_1	Block	O	
AlmThm	geGeneralACT	Thermal alarm	O	
AlmThmPhA	geSPS_1	Thermal alarm phase A	E	
AlmThmPhB	geSPS_1	Thermal alarm phase B	E	
AlmThmPhC	geSPS_1	Thermal alarm phase C	E	

Settings				
PTTREna	geSPG_2	Function	E	
ConsTmHeat	geFloatASG_1_2	Heat time constant	E	
ConsTmCool	geFloatASG_1_2	Cool time constant	E	
StrVal	geFloatASG_2	Pickup level	O	
AlmVal	geFloatASG_2	Alarm level	O	
EventEna	geSPG_2	Snapshot events enabled	E	

2.2.11 PTRC (Protection trip conditioning)

2.2.11.1 PTRC

This logical node shall be used to connect the operate outputs of one or more protection functions to a common trip to be transmitted to XCBR logical node and has 1 instance inside the device.

PTRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTRC		Trip bus		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Op	geGeneralACT	Operate	M	

2.3 Logical Nodes for protection related functions. LN Group: R

2.3.1 RDIR (Directional element)

2.3.1.1 gePhsRDIR_2

This logical node class is used for phase directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	gePhsACD	Direction	M	
Op	gePhsACT	Operate	O	
Blk	geSPS_1	Block	O	
BlkIn	geGeneralACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geIntASG_3	Minimum operating current	O	
VMemTms	geFloatASG_1_2	Voltage Memory Time	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.3.1.2 geNdRDIR_2

This logical node class is used for neutral directional elements and has 3 instances inside the device.

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	geNeutACD	Direction	M	
Op	geNeutACT	Operate	O	
Blk	geSPS_1	Block	O	
BlkIn	geNeutACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geIntASG_3	Minimum operating current	O	
PolQty	geING_9	Polarizing quantity	O	
SnpshtEvEna	geSPG_2	Snapshot events enabled	O	

2.3.1.3 geGndRDIR_2

This logical node class is used for ground directional elements (3 instances) and for sensitive ground directional (3 instances).

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Dir	geNeutACD	Direction	M	
Op	geNeutACT	Operate	O	
Blk	geSPS_1	Block	O	
BlkIn	geNeutACT_1	Block Input	O	
Settings				
RDIREna	geSPG_2	Function	O	
ChrAng	geFloatASG_2	Characteristic angle	O	
PolOpMod	geING_0_2	Direction	O	
BlkMod	geING_0_2	Block Logic	O	
BlkValV	geIntASG_3	Minimum operating current	O	
PolQty	geING_9	Polarizing quantity	O	
EventEna	geSPG_2	Snapshot events enabled	O	

2.3.2 RREC (Autoreclosing)

2.3.2.1 geRREC

This logical node class is used for autorecloser and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RREC		Autoreclosing Element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
Op	geGeneralACT		M	
OpCls	geGeneralACT	Direction	M	
AutoRecSt	geAutoRecStENS	Operate	M	
AutoRecLo	geINS_1	Block	O	
AutoRecBlk	geINS_1	Block Input	O	
Settings				
RRECEna	geSPG	Function	O	
MaxNumShot	geING_0	Max. Number Shots	O	
Rec1Tmms1	geING_8	Dead Time 1	O	
Rec1Tmms2	geING_8	Dead Time 2	O	
Rec1Tmms3	geING_8	Dead Time 3	O	
Rec1Tmms4	geING_8	Dead Time 4	O	
RclTmms	geING_8	Reclaim time		
CondEna	geSPG	Cond. Permission		
HoldTmms	geFloatASG_1	Hold Time		
RsTmms	geFloatASG_1	Reset Time		

2.3.3 RBRF (Breaker failure)

2.3.3.1 RBRF:

This logical node class is used for breaker failure and has 1 instance inside the device.

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RBRF		Breaker failure element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
OpEx	geGeneralACT	Direction	M	

2.3.4 RFLO (Fault Locator)

2.3.4.1 ge RFLO

This logical node class is used for modeling the fault locator and has 1 instance inside the device.

RFLO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RFLO		Fault locator element		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
FltRprtTrg	geSPS_1	Fault Report Trigger	O	
ClrFltRprts	geSPS_1	Clear fault reports	O	
FltZ	geFloatCMV	Fault impedance	M	
FltDiskm	geFloatMV_3	Fault distance in km	O	
RPriFlt	geFloatMV_2	Primary Fault Resistance	O	
XPriFlt	geFloatMV_2	Primary Fault Reactance	O	
RSeFlt	geFloatMV_2	Secondary Fault Resistance	O	
XSeFlt	geFloatMV_2	Secondary Fault Reactance	O	
RFault	geFloatMV_2	Fault Resistance	O	
FltTyp	geINS_1	Fault type	O	
FltRprtNum	geINS_1	Fault report number	O	
PreFlaMod	geFloatMV_2	Prefault Ia module	O	
PreFlaAng	geFloatMV_2	Prefault Ia angle	O	
PreFlbMod	geFloatMV_2		O	
PreFlbAng	geFloatMV_2		O	
PreFlcMod	geFloatMV_2		O	
PreFlcAng	geFloatMV_2		O	
PreFlgMod	geFloatMV_2		O	
PreFlgAng	geFloatMV_2		O	
PreFlsgMod	geFloatMV_2		O	
PreFlsgAng	geFloatMV_2		O	
PreFVabMod	geFloatMV_2		O	
PreFVabAng	geFloatMV_2		O	
PreFVbcMod	geFloatMV_2		O	
PreFVbcAng	geFloatMV_2		O	
PreFVcaMod	geFloatMV_2		O	
PreFVcaAng	geFloatMV_2		O	
PstFlaMod	geFloatMV_2	Postfault Ia module	O	
PstFlaAng	geFloatMV_2	Postfault Ia angle	O	
PstFlbMod	geFloatMV_2		O	
PstFlbAng	geFloatMV_2		O	
PstFlcMod	geFloatMV_2		O	
PstFlcAng	geFloatMV_2		O	
PstFlgMod	geFloatMV_2		O	
PstFlgAng	geFloatMV_2		O	
PstFlsgMod	geFloatMV_2		O	
PstFltIsgAng	geFloatMV_2		O	
PstFVabMod	geFloatMV_2		O	
PstFVabAng	geFloatMV_2		O	
PstFVbcMod	geFloatMV_2		O	
PstFVbcAng	geFloatMV_2		O	
PstFVcaMod	geFloatMV_2		O	
PstFVcaAng	geFloatMV_2		O	
Settings				

RFLOEna	geSPG	Function		
Z1Mod	geFloatASG_1	Pos.Seq. Module		
Z1Ang	geIntASG_1	Pos.Seq. Angle		
Z0Mod	geFloatASG_1	Zero Seq. Module		
Z0Ang	geIntASG_1	Zero Seq. Angle		
LinLenkm	geFloatASG	Line length		
ShwFltHMI	geSPG	Show fault in HMI		
EventEna	geSPG	Snapshot Events enabled		
PhCtPol	geSPG	Phase CT Polarity		

2.3.5 RSYN (Synchronisation-check)

2.3.5.1 RSYN

This logical node class is used modeling the synchrocheck function and has 1 instance inside the device

RSYN class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RSYN		Synchronism-check		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status Information				
SynBlkIn	geSPS_1	Block signal	O	
SynOp	geSPS_1	Closing permission signal	O	
Rel	geSPS	Release	M	
SynCondOp	geSPS_1	Closing perm. according to logic	O	
DLDBOp	geSPS_1	Closing perm. in DLDB condition	O	
DLLBOp	geSPS_1	Closing perm. in DLLB condition	O	
LLDBOp	geSPS_1	Closing perm. in LLDB condition	O	
HzInd	geSPS	Frequency difference indicator	O	
BusHzHiLinHz	geSPS_1	Busbar frequency > line frequency	O	
BusHzLoLinHz	geSPS_1	Busbar frequency < line frequency	O	
Measured values				
DifVClc	geFloatMV	Calculated difference in voltage	O	
DifHzClc	geFloatMV	Calculated difference in frequency	O	
Settings				
RSYNEna	geSPG	Function	O	
DeaBusVal	geFloatASG	Dead bus value	O	
LivBusVal	geFloatASG	Live bus value	O	
DeaLinVal	geFloatASG	Dead line value	O	
LivLinVal	geFloatASG	Live line value	O	
DifV	geFloatASG	Difference voltage	O	
DifAng	geFloatASG	Difference angle	O	
DifHz	geIntASG	Difference frequency	O	
TotTmms	geING_8	Total time of synch. process	O	
DLDBEna	geSPG	Dead line - dead bus permission	O	
LLDBEna	geSPG	Live line - dead bus permission	O	
DLLBEna	geSPG	Dead line - live bus permission	O	
EventEna	geSPG	Snapshot events enabled	O	

2.3.6 RDRE (Disturbance recorder function)

This logical node class is used modeling the disturbance recording function and has 1 instance inside the device. RBDR and RDRE logical nodes make available all attributes needed for the COMTRADE file.

RDRE class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
RDRE		Disturbance recorder		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
RcdMade	geSPS	Recording made	M	
FltNum	geINS	Fault number	M	
CycRcd	geINS_1	Cycles per record	E	
RcdNum	geINS_1	Available records	E	
Settings				
RDREEna	geSPG	Oscillography function enable	E	
TrgPos	geINS_0	Trigger position	E	
SmpCyc	geINS_10	Samples per cycle	E	
MaxNumRcd	geINS_8	Maximum number of records	O	
RcdMod	geINS_11	Recorder operation mode	O	
EventEna	geSPG	Snapshot events enabled	E	

2.3.7 RBDR (Disturbance recorder channel binary):

This logical node class is used for providing the circuit component and phase identification and has 1 instance inside the device. RBDR and RDRE logical nodes make available all attributes needed for the COMTRADE file.

RBDR class				
Attribute Name	**Attribute type**	**Explanation**	**M/O/C/E**	**Notes**
RBDR		Disturbance recorder channel binary		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name Plate	M	
Status information				
ChTrg	geSPS	Channel triggered	M	
FltNum	geINS	Fault Number	M	
DigCh01	geSPS_01		O	
...	...	...	...	
DigCh16	geSPS_01		O	

2.4 Logical Nodes for control. LN Group: C

2.4.1 CSWI (Switch controller)

2.4.1.1 geCSWI

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to first nine switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN.

CSWI class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
CSWI		Switch controller		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
Loc	geSPS	Local operation	O	Local/Remote
Pos	geDPC_1	Switch position	M	Switch open, close, undefined

2.4.2 CILO (Interlocking)

2.4.2.1 geCILO -> 16 switchgear

This logical node class is used for interlocking the operations performed over the switchgears and has 16 instances inside the device.

CILO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
CILO		Switch controller		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
EnaOpn	geSPS	Enable Open	M	
EnaCls	geSPS	Enable Close		

2.5 Logical Nodes for generic references. LN Group: G

2.5.1 GGIO (Generic process I/O)

2.5.1.1 geBoardGGIO

This logical node class is used is used to map digital and analogue inputs of I/O boards F, G, H and J.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
BoardSt	geSPS_1	Board status	O	
Ind1	geSPS	Status contact input 1	O	
Ind2	geSPS	Status contact input 2	O	
..	..	..	..	
Ind32	geSPS	Status contact input 32	O	
Ind33	geSPS	Status contact output 1	O	
..	..		..	
Ind48	geSPS	Status contact output 16	O	
Measured and metered values				
AnIn1	geFloatMV	Analog input 1	O	
AnIn2	geFloatMV	Analog input 2	O	
..	..		..	
AnIn8	geFloatMV	Analog input 8	O	
Settings				
VThrldA	geIntASG_1	Voltage threshold A	O	
VThrldB	geIntASG_1	Voltage threshold B	O	
VThrldC	geIntASG_1	Voltage threshold C	O	
VThrldD	geIntASG_1	Voltage threshold D	O	
DbceTmmsA	geING_0	Debounce time A	O	
DbceTmmsB	geING_0	Debounce time B	O	
DbceTmmsC	geING_0	Debounce time C	O	
DbceTmmsD	geING_0	Debounce time D	O	
InTyp01	geING_0	Type input 1	O	
InTyp02	geING_0	Type input 2	O	
..	..	..	..	
InTyp32	geING_0	Type input 32	O	
DlInTmms01	geING_0	Delay time input 1	O	
DlInTmms02	geING_0	Delay time input 2	O	
..	..	..	..	
DlInTmms32	geING_0	Delay time input 32	O	
OutLogic01	geING_0	Logic output 1	O	
OutLogic02	geING_0	Logic output 2	O	
..	..	..	..	
OutLogic16	geING_0	Logic output 16	O	
OutTyp01	geING_0	Type output 1	O	
OutTyp02	geING_0	Type output 2	O	
..		..	..	
OutTyp16	geING_0	Type output 16	O	

PlsOutms01	geING_0	Pulse time output 1	O	
PlsOutms02	geING_0	Pulse time output 2	O	
..	..		..	
PlsOutms16	geING_0	Pulse time output 16	O	
Rng01	geING_0	Range analog input 1	O	
Rng02	geING_0	Range analog input 2	O	
..	..	..	..	
Rng08	geING_0	Range analog input 8	O	
OscTmmsA	geING_0	Oscillation time A	O	
OscTmmsB	geING_0	Oscillation time B	O	
OscTmmsC	geING_0	Oscillation time C	O	
OscTmmsD	geING_0	Oscillation time D	O	
NumChgs	geING_0	Number of transient changes	O	
EventEna	geSPG	Snapshot Events enabled	O	

2.5.1.2 geVirtualGGIO

This logical node class is used is used to map the latched and self reset virtual Inputs.

GGIO class				
Attribute Name	**Attribute Type**	**Explanation**	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Controls				
DPCSO01	geSPC	Virtual input 1	O	
DPCSO01	geSPC	Virtual input 2	O	
..	..	..	..	
DPCSO64	geSPC	Virtual input 32	O	

2.5.1.3 geEventsGGIO

This logical node class is used to map data from the list of any all internal digital states (PLC control events).

GGIO class				
Attribute Name	**Attribute Type**	Explanation	**M/O/E**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	Status-only
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Control Event 1	O	
Ind2	SPS	Control Event 2	O	Control Event 2
.....	.....	.....	.....	.....
Ind192	SPS	Control Event 32	O	Control Event 32

2.5.1.4 geRemoteInputsGGIO

This logical node class is used to map data from incoming GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital input 1	O	
Ind2	geSPS	Remote digital input 2	O	
..	..	..	..	
Ind64	geSPS	Remote digital input 32	O	
AnIn1	geFloatMV	Remote float input 1	O	
AnIn2	geFloatMV	Remote float input 2	O	
..	..	..	..	
AnIn8	geFloatMV	Remote float input 8	O	
AnIn9	geIntMV_1	Remote integer input 1	O	
AnIn10	geIntMV_1	Remote integer input 2	O	
..	..	..	..	
AnIn16	geIntMV_1	Remote integer input 8	O	
Settings				
OscTmms	geING_0	Oscillation time remote inputs	O	
NumChgs	geING_0	Number of transient changes	O	

2.5.1.5 geRemoteOutputsGGIO

This logical node class is used to map PLC digital states for outgoing GOOSE messages.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Ind1	geSPS	Remote digital output 1	O	
Ind2	geSPS	Remote digital output 2	O	
..	..	..	..	
Ind32	SgePS	Remote digital output 32	O	

2.5.1.6 geDigitalCountersGGIO

This logical node is used for modeling the eight digital counters of F650 relay.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	geModENC	Mode	M	
Beh	geBehENS	Behavior	M	
Health	geHealthENS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Cnt1	geBCR_2	Digital counter 1	O	
..	..	..	..	
Cnt8	geBCR_2	Digital counter 8	O	
CntBlk1	geSPS_1	Digital counter 1 block	O	
..	..	..		
CntBlk8	geSPS_1	Digital counter 8 block	O	
CntHi1	geSPS_1	Digital counter 1 high	O	
..	..	..		
CntHi8	geSPS_1	Digital counter 8 high	O	
CntEq1	geSPS_1	Digital counter 1 equal	O	
..	..	..		
CntEq8	geSPS_1	Digital counter 8 equal	O	
CntLo1	geSPS_1	Digital counter 1 low	O	
..	..	..		
CntLo8	geSPS_1	Digital counter 8 low	O	
CntUp1	geSPS_1	Digital counter 1 up	O	
..	..	..		
CntUp8	geSPS_1	Digital counter 8 up	O	
CntDwn1	geSPS_1	Digital counter 1 down	O	
..	..	..		
CntDwn8	geSPS_1	Digital counter 8 down	O	
CntSetPre1	geSPS_1	Digital counter 1 set preset	O	
..	..	..		
CntSetPre8	geSPS_1	Digital counter 8 set preset	O	
CntRst1	geSPS_1	Digital counter 1 reset	O	
..	..	..		
CntRst8	geSPS_1	Digital counter 8 reset	O	
CntFrzRst1	geSPS_1	Digital counter 1 FreezeReset	O	
..	..	..		
CntFrzRst8	geSPS_1	Digital counter 8 FreezeReset	O	
CntFrzCnt1	geSPS_1	Digital counter 1 FreezeCount	O	
..	..	..		
CntFrzCnt8	geSPS_1	Digital counter 8 FreezeCount	O	

2.6 Logical Nodes for metering and measurement. LN Group: M

2.6.1 MMXU (Measurement)

2.6.1.1 geMMXU

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU		Measurement		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
TotW	geFloatMV	Total active power (P)	O	
TotVAr	geFloatMV	Total reactive power (Q)	O	
TotVA	geFloatMV	Total apparent power (S)	O	
TotPF	geFloatMV	Average power factor (PF)	O	
Hz	geFloatMV	Line Frequency	O	
PPV	geFloatDEL	Phase to phase voltages (VL1L2,...)	O	
PhV	geFloatPhsWYE	Phase to ground voltages (VL1ER, ...)	O	
A	geFloatWYE	Phase currents (IL1, ...)	O	
AuxV	geFloatCMV_1	Auxiliary Phase Voltage	O	
BusHz	geFloatMV_1			

2.6.2 MSQI (Sequence and imbalance)

2.6.2.1 geMSQI

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MSQI		Measurement		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
SeqA	geFloatSEQ		O	
SeqV	geFloatSEQ		O	

2.6.3 MMTR (Metering)

2.6.3.1 geMMTR

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR		Measurement		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	

Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Measured values				
SupWh	geBCR		O	
SupVArh	geBCR		O	
DmdWh	geBCR		O	
DmdVArh	geBCR		O	
CntPsWh	geFloatMV_1		O	
CntNgWh	geFloatMV_1		O	
CntPsVArh	geFloatMV_1		O	
CntNgVArh	geFloatMV_1		O	

2.7 Logical Nodes for switchgear. LN Group: X

2.7.1 XCBR (Circuit Breaker)

2.7.1.1 geXCBR -> 1 circuit breaker

This logical node is used for modeling the circuit breaker of F650 relay

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
OpCnt	geINS	Operation counter	M	Breaker openings
SumSwARs			O	
CBOpCap	geCBOpCapENS	Cicruit breaker operating capability	O	
Controls				
Pos	geDPC_1	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
Settings				
ThAlSwA	geFloatASG_1	Maximum KI2t	O	
SumSwATmms	geFloatASG_1	KI2t Integ. Time	O	
ExNumTr	geIntASG_1	Maximum Openings	O	
ExNumTr1hr	geIntASG_1	Max.Openings 1 hour	O	

2.7.2 XSWI (Circuit switch)

2.7.2.1 geXSWI

In the F650 there are up to 16 configurable switchgears. Currently sixteen XSWI and sixteen CSWI are implemented and mapped to all switchgears in F650. XSWI and CSWI Logical Nodes can be seen as paired objects in F650 as one pair of XSWI and CSWI map to the same switchgear. XSWI1 and CSWI1 map to Switchgear1, XSWI2 and CSWI2 map to Switchgear2, etc. The difference between XSWI and CSWI in F650 is that control commands cannot be sent directly via XSWI LN. Control commands have to be sent via CSWI LN. "Pos" attribute is not controllable in XSWI it has ctlModel = Status-only. In order to control the switch mapped to given XSWI the corresponding CSWI LN should be used.

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XSWI		Circuit switch		
Data				
Common Logical Node Information				
Mod	geModINC	Mode	M	
Beh	geBehINS	Behavior	M	
Health	geHealthINS	Health	M	
NamPlt	geLPL	Name plate	M	
Status information				
Loc	geSPS	Local operation	M	Local / Remote
EEHealth	geEEHealthENS	Ext. equipment health	O	
OpCnt	geINS	Operation counter	M	Breaker openings
Controls				
Pos	geDPC_2	Switch position	M	Breaker open, close
BlkOpn	geSPC_1	Block opening	M	Virtual output
BlkClr	geSPC_1	Block closing	M	Virtual output
SwTyp	geSwTypENS	Switch type	M	
SwOpCap	geSwOpCapENS	Switch operating capability		

3. Common Data Class

3.1 Common Data Class for status information

3.1.1 Single Point Status (SPS)

SPS class (Single point status)					
gsSPS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geSPS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					

d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.2 Integer Status (INS)

INS class (Integer status)					
geINS					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	INT32	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geINS_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Boolean	ST	dchg		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.3 Enumerated Status (ENS)

ENS class (Enumerated status)					
geAutoRecStINS (AutoRecSt)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dchg	Ready,InProgress,Successful,..	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geBehINS (Beh)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dchg	On,blocked,test,test/blocked,Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geHealthINS (Health)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dchg	Ok,Warning,Alarm	M

q	BVstring13	ST	qchg		M
t	Utctime	ST			M
					CONFIGURATION, DESCRIPTION AND EXTENSION
d	Vstring255	DC			O
geEEHealthINS (EEHealth)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	INT32	ST	dchg	Ok,Warning,Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geCBOpCapINS (CBOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enumerated	ST	dchg	None,Open,Close-Open,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geSwOpCapINS (SwOpCap)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enumerated	ST	dchg	None,Open,Close,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
geSwTypINS (SwTyp)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enumerated	ST	dchg	Load Break, Disconnector,...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.1.4 Protection activation information (ACT)

ACT class (Protection activation information)					
gePhsACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O

Configuration, Description And Extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
gePhsACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
phsA	Boolean	ST	dchg		O
phsB	Boolean	ST	dchg		O
phsC	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
geNeutACT_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
neut	Boolean	ST	dchg		O
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
cdcNs	Vstring255	EX			O
cdcName	Vstring255	EX			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACT					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
originSrc	Struct	ST			O
Configuration, Description And Extension					
d	Vstring255	DC			O
geGeneralACT_1					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Control And Status					
general	Boolean	ST	dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.1.5 Directional protection activation information (ACD)

ACD class (Directional protection activation information)					
gePhsACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
gePhsACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
phsA	Boolean	ST	Dchg		GC_2(1)
dirPhsA	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(1)
phsB	Boolean	ST	dchg		GC_2(2)
dirPhsB	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(2)
phsC	Boolean	ST	dchg		GC_2(3)
dirPhsC	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(3)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geNeutACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					

d	Vstring255	DC			O
geNeutACD_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geGeneralACD					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
general	Boolean	ST	Dchg		M
dirGeneral	Enumerated (Byte)	ST	Dchg	unknown | forward | backward | both	M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.1.6 Binary counter reading (BCR)

BCR class (Binary counter reading)					
geBCR					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
actVal	Int64	ST	Dchg		M
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
units	Unit	CF			O
pulsQty	Float32	CF			M
d	Vstring255	DC			O
geBCR_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Control And Status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
geBCR_2					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Control And Status					
actVal	Int64	ST	dchg		M
frVal	Int64	ST	dchg		GC_2_1
frTm	Utctime	ST			GC_2_1
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
Configuration, Description And Extension					
pulsQty	Float32	CF			M
frEna	Boolean	CF			GC_2_1
strTm	Utctime	CF			GC_2_1
frPd	Int32	CF			GC_2_1
frRs	Boolean	CF			GC_2_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2 Common data class specifications for measurand information

3.2.1 Measured Value (MV)

MV class (Measured value)					
geFloatMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, description and extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	FloatAnalogueValue				
	FLOAT32				GC_1
	INT32U				
d	Vstring255	DC			O
geFloatMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					

Measured Attributes					
instMag	FloatAnalogueValue	MX	------		O
f	FLOAT32				GC_1
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	FloatAnalogueValue				
f	FLOAT32				GC_1
hlim	FloatAnalogueValue				
f	FLOAT32				GC_1
lLim	FloatAnalogueValue				
f	FLOAT32				GC_1
llLim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	FloatAnalogueValue				
	FLOAT32				GC_1
	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M
geFloatMV_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
mag	FloatAnalogueValue	MX	dchg		M
f	FLOAT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
d	Vstring255	DC			O
geIntMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					

Measured Attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
d	Vstring255	DC			O
geIntMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instMag	IntAnalogueValue	MX	------		O
i	INT32				GC_1
mag	IntAnalogueValue	MX	dchg		M
i	INT32				GC_1
range	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	ENUMERATED(Byte)				M
Multiplier	ENUMERATED(Byte)				O
db	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
hhLim	IntAnalogueValue				
i	INT32U				GC_1
hlim	IntAnalogueValue				
i	UINT32				GC_1
lLim	IntAnalogueValue				
i	INT32U				GC_1
llLim	IntAnalogueValue				
i	INT32U				GC_1
min	IntAnalogueValue				
i	INT32U				GC_1
max	IntAnalogueValue				
i	INT32U				GC_1
limDb	IntAnalogueValue				
	INT32U				GC_1
	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			AC_DLN_M

3.2.2 Complex Measured Value (CMV)

CMV class (Complex measured value)					
geFloatCMV					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
geFloatCMV_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Measured Attributes					
instCVal	FloatVector	MX	------		O
mag	FloatAnalogueValue				
f	FLOAT32				
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
range	ENUMERATED(Byte)	MX	dchg		O
rangeAng	ENUMERATED(Byte)	MX	dchg		O
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
Configuration, Description And Extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
db	INT32U	CF			O
dbAng	INT32U	CF			O
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
rangeAngC	RangeConfig	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

3.2.3 Phase to ground related measured values of a three phase system (WYE)

WYE class					
geFloatPhsWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
Configuration, Description And Extension					
d	Vstring255	DC			O
geFloatWYE					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_0				GC_1
phsB	CMV_0				GC_1
phsC	CMV_0				GC_1
neut	CMV_0				GC_1
net	CMV_0				GC_1
res	CMV_0				GC_1
Configuration, Description And Extension					
d	Vstring255	DC			O

3.2.4 Phase to phase related measured values of a three phase system (DEL)

DEL class (Phase to phase related measured values of a three phase system)					
geFloatDEL					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsAB	CMV_0				GC_1
phsBC	CMV_0				GC_1
phsCA	CMV_0				GC_1
Configuration, Description And Extension					
d	Vstring255	DC			O

3.2.5 Sequence (SEQ)

SEQ class (Sequence)					
geFloatSEQ					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
c1	CMV_0				GC_1
c2	CMV_0				GC_1
c3	CMV_0				GC_1
Measured Attributes					
seqT	enumerated	MX		Pos-neg-zero | dir-quad-zero	O
Configuration, Description And Extension					
d	Vstring255	DC			O

3.3 Common data class specifications for controllable status information

3.3.1 Controllable single point (SPC).

SPC class						
geSPC						
Attribute Name		Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute						
Control And Status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF		ctlModel	M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
cdcNs		Vstring255	EX			
cdcName		Vstring255	EX			
geSPC_1						
Attribute Name		Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute						
Control And Status						
stVal		Boolean	ST		FALSE | TRUE	AC_ST
Q		Quality	ST			AC_ST
t		TimeStamp	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF		ctlModel_1	M
d		Vstring255	DC			O

3.3.2 Controllable double point (DPC)

DPC class (Controllable double point)						
geDPC						
Attribute Name		Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute						
Control And Status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST

t		Utctime	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF			M
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
cdcNs		Vstring255	EX			
cdcName		Vstring255	EX			
geDPC_1						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
Control And Status						
Oper	ctlVal	Boolean	CO			AC_CO_M
	origin	Originator	CO,ST			AC_CO_M
	orCat	ENUMERATED				M
	orIdent	OCTECT64				M
	ctlNum	INT8U	CO,ST			M
	T	Btime6	CO			M
	Test	Boolean	CO			M
	Check	ENUMERATED	CO			M
Cancel						
SBO						
SBOw						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF			M
sboTimeout		INT32U	CF			AC_CO_O
sboClass		ENUMERATED	CF			AC_CO_O
operTimeout		INT32U	CF			AC_CO_O
d		Vstring255	DC			O
cdcNs		Vstring255	EX			
cdcName		Vstring255	EX			
geDPC_2						
Attribute Name		**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute						
Control And Status						
stVal		CODE ENUM	ST	dchg	intermediate-state | off | on | bad-state	M
q		BVstring13	ST	qchg		AC_ST
t		Utctime	ST			AC_ST
Configuration, Description And Extension						
ctlModel		ENUMERATED	CF			M
d		Vstring255	DC			O

3.3.3 Controllable enumerated status (ENC)

ENC class (Controllable integer status)					
geModINC (type Mod)					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Status					
stVal	Enum	ST	dcgh		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M

Configuration, Description And Extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.4 Common data class specifications for status settings

3.4.1 Single point setting (SPG)

SPG class					
geSPG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SP			AC_NSG_M
configuration, description and extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geSPG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.4.2 Integer status setting (ING)

ING class					
geING_0					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SP			AC_NSG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_0_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geING_8					

Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Setting					
setVal	Boolean	SP			AC_NSG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_8_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
minVal	INT32	CF			O
maxVal	INT32	CF			O
stepSize	INT32	CF			O
d	Vstring255	DC			O
geING_9					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
d	Vstring255	DC			O
geING_10					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SG			AC_SG_M
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			
geING_11					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Boolean	SP			
Configuration, Description And Extension					
d	Vstring255	DC			O
dataNs	Vstring255	EX			

3.4.3 Enumerated status setting (ENG)

ENG class					
geENG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Enumerated	SP		PolQty	AC_NSG_M
Configuration, Description And Extension					
d	Vstring255	DC			O

geENG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setVal	Enumerated	SG		PolQty	AC_SG_M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.4.4 Object reference setting

ORG class					
geORG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setSrcRef	ObjectReference	SP		Object reference	M
Configuration, Description And Extension					
d	Vstring255	DC			O

3.5 Common data class specifications for analogue settings

3.5.1 Analog setting (ASG)

ASG class					
geIntASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geIntASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SP			AC_NSG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1

d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SG			AC_NSG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geIntASG_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	IntAnalogueValue	SG			AC_SG_M
i	INT32				GC_1
Configuration, Description And Extension					
units	Unit	CF			
minVal	IntAnalogueValue	CF			O
i	INT32				GC_1
maxVal	IntAnalogueValue	CF			O
i	INT32				GC_1
stepSize	IntAnalogueValue	CF			O
i	INT32				GC_1
d	Vstring255	DC			O
geFloatASG					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
geFloatASG_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SP			AC_NSG_M
f	FLOAT32				GC_1
Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1

maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geFloatASG_1_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SG			AC_NSG_M
f	FLOAT32				GC_1
Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O
dataNs	Vstring255	EX			O
geFloatASG_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setMag	FloatAnalogueValue	SG			AC_SG_M
f	FLOAT32				GC_1
Configuration, Description And Extension					
Units	Unit	CF			
minVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
maxVal	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
stepSize	FloatAnalogueValue	CF			O
f	FLOAT32				GC_1
d	Vstring255	DC			O

3.5.2 Setting curve (CURVE)

geCURVE_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setCharact	ENUMERATED	SG			O
d	Vstring255	DC			O
geCURVE_4					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
Setting					
setCharact	ENUMERATED	SG			O
d	Vstring255	DC			O

3.6 Common data class specifications for description information

3.6.1 Device name plate (DPL)

DPL class (Device name plate)					
geDPL					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Control And Status					
vendor	Vstring255	DC			M
hwRev	Vstring255	DC			O
swRev	Vstring255	DC			O
serNum	Vstring255	DC			O
model	Vstring255	DC			O

3.6.2 Logical node name plate (LPL)

LPL class (Logical node name plate)					
geLPL					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Control And Status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
geLPL_1					
Attribute Name	Attribute Type	FC	TrgOp	Value/Value Range	M/O/C
DataAttribute					
Control And Status					
vendor	Vstring255	DC			M
swRev	Vstring255	DC			M
d	Vstring255	DC			M
configRev	Vstring255	DC			AC_LN0_M
IdNs	Vstring255	EX			O

4. Enum Types

4.2 New Enum Types

4.2.1 setCharact_2

Value	Description	Remarks
0	Definite Time	
1	Inverse Time	

4.2.2 SamplesCycle

Value	Description	Remarks
0	64 samples/cycle	
1	32 samples/cycle	

2	16 samples/cycle	
3	8 samples/cycle	
4	4 samples/cycle	

7.3.7.3.7 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "B", "C", "D", "E" and IEC 61850 Edition 1

Reference documentation: **TICS for 650 family of relays v1_7 firm3_60**.

This document describes the:

- Introduction
- TICS Template

1 Introduction

This document provides a template for the tissues conformance statement (TICS). According to the UCA QAP the TICS is required to perform a conformance test and is referenced on the final certificate.

In this TICS template only tissues with a “green” status are considered since they become mandatory and thus must be included in the UCA Device conformance test procedures.

“Green” Tissues listed in this document represent the current status of all Tissues for a date of the document creation.

As for some of the remaining tissues, they are not yet included in the test procedures, either because they are just a recommendation or optional within the IEC 61850 documents, or because their respective proposals are not defined in such detail to be implemented or tested, or because they are simply not applicable, just editorial, with no change for implementation and testing.

The supported (“Sup”) column indicates:

- Y: yes, the tissue is implemented in the device.
- N: no, the tissue is not implemented in the device.
- N/A: not applicable, the tissue is not applicable for the device.

2 TICS Template

Tissue No.	Supported? (Y / N / N/A)	Comments about implementation
IEC 61850 General		
141	N	
146	Y	
173	Y	
IEC 61850 Part 6		
1	N/A	
3	Y	
4	Y	
5	Y	
6	N/A	
7	N/A	
8	Y	
9	N/A	
10	Y	
11	N/A	
12	N/A	
13	N/A	
14	N/A	
15	N/A	
16	N/A	
17	N/A	
18	N/A	
24	N/A	

130	N/A	
157	N/A	
169	N/A	
170	N/A	
176	N/A	
186	Y	Technically it would be possible to include Control Block's attributes as Data Set members, however Data Sets in this device are fixed and it is not possible to modify them.
197	N/A	
201	N/A	
211	N/A	
245	N/A	
IEC 61850 Part 7-2		
29	N/A	
30	N/A	
31	N/A	
32	N/A	
33	N/A	
34	N/A	
35	Y	
36	N/A	
37	N/A	
38	N/A	
39	N/A	
40	N/A	
41	Y	
42	N/A	
43	N/A	
44	N/A	
45	N/A	
47	N/A	
48	N/A	
50	N/A	
51	N/A	
52	N/A	
53	N	
137	N/A	
142	N	
IEC 61850 Part 7-3		
28	N/A	No CDC APC present in Data Model.
54	N/A	
55	N/A	
56	N/A	
57	N/A	
58	N/A	
59	N/A	
60	N/A	
61	N/A	
62	N/A	
63	N/A	
64	N/A	
65	N/A	

Tissue No.	Supported? (Y / N / N/A)	Comments about implementation
IEC 61850 Part 7-3(cont.)		
68	Y	In ACT CDC's attribute origin is present in (ST) FC.
138	N/A	
161	N/A	
164	N/A	
171	Y	
182	N/A	
205	N/A	
213	N/A	
217	N/A	
219	N/A	
IEC 61850 Part 7-4		
69	N/A	
70	N/A	
71	N/A	
72	N/A	
73	N/A	No SIMG, SIML logical nodes in Data Model.
74	N/A	
75	N/A	No GAPC logical node in Data Model.
76	N/A	
77	N/A	
78	N/A	
79	Y	
80	N/A	No TCTR, TVTR logical nodes in Data Model.
82	N/A	
83	N	
84	N/A	
85	N/A	
86	N/A	
87	N/A	
88	N/A	
89	N/A	
90	N/A	No CPOW logical node in Data Model.
91	N/A	No SIMG logical node in Data Model.
92	N/A	No SIML logical node in Data Model.
94	N/A	
95	N/A	
96	N/A	No GSAL logical node in Data Model.
97	N/A	
98	N/A	
99	N/A	
100	N/A	
101	N/A	No RDRE, RADR, RBDR logical nodes in Data Model.
102	N/A	
104	N	
105	N/A	
106	N/A	
107	N/A	
108	N/A	
133	Y	

Tissue No.	Supported? (Y / N / N/A)	Comments about implementation
IEC 61850 Part 7-4 (cont.)		
134	N/A	
145	N/A	
147	N/A	Mod, Beh always have value 1.
148	N/A	
216	N/A	
IEC 61850 Part 8-1		
109	N/A	This Tissue is informational only.
110	N/A	
111	N/A	
112	N/A	
113	N/A	
114	N/A	
115	N/A	
116	Y	
117	N/A	
118	N	
119	N/A	MMS GetCapabilities is not supported.
120	Y	
121	N/A	
122	N/A	
123	N/A	
128	N	
143	N/A	
144	N/A	No CDC APC present in Data Model.
196	Y	
260	Y	
IEC 61850 Part 9-2		
124	N/A	
125	N/A	
126	N/A	
127	N/A	
139	N/A	

7.3.7.3.8 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2

Reference documentation: **TICS for 650 family of relays v1_0 firm7_20**.

This document describes the:

- Introduction
- TICS Template

1 Introduction

This document provides a template for the tissues conformance statement (TICS). According to the UCA QAP the TICS is required to perform a conformance test and is referenced on the final certificate.

In this TICS template only tissues with a "green" status are considered since they become mandatory and thus must be included in the UCA Device conformance test procedures.

"Green" Tissues listed in this document represent the current status of all Tissues for a date of the document creation. As for some of the remaining tissues, they are not yet included in the test procedures, either because they are just a recommendation or optional within the IEC 61850 documents, or because their respective proposals are not defined in such detail to be implemented or tested, or because they are simply not applicable, just editorial, with no change for implementation and testing.

The supported ("Sup") column indicates:

- Y: yes, the tissue is implemented in the device.
- N: no, the tissue is not implemented in the device.
- N/A: not applicable, the tissue is not applicable for the device.

2 TICS Template

Tissue No.	Supported? (Y / N / N/A)	Comments about implementation
IEC 61850 Part 6		
658	N/A	
663	Y	
668	N/A	
687	N/A	
719	Y	
721	N/A	
768	Y	
770	Y	
779	Y	
788	N/A	
789	Y	
804	N/A	
806	N/A	
807	N/A	
822	N/A	
823	N/A	
824	N/A	
825	N/A	
845	N/A	
853	N/A	

Tissue No.	Supported? (Y / N / N/A)	Comments about implementation
IEC 61850 Part 6		
855	N/A	
856	N/A	
857	N/A	
886	N/A	
901	N/A	
936	N/A	
1168	N/A	
1175	N/A	
IEC 61850 Part 7-1		
828	Y	
1151	N/A	
1196	N/A	
IEC 61850 Part 7-2		
778	Y	
780	Y	
783	N/A	
786	Y	
820	N/A	
858	N/A	
861	N/A	
876	N/A	
1038	N/A	
1050	N/A	
1062	N/A	
1071	Y	
1091	N/A	
1127	N/A	
1163	N/A	
1202	Y	
IEC 61850 Part 7-3		
697	N/A	
698	N/A	
722	N/A	
919	N/A	
925	N/A	
926	Y	
IEC 61850 Part 7-4		
671	N/A	
674	N/A	
675	N/A	
676	N/A	
677	N/A	
679	N/A	
680	N/A	
681	N/A	
682	N/A	
683	N/A	
685	N/A	
686	N/A	

Tissue No.	Supported? (Y / N / N/A)	Comments about implementation
IEC 61850 Part 7-4		
694	N/A	
696	N/A	
712	N/A	
713	N/A	
724	N/A	
725	N/A	
734	N/A	
735	N/A	
736	N/A	
742	N/A	
743	N/A	
744	N/A	
772	N/A	
773	N/A	
774	N/A	
775	N/A	
776	N/A	
800	N/A	
802	N/A	
808	N/A	
831	N/A	
838	N/A	
844	N/A	
849	N/A	
877	N/A	
909	N/A	
920	N/A	
932	N/A	
939	N/A	
991	N/A	
1007	Y	
1044	N/A	
1077	N/A	
IEC 61850 Part 8-1		
784	N/A	
817	N/A	
834	Y	
951	N/A	
1040	N/A	
1178	Y	

Note: Tissues 675, 735, 772, 775, 776, 878 are not relevant for conformance testing

Compare the TISSUE database for more details: www.tissues.iec61850.com

7.3.7.3.9 TICS for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **TICS For F650 relay V3_05 firm7_52**

Mandatory Intop Tissues

During the October 2006 meeting IEC TC57 working group 10 decided that:

- green Tissues with the category "IntOp" are mandatory for IEC 61850 edition 1
- Tissues with the category "Ed.2" Tissues should not be implemented.

The table below gives an overview of the implemented IntOp Tissues.

Part	Tissue No.	Description	Implemented Y / N/A
8-1	116	GetNameList with empty response?	Y
	165	Improper Error Response for GetDataSetValues	N/A
	183	GetNameList error handling	N/A
	246	Control negative response (SBOns) with LastApplError	N/A
	545	Skip file directories with no files	N/A
7-4	252	AlmThm should have CDC SPS	Y
7-3	28	Definition of APC	N/A
	54	Point def xVal, not cVal	N/A
	55	Ineut = Ires ?	N/A
	63	mag in CDC CMV	N/A
	65	Deadband calculation of a Vector and trigger option	N/A
	219	operTm in ACT	N/A
	270	WYE and DEL rms values	N/A
	1199	BCR	N/A

7-2	30	control parameter T	N/A
	31	Typo	N/A
	32	Typo in syntax	N/A
	35	Typo Syntax Control time	Y
	36	Syntax parameter DSet-Ref missing	N/A
	37	Syntax GOOSE "T" type	N/A
	39	Add DstAddr to GoCB	N/A
	40	GOOSE Message "AppID" to "GoID"	N/A
	41	GsCB "AppID" to "GsID"	Y
	42	SV timestamp: "EntryTime" to "TimeStamp"	N/A
	43	Control "T" semantic	N/A
	44	AddCause - Object not sel	N/A
	45	Missing AddCauses	N/A
	46	Synchro check cancel	N/A
	47	"." in LD Name?	N/A
	49	BRCB TimeOfEntry (part of #453)	-
	50	LNName start with number?	N/A
	51	ARRAY [0..num] missing	N/A
	52	Ambiguity GOOSE SqNum	N/A
	53	Add DstAddr to GsCB, SV	N/A
	151	Name constraint for control blocks etc.	N/A
	166	DataRef attribute in Log	N/A
	185	Logging - Integrity periode	N/A
	189	SV Format	N/A
	190	BRCB: EntryId and TimeOfEntry (part of #453)	-
	191	BRCB: Integrity and buffering reports (part of #453)	-
	278	EntryId not valid for a server (part of #453)	-
	297	Sequence number	N/A
	298	Type of SqNum	N/A
	305	Reporting with BufTm = 0	N/A
	322	Write Configuration attribute of BRCBs	N/A
	329	Reporting and BufOvl	N/A
	333	Enabling of an incomplete GoCB	N/A
	335	Clearing of BufOvfl	N/A
	348	URCB class and report	N/A
	349	BRCB TimeOfEntry has two definitions	N/A
	453	Combination of all reporting and logging tissues	N/A
	1281	Trigger option GI is by default	N/A
Part 6	1	Syntax	N/A
	5	tExtensionAttributeNameEnum is restricted	Y
	8	SIUnit enumeration for W	Y
	10	Base type for bitstring usage	Y
	17	DAI/SDI elements syntax	Y
	169	Ordering of enum differs from 7-3	N/A
	245	Attribute RptId in SCL	N/A
	529	Replace sev - Unknown by unknown	N/A

NOTE: Tissue 49, 190, 191, 275 and 278 are part of tissue #453, all other technical tissues in the table are mandatory if applicable.

NOTE: Editorial tissues are marked as "N/A".

7.3.7.3.10 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "B", "C", "D", "E" and IEC 61850 Edition 1

Reference documentation: **PIXIT for 650 family of relays v1_5 firm3_60**.

This document describes the:

- PIXIT for Association Model
- PIXIT for Server model
- PIXIT for Dataset model
- PIXIT for Reporting model
- PIXIT for Generic substation events model
- PIXIT for Control model
- PIXIT for Time and time synchronisation model
- PIXIT for File transfer model

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in 650 family of relays

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Contents of this document: Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

1 PIXIT For Association Model

Description	Value/Clarification
Maximum number of clients that can set-up an association simultaneously	5
Lost connection detection time range (default range of TCP_KEEPALIVE is 1 – 20 seconds)	20 seconds
Is authentication supported	N
What association parameters are necessary for successful association	Only local selectors are checked: Y Transport selector (00 01) Y Session selector (00 01) Y Presentation selector (00 00 00 01) N AP Title N AE Qualifier
What is the maximum and minimum MMS PDU size	Max MMS PDU size: 256000 There is no established minimum MMS PDU size, however recommended MMS PDU size is at least 32000.
What is the typical startup time after a power supply interrupt	210 SECONDS

2 PIXIT for Server model

Description	Value/Clarification
Which analogue value (MX) quality bits are supported (can be set by server)	**Validity:** Y Good N Invalid N Reserved N Questionable N Overflow N OutofRange N BadReference N Oscillatory N Failure N OldData N Inconsistent N Inaccurate **Source:** Y Process N Substituted N Test N OperatorBlocked
Which status value (ST) quality bits are supported (can be set by server)	**Validity:** Y Good N Invalid N Reserved N Questionable N BadReference N Oscillatory N Failure N OldData N Inconsistent N Inaccurate **Source:** Y Process N Substituted N Test N OperatorBlocked
What is the maximum number of data values in one GetDataValues request	MMS PDU SIZE / 4
What is the maximum number of data values in one SetDataValues request	MMS PDU SIZE / 4
Additional Items:	
Behavior of stepSize attribute checks	When a client attempts to write value of setVal (CDC ING) or setMag (CDC ASG), which is not a multiple of stepSize attribute of the associated CF, then the device truncates the value to the nearest stepSize not greater than the value intended to be written.

3 PIXIT for Dataset model

Description	Value/Clarification
What is the maximum number of data elements in one data set	Data sets cannot be created via MMS services. Data sets can be created via ICD/CID file and maximum number of elements in one data set is 64. The exception to that is the predefined data set “eveGGIO1$ST” which contains 192 elements.
How many persistent data sets can be created by one or more clients	Data sets cannot be created via MMS services. Data sets can be created via ICD/CID file and maximum number of all persistent data sets in F650 relay is 20.
How many non-persistent data sets can be created by one or more clients	0

4 PIXIT for Reporting model

Description	Value/Clarification
The supported trigger conditions are:	Y integrity Y data change N quality change N data update Y general interrogation
The supported optional fields are:	Y sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y segmentation
Can the server send segmented reports?	Y
Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Multi client URCB approach (compare IEC 61850-7-2 $14.2.1)	Option b) of IEC 61850-7-2 $14.2.1 is implemented which means that each client has it's own set of URCB's.
What is the format of EntryID	Signed 32 bit integer.
What is the buffer size for each BRCB or how many reports can be buffered	Buffer size = 50000 bytes.
Pre-configured RCB attributes that cannot be changed online when RptEna = FALSE	DatSet attributes are always fixed
Additional Items:	
BufTm=0 behavior	When BufTm=0 multiple data can be placed in one report if changes of these data have been detected at the same time, it means during the same scan period. The scan period for analogues is 500 milliseconds.
Integrity period	Configurable >= 500 milliseconds
EntryID	EntryID is incremented only if the EntryID bit is set in OptFlds. A valid EntryID that can be written by a client should be equal or smaller than the EntryID in BRCB. This is because the client should only request retransmission of reports that had already been sent.
GI reports	Can be triggered independently from the GI bit in TrgOps
Behavior at buffer overflow	When buffer overflow occurs all reports generated after buffer overflow has the BufOvfl flag set. To stop sending reports with the BufOvfl flag, the client should disable BRCB and clear the BufOvfl flag by setting PurgeBuf=TRUE.
Sending of already buffered reports after enabling BRCB	All reports that have been already buffered, after setting the RptEna=TRUE are sent in chronological order, e.g. the oldest reports are sent first.

Multi client access to BRCB	It is possible to access and configure the same BRCB from different clients, however, it is recommended that each BRCB be accessed and configured by only one client. Note the following restriction: The first client to enable a BRCB establishes the "minimum MMS PDU size" required for this BRCB. This BRCB can then be enabled by any client which has the MMS PDU size at least as big as the established "minimum MMS PDU size" for that BRCB. This restriction is required since the initial use may have left buffered reports in the BRCB. The "minimum MMS PDU size" was used for segmentation of the reports. If a client enable the BRCB with a smaller "minimum MMS PDU size", the reports stored in a buffer cannot be sent to this client due to their larger size.

5 PIXIT for Generic substation events model

GOOSE

Description	Value/Clarification
Note about internal variable "Remote Device" and GOOSE validity checks	For each incoming GOOSE in the device there is an associated internal variable called "Remote Device". This variable can have value ONLINE or OFFLINE. Value ONLINE means that the incoming GOOSE messages from the configured sender have been positively validated by MAC destination, gocbRef, datSet and goID. Value OFFLINE means that there are no GOOSE messages from configured sender or that incoming GOOSE messages from this sender have been invalidated by MAC destination or gocbRef or datSet or goID. The variable "Remote Device" can have value ONLINE (it has been validated by MAC destination, gocbRef, datSet and goID) but if the GOOSE message has been invalidated by confRev or ndsCom or numDatSetEntries or allData or if the order of data set elements is not correct then the incoming data from GOOSE message is ignored.

What elements of a subscribed GOOSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions.	N source MAC address Y destination MAC address (Should be multicast, if it is not multicast the status of the internal variable "Remote Device" goes to OFFLINE) N VLAN id N VLAN priority Y Ethertype = 0x88B8 N APPID Y gocbRef (should match setting, if not the status of the internal variable "Remote Device" goes to OFFLINE.) N timeAllowedtoLive Y datSet (should match setting, if not the status of the internal variable "Remote Device" goes to OFFLINE) Y goID (should match setting, if not the status of then internal variable "Remote Device" goes to OFFLINE) N t N stNum N sqNum N test Y confRev (should match setting, if not the status of the internal variable "Remote Device" is not affected but the incoming data from GOOSE message is ignored) Y ndsCom (should have value FALSE, if it has value TRUE the status of the internal variable "Remote Device" is not affected but the incoming data from GOOSE message is ignored) Y numDatSetEntries (should match expected number of data set entries, if not the status of the internal variable "Remote Device" is not affected but the incoming data from GOOSE message is ignored) Y allData (should match expected data set, if not the status of the internal variable "Remote Device" is not affected but the incoming data from GOOSE message is ignored)
What is the behavior when one subscribed GOOSE message isn't received or syntactically incorrect (missing GOOSE)	A single "missing" or syntactically incorrect GOOSE message is ignored.
What is the behavior when one subscribed GOOSE message exceeds the previous time Allowed to Live (TAL)	A single late GOOSE message does change the status of the internal variable "Remote Device" to OFFLINE.
What is the behavior when a subscribed GOOSE message is out-of-order	Sequence number is ignored the message is accepted.
What is the behavior when a subscribed GOOSE message is duplicated	N Sequence number is ignored the message is accepted.
Additional Items:	
Maximum number of GOOSE messages that can be sent	4
Maximum number of GOOSE messages that can be received	8
Interpretation of quality at subscriber side	Quality is not required to be in the data set. If configured in data set and received its value is by default ignored. However it is possibe to map quality to Bistring13 object at subscriber side and then use any of its 13 bits.
Restrictions on Data Set elements for transmission GOOSE	Data Set elements for transmission GOOSE have to be Data Attributes (leaf objects). The exception to this rule is FixedGOOSE (only use between GE devices).

GSSE

Description	Value/Clarification
What elements of a subscribed GSSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. For example: Destination MAC address = as multicast SendingIED = valid reference, not NULL timeAllowedtoLive > 0 numDatSetEntries = matches with number of datSet members & allData members	N source MAC address Y destination MAC address Y timeAllowedtoLive Y SendingIED N t N stNum N sqNum Y numDatSetEntries
What is the behavior when one subscribed GSSE message isn't received or syntactically incorrect (missing GSSE)?	A single "missing" GSSE message is ignored.
What is the behavior when one subscribed GSSE message exceeds the previous time Allowed to Live (TAL)?	It signals this GSSE as "offline".
What is the behavior when a subscribed GSSE message is out-of-order?	Sequence number is ignored.
What is the behavior when a subscribed GSSE message is duplicated?	Sequence number is ignored.

6 PIXIT for Control model

Description	Value/Clarification
Supported control modes:	Y status-only Y direct-with-normal-security Y sbo-with-normal-security Y direct-with-enhanced-security Y sbo-with-enhanced-security ***Note:*** control models: -sbo-with-normal-security -direct-with-enhanced-security -sbo-with-enhanced-security are available only for Pos attribute in logical nodes XCBR and CSWI
Is Time activated operate (operTm) supported?	N
What is the behavior of the DUT when the test attribute is set in the SelectWithValue and/or Operate request?	DUT ignores the test value and executes the command as usual.
What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request?	DUT ignores the test value and executes the command as usual.
Is "operate-many" supported?	N
Is pulse configuration supported?	N
What check conditions are supported?	N synchrocheck N interlock-check

Description (cont.)	Value/Clarification (cont.)
Supported service error types:	Y instance-not-available Y instance-in-use Y access-violation Y access-not-allowed-in-current-state Y parameter-value-inappropriate Y parameter-value-inconsistent Y class-not-supported Y instance-locked-by-other-client Y control-must-be-selected Y type-conflict Y failed-due-to-communications-constraint Y failed-due-to-server-constraint
What additional cause diagnosis are supported?	N Unknown Y Not-supported N Blocked-by-switching-hierarchy N Select-failed Y Invalid-position Y Position-reached N Parameter-change-in-execution N Step-limit N Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected
How to force a “test-not-ok” respond with SelectWithValue request?	Not applicable.
How to force a “test-not-ok” respond with Operate request?	Not applicable.
Which origin categories are supported? What happens if the orCat is not supported?	orCat values are checked only for XCBR1COPos. The permission to do the operation depends on the position of LOCAL/REMOTE switch on the front panel of relay and also on the orCat value received. The following table shows the behavior. “Yes” means operation is permitted “No” means operation is not permitted.
	OrCat
	2,3,5,6
	When invalid orCat is received or LOCAL/REMOTE switch is in LOCAL position then DUT responds with negative value OBJECT-ACCESS-DENIED. Additionally in case of Direct Control with Enhanced Security or SBO with Enhanced Security when invalid orCat is received the DUT sends InformationReport with AddCause = not-supported.
Does the IED accept an select/operate with the same ctlVal as the current status value?	Y Select N Operate
Does the IED accept a select/operate on the same control object from 2 different clients at the same time?	N Select N Operate for SBO, SBO Enhanced Y Operate for Direct-Control and Direct-Control Enhanced. However in case of Direct-Control with Enhanced Security as long as the control object has not returned to state Ready the Operate request from the second client is rejected.

Description (cont.)	Value/Clarification (cont.)
Additional Items:	
The following control models are available only for Pos controllable attribute of XCBR LN. For the rest of controllable objects only direct-with-normal-security model is permitted.	sbo-with-normal-security direct-with-enhanced-security sbo-with-enhanced-security
Behavior of DUT in case of control models direct-with-enhanced-security or sbo-with-enhanced-security	After reception of “Operate” service the DUT checks whether the operation has been successfully done. The timeout DUT internally checks for operation realisation is fixed at 30 seconds. If this timeout elapses and the operation has not been finished the DUT sends negative Command Termination service to the client. If the operation finishes within the 30 seconds timeout the DUT sends positive Command Termination service to the client. In case of direct-with-enhanced-security when the DUT is waiting for operation result new “Operate” requests from any client are rejected until the pending operation finalized successfully or the 30 seconds timeout elapses.

7 PIXIT for Time and time synchronisation model

Description	Value/Clarification
What quality bits are supported	N LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
What is the behavior when the time synchronization signal/messages are lost	Internal clock is used.
When is the quality bit "Clock failure" set?	It is set when SNTP packet with LI field (Leap Indicator) with both bits set to ON is received.
When is the quality bit "Clock not synchronised” set?	It is set when the communication is lost with the time server. The timeout for setting this bit is 1 minute for unicast mode, 5 minutes for anycast mode and up to 18 minutes for broadcast mode. After startup the device has not set this quality bit even if the time server is not present or not working. The bit is set when the corresponding timeout elapses.

8 PIXIT for File transfer model

Description	Value/Clarification
What is structure of files and directories?	The main directory for files is “/LD/XXXLD/” where XXXLD is the Logical Device name. COMTRADE files are located in “/LD/XXXLD/COMTRADE/” directory. All other files are in “/LD/XXXLD/” directory. The device retrieves the content and/or definition of files when the client’s request contains the filename with full path or only the filename without path. Relative paths like "/XXXLD/file1" or "COMTRADE/file1" are not allowed and are returned by the server with error code “file-non-existing".

7.3.7.3.11 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 2

Reference documentation: **PIXIT for 650 family of relays v1_6 firm7_20**.

This document describes the:

- PIXIT for Association Model
- PIXIT for Server model
- PIXIT for Dataset model
- PIXIT for Reporting model
- PIXIT for Generic substation events model
- PIXIT for Control model
- PIXIT for Time and time synchronisation model
- PIXIT for File transfer model

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in 650 family of relays.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10.

Contents of this document: Each chapter specifies the PIXIT for each applicable ACSI service model as structured in IEC 61850-10.

1 PIXIT For Association Model

Description	Value/Clarification
Maximum number of clients that can set-up an association simultaneously	5
TCP_KEEPALIVE value. The recommended range is between 1 and 20s	5 seconds but if no application message is detected within the As3 value, the device closes the connection.
Lost connection detection time	120 seconds (Configurable)
Authentication is not supported yet	
What association parameters are necessary for successful association?	Y Transport selector Y Session selector Y Presentation selector N AP Title N AE Qualifier
If association parameters are necessary for association, describe the correct values e.g.	Transport selector 0001 Session selector 0001 Presentation selector 00000001 AP Title N/A AE Qualifier N/A
What is the maximum and minimum MMS PDU size?	Max MMS PDU size 120000 Min MMS PDU size 32000.
What is the maximum start up time after a power supply interrupt?	90 seconds

2 PIXIT for Server model

Description	Value/Clarification
Which analogue value (MX) quality bits are supported (can be set by server)?	**Validity:** Y Good Y Invalid N Reserved Y Questionable N Overflow Y OutofRange Y BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** N Process N Substituted N Test N OperatorBlocked
Which status value (ST) quality bits are supported (can be set by server)?	**Validity:** Y Good Y Invalid N Reserved Y Questionable N BadReference Y Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** Y Process Y Substituted Y Test N OperatorBlocked
What is the maximum number of data object references in one GetDataValues request?	Deprecated
What is the maximum number of data object references in one SetDataValues request?	Deprecated
Which Mode values are supported [1]	Y On N [On-]Blocked N Test N Test/Blocked N Off

1. IEC 61850-6:2009 clause 9.5.6 states that if only a subrange of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing

3 PIXIT for Dataset model

Description	Value/Clarification
What is the maximum number of data elements in one data set? (compare ICD setting)	576
How many persistent data sets can be created by one or more clients? (this number includes predefined datasets)	Not Supported
How many non-persistent data sets can be created by one or more clients?	Not Supported

4 PIXIT for Substitution model

Description	Value/Clarification
Are substituted values stored in volatile memory?	Not Supported

5 PIXIT for Setting group control model

Description	Value/Clarification
What is the number of supported setting groups for each logical device?	3 groups for "PRO" logical device 3
What is the effect of when and how the non-volatile storage is updated? (compare IEC 61850-8-1 $16.2.4)	The server saves to non-volatile storage 25 seconds after confirmation.
Can multiple clients edit the same setting group	No
What happens if the association is lost while editing a setting group?	Lost Permission and EditSG = 0
Is EditSG value 0 allowed	Yes
When ResvTms is not present how long is an edit setting group locked?	While EditSG > 0

6 PIXIT for Reporting model

Description	Value/Clarification
The supported trigger conditions are: (compare PICS)	Y integrity Y data change Y quality change N data update Y general interrogation
The supported optional fields are:	Y sequence-number Y report-time-stamp Y reason-for-inclusion Y data-set-name Y data-reference Y buffer-overflow Y entryID Y conf-rev Y segmentation
Can the server send segmented reports?	Y
Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Multi client URCB approach (compare IEC 61850-7-2:2003 $14.2.1)	Each URCB is visible to all clients

What is the format of EntryID?	Deprecated
What is the buffer size for each BRCB or how many reports can be buffered?	Buffer size = 50000 Bytes
Pre-configured RCB attributes that are dynamic, compare SCL report settings:	Deprecated
Can the reported data set contain: - structured data objects - data attributes	 Y Y (timestamp attributes are not supported)
What is the scan cycle for binary events? Is this fixed or configurable?	Event Driven Fixed
Does the device support to pre-assign a RCB to a specific client in the SCL?	N
After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart?	Restored from original configuration

7 PIXIT for Logging model

Description	Value/Clarification
What is the default value of LogEna? (Compare IEC 61850-8-1 $17.3.3.2.1, the default value should be FALSE)	Not supported
What is the format of EntryID?	Deprecated
Are there are multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition? (Compare IEC 61850-8-1 $17.3.3.3.2)	Not supported
Pre-configured LCB attributes that cannot be changed online:	Not supported

8 PIXIT for GOOSE publish model

Description	Value/Clarification
Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set?	N
What is the behavior when the GOOSE publish configuration is incorrect?	DUT keeps GoEna=F. Configuration tool does not allow wrong configuration to be uploaded into device e.g. empty dataset.
Published FCD supported common data classes are:	SPS, INS, ENS, ACT, ACD, MV, CMV, SAV, WYE, DEL, SEQ, INC, ENC, SPC, DPC, INC, ENC. (Only the elements with FC=ST or MX are published).
What is the slow retransmission time? Is it fixed or configurable?	Configured by SCL or GoCB MaxTime
What is the fastest retransmission time? Is it fixed or configurable?	MinTime = 5 ms Fixed
Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)?	Y
What is the initial GOOSE sqNum after restart?	sqNum = 1
Can the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y Y (timestamp attributes are not supported)
How is the retransmission curve after a change?	sqNum = 0 New change sqNum = 1 -> 5ms later with TAL = 1000 sqNum = 2 -> 10ms later with TAL = 1000 sqNum = 3 -> 15ms later with TAL = 4000 sqNum = 4 -> 1000ms later with TAL = Update time* multiplied by 4 sqNum = 5 -> Update time* later with TAL = Update time* multiplied by 4 sqNum = 6-> Update time* later with TAL = Update time* multiplied by 4 sqNum = 7 .... ***Update time** is configured in the ICT

9 PIXIT for GOOSE subscribe model

Description	Value/Clarification
What elements of a subscribed GOOSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: - The VLAN tag may be removed by a ethernet switch and will not be checked. - The simulation flag will always be checked (Ed2) - The ndsCom shall always be checked (Ed2)	Y destination MAC address Y APPID N gocbRef Y timeAllowedtoLive N datSet Y goID N t N stNum N sqNum Y simulation / test N confRev Y ndsCom Y numDatSetEntries
When is a subscribed GOOSE marked as lost? (TAL = time allowed to live value from the last received GOOSE message)	Message does not arrive after TAL
What is the behavior when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)	Message is ignored, but when the next correct message is received, it proceeds as normal.
What is the behavior when a subscribed GOOSE message is out-of-order?	Message proceeds.
What is the behavior when a subscribed GOOSE message is duplicated?	Message is ignored.
Does the device subscribe to GOOSE messages with and without the VLAN tag?	Y
Can the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y N
Subscribed FCD supported common data classes are:	DUT can receive all kinds of data but only digitals can be mapped.
Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode?	N
What is the behavior when a subscribed GOOSE message with TAL = 0 is received by the subscriber?	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.
What is the behavior when a subscribed GOOSE message hasn't the expected data structure?	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.

10 PIXIT for Control model

Description	Value/Clarification
What control models are supported? (compare PICS)	Deprecated
Is the control model fixed, configurable and/or dynamic?	Configurable & Dynamic
Is TimeActivatedOperate supported? (compare PICS or SCL)	Deprecated
Is "operate-many" supported? (compare sboClass)	Deprecated
Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request? (when N test procedure Ctl2 is applicable)	N
What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request?	Deprecated
Is pulse configuration supported? (compare pulseConfig)	Deprecated

What is the behavior of the DUT when the check conditions are set? Is this behavior fixed, configurable or changeable online?	N synchrocheck N interlock-check DUT ignores the check value and always performs the check
Which additional cause diagnoses are supported?	Y Unknown Y Not-supported Y Blocked-by-switching-hierarchy N Select-failed Y Invalid-position Y Position-reached N Step-limit Y Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected **Edition 1 specific values:** N Parameter-change-in-execution **Edition 2 specific values:** Y Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution
How to force a “test-not-ok” response with SelectWithValue request?	Device in local mode
How to force a “test-not-ok” response with Select request?	
How to force a “test-not-ok” response with Operate request?	DOns: Sending T=1 SBOns: Sending T=1 DOes:Sending T=1 SBOes: Sending T=1
Which origin categories are supported/accepted?	N bay-control Y station-control Y remote-control N automatic-bay Y automatic-station Y automatic-remote N maintenance N process
What happens if the orCat value is not supported or invalid?	DOns: control is rejected (Oper-ObjectAccessDenied). SBOns: control is rejected (Oper-ObjectAccessDenied). DOes:control is rejected (Oper-ServiceError, ObjectAccessDenied). SBOes: control is rejected (SBOw-ServiceError, ObjectAccessDenied).
Does the IED accept a SelectWithValue/Operate with the same control value as the current status value? Is this behavior configurable?	N DOns N SBOns N DOes N SBOes N Configurable

Does the IED accept a select/operate on the same control object from two different clients at the same time?	N DOns N SBOns N DOes N SBOes
Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)?	N SBOns N SBOes
Is the internal validation for SBOes performed during the SelectWithValue and/or Operate step?	SelectWithValue and Operate
Can a control operation be blocked by Mod=Off or [On-]Blocked? (Compare PIXIT-Sr5)	Deprecated
Does the IED support local/remote operation?	Y (Only for XCBR)
Does the IED send an InformationReport with LastApplError as part of the Operate response for control with normal security?	N SBOns N DOns
How to force a "parameter-change-in-execution"?	N/A SBOns N/A SBOes

11 PIXIT for Time synchronisation model

Description	Value/Clarification
What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized.
Describe the behavior when the time server(s) ceases to respond? What is the time server lost detection time	On one time server: An event is generated On all time servers: An event is generated 60 seconds
How long does it take to take over the new time from time server?	2 seconds
When is the time quality bit "ClockFailure" set?	Never
When is the time quality bit "Clock not Synchronized" set?	60 seconds after the time server(s) ceases to respond.
Is the timestamp of a binary event adjusted to the configured scan cycle?	Deprecated
Does the device support time zone and daylight saving?	Y
Which attributes of the SNTP response packet are validated?	Y Leap indicator not equal to 3 Y Mode is equal to SERVER N OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N other (describe)
Do the COMTRADE files have local time or UTC time and is this configurable?	Local N

12 PIXIT for File transfer model

Description	Value/Clarification
What is structure of files and directories? Where are the COMTRADE files stored? Are comtrade files zipped and what files are included in each zip file?	 /COMTRADE N
Directory names are separated from the file name by:	"/"
The maximum file name size including path? (recommended 64 chars)	255 chars
Are directory/file name case sensitive?	Y
Maximum file size for SetFile?	
Is the requested file path included in the MMS fileDirectory respond file name?	Y
Is the wild char supported MMS fileDirectory request?	N

Can two clients get a file at the same time?	Y same file Y different files
Which files can be deleted?	

13 PIXIT for Service tracking model

Description	Value/Clarification
Which ACSI services are tracked by LTRK.GenTrk?	N/A

7.3.7.3.12 PIXIT for 650 family of relays whose order code has Rear Ethernet Communication Board 2 option "H", "G", "K", "J", "L", "M" and IEC 61850 Edition 1

Reference documentation: **PIXIT For F650 relay V1_10 firm7_52**.

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in:

F650 Bay Controller with firmware version 7.52

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10. The PIXIT entries contain information which is not available in the PICS, MICS, TICS documents or SCL file.

Each table specifies the PIXIT for applicable ACSI service model as structured in IEC 61850-10. The "Ed" column indicates if the entry is applicable for IEC 61850 Edition 1 and/or Edition 2.

1 PIXIT For Association Model

ID	Ed	Description	Value/Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously?	5
As2	1, 2	TCP_KEEPALIVE value: The recommended range is between 1 and 20s	5 seconds but if no application message is detected within the As3 value, the device closes the connection.
As3	1, 2	Lost connection detection time:	120 seconds (Configurable)
As4	-	Authentication is not supported yet.	
As5	1, 2	What association parameters are necessary for successful association?	Y Transport selector Y Session selector Y Presentation selector N AP Title N AE Qualifier
As6	1, 2	If association parameters are necessary for association, the correct values are:	Transport selector 0001 Session selector 0001 Presentation selector 00000001
As7	1, 2	What is the maximum and minimum MMS PDU size?	Max MMS PDU size120000 Min MMS PDU size7000.
As8	1, 2	What is the maximum start up time after a power supply interrupt?	90 seconds

2 PIXIT for Server model

ID	Ed	Description	Value/Clarification
Sr1	1, 2	Which analogue value (MX) quality bits are supported (can be set by server)?	**Validity:** Y Good Y Invalid N Reserved Y Questionable N Overflow Y OutofRange Y BadReference N Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** N Process N Substituted N Test N OperatorBlocked
Sr2	1, 2	Which status value (ST) quality bits are supported (can be set by server)?	**Validity:** Y Good, Y Invalid N Reserved Y Questionable N BadReference Y Oscillatory Y Failure N OldData N Inconsistent N Inaccurate **Source:** Y Process Y Substituted Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one GetDataValues request?	Deprecated
Sr4	-	What is the maximum number of data object references in one SetDataValues request?	Deprecated
Sr5	1	Which Mode values are supported? [1]	Y On N [On-]Blocked N Test N Test/Blocked N Off

1. IEC 61850-6:2009 clause 9.5.6 states that if only a subrange of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing

3 PIXIT for Dataset model

ID	Ed	Description	Value/Clarification
Ds1	1	What is the maximum number of data elements in one data set? (compare ICD setting)	576
Ds2	1	How many persistent data sets can be created by one or more clients? (this number includes predefined datasets)	Not Supported
Ds3	1	How many non-persistent data sets can be created by one or more clients?	Not Supported

4 PIXIT for Substitution model

ID	Ed	Description	Value/Clarification
Sb1	1	Are substituted values stored in volatile memory?	Not Supported

5 PIXIT for Setting group control model

ID	Ed	Description	Value/Clarification
Sg1		What is the number of supported setting groups for each logical device?	6 groups for "PRO" logical device 3
Sg2		What is the effect of when and how the non-volatile storage is updated? (compare IEC 61850-8-1 $16.2.4)	The server saves to non-volatile storage 25 seconds after confirmation.
Sg3		Can multiple clients edit the same setting group?	N
Sg4		What happens if the association is lost while editing a setting group?	Lost Permission and EditSG = 0
Sg5		Is EditSG value 0 allowed?	Y
Sg6		When ResvTms is not present, how long is an edit setting group locked?	While EditSG > 0

6 PIXIT for Reporting model

ID	Ed	Description	Value/Clarification
Rp1	1	The supported trigger conditions are: (compare PICS)	Y Integrity Y Data change Y Quality change N Data update Y General interrogation
Rp2	1	The supported optional fields are:	Y Sequence-number Y Report-time-stamp Y Reason-for-inclusion Y Data-set-name Y Data-reference Y Buffer-overflow Y EntryID Y Conf-rev Y Segmentation
Rp3	1, 2	Can the server send segmented reports	Y
Rp4	1, 2	Mechanism on second internal data change notification of the same analogue data value within buffer period: (Compare IEC 61850-7-2 $14.2.2.9)	Send report immediately
Rp5	1	Multi client URCB approach: (compare IEC 61850-7-2:2003 $14.2.1)	Each URCB is visible to all clients

Rp6	-	What is the format of EntryID?	Deprecated
Rp7	1, 2	What is the buffer size for each BRCB or how many reports can be buffered?	Buffer size = 50000 Bytes
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings:	Deprecated
Rp9	1	Can the reported data set contain: - structured data objects - data attributes	 Y Y (timestamp attributes are not supported)
Rp10	1, 2	What is the scan cycle for binary events? Is this fixed or configurable?	Event Driven Fixed
Rp11	1	Does the device support the pre-assignment of an RCB to a specific client in the SCL?	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart?	Restored from original configuration

7 PIXIT for Logging model

ID	Ed	Description	Value/Clarification
Lg1	1, 2	What is the default value of LogEna (Compare IEC 61850-8-1 $17.3.3.2.1, the default value should be FALSE)	Not Supported
Lg2	-	What is the format of EntryID	Deprecated
Lg3	1, 2	Are there are multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition (Compare IEC 61850-8-1 $17.3.3.3.2)	Not Supported
Lg4	1	Pre-configured LCB attributes that cannot be changed online	Not Supported

8 PIXIT for GOOSE publish model

ID	Ed	Description	Value/Clarification
Gp1	1, 2	Can the test (Ed1)/simulation (Ed2) flag in the published GOOSE be set?	N
Gp2	1	What is the behavior when the GOOSE publish configuration is incorrect?	DUT keeps GoEna=F. Configuration tool does not allow wrong configuration to be uploaded into device e.g. empty dataset.
Gp3	1, 2	Published FCD supported common data classes are:	SPS, INS, ENS, ACT, ACD, MV, CMV, SAV, WYE, DEL, SEQ, INC, ENC, SPC, DPC, INC, ENC. (Only the elements with FC=ST or MX are published.)
Gp4	1, 2	What is the slow retransmission time? Is it fixed or configurable?	Configured by SCL or GoCB MaxTime
Gp5	1, 2	What is the fastest retransmission time? Is it fixed or configurable?	MinTime = 5 ms Fixed
Gp6	-	Can the GOOSE publish be turned on/off by using SetGoCBValues(GoEna)?	Y
Gp7	1, 2	What is the initial GOOSE sqNum after restart?	sqNum = 1
Gp8	1	Can the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y Y (timestamp attributes are not supported)

Gp9		How is the retransmission curve after a change?	sqNum = 0 New change sqNum = 1 -> 5ms later with TAL = 1000 sqNum = 2 -> 10ms later with TAL = 1000 sqNum = 3 -> 15ms later with TAL = 4000 sqNum = 4 -> 1000ms later with TAL = Update time* multipled by 4 sqNum = 5 -> Update time* later with TAL = Update time* multipled by 4 sqNum = 6-> Update time* later with TAL = Update time* multipled by 4 sqNum = 7 .... *Update time is configured in the ICT

9 PIXIT for GOOSE subscribe model

ID	Ed	Description	Value/Clarification
Gs1	1, 2	What elements of a subscribed GOOSE header are checked to decide the message is valid and the allData values are accepted? If yes, describe the conditions. Notes: - The VLAN tag may be removed by a ethernet switch and shall not be checked - The simulation flag shall always be checked (Ed2) - The ndsCom shall always be checked (Ed2)	Y Destination MAC address Y APPID N gocbRef Y timeAllowedtoLive N datSet Y goID N t N stNum N sqNum Y simulation/test N confRev Y ndsCom Y numDatSetEntries
Gs2	1, 2	When is a subscribed GOOSE marked as lost? (TAL = time allowed to live value from the last received GOOSE message)	Message does not arrive after TAL.
Gs3	1, 2	What is the behavior when one or more subscribed GOOSE messages isn't received or syntactically incorrect (missing GOOSE)?	Message is ignored, but when the next correct message is received, it proceeds as normal.
Gs4	1, 2	What is the behavior when a subscribed GOOSE message is out of order?	Message proceeds.
Gs5	1, 2	What is the behavior when a subscribed GOOSE message is duplicated?	Message is ignored.
Gs6	1	Does the device subscribe to GOOSE messages with and without the VLAN tag?	Y
Gs7	1	Can the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y N
Gs8	1, 2	Subscribed FCD supported common data classes are:	DUT can receive all kinds of data but only digitals can be mapped.
Gs9	1, 2	Are subscribed GOOSE with test=T (Ed1)/simulation=T (Ed2) accepted in test/simulation mode?	N
Gs10	2	What is the behavior when a subscribed GOOSE message with TAL = 0 is received by the subscriber?	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.
Gs11	2	What is the behavior when a subscribed GOOSE message doesn't have the expected data structure?	The message is ignored. The mechanism applies where the new GOOSE message is not received within a TAL.

10 PIXIT for Control model

ID	Ed	Description	Value/Clarification
Ct1	-	What control models are supported? (compare PICS)	Deprecated
Ct2	1, 2	Is the control model fixed, configurable and/or dynamic?	Configurable and Dynamic
Ct3	-	Is TimeActivatedOperate supported? (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported? (compare sboClass)	Deprecated
Ct5	1	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request? (when N test procedure Ctl2 is applicable)	N
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request?	Deprecated
Ct7	-	Is pulse configuration supported? (compare pulseConfig)	Deprecated
Ct8	1, 2	What is the behavior of the DUT when the check conditions are set? Is this behavior fixed, configurable or online changeable?	N synchrocheck N interlock-check DUT ignores the check value and always perform the check
Ct9	1, 2	Which additional cause diagnosis are supported?	Y Unknown Y Not-supported Y Blocked-by-switching-hierarchy N Select-failed Y Invalid-position Y Position-reached N Step-limit N Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchrocheck Y Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel Y Time-limit-over N Abortion-by-trip Y Object-not-selected **Edition 1 specific values:** N Parameter-change-in-execution **Edition 2 specific values:** Y Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None Y Inconsistent-parameters Y Locked-by-other-client N Parameter-change-in-execution
Ct10	1, 2	How to force a "test-not-ok" response with SelectWithValue request?	Device in local mode
Ct11	1, 2	How to force a "test-not-ok" response with Select request?	
Ct12	1, 2	How to force a "test-not-ok" response with Operate request?	DOns: Sending T=1 SBOns: Sending T=1 DOes: Sending T=1 SBOes: Sending T=1

Ct13	1, 2	Which origin categories are supported/accepted?	N bay-control Y station-control Y remote-control N automatic-bay Y automatic-station Y automatic-remote N maintenance N process
Ct14	1, 2	What happens if the orCat value is not supported or invalid?	DOns: control is rejected (Oper- ObjectAccessDenied) SBOns: control is rejected (Oper- ObjectAccessDenied) DOes: control is rejected (Oper- ServiceError, ObjectAccessDenied) SBOes: control is rejected (SBOw- ServiceError,ObjectAccessDenied)
Ct15	1, 2	Does the IED accept a SelectWithValue/Operate with the same control value as the current status value? Is this behavior configurable?	N DOns N SBOns N DOes N SBOes N Configurable
Ct16	1, 2	Does the IED accept a select/operate on the same control object from two different clients at the same time?	N DOns N SBOns N DOes N SBOes
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	N SBOns N SBOes
Ct18	1, 2	Is for SBOes the internal validation performed during the SelectWithValue and/or Operate step?	SelectWithValue and Operate
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked? (Compare PIXIT-Sr5)	Deprecated
Ct20	1, 2	Does the IED support local/remote operation?	Y (Only for XCBR)
Ct21	1, 2	Does the IED send an InformationReport with LastApplError as part of the Operate response for control with normal security?	N SBOns N DOns
Ct22	2	How to force a "parameter-change-in-execution"?	N/A SBOns N/A SBOes
Ct23	1, 2	How many SBOns/SBOes control objects be selected at the same time?	SBOns: n = "1" DOns: n = "1"
Ct24	1, 2	Does the DUT support any operate timeout >0?	Y
Ct25	1, 2	When CDC=DPC is supported, is it possible to have DPC (Controllable Double Point) go to the intermediate state? (00)	N

11 PIXIT for Time synchronisation model

ID	Ed	Description	Value/Clarification
Tm1	1, 2	What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown N ClockFailure Y ClockNotSynchronized.
Tm2	1, 2	Describe the behavior when the time server(s) ceases to respond. What is the time server lost detection time?	On one time server: An event is generated On all time servers: An event is generated 180 seconds
Tm3	1, 2	How long does it take to take over the new time from the time server?	2 seconds
Tm4	1, 2	When is the time quality bit "ClockFailure" set?	Never
Tm5	1, 2	When is the time quality bit "Clock not Synchronized" set?	60 seconds after the time server(s) ceases to respond.
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle?	Deprecated
Tm7	1	Does the device support time zone and daylight saving?	Y

Tm8	1, 2	Which attributes of the SNTP response packet are validated?	Y Leap indicator not equal to 3 Y Mode is equal to SERVER N OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N Other (describe)
Tm9	1, 2	Do the COMTRADE files have local time or UTC time? Is this configurable?	Local N

12 PIXIT for File transfer model

ID	Ed	Description	Value/Clarification
Ft1	1	What is structure of files and directories? Where are the COMTRADE files stored? Are comtrade files zipped? What files are included in each zip file?	/COMTRADE N
Ft2	1, 2	Directory names are separated from the file name by:	"/"
Ft3	1	The maximum file name size including path: (recommended 64 chars)	255 chars
Ft4	1, 2	Are directory/file name case sensitive?	Case sensitive
Ft5	1, 2	Maximum file size for SetFile?	N/A
Ft6	1	Is the requested file path included in the MMS fileDirectory response file name?	Y
Ft7	1	Is the wild char supported MMS fileDirectory request?	No
Ft8	1, 2	Is it allowed that two clients get a file at the same time?	Y same file Y different files
Ft9	1, 2	Which files can be deleted?	N/A

13 PIXIT for Service tracking model

ID	Ed	Description	Value/Clarification
Tr1	2	Which ACSI services are tracked by LTRK.GenTrk?	N/A

7.4 IEC 61850 FUNCTIONALITY

7.4.1 Client Connections

The 650 Family relay supports up to five IEC61850 concurrent client connections, i.e. a maximum of 5 different IEC 61850 clients can connect to it.

The "UseLocSta" setting, which enables/disables usage of LLN0.LocSta, has been implemented in 61850 configurator, in order to verify the origin of the 61850 command. This setting has been added into the CID file, and is configurable using EnerVista IEC61850 version 8.14 or above. In order to access "UseLocSta", a .cid file must be opened in the IEC61850 Configurator menu and it can then be found using the path **GE_F650 > Server Configuration > UseLocSta**. If TRUE, it takes into consideration the LLN0.LocSta values during IEC61850 command execution and if FALSE, LLN0.LocSta values are ignored. If UseLocSta is not implemented, the operation over Logical Nodes XCBR/CSWI/XSWI/vinGGIO will not take LocSta status into consideration.

To activate the use of LocSta, set the value of "UseLocSta" to TRUE using EnerVista IEC61850 Configurator, save the CID file, download it to the relay and reboot it.

The data object "Loc" shows the control behavior of the logical node. In the datamodel of 650 relays, it appears in LLN0/XCBR/XSWI/CSWI Logical Nodes and it is internally mapped to the Local/Remote status of the device.

Note: The saving process is updated in ICD FILE STATUS in System Info and it is recommended that the relay is not rebooted until the process finishes (OK WITHOUT DAIS or OK), otherwise the last value of "LocSta" could be lost.

7.4.2 GOOSES

650 relays support transmission and reception of configurable IEC 61850 Generic Object Oriented Substation Event (GOOSE). If GOOSE communications need to be enabled, Remote comms setting must be set to GOOSE in EnerVista 650 Setup at **Setpoint > Input/Output > Remote Comms**.

Configurable GOOSE is recommended for implementations that require GOOSE data transfer between 650 relays and devices from other manufacturers.

7.4.2.1 TRANSMISSION GOOSES

A maximum of four different transmission GOOSE applications are supported. Data Sets for transmissions GOOSES can have a maximum of 128 elements and can be leaf elements (Data Attributes), or complex structures (Data Objects).

7.4.2.2 RECEPTION GOOSES

650 relays can be subscribed up to 24 different remote devices. A maximum of 32 Remote Inputs (digital signals), 32 Remote Goose Digital inputs and 16 Remote Goose Analog Inputs can be configured to be subscribed to.

The elements of Data Sets for reception GOOSES can be of any types supported in IEC 61850 standard and can be both leaf elements (Data Attributes) and complex structures (Data Objects). However F650 relay can map to its internal variables incoming data of type Boolean, Float, Integer and any of the bits from Bitstring data type.

7.4.3 IEC 61850 Server

The IEC 61850 Server (i.e., 650 relay) reports data to the IEC 61850 Client, such as Local HMI, RTU and Gateway with the information of logical device, data sets, data control block, logical nodes and their data attributes.

7.4.3.1 LOGICAL DEVICES AND REPORTS

Supported buffered and un-buffered report, the report triggers are shown in the following Supported Triggers list.

Supported Triggers List:

- Data-Change
- Quality-Change
- Integrity
- General Interrogation

Supported buffered and un-buffered report option fields are shown in the following Field list.

Field List:

- Sequence number
- Report time stamp
- Reason-for-inclusion
- Dataset-name
- Data-reference
- Buffer-overflow (Buffered reports only)
- Entry id (Buffered reports only)
- Conf- revision

Report control block configuration settings are modified from IEC61850 configurator writing directly in a CID file. There is no Modbus register assigned to those. The datasets for reports are fully configurable with CDCs from any Logical Node. The Description field in the LN is fixed text and it cannot be updated from the Modbus settings

By default,

- if Unbuffered report is selected, 5 Unbuffered Report Control Blocks are created. This figure can be modified from 1 to 5.
- If Buffered report is selected, 1 Unbuffered Report Control Block is created. This figure can be modified from 1 to 5.

7.5 IEC 61850 Status

7.5.1 GOOSES Status

Different status information related with GOOSE transmission/reception process that can be checked through EnerVista 650 Setup:

In **Actual > Inputs/Outputs > Remote Inputs > Remote GOOSE Digital Inputs**:

Rem GOOSE Dig Inp X - Provides status of Remote Goose Digital input X that relay is subscribed to. The green LED lights up if Remote GOOSE Digital Input was set to 1 last time it was received and it turns off if the last Remote GOOSE Digital Input was set to 0.

There is a maximum of 32 Remote GOOSE Digital Inputs that the relay can be subscribed to.

In A**ctual > Inputs/Outputs > Remote Inputs > Remote Inputs**:

Remote Input X - Provides status of Remote input X that relay is subscribed to. The green LED lights up if Remote Input was set to 1 last time it was received and it turns off if the last Remote Input was set to 0

There is a maximum of 32 Remote Inputs that relay can be subscribed to. These remote inputs are digital signals.

In **Actual > Inputs/Outputs > Remote Inputs > Remote GOOSE Analog Inputs:**

Rem GOOSE Ana Inp X- This is the last analog value received in the Remote GOOSE Analog Input configured.

The relay can be subscribed to up to maximum of 8 different float remote GOOSE analog values and 8 different integer remote GOOSE analog values.

In **Actual > Inputs/Outputs > Remote Inputs > Remote Devices:**

Remote Device X - Provides information about status of device that is transmitting GOOSES, that the relay is subscribed to. The green LED lights up if remote device is transmitting GOOSES and it turns off if GOOSE communication is lost with this remote device.

A maximum of 24 different Remote devices can be configured in CID

ALL REM DEV ONLINE - Provides status of Remote Devices that are transmitting GOOSES that the relay is subscribed to. If GOOSE communication with all configured Remote Devices is active, the green LED lights up. If GOOSE communication is lost with any of configured remote devices, it turns off.

In **Actual > Inputs/Outputs > Remote Outputs > Remote GOOSE Digital Outputs:**

Rem GOOSE Dig Out X - Provides status of Remote Goose Digital outputs that are configured to be transmitted by the relay. The green LED lights up if Remote GOOSE Digital Output is set to 1 and it turns off if Remote GOOSE Digital Output is set to 0

7.5.2 IEC 61850 CID Status

Internal Status of CID and its validation can be checked in EnerVista in the following path:

Actual Values > Status > System Info

ICD Edition:

This field shows which IEC 61850 Edition if CID that relays is working with. For F650. See 7.1 IEC 61850 Overview on page 7–1.

ICD FILE STATUS:

This field provides status of CID that is running in the relay.

ICD FILE STATUS	UNKNOWN: When the relay has not the IEC61850 protocol in the relay model the ICD status is unknown to the unit.
	ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 is not operative (the IEC 61850 client, reports and gooses do not work). It is advisable to include the ICD ERROR in the main error signal configured for specific applications.
	MODIFIED: The settings have been changed in the ICD but they are still not written in the ICD file in the relay.
	IN PROGRESS: The ICD settings are being written to the file in the relay.
	OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
	OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the ICD setting prevails over the relay settings.
	DEFAULT: There is no CID file in NotValidated or in Validated and default CID has been loaded. After a reboot, the default CID file is considered as the normal CID file.
	ERROR HEADER CID: there is a discrepancy in the information about product model or firmware version between the firmware of the relay and the CID file. If this message is displayed, the relay will not be able to communicate by using IEC 61850 until this discrepancy is resolved. CID version and firmware version must match in order to get a completely functional relay.
	ERROR SG CID is displayed if the relay has the Setting Group function disabled but the managed CID file has the Settings Groups available or the relay has the Setting Group function enabled but the managed CID file does not.

ICD STATUS NOTVAL:

This field provides information about the NotValidated folder, which is the folder where CIDs that are sent to the relay are stored prior to be validated and marked "Valid".

ICD STATUS NOTVAL	UNKNOWN: No 61850 protocol
	ERROR: The CID file in notvalidated is not valid
	NOTVALIDATED EMPTY: There is no CID file in notvalidated
	IN PROGRESS: The ICD settings are being written to the file in the relay.
	PASSED TO VALIDATED: New valid CID file in notvalidated has been passed to validated
	ERROR HEADER CID: There is a discrepancy in the information about product model or firmware version between the firmware of the relay and the CID file. If this message is displayed, the relay will not be able to communicate by using IEC 61850 until this discrepancy is resolved. CID version and firmware version must match in order to get a completely functional relay.

NOTICE

1. WATCH OUT! If the ICD status is "MODIFIED" or "IN PROGRESS" it is not advisable to switch off the unit because the latest settings will not be stored in the unit.

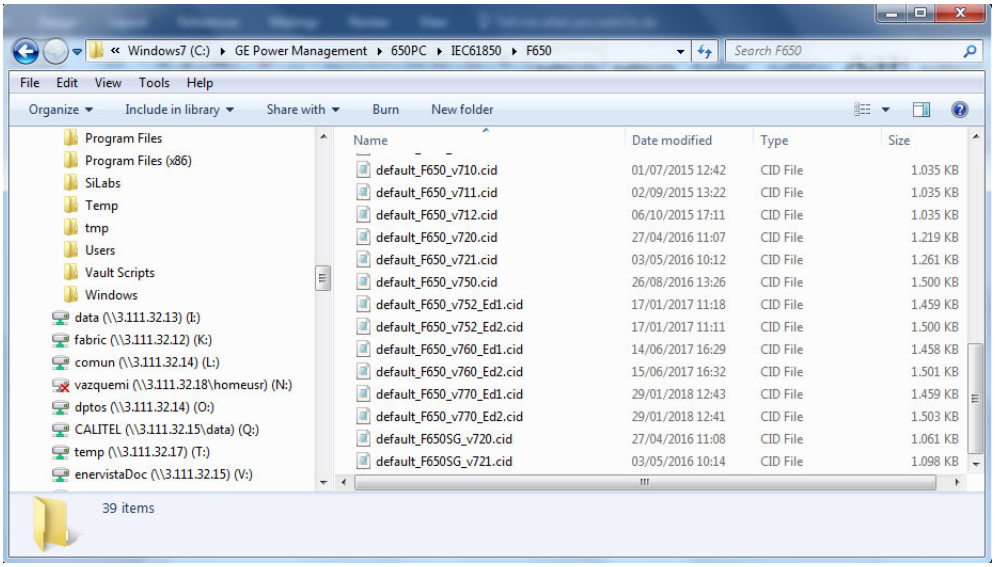
2. In the case that ERROR SG CID is displayed in the ICD Status, ensure that the managed CID has Setting Group enabled if the Setting Groups function is enabled, or ensure that the managed CID has Setting Group disabled if the Setting Groups function is disabled.

For firmware versions 7.20 and 7.21:

- default_F650SG_v7XX.cid: CID file with setting group option enabled
- default_F650_v7XX.cid: CID file with setting group option disabled

For firmware versions below 7.20 or above 7.21:

- default_F650_v7XX.cid: CID file with setting group option disabled/enabled



3. Take into in account that if ERROR HEADER CID value is displayed in the ICD STATUS or ICD STATUS NOT VAL section in **Actual Values > Status > System info**, the relay cannot communicate using IEC 61850 until this discrepancy is resolved. CID version and firmware version must match for a fully functional relay.

7.6 IEC 61850 Configurator

7.6.1 Overview

The 650 family relays support the IEC 61850 protocol which is identified by order code option "6" or "7" (Communication protocol option). This configuration tool can be used with 650 family relays supporting IEC 61850 communication protocol and with firmware version 3.60 or above.

The "IEC 61850 Configurator" tool is located in the top-level menu in EnerVista 650 Setup and it can be used to browse and edit 650 relay's CID/IEC files:

- ICD/CID Settings
- Reports
- GOOSE Reception
- GOOSE Transmission

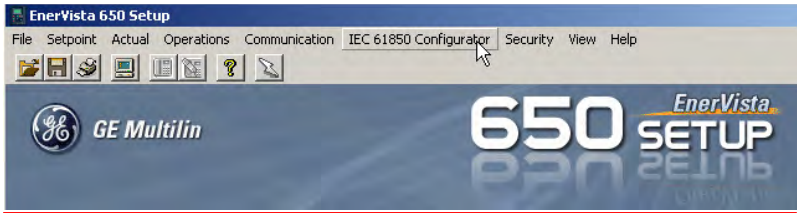


Figure 7-5: IEC61850 configurator menu location

Important Notes:

For firmware versions below 3.60, basic IEC 61850 configuration is located in **Setpoint > 61850 Configuration** (Domain name parameters, Ethernet parameters, MMXU parameters). With this tool some 61850 parameters can be configured in the *650.icd file, and then the .icd file can be uploaded to the relay.

7.6.2 Online/Offline operation modes

Two different working modes can be distinguished in the IEC 61850 Configurator: Offline mode and Online mode.

Offline Operation Mode: When user is not communicating with 650 Family relay, IEC 61850 Configurator tool can be used to work offline mode. In this case, if IEC 61850 Configurator menu is clicked at the menu toolbar in EnerVista, the following windows prompts to allow selection of the IED version to be configured.

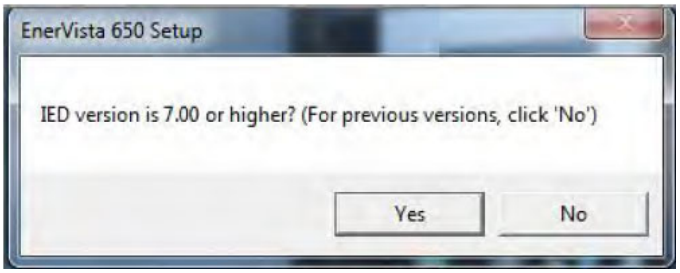


Figure 7-6: IED version verification

- Click **Yes** to browse and edit CID/ICD files for firmware versions above 7.XX
- Click **No** to browse and edit IEC files for firmware versions below 7.XX

Online Operation Mode: When communicating with an F650 using the EnerVista 650 Setup software, the IEC61850 Configurator tool allows access to the CID/IEC of the connected device, or to send a previously configured file.

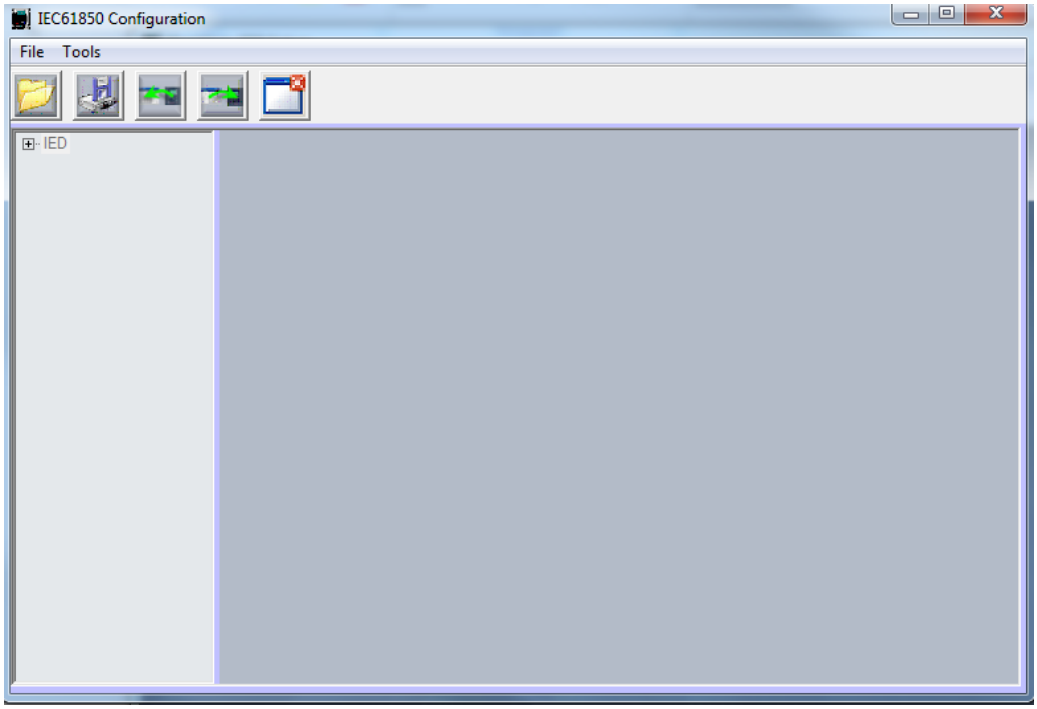


Figure 7-7: IEC 61850 Configurator main screen

7.6.3 IEC 61850 configurator details

The IEC61850 Configurator allows editing in all sections of the IEC61850 CID file. Other operations cannot be performed in the EnerVista 650 Setup software if the IEC 61850 Configurator is open. Close the IEC61850 session to perform other operations.

In the following sections, detailed information about CID configuration for firmware version 8.00 is described. These same steps apply to CID configuration for all 650 family firmware versions 7.00 and above.

7.6.3.1 IEC 61850 configurator interface.

Four different areas can be identified in IEC 61850 configurator interface, as shown in the figure that follows:

- Menu toolbar
- Quick menu toolbar
- IEC 61850 IED Explorer window
- Configuration area

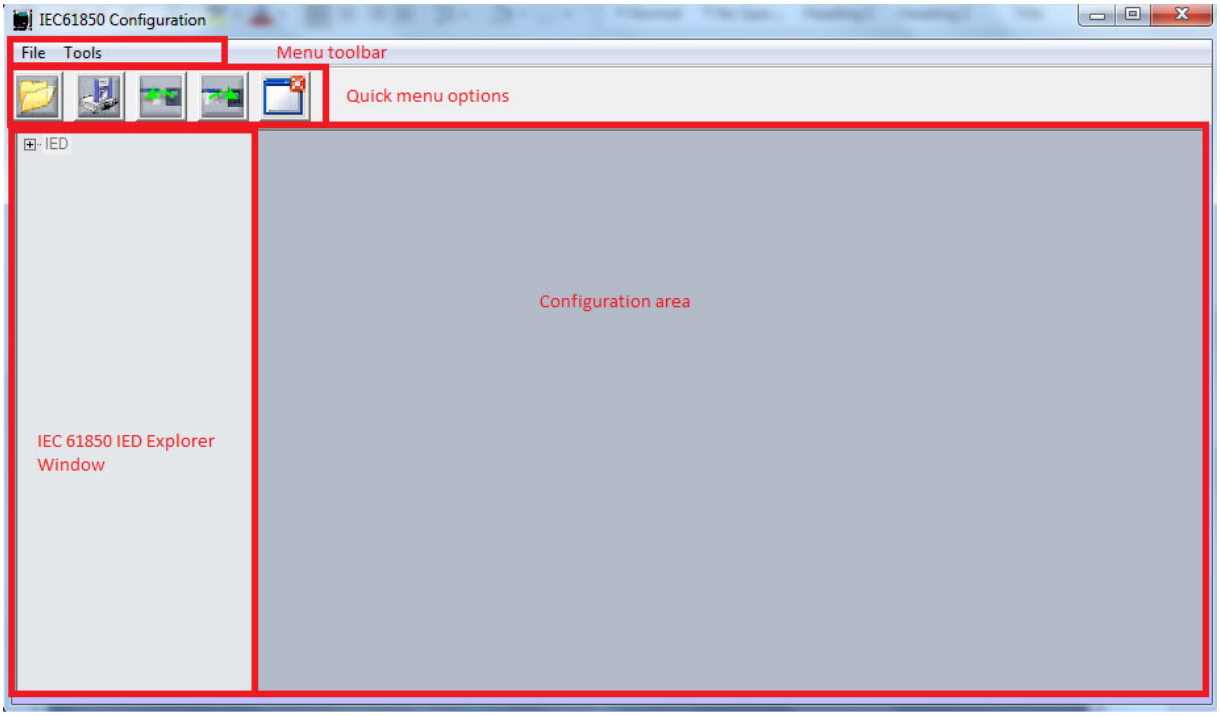


Figure 7-8: IEC 61850 Configurator interface

7.6.3.1.1 Menu toolbar

Two menus available in this area:

File Menu: (See 7.6.3.1.2 Quick Menu Toolbar for detailed information)

- Open *.cid file
- Save *.cid file
- Receive CID file from device
- Send CID file to the device
- Import CID from SCD
- Exit

The Import CID from SCD menu option allows the user to select the SCD file and use it to import the CID from the 650. A new window is displayed as shown below.

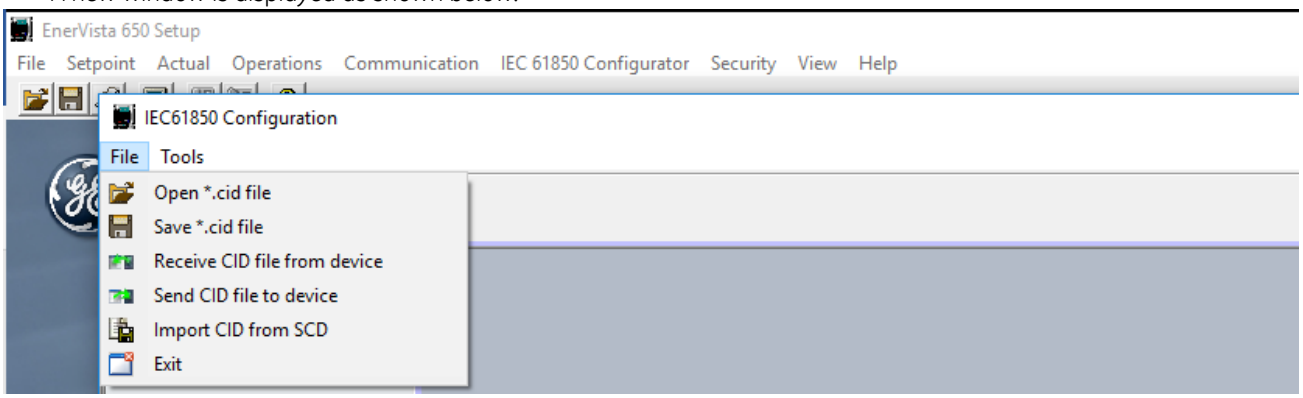


Figure 7-9: File Menu Options

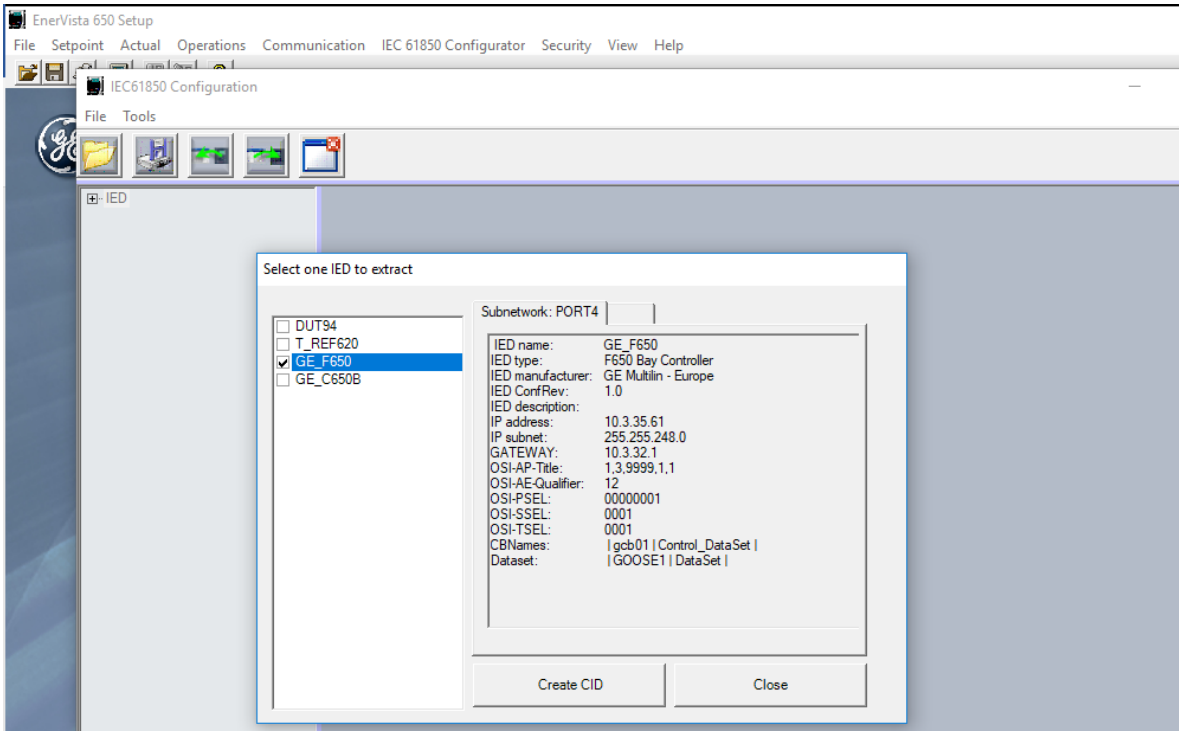


Figure 7-10: IED Extraction

Note: This functionality only works when the CID has been exported using EnerVista from SCDs coming from SCT tools that

expect information in intAddr field in line with the 650 Edition 2 CID default template (version 7.71 or above) provided with EnerVista 650 8.12 or above.

Tools Menu: (CID conversion tools)

A CID file converter menu option is available in the IEC 61850 Configurator menu: **Tools > ConvertCIDFiles**. The CID file converter enables CID file conversion, allowing for conversion of CID files in parallel with relay firmware updates. The main parts of the CID file that are maintained are the configurable fields at the Communication and IED levels, the public and private Settings, Datasets, Report Control Blocks, GOOSE Transmission Control Blocks and GOOSE Reception.

To convert a CID file, follow these steps:

1. In the IEC61850 Configurator, select **Tool > ConvertCIDFiles**.

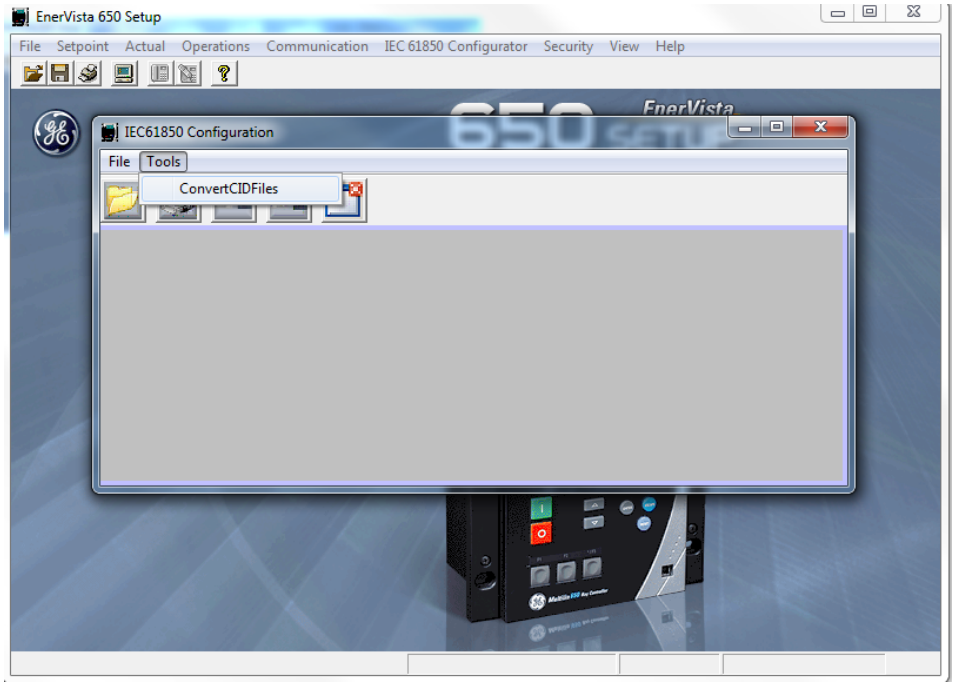


Figure 7-11: ConvertCIDFiles option

2. Select a CID file to convert in the **CID file (*.cid)** field.

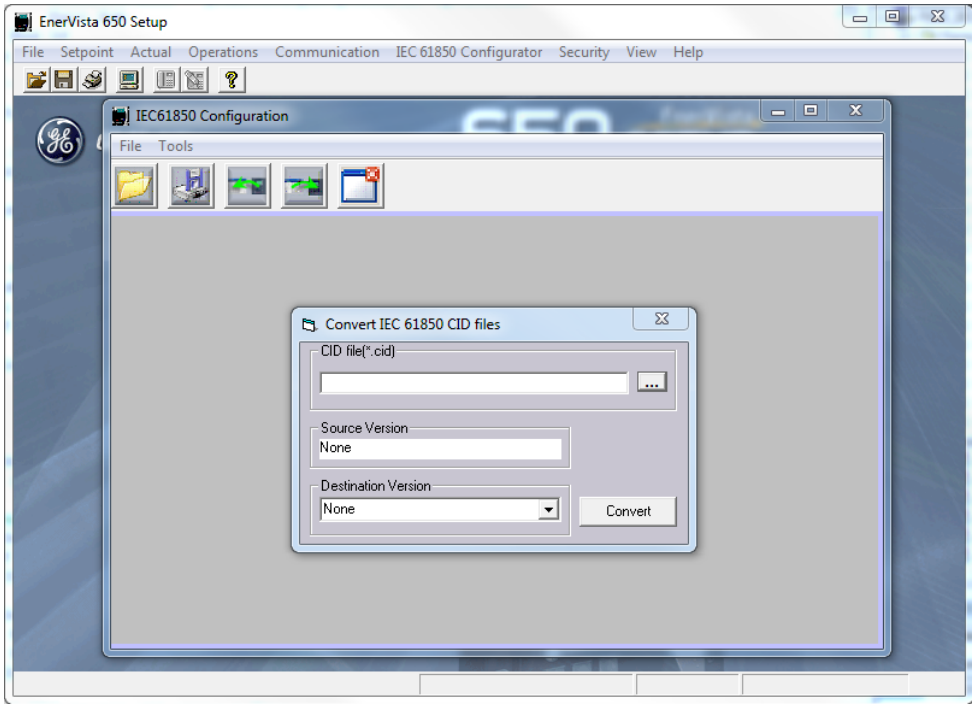
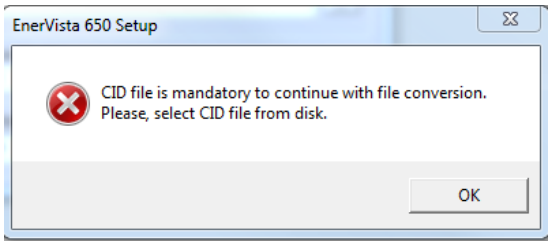


Figure 7-12: Main window in IEC61850 CID files conversion tool

3. If no **CID file** is selected, an error message is displayed.



4. The CID file Converter fills in the firmware version of the selected CID file under **Source Version**. Select the new firmware version for the CID file under **Destination Version**.

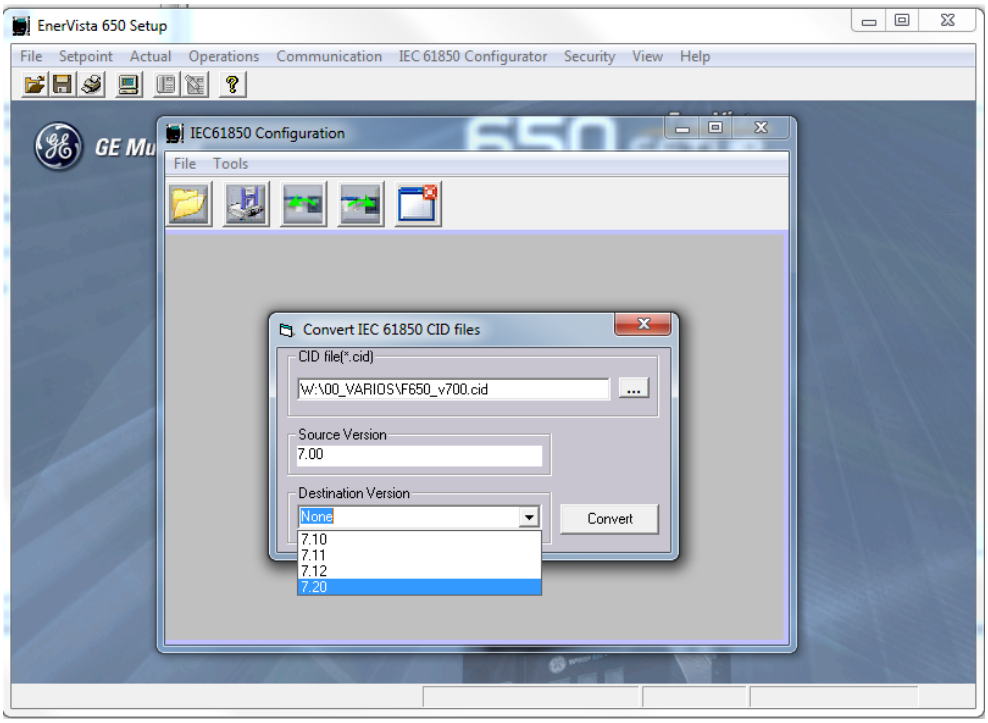
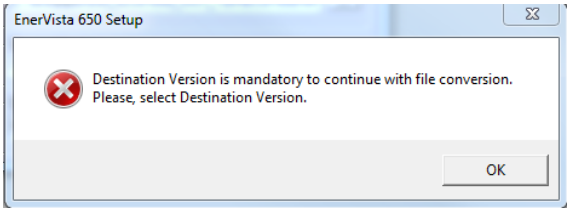


Figure 7-13: Selection of CID files versions

5. If no **Destination Version** is selected, an error message is displayed.



Note: For successful conversion, the default CID file templates installed with the EnerVista 650 Setup must be in the installed folder location with their original names, as shown.

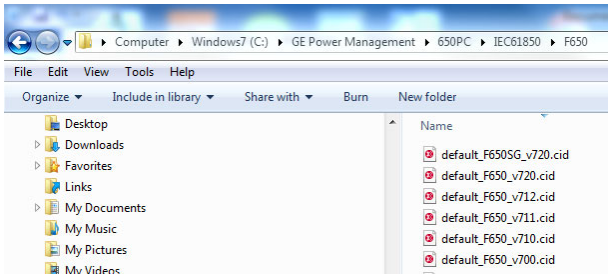


Figure 7-14: Requirements for CID conversion

6. Click **Convert** to start the conversion process. When the conversion is finished, a successful conversion message is

displayed, followed by a message confirming the name and location of the converted file.

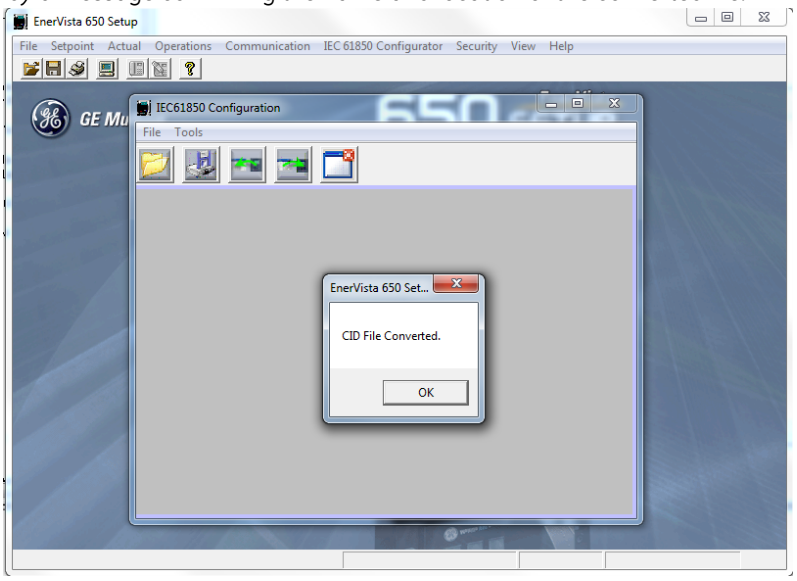


Figure 7-15: Successful CID conversion

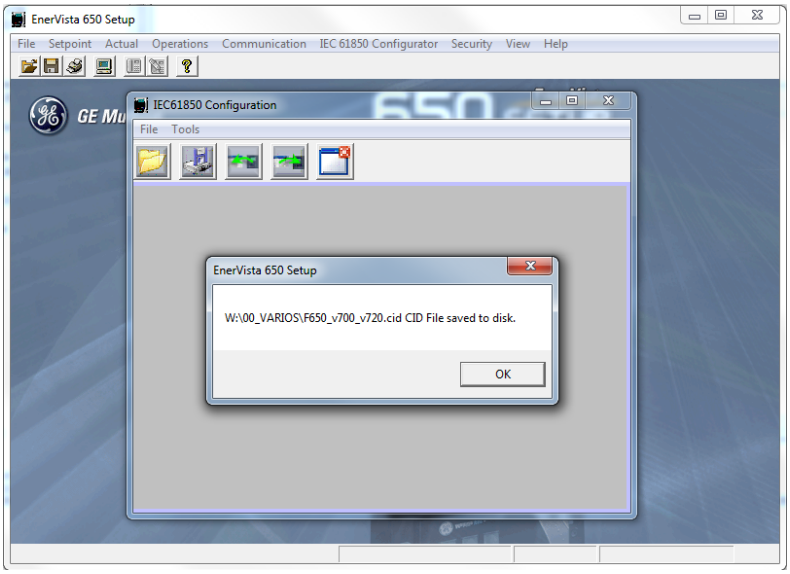


Figure 7-16: CID file created and saved to disk

7.6.3.1.2 Quick Menu Toolbar

Menu Action	Tool Bar Icons
Open *.cid file	
Save*.cid file	
Receive CID file from device	
Send CID file to device	
Exit	

Open *CID file

The **Open *CID file** menu allows the user to work in offline mode to configure IEC 61850 protocol in 650 devices. In that occasion, the tool shall work with *.cid file extension which contain the icd file from the device.

Find the "default_F650_vXXX.cid" corresponding to the firmware version related to EnerVista installation in the EnerVista 650 Setup software default files.

To download the active CID file from the relay:

1. Open the EnerVista Setup software, and click **IEC 61850 Configurator** on the menu bar.
2. Select **File > Receive CID file from device**, or click the download button.
3. Connect to the relay as prompted if you are not already connected.

   Once the download completes, a message displays indicating a successful download. The CID file can then be saved locally.
4. Select **File > Open *.cid file**, or click the **Open** button. Select the CID file to view and edit in the IEC 61850 Configurator.
5. Check the title bar of the IEC61850 Configurator to see the name of the CID file, as shown in the figure below.

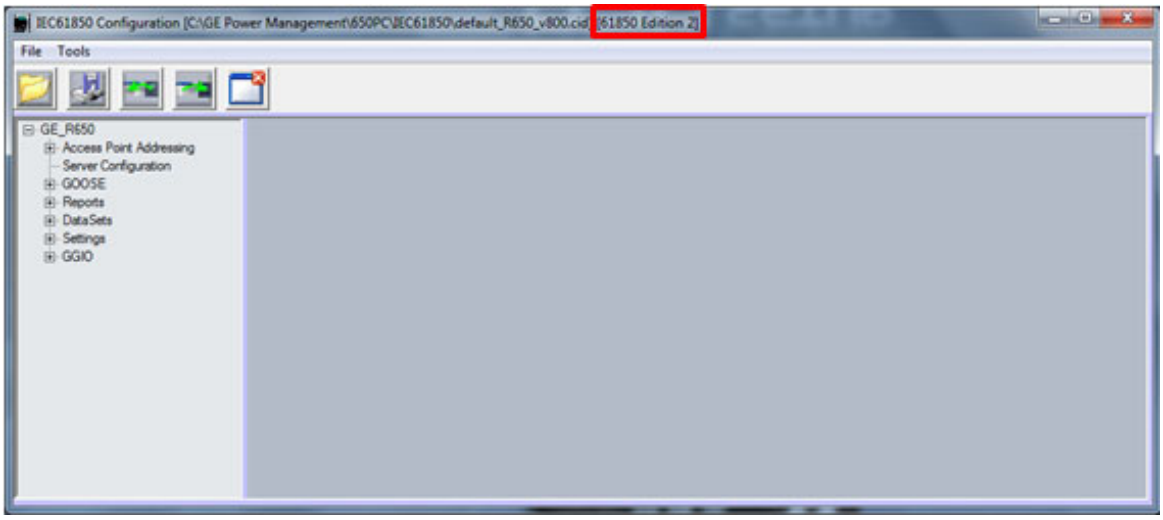


Figure 7-1: Information about the IEC 61850 Edition

For all scenarios, after opening the file all ICD data is displayed in the tree on the left and the user can start configuring the IEC 61850 protocol in 650 devices.

To determine whether the relay is working with CID Edition 1 or Edition 2, check **EnerVista > Actual Values > System Info** for firmware versions above 7.60.

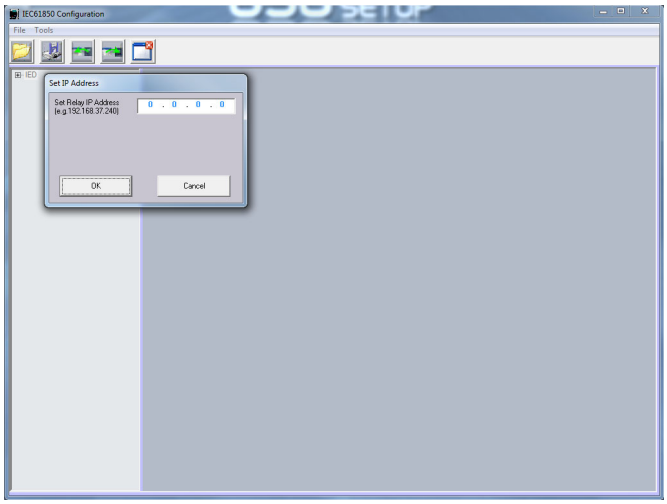
Save CID file

After modifying the files using this tool the user can save them in the computer under the *.cid format, using the **Save *cid file** option.

Receive CID file from device

Select the option **Receive CID file from device** to retrieve the IEC 61850 files from the 650 device for visualization or further modifications.

- If the user is already communicating with the 650 device using the **Modbus/TCP** option in the **Communication** menu the retrieve files options are performed over the IP Address selected in the **Communication** menu.
- If the user is not communicating with a relay when the **Receive CID file from device** option is selected, the program pops up a menu asking for the IP Address of the unit.



Enter the IP address and click OK to initiate connection.

- If connection fails, an error message is shown (see below).
- If file transfer is performed successfully, a success message is shown.

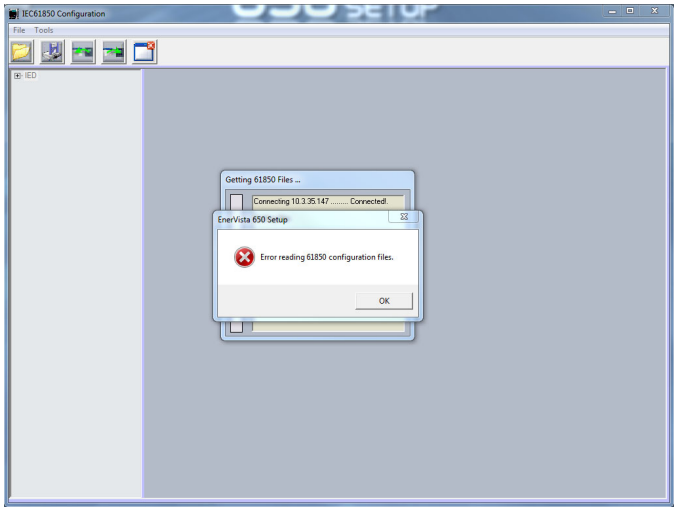


Figure 7-2: Error message pop up window

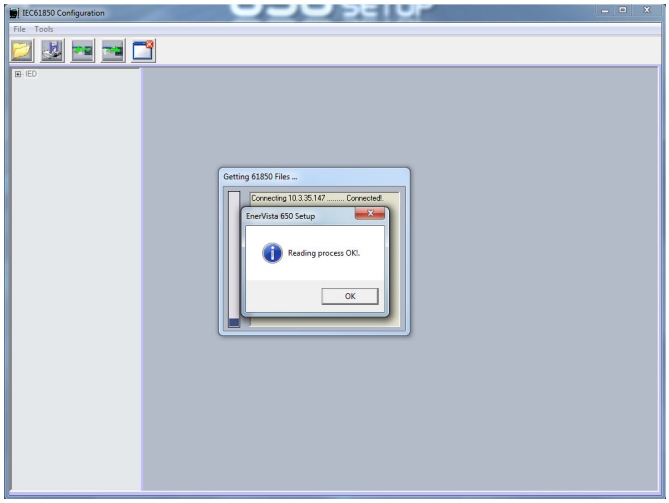


Figure 7-3: File transfer successfully performed

After retrieving the CID file it can be saved on the local PC by clicking the **Open** button and selecting the received file. All ICD data is displayed in the tree on the left, and the IEC 61850 protocol is ready to configure.

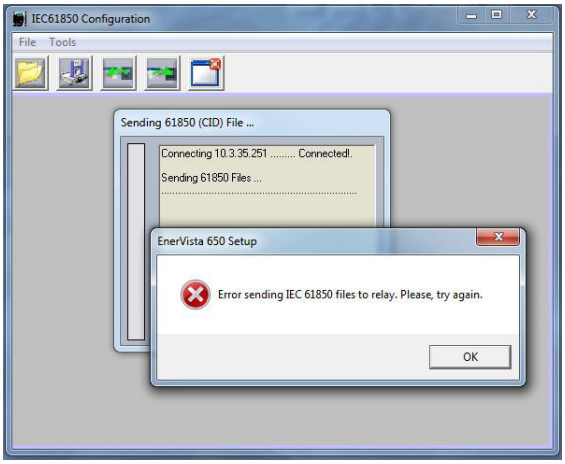
Send CID file to device

The user can send the IEC 61850 files to the 650 relays using the **Send IEC 61850/CID file to device** menu, this menu can be user either in offline or online mode.

If the user is already communicating with the 650 device using the **Modbus/TCP** option in the **Communication** menu the send files options are performed over the IP Address selected on the **Communication** menu.

If the user is working in offline mode using the **Open IEC 61850/CID file from disk** option, when the "**end IEC 61850 file to device** option is selected, the program shall pop up a window to introduce the IP Address.

- If file transfer fails, error message will be displayed.
- If file is successfully sent, the program will display a pop up message asking to reboot the relay, as shown.



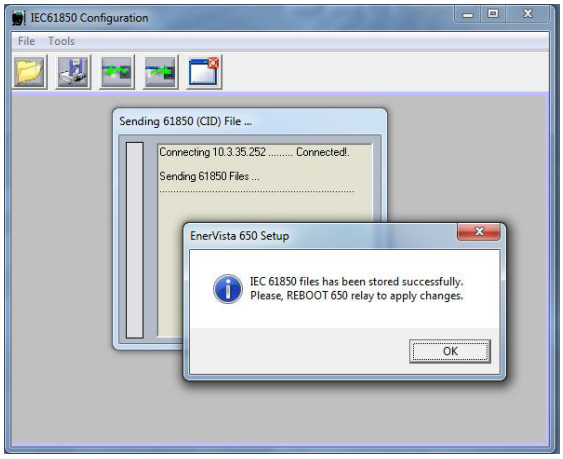


Figure 7-4: Send file successfully performed

These pop-up menus also appear the **Send IEC 61850 file to device** option is selected after retrieving the files using the **Receive IEC 61850 file from device**.

Exit

When **Exit** is selected, the program prompts to save the configuration to disk or send it to the relay.

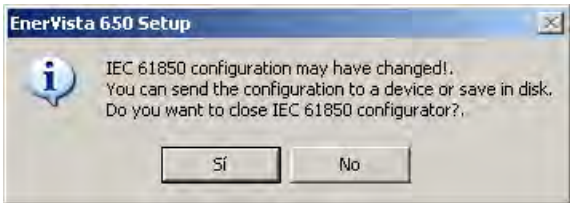


Figure 7-5: Exit IEC 61850 Configurator

7.6.3.1.3 IEC 61850 IED Explorer Window

After opening a CID file, the IED Explorer "tree" will be displayed in this area. Six different items are available in this menu:

- Access Point Addressing
- Server Configuration
- Settings
- DataSets
- Reports
- GOOSE

To Modify the Parameters

1. Select a parameter in the ICD Explorer window to open the Attributes window in the right part of the screen.
2. In the Configuration area, double click in the parameter column of the table and enter the new value for that setting. To confirm changes, double-click out of parameter field.

Access Point Addressing

Following settings can be configured in this section.

SETTING	PARAMETER
IP	0.0.0.0
IP-SUBNET	0.0.0.0
IP-GATEWAY	0.0.0.0
OSI-AP-Title	1,3,9999,1,1
OSI-AE-Qualifier	12
OSI-PSEL	00000001
OSI-SSEL	0001
OSI-TSEL	0001
GOOSE-Port	0
MMS-Port	102
MMS-Connection-Timeout	120 s

- IP, IP-SUBNET, IP-GATEWAY: The parameters are the configured ETH_A IP details configured in the device through EnerVista: **Setpoints > Product Setup > Communications > Network**
- OSI-AP-Title, OSI-AE-Qualifier, OSI-PSEL, OSI-SSEL, OSI-TSEL: The parameters must be configured according to the IEC 61850 standard
- GOOSE-port: Three different options are available in this dropbox depending which port wants to be selected for GOOSE transmission (ETHA-ETHB-Both) the user to change the GOOSE port number for GOOSE communication.
- MMS-Port: The range of the setting is 1 to 65535, in steps of 1. The setting allows the user to change the TCP port number for MMS connections.
- MMS- Connection-Timeout: The setting is useful for detecting "fail" IEC 61850 connections. The timer must be application specific for IEC 61850. If there is no data traffic on an established connection for more than this setting time, the connection is disconnected from the server

Server Configuration

SETTING	PARAMETER
IED NAME	TEMPLATE
UseDoiDai	false
Power Max and Min Automatic Calculation	true
PRO functional IdName	PRO
CON functional IdName	CON

- **IED NAME**: Up to 64 alphanumeric characters. The IED Name represents the MMS domain name (IEC 61850 logical device) where all IEC/MMS logical nodes are located. Valid characters for these values are upper and lowercase letters, numbers, and the underscore (_) character, and the first character in the string must be a letter. This conforms to the IEC 61850 standard. Default value is "GEDevice"
- **UseDoiDai**:
  - If this setting is set to false: the relay works only with the settings located in the relay's memory and the changes performed on the ICD in settings related with the protection and control functions are only stored on the ICD file but not updated in the relay.
  - If this setting is set to true, you are selecting the ICD file settings to prevail over the relay settings. This means that after changing settings in the ICD and powering the relay off and on the unit works with the settings included in the ICD.

  All setting changes performed through the HMI or EnerVista 650 Setup are automatically updated over the ICD file, likewise if there is any change in the ICD file these changes are updated in the relay settings. The relay starts working with the new ICD file after sending the file to the unit and powering the relay off and on.
- **Power Max and Min Automatic Calculation** *:
  - If set to True, Max and Min values used for Power reporting are automatically calculated based on the CT Ratio and VT Ratio setpoints.
  - If set to False, Max and Min values used for Power reporting are configurable in the Settings / Max and Min tab.

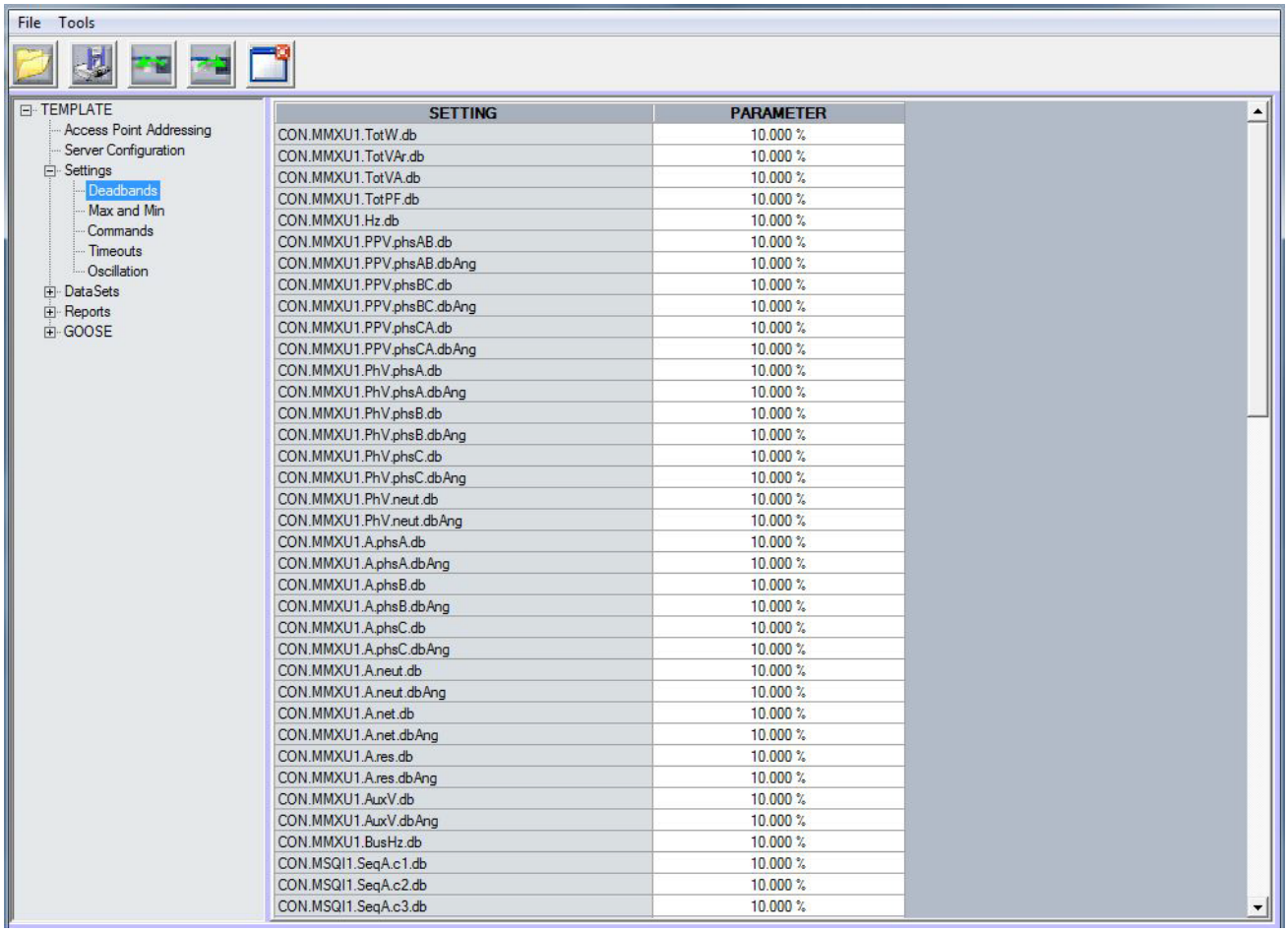
  *This setting is only available for Firmware version 7.70 and above.
- **PRO functional IdName**: ID name of logical device where all protection logical nodes are available. The logical device name is used to identify the IEC 61850 logical device that exists within the F650 and this name is composed of two parts: the IED NAME and the PRO/CON functional IdName. Default name for PRO functional IdName is PRO
- **CON functional IdName**: ID name of logical device where all control logical nodes are available. Default name for CON functional IdName is CON

Settings

Four different levels are available under setting section:

- Deadbands
- Commands
- Timeouts
- Oscillation
- Max and Min

DEADBANDS



SETTING	PARAMETER
CON.MMXU1.TotW.db	10.000 %
CON.MMXU1.TotVAr.db	10.000 %
CON.MMXU1.TotVA.db	10.000 %
CON.MMXU1.TotPF.db	10.000 %
CON.MMXU1.Hz.db	10.000 %
CON.MMXU1.PPV.phsAB.db	10.000 %
CON.MMXU1.PPV.phsAB.dbAng	10.000 %
CON.MMXU1.PPV.phsBC.db	10.000 %
CON.MMXU1.PPV.phsBC.dbAng	10.000 %
CON.MMXU1.PPV.phsCA.db	10.000 %
CON.MMXU1.PPV.phsCA.dbAng	10.000 %
CON.MMXU1.PhV.phsA.db	10.000 %
CON.MMXU1.PhV.phsA.dbAng	10.000 %
CON.MMXU1.PhV.phsB.db	10.000 %
CON.MMXU1.PhV.phsB.dbAng	10.000 %
CON.MMXU1.PhV.phsC.db	10.000 %
CON.MMXU1.PhV.phsC.dbAng	10.000 %
CON.MMXU1.PhV.neut.db	10.000 %
CON.MMXU1.PhV.neut.dbAng	10.000 %
CON.MMXU1.A.phsA.db	10.000 %
CON.MMXU1.A.phsA.dbAng	10.000 %
CON.MMXU1.A.phsB.db	10.000 %
CON.MMXU1.A.phsB.dbAng	10.000 %
CON.MMXU1.A.phsC.db	10.000 %
CON.MMXU1.A.phsC.dbAng	10.000 %
CON.MMXU1.A.neut.db	10.000 %
CON.MMXU1.A.neut.dbAng	10.000 %
CON.MMXU1.A.net.db	10.000 %
CON.MMXU1.A.net.dbAng	10.000 %
CON.MMXU1.A.res.db	10.000 %
CON.MMXU1.A.res.dbAng	10.000 %
CON.MMXU1.AuxV.db	10.000 %
CON.MMXU1.AuxV.dbAng	10.000 %
CON.MMXU1.BusHz.db	10.000 %
CON.MSQI1.SeqA.c1.db	10.000 %
CON.MSQI1.SeqA.c2.db	10.000 %
CON.MSQI1.SeqA.c3.db	10.000 %

Figure 7-17: Configuration of deadbands for MMXU

Range: 1 to 100.000 %

The MMXU deadband settings represent the deadband values used to determine when to update the MMXU "mag" and "cVal" values from the associated "instmag" and "instcVal" values. The "mag" and "cVal" values are used for the IEC 61850 buffered and unbuffered reports. The settings correspond to the associated "db" data items in the CF functional constraint of the MMXU logical node, as per the IEC 61850 standard. According to IEC 61850-7-3, the db value "shall represent the percentage of difference between the maximum and minimum in units of 0.001%". Thus, it is important to know the maximum value for each MMXU measured quantity, since this represents the 100.00% value for the deadband and therefore A value of 1000 represents the 1% of the scale.

The equations to calculate minimum (min) and maximum (max) values in the MMXU nodes of F650 are as follows:

MMXU Node Value	To Calculate Min/Max for F650/C650
TotW , TotVar (MW, MVAr)	**For firmware below 7.70:** max = (Phase CT Ratio *160) * (Phase VT Ratio * 300)/1000000 min = -max **For firmware 7.70 or above:** If Power Max and Min Automatic Calculation setting is set to false: max = configurable value (Value is referred to primary values) min = configurable value (Value is referred to primary values) If Power Max and Min Automatic Calculation Setting is set to true: max value will be the same as for firmware below 7.70 min value will be the same as for firmware below 7.70 **Note**: When max/min values are configurable, setting these values below accuracy levels could result in unpredictable behavior.
TotVA (MVA)	**For firmware below 7.70:** max = (Phase CT Ratio *160) * (Phase VT Ratio * 300)/1000000 min = 0 **For firmware 7.70 or above:** If Power Max and Min Automatic Calculation setting is set to false: max = configurable value min = configurable positive value If Power Max and Min Automatic Calculation Setting is set to true: max value will be the same as for firmware below 7.70 min = 0 Note: When max/min values are configurable, setting these values below accuracy levels could result in unpredictable behavior.
Hz dbAng angle dB = (DB percentage* 360)	max = 70 min = 0
Hz Rte	max = 15 min = -15
PPV/PhV /Seq (measurement in kV)	max= VT Ratio /1000 * 300; min = 0
A$phsA, phsB, phsC, A$neut, A$res (kA) SeqA$c1, c2 ,c3	max=((Phase or Ground CT Ratio) /1000)*160; min = 0

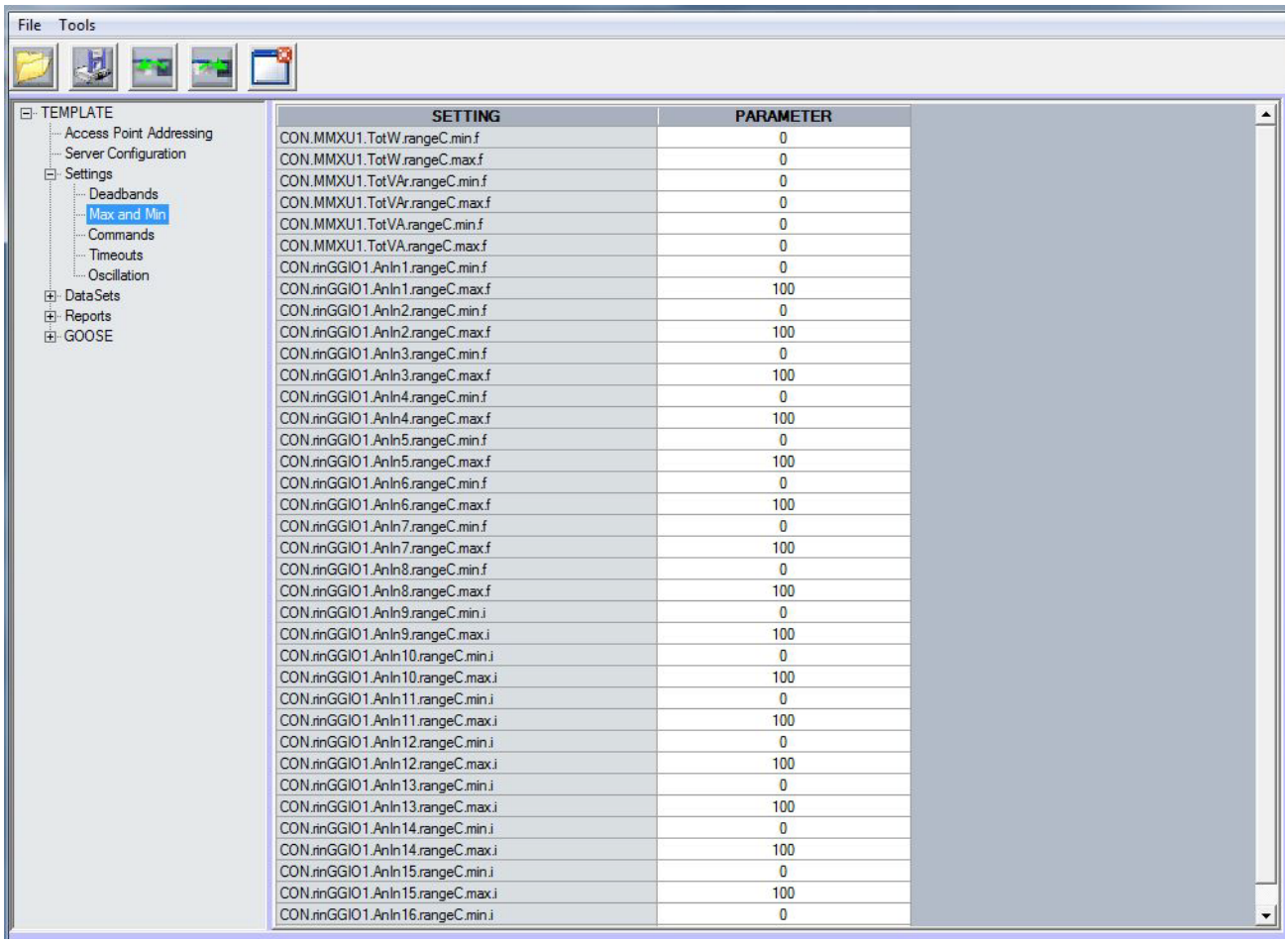
MMXU Node Value	To Calculate Min/Max for F650/C650
dbAng	angle dB = (DB percentage* 360) For firmware versions below 5.00: There is one common deadband used both for angles and magnitudes in the corresponding phasor measurement (current or voltage). Take this into account when using reports with data change, because in some cases the angle value can trigger reports quite often due to the difficulty in calculating a common deadband for both values (angle and magnitude). In these cases it is advisable to use the integrity report in firmware versions lower than 5.00. For firmware versions above 5.00: The 650 family of relays implements separate deadbands for magnitude and angle for phasors (voltages and currents). Thus, for example, the phase A current attribute in the 650 relay includes two deadbands, one for phase A current magnitude and the other for phase A current angle. The deadband for magnitude is the db parameter while the deadband for angle is the dbAng parameter In addition to the MMXU logical node, MSQI and Remote Input GGIO (default name rinGGIO1) also have attributes that are analogue values and contain db parameters to establish deadbands. For firmware version below 7.00, deadbands are available in ICD/CID tab.

WARNING: If deadbands are configured to allow measurement oscillation reporting below accuracy level, relay could present with some unexpected behaviors.

MAX AND MIN

Max and min values for analog inputs and power reporting* are configurable on this tab.

**Max and min values for Power reporting are only available when the Power Max and Min Automatic Calculation setting is set to false (See Server Configuration on page 7–228)*



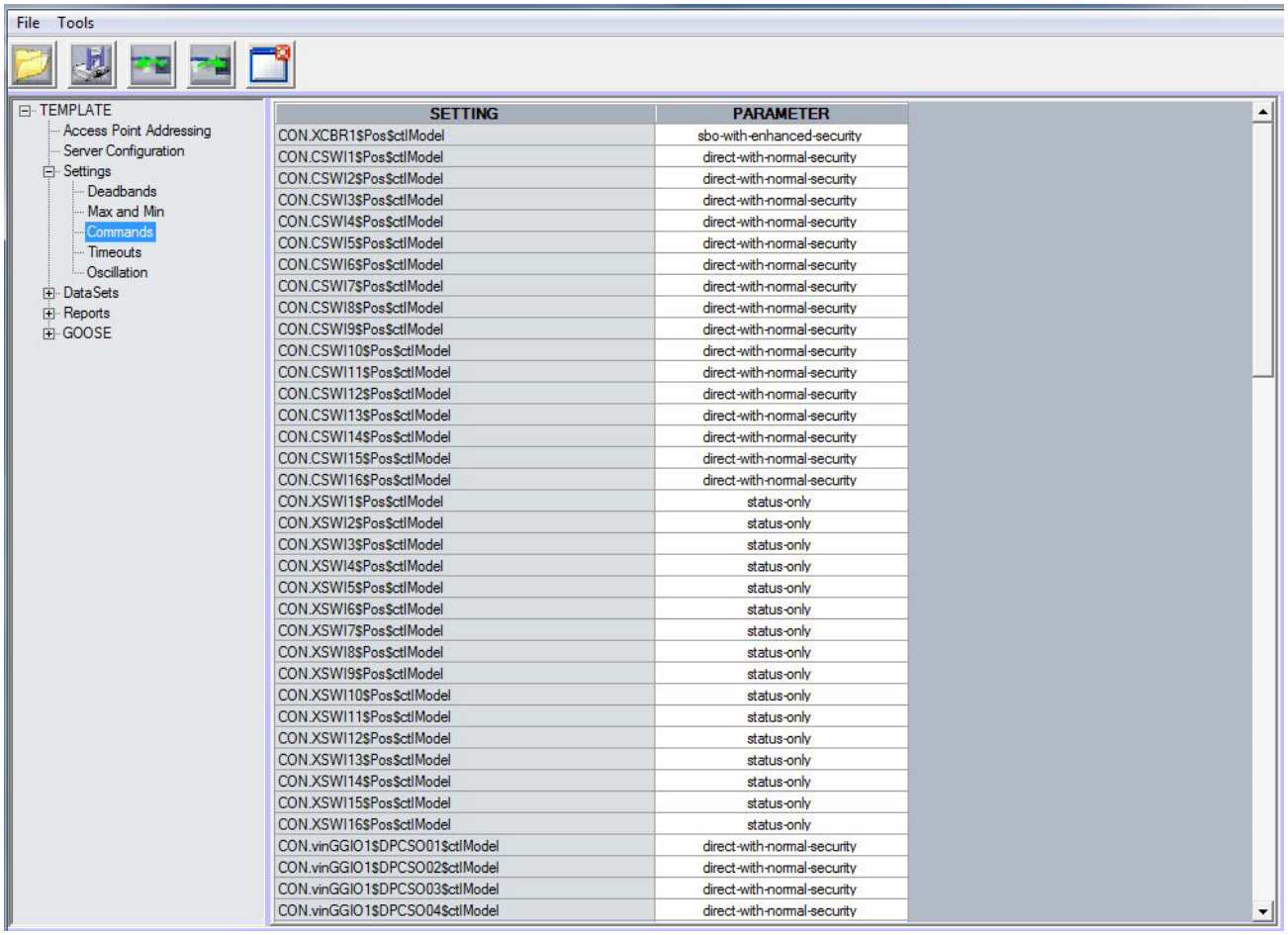
SETTING	PARAMETER
CON.MMXU1.TotW.rangeC.min.f	0
CON.MMXU1.TotW.rangeC.max.f	0
CON.MMXU1.TotVAr.rangeC.min.f	0
CON.MMXU1.TotVAr.rangeC.max.f	0
CON.MMXU1.TotVA.rangeC.min.f	0
CON.MMXU1.TotVA.rangeC.max.f	0
CON.rinGGIO1.AnIn1.rangeC.min.f	0
CON.rinGGIO1.AnIn1.rangeC.max.f	100
CON.rinGGIO1.AnIn2.rangeC.min.f	0
CON.rinGGIO1.AnIn2.rangeC.max.f	100
CON.rinGGIO1.AnIn3.rangeC.min.f	0
CON.rinGGIO1.AnIn3.rangeC.max.f	100
CON.rinGGIO1.AnIn4.rangeC.min.f	0
CON.rinGGIO1.AnIn4.rangeC.max.f	100
CON.rinGGIO1.AnIn5.rangeC.min.f	0
CON.rinGGIO1.AnIn5.rangeC.max.f	100
CON.rinGGIO1.AnIn6.rangeC.min.f	0
CON.rinGGIO1.AnIn6.rangeC.max.f	100
CON.rinGGIO1.AnIn7.rangeC.min.f	0
CON.rinGGIO1.AnIn7.rangeC.max.f	100
CON.rinGGIO1.AnIn8.rangeC.min.f	0
CON.rinGGIO1.AnIn8.rangeC.max.f	100
CON.rinGGIO1.AnIn9.rangeC.min.i	0
CON.rinGGIO1.AnIn9.rangeC.max.i	100
CON.rinGGIO1.AnIn10.rangeC.min.i	0
CON.rinGGIO1.AnIn10.rangeC.max.i	100
CON.rinGGIO1.AnIn11.rangeC.min.i	0
CON.rinGGIO1.AnIn11.rangeC.max.i	100
CON.rinGGIO1.AnIn12.rangeC.min.i	0
CON.rinGGIO1.AnIn12.rangeC.max.i	100
CON.rinGGIO1.AnIn13.rangeC.min.i	0
CON.rinGGIO1.AnIn13.rangeC.max.i	100
CON.rinGGIO1.AnIn14.rangeC.min.i	0
CON.rinGGIO1.AnIn14.rangeC.max.i	100
CON.rinGGIO1.AnIn15.rangeC.min.i	0
CON.rinGGIO1.AnIn15.rangeC.max.i	100
CON.rinGGIO1.AnIn16.rangeC.min.i	0

Figure 7-18: Max and Min

COMMANDS

In the F650 relay IEC 61850 controllable data exist in logical nodes vinGGIO, XCBR and CSWI:

- vinGGIO maps to Virtual Inputs of F650.
- XCBR represents the circuit breaker.
- CSWI logical nodes represent switchgear of F650 relay.



SETTING	PARAMETER
CON.XCBR1PosctlModel	sbo-with-enhanced-security
CON.CSWI1PosctlModel	direct-with-normal-security
CON.CSWI2PosctlModel	direct-with-normal-security
CON.CSWI3PosctlModel	direct-with-normal-security
CON.CSWI4PosctlModel	direct-with-normal-security
CON.CSWI5PosctlModel	direct-with-normal-security
CON.CSWI6PosctlModel	direct-with-normal-security
CON.CSWI7PosctlModel	direct-with-normal-security
CON.CSWI8PosctlModel	direct-with-normal-security
CON.CSWI9PosctlModel	direct-with-normal-security
CON.CSWI10PosctlModel	direct-with-normal-security
CON.CSWI11PosctlModel	direct-with-normal-security
CON.CSWI12PosctlModel	direct-with-normal-security
CON.CSWI13PosctlModel	direct-with-normal-security
CON.CSWI14PosctlModel	direct-with-normal-security
CON.CSWI15PosctlModel	direct-with-normal-security
CON.CSWI16PosctlModel	direct-with-normal-security
CON.XSWI1PosctlModel	status-only
CON.XSWI2PosctlModel	status-only
CON.XSWI3PosctlModel	status-only
CON.XSWI4PosctlModel	status-only
CON.XSWI5PosctlModel	status-only
CON.XSWI6PosctlModel	status-only
CON.XSWI7PosctlModel	status-only
CON.XSWI8PosctlModel	status-only
CON.XSWI9PosctlModel	status-only
CON.XSWI10PosctlModel	status-only
CON.XSWI11PosctlModel	status-only
CON.XSWI12PosctlModel	status-only
CON.XSWI13PosctlModel	status-only
CON.XSWI14PosctlModel	status-only
CON.XSWI15PosctlModel	status-only
CON.XSWI16PosctlModel	status-only
CON.vinGGIO1$DPCSO01$ctlModel	direct-with-normal-security
CON.vinGGIO1$DPCSO02$ctlModel	direct-with-normal-security
CON.vinGGIO1$DPCSO03$ctlModel	direct-with-normal-security
CON.vinGGIO1$DPCSO04$ctlModel	direct-with-normal-security

Figure 7-19: Commands

vinGGIO

Controllable data in vinGGIO logical node are SPCSO1 - SPCSO64 and DPCSO1 - DPCSO16. Signals SPCSO1 - SPCSO32 map to 32 Virtual Inputs Latched in F650 relay and signals SPCSO33 - SPCSO64 map to Virtual Inputs Self-Reset. DPCSO1 - DPCSO16 are double control points and operate on pairs of Virtual Inputs Latched. Thus DPCSO1 - DPCSO16 map to 32 Virtual Inputs Latched and an operation of one attribute DPCSO always operate on two Virtual Inputs Latched, one Virtual Input of the pair is set to "1" and the other Virtual Input of the pair is set to "0". In vinGGIO logical node only control mode "direct control with normal security" can be used.

XCBR, CSWI, recPhXCSWI

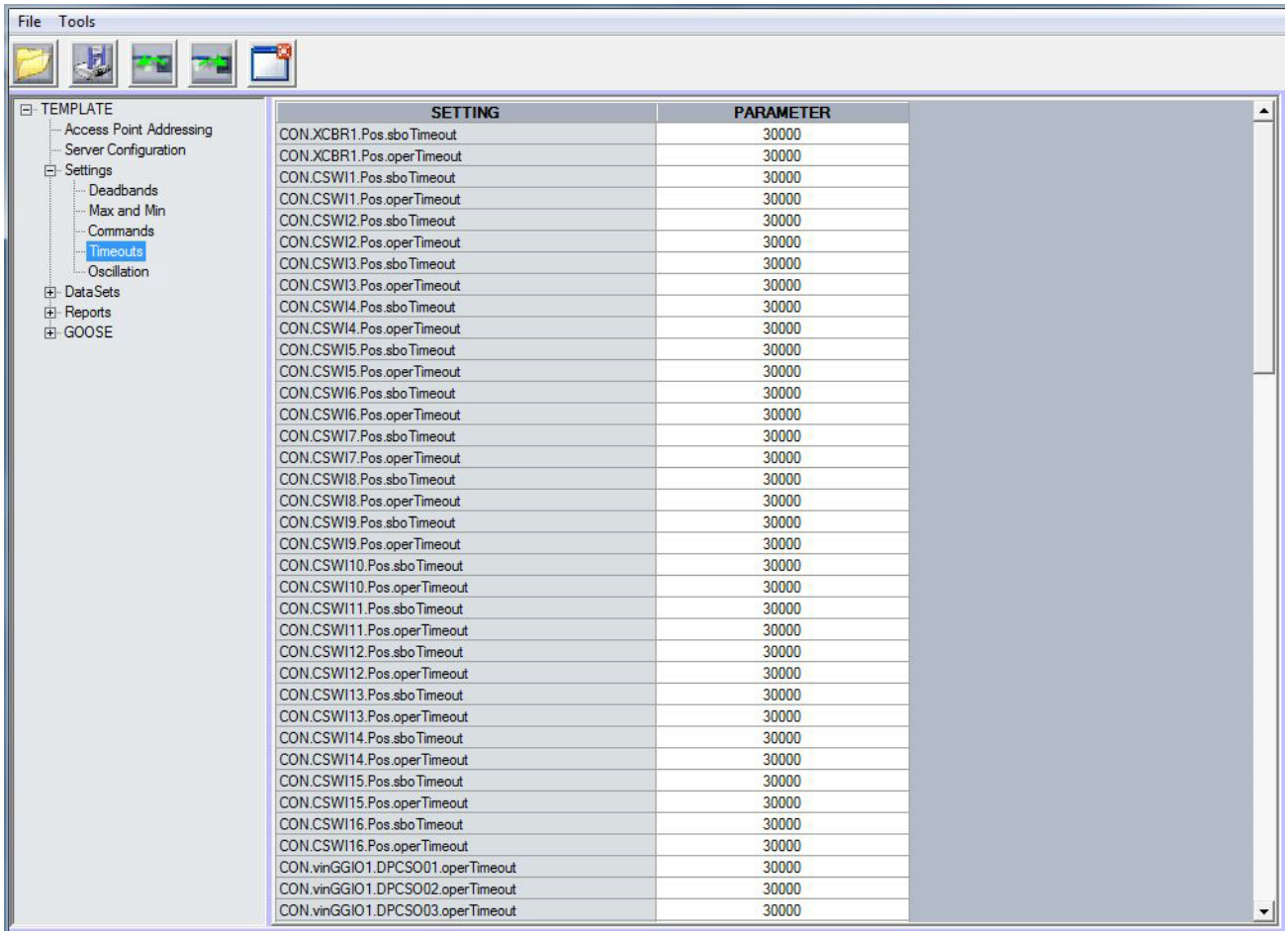
Controllable data in these logical nodes are Pos (position) objects. These are operations used to change state of breaker, switch or recloser.

F650 relays supports all four IEC 61850 control modes (ctlModel), which are:

- Direct control with normal security (direct-with-normal-security)
- SBO control with normal security (sbo-with-normal-security)

- Direct control with enhanced security (direct-with-enhanced-security)
- SBO control with enhanced security (sbo-with-enhanced-security)

TIMEOUTS



SETTING	PARAMETER
CON.XCBR1.Pos.sboTimeout	30000
CON.XCBR1.Pos.operTimeout	30000
CON.CSWI1.Pos.sboTimeout	30000
CON.CSWI1.Pos.operTimeout	30000
CON.CSWI2.Pos.sboTimeout	30000
CON.CSWI2.Pos.operTimeout	30000
CON.CSWI3.Pos.sboTimeout	30000
CON.CSWI3.Pos.operTimeout	30000
CON.CSWI4.Pos.sboTimeout	30000
CON.CSWI4.Pos.operTimeout	30000
CON.CSWI5.Pos.sboTimeout	30000
CON.CSWI5.Pos.operTimeout	30000
CON.CSWI6.Pos.sboTimeout	30000
CON.CSWI6.Pos.operTimeout	30000
CON.CSWI7.Pos.sboTimeout	30000
CON.CSWI7.Pos.operTimeout	30000
CON.CSWI8.Pos.sboTimeout	30000
CON.CSWI8.Pos.operTimeout	30000
CON.CSWI9.Pos.sboTimeout	30000
CON.CSWI9.Pos.operTimeout	30000
CON.CSWI10.Pos.sboTimeout	30000
CON.CSWI10.Pos.operTimeout	30000
CON.CSWI11.Pos.sboTimeout	30000
CON.CSWI11.Pos.operTimeout	30000
CON.CSWI12.Pos.sboTimeout	30000
CON.CSWI12.Pos.operTimeout	30000
CON.CSWI13.Pos.sboTimeout	30000
CON.CSWI13.Pos.operTimeout	30000
CON.CSWI14.Pos.sboTimeout	30000
CON.CSWI14.Pos.operTimeout	30000
CON.CSWI15.Pos.sboTimeout	30000
CON.CSWI15.Pos.operTimeout	30000
CON.CSWI16.Pos.sboTimeout	30000
CON.CSWI16.Pos.operTimeout	30000
CON.vinGGIO1.DPCSO01.operTimeout	30000
CON.vinGGIO1.DPCSO02.operTimeout	30000
CON.vinGGIO1.DPCSO03.operTimeout	30000

Figure 7-20: Timeouts

There is a configurable timeout for SBO control modes and for operation in logical nodes listed above. The value range for SBO timeout is 500 ms - 60 seconds.

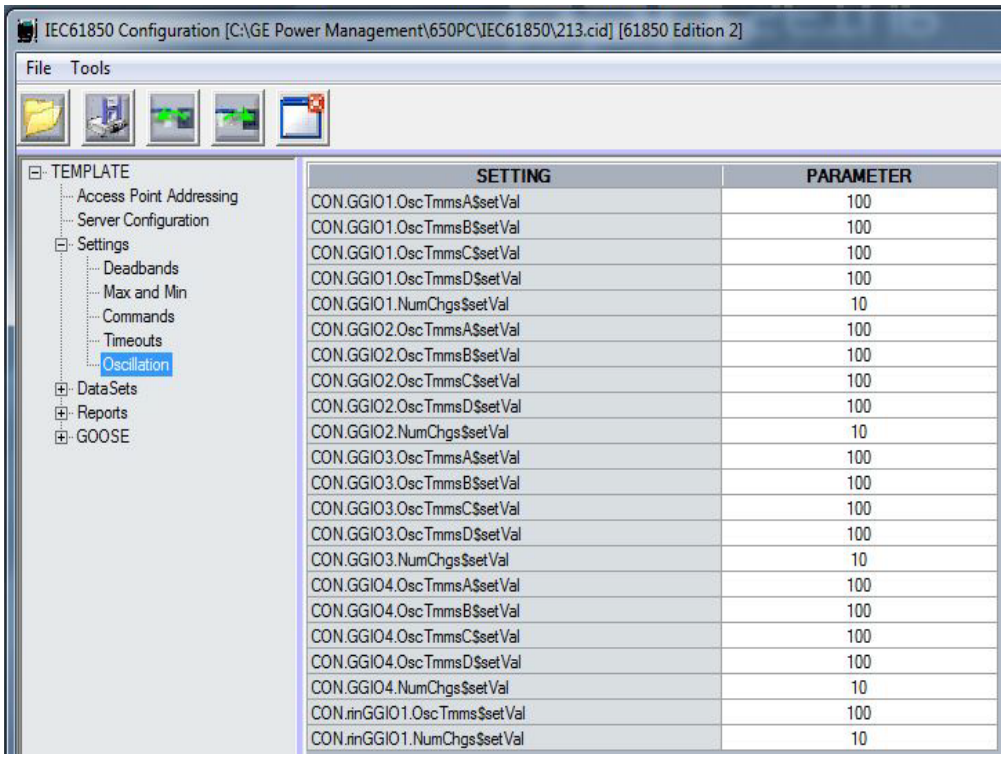
The sboClass attribute can only have value "operate-once", "operate-many" pattern is not supported in IEC 61850 SBO controls in 650 relay.

OSCILLATION

There are two settings used for the detection of the digital inputs of I/O boards and rinGGIO LN oscillation, OscTmms and NumChgs.

·OscTmms: time between two changes in the same direction (from 0 to 1 or from 1 to 0) to consider that a signal is oscillating. There are four settings for each GGIO (OscTmmsA, OscTmmsB, OscTmmsC and OscTmmsD), one for each group of inputs, and one in rinGGIO logical node.

·NumChgs: number of changes that have to be produced in an oscillatory signal to be consider as invalid and not to continue sending changes of the signal, sending the value of the signal when it was consider as oscillatory.



SETTING	PARAMETER
CON.GGIO1.OscTmmsA$setVal	100
CON.GGIO1.OscTmmsB$setVal	100
CON.GGIO1.OscTmmsC$setVal	100
CON.GGIO1.OscTmmsD$setVal	100
CON.GGIO1.NumChgs$setVal	10
CON.GGIO2.OscTmmsA$setVal	100
CON.GGIO2.OscTmmsB$setVal	100
CON.GGIO2.OscTmmsC$setVal	100
CON.GGIO2.OscTmmsD$setVal	100
CON.GGIO2.NumChgs$setVal	10
CON.GGIO3.OscTmmsA$setVal	100
CON.GGIO3.OscTmmsB$setVal	100
CON.GGIO3.OscTmmsC$setVal	100
CON.GGIO3.OscTmmsD$setVal	100
CON.GGIO3.NumChgs$setVal	10
CON.GGIO4.OscTmmsA$setVal	100
CON.GGIO4.OscTmmsB$setVal	100
CON.GGIO4.OscTmmsC$setVal	100
CON.GGIO4.OscTmmsD$setVal	100
CON.GGIO4.NumChgs$setVal	10
CON.rinGGIO1.OscTmms$setVal	100
CON.rinGGIO1.NumChgs$setVal	10

DataSet

Two different sections will be differentiated under this section:

- Summary
- DataSetXX

SUMMARY

In this screen, user can find a list with information about where a configured DataSetXX has been used (Report and/ or GOOSE).

If a DataSetXX is shared by more than one Report/GOOSE, all elements will be listed in DataSetXX Parameter field, separated by commas.

SETTING	PARAMETER
DataSet01 shared by	TxGoose1, Report1
DataSet02 shared by	Report2
DataSet03 shared by	Report03
DataSet04 shared by	
DataSet05 shared by	
DataSet06 shared by	
DataSet07 shared by	
DataSet08 shared by	
DataSet09 shared by	
DataSet10 shared by	
DataSet11 shared by	
DataSet12 shared by	
DataSet13 shared by	
DataSet14 shared by	
DataSet15 shared by	
DataSet16 shared by	
DataSet17 shared by	
DataSet18 shared by	
DataSet19 shared by	
DataSet20 shared by	

Shift + ↑ to move a selected member up
Shift + ↓ to move a selected member down

Figure 7-21: DataSetXX summary view

DataSetXX:

In this section, the user may configure up to 20 different DataSets as follows:

DataSetXX name: It must be assigned initially. The first character of this attribute must be a letter (upper or lower case). The rest must be a number, a letter (upper or lower case or a "_". The number of characters allowed in 32

If this name is not configured, the following message will prompt when trying to drag any new element:

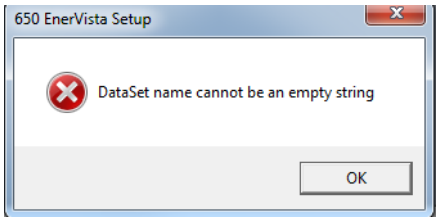


Figure 7-22: DataSet name not configured.

DataSetXX MemberX: After the DataSet name is defined, members can be added by dragging and dropping elements from the complete data model of the IED displayed below to the Data Set.

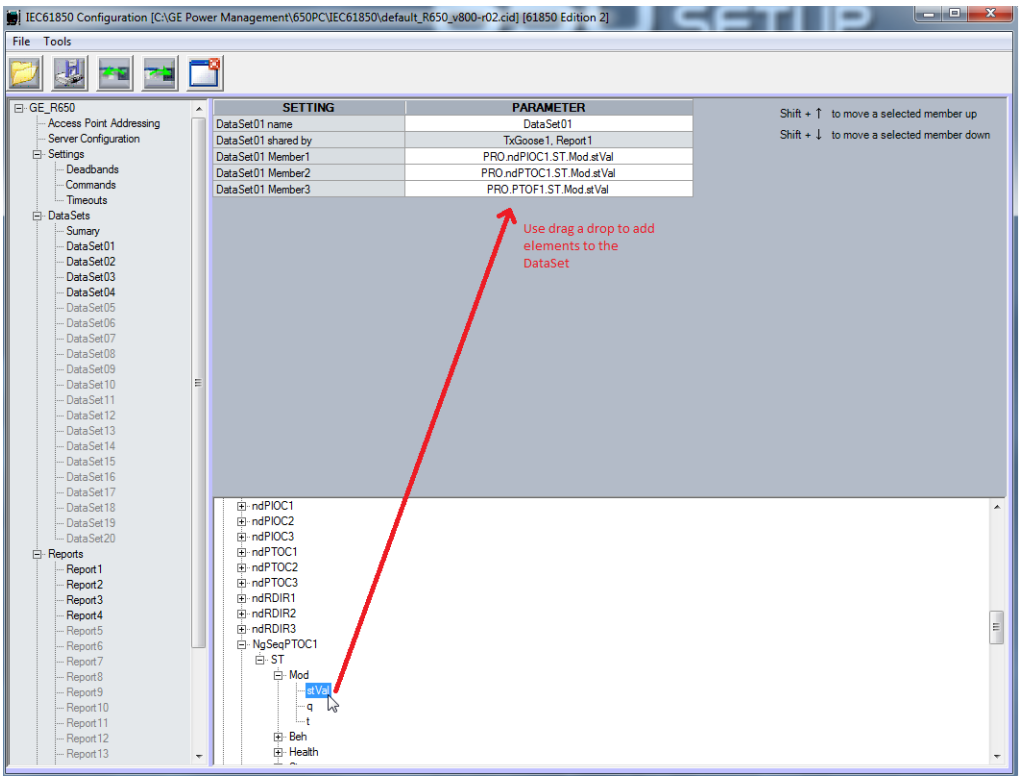


Figure 7-23: Adding attributes to a DataSet

There is a counter in the right-up corner of configuration area where users can visualize how many basic attributes have been added to a DataSetXX. This counter will increase automatically when basic attributes are dragged and dropped.

For example id CON.MMXU1.MX.A.net.cVal is dragged and dropped into DataSet, counter will be increased to two as there are two basic attributes in it (CON.MMXU1.MX.A.net.cVal.mag and CON.MMXU1.MX.A.net.cVal .ang)

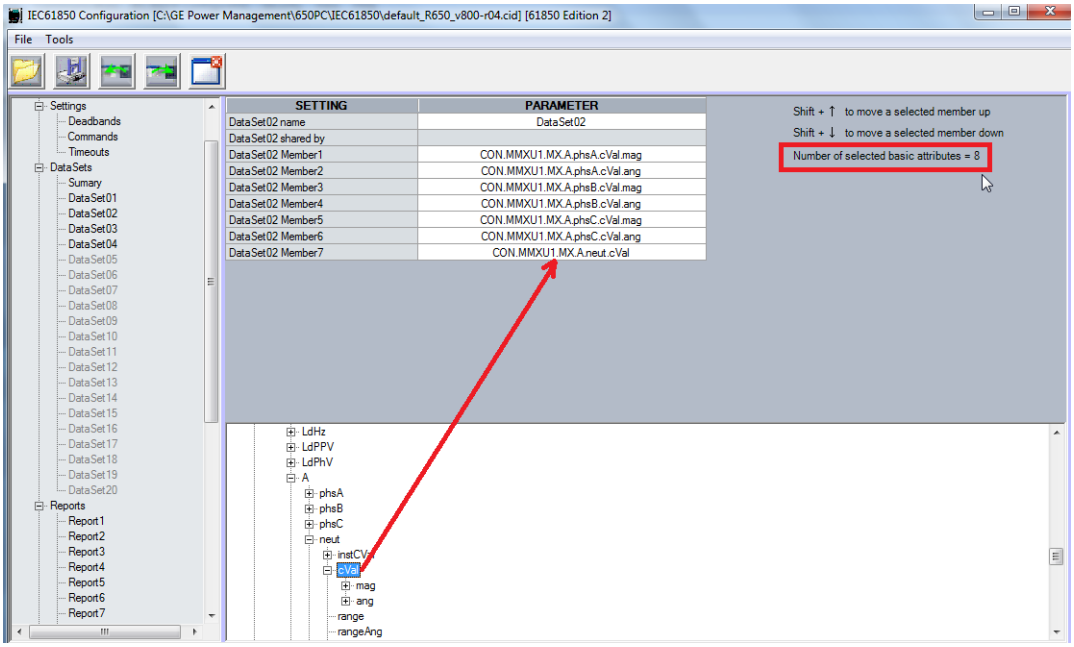


Figure 7-24: Basic attributes counter

To change the Order of the configured DataSet:

1. Select DataSet Member to be moved.
2. Click on Shift and up/down key.

To delete a Dataset Member:

1. Click on DataMember.
2. Press **SUPR** key.

To remove a DataSetXX:

1. Select DataSetXX in the IEC 61850 IED Explorer window.
2. Right-click and select **Delete DataSet** as shown:

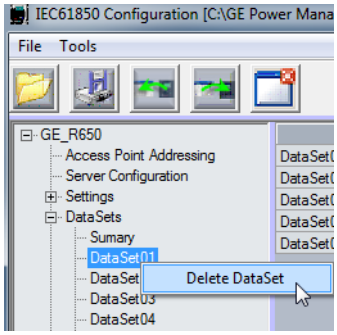


Figure 7-25: Delete DataSet

Reports

The 650 family relay supports both IEC 61850 buffered and unbuffered reporting. The device has configurable reports, which include user-defined Data Sets and Report Control Blocks. Reporting is based on Data Sets, which are collections of Data that can be included in Reports. The Report Control Block is a group of parameters which permit IEC 61850 customization of the reports being sent by the IEC 61850 server. For example, the IntgPd parameter of the Report Control Block contains the value in milliseconds of the interval between Integrity Reports sent by IEC 61850 servers.

A 650 family relay can have up to 20 different reports and up to 20 different Data Sets linked (only one DataSet can be linked to one Report). In the reports, each Dataset can be configured with a maximum of 576 Dataset Members.

All settings/datasets assigned to different reports can configured as described in this section. Up to 20 different reports can be configured.

SETTING	PARAMETER
Report1 Name	Report1
Report1 RptID	1
Report1 DatSet	DataSet01
Report1 ConfRev	1
Report1 OptFlds	Click to view or edit (223)
Report1 BufTm	0 ms
Report1 TrgOps	Click to view or edit (5)
Report1 IntgPd	60 ms
Report1 Buffered	True
Report1 Max Clients	1

ReportX Name:

The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed in IEC61850 Configurator is 30 and IEC61850 MMS Library adds two more characters indicating the number of the instance of the RCB depending on the number of IEC61850 clients configured

ReportX RptID:

The attribute RptID is the client-specified report identifier of the RCB that has caused the generation of the report.

ReportX DatSet:

This dropbox lists only DataSets configured in DataSet section with less than 576 DataSet Members. Select the Dataset that is going to be assigned to Report X,

ReportX ConfRev:

It represents the configuration revision number of the control block

ReportX OptFlds:

Different options for report triggers are listed in this dropbox list. One or more options the report triggers are shown in the Supported Triggers list:

- Data-Change
- Quality-Change
- Integrity
- General Interrogation

ReportX BufTm:

This setting is only considered if ReportX Buffer setting is set to true. In case of an event that causes a report the server will wait for BufTm ms for other events. All data that is to be reported because of events in this time span is sent in a single report. If connection with client is lost, events will be logged during BufTm and they will be sent when client connects again.

ReportX IntgPd

Only working if general interrogation is configured in trigger options. The integrity period specifies an interval in ms for the periodic sending of integrity reports.

ReportX Buffered:

The standard distinguishes between two types of reporting: buffered reporting and unbuffered reporting. With buffered reporting reports are buffered by the server in case a connection to the client is interrupted. This way reports can be sent after the client has connected again. Buffered reporting is configured through buffered report control blocks (BRCB). Unbuffered reporting is configured through unbuffered report control blocks (URCB).

If it set to true, report will be configured as buffered report control block (BRCB). If set to false, report will be configured as unbuffered report control block (URCB)

ReportX Max Clients:

Number of clients that can be connected to a report control block. Up to 5 different clients can be configured

GOOSE

TxGOOSE

In this section, configure four different transmission GOOSE: TXGOOSEX.

SETTING	PARAMETER
TxGOOSE1 Name	TxGoose1
TxGOOSE1 Desc.	
TxGOOSE1 GoID	TxGOOSE1
TxGOOSE1 DataSet	DataSet01
TxGOOSE1 CONFREV	1
TxGOOSE1 Enabled	true
TxGOOSE1 DST MAC	01-0C-CD-01-00-01
TxGOOSE1 VLAN PRIORITY	4
TxGOOSE1 VLAN ID	000
TxGOOSE1 ETYPE APPID	0000
TxGOOSE1 MAX TIME	10000

Figure 7-26: Transmitted GOOSE settings

TxGOOSEX Name:

The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed is 32.

TxGOOSEX Desc:

The maximum number of characters allowed is 32.

TxGOOSEX GoID:

The maximum number of characters allowed is 129

TxGOOSEX DataSet:

Select DataSet to be transmitted in this TxGOOSE. Only DataSets configured with 128 elements or less will be displayed in this dropbox.

TxGOOSEX CONFREV:

It can be used to indicate GOOSE configuration revision

TxGOOSEX Enabled:

To enable/disable transmission GOOSE

TxGOOSEX DST MAC:

The standard MAC address limit. 6 pairs of letters (from A to F, upper case or lower case) or numbers separated by colons.

Make sure to configure the MAC with the least significant bit in the most significant byte, set to 1. Example: 01: 0C: CD: 00: 00: 04

TxGOOSEX VLAN PRIORITY:

A number from 0 to 7 can be configured. IEC 61850 recommends a default priority value of 4 for GOOSE. Ethernet traffic that does not contain a priority tag has a default priority of 1. More details are specified in IEC 61850 part 8-1.

TxGOOSEX VLAN ID:

The maximum number of characters allowed is 3. IEC61850 Configurator allows characters limited to 0 to 9, A to F and it saves in the CID file the hexadecimal value (max FFF).

TxGOOSEX ETYPE APPID:

All characters must be numerical. The maximum number of characters allowed is 4. IEC61850 Configurator allows characters limited to 0 to 9, A to F and it saves in the CID file the hexadecimal value (max FFFF).

IEC 61850 recommends that the Ethertype Application ID number be configured according to the GOOSE source. In the F650, the transmitted GOOSE Application ID number must match the configured receive Application ID number in the receiver. A common number may be used for all GOOSE transmitters in a system. More details are specified in IEC 61850 part 8-1.

TxGOOSEX MAX TIME:

Time allowed to live. The maximum time packet remains alive after transmission. It must be configured in ms

Mapping TxGOOSES

For transmission GOOSE you can create Data Sets with drag-and-drop selecting the desired data attributes in the data model tree and dragging them to the DataSet panel. Data Sets can be directly formed by attributes of all Logical Nodes. For example they can contains status of protection functions as:

- PTOC1.ST.Op.phsA- "Time Overcurrent Function 1 Operate Phase A"
- PTUF2.ST.Str.general- "Underfrequency Function 2 Trip General"
- XCBR1.ST.Pos.stVal- "Circuit Breaker Position"
- etc.

There is also a dedicated logical node in F650 which can be used for mapping of internal signals to be transmitted via GOOSE. This logical node is rouGGIO1. It contains 32 digital indications with associated quality flags and timestamps. rouGGIO1 permits flexible mapping of any of relay's digital signals to outgoing GOOSE messages. This can be useful when transmission via GOOSE of internal signals that are not mapped to any IEC 61850 logical node in the F650 is required. An example of such signals are "Virtual Outputs" which are internal variables of F650 derived from PLC logic equations.

Mapping of signals to rouGGIO1 indications is performed in EnerVista 650 Setup software in menu **Setpoint > Relay Configuration > Remote Outputs**. rouGGIO1 indications are called **Rem GOOSE Dig Out 1**, **Rem GOOSE Dig Out 2**, etc. in this menu, and are listed after the DNA and UserSt bits.

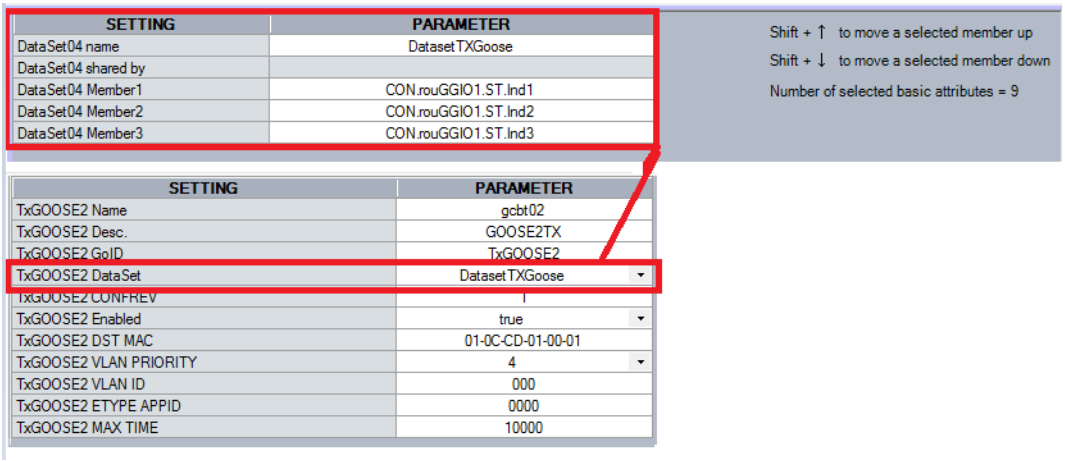


Figure 7-27: Example of rouGGIO mapping in Dataset

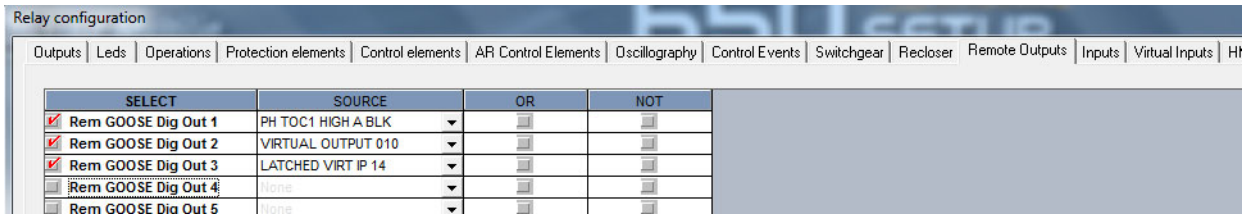


Figure 7-28: Example of rouGGIO mapping in Setpoint > Relay configuration

RxGOOSE

650 relays can subscribe to up to 24 different remote devices. A maximum of 32 Remote Inputs (digital signals), 32 Remote Goose Digital Inputs, and 16 Remote Goose Analog Inputs can be configured as subscriptions.

Mapping RxGOOSES

In order to configure reception of configurable GOOSE in a 650 relay, it is necessary to have the ICD/CID file of the sending IED. This means that the first transmission GOOSE must be configured in the sender, and then the ICD/CID file must be imported using the **IEC 61850 Configurator** tool in the EnerVista 650 Setup software.

To import a CID file from a remote IED:

1. In the IED list panel, select LGOS X, right-click and select **Add IED** to add a new IED for GOOSE reception. Up to 24 different CIDs can be imported.

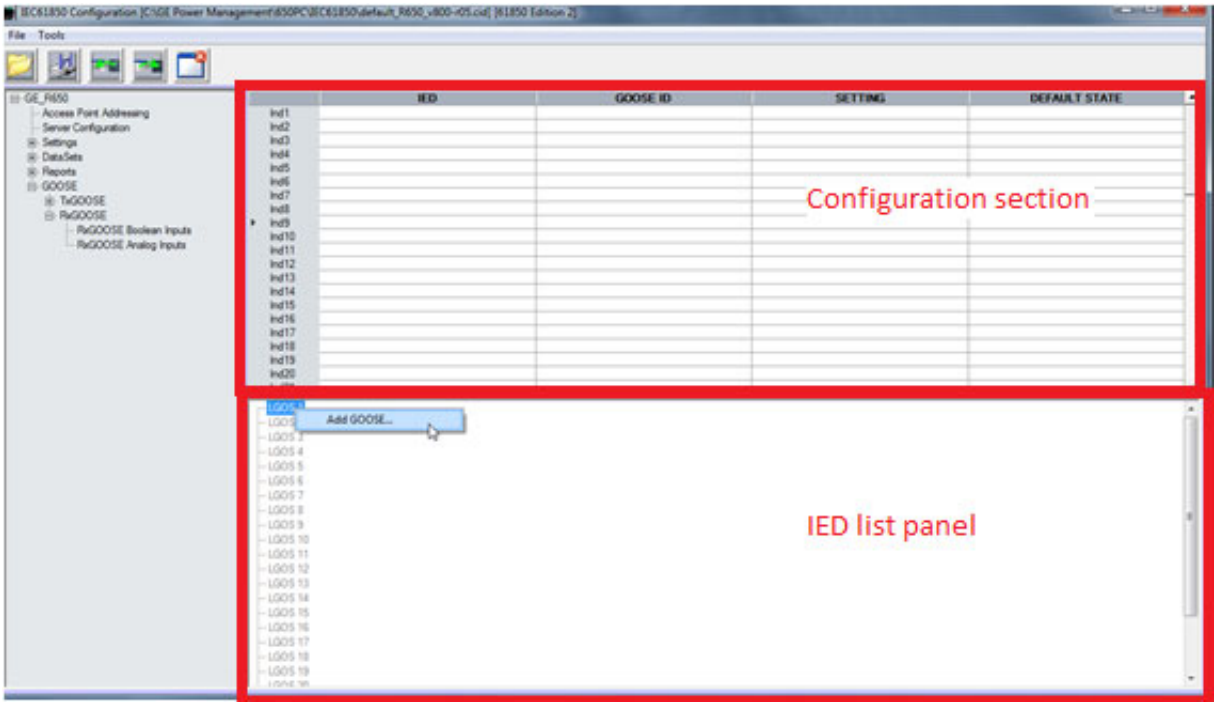


Figure 7-29: Import CID file

2. A pop-up window allows selection of the CID file to import, with transmission GOOSES previously configured.

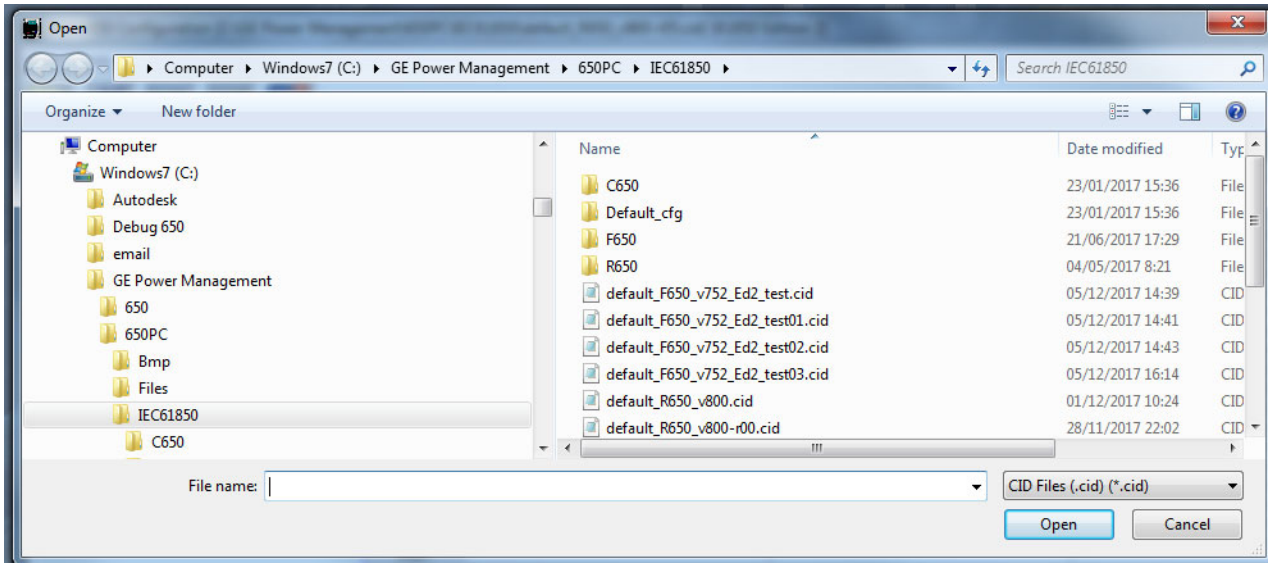


Figure 7-30: CID file selection

3. After selecting the CID file, all configured transmission GOOSES are imported and all GOOSE FCDAs are displayed as shown:

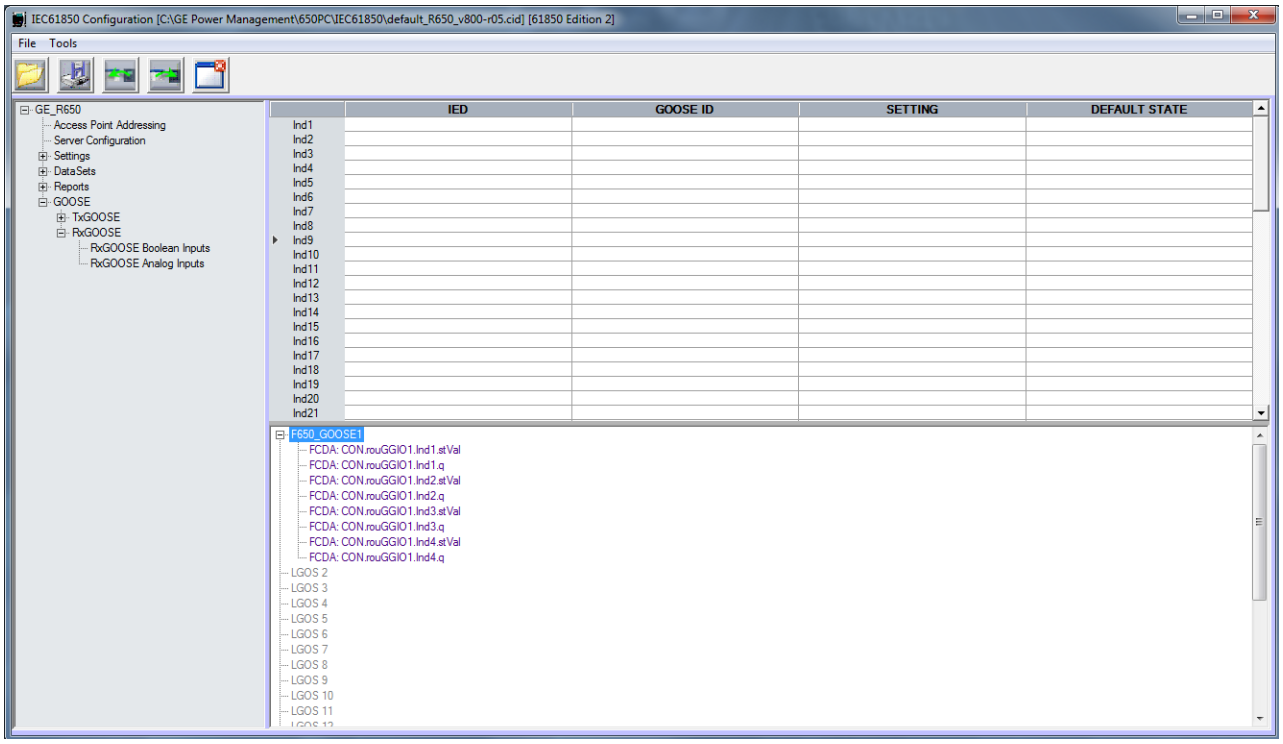


Figure 7-31: Imported CID file

4. If any imported transmission GOOSE needs to be deleted, updated, moved up/down or the header needs to be edited, right-click on the imported GOOSE in the IED panel list

Figure 7-32: Transmission GOOSE menu

If a new CID is imported and it contains a GOOSE ID that it is already present in the IED panel list, the following message displays and no transmission GOOSES from the imported CID are added to IED panel list.

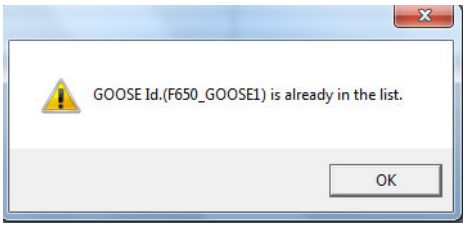


Figure 7-33: Warning message: Same GOOSE ID detected

Up to 32 Remote Inputs and 32 Goose Digital Inputs can be configured in a reception goose (RXGOOSE). The configuration section shows a list with 64 different rows. The first 32 values are shown on the Remote Goose Digital Inputs screen and the remaining 32 values are on the Remote Inputs screen.

To configure RxGOOSE Boolean Inputs follow these steps:

1. Boolean signals can be dragged and dropped from an imported remote IED transmission GOOSE into the Configuration section.

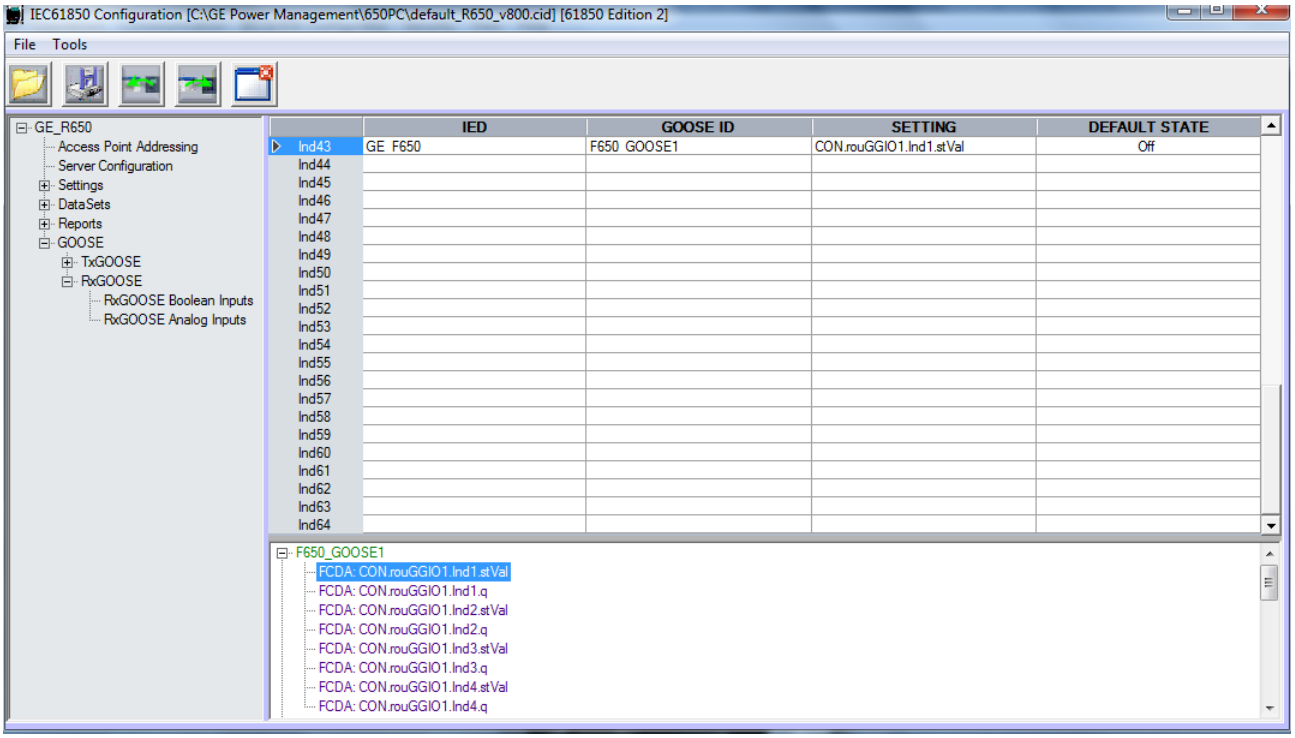


Figure 7-34: RXGOOSE Boolean Input

2. When a boolean signal is dragged and dropped into any IndX element, four columns show the following information:
   - **IED**: IED name configured in imported CID
   - **GOOSE ID**: Goose ID configured in imported CID
   - **SETTING**: FCDA of boolean signal from imported CID that has been dragged and dropped into the configuration area.
   - **DEFAULT STATE**: Value that signal shows when status has not been updated from the remote device.

Removing Boolean inputs:

- To remove a configured boolean signal, right-click on it and select **Remove Input**.

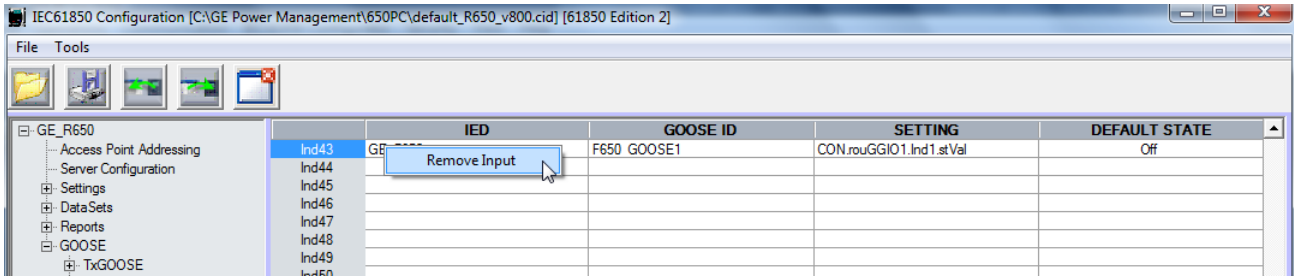


Figure 7-35: RXGOOSE Boolean input - Remove Input

To configure quality bits, follow these steps

1. Quality bits of Boolean signals can be dragged and dropped from an imported remote IED transmission GOOSE into the Configuration section. When a quality bit is dragged and dropped, a pop-up window opens to allow the selection of one of the thirteen quality bits available.

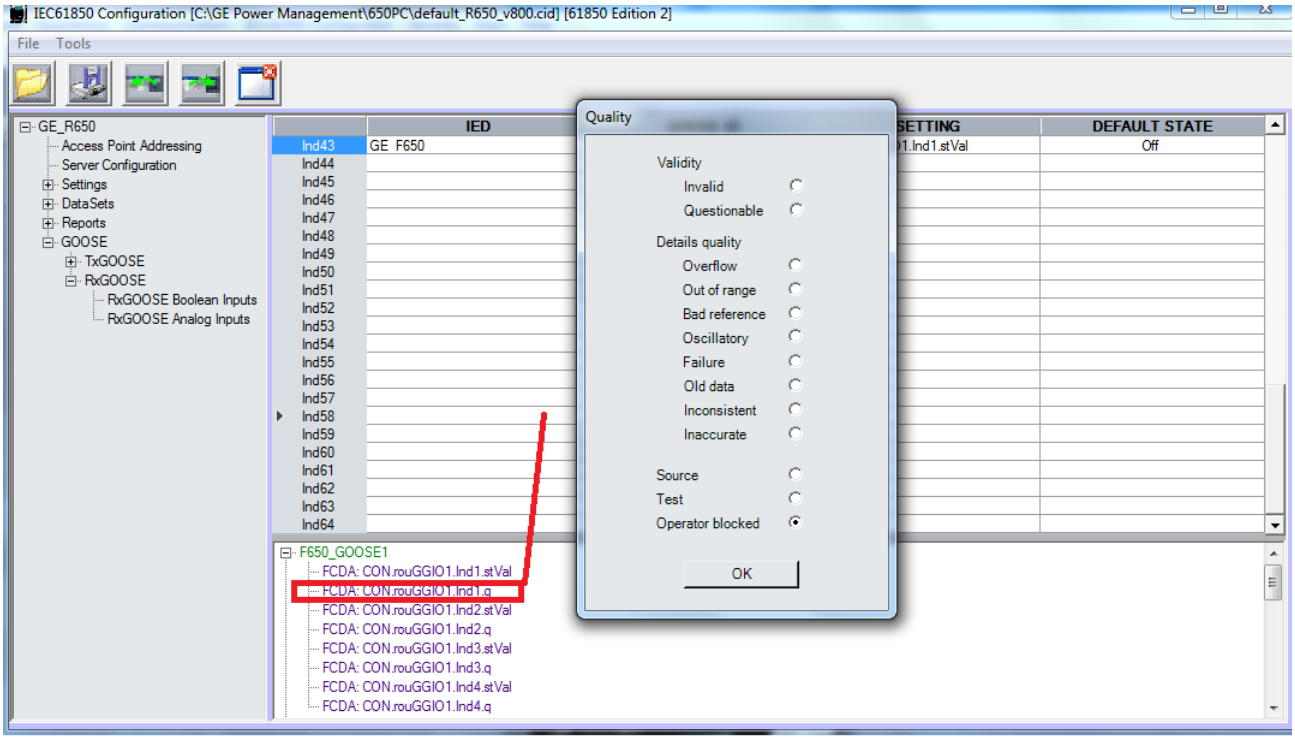


Figure 7-36: RXGOOSE Boolean input - Quality bit selection

2. Once a quality bit is selected, click **OK**, and the selected quality bit is shown in the Setting column of the Configuration area.

	IED	GOOSE ID	SETTING	DEFAULT STATE
Ind43	GE_F650	F650_GOOSE1	CON.rouGGIO1.Ind1.stVal	Off
Ind44	GE_F650	F650_GOOSE1	CON.rouGGIO1.Ind1.q[Bit2]	Off
Ind45				
Ind46				
Ind47				

Figure 7-37: RXGOOSE Boolean input - Selected quality bits shown

To configure RxGOOSE Analog Inputs, follow these steps:

Up to 8 float analog inputs (AnInX.mag.f) and 8 integer analog inputs (AnInX.mag.i) can configured in RXGOOSE Analog Inputs, as shown:

	IED	GOOSE ID	SETTING
AnIn1.mag.f			
AnIn2.mag.f			
AnIn3.mag.f			
AnIn4.mag.f			
AnIn5.mag.f			
AnIn6.mag.f			
AnIn7.mag.f			
AnIn8.mag.f			
AnIn9.mag.i			
AnIn10.mag.i			
AnIn11.mag.i			
AnIn12.mag.i			
AnIn13.mag.i			
AnIn14.mag.i			
AnIn15.mag.i			
AnIn16.mag.i			

Figure 7-38: RXGOOSE Analog Inputs

1. Add both float and Integer analog inputs by dragging and dropping values from the transmission GOOSES imported in the IED Panel list into AnInX.mag.X rows in the Configuration section.
2. When an analog signal is dragged and dropped into any element, three columns show the following information:
   - **IED**: IED name configured in imported CID
   - **GOOSE ID**: Goose ID configured in imported CID
   - **SETTING**: FCDA of Analog signal from imported CID that it has been dragged and dropped into configuration area.

   If the analog signal being dragged and dropped has been previously added from the IED panel list, the following warning message pops up:

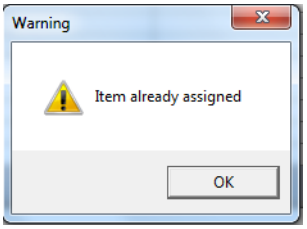
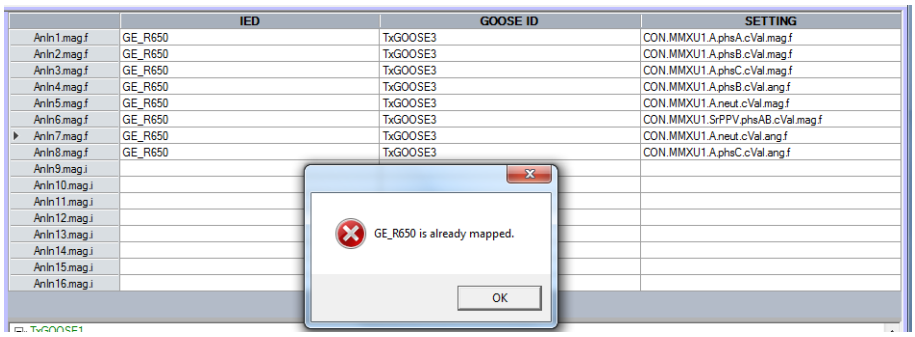


Figure 7-39: Warning message - Duplicate item

When all 8 Analog Inputs of one type (such as float) have been mapped, and an additional float analog value is dragged a dropped into the Configuration area, an error message is shown

:



In order to replace an Analog Input, first remove the existing Analog Input.

Removing Analog inputs:

- To remove a configured analog signal, right-click it and select **Remove Input**.

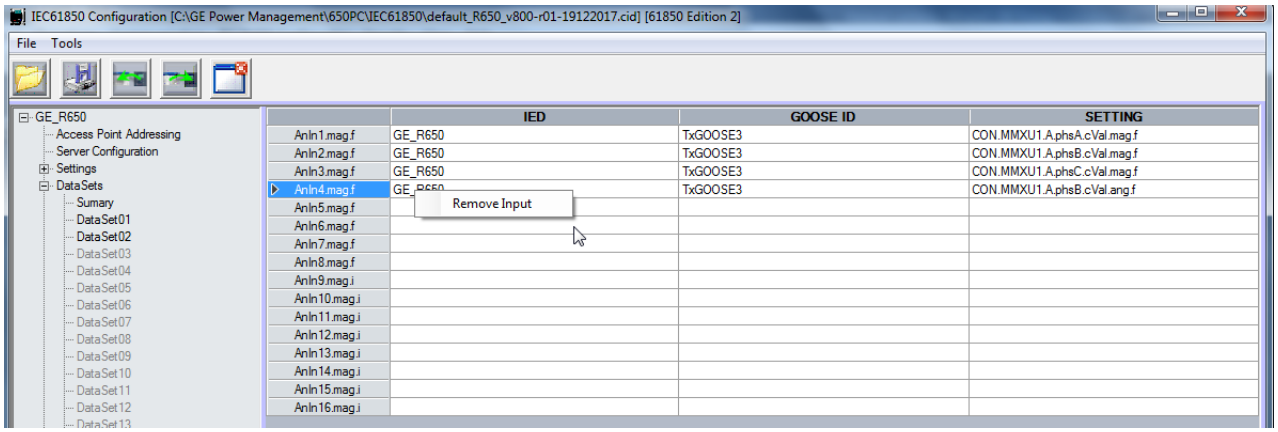


Figure 7-40: RXGOOSE Analog input- Removing inputs

7.6.3.2 Configuration of setting groups

The Logical Nodes affected by the implementation of the setting groups are:

- For firmware version below 7.50: LLN0, PIOC, PTOC, PTOF, PTOV, PTUV, PTUF and RDIR.
- For firmware version 7.50 or above: LLN0, PIOC, PTOC, PTOF, PTOV, PTUV, PTUF, RDIR, PTTR, PFRC, PDIS, PDOP, PRTR

The definition of the Logical Node LLN0 is shown in 7.2.7.3.3 or 7.2.7.3.4. The rest of the mentioned Logical Nodes are affected in the way that the setting data contained in those Logical Nodes have as many values as setting groups are defined:

- For firmware version below 7.50: 3 setting group for F650 relay
- For firmware version 7.50 or above: 6 setting group for F650 relay

Each setting data contained in those Logical Nodes has a type derived from one of the following common data classes defined in the standard IEC 61850-7-3: ING, SPG, ASG and CURVE. The setting data attributes of these common data classes have functional constraints SG (setting group) and SE (setting group editable) when the setting group function is enabled and SP (setpoint) when it is not.

When the setting group function is enabled the F650 relay has the following instances of the Logical Nodes mentioned before:

PIOC

- Phase instantaneous overcurrent: SGphHiPIOC1 and SGphLoPIOC1*/ phHiPIOC1 and phLoPIOC1
- Neutral instantaneous overcurrent: SGndPIOC1*/ ndPIOC1
- Ground instantaneous overcurrent: SGgndPIOC1*/ gndPIOC1
- Sensitive ground instantaneous overcurrent: SGhsePIOC1*/ hsePIOC1
- Isolated ground instantaneous overcurrent: IsoGndPIOC**
- Broken conductor: BknCndPIOC**

PTOC

- Phase time overcurrent: SGphHiPTOC1 and SGphLoPTOC1*/ phHiPTOC1 and phLoPTOC1
- Neutral time overcurrent: SGndPTOC1*/ ndPTOC1
- Ground time overcurrent: SGgndPTOC1*/ gndPTOC1
- Sensitive ground time overcurrent: SGhsePTOC1*/ hsePTOC1
- Sensitive ground time overcurrent: hsePTOC**
- Negative sequence time overcurrent: NgSeqPTOC**

PTOF

- Overfrequency: SGPTOF1*/ PTOF1

PTOV

- Phase overvoltage: SGphsPTOV1*/ phsPTOV1
- Auxiliary overvoltage: SGauxPTOV1*/ auxPTOV1
- Neutral overvoltage: SGneuHiPTOV1 and SGneuLoPTOV1*/ neuHiPTOV1 and neuLoPTOV1

PTUV

- Phase undervoltage: SGphsPTUV1*/ phsPTUV1
- Auxiliary undervoltage: SGauxPTUV1*/ auxPTUV1

PTUF

- Underfrequency: SGPTUF1*/ PTUF1

RDIR

- Phase directional element: SGphsRDIR1*/ phsRDIR1
- Neutral directional element: SGndRDIR1*/ ndRDIR1
- Ground directional element: SGgndRDIR1*/ gndRDIR1
- Sensitive ground directional element: SGhseRDIR1*/ hseRDIR1

PDOP

- Forward overpower: FwdPDOP **
- Directional overpower: DirPDOP**
- Wattmeter ground overpower: WattPDOP**

PFRC

- Frequency rate of change: PFRC**

PDIS

- Load encroachment: LodEncPDIS**

PRTR

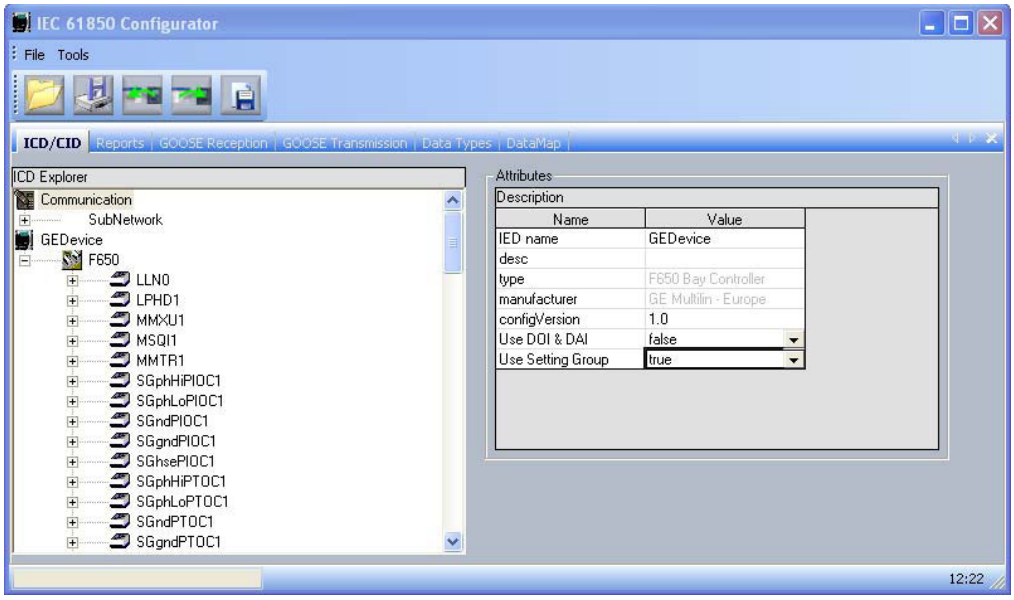
- Locked Rotor: LockedPRTR**

*These logical nodes model the corresponding protection function for setting groups in firmware version from 7.20 to below 7.50

**These functions have been included from firmware version 7.50.

If “Use Setting Group” is set to true for firmware version from 7.20 to below 7.50, the new instances of the Logical Nodes are accessible with the IEC 61850 Configurator as is shown in the following figure.

Firmware versions from 7.20 to below 7.50



Firmware versions 7.50 and above

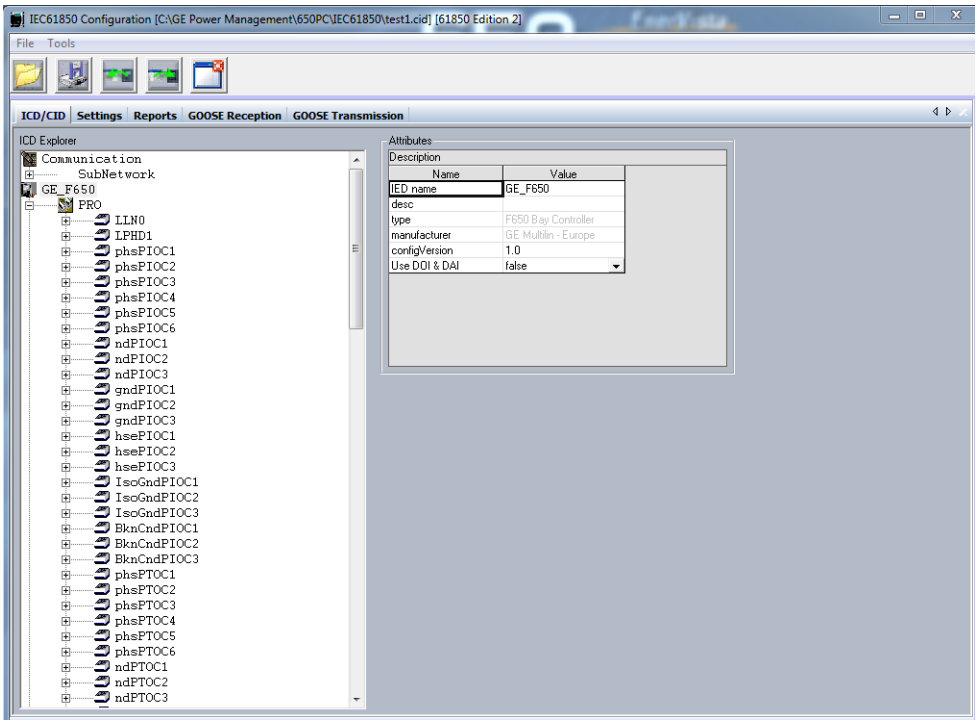


Figure 7-41: IEC 61850 Configurator

The setting grouping permission can be enabled or disabled using the relay HMI or using menu path **Setpoint > Control Elements > Setting Group** in the EnerVista 650 Setup program as shown in the figure.

For versions below 7.50 it can be enabled or disabled in the IEC61850 Configurator by setting **Use Setting Group** to true or false.

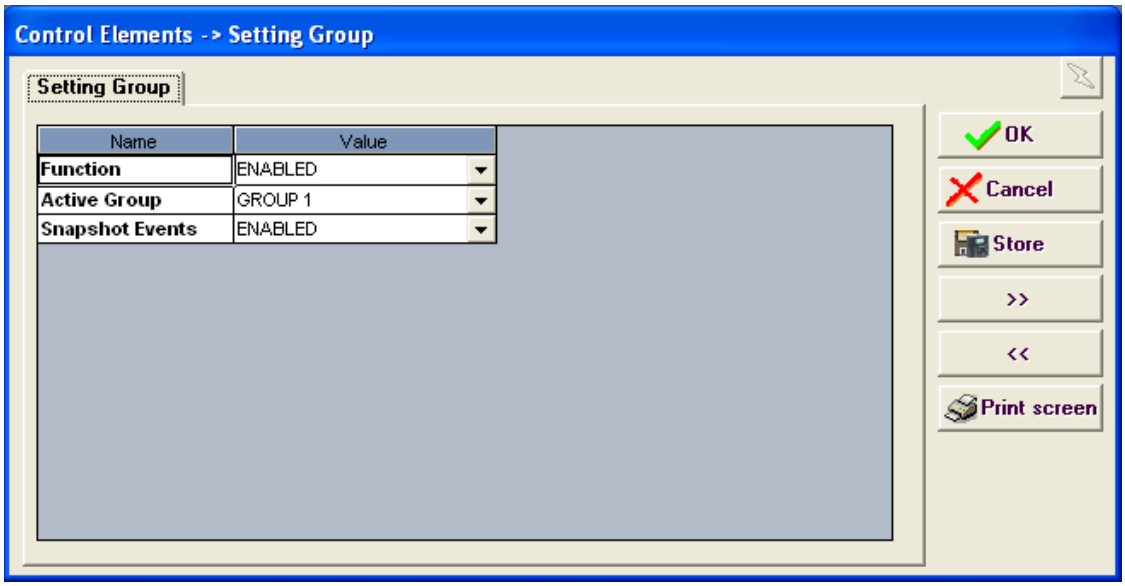


Figure 7-42: Control elements - setting group

The next figure is a capture of an MMS browser where SGCB class attributes are shown and configured, setting ActSG with the value 1 that corresponds with the first setting group in the F650 relay and EditSG with the value 2 that corresponds with the second setting group.

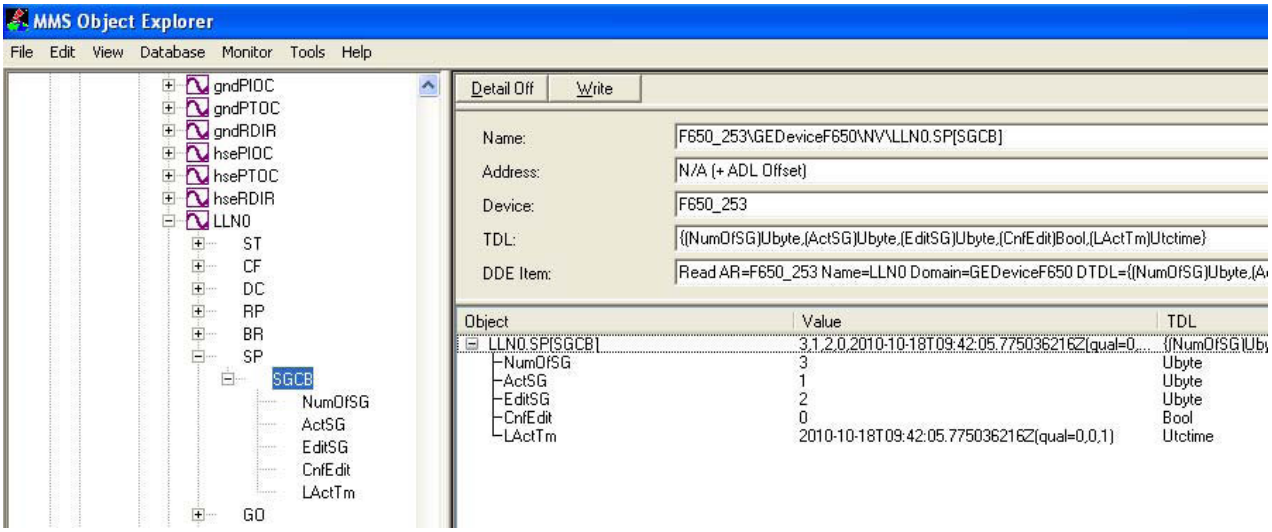
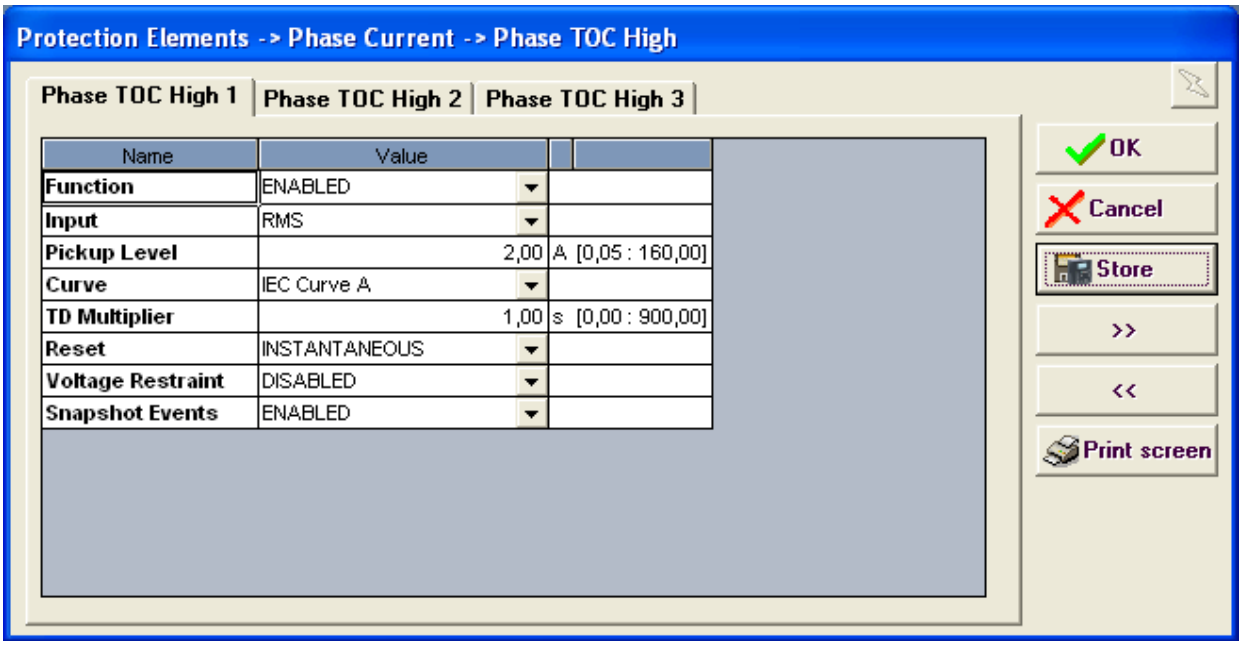
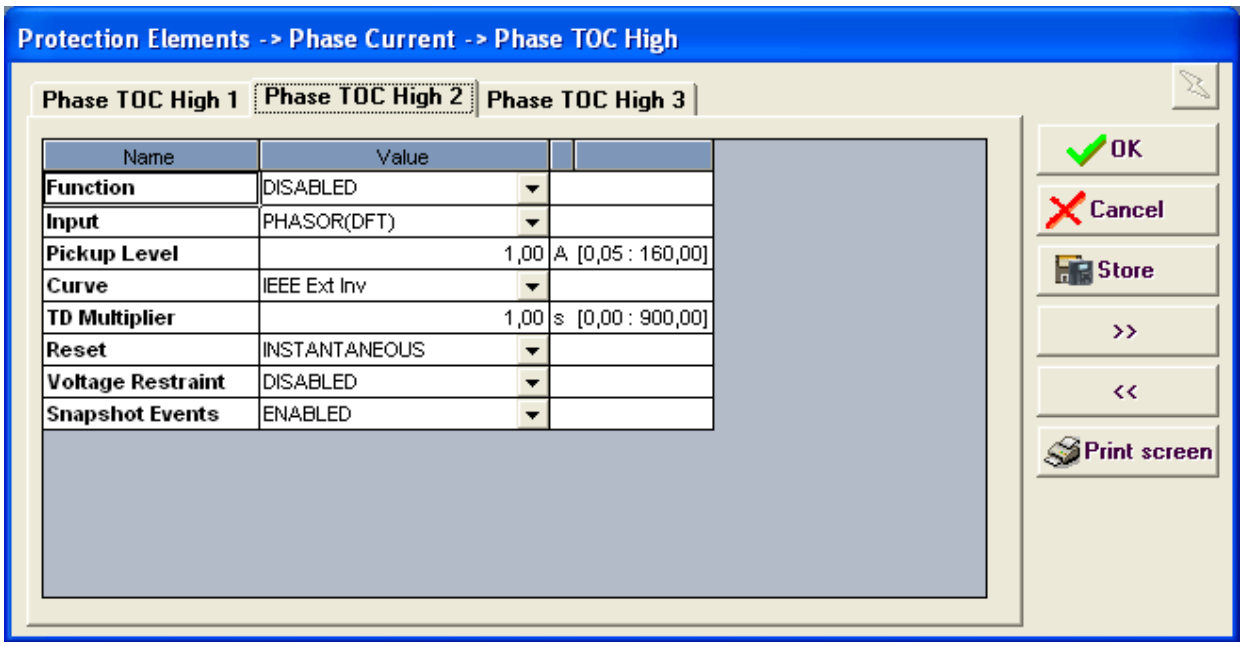


Figure 7-43: MMS object explorer

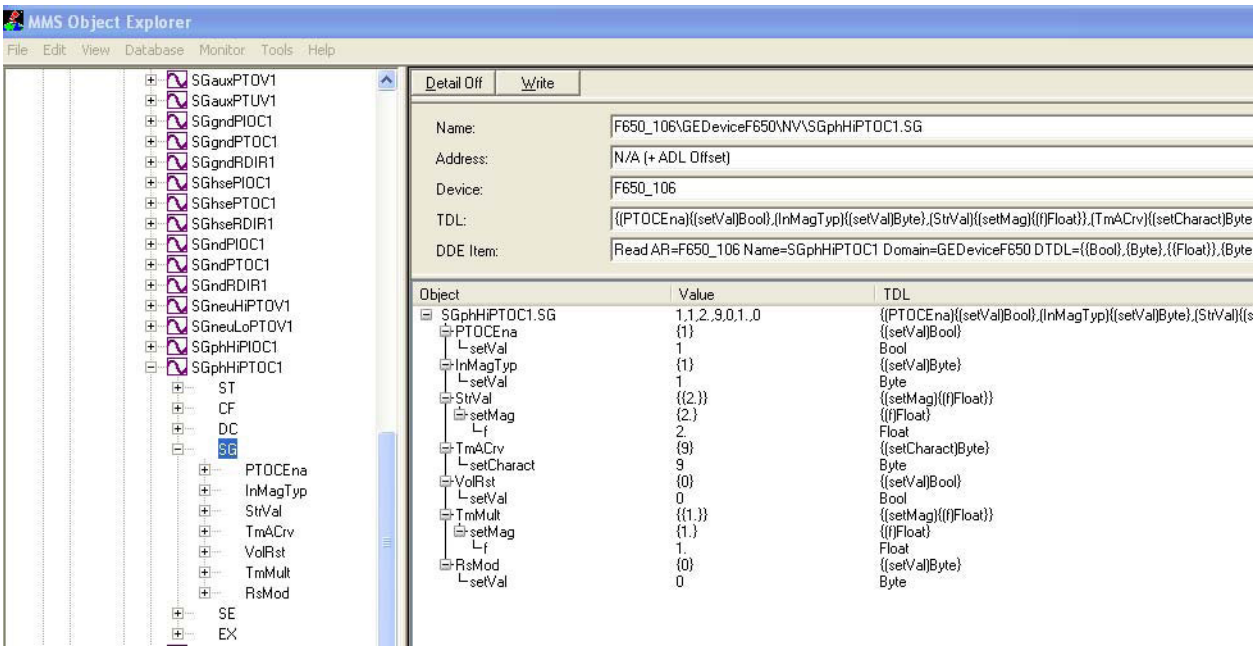
Firmware versions from 7.20 to below 7.50

The settings for the groups 1 and 2 of high level of Phase Time Overcurrent protection function are shown in the next figures.

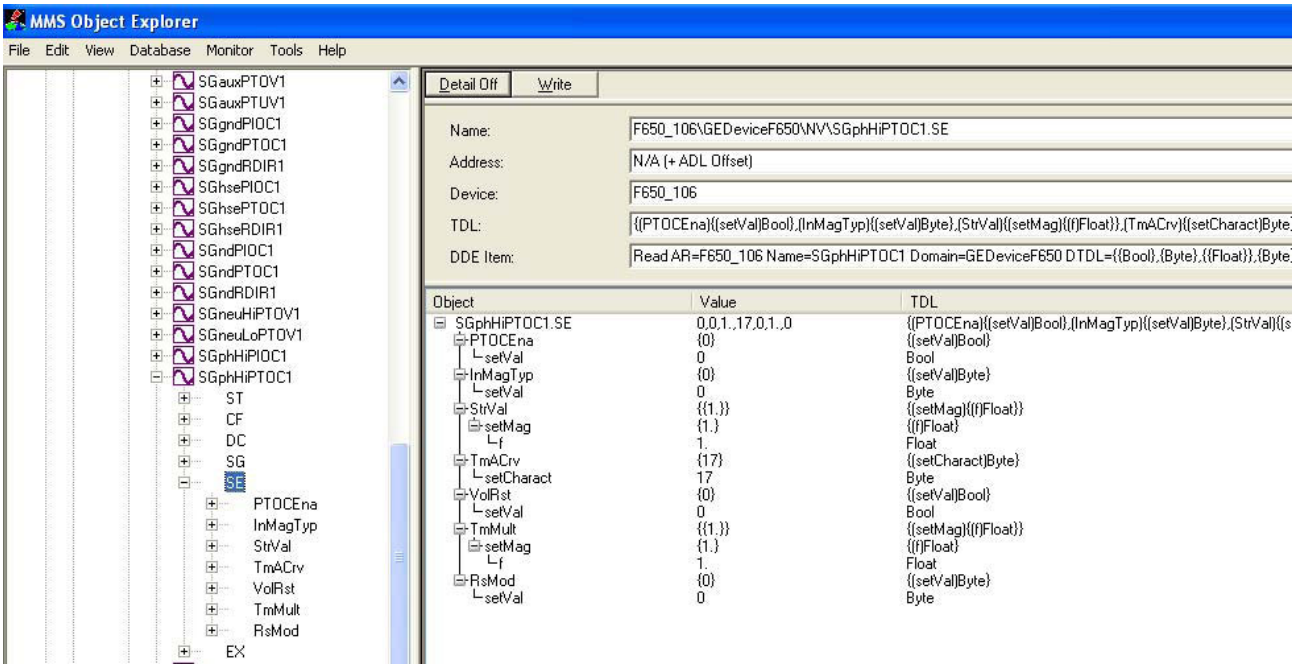




As it is shown in the figure, the values of the settings of the setting group indicated with the ActSg are the ones with the FC = SG in Logical Node SGphHiPTOC1, therefore the ones used by the high level of Phase Time Overcurrent protection function in the relay.

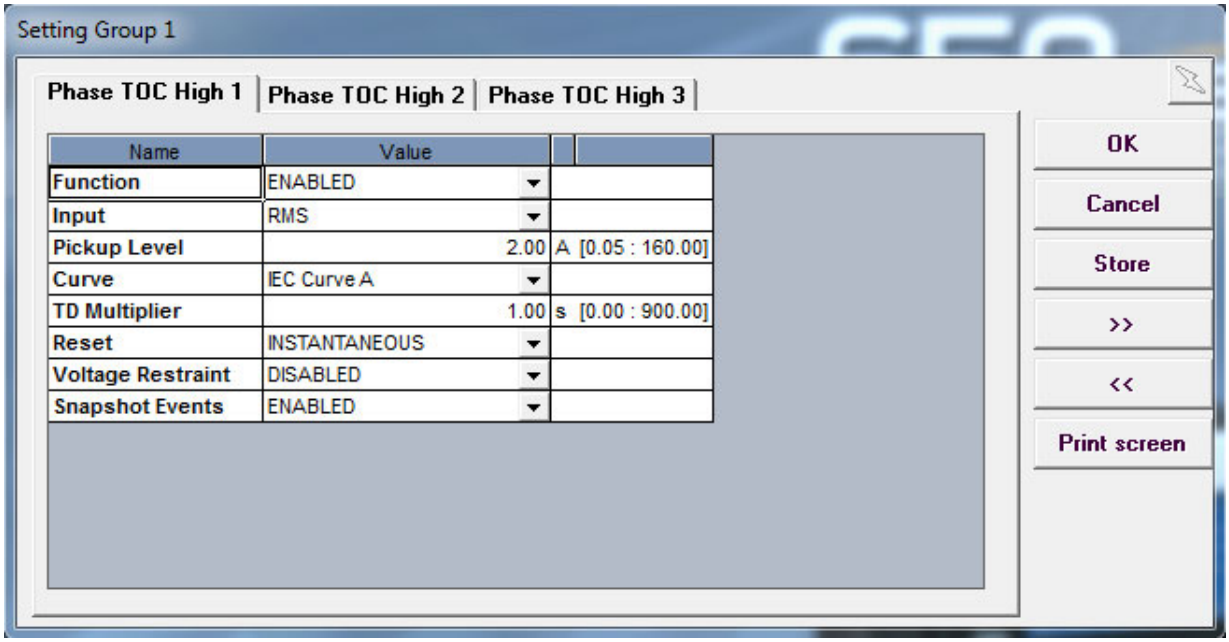


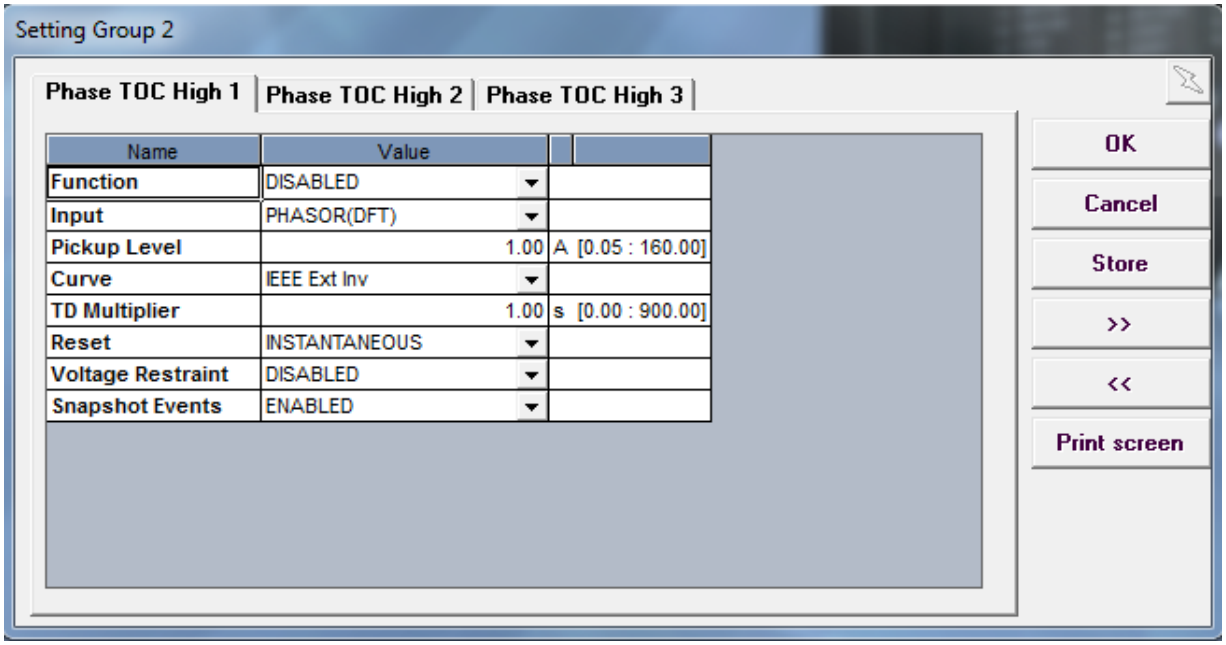
On the other hand, as it is shown in the figure, the values of the settings of the setting group indicated with the EditSg are the ones with the FC = SE in Logical Node SGphHiPTOC1.



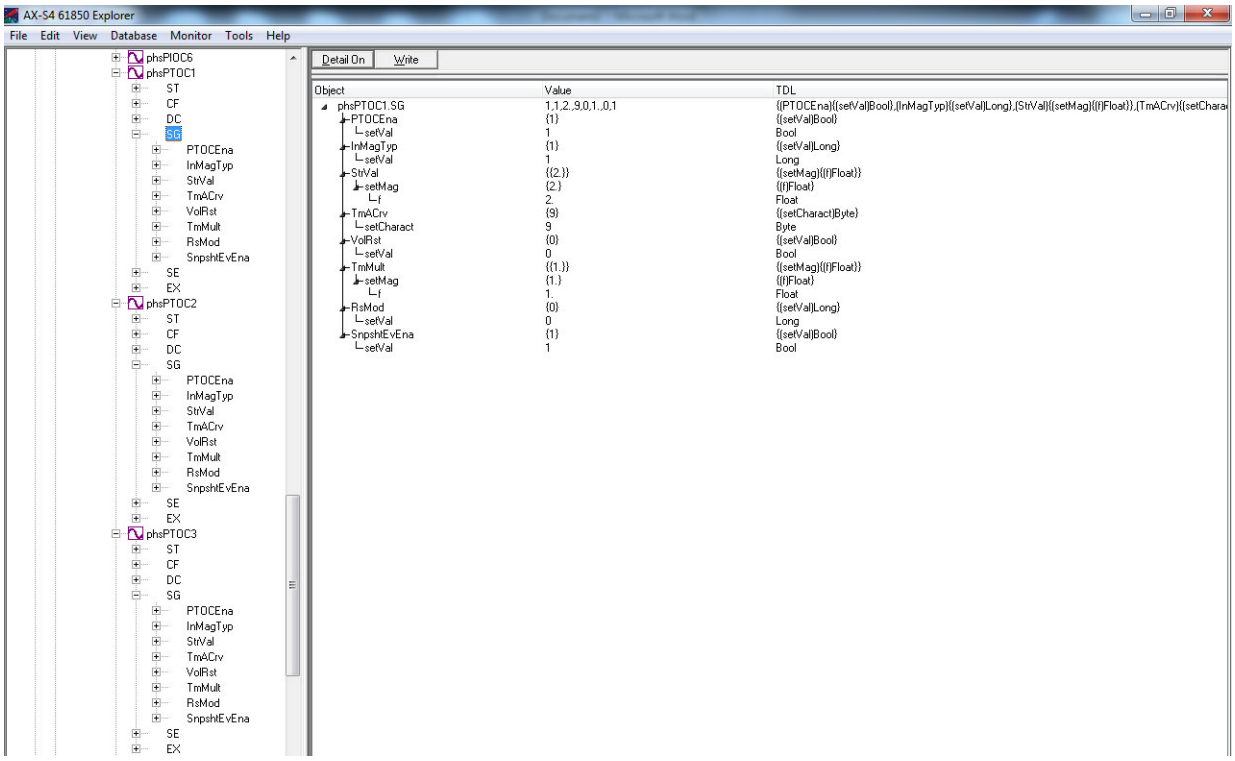
Firmware versions 7.50 and above

The settings for the high level Phase Time Overcurrent protection function (Phase TOC High 1, 2 and 3) on setting groups 1 (ActSG) and 2 (EditSG) are shown in the next figures.

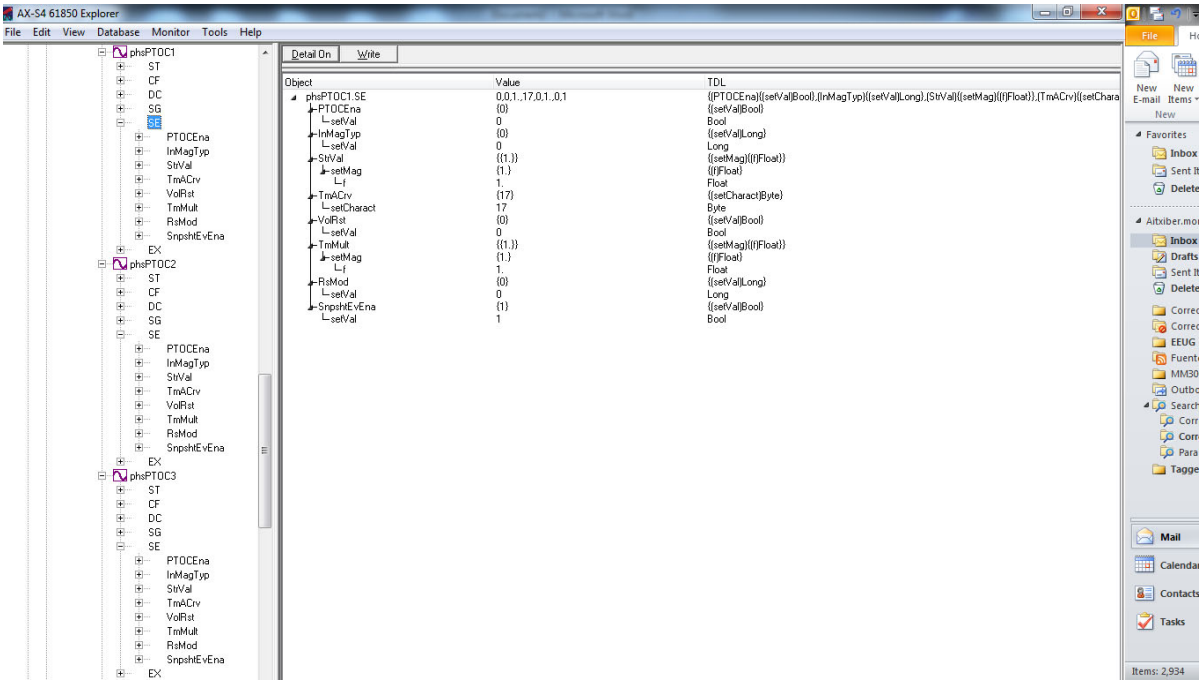




As it is shown in the figure, the values of the settings of the setting group indicated with the ActSg are the ones with the FC = SG in Logical Nodes phPTOC1, phPTOC2 and phPTOC3. Therefore the ones used by the high level of Phase Time Overcurrent protection function in the relay.



On the other hand, as it is shown in the figure, the values of the settings of the setting group indicated with the EditSg are the ones with the FC = SE in Logical Nodes phPTOC1, phPTOC2 and phPTOC3.



F650 Digital Bay Controller

Chapter 8: Security

8.1 Security level for firmware versions prior to 9.00

8.1.1 Adding users

New users can only be added by users that have **Administrator Access (or Admin Rights)**. The **Enable Security** check box located in the **Security** > **User Management** window must be enabled.

Remember: (**In order to add new users and assign user rights)**

- **must be logged in with Administrator Permission**

and Enable Security check box must be enabled

NOTE: Only Administrators have access to the User Management dialog box.
Following is a list of all of the User Rights Options available to be granted to users, and their functions.

Table 8-1: User rights and functions

RIGHT	FUNCTION
Delete Entry	If this box is checked when the Administrator exits the User Management dialog box, the program asks to confirm the delete before the selected user is permanently deleted from the list.
Admin.	WARNING: When this box is checked, the user becomes an EnerVista 650 Setup Administrator, receiving all Administrative rights.
Actual Values	When this box is checked, the user is able to *view* **Actual Values** and all records excluding event recorder.
Settings	When this box is checked, the user is able to *view and modify* **Settings (Protection, control, inputs/outputs and calibration)**.
Commands	When this box is checked, the user is able to use **Commands**.
Event Recorder	When this box is checked, the user is able to use **Event Recorder**.
Force IO	When this box is checked, the user is able to use **Force IO** application.
Logic Configuration	When this box is checked, the user is able to *view and modify* **Relay Configuration and Logic Configuration**.
Upgrade	When this box is checked, the user is able to **upgrade firmware, bootware** and to **upload** and **download info files to/from relay.**

By default, Administrator and Service users are created with "password" as default password.

8.1.2 Changing passwords

Users are prompted to change their password after the first successful log in or through clicking **Security** from the toolbar, and choose **Change Password**.

Figure 8-1: Change security

When the operator enters a new password for the first time, he/she should also enter a personal question that only they can answer. There is a limit of 50 characters available to enter the personal question. One example, as in the above diagram, would be "What is my mother's maiden name?". This question is posed to the user if the user forgets their password and would like to know what their password was.

8.1.3 Enabling security

EnerVista 650 Setup Security Control is disabled by default. Users don't have to log in through user name and password after installation and are granted access as Administrator.

Security Control can be enabled through **Security** from the tool bar when logged on as an Administrator. Click **User Management**:

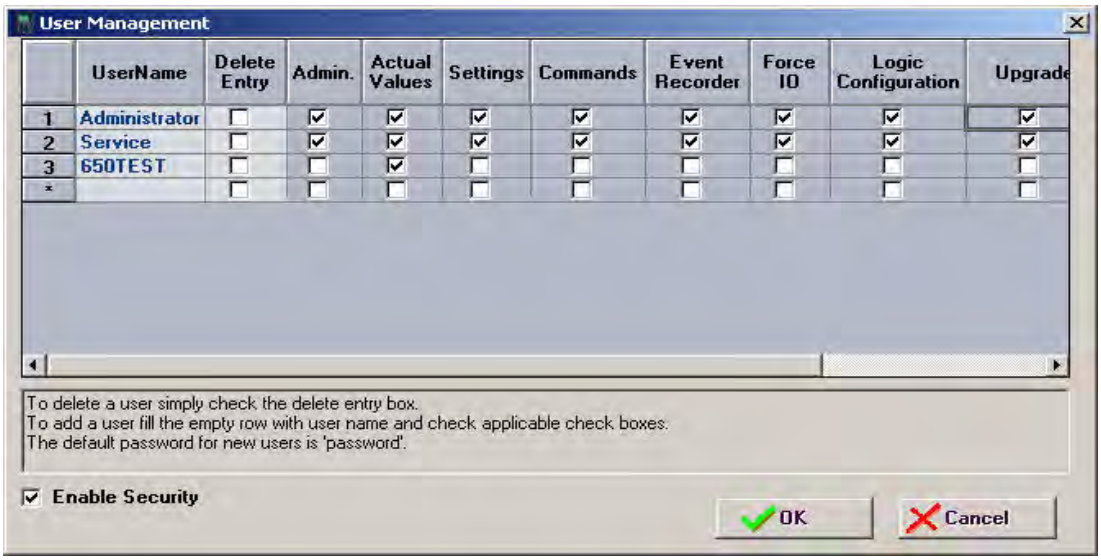


Figure 8-2: Enabling security

Security Control is enabled by checking the **ENABLE SECURITY** check box. The first time the enable security option is selected it is necessary to close and reopen the EnerVista 650 Setup software to start working under security management.

8.1.4 Logging into EnerVista 650 Setup

Users have to log on in order to use EnerVista 650 Setup program after Security Control has been enabled. After the start up of EnerVista 650 Setup, a dialog prompts for user name and password.

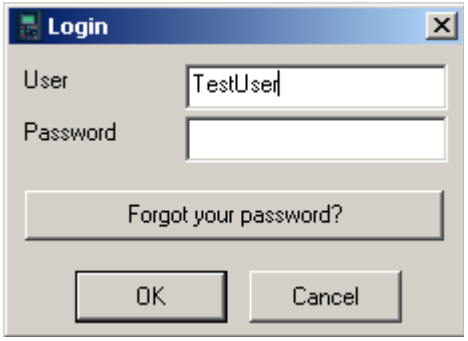


Figure 8-3: Login user

The user name field displays the last log in user name as default, in this example, TestUser. For the first log in session of any user name, the default password is "password". The user is prompt to change the password to something else after the first successfully log in.

Log on can also be done by clicking **Security** from the toolbar and choose **Login New User**. The user is prompted with the same log in dialog box for a different user name and password combination.

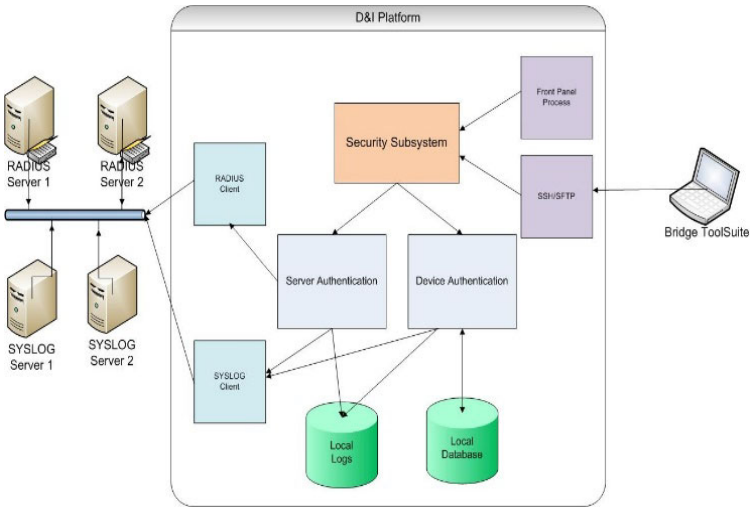
In case a user has forgotten their log in password, the **Forgot Password** function can be used to retrieve the password.

Figure 8-4: Forgot your password?

A question, which is pre-set by the user, is asked. The password is retrieved for entering the right answer.

8.2 Security level for firmware versions 9.00 and higher

8.2.1 Cybersecurity Overview



The bulk of the Cyber Security implementation consists of RBAC Cybersecurity mode, Centralized Authentication, Remote Logging and System Hardening.

The relay's cyber-security functionality shall be implemented to meet the NERC-CIPv6 and IEEE 1686 requirements. And it is planned to offer Cyber security function in two flavors as ordering options:

- Basic Cyber Security
- Advanced Cyber Security

The main features for each of the CyberSecurity order option will be as follows:

Basic Cyber Security: The relay with Basic security option will support the following:

1. Device / Local Authentication

b. RBAC: 4 fixed roles: Administrator, Engineer, Operator & Viewer

c. Password complexity = Disabled by default (minimum password length: 4)

d. Default Password: "ChangeMe1#"

e. Flag for Failed authentication, User lockout for configurable period

f. Encrypted communication over ethernet

g. Inactivity Timeout

h. Security event storage on IED

i. Secure firmware download

j. Hardening

1)Enable / Disable communication ports

2)Enable / Disable protocols

Advanced Cyber Security:

1.All features for Basic security

b.Remote / Server Authentication- RADIUS

c.Syslog – security events

d.Password Complexity = Enabled by default.

Note: The default password as per the complexity rules is : **ChangeMe1#**

8.2.2 Settings

8.2.2.1 Basic Security

The device's Basic Security relay supports 4 fixed roles: Administrator, Engineer, Operator, Viewer.

HMI Path: **View/Change Settings -> Product Setup -> Security**

Enervista Path: **Setpoint -> Product Setup -> Security**

Settings available under this path are divided in two main groups:

- Security Config
- Security Password

Setpoint > Product Setup > Security > Security Config				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
This setting allows a user to login with a specific role	Security Login	Viewer	N/A	[Viewer-Administrator-Engineer-Operator]
This setting logs out the current user and logs it in as Viewer	Security Logout	No	N/A	[Yes - No]
This feature allows to bypass security - user authentication	Bypass Access	DISABLED	N/A	[DISABLED – Local - HMI]
This setting allows user to configure password adhere to complexity rules or regarlar 4-20 characters password.	PW Complexity	DISABLED	N/A	[DISABLED – ENABLED]
Access Lockout	Acc Lockout	3	min	[0 : 99]
Access Lockout Time is the duration in minutes for lockout	Acc Lockout Time	3	min	[0 : 9999]
Access Timeout HMI	Acc Timeout HMI	5	min	[2 : 999]
Access Timeout Other	Acc Timeout Othr	5	min	[2 : 999]
Require Password for Reset Key	Req PW Reset Key	ENABLED	N/A	[DISABLED – ENABLED]
Require Password for Date/Time change	Req PW D/T Change	ENABLED	N/A	[DISABLED – ENABLED]
Require Password for control	Req PW Ctrl	ENABLED	N/A	[DISABLED – ENABLED]
Bypass Password for remote control	Bypass PW Rem Ctrl	DISABLED	N/A	[DISABLED – ENABLED]
Require Password for Setting Group	Req PW Setting Group	ENABLED	N/A	[DISABLED – ENABLED]

8.2.2.1.1 Security Config

The relay settings for the Security Config are as follows:

Security Login: This setting allows a user to login with a specific role.

1) Whenever a new role is logged in, the user is prompted with a display to enter password.

2) If the user enters the wrong password, "Authentication Failed!" message is displayed.

3) If the maximum failed authentications occur an "Account Blocked!" message is displayed.

4) The "Viewer" is the default choice and it does not require a password.

5) If the authentication is successful, EnerVista 650 Setup will show in the status bar the logged user name.

Secrity Logout: This setting logs out the current user and logs it in as Viewer. If the user is already a Viewer, this setting does nothing. When logging out, a switch to Viewer role is performed.

Bypass Access: The "Bypass Access" feature allows to bypass security - user authentication. Once this setting is other than "Disabled", then user gets Administrator access rights on the configured interface. For example, if user configures it as "Local" then no user authentication is needed for accessing the device over USB or HMI.

Other possible option for 650 is to bypass authentication for "HMI" - where user can view & modify all the settings, view actual values or execute commands.

The use of this feature should be restricted only in commissioning phase or when it is considered safe.

Mode	Local (HMI or USB)
Secure Mode	Authentication — Role Based Access Control (RBAC), and Encrypted passwords
Bypass access Mode	No passwords for allowed RBAC levels

PW Complexity: When "PW complexity" is set to "Enabled", it allows user to configure password strings which adhere to complexity rules defined in Password complexity chapter. When the setting is configured as "Disabled" then user can change the password to any string with minimum length of 4 characters maximum length of 20 characters.

For basic security IED, Password complexity is set to "Disabled" by default.

Acc Lockout: Access lockout is the number of failed authentications (default is 3 and maximum is 99) before the device blocks subsequent authentication attempts for the lockout period. A value of 0 shall mean Lockout is disabled.

Acc Lockout Time: Access lockout time is the duration in minutes for lockout. After configured times of failed authentication, particular role gets locked-out for configured "Acc Lockout Time". After this period, user will be allowed to login again for that role.

Acc Timeout HMI: If user is logged in through HMI then he can be inactive for the period configured as "Acc Timeout HMI" before getting auto-logged out.

Acc Timeout Othr: Access Timeout Other is the time authorized user can be inactive, before automatically getting logged out. This timeout shall apply to all users & roles, independent of the communication channel (serial, Ethernet or USB) but not for HMI users.

Req PW Reset Key: This setting is only available to the Administrator. It is used for the purpose of bypassing security. If this setting is enabled and an alarm or trip occurs on the relay, the Reset button is not available to the Viewer.

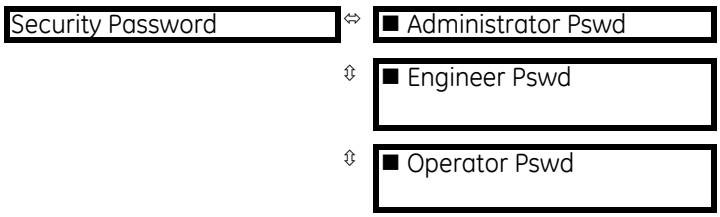
Req PW D/T Change: The date/time can be set by any role, if this setting is disabled. If this setting is enabled the date/time can only be set by the Administrator and Engineer.

Req PW Ctrl: If this setting is disabled, Operator controls do not require a password. If this setting is enabled, the password for users with access privilege is required.

Bypass PW Rem Ctrl: This setting is only applicable to Basic cybersecurity order code, it is disabled by default. If it is enabled, then no password is required for the remote controls.

Req PW Setting Group: This setting is only applicable to Basic cybersecurity order code, it is disabled by default. If it is enabled, then no password is required for the setting groups.

8.2.2.1.2 Security Password:



Range: 4 to 20 ASCII char when Password Complexity disabled

8 to 20 ASCII char when Password Complexity enabled following password complexity

rules

Default: **ChangeMe1#** (for both basic and advanced security IED)

For Basic Security option, this window allows user to configure password for various roles.

e. A user connected to the device with **Administrator** privileges, can modify password for all other roles.

f. If a user connected to the device as other than **Administrator** role, tries to select **Change Passwords** option, then HMI as well as EnerVista 650 Setup will allow changing password for the user's own account.

If a non-admin user tries to change other account password, then HMI as well as EnerVista 650 Setup will prohibit it.

The password rules validation shall be done only when password complexity is set to enabled. When the complexity is enabled and user tries to modify the password, then it Will be nice to show password complexity rules. Once user tries to save new password, make sure that the string adheres to all the password complexity rules. If any of the rule is not met, then proper error message needs to be shown to user regarding which rule/s is/are not met.

8.2.2.2

8.2.2.3 Advanced security

In addition to Basic Security, Advanced security offers Server authentication & authorization, syslog capability, Configurable user credentials.

The settings menu would be as shown below:

HMI Path: **View/Change Settings -> Product Setup -> Security**

Enervista Path: **Setpoint -> Product Setup -> Security**

Settings available under this path are divided in two main groups:

- Syslog
- Security Config
- Adv Security Password
- User Config
- Server Config
- CA Certificate

8.2.2.3.1 Syslog:

Support for *SysLog* is only required in product variants supporting advanced security order-code.

The device shall support 2 Syslog servers for redundancy. The product shall always attempt to send *security events* to the primary & Secondary *SysLog* server. The product shall communicate with the external *SysLog* servers using *UDP/IP* .

Syslog	⇕ IP Prim Octet1	Range: 0.to 255 Default: 0
	⇕ IP Prim Octet2	Range: 0.to 255 Default: 0
	⇕ IP Prim Octet3	Range: 0.to 255 Default: 0
	⇕ IP Prim Octet4	Range: 0.to 255 Default: 0
	⇕ IP Prim Port	Range: 1 to 65535 Default: 514
	⇕ IP Sec Octet1	Range: 0.to 255 Default: 0
	⇕ IP Sec Octet2	Range: 0.to 255 Default: 0
	⇕ IP Sec Octet3	Range: 0.to 255 Default: 0
	⇕ IP Sec Octet4	Range: 0.to 255 Default: 0

⇕ IP Sec Port

Range: 1 to 65535

Default: 514

8.2.2.3.2 Security Config

Setpoint > Product Setup > Security > Security Config				
Setting Description	**Name**	**Default Value**	**Step**	**Range**
This setting allows a user to login with a specific role, it is only available in HMI	Security Login		N/A	[EnerVista 650 Setup can show pop-up screen to enter user credentials] [20 Alphanumeric Characters for HMI]
This setting logs out the current user and logs it in as Viewer, it is only available in HMI	Security Logout	No	N/A	[Yes - No]
Authentication Method	Auth Method	Device/ Server	N/A	[Device - Server/Device - Device/Server]
This feature allows to bypass security - user authentication	Bypass Access	DISABLED	N/A	[DISABLED – Local - HMI]
This setting allows user to configure password adhere to complexity rules or regarlar 4-20 characters password.	PW Complexity	ENABLED	N/A	[DISABLED – ENABLED]
Access Lockout	Acc Lockout	3	min	[0 : 99]
Access Lockout Time is the duration in minutes for lockout	Acc Lockout Time	3	min	[0 : 9999]
Access Timeout HMI	Acc Timeout HMI	5	min	[2 : 999]
Access Timeout Other	Acc Timeout Othr	5	min	[2 : 999]
Require Password for Reset Key	Req PW Reset Key	ENABLED	N/A	[DISABLED – ENABLED]
Require Password for Date/Time change	Req PW D/T Change	ENABLED	N/A	[DISABLED – ENABLED]
Require Password for control	Req PW Ctrl	ENABLED	N/A	[DISABLED – ENABLED]
Bypass Password for remote control	Bypass PW Rem Ctrl	ENABLED	N/A	[DISABLED – ENABLED]
Require Password for Setting Group	Req PW Setting Group	ENABLED	N/A	[DISABLED – ENABLED]

Security Login: This setting is not avaialble in EnerVista.

Secrity Logout: This setting is not avaialble in EnerVista.

Auth Method: This setting allows user to configure the priority for authentication method for each authentication attempt. If user selects "Device" Authentication, then only Local authentication will be utilized. The relay will not communicate with RADIUS server for authentication. When user selects "Server/Device" Authentication then the relay will first connect with remote RADIUS server for authentication but if that is not reachable then it will authenticate user based on local database of credentials. If user configures "Device/Server" authentication, then priority for authentication will be given to device credentials database driven. If that fails, then the relay will try to connect to remote RADIUS server for authentication.

Bypass Access: The "Bypass Access" feature allows to bypass security - user authentication. Once this setting is other than "Disabled", then user gets Administrator access rights on the configured interface. For example, if user configures it as "Local" then no user authentication is needed for accessing the device over USB or HMI.

The setting is configurable to user connected to relay as "Administrator". The use of this feature should be restricted only in commissioning phase or when it is considered safe.

Mode	Local (HMI or USB)
Secure Mode	Authentication — Role Based Access Control (RBAC), and Encrypted passwords
Bypass access Mode	No passwords for allowed RBAC levels

PW Complexity: When "PW complexity" is set to "Enabled", it allows user to configure password strings which adhere to complexity rules defined in Password complexity chapter. When the setting is configured as "Disabled" then user can change the password to any string with minimum length of 8 characters and maximum length of 20 characters. For advanced security IED, Password complexity is set to "Enabled" by default.

8.2.2.3.3 Adv Security Password

Adv Security Password	⇕	UserPW0	Range: 20 char long password Default: ChangeMe1#
…… and so on. Settings for total 10 users		…….	……
Message	⇕	UserPW9	Range: 20 char long password Default: ChangeMe1#

8.2.2.3.4 User Config

User Config	ô	UserName0	Range: ASCII characters, max length: 20 Default: “Viewer”
Message	⇕	UserName1	Range: ASCII characters, max length: 20 Default: “Administrator”
Message	⇕	UserName2	Range: ASCII characters, max length: 20 Default: “Engineer”
Message	⇕	UserName3	Range: ASCII characters, max length: 20 Default: “Operator”
…… and so on. Settings for total 10 users		…….	……

Message		⇳	UserName9		Range: ASCII characters, max length: 20 Default: “User9”
Message		⇳	UserRole0		Range: Viewer, Administrator, Engineer, Operator Default: Viewer
Message			UserRole1		Range: Viewer, Administrator, Engineer, Operator Default: Administrator
Message		⇳	UserRole2		Range: Viewer, Administrator, Engineer, Operator Default: Engineer
Message		⇳	UserRole3		Range: Administrator, Engineer, Operator, Operator Default: Operator
…… and so on. Settings for total 10 users			……		……
Message		⇳	UserRole9		Range: Viewer, Administrator, Engineer, Operator Default: Viewer

For advanced security relay, user can configure upto 10 configurable user accounts. As part of this, he can configure a username (length can be upto 20 ASCII char), Password for the username (max length can be 20 ASCII char) & assign a device supported user role (range : Administrator, Engineer, Operator, Viewer).

In advanced security option, “Administrator” is eligible to configure various accounts and is eligible to modify passwords for all available accounts. Non-Admin user should be able to modify their own account password.

It is recommended to have more than one “Administrator” account.

8.2.2.3.5 Server Config

Server Config		⇔	RADIUS IP Prm Octet1		Range: 0 to 255 Default: 0
Message		⇳	RADIUS IP Prm Octet2		Range: 0 to 255 Default: 0
Message		⇳	RADIUS IP Prm Octet3		Range: 0 to 255 Default: 0
Message		⇳	RADIUS IP Prm Octet4		Range: 0 to 255 Default: 0

Message	⇳	RADIUS IP Sec Octet1	Range: 0 to255 Default: 0
Message	⇳	RADIUS IP Sec Octet2	Range: 0 to 255 Default: 0
Message	⇳	RADIUS IP Sec Octet3	Range: 0 to 255 Default: 0
Message	⇳	RADIUS IP Sec Octet4	Range: 0 to 255 Default: 0
Message		RADIUS Auth Port	Range: 1 to 65535 Default: 1812
Message	ô	Vendor ID	Range: 1 to 65535 Default: 2910
Message	ô	RADIUS Auth Meth	Range: PEAPv0, EAP-TTLS, PAP Default: EAP-TTLS
Message	ô	RADIUS Timeout	Range: 0 to 9999 sec Default: 10 s
Message	ô	RADIUS Retries	Range: 0 to 9999 sec Default: 3
Message	ô	RADIUS Secret	Range: ASCII char string: Max 246 char
	ô	CA Certificate Upload	File upload option through Enervista 650 Setup

8.2.2.3.6 Server RADIUS

This section shall help configure RADIUS sever in the device IED that shall enable remote authentication support.

Setting Name	Description	Min	Max	Default
RADIUS IP Prim	IP address of primary Radius server. Default value indicates no Primary Radius server is configured, and hence Radius is disabled.	0.0.0.0	223.255.255.254	0.0.0.0
RADIUS IP Sec	IP address of secondary Radius server. Default value indicates no secondary Radius server is configured, and hence Radius is disabled.	0.0.0.0	223.255.255.254	0.0.0.0
RADIUS Authentication Port	Radius authentication port	1	65535	1812

Vendor ID	An identifier that specifies Radius vendor specific attributes used with the protocol.	1	65535	Value that represents General Electric (2910)
Radius Authentication Method	Authentication method used by Radius server. Range: PEAPv0, EAP-TTLS, PAP			EAP-TTLS
Timeout	Timeout in seconds in between re-transmission requests	0	9999	10
Retries	Number of retries before giving up	0	9999	3
Radius Authentication (Shared) Secret	Shared Secret used in authentication. It is only displayed as asterisks. This setting must meet the CyberSentry™ password requirements.	See password section for requirements	245 characters	N/A
Confirm Radius Authentication (Shared) Secret	Confirmation of the shared secret. Only display as asterisks.	See password section for requirements	245 characters	N/A

The device shall support redundant RADIUS servers.

8.2.3 RBAC (Role Based Access Control)

8.2.3.1 Roles Vs Access Matrix / Role Assignment:

User can access the device IED through the configuration tool or the device's HMI. Based on role of the user, he will be eligible to perform different operations.

R: Read
RW: Read/Write
X: No access

		Administrator	Engineer	Operator	Viewer
Settings					
	Security settings	RW	R	R	R
	Change own PW (Basic security)	Yes	Yes	Yes	X
	Change own PW (Advanced security)	Yes	Yes	Yes	Yes
	Create New / Modify users, assign roles (advanced security OC)	RW	X	X	X
	Non-Security settings	RW	RW	R	R
	PLC	RW	RW	R	R
	Output Simulation	RW	RW	X	X
	IEC61850 settings	RW	RW	R	R
Commands					
	Date change	RW	RW	X	X
	BKR related	RW	RW	RW	X
	Clear records	RW	RW	X	X
File operations					
	Config File read	R	R	R	R

	Config File write	W	W	X	X
Upload FW		W	X	X	X
Actual Values					
	Status	R	R	R	R
	Metering	R	R	R	R
Reports					
	Events	R	R	R	R
	Waveforms	R	R	R	R
	Security Audit log	R	X	X	X

8.2.3.2 Session management functionality:

RBAC microservice is in charge of session management. Every login attempt will connect to the microservice and it will allow or deny the login of the user.

In Basic Security, default connection is done as Viewer, without password requirement.
Once logged as Viewer, the user can change the role and login as Administrator, Operator or Engineer.

In Basic Security, once logged out from major roles, the connection comes back to Viewer role.

In case of Advanced Security, a username and password will be required. If the login is successful, the access level will correspond to the role defined to this user.
The user cannot change its own role. So, in case of more rights needed, another different user with the corresponding role should be logged in.

The maximum number of concurrent sessions is only one for all roles, except of Viewer role, which has the limit of 5 sessions.

There is a **session timeout** adjustable by settings. This timeout means that open sessions are automatically closed if they remain inactive till the timer elapses. This inactivity timer defines the period that IED waits in idleness before a logged in user will be automatically logged out.

There is a **lockout period** adjustable by settings. For each account, when a maximum number of failed login attempts is reached, it is locked during the specified period. It doesn't matter the interface the login comes from. The account will be unlocked at the first successful login passed the lockout period.

If the **Authentication Method** setting is changed, the logged in user will be forced to logout.

The EnerVista 650 Setup shall check if the login was successful as follow:

8.2.3.3 Password Complexity

Below are the password complexity rules which user need to adhere to, when "PW Complexity" setting is configured as "Enabled"

Complexity:

oPasswords cannot contain the user's account name or parts of the user's full name that exceed two consecutive characters.

oMust be at least 8 characters in length. Max length can be 20 ASCII char

oPasswords must contain characters from all four categories:

-English uppercase characters (A through Z).

-English lowercase characters (a through z).

-Numeric: Base 10 digits (0 through 9).

-Special non-alphanumeric (such as @,!,#,{, but not limited to only those, etc.)

8.2.4 Authentication Methods

8.2.4.1 Requirements/specifications:

1. Only Administrator role can change Bypass configuration

b. Provide Local and HMI Bypass options

c. Device Auth: local device database storage of user credentials

d. Passwords stored on the IED must be encrypted

e. Only Administrator can change local device passwords & each user can change their own password

f. Server Auth: different database from Device Authentication

g. RADIUS database must not be locally stored

h. 2 RADIUS servers for redundancy

i. Always attempt to authenticate with primary RADIUS server first

j. User configurable timeout and retry when connecting with RADIUS servers

k. Report the status of RADIUS servers: not configured, Primary, Secondary, Failed

l. Support for PAP, PEAPv0 and EAP-TTLS RADIUS authentication protocols

m. Server CA certificate verification for RADIUS EAP

n. Support a shared secret as RADIUS client authentication (with password complexity rules)

8.2.4.2 Bypass

In Bypass mode, IED does not provide security, any user can login IED to access. IED does not validate user and password. The bypass security feature provides an easier access, with no authentication and encryption for those special situations when this is considered safe. Only the Administrator, can enable this feature

There are three modes for authentication bypass:

1)Disable – Will disable Bypass completely

2)HMI: will bypass authentication for front panel

3)Local: will bypass authentication for

·Front USB

·Serial Port (RS 485)

8.2.4.3 Device Authentication

In Device Authentication mode, IED provide local RBAC Server security. The IED supports unique device usernames, and stores device passwords securely.

1) RBAC

a. 4 pre-defined roles: Admin, Engineer, Operator, Viewer- Basic Cyber security

b. 10 Usernames that can be assigned roles- Advanced Cybersecurity

c. Password complexity

d. Default password (example: ChangeMe1#)

e. Session management

f. Bypass setting

g. Authentication method options

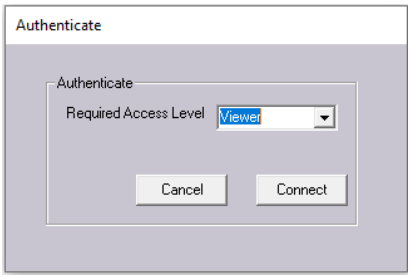
i.Device

ii.Device / Server

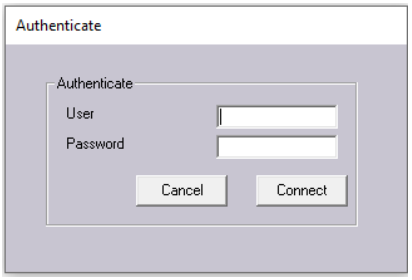
iii.Server / Device

Only Administrator can change other user's passwords. All device users can change their own passwords. For password reset/recovery procedure the Administrator role will be required.

Viewer access level has no password associated in Basic Security.



In Advanced Security relay, all users need to enter username as well as password to get access privileges.

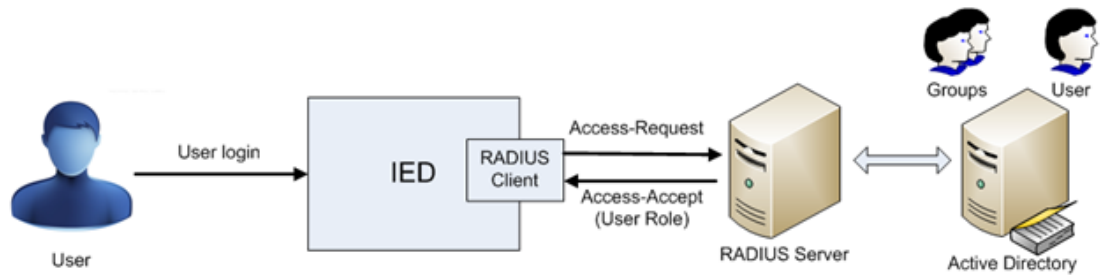


The default password for both Basic Security and Advanced Security relay is "**ChangeMe1#**"

8.2.4.4 Server Authentication

In Server Authentication mode, IED authenticates the user using RADIUS server. RADIUS client resides in the product and connects to the RADIUS server.

Two servers are supported in the configuration for redundancy. The IED will try each in sequence until one respond. When the first RADIUS server is unavailable, the next server in the list is tried for RADIUS Authentication.



IED will first try the server 1 up to the configured number of retries leaving request timeout between each request. If after this point it still don't have a valid answer from server 1, it switches to server 2 and repeats for up to the number of configured retries again. If it maxes out on retries on the second server, it gives up entirely on Server Authentication and fallback to device authentication (Only if Authentication Method Server and Device is selected). A "RADIUS Server unavailable" security event is also logged under this condition.

IED will authenticate and authorize RADIUS users using the following authentication stack:

- Primary Radius if enabled (stop on invalid credential failure, continue all other failures)
- Secondary Radius if enabled (stop on invalid credential failure, continue all other failures)

The RADIUS implementation supports the following authentication protocols:

- PEAPv0 with inner authentication method MS-CHAPv2 (To support Microsoft NPS server)
- EAP-TTLS with inner authentication method PAP (To support RSA AM)
- PAP (unsecured, to support any RADIUS server)

When using PEAPv0 or EAP-TTLS-PAP the RADIUS implementation shall use CA certificate to establish the TLS connection.

The EAP-TTLS RADIUS implementations are not required to support Client certificate authentication.

The RADIUS implementation will query the Role ID vendor attribute and establish the logged in user security context with that role.

In case of Server Authentication mode but if the RADIUS server is not operational, IED will try Device Authentication.

8.2.5 Secure communication

8.2.5.1 Requirements/specifications

1. Secure file transfer protocol (SFTP)

b. Secure communication between

c. the configuration tool and the device: Modbus/SSH

8.2.5.2 Number of concurrent sessions:

For 650 IED max TCP connections supported are 5.

At a time only **one non-Viewer** can connect to the IED.

Administrator: Complete read and write access to all settings and commands.

Engineer: This role has almost same rights as "Administrator", except security settings modification as well as some of the commands & FW upload is not allowed.

Operator: The operator has access to read all settings as well as actual values. This role is also entitled to execute commands and can also close or open breakers.

Viewer: Has read only access to all the device settings. This role will allow multiple concurrent access. This role will have no download access to any files on the device.

At a time, only single non-Viewer user can connect to the device. Up-to 5 number of Viewers can connect to device at given time.

8.2.5.2.1 Ensuring non-viewer user may always login

It is mandatory that one Modbus connection is always reserved for Administrator or non-Viewer user. This is to make sure; a user can take immediate action/ give command when there is need.

The following will be implemented -

1)Only maximum of 4 Viewer/Observer connections are allowed.

2)Maximum 1 non-viewer connection

8.2.5.3 Modbus/SSH

The SSH server reside in the IED. It securely encrypts the Modbus commands and data between the EnerVista 650 Setup and itself using port forwarding. SSH 2.0 is supported.

The port forwarding feature is available only on TCP/IP frames. UDP is not supported. The SSH server on the product runs on port 22.

The SSH server has a timeout for authentication and disconnect if the authentication has not been accepted within the timeout period.

8.2.5.4 SFTP

The SFTP commands will be limited for a given period of time to avoid DOS attacks and also implement role based access to the file. FW will validate the file before processing it.

8.2.5.5 Non-encrypted/Clear text MODBUS

In multiple scenarios, we have seen users willing to use plain or non-encrypted MODBUS communication with SCADA applications. To provide this possibility to users, we need to support following setting:

Setting “MODBUS TCP”:

Range: Disable/Enable,

Default: Disable

User with “Administrator” role can configure this setting. Once the setting is configured to other than “Disabled”, IED will allow communication with 3rd party SCADA application in plain text MODBUS over port 502. Also, for configuration change, the relay IED shall register a security even to, show target message & alarm to indicate user.

When “MODBUS TCP” is configured to “Enabled”: then legitimate user can read or write over plain MODBUS using port 502 on successful authentication.

When “MODBUS TCP” is configured to “Disabled”: the port 502 will be closed.

NOTE1: EnerVista 650 Setup configuration tool will always communicate with IED over SSH using port22.

8.2.6 Other Features

8.2.6.1 Events & PLC Operands

Table below shows complete list of events & Flex-operands. Description column gives details about scenarios they get asserted.

Column E – Show in SnapshotEvent Recorder

Column F – Show as PLC Operand (Digital status)

Element	Operand Syntax	S	F	Description
Security	Role Login	X	X	An event to indicate when a certain role logged in
	Username Login	X	X	This is valid only for "Advanced security" relay. The event is to indicate login occurrence by particular user
	Role Logout	X	X	An event to indicate when a certain role logged out or timed out.
	Username Logout	X	X	This is valid only for "Advanced security" relay. The event is to indicate logout occurrence by particular user
	Access Ctrl Bypassed	X	X	The operand will get activated when "Bypass Access" function is set to other than "Disabled"
	Access Ctrl Active	X	X	The operand will get activated when "Bypass Access" function is set to "Disabled"
	Role Lockout	X	X	The user lockout has occurred because of number of failed authentication attempts higher than configured limit. This is valid only for "basic security" relay.
	Username Lockout	X	X	The user lockout has occurred because of number of failed authentication attempts higher than configured limit. This is valid only for "Advanced security" relay.
	Authent Failure	X	X	When any authentication attenpt is failed, the event will get recorded
	Setting change	X	X	An event to indicate setting change(s). Origin: Username and IP:MAC
	Clear Events	X	X	Clear event records command was issued. Origin: Username and IP:MAC
	Clear Transient	X	X	Clear transient records command was issued.

	Clear Flt Record	X	X	Clear Fault Reports command was issued
RADIUS	RADIUS Not Confg	X	X	Both RADIUS servers (Primary as well as secondary) not configured
	Pri RADIUS Active		X	The operand will get asserted when "Primary RADIUS server" is being utilized by relay for remote authentication
	Prim RADIUS Unavailable	X	X	The event will get generated by the relay when configured Primary RADIUS server is not available or not reachable for authentication
	Sec RADIUS Active		X	The operand will get asserted when "Secondary RADIUS server" is being utilized by relay for remote authentication
	Sec RADIUS Unavailable	X	X	The event will get generated by the relay when configured Secondary RADIUS server is not available or not reachable for authentication
	RADIUS Unavailable		X	When both Primary as well as Secondary RADIUS servers are not available or not reachable, then this particular operand can update the status
Syslog	Syslog Not Config	X	X	the SysLog function is not configured
	Prim Syslog Active **		X	The operand will get asserted when the relay is sending out syslog messages to syslog server configured as "Primary Syslog server"
	Prim Syslog Unavailable **	X	X	The event will get logged when the relay detects unavailability of syslog server configured as "Primary server"
	Sec Syslog Active **		X	The operand will get asserted when the relay is sending out syslog messages to syslog server configured as "Secondary Syslog server"
	Sec Syslog Unavailable **	X	X	The event will get logged when the relay detects unavailability of syslog server configured as secondary server
	Syslog Unavailable **		X	The operand will get asserted when the relay detects unavailability of any of the syslog server

8.2.6.2 Syslog Events

Following events will be published to Syslog Server by the relay:

Event	Level	Description
FAILED_AUTH, ORIGIN, TIMESTAMP	Warning (4)	A failed authentication with origin information (username and IP:MAC address), a time stamp in UTC time when it occurred.

USER_LOCKOUT, ORIGIN, TIMESTAMP:	Error (3)	The user lockout has occurred because of too many failed authentication attempts. Origin: user name and IP:MAC address
SETTING_CHG, ORIGIN, TIMESTAMP:	Notice (5)	An event to indicate setting change(s). Origin: Username and IP:MAC
LOGIN, ORIGIN, TIMESTAMP:	Warning (4)	An event to indicate when a certain role logged in. Origin: Username and IP:MAC
MANUAL_LOGOUT, ORIGIN, TIMESTAMP:	Warning (4)	An event to indicate when a certain user logged out. Origin: Username and IP:MAC
TIMED_LOGOUT, ORIGIN, TIMESTAMP:	Warning (4)	An event to indicate when a certain user timed out. Origin: Username and IP:MAC
PRIM_RADIUS_UNREACH, ORIGIN, TIMESTAMP:	Critical (2)	RADIUS server is unreachable. Origin: RADIUS server IP address and port number
SEC_RADIUS_UNREACH, ORIGIN, TIMESTAMP:	Critical (2)	RADIUS server is unreachable. Origin: RADIUS server IP address and port number
CLEAR_EVENT_RECORDS, ORIGIN, TIMESTAMP:	Warning (4)	Clear event records command was issued. Origin: Username and IP:MAC
CLEAR_TRANSIENT_RECORDS, ORIGIN, TIMESTAMP:	Notice (5)	Clear transient records command was issued. Origin: Username and IP:MAC
BYPASS ACCESS ACTIVATED	Critical (1)	Bypass access has been activated
BYPASS ACCESS DEACTIVATED	Critical (1)	Bypass access has been deactivated
PRIM_SYSLOG_UNREACHABLE	Critical (2)	SYSLOG server is unreachable. Origin: SYSLOG server IP address and port number
SEC_SYSLOG_UNREACHABLE	Critical (2)	SYSLOG server is unreachable. Origin: SYSLOG server IP address and port number
MODBUS TCP Enabled	Warning (4)	Port 502 has been opened for Read/Write
MODBUS TCP Disabled	Warning (4)	Port 502 closed
Firmware upload successful	Notice (5)	[IEEE 1686] requires audit logging for firmware related aspects. A software is generic that includes also firmware.

8.2.6.3 Security event on IED

Security_Events.CSV file stores security events information. A total of minimum 1024 events are stored in a circular buffer in non-volatile memory. Once the file reaches its max limit, oldest event Will get over-written by newest security event.

FORMAT: Following information Will be supported & stored in events file for each event: Event Number, Data/Time, Username, IP Address, Role, Activity value

The timestamp is the UTC time.

This file will be stored on IED & will be accessible from EnerVista 650 Setup for user with “Administrator” role. For Basic security, this is the only file to give security audit information to user. And this file will be useful for advanced security user if in case syslog is not configured or non-functional due to some issue.

8.2.7 Product Hardening

The IED supports the ability to turn off any of the following specific physical ports :

1. front USB serial port

b. rear port RS485

c. 2 Ethernet ports

d. rear Port 3 - CAN IO/RS485/Ethernet

The IED supports the ability to turn off any of the following specific communication protocols:

- IEC 61850 (MMS and GOOSE)
- Modbus
- DNP OE
- DNP serial
- IEC 104
- SNTP

Serial Protocols (only supports one protocol on serial ports) can be disabled by disabling the serial port.

Time synchronization protocols can be selectively enabled/disabled based on the configuration.

- IRIG-B
- PTP
- SNTP

8.2.7.1 Product Hardening setpoints table

According to the product hardening requirement these are the settings needed:

Enable/Disable physical ports:

Setting path	Setting Name	Description	Range	Default value
Product Setup > Communication >**Serial Ports**	COM1	This existing setting it is used to disable/ enable the first rear serial port	Enum value: 0: Disabled 1: Enabled	1: Enabled
Product Setup > Communication >**Serial Ports**	COM2	This existing setting it is used to disable/ enable the second rear serial port or the USB port from the front	Enum value: 0: Disabled 1: Enabled	1: Enabled
Product Setup > Communication settings > Network(Ethernet) > **Ethernet A**	Function	This existing setting it is used to disable/ enable the Ethernet port A	Enum value: 0: Disabled 1: Enabled	1: Enabled
Product Setup > Communication settings > Network(Ethernet) > **Ethernet B**	Function	This existing setting it is used to disable/ enable the Ethernet port B	Enum value: 0: Disabled 1: Enabled	1: Enabled

Product Setup > Communication settings > Network(Ethernet) > **Ethernet E**	Function	This existing setting it is used to disable/ enable the Ethernet port E	Enum value: 0: Disabled 1: Enabled	1: Enabled

Protocols enable / disable capability

Setting Path	Setting Name	Description	Range	Default value
Product Setup > Communication settings > Modbus Protocol	Function	This existing setting it is used to disable/enable the Modbus protocol	Enum value: 0: Disabled 1: Enabled	1: Enabled
Product Setup > Communication settings > DNP3 Slave > DNP3 Slave 1	Physical Port	This existing setting it is used to disable/enable the DNP3 protocol Slave 1	Enum value: 0: None 1: COM1 2: COM2 3: NETWORK_TCP 4: NETWORK_UDP	0: None
Product Setup > Communication settings > DNP3 Slave > DNP3 Slave 2	Physical Port	This existing setting it is used to disable/enable the DNP3 protocol Slave 2	Enum value: 0: None 1: COM1 2: COM2 3: NETWORK_TCP 4: NETWORK_UDP	0: None
Product Setup > Communication settings > DNP3 Slave > DNP3 Slave 3	Physical Port	This existing setting it is used to disable/enable the DNP3 protocol Slave 3	Enum value: 0: None 1: COM1 2: COM2 3: NETWORK_TCP 4: NETWORK_UDP	0: None
Setup > Communication settings > IEC 870-5-104	Function	This existing setting it is used to disable/enable the 104 protocol	Enum value: 0: Disabled 1: Enabled	0: Disabled

Product Setup > Communication settings > SNTP > SNTP Client 1	Function	This existing setting it is used to disable/enable the SNTP protocol Client 1	Enum value: 0: Disabled 1: Unicast 2: Broadcast 3: Anycast	0: Disabled
Product Setup > Communication settings > SNTP > SNTP Client 2	Function	This existing setting it is used to disable/enable the SNTP protocol Client 2	Enum value: 0: Disabled 1: Unicast 2: Broadcast 3: Anycast	0: Disabled
Product Setup > Communication settings >PTP-1588	PTP Function	This existing setting it is used to disable/enable the PTP protocol	Enum value: 0: Disabled 1: Enabled	0: Disabled
Product Setup > Communication settings >Web Sever	Function	This existing setting it is used to disable/enable the Web Server	Enum value: 0: Disabled 1: Enabled	0: Disabled
Product Setup > Communication settings >IEC61850 MMS	Function	This existing setting it is used to disable/enable the IEC61850 MMS Server	Enum value: 0: Disabled 1: Enabled	1: Enabled
Product Setup > Communication settings >SFTP/SSH	Function	This existing setting it is used to disable/enable the SFTP/SSH protocol	Enum value: 0: Disabled 1: Enabled	1: Enabled
Product Setup > Time Settings	IRIG-B Function	This existing setting it is used to disable/enable the IRIG-B	Enum value: 0: Disabled 1: Enabled	0: Disabled
Product Setup > Communication settings >TFTP	Function	This existing setting it is used to disable/enable the TFTP protocol	Enum value: 0: Disabled 1: Enabled	0: Disabled
Product Setup > Security >Server Config	RADIUS IP Prm Octect1	Primary Radius IP If both IP's are 0.0.0.0 the radius will be disabled	0 to 255	0
	RADIUS IP Prm Octect2		0 to 255	0
	RADIUS IP Prm Octect3		0 to 255	0
	RADIUS IP Prm Octect4		0 to 255	0
	RADIUS IP Sec Octect1		0 to 255	0

	RADIUS IP Sec Octect2		0 to 255	0
	RADIUS IP Sec Octect3		0 to 255	0
	RADIUS IP Sec Octect4		0 to 255	0
Product Setup > Security >Syslog	IP Prim Octet1	If IP is 0.0.0.0 the syslog will be disabled	0 to 255	0
	IP Prim Octet2		0 to 255	0
	IP Prim Octet3		0 to 255	0
	IP Prim Octet4		0 to 255	0
	IP Sec Octet1		0 to 255	0
	IP Sec Octet2		0 to 255	0
	IP Sec Octet3		0 to 255	0
	IP Sec Octet4		0 to 255	0

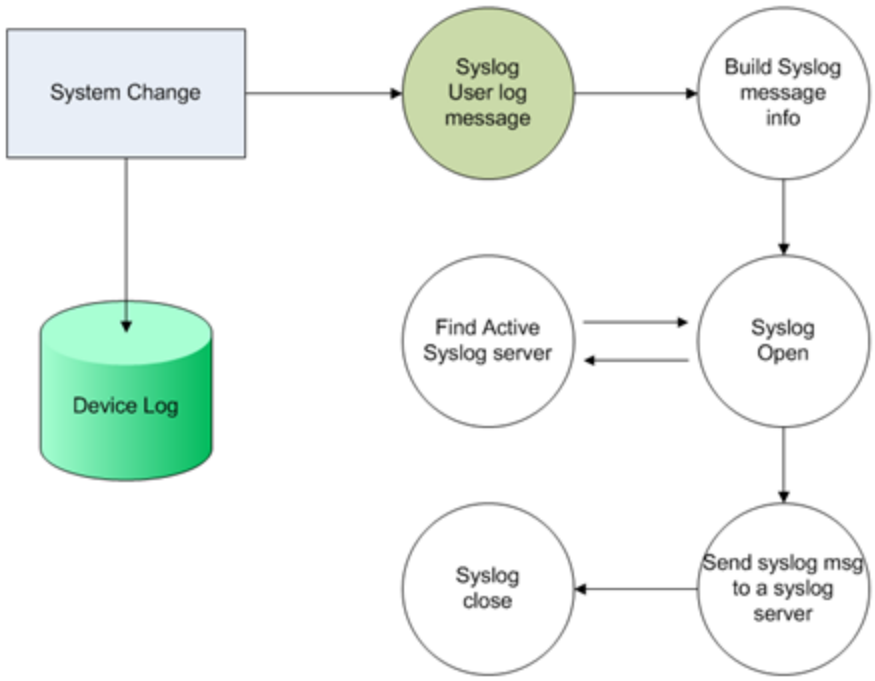
8.2.8 Security Logging - Syslog

The IED supports security event reporting through the Syslog protocol for supporting Security Information Event Management (SIEM) systems for centralized cyber security Monitoring over UDP protocol.

2 syslog servers are supported in the configuration for redundancy. The IED will try each in sequence until one respond

The IED logs to a remote syslog server:

- User log events, whether successful or unsuccessful
- Error log events
- Kernel error log events



8.2.9 LOST PASSWORD

The relay allows modification of all user account passwords by user with “Administrator” privileges. Also, non-Admin user can update their own passwords.

For “Advanced security” the relay, it is advised to have more than one user with “Administrator” role. This will help in case “Administrator” password is lost. Other Local “Administrator” account or Remote authentication user “Administrator” can modify the password for the “Administrator” whose password is lost.

If Remote authentication server is not configured or is unreachable, and if there is single “Administrator” configured on IED for local authentication then the only way to reset “Administrator” password is to execute command from HMI. This action will default passwords for all accounts. For basic as well as advanced security relay will set passwords for all accounts as “**ChangeMe1#**”

For user information, we can ask them to contact GE customer support if “Administrator” password is lost.

Access IED from HMI as other role. Go to Settings -> Product setup -> Install: Screen will have option to enter “Service command”. User can enter command “20167” to reset passwords for all accounts. This action is needed from HMI only. We need not share this code in the user manual. Customer need to contact GE customer support to get this code. In the relay, “Observer/Viewer” shall be able to enter service command on HMI to reset passwords.

F650 Digital Bay Controller

Chapter 9: Bootcode and firmware upgrade

9.1 Firmware upgrade versions below 7.00.

This section explains how to upgrade the F650 boot code and firmware for version below 7.00.

NOTICE BEFORE PERFORMING THE UPGRADE PROCEDURE CHECK THAT BOOT AND FIRMWARE VERSION MATCH.

The boot code and firmware versions can be seen in the relay main screen: The relay firmware version appears after the text “F650“(5.70 in Figure 9-1: Main screen) with the boot program version (6.00 in Figure 9-1: Main screen) followed by “GENERAL ELECTRIC”, the relay model and the default front RS232/USB port communication parameters.

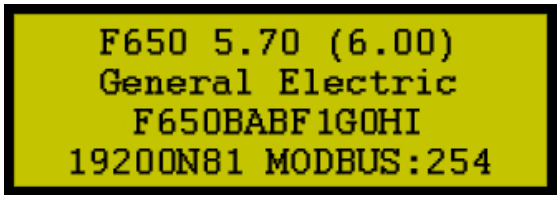


Figure 9-1: Main screen

BOOT CODE RELEASE NOTES

It is mandatory to maintain version compatibility between firmware and boot code in the upgrade procedure, otherwise the relay does not start after upgrading.

FIRMWARE BOOTWARE AND 650 PC PROGRAM VERSIONS COMPATIBILITY		
FIRMWARE CODE	BOOT CODE	ENERVISTA 650 PC
5.72	6.00	7.20
5.70	6.00	7.20
5.68	6.00	7.20
5.64	5.60	7.20
5.40	5.44-5.40	7.20
5.00	5.44-5.40	7.20
4.00	5.44-5.40-5.00-4.10	7.20
3.71	5.44-5.40-5.00-4.10	7.20
3.70	5.44-5.40-5.00-4.10	7.20
2.20	5.40-5.00, 4.10, 4.00	7.20

NOTICE

A STEP LIST SUMMARY that allows the user to control the upgrading process is included at the end of this section. It is necessary to read paragraphs 1 to 4 of chapter 9 of manual GEK-106310 before accomplishing the F650 UPGRADE PROCEDURE.

Be aware that boot program and firmware upgrades erase all data contained in the relay, thus it is advisable to save all data, oscillography, events, settings and configuration files before proceeding.

RELAYS WITH FIBER OPTIC ETHERNET

The upgrade of the boot program (BOOTCODE) must be performed by crossed Ethernet copper cable connected to the

PC. It is not necessary to change the internal switch from fiber to RJ45, because the upgrade is made at 10Mb/s.

This does not apply to the firmware upgrade, which can be done either via Ethernet Fiber connection, or through the

RJ45 cable connection.

For upgrading firmware versions lower than 3.20 or upgrading bootware, be aware to calibrate the unit offset, after upgrading it, in **Communication > Calibration > Offset Calibration**. No analog currents nor analog voltages must be injected in the unit during this process.

9.1.1 Communication parameters

1. Ethernet Connection/Type - Both boot code and firmware upgrade processes require Ethernet communications. It is strongly recommended to use a direct connection between the PC and the relay using a Cross-Over RJ45 Ethernet cable, instead a direct connection through a hub or switch. Upgrading through Local Area Network (LAN) must be avoided.

   Serial RS232 Communication - Serial communication is necessary only to perform the bootware upgrade for versions previous to 7.00.

2. Relay IP Address - An IP address must be assigned to the relay in the Ethernet parameters via HMI at **Product Setup > Communication > Ethernet > Ethernet1** menu, or via EnerVista 650 Setup software at **Setpoint > Product Setup > Communication Settings > Network (Ethernet) 1** as shown in the table below:

Table 9-1: Ethernet parameters

Product Setup > Communication Settings > Network (Ethernet) 1			
Name	**Value**	**Units**	**Range**
IP Address Oct1	192		[0 : 255]
IP Address Oct2	168		[0 : 255]
IP Address Oct3	37		[0 : 255]
IP Address Oct4	177		[0 : 255]
Netmask Oct1	255		[0 : 255]
Netmask Oct2	255		[0 : 255]
Netmask Oct3	255		[0 : 255]
Netmask Oct4	0		[0 : 255]
Gateway IP Oct1	192		[0 : 255]
Gateway IP Oct2	168		[0 : 255]
Gateway IP Oct3	37		[0 : 255]
Gateway IP Oct4	10		[0 : 255]

3. PC IP Address - In case the boot code has been previously updated to the relay (section 9.2), the IP address and other parameters already assigned in the process are:

   IP Address:192.168.37.177

   Netmask:255.255.255.0

   Gateway:192.168.37.10

Then the PC settings should be the same pattern as follows:

   IP Address:192.168.37.xxx

   Netmask:255.255.255.0

   Gateway:192.168.37.10 (if desired)

Where XXX is a number between 0 and 255 that is not assigned to any other device to avoid collisions.

4. Other Network, Communications and Data Flow checks

- According to the model number of the relay, to enable the 10/100 BASE TX-CABLE option in the relay communication board, a specific jumper in this board must be changed. See detailed instructions in paragraph 3.4.3 of Instruction Manual GEK-106310AE.
- IP address, netmask, gateway are correct and match the parameters used in the computer to perform the procedure. See table 9.1 (on this chapter) of Manual GEK-106310AE **COMMUNICATION PARAMETERS.**

9.1.2 Bootware version upgrade

Boot code upgrade is performed using EnerVista 650 Setup, and the most recent version of EnerVista 650 setup software should be used. It is required that no active communication is currently established between the program and the relay, and that no configuration files are open.

During the boot code upgrading process, all the data stored in the relay is lost. Save all calibration, settings, oscillography, etc. from the relay before starting the upgrade.

9.1.2.1 Bootware upgrade

1. Windows XP, Windows 7 and Windows 8 Operating Systems must be used for installation and the reliable operation of EnerVista 650 Setup program and bootware/firmware relay upgrade.
2. To upgrade the boot code, it is required to connect an RS232 cable to the front of the relay, and an Ethernet cable to the rear port (ETH_1/ETH_2 or ETH_E/ETH_A/ETH_B).
3. If it is being used a USB-to-Serial RS232 Cable Converter, it must be a RS-232C standard compliant, powered by the User computer's USB bus and with DB9 male connector. To ensure the correct state of communication between the computer and the relay along the whole upgrading process, all other USB devices must be unplugged. Due to the extended variety of USB-to-Serial Cable Converters existing nowadays in the market, with different characteristics, even different charge imposed to the USB bus of the PC, it is strongly recommended to use the GE USB-to-Serial RS232 Cable Converter, part number GE0100-0001.
4. When using USB-to-Serial RS232 cable it is necessary first to determine the COM Port number the Laptop uses through the USB device. Depending in the actual F650 upgrade task under operation, the procedure is as follows:

   4.1 Firmware upgrade: It is not necessary to use a serial cable

   4.2 Bootware and firmware upgrade being the relay fully operative with the actual F/W version: The COM port number must be determined by using the 650 Setup program. With USB device disconnected from the Laptop and from the relay, start the 650 Setup program. At the top menu bar choose **Communication > Computer > Communication Port** menu and check the allowable serial ports displayed.Return to the main 650 Setup screen and connect the USB device to PC and select **Communication > Computer > Communication Port** to display the allowed serial ports. The new one port number shown is the USB port number to be used for the upgrade process.

   4.3 Bootware and firmware upgrade being the relay blocked at startup (no preliminary communication PC-Relay allowable): Repeat the process described above in 4.2 to determine the COM PORT number and continue with upgrade process.
5. Once the COM PORT number is determined, set it in **Communication > Computer** together with and the **Baud Rate** and **Parity** parameters. Click **Store**.
6. Start the EnerVista F650 Setup program and select **Communication > Upgrade Relay**.

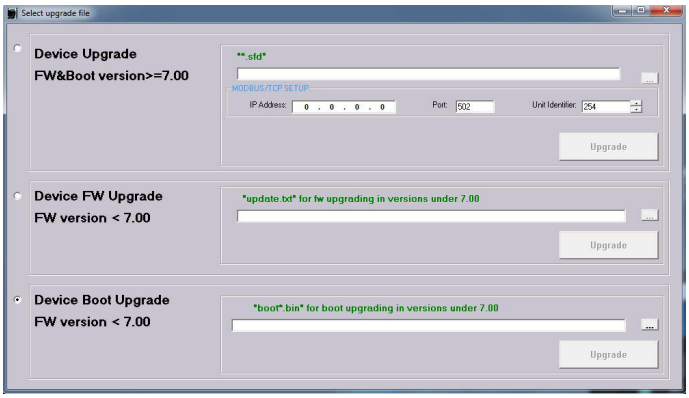


Figure 9-2: Upgrade device

7. Select **Device Boot Upgrade. FW version<7.00** and click the […] button. The next new window requires the bootware file retrieved from https://www.gevernova.com/grid-solutions and previously stored in the PC.

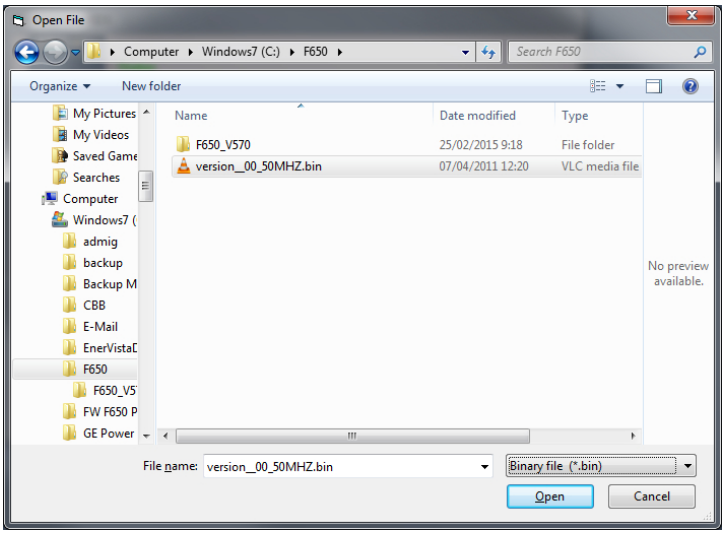


Figure 9-3: Boot code file selection

8. Choose the bootware file and click **Open** button:

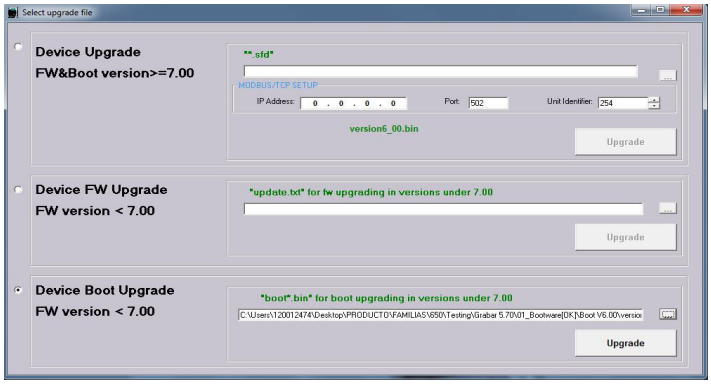


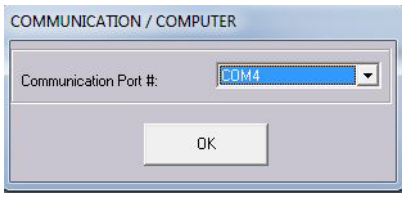
Figure 9-4: Upgrade selected BOOT file

9. Click **Upgrade**. A warning messages is shown:

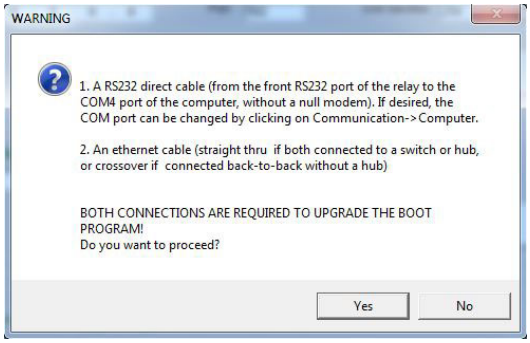
If calibration files were saved click **Yes,** otherwise click **No** to cancel the upgrade process and save first the calibration files according to section 4.1.11.

Figure 9-5: Warning message to save setting and configuration files

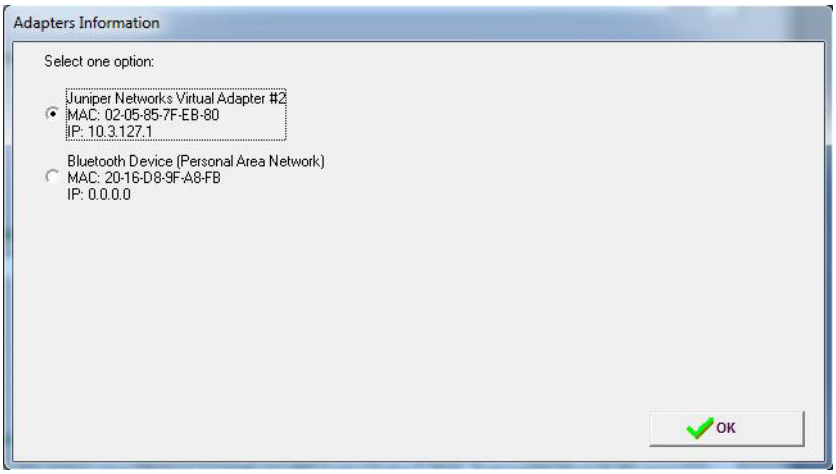
10. Parameters already set in step 5 are operative during serial communications. If they have not been previously set a pop up window prompts for the serial COM port to be used during upgrading.



11. During the upgrade, the system shows the following message indicating the procedure to be followed.



If you click **Yes**, the next window allows you to choose the Network adapter for your Ethernet connection to the relay.



12. After selecting the Network adapter, a window to choose a temporary IP address is shown. It is advisable to set the same IP address that is going to be used later in the relay for Ethernet connection.

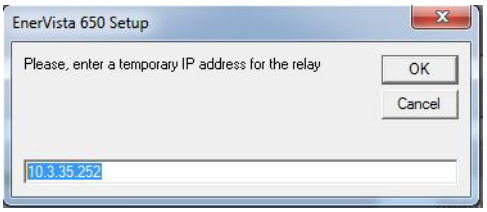


Figure 9-6: setting address

13. After entering the temporary IP Address, the next new window requires the bootware file retrieved from https://www.gevernova.com/grid-solutions and previously stored someplace in the PC.

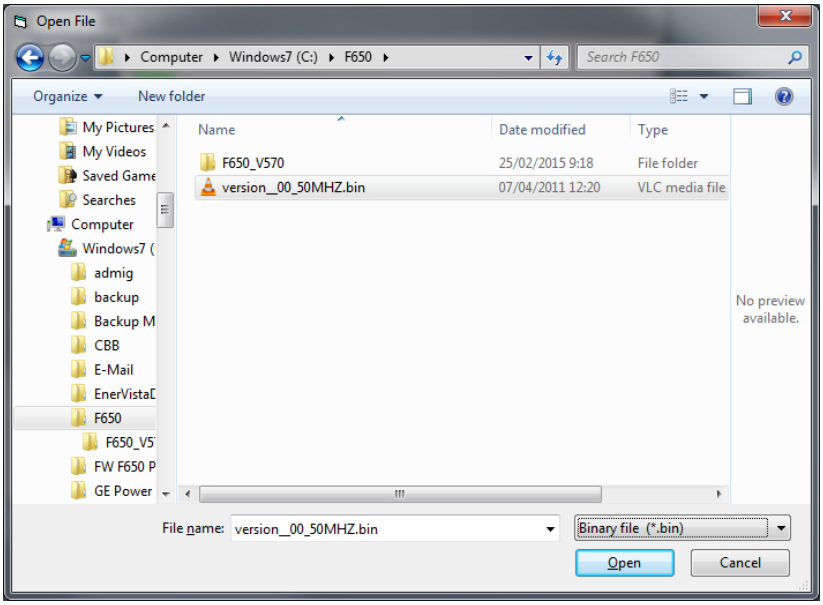


Figure 9-7: Boot code file selection

14. Choose the bootware file and click **Open** button.

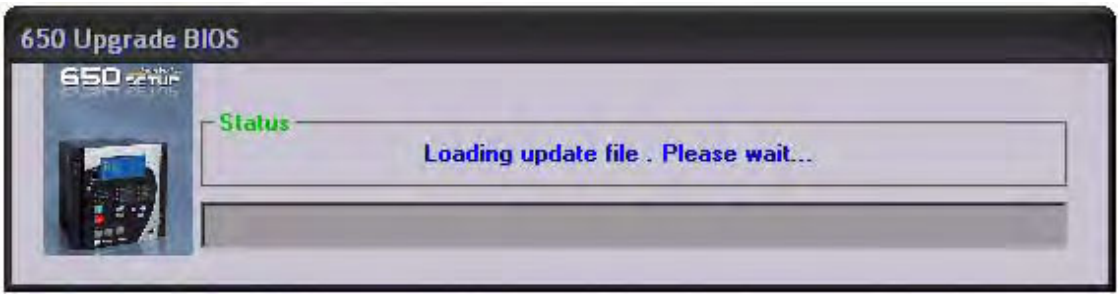


Figure 9-8: Loading boot code file

15. Then the program shows a message requiring switch OFF and ON the relay while the progress bar is in course, to start the upgrading process.

Figure 9-9: Relay switch off-on message

16. It is important to switch the Relay OFF and ON again during the time shown by the progress bar; in case this time expires, the program offers the option to continue with the process or to postpone, verify the correct RS232 connections and try again later. Notice that the serial COM PORT used in the boot upgrade procedure is the one selected in step 4 above.

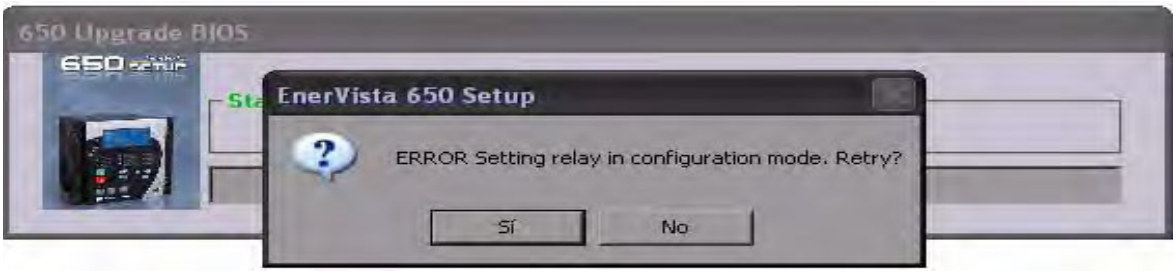
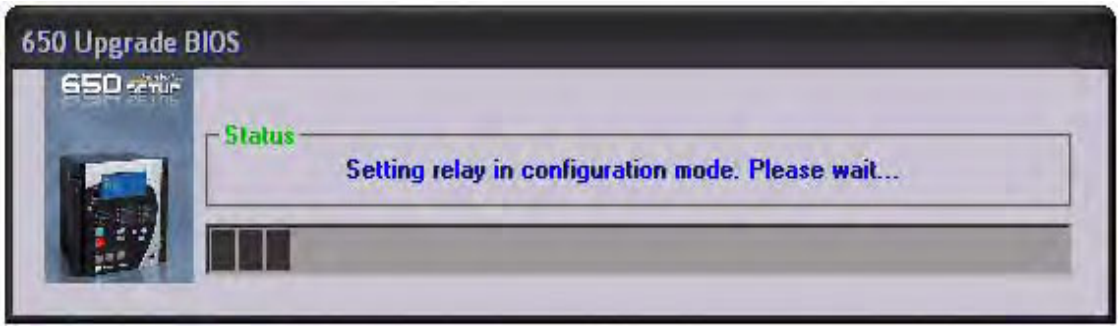


Figure 9-10: loading update file error message

If the relay gets stuck during the upgrading process after switching OFF and ON the relay, giving error message shown, it is due to no serial communication via the front RS232 port. Check the serial cable and serial settings connection. At this point the relay will not be upgraded.

After switching it OFF and ON it will continue working with the former firmware and bootware versions.

17. After switching the relay OFF and ON, if the serial communication between EnerVista 650 Setup and the relay is correct the program shows the following message:



Then it requires the confirmation to proceed to upgrade:

18. Click **Yes** to start the process, beginning with the relay flash memory deletion.

    At this point all the information stored in the relay is lost. Until now, no important change has been made to the relay, the boot memory upgrading process has just been prepared.

    This process can take several minutes, during which a progress bar is displayed.

19. If the process is successful, continue to step 20.

    If the process is unsuccessful and the relay gets stuck at **"Sending file imagen_kernel..."** (see figure below)

    This error may be due to no communication via the Ethernet port. At this point serial communications work properly, the relay flash memory has been erased, and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI shows the message **"OS Loading..."** and the relay does not start up.

    In this case refer to step 4 above

If all points from step 4 are correct but the problem persists:

Disable and **Enable** the Ethernet connection while the files are being sent (during the "Sending file..." message - previous figure). To do this, in Windows OS go to **Startup > Control Panel > Network Connection > Local Network,** right-click and select **Disable**. Now the Local Network status Icon is shown as **Disabled**. In the same screen right-click **Local Network**, select **Enable**, and wait until **Enabled** status is shown.

20. Once the memory has been erased and the files upgraded in the relay, the parameters for the Ethernet communications must be set. The requested values are the IP address and the gateway.

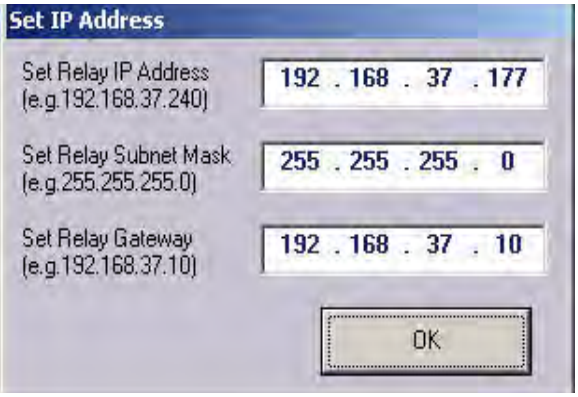


Figure 9-11: IP address setpoint window

These values should match the LAN structure where the relay will be connected.

The relay IP address should have the first three octets corresponding with the gateway and the last octet must be a free IP address reserved to the relay to avoid possible collisions with other devices.

The gateway must be the one used in the LAN structure connecting the relay

21. After assigning the Ethernet parameters, the upgrade of the boot code is complete and successful.

22. A window is displayed with the message: **Setting Default IP address**, followed by:

Figure 9-12: BOOTware upgrade successful process

After boot code upgrade, the equipment firmware must also be upgraded.

9.1.3 Firmware version upgrade

9.1.3.1 Introduction

1. Save relay settings and configuration to a file before proceeding, as they will be lost during upgrade.
2. Save calibration settings to a file for firmware revisions lower than 1.50, before upgrading the F650 to a new firmware version.
3. For firmware revision higher than 1.50 when only upgrading the firmware (no bootware upgrade), the calibration files are not modified and do not need to be saved.
4. Special care should be taken when the boot code has been previously upgraded: all data (including calibration settings) is lost.
5. In case of errors during the firmware upgrade process, repeat the entire process as many times as necessary. This is possible thanks to an independent boot memory (bootcode).
6. A pure firmware upgrade process should use the EnerVista 650 Setup software and Ethernet connection (Port ETH_1 or ETH2) via a **Cross-Over RJ45 Ethernet cable.**

Note: Downgrading firmware versions can cause errors in measurements.

9.1.3.2 Firmware upgrade

1. Once communication with the relay through the Ethernet connection has been verified, enter the EnerVista 650 Setup program and select **Communication > Upgrade Relay**.

Figure 9-13: Upgrade device

2. Select **Device FW Upgrade FW version <7.00** and click [...]. to browse for the new firmware file.

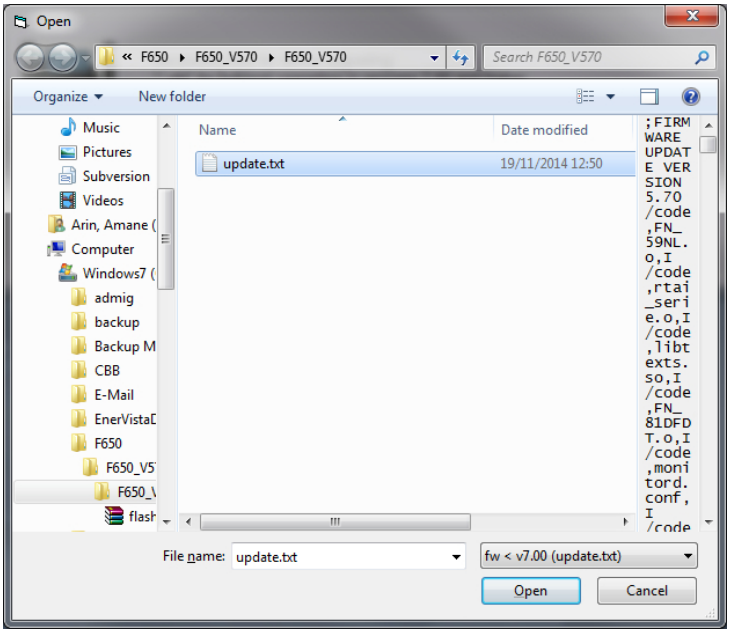


Figure 9-14: Select firmware file

3. Once the new firmware file has been selected, click **Upgrade** to continue.

Figure 9-15: Upgrade firmware selected file

4. Fill in the device IP address, serial number, and order code as needed. (The order code is not required for firmware versions below 1.70).

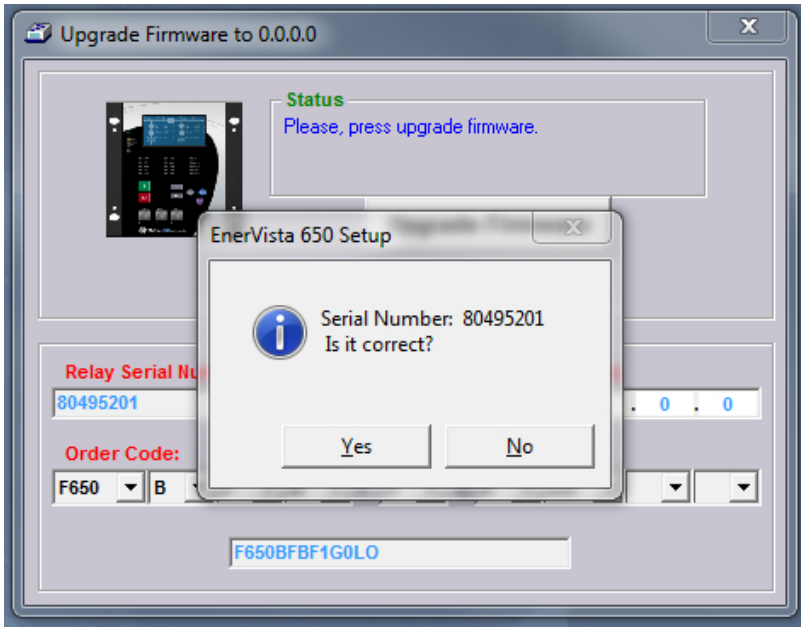
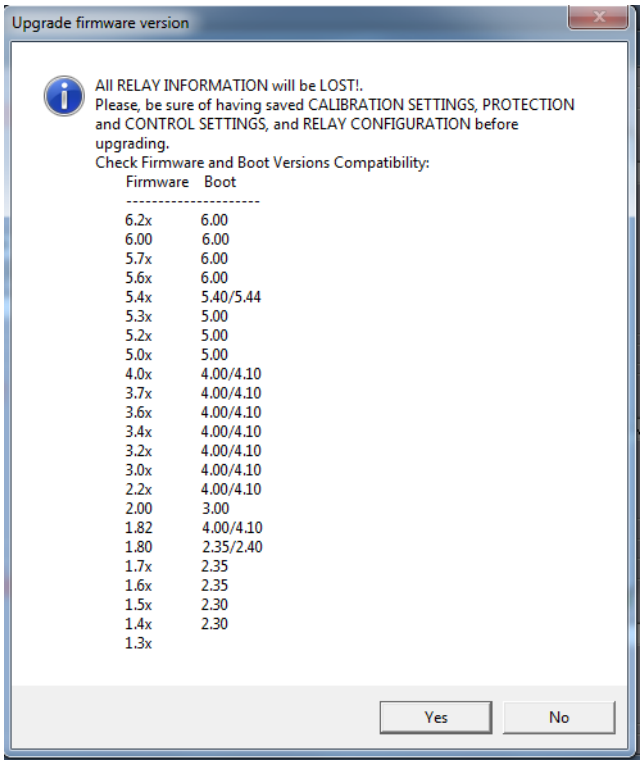


Figure 9-16: Relay serial number

5. If the relay is not an enhanced model or one with control functionality, click **Upgrade Firmware** to continue the process (see the following figure).

At this point, proceeding with the upgrade erases all data stored in the equipment, including the calibration settings in firmware versions below 1.50. It is necessary to save all settings to a file now if you have not already done so.



Click **Yes** to continue. A message is displayed indicating that a local network reboot is necessary (see following figure). Proceed as follows:

- In the Windows Control Panel (**Start > Control Panel**), navigate to **Network Connection > Local Network**. Right-click and select **Disable**. Confirm that the Local Network status is now Disabled. Restart the local network in the same screen (right-click and select **Enable**). Wait until the local network status is Enabled before continuing.
- Click **Upgrade Firmware** to continue the process (as shown).

Figure 9-17: Advisory for local network reboot

6. When upgrading models with Enhanced protection or control functionality (see model selection), the upgrade program requires a password to continue (as shown).

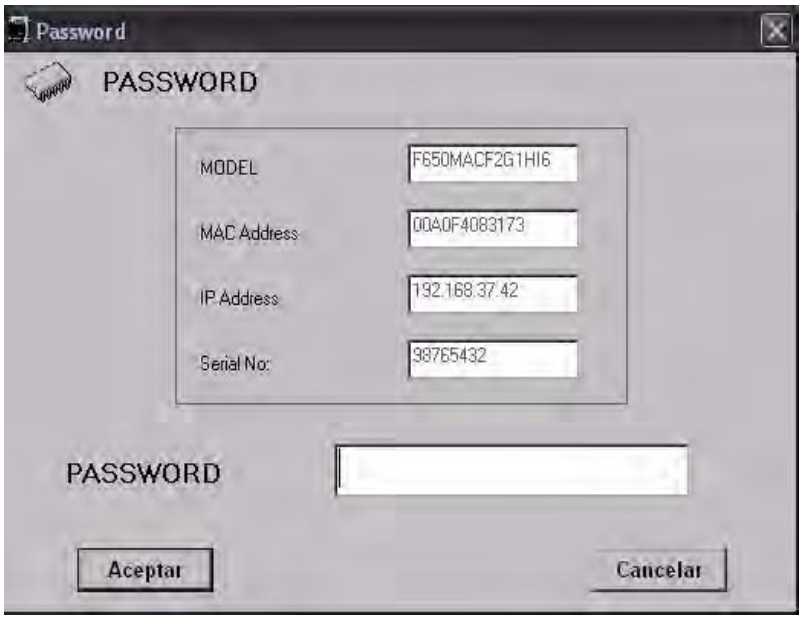


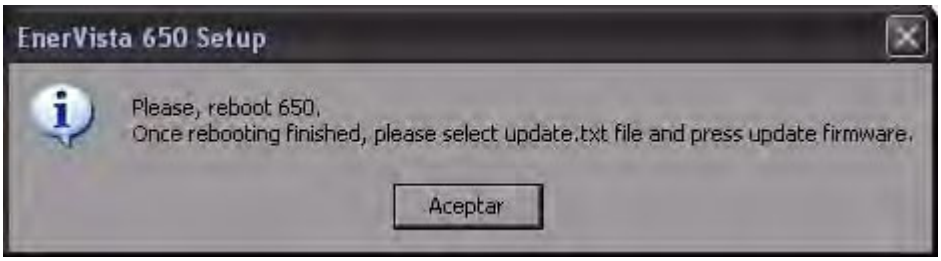
Figure 9-18: Relay upgrade password

For a model with specialized functionality and a password requirement, contact GE Multilin.

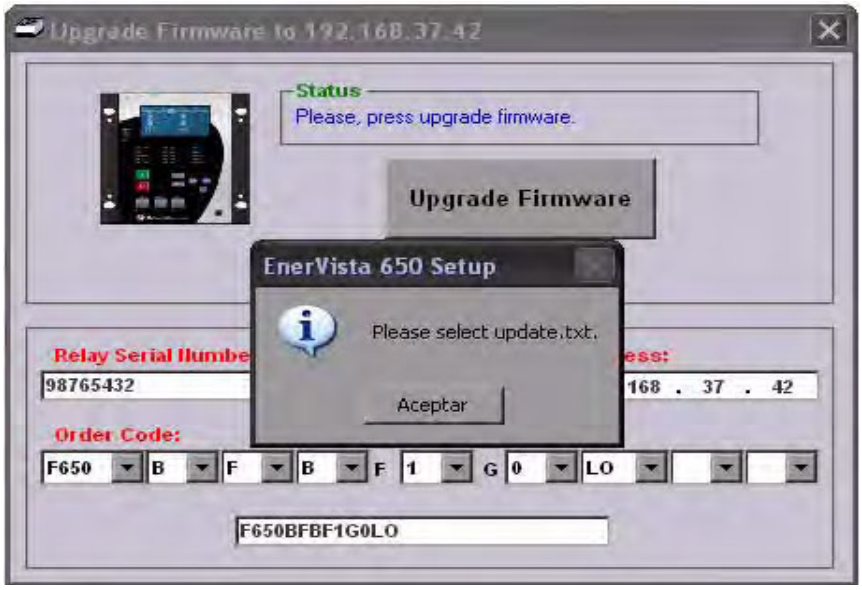
The following parameters must be clearly indicated in the order:

- Unit serial number
- Current model option (before memory upgrade)
- Desired model option (after memory upgrade)
- Unit MAC address (available in the identification label)

7. Once the upgrade parameters have been entered, click **OK**. When communication has been established, the program shows a message requesting a reboot of the 650 (turn the relay off and then back on) to continue with the upgrade process.



8. Once the relay has been rebooted, you are prompted to select the new firmware upgrade file (update.txt).



The upgrade files, including update.txt, can be obtained online (https://www.gevernova.com/grid-solutions) or from the Technical Service Dept. at any GE Multilin facility. Save the files in a directory in the root drive or the PC desktop. Extract any zipped files.

Browse to the "update.txt" file and click **Open**.

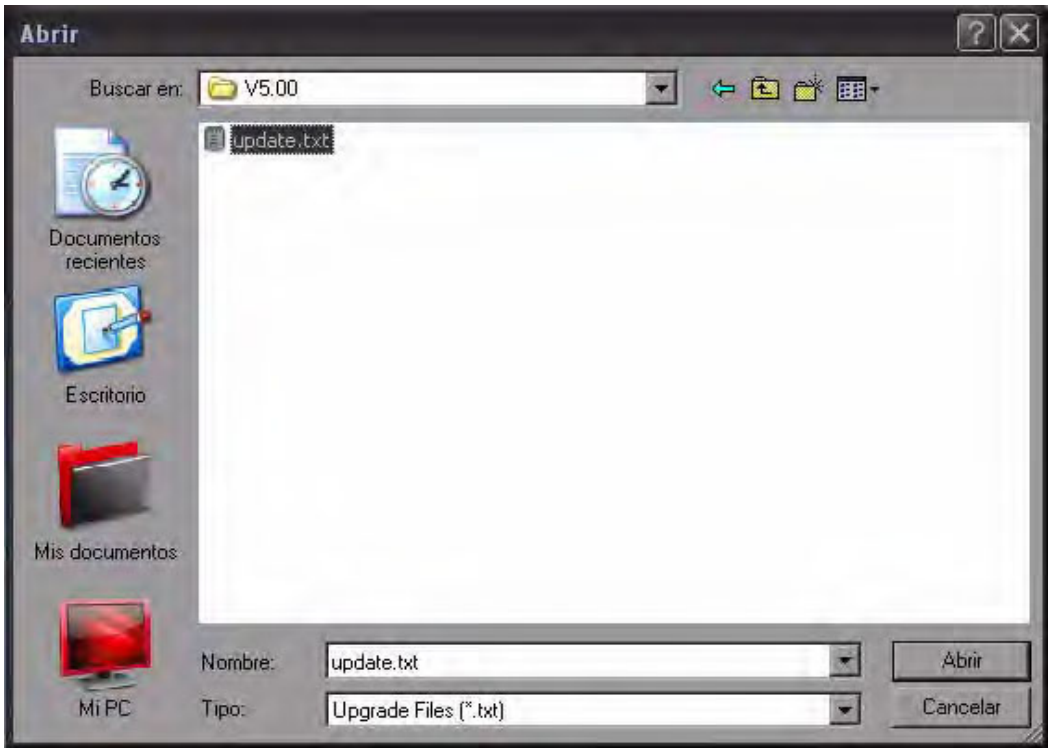


Figure 9-19: Firmware file selection

9. A voltage range selection window appears (see following figure). This voltage range is closely related to the serial number of the relay. For relays manufactured with firmware version 5.70 or higher (from May 2015 onwards), the EnerVista 650 Setup program automatically selects the appropriate voltage range for the unit based on the serial number, showing the selection with a step line square over the proper option. Click **OK**.

   In case an incorrect option is selected, metering errors may arise during normal operation (current and voltage values incorrectly displayed). In order to correct this behavior, the firmware upgrade process must be repeated and the correct option must be selected.

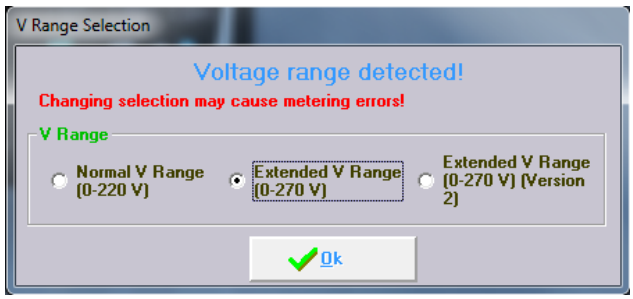


Figure 9-20: AC voltage range selection - extended V range (version 2)

10. Click **Yes**.
11. The Upgrade Firmware button is now enabled (figure below). Click to start the upgrade.

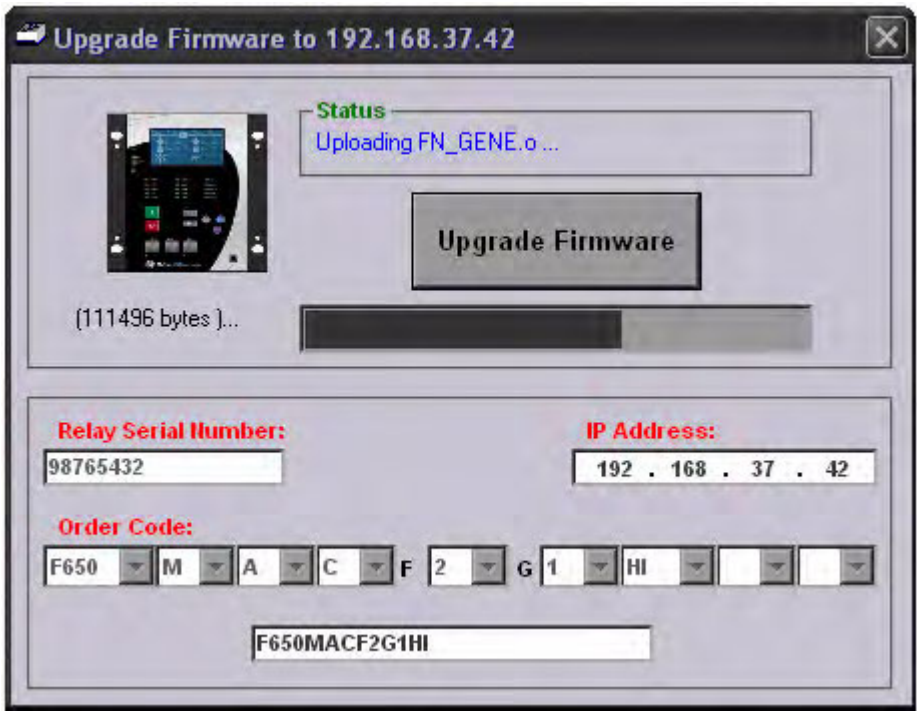


Figure 9-21: Initiate upgrade

During the upgrade process, the program displays the files that are being upgraded.

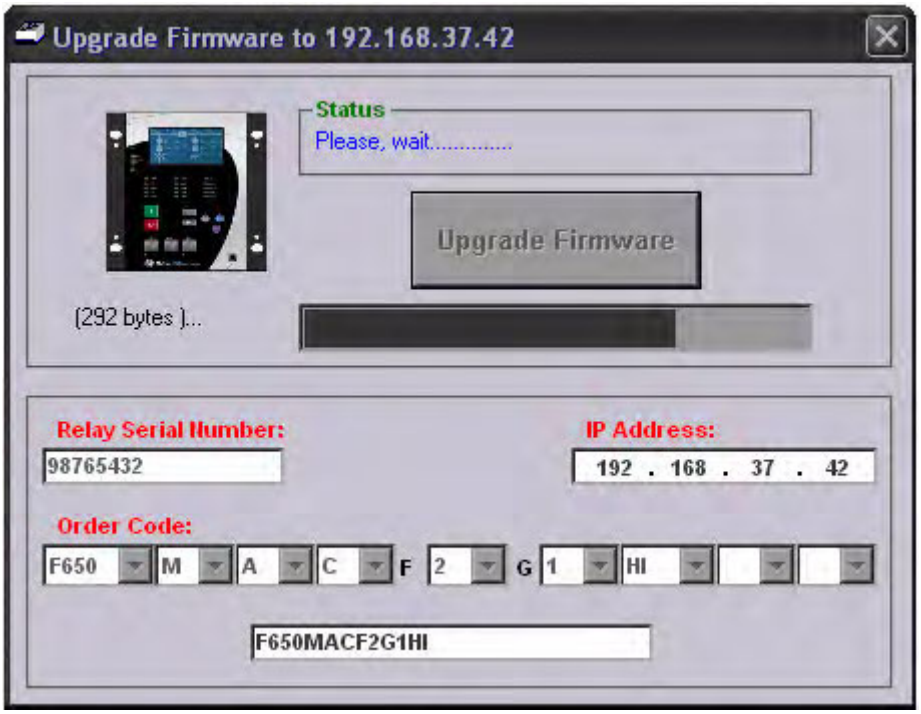


Figure 9-22: Firmware file selection

12. When the file transfer is finished, a message is displayed indicating that it is necessary to wait before resetting the unit, in order to start working with the new firmware version in the relay (figure below).

13. When the whole process has finished a message is displayed asking to switch the F650 on and off (figure below).

Figure 9-23: Firmware file selection

14. Click **OK (Aceptar)**. At this point, the firmware upgrade is finished and the relay can be powered OFF and ON to check that the firmware has been upgraded properly.

15. User settings and logic files downloading

When upgrading the firmware the entire settings and relay configuration are reset to factory default values. Then the User is committed to download the settings, configuration and logic files to the relay in order to get it fully operative.

Calibration settings and configuration must be reloaded to the relay the relay.

To recover and download the different files to the relay go to EnerVista 650 Setup and at the top menu bar choose:

- **Communication > Calibration > Set Calibration Files**: to restore calibration settings, if necessary.
- **File > Config File (*.650) Converter**: to convert the setting and configuration file *.650 for the relay (if it was in a previous version format).
- **File > Send Info to Relay:** to send the new settings and configuration file to the unit.

9.1.4 Summary of main steps

9.1.4.1 Boot code upgrade (*)

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect a RS-232cable to the front port relay and connect an Ethernet cable to the rear Ethernet port (crossover cable for back-to-back connection and straight-through Ethernet cable for hub or switch).
3. Save all calibration settings to a file.
4. Save all data from the relay (settings, oscillography, events).
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Follow the upgrade instructions, and select the boot program bin file.
7. Reboot the relay as required by the upgrade program.
8. Continue with the upgrade instructions, setting the IP address and gateway when prompted.

9.1.4.2 Firmware upgrade(*)

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect an Ethernet cable to the rear Ethernet port (a cross-over cable for back-to-back connection and straight-through cable for hub or switch).
3. Set the appropriate IP address in the relay.
4. Set the appropriate IP address in the PC.
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Enter the IP address, serial number, ad order code of the relay as prompted.
7. Reboot the relay as required by the upgrade program.
8. Locate the upgrade.txt file for the correct relay model.
9. Click Upgrade Firmware to initiate the upgrade process.
10. Reboot the relay as required by the upgrade program to complete the upgrade process.
11. Set calibration settings (from the PC to the relay) for versions lower than 1.50.
12. All settings and configuration are now set to the factory default.
13. Send new settings and configuration files to the relay if needed.

(*) The boot code upgrade must be performed using a crossed copper cable (RJ45) connected to the PC. It is not necessary to modify the internal fiber/cable switch, as the upgrade is carried out at 10 Mb/s, and thus there is no cable/fiber conflict.This does not apply to the firmware upgrade, which can be performed either with the Ethernet fiber connection, or with the cable connection.

Note: See chapter 13 F650 TROUBLESHOOTING GUIDE if there is any problem during the upgrade process.

9.2 Firmware upgrade version 7.00 or above

This section explains how to upgrade the F650 firmware code for version V7.00 or higher.

BOOT CODE RELEASE NOTES

It is mandatory to maintain version compatibility between firmware and boot code in the upgrade procedure, otherwise the relay will not start after upgrading.

BEFORE PERFORMING THE UPGRADE PROCEDURE CHECK THAT BOOT AND FIRMWARE VERSION MATCH.

Firmware	Bootware	EnerVista
7.12	7.12	Latest EnerVista version available
7.20	7.12	Latest EnerVista version available
7.21	7.12	Latest EnerVista version available
7.50	7.12	Latest EnerVista version available
7.52	7.12	Latest EnerVista version available
7.60	7.60	Latest EnerVista version available
7.70	7.70	Latest EnerVista version available
7.71	7.71	Latest EnerVista version available

9.2.1 Communication parameters

1. Ethernet Connection/Type - Firmware upgrade processes require Ethernet communications. It is strongly recommended to use a direct connection between the PC and the relay using a Cross-Over RJ45 Ethernet cable, instead a direct connection through a hub or switch.

2. Relay IP Address - It must be assigned a IP address to the relay in the Ethernet parameters via HMI at **Product Setup > Communication > Ethernet > Ethernet E, A** or **B** menu or via EnerVista 650 Setup at **Setpoint > Product Setup > Communication Settings > Network (Ethernet) E, A** or **B** as shown in the Table below.

Table 9-2: Ethernet parameters

PRODUCT SETUP > COMMUNICATION SETTINGS > NETWORK (ETHERNET)			
NAME	EVALUE	UNITS	RANGE
IP Address Oct1	192		[0 : 255]
IP Address Oct2	168		[0 : 255]
IP Address Oct3	37		[0 : 255]
IP Address Oct4	177		[0 : 255]
Netmask Oct1	255		[0 : 255]
Netmask Oct2	255		[0 : 255]
Netmask Oct3	255		[0 : 255]
Netmask Oct4	0		[0 : 255]

PRODUCT SETUP > COMMUNICATION SETTINGS > ROUTING			
NAME	EVALUE	UNITS	RANGE
Default RT GWY Oct1	192		[0 : 255]
Default RT GWY Oct2	168		[0 : 255]
Default RT GWY Oct3	37		[0 : 255]
Default RT GWY Oct4	10		[0 : 255]

3. Example of IP Address Configuration:

The IP address and other parameters already assigned in the process are:
IP Address:192.168.37.177
Netmask:255.255.255.0
Gateway:192.168.37.10

Note: To assure that the configuration is correctly setup it is possible to perform a ping command from the PC.

Then the PC settings should be the same pattern as follows:

IP Address:192.168.37.xxx

Netmask:255.255.255.0

Gateway:192.168.37.10 (if desired)

Where XXX is a number between 0 and 255 that is not assigned to any other device to avoid collisions.

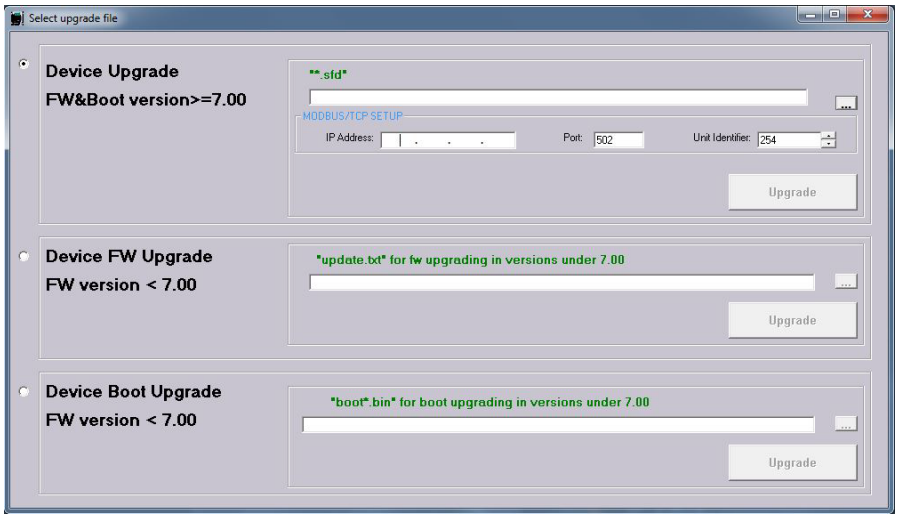
9.2.2 Firmware version upgrade

9.2.2.1 Introduction

1. The relay settings and configuration will be lost, so it is advisable to save them to a file.
2. In case of error during the firmware upgrading process, the user can repeat the whole process as many times as necessary.
3. Firmware upgrading process should be done using the EnerVista 650 Setup software and Ethernet connection (Port ETH_E, A or B) via **Cross-Over RJ45 Ethernet cable or Fiber Optic cable** (depending on order code option).
   Note that ETH_A and ETH_B ports cannot be used if PRP configuration is selected.

9.2.2.2 Firmware upgrade

1. Once the communication with the relay through Ethernet connection has been verified, enter the EnerVista 650 Setup program, select Communication and the **Upgrade Relay** option on the top menu bar.



2. Select **Device Upgrade FW&Boot>=7.00** and click […] to browse for the file. The appropriate *.SFD file should be obtained from https://www.gevernova.com/grid-solutions or from The Technical Service Dept. at any GE Multilin facility. The file must be saved in the root drive or in the desktop of the PC. Choose the corresponding firmware file for upgrading the device.

3. Enter communication parameters for the relay being upgraded and click **Upgrade.**

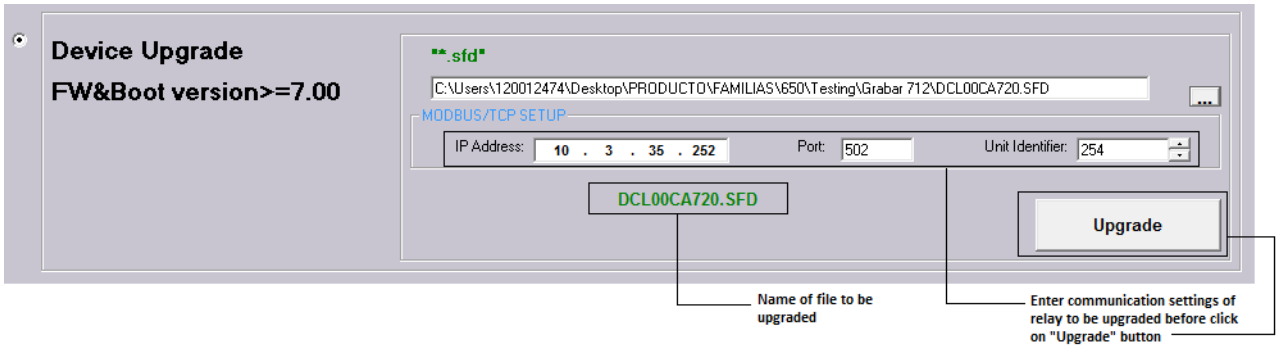
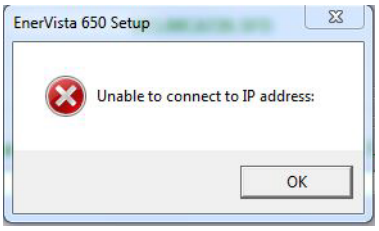
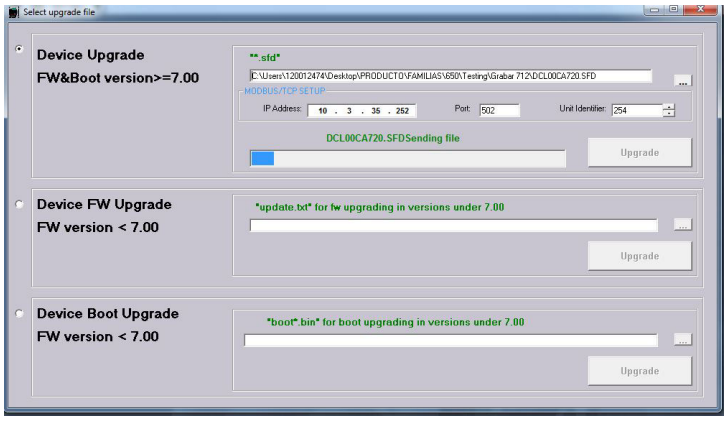


Figure 9-24: Relay communication parameters

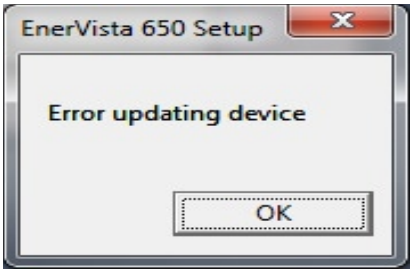
If the IP address is incorrect one, the following message is shown:



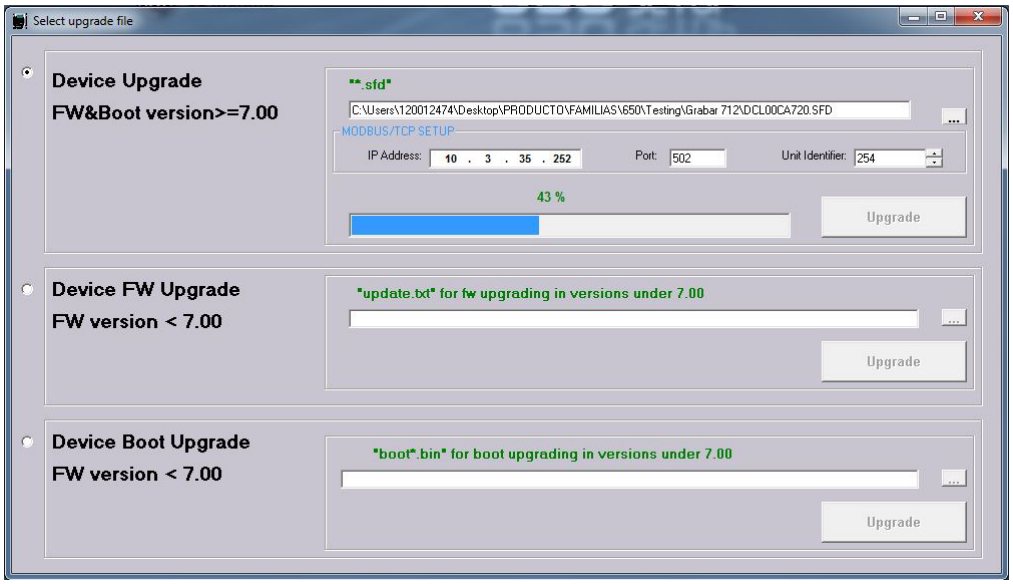
4. If the IP address is correctly set, then the message "*.SFD Sending file" is displayed. A sending file status bar shows the progress of the upgrade.



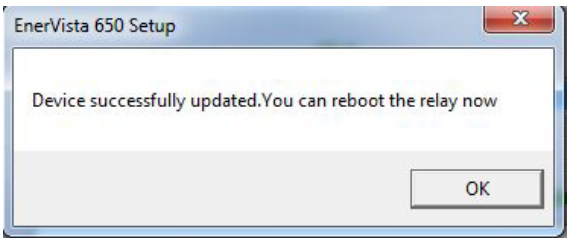
5. If the file is not sent successfully, the following message box is displayed.



6. After sending the file successfully, the upgrade process starts:



7. When the flashing upgrade process finishes, a message is displayed requesting a relay reboot.



8. User settings and logic files downloading

When upgrading the firmware the entire settings and relay configuration are reset to factory default values. Then the User is committed to download the settings, configuration and logic files to the relay in order to get it fully operative.

Calibration settings and configuration must be loaded to the relay once the upgrade process has finished.

To recover and download the different files to the relay use EnerVista 650 Setup and at the top menu bar choose:

- **Communication > Calibration > Set Calibration Files**: to restore in the relay the calibration settings if necessary.
- **File > Config File (*.650) Converter**: to convert the setting and configuration file *.650 for the relay (if it was in a previous version format).
- **File > Send Info to Relay**: to send the new settings and configuration file to the unit.

9.2.2.3 Order code upgrade process

In the case of a relay model with specialized functionality (or a new order code requirement) with password requirement (see model selection), the program requests a password to continue.

1. To reach the window where the password is requested, the user must be communicating with the relay (ONLINE MODE). On the File menu the following submenu is available (for firmware versions above 7.00):

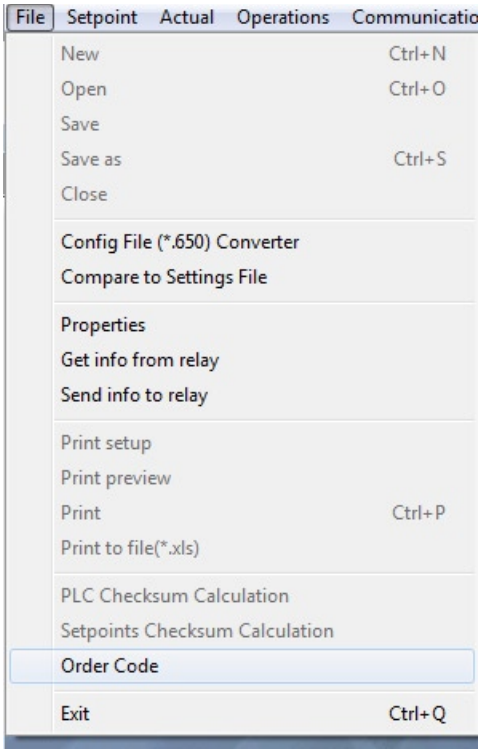


Figure 9-25: Order code submenu

2. Click Order Code on the menu and the following window is displayed:

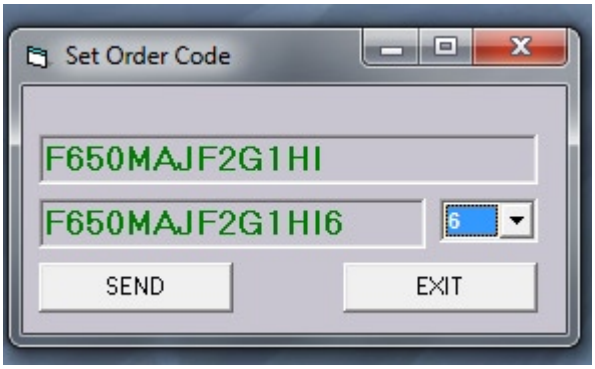


Figure 9-26: Set order code

3. This window only allows changing the last digit, which refers to supported communications protocols options. Click Send:

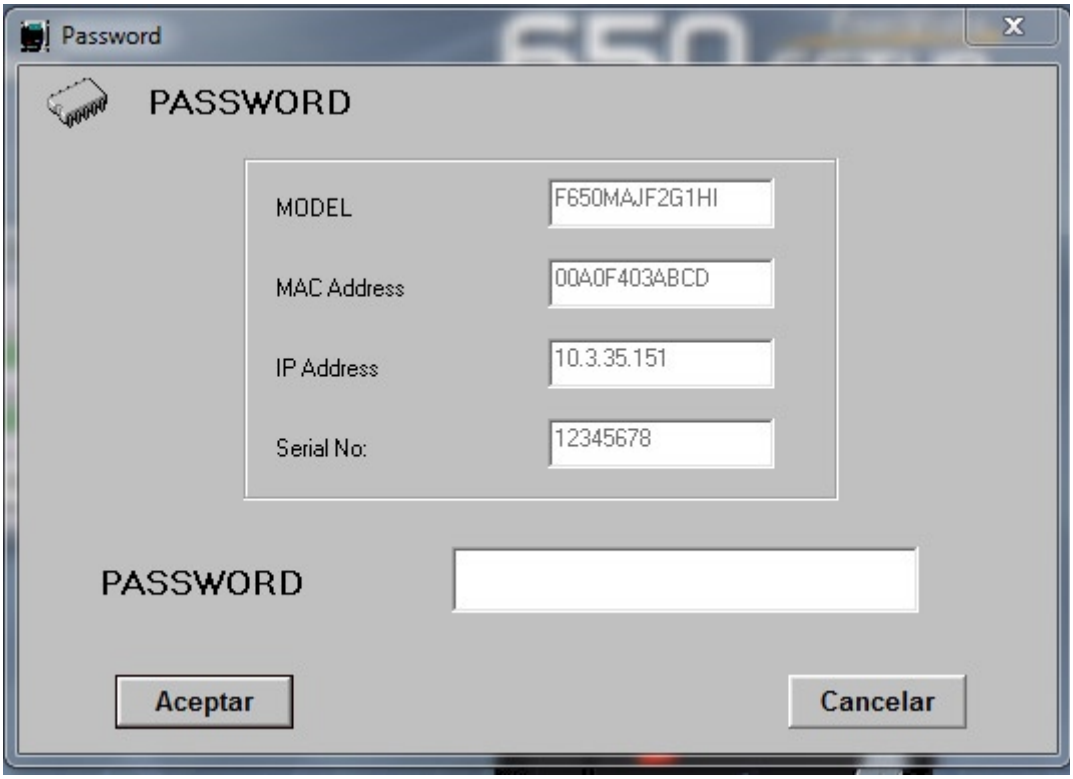


Figure 9-27: Password requirement (special models)

4. The users must contact GE Multilin and provide the following parameters in their order:
   - Unit serial number
   - Current model option (before memory upgrade)
   - Desired model option (after memory upgrade)
   - Unit MAC address (available in the identification label)
5. Once the password is obtained, enter it when prompted.Tthe following messages appear if the password is

correct.:

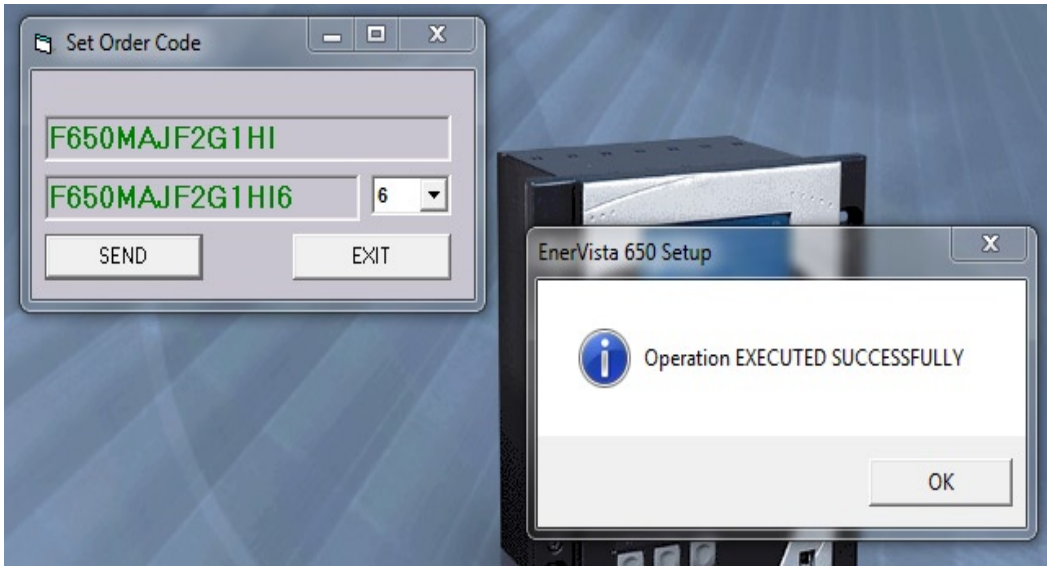


Figure 9-28: Executed successfully

6. After the successful operation, the SEND button is disabled. It is not allowed to make another change from here, so it can be seen what changes have been made. The new order code appears on the status bar.

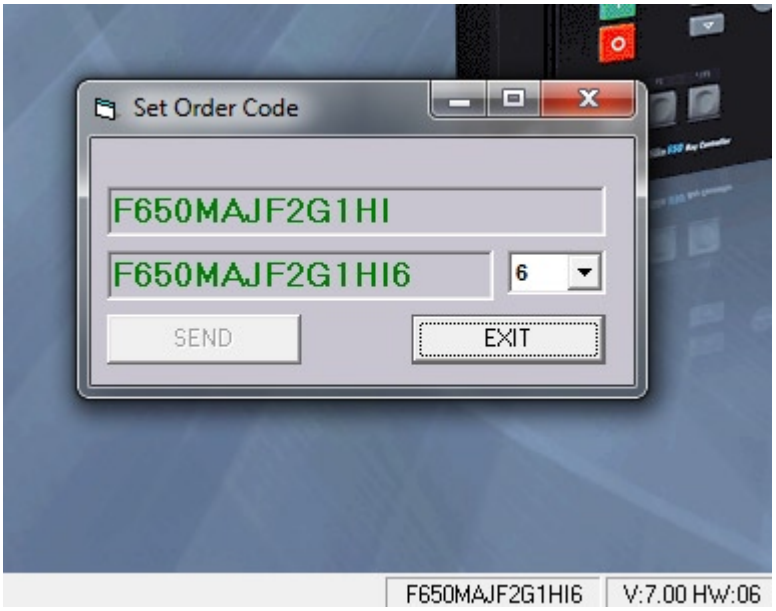


Figure 9-29: New order code

9.2.3 Summary of main firmware upgrade steps

1. Install the proper version of the EnerVista 650 Setup software.
2. Connect an Ethernet cable to the rear Ethernet port (a cross-over cable for back-to-back connection and straight-through cable for hub or switch).
3. Set the appropriate IP address in the relay.
4. Set the appropriate IP address in the PC.
5. In the EnerVista 650 Setup software, select **Communication > Upgrade Relay**.
6. Select the appropriate file (DCL000CAXXX.SDF) for the upgrade.
7. Enter the IP address, serial number, and unit identifier of the relay as prompted.
8. Click **Upgrade File** to initiate the upgrade process.
9. Reboot the relay as required by the upgrade program to complete the upgrade process.
10. All setting and configuration are now set to the factory default.
11. Send new settings and configuration files to the relay if needed.

NOTICE

1. See chapter 13 F650 trouble shooting guide, if there is any problem during the upgrading process.

2. For the relay firmware upgraded to version 9.00 or higher, it can not be downgraded back to the versions below 9.00.

F650 Digital Bay Controller

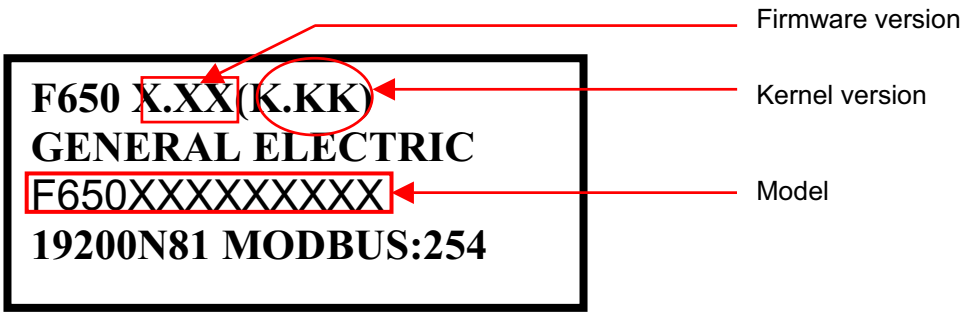
Chapter 10: Commissioning

10.1 Visual inspection

Verify that the relay has not suffered any damage during transportation, and that all screws are correctly fixed, and all relay terminal boards are in good condition.

Verify that the information shown on the relay front plate corresponds to the data shown on the display, and to the requested relay model.

Display information:



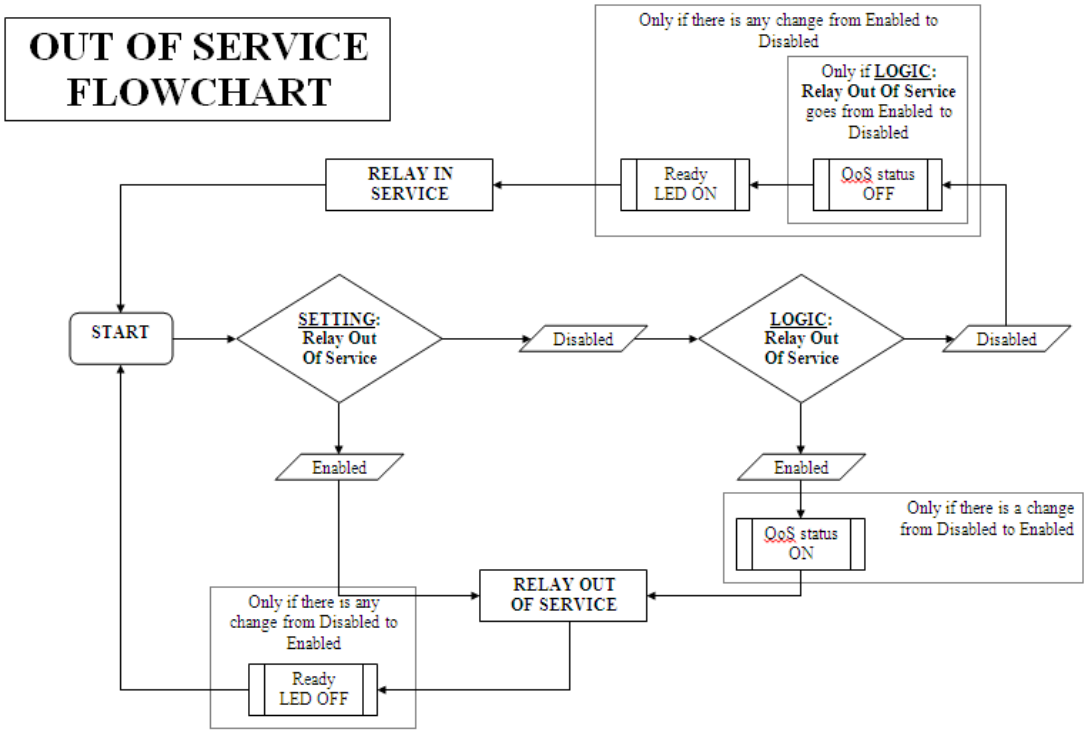
10.2 Out of service setting

The **Relay Out Of Service** setting is configured in **Setpoint > System Setup > Miscellaneous**. The unit also has an **Out of Service** status that is configured in **Relay configuration > Protection elements**. When active, these states stop all changes to PLC equations and functions, including changes to the input/output boards, so if there is a

change in any input or output the unit will not show this change until it has returned to ready mode. For example if an output is closed and the unit goes to the **Out of Service** state, the output is kept closed even if the state that closed it changes and would otherwise open the output. When the unit goes out of the **Out of Service** state, the output is then opened.

When the **Out of Service** status goes to ON, or the setting has been changed to Enabled, the ready LED also changes to red. Be careful if ready LED is linked to an output, because the output will not change its state. To set outputs to ready state see factory default Logic & Configuration in the detailed manual. Take notice that, in the default configuration, the general setting out of service is enabled, so it is necessary to change to disabled to start working with the unit

The following figure shows the flow chart of these states



10.3 General considerations, power supply network

All devices running on AC current are affected by frequency. As a non-sine wave is the result of a fundamental wave plus a series of harmonics from this fundamental wave, we can infer that devices running on AC current are influenced by the applied waveform.

For a correct testing of relays running on AC current, it is fundamental to use a current and/or voltage senoidal waveform. The pureness of a senoidal wave (lack of harmonics) cannot be expressed specifically for a specific relay. However, any relay incorporating sintonized circuits, R-L and R-C circuits, is affected by non-senoidal waveforms, as in the case of F650.

These relays respond to the voltage waveform in a different way to the majority of AC current voltmeters. If the power supply network used for the testing contains wide harmonics, the voltmeter and relay responses are different.

Relays have been calibrated in factory using a Network of 50 or 60 Hz with a minimum harmonic content. When the relay is tested, a power supply network with no harmonics in its waveform must be used.

The ammeters and chronometers used for testing the pickup current and relay operation time must be calibrated and their accuracy must be better than the relay's. The power supply used in the tests must remain stable, mainly in the levels near the operation thresholds.

It is important to point out that the accuracy with which the test is performed depends on the network and on the instruments used. Functional tests performed with unsuitable power supply network and instruments are useful to check that the relay operates properly and therefore its operating characteristics are verified in an approximate manner. However, if the relay would be calibrated in these conditions, its operational characteristics would be outside the tolerance range values.

The following sections detail the list of tests for verifying the complete relay functionality.

10.4 Isolation tests

During all tests, the screw located on the rear of the relay must be grounded.

For verifying isolation, independent groups are created, and voltage is applied as follows:

2200 RMS volts will be applied **progressively** among all terminals in a group, short-circuited between them and the case, during one second.

2200 RMS volts will be applied **progressively** between groups, during one second.

WARNING: No communication circuit shall be tested for isolation.

Groups to be created depend on the type of modules included in F650, selectable according to the model.

The following table shows the different groups depending on the module type:

SOURCE 1:	**G1**: H10, H18
	G2: H13, H14, H15
SOURCE 2:	**G1**: H1, H9
	G2: H4, H5, H6
MAGNETIC MODULE.	**G1**: A5..A12
	G2: B1..B12
I/O F1 (MIXED)	**G1** (Inp. 1): F1..9
	G2 (Inp. 2): F10..18
	G3 (Out.): F19..36
I/O F2 (SUPERVISION)	**G1** (Spv 1): F1..4
	G2 (Inp. 1): F5..9
	G3 (Inp. 2): F10..14
	G4 (Spv 2): F15..18
	G5 (Out.): F19..30
	G6 (Out.): F31.36
I/O G1 (MIXED)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18
	G3 (Out.): G19..36
I/O G4 (32DI)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18
	G3 (Inp. 3): G19..28
	G4 (Inp. 3): G29..36
I/O G5 (analog)	**G1** (Inp. 1): G1..9
	G2 (Inp. 2): G10..18

10.5 Indicators

Feed the relay and verify that when commanding a LED reset operation, all LED indicators light up and they are turned off when pressing the **ESC** key for more than 3 seconds.

10.6 Power supply testing

Feed the relay with the minimum and maximum voltage. For each voltage value, verify that the alarm relay is activated when there is voltage, and it is deactivated when there is no feed. If the power supply source incorporates AC feed, this test is also performed for VAC.

If the relay incorporates a redundant power supply, these tests shall be performed on both power supplies.

Voltage values to be applied are the ones indicated below according to the relay model:

Supply	V Min.	V Max.
HI/HIR 110-250 Vdc 120-230 Vac	 88 Vdc 96 Vac	 300 Vdc 250 Vac
LO/LOR 24-48 Vdc	 19.2 Vdc	 57.6 Vdc

NOTE: Codes HIR and LOR correspond to a redundant power supply

10.7 Communications

Verify that available communication ports allow communication with the relay.

Ports to be checked are as follows:

Front:RS232

Rear:2 x RS485, 2 x Fiber Optic - Serial, 2 x Fiber Optic - Ethernet, 1 x RJ45 - Ethernet.

A computer with EnerVista 650 Setup software and an appropriate connector must be used.

10.8 Verification of measurement

Set the relay as follows

GENERAL SETTINGS			
NAME	VALUE	UNITS	RANGE
PHASE CT RATIO	1.0	0.1	1.0-6000.0
GROUND CT RATIO	1.0	0.1	1.0-6000.0
STV GROUND CT RATIO	1.0	0.1	1.0-6000.0
PHASE VT RATIO	1.0	0.1	1.0-6000.0
PHASE VT CONNECTION	WYE	N/A	WYE – DELTA
NOMINAL VOLTAGE	100 V	0.1	1-2250 V
NOMINAL FREQUENCY	50 Hz	1 Hz	50-60 Hz

PHASE ROTATION	ABC	N/A	ABC – ACB
FREQUENCY REFERENCE	VI	N/A	VI-VII-VIII
AUXILIARY VOLTAGE	VX	N/A	VX – VN

NOTE:

ALL ANGLES INDICATED ARE LAGGING ANGLES

ALL VALUES OBTAINED IN THIS TEST MUST BE THE ONES CORRESPONDING TO THE PHASOR ONES

10.8.1 Voltages

Apply the following voltage and frequency values to the relay:

CHANNEL	ANGLE	FREQUENCY					
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
VI	0º	0	5	50	100	150	200
VII	120º	0	5	50	100	150	200
VIII	240º	0	5	50	100	150	200
VX	0º	0	5	50	100	150	200

Verify that the relay measures the values with an error of ±1% of the applied value from 10V to 208V.

10.8.2 Phase currents

Apply the following current and frequency values to the relay:

CHANNEL	ANGLE	FREQUENCY					
		50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
Ia (A)	45º	0	15	10	5	1	0.1
Ib (A)	165º	0	15	10	5	1	0.1
Ic (A)	285º	0	15	10	5	1	0.1
IG (A)	0º	0	15	10	5	1	0.1
ISG (A)	0º	0	5	1	0.1	0.01	0.005

Verify that the relay measures the values with an error lower than ±0.5% of the test value or ± 10 mA, whichever is greater, for phases and ground.

Verify that the relay measures the values with an error lower than ±1.5% of the test value or ± 1 mA, whichever is greater, for sensitive ground (SG).

Percent of Load-to-Trip

The relevant actual values displays are shown below:

Actual > Metering > Primary Values > Current > % of Load-to-trip

Percent of load-to-trip is calculated from the phase with the highest current reading. It is the ratio of this current to the lowest pickup setting among the phase time and instantaneous overcurrent protection features. If all of these features are disabled, the value displayed is “0”.

- Inject current of various values into Phase A.
- Verify that percent load-to-trip is calculated as the correct percentage of the most sensitive operational Phase Overcurrent element and displayed.
- Repeat for phases B and C.

10.8.3 Active, reactive power, and COSJ metering

Equations to be applied for powers in a wye connection are as follows:

Power per phase	Three-phase power
P=V*I*Cosφ	P=Pa+Pb+Pc
Q=V*I*Senφ	Q=Qa+Qb+Qc

Apply the following current and voltage values:

APPLIED VOLTAGE AND CURRENT VALUES PER PHASE			
Phase a	**Phase b**	**Phase c**	**V-I Angles**
VI = 50 V, 0°	VII = 50 V, 120°	VIII = 50V, 240°	φ=45°
Ia = 10∠45°	Ib= 10∠165°	Ic = 10∠285°	**Cosφ= 0.707**

With the indicated voltage and current values, verify that the power measure corresponds to expected values indicated in the following table:

EXPECTED POWER VALUES			
Phase a	**Phase b**	**Phase c**	**Three-phase**
Pa = 353.55 W	Pb = 353.55 W	Pc = 353.55 W	P = 1060.66 W
Qa = 353.55 VAr	Qb = 353.55 VAr	Qc = 353.55 VAr	Q = 1060.66 VAr

Maximum admissible error is ± 1% of the test value for P and Q, and 0.02 for cosj.

10.8.4 Frequency

Frequency measure on channel VII (terminals A7-A8):

Apply 50 Vac at 50 Hz on channel VII. Maximum admissible error:± 10 mHz.

Apply 50 Vac at 60 Hz on channel VII. Maximum admissible error: ± 12 mHz.

Frequency measure on channel Vx (terminals A11-A12):

Apply 50 Vac at 50 Hz on channel Vx. Maximum admissible error:± 10 mHz.

Apply 50 Vac at 60 Hz on channel Vx. Maximum admissible error: ± 12 mHz.

Results:

Channel	Voltage (V)	Set Frequency (Hz)	Measured Frequency (Hz)
VII	50	50 Hz	
		60 Hz	
VX	50	50 Hz	
		60 Hz	

10.9 Inputs and outputs

During all tests, the screw on the rear of the relay must be grounded.

10.9.1 Digital inputs

During this test, the user determines the activation/deactivation points for every input in the relay for the set voltage value of 30 Volts.

Verify that the error does not exceed ± 10% (+10% on activation, -10% on deactivation).

Default board settings for the input test can be modified in EnerVista 650 Setup software in:

Setpoint > Inputs/Outputs > Contact I/O > Board X

X, is substituted by the corresponding board:

F for board in first slot

G for board in second slot

H for board in first slot of CIO module

J for board in second slot of CIO module

Test settings for mixed board (type 1:16 inputs and 8 outputs):

I/O Board Type 1 (MIXED)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC16 (CC16)	POSITIVE

The inputs test is completed by groups of 8 inputs, as this type of board has 2 groups of 8 inputs with the same common. For the first 8 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 8 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC16) must also be set to POSITIVE.

Test settings for mixed board (type 2: 8 digital inputs, 4 blocks for supervision and 8 outputs):

I/O Board Type 2 (SUPERVISION)	
Voltage Threshold A_X	30 V
Voltage Threshold B_X	40 V
Debounce Time A_X	5 ms
Debounce Time B_X	5 ms
Input Type_X_CC1 (CC1)	POSITIVE
...	...
Input Type_X_CC8 (CC8)	POSITIVE

The inputs test is completed by groups of 4 inputs, as this type of board has 2 groups of 4 inputs with the same common. For the first 4 inputs, the voltage threshold setting is determined by Voltage Threshold A. For the next 4 inputs, the setting is Voltage Threshold B. Inputs (or contact converters, CC1 – CC8) must also be set to POSITIVE.

If the relay incorporates more input modules, these tests must also be applied to them.

10.9.2 Contact outputs

The correct activation of every output to be verified.

For every output, activation command of a single contact must be given, and then verify that only that contact is activated. Go to EnerVista 650 Setup Software (***Setpoint > Inputs/Outputs > Force Outputs***).

For switched contacts, the change of state of both contacts shall be verified.

10.9.3 Circuit continuity supervision inputs

Supervision inputs are tested as normal inputs, revising the voltage level that is 19 Volts.

Coil 1:

Apply 19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F1-F2) and 52/b (terminals F3-F4)"Coil 1" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

Coil 2:

Apply 19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Apply -19 Vdc to both 52/a (terminals F15-F16) and 52/b (terminals F17-F18)"Coil 2" circuit supervision inputs and verify that they are activated.

Remove voltage from both inputs and verify that it takes them 500 ms to change state (deactivate).

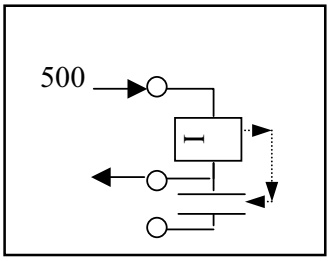
10.9.4 Latching circuits

Send a closing command to the latched contact (F31-F33).

Make circulate a current of 500 mA through the contact in series with the sensing terminal.

Send an opening command and verify that the contact does not open.

Interrupt current and check that the contact is released.



Repeat the test for the other latched contact (F34-F36).

10.10 Connections for testing protection elements

Connect current sources to the relay according to the wiring diagram. Current and voltage input terminals are as follows:

Phase	Connections
Current	
IA	B1-B2
IB	B3-B4
IC	B5-B6
IG	B9-B10
ISG	B11-B12
Voltage	
VI	A5-A6
VII	A7-A8
VIII	A9-A10
VX	A11-A12

10.11 Instantaneous overcurrent (50PH, 50PL, 50N, 50G, 50SG)

Set the relay to trip for the protection element being tested. Configure any of the outputs to be enabled only by the protection element being tested.

Apply 0.9 times the Pickup current and check that the relay does not trip.

Gradually increase the current value and verify that the relay operates between 1 and 1.1 times the set pickup current. The relay must trip by instantaneous in a time frame of 10 to 55 ms. All the relay trip contacts must operate, as well as the contact set as 50.

Remove current and apply it again suddenly to a value of 4 times the pickup current. The relay should trip instantaneously in a time frame of 10 to 45 ms.

Test one point for each phase and group of the protection element.

50 ELEMENTS TEST PARAMETERS
Element Settings (50PH, 50PL, 50G and 50SG)

Setting	Value	Units
Function	Enabled	
Input	RMS	NA
Pickup Level	3	A
Delay time	0	Seconds
Test Execution		
Configure one output for 50 Trip		
Apply times I pickup	**Element Trip**	**Tripping times (ms)**
0.9 x Pickup	NO	NA
1.1 x Pickup	YES	10-55
4 x Pickup	YES	10-45
Elements	**Phase**	**Group**
50PH and 50PL	IA	0
	IB	0
	IC	0
50G	IG	0
50SG (*)	ISG	0

Note (*): Only available for Enhanced models

10.12 Time overcurrent (51PH, 51PL, 51N, 51G, 46)

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Apply 0.9 times the Pickup current and check that the relay does not trip.

Apply 1.5 times the Pickup current. The relay should trip according to the time corresponding to its set curve.

Apply 5 times the Pickup current. The relay should trip according to the time corresponding to its set curve.

Protection Element Settings (51PH, 51PL, 51N, 51G and 46)						
Setting			**Value**		**Unit**	
Function			**Enabled**			
Input			**Phasor (DFT)**			
Pickup Level			**1**		**A**	
Curve			**Modify for each test**			
TD Multiplier			**Modify for each test**			
Voltage Restraint			**Disabled**			
Element	**Phase**	**Curve type**	**Dial**	**Times Ipickup**	**Tripping times (sec)**	
					EXPECTED	**Admissible**
51PH	IA	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.90]
				5	0.648	[0.600 – 0.710]
	IB	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]

51PL	IC	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
	IB	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]
51N	IC	IEEE Ext Inv	0.5	0.9	NA	
				1.5	11.34	[11.00 – 11.60]
				5	0.648	[0.600 – 0.710]
51G	IG	Definite Time	2	0.9	NA	
				5	2.000	[1.900 – 2.100]
46	I2	IEC Curve A	0.05	0.9	NA	
				1.5	0.860	[0.750 – 0.950]
				5	0.214	[0.200 – 0.300]

10.13 Directional elements (67P, 67N, 67G, 67SG)

In order to test directional units in the relay, instantaneous trips are commanded.

Two points are tested, per phase, test element.

In order to test the directional units, configure (in the **Setpoint > Relay Configuration > Protection Elements** screen of the EnerVista 650 Setup program), some overcurrent element to be supervised by a directional unit. This way, if the directional element is enabled and detects the fault in the block direction, then the overcurrent unit does not operate. If the directional element is not enabled or if it is enabled and it detects a fault in a trip direction, then the overcurrent unit operates if the set current level is exceeded.

10.13.1 67P element

Activate only protection elements 50PH and 67P and set the relay as follows:

67P Settings		50PH Settings	
Function	Enabled	Function	Enabled
MTA	45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Block Logic	PERMISSION	Trip Delay	0.30
Pol V Threshold	30 V	Reset Delay	0.00

Configure one of the outputs to be activated only by unit 50PH.

Apply the following tests:

Elements	Phase under test			Polarization Phase			Element trip
	Channel	Magnitude		Channel	Magnitude		
		Mod	Arg		Mod	Arg	

50PH/67P	IA	2 A	0º	VIII	60 V	0º	NO
					60 V	180º	YES
	IB	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
	IC	2 A	0º	VII	60 V	0º	NO
					60 V	180º	YES

10.13.2 67N element

Activate only protection elements 50N and 67N and set the relay as follows:

67N Settings		**50N Settings**	
Function	ENABLED	Function	ENABLED
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50G.

Apply the following tests:

Elements	**Phase under test**			**Polarization Phase**			**Element trip**
	Channel	**Magnitude**		**Channel**	**Magnitude**		
		Mod	**Arg**		**Mod**	**Arg**	
50N/67N	IA	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
	IB	0 A	0º	VII	0 V	0º	
	IC	0 A	0º	VIII	0 V	0º	

10.13.3 67G element

Activate only protection elements 50G and 67G and set the relay as follows:

67G Settings		**50G Settings**	
Function	Enabled	Function	Enabled
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50G.

Apply the following tests:

Elements	Phase under test			Polarization Phase			Element trip
	Channel	Magnitude		Channel	Magnitude		
		Mod	Arg		Mod	Arg	
50G/67G	IG	2 A	0º	VI	60V	0º	NO
					60V	180º	YES
				VII		0º	
				VIII		0º	

10.13.4 67SG element

Activate only protection elements 50SG and 67SG and set the relay as follows:

67SG Settings		50SG Settings	
Function	Enabled	Function	Enabled
MTA	-45 Deg	Input	PHASOR (DFT)
Direction	FORWARD	Pickup Level	0.50 A
Polarization	VO	Trip Delay	0.30
Block Logic	PERMISSION	Reset Delay	0.00
Pol V Threshold	10 V		

Configure one of the outputs to be activated only by unit 50SG.

Apply the following tests:

Elements	Phase under test			Polarization Phase			Element trip
	Channel	Magnitude		Channel	Magnitude		
		Mod	Arg		Mod	Arg	
50SG/67SG	ISG	2 A	0º	VI	60 V	0º	NO
					60 V	180º	YES
				VII	0 V	0º	
				VIII	0 V	0º	

10.14 Undervoltage elements (27P, 27X)

10.14.1 27P element

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

PHASE UV (27P)	
Function	ENABLED
Mode	PHASE-GROUND

Pickup Level	50 V
Curve	DEFINITE TIME
Delay	2.00 sec
Minimum Voltage	30 V
Logic	ANY PHASE
Supervised by 52	DISABLED

Apply voltage as indicated on the table over the undervoltage setting level and verify that the relay does not trip.

Decrease voltage level gradually and verify that the relay trips for the set voltage (with an admissible error of 5%).

Element	Phase	Curve	Pickup Level	Delay	Applied Voltage	Tripping times (s)	
						Expected	Admissible
27P	VI	DEFINITE TIME	50 V	2	55 V	NO TRIP	NA
					45 V	2.000 sec	[2.000 – 2.100]

10.14.2 27X element

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows

GENERAL SETTINGS	
Auxiliary Voltage	VX

AUXILIARY UV (27X)	
Function	ENABLED
Pickup Level	50 V
Curve	DEFINITE TIME
Delay	2.00 sec

Apply voltage as indicated on the table over the undervoltage setting level and verify that the relay does not trip.

Decrease voltage level gradually and verify that the relay trips for the set voltage (with an admissible error of 5%).

Element	Input	Curve	Pickup Level	Delay	Applied Voltage	Tripping time (s)	
						Expected	Admissible
27X	VX	DEFINITE TIME	50 V	2	55 V	NO TRIP	NA
					45 V	2.000 sec	[2.000 – 2.100]

10.15 Overvoltage elements (59P, 59X, 59NH, 59NL, 47)

10.15.1 59P element

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

PHSE OV (59P)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00

Logic	ANY PHASE

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip. Verify that the relay trips for the set voltage (with an admissible error of 5%).

Element	Phase	Pickup Level (volts)	Trip Delay (seconds)	Applied Voltage (V)	Tripping time (s)	
					Expected	Admissible
59P	VII	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

10.15.2 59X element

Set the relay as follows:

GENERAL SETTINGS	
Auxiliary Voltage	VX

AUXILIARY OV (59P)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00
Logic	ANY PHASE

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip. Verify that the relay trips for the set voltage (with an admissible error of 5%).

Element	Input	Pickup Level (volts)	Trip Delay (seconds)	Applied Voltage (V)	Tripping time (s)	
					Expected	Admissible
59X	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

10.15.3 59NH and 59NL elements

Set the relay as follows

GENERAL SETTINGS	
Auxiliary Voltage	VN

NEUTRAL OV HIGH/LOW (59NH/59NL)	
Function	ENABLED
Pickup Level	120 V
Trip Delay	2.00
Reset Delay	0.00

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

Elements	Input	Pickup Level (volts)	Trip Delay (seconds)	Applied Voltage (V)	Tripping time (s)	
					Expected	Admissible
59NH/59NL	VX	120	2	114	NO TRIP	NA
				132	2	[1.9–2.1]
				132	2	[1.9 – 2.1]

This element can also be tested by applying only phase voltages. For this purpose, it is necessary to set Auxiliary Voltage = VX. In this condition, Vn voltage is calculated as a sum of the phase voltages.

10.15.4 47 element - Neg Seq OV

Set the relay as follows:

NEG SEQ OV (47)	
Function	ENABLED
Pickup Level	50 V
Trip Delay	2.00
Reset Delay	0.00

Apply voltage as indicated on the table under the overvoltage setting level and verify that the relay does not trip.

Verify that the relay trips for the set voltage (with an admissible error of 5%).

Channel	Applied Voltage (V)	Angle	Tripping time (s)	
			Expected	Admissible
VI	65	0°	NO TRIP	NA
VII	65	120°		
VIII	65	240°		
VI	55	0°	2	[1.9–2.1]
VII	55	240°		
VIII	55	120°		
VI	45	0°	NO TRIP	NA
VII	45	240°		
VIII	45	120°		

NOTE: All angles mentioned on the tables are delay angles, where a balanced ABC system would be composed by:

Channel	Applied Voltage (V)	Angle
VI	65	0°
VII	65	120°
VIII	65	240°

10.16 Frequency elements (81O/81U)

Set the relay to trip for the protection element being tested. Configure any of the outputs to be activated only by the protection element being tested.

Set the relay as follows:

GENERAL SETTINGS	
Nominal Frequency	50 Hz

ELEMENT SETTINGS		
FREQUENCY (81)	**81U**	**81O**
Function	ENABLED	ENABLED
Pickup Level	47.50 Hz	52.50 Hz
Trip Delay	2.00 sec	2.00 sec
Reset Delay	0.00 sec	0.00 sec
Minimum Voltage	30 V	30 V

Apply voltage as indicated on the table, modifying frequency from the maximum threshold (48 Hz) to the minimum (46 Hz) for 81U, and from the minimum (52 Hz) to the maximum (54 Hz) for 81O, in steps of 10 mHz.

Verify that the relay trips at the set frequency in the corresponding element with an error of 3% ó ±50 mHz.

Apply a voltage that is lower than the “Minimum Voltage” setting, with a frequency under (81U) or over (81O) the setting, and verify that the relay does not trip.

Elements	Phase	Pickup Level (Hz)	Trip Delay (seconds)	Applied Voltage (V)	Frequency Thresholds	Tripping Time (s)	
						Expected	Admissible
81U	VII	47.5	2	80	48 Hz	No trip	NA
					46 Hz	2	[1.9 -2.1]
				25	46 Hz	No trip	NA
81 O	VII	52.5	2	80	52 Hz	No trip	NA
					54 Hz	2	[1.9 –2.1]
				25	54 Hz	No trip	NA

10.17 Recloser (79)

Set protection element 79 as follows:

RECLOSER	
Function	ENABLED
Max Number Shots	4
Dead Time 1	2.10 sec
Dead Time 2	4.10 sec
Dead Time 3	6.10 sec
Dead Time 4	8.10 sec
Reclaim Time	3.00 sec
Cond. Permission	ENABLED
Hold Time	7.00 sec
Reset Time	5.00 sec

Set the relay to trip by 50PH, and configure the signals necessary to test the 79 element:

Configure one output as AR RECLOSE

Configure the AR INITIATE signal with the 50PH trip

Configure the AR LEVEL BLOCK signal with a digital input

Configure the AR CONDS INPUT with the digital signal desired

50PH Settings	
Function	ENABLED
Input	RMS
Pickup Level	3 A
Trip Delay	0.00 s
Reset Delay	0.00 s

10.17.1 Reclosing cycle

Connect a latching relay simulating the breaker managed by the F650 unit.

Once the relay is set, close the breaker and wait for 5 seconds.

After this time, the recloser is ready to initiate the reclosing cycle.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 2.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 4.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 6.1 seconds.

Command a 50PH trip and verify that the breaker opens and the relay recloses in 8.1 seconds.

Command a 50PH trip and verify that the breaker opens and the recloser passes to Lockout.

Verify the correct operation of programmed outputs

Tripping times must be within the following values:

Reclosing Cycle		
N° shot	Expected time	Admissible time
1	2.1 sec	[1.8 – 2.3]
2	4.1 sec	[3.8 – 4.3]
3	6.1 sec	[5.8 – 6.3]
4	8.1 sec	[7.8 – 8.3]

10.17.2 Recloser status

BLOCK

Activate the block input and verify that the recloser is in BLOCK status.

Close the breaker and wait for 5 seconds.

Command a trip and verify that the breaker opens but there is no reclose.

INHIBITION BY RECLOSING CONDITIONS

Close the breaker and wait for 5 seconds.

Command a trip, verify that the breaker opens and wait for the first shot.

Activate the inhibition input and command a new trip.

Verify that the breaker opens, wait for 8 seconds and verify that the relay does not reclose.

10.17.3 External reclose initiation

Close the breaker and wait for 5 seconds.

Activate the reclose initiation input and open the breaker, verify that the relay executes the first shot

10.18 Thermal image element (49)

Disable all protection elements except for Thermal Model (49).

Set the pickup level to 2 A.

Set the time constant t1 to 3 minutes and t2 to one time t1.

Apply currents of 2, 5, and 10 times the tap and ensure that the operation times are within the range described on the following table:

Rated Current (A)	Applied Current (A)	Times of set tap	Operation time (s)
	4.0	2	48.5 - 53.6
5	10.0	5	7.06 - 7.80
	20.0	10	1.77 - 1.95

After each measuring, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

Repeat the test selecting a time constant t1 of 60 minutes. Verify that the operation time is within the range described on the following table:

Rated Current (A)	Applied Current (A)	Times of set tap	Operation time (s)
	4.0	2	960 - 1072
5	10.0	5	141 - 156
	20.0	10	35.4 - 39

After each measuring, the thermal element must be reset to zero in order to start the next test at a zero thermal status condition.

F650 Digital Bay Controller

Chapter 11: Application examples

11.1 Example 1: Communication & protection settings

11.1.1 Description

The requirements for this setting exercise are:

Communicate the relay via serial cable or Ethernet 10/100 Base T cable using EnerVista 650 Setup program.

Set some Phase Time Overcurrent protection function to operate at 5A, Inverse curve IEC, Dial 0.1

Set some Output contact on board F to be operated and sealed by the operation of the phase TOC.

Set some LED to show the operation of the phase TOC

Set some Operation to reset the output contact after dropout of the phase TOC since the front F1 pushbutton.

Set some Oscillography channel to record the pickup of phase TOC and output contact closing action.

To test the operation of this Phase Time Overcurrent protection

11.1.2 Communicate with the relay

This procedure describes the connection between any Laptop and some F650 relay using the **EnerVista 650 SETUP** program

For any one of these connections check first the communication parameters as follows:

Serial Communication (RS232 or USB front port of the relay)

With the ESC key check on the main front screen the serial communication parameters (Baud rate, parity, data bits, stop bit and ID number).

Connect the serial cable PC-F650

Open the EnerVista 650 SETUP program in the PC and under **Communication** ⇓ **Computer** menu check that the serial communication parameters displayed are the same read in the front of the relay. Check also that:

Control Type is set to No Control Type

Startup Mode is set to Communicate with relay

Click **ON** key.

Ethernet LAN (10/100 Base T rear port of the relay)

In the Laptop choose **My PC-Control Panel-Network-Protocols-Protocol TCP/IP-Advance** and set in **IP Address** screen the following:

IP Address 192.168.37.126

Netmask 255.255.255.0

In the front of F650 go to the **Main Settings** screen.

choose **Change Settings.**

Choose **Comm Settings** and press down the rotating knob or down key.

Choose **Network 0.** It is displayed **IP Address OCT 1** and set it according to the following table:

Sequence		
Action	**Setting**	**Action**
----	IP Address OCT 1	Set to 192
Move rotating knob clockwise	IP Address OCT 2	Set to 168
Move rotating knob clockwise	IP Address OCT 3	Set to 37
Move rotating knob clockwise	IP Address OCT 4	Set to 125
Move rotating knob clockwise	Netmask OCT 2	Set to 255
Move rotating knob clockwise	Netmask OCT 3	Set to 255
Move rotating knob clockwise	Netmask OCT 4	Set to 0
Move rotating knob clockwise	Netway IP OCT 1	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 2	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 3	Leave default setting without any change
Move rotating knob clockwise	Netway IP OCT 4	Leave default setting without any change
Move rotating knob clockwise	Press INTRO	Press enter to validate settings

Go to **General Settings. General Settings 0** is now displayed.

Set ModBus Port Number to 502.

Set ModBus Address COM1 to 254.

Move clockwise the rotating knob or press the down key to find **Press Enter to End** and press it down to validate the setting.

Connect a crossover 10/100 MB Ethernet cable from PC to the relay.

Open the EnerVista 650 SETUP program in the PC and under **Communication** ⇓ **Computer** menu and set:

IP Address 192.168.37.125

Port 502

Unit Identifier 254

Control Type to ModBus/TCP

Startup Mode to Communicate with relay

Click **ON** key.

The program starts connection with the relay showing the progress screen.

11.1.3 Set the protection function

Once the relay has been connected set protection functions and outputs according to the following steps:

Open EnerVista 650 SETUP program and under:

SETPOINT ⇓ SYSTEM SETUP ⇒ ⇓ GENERAL SETTINGS

Name	Value
Phase CT Ratio	1.0 (default)
Ground CT Ratio	1.0 (default)
Stv Ground CT Ratio	1.0 (default)
Phase VT Ratio	1.0 (default)
Phase VT Connection	Wye
Nominal Voltage	100.0 (default)
Nominal Frequency	50
Phase Rotation	ABC
Frequency Reference	VI (default)
Auxiliary Voltage	VX (default)

Under

SETPOINT ⇓ PROTECTION ELEMENTS ⇒ ⇓ PHASE CURRENT ⇒ ⇓ PHASE TOC HIGH ⇒ PHASE TOC HIGH 1

Name	Value
Function	Enabled
Input	Phasor DFT
Pickup Level	5.0 A
Curve	IEC Curve A
TD Multiplier	0.1
Reset	Instantaneous
Voltage Restraint	Disabled

Under

SETPOINT ⇓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F

Name	Value
Output Logic_00_00	Positive
Output Type_00_00	Latch

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OUTPUTS

Select	Name	Source	OR
Contact Output Operate 00 (Board F)	C Output Oper_00_00	**Press for Logic**	✓
		Phase TOC A Op Phase TOC B Op Phase TOC C Op	
Contact Output Reset 00 (Board F)	C Output Reset_00_00	Operation bit 000	

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ LEDS

Select	Name	Source
☑ Led 5	C Output Op 00	C Output_00_00

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OPERATIONS

Select	☑ Operation 0
Command Text	Reset C Output 00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F1
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Master 4	---

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OSCILLOGRAPHY

Select	Name	Source
☑ Digital Channel 1	C Output Op_00_00	C Output Oper_00_00
☑ Digital Channel 2	C Output_00_00	C Output_00_00

11.1.4 Test

Apply 7.5 A in phase A (terminals B1-B2) until contact 00 on Board F operates (terminals F19-F21 should be and remain closed), and LED 5 should be lit. Check that operating time is in the order of 1.7 seconds.

Remove current from terminals B1-B2

Press pushbutton F1 and check that contact 00 on Board F has been open.

Check that LED 5 in the front of the relay has been turned off.

Repeat the process for phase B (terminals B3-B4) and for phase C (terminals B5-B6)

Under **Actual ⇓ Waveform Capture** menu retrieve the last oscillography recording stored, open it using GE_OSC program and check that the two digital signals as well as the current signal were kept.

11.2 Example 2: TOC protection & reclosing settings

11.2.1 Description

The purpose of this exercise is to introduce the F650 User about the way to set a protection scheme including:

Trip operation of a phase time overcurrent protection.

Two reclosing shots with successful fault clearing.

Synchronism check action to verify two ends voltage conditions previous to perform each reclosing action.

11.2.2 Communicate with the relay

This procedure is described in Example Nº 1. Therefore check the actual PC communication status to assure a fast and reliable communication with F650 relay.

11.2.3 Set the protection function

This procedure is fully described in paragraph 13.3 (see Example Nº 1). Therefore it is not necessary to explain it here again except about the small modifications required for the actual exercise, as well the additional settings not used until now (i.e. recloser and synchrocheck).

Therefore, by having the F650 set like in the previous exercise (paragraph 13), the new settings and changes to be done in the relay to work in a protection-reclosing scheme are:

Under

SETPOINT ⇓ SYSTEM SETUP ⇒ BREAKER ⇒ ⇓ BREAKER SETTINGS

Name	Value
Number of Switchgear	1

Under

SETPOINT ⇓ INPUTS/OUTPUTS ⇒ CONTACT I/O ⇒ BOARD F

Name	Value
Output Logic_00_00	Positive
Voltage Threshold B_00	80V
Debounce Time B_00	10 ms
Input Type_00_00 (CC1)	Positive
Delay Input Time_00_00 (CC1)	0 ms
Output Type_00_00	Normal
Pulse Output Time_00_00	500 ms

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ PROTECTION ELEMENTS

Select	Source	OR
AR Initiate	**Press for Logic**	✔
	Phase TOC A Op Phase TOC B Op Phase TOC C Op	
AR Conds Input	Sync Close Perm	

11.2.4 Set the recloser

Under

SETPOINT ⇓ CONTROL ELEMENTS ⇓ AUTORECLOSE

Name	Value
Function	Enabled
Max. Number of shots	2
Dead Time 1	2.0s
Dead Time 2	4.0s
Dead Time 3	---
Dead Time 4	---
Reclaim Time	0.05s
Condition Permission	Enabled
Hold Time	0.1s
Reset Time	1.9s

11.2.5 Set the synchrocheck

Under

SETPOINT ⇓ CONTROL ELEMENTS ⇒ ⇓ OTHER FUNCTIONS ⇒ ⇓ SYNCHROCHECK

The synchrocheck function and its permission to close is a condition in the present exercise to allow the recloser to give the different programmed shots. Should not this condition be required these settings are non relevant, but if does like in the present case the synchrocheck function must be set as follows

Name	Value
Function	Enabled
Dead Bus Level	10V
Live Bus Level	50V
Dead Line Level	10V
Live Line Level	50V
Max. Volt Difference	10
Max. Angle Difference	10°
Max. Freq. Difference	20mHz
Breaker Closing Time	0.07s
DL-DB Function	Disabled
LL-DB Function	Disabled
DL-LB Function	Disabled

Additional comments on scheme

The programmed operation of a TOC protection with reclosing and synchrocheck features for the F650 relay is shown in F650 Tripping and reclosing scheme Figure 11-1: F650 tripping and reclosing scheme Some conclusions follows:

The recloser cycle ends at lockout status since a permanent fault remains after two unsuccessful reclosing trials.

The holding time for reclosing conditions can be very low since the processor internal time to check them is instantaneously if they are present at this moment. Depending in the application reclosing conditions might come later especially when commands are sent from dispatching center. If does then this timing must be set properly.

The F650 trip contact over-travel is the time the contact remains closed for some definite time to assure the tripping action of the breaker, specially in CB's with large tripping times (bulk or other CB's). This time delay has been set in group SETPOINT ⇓ CONTROL ELEMENTS ⇒ INPUTS/OUTPUTS ⇒ BOARD F

To test the reclosing scheme one current and two voltages signals equipment with phase and frequency shifting capability must be used. The current source must be switched OFF and ON in the time ranges described in the scheme

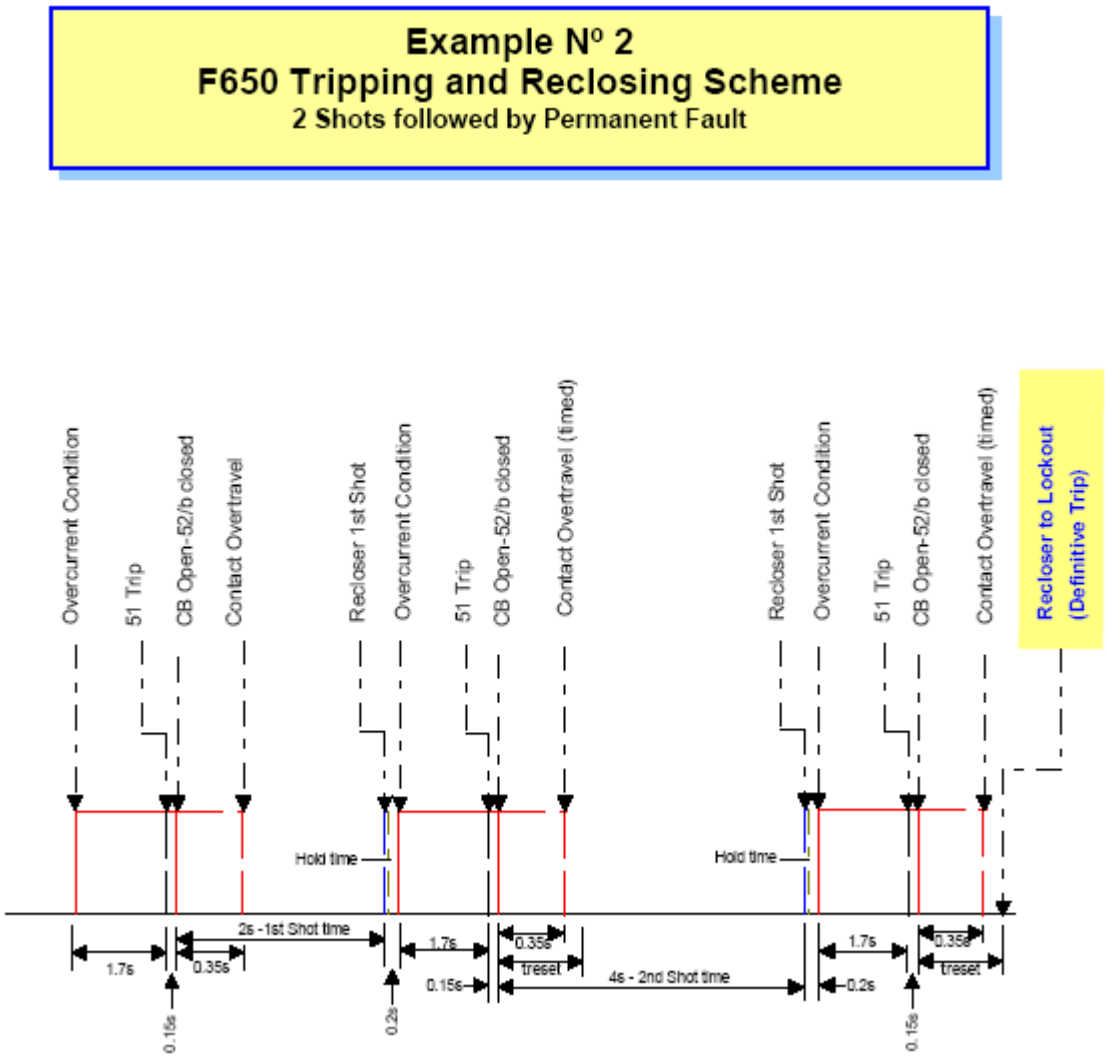


Figure 11-1: F650 tripping and reclosing scheme

11.3 Example 3: Set an operation

11.3.1 Description

This simple operation describes how to program and set an operation command on the F650 relay. In the present case the operation is:

To configure some F650 output contact to be operated since the front of the relay.

To set some LED to show the operation of the output contact (while being closed).

To close a F650 output contact using a front key pushbutton.

To reset the output contact and LED using another front key pushbutton.

11.3.2 Procedure

Set the following values:

Under

SETPOINT ⇓ CONTROL ELEMENTS Þ INPUTS/OUTPUTS ⇒ BOARD F

Name	Value
Output Logic_00_00	Positive
Output Type_00_00	Latch
Pulse Output Time	10000ms *

*** T**his setting is non-relevant since it applies only when "**pulse**" type is chosen

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OUTPUTS

Select	Name	Source
☑ Contact Output Operate 00 (Board F)	C_Output Oper_00_00	Operation_bit000
☑ Contact Output Reset 00 (Board F)	C_Output Reset_00_00	Operation_bit001

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ LEDS

Select	Name	Source
☑ Led 14	Close Contact_00_00	C_Output_00_00

Under

SETPOINT ⇓ RELAY CONFIGURATION ⇒ OPERATIONS

Select	☑ Operation 0
Command Text	Close C_Output_00_00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F2
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Master 4	---

In the same window (next rows)

Select	☑ Operation 1
Command Text	Reset C_Output_00_00
Interlock Type	None
Interlocks	---
Final State Type	None
Final States	---
Frontal Key	F1
Contact Input	None
Virtual Output	None
Time Out	500 (default)
MMI	---
Com1	---
Com 2	---
ETH-Master 1	---
ETH Master 2	---
ETH Master 3	---
ETH Master 4	---

11.3.3 Test

In the main front screen press **F2** key.

A message showing "Press Enter to Confirm Key ®**F2**¬" is displayed.

Press **Enter**.

Check that contact_00_00 (board F) has been closed.

Check that the front LED 14th is lit.

In the main front screen press **F1** key.

A message showing "Press Enter to Confirm Key ®**F1**¬" is displayed.

Press **Enter**.

Check that contact_00_00 (board F) has been opened.

Check that the front LED 14th has been switched off

F650 Digital Bay Controller

Chapter 12: Frequently asked questions

12.1 Communications

Q1. Does the F650 support DNP and ModBus over the Ethernet port?

A1. F650 units support both protocols over both the asynchronous serial ports and the Ethernet LAN synchronous port using TCP/IP and UDP/IP layers over the Ethernet.

Q2. Does this equipment support dual IP access?

A2. Yes, it supports two independent IP addresses in aliasing mode. Those address go in the communications settings Network0 and Network1.

Q3. Is the protocol IEC 870-103 supported by the F650?

A3. Yes, IEC 870-103 is supported by the F650 in firmware version 5.00 and higher.

Q4. Can the F650 be used as a DNP master station?

A4. Not at this moment. It works as a slave IED station for all protocols.

Q5. How many communication ports are included in the F650?

A5. The equipment has 2 different boards, one for asynchronous serial ports and another for a high-speed synchronous Ethernet port. The first board has 2 comm ports, COM1 and COM2. COM2 is multiplexed with the front serial RS232 port, whereas the COM1 port is completely independent from COM2.

The synchronous LAN port is ETH_1/ETH2 or ETH_E/ETH_A/ETH_B (Depending on model.

Q6. Are there one or two Ethernet ports?

A6. The equipment has only 1 Ethernet port. For redundant fiber optic versions, redundancy is done at the physical level (fiber optic) but there is just one port.

Q7. How many different communication Ethernet sessions can be opened through the LAN port?

A7. ModBus TCP/IP:4 sockets

DNP TCP/IP:3 sessions (from version 1.72 on)

Q8. May I use the cooper 10/100 BaseTX connection included in the basic model with all protocols?

A8. Yes, it may be used with all protocols. In noisy substation environments and/or long distances, it is recommended to use fiber optic options due to much better EMC performance and immunity. For fiber optic models, it is necessary to adjust an internal jumper to use the copper port.

Q9. Remote I/O CAN bus. Does it support DeviceNet protocol?

A9. No it does not support DeviceNet.

Q10. Which functions are available in the relay web server?

A10. Currently, it includes several functions for viewing measures and retrieving information.

Q11. Q11 May I use URPC to program the relay?

A11. Only oscillography records may be viewed with URPC once downloaded to a file using the ENERVISTA 650 Setup software.

Q12. May I connect URs and F650s to the same Ethernet?

A12. Yes, either in cable as in fiber, or even mix them.

Q13. How do I connect with fiber 10-BASE-FL UR relays with 100-BASE-FX F650 relays?

A13. Take into account that an UR is never connected directly to a F650 (neither two UR nor two F650 with each other) but they are always connected through a hub or switch. The hub or switch where the URs are connected must be 10-BASE-FL and the hub or switch for the F650 must be 100-BASE-FX.

Q14. How do I connect with cable 10_BASE-T UR relays with 10/100-BASE-TX F650 relays?

A14. The answer to this question is as described before but also in this case there is an advantage added, because the hub 10-BASE-TX port is able to understand a 10-BASE-T port. This means that a hub 10-BASE-T port may be connected to an UR or a F650, and a hub 10/100-BASE-TX port may be connected either to an UR or F650.

Q15. What happens with fiber optic connectors compatibility, because the hub that I have has a different connector to the one of the F650, although both are 100-BASE-FX?

A15. Just buy fiber cables with the appropriate male connectors. For the UR and F650 side we need the same connectors, ST type, for the hub side, the correspondent ones. And in what concerns to the fiber type, it is used the same for 10 as for 100, it is the 50/125 or 62.5/125 multimode, this last one allows longer distances.

Q16. What is the difference between a hub and a switch?

A16. In a repeater type hub (shared hub), one unit talks and the rest listen. If all the units are talking at the same time there may be collisions in the messages, what may produce certain communication delays.

The switch (switched hub) has very powerful processors and a lot of memory and it is much more expensive than the hub. It directs messages to the proper destination avoiding collisions and allowing a much more efficient communication.

Q17. Why do we have 10/100 compatibility for cable but not for fiber?

A17. The cable has some advantages that the fiber does not have, and it is that the signal attenuation in short and medium distances, is worthless and this is truth for low and high frequency signals. By the contrary, the light in one fiber optic is highly attenuated, being much worse in case of high frequencies than in the low ones. The 10-BASE-FL fiber transmission is performed in a wavelength of 850nm, what allows a less expensive electronic than the 1300 nm used in 100-BASE-FX fiber transmission. Using, in both cases, the same glass multimode fiber type, the attenuation to 1300 nm is lower than the 850 nm ones, this way the greater attenuation of the 100 Mbits is compensated. There is another fiber standard, the 100-BASE-SX, which uses 850 nm to 100 Mbits, being compatible with the 10-BASE-FL one, although it sacrifices the maximum distance to 300 m. Nowadays, this standard has not had success among Ethernet equipment manufacturers and suppliers.

12.2 Protection

Q1. Does the F650 support IRIG-B signals? Which type and accuracy? How many units may be connected to the same source?

A1. Yes, the F650 includes an IRIG-B input for all models, including the basic ones.

It uses DC level format B. Formats used are B0000, B0002 and B0003.

Actual accuracy is 1 millisecond. Internal sampling rate allows true 1 ms accuracy time tagging.

The input burden is very low. The maximum number of units that may be connected to a generator depends on its output driving capability. Up to 60 units have been successfully connected with equipments commonly used in the market.

Q2. Does the equipment work with dry inputs in both AC and DC?

A2. The equipment works only with DC inputs.

Inputs should be driven with externally generated DC current. No special 48 Vdc or other outputs are included in the equipment to drive these inputs; therefore, contacts connected to the equipment should be connected to a DC source.

Q3. Is it oscillography programmable?

A3. Yes, the sampling rate is programmable (4, 8, 16, 32 or 64 samples per input). The depth depends on the sampling rate.

Q4. Do I have to select a different model for 1 or 5 A?

A4. No. The same model is able to work with either /1 A or /5 A rated secondary currents. There are high accuracy sensing transformers that allow the use of any current input through the same terminals to reduce the spares and simplify wiring.

Q5. In my installation, several digital inputs become active when I energize the transformer. How can I reduce sensitivity?

A5. By selecting debounce time and/or voltage threshold, the relay may adapt its sensitivity to different applications. Select the maximum voltage threshold and debounce time (recommended 15 ms) to minimize AC coupling effects.

12.3 Control & HMI

Q1. What is the difference between Get/Send info from/to relay and Upload/Download info files to/from relay?

A1. Get/Send are used for settings and configuration storage that although both are in a unique file, are sent separately in two times. Upload/Download are used for project or PLC files group storage. These files are the setting_configuration file source. To operate, the F650 does not need the source files; the Upload/Download tool is destined to serve as historic file.

Q2. Can I program interlocks?

A2. Yes, via ENERVISTA 650 Setup interlocks may be programmed from very simple to advanced schemes.

Q3. Can we rotate the display 90 degrees to show feeders vertically?

A3. No. The product has been designed to view it in horizontal mode (landscape) due to the following reasons:

It is easier to read the LCD display because it has been designed for horizontal positions. Compatibility between text display (4x20 characters) and LCD display (16x40 characters or 128x240 pixels). Refresh speed is better in horizontal than vertical format.

Q4. Do I need a laptop or tablet to program the unit?

A4. No, all main operations can easily be performed with just the incorporated HMI. A tablet or laptop may be required to download large quantities of information (such as oscillograms, etc.) but they are not mandatory for a conventional user that just needs to change settings, view measurements, states, etc.

Q5. Is there password security for protection and control?

A5. Yes, there are two passwords. An independent password for protection changes and control operations is available since version 1.44

Q6. Is it possible to have a remote HMI installed in the front of the panel with the rest of the relay in the rear side?

A6. Not in the present version.

Q7. Is it possible to program a default screen for the HMI?

A7. In graphic display versions the user may program a custom screen with the single-line diagram, measurements, etc. In text display models, there is a choice of logo, measurements, or scrolling both screens.

Q8. May I force inputs and outputs to ease commissioning and testing?

A8. Yes.

Q9. How can I disable the rotary knob buzzer?

A9. Press ESC key more than 3 seconds and then press the knob during a short pulse.

Q10. How can I disable/enable beep sound HMI keypad in models with Enhanced HMI?

A10. To disable: Press ESC push-button more than 3 seconds and then press ENTER push-button while keeping ESC push button pressed.

To enable: Press ESC push-button more than 3 seconds. After this time, press the ENTER push-button and then Up/down key while keeping ESC push-button pressed.

Q11. Why do appear strange texts on the display when switching on the relay?

A11. You have pressed any button and the HMI has entered test mode.

The display messages are updated after a few minutes, once the relay has completed the starting sequence.

12.4 Relay configuration

Q1. Does the "Service" contact on the Power Supply board cover all possible failures or do I have to create an output on the I/O board that includes all the internal errors I can access in the logic?

A1. The power supply ready contact only monitor hardware failures in the power supply, to monitor the internal error of the unit it is necessary to configure a virtual output to and the assign it to the device desired (contact output, LED, etc.).

Q2. I set an output contact as "Latched". If I do not set a "reset" condition, will it reset from the "ESC" key?

A2. No, you have to configure the contact output reset signal (in ***Setpoint > Relay Configuration > Outputs***).

The ESC key only reset the LED indicators.

F650 Digital Bay Controller

Chapter 13: F650 troubleshooting guide

13.1 Symptoms and recommended actions

F650 units have been designed and verified using the most advanced and reliable equipment. Mounting and testing automation ensure a high consistency of the final product. Before sending a unit back to the factory, we strongly suggest you follow the recommendations below. These actions may solve the problem, and if not they will help define the problem for quicker repair.

To send a unit back to the factory for repair, use the appropriate RETURN MATERIAL AUTHORIZATION process, and follow the shipping instructions provided by our Service Department, especially in the case of international shipments. This will lead to a faster and more efficient solution to your problem.

Category	Symptom	Possible cause	Recommended action
Protection	The relay does not trip	-Function not permitted	-Set the function permission to ENABLED
		- Function blocked	-Check Protection units block screen
		- Output not assigned	-Program the output to the desired function using ENERVISTA 650 Setup logic configuration
		- The unit is not set to ready	- Verify that the general setting is set to disable and the out of service state is not active

General	When feeding the unit, no indicator is lit up	-Insufficient power supply - Wrong versions -Fuse failure - Loose fuse -Incorrect wiring	-Verify the voltage level using a multimeter in the power supply terminals, and check that it is within the model range -Check relay and ENERVISTA 650 Setup versions are the same -Remove power supply, dismount the power supply module and replace the fuse -Same as above with same fuse -Make sure that terminals labeled + and – are connected to the 9-pin connector corresponding to the power source
Communication	The relay does not communicate via the front RS232 port	-Incorrect cable -Damaged cable -Relay or PC not grounded -Incorrect baud rate, port, address, etc.	-Make sure you are using a straight cable -Replace the cable -Ensure ground connection -Test other ports, other baud rates, etc. Make sure that the communication parameters in the computer match the ones in the relay.
General	After Updating the firmware the relay does not start up and always shows the message “Os Loading…”.	Check that the bootware version match with the firmware version	-If there is an incompatibility between boot and firmware version, update to the corresponding boot and after that update the firmware version -If the boot and firmware versions are correct, perform the firmware update procedure again.

Category	Symptom	Possible cause	Recommended action
Communications	Cannot see properly the web server in F650 with Windows XP. Some windows are in grey with a red cross mark.	1.- Disabled Java options in Advanced Internet Explorer properties or high level of security 2.- Nor Java Virtual Machine installed.	1.1- Go to Advanced in Internet options for Internet explorer and select the three selections in Microsoft VM (Java Virtual Machine) and deselect any other virtual machine not Microsoft, for example SUN. In case Microsoft VM is not installed in the computer, the user must install it using the Microsoft VM installation program msjavx86.exe For Internet Explorer 6.0 or higher it is not included by default. 1.2.- Try to set a lower level of security in Internet Explorer options. 1.3.-Delete temporary internet files in "General" screen in internet explorer options. Communication EnerVista 650 Setup does not retrieve osc, fault reports and Data Logger files Bad communication in TFTP using Windows 2000 Disable and Enable the Ethernet connection on Control Panel inside Windows 2000. Try again 2.1- Install either Microsoft or Sun Java Virtual Machine
Communication	EnerVista 650 Setup does not retrieve osc, fault reports and Data Logger files	Bad communication in TFTP using Windows 2000	Disable and Enable the Ethernet connection on Control Panel inside Windows 2000. Try again to retrieve files from relay
Firmware and bootware upgrade			

Bootware	The relay gets stuck during the upgrading process after switching off and on the relay, giving the following error message: “ERROR Setting relay in configuration mode. Retry?	- The relay does not communicate via the front RS232 port	To perform the bootware upgrading process it is necessary to connect the unit thought the front RS232 port. check: • Serial cable correct (straight through) and undamaged. • Settings selection in EnerVista 650 Setup: Communication > Computer Settings”: o Com port selected must be the one that is being used to perform this procedure o Parity set to NONE o Baud rate set to 19200 o Control type: No control type o Modbus slave number: any **Note: if the bootware upgrade procedure got stuck at this point the relay will not be upgraded. After reboot the relay will continue working with the former firmware and bootware versions**.

Category	Symptom	Possible cause	Recommended action
Bootware	The relay gets stuck at “Sending file imagen_kernel...”	-The Ethernet connection does not work properly.	Serial communications work properly and the flash memory has been erased but Ethernet communication does not work properly, check: • RJ45 cable used (crossover cable for back-to-back connection and straight through Ethernet cable for hub or switch) • IP address and netmask, gateway are correct and correspond to the ones used in the computer performing the procedure. See chapter 5.2.1 Communication settings • Ethernet board parameters selection, check that: o 802.1p QOS is Enabled o Flow control is Auto o Speed & Duplex is Auto (or 10 Mb Full) • If the above points are correct but the problem persists: o Force the Speed & Duplex to 10 Mb Full o Disable and enable the Ethernet connection while the files are being sent (during the “sending file...” message **Note: if the bootware upgrade procedure is stuck at this point, the relay flash memory has been erased and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI shows the message “Os Loading...” and the relay does not start up**.
Firmware	The procedure can not start due to ethernet problems	-The Ethernet connection does not work properly.	• Check the same as in the point above for bootware. Note: if the firmware upgrade procedure is stuck at this point the relay will not be upgraded. After switching it off and on it will continue working with the former firmware and bootware versions.
Firmware	Program messages “file” do not exist in local drive	- File path is too long - File has no file attributes	• Check the path length, copy the files in a shorter path and restart the upgrade procedure. • Check the unzip process to see if the file properties are properly set to “File”. • **Note: if the firmware upgrade procedure is stuck after having been started, the former firmware has been erased and the upgrade procedure must be completed to start working with the unit. If the procedure is not completed, the HMI shows the message “Os Loading...” and the relay does not start up.**

Firmware	It is not possible to upgrade models without IEC 61850 to models with IEC 61850 automatically	- IEC 61850 upgrade from standard models is password protected.	• To upgrade from a standard model to a 6 model, ask the factory for an upgrade package, depending on the hardware the existing unit has. If it is hardware 00 a hardware and firmware change is required (password protected), if it is hardware 01 or above only a firmware change is required (password protected).
Firmware	During the upgrading process for models with IEC 61850 sometimes it ask for password and sometimes not.	- Communication problems during the upgrade procedure. -The procedure has been not performed in a continuous way.	• EnerVista 650 Setup program does not ask for a password if the relay model is IEC61850 and the procedure is completed. • If during the process there is any problem and it has to be restarted, this second time the program will ask to confirm the IEC password. • If the EnerVista 650 Setup program is closed and started again during the bootware and firmware upgrade process, the program will ask to confirm the IEC password.
Firmware	Password for IEC61850 incorrect	- Model change - Incorrect mac or serial number	• The password is tied to the model, MAC Address and serial number, so a change in any of these requires a password change. • If the model has been modified to add or replace any boards or communication protocol, the IEC 61850 passwords needs to be updated (contact the factory).
EnerVista 650 Setup	InstallShield Setup Initialization Error 6001	A previous installation of any product using InstallShield for installation may have corrupted some of the InstallShield files used in the EnerVista 650 Setup installation	Delete (or rename) the 0701 folder located in "C:\Program Files\Common Files\InstallShield\Professional\Run Time\" and retry installation

F650 Digital Bay Controller

Appendix A: Logic Operands

A.1 Operands - F650 - model FX - GX

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Auto-check internal states (critical)		
DSP Internal States (Critical to metering and protection)	DSP COMM ERROR	DSP Communication Error: (0) Right communications between DSP and main processor; (1) Communication Error between DSP and main processor
	MAGNETIC MODULE ERROR	Magnetic Module Error: (0) Right Communication between DSP and magnetic module processor; (1) Communication Error between DSP and magnetic module processor
	CALIBRATION ERROR	Calibration Error: (0) Right calibration values stored; (1) The calibration values stored are out of the calibration limits.
Flash Internal States (Critical to Relay configuration and stored data)	E2PROM STATUS	E2prom status:(0) Not configured or problems during writing process; (1) Configured and OK
IO Board States (Critical to operation and protection)	BOARD F STATUS	Board F status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD G STATUS	Board G status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD H STATUS	Board H status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
	BOARD J STATUS	Board J status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board.
IEC61850 INTERNAL STATES (NON CRITICAL)		

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
IEC61850 Internal States	ICD STATUS	UNKNOWN: when the relay has not the IEC61850 protocol in the relay model the ICD status is unknown to the unit
		ICD ERROR: There is an error in the ICD file and the relay ICD is not operative. To solve this issue it is necessary to send a correct ICD to the relay using the IEC61850 configurator tool. When the ICD error is raised the IEC 61850 will not be operative (the IEC 61850 client, reports and gooses will not work). It is advisable to include the ICD ERROR in the main error signal configured for specific applications.
		MODIFIED: The settings have been changed in the icd but they are still not written in the icd file in the relay
		IN PROGRESS: The icd setting are being written to the file in the relay
		OK WITHOUT DAIS: The relay has not got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file.
		OK: The relay has got the "Use DOI &DAI" setting enabled (true) and it is working properly with the ICD file. When that setting is set to true the icd setting prevails over the relay settings.
OTHER INTERNAL STATES (NON CRITICAL)		
Other internal states	USER MAP STATUS	User map status: (0) Not configured; (1) Configured
	FACTORY CALIBRATION	Calibration status (0) Relay calibrated; (1) Not calibrated
	FLEXCURVE A STATUS	User curve A: (0) Not configured (1) Configured
	FLEXCURVE B STATUS	User curve B: (0) Not configured (1) Configured
	FLEXCURVE C STATUS	User curve C: (0) Not configured (1) Configured
	FLEXCURVE D STATUS	User curve D: (0) Not configured (1) Configured
	Green Zone	Memory internal status
	Yellow Zone	Memory internal status
	Orange Zone	Memory internal status
	Red Zone	Memory internal status
	UpTime	System Time
Auto-check Internal States (Not available)	TIMER STATUS	Real time clock auto-check (not available)
	GRAPHIC STATUS	Graphic display status (not available)
	ALARM TEXT ARRAY	Text display status (not available)

OPERANDS - F650 - MODEL FX - GX

Internal System Status

Note: It is advisable to use the critical alarms to raise an event or to light a warning LED for maintenance purposes. See the example below, the Board X Status depends on the relay model.

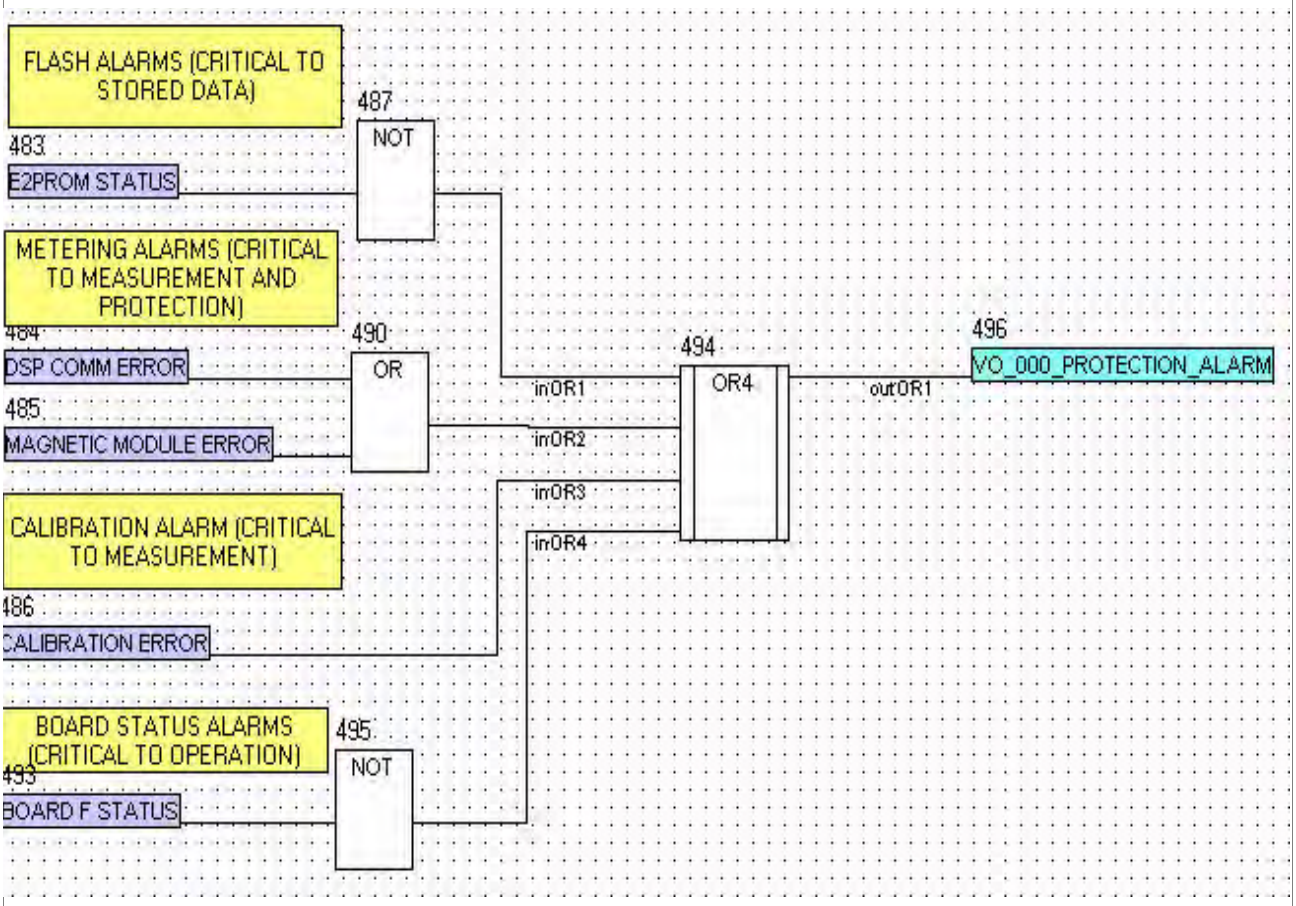


Figure A–1: Protection Alarm Signal

Configurable Logic Outputs (512 elements)	VIRTUAL OUTPUT 000	Configurable logic output 000
	VIRTUAL OUTPUT 001	Configurable logic output 001
	...	...
	VIRTUAL OUTPUT 511	Configurable logic output 511
Operation Bits (24 elements)	OPERATION BIT 1	Operation bit 001: (0) the configured time expires or when success conditions are met;(1) operation 1 is executed and interlocks are fulfilled.
	OPERATION BIT 2	Operation bit 002: (0) the configured time expires or when success conditions are met;(1) operation 2 is executed and interlocks are fulfilled.
	...	...
	OPERATION BIT 24	Operation bit 024: (0) the configured time expires or when success conditions are met;(1) operation 24 is executed and interlocks are fulfilled.

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Control Event Bits (128 elements)	CONTROL EVENT 1	Control Event 1 Activation Bit
	CONTROL EVENT 2	Control Event 2 Activation Bit
	...	...
	CONTROL EVENT 128	Control Event 128 Activation Bit
Latched Virtual Inputs (32 elements)	LATCHED VIRT IP 1	Latched virtual input 1
	LATCHED VIRT IP 2	Latched virtual input 2
	...	...
	LATCHED VIRT IP 32	Latched virtual input 32
Self Reset Virtual Inputs (32 elements)	SELF-RST VIRT IP 1	Self reset virtual input 1
	SELF-RST VIRT IP 2	Self reset virtual input 2
	...	...
	SELF-RST VIRT IP 32	Self reset virtual input 32
Contact Inputs Type 1Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC16	Input 16 (CC16) in Board X
Contact Inputs Type 2 Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC8	Input 8 (CC8) in Board X
	CONT IP_X_CC9 (Va_COIL1)	Contact Input 09 (Va_COIL1) for slot X. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC10 (Vb_COIL1)	Contact Input 10 (Vb_COIL1) for slot X. Input voltage (Vb) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC11 (Va_COIL2)	Contact Input 11 (Va_COIL2) for slot X. Input voltage (Va) detected, Circuit 1. Complete circuit supervised
	CONT IP_X_CC12 (Vb_COIL2)	Contact Input 12 (Vb_COIL2) for slot X. Input voltage (Vb) detected, Circuit 2. Complete circuit supervised
	CONT IP_X_CC13 (O7_SEAL)	Contact Input 13 (07_SEAL) for slot X. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_X_CC14 (O8_SEAL)	Contact Input 14 (08_SEAL) for slot X. Current detected. Contact output associated with current flow > 100 mA latched
	CONT IP_X_CC15 (SUP_COIL1)	Contact Input 15 (SUP_COIL1) for slot X. Output for circuit 1 supervision element
	CONT IP_X_CC16 (SUP_COIL2)	Contact Input 16 (SUP_COIL2) for slot X. Output for circuit 2 supervision element
Contact Inputs Type 4 Board	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC32	Input 32 (CC32) in Board X

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Contact Inputs Type 5 Board (Digital Values)	CONT IP_X_CC1	Input 1 (CC1) in Board X
	CONT IP_X_CC2	Input 2 (CC2) in Board X
	...	...
	CONT IP_X_CC16	Input 16 (CC16) in Board X
Contact Inputs Type 5 Board (Analog Values)	ANALOG_INP_X_01	Analog Input 01 in Board X
	ANALOG_INP_X_02	Analog Input 02 in Board X
	ANALOG_INP_X_03	Analog Input 03 in Board X
	...	...
	ANALOG_INP_X_08	Analog Input 08 in Board X
Contact Outputs Type 1 & 2 Board Activation signals	CONT OP OPER_X_01	Logic signal for Output 1 activation. Board X
	CONT OP OPER_X_02	Logic signal for Output 2 activation. Board X
	...	...
	CONT OP OPER_X_08	Logic signal for Output 8 activation. Board X
Contact Outputs Type 1 & 2 Board Reset signals	CONT RESET_X_01	board X, 01 latched output reset
	CONT RESET_X_02	board X, 02 latched output reset
	...	...
	CONT RESET_X_08	board X, 08 latched output reset
Contact Outputs Type 1 & 2 Board Status	CONT OP_X_01	Contact output 1 Board X operation
	CONT OP_X_02	Contact output 2 Board X operation
	...	...
	CONT OP_X_8	Contact output 8 Board X operation
Board Status	BOARD X STATUS	Board X status: (0) Inactive - There is no communication with the board (1) Active - There is communication with the board
Switchgear status (16 elements)	SWITCH 1 A INPUT	Contact input type A to switchgear Function 1
	SWITCH 1 B INPUT	Contact input type B to switchgear Function 1
	SWITCH 2 A INPUT	Contact input type A to switchgear Function 2
	SWITCH 2 B INPUT	Contact input type B to switchgear Function 2
	...	...
	SWITCH 16 A INPUT	Contact input type A to switchgear Function 16
	SWITCH 16 B INPUT	Contact input type B to switchgear Function 16
Switchgear outputs (16 elements)	SWITCH 1 A STATUS	Contact logic output type A from switchgear Function 1
	SWITCH 1 B STATUS	Contact logic output type B from switchgear Function 1
	SWITCH 2 A STATUS	Contact logic output type A from switchgear Function 2
	SWITCH 2 B STATUS	Contact logic output type B from switchgear Function 2
	...	...
	SWITCH 16 A STATUS	Contact logic output type A from switchgear Function 16
	SWITCH 16 B STATUS	Contact logic output type B from switchgear Function 16

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Switchgear states (16 elements)	SWITCH 1 OPEN	switchgear 1 open
	SWITCH 1 CLOSED	switchgear 1 closed
	SWITCH 1 00_ERROR	Error 00 switchgear 1 (contact A = 0, contact B = 0)
	SWITCH 1 11_ERROR	Error 11 switchgear 1 (contact A = 1, contact B = 1)
	SWITCH 2 OPEN	Switchgear 2 open
	SWITCH 2 CLOSED	Switchgear 2 closed
	SWITCH 2 00_ERROR	Error 00 switchgear 2 (contact A = 0, contact B = 0)
	SWITCH 2 11_ERROR	Error 11 switchgear 2 (contact A = 1, contact B = 1)
	...	...
	SWITCH 16 OPEN	Switchgear 16 open
	SWITCH 16 CLOSED	Switchgear 16 closed
	SWITCH 16 00_ERROR	Error 00 switchgear 16 (contact A = 0, contact B = 0)
	SWITCH 16 11_ERROR	Error 11 switchgear 16 (contact A = 1, contact B = 1)
Switchgear Open-Close Initializing States	SWITCH 1 OPEN INIT	Switchgear 1 opening initiation
	SWITCH 1 CLOSE INIT	Switchgear 1 closing initiation
	SWITCH 2 OPEN INIT	Switchgear 2 opening initiation
	SWITCH 2 CLOSE INIT	Switchgear 2 closing initiation
	...	...
	SWITCH 16 OPEN INIT	Switchgear 16 opening initiation
	SWITCH 16 CLOSE INIT	Switchgear 16 closing initiation
Switchgear Fail States	SWGR 1 FAIL TO OPEN	Failure to open Switchgear 1
	SWGR 2 FAIL TO OPEN	Failure to open Switchgear 2
	...	...
	SWGR 16 FAIL TO OPEN	Failure to open Switchgear 16
	SWGR 1 FAIL TO CLOSE	Failure to close Switchgear 1
	SWGR 2 FAIL TO CLOSE	Failure to close Switchgear 2
	...	...
	SWGR 16 FAIL TO CLOSE	Failure to close Switchgear 16

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
LEDS HMI (16 Elements)	READY LED	Ready LED: (0-Red) Relay out of service, protection OUT OF ORDER (1-Green) Relay in service; protection READY
	LED 1	Programmable LED 1 status: Red color Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 2	Programmable LED 2 status: Red color Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 3	Programmable LED 3 status: Red color Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 4	Programmable LED 4 status: Red color Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 5	Programmable LED 5 status: Red color Latched by hardware. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 6	Programmable LED 6 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 7	Programmable LED 7 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 8	Programmable LED 8 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 9	Programmable LED 9 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 10	Programmable LED 10 status: Orange color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 11	Programmable LED 11 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 12	Programmable LED 12 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 13	Programmable LED 13 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 14	Programmable LED 14 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
	LED 15	Programmable LED 15 status: Green color. Not latched. Latching possibility via PLC. Reset by hardware (ESC) and programmable (LED RESET INPUT)
LEDs reset input (programmable)	LED RESET INPUT	Programmable input for remote LED reset

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
	I Key	I key operation (Programmable signal via PLC)
	O Key	O key operation (Programmable signal via PLC)
Programmable Keypad Status (HMI)	*/F3 Key	*/F3 key operation (Programmable signal via PLC)
	F1 Key	F1 key operation (Programmable signal via PLC)
	F2 Key	F2 key operation (Programmable signal via PLC)
LOCAL/REMOTE Operation status LEDs	LOCAL/REMOTE OPERATION MODE	Local/remote status for operations 1 = Local, 0 = Remote. Selectable through the front pushbutton (Hardware) and also through communications (software).
	OPERATIONS BLOCKED	Operations OFF status (1) Command execution block (operations blocked both in local and remote mode).Selectable through the front pushbutton (Hardware) and also through communications (software).
LOCAL/REMOTE/OFF Selection	CHANGE LOCAL-REMOTE	Changing local-remote status by communications
	CHANGE OP BLOCKED	Operations Block-Unblock signal
HMI Back light	HMI BACKLIGHT ON	"Switching on back light" signal (the display is switched on by communications
	HMI BACKLIGHT OFF	"Switching off back light" signal (the display is switched off by communications
Internal System Status (cont.)		

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Oscillography States	OSC DIG CHANNEL 1	Oscillography Digital channel 1 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 2	Oscillography Digital channel 2 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 3	Oscillography Digital channel 3 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 4	Oscillography Digital channel 4 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 5	Oscillography Digital channel 5 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 6	Oscillography Digital channel 6 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 7	Oscillography Digital channel 7 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 8	Oscillography Digital channel 8 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 9	Oscillography Digital channel 9 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 10	Oscillography Digital channel 10: (1) Active ; (0) Not Active
	OSC DIG CHANNEL 11	Oscillography Digital channel 11 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 12	Oscillography Digital channel 12 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 13	Oscillography Digital channel 13 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 14	Oscillography Digital channel 14 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 15	Oscillography Digital channel 15 : (1) Active ; (0) Not Active
	OSC DIG CHANNEL 16	Oscillography Digital channel 16 : (1) Active ; (0) Not Active
	OSCILLO TRIGGER	Oscillo trigger activation (1) Active ; (0) Not active
Fault Report (Fault locator)	FAULT REPORT TRIGG	Fault report trigger (1) Active ; (0) Not active
	CLEAR FAULT REPORTS	Fault report removal from HMI and ModBus (volatile memory)
Energy Counters	FREEZE ENERGY CNT	Energy counter freeze
	UNFREEZE ENERGY CNT	Energy counter unfreeze
	RESET ENERGY CNT	Energy counter reset
Demand Inputs	DEMAND TRIGGER INP	Demand trigger (for Block interval algorithm)
	DEMAND RESET INP	Demand reset
	GROUP 1 ACT ON	Group 1 activation, and deactivation of groups 2 & 3
	GROUP 2 ACT ON	Group 2 activation, and deactivation of groups 1 & 3
	GROUP 3 ACT ON	Group 3 activation, and deactivation of groups 1 & 2
Setting Groups	SETT GROUPS BLOCK	Group change input blocked
	GROUP 1 BLOCKED	Settings Group 1 blocked
	GROUP 2 BLOCKED	Settings Group 2 blocked
	GROUP 3 BLOCKED	Settings Group 3 blocked

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase IOC High	PH IOC1 HIGH A BLK	Phase instantaneous overcurrent element block Group 1 phase A
	PH IOC1 HIGH B BLK	Phase instantaneous overcurrent element block Group 1 phase B
	PH IOC1 HIGH C BLK	Phase instantaneous overcurrent element block Group 1 phase C
	PH IOC1 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase A
	PH IOC1 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase A
	PH IOC1 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase B
	PH IOC1 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase B
	PH IOC1 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 1 phase C
	PH IOC1 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 phase C
	PH IOC1 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 1 any phase
	PH IOC1 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 1 any phase
	PH IOC2 HIGH A BLK	Phase instantaneous overcurrent element block Group 2 phase A
	PH IOC2 HIGH B BLK	Phase instantaneous overcurrent element block Group 2 phase B
	PH IOC2 HIGH C BLK	Phase instantaneous overcurrent element block Group 2 phase C
	PH IOC2 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase A
	PH IOC2 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase A
	PH IOC2 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase B
	PH IOC2 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase B
	PH IOC2 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 2 phase C
	PH IOC2 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 phase C
	PH IOC2 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 2 any phase
	PH IOC2 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 2 any phase
	PH IOC3 HIGH A BLK	Phase instantaneous overcurrent element block Group 3 phase A
	PH IOC3 HIGH B BLK	Phase instantaneous overcurrent element block Group 3 phase B
OPERANDS - F650 - MODEL FX - GX		

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Internal System Status (cont.)		
Phase IOC High	PH IOC3 HIGH C BLK	Phase instantaneous overcurrent element block Group 3 phase C
	PH IOC3 HIGH A PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase A
	PH IOC3 HIGH A OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase A
	PH IOC3 HIGH B PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase B
	PH IOC3 HIGH B OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase B
	PH IOC3 HIGH C PKP	Phase instantaneous overcurrent element pickup high level Group 3 phase C
	PH IOC3 HIGH C OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 phase C
	PH IOC3 HIGH PKP	Phase instantaneous overcurrent element pickup high level Group 3 any phase
	PH IOC3 HIGH OP	Phase instantaneous overcurrent element operation (trip) high level Group 3 any phase

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase IOC Low	PH IOC1 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 1 phase A
	PH IOC1 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 1 phase B
	PH IOC1 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 1 phase C
	PH IOC1 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase A
	PH IOC1 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase A
	PH IOC1 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase B
	PH IOC1 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase B
	PH IOC1 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 1 phase C
	PH IOC1 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 phase C
	PH IOC1 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 1 any phase
	PH IOC1 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 1 any phase
	PH IOC2 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 2 phase A
	PH IOC2 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 2 phase B
	PH IOC2 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 2 phase C
	PH IOC2 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase A
	PH IOC2 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase A
	PH IOC2 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase B
	PH IOC2 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase B
	PH IOC2 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 2 phase C
	PH IOC2 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 phase C
	PH IOC2 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 2 any phase
	PH IOC2 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 2 any phase
	PH IOC3 LOW A BLK	Phase instantaneous overcurrent element block Low level Group 3 phase A

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase IOC Low	PH IOC3 LOW B BLK	Phase instantaneous overcurrent element block Low level Group 3 phase B
	PH IOC3 LOW C BLK	Phase instantaneous overcurrent element block Low level Group 3 phase C
	PH IOC3 LOW A PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase A
	PH IOC3 LOW A OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase A
	PH IOC3 LOW B PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase B
	PH IOC3 LOW B OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase B
	PH IOC3 LOW C PKP	Phase instantaneous overcurrent element pickup low level Group 3 phase C
	PH IOC3 LOW C OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 phase C
	PH IOC3 LOW PKP	Phase instantaneous overcurrent element pickup low level Group 3 any phase
	PH IOC3 LOW OP	Phase instantaneous overcurrent element operation (trip) low level Group 3 any phase
Neutral IOC	NEUTRAL IOC1 BLOCK	Neutral instantaneous overcurrent element block Group 1
	NEUTRAL IOC1 PKP	Neutral instantaneous overcurrent element pickup Group 1
	NEUTRAL IOC1 OP	Neutral instantaneous overcurrent element operation (trip) Group 1
	NEUTRAL IOC2 BLOCK	Neutral instantaneous overcurrent element block Group 2
	NEUTRAL IOC2 PKP	Neutral instantaneous overcurrent element pickup Group 2
	NEUTRAL IOC2 OP	Neutral instantaneous overcurrent element operation (trip) Group 2
	NEUTRAL IOC3 BLOCK	Neutral instantaneous overcurrent element block Group 3
	NEUTRAL IOC3 PKP	Neutral instantaneous overcurrent element pickup Group 3
	NEUTRAL IOC3 OP	Neutral instantaneous overcurrent element operation (trip) Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Ground IOC	GROUND IOC1 BLOCK	Ground instantaneous overcurrent element block Group 1
	GROUND IOC1 PKP	Ground instantaneous overcurrent element pickup Group 1
	GROUND IOC1 OP	Ground instantaneous overcurrent element operation (trip) Group 1
	GROUND IOC2 BLOCK	Ground instantaneous overcurrent element block Group 2
	GROUND IOC2 PKP	Ground instantaneous overcurrent element pickup Group 2
	GROUND IOC2 OP	Ground instantaneous overcurrent element operation (trip) Group 2
	GROUND IOC3 BLOCK	Ground instantaneous overcurrent element block Group 3
	GROUND IOC3 PKP	Ground instantaneous overcurrent element pickup Group 3
	GROUND IOC3 OP	Ground instantaneous overcurrent element operation (trip) Group 3
Sensitive Ground IOC	SENS GND IOC1 BLK	Sensitive ground instantaneous overcurrent element block Group 1
	SENS GND IOC1 PKP	Sensitive ground instantaneous overcurrent element pickup Group 1
	SENS GND IOC1 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 1
	SENS GND IOC2 BLK	Sensitive ground instantaneous overcurrent element block Group 2
	SENS GND IOC2 PKP	Sensitive ground instantaneous overcurrent element pickup Group 2
	SENS GND IOC2 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 2
	SENS GND IOC3 BLK	Sensitive ground instantaneous overcurrent element block Group 3
	SENS GND IOC3 PKP	Sensitive ground instantaneous overcurrent element pickup Group 3
	SENS GND IOC3 OP	Sensitive ground instantaneous overcurrent element operation (trip) Group 3
Isolated Ground	ISOLATED GND1 BLK	Isolated ground instantaneous overcurrent element block Group 1
	ISOLATED GND1 PKP	Isolated ground instantaneous overcurrent element pickup Group 1
	ISOLATED GND1 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 1
	ISOLATED GND2 BLK	Isolated ground instantaneous overcurrent element block Group 2
	ISOLATED GND2 PKP	Isolated ground instantaneous overcurrent element pickup Group 2
	ISOLATED GND2 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 2
	ISOLATED GND3 BLK	Isolated ground instantaneous overcurrent element block Group 3
	ISOLATED GND3 PKP	Isolated ground instantaneous overcurrent element pickup Group 3
	ISOLATED GND3 OP	Isolated ground instantaneous overcurrent element operation (trip) Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase TOC High	PH TOC1 HIGH A BLK	Phase timed overcurrent element block Group 1 phase A
	PH TOC1 HIGH B BLK	Phase timed overcurrent element block Group 1 phase B
	PH TOC1 HIGH C BLK	Phase timed overcurrent element block Group 1 phase C
	PH TOC1 HIGH A PKP	Phase timed overcurrent element pickup Group 1 phase A
	PH TOC1 HIGH A OP	Phase timed overcurrent element operation (trip) Group 1 phase A
	PH TOC1 HIGH B PKP	Phase timed overcurrent element pickup Group 1 phase B
	PH TOC1 HIGH B OP	Phase timed overcurrent element operation (trip) Group 1 phase B
	PH TOC1 HIGH C PKP	Phase timed overcurrent element pickup Group 1 phase C
	PH TOC1 HIGH C OP	Phase timed overcurrent element operation (trip) Group 1 phase C
	PH TOC1 HIGH PKP	Phase timed overcurrent element pickup Group 1 any phase
	PH TOC1 HIGH OP	Phase timed overcurrent element operation (trip) Group 1 any phase
	PH TOC2 HIGH A BLK	Phase timed overcurrent element block Group 2 phase A
	PH TOC2 HIGH B BLK	Phase timed overcurrent element block Group 2 phase B
	PH TOC2 HIGH C BLK	Phase timed overcurrent element block Group 2 phase C
	PH TOC2 HIGH A PKP	Phase timed overcurrent element pickup Group 2 phase A
	PH TOC2 HIGH A OP	Phase timed overcurrent element operation (trip) Group 2 phase A
	PH TOC2 HIGH B PKP	Phase timed overcurrent element pickup Group 2 phase B
	PH TOC2 HIGH B OP	Phase timed overcurrent element operation (trip) Group 2 phase B
	PH TOC2 HIGH C PKP	Phase timed overcurrent element pickup Group 2 phase C
	PH TOC2 HIGH C OP	Phase timed overcurrent element operation (trip) Group 2 phase C
	PH TOC2 HIGH PKP	Phase timed overcurrent element pickup Group 2 any phase
	PH TOC2 HIGH OP	Phase timed overcurrent element operation (trip) Group 2 any phase
	PH TOC3 HIGH A BLK	Phase timed overcurrent element block Group 3 phase A
	PH TOC3 HIGH B BLK	Phase timed overcurrent element block Group 3 phase B
	PH TOC3 HIGH C BLK	Phase timed overcurrent element block Group 3 phase C

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase TOC High	PH TOC3 HIGH A PKP	Phase timed overcurrent element pickup Group 3 phase A
	PH TOC3 HIGH A OP	Phase timed overcurrent element operation (trip) Group 3 phase A
	PH TOC3 HIGH B PKP	Phase timed overcurrent element pickup Group 3 phase B
	PH TOC3 HIGH B OP	Phase timed overcurrent element operation (trip) Group 3 phase B
	PH TOC3 HIGH C PKP	Phase timed overcurrent element pickup Group 3 phase C
	PH TOC3 HIGH C OP	Phase timed overcurrent element operation (trip) Group 3 phase C
	PH TOC3 HIGH PKP	Phase timed overcurrent element pickup Group 3 any phase
	PH TOC3 HIGH OP	Phase timed overcurrent element operation (trip) Group 3 any phase
Phase TOC Low	PH TOC1 LOW A BLK	Phase timed overcurrent element block Low level Group 1 phase A
	PH TOC1 LOW B BLK	Phase timed overcurrent element block Low level Group 1 phase B
	PH TOC1 LOW C BLK	Phase timed overcurrent element block Low level Group 1 phase C
	PH TOC1 LOW A PKP	Phase timed overcurrent element pickup low level Group 1 phase A
	PH TOC1 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 1 phase A
	PH TOC1 LOW B PKP	Phase timed overcurrent element pickup low level Group 1 phase B
	PH TOC1 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 1 phase B
	PH TOC1 LOW C PKP	Phase timed overcurrent element pickup low level Group 1 phase C
	PH TOC1 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 1 phase C
	PH TOC1 LOW PKP	Phase timed overcurrent element pickup low level Group 1 any phase
	PH TOC1 LOW OP	Phase timed overcurrent element operation (trip) low level Group 1 any phase
	PH TOC2 LOW A BLK	Phase timed overcurrent element block Low level Group 2 phase A
	PH TOC2 LOW B BLK	Phase timed overcurrent element block Low level Group 2 phase B
	PH TOC2 LOW C BLK	Phase timed overcurrent element block Low level Group 2 phase C
	PH TOC2 LOW A PKP	Phase timed overcurrent element pickup low level Group 2 phase A
	PH TOC2 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 2 phase A
	PH TOC2 LOW B PKP	Phase timed overcurrent element pickup low level Group 2 phase B

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase TOC Low	PH TOC2 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 2 phase B
	PH TOC2 LOW C PKP	Phase timed overcurrent element pickup low level Group 2 phase C
	PH TOC2 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 2 phase C
	PH TOC2 LOW PKP	Phase timed overcurrent element pickup low level Group 2 any phase
	PH TOC2 LOW OP	Phase timed overcurrent element operation (trip) low level Group 2 any phase
	PH TOC3 LOW A BLK	Phase timed overcurrent element block Low level Group 3 phase A
	PH TOC3 LOW B BLK	Phase timed overcurrent element block Low level Group 3 phase B
	PH TOC3 LOW C BLK	Phase timed overcurrent element block Low level Group 3 phase C
	PH TOC3 LOW A PKP	Phase timed overcurrent element pickup low level Group 3 phase A
	PH TOC3 LOW A OP	Phase timed overcurrent element operation (trip) low level Group 3 phase A
	PH TOC3 LOW B PKP	Phase timed overcurrent element pickup low level Group 3 phase B
	PH TOC3 LOW B OP	Phase timed overcurrent element operation (trip) low level Group 3 phase B
	PH TOC3 LOW C PKP	Phase timed overcurrent element pickup low level Group 3 phase C
	PH TOC3 LOW C OP	Phase timed overcurrent element operation (trip) low level Group 3 phase C
	PH TOC3 LOW PKP	Phase timed overcurrent element pickup low level Group 3 any phase
	PH TOC3 LOW OP	Phase timed overcurrent element operation (trip) low level Group 3 any phase
Neutral TOC	NEUTRAL TOC1 BLOCK	Neutral timed overcurrent element block Group 1
	NEUTRAL TOC1 PKP	Neutral timed overcurrent element pickup Group 1
	NEUTRAL TOC1 OP	Neutral timed overcurrent element operation (trip) Group 1
	NEUTRAL TOC2 BLOCK	Neutral timed overcurrent element block Group 2
	NEUTRAL TOC2 PKP	Neutral timed overcurrent element pickup Group 2
	NEUTRAL TOC2 OP	Neutral timed overcurrent element operation (trip) Group 2
	NEUTRAL TOC3 BLOCK	Neutral timed overcurrent element block Group 3
	NEUTRAL TOC3 PKP	Neutral timed overcurrent element pickup Group 3
	NEUTRAL TOC3 OP	Neutral timed overcurrent element operation (trip) Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Ground TOC	GROUND TOC1 BLOCK	Ground timed overcurrent element block Group 1
	GROUND TOC1 PKP	Ground timed overcurrent element pickup Group 1
	GROUND TOC1 OP	Ground timed overcurrent element operation (trip) Group 1
	GROUND TOC2 BLOCK	Ground timed overcurrent element block Group 2
	GROUND TOC2 PKP	Ground timed overcurrent element pickup Group 2
	GROUND TOC2 OP	Ground timed overcurrent element operation (trip) Group 2
	GROUND TOC3 BLOCK	Ground timed overcurrent element block Group 3
	GROUND TOC3 PKP	Ground timed overcurrent element pickup Group 3
	GROUND TOC3 OP	Ground timed overcurrent element operation (trip) Group 3
Sensitive Ground TOC	SENS GND TOC1 BLOCK	Sensitive ground timed overcurrent element block Group 1
	SENS GND TOC1 PKP	Sensitive ground timed overcurrent element pickup Group 1
	SENS GND TOC1 OP	Sensitive ground timed overcurrent element operation (trip) Group 1
	SENS GND TOC2 BLOCK	Sensitive ground timed overcurrent element block Group 2
	SENS GND TOC2 PKP	Sensitive ground timed overcurrent element pickup Group 2
	SENS GND TOC2 OP	Sensitive ground timed overcurrent element operation (trip) Group 2
	SENS GND TOC3 BLOCK	Sensitive ground timed overcurrent element block Group 3
	SENS GND TOC3 PKP	Sensitive ground timed overcurrent element pickup Group 3
	SENS GND TOC3 OP	Sensitive ground timed overcurrent element operation (trip) Group 3
Negative Sequence TOC	NEG SEQ TOC1 BLOCK	Negative sequence timed overcurrent element block Group 1
	NEG SEQ TOC1 PKP	Negative sequence timed overcurrent element pickup Group 1
	NEG SEQ TOC1 OP	Negative sequence timed overcurrent element operation Group 1
	NEG SEQ TOC2 BLOCK	Negative sequence timed overcurrent element block Group 2
	NEG SEQ TOC2 PKP	Negative sequence timed overcurrent element pickup Group 2
	NEG SEQ TOC2 OP	Negative sequence timed overcurrent element operation Group 2
	NEG SEQ TOC3 BLOCK	Negative sequence timed overcurrent element block Group 3
	NEG SEQ TOC3 PKP	Negative sequence timed overcurrent element pickup Group 3
	NEG SEQ TOC3 OP	Negative sequence timed overcurrent element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Thermal Image	THERMAL1 BLOCK	Thermal image block Group 1
	THERMAL1 A RST	Thermal image phase A Group 1 element reset
	THERMAL1 B RST	Thermal image phase B Group 1 element reset
	THERMAL1 C RST	Thermal image phase C Group 1 element reset
	THERMAL1 ALARM	Thermal image element alarm any phase Group 1
	THERMAL1 OP	Thermal image element operation any phase Group 1
	THERMAL1 A ALRM	Thermal image element alarm phase A Group 1
	THERMAL1 A OP	Thermal image element operation phase A Group 1
	THERMAL1 B ALRM	Thermal image element alarm phase B Group 1
	THERMAL1 B OP	Thermal image element operation phase B Group 1
	THERMAL1 C ALRM	Thermal image element alarm phase C Group 1
	THERMAL1 C OP	Thermal image element operation phase C Group 1
	THERMAL2 BLOCK	Thermal image block Group 2
	THERMAL2 A RST	Thermal image phase A Group 2 element reset
	THERMAL2 B RST	Thermal image phase B Group 2 element reset
	THERMAL2 C RST	Thermal image phase C Group 2 element reset
	THERMAL2 ALARM	Thermal image element alarm any phase Group 2
	THERMAL2 OP	Thermal image element operation any phase Group 2
	THERMAL2 A ALRM	Thermal image element alarm phase A Group 2
	THERMAL2 A OP	Thermal image element operation phase A Group 2
	THERMAL2 B ALRM	Thermal image element alarm phase B Group 2
	THERMAL2 B OP	Thermal image element operation phase B Group 2
	THERMAL2 C ALRM	Thermal image element alarm phase C Group 2
	THERMAL2 C OP	Thermal image element operation phase C Group 2
	THERMAL3 BLOCK	Thermal image block Group 3
	THERMAL3 A RST	Thermal image phase A Group 3 element reset
	THERMAL3 B RST	Thermal image phase B Group 3 element reset
	THERMAL3 C RST	Thermal image phase C Group 3 element reset
	THERMAL3 ALARM	Thermal image element alarm any phase Group 3
	THERMAL3 OP	Thermal image element operation any phase Group 3
	THERMAL3 A ALRM	Thermal image element alarm phase A Group 3
	THERMAL3 A OP	Thermal image element operation phase A Group 3
	THERMAL3 B ALRM	Thermal image element alarm phase B Group 3
	THERMAL3 B OP	Thermal image element operation phase B Group 3
	THERMAL3 C ALRM	Thermal image element alarm phase C Group 3
	THERMAL3 C OP	Thermal image element operation phase C Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase Directional	PHASE DIR1 BLK INP	Phase directional block Group 1
	PHASE DIR1 BLOCK A	Phase directional element block Group 1 Phase A
	PHASE DIR1 A OP	Phase directional element operation Group 1 Phase A
	PHASE DIR1 BLOCK B	Phase directional element block Group 1 Phase B
	PHASE DIR1 B OP	Phase directional element operation Group 1 Phase B
	PHASE DIR1 BLOCK C	Phase directional element block Group 1 Phase C
	PHASE DIR1 C OP	Phase directional element operation Group 1 Phase C
	PHASE DIR2 BLK INP	Phase directional block Group 2
	PHASE DIR2 BLOCK A	Phase directional element block Group 2 Phase A
	PHASE DIR2 A OP	Phase directional element operation Group 2 Phase A
	PHASE DIR2 BLOCK B	Phase directional element block Group 2 Phase B
	PHASE DIR2 B OP	Phase directional element operation Group 2 Phase B
	PHASE DIR2 BLOCK C	Phase directional element block Group 2 Phase C
	PHASE DIR2 C OP	Phase directional element operation Group 2 Phase C
	PHASE DIR3 BLK INP	Phase directional block Group 3
	PHASE DIR3 BLOCK A	Phase directional element block Group 3 Phase A
	PHASE DIR3 A OP	Phase directional element operation Group 3 Phase A
	PHASE DIR3 BLOCK B	Phase directional element block Group 3 Phase B
	PHASE DIR3 B OP	Phase directional element operation Group 3 Phase B
	PHASE DIR3 BLOCK C	Phase directional element block Group 3 Phase C
	PHASE DIR3 C OP	Phase directional element operation Group 3 Phase C
Neutral Directional	NEUTRAL DIR1 BLK INP	Neutral directional element block input signal Group 1
	NEUTRAL DIR1 BLOCK	Neutral directional element blocked Group 1
	NEUTRAL DIR1 OP	Neutral directional element operation Group 1
	NEUTRAL DIR2 BLK INP	Neutral directional element block input signal Group 2
	NEUTRAL DIR2 BLOCK	Neutral directional element blocked Group 2
	NEUTRAL DIR2 OP	Neutral directional element operation Group 2
	NEUTRAL DIR3 BLK INP	Neutral directional element block input signal Group 3
	NEUTRAL DIR3 BLOCK	Neutral directional element blocked Group 3
	NEUTRAL DIR3 OP	Neutral directional element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Ground Directional	GROUND DIR1 BLK INP	Ground directional element block input signal Group 1
	GROUND DIR1 BLOCK	Ground directional element blocked Group 1
	GROUND DIR1 OP	Ground directional element operation Group 1
	GROUND DIR2 BLK INP	Ground directional element block input signal Group 2
	GROUND DIR2 BLOCK	Ground directional element blocked Group 2
	GROUND DIR2 OP	Ground directional element operation Group 2
	GROUND DIR3 BLK INP	Ground directional element block input signal Group 3
	GROUND DIR3 BLOCK	Ground directional element blocked Group 3
	GROUND DIR3 OP	Ground directional element operation Group 3
Sensitive Ground Directional	SENS GND DIR1 BLK IP	Sensitive ground directional element block input Group 1
	SENS GND DIR1 BLOCK	Sensitive Ground directional element block Group 1
	SENS GND DIR1 OP	Sensitive Ground directional element operation Group 1
	SENS GND DIR2 BLK IP	Sensitive ground directional element block input Group 2
	SENS GND DIR2 BLOCK	Sensitive Ground directional element block Group 2
	SENS GND DIR2 OP	Sensitive Ground directional element operation Group 2
	SENS GND DIR3 BLK IP	Sensitive ground directional element block input Group 3
	SENS GND DIR3 BLOCK	Sensitive Ground directional element block Group 3
	SENS GND DIR3 OP	Sensitive Ground directional element operation Group 3
Fuse failure	VT FUSE FAILURE	Fuse failure operation
Phase UV	PHASE UV1 BLOCK	Phase undervoltage element block Group 1
	PHASE UV1 A PKP	Undervoltage element pickup AG Group 1
	PHASE UV1 A OP	Undervoltage element operation AG Group 1
	PHASE UV1 B PKP	Undervoltage element pickup BG Group 1
	PHASE UV1 B OP	Undervoltage element operation BG Group 1
	PHASE UV1 C PKP	Undervoltage element pickup CG Group 1
	PHASE UV1 C OP	Undervoltage element operation CG Group 1
	PHASE UV1 AB PKP	Undervoltage element pickup AB Group 1
	PHASE UV1 AB OP	Undervoltage element operation AB Group 1
	PHASE UV1 BC PKP	Undervoltage element pickup BC Group 1
	PHASE UV1 BC OP	Undervoltage element operation BC Group 1
	PHASE UV1 CA PKP	Undervoltage element pickup CA Group 1

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase UV	PHASE UV1 CA OP	Undervoltage element operation CA Group 1
	PHASE UV1 PKP	Pickup of any of the above mentioned elements
	PHASE UV1 OP	Operation of any of the above mentioned elements
	PHASE UV2 BLOCK	Phase undervoltage element block Group 2
	PHASE UV2 A PKP	Undervoltage element pickup AG Group 2
	PHASE UV2 A OP	Undervoltage element operation AG Group 2
	PHASE UV2 B PKP	Undervoltage element pickup BG Group 2
	PHASE UV2 B OP	Undervoltage element operation BG Group 2
	PHASE UV2 C PKP	Undervoltage element pickup CG Group 2
	PHASE UV2 C OP	Undervoltage element operation CG Group 2
	PHASE UV2 AB PKP	Undervoltage element pickup AB Group 2
	PHASE UV2 AB OP	Undervoltage element operation AB Group 2
	PHASE UV2 BC PKP	Undervoltage element pickup BC Group 2
	PHASE UV2 BC OP	Undervoltage element operation BC Group 2
	PHASE UV2 CA PKP	Undervoltage element pickup CA Group 2
	PHASE UV2 CA OP	Undervoltage element operation CA Group 2
	PHASE UV2 PKP	Pickup of any of the above mentioned elements
	PHASE UV2 OP	Operation of any of the above mentioned elements
	PHASE UV3 BLOCK	Phase undervoltage element block Group 3
	PHASE UV3 A PKP	Undervoltage element pickup AG Group 3
	PHASE UV3 A OP	Undervoltage element operation AG Group 3
	PHASE UV3 B PKP	Undervoltage element pickup BG Group 3
	PHASE UV3 B OP	Undervoltage element operation BG Group 3
	PHASE UV3 C PKP	Undervoltage element pickup CG Group 3
	PHASE UV3 C OP	Undervoltage element operation CG Group 3
	PHASE UV3 AB PKP	Undervoltage element pickup AB Group 3
	PHASE UV3 AB OP	Undervoltage element operation AB Group 3
	PHASE UV3 BC PKP	Undervoltage element pickup BC Group 3
	PHASE UV3 BC OP	Undervoltage element operation BC Group 3
	PHASE UV3 CA PKP	Undervoltage element pickup CA Group 3
	PHASE UV3 CA OP	Undervoltage element operation CA Group 3
	PHASE UV3 PKP	Pickup of any of the above mentioned elements
	PHASE UV3 OP	Operation of any of the above mentioned elements

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Phase OV	PHASE OV1 BLOCK	Phase overvoltage element block Group 1
	PHASE OV1 AB PKP	Overvoltage element pickup AB Group 1
	PHASE OV1 AB OP	Overvoltage element operation AB Group 1
	PHASE OV1 BC PKP	Overvoltage element pickup BC Group 1
	PHASE OV1 BC OP	Overvoltage element operation BC Group 1
	PHASE OV1 CA PKP	Overvoltage element pickup CA Group 1
	PHASE OV1 CA OP	Overvoltage element operation CA Group 1
	PHASE OV1 PKP	Pickup of any of the above mentioned elements
	PHASE OV1 OP	Operation of any of the above mentioned elements
	PHASE OV2 BLOCK	Phase overvoltage element block Group 2
	PHASE OV2 AB PKP	Overvoltage element pickup AB Group 2
	PHASE OV2 AB OP	Overvoltage element operation AB Group 2
	PHASE OV2 BC PKP	Overvoltage element pickup BC Group 2
	PHASE OV2 BC OP	Overvoltage element operation BC Group 2
	PHASE OV2 CA PKP	Overvoltage element pickup CA Group 2
	PHASE OV2 CA OP	Overvoltage element operation CA Group 2
	PHASE OV2 PKP	Pickup of any of the above mentioned elements
	PHASE OV2 OP	Operation of any of the above mentioned elements
	PHASE OV3 BLOCK	Phase overvoltage element block Group 3
	PHASE OV3 AB PKP	Overvoltage element pickup AB Group 3
	PHASE OV3 AB OP	Overvoltage element operation AB Group 3
	PHASE OV3 BC PKP	Overvoltage element pickup BC Group 3
	PHASE OV3 BC OP	Overvoltage element operation BC Group 3
	PHASE OV3 CA PKP	Overvoltage element pickup CA Group 3
	PHASE OV3 CA OP	Overvoltage element operation CA Group 3
	PHASE OV3 PKP	Pickup of any of the above mentioned elements
	PHASE OV3 OP	Operation of any of the above mentioned elements
Neutral OV High	NEUTRAL OV1 HIGH BLK	Neutral overvoltage element block high level Group 1
	NEUTRAL OV1 HIGH PKP	Neutral overvoltage element pickup high level Group 1
	NEUTRAL OV1 HIGH OP	Neutral overvoltage element operation high level Group 1
	NEUTRAL OV2 HIGH BLK	Neutral overvoltage element block high level Group 2
	NEUTRAL OV2 HIGH PKP	Neutral overvoltage element pickup high level Group 2
	NEUTRAL OV2 HIGH OP	Neutral overvoltage element operation high level Group 2
	NEUTRAL OV3 HIGH BLK	Neutral overvoltage element block high level Group 3
	NEUTRAL OV3 HIGH PKP	Neutral overvoltage element pickup high level Group 3
	NEUTRAL OV3 HIGH OP	Neutral overvoltage element operation high level Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Neutral OV Low	NEUTRAL OV1 LOW BLK	Neutral overvoltage element block low level Group 1
	NEUTRAL OV1 LOW PKP	Neutral overvoltage element pickup low level Group 1
	NEUTRAL OV1 LOW OP	Neutral overvoltage element operation low level Group 1
	NEUTRAL OV2 LOW BLK	Neutral overvoltage element block low level Group 2
	NEUTRAL OV2 LOW PKP	Neutral overvoltage element pickup low level Group 2
	NEUTRAL OV2 LOW OP	Neutral overvoltage element operation low level Group 2
	NEUTRAL OV3 LOW BLK	Neutral overvoltage element block low level Group 3
	NEUTRAL OV3 LOW PKP	Neutral overvoltage element pickup low level Group 3
	NEUTRAL OV3 LOW OP	Neutral overvoltage element operation low level Group 3
Auxiliary UV	AUXILIARY UV1 BLOCK	Auxiliary undervoltage element block Group 1
	AUXILIARY UV1 PKP	Auxiliary undervoltage element pickup Group 1
	AUXILIARY UV1 OP	Auxiliary undervoltage element operation Group 1
	AUXILIARY UV2 BLOCK	Auxiliary undervoltage element block Group 2
	AUXILIARY UV2 PKP	Auxiliary undervoltage element pickup Group 2
	AUXILIARY UV2 OP	Auxiliary undervoltage element operation Group 2
	AUXILIARY UV3 BLOCK	Auxiliary undervoltage element block Group 3
	AUXILIARY UV3 PKP	Auxiliary undervoltage element pickup Group 3
	AUXILIARY UV3 OP	Auxiliary undervoltage element operation Group 3
Auxiliary OV	AUXILIARY OV1 BLOCK	Auxiliary overvoltage element block Group 1
	AUXILIARY OV1 PKP	Auxiliary Overvoltage element pickup Group 1
	AUXILIARY OV1 OP	Auxiliary overvoltage element operation Group 1
	AUXILIARY OV2 BLOCK	Auxiliary overvoltage element block Group 2
	AUXILIARY OV2 PKP	Auxiliary Overvoltage element pickup Group 2
	AUXILIARY OV2 OP	Auxiliary overvoltage element operation Group 2
	AUXILIARY OV3 BLOCK	Auxiliary overvoltage element block Group 3
	AUXILIARY OV3 PKP	Auxiliary Overvoltage element pickup Group 3
	AUXILIARY OV3 OP	Auxiliary overvoltage element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Negative Sequence OV	NEG SEQ OV1 BLOCK	Negative sequence overvoltage element block Group 1
	NEG SEQ OV1 PKP	Negative sequence overvoltage element pickup Group 1
	NEG SEQ OV1 OP	Negative sequence overvoltage element operation Group 1
	NEG SEQ OV2 BLOCK	Negative sequence overvoltage element block Group 2
	NEG SEQ OV2 PKP	Negative sequence overvoltage element pickup Group 2
	NEG SEQ OV2 OP	Negative sequence overvoltage element operation Group 2
	NEG SEQ OV3 BLOCK	Negative sequence overvoltage element block Group 3
	NEG SEQ OV3 PKP	Negative sequence overvoltage element pickup Group 3
	NEG SEQ OV3 OP	Negative sequence overvoltage element operation Group 3
Overfrequency	OVERFREQ1 BLOCK	Overfrequency element block Group 1
	OVERFREQ1 PKP	Overfrequency element pickup Group 1
	OVERFREQ1 OP	Overfrequency element operation Group 1
	OVERFREQ2 BLOCK	Overfrequency element block Group 2
	OVERFREQ2 PKP	Overfrequency element pickup Group 2
	OVERFREQ2 OP	Overfrequency element operation Group 2
	OVERFREQ3 BLOCK	Overfrequency element block Group 3
	OVERFREQ3 PKP	Overfrequency element pickup Group 3
	OVERFREQ3 OP	Overfrequency element operation Group 3
Underfrequency	UNDERFREQ1 BLOCK	Underfrequency element block Group 1
	UNDERFREQ1 PKP	Underfrequency element pickup Group 1
	UNDERFREQ1 OP	Underfrequency element operation Group 1
	UNDERFREQ2 BLOCK	Underfrequency element block Group 2
	UNDERFREQ2 PKP	Underfrequency element pickup Group 2
	UNDERFREQ2 OP	Underfrequency element operation Group 2
	UNDERFREQ3 BLOCK	Underfrequency element block Group 3
	UNDERFREQ3 PKP	Underfrequency element pickup Group 3
	UNDERFREQ3 OP	Underfrequency element operation Group 3
Frequency rate of change	FREQ RATE1 BLOCK	Frequency rate of change element block Group 1
	FREQ RATE1 PKP	Frequency rate of change element pickup Group 1
	FREQ RATE1 OP	Frequency rate of change element operation Group 1
	FREQ RATE2 BLOCK	Frequency rate of change element block Group 2
	FREQ RATE2 PKP	Frequency rate of change element pickup Group 2
	FREQ RATE2 OP	Frequency rate of change element operation Group 2
	FREQ RATE3 BLOCK	Frequency rate of change element block Group 3
	FREQ RATE3 PKP	Frequency rate of change element pickup Group 3
	FREQ RATE3 OP	Frequency rate of change element operation Group 3

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Broken Conductor	BROKEN CONDUCT1 BLK	Broken conductor block Group 1
	BROKEN CONDUCT1 PKP	Broken conductor element Pickup Group 1
	BROKEN CONDUCT1 OP	Broken conductor element operation Group 1
	BROKEN CONDUCT2 BLK	Broken conductor block Group 2
	BROKEN CONDUCT2 PKP	Broken conductor element Pickup Group 2
	BROKEN CONDUCT2 OP	Broken conductor element operation Group 2
	BROKEN CONDUCT3 BLK	Broken conductor block Group 3
	BROKEN CONDUCT3 PKP	Broken conductor element Pickup Group 3
	BROKEN CONDUCT3 OP	Broken conductor element operation Group 3
Forward Power (32FP)	FWD PWR1 BLOCK	Forward power element block Group 1
	FWD PWR1 STG1 PKP	Forward Power element pickup level 1 Group 1
	FWD PWR1 STG1 OP	Forward Power element operation level 1 Group 1
	FWD PWR1 STG2 PKP	Forward Power element pickup level 2 Group 1
	FWD PWR1 STG2 OP	Forward Power element operation level 2 Group 1
	FWD PWR2 BLOCK	Forward power element block Group 2
	FWD PWR2 STG1 PKP	Forward Power element pickup level 1 Group 2
	FWD PWR2 STG1 OP	Forward Power element operation level 1 Group 2
	FWD PWR2 STG2 PKP	Forward Power element pickup level 2 Group 2
	FWD PWR2 STG2 OP	Forward Power element operation level 2 Group 2
	FWD PWR3 BLOCK	Forward power element block Group 3
	FWD PWR3 STG1 PKP	Forward Power element pickup level 1 Group 3
	FWD PWR3 STG1 OP	Forward Power element operation level 1 Group 3
	FWD PWR3 STG2 PKP	Forward Power element pickup level 2 Group 3
	FWD PWR3 STG2 OP	Forward Power element operation level 2 Group 3
	KI2t PHASE A ALARM	$K \cdot I^2t$ phase A Alarm
	KI2t PHASE B ALARM	$K \cdot I^2t$ phase B Alarm
	KI2t PHASE C ALARM	$K \cdot I^2t$ phase C Alarm
Breaker Maintenance	BKR OPENINGS ALARM	Maximum Breaker openings alarm
	BKR OPEN 1 HOUR ALRM	Maximum Breaker openings in one hour alarm
	RESET KI2t COUNTERS	KI^2t Breaker aging counter reset
	RESET BKR COUNTERS	Breaker openings and closings counters reset

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Breaker Status	BREAKER OPEN	Breaker Opened
	BREAKER CLOSED	Breaker closed
	BREAKER UNDEFINED	Breaker undefined (52a and 52b have the same status)
Breaker Failure	BKR FAIL INITIATE	Breaker failure initiation
	BKR FAIL NO CURRENT	Breaker failure without current
	BKR FAIL SUPERVISION	Breaker failure 1st level (supervision – retrip)
	BKR FAIL HISET	Breaker failure 2nd level (high level)
	BKR FAIL LOWSET	Breaker failure 3rd level (low level)
	INTERNAL ARC	Internal arc
	BKR FAIL 2nd STEP	Breaker failure second step
Synchrocheck	Synchrocheck BLK INP	Synchronism element block
	Synchrocheck OP	Synchronsim condition (Dv, Dj and Df are within the set range)
	SYNCHK CLOSE PERM	Closing permission for the synchronism element: (SYNCHK OP) OR (SYNCHK CON OP)
	Synchrocheck COND OP	Active if when it is set, any of the three following conditions is met:
	DL-DB OPERATION	Dead line – dead bus condition
	DL-LB OPERATION	Dead line – live bus condition
	LL-DB OPERATION	Live line – dead bus condition
	SLIP CONDITION	Slip conditions are met
	BUS FREQ > LINE FREQ	Bus Frequency higher than line frequency
	BUS FREQ < LINE FREQ	Bus Frequency lower than line frequency

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Autorecloser	AR LEVEL BLOCK	Recloser element block by level
	AR PULSE BLOCK	Recloser element block by pulse
	AR PULSE UNBLOCK	Recloser element unblock by pulse
	AR INITIATE	Reclose initiate
	AR CONDS INPUT	Reclose permission condition in input to Function 1 = there are conditions
	AR CLOSE BREAKER	Closing permission for the recloser
	AR OUT OF SERVICE	Recloser out of service
	AR READY	Recloser READY
	AR LOCKOUT	Recloser in LOCKOUT
	AR BLOCK	Recloser BLOCKED
	AR RCL IN PROGRESS	Recloser – Cycle in progress
	AR LCK BY ANOMALY	Recloser – LOCKOUT by anomaly (reclosing command during cycle in progress)
	AR LCK BY FAIL OPEN	Recloser – LOCKOUT by failure to open
	AR LCK BY FAIL CLOSE	Recloser – LOCKOUT by failure to close
	AR LCK BY USER	Recloser – LOCKOUT by external operation (e.g.: manual opening with cycle in progress)
	AR LCK BY CONDS	Recloser – LOCKOUT by lack of reclosing conditions
	AR LCK BY TRIPS	Recloser – LOCKOUT by number of trips
	AR LCK BY SHOTS	Recloser – LOCKOUT by number of shots
	AR BLK AFTER 1 SHOT	Recloser – Block after first shot
	AR BLK AFTER 2 SHOT	Recloser – Block after second shot
	AR BLK AFTER 3 SHOT	Recloser – Block after third shot
	AR BLK AFTER 4 SHOT	Recloser – Block after fourth shot
Autorecloser	AR BLOCK BY LEVEL	Recloser – Block by level
	AR BLOCK BY PULSE	Recloser – Block by command (pulse)
Default Channel (not used)	Default Channel	Channel not used

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Directional Power	DIR PWR1 BLOCK	Directional power element block Group 1
	DIR PWR1 STG1 PKP	Directional Power element pickup level 1 Group 1
	DIR PWR1 STG1 OP	Directional Power element operation level 1 Group 1
	DIR PWR1 STG2 PKP	Directional Power element pickup level 2 Group 1
	DIR PWR1 STG2 OP	Directional Power element operation level 2 Group 1
	DIR PWR1 STG PKP	Directional power element pickup Group 1
	DIR PWR1 STG OP	Directional Power element operation Group 1
	DIR PWR2 BLOCK	Directional power element block Group 2
	DIR PWR2 STG1 PKP	Directional Power element pickup level 1 Group 2
	DIR PWR2 STG1 OP	Directional Power element operation level 1 Group 2
	DIR PWR2 STG2 PKP	Directional Power element pickup level 2 Group 2
	DIR PWR2 STG2 OP	Directional Power element operation level 2 Group 2
	DIR PWR2 STG PKP	Directional power element pickup Group 2
	DIR PWR2 STG OP	Directional Power element operation Group 2
	DIR PWR3 BLOCK	Directional power element block Group 3
	DIR PWR3 STG1 PKP	Directional Power element pickup level 1 Group 3
	DIR PWR3 STG1 OP	Directional Power element operation level 1 Group 3
	DIR PWR3 STG2 PKP	Directional Power element pickup level 2 Group 3
	DIR PWR3 STG2 OP	Directional Power element operation level 2 Group 3
	DIR PWR3 STG PKP	Directional power element pickup Group 3
	DIR PWR3 STG OP	Directional Power element operation Group 3
Locked Rotor	LOCKED ROTOR1 BLK	Locked rotor element block Group 1
	LOCKED ROTOR1 PKP	Locked rotor element pickup Group 1
	LOCKED ROTOR1 OP	Locked rotor element operation Group 1
	LOCKED ROTOR2 BLK	Locked rotor element block Group 2
	LOCKED ROTOR2 PKP	Locked rotor element pickup Group 2
	LOCKED ROTOR2 OP	Locked rotor element operation Group 2
	LOCKED ROTOR3 BLK	Locked rotor element block Group 3
	LOCKED ROTOR3 PKP	Locked rotor element pickup Group 3
	LOCKED ROTOR3 OP	Locked rotor element operation Group 3
Pulse Counters	PulseCntr Value 1	Pulse counter element value Group 1
	PulseCntr Value 2	Pulse counter element value Group 2
	...	...
	PulseCntr Value 8	Pulse counter element value Group 8
	PulseCntr Freeze 1	Pulse counter element freeze value Group 1
	PulseCntr Freeze 2	Pulse counter element freeze value Group 2
	...	...
	PulseCntr Freeze 8	Pulse counter element freeze value Group 8
Analog comparators	Analog Level 01	Analog comparator element level Group 1
	Analog Level 02	Analog comparator element level Group 2
	...	...
	Analog Level 20	Analog comparator element level Group 20

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Load Encroachment	LOAD ENCR1 BLK	Load Encroachment element block Group 1
	LOAD ENCR1 PKP	Load Encroachment element pickup Group 1
	LOAD ENCR1 OP	Load Encroachment element operation Group 1
	LOAD ENCR2 BLK	Load Encroachment element block Group 2
	LOAD ENCR2 PKP	Load Encroachment element pickup Group 2
	LOAD ENCR2 OP	Load Encroachment element operation Group 2
	LOAD ENCR3 BLK	Load Encroachment element block Group 3
	LOAD ENCR3 PKP	Load Encroachment element pickup Group 3
	LOAD ENCR3 OP	Load Encroachment element operation Group 3
Wattmetric Ground Fault High (Logic Operands)	32N1 HIGH BLOCK	wattmetric Ground Fault Element Block High Level Group 1
	32N1 HIGH PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) High Level Group 1
	32N1 HIGH OC PKP	wattmetric Ground Fault Element Overcurrent Pickup High Level Group 1
	32N1 HIGH OP	wattmetric Ground Fault Element Operation High Level Group 1
	32N2 HIGH BLOCK	wattmetric Ground Fault Element Block High Level Group 2
	32N2 HIGH PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) High Level Group 2
	32N2 HIGH OC PKP	wattmetric Ground Fault Element Overcurrent Pickup High Level Group 2
	32N2 HIGH OP	wattmetric Ground Fault Element Operation High Level Group 2
	32N3 HIGH BLOCK	wattmetric Ground Fault Element Block High Level Group 3
	32N3 HIGH PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) High Level Group 3
	32N3 HIGH OC PKP	wattmetric Ground Fault Element Overcurrent Pickup High Level Group 3
	32N3 HIGH OP	wattmetric Ground Fault Element Operation High Level Group 3
wattmetric Ground Fault High (Power Measurements)	32N1 HIGH POWER	wattmetric Ground Fault Element High Level Group 1 Power Value (watts)
	32N2 HIGH POWER	wattmetric Ground Fault Element High Level Group 2 Power Value (watts)
	32N3 HIGH POWER	wattmetric Ground Fault Element High Level Group 3 Power Value (watts)

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
wattmetric Ground Fault Low (Logic Operands)	32N1 LOW BLOCK	wattmetric Ground Fault Element Block Low Level Group 1
	32N1 LOW PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Low Level Group 1
	32N1 LOW OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Low Level Group 1
	32N1 LOW OP	wattmetric Ground Fault Element Operation Low Level Group 1
	32N2 LOW BLOCK	wattmetric Ground Fault Element Block Low Level Group 2
	32N2 LOW PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Low Level Group 2
	32N2 LOW OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Low Level Group 2
	32N2 LOW OP	wattmetric Ground Fault Element Operation Low Level Group 2
	32N3 LOW BLOCK	wattmetric Ground Fault Element Block Low Level Group 3
	32N3 LOW PKP	wattmetric Ground Fault Element Global Pickup (current, voltage and power) Low Level Group 3
	32N3 LOW OC PKP	wattmetric Ground Fault Element Overcurrent Pickup Low Level Group 3
	32N3 LOW OP	wattmetric Ground Fault Element Operation Low Level Group 3
wattmetric Ground Fault Low (Power Measurements)	32N1 LOW POWER	wattmetric Ground Fault Element Low Level Group 1 Power Value (watts)
	32N2 LOW POWER	wattmetric Ground Fault Element Low Level Group 2 Power Value (watts)
	32N3 LOW POWER	wattmetric Ground Fault Element Low Level Group 3 Power Value (watts)
Remote Outputs	DNA 1	1 output on. Remote Output DNA 1 Operation (GSSE/GOOSE)
	DNA 2	1 output on. Remote Output DNA 2 Operation (GSSE/GOOSE)
	...	...
	DNA 32	1 output on. Remote Output DNA 32 Operation (GSSE/GOOSE)
	User St 1	1 output on. Remote Output UserSt 1 Operation (GSSE/GOOSE)
	User St 2	1 output on. Remote Output UserSt 2 Operation (GSSE/GOOSE)
	...	...
	User St 64	1 output on. Remote Output UserSt 64 Operation (GSSE/GOOSE)
	Rem GOOSE Dig Out 1	1 output on. Remote Output GOOSE 1 Operation (GOOSE)
	Rem GOOSE Dig Out 2	1 output on. Remote Output GOOSE 2 Operation (GOOSE)
	...	...
	Rem GOOSE Dig Out 32	1 output on. Remote Output GOOSE 32 Operation (GOOSE)

OPERANDS - F650 - MODEL FX - GX		
Internal System Status		
Remote Inputs	Remote Input 1	Flag is set, logic =1
	Remote Input 2	Flag is set, logic =1
	...	...
	Remote Input 32	Flag is set, logic =1
Remote Devices	Remote Device 1	Flag is set, logic =1
	Remote Device 2	Flag is set, logic =1
	...	...
	Remote Device 16	Flag is set, logic =1
GOOSE DIG INPUTS	Rem GOOSE Dig Input 1	Flag is set, logic = 1
	Rem GOOSE Dig Input 2	Flag is set, logic =1
	...	...
	Rem GOOSE Dig Input 32	Flag is set, logic =1
GOOSE Analog Inputs (FLOAT AND INTEGER)	Rem Ana Inp FLOAT 1	Analog Input 1 (Float type)
	Rem Ana Inp FLOAT 2	Analog Input 2 (Float type)
	...	...
	Rem Ana Inp FLOAT 8	Analog Input 8 (Float type)
	Rem Ana Inp INT 1	Analog Input 1 (Integer type)
	Rem Ana Inp INT 2	Analog Input 2 (Integer type)
	...	...
	Rem Ana Inp INT 8	Analog Input 8 (Integer type)

F650 Digital Bay Controller

Appendix B: MODBUS protocol

B.1 Introduction

This section describes the MODBUS memory map and how to read and write data from and to the F650 relay using MODBUS protocol. The MODBUS protocol is an industrial communications protocol based on a master/slave architecture (RTU-Serial) or a client/server architecture (TCP/IP). Refer to http://www.modbus.org/ for more information about this protocol.

A generic memory map has been created, **compatible between versions**, with all possible items that an F650 may have, independent of type or configuration to prevent an existing integration from being affected by version changes. This memory map describes each item including the data type, length, memory position, object version, etc. Moreover, the memory map groups the different objects into subgroups, such as status and settings groups.

Each object has a **unique** memory position for the whole family. Only after reading the objects of a particular relay model, it is possible to elaborate its own MODBUS memory map. This map is only valid for that particular relay and memory version. From one version to another the memory positions of existing objects remain fixed, and new objects are assigned new addresses, which again remain the same for following versions.

View the Memory Map using **EnerVista 650 Setup software**, menu:
View > MODBUS Memory map

B.2 MODBUS F650

B.2.1 Implemented MODBUS functionality

The implemented protocol is standard MODBUS, so any SCADA or PLC can easily communicate with F650 units.

The F650 unit always works as a slave/server, and thus never initiates communication; it is always the master/client (EnerVista 650 Software or PLC, i.e.) that initiates communication.

Only two MODBUS codes are implemented in all firmware versions:

- **Read function 3 (03h) and 4 (04h)**
- **Write function 16 (10h)**

Starting from firmware version 7.50 and above, two custom MODBUS functions have also been implemented:

- **Read function 66 (42h)**
- **Write function 67 (43h)**

The two new custom function codes allow the master/server to read/write settings of protection functions affected by the setting groups. If these MODBUS function codes are used, the master/server has access to read/write protection element settings that belong to any setting group. In contrast, if read function 3 or Write function 4 is used, only protection elements settings in the **active setting group** can be accessed/modified.

B.2.2 Physical layer

MODBUS protocol is independent of hardware. The physical layer may be in different hardware configurations: USB, RS232, RS485, fiber optic or Ethernet.

F650 units incorporate a front USB or RS232 port, and can mount two rear RS485 or fiber optic ports, and a 1mixture of 10/100Base TX and 10/100Base FX ports, depending on the specific order code of each F650 unit. The data flow in any of these configurations is “half-duplex”.

B.2.2.1 Serial layer

The port baud rate and the parity are independent and programmable for each communication port. Any port may be programmed to baud rates of: 1200, 2400, 4800, 9600, 19200, 38400, 57600 or 115200. Parity may be even, odd, or none.

The master must know the slave address with which it is going to communicate. No unit operates after a master request if the message address is not its own, unless the address is 0, which is the broadcast address. In this case the relay operates, but won’t send a reply.

B.2.2.2 B.2.2.2 TCP/IP layer

The rear ethernet or fiber optic ports are used for this connection layer.

The settings for this type of connection are gathered from the Ethernet and MODBUS protocol setpoint menus, where the IP addresses and TCP port are configured, among other settings.

B.2.3 Data link layer

Communication is performed in strings, with data groups sent asynchronously. The master/client transmits a string to the slave/server and the slave/server responds with another string (except for the case of broadcast communication). For the MODBUS serial connection, a timeout or a pause in communication marks the end of a string. The length of this timeout is equal to 3 characters, thus it varies depending on the baud rate.

The following table shows the generic string format, valid for transmission and reception. However, each function has its own particularities, as described later in this manual.

MODBUS FORMAT		
CLIENT ADDRESS [A]	1 byte	Each device in a communications bus must have a unique address to prevent two units from responding at the same time to the same request. All relay ports use this address, which can be programmed to any value between 1 and 254. When the master transmits a string with the slave address 0, this indicates that it is a Broadcast. Every slave in the communication bus performs the requested action, but none of them responds to the master. Broadcast is only accepted for writing since no unit responds.

FUNCTION CODE [B]	1 byte	This is one of the function codes supported by the equipment. The generic function codes are 3 and 4 for reading and 16 for writing. Special read function 66 and write function 67 are available only for firmware version 7.50 or above. When the slave responds with an exception to any of these strings, it places to 1 the most important bit of the corresponding function. For example, an exception to function 3 is indicated with an 83 as function code, and an exception to function 16 or 0x10 in hexadecimal, is indicated with a 0x90.
SETTING GROUP SELECTED [B1]	1byte	This part of string format only applies to read function 66 and write function 67 (fw 7.50 or above).This byte indicates the setting group being read or written. Values should are as follow: 0 [Decimal]→ Setting Group 1 1 [Decimal]→ Setting Group 2 … 5 [Decimal]→ Setting Group 6
DATA [C]	N bytes	This section includes a variable number of bytes, depending on the function code. It may include: addresses, data length, settings, commands or exception codes sent by the client.
CRC [D]	2 bytes	Two-byte control code. ModBus/RTU includes a 16-bit CRC in each string for error detection. If the slave detects a string with errors, based on an incorrect CRC, it neither performs an action, nor responds to the master. The CRC order is LSB-MSB.
TIME OUT	Required time to transmit 3.5 Bytes	A string is finished when nothing is received during a period of 3.5 bytes, with the actual time varying depending on baud rate: 15 ms at 2400 bps 2 ms at 19200 bps 300 µs at 115200 bps etc.

B.2.4 Generic reading

MASTER/CLIENT SLAVE/SERVER

Request

Reading function 3 or 4:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 04 01 09 00 01 XX XX

Data addr. Regs.

Reading function 66:

+[A]+ +[B]+ +[B1]++[C]----------+ +[D]--+

01 42 00 01 09 00 01 XX XX

SG Data addr. Regs.

OK Response

Reading function 3 or 4:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 04 02 00 08 XX XX

Bytes...Data .....

Reading function 66:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 42 02 00 08 XX XX

Bytes...Data .....

Error Response

R
e

ading function 3 or 4:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 84 03 XX XX

Error code.....

Reading function 66:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 C2 03 XX XX

B.2.5 Generic writing

MASTER/CLIENT SLAVE/SERVER

Request

Writing function 16:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 10 00 87 00 02 04 00 0A 01 02 XX XX

Data addr. Regs. Bytes .....Data.....

Writing function 67:

+[A]+ +[B]+ +[B1]++[C]----------+ +[D]--+

01 43 00 09 C1 00 01 02 00 03 XX XX

SG Data addr. Regs. Bytes Data

OK Response

Writing function 16:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 10 00 87 00 02 XX XX

Data Addr…....Regs .....

Writing function 67:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 43 09 C1 00 01 XX XX

Data Addr…....Regs .....

Error Response

Writing function 16:

+[A]+ +[B]+ +[C]----------+ +[D]--+

01 90 07 XX XX

Error code.....

Writing function 67:

+[A]+ +[B]+ +[C]----------+ -+ +[D]--+

01 C3 03 XX XX

B.2.6 Function codes

CODE		MODBUS NAME	F650 DEFINITION	COMMENT
HEX	DEC			
03	3	Read Holding Registers	Reading of any value	These functions allow the master to read one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be read in a single package is 125, equivalent to 250 bytes.
04	4	Read Input Registers	Reading of any value	
42	66	Setting Group Read	Reading of values affected by setting groups	This function allows the master to read any setting/actual value that belongs to any setting groups, active or not, in one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be read in a single package is 125, equivalent to 250 bytes.
10	16	Preset Multiple Registers	Writing	This function allows the master to write one or more registers, representing one or more settings. Registers are 2-byte long values, transmitted with the most important byte first. The maximum number of registers that can be written in a single package is 125, equivalent to 250 bytes.

43	67	Setting Group Write	Writing of values affected by setting	This function allows the master to write any setting that belongs to any setting group, active or not, in one or more consecutive relay addresses. Registers are always 16-bits long, with the most important byte first. The maximum number of registers that can be written in a single package is 125, equivalent to 250 bytes.

B.2.7 Exception and error responses

The following table shows error codes defined in ModBus protocol:

01	ILLEGAL FUNCTION	Slave does not support the function code received.
02	ILLEGAL DATA ADDRESS	Master is using an incorrect address.
03	ILLEGAL DATA VALUE	Slave has detected an invalid value.
04	ILLEGAL RESPONSE LENGTH	Response to the master's request exceeds the maximum size for that function code.
05	ACKNOWLEDGE	Generic acknowledgment.
06	SLAVE DEVICE BUSY	Slave is busy and cannot perform the requested operation.
07	NEGATIVE ACKNOWLEDGE	Negative acknowledgment.

B.3 Data type

TYPE	LENGTH	DESCRIPTIÓN
F1	1	Boolean data type. As it is a bit, for evaluating it we need a memory address and a bit. For example: Value *0x1A41-0001101001000001b* Bit 15 0 Bit 14 0 Bit 13 0 Bit 12 1 Bit 11 1 Bit 10 0 Bit 09 1 Bit 08 0 Bit 07 0 Bit 06 1 Bit 05 0 Bit 04 0 Bit 03 0 Bit 02 0 Bit 01 0 Bit 00 1
F2	2	Integer with 4 bytes sign. Must be scaled, by multiplying the sent value by 1000, or dividing the received value by 1000. For example, if a value of 34509 is received, the converted value is 34.509. To write the value 334, the value 334000 is sent. This prevents the loss of accuracy involved in using float values. Example: 12312d=0x00003018. Real Value = 12312/1000=12.312
F3	2	4-byte Floating Example: 1240.556 = 0x449B11CB
F4	1	Integer with 2 bytes sign. Example: 123 = 0x007B
F5	2	Integer without 4 bytes sign. Example: 12312 = 0x00003018
F6	4	8 bytes Float Example: 123.324 = 0x405ED4BC6A7EF9DB

F7	1	Characters without sign. As it needs to be sent in a register, i.e. in two bytes, the character goes below. *Example: 'β' = 0x00E1*
F8	1	Characters with sign As it needs to be sent in a register, i.e. in two bytes, the character goes below. Example: 'A' = 0x0041
F9	16	String. Chain of characters with a fixed length (32 bytes). The end of the string is marked with "\0". Example: "ABC" = 0x41x42x43x00....
F10	1	This is a 16-bit integer without sign. Each value that can be taken by this integer has a correspondence in the database Auxiliary Table. In this table we can find the corresponding chain, which must be shown for each value. In memory, only an integer value is received. Example: 0, 1Correspond to CLOSE, OPEN
F11	3	Milliseconds passed since January/1/2000 at 00:00:00.000.
F12	1	Unsigned int 16 bit (enumerated), example: In MODBUS address Ox0EBE is the FAULT TYPE 0=GROUND 1=PHASE 2=3 PH 3=AG 4=ABG 5=AB 6=BG 7=BCG 8=BC 9=CG 10=CAG 11=CA 12=NAF

B.4 MODBUS data

B.4.1 Data management

The data managed in ModBus differs in size and functionality. Depending on the functionality and importance of certain data, the use of ModBus is optimized in time for real time processes, as in the case of events.

Although some configuration settings, such as GRAPHIC, PLC equations, TEXTS, and ALARM and LED configuration can be read and written using ModBus protocol, formats are not shown because they are subject to change. Use the EnerVista 650 Setup program to manage and format configuration settings.

B.4.2 Writing settings

The process for changing protection functionality usually involves the modification of a group of settings that belong to a particular protection function. This guarantees protection functionality and offers versatility for possible legacy programs.

Writing settings must be performed in two consecutive steps: Writing and Confirmation.

In order to perform this process, the MODBUS master must write the selected settings and then confirm the operation by writing a register in the last position of this group. For safety reasons, there is a set time window within which the confirm settings modification must be completed. The time window between the last settings being written to confirmation cannot exceed 15 seconds.

B.4.3 Snapshot events

In the F650, the NEW EVENTS concept has been extended, providing additional functionality. These are the events created after the last request.

Firmware version 1.60 adds a new way of reading snapshot events in binary format. Before this version, the relay sent information only in ASCII format. The snapshot event retrieval is similar to the ASCII.

SNAPSHOT EVENT READING IN ASCII FORMAT

1. **Write a message to the '0xfe00' address,** including the file name to open:

   "EVE .TXT": to read all events.

   "NEW_EVE.TXT": to read events created from the last request of this same file.

   "EVE0234 .TXT ": to read events starting, for example, from event number 234.

2. **Subsequent messages read the 0xff00 address**, in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data bytes sent, and 244 data bytes). If the number of data bytes sent is lower than 244, this indicates that it is the last message.

   If during this process there is an error response, the request can be repeated in address 0xff02 reading 246 bytes (2 bytes that indicate the number of bytes sent, and 244 data bytes).

   In the second step, many BUSY responses may be produced, because an ASCII file is being created internally.

SNAPSHOT EVENT READING IN BINARY FORMAT:

1. **Write a message to the '0xfe00' address,** including the file name to open:

   "EVE .BIN": to read all events.

   "NEW_EVE.BIN": to read events created from the last request of this same file.

   "EVE0234 .BIN ": to read events starting, for example, from event number 234.

2. **Subsequent messages read the 0xff00 address**, in blocks of 250 bytes (4 bytes that indicate the point value to the file, 2 bytes that indicate the number of data bytes sent, and 244 data bytes). If the number of data bytes sent is lower than 244, this indicates that it is the last message.

   If during this process there is an error response, the request can be repeated in address 0xff02 reading 246 bytes (2 bytes that indicate the number of bytes sent, and 244 data bytes).

Each Snapshot event includes:

1st byte: event format code.

N bytes: Event information structured depending on the code

There is only one format type with code 0. Its structure is as follows:

- UINT16: event handle.
- 8 bytes: event date and time.
- 29 bytes: event cause. (string end in null).
- UINT32: Phasor Ia (scaled to 1000).
- UINT32: Phasor Ib (scaled to 1000).
- UINT32: Phasor Ic (scaled to 1000).
- UINT32: Line Frequency (scaled to 1000).
- UINT32: Phasor Ig (scaled to 1000).
- UINT32: Phasor Isg (scaled to 1000).
- UINT32: Zero seq I0 (scaled to 1000).
- UINT32: Positive seq I1 (scaled to 1000).
- UINT32: Negative seq I2 (scaled to 1000).
- UINT32: Phasor Van (scaled to 1000).
- UINT32: Phasor Vbn (scaled to 1000).
- UINT32: Phasor Vcn (scaled to 1000).
- UINT32: Positive Seq V1 (scaled to 1000).
- UINT32: Negative Seq V2 (scaled to 1000).
- UINT32: Zero Seq V0 (scaled to 1000).

- UINT32: 3 Phase Power Factor (scaled to 1000).

Example:

1st step:

[0xFE 0x10 0xFE 0x00 0x00 0x06 0x0C 0x4E 0x45 0x57 0x5F 0x45 0x56 0x45 0x2E 0x54 0x58 0x54 0x00 0x16 0xB0] **--------> RELAY**

PC <--------- [0xFE 0x10 0xFE 0x00 0x00 0x06 0x65 0xEC]

2nd step:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

The relay responds with “SLAVE DEVICE BUSY”:

PC <--------- 0xFE 0x83 0x06 0xF1 0x02]

The request is repeated:

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **--------> RELAY**

Now the relay sends the events format:

[A] Position within file (Unsigned 32 bits)

[B] Block size (Unsigned 16 bits)

PC ←--------- [0xFE 0x03 0xFA 0x00 0x00 0x00 0x00 0x00 0xF4 0x46 0x4F 0x52 0x4D 0x41

.....[A]..... .....[B]..... F O R M A

0x54 0x2C 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30

T , E V E N T _ F 6 5 0 _ V 0

0x30 0x2C 0x45 0x76 0x65 0x6E 0x74 0x20 0x4E 0x75 0x6D 0x2C 0x44 0x61 0x74

0 , E v e n t N u m , D a t

0x65 0x2F 0x54 0x69 0x6D 0x65 0x3C 0x48 0x65 0x78 0x3E 0x2C 0x43 0x61 0x75

e / T i m e . . . etc . . .

0x73 0x65 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x61 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x62 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x63 0x2C 0x4C 0x69 0x6E 0x65 0x20 0x46 0x72 0x65 0x71 0x75 0x65 0x6E 0x63 0x79 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x67 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x49 0x73 0x67 0x2C 0x5A 0x65 0x72 0x6F 0x20 0x73 0x65 0x71 0x20 0x49 0x30 0x2C 0x50 0x6F 0x73 0x69 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x49 0x31 0x2C 0x4E 0x65 0x67 0x61 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x49 0x32 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x61 0x6E 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x62 0x6E 0x2C 0x50 0x68 0x61 0x73 0x6F 0x72 0x20 0x56 0x63 0x6E 0x2C 0x50 0x6F 0x73 0x69 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x56 0x31 0x2C 0x4E 0x65 0x67 0x61 0x74 0x69 0x76 0x65 0x20 0x53 0x65 0x71 0x20 0x56 0x32 0x2C 0x5A 0x65 0x72 0x6F 0x20 0x53 0x65 0x71 0x20 0x56 0x30 0x2C 0x33 0x20 0x50 0x68 0x4C 0xF3]

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **---------> RELAY**

PC <--------- [0xFE 0x03 0xFA 0x00 0x00 0x00 0xF4 0x00 0xF4 0x61 0x73 0x65 0x20 0x50 0x6F

0x77 0x65 0x72 0x20 0x46 0x61 0x63 0x74 0x6F 0x72 0x0D 0x0A

CR LF (here the format ends)

0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x35 0x36 0x35

E V E N T _ F 6 5 0 _ V 0 0 , 5 6 5

0 x37 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x66 0x63 0x39 0x38 0x66

7 , 0 0 0 0 0 0 1 6 f 3 9 8 f

0x34 0x33 0x39 0x2C 0x4C 0x6F 0x63 0x61 0x6C 0x20 0x6D 0x6F 0x64 0x65 0x2C

4 3 9 , l o c a l m o d e ,

0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30

....

0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A

CR LF (a line ends)

0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x35 0x36 0x35 0x38 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x66 0x63 0x39 0x38 0x66 0x34 0x33 0x39 0x2C 0x28 0x31 0x29 0x56 0x69 0x72 0x74 0x75 0x61 0x6C 0x20 0x4F 0x75 0x74 0x38 0x39 0x36 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x34 0x24]

[0xFE 0x03 0xFF 0x00 0x00 0x7D 0xA1 0xF0] **---------> RELAY**

PC <---------[0xFE 0x03 0xFA 0x00 0x00 0x01 0xE8 0x00 0x47 0x30 0x0047 **=> last string**

0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A

CR LF (a line ends)

0x00 0x00 0x30 0x0D 0x0A 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0x5F 0x56 0x30 0x30 0x2C 0x33 0x30 0x39 0x38 0x2C 0x30 0x30 0x30 0x30 0x30 0x30 0x31 0x36 0x65 0x62 0x61 0x33 0x33 0x62 0x62 0x38 0x2C 0x43 0x6F 0x6E 0x74 0x61 0x63 0x74 0x20 0x4F 0x75 0x74 0x70 0x75 0x74 0x5F 0x30 0x30 0x5F 0x30 0x30 0x20 0x4F 0x4E 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x32 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x30 0x2E 0x30 0x30 0x31 0x2C 0x30 0x2E 0x30 0x30 0x30 0x2C 0x31 0x2E 0x30 0x30 0x30 0x0D 0x0A 0x45 0x56 0x45 0x4E 0x54 0x5F 0x46 0x36 0x35 0x30 0xDB 0xB4]

B.4.4 Operations

To execute an operation, write the bit corresponding to that operation. For this purpose, there are two memory records with bits representing operations. These records are 0xAFFE and 0xAFFF.

Each operation is assigned one bit in the register:

Operation 1: bit 0 '0xaffe'

Operation 2: bit 1'0xaffe'

...

Operation 16: bit 15'0xaffe'

Operation 17: bit 0'0xafff'

...

Operation 24: bit 7'0xafff'

The register format is Big Endian; this means that the first byte arriving is the one with more weight. Operations commands are affected depending on the physical communication channel they use: serial port, ethernet ports, mmi, etc.

Refer to section 4.2.3.2 Command push button on page 4–73.

The operations channels are:

0 - MMI

1 - OPER REMOTE

2 - COM 1- COMMUNICATION

3 - COM 2- COMMUNICATION

4 - RED 1- COMMUNICATION

5 - RED 2- COMMUNICATION

6 - RED 3- COMMUNICATION

7 - RED 4- COMMUNICATION

Example, operation 1 is going to perform:

[0xFE 0x10 0xAF 0xFE 0x00 0x01 0x02 0x00 0x01 0x68 0xB0] **---------> RELAY**

PC <--------- [0xFE 0x10 0xAF 0xFE 0x00 0x01 0x55 0x22] **(ACK (acknowledge) the operation)**

B.4.5 Force outputs of IO boards

To ease and test IO boards' outputs physical wiring, each IO boards' contact outputs can be forced to actuate with this MODBUS command. Proceed as with a file access (open, write, and close).

For example, to write to a mixed board (16 inputs and 8 outputs):

1 - OPEN OUTPUT FILE: write to 0xFE20, 3 registers with the name **OUTPUT**

2 - WRITE TO FILE: write to 0xFF20, 5 REGISTERS, the first one is the board slot (F=0, G=1, H=2, J=3 and so on) and the restraint ones are the bytes of bits (bits are grouped byte to byte).

3 - CLOSE OUTPUT FILE: write msg to 0xFE 28 of 3 registers with the name **OUTPUT**

Example, activate the two lower relays to board ‘0’:

1 Open:

[0xFE 0x10 0xFE 0x20 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0xA8 0x42] **---------> RELAY**

O U T P U T

PC <---------[0xFE 0x10 0xFE 0x20 0x00 0x03 0xA4 0x25]

2 Write:

[0xFE 0x10 0xFF 0x20 0x00 0x05 0x0A 0x00 0x00 0x03 0x00 0x00 0x00 0x00 0x00 0x00 0x00

0x0000 0x03

0xAE 0x8D] **---------> RELAY**

PC <--------- [0xFE 0x10 0xFF 0x20 0x00 0x05 0x25 0xDB]

3 Close:

[0xFE 0x10 0xFE 0x28 0x00 0x03 0x06 0x4F 0x55 0x54 0x50 0x55 0x54 0x29 0xA8] ---------> RELAY

PC <--------- [0xFE 0x10 0xFE 0x28 0x00 0x03 0x25 0xE7]

B.4.6 Control events

This section explains control events, not to be confused with the snapshot events. A control event is the value change from 0 to 1 or from 1 to 0 of one bit, and is associated with a time label showing when the change occurred.

In the F650, any status or combination of status may generate an event. The F650 has **192 control events** available. The first **128 control events** are user-configurable through a table from the EnerVista 650 Setup menu: **Setpoint > Relay configuration**. The remaining **64 control events** are associated with the 16 possible switchgear, each one generating 4 status bits:

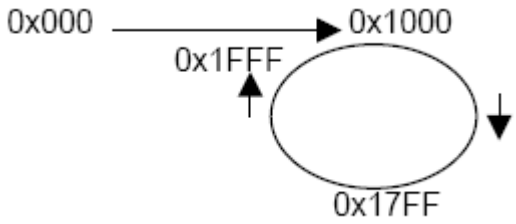
- **Open (52B ON, 52A OFF)**
- **Close (52A ON, 52B OFF)**
- **Error 00 (52A&52B OFF)**
- **Error 11 (52A&52B ON)**

Internally the events buffer is a circular FIFO of 255 events. The addresses for managing this FIFO are:

- **0x03FF:** Number of the next event
- **0xFCFF:** Access to the oldest event
- **0xFD00 to 0xFDFF:** Access to any stored event (circular queue)

The address **0x03FF** stores the number of the next event. For example, if the number 7677 is stored, the last event stored is number 7676. This value is initially 0, and it is increases from 0 to 2^12 + 1 carry bit as events are generated.

The carry bit indicates whether the F650 has been started, since when the relay starts, whether due to lack of power supply or a configuration change, the carry bit is set to 0. When events are generated, the event number is increased up to a maximum value of 0x1FFF; in the next event the number is 0x1000, thus the carry bit is always 1, until the F650 is restarted. This is shown in the following figure:



B.4.6.1 Event structure

Each event has 14 bytes, with the following format:

- Short (2 bytes): event number (0 - 2^12 + carry bit)
- Short (2 bytes): event bit number (from 0 to 191).
- Short (2 bytes): the 0 bit indicates the event value (0 or 1) and the 15 bit indicates whether this is a valid event (all events are initially set to 0)
- Double unsigned (8 bytes): milliseconds from 1 January 2000

The 0xFCFF address is useful when reading all the available events in the F650, as is done following a master start up.

WARNING! Unlike a standard ModBus address, these addresses consist of 14 bytes each one, instead of the 2 used in ModBus. This way, each event, which has a structure of 14 bytes, is contained in one address, as shown on the table below:

0xFD00	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte
.....														
0xFDFF	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte	1byte

For example, the events buffer could contain the following information:

Circular queue

Event Number	7424	7425	.....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

105 registers: 15 events * 7 registers.

NOTE: In this example the 0x03FF address has event number 7677 because 7676 was the last event number used.

B.4.6.2 Event collection process

ALL EVENTS

When reading all events, there are two possible approaches:

First option: start from the oldest event, in address 0xFCFF, and read the events 15 by 15. The initial request frame sent to the relay is as follows:

[0xFE 0x03 **0xFC 0xFF** **0x00 0x69** 0x91 0x8B] ---------> RELAY

105 registers: 15 events * 7 registers.

Address request of all the events

Within this frame the buffer pointer is set to the oldest event, or number 7421 in the example. 15 events are returned, ending with number 7435.

In order to read the following 15 events, numbered from 7436 to 7450, calculate the initial address and send another request frame:

Hex(7436)=	0x1D0C
0x1D0C AND 0x00FF=	0xOC
0xFD00+0x0C=	0xFD0C: **initial address**

[0xFE 0x03 **0xFD 0x0C** 0x00 0x69 0x60 0x44] **---------> RELAY**

Either continue until the relay responds with a 0 event, or stop at the last recorded event by reading the number of the next upcoming event from address 0x03FF and comparing against the last event read.

Second option: read the circular event queue directly, from address 0xFD00 to 0xFDFF, and then rearrange the retrieved events by event number.

Once all events have been read, subsequent queries should only request new events.

NEW EVENTS

The 0x03FF address contains the number of the next event to be written. Based on this, the number of events recorded since the last query can be determined.For example, if the relay indicates that the next event to be generated is number 7677 and events up to number 7674 have already been read, there are two new events. A frame must be sent to read the two new events, 7675 and 7676, and the corresponding 28 bytes.

Circular queue

Event Number	7424	7425	.....	7675	7676	7421	7422	7423
Address	0xFD00	0xFD01		0xFDFB	0xFDFC	0xFDFD	0xFDFE	0xFDFF

NOTE: In this example the 0x03FF address has event number 7677 because 7676 was the last event number used.

Hex(7675)=0x1DFB

0x1DFB AND 0xFF=0xFB

0xFD00+0xFB=0xFDFB: **reading address (*)**

[0xFE 0x03 **0xFD 0xFB 0x00 0x0E** 0x90 0x5C] **---------> RELAY**

B.4.6.3 Control events from the command line

Starting EnerVista 650 Setup from the command line allows the transfer of control events to a file. For this purpose, we need to indicate the event number from which event controls are to be retrieved, and the file where they are to be stored.

Communication can be established via serial communication by specifying the port and access baud rate, or via Ethernet through the IP address and communication port. The relay number from which events are to be retrieved must also be indicated.

For executing this Operation, 6 parameters must be written, for both cases, serial communication or Ethernet.

SERIAL COMUNICATION

EnerVista 650 Setup –e event number "File name" –com port: baud_rate relay_number

E.g.: EnerVista 650 Setup –e 6 “C:\GE Power Management\EnerVista 650 Setup\files\Events\eventos.txt” –com 1:19200 254

ETHERNET COMMUNICATION

EnerVista 650 Setup –e event number "File name" –ip “IP address”: port relay_number

E.g.: EnerVista 650 Setup –e 6 “C:\GE Power Management\EnerVista 650 Setup\files\Events \eventos.txt” –ip 192.168.37.240:502 254

The created file format looks as follows:

#Event Number, Event Id,Event Text,Event Data Time,Event Value(0,1)#

6,1,Local,09-Sep-2003 17:42:40.782,1

7,1,Local,09-Sep-2003 17:42:43.236,0

8,2,Remote,09-Sep-2003 17:42:43.236,1

B.4.6.4 Event status request (alarms)

To retrieve events that have been configured as alarms, see the following addresses:

0xF000: 24 registers, the first 12 indicate the status active/inactive and the last 12 indicate the status of acknowledged/not acknowledged.

0xF018: 12 event alarm status (active - not active, acknowledged – not acknowledged) registers.

0xF024: date and hour of the event bits starts (groups of 16 dates and hour must be asked for).

To obtain an instantaneous snapshot of all events and alarms states, do the following:

1. Read the head of events FIFO (0x03FF).
2. Read the addresses above.
3. Finally, read the head again to confirm that it has not changed. If it had changed, restart the procedure.

NOTE: The message must request the address and the quantity of bytes indicated in each zone. If another quantity is needed, it will not respond with the requested data.

B.4.6.5 Acknowledging alarms

For acknowledging the alarms we must simply write message to the 0xf324 address with 12 data registers. Each bit means an event, if we want to acknowledge an alarm, its corresponding bit must be set to ‘1’ (in order within the 192 bits).

NOTE: it must be borne in mind the independence of the acknowledgment condition, for its reading and its change, depending on the communication channel

There are 6 channels:

LOCAL: by MMI or COM-2 (front and rear accessible).

REMOTE: by COM-1

NET 1: nowadays by any net communication

NET 2: (it does not exist in version 1.4x and lower)

NET 3: (it does not exist in version 1.4x and lower)

NET 4: (it does not exist in version 1.4x and lower)

B.4.7 Write virtual inputs

For forcing Virtual Inputs, a message with 4 indivisible records must be written at address 0xF430, so that each bit corresponds to a Virtual Input. Values are not correct if the first 4 records are not written in the same message. The first 32 are LATCHED (internally stored in flash memory), and the last 32 are SELF-RST (activated to 1 and deactivated in the next pass by the PLC).

For reading the status of Virtual Inputs, it is necessary to start with address 0x0083(bit 0x004) up to 0x0087 (bit 0x0200).

B.4.8 User map

F650 units incorporate a powerful feature called ModBus User Map, that allows to read 256 non-consecutive data records (settings and statuses). It is often required for a master computer to interrogate repeatedly several connected slave relays. If those values are dispersed along the memory map, reading them may require several petitions, and this may cause a communications overload. The User Map can be programmed to get several memory addresses together in a block of consecutive addresses of the User Map, so that they can be accessible with a single reading operation.

The User Map has two sections:

A record index area (addresses 0x3384 to 0x3483), containing 256 statuses and/or setting record addresses.

A record area (addresses 0xF330 to 0xF42F), containing the values for addresses indicated in the index area.

Data records that are separated in the rest of the memory map can be remapped to an address of an adjacent record in the User Map area. For programming the map this way, addresses for the required records must be written in the index area. This avoids the need for several reading operations, thus improving data transmission yield.

For instance, if Contact Outputs from Board F (address 0x008B) and Board G (address 0x00B0) values are required, these addresses must be mapped as follows:

In address 0x3384, write 0x008B.

In address 0x3385 XXX write 0x00B0.

The reading of records 0xF330 and 0xF331, applying the corresponding bit masks, provides the required information about the two boards Contact Outputs.

NOTE: Only single data can be set in the map, i.e. data that are in the memory map and can be read. This feature is not valid for events, waveform records, etc. that are not located in a map address.

B.4.9 Retrieve oscillography

For firmware versions below 7.xx, in case of not using the quickest download method by TFTP, ModBus can be used for downloading oscillography, in the same way that events (snap-shots). First of all, open file with writing message in 0xfe40, where desired file to open is indicated, it can be:

OSC01.DAT (COMTRADE data file in binary)

OSC02.CFG (COMTRADE configuration file)

OSC01.HDR (COMTRADE header file)

OSC02.DAT

OSC02.HDR

...

For reading the oscillography in several strings, several reading requests must be sent to 0xff40 address. For reading the previous message a reading petition must be sent to 0xff42 address. The maximum number of bytes to be read in each part is 244.

Note: For firmware versions 7.xx and above, this feature is not available.

B.4.10 Time synchronization

Time synchronization consists of setting the relay date and time.

This is similar to other settings group entries, with some unique characteristics:

- The data type is specific to time.
- Once the data is changed, varies with time, it is a changing setting that can be read.
- It shares the time change with IRIG-B (this has more priority) and with a possible modification from MMI or another protocols.
- When the relay is disconnected from its auxiliary power supply for extended periods (days) the time remains in a chip, fed by a capacitor (it does not need maintenance).
- And last, there are synchronism between the real time chip and the microprocessor time.

Time synchronization is made by a reading message over 0xfff0 address, either with the address of a single relay, if a writing confirmation is desired, or in broadcast, to synchronize several relays simultaneously.

Date/time format is stored in 4 MODBUS registers (8 bytes, Big Endian format), which indicates elapsed milliseconds from the 1st of January 2000 at 00:00:00.000.

Reading example:

[0xFE 0x03 0xFF 0xF0 0x00 0x04 0x60 0x21] **---------> RELAY**

PC <---------- [0xFE 0x03 0x08 0x00 0x00 0x00 0x17 0x05 0xFA 0xD5 0xBA 0x2D 0x1D]

Synchronism example:

[0xFE 0x10 0xFF 0xF0 0x00 0x04 0x08 0x00 0x00 0x00 0x17 0x9B 0x53 0x3F 0x60 0xA4 0x2B] **---------> RELAY**

PC <---------- [0xFE 0x10 0xFF 0xF0 0x00 0x04 0xE5 0xE2]

B.4.11 Queuing messages

In ModBus protocol, as in other protocols, exists an internal procedure in message reception and transmission.

When a relay gets a string, determined by a silence of 3 or 4 characters, it is queued in a FIFO queue, for a later processing in its own protocol. When the protocol is free of execution, it searches in the queue for strings to respond of the FIFO. If there is such string, it processes it and then it is responded.

Several criteria have been adopted for real time operation:

- Each reading or writing is answered as soon as possible.
- This implies that when settings are changed and answered, a writing request recognition is indicated and then, the modification of internal settings is performed, and finally, after confirmation is sent, settings are stored in a non-volatile memory device.

NOTE: As the relay is internally a modular system, it is possible that the response of some processes is slower than what is expected by the external program, considering the message as missed and sending again another request. If so, there will be 2 queued messages and therefore, 2 message responses. For this reason, response message 'ACK' must be verified with its request, and special attention must be paid to setting confirmation writings, especially with reference to time-out. EnerVista 650 Setup software is recommended to do the configuration modifications, as this software takes into account all these details.

B.4.12 Traces and troubleshooting

The tracer is a debugging tool to view the strings in any writing or reading process in ModBus. This tracer is activated in the menu from EnerVista 650 Setup: **View, Traces**.

With this option enabled, request and response strings are shown. If, for instance, the request and response strings view is desired, between F650 and the relay, do the following:

1 - Activate traces, from **View > Traces**, and a new window opens at the bottom of the main window.

2 - Open the general settings menu: **Setpoint > System Setup > General Settings**

The screen displays the group settings, and on the left side bottom the relay read request is shown:

<0001><06/18/03 12:14:15>[0xFE 0x03 0x21 0x8A 0x00 0x16 0xFB 0xDD]

On the right the settings response is shown:

0001><06/18/03 12:14:15>[0xFE 0x03 0x2C 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x3F 0x80 0x00 0x00 0x00 0x00 0x42 0xC8 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x01 0x00 0xFE 0x00 0xFE 0x00 0x06 0x00 0x06 0x00 0x00 0x01 0xF6 0xAC 0xB5]

This way, any request or mechanism to obtain information from the relay can be viewed string by string.

There is another tool for tracing the relay memory: in the EnerVista 650 Setup menu: **Communication > Troubleshooting**, any read of any address can be requested, and the PC forms the request string together with the check-sum register.

B.4.13 MODBUS CRC generation function

This section describes the C programming language implementation to calculate the CRC of the message string check in ModBus, in a Big-Endian format.

The implemented function in the F650 called here fn_035c_cr16 returns an unsigned 16 bit type (2 bytes) with the CRC of the message defined in the function parameters as:

p = pointer to the MODBUS message string to calculate the CRC

us = length in bytes of the MODBUS message (header + data) minus 2 bytes (the CRC of the message itself)

USHORT fn_035c_cr16(UCHAR *p, UNSIGNED us)

```
{
const UCHAR hi[] = {
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X1,0Xc0,0X80,0X41,0X0,0Xc1,0X81,0X40,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40,0X0,0Xc1,0X81,0X40,
0X1,0Xc0,0X80,0X41,0X1,0Xc0,0X80,0X41,0X0,0Xc1,
0X81,0X40,0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,
0X0,0Xc1,0X81,0X40,0X1,0Xc0,0X80,0X41,0X1,0Xc0,
0X80,0X41,0X0,0Xc1,0X81,0X40};
```

```
const UCHAR lo[] = {
0X0,0Xc0,0Xc1,0X1,0Xc3,0X3,0X2,0Xc2,0Xc6,0X6,
0X7,0Xc7,0X5,0Xc5,0Xc4,0X4,0Xcc,0Xc,0Xd,0Xcd,
0Xf,0Xcf,0Xce,0Xe,0Xa,0Xca,0Xcb,0Xb,0Xc9,0X9,
0X8,0Xc8,0Xd8,0X18,0X19,0Xd9,0X1b,0Xdb,0Xda,0X1a,
0X1e,0Xde,0Xdf,0X1f,0Xdd,0X1d,0X1c,0Xdc,0X14,0Xd4,
0Xd5,0X15,0Xd7,0X17,0X16,0Xd6,0Xd2,0X12,0X13,0Xd3,
0X11,0Xd1,0Xd0,0X10,0Xf0,0X30,0X31,0Xf1,0X33,0Xf3,
0Xf2,0X32,0X36,0Xf6,0Xf7,0X37,0Xf5,0X35,0X34,0Xf4,
0X3c,0Xfc,0Xfd,0X3d,0Xff,0X3f,0X3e,0Xfe,0Xfa,0X3a,
0X3b,0Xfb,0X39,0Xf9,0Xf8,0X38,0X28,0Xe8,0Xe9,0X29,
0Xeb,0X2b,0X2a,0Xea,0Xee,0X2e,0X2f,0Xef,0X2d,0Xed,
0Xec,0X2c,0Xe4,0X24,0X25,0Xe5,0X27,0Xe7,0Xe6,0X26,
0X22,0Xe2,0Xe3,0X23,0Xe1,0X21,0X20,0Xe0,0Xa0,0X60,
0X61,0Xa1,0X63,0Xa3,0Xa2,0X62,0X66,0Xa6,0Xa7,0X67,
0Xa5,0X65,0X64,0Xa4,0X6c,0Xac,0Xad,0X6d,0Xaf,0X6f,
0X6e,0Xae,0Xaa,0X6a,0X6b,0Xab,0X69,0Xa9,0Xa8,0X68,
0X78,0Xb8,0Xb9,0X79,0Xbb,0X7b,0X7a,0Xba,0Xbe,0X7e,
0X7f,0Xbf,0X7d,0Xbd,0Xbc,0X7c,0Xb4,0X74,0X75,0Xb5,
0X77,0Xb7,0Xb6,0X76,0X72,0Xb2,0Xb3,0X73,0Xb1,0X71,
0X70,0Xb0,0X50,0X90,0X91,0X51,0X93,0X53,0X52,0X92,
0X96,0X56,0X57,0X97,0X55,0X95,0X94,0X54,0X9c,0X5c,
0X5d,0X9d,0X5f,0X9f,0X9e,0X5e,0X5a,0X9a,0X9b,0X5b,
0X99,0X59,0X58,0X98,0X88,0X48,0X49,0X89,0X4b,0X8b,
0X8a,0X4a,0X4e,0X8e,0X8f,0X4f,0X8d,0X4d,0X4c,0X8c,
0X44,0X84,0X85,0X45,0X87,0X47,0X46,0X86,0X82,0X42,
0X43,0X83,0X41,0X81,0X80,0X40 };

    UCHAR chi;
    UCHAR clo;
    USHORT ui;

    chi = 0xff;
    clo = 0xff;
    while(us--)
    {   ui = chi ^ *p++;
    chi = clo ^ hi[ui];
    clo = lo[ui];
    }
    ui = chi;
    ui = ui << 8;
    ui = ui | clo;      // Big-Endian format
```

```
    return(ui);
}
```

If it is Little-Endian format the returned bytes must be interchanged: each unsigned 16 bit type's bytes need to be swapped.

B.5 Memory map

The Memory map can be obtained from EnerVista 650 Setup software, menu:

View > ModBus Memory map

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estado CPU - CPU Status							
0x0003	0x0100	TIMER STATUS	F001		R	1	
0x0003	0x0200	E2PROM STATUS	F001		R	1	
Salidas Virtuales (512 elementos) - Virtual Outputs							
0x0005	0x0400	VIRTUAL OUTPUT 000	F001		R	1	
0x0005	0x0800	VIRTUAL OUTPUT 001	F001		R	1	
...	...	...	...	...	...	...	...
0x0025	0x0200	VIRTUAL OUTPUT 511	F001		R	1	
Salidas virtuales analógicas- Virtual Output Analog							
0x07D0		INT32_000	F005	1.000	R	2	
0x07D2		INT32_001	F005	1.000	R	2	
0x07D4		INT32_002	F005	1.000	R	2	
0x07D6		INT32_003	F005	1.000	R	2	
0x07D8		INT32_004	F005	1.000	R	2	
0x07DA		INT32_005	F005	1.000	R	2	
0x07DC		INT32_006	F005	1.000	R	2	
0x07DE		INT32_007	F005	1.000	R	2	
0x07E0		INT32_008	F005	1.000	R	2	
0x07E2		INT32_009	F005	1.000	R	2	
0x07E4		INT32_010	F005	1.000	R	2	
0x07E6		INT32_011	F005	1.000	R	2	
0x07E8		INT32_012	F005	1.000	R	2	
0x07EA		INT32_013	F005	1.000	R	2	
0x07EC		INT32_014	F005	1.000	R	2	
0x07EE		INT32_015	F005	1.000	R	2	
0x07F0		INT32_016	F005	1.000	R	2	
0x07F2		INT32_017	F005	1.000	R	2	
0x07F4		INT32_018	F005	1.000	R	2	
0x07F6		INT32_019	F005	1.000	R	2	
0x07F8		INT32_020	F005	1.000	R	2	
0x07FA		INT32_021	F005	1.000	R	2	
0x07FC		INT32_022	F005	1.000	R	2	
0x07FE		INT32_023	F005	1.000	R	2	
0x0800		INT32_024	F005	1.000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0802		INT32_025	F005	1.000	R	2	
0x0804		INT32_026	F005	1.000	R	2	
0x0806		INT32_027	F005	1.000	R	2	
0x0808		INT32_028	F005	1.000	R	2	
0x080A		INT32_029	F005	1.000	R	2	
0x080C		INT32_030	F005	1.000	R	2	
0x080E		INT32_031	F005	1.000	R	2	
0x0810		INT32_032	F005	1.000	R	2	
0x0812		INT32_033	F005	1.000	R	2	
0x0814		INT32_034	F005	1.000	R	2	
0x0816		INT32_035	F005	1.000	R	2	
0x0818		INT32_036	F005	1.000	R	2	
0x081A		INT32_037	F005	1.000	R	2	
0x081C		INT32_038	F005	1.000	R	2	
0x081E		INT32_039	F005	1.000	R	2	
0x0820		INT32_040	F005	1.000	R	2	
0x0822		INT32_041	F005	1.000	R	2	
0x0824		INT32_042	F005	1.000	R	2	
0x0826		INT32_043	F005	1.000	R	2	
0x0828		INT32_044	F005	1.000	R	2	
0x082A		INT32_045	F005	1.000	R	2	
0x082C		INT32_046	F005	1.000	R	2	
0x082E		INT32_047	F005	1.000	R	2	
0x0830		INT32_048	F005	1.000	R	2	
0x0832		INT32_049	F005	1.000	R	2	
0x0834		FLT32_000	F003	1.000	R	2	
0x0836		FLT32_001	F003	1.000	R	2	
0x0838		FLT32_002	F003	1.000	R	2	
0x083A		FLT32_003	F003	1.000	R	2	
0x083C		FLT32_004	F003	1.000	R	2	
0x083E		FLT32_005	F003	1.000	R	2	
0x0840		FLT32_006	F003	1.000	R	2	
0x0842		FLT32_007	F003	1.000	R	2	
0x0844		FLT32_008	F003	1.000	R	2	
0x0846		FLT32_009	F003	1.000	R	2	
0x0848		FLT32_010	F003	1.000	R	2	
0x084A		FLT32_011	F003	1.000	R	2	
0x084C		FLT32_012	F003	1.000	R	2	
0x084E		FLT32_013	F003	1.000	R	2	
0x0850		FLT32_014	F003	1.000	R	2	
0x0852		FLT32_015	F003	1.000	R	2	
0x0854		FLT32_016	F003	1.000	R	2	
0x0856		FLT32_017	F003	1.000	R	2	
0x0858		FLT32_018	F003	1.000	R	2	
0x085A		FLT32_019	F003	1.000	R	2	
0x085C		FLT32_020	F003	1.000	R	2	
0x085E		FLT32_021	F003	1.000	R	2	
0x0860		FLT32_022	F003	1.000	R	2	
0x0862		FLT32_023	F003	1.000	R	2	
0x0864		FLT32_024	F003	1.000	R	2	
0x0866		FLT32_025	F003	1.000	R	2	
0x0868		FLT32_026	F003	1.000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x086A		FLT32_027	F003	1.000	R	2	
0x086C		FLT32_028	F003	1.000	R	2	
0x086E		FLT32_029	F003	1.000	R	2	
0x0870		FLT32_030	F003	1.000	R	2	
0x0872		FLT32_031	F003	1.000	R	2	
0x0874		FLT32_032	F003	1.000	R	2	
0x0876		FLT32_033	F003	1.000	R	2	
0x0878		FLT32_034	F003	1.000	R	2	
0x087A		FLT32_035	F003	1.000	R	2	
0x087C		FLT32_036	F003	1.000	R	2	
0x087E		FLT32_037	F003	1.000	R	2	
0x0880		FLT32_038	F003	1.000	R	2	
0x0882		FLT32_039	F003	1.000	R	2	
0x0884		FLT32_040	F003	1.000	R	2	
0x0886		FLT32_041	F003	1.000	R	2	
0x0888		FLT32_042	F003	1.000	R	2	
0x088A		FLT32_043	F003	1.000	R	2	
0x088C		FLT32_044	F003	1.000	R	2	
0x088E		FLT32_045	F003	1.000	R	2	
0x0890		FLT32_046	F003	1.000	R	2	
0x0892		FLT32_047	F003	1.000	R	2	
0x0894		FLT32_048	F003	1.000	R	2	
0x0896		FLT32_049	F003	1.000	R	2	
Maniobras (24 elementos) - Operations							
0x0025	0x0400	OPERATION BIT 1	F001		R	1	
0x0025	0x0800	OPERATION BIT 2	F001		R	1	
...	...	...	...	...	...	...	..
0x0026	0x0002	OPERATION BIT 24	F001		R	1	
Eventos de control (128 elementos) - Control Events							
0x003D	0x0400	CONTROL EVENT 1	F001		R	1	
0x003D	0x0800	CONTROL EVENT 2	F001		R	1	
...	...	...	...	...	...	...	...
0x0045	0x0200	CONTROL EVENT 128	F001		R	1	
Salidas Virtuales Latcheadas (16 elementos) - Latched virtual outputs							
0x0045	0x0400	V.O. Latched 1	F001		R	1	
---	---	---	---	---	---	---	---
0x0045	0x1000	V.O. Latched 3	F001		R	1	
0x0046	0x0200	V.O. Latched 16	F001		R	1	
Reset Salidas Virtuales Latcheadas - Reset Latched virtual outputs							
0x0046	0x0400	Reset V.O. Latched	F001		R	1	
Entradas Virtuales con sellado (32 elementos) - Virtual Input Latched							
0x0083	0x0400	LATCHED VIRT IP 1	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0083	0x0800	LATCHED VIRT IP 2	F001		R	1	
...	...	...	...	...	...	...	...
0x0085	0x0200	LATCHED VIRT IP 32	F001		R	1	
Entradas Virtuales Autoresetables (32 elementos) - Virtual Input Self Reset							
0x0085	0x0400	SELF-RST VIRT IP 1	F001		R	1	
0x0085	0x0800	SELF-RST VIRT IP 2	F001		R	1	
...	...	...	...	...	...	...	...
0x0087	0x0200	SELF-RST VIRT IP 32	F001		R	1	
Estado Pantalla - Display Status (does not apply to C650 models)							
0x0087	0x0400	GRAPHIC STATUS	F001		R	1	
0x0087	0x0800	ALARM TEXT ARRAY	F001		R	1	
Estado Entradas Tarjeta F (32 elementos) - Board F: Contact Input Status							
0x0087	0x1000	CONT IP_F_CC1	F001		R	1	
0x0087	0x2000	CONT IP_F_CC2	F001		R	1	
...	...	...	...	....	...	...	...
0x0089	0x0800	CONT IP_F_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta F (16 elementos) - Board F: Contact Output Operate -logical status-							
0x0089	0x1000	CONT OP OPER_F_01	F001		R	1	
0x0089	0x2000	CONT OP OPER_F_02	F001		R	1	
...	...	...	...	...	...	...	...
0x008A	0x0800	CONT OP OPER_F_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta F (16 elementos) - Board F: Contact Output Resets							
0x008A	0x1000	CONT OP RESET_F_1	F001		R	1	
0x008A	0x2000	CONT OP RESET_F_2	F001		R	1	
...	...	...	...	...	...	...	...
0x008B	0x0800	CONT OP RESET_F_16	F001		R	1	
Estado Salidas Tarjeta F (16 elementos) - Board F: Contact Outputs -physical status-							
0x008B	0x1000	CONT OP_F_01	F001		R	1	
0x008B	0x2000	CONT OP_F_02	F001		R	1	
...	...	...	...	...	...	...	...
0x008C	0x0800	CONT OP_F_16	F001		R	1	
Estado Tarjeta F - Board F Status							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x008C	0x1000	BOARD F STATUS	F001		R	1	
Estado Entradas Tarjeta G (32 elementos) - Board G: Contact Input Status							
0x00AC	0x2000	CONT IP_G_CC1	F001		R	1	
0x00AC	0x4000	CONT IP_G_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x00AE	0x1000	CONT IP_G_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta G (16 elementos) - Board G: Contact Output Operate -logical status-							
0x00AE	0x2000	CONT OP OPER_G_01	F001		R	1	
0x00AE	0x4000	CONT OP OPER_G_02	F001		R	1	
...	...	...	...	...	...	...	...
0x00AF	0x1000	CONT OP OPER_G_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta G (16 elementos) - Board G: Contact Output Resets							
0x00AF	0x2000	CONT OP RESET_G_01	F001		R	1	
0x00AF	0x4000	CONT OP RESET_G_02	F001		R	1	
...	...	...	...	...	...	...	...
0x00B0	0x1000	CONT OP RESET_G_16	F001		R	1	
Estado Salidas Tarjeta G (16 elementos) - Board G: Contact Outputs -physical status-							
0x00B0	0x2000	CONT OP_G_01	F001		R	1	
0x00B0	0x4000	CONT OP_G_02	F001		R	1	
...	...	...	...	...	...	...	...
0x00B1	0x1000	CONT OP_G_16	F001		R	1	
Estado Tarjeta G - Board G Status							
0x00B1	0x2000	BOARD G STATUS	F001		R	1	
LEDS HMI (16 elementos) - HMI Leds							
0x00D1	0x4000	READY LED	F001		R	1	
0x00D1	0x8000	LED 1	F001		R	1	
0x00D1	0x0001	LED 2	F001		R	1	
0x00D1	0x0002	LED 3	F001		R	1	
0x00D1	0x0004	LED 4	F001		R	1	
0x00D1	0x0008	LED 5	F001		R	1	
0x00D1	0x0010	LED 6	F001		R	1	
0x00D1	0x0020	LED 7	F001		R	1	
0x00D1	0x0040	LED 8	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x00D1	0x0080	LED 9	F001		R	1	
LEDS HMI (16 elementos) - HMI Leds (cont.)							
0x00D2	0x0100	LED 10	F001		R	1	
0x00D2	0x0200	LED 11	F001		R	1	
0x00D2	0x0400	LED 12	F001		R	1	
0x00D2	0x0800	LED 13	F001		R	1	
0x00D2	0x1000	LED 14	F001		R	1	
0x00D2	0x2000	LED 15	F001		R	1	
Teclas HMI - HMI Keys							
0x00D2	0x4000	I Key	F001		R	1	
0x00D2	0x8000	O Key	F001		R	1	
0x00D2	0x0001	* Key	F001		R	1	
Señales estado LOCAL/REMOTO para maniobras - LOCAL/REMOTE Operation status signals							
0x00D2	0x0002	F1 Key	F001		R	1	
0x00D2	0x0004	F2 Key	F001		R	1	
0x00D2	0x0008	LOCAL OPERATION MODE	F001		R	1	
0x00D2	0x0010	OPERATIONS BLOCKED	F001		R	1	
Estados Internos - Internal States							
0x00D2	0x0020	DSP COMM ERROR	F001		R	1	
0x00D2	0x0040	MAGNETIC MODULE ERROR	F001		R	1	
Entrada Reset Leds (configurable) -Led reset Input							
0x00D2	0x0080	LED RESET INPUT	F001		R	1	
Entradas Cambio Estado Local-Remoto-OFF (configurable) - Local-Remote-Off Input selection							
0x00D3	0x0100	CHANGE LOCAL-REMOTE	F001		R	1	
0x00D3	0x0200	CHANGE OP BLOCKED	F001		R	1	
Entradas Cambio Estado iluminación pantalla (configurable) - Backlight status selection							
0x00D3	0x1000	HMI BACKLIGHT ON	F001		R	1	
0x00D3	0x2000	HMI BACKLIGHT OFF	F001		R	1	
Estado PLC Fuera de Servicio - Out of Service PLC Status							
0x00D4	0x4000	OUT OF SERVICE	F001		R	1	
0x00D4	0x8000	PLC ERROR	F001		R	1	
0x00D4	0x0001	General Trip	F001		R	1	
0x00D4	0x0002	NET CONF ERROR	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x00D4	0x0004	ST HMI BACKLIGHT	F001		R	1	
0x00D4	0x0008	ORDERCODE ERROR	F001		R	1	
0x00D4	0x0010	LINK STATUS PORT E	F001		R	1	
0x00D4	0x0020	LINK STATUS PORT A	F001		R	1	
0x00D4	0x0040	LINK STATUS PORT B	F001		R	1	
Estados Sobrecorriente instantanea de fases nivel alto - Phase IOC High States							
0x00F2	0x0080	PH IOC1 HIGH A BLK	F001		R	1	
0x00F3	0x0100	PH IOC1 HIGH B BLK	F001		R	1	
0x00F3	0x0200	PH IOC1 HIGH C BLK	F001		R	1	
0x00F3	0x0400	PH IOC1 HIGH A PKP	F001		R	1	
0x00F3	0x0800	PH IOC1 HIGH A OP	F001		R	1	
0x00F3	0x1000	PH IOC1 HIGH B PKP	F001		R	1	
0x00F3	0x2000	PH IOC1 HIGH B OP	F001		R	1	
0x00F3	0x4000	PH IOC1 HIGH C PKP	F001		R	1	
0x00F3	0x8000	PH IOC1 HIGH C OP	F001		R	1	
0x00F3	0x0001	PH IOC1 HIGH PKP	F001		R	1	
0x00F3	0x0002	PH IOC1 HIGH OP	F001		R	1	
0x00F8	0x0004	PH IOC2 HIGH A BLK	F001		R	1	
0x00F8	0x0008	PH IOC2 HIGH B BLK	F001		R	1	
0x00F8	0x0010	PH IOC2 HIGH C BLK	F001		R	1	
0x00F8	0x0020	PH IOC2 HIGH A PKP	F001		R	1	
0x00F8	0x0040	PH IOC2 HIGH A OP	F001		R	1	
0x00F8	0x0080	PH IOC2 HIGH B PKP	F001		R	1	
0x00F9	0x0100	PH IOC2 HIGH B OP	F001		R	1	
0x00F9	0x0200	PH IOC2 HIGH C PKP	F001		R	1	
0x00F9	0x0400	PH IOC2 HIGH C OP	F001		R	1	
0x00F9	0x0800	PH IOC2 HIGH PKP	F001		R	1	
0x00F9	0x1000	PH IOC2 HIGH OP	F001		R	1	
0x00FE	0x2000	PH IOC3 HIGH A BLK	F001		R	1	
0x00FE	0x4000	PH IOC3 HIGH B BLK	F001		R	1	
0x00FE	0x8000	PH IOC3 HIGH C BLK	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x00FE	0x0001	PH IOC3 HIGH A PKP	F001		R	1	
0x00FE	0x0002	PH IOC3 HIGH A OP	F001		R	1	
0x00FE	0x0004	PH IOC3 HIGH B PKP	F001		R	1	
0x00FE	0x0008	PH IOC3 HIGH B OP	F001		R	1	
0x00FE	0x0010	PH IOC3 HIGH C PKP	F001		R	1	
0x00FE	0x0020	PH IOC3 HIGH C OP	F001		R	1	
0x00FE	0x0040	PH IOC3 HIGH PKP	F001		R	1	
0x00FE	0x0080	PH IOC3 HIGH OP	F001		R	1	
Sobrecorriente instantanea de fases nivel bajo - Phase IOC Low States							
0x0104	0x0100	PH IOC1 LOW A BLK	F001		R	1	
0x0104	0x0200	PH IOC1 LOW B BLK	F001		R	1	
0x0104	0x0400	PH IOC1 LOW C BLK	F001		R	1	
0x0104	0x0800	PH IOC1 LOW A PKP	F001		R	1	
0x0104	0x1000	PH IOC1 LOW A OP	F001		R	1	
0x0104	0x2000	PH IOC1 LOW B PKP	F001		R	1	
0x0104	0x4000	PH IOC1 LOW B OP	F001		R	1	
0x0104	0x8000	PH IOC1 LOW C PKP	F001		R	1	
0x0104	0x0001	PH IOC1 LOW C OP	F001		R	1	
0x0104	0x0002	PH IOC1 LOW PKP	F001		R	1	
0x0104	0x0004	PH IOC1 LOW OP	F001		R	1	
0x0109	0x0008	PH IOC2 LOW A BLK	F001		R	1	
0x0109	0x0010	PH IOC2 LOW B BLK	F001		R	1	
0x0109	0x0020	PH IOC2 LOW C BLK	F001		R	1	
0x0109	0x0040	PH IOC2 LOW A PKP	F001		R	1	
0x0109	0x0080	PH IOC2 LOW A OP	F001		R	1	
0x010A	0x0100	PH IOC2 LOW B PKP	F001		R	1	
Sobrecorriente instantanea de fases nivel bajo - Phase IOC Low States (cont.)							
0x010A	0x0200	PH IOC2 LOW B OP	F001		R	1	
0x010A	0x0400	PH IOC2 LOW C PKP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x010A	0x0800	PH IOC2 LOW C OP	F001		R	1	
0x010A	0x1000	PH IOC2 LOW PKP	F001		R	1	
0x010A	0x2000	PH IOC2 LOW OP	F001		R	1	
0x010F	0x4000	PH IOC3 LOW A BLK	F001		R	1	
0x010F	0x8000	PH IOC3 LOW B BLK	F001		R	1	
0x010F	0x0001	PH IOC3 LOW C BLK	F001		R	1	
0x010F	0x0002	PH IOC3 LOW A PKP	F001		R	1	
0x010F	0x0004	PH IOC3 LOW A OP	F001		R	1	
0x010F	0x0008	PH IOC3 LOW B PKP	F001		R	1	
0x010F	0x0010	PH IOC3 LOW B OP	F001		R	1	
0x010F	0x0020	PH IOC3 LOW C PKP	F001		R	1	
0x010F	0x0040	PH IOC3 LOW C OP	F001		R	1	
0x010F	0x0080	PH IOC3 LOW PKP	F001		R	1	
0x0110	0x0100	PH IOC3 LOW OP	F001		R	1	
Estados Sobreintensidad instantánea de Neutro - Neutral IOC States							
0x0115	0x0200	NEUTRAL IOC1 BLOCK	F001		R	1	
0x0115	0x0400	NEUTRAL IOC1 PKP	F001		R	1	
0x0115	0x0800	NEUTRAL IOC1 OP	F001		R	1	
0x011A	0x1000	NEUTRAL IOC2 BLOCK	F001		R	1	
0x011A	0x2000	NEUTRAL IOC2 PKP	F001		R	1	
0x011A	0x4000	NEUTRAL IOC2 OP	F001		R	1	
0x011F	0x8000	NEUTRAL IOC3 BLOCK	F001		R	1	
0x011F	0x0001	NEUTRAL IOC3 PKP	F001		R	1	
0x011F	0x0002	NEUTRAL IOC3 OP	F001		R	1	
Estados Sobreintensidad instantánea de Tierra - Ground IOC States							
0x0124	0x0004	GROUND IOC1 BLOCK	F001		R	1	
0x0124	0x0008	GROUND IOC1 PKP	F001		R	1	
0x0124	0x0010	GROUND IOC1 OP	F001		R	1	
0x0129	0x0020	GROUND IOC2 BLOCK	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0129	0x0040	GROUND IOC2 PKP	F001		R	1	
0x0129	0x0080	GROUND IOC2 OP	F001		R	1	
0x012F	0x0100	GROUND IOC3 BLOCK	F001		R	1	
0x012F	0x0200	GROUND IOC3 PKP	F001		R	1	
0x012F	0x0400	GROUND IOC3 OP	F001		R	1	
Estados Sobreintensidad instantánea de Tierra Sensible - Sensitive Ground IOC States							
0x0134	0x0800	SENS GND IOC1 BLK	F001		R	1	
0x0134	0x1000	SENS GND IOC1 PKP	F001		R	1	
0x0134	0x2000	SENS GND IOC1 OP	F001		R	1	
0x0139	0x4000	SENS GND IOC2 BLK	F001		R	1	
0x0139	0x8000	SENS GND IOC2 PKP	F001		R	1	
0x0139	0x0001	SENS GND IOC2 OP	F001		R	1	
0x013E	0x0002	SENS GND IOC3 BLK	F001		R	1	
0x013E	0x0004	SENS GND IOC3 PKP	F001		R	1	
0x013E	0x0008	SENS GND IOC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada de Fases Nivel Alto - Phase TOC High States							
0x0143	0x0010	PH TOC1 HIGH A BLK	F001		R	1	
0x0143	0x0020	PH TOC1 HIGH B BLK	F001		R	1	
0x0143	0x0040	PH TOC1 HIGH C BLK	F001		R	1	
0x0143	0x0080	PH TOC1 HIGH A PKP	F001		R	1	
0x0144	0x0100	PH TOC1 HIGH A OP	F001		R	1	
0x0144	0x0200	PH TOC1 HIGH B PKP	F001		R	1	
0x0144	0x0400	PH TOC1 HIGH B OP	F001		R	1	
0x0144	0x0800	PH TOC1 HIGH C PKP	F001		R	1	
0x0144	0x1000	PH TOC1 HIGH C OP	F001		R	1	
0x0144	0x2000	PH TOC1 HIGH PKP	F001		R	1	
0x0144	0x4000	PH TOC1 HIGH OP	F001		R	1	
0x0149	0x8000	PH TOC2 HIGH A BLK	F001		R	1	
0x0149	0x0001	PH TOC2 HIGH B BLK	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0149	0x0002	PH TOC2 HIGH C BLK	F001		R	1	
0x0149	0x0004	PH TOC2 HIGH A PKP	F001		R	1	
0x0149	0x0008	PH TOC2 HIGH A OP	F001		R	1	
0x0149	0x0010	PH TOC2 HIGH B PKP	F001		R	1	
0x0149	0x0020	PH TOC2 HIGH B OP	F001		R	1	
0x0149	0x0040	PH TOC2 HIGH C PKP	F001		R	1	
0x0149	0x0080	PH TOC2 HIGH C OP	F001		R	1	
0x014A	0x0100	PH TOC2 HIGH PKP	F001		R	1	
Estados Sobreintensidad Temporizada de Fases Nivel Alto - Phase TOC High States(cont.)							
0x014A	0x0200	PH TOC2 HIGH OP	F001		R	1	
0x014F	0x0400	PH TOC3 HIGH A BLK	F001		R	1	
0x014F	0x0800	PH TOC3 HIGH B BLK	F001		R	1	
0x014F	0x1000	PH TOC3 HIGH C BLK	F001		R	1	
0x014F	0x2000	PH TOC3 HIGH A PKP	F001		R	1	
0x014F	0x4000	PH TOC3 HIGH A OP	F001		R	1	
0x014F	0x8000	PH TOC3 HIGH B PKP	F001		R	1	
0x014F	0x0001	PH TOC3 HIGH B OP	F001		R	1	
0x014F	0x0002	PH TOC3 HIGH C PKP	F001		R	1	
0x014F	0x0004	PH TOC3 HIGH C OP	F001		R	1	
0x014F	0x0008	PH TOC3 HIGH PKP	F001		R	1	
0x014F	0x0010	PH TOC3 HIGH OP	F001		R	1	
Estados Sobreintensidad Temporizada de Neutro - Neutral TOC States							
0x0154	0x0020	NEUTRAL TOC1 BLOCK	F001		R	1	
0x0154	0x0040	NEUTRAL TOC1 PKP	F001		R	1	
0x0154	0x0080	NEUTRAL TOC1 OP	F001		R	1	
0x015A	0x0100	NEUTRAL TOC2 BLOCK	F001		R	1	
0x015A	0x0200	NEUTRAL TOC2 PKP	F001		R	1	
0x015A	0x0400	NEUTRAL TOC2 OP	F001		R	1	
0x015F	0x0800	NEUTRAL TOC3 BLOCK	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x015F	0x1000	NEUTRAL TOC3 PKP	F001		R	1	
0x015F	0x2000	NEUTRAL TOC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada de Tierra - Ground TOC States							
0x0164	0x4000	GROUND TOC1 BLOCK	F001		R	1	
0x0164	0x8000	GROUND TOC1 PKP	F001		R	1	
0x0164	0x0001	GROUND TOC1 OP	F001		R	1	
0x0169	0x0002	GROUND TOC2 BLOCK	F001		R	1	
0x0169	0x0004	GROUND TOC2 PKP	F001		R	1	
0x0169	0x0008	GROUND TOC2 OP	F001		R	1	
0x016E	0x0010	GROUND TOC3 BLOCK	F001		R	1	
0x016E	0x0020	GROUND TOC3 PKP	F001		R	1	
0x016E	0x0040	GROUND TOC3 OP	F001		R	1	
Estados Sobreintensidad Temporizada Tierra Sensible - Sensitive Ground TOC States							
0x0173	0x0080	SENS GND TOC1 BLOCK	F001		R	1	
0x0174	0x0100	SENS GND TOC1 PKP	F001		R	1	
0x0174	0x0200	SENS GND TOC1 OP	F001		R	1	
0x0179	0x0400	SENS GND TOC2 BLOCK	F001		R	1	
0x0179	0x0800	SENS GND TOC2 PKP	F001		R	1	
0x0179	0x1000	SENS GND TOC2 OP	F001		R	1	
0x017E	0x2000	SENS GND TOC3 BLOCK	F001		R	1	
0x017E	0x4000	SENS GND TOC3 PKP	F001		R	1	
0x017E	0x8000	SENS GND TOC3 OP	F001		R	1	
Estados Subtensión de fases - Phase UV States							
0x0183	0x0001	PHASE UV1 BLOCK	F001		R	1	
0x0183	0x0002	PHASE UV1 A PKP	F001		R	1	
0x0183	0x0004	PHASE UV1 A OP	F001		R	1	
0x0183	0x0008	PHASE UV1 B PKP	F001		R	1	
0x0183	0x0010	PHASE UV1 B OP	F001		R	1	
0x0183	0x0020	PHASE UV1 C PKP	F001		R	1	
0x0183	0x0040	PHASE UV1 C OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0183	0x0080	PHASE UV1 AB PKP	F001		R	1	
Estados Subtensión de fases - Phase UV States(cont.)							
0x0184	0x0100	PHASE UV1 AB OP	F001		R	1	
0x0184	0x0200	PHASE UV1 BC PKP	F001		R	1	
0x0184	0x0400	PHASE UV1 BC OP	F001		R	1	
0x0184	0x0800	PHASE UV1 CA PKP	F001		R	1	
0x0184	0x1000	PHASE UV1 CA OP	F001		R	1	
0x0184	0x2000	PHASE UV1 PKP	F001		R	1	
0x0184	0x4000	PHASE UV1 OP	F001		R	1	
0x0189	0x8000	PHASE UV2 BLOCK	F001		R	1	
0x0189	0x0001	PHASE UV2 A PKP	F001		R	1	
0x0189	0x0002	PHASE UV2 A OP	F001		R	1	
0x0189	0x0004	PHASE UV2 B PKP	F001		R	1	
0x0189	0x0008	PHASE UV2 B OP	F001		R	1	
0x0189	0x0010	PHASE UV2 C PKP	F001		R	1	
0x0189	0x0020	PHASE UV2 C OP	F001		R	1	
0x0189	0x0040	PHASE UV2 AB PKP	F001		R	1	
0x0189	0x0080	PHASE UV2 AB OP	F001		R	1	
0x018A	0x0100	PHASE UV2 BC PKP	F001		R	1	
0x018A	0x0200	PHASE UV2 BC OP	F001		R	1	
0x018A	0x0400	PHASE UV2 CA PKP	F001		R	1	
0x018A	0x0800	PHASE UV2 CA OP	F001		R	1	
0x018A	0x1000	PHASE UV2 PKP	F001		R	1	
0x018A	0x2000	PHASE UV2 OP	F001		R	1	
0x018F	0x4000	PHASE UV3 BLOCK	F001		R	1	
0x018F	0x8000	PHASE UV3 A PKP	F001		R	1	
0x018F	0x0001	PHASE UV3 A OP	F001		R	1	
0x018F	0x0002	PHASE UV3 B PKP	F001		R	1	
0x018F	0x0004	PHASE UV3 B OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x018F	0x0008	PHASE UV3 C PKP	F001		R	1	
0x018F	0x0010	PHASE UV3 C OP	F001		R	1	
0x018F	0x0020	PHASE UV3 AB PKP	F001		R	1	
0x018F	0x0040	PHASE UV3 AB OP	F001		R	1	
0x018F	0x0080	PHASE UV3 BC PKP	F001		R	1	
0x0190	0x0100	PHASE UV3 BC OP	F001		R	1	
0x0190	0x0200	PHASE UV3 CA PKP	F001		R	1	
0x0190	0x0400	PHASE UV3 CA OP	F001		R	1	
0x0190	0x0800	PHASE UV3 PKP	F001		R	1	
0x0190	0x1000	PHASE UV3 OP	F001		R	1	
Estados Sobretensión de Secuencia Negativa - Negative Sequence OV States							
0x0195	0x2000	NEG SEQ OV1 BLOCK	F001		R	1	
0x0195	0x4000	NEG SEQ OV1 PKP	F001		R	1	
0x0195	0x8000	NEG SEQ OV1 OP	F001		R	1	
0x019A	0x0001	NEG SEQ OV2 BLOCK	F001		R	1	
0x019A	0x0002	NEG SEQ OV2 PKP	F001		R	1	
0x019A	0x0004	NEG SEQ OV2 OP	F001		R	1	
0x019F	0x0008	NEG SEQ OV3 BLOCK	F001		R	1	
0x019F	0x0010	NEG SEQ OV3 PKP	F001		R	1	
0x019F	0x0020	NEG SEQ OV3 OP	F001		R	1	
Estados Imagen Térmica - Thermal Image States							
0x01A4	0x0040	THERMAL1 BLOCK	F001		R	1	
0x01A4	0x0080	THERMAL1 A RST	F001		R	1	
0x01A5	0x0100	THERMAL1 B RST	F001		R	1	
0x01A5	0x0200	THERMAL1 C RST	F001		R	1	
0x01A5	0x0400	THERMAL1 ALARM	F001		R	1	
0x01A5	0x0800	THERMAL1 OP	F001		R	1	
0x01A5	0x1000	THERMAL1 A ALRM	F001		R	1	
0x01A5	0x2000	THERMAL1 A OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x01A5	0x4000	THERMAL1 B ALRM	F001		R	1	
0x01A5	0x8000	THERMAL1 B OP	F001		R	1	
0x01A5	0x0001	THERMAL1 C ALRM	F001		R	1	
0x01A5	0x0002	THERMAL1 C OP	F001		R	1	
0x01AA	0x0004	THERMAL2 BLOCK	F001		R	1	
0x01AA	0x0008	THERMAL2 A RST	F001		R	1	
0x01AA	0x0010	THERMAL2 B RST	F001		R	1	
0x01AA	0x0020	THERMAL2 C RST	F001		R	1	
0x01AA	0x0040	THERMAL2 ALARM	F001		R	1	
0x01AA	0x0080	THERMAL2 OP	F001		R	1	
0x01AB	0x0100	THERMAL2 A ALRM	F001		R	1	
0x01AB	0x0200	THERMAL2 A OP	F001		R	1	
0x01AB	0x0400	THERMAL2 B ALRM	F001		R	1	
0x01AB	0x0800	THERMAL2 B OP	F001		R	1	
0x01AB	0x1000	THERMAL2 C ALRM	F001		R	1	
0x01AB	0x2000	THERMAL2 C OP	F001		R	1	
0x01B0	0x4000	THERMAL3 BLOCK	F001		R	1	
0x01B0	0x8000	THERMAL3 A RST	F001		R	1	
0x01B0	0x0001	THERMAL3 B RST	F001		R	1	
0x01B0	0x0002	THERMAL3 C RST	F001		R	1	
0x01B0	0x0004	THERMAL3 ALARM	F001		R	1	
0x01B0	0x0008	THERMAL3 OP	F001		R	1	
0x01B0	0x0010	THERMAL3 A ALRM	F001		R	1	
0x01B0	0x0020	THERMAL3 A OP	F001		R	1	
0x01B0	0x0040	THERMAL3 B ALRM	F001		R	1	
0x01B0	0x0080	THERMAL3 B OP	F001		R	1	
0x01B1	0x0100	THERMAL3 C ALRM	F001		R	1	
0x01B1	0x0200	THERMAL3 C OP	F001		R	1	
Estados Unidad Direccional de Fases - Phase Directional States							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x01B6	0x0400	PHASE DIR1 BLK INP	F001		R	1	
0x01B6	0x0800	PHASE DIR1 BLOCK A	F001		R	1	
0x01B6	0x1000	PHASE DIR1 A OP	F001		R	1	
0x01B6	0x2000	PHASE DIR1 BLOCK B	F001		R	1	
0x01B6	0x4000	PHASE DIR1 B OP	F001		R	1	
0x01B6	0x8000	PHASE DIR1 BLOCK C	F001		R	1	
0x01B6	0x0001	PHASE DIR1 C OP	F001		R	1	
0x01BB	0x0002	PHASE DIR2 BLK INP	F001		R	1	
0x01BB	0x0004	PHASE DIR2 BLOCK A	F001		R	1	
0x01BB	0x0008	PHASE DIR2 A OP	F001		R	1	
0x01BB	0x0010	PHASE DIR2 BLOCK B	F001		R	1	
0x01BB	0x0020	PHASE DIR2 B OP	F001		R	1	
0x01BB	0x0040	PHASE DIR2 BLOCK C	F001		R	1	
0x01BB	0x0080	PHASE DIR2 C OP	F001		R	1	
Estados Unidad Direccional de Fases - Phase Directional States(cont.)							
0x01C1	0x0100	PHASE DIR3 BLK INP	F001		R	1	
0x01C1	0x0200	PHASE DIR3 BLOCK A	F001		R	1	
0x01C1	0x0400	PHASE DIR3 A OP	F001		R	1	
0x01C1	0x0800	PHASE DIR3 BLOCK B	F001		R	1	
0x01C1	0x1000	PHASE DIR3 B OP	F001		R	1	
0x01C1	0x2000	PHASE DIR3 BLOCK C	F001		R	1	
0x01C1	0x4000	PHASE DIR3 C OP	F001		R	1	
Estados Unidad Direccional de Neutro - Neutral Directional States							
0x01C6	0x8000	NEUTRAL DIR1 BLK INP	F001		R	1	
0x01C6	0x0001	NEUTRAL DIR1 BLOCK	F001		R	1	
0x01C6	0x0002	NEUTRAL DIR1 OP	F001		R	1	
0x01CB	0x0004	NEUTRAL DIR2 BLK INP	F001		R	1	
0x01CB	0x0008	NEUTRAL DIR2 BLOCK	F001		R	1	
0x01CB	0x0010	NEUTRAL DIR2 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x01D0	0x0020	NEUTRAL DIR3 BLK INP	F001		R	1	
0x01D0	0x0040	NEUTRAL DIR3 BLOCK	F001		R	1	
0x01D0	0x0080	NEUTRAL DIR3 OP	F001		R	1	
Estados Unidad Direccional de Tierra - Ground Directional States							
0x01D6	0x0100	GROUND DIR1 BLK INP	F001		R	1	
0x01D6	0x0200	GROUND DIR1 BLOCK	F001		R	1	
0x01D6	0x0400	GROUND DIR1 OP	F001		R	1	
0x01DB	0x0800	GROUND DIR2 BLK INP	F001		R	1	
0x01DB	0x1000	GROUND DIR2 BLOCK	F001		R	1	
0x01DB	0x2000	GROUND DIR2 OP	F001		R	1	
0x01E0	0x4000	GROUND DIR3 BLK INP	F001		R	1	
0x01E0	0x8000	GROUND DIR3 BLOCK	F001		R	1	
0x01E0	0x0001	GROUND DIR3 OP	F001		R	1	
Estados Fallo de Interruptor - Breaker Failure States							
0x01E5	0x0002	BKR FAIL INITIATE	F001		R	1	
0x01E5	0x0004	BKR FAIL NO CURRENT	F001		R	1	
0x01E5	0x0008	BKR FAIL SUPERVISION	F001		R	1	
0x01E5	0x0010	BKR FAIL HISET	F001		R	1	
0x01E5	0x0020	BKR FAIL LOWSET	F001		R	1	
0x01E5	0x0040	INTERNAL ARC	F001		R	1	
0x01E5	0x0080	BKR FAIL 2nd STEP	F001		R	1	
Estados Fallo de Fusible - Fuse failure States							
0x01EB	0x0100	VT FUSE FAILURE	F001		R	1	
Estados Unidad de Sincronismo - Synchrocheck States							
0x01F0	0x0200	Synchrocheck BLK INP	F001		R	1	
0x01F0	0x0400	Synchrocheck OP	F001		R	1	
0x01F0	0x0800	SYNCHK CLOSE PERM	F001		R	1	
0x01F0	0x1000	Synchrocheck COND OP	F001		R	1	
0x01F0	0x2000	DL-DB OPERATION	F001		R	1	
0x01F0	0x4000	DL-LB OPERATION	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x01F0	0x8000	LL-DB OPERATION	F001		R	1	
0x01F0	0x0001	SLIP CONDITION	F001		R	1	
0x01F0	0x0002	BUS FREQ > LINE FREQ	F001		R	1	
0x01F0	0x0004	BUS FREQ < LINE FREQ	F001		R	1	
Estados Reenganchador (bit) - Autorecloser States							
0x01F5	0x0008	AR LEVEL BLOCK	F001		R	1	
0x01F5	0x0010	AR PULSE BLOCK	F001		R	1	
0x01F5	0x0020	AR PULSE UNBLOCK	F001		R	1	
0x01F5	0x0080	AR INITIATE	F001		R	1	
0x01F6	0x0100	AR CONDS INPUT	F001		R	1	
0x01F6	0x0200	AR CLOSE BREAKER	F001		R	1	
0x01F6	0x0400	AR OUT OF SERVICE	F001		R	1	
0x01F6	0x0800	AR READY	F001		R	1	
0x01F6	0x1000	AR LOCKOUT	F001		R	1	
0x01F6	0x2000	AR BLOCK	F001		R	1	
0x01F6	0x4000	AR RCL IN PROGRESS	F001		R	1	
0x01F6	0x8000	AR LCK BY ANOMALY	F001		R	1	
0x01F6	0x0001	AR LCK BY FAIL OPEN	F001		R	1	
0x01F6	0x0002	AR LCK BY FAIL CLOSE	F001		R	1	
0x01F6	0x0004	AR LCK BY USER	F001		R	1	
0x01F6	0x0008	AR LCK BY CONDS	F001		R	1	
0x01F6	0x0010	AR LCK BY TRIPS	F001		R	1	
0x01F6	0x0020	AR LCK BY SHOTS	F001		R	1	
0x01F6	0x0040	AR BLK AFTER 1 SHOT	F001		R	1	
0x01F6	0x0080	AR BLK AFTER 2 SHOT	F001		R	1	
0x01F7	0x0100	AR BLK AFTER 3 SHOT	F001		R	1	
0x01F7	0x0200	AR BLK AFTER 4 SHOT	F001		R	1	
0x01F7	0x0400	AR BLOCK BY LEVEL	F001		R	1	
0x01F7	0x0800	AR BLOCK BY PULSE	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobretensión de Neutro Nivel Alto - Neutral OV High States							
0x01FC	0x1000	NEUTRAL OV1 HIGH BLK	F001		R	1	
0x01FC	0x2000	NEUTRAL OV1 HIGH PKP	F001		R	1	
0x01FC	0x4000	NEUTRAL OV1 HIGH OP	F001		R	1	
0x0201	0x8000	NEUTRAL OV2 HIGH BLK	F001		R	1	
0x0201	0x0001	NEUTRAL OV2 HIGH PKP	F001		R	1	
0x0201	0x0002	NEUTRAL OV2 HIGH OP	F001		R	1	
0x0206	0x0004	NEUTRAL OV3 HIGH BLK	F001		R	1	
0x0206	0x0008	NEUTRAL OV3 HIGH PKP	F001		R	1	
0x0206	0x0010	NEUTRAL OV3 HIGH OP	F001		R	1	
Estados Sobretensión de Neutro Nivel Bajo - Neutral OV Low States							
0x020B	0x0020	NEUTRAL OV1 LOW BLK	F001		R	1	
0x020B	0x0040	NEUTRAL OV1 LOW PKP	F001		R	1	
0x020B	0x0080	NEUTRAL OV1 LOW OP	F001		R	1	
0x0211	0x0100	NEUTRAL OV2 LOW BLK	F001		R	1	
0x0211	0x0200	NEUTRAL OV2 LOW PKP	F001		R	1	
0x0211	0x0400	NEUTRAL OV2 LOW OP	F001		R	1	
0x0216	0x0800	NEUTRAL OV3 LOW BLK	F001		R	1	
0x0216	0x1000	NEUTRAL OV3 LOW PKP	F001		R	1	
0x0216	0x2000	NEUTRAL OV3 LOW OP	F001		R	1	
Estados Subtensión Auxiliar - Auxiliary UV States							
0x021B	0x4000	AUXILIARY UV1 BLOCK	F001		R	1	
0x021B	0x8000	AUXILIARY UV1 PKP	F001		R	1	
0x021B	0x0001	AUXILIARY UV1 OP	F001		R	1	
0x0220	0x0002	AUXILIARY UV2 BLOCK	F001		R	1	
0x0220	0x0004	AUXILIARY UV2 PKP	F001		R	1	
0x0220	0x0008	AUXILIARY UV2 OP	F001		R	1	
0x0225	0x0010	AUXILIARY UV3 BLOCK	F001		R	1	
0x0225	0x0020	AUXILIARY UV3 PKP	F001		R	1	
0x0225	0x0040	AUXILIARY UV3 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Estados Sobretensión de Fases - Phase OV States							
0x022A	0x0080	PHASE OV1 BLOCK	F001		R	1	
0x022B	0x0100	PHASE OV1 AB PKP	F001		R	1	
0x022B	0x0200	PHASE OV1 AB OP	F001		R	1	
0x022B	0x0400	PHASE OV1 BC PKP	F001		R	1	
0x022B	0x0800	PHASE OV1 BC OP	F001		R	1	
0x022B	0x1000	PHASE OV1 CA PKP	F001		R	1	
0x022B	0x2000	PHASE OV1 CA OP	F001		R	1	
0x022B	0x4000	PHASE OV1 PKP	F001		R	1	
0x022B	0x8000	PHASE OV1 OP	F001		R	1	
0x0230	0x0001	PHASE OV2 BLOCK	F001		R	1	
0x0230	0x0002	PHASE OV2 AB PKP	F001		R	1	
0x0230	0x0004	PHASE OV2 AB OP	F001		R	1	
0x0230	0x0008	PHASE OV2 BC PKP	F001		R	1	
0x0230	0x0010	PHASE OV2 BC OP	F001		R	1	
0x0230	0x0020	PHASE OV2 CA PKP	F001		R	1	
0x0230	0x0040	PHASE OV2 CA OP	F001		R	1	
0x0230	0x0080	PHASE OV2 PKP	F001		R	1	
0x0231	0x0100	PHASE OV2 OP	F001		R	1	
0x0236	0x0200	PHASE OV3 BLOCK	F001		R	1	
0x0236	0x0400	PHASE OV3 AB PKP	F001		R	1	
0x0236	0x0800	PHASE OV3 AB OP	F001		R	1	
0x0236	0x1000	PHASE OV3 BC PKP	F001		R	1	
0x0236	0x2000	PHASE OV3 BC OP	F001		R	1	
0x0236	0x4000	PHASE OV3 CA PKP	F001		R	1	
0x0236	0x8000	PHASE OV3 CA OP	F001		R	1	
0x0236	0x0001	PHASE OV3 PKP	F001		R	1	
0x0236	0x0002	PHASE OV3 OP	F001		R	1	
Estados Sobretensión Auxiliar - Auxiliary OV States							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x023B	0x0004	AUXILIARY OV1 BLOCK	F001		R	1	
0x023B	0x0008	AUXILIARY OV1 PKP	F001		R	1	
0x023B	0x0010	AUXILIARY OV1 OP	F001		R	1	
0x0240	0x0020	AUXILIARY OV2 BLOCK	F001		R	1	
0x0240	0x0040	AUXILIARY OV2 PKP	F001		R	1	
0x0240	0x0080	AUXILIARY OV2 OP	F001		R	1	
0x0246	0x0100	AUXILIARY OV3 BLOCK	F001		R	1	
0x0246	0x0200	AUXILIARY OV3 PKP	F001		R	1	
0x0246	0x0400	AUXILIARY OV3 OP	F001		R	1	
Estados Sobreintensidad Temporizada de Secuencia Negativa - Negative Sequence TOC States							
0x024B	0x0800	NEG SEQ TOC1 BLOCK	F001		R	1	
0x024B	0x1000	NEG SEQ TOC1 PKP	F001		R	1	
0x024B	0x2000	NEG SEQ TOC1 OP	F001		R	1	
0x0250	0x4000	NEG SEQ TOC2 BLOCK	F001		R	1	
0x0250	0x8000	NEG SEQ TOC2 PKP	F001		R	1	
0x0250	0x0001	NEG SEQ TOC2 OP	F001		R	1	
0x0255	0x0002	NEG SEQ TOC3 BLOCK	F001		R	1	
0x0255	0x0004	NEG SEQ TOC3 PKP	F001		R	1	
0x0255	0x0008	NEG SEQ TOC3 OP	F001		R	1	
Estados Sobrefrecuencia - Overfrequency States							
0x025A	0x0010	OVERFREQ1 BLOCK	F001		R	1	
0x025A	0x0020	OVERFREQ1 PKP	F001		R	1	
0x025A	0x0040	OVERFREQ1 OP	F001		R	1	
0x025F	0x0080	OVERFREQ2 BLOCK	F001		R	1	
0x0260	0x0100	OVERFREQ2 PKP	F001		R	1	
0x0260	0x0200	OVERFREQ2 OP	F001		R	1	
0x0265	0x0400	OVERFREQ3 BLOCK	F001		R	1	
0x0265	0x0800	OVERFREQ3 PKP	F001		R	1	
0x0265	0x1000	OVERFREQ3 OP	F001		R	1	
Estados Subfrecuencia - Underfrequency States							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x026A	0x2000	UNDERFREQ1 BLOCK	F001		R	1	
0x026A	0x4000	UNDERFREQ1 PKP	F001		R	1	
0x026A	0x8000	UNDERFREQ1 OP	F001		R	1	
0x026F	0x0001	UNDERFREQ2 BLOCK	F001		R	1	
0x026F	0x0002	UNDERFREQ2 PKP	F001		R	1	
0x026F	0x0004	UNDERFREQ2 OP	F001		R	1	
0x0274	0x0008	UNDERFREQ3 BLOCK	F001		R	1	
0x0274	0x0010	UNDERFREQ3 PKP	F001		R	1	
0x0274	0x0020	UNDERFREQ3 OP	F001		R	1	
0x04D9	0x0001	OVERFREQ5 BLOCK	F001		R	1	
0x04D9	0x0002	OVERFREQ5 PKP	F001		R	1	
0x04D9	0x0004	OVERFREQ5 OP	F001		R	1	
0x04DA	0x0001	UNDERFREQ5 BLOCK	F001		R	1	
0x04DA	0x0002	UNDERFREQ5 PKP	F001		R	1	
0x04DA	0x0004	UNDERFREQ5 OP	F001		R	1	
0x04DB	0x0001	OVERFREQ6 PKP	F001		R	1	
0x04DB	0x0002	OVERFREQ6 OP	F001		R	1	
0x04DB	0x0004	UNDERFREQ6 BLOCK	F001		R	1	
0x04DC	0x0001	UNDERFREQ6 PKP	F001		R	1	
0x04DC	0x0002	UNDERFREQ6 OP	F001		R	1	
0x04DC	0x0004	OVERFREQ5 PKP	F001		R	1	
Estados de 60CTs- 60CTs Failure States							
0x04DD	0x0002	CT Failure PKP	F001		R	1	
0x04DD	0x0004	CT Failure OP	F001		R	1	
0x04DD	0x0008	CT Failure BLOCK	F001		R	1	
Estados de Inhibición por 2nd armónico- 2nd Harmonic Inhibit States							
0x04DE	0x0002	2nd HRMC PKP	F001		R	1	
0x04DE	0x0004	2nd HRMC OP	F001		R	1	
0x04DE	0x0008	2nd HRMC BLOCK	F001		R	1	
Estados Calibración - Calibration States							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0279	0x0040	FACTORY CALIBRATION	F001		R	1	
0x0279	0x0080	CALIBRATION ERROR	F001		R	1	
Estados Oscilografía - Oscillography States							
0x027A	0x0100	OSC DIG CHANNEL 1	F001		R	1	
0x027A	0x0200	OSC DIG CHANNEL 2	F001		R	1	
0x027A	0x0400	OSC DIG CHANNEL 3	F001		R	1	
0x027A	0x0800	OSC DIG CHANNEL 4	F001		R	1	
0x027A	0x1000	OSC DIG CHANNEL 5	F001		R	1	
0x027A	0x2000	OSC DIG CHANNEL 6	F001		R	1	
0x027A	0x4000	OSC DIG CHANNEL 7	F001		R	1	
0x027A	0x8000	OSC DIG CHANNEL 8	F001		R	1	
0x027A	0x0001	OSC DIG CHANNEL 9	F001		R	1	
0x027A	0x0002	OSC DIG CHANNEL 10	F001		R	1	
0x027A	0x0004	OSC DIG CHANNEL 11	F001		R	1	
0x027A	0x0008	OSC DIG CHANNEL 12	F001		R	1	
0x027A	0x0010	OSC DIG CHANNEL 13	F001		R	1	
0x027A	0x0020	OSC DIG CHANNEL 14	F001		R	1	
0x027A	0x0040	OSC DIG CHANNEL 15	F001		R	1	
0x027A	0x0080	OSC DIG CHANNEL 16	F001		R	1	
0x027B	0x0100	OSCILLO TRIGGER	F001		R	1	
Estados Localizador de Faltas - Fault Report States							
0x0280	0x0200	FAULT REPORT TRIGG	F001		R	1	
0x0280	0x0400	CLEAR FAULT REPORTS	F001		R	1	
Agrupamiento de Funciones - Group States							
0x028F	0x0400	GROUP 1 ACT ON	F001		R	1	
0x028F	0x0800	GROUP 2 ACT ON	F001		R	1	
0x028F	0x1000	GROUP 3 ACT ON	F001		R	1	
0x028F	0x2000	SETT GROUPS BLOCK	F001		R	1	
0x028F	0x4000	GROUP 1 BLOCKED	F001		R	1	
0x028F	0x8000	GROUP 2 BLOCKED	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x028F	0x0001	GROUP 3 BLOCKED	F001		R	1	
Canal por defecto - Default Channel (not used)							
0x0294	0x0002	Default Channel	F001		R	1	
Estados Unidad de Conductor Roto - Broken Conductor							
0x0294	0x0004	BROKEN CONDUCT1 BLK	F001		R	1	
0x0294	0x0008	BROKEN CONDUCT1 PKP	F001		R	1	
0x0294	0x0010	BROKEN CONDUCT1 OP	F001		R	1	
0x0299	0x0020	BROKEN CONDUCT2 BLK	F001		R	1	
0x0299	0x0040	BROKEN CONDUCT2 PKP	F001		R	1	
0x0299	0x0080	BROKEN CONDUCT2 OP	F001		R	1	
0x029F	0x0100	BROKEN CONDUCT3 BLK	F001		R	1	
0x029F	0x0200	BROKEN CONDUCT3 PKP	F001		R	1	
0x029F	0x0400	BROKEN CONDUCT3 OP	F001		R	1	
Estados Energía - Energy States							
0x02A4	0x0800	FREEZE ENERGY CNT	F001		R	1	
0x02A4	0x1000	UNFREEZE ENERGY CNT	F001		R	1	
0x02A4	0x2000	RESET ENERGY CNT	F001		R	1	
Estados Unidad de Tierra Aislada - Isolated Ground States							
0x02B8	0x4000	ISOLATED GND1 BLK	F001		R	1	
0x02B8	0x8000	ISOLATED GND1 PKP	F001		R	1	
0x02B8	0x0001	ISOLATED GND1 OP	F001		R	1	
0x02C7	0x0002	ISOLATED GND2 BLK	F001		R	1	
0x02C7	0x0004	ISOLATED GND2 PKP	F001		R	1	
0x02C7	0x0008	ISOLATED GND2 OP	F001		R	1	
0x02D6	0x0010	ISOLATED GND3 BLK	F001		R	1	
0x02D6	0x0020	ISOLATED GND3 PKP	F001		R	1	
0x02D6	0x0040	ISOLATED GND3 OP	F001		R	1	
Estados Unidad Direccional de Tierra Sensible - Sensitive Ground Directional States							
0x02E5	0x0080	SENS GND DIR1 BLK IP	F001		R	1	
0x02E6	0x0100	SENS GND DIR1 BLOCK	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x02E6	0x0200	SENS GND DIR1 OP	F001		R	1	
0x02EB	0x0400	SENS GND DIR2 BLK IP	F001		R	1	
0x02EB	0x0800	SENS GND DIR2 BLOCK	F001		R	1	
0x02EB	0x1000	SENS GND DIR2 OP	F001		R	1	
0x02F0	0x2000	SENS GND DIR3 BLK IP	F001		R	1	
0x02F0	0x4000	SENS GND DIR3 BLOCK	F001		R	1	
0x02F0	0x8000	SENS GND DIR3 OP	F001		R	1	
Estados Unidad de Potencia Máxima Directa - Forward Power(32FP) States							
0x02F5	0x0001	FWD PWR1 BLOCK	F001		R	1	
0x02F5	0x0002	FWD PWR1 STG1 PKP	F001		R	1	
0x02F5	0x0004	FWD PWR1 STG1 OP	F001		R	1	
0x02F5	0x0008	FWD PWR1 STG2 PKP	F001		R	1	
0x02F5	0x0010	FWD PWR1 STG2 OP	F001		R	1	
0x02FA	0x0020	FWD PWR2 BLOCK	F001		R	1	
0x02FA	0x0040	FWD PWR2 STG1 PKP	F001		R	1	
0x02FA	0x0080	FWD PWR2 STG1 OP	F001		R	1	
0x02FB	0x0100	FWD PWR2 STG2 PKP	F001		R	1	
0x02FB	0x0200	FWD PWR2 STG2 OP	F001		R	1	
0x0300	0x0400	FWD PWR3 BLOCK	F001		R	1	
0x0300	0x0800	FWD PWR3 STG1 PKP	F001		R	1	
0x0300	0x1000	FWD PWR3 STG1 OP	F001		R	1	
0x0300	0x2000	FWD PWR3 STG2 PKP	F001		R	1	
0x0300	0x4000	FWD PWR3 STG2 OP	F001		R	1	
Entradas Demanda - Demand Inputs							
0x0305	0x8000	DEMAND TRIGGER INP	F001		R	1	
0x0305	0x0001	DEMAND RESET INP	F001		R	1	
Estado Entradas Tarjeta H (32 elementos) - Board H: Contact Input States							
0x0319	0x0002	CONT IP_H_CC1	F001		R	1	
0x0319	0x0004	CONT IP_H_CC2	F001		R	1	
...	...	...	...	...	...	...	...

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x031B	0x0001	CONT IP_H_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta H (16 elementos) - Board H: Contact Output Operate -logical States-							
0x031B	0x0002	CONT OP OPER_H_01	F001		R	1	
0x031B	0x0004	CONT OP OPER_H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x031C	0x0001	CONT OP OPER_H_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta H (16 elementos) - Board H: Contact Output Resets							
0x031C	0x0002	CONT OP RESET_H_01	F001		R	1	
0x031C	0x0004	CONT OP RESET_H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x031D	0x0001	CONT OP RESET_H_16	F001		R	1	
Estado Salidas Tarjeta H (16 elementos) - Board H: Contact Outputs -physical States-							
0x031D	0x0002	CONT OP_H_01	F001		R	1	
0x031D	0x0004	CONT OP_H_02	F001		R	1	
...	...	...	...	...	...	...	...
0x031E	0x0001	CONT OP_H_16	F001		R	1	
Estado Tarjeta H - Board H Status							
0x031E	0x0002	BOARD H STATUS	F001		R	1	
Estado Entradas Tarjeta J (32 elementos) - Board J: Contact Input States							
0x033E	0x0004	CONT IP_J_CC1	F001		R	1	
0x033E	0x0008	CONT IP_J_CC2	F001		R	1	
...	...	...	...	...	...	...	...
0x0340	0x0002	CONT IP_J_CC32	F001		R	1	
Estado Señales Activación salidas Tarjeta J (16 elementos) - Board J: Contact Output Operate -logical States-							
0x0340	0x0004	CONT OP OPER_J_01	F001		R	1	
0x0340	0x0008	CONT OP OPER_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0341	0x0002	CONT OP OPER_J_16	F001		R	1	
Estado Señales Reposición de Salidas Tarjeta J (16 elementos) - Board J: Contact Output Resets							
0x0341	0x0004	CONT OP RESET_J_01	F001		R	1	
0x0341	0x0008	CONT OP RESET_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0342	0x0002	CONT OP RESET_J_16	F001		R	1	
Estado Salidas Tarjeta J (16 elementos) - Board J: Contact Outputs -physical states-							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0342	0x0004	CONT OP_J_01	F001		R	1	
0x0342	0x0008	CONT OP_J_02	F001		R	1	
...	...	...	...	...	...	...	...
0x0343	0x0002	CONT OP_J_16	F001		R	1	
Estado Tarjeta J - Board J Status							
0x0343	0x0004	BOARD J STATUS	F001		R	1	
Estados Sobrecorriente Temporizada de Fases Nivel Bajo - Phase TOC Low States							
0x0363	0x0008	PH TOC1 LOW A BLK	F001		R	1	
0x0363	0x0010	PH TOC1 LOW B BLK	F001		R	1	
0x0363	0x0020	PH TOC1 LOW C BLK	F001		R	1	
0x0363	0x0040	PH TOC1 LOW A PKP	F001		R	1	
0x0363	0x0080	PH TOC1 LOW A OP	F001		R	1	
0x0364	0x0100	PH TOC1 LOW B PKP	F001		R	1	
0x0364	0x0200	PH TOC1 LOW B OP	F001		R	1	
0x0364	0x0400	PH TOC1 LOW C PKP	F001		R	1	
0x0364	0x0800	PH TOC1 LOW C OP	F001		R	1	
0x0364	0x1000	PH TOC1 LOW PKP	F001		R	1	
0x0364	0x2000	PH TOC1 LOW OP	F001		R	1	
0x0369	0x4000	PH TOC2 LOW A BLK	F001		R	1	
0x0369	0x8000	PH TOC2 LOW B BLK	F001		R	1	
0x0369	0x0001	PH TOC2 LOW C BLK	F001		R	1	
0x0369	0x0002	PH TOC2 LOW A PKP	F001		R	1	
0x0369	0x0004	PH TOC2 LOW A OP	F001		R	1	
0x0369	0x0008	PH TOC2 LOW B PKP	F001		R	1	
Estados Sobrecorriente Temporizada de Fases Nivel Bajo - Phase TOC Low States(cont.)							
0x0369	0x0010	PH TOC2 LOW B OP	F001		R	1	
0x0369	0x0020	PH TOC2 LOW C PKP	F001		R	1	
0x0369	0x0040	PH TOC2 LOW C OP	F001		R	1	
0x0369	0x0080	PH TOC2 LOW PKP	F001		R	1	
0x036A	0x0100	PH TOC2 LOW OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x036F	0x0200	PH TOC3 LOW A BLK	F001		R	1	
0x036F	0x0400	PH TOC3 LOW B BLK	F001		R	1	
0x036F	0x0800	PH TOC3 LOW C BLK	F001		R	1	
0x036F	0x1000	PH TOC3 LOW A PKP	F001		R	1	
0x036F	0x2000	PH TOC3 LOW A OP	F001		R	1	
0x036F	0x4000	PH TOC3 LOW B PKP	F001		R	1	
0x036F	0x8000	PH TOC3 LOW B OP	F001		R	1	
0x036F	0x0001	PH TOC3 LOW C PKP	F001		R	1	
0x036F	0x0002	PH TOC3 LOW C OP	F001		R	1	
0x036F	0x0004	PH TOC3 LOW PKP	F001		R	1	
0x036F	0x0008	PH TOC3 LOW OP	F001		R	1	
Estados Contactos Configuración Aparamenta (16 elementos) - Switchgear Contact Configuration States							
0x0374	0x0010	SWITCH 1 A INPUT	F001		R	1	
0x0374	0x0020	SWITCH 1 B INPUT	F001		R	1	
0x0374	0x0040	SWITCH 2 A INPUT	F001		R	1	
0x0374	0x0080	SWITCH 2 B INPUT	F001		R	1	
...	...	...	...	...	...	...	...
0x0376	0x0004	SWITCH 16 A INPUT	F001		R	1	
0x0376	0x0008	SWITCH 16 B INPUT	F001		R	1	
Estados Contactos Aparamenta (16 elementos) - Switchgear Contact States							
0x0376	0x0010	SWITCH 1 A STATUS	F001		R	1	
0x0376	0x0020	SWITCH 1 B STATUS	F001		R	1	
0x0376	0x0040	SWITCH 2 A STATUS	F001		R	1	
0x0376	0x0080	SWITCH 2 B STATUS	F001		R	1	
...	...	...	...	...	...	...	...
0x0378	0x0004	SWITCH 16 A STATUS	F001		R	1	
0x0378	0x0008	SWITCH 16 B STATUS	F001		R	1	
Estados Aparamenta (16 elementos) - Switchgear States							
0x0378	0x0010	SWITCH 1 OPEN	F001		R	1	
0x0378	0x0020	SWITCH 1 CLOSED	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0378	0x0040	SWITCH 1 00_ERROR	F001		R	1	
0x0378	0x0080	SWITCH 1 11_ERROR	F001		R	1	
0x0379	0x0100	SWITCH 2 OPEN	F001		R	1	
0x0379	0x0200	SWITCH 2 CLOSED	F001		R	1	
0x0379	0x0400	SWITCH 2 00_ERROR	F001		R	1	
0x0379	0x0800	SWITCH 2 11_ERROR	F001		R	1	
...	...	...	...	...	...	...	...
0x037C	0x0001	SWITCH 16 OPEN	F001		R	1	
0x037C	0x0002	SWITCH 16 CLOSED	F001		R	1	
0x037C	0x0004	SWITCH 16 00_ERROR	F001		R	1	
0x037C	0x0008	SWITCH 16 11_ERROR	F001		R	1	
Estados Inicio Apertura y Cierre Aparamenta - Switchgear Open-Close Initializing States							
0x037C	0x0010	SWITCH 1 OPEN INIT	F001		R	1	
0x037C	0x0020	SWITCH 1 CLOSE INIT	F001		R	1	
0x037C	0x0040	SWITCH 2 OPEN INIT	F001		R	1	
0x037C	0x0080	SWITCH 2 CLOSE INIT	F001		R	1	
...	...	...	...	...	...	...	...
0x037E	0x0004	SWITCH 16 OPEN INIT	F001		R	1	
0x037E	0x0008	SWITCH 16 CLOSE INIT	F001		R	1	
Estados Fallo Apertura y Cierre Aparamenta - Switchgear Fail States							
0x037E	0x0010	SWGR 1 FAIL TO OPEN	F001		R	1	
0x037E	0x0020	SWGR 2 FAIL TO OPEN	F001		R	1	
...	...	...	...	...	...	...	...
0x037F	0x0008	SWGR 16 FAIL TO OPEN	F001		R	1	
0x037F	0x0010	SWGR 1 FAIL TO CLOSE	F001		R	1	
0x037F	0x0020	SWGR 2 FAIL TO CLOSE	F001		R	1	
...	...	...	...	...	...	...	...
0x0380	0x0008	SWGR 16 FAIL TO CLOSE	F001		R	1	
0x0380	0x0010	SWGR 1 BLOCK OPENING	F001		R	1	
0x0380	0x0020	SWGR 2 BLOCK OPENING	F001		R	1	
0x0380	0x0040	SWGR 3 BLOCK OPENING	F001		R	1	
0x0380	0x0080	SWGR 4 BLOCK OPENING	F001		R	1	
0x0381	0x0100	SWGR 5 BLOCK OPENING	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0381	0x0200	SWGR 6 BLOCK OPENING	F001		R	1	
0x0381	0x0400	SWGR 7 BLOCK OPENING	F001		R	1	
0x0381	0x0800	SWGR 8 BLOCK OPENING	F001		R	1	
0x0381	0x1000	SWGR 9 BLOCK OPENING	F001		R	1	
0x0381	0x2000	SWGR 10 BLOCK OPENING	F001		R	1	
0x0381	0x4000	SWGR 11 BLOCK OPENING	F001		R	1	
0x0381	0x8000	SWGR 12 BLOCK OPENING	F001		R	1	
0x0381	0x0001	SWGR 13 BLOCK OPENING	F001		R	1	
0x0381	0x0002	SWGR 14 BLOCK OPENING	F001		R	1	
0x0381	0x0004	SWGR 15 BLOCK OPENING	F001		R	1	
0x0381	0x0008	SWGR 16 BLOCK OPENING	F001		R	1	
0x0381	0x0010	SWGR 1 BLOCK CLOSING	F001		R	1	
0x0381	0x0020	SWGR 2 BLOCK CLOSING	F001		R	1	
0x0381	0x0040	SWGR 3 BLOCK CLOSING	F001		R	1	
0x0381	0x0080	SWGR 4 BLOCK CLOSING	F001		R	1	
0x0382	0x0100	SWGR 5 BLOCK CLOSING	F001		R	1	
0x0382	0x0200	SWGR 6 BLOCK CLOSING	F001		R	1	
0x0382	0x0400	SWGR 7 BLOCK CLOSING	F001		R	1	
0x0382	0x0800	SWGR 8 BLOCK CLOSING	F001		R	1	
0x0382	0x1000	SWGR 9 BLOCK CLOSING	F001		R	1	
0x0382	0x2000	SWGR 10 BLOCK CLOSING	F001		R	1	
0x0382	0x4000	SWGR 11 BLOCK CLOSING	F001		R	1	
0x0382	0x8000	SWGR 12 BLOCK CLOSING	F001		R	1	
0x0382	0x0001	SWGR 13 BLOCK CLOSING	F001		R	1	
0x0382	0x0002	SWGR 14 BLOCK CLOSING	F001		R	1	
0x0382	0x0004	SWGR 15 BLOCK CLOSING	F001		R	1	
0x0382	0x0008	SWGR 16 BLOCK CLOSING	F001		R	1	
Estados Interruptor - Breaker States							
0x0390	0x0010	KI2t PHASE A ALARM	F001		R	1	
0x0390	0x0020	KI2t PHASE B ALARM	F001		R	1	
0x0390	0x0040	KI2t PHASE C ALARM	F001		R	1	
0x0390	0x0080	BKR OPENINGS ALARM	F001		R	1	
0x0391	0x0100	BKR OPEN 1 HOUR ALRM	F001		R	1	
0x0391	0x0200	BREAKER OPEN	F001		R	1	
0x0391	0x0400	BREAKER CLOSED	F001		R	1	
0x0391	0x0800	BREAKER UNDEFINED	F001		R	1	
0x0391	0x1000	RESET KI2t COUNTERS	F001		R	1	
0x0391	0x2000	RESET BKR COUNTERS	F001		R	1	
Estado Mapa Usuario - User Map State							
0x039B	0x4000	USER MAP STATUS	F001		R	1	
Estado Curvas Usuario - Flex Curves States							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x039B	0x8000	FLEXCURVE A STATUS	F001		R	1	
0x03A0	0x0001	FLEXCURVE B STATUS	F001		R	1	
0x03A5	0x0002	FLEXCURVE C STATUS	F001		R	1	
0x03AA	0x0004	FLEXCURVE D STATUS	F001		R	1	
Estados Internos Sistema - Internal System States							
0x03B1	0x0008	Green Zone **	F001		R	1	
0x03B1	0x0010	Yellow Zone **	F001		R	1	
0x03B1	0x0020	Orange Zone **	F001		R	1	
0x03B1	0x0040	Red Zone **	F001		R	1	
**For version previous to 7.00							
Estados Unidad direccional de potencia - Directional Power States							
0x03B2	0x8000	DIR PWR1 BLOCK	F001		R	1	
0x03B2	0x0001	DIR PWR1 STG1 PKP	F001		R	1	
0x03B2	0x0002	DIR PWR1 STG1 OP	F001		R	1	
0x03B2	0x0004	DIR PWR1 STG2 PKP	F001		R	1	
0x03B2	0x0008	DIR PWR1 STG2 OP	F001		R	1	
0x03B2	0x0010	DIR PWR1 STG PKP	F001		R	1	
0x03B2	0x0020	DIR PWR1 STG OP	F001		R	1	
0x03B7	0x0040	DIR PWR2 BLOCK	F001		R	1	
0x03B7	0x0080	DIR PWR2 STG1 PKP	F001		R	1	
0x03B8	0x0100	DIR PWR2 STG1 OP	F001		R	1	
0x03B8	0x0200	DIR PWR2 STG2 PKP	F001		R	1	
0x03B8	0x0400	DIR PWR2 STG2 OP	F001		R	1	
0x03B8	0x0800	DIR PWR2 STG PKP	F001		R	1	
0x03B8	0x1000	DIR PWR2 STG OP	F001		R	1	
0x03BD	0x2000	DIR PWR3 BLOCK	F001		R	1	
0x03BD	0x4000	DIR PWR3 STG1 PKP	F001		R	1	
0x03BD	0x8000	DIR PWR3 STG1 OP	F001		R	1	
0x03BD	0x0001	DIR PWR3 STG2 PKP	F001		R	1	
0x03BD	0x0002	DIR PWR3 STG2 OP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x03BD	0x0004	DIR PWR3 STG PKP	F001		R	1	
0x03BD	0x0008	DIR PWR3 STG OP	F001		R	1	
Estados Unidad de Rotor Bloqueado - Locked Rotor (48)							
0x03C2	0x0010	LOCKED ROTOR1 BLK	F001		R	1	
0x03C2	0x0020	LOCKED ROTOR1 PKP	F001		R	1	
0x03C2	0x0040	LOCKED ROTOR1 OP	F001		R	1	
0x03C3	0x0080	LOCKED ROTOR2 BLK	F001		R	1	
0x03C4	0x0100	LOCKED ROTOR2 PKP	F001		R	1	
0x03C4	0x0200	LOCKED ROTOR2 OP	F001		R	1	
0x03C5	0x0400	LOCKED ROTOR3 BLK	F001		R	1	
0x03C5	0x0800	LOCKED ROTOR3 PKP	F001		R	1	
0x03C5	0x1000	LOCKED ROTOR3 OP	F001		R	1	
Estados Salidas Remotas DNA - DNA Remote Output Status							
0x03E5	0x0008	DNA 1	F001		R	1	
0x03E5	0x0010	DNA 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03E7	0x0004	DNA 32	F001		R	1	
Estados Salidas Remotas Usuario - UserSt Remote Output Status							
0x03E7	0x0008	UserSt 1	F001		R	1	
0x03E5	0x0010	UserSt 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03EB	0x0004	UserSt 64	F001		R	1	
Estados Entradas Remotas - Remote Inputs Status							
0x03EB	0x0008	Remote Input 1	F001		R	1	
0x03EB	0x0010	Remote Input 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03ED	0x0004	Remote Input 32	F001		R	1	
Estados Dispositivos Remotos - Remote Devices Status							
0x03ED	0x0008	Remote Device 1	F001		R	1	
0x03ED	0x0010	Remote Device 2	F001		R	1	
...	...	...	...	...	...	...	...
0x03EF	0x0400	Remote Device 24	F001		R	1	
Estados Sicronizacion Remota - SNTP/IRIG B Status (Do not apply to C650 models)							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x03F2	0x0008	SNTP FAILURE	F001		R	1	
0x03F2	0x0010	IRIGB FAILURE	F001		R	1	
0x03F3	0x0001	CNT PULSES FREEZE	F001		R	1	
0x03F3	0x0002	CNT PULSES UNFREEZE	F001		R	1	
0x03F3	0x0004	CNT PULSES RESET	F001		R	1	
Comparadores analógicos-Analog Comparators							
0x03F8	0x0020	Analog Level 01	F001		R	1	
0x03F8	0x0040	Analog Level 02	F001		R	1	
0x03F8	0x0080	Analog Level 03	F001		R	1	
0x03F9	0x0100	Analog Level 04	F001		R	1	
0x03F9	0x0200	Analog Level 05	F001		R	1	
0x03F9	0x0400	Analog Level 06	F001		R	1	
0x03F9	0x0800	Analog Level 07	F001		R	1	
0x03F9	0x1000	Analog Level 08	F001		R	1	
0x03F9	0x2000	Analog Level 09	F001		R	1	
0x03F9	0x4000	Analog Level 10	F001		R	1	
0x03F9	0x8000	Analog Level 11	F001		R	1	
0x03F9	0x0001	Analog Level 12	F001		R	1	
0x03F9	0x0002	Analog Level 13	F001		R	1	
0x03F9	0x0004	Analog Level 14	F001		R	1	
0x03F9	0x0008	Analog Level 15	F001		R	1	
0x03F9	0x0010	Analog Level 16	F001		R	1	
0x03F9	0x0020	Analog Level 17	F001		R	1	
0x03F9	0x0040	Analog Level 18	F001		R	1	
0x03F9	0x0080	Analog Level 19	F001		R	1	
0x03FA	0x0100	Analog Level 20	F001		R	1	
Estados Derivada de Frecuencia - Frequency Rate of Change States							
0x03FC	0x0002	FREQ RATE1 BLOCK	F001		R	1	
0x03FC	0x0004	FREQ RATE1 PKP	F001		R	1	
0x03FC	0x0008	FREQ RATE1 OP	F001		R	1	
0x0401	0x0010	FREQ RATE2 BLOCK	F001		R	1	
0x0401	0x0020	FREQ RATE2 PKP	F001		R	1	
0x0401	0x0040	FREQ RATE2 OP	F001		R	1	
0x0406	0x0080	FREQ RATE3 BLOCK	F001		R	1	
0x0407	0x0100	FREQ RATE3 PKP	F001		R	1	
0x0407	0x0200	FREQ RATE3 OP	F001		R	1	
Estados función inversión de carga-Load Encroachment Status							
0x040C	0x0400	LOAD ENCR1 BLOC	F001		R	1	
0x040C	0x0800	LOAD ENCR1 PKP	F001		R	1	
0x040C	0x1000	LOAD ENCR1 OP	F001		R	1	
0x0411	0x2000	LOAD ENCR2 BLOCK	F001		R	1	
0x0411	0x4000	LOAD ENCR2 PKP	F001		R	1	
0x0411	0x8000	LOAD ENCR2 OP	F001		R	1	
0x0416	0x0001	LOAD ENCR3 BLOCK	F001		R	1	
0x0416	0x0002	LOAD ENCR3 PKP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0416	0x0004	LOAD ENCR3 OP	F001		R	1	
0x041B	0x0008	NUM OF STARTS BLOCK	F001		R	1	
0x041B	0x0010	NUMBER OF STARTS OP	F001		R	1	
Entradas digitales GOOSE-Rem GOOSE digital Inputs							
0x0421	0x2000	Rem GOOSE Dig Inp 1	F001		R	1	
0x0421	0x4000	Rem GOOSE Dig Inp 2	F001		R	1	
0x0421	0x8000	Rem GOOSE Dig Inp 3	F001		R	1	
0x0421	0x0001	Rem GOOSE Dig Inp 4	F001		R	1	
0x0421	0x0002	Rem GOOSE Dig Inp 5	F001		R	1	
0x0421	0x0004	Rem GOOSE Dig Inp 6	F001		R	1	
0x0421	0x0008	Rem GOOSE Dig Inp 7	F001		R	1	
0x0421	0x0010	Rem GOOSE Dig Inp 8	F001		R	1	
0x0421	0x0020	Rem GOOSE Dig Inp 9	F001		R	1	
0x0421	0x0040	Rem GOOSE Dig Inp 10	F001		R	1	
0x0421	0x0080	Rem GOOSE Dig Inp 11	F001		R	1	
0x0422	0x0100	Rem GOOSE Dig Inp 12	F001		R	1	
0x0422	0x0200	Rem GOOSE Dig Inp 13	F001		R	1	
0x0422	0x0400	Rem GOOSE Dig Inp 14	F001		R	1	
0x0422	0x0800	Rem GOOSE Dig Inp 15	F001		R	1	
0x0422	0x1000	Rem GOOSE Dig Inp 16	F001		R	1	
0x0422	0x2000	Rem GOOSE Dig Inp 17	F001		R	1	
0x0422	0x4000	Rem GOOSE Dig Inp 18	F001		R	1	
0x0422	0x8000	Rem GOOSE Dig Inp 19	F001		R	1	
0x0422	0x0001	Rem GOOSE Dig Inp 20	F001		R	1	
0x0422	0x0002	Rem GOOSE Dig Inp 21	F001		R	1	
0x0422	0x0004	Rem GOOSE Dig Inp 22	F001		R	1	
0x0422	0x0008	Rem GOOSE Dig Inp 23	F001		R	1	
0x0422	0x0010	Rem GOOSE Dig Inp 24	F001		R	1	
0x0422	0x0020	Rem GOOSE Dig Inp 25	F001		R	1	
0x0422	0x0040	Rem GOOSE Dig Inp 26	F001		R	1	
0x0422	0x0080	Rem GOOSE Dig Inp 27	F001		R	1	
0x0423	0x0100	Rem GOOSE Dig Inp 28	F001		R	1	
0x0423	0x0200	Rem GOOSE Dig Inp 29	F001		R	1	
0x0423	0x0400	Rem GOOSE Dig Inp 30	F001		R	1	
0x0423	0x0800	Rem GOOSE Dig Inp 31	F001		R	1	
0x0423	0x1000	Rem GOOSE Dig Inp 32	F001		R	1	
Salidas digitales GOOSE-Remote GOOSE digital Outputs							
0x0423	0x2000	Rem GOOSE Dig Out 1	F001		R	1	
0x0423	0x4000	Rem GOOSE Dig Out 2	F001		R	1	
0x0423	0x8000	Rem GOOSE Dig Out 3	F001		R	1	
0x0423	0x0001	Rem GOOSE Dig Out 4	F001		R	1	
0x0423	0x0002	Rem GOOSE Dig Out 5	F001		R	1	
0x0423	0x0004	Rem GOOSE Dig Out 6	F001		R	1	
0x0423	0x0008	Rem GOOSE Dig Out 7	F001		R	1	
0x0423	0x0010	Rem GOOSE Dig Out 8	F001		R	1	
0x0423	0x0020	Rem GOOSE Dig Out 9	F001		R	1	
0x0423	0x0040	Rem GOOSE Dig Out 10	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0423	0x0080	Rem GOOSE Dig Out 11	F001		R	1	
0x0424	0x0100	Rem GOOSE Dig Out 12	F001		R	1	
0x0424	0x0200	Rem GOOSE Dig Out 13	F001		R	1	
0x0424	0x0400	Rem GOOSE Dig Out 14	F001		R	1	
0x0424	0x0800	Rem GOOSE Dig Out 15	F001		R	1	
0x0424	0x1000	Rem GOOSE Dig Out 16	F001		R	1	
0x0424	0x2000	Rem GOOSE Dig Out 17	F001		R	1	
0x0424	0x4000	Rem GOOSE Dig Out 18	F001		R	1	
0x0424	0x8000	Rem GOOSE Dig Out 19	F001		R	1	
0x0424	0x0001	Rem GOOSE Dig Out 20	F001		R	1	
0x0424	0x0002	Rem GOOSE Dig Out 21	F001		R	1	
0x0424	0x0004	Rem GOOSE Dig Out 22	F001		R	1	
0x0424	0x0008	Rem GOOSE Dig Out 23	F001		R	1	
0x0424	0x0010	Rem GOOSE Dig Out 24	F001		R	1	
0x0424	0x0020	Rem GOOSE Dig Out 25	F001		R	1	
0x0424	0x0040	Rem GOOSE Dig Out 26	F001		R	1	
0x0424	0x0080	Rem GOOSE Dig Out 27	F001		R	1	
0x0425	0x0100	Rem GOOSE Dig Out 28	F001		R	1	
0x0425	0x0200	Rem GOOSE Dig Out 29	F001		R	1	
0x0425	0x0400	Rem GOOSE Dig Out 30	F001		R	1	
0x0425	0x0800	Rem GOOSE Dig Out 31	F001		R	1	
0x0425	0x1000	Rem GOOSE Dig Out 32	F001		R	1	
Estados Función 32N (Nivel Alto y Nivel Bajo) - Wattmetric Ground Fault Status (High and Low Level)							
0x0450	0x0080	32N1 HIGH BLOCK	F001		R	1	
0x0451	0x0100	32N1 HIGH PKP	F001		R	1	
0x0451	0x0200	32N1 HIGH OC PKP	F001		R	1	
0x0451	0x0400	32N1 HIGH OP	F001		R	1	
0x0452	0x0800	32N2 HIGH BLOCK	F001		R	1	
0x0452	0x1000	32N2 HIGH PKP	F001		R	1	
0x0452	0x2000	32N2 HIGH OC PKP	F001		R	1	
0x0452	0x4000	32N2 HIGH OP	F001		R	1	
0x0453	0x8000	32N3 HIGH BLOCK	F001		R	1	
0x0453	0x0001	32N3 HIGH PKP	F001		R	1	
0x0453	0x0002	32N3 HIGH OC PKP	F001		R	1	
0x0453	0x0004	32N3 HIGH OP	F001		R	1	
0x0454	0x0008	32N1 LOW BLOCK	F001		R	1	
0x0454	0x0010	32N1 LOW PKP	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0454	0x0020	32N1 LOW OC PKP	F001		R	1	
0x0454	0x0040	32N1 LOW OP	F001		R	1	
0x0455	0x0080	32N2 LOW BLOCK	F001		R	1	
0x0456	0x0100	32N2 LOW PKP	F001		R	1	
0x0456	0x0200	32N2 LOW OC PKP	F001		R	1	
0x0456	0x0400	32N2 LOW OP	F001		R	1	
0x0457	0x0800	32N3 LOW BLOCK	F001		R	1	
0x0457	0x1000	32N3 LOW PKP	F001		R	1	
0x0457	0x2000	32N3 LOW OC PKP	F001		R	1	
0x0457	0x4000	32N3 LOW OP	F001		R	1	
Digital Counters actual values							
0x04A4	0x0002	DIGCNT 1 BLOCK	F001		R	1	
0x04A4	0x0004	DIGCNT 2 BLOCK	F001		R	1	
0x04A4	0x0008	DIGCNT 3 BLOCK	F001		R	1	
0x04A4	0x0010	DIGCNT 4 BLOCK	F001		R	1	
0x04A4	0x0020	DIGCNT 5 BLOCK	F001		R	1	
0x04A4	0x0040	DIGCNT 6 BLOCK	F001		R	1	
0x04A4	0x0080	DIGCNT 7 BLOCK	F001		R	1	
0x04A5	0x0100	DIGCNT 8 BLOCK	F001		R	1	
0x04A5	0x0200	DIGCNT 1 HI	F001		R	1	
0x04A5	0x0400	DIGCNT 2 HI	F001		R	1	
0x04A5	0x0800	DIGCNT 3 HI	F001		R	1	
0x04A5	0x1000	DIGCNT 4 HI	F001		R	1	
0x04A5	0x2000	DIGCNT 5 HI	F001		R	1	
0x04A5	0x4000	DIGCNT 6 HI	F001		R	1	
0x04A5	0x8000	DIGCNT 7 HI	F001		R	1	
0x04A5	0x0001	DIGCNT 8 HI	F001		R	1	
0x04A5	0x0002	DIGCNT 1 EQ	F001		R	1	
0x04A5	0x0004	DIGCNT 2 EQ	F001		R	1	
0x04A5	0x0008	DIGCNT 3 EQ	F001		R	1	
0x04A5	0x0010	DIGCNT 4 EQ	F001		R	1	
0x04A5	0x0020	DIGCNT 5 EQ	F001		R	1	
0x04A5	0x0040	DIGCNT 6 EQ	F001		R	1	
0x04A5	0x0080	DIGCNT 7 EQ	F001		R	1	
0x04A6	0x0100	DIGCNT 8 EQ	F001		R	1	
0x04A6	0x0200	DIGCNT 1 LO	F001		R	1	
0x04A6	0x0400	DIGCNT 2 LO	F001		R	1	
0x04A6	0x0800	DIGCNT 3 LO	F001		R	1	
0x04A6	0x1000	DIGCNT 4 LO	F001		R	1	
0x04A6	0x2000	DIGCNT 5 LO	F001		R	1	
0x04A6	0x4000	DIGCNT 6 LO	F001		R	1	
0x04A6	0x8000	DIGCNT 7 LO	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x04A6	0x0001	DIGCNT 8 LO	F001		R	1	
0x04A6	0x0002	DIGCNT 1 UP	F001		R	1	
0x04A6	0x0004	DIGCNT 2 UP	F001		R	1	
0x04A6	0x0008	DIGCNT 3 UP	F001		R	1	
0x04A6	0x0010	DIGCNT 4 UP	F001		R	1	
0x04A6	0x0020	DIGCNT 5 UP	F001		R	1	
0x04A6	0x0040	DIGCNT 6 UP	F001		R	1	
0x04A6	0x0080	DIGCNT 7 UP	F001		R	1	
0x04A7	0x0100	DIGCNT 8 UP	F001		R	1	
0x04A7	0x0200	DIGCNT 1 DOWN	F001		R	1	
0x04A7	0x0400	DIGCNT 2 DOWN	F001		R	1	
0x04A7	0x0800	DIGCNT 3 DOWN	F001		R	1	
0x04A7	0x1000	DIGCNT 4 DOWN	F001		R	1	
0x04A7	0x2000	DIGCNT 5 DOWN	F001		R	1	
0x04A7	0x4000	DIGCNT 6 DOWN	F001		R	1	
0x04A7	0x8000	DIGCNT 7 DOWN	F001		R	1	
0x04A7	0x0001	DIGCNT 8 DOWN	F001		R	1	
0x04A7	0x0002	DIGCNT 1 SETPRESET	F001		R	1	
0x04A7	0x0004	DIGCNT 2 SETPRESET	F001		R	1	
0x04A7	0x0008	DIGCNT 3 SETPRESET	F001		R	1	
0x04A7	0x0010	DIGCNT 4 SETPRESET	F001		R	1	
0x04A7	0x0020	DIGCNT 5 SETPRESET	F001		R	1	
0x04A7	0x0040	DIGCNT 6 SETPRESET	F001		R	1	
0x04A7	0x0080	DIGCNT 7 SETPRESET	F001		R	1	
0x04A8	0x0100	DIGCNT 8 SETPRESET	F001		R	1	
0x04A8	0x0200	DIGCNT 1 RESET	F001		R	1	
0x04A8	0x0400	DIGCNT 2 RESET	F001		R	1	
0x04A8	0x0800	DIGCNT 3 RESET	F001		R	1	
0x04A8	0x1000	DIGCNT 4 RESET	F001		R	1	
0x04A8	0x2000	DIGCNT 5 RESET	F001		R	1	
0x04A8	0x4000	DIGCNT 6 RESET	F001		R	1	
0x04A8	0x8000	DIGCNT 7 RESET	F001		R	1	
0x04A8	0x0001	DIGCNT 8 RESET	F001		R	1	
0x04A8	0x0002	DIGCNT 1 FREEZERESET	F001		R	1	
0x04A8	0x0004	DIGCNT 2 FREEZERESET	F001		R	1	
0x04A8	0x0008	DIGCNT 3 FREEZERESET	F001		R	1	
0x04A8	0x0010	DIGCNT 4 FREEZERESET	F001		R	1	
0x04A8	0x0020	DIGCNT 5 FREEZERESET	F001		R	1	
0x04A8	0x0040	DIGCNT 6 FREEZERESET	F001		R	1	
0x04A8	0x0080	DIGCNT 7 FREEZERESET	F001		R	1	
0x04A9	0x0100	DIGCNT 8 FREEZERESET	F001		R	1	
0x04A9	0x0200	DIGCNT 1 FREEZECOUNT	F001		R	1	
0x04A9	0x0400	DIGCNT 2 FREEZECOUNT	F001		R	1	
0x04A9	0x0800	DIGCNT 3 FREEZECOUNT	F001		R	1	
0x04A9	0x1000	DIGCNT 4 FREEZECOUNT	F001		R	1	
0x04A9	0x2000	DIGCNT 5 FREEZECOUNT	F001		R	1	
0x04A9	0x4000	DIGCNT 6 FREEZECOUNT	F001		R	1	
0x04A9	0x8000	DIGCNT 7 FREEZECOUNT	F001		R	1	
0x04A9	0x0001	DIGCNT 8 FREEZECOUNT	F001		R	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Cold Load Pick up actual values							
0x04D8	0x0002	Cold Load PKP	F001		R	1	
0x04D8	0x0004	Cold Load OP	F001		R	1	
0x04D8	0x0008	Cold Load BLOCK	F001		R	1	
Entradas Analógicas (Tarjetas F y G)- Analog Inputs (F and G boards) (Not applicable to C650 models)							
0x0B06		ANALOG_INP_F_01	F002	1000	R	2	
0x0B08		ANALOG_INP_F_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x0B14		ANALOG_INP_F_08	F002	1000	R	2	
0x0B86		ANALOG_INP_G_01	F002	1000	R	2	
0x0B88		ANALOG_INP_G_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x0B94		ANALOG_INP_G_08	F002	1000	R	2	
Medidas en Valores Secundarios - Analog measures in Secondary Values							
0x0C00		Phasor Ia	F002	1000	R	2	
0x0C02		RMS Ia	F002	1000	R	2	
0x0C04		Ia Real	F002	1000	R	2	
0x0C06		Ia Imag	F002	1000	R	2	
0x0C08		Phasor Ib	F002	1000	R	2	
0x0C0A		RMS Ib	F002	1000	R	2	
0x0C0C		Ib Real	F002	1000	R	2	
0x0C0E		Ib Imag	F002	1000	R	2	
0x0C10		Phasor Ic	F002	1000	R	2	
0x0C12		RMS Ic	F002	1000	R	2	
0x0C14		Ic Real	F002	1000	R	2	
0x0C16		Ic Imag	F002	1000	R	2	
0x0C18		Phasor In	F002	1000	R	2	
0x0C1A		In Real	F002	1000	R	2	
0x0C1C		In Imag	F002	1000	R	2	
0x0C1E		Phasor Ig	F002	1000	R	2	
0x0C20		RMS Ig	F002	1000	R	2	
0x0C22		Ig Real	F002	1000	R	2	
0x0C24		Ig Imag	F002	1000	R	2	
0x0C26		Phasor Isg	F002	1000	R	2	
0x0C28		RMS Isg	F002	1000	R	2	
0x0C2A		Isg Real	F002	1000	R	2	
0x0C2C		Isg Imag	F002	1000	R	2	
0x0C2E		Zero seq I0	F002	1000	R	2	
0x0C30		I0 Real	F002	1000	R	2	
0x0C32		I0 Imag	F002	1000	R	2	
0x0C34		Positive Seq I1	F002	1000	R	2	
0x0C36		I1 Real	F002	1000	R	2	
0x0C38		I1 Imag	F002	1000	R	2	
0x0C3A		Negative Seq I2	F002	1000	R	2	
0x0C3C		I2 Real	F002	1000	R	2	
0x0C3E		I2 Imag	F002	1000	R	2	
0x0C40		Phasor Vab	F002	1000	R	2	
0x0C42		Vab Real	F002	1000	R	2	
0x0C44		Vab Imag	F002	1000	R	2	
0x0C46		Phasor Vbc	F002	1000	R	2	
0x0C48		Vbc Real	F002	1000	R	2	
0x0C4A		Vbc Imag	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0C4C		Phasor Vca	F002	1000	R	2	
0x0C4E		Vca Real	F002	1000	R	2	
0x0C50		Vca Imag	F002	1000	R	2	
0x0C52		Phasor Van	F002	1000	R	2	
0x0C54		Va Real	F002	1000	R	2	
0x0C56		Va Imag	F002	1000	R	2	
0x0C58		Phasor Vbn	F002	1000	R	2	
0x0C5A		Vb Real	F002	1000	R	2	
0x0C5C		Vb Imag	F002	1000	R	2	
0x0C5E		Phasor Vcn	F002	1000	R	2	
0x0C60		Vc Real	F002	1000	R	2	
0x0C62		Vc Imag	F002	1000	R	2	
0x0C64		Phasor Vn	F002	1000	R	2	
0x0C66		Vn Real	F002	1000	R	2	
0x0C68		Vn Imag	F002	1000	R	2	
0x0C6A		Positive Seq V1	F002	1000	R	2	
0x0C6C		V1 Real	F002	1000	R	2	
0x0C6E		V1 Imag	F002	1000	R	2	
0x0C70		Negative Seq V2	F002	1000	R	2	
0x0C72		V2 Real	F002	1000	R	2	
0x0C74		V2 Imag	F002	1000	R	2	
0x0C76		Zero Seq V0	F002	1000	R	2	
0x0C78		V0 Real	F002	1000	R	2	
0x0C7A		V0 Imag	F002	1000	R	2	
0x0C7C		Phasor Vx	F002	1000	R	2	
0x0C7E		Vx Real	F002	1000	R	2	
0x0C80		Vx Imag	F002	1000	R	2	
0x0C82		Nominal Voltage	F002	1000	R	2	
0x0C84		VL Real	F002	1000	R	2	
0x0C86		VL Imag	F002	1000	R	2	
0x0C88		VBB Real	F002	1000	R	2	
0x0C8A		VBB Imag	F002	1000	R	2	
0x0C8C		Line Voltage	F002	1000	R	2	
0x0C8E		Bus Voltage	F002	1000	R	2	
0x0C90		Line Frequency	F002	1000	R	2	
0x0C92		Bus Frequency	F002	1000	R	2	
0x0C94		Phase A Apparent Pwr	F002	1000	R	2	
0x0C96		Phase B Apparent Pwr	F002	1000	R	2	
0x0C98		Phase C Apparent Pwr	F002	1000	R	2	
0x0C9A		Phase A Real Pwr	F002	1000	R	2	
0x0C9C		Phase B Real Pwr	F002	1000	R	2	
0x0C9E		Phase C Real Pwr	F002	1000	R	2	
0x0CA0		Phase A Reactive Pwr	F002	1000	R	2	
0x0CA2		Phase B Reactive Pwr	F002	1000	R	2	
0x0CA4		Phase C Reactive Pwr	F002	1000	R	2	
0x0CA6		3 Phase Apparent Pwr	F002	1000	R	2	
0x0CA8		3 Phase Real Pwr	F002	1000	R	2	
0x0CAA		3 Phase Reactive Pwr	F002	1000	R	2	
0x0CAC		Phase A Power Factor	F002	1000	R	2	
0x0CAE		Phase B Power Factor	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0CB0		Phase C Power Factor	F002	1000	R	2	
0x0CB2		3 Phase Power Factor	F002	1000	R	2	
Ratios corriente y tensión - Current and Voltage Ratios							
0x0CB4		CT Ratio	F002	1000	R	2	
0x0CB6		CT Ratio Ig	F002	1000	R	2	
0x0CB8		CT Ratio Isg	F002	1000	R	2	
0x0CBA		PT Ratio	F002	1000	R	2	
Angulos - Angles							
0x0CBC		Ia Angle	F002	1000	R	2	
0x0CBE		Ib Angle	F002	1000	R	2	
0x0CC0		Ic Angle	F002	1000	R	2	
0x0CC2		In Angle	F002	1000	R	2	
0x0CC4		Ig Angle	F002	1000	R	2	
0x0CC6		Isg Angle	F002	1000	R	2	
0x0CC8		Va Angle	F002	1000	R	2	
0x0CCA		Vb Angle	F002	1000	R	2	
0x0CCC		Vc Angle	F002	1000	R	2	
0x0CCE		Vn Angle	F002	1000	R	2	
0x0CD0		Vx Angle	F002	1000	R	2	
0x0CD2		Vab Angle	F002	1000	R	2	
0x0CD4		Vbc Angle	F002	1000	R	2	
0x0CD6		Vca Angle	F002	1000	R	2	
Frequency rate of change value							
0x0CD8		df/dt	F002	10000	R	2	
Versión del HMI - HMI Version							
0x0CE2		HMI Version	F004	1000	R	1	
0x0CE3		DISPLAY TYPE	F004	1000	R	1	
0x0CE4		PreFault Ia Mod	F002	1000000	R	2	
0x0CE6		PreFault Ia Ang	F003	1000	R	2	
0x0CE8		PreFault Ib Mod	F002	1000000	R	2	
0x0CEA		PreFault Ib Ang	F003	1000	R	2	
0x0CEC		PreFault Ic Mod	F002	1000000	R	2	
0x0CEE		PreFault Ic Ang	F003	1000	R	2	
0x0CF0		PreFault Vab Mod	F002	1000000	R	2	
0x0CF2		PreFault Vab Ang	F003	1000	R	2	
0x0CF4		PreFault Vbc Mod	F002	1000000	R	2	
0x0CF6		PreFault Vbc Ang	F003	1000	R	2	
0x0CF8		PreFault Vca Mod	F002	1000000	R	2	
0x0CFA		PreFault Vca Ang	F003	1000	R	2	
0x0CFC		PreFault Ig Mod	F002	1000000	R	2	
0x0CFE		PreFault Ig Ang	F003	1000	R	2	
0x0D00		PreFault Isg Mod	F002	1000000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0D02		PreFault Isg Ang	F003	1000	R	2	
0x0D04		PostFault Ia Mod	F002	1000000	R	2	
0x0D06		PostFault Ia Ang	F003	1000	R	2	
0x0D08		PostFault Ib Mod	F002	1000000	R	2	
0x0D0A		PostFault Ib Ang	F003	1000	R	2	
0x0D0C		PostFault Ic Mod	F002	1000000	R	2	
0x0D0E		PostFault Ic Ang	F003	1000	R	2	
0x0D10		PostFault Vab Mod	F002	1000000	R	2	
0x0D12		PostFault Vab Ang	F003	1000	R	2	
0x0D14		PostFault Vbc Mod	F002	1000000	R	2	
0x0D16		PostFault Vbc Ang	F003	1000	R	2	
0x0D18		PostFault Vca Mod	F002	1000000	R	2	
0x0D1A		PostFault Vca Ang	F003	1000	R	2	
0x0D1C		PostFault Ig Mod	F002	1000000	R	2	
0x0D1E		PostFault Ig Ang	F003	1000	R	2	
0x0D20		PostFault Isg Mod	F002	1000000	R	2	
0x0D22		PostFault Isg Ang	F003	1000	R	2	
Valores Imagen Térmica - Thermal Image Values							
0x0DD9		THERMAL1 IMAGE A	F003	1	R	2	
0x0DDB		THERMAL1 IMAGE B	F003	1	R	2	
0x0DDD		THERMAL1 IMAGE C	F003	1	R	2	
0x0DE4		THERMAL2 IMAGE A	F003	1	R	2	
0x0DE6		THERMAL2 IMAGE B	F003	1	R	2	
0x0DE8		THERMAL2 IMAGE C	F003	1	R	2	
0x0DEF		THERMAL3 IMAGE A	F003	1	R	2	
0x0DF1		THERMAL3 IMAGE B	F003	1	R	2	
0x0DF3		THERMAL3 IMAGE C	F003	1	R	2	
Diferencia de tensión para la función de sincronismo-Voltage Difference for synchrocheck unit							
0x0E31		VOLTAGE DIFFERENCE	F002	10000	R	2	
Diferencia de Frecuencia para la función de sincronismo-Frequency Difference for synchrocheck unit							
0x0E33		FREQ. DIFFERENCE	F002	10000	R	2	
Estados Reenganchador (Enumerado) - Autorecloser Status							
0x0E36		AR STATUS	F012		R	1	0=OUT OF SERVICE
							1=READY
							2=LOCKOUT
							3=BLOCK
							4=RECLOSE IN PROGRESS
0x0E37		AR LOCKOUT MODE	F012		R	1	0=NONE
							1=ANOMALY
							2=FAIL TO OPEN
							3=FAIL TO CLOSE

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							4=MANUAL
							5=NO CONDITIONS
							6=MAX NUMBER OF TRIPS
							7=LAST SHOT
0x0E38		AR BLOCK MODE	F012		R	1	0=NONE
							1=LEVEL
							2=PULSE
							3=LEVEL+PULSE
Estados Oscilografía - Oscillography States							
0x0EB6		NUMBER OF TRIGGERS	F004	1	R	1	
0x0EB7		CYCLES PER RECORD	F004	1	R	1	
0x0EB8		AVAILABLE RECORDS	F004	1	R	1	
Estados Localizador de Faltas - Fault Report States							
0x0EBB		FAULT DATE	F011		R	3	
0x0EBE		FAULT TYPE	F012		R	1	0=GROUND
							1=PHASE
							2=3 PH
							3=AG
							4=ABG
							5=AB
							6=BG
							7=BCG
							8=BC
							9=CG
							10=CAG
							11=CA
							12=NAF
0x0EBF		FAULT LOCATION	F003	1	R	2	
0x0EC1		FAULT REPORT NUMBER	F005	1	R	2	
0x0EC3		R Primary	F003	1000	R	2	
0x0EC5		R Secondary	F003	1000	R	2	
0x0EC7		X Primary	F003	1000	R	2	
0x0EC9		X Secondary	F003	1000	R	2	
0x0ECB		FAULT RESISTANCE	F003		R	2	
Medidas en Valores Primarios - Analog measures in Primary Values							
0x0EE2		Phasor Ia Primary	F002	1000	R	2	
0x0EE4		Phasor Ib Primary	F002	1000	R	2	
0x0EE6		Phasor Ic Primary	F002	1000	R	2	
0x0EE8		Phasor Ig Primary	F002	1000	R	2	
0x0EEA		Phasor Isg Primary	F002	1000	R	2	
0x0EEC		Phasor In Primary	F002	1000	R	2	
0x0EEE		RMS Ia Primary	F002	1000	R	2	
0x0EF0		RMS Ib Primary	F002	1000	R	2	
0x0EF2		RMS Ic Primary	F002	1000	R	2	
0x0EF4		RMS Ig Primary	F002	1000	R	2	
0x0EF6		RMS Isg Primary	F002	1000	R	2	
0x0EF8		I0 Primary	F002	1000	R	2	
0x0EFA		I1 Primary	F002	1000	R	2	
0x0EFC		I2 Primary	F002	1000	R	2	
0x0EFE		V0 Primary	F002	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0F00		V1 Primary	F002	1000	R	2	
0x0F02		V2 Primary	F002	1000	R	2	
0x0F04		Vab Primary	F002	1000	R	2	
0x0F06		Vbc Primary	F002	1000	R	2	
0x0F08		Vca Primary	F002	1000	R	2	
0x0F0A		Va Primary	F002	1000	R	2	
0x0F0C		Vb Primary	F002	1000	R	2	
0x0F0E		Vc Primary	F002	1000	R	2	
0x0F10		Vn Primary	F002	1000	R	2	
0x0F12		Vx Primary	F002	1000	R	2	
0x0F14		VBB Primary	F002	1000	R	2	
0x0F16		VL Primary	F002	1000	R	2	
0x0F18		Phase A Real Pwr	F002	1000	R	2	
0x0F1A		Phase A Reactive Pwr	F002	1000	R	2	
Medidas en Valores Primarios - Analog measures in Primary Values (cont.)							
0x0F1C		Phase A Apparent Pwr	F002	1000	R	2	
0x0F1E		Phase B Real Pwr	F002	1000	R	2	
0x0F20		Phase B Reactive Pwr	F002	1000	R	2	
0x0F22		Phase B Apparent Pwr	F002	1000	R	2	
0x0F24		Phase C Real Pwr	F002	1000	R	2	
0x0F26		Phase C Reactive Pwr	F002	1000	R	2	
0x0F28		Phase C Apparent Pwr	F002	1000	R	2	
0x0F2A		3 Phase Real Pwr	F002	1000	R	2	
0x0F2C		3 Phase Reactive Pwr	F002	1000	R	2	
0x0F2E		3 Phase Apparent Pwr	F002	1000	R	2	
0x0F30		Phase A Power Factor	F002	1000	R	2	
0x0F32		Phase B Power Factor	F002	1000	R	2	
0x0F34		Phase C Power Factor	F002	1000	R	2	
0x0F36		3 Phase Power Factor	F002	1000	R	2	
0x0F38		Line Frequency	F002	1000	R	2	
0x0F3A		Bus Frequency	F002	1000	R	2	
0x0F3C		Positive MWatthour	F002	1000	R	2	
0x0F3E		Negative MWatthour	F002	1000	R	2	
0x0F40		Positive MVarhour	F002	1000	R	2	
0x0F42		Negative MVarhour	F002	1000	R	2	
0x0F44		Pos MWatthour Cnt	F002	1000	R	2	
0x0F46		Neg MWatthour Cnt	F002	1000	R	2	
0x0F48		Pos MVarhour Cnt	F002	1000	R	2	
0x0F4A		Neg MVarhour Cnt	F002	1000	R	2	
0x0F4C		% of Load-To-Trip	F002	1000	R	2	
Medidas Demanda - Demand measures							
0x0FAB		DEMAND IA	F002	1000	R	2	
0x0FAD		DEMAND IA MAX	F002	1000	R	2	
0x0FAF		DEMAND IA DATE	F011		R	3	
0x0FB2		DEMAND IB	F002	1000	R	2	
0x0FB4		DEMAND IB MAX	F002	1000	R	2	
0x0FB6		DEMAND IB DATE	F011		R	3	
0x0FB9		DEMAND IC	F002	1000	R	2	
0x0FBB		DEMAND IC MAX	F002	1000	R	2	
0x0FBD		DEMAND IC DATE	F011		R	3	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x0FC0		DEMAND IG	F002	1000	R	2	
0x0FC2		DEMAND IG MAX	F002	1000	R	2	
0x0FC4		DEMAND IG DATE	F011		R	3	
0x0FC7		DEMAND ISG	F002	1000	R	2	
0x0FC9		DEMAND ISG MAX	F002	1000	R	2	
0x0FCB		DEMAND ISG DATE	F011		R	3	
0x0FCE		DEMAND I2	F002	1000	R	2	
0x0FD0		DEMAND I2 MAX	F002	1000	R	2	
0x0FD2		DEMAND I2 DATE	F011		R	3	
0x0FD5		DEMAND W	F002	1000	R	2	
0x0FD7		DEMAND W MAX	F002	1000	R	2	
0x0FEA		DEMAND W MIN	F002	1000	R	2	
0x0FD9		DEMAND W DATE	F011		R	3	
0x0FDC		DEMAND VAR PWR	F002	1000	R	2	
0x0FDE		DEMAND VAR MAX	F002	1000	R	2	
0x0FEC		DEMAND VAR MIN	F002	1000	R	2	
0x0FE0		DEMAND VAR DATE	F011		R	3	
0x0FE3		DEMAND VA PWR	F002	1000	R	2	
0x0FE5		DEMAND VA MAX	F002	1000	R	2	
0x0FEE		DEMAND VA MIN	F002	1000	R	2	
0x0FE7		DEMAND VA DATE	F011		R	3	
Entradas Analógicas (Tarjetas J y H)- Analog Inputs (J and H boards)							
0x0FFE		ANALOG_INP_H_01	F002	1000	R	2	
0x1000		ANALOG_INP_H_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x100C		ANALOG_INP_H_08	F002	1000	R	2	
0x107E		ANALOG_INP_J_01	F002	1000	R	2	
0x1080		ANALOG_INP_J_02	F002	1000	R	2	
...		...	...	...	...	...	...
0x108C		ANALOG_INP_J_08	F002	1000	R	2	
Contadores de Interruptor - Breaker Counters							
0x111D		BREAKER OPENINGS	F005	1	R	2	
0x111F		BREAKER CLOSINGS	F005	1	R	2	
0x1121		KI2t PHASE A	F003	1	R	2	
0x1123		KI2t PHASE B	F003	1	R	2	
0x1125		KI2t PHASE C	F003	1	R	2	
0x1127		BKR OPENING TIME	F003	1	R	2	
0x1129		BKR CLOSING TIME	F003	1	R	2	
0x112B		BKR OPEN TIMING	F003	1	R	2	
0x112D		BKR CLOSE TIMING	F003	1	R	2	
Registrador de Datos - Data Logger							
0x1153		OLDEST SAMPLE TIME	F011		R	3	
0x1156		NEWEST SAMPLE TIME	F011		R	3	
0x1159		DATA LOGGER CHANNELS	F004	1	R	1	
0x115A		DATA LOGGER DAYS	F003	1	R	2	
Estados Internos Sistema - Internal System States							
0x1160		Kswapd Time **	F005	1	R	2	
0x1162		mtd2 Time **	F005	1	R	2	
0x1164		mtd3 Time **	F005	1	R	2	
0x1166		CPU Rtai **	F005	1	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x1168		CPU Linux **	F005	1	R	2	
0x116A		Total RAM	F005	1024	R	2	
0x116C		Used DRAM	F005	1024	R	2	
0x116E		Free RAM **	F005	1024	R	2	
0x1170		Shared RAM **	F005	1024	R	2	
0x1172		Buffer RAM **	F005	1024	R	2	
0x1174		Cached RAM **	F005	1024	R	2	
0x1176		Green Counter **	F005	1	R	2	
0x1178		Yellow Counter **	F005	1	R	2	
0x117A		Orange Counter **	F005	1	R	2	
0x117C		Red Counter **	F005	1	R	2	
0x117E		UpTime	F005	1	R	2	
0x1180		DSP Counter	F005	1000	R	2	
0x1182		CPU Usage	F004	1000	R	1	
0x120E		ICD STATUS	F012		R	1	0=UNKNOWN
							1=ICD ERROR
							2=MODIFIED
							3=IN PROGRESS
							4=OK WITHOUT DAIS
							5=OK
							6=NotValidated Empty
							7=Passed to Validated
							8=Default
							9=ERROR HEADER CID
							10=ERROR SG CID
0x120F		ICD STATUS NOTVAL	F012		R	1	0=UNKNOWN
							1=ICD ERROR
							2=MODIFIED
							3=IN PROGRESS
							4=OK WITHOUT DAIS
							5=OK
							6=NotValidated Empty
							7=Passed to Validated
							8=Default
							9=ERROR HEADER CID
							10=ERROR SG CID

** For version previous to 7.00

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Valor del Contador de Pulsos-Pulse Counter Value							
0x121B		PulseCntr Value 1	F002	1000 000	R	2	
0x121D		PulseCntr Value 2	F002	1000 000	R	2	
0x121F		PulseCntr Value 3	F002	1000 000	R	2	
0x1221		PulseCntr Value 4	F002	1000 000	R	2	
0x1223		PulseCntr Value 5	F002	1000 000	R	2	
0x1225		PulseCntr Value 6	F002	1000 000	R	2	
0x1227		PulseCntr Value 7	F002	1000 000	R	2	
0x1229		PulseCntr Value 8	F002	1000 000	R	2	
Valor del Contador de Pulsos Congelado-Freeze Pulse Counter Value							
0x122B		PulseCntr Freeze 1	F002	1000 000	R	2	
0x122D		PulseCntr Freeze 2	F002	1000 000	R	2	
0x122F		PulseCntr Freeze 3	F002	1000 000	R	2	
0x1231		PulseCntr Freeze 4	F002	1000 000	R	2	
0x1233		PulseCntr Freeze 5	F002	1000 000	R	2	
0x1235		PulseCntr Freeze 6	F002	1000 000	R	2	
0x1237		PulseCntr Freeze 7	F002	1000 000	R	2	
0x1239		PulseCntr Freeze 8	F002	1000 000	R	2	
0x1263		GLOBAL STARTS CNT	F005	1000	R	2	
0x1265		BLOCK LOCKOUT TIME	F005	1000	R	2	
Entradas analógicas remotas tipo float- Float Remote Analog Input							
0x126D		Rem Ana Inp FLOAT 1	F003	1000	R	2	
0x126F		Rem Ana Inp FLOAT 2	F003	1000	R	2	
0x1271		Rem Ana Inp FLOAT 3	F003	1000	R	2	
0x1273		Rem Ana Inp FLOAT 4	F003	1000	R	2	
0x1275		Rem Ana Inp FLOAT 5	F003	1000	R	2	
0x1277		Rem Ana Inp FLOAT 6	F003	1000	R	2	
0x1279		Rem Ana Inp FLOAT 7	F003	1000	R	2	
0x127B		Rem Ana Inp FLOAT 8	F003	1000	R	2	
Entradas analogicas remotas tipo entero- Integer Remote Analog Input							
0x127D		Rem Ana Inp INT 1	F005	1000	R	2	
0x127F		Rem Ana Inp INT 2	F005	1000	R	2	
0x1281		Rem Ana Inp INT 3	F005	1000	R	2	
0x1283		Rem Ana Inp INT 4	F005	1000	R	2	
0x1285		Rem Ana Inp INT 5	F005	1000	R	2	
0x1287		Rem Ana Inp INT 6	F005	1000	R	2	
0x1289		Rem Ana Inp INT 7	F005	1000	R	2	
0x128B		Rem Ana Inp INT 8	F005	1000	R	2	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Medidas Potencia Función 32N (Nivel Alto y Bajo) - wattmetric Ground Fault Power Measurements (High and Low Level)							
0x1349		32N1 HIGH POWER	F002	1000	R	2	
0x1350		32N2 HIGH POWER	F002	1000	R	2	
0x1357		32N3 HIGH POWER	F002	1000	R	2	
0x135E		32N1 LOW POWER	F002	1000	R	2	
0x1365		32N2 LOW POWER	F002	1000	R	2	
0x136C		32N3 LOW POWER	F002	1000	R	2	
Digital Counters Status							
0x147D		DIGCNT 1 VALUE	F005	1000	R	2	
0x147F		DIGCNT 2 VALUE	F005	1000	R	2	
0x1481		DIGCNT 3 VALUE	F005	1000	R	2	
0x1483		DIGCNT 4 VALUE	F005	1000	R	2	
0x1485		DIGCNT 5 VALUE	F005	1000	R	2	
0x1487		DIGCNT 6 VALUE	F005	1000	R	2	
0x1489		DIGCNT 7 VALUE	F005	1000	R	2	
0x148B		DIGCNT 8 VALUE	F005	1000	R	2	
0x148D		DIGCNT 1 FROZENVALUE	F005	1000	R	2	
0x148F		DIGCNT 2 FROZENVALUE	F005	1000	R	2	
0x1491		DIGCNT 3 FROZENVALUE	F005	1000	R	2	
0x1493		DIGCNT 4 FROZENVALUE	F005	1000	R	2	
0x1495		DIGCNT 5 FROZENVALUE	F005	1000	R	2	
0x1497		DIGCNT 6 FROZENVALUE	F005	1000	R	2	
0x1499		DIGCNT 7 FROZENVALUE	F005	1000	R	2	
0x149B		DIGCNT 8 FROZENVALUE	F005	1000	R	2	
0x149D		DIGCNT 1 FROZENDATE	F011		R	3	
0x14A0		DIGCNT 2 FROZENDATE	F011		R	3	
0x14A3		DIGCNT 3 FROZENDATE	F011		R	3	
0x14A6		DIGCNT 4 FROZENDATE	F011		R	3	
0x14A9		DIGCNT 5 FROZENDATE	F011		R	3	
0x14AC		DIGCNT 6 FROZENDATE	F011		R	3	
0x14AF		DIGCNT 7 FROZENDATE	F011		R	3	
0x14B2		DIGCNT 8 FROZENDATE	F011		R	3	
PTP 1588 Status							
0x14E5		RTC Sync Source	F012	1000	R	1	0=INTERNAL
							1=PTP-PORT
							2=SNTP
							3=IRIG-B
							4=SNTP2
0x14E6		GrandMaster-ID LOW	F009	1000	R	4	
0x14EA		GrandMaster-ID HIGH	F009	1000	R	4	
0x14EE		PTP ACCURACY	F005	1000	R	2	
0x14F0		PTP PORT A STATE	F012	1000	R	1	0=DISABLED
							1=NO SIGNAL
							2=CALIBRATING
							3=SYNCHD_NO_PDELAY
							4=SYNCHRONIZED
0x14F1		PTP PORT B STATE	F012	1000	R	1	0=DISABLED
							1=NO SIGNAL
							2=CALIBRATING

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							3=SYNCHD_NO_PDELAY
							4=SYNCHRONIZED
Application Versions (Part II)							
0x14F3		Boot Version	F004	1000	R	1	
0x14F4		Boot Date	F009		R	10	
0x14FE		Kinetis Boot Version	F004	1000	R	1	
0x14FF		Kinetis Boot Date	F009		R	10	
0x1509		Kinetis Loader Ver	F004	1000	R	1	
0x150A		Kinetis Loader Date	F009		R	10	
0x1514		Kinetis App Version	F004	1000	R	1	
0x1515		Kinetis App Date	F009		R	10	
0x151F		DSP Version	F004	1000	R	1	
0x1520		DSP Date	F009		R	16	
Internal System States (Part II)							
0x1530		DSP Status	F005	1000	R	2	
Application Versions (Part III)							
0x1535		Firmware Date	F009		R	10	
0x153F		FPGA Version	F009	1000	R	4	
Internal System States (Part III)							
0x1543		FLASH Usage	F004	1000	R	1	
0x1544		KINETIS Status	F012		R	1	0=ERROR
							1=BOOT_MODE
							2=APP_MODE
0x1545		CPU MAX Usage	F004	1000	R	1	
Application Versions (Part IV)							
0x1546		RM PRP HSR Version	F009	1000	R	4	
0x154A		RM RSTP Version	F009	1000	R	4	
0x154E		RM LLA Version	F009	1000	R	4	
0x1552		RM Bypass Version	F009	1000	R	4	
Internal System States (Part IV)							
0x1556		Temp Current Value	F004	1000	R	1	
0x1557		Temp Max Value	F004	1000	R	1	
0x1558		Temp Min Value	F004	1000	R	1	
0x1559		Scan Cycle Average	F004	1000	R	1	
0x155A		Scan Cycle Rate	F004	1000	R	1	
0x155C		PLC Checksum	F005	1000	R	2	
0x155E		Settings Checksum	F005	1000	R	2	
Application Versions (Part V)							
0x1560		CPU Revision	F004	1000	R	1	
Redundancy status							
0x157C		PRP_HSR A tx	F005	1000	R	2	
0x157E		PRP_HSR B tx	F005	1000	R	2	
0x1580		PRP_HSR A err	F005	1000	R	2	
0x1582		PRP_HSR B err	F005	1000	R	2	
0x1584		RSTP PortA State	F012		R	1	0=DISCARDING
							1=LEARNING
							2=FORWARDING
0x1585		RSTP PortB State	F012		R	1	0=DISCARDING
							1=LEARNING

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=FORWARDING
Mapa de Usuario - User Map							
0xF330		Address 00	F004	1	R	1	
0xF331		Address 01	F004	1	R	1	
...	...	...	...	...	...	...	...
0xF42F		Address 255	F004	1	R	1	
Textos Maniobras - Commands text							
0x1C00		OPERATION 1	F009	1	R/W	16	
0x1C10		OPERATION 2	F009	1	R/W	16	
...	...	...	...	...	...	...	...
0x1DF0		OPERATION24	F009	1	R/W	16	
0x1E00		Confirmation address			W	1	
PLC Timer Masks							
0x1E01		TIMER MASK 01	F005	1	R/W	2	[0 , 86400000] ms
0x1E03		TIMER MASK 02	F005	1	R/W	2	[0 , 86400000] ms
0x1E05		TIMER MASK 03	F005	1	R/W	2	[0 , 86400000] ms
0x1E07		TIMER MASK 04	F005	1	R/W	2	[0 , 86400000] ms
0x1E09		TIMER MASK 05	F005	1	R/W	2	[0 , 86400000] ms
0x1E0B		TIMER MASK 06	F005	1	R/W	2	[0 , 86400000] ms
0x1E0D		TIMER MASK 07	F005	1	R/W	2	[0 , 86400000] ms
0x1E0F		TIMER MASK 08	F005	1	R/W	2	[0 , 86400000] ms
0x1E11		TIMER MASK 09	F005	1	R/W	2	[0 , 86400000] ms
0x1E13		TIMER MASK 10	F005	1	R/W	2	[0 , 86400000] ms
0x1E15		TIMER MASK 11	F005	1	R/W	2	[0 , 86400000] ms
0x1E17		TIMER MASK 12	F005	1	R/W	2	[0 , 86400000] ms
0x1E19		TIMER MASK 13	F005	1	R/W	2	[0 , 86400000] ms
0x1E1B		TIMER MASK 14	F005	1	R/W	2	[0 , 86400000] ms
0x1E1D		TIMER MASK 15	F005	1	R/W	2	[0 , 86400000] ms
0x1E1F		TIMER MASK 16	F005	1	R/W	2	[0 , 86400000] ms
0x1E3F		Confirmation address			W	1	
Ajustes Tarjeta F - Board F Settings							
Ajustes de Tensión Tarjeta F - Board F Voltage Settings							
0x1E41		Voltage Threshold A_F	F004	1	R/W	1	[10 , 230] V
0x1E42		Voltage Threshold B_F	F004	1	R/W	1	[10 , 230] V
0x1EE6		Voltage Threshold C_F	F004	1	R/W	1	[10 , 230] V
0x1EE7		Voltage Threshold D_F	F004	1	R/W	1	[10 , 230] V
Ajustes Tiempo Antirrebotes Tarjeta F - Board F Debounce Time Settings							
0x1E43		Debounce Time A_F	F004	1	R/W	1	[1 , 50] ms
0x1E44		Debounce Time B_F	F004	1	R/W	1	[1 , 50] ms
0x1EE8		Debounce Time C_F	F004	1	R/W	1	[1 , 50] ms
0x1EE9		Debounce Time D_F	F004	1	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta F (32 elementos) - Board F Input Type Setting (32 items)							
0x1E45		Input Type_F_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x1E46		Input Type_F_CC2	F012	1	R/W	1	0=POSITIVE-EDGE

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x1E64		Input Type_F_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajuste Tiempo Retardo Entradas Tarjeta F (32 elementos) - Board F Delay Input Time Setting (32 items)							
0x1E65		Delay Input Time_F_CC1	F005	1	R/W	2	[0 , 60000] ms
0x1E67		Delay Input Time_F_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x1EA3		Delay Input Time_F_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajuste Lógica de Salidas Tarjeta F (16 elementos) - Board F Output Logic Settings (16 items)							
0x1EA5		Output Logic_F_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x1EA6		Output Logic_F_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x1EB4		Output Logic_F_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajuste Tipo de Salidas Tarjeta F (16 elementos) - Board F Output Type Settings (16 items)							
0x1EB5		Output Type_F_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x1EB6		Output Type_F_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x1EC4		Output Type_F_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Tiempo Pulso de Salida Tarjeta F - Board F Pulse Output Time Settings (16 items)							
0x1EC5		Pulse Output Time_F_01	F005	1	R/W	2	[0 , 60000] ms
0x1EC7		Pulse Output Time_F_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x1EE3		Pulse Output Time_F_16	F005	1	R/W	2	[0 , 60000] ms
0x1EE5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica F (8 elementos) - Board F Analog Input Range Settings (8 items)							
0x1EEA		Range_F_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2=0 to 1 mA
							3=-1 to 1 mA
							4=0 to 5 mA
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA
0x1EEB		Range_F_02	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=0 to 1 mA
							3=-1 to 1 mA
							4=0 to 5 mA
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA
...	...	...	...	...	...	...	...
0x1EF1		Range_F_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2=0 to 1 mA
							3=-1 to 1 mA
							4=0 to 5 mA
							5=0 to 10 mA
							6=0 to 20 mA
							7=4 to 20 mA
Ajuste Rango de Medida de Entrada Analógica F (8 elementos) - Board F Analog Input Measurement Range (8 items)							
0x1EF2		Min Value_F_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EF4		Min Value_F_02	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EF6		Min Value_F_03	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EF8		Min Value_F_04	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EFA		Min Value_F_05	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EFC		Min Value_F_06	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1EFE		Min Value_F_07	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F00		Min Value_F_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F02		Max Value_F_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F04		Max Value_F_02	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F06		Max Value_F_03	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F08		Max Value_F_04	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F0A		Max Value_F_05	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F0C		Max Value_F_06	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F0E		Max Value_F_07	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F10		Max Value_F_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x1F12		Channelx1a_F_01	F003	1000	R/W	2	[0,950 , 1,050]
0x1F14		Channelx1a_F_02	F003	1000	R/W	2	[0,950 , 1,050]
0x1F16		Channelx1a_F_03	F003	1000	R/W	2	[0,950 , 1,050]
0x1F18		Channelx1a_F_04	F003	1000	R/W	2	[0,950 , 1,050]
0x1F1A		Channelx1a_F_05	F003	1000	R/W	2	[0,950 , 1,050]
0x1F1C		Channelx1a_F_06	F003	1000	R/W	2	[0,950 , 1,050]
0x1F1E		Channelx1a_F_07	F003	1000	R/W	2	[0,950 , 1,050]
0x1F20		Channelx1a_F_08	F003	1000	R/W	2	[0,950 , 1,050]
0x1F22		Channelx1b_F_01	F004	1000	R/W	1	[-1000 , 1000]
0x1F23		Channelx1b_F_02	F004	1000	R/W	1	[-1000 , 1000]
0x1F24		Channelx1b_F_03	F004	1000	R/W	1	[-1000 , 1000]
0x1F25		Channelx1b_F_04	F004	1000	R/W	1	[-1000 , 1000]
0x1F26		Channelx1b_F_05	F004	1000	R/W	1	[-1000 , 1000]
0x1F27		Channelx1b_F_06	F004	1000	R/W	1	[-1000 , 1000]
0x1F28		Channelx1b_F_07	F004	1000	R/W	1	[-1000 , 1000]
0x1F29		Channelx1b_F_08	F004	1000	R/W	1	[-1000 , 1000]
0x1F2A		Channelx10a_F_01	F003	1000	R/W	2	[0,950 , 1,050]
0x1F2C		Channelx10a_F_02	F003	1000	R/W	2	[0,950 , 1,050]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x1F2E		Channelx10a_F_03	F003	1000	R/W	2	[0,950 , 1,050]
0x1F30		Channelx10a_F_04	F003	1000	R/W	2	[0,950 , 1,050]
0x1F32		Channelx10a_F_05	F003	1000	R/W	2	[0,950 , 1,050]
0x1F34		Channelx10a_F_06	F003	1000	R/W	2	[0,950 , 1,050]
0x1F36		Channelx10a_F_07	F003	1000	R/W	2	[0,950 , 1,050]
0x1F38		Channelx10a_F_08	F003	1000	R/W	2	[0,950 , 1,050]
0x1F3A		Channelx10b_F_01	F004	1000	R/W	1	[-1000 , 1000]
0x1F3B		Channelx10b_F_02	F004	1000	R/W	1	[-1000 , 1000]
0x1F3C		Channelx10b_F_03	F004	1000	R/W	1	[-1000 , 1000]
0x1F3D		Channelx10b_F_04	F004	1000	R/W	1	[-1000 , 1000]
0x1F3E		Channelx10b_F_05	F004	1000	R/W	1	[-1000 , 1000]
0x1F3F		Channelx10b_F_06	F004	1000	R/W	1	[-1000 , 1000]
0x1F40		Channelx10b_F_07	F004	1000	R/W	1	[-1000 , 1000]
0x1F41		Channelx10b_F_08	F004	1000	R/W	1	[-1000 , 1000]
0x1F42		Calibration Type_F	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
0x1FE4		Confirmation address			W	1	
Ajustes Tarjeta G - Board G Settings							
Ajustes de Tensión Tarjeta G - Board G Voltage Settings							
0x1FE6		Voltage Threshold A_G	F004	1	R/W	1	[10 , 230] V
0x1FE7		Voltage Threshold B_G	F004	1	R/W	1	[10 , 230] V
0x208B		Voltage Threshold C_G	F004	1	R/W	1	[10 , 230] V
0x208C		Voltage Threshold D_G	F004	1	R/W	1	[10 , 230] V
Tiempo Antirrebotes Tarjeta G - Board G Debounce Time Settings							
0x1FE8		Debounce Time A_G	F004	1	R/W	1	[1 , 50] ms
0x1FE9		Debounce Time B_G	F004	1	R/W	1	[1 , 50] ms
0x208D		Debounce Time C_G	F004	1	R/W	1	[1 , 50] ms
0x208E		Debounce Time D_G	F004	1	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta G (32 elementos) - Board G Input Type Settings (32 items)							
0x1FEA		Input Type_G_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x1FEB		Input Type_G_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x2009		Input Type_G_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajustes Tiempo Retardo Entradas Tarjeta G (32 elementos) - Board G Delay Input Time Settings (32 items)							
0x200A		Delay Input Time_G_CC1	F005	1	R/W	2	[0 , 60000] ms
0x200C		Delay Input Time_G_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2048		Delay Input Time_G_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajustes Lógica de Salidas Tarjeta G (16 elementos) - Board G Output Logic Settings (16 items)							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x204A		Output Logic_G_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x204B		Output Logic_G_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x2059		Output Logic_G_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajustes Tipo de Salidas Tarjeta G (16 elementos) - Board G Output Type Settings (16 items)							
0x205A		Output Type_G_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x205B		Output Type_G_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x2069		Output Type_G_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajustes Tiempo Pulso de Salida Tarjeta G - Board G Pulse Output Time Settings (16 items)							
0x206A		Pulse Output Time_G_01	F005	1	R/W	2	[0 , 60000] ms
0x206C		Pulse Output Time_G_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2088		Pulse Output Time_G_16	F005	1	R/W	2	[0 , 60000] ms
0x208A		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica G (8 elementos) - Board G Analog Input Range Settings (8 items)							
0x208F		Range_G_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
...	...	...	...	...	...	...	...
0x2096		Range_G_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
Ajustes Rango de Medida de Entrada Analógica G (8 elementos) - Board G Analog Input Measurement Range Settings (8 items)							
0x2097		Min Value_G_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x2099		Min Value_G_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x20A5		Min Value_G_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x20A7		Max Value_G_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x20A9		Max Value_G_02	F003	1	R/W	2	[-9999.99 , 9999.99]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
0x20B5		Max Value_G_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x20B7		Channelx1a_G_01	F003	1000	R/W	2	[0,950 , 1,050]
0x20B9		Channelx1a_G_02	F003	1000	R/W	2	[0,950 , 1,050]
0x20BB		Channelx1a_G_03	F003	1000	R/W	2	[0,950 , 1,050]
0x20BD		Channelx1a_G_04	F003	1000	R/W	2	[0,950 , 1,050]
0x20BF		Channelx1a_G_05	F003	1000	R/W	2	[0,950 , 1,050]
0x20C1		Channelx1a_G_06	F003	1000	R/W	2	[0,950 , 1,050]
0x20C3		Channelx1a_G_07	F003	1000	R/W	2	[0,950 , 1,050]
0x20C5		Channelx1a_G_08	F003	1000	R/W	2	[0,950 , 1,050]
0x20C7		Channelx1b_G_01	F004	1000	R/W	1	[-1000 , 1000]
0x20C8		Channelx1b_G_02	F004	1000	R/W	1	[-1000 , 1000]
0x20C9		Channelx1b_G_03	F004	1000	R/W	1	[-1000 , 1000]
0x20CA		Channelx1b_G_04	F004	1000	R/W	1	[-1000 , 1000]
0x20CB		Channelx1b_G_05	F004	1000	R/W	1	[-1000 , 1000]
0x20CC		Channelx1b_G_06	F004	1000	R/W	1	[-1000 , 1000]
0x20CD		Channelx1b_G_07	F004	1000	R/W	1	[-1000 , 1000]
0x20CE		Channelx1b_G_08	F004	1000	R/W	1	[-1000 , 1000]
0x20CF		Channelx10a_G_01	F003	1000	R/W	2	[0,950 , 1,050]
0x20D1		Channelx10a_G_02	F003	1000	R/W	2	[0,950 , 1,050]
0x20D3		Channelx10a_G_03	F003	1000	R/W	2	[0,950 , 1,050]
0x20D5		Channelx10a_G_04	F003	1000	R/W	2	[0,950 , 1,050]
0x20D7		Channelx10a_G_05	F003	1000	R/W	2	[0,950 , 1,050]
0x20D9		Channelx10a_G_06	F003	1000	R/W	2	[0,950 , 1,050]
0x20DB		Channelx10a_G_07	F003	1000	R/W	2	[0,950 , 1,050]
0x20DD		Channelx10a_G_08	F003	1000	R/W	2	[0,950 , 1,050]
0x20DF		Channelx10b_G_01	F004	1000	R/W	1	[-1000 , 1000]
0x20E0		Channelx10b_G_02	F004	1000	R/W	1	[-1000 , 1000]
0x20E1		Channelx10b_G_03	F004	1000	R/W	1	[-1000 , 1000]
0x20E2		Channelx10b_G_04	F004	1000	R/W	1	[-1000 , 1000]
0x20E3		Channelx10b_G_05	F004	1000	R/W	1	[-1000 , 1000]
0x20E4		Channelx10b_G_06	F004	1000	R/W	1	[-1000 , 1000]
0x20E5		Channelx10b_G_07	F004	1000	R/W	1	[-1000 , 1000]
0x20E6		Channelx10b_G_08	F004	1000	R/W	1	[-1000 , 1000]
0x20E7		Calibration Type_G	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
0x2189		Confirmation address			W	1	
Ajustes Tarjeta H (MODULO CIO) - Board H Settings (CIO MODULE)							
Ajustes Tipo Tarjeta H - Board H Board Type Settings							
0x2F5B		I/O Board Type	F012	1	R/W	1	0=NONE
							1=16INP + 8OUT
							2=8INP + 8OUT + SUPV
							4=32INP
							5=16INP + 8ANA
Ajustes de Tensión Tarjeta H - Board H Voltage Settings							
0x2F5C		Voltage Threshold A_H	F004	1	R/W	1	[10 , 230] V
0x2F5D		Voltage Threshold B_H	F004	1	R/W	1	[10 , 230] V

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3001		Voltage Threshold C_H	F004	1	R/W	1	[10 , 230] V
0x3002		Voltage Threshold D_H	F004	1	R/W	1	[10 , 230] V
Tiempo Antirrebotes Tarjeta H - Board H Debounce Time Settings							
0x2F5E		Debounce Time A_H	F004	1	R/W	1	[1 , 50] ms
0x2F5F		Debounce Time B_H	F004	1	R/W	1	[1 , 50] ms
0x3003		Debounce Time C_H	F004	1	R/W	1	[1 , 50] ms
0x3004		Debounce Time D_H	F004	1	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta H (32 elementos) - Board H Input Type Settings (32 items)							
0x2F60		Input Type_H_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x2F61		Input Type_H_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x2F7F		Input Type_H_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajuste Tiempo Retardo Entradas Tarjeta H (32 elementos) - Board H Delay Input Time Settings (32 items)							
0x2F80		Delay Input Time_H_CC1	F005	1	R/W	2	[0 , 60000] ms
0x2F82		Delay Input Time_H_CC2	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2FBE		Delay Input Time_H_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajuste Lógica de Salidas Tarjeta H (16 elementos) - Board H Output Logic Settings (16 items)							
0x2FC0		Output Logic_H_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x2FC1		Output Logic_H_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x2FCF		Output Logic_H_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajuste Tipo de Salidas Tarjeta H (16 elementos) - Board H Output Type Settings (16 items)							
0x2FD0		Output Type_H_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x2FD1		Output Type_H_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x2FDF		Output Type_H_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajuste Tiempo Pulso de Salida Tarjeta H - Board H Pulse Output Time Settings (16 items)							
0x2FE0		Pulse Output Time_H_01	F005	1	R/W	2	[0 , 60000] ms
0x2FE2		Pulse Output Time_H_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x2FFE		Pulse Output Time_H_16	F005	1	R/W	2	[0 , 60000] ms

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3000		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica H (8 elementos) - Board H Analog Input Range Settings (8 items)							
0x3005		Range_H_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
...	...	...	...	...	...	...	...
0x300C		Range_H_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
Ajuste Rango de Medida de Entrada Analógica H (8 elementos) - Board H: Analog Input Measurement Range (8 items)							
0x300D		Min Value_H_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x300F		Min Value_H_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x301B		Min Value_H_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x301D		Max Value_H_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x301F		Max Value_H_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x302B		Max Value_H_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x302D		Channelx1a_H_01	F003	1000	R/W	2	[0,950 , 1,050]
0x302F		Channelx1a_H_02	F003	1000	R/W	2	[0,950 , 1,050]
0x3031		Channelx1a_H_03	F003	1000	R/W	2	[0,950 , 1,050]
0x3033		Channelx1a_H_04	F003	1000	R/W	2	[0,950 , 1,050]
0x3035		Channelx1a_H_05	F003	1000	R/W	2	[0,950 , 1,050]
0x3037		Channelx1a_H_06	F003	1000	R/W	2	[0,950 , 1,050]
0x3039		Channelx1a_H_07	F003	1000	R/W	2	[0,950 , 1,050]
0x303B		Channelx1a_H_08	F003	1000	R/W	2	[0,950 , 1,050]
0x303D		Channelx1b_H_01	F004	1000	R/W	1	[-1000 , 1000]
0x303E		Channelx1b_H_02	F004	1000	R/W	1	[-1000 , 1000]
0x303F		Channelx1b_H_03	F004	1000	R/W	1	[-1000 , 1000]
0x3040		Channelx1b_H_04	F004	1000	R/W	1	[-1000 , 1000]
0x3041		Channelx1b_H_05	F004	1000	R/W	1	[-1000 , 1000]
0x3042		Channelx1b_H_06	F004	1000	R/W	1	[-1000 , 1000]
0x3043		Channelx1b_H_07	F004	1000	R/W	1	[-1000 , 1000]
0x3044		Channelx1b_H_08	F004	1000	R/W	1	[-1000 , 1000]
0x3045		Channelx10a_H_01	F003	1000	R/W	2	[0,950 , 1,050]
0x3047		Channelx10a_H_02	F003	1000	R/W	2	[0,950 , 1,050]
0x3049		Channelx10a_H_03	F003	1000	R/W	2	[0,950 , 1,050]
0x304B		Channelx10a_H_04	F003	1000	R/W	2	[0,950 , 1,050]
0x304D		Channelx10a_H_05	F003	1000	R/W	2	[0,950 , 1,050]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x304F		Channelx10a_H_06	F003	1000	R/W	2	[0,950 , 1,050]
0x3051		Channelx10a_H_07	F003	1000	R/W	2	[0,950 , 1,050]
0x3053		Channelx10a_H_08	F003	1000	R/W	2	[0,950 , 1,050]
0x3055		Channelx10b_H_01	F004	1000	R/W	1	[-1000 , 1000]
0x3056		Channelx10b_H_02	F004	1000	R/W	1	[-1000 , 1000]
0x3057		Channelx10b_H_03	F004	1000	R/W	1	[-1000 , 1000]
0x3058		Channelx10b_H_04	F004	1000	R/W	1	[-1000 , 1000]
0x3059		Channelx10b_H_05	F004	1000	R/W	1	[-1000 , 1000]
0x305A		Channelx10b_H_06	F004	1000	R/W	1	[-1000 , 1000]
0x305B		Channelx10b_H_07	F004	1000	R/W	1	[-1000 , 1000]
0x305C		Channelx10b_H_08	F004	1000	R/W	1	[-1000 , 1000]
0x305D		Calibration Type_H	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
0x30FF		Confirmation address			W	1	
Ajustes Tarjeta J (MODULO CIO) - Board J Settings (CIO MODULE)							
Ajustes Tipo Tarjeta J - Board J Board Type Settings							
0x3100		I/O Board Type_J	F012	1	R/W	1	0=NONE
							1=16INP + 8OUT
							2=8INP + 8OUT + SUPV
							4=32INP
							5=16INP + 8ANA
Ajustes de Tensión Tarjeta J - Board J Voltage Settings							
0x3101		Voltage Threshold A_J	F004	1	R/W	1	[10 , 230] V
0x3102		Voltage Threshold B_J	F004	1	R/W	1	[10 , 230] V
0x31A6		Voltage Threshold C_J	F004	1	R/W	1	[10 , 230] V
0x31A7		Voltage Threshold D_J	F004	1	R/W	1	[10 , 230] V
Ajustes Tiempo Antirrebotes Tarjeta J - Board J Debounce Time Settings							
0x3103		Debounce Time A_J	F004	1	R/W	1	[1 , 50] ms
0x3104		Debounce Time B_J	F004	1	R/W	1	[1 , 50] ms
0x31A8		Debounce Time C_J	F004	1	R/W	1	[1 , 50] ms
0x31A9		Debounce Time D_J	F004	1	R/W	1	[1 , 50] ms
Ajuste Tipo de Entrada Tarjeta J (32 elementos) - Board J Input Type Settings (32 items)							
0x3105		Input Type_J_CC1	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
0x3106		Input Type_J_CC2	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
...	...	...	...	...	...	...	...
0x3124		Input Type_J_CC32	F012	1	R/W	1	0=POSITIVE-EDGE
							1=NEGATIVE-EDGE
							2=POSITIVE
							3=NEGATIVE
Ajustes Tiempo Retardo Entradas Tarjeta J (32 elementos) - Board J Delay Input Time Settings (32 items)							
0x3125		Delay Input Time_J_CC1	F005	1	R/W	2	[0 , 60000] ms
0x3127		Delay Input Time_J_CC2	F005	1	R/W	2	[0 , 60000] ms

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
...	...	...	...	...	...	...	...
0x3163		Delay Input Time_J_CC32	F005	1	R/W	2	[0 , 60000] ms
Ajustes Lógica de Salidas Tarjeta J (16 elementos) - Board J Output Logic Settings (16 items)							
0x3165		Output Logic_J_01	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
0x3166		Output Logic_J_02	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
...	...	...	...	...	...	...	...
0x3174		Output Logic_J_16	F012	1	R/W	1	0=POSITIVE
							1=NEGATIVE
Ajustes Tipo de Salidas Tarjeta J (16 elementos) - Board J Output Type Settings (16 items)							
0x3175		Output Type_J_01	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
0x3176		Output Type_J_02	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
...	...	...	...	...	...	...	...
0x3184		Output Type_J_16	F012	1	R/W	1	0=NORMAL
							1=PULSE
							2=LATCH
Ajustes Tiempo Pulso de Salida Tarjeta J - Board J Pulse Output Time Settings (16 items)							
0x3185		Pulse Output Time_J_01	F005	1	R/W	2	[0 , 60000] ms
0x3187		Pulse Output Time_J_02	F005	1	R/W	2	[0 , 60000] ms
...	...	...	...	...	...	...	...
0x31A3		Pulse Output Time_J_16	F005	1	R/W	2	[0 , 60000] ms
0x31A5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajuste Rango de Entrada Analogica J (8 elementos) - Board J Analog Input Range Settings (8 items)							
0x31AA		Range_J_01	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
...	...	...	...	...	...	...	...
0x31B1		Range_J_08	F012	1	R/W	1	0=NONE
							1=-1 to 0 mA
							2= 0 to 1mA
							3=-1 to 1mA
							4= 0 to 5 mA
							5= 0 to 10mA
							6= 0 to 20mA
							7= 4 to 20mA
Ajustes Rango de Medida de Entrada Analógica J (8 elementos) - Board J Analog Input Measurement Range Settings (8 items)							
0x31B2		Min Value_J_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31B4		Min Value_J_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x31C0		Min Value_J_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31C2		Max Value_J_01	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31C4		Max Value_J_02	F003	1	R/W	2	[-9999.99 , 9999.99]
...	...	...	...	...	...	...	...
0x31D0		Max Value_J_08	F003	1	R/W	2	[-9999.99 , 9999.99]
0x31D2		Channelx1a_J_01	F003	1000	R/W	2	[0,950 , 1,050]
0x31D4		Channelx1a_J_02	F003	1000	R/W	2	[0,950 , 1,050]
0x31D6		Channelx1a_J_03	F003	1000	R/W	2	[0,950 , 1,050]
0x31D8		Channelx1a_J_04	F003	1000	R/W	2	[0,950 , 1,050]
0x31DA		Channelx1a_J_05	F003	1000	R/W	2	[0,950 , 1,050]
0x31DC		Channelx1a_J_06	F003	1000	R/W	2	[0,950 , 1,050]
0x31DE		Channelx1a_J_07	F003	1000	R/W	2	[0,950 , 1,050]
0x31E0		Channelx1a_J_08	F003	1000	R/W	2	[0,950 , 1,050]
0x31E2		Channelx1b_J_01	F004	1000	R/W	1	[-1000 , 1000]
0x31E3		Channelx1b_J_02	F004	1000	R/W	1	[-1000 , 1000]
0x31E4		Channelx1b_J_03	F004	1000	R/W	1	[-1000 , 1000]
0x31E5		Channelx1b_J_04	F004	1000	R/W	1	[-1000 , 1000]
0x31E6		Channelx1b_J_05	F004	1000	R/W	1	[-1000 , 1000]
0x31E7		Channelx1b_J_06	F004	1000	R/W	1	[-1000 , 1000]
0x31E8		Channelx1b_J_07	F004	1000	R/W	1	[-1000 , 1000]
0x31E9		Channelx1b_J_08	F004	1000	R/W	1	[-1000 , 1000]
0x31EA		Channelx10a_J_01	F003	1000	R/W	2	[0,950 , 1,050]
0x31EC		Channelx10a_J_02	F003	1000	R/W	2	[0,950 , 1,050]
0x31EE		Channelx10a_J_03	F003	1000	R/W	2	[0,950 , 1,050]
0x31F0		Channelx10a_J_04	F003	1000	R/W	2	[0,950 , 1,050]
0x31F2		Channelx10a_J_05	F003	1000	R/W	2	[0,950 , 1,050]
0x31F4		Channelx10a_J_06	F003	1000	R/W	2	[0,950 , 1,050]
0x31F6		Channelx10a_J_07	F003	1000	R/W	2	[0,950 , 1,050]
0x31F8		Channelx10a_J_08	F003	1000	R/W	2	[0,950 , 1,050]
0x31FA		Channelx10b_J_01	F004	1000	R/W	1	[-1000 , 1000]
0x31FB		Channelx10b_J_02	F004	1000	R/W	1	[-1000 , 1000]
0x31FC		Channelx10b_J_03	F004	1000	R/W	1	[-1000 , 1000]
0x31FD		Channelx10b_J_04	F004	1000	R/W	1	[-1000 , 1000]
0x31FE		Channelx10b_J_05	F004	1000	R/W	1	[-1000 , 1000]
0x31FF		Channelx10b_J_06	F004	1000	R/W	1	[-1000 , 1000]
0x3200		Channelx10b_J_07	F004	1000	R/W	1	[-1000 , 1000]
0x3201		Channelx10b_J_08	F004	1000	R/W	1	[-1000 , 1000]
0x3202		Calibration Type_J	F012	1000	R/W	1	0=NONE
							1=OFFSET
							2=CALIBRATION
							3=GET CALIBRATION
0x32A4		Confirmation address			W	1	
Ajustes Generales - General Settings							
0x218A		Phase CT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x218C		Ground CT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x218E		Stv Ground CT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x2190		Phase VT Ratio	F003	1	R/W	2	[1.0 , 6000.0]
0x2192		Phase VT Connection	F012	1	R/W	1	0=WYE
							1=DELTA

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2193		Nominal Voltage	F003	1	R/W	2	[1.0 , 250.0] V
0x2195		Nominal Frequency	F012	1	R/W	1	0=50 Hz
							1=60 Hz
0x2196		Phase Rotation	F012	1	R/W	1	0=ABC
							1=ACB
0x2197		Frequency Reference	F012	1	R/W	1	0=VI
							1=VII
							2=VIII
0x2198		Auxiliary Voltage	F012	1	R/W	1	0=Vx
							1=VN
0x2199		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x219B		Primary Meter Units	F012	1	R/W	1	0=KA_KV
							1=A_V
0x219C		Device Name	F009	1	R/W	8	
0x2203		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Alto Grupo 1 - Phase IOC High 1 Settings							
0x2204		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2205		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2206		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2208		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x220A		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x220C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x221F		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Alto Grupo 2 - Phase IOC High 2 Settings							
0x2220		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2221		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2222		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2224		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2226		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2228		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x223B		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Alto Grupo 3 - Phase IOC High 3 Settings							
0x223C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x223D		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x223E		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2240		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2242		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2244		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2257		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Bajo Grupo 1 - Phase IOC Low 1 Settings							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2258		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2259		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x225A		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x225C		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x225E		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2260		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2273		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Bajo Grupo 2 - Phase IOC Low 2 Settings							
0x2274		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2275		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2276		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2278		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x227A		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x227C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x228F		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Fases Nivel Bajo Grupo 3 - Phase IOC Low 3 Settings							
0x2290		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2291		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2292		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2294		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2296		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2298		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22AB		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Neutro Grupo 1 - Neutral IOC 1 Settings							
0x22AC		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22AD		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x22AF		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22B1		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22B3		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22C6		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Neutro Grupo 2 - Neutral IOC 2 Settings							
0x22C7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22C8		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x22CA		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22CC		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22CE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22E1		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Instantánea de Neutro Grupo 3 - Neutral IOC 3 Settings							
0x22E2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22E3		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x22E5		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22E7		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x22E9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22FC		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Grupo 1 - Ground IOC 1 Settings							
0x22FD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x22FE		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x22FF		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2301		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2303		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2305		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2318		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Grupo 2 - Ground IOC 2 Settings							
0x2319		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x231A		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x231B		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x231D		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x231F		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2321		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2334		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Grupo 3 - Ground IOC 3 Settings							
0x2335		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2336		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2337		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2339		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x233B		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x233D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2350		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Sensible Grupo 1 - Sensitive Ground IOC 1 Settings							
0x2351		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2352		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2353		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x2355		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2357		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2359		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x236C		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Sensible Grupo 2 - Sensitive Ground IOC 2 Settings							
0x236D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x236E		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x236F		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x2371		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2373		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2375		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2388		Confirmation address			W	1	
Ajustes Sobreintensidad Instantánea de Tierra Sensible Grupo 3 - Sensitive Ground IOC 3 Settings							
0x2389		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x238A		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x238B		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x238D		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x238F		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2391		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23A4		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 1 - Phase TOC High 1 Settings							
0x23A5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23A6		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x23A7		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23A9		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x23AA		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x23AC		Reset	F012	1	R/W	1	0=INSTANTANEOUS
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 1 - Phase TOC High 1 Settings (cont.)							
							1=LINEAR
0x23AD		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23AE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23C1		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 2 - Phase TOC High 2 Settings							
0x23C2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23C3		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x23C4		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23C6		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x23C7		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x23C9		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x23CA		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23CB		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23DE		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 3 - Phase TOC High 3 Settings							
0x23DF		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x23E0		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x23E1		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23E3		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x23E4		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x23E6		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x23E7		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23E8		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23FB		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Neutro Grupo 1 - Neutral TOC 1 Settings							
0x23FC		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x23FD		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x23FF		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2400		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2402		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2403		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2416		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Neutro Grupo 2 - Neutral TOC 2 Settings							
0x2417		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2418		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x241A		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x241B		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x241D		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x241E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2431		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Neutro Grupo 3 - Neutral TOC 3 Settings							
0x2432		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x2433		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2435		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2436		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2438		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2439		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x244C		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Grupo 1 - Ground TOC 1 Settings							
0x244D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x244E		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x244F		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2451		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Sobreintensidad Temporizada de Tierra Grupo 1 - Ground TOC 1 Settings (cont.)							
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2452		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2454		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2455		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2468		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Grupo 2 - Ground TOC 2 Settings							
0x2469		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x246A		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x246B		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x246D		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x246E		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2470		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2471		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2484		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Grupo 3 - Ground TOC 3 Settings							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2485		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2486		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x2487		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2489		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x248A		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x248C		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x248D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24A0		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 1 - Sensitive Ground TOC 1 Settings							
0x24A1		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24A2		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x24A3		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x24A5		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							11=ANSI Ext Inv
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 1 - Sensitive Ground TOC 1 Settings (cont.)							
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x24A6		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x24A8		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x24A9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24BC		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 2 - Sensitive Ground TOC 2 Settings							
0x24BD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24BE		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x24BF		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x24C1		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x24C2		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x24C4		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x24C5		Snapshot Events	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x24D8		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Tierra Sensible Grupo 3 - Sensitive Ground TOC 3 Settings							
0x24D9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24DA		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x24DB		Pickup Level	F003	1	R/W	2	[0.005 , 16.000] A
0x24DD		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x24DE		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x24E0		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x24E1		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24F4		Confirmation address			W	1	
Ajustes Subtensión de Fases Grupo 1 - Phase UV 1 Settings							
0x24F5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x24F6		Mode	F012	1	R/W	1	0=PHASE-PHASE
							1=PHASE-GROUND
0x24F7		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x24F9		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x24FA		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x24FC		Minimum Voltage	F003	1	R/W	2	[0 , 300] V
0x24FE		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x24FF		Supervised by 52	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x2500		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2513		Confirmation address			W	1	
Ajustes Subtensión de Fases Grupo 2 - Phase UV 2 Settings							
0x2514		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2515		Mode	F012	1	R/W	1	0=PHASE-PHASE
							1=PHASE-GROUND
0x2516		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2518		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2519		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x251B		Minimum Voltage	F003	1	R/W	2	[0 , 300] V
0x251D		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x251E		Supervised by 52	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x251F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2532		Confirmation address			W	1	
Ajustes Subtensión de Fases Grupo 3 - Phase UV 3 Settings							
0x2533		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2534		Mode	F012	1	R/W	1	0=PHASE-PHASE
							1=PHASE-GROUND
0x2535		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2537		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2538		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x253A		Minimum Voltage	F003	1	R/W	2	[0 , 300] V
0x253C		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x253D		Supervised by 52	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x253E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2551		Confirmation address			W	1	
Ajustes Sobretensión de Fases Secuencia Negativa Grupo 1 - Negative Sequence OV 1 Settings							
0x2552		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2553		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2555		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2557		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2559		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x256C		Confirmation address			W	1	
Ajustes Sobretensión de Fases Secuencia Negativa Grupo 2 - Negative Sequence OV 2 Settings							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x256D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x256E		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2570		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2572		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2574		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2587		Confirmation address			W	1	
Ajustes Sobretensión de Fases Secuencia Negativa Grupo 3 - Negative Sequence OV 3 Settings							
0x2588		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2589		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x258B		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x258D		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x258F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25A2		Confirmation address			W	1	
Ajustes Imagen Térmica Grupo 1 - Thermal Model 1 Settings							
0x25A3		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25A4		Heat Time Constant	F003	1	R/W	2	[3.0 , 600.0] min
0x25A6		Cool Time Constant	F003	1	R/W	2	[1.00 , 6.00]
0x25A8		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x25AA		Alarm Level	F003	1	R/W	2	[1.0 , 110.0] %
0x25AC		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25BF		Confirmation address			W	1	
Ajustes Imagen Térmica Grupo 2 - Thermal Model 2 Settings							
0x25C0		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25C1		Heat Time Constant	F003	1	R/W	2	[3.0 , 600.0] min
0x25C3		Cool Time Constant	F003	1	R/W	2	[1.00 , 6.00]
0x25C5		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x25C7		Alarm Level	F003	1	R/W	2	[1.0 , 110.0] %
0x25C9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25DC		Confirmation address			W	1	
Ajustes Imagen Térmica Grupo 3 - Thermal Model 3 Settings							
0x25DD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25DE		Heat Time Constant	F003	1	R/W	2	[3.0 , 600.0] min
0x25E0		Cool Time Constant	F003	1	R/W	2	[1.00 , 6.00]
0x25E2		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x25E4		Alarm Level	F003	1	R/W	2	[1.0 , 110.0] %
0x25E6		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x25F9		Confirmation address			W	1	
Ajustes Unidad Direccional de Fases Grupo 1 - Phase Directional 1 Settings							
0x25FA		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x25FB		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x25FD		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x25FE		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x25FF		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x2601		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2602		Voltage Memory Time	F003	1000	R/W	2	[0,00 , 3,00] s
0x2614		Confirmation address			W	1	
Ajustes Unidad Direccional de Fases Grupo 2 - Phase Directional 2 Settings							
0x2615		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2616		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2618		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x2619		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x261A		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x261C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x261D		Voltage Memory Time	F003	1000	R/W	2	[0,00 , 3,00] s
0x262F		Confirmation address			W	1	
Ajustes Unidad Direccional de Fases Grupo 3 - Phase Directional 3 Settings							
0x2630		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2631		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2633		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x2634		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2635		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x2637		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2638		Voltage Memory Time	F003	1000	R/W	2	[0,00 , 3,00] s
0x264A		Confirmation address			W	1	
Ajustes Unidad Direccional de Neutro Grupo 1 - Neutral Directional 1 Settings							
0x264B		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x264C		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x264E		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x264F		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x2650		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2651		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x2653		Snapshot Events	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x2666		Confirmation address			W	1	
Ajustes Unidad Direccional de Neutro Grupo 2 - Neutral Directional 2 Settings							
0x2667		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2668		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x266A		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x266B		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x266C		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x266D		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x266F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2682		Confirmation address			W	1	
Ajustes Unidad Direccional de Neutro Grupo 3 - Neutral Directional 3 Settings							
0x2683		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2684		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2686		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x2687		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x2688		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2689		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x268B		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x269E		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Grupo 1 - Ground Directional 1 Settings							
0x269F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26A0		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x26A2		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x26A3		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x26A4		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x26A5		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x26A7		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26BA		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes Unidad Direccional de Tierra Grupo 2 - Ground Directional 2 Settings							
0x26BB		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26BC		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x26BE		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x26BF		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x26C0		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x26C1		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x26C3		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26D6		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Grupo 3 - Ground Directional 3 Settings							
0x26D7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26D8		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x26DA		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x26DB		Polarization	F012	1	R/W	1	0=VO
							1=IP
							2=VO + IP
							3=VO*IP
0x26DC		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x26DD		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x26DF		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26F2		Confirmation address			W	1	
Ajustes Fallo Interruptor - Breaker Failure Settings							
0x26F3		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x26F4		Supervision Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26F6		Hiset Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26F8		Lowset Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26FA		Internal Arc Pickup	F003	1	R/W	2	[0.05 , 160.00] A
0x26FC		Internal Arc Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x26FE		Supervision Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2700		HiSet Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2702		LowSet Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2704		2nd Step Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2706		No Current Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2708		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x271B		Confirmation address			W	1	
Ajustes Fallo Fusible - Fuse Failure Settings							
0x271C		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x271D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2730		Confirmation address			W	1	
Ajustes Sincronismo - Synchrocheck Settings							
0x2731		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2732		Dead Bus Level	F003	1	R/W	2	[0.00 , 300.00] V
0x2734		Live Bus Level	F003	1	R/W	2	[0.00 , 300.00] V
0x2736		Dead Line Level	F003	1	R/W	2	[0.00 , 300.00] V
0x2738		Live Line Level	F003	1	R/W	2	[0.00 , 300.00] V
0x273A		Max Volt Difference	F003	1	R/W	2	[2.00 , 300.00] V
0x273C		Max Angle Difference	F003	1	R/W	2	[2.0 , 80.0] Deg
0x273E		Max Freq Difference	F003	1	R/W	2	[10 , 5000] mHz
0x2740		Time	F003	1	R/W	2	[0.01 , 600.00] s
0x2742		DL-DB Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2743		LL-DB Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2744		DL-LB Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2745		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2762		Confirmation address			W	1	
Ajustes Reenganchador - Recloser Settings							
0x2763		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2764		Max Number Shots	F004	1	R/W	1	[1 , 4]
0x2765		Dead Time 1	F003	1	R/W	2	[0.00 , 900.00] s
0x2767		Dead Time 2	F003	1	R/W	2	[0.00 , 900.00] s
0x2769		Dead Time 3	F003	1	R/W	2	[0.00 , 900.00] s
0x276B		Dead Time 4	F003	1	R/W	2	[0.00 , 900.00] s
0x276D		Reclaim Time	F003	1	R/W	2	[0.00 , 900.00] s
0x276F		Cond. Permission	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2770		Hold Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2772		Reset Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2774		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x278B		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Alto Grupo 1 - Neutral OV High 1 Settings							
0x278C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x278D		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x278F		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2791		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2793		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27A6		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Alto Grupo 2 - Neutral OV High 2 Settings							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x27A7		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27A8		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x27AA		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27AC		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27AE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27C1		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Alto Grupo 3 - Neutral OV High 3 Settings							
0x27C2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27C3		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x27C5		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27C7		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27C9		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27DC		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Bajo Grupo 1 - Neutral OV Low 1 Settings							
0x27DD		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27DE		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x27E0		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27E2		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27E4		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27F7		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Bajo Grupo 2 - Neutral OV Low 2 Settings							
0x27F8		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x27F9		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x27FB		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27FD		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x27FF		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2812		Confirmation address			W	1	
Ajustes Sobretensión de Neutro Nivel Bajo Grupo 3 - Neutral OV Low 3 Settings							
0x2813		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2814		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2816		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2818		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x281A		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x282D		Confirmation address			W	1	
Ajustes Subtensión Auxiliar Grupo 1 - Auxiliary UV 1 Settings							
0x282E		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x282F		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2831		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2832		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2834		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2847		Confirmation address			W	1	
Ajustes Subtensión Auxiliar Grupo 2 - Auxiliary UV 2 Settings							
0x2848		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2849		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x284B		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x284C		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x284E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2861		Confirmation address			W	1	
Ajustes Subtensión Auxiliar Grupo 3 - Auxiliary UV 3 Settings							
0x2862		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2863		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2865		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
0x2866		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2868		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x287B		Confirmation address			W	1	
Ajustes Sobretensión de Fases Grupo 1 - Phase OV 1 Settings							
0x287C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x287D		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x287F		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2881		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2883		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x2884		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2897		Confirmation address			W	1	
Ajustes Sobretensión de Fases Grupo 2 - Phase OV 2 Settings							
0x2898		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2899		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x289B		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x289D		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x289F		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x28A0		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28B3		Confirmation address			W	1	
Ajustes Sobretensión de Fases Grupo 3 - Phase OV 3 Settings							
0x28B4		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x28B5		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x28B7		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28B9		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28BB		Logic	F012	1	R/W	1	0=ANY PHASE
							1=TWO PHASES
							2=ALL PHASES
0x28BC		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28CF		Confirmation address			W	1	
Ajustes Sobretensión Auxiliar Grupo 1 - Auxiliary OV 1 Settings							
0x28D0		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28D1		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x28D3		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28D5		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28D7		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28EA		Confirmation address			W	1	
Ajustes Sobretensión Auxiliar Grupo 2 - Auxiliary OV 2 Settings							
0x28EB		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x28EC		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x28EE		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28F0		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x28F2		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2905		Confirmation address			W	1	
Ajustes Sobretensión Auxiliar Grupo 3 - Auxiliary OV 3 Settings							
0x2906		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2907		Pickup Level	F003	1	R/W	2	[3 , 300] V
0x2909		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x290B		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x290D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2920		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 1 - Negative Sequence TOC 1 Settings							
0x2921		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2922		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x2924		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2925		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2927		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2928		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x293B		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 2 - Negative Sequence TOC 2 Settings							
0x293C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x293D		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x293F		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 2 - Negative Sequence TOC 2 Settings (cont.)							
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x2940		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x2942		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x2943		Snapshot Events	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x2956		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Secuencia Negativa Grupo 3 - Negative Sequence TOC 3 Settings							
0x2957		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2958		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x295A		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x295B		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x295D		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x295E		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2971		Confirmation address			W	1	
Ajustes Sobrefrecuencia Grupo 1 - Overfrequency 1 Settings							
0x2972		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2973		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x2975		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2977		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2979		Minimum Voltage	F003	1	R/W	2	[10 , 300] V
0x297B		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x298E		Confirmation address			W	1	
Ajustes Sobrefrecuencia Grupo 2 - Overfrequency 2 Settings							
0x298F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2990		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x2992		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2994		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2996		Minimum Voltage	F003	1	R/W	2	[10 , 300] V
0x2998		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29AB		Confirmation address			W	1	
Ajustes Sobrefrecuencia Grupo 3 - Overfrequency 3 Settings							
0x29AC		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29AD		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x29AF		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29B1		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29B3		Minimum Voltage	F003	1	R/W	2	[10 , 300] V
0x29B5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29C8		Confirmation address			W	1	
Ajustes Subfrecuencia Grupo 1 - Underfrequency 1 Settings							
0x29C9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29CA		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x29CC		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29CE		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29D0		Minimum Voltage	F003	1	R/W	2	[10 , 300] V
0x29D2		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29E5		Confirmation address			W	1	
Ajustes Subfrecuencia Grupo 2 - Underfrequency 2 Settings							
0x29E6		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x29E7		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x29E9		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29EB		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x29ED		Minimum Voltage	F003	1	R/W	2	[10 , 300] V
0x29EF		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A02		Confirmation address			W	1	
Ajustes Subfrecuencia Grupo 3 - Underfrequency 3 Settings							
0x2A03		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A04		Pickup Level	F003	1	R/W	2	[20.00 , 65.00] Hz
0x2A06		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2A08		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2A0A		Minimum Voltage	F003	1	R/W	2	[10 , 300] V
0x2A0C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A1F		Confirmation address			W	1	
Ajustes Oscilografía - Oscillography Settings							
0x2A7C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A7D		Trigger Position	F004	1	R/W	1	[5 , 95] %
0x2A7E		Samples/Cycle	F012	1	R/W	1	0=64
							1=32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=16
							3=8
							4=4
0x2A7F		Max. Number Osc.	F004	1	R/W	1	[1 , 20]
0x2A80		Automatic Overwrite	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A81		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A92		Confirmation address			W	1	
Ajustes Localizador de Faltas - Fault Report Settings							
0x2A93		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A94		Pos Seq Module	F003	1	R/W	2	[0.01 , 250.00] Ohm
0x2A96		Pos Seq Angle	F003	1	R/W	2	[25 , 90] Deg
0x2A98		Zero Seq Module	F003	1	R/W	2	[0.01 , 750.00] Ohm
0x2A9A		Zero Seq Angle	F003	1	R/W	2	[25 , 90] Deg
0x2A9C		Line Length	F003	1	R/W	2	[0.0 , 2000.0]
0x2A9E		Show Fault On HMI	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2A9F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2AA0		CT Direction	F012	1000	R/W	1	0=REVERSE
							1=FORWARD
0x2AB1		Confirmation address			W	1	
Ajustes de Agrupamiento de Funciones - Setting Groups Settings							
0x2AB2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2AB3		Active Group	F012	1	R/W	1	0=GROUP 1
							1=GROUP 2
							2=GROUP 3
0x2AB4		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2AC7		Confirmation address			W	1	
Textos Canales Digitales - Osc digital channels text							
0x2AC8		Channel 1 Txt	F009	1	R/W	16	
0x2AD8		Channel 2 Txt	F009	1	R/W	16	
Textos Canales Digitales - Osc digital channels text(cont.)							
0x2AE8		Channel 3 Txt	F009	1	R/W	16	
0x2AF8		Channel 4 Txt	F009	1	R/W	16	
0x2B08		Channel 5 Txt	F009	1	R/W	16	
0x2B18		Channel 6 Txt	F009	1	R/W	16	
0x2B28		Channel 7 Txt	F009	1	R/W	16	
0x2B38		Channel 8 Txt	F009	1	R/W	16	
0x2B48		Channel 9 Txt	F009	1	R/W	16	
0x2B58		Channel 10 Txt	F009	1	R/W	16	
0x2B68		Channel 11 Txt	F009	1	R/W	16	
0x2B78		Channel 12 Txt	F009	1	R/W	16	
0x2B88		Channel 13 Txt	F009	1	R/W	16	
0x2B98		Channel 14 Txt	F009	1	R/W	16	
0x2BA8		Channel 15 Txt	F009	1	R/W	16	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2BB8		Channel 16 Txt	F009	1	R/W	16	
0x2C07		Confirmation address			W	1	
Ajustes Conductor Roto Grupo 1 - Broken conductor 1 Settings							
0x2C08		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2C09		Tap	F003	1	R/W	2	[20.0 , 100.0] %
0x2C0B		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2C0D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2C0E		Operation Threshold	F003	1	R/W	2	[0.000 , 1.000] A
0x2C20		Confirmation address			W	1	
Ajustes Conductor Roto Grupo 2 - Broken conductor 2 Settings							
0x2C21		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2C22		Tap	F003	1	R/W	2	[20.0 , 100.0] %
0x2C24		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2C26		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2C27		Operation Threshold	F003	1	R/W	2	[0.000 , 1.000] A
0x2C39		Confirmation address			W	1	
Ajustes Conductor Roto Grupo 3 - Broken conductor 3 Settings							
0x2C3A		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2C3B		Tap	F003	1	R/W	2	[20.0 , 100.0] %
0x2C3D		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2C3F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2C40		Operation Threshold	F003	1	R/W	2	[0.000 , 1.000] A
0x2C52		Confirmation address			W	1	
Ajustes Ethernet 1 (or “A”)- ETHERNET 1 (or “A”) Settings							
0x2C53		IP Address Oct1	F004	1	R/W	1	[0 , 255]
0x2C54		IP Address Oct2	F004	1	R/W	1	[0 , 255]
0x2C55		IP Address Oct3	F004	1	R/W	1	[0 , 255]
0x2C56		IP Address Oct4	F004	1	R/W	1	[0 , 255]
0x2C57		Netmask Oct1	F004	1	R/W	1	[0 , 255]
0x2C58		Netmask Oct2	F004	1	R/W	1	[0 , 255]
0x2C59		Netmask Oct3	F004	1	R/W	1	[0 , 255]
0x2C5A		Netmask Oct4	F004	1	R/W	1	[0 , 255]
0x2C5B		Gateway IP Oct1	F004	1	R/W	1	[0 , 255]
0x2C5C		Gateway IP Oct2	F004	1	R/W	1	[0 , 255]
0x2C5D		Gateway IP Oct3	F004	1	R/W	1	[0 , 255]
0x2C5E		Gateway IP Oct4	F004	1	R/W	1	[0 , 255]
0x2C86		Confirmation address			W	1	
Ajustes Ethernet 2 (or “B”) - ETHERNET 2 (or “B”) Settings							
0x2C87		IP Address Oct1	F004	1	R/W	1	[0 , 255]
0x2C88		IP Address Oct2	F004	1	R/W	1	[0 , 255]
0x2C89		IP Address Oct3	F004	1	R/W	1	[0 , 255]
0x2C8A		IP Address Oct4	F004	1	R/W	1	[0 , 255]
0x2C8B		Netmask Oct1	F004	1	R/W	1	[0 , 255]
0x2C8C		Netmask Oct2	F004	1	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2C8D		Netmask Oct3	F004	1	R/W	1	[0 , 255]
0x2C8E		Netmask Oct4	F004	1	R/W	1	[0 , 255]
0x2C8F		Gateway IP Oct1	F004	1	R/W	1	[0 , 255]
0x2C90		Gateway IP Oct2	F004	1	R/W	1	[0 , 255]
0x2C91		Gateway IP Oct3	F004	1	R/W	1	[0 , 255]
0x2C92		Gateway IP Oct4	F004	1	R/W	1	[0 , 255]
0x2CBA		Confirmation address			W	1	
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings							
0x2CBB		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK
0x2CBC		Address	F005	1	R/W	2	[0 , 65534]
0x2CBE		IP Addr Client1 Oct1	F004	1	R/W	1	[0 , 255]
0x2CBF		IP Addr Client1 Oct2	F004	1	R/W	1	[0 , 255]
0x2CC0		IP Addr Client1 Oct3	F004	1	R/W	1	[0 , 255]
0x2CC1		IP Addr Client1 Oct4	F004	1	R/W	1	[0 , 255]
0x2CC2		IP Addr Client2 Oct1	F004	1	R/W	1	[0 , 255]
0x2CC3		IP Addr Client2 Oct2	F004	1	R/W	1	[0 , 255]
0x2CC4		IP Addr Client2 Oct3	F004	1	R/W	1	[0 , 255]
0x2CC5		IP Addr Client2 Oct4	F004	1	R/W	1	[0 , 255]
0x2CC6		IP Addr Client3 Oct1	F004	1	R/W	1	[0 , 255]
0x2CC7		IP Addr Client3 Oct2	F004	1	R/W	1	[0 , 255]
0x2CC8		IP Addr Client3 Oct3	F004	1	R/W	1	[0 , 255]
0x2CC9		IP Addr Client3 Oct4	F004	1	R/W	1	[0 , 255]
0x2CCA		IP Addr Client4 Oct1	F004	1	R/W	1	[0 , 255]
0x2CCB		IP Addr Client4 Oct2	F004	1	R/W	1	[0 , 255]
0x2CCC		IP Addr Client4 Oct3	F004	1	R/W	1	[0 , 255]
0x2CCD		IP Addr Client4 Oct4	F004	1	R/W	1	[0 , 255]
0x2CCE		IP Addr Client5 Oct1	F004	1	R/W	1	[0 , 255]
0x2CCF		IP Addr Client5 Oct2	F004	1	R/W	1	[0 , 255]
0x2CD0		IP Addr Client5 Oct3	F004	1	R/W	1	[0 , 255]
0x2CD1		IP Addr Client5 Oct4	F004	1	R/W	1	[0 , 255]
0x2CD2		TCP/UDP Port	F005	1	R/W	2	[0 , 65535]
0x2CD4		Unsol Resp Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2CD5		Unsol Resp TimeOut	F005	1	R/W	2	[0 , 60] s
0x2CD7		Unsol Resp Max Ret	F004	1	R/W	1	[0 , 255]
0x2CD8		Unsol Resp Dest Adr	F005	1	R/W	2	[0 , 65519]
0x2CDA		Current Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings (cont.)							
							7=100
							8=1000
							9=10000

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2CDB		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDC		Power Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDD		Energy Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDE		Other Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2CDF		Current Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE1		Voltage Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE3		Power Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE5		Energy Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE7		Other Deadband	F005	1	R/W	2	[0 , 65535]
0x2CE9		Msg Fragment Size	F005	1	R/W	2	[30 , 2048]
0x2CEB		Binary Input Block 1	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
Ajustes DNP 3.0 Esclavo 1 - DNP 3.0 Slave 1 Settings (cont.)							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CEC		Binary Input Block 2	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CED		Binary Input Block 3	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CEE		Binary Input Block 4	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CEF		Binary Input Block 5	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CF0		Binary Input Block 6	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							8=CTL EVENTS 113-128
Ajustes DNP 3.0 Esclavo 2 - DNP 3.0 Slave 1 Settings (cont.)							
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CF1		Binary Input Block 7	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CF2		Binary Input Block 8	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2CF3		Binary Input Block 9	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CF4		Binary Input Block 10	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
Ajustes DNP3.0 Esclavo 1 - DNP 3.0 Slave 2 Settings							
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2CF5		Default Analog Map	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2CF6		Analog Input Point 0	F004	1000	R/W	1	[0 , 32767]
0x2CF7		Analog Input Point 1	F004	1000	R/W	1	[0 , 32767]
0x2CF8		Analog Input Point 2	F004	1000	R/W	1	[0 , 32767]
0x2CF9		Analog Input Point 3	F004	1000	R/W	1	[0 , 32767]
0x2CFA		Analog Input Point 4	F004	1000	R/W	1	[0 , 32767]
0x2CFB		Analog Input Point 5	F004	1000	R/W	1	[0 , 32767]
0x2CFC		Analog Input Point 6	F004	1000	R/W	1	[0 , 32767]
0x2CFD		Analog Input Point 7	F004	1000	R/W	1	[0 , 32767]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2CFE		Analog Input Point 8	F004	1000	R/W	1	[0 , 32767]
0x2CFF		Analog Input Point 9	F004	1000	R/W	1	[0 , 32767]
0x2D00		Analog Input Point 10	F004	1000	R/W	1	[0 , 32767]
0x2D01		Analog Input Point 11	F004	1000	R/W	1	[0 , 32767]
0x2D02		Analog Input Point 12	F004	1000	R/W	1	[0 , 32767]
0x2D03		Analog Input Point 13	F004	1000	R/W	1	[0 , 32767]
0x2D04		Analog Input Point 14	F004	1000	R/W	1	[0 , 32767]
0x2D05		Analog Input Point 15	F004	1000	R/W	1	[0 , 32767]
0x2D06		Analog Input Point 16	F004	1000	R/W	1	[0 , 32767]
0x2D07		Analog Input Point 17	F004	1000	R/W	1	[0 , 32767]
0x2D08		Analog Input Point 18	F004	1000	R/W	1	[0 , 32767]
0x2D09		Analog Input Point 19	F004	1000	R/W	1	[0 , 32767]
0x2D0A		Analog Input Point 20	F004	1000	R/W	1	[0 , 32767]
0x2D0B		Analog Input Point 21	F004	1000	R/W	1	[0 , 32767]
0x2D0C		Analog Input Point 22	F004	1000	R/W	1	[0 , 32767]
0x2D0D		Analog Input Point 23	F004	1000	R/W	1	[0 , 32767]
0x2D0E		Analog Input Point 24	F004	1000	R/W	1	[0 , 32767]
0x2D0F		Analog Input Point 25	F004	1000	R/W	1	[0 , 32767]
0x2D10		Analog Input Point 26	F004	1000	R/W	1	[0 , 32767]
0x2D11		Analog Input Point 27	F004	1000	R/W	1	[0 , 32767]
0x2D12		Analog Input Point 28	F004	1000	R/W	1	[0 , 32767]
0x2D13		Analog Input Point 29	F004	1000	R/W	1	[0 , 32767]
0x2D14		Analog Input Point 30	F004	1000	R/W	1	[0 , 32767]
0x2D15		Analog Input Point 31	F004	1000	R/W	1	[0 , 32767]
0x2D1C		Confirmation address			W	1	
0x2D1D		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK

Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 Settings							
0x2D1E		Address	F005	1	R/W	2	[0 , 65534]
0x2D20		IP Addr Client1 Oct1	F004	1	R/W	1	[0 , 255]
0x2D21		IP Addr Client1 Oct2	F004	1	R/W	1	[0 , 255]
0x2D22		IP Addr Client1 Oct3	F004	1	R/W	1	[0 , 255]
0x2D23		IP Addr Client1 Oct4	F004	1	R/W	1	[0 , 255]
0x2D24		IP Addr Client2 Oct1	F004	1	R/W	1	[0 , 255]
0x2D25		IP Addr Client2 Oct2	F004	1	R/W	1	[0 , 255]
0x2D26		IP Addr Client2 Oct3	F004	1	R/W	1	[0 , 255]
0x2D27		IP Addr Client2 Oct4	F004	1	R/W	1	[0 , 255]
0x2D28		IP Addr Client3 Oct1	F004	1	R/W	1	[0 , 255]
0x2D29		IP Addr Client3 Oct2	F004	1	R/W	1	[0 , 255]
0x2D2A		IP Addr Client3 Oct3	F004	1	R/W	1	[0 , 255]
0x2D2B		IP Addr Client3 Oct4	F004	1	R/W	1	[0 , 255]
0x2D2C		IP Addr Client4 Oct1	F004	1	R/W	1	[0 , 255]
0x2D2D		IP Addr Client4 Oct2	F004	1	R/W	1	[0 , 255]
0x2D2E		IP Addr Client4 Oct3	F004	1	R/W	1	[0 , 255]
0x2D2F		IP Addr Client4 Oct4	F004	1	R/W	1	[0 , 255]
0x2D30		IP Addr Client5 Oct1	F004	1	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2D31		IP Addr Client5 Oct2	F004	1	R/W	1	[0 , 255]
0x2D32		IP Addr Client5 Oct3	F004	1	R/W	1	[0 , 255]
0x2D33		IP Addr Client5 Oct4	F004	1	R/W	1	[0 , 255]
0x2D34		TCP/UDP Port	F005	1	R/W	2	[0 , 65535]
0x2D36		Unsol Resp Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2D37		Unsol Resp TimeOut	F005	1	R/W	2	[0 , 60] s
0x2D39		Unsol Resp Max Ret	F004	1	R/W	1	[0 , 255]
0x2D3A		Unsol Resp Dest Adr	F005	1	R/W	2	[0 , 65519]
0x2D3C		Current Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D3D		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D3E		Power Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D3F		Energy Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 Settings (cont.)							
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2D40		Other Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D41		Current Deadband	F005	1	R/W	2	[0 , 65535]
0x2D43		Voltage Deadband	F005	1	R/W	2	[0 , 65535]
0x2D45		Power Deadband	F005	1	R/W	2	[0 , 65535]
0x2D47		Energy Deadband	F005	1	R/W	2	[0 , 65535]
0x2D49		Other Deadband	F005	1	R/W	2	[0 , 65535]
0x2D4B		Msg Fragment Size	F005	1	R/W	2	[30 , 2048]
0x2D4D		Binary Input Block 1	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 (cont.)							
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
0x2D4E		Binary Input Block 2	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D4F		Binary Input Block 3	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D50		Binary Input Block 4	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D51		Binary Input Block 5	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D52		Binary Input Block 6	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 (cont.)							
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D53		Binary Input Block 7	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D54		Binary Input Block 8	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D55		Binary Input Block 9	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2D56		Binary Input Block 10	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
Ajustes DNP3.0 Esclavo 2 - DNP 3.0 Slave 2 (cont.)							
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							18=BOARD J 17-32
0x2D57		Default Analog Map	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2D58		Analog Input Point 0	F004	1000	R/W	1	[0 , 32767]
0x2D59		Analog Input Point 1	F004	1000	R/W	1	[0 , 32767]
0x2D5A		Analog Input Point 2	F004	1000	R/W	1	[0 , 32767]
0x2D5B		Analog Input Point 3	F004	1000	R/W	1	[0 , 32767]
0x2D5C		Analog Input Point 4	F004	1000	R/W	1	[0 , 32767]
0x2D5D		Analog Input Point 5	F004	1000	R/W	1	[0 , 32767]
0x2D5E		Analog Input Point 6	F004	1000	R/W	1	[0 , 32767]
0x2D5F		Analog Input Point 7	F004	1000	R/W	1	[0 , 32767]
0x2D60		Analog Input Point 8	F004	1000	R/W	1	[0 , 32767]
0x2D61		Analog Input Point 9	F004	1000	R/W	1	[0 , 32767]
0x2D62		Analog Input Point 10	F004	1000	R/W	1	[0 , 32767]
0x2D63		Analog Input Point 11	F004	1000	R/W	1	[0 , 32767]
0x2D64		Analog Input Point 12	F004	1000	R/W	1	[0 , 32767]
0x2D65		Analog Input Point 13	F004	1000	R/W	1	[0 , 32767]
0x2D66		Analog Input Point 14	F004	1000	R/W	1	[0 , 32767]
0x2D67		Analog Input Point 15	F004	1000	R/W	1	[0 , 32767]
0x2D68		Analog Input Point 16	F004	1000	R/W	1	[0 , 32767]
0x2D69		Analog Input Point 17	F004	1000	R/W	1	[0 , 32767]
0x2D6A		Analog Input Point 18	F004	1000	R/W	1	[0 , 32767]
0x2D6B		Analog Input Point 19	F004	1000	R/W	1	[0 , 32767]
0x2D6C		Analog Input Point 20	F004	1000	R/W	1	[0 , 32767]
0x2D6D		Analog Input Point 21	F004	1000	R/W	1	[0 , 32767]
0x2D6E		Analog Input Point 22	F004	1000	R/W	1	[0 , 32767]
0x2D6F		Analog Input Point 23	F004	1000	R/W	1	[0 , 32767]
0x2D70		Analog Input Point 24	F004	1000	R/W	1	[0 , 32767]
0x2D71		Analog Input Point 25	F004	1000	R/W	1	[0 , 32767]
0x2D72		Analog Input Point 26	F004	1000	R/W	1	[0 , 32767]
0x2D73		Analog Input Point 27	F004	1000	R/W	1	[0 , 32767]
0x2D74		Analog Input Point 28	F004	1000	R/W	1	[0 , 32767]
0x2D75		Analog Input Point 29	F004	1000	R/W	1	[0 , 32767]
0x2D76		Analog Input Point 30	F004	1000	R/W	1	[0 , 32767]
0x2D77		Analog Input Point 31	F004	1000	R/W	1	[0 , 32767]
0x2D7E		Confirmation address			W	1	
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3							
0x2D7F		Physical Port	F012	1	R/W	1	0=NONE
							1=COM1
							2=COM2
							3=NETWORK
0x2D80		Address	F005	1	R/W	2	[0 , 65534]
0x2D82		IP Addr Client1 Oct1	F004	1	R/W	1	[0 , 255]
0x2D83		IP Addr Client1 Oct2	F004	1	R/W	1	[0 , 255]
0x2D84		IP Addr Client1 Oct3	F004	1	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2D85		IP Addr Client1 Oct4	F004	1	R/W	1	[0 , 255]
0x2D86		IP Addr Client2 Oct1	F004	1	R/W	1	[0 , 255]
0x2D87		IP Addr Client2 Oct2	F004	1	R/W	1	[0 , 255]
0x2D88		IP Addr Client2 Oct3	F004	1	R/W	1	[0 , 255]
0x2D89		IP Addr Client2 Oct4	F004	1	R/W	1	[0 , 255]
0x2D8A		IP Addr Client3 Oct1	F004	1	R/W	1	[0 , 255]
0x2D8B		IP Addr Client3 Oct2	F004	1	R/W	1	[0 , 255]
0x2D8C		IP Addr Client3 Oct3	F004	1	R/W	1	[0 , 255]
0x2D8D		IP Addr Client3 Oct4	F004	1	R/W	1	[0 , 255]
0x2D8E		IP Addr Client4 Oct1	F004	1	R/W	1	[0 , 255]
0x2D8F		IP Addr Client4 Oct2	F004	1	R/W	1	[0 , 255]
0x2D90		IP Addr Client4 Oct3	F004	1	R/W	1	[0 , 255]
0x2D91		IP Addr Client4 Oct4	F004	1	R/W	1	[0 , 255]
0x2D92		IP Addr Client5 Oct1	F004	1	R/W	1	[0 , 255]
0x2D93		IP Addr Client5 Oct2	F004	1	R/W	1	[0 , 255]
0x2D94		IP Addr Client5 Oct3	F004	1	R/W	1	[0 , 255]
0x2D95		IP Addr Client5 Oct4	F004	1	R/W	1	[0 , 255]
0x2D96		TCP/UDP Port	F005	1	R/W	2	[0 , 65535]
0x2D98		Unsol Resp Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2D99		Unsol Resp TimeOut	F005	1	R/W	2	[0 , 60] s
0x2D9B		Unsol Resp Max Ret	F004	1	R/W	1	[0 , 255]
0x2D9C		Unsol Resp Dest Adr	F005	1	R/W	2	[0 , 65519]
0x2D9E		Current Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2D9F		Voltage Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3 (cont.)							
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA0		Power Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							6=10
							7=100
							8=1000
							9=10000
0x2DA1		Energy Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA2		Other Scale Factor	F012	1	R/W	1	0=0.00001
							1=0.0001
							2=0.001
							3=0.01
							4=0.1
							5=1
							6=10
							7=100
							8=1000
							9=10000
0x2DA3		Current Deadband	F005	1	R/W	2	[0 , 65535]
0x2DA5		Voltage Deadband	F005	1	R/W	2	[0 , 65535]
0x2DA7		Power Deadband	F005	1	R/W	2	[0 , 65535]
0x2DA9		Energy Deadband	F005	1	R/W	2	[0 , 65535]
0x2DAB		Other Deadband	F005	1	R/W	2	[0 , 65535]
0x2DAD		Msg Fragment Size	F005	1	R/W	2	[30 , 2048]
0x2DAF		Binary Input Block 1	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3 (cont.)							
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB0		Binary Input Block 2	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB1		Binary Input Block 3	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB2		Binary Input Block 4	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB3		Binary Input Block 5	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB4		Binary Input Block 6	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3 (cont.)							
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							18=BOARD J 17-32
0x2DB5		Binary Input Block 7	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB6		Binary Input Block 8	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB7		Binary Input Block 9	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB8		Binary Input Block 10	F012	1	R/W	1	0=NOT USED
							1=CTL EVENTS 1-16
							2=CTL EVENTS 17-32
							3=CTL EVENTS 33-48
							4=CTL EVENTS 49-64
							5=CTL EVENTS 65-80
							6=CTL EVENTS 81-96
							7=CTL EVENTS 97-112
							8=CTL EVENTS 113-128
							9=SWITCHGEAR 1-8
							10=SWITCHGEAR 9-16
							11=BOARD F 1-16
							12=BOARD F 17-32
							13=BOARD G 1-16
							14=BOARD G 17-32
							15=BOARD H 1-16
							16=BOARD H 17-32
							17=BOARD J 1-16
							18=BOARD J 17-32
0x2DB9		Default Analog Map	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2DBA		Analog Input Point 0	F004	1000	R/W	1	[0 , 32767]
0x2DBB		Analog Input Point 1	F004	1000	R/W	1	[0 , 32767]
0x2DBC		Analog Input Point 2	F004	1000	R/W	1	[0 , 32767]
0x2DBD		Analog Input Point 3	F004	1000	R/W	1	[0 , 32767]
0x2DBE		Analog Input Point 4	F004	1000	R/W	1	[0 , 32767]
0x2DBF		Analog Input Point 5	F004	1000	R/W	1	[0 , 32767]
0x2DC0		Analog Input Point 6	F004	1000	R/W	1	[0 , 32767]
0x2DC1		Analog Input Point 7	F004	1000	R/W	1	[0 , 32767]
0x2DC2		Analog Input Point 8	F004	1000	R/W	1	[0 , 32767]
0x2DC3		Analog Input Point 9	F004	1000	R/W	1	[0 , 32767]
0x2DC4		Analog Input Point 10	F004	1000	R/W	1	[0 , 32767]
0x2DC5		Analog Input Point 11	F004	1000	R/W	1	[0 , 32767]
0x2DC6		Analog Input Point 12	F004	1000	R/W	1	[0 , 32767]
Ajustes DNP 3.0 Esclavo 3 - DNP 3.0 Slave 3 (cont.)							
0x2DC7		Analog Input Point 13	F004	1000	R/W	1	[0 , 32767]
0x2DC8		Analog Input Point 14	F004	1000	R/W	1	[0 , 32767]
0x2DC9		Analog Input Point 15	F004	1000	R/W	1	[0 , 32767]
0x2DCA		Analog Input Point 16	F004	1000	R/W	1	[0 , 32767]
0x2DCB		Analog Input Point 17	F004	1000	R/W	1	[0 , 32767]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2DCC		Analog Input Point 18	F004	1000	R/W	1	[0 , 32767]
0x2DCD		Analog Input Point 19	F004	1000	R/W	1	[0 , 32767]
0x2DCE		Analog Input Point 20	F004	1000	R/W	1	[0 , 32767]
0x2DCF		Analog Input Point 21	F004	1000	R/W	1	[0 , 32767]
0x2DD0		Analog Input Point 22	F004	1000	R/W	1	[0 , 32767]
0x2DD1		Analog Input Point 23	F004	1000	R/W	1	[0 , 32767]
0x2DD2		Analog Input Point 24	F004	1000	R/W	1	[0 , 32767]
0x2DD3		Analog Input Point 25	F004	1000	R/W	1	[0 , 32767]
0x2DD4		Analog Input Point 26	F004	1000	R/W	1	[0 , 32767]
0x2DD5		Analog Input Point 27	F004	1000	R/W	1	[0 , 32767]
0x2DD6		Analog Input Point 28	F004	1000	R/W	1	[0 , 32767]
0x2DD7		Analog Input Point 29	F004	1000	R/W	1	[0 , 32767]
0x2DD8		Analog Input Point 30	F004	1000	R/W	1	[0 , 32767]
0x2DD9		Analog Input Point 31	F004	1000	R/W	1	[0 , 32767]
0x2DE0		Confirmation address			W	1	
Miscellaneous Settings							
0x2DE2		Relay Out Of Service	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x2DE3		Local/Remote Blocked	F012	1000	R/W	1	0=OFF
							1=ON
0x2DE4		Active Language	F004	1000	R/W	1	[0 , 1]
0x2DF5		Confirmation address			W	1	
Ajustes Unidad Sobreintensidad Instantánea de Tierra Aislada Grupo 1 - Isolated Ground IOC 1 Settings							
0x2DF6		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2DF7		Vh Level	F003	1	R/W	2	[2 , 70] V
0x2DF9		Il LEVEL	F003	1	R/W	2	[0.005 , 0.400] A
0x2DFB		Vl LEVEL	F003	1	R/W	2	[2 , 70] V
0x2DFD		Ih LEVEL	F003	1	R/W	2	[0.005 , 0.400] A
0x2DFF		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2E01		Time to inst	F003	1	R/W	2	[0.00 , 900.00] s
0x2E03		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E16		Confirmation address			W	1	
Ajustes Unidad Sobreintensidad Instantánea de Tierra Aislada Grupo 2 - Isolated Ground IOC 2 Settings							
0x2E17		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E18		Vh Level	F003	1	R/W	2	[2 , 70] V
0x2E1A		Il LEVEL	F003	1	R/W	2	[0.005 , 0.400] A
0x2E1C		Vl LEVEL	F003	1	R/W	2	[2 , 70] V
0x2E1E		Ih LEVEL	F003	1	R/W	2	[0.005 , 0.400] A
0x2E20		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2E22		Time to inst	F003	1	R/W	2	[0.00 , 900.00] s
0x2E24		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E37		Confirmation address			W	1	
Ajustes Unidad Sobreintensidad Instantánea de Tierra Aislada Grupo 3 - Isolated Ground IOC 3 Settings							
0x2E38		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E39		Vh Level	F003	1	R/W	2	[2 , 70] V

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2E3B		II LEVEL	F003	1	R/W	2	[0.005 , 0.400] A
0x2E3D		VI LEVEL	F003	1	R/W	2	[2 , 70] V
0x2E3F		Ih LEVEL	F003	1	R/W	2	[0.005 , 0.400] A
0x2E41		Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x2E43		Time to inst	F003	1	R/W	2	[0.00 , 900.00] s
0x2E45		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E58		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Sensible Grupo 1 - Sensitive Ground Directional 1 Settings							
0x2E59		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E5A		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2E5C		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
Ajustes Unidad Direccional de Tierra Sensible Grupo 1 - Sensitive Ground Directional 1 Settings (cont.)							
0x2E5D		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2E5E		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x2E60		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E73		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Sensible Grupo 2 - Sensitive Ground Directional 2 Settings							
0x2E74		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E75		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2E77		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x2E78		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2E79		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x2E7B		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E8E		Confirmation address			W	1	
Ajustes Unidad Direccional de Tierra Sensible Grupo 3 - Sensitive Ground Directional 3 Settings							
0x2E8F		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2E90		MTA	F003	1	R/W	2	[-90 , 90] Deg
0x2E92		Direction	F012	1	R/W	1	0=REVERSE
							1=FORWARD
0x2E93		Block Logic	F012	1	R/W	1	0=PERMISSION
							1=BLOCK
0x2E94		Pol V Threshold	F003	1	R/W	2	[0 , 300] V
0x2E96		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2EA9		Confirmation address			W	1	
Ajustes Unidad de Potencia Máxima Directa Grupo 1 - Forward Power 1 Settings							
0x2EAA		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2EAB		Blk Time After Close	F003	1	R/W	2	[0.00 , 900.00] s
0x2EAD		Stage 1 Tap	F003	1	R/W	2	[0.00 , 10000.00] MW

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x2EAF		Stage 1 Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2EB1		Stage 2 Tap	F003	1	R/W	2	[0.00 , 10000.00] MW
0x2EB3		Stage 2 Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2EB5		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2EC8		Confirmation address			W	1	
Ajustes Unidad de Potencia Máxima Directa Grupo 2 - Forward Power 2 Settings							
0x2EC9		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2ECA		Blk Time After Close	F003	1	R/W	2	[0.00 , 900.00] s
0x2ECC		Stage 1 Tap	F003	1	R/W	2	[0.00 , 10000.00] MW
0x2ECE		Stage 1 Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2ED0		Stage 2 Tap	F003	1	R/W	2	[0.00 , 10000.00] MW
0x2ED2		Stage 2 Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2ED4		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2EE7		Confirmation address			W	1	
Ajustes Unidad de Potencia Máxima Directa Grupo 3 - Forward Power 3 Settings							
0x2EE8		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2EE9		Blk Time After Close	F003	1	R/W	2	[0.00 , 900.00] s
0x2EEB		Stage 1 Tap	F003	1	R/W	2	[0.00 , 10000.00] MW
0x2EED		Stage 1 Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2EEF		Stage 2 Tap	F003	1	R/W	2	[0.00 , 10000.00] MW
0x2EF1		Stage 2 Time	F003	1	R/W	2	[0.00 , 900.00] s
0x2EF3		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F06		Confirmation address			W	1	
Ajustes Demanda - Demand Settings							
0x2F07		Demand Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F08		CRNT Demand Method	F012	1	R/W	1	0=THERMAL EXPONENTIAL
							1=BLOCK INTERVAL
							2=ROLLING DEMAND
0x2F09		POWER Demand Method	F012	1	R/W	1	0=THERMAL EXPONENTIAL
							1=BLOCK INTERVAL
							2=ROLLING DEMAND
0x2F0A		Demand Interval	F012	1	R/W	1	0=5 Minutes
							1=10 Minutes
							2=15 Minutes
							3=20 Minutes
							4=30 Minutes
							5=60 Minutes
0x2F0B		Trigger Enabled	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F0C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x2F1F		Confirmation address			W	1	
Ajustes Protocolo IEC 870-5-104 Settings							
0x2F20		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x2F21		TCP Port	F005	1	R/W	2	[0 , 65535]
0x2F23		Common Addr of ASDU	F005	1	R/W	2	[0 , 65535]
0x2F25		Cyclic Meter Period	F005	1	R/W	2	[0 , 3600]
0x2F27		Synchronization Event	F005	1	R/W	2	[0 , 3600]
0x2F5A		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 1 - Phase TOC Low 1 Settings							
0x32A5		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32A6		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x32A7		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x32A9		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x32AA		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x32AC		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x32AD		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32AE		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32C1		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 2 - Phase TOC Low 2 Settings							
0x32C2		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32C3		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x32C4		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x32C6		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 2 - Phase TOC Low 2 Settings (cont.)							
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x32C7		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x32C9		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x32CA		Voltage Restraint	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32CB		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32DE		Confirmation address			W	1	
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 3 - Phase TOC Low 3 Settings							
0x32DF		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32E0		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x32E1		Pickup Level	F003	1	R/W	2	[0.05 , 160.00] A
0x32E3		Curve	F012	1	R/W	1	0=IEEE Ext Inv
							1=IEEE Very Inv
							2=IEEE Mod Inv
							3=IEC Curve A
							4=IEC Curve B
							5=IEC Curve C
							6=IEC Long-Time Inv
							7=IEC Short-Time Inv
							8=IAC Ext Inv
							9=IAC Very Inv
							10=IAC Mod Inv
							11=ANSI Ext Inv
							12=ANSI Very Inv
							13=ANSI Norm Inv
							14=ANSI Mod Inv

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							15=I2t
							16=Definite Time
							17=Rectifier Curve
							18=User Curve A
							19=User Curve B
							20=User Curve C
							21=User Curve D
0x32E4		TD Multiplier	F003	1	R/W	2	[0.00 , 900.00] s
0x32E6		Reset	F012	1	R/W	1	0=INSTANTANEOUS
							1=LINEAR
0x32E7		Voltage Restraint	F012	1	R/W	1	0=DISABLED
Ajustes Sobreintensidad Temporizada de Fases Nivel Alto Grupo 3 - Phase TOC Low 3 Settings (cont.)							
							1=ENABLED
0x32E8		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x32FB		Confirmation address			W	1	
Ajustes Aparamenta (16 elementos) - Switchgear Settings (16 items)							
0x32FC		CONTACTS TYPE_01	F012	1	R/W	1	0=52a + 52b
							1=52a
							2=52b
							3=NONE
0x32FD		CONTACTS TYPE_02	F012	1	R/W	1	0=52a + 52b
							1=52a
							2=52b
							3=NONE
...	...	...	...	...	...	...	...
0x330B		CONTACTS TYPE_16	F012	1	R/W	1	0=52a + 52b
							1=52a
							2=52b
							3=NONE
0x330C		FAIL TO OPEN 01 t	F004	1	R/W	1	[0 , 30000] ms
0x330D		FAIL TO OPEN 02 t	F004	1	R/W	1	[0 , 30000] ms
...	...	...	...	...	...	...	...
0x331B		FAIL TO OPEN 16 t	F004	1	R/W	1	[0 , 30000] ms
0x331C		FAIL TO CLOSE 01 t	F004	1	R/W	1	[0 , 30000] ms
0x331D		FAIL TO CLOSE 02 t	F004	1	R/W	1	[0 , 30000] ms
...	...	...	...	...	...	...	...
0x332B		FAIL TO CLOSE 16 t	F004	1	R/W	1	[0 , 30000] ms
0x332C		Snapshot Events SWGR 1	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x332D		Snapshot Events SWGR 2	F012	1	R/W	1	0=DISABLED
							1=ENABLED
...	...	...	...	...	...	...	...
0x333B		Snapshot Events SWGR 16	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x334C		Confirmation address			W	1	
Ajustes Interruptor - Breaker Settings							
0x334D		Number of Switchgear	F004	1	R/W	1	[1 , 16]
0x334E		Maximum KI2t	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x3350		KI2t Integ. Time	F003	1	R/W	2	[0.03 , 0.25] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3352		Maximum Openings	F004	1	R/W	1	[0 , 9999]
0x3353		Max.Openings 1 hour	F004	1	R/W	1	[1 , 60]
0x3354		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3367		Confirmation address			W	1	
Ajustes Contadores Interruptor - Breaker Maintenance Settings							
0x3368		KI2t BKR Ph A Cnt	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x336A		KI2t BKR Ph B Cnt	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x336C		KI2t BKR Ph C Cnt	F003	1	R/W	2	[0.00 , 9999.99] (KA)2 s
0x336E		BKR Openings Cnt	F004	1	R/W	1	[0 , 9999]
0x336F		BKR Closings Cnt	F004	1	R/W	1	[0 , 9999]
0x3383		Confirmation address			W	1	
Ajustes Mapa Usuario Modbus - Modbus User Map Settings							
0x3384		Address 00	F004	1	R/W	1	[0 , 65535]
0x3385		Address 01	F004	1	R/W	1	[0 , 65535]
...	...	...	...	...	...	...	...
0x3483		Address 255	F004	1	R/W	1	[0 , 65535]
0x3494		Confirmation address			W	1	
Ajustes Curva Usuario A - Flex Curves A Settings							
0x3495		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x3497		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x3499		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x349B		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x349D		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x349F		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A1		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A3		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A5		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A7		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34A9		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34AB		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34AD		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34AF		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B1		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B3		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B5		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B7		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34B9		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34BB		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34BD		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34BF		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C1		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C3		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C5		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C7		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34C9		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34CB		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34CD		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34CF		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D1		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x34D3		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D5		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D7		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34D9		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34DB		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34DD		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34DF		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E1		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E3		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E5		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E7		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34E9		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34EB		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34ED		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34EF		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario A - Flex Curves A Settings (cont.)							
0x34F1		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F3		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F5		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F7		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34F9		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34FB		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34FD		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x34FF		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3501		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3503		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3505		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3507		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3509		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x350B		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x350D		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x350F		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3511		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3513		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3515		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3517		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3519		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x351B		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x351D		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x351F		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3521		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3523		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3525		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3527		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3529		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x352B		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x352D		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x352F		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3531		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3533		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3535		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3537		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3539		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x353B		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x353D		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x353F		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3541		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3543		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3545		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3547		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3549		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x354B		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x354D		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x354F		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3551		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3553		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3555		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3557		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario A - Flex Curves A Settings (cont.)							
0x3559		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x355B		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x355D		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x355F		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3561		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3563		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3565		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3567		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3569		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x356B		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x356D		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x356F		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3571		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3573		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3575		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3577		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3579		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x357B		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x357D		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x357F		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3581		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3583		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3598		Confirmation address			W	1	
Ajustes Curva Usuario B - Flex Curves B Settings							
0x3599		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x359B		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x359D		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x359F		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A1		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A3		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A5		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x35A7		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35A9		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35AB		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35AD		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35AF		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B1		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B3		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B5		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B7		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35B9		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35BB		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35BD		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35BF		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C1		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C3		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C5		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C7		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35C9		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35CB		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35CD		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario B - Flex Curves B Settings (cont.)							
0x35CF		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D1		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D3		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D5		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D7		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35D9		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35DB		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35DD		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35DF		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E1		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E3		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E5		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E7		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x35E9		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35EB		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35ED		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35EF		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F1		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F3		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F5		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F7		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35F9		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35FB		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35FD		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x35FF		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3601		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3603		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3605		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3607		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3609		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x360B		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x360D		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x360F		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3611		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3613		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3615		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3617		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3619		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x361B		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x361D		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x361F		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3621		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3623		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3625		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3627		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3629		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x362B		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x362D		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x362F		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3631		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3633		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3635		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario B - Flex Curves B Settings (cont.)							
0x3637		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3639		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x363B		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x363D		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x363F		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3641		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3643		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3645		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3647		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3649		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x364B		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x364D		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x364F		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3651		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3653		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3655		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3657		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3659		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x365B		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x365D		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x365F		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3661		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3663		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3665		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3667		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3669		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x366B		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x366D		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x366F		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3671		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3673		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3675		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3677		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3679		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x367B		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x367D		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x367F		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3681		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3683		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3685		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3687		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x369C		Confirmation address			W	1	
Ajustes Curva Usuario C - Flex Curves C							
0x369D		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x369F		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A1		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A3		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A5		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A7		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36A9		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36AB		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario C - Flex Curves C (cont.)							
0x36AD		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36AF		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B1		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B3		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B5		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B7		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36B9		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36BB		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36BD		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36BF		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C1		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C3		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C5		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C7		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36C9		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36CB		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36CD		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36CF		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D1		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D3		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D5		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D7		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36D9		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36DB		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x36DD		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36DF		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E1		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E3		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E5		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E7		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36E9		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36EB		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x36ED		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36EF		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F1		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F3		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F5		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F7		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36F9		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36FB		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36FD		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x36FF		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3701		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3703		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3705		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3707		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3709		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x370B		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x370D		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x370F		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3711		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3713		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario C - Flex Curves C (cont.)							
0x3715		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3717		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3719		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x371B		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x371D		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x371F		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3721		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3723		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3725		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3727		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3729		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x372B		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x372D		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x372F		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3731		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3733		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3735		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3737		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3739		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x373B		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x373D		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x373F		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3741		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3743		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3745		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3747		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3749		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x374B		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x374D		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x374F		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3751		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3753		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3755		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3757		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3759		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x375B		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x375D		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x375F		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3761		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3763		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3765		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3767		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3769		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x376B		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x376D		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x376F		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3771		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3773		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3775		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3777		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3779		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario C - Flex Curves C (cont.)							
0x377B		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x377D		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x377F		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3781		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3783		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3785		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3787		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3789		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x378B		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A0		Confirmation address			W	1	
Ajustes Curva Usuario D - Flex Curves D							
0x37A1		Time 0.00xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A3		Time 0.05xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A5		Time 0.10xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A7		Time 0.15xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37A9		Time 0.20xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37AB		Time 0.25xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37AD		Time 0.30xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37AF		Time 0.35xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x37B1		Time 0.40xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B3		Time 0.45xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B5		Time 0.48xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B7		Time 0.50xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37B9		Time 0.52xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37BB		Time 0.54xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37BD		Time 0.56xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37BF		Time 0.58xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C1		Time 0.60xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C3		Time 0.62xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C5		Time 0.64xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C7		Time 0.66xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37C9		Time 0.68xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37CB		Time 0.70xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37CD		Time 0.72xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37CF		Time 0.74xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D1		Time 0.76xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D3		Time 0.78xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D5		Time 0.80xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D7		Time 0.82xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37D9		Time 0.84xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37DB		Time 0.86xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37DD		Time 0.88xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37DF		Time 0.90xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E1		Time 0.91xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E3		Time 0.92xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E5		Time 0.93xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E7		Time 0.94xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37E9		Time 0.95xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37EB		Time 0.96xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37ED		Time 0.97xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
0x37EF		Time 0.98xPKP [RST]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario D - Flex Curves D (cont.)							
0x37F1		Time 1.03xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F3		Time 1.05xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F5		Time 1.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F7		Time 1.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37F9		Time 1.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37FB		Time 1.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37FD		Time 1.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x37FF		Time 1.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3801		Time 1.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3803		Time 1.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3805		Time 1.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3807		Time 2.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3809		Time 2.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x380B		Time 2.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x380D		Time 2.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x380F		Time 2.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3811		Time 2.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3813		Time 2.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3815		Time 2.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3817		Time 2.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3819		Time 2.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x381B		Time 3.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x381D		Time 3.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x381F		Time 3.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3821		Time 3.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3823		Time 3.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3825		Time 3.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3827		Time 3.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3829		Time 3.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x382B		Time 3.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x382D		Time 3.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x382F		Time 4.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3831		Time 4.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3833		Time 4.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3835		Time 4.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3837		Time 4.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3839		Time 4.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x383B		Time 4.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x383D		Time 4.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x383F		Time 4.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3841		Time 4.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3843		Time 5.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3845		Time 5.10xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3847		Time 5.20xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3849		Time 5.30xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x384B		Time 5.40xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x384D		Time 5.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x384F		Time 5.60xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3851		Time 5.70xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3853		Time 5.80xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3855		Time 5.90xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
Ajustes Curva Usuario D - Flex Curves D (cont.)							
0x3857		Time 6.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3859		Time 6.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x385B		Time 7.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x385D		Time 7.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x385F		Time 8.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3861		Time 8.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3863		Time 9.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3865		Time 9.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3867		Time 10.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3869		Time 10.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x386B		Time 11.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x386D		Time 11.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x386F		Time 12.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3871		Time 12.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3873		Time 13.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3875		Time 13.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3877		Time 14.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3879		Time 14.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x387B		Time 15.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x387D		Time 15.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x387F		Time 16.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3881		Time 16.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3883		Time 17.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3885		Time 17.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3887		Time 18.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x3889		Time 18.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x388B		Time 19.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x388D		Time 19.50xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x388F		Time 20.00xPKP [OP]	F003	1	R/W	2	[0.000 , 65.535] s
0x38A4		Confirmation address			W	1	
Ajustes Protocolo Modbus - MODBUS Settings							
0x38A5		Modbus Address COM1	F004	1	R/W	1	[1 , 255]
0x38A6		Modbus Address COM2	F004	1	R/W	1	[1 , 255]
0x38A7		Modbus Port Number	F005	1	R/W	2	[0 , 65535]
0x38BC		Confirmation address			W	1	
Ajustes Puertos Serie - SERIAL PORTS Settings							
0x38BD		COM1 Baud Rate	F012	1	R/W	1	0=300
							1=600
							2=1200
							3=2400
							4=4800
							5=9600
							6=19200
							7=38400
							8=57600
							9=115200
0x38BE		COM2 Baud Rate	F012	1	R/W	1	0=300
							1=600
							2=1200
							3=2400
							4=4800
							5=9600
							6=19200
							7=38400
							8=57600
							9=115200
0x38BF		COM1 Parity	F012	1000	R/W	1	0=NONE
							1=ODD
							2=EVEN
0x38C0		COM2 Parity	F012	1000	R/W	1	0=NONE
							1=ODD
							2=EVEN
0x38D3		Confirmation address			W	1	
Ajustes Registrador de Datos - Data Logger Settings							
0x38D4		Function	F012	1	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x38D5		Data Logger Rate	F012	1	R/W	1	0=1 s
							1=5 Minutes
							2=10 Minutes
							3=15 Minutes
							4=20 Minutes
							5=30 Minutes
							6=60 Minutes
0x38D6		Data Logger Chnl 1	F004	1	R/W	1	[0 , 32767]
0x38D7		Data Logger Chnl 2	F004	1	R/W	1	[0 , 32767]
0x38D8		Data Logger Chnl 3	F004	1	R/W	1	[0 , 32767]
0x38D9		Data Logger Chnl 4	F004	1	R/W	1	[0 , 32767]
0x38DA		Data Logger Chnl 5	F004	1	R/W	1	[0 , 32767]
0x38DB		Data Logger Chnl 6	F004	1	R/W	1	[0 , 32767]
0x38DC		Data Logger Chnl 7	F004	1	R/W	1	[0 , 32767]
0x38DD		Data Logger Chnl 8	F004	1	R/W	1	[0 , 32767]
0x38DE		Data Logger Chnl 9	F004	1	R/W	1	[0 , 32767]
0x38DF		Data Logger Chnl 10	F004	1	R/W	1	[0 , 32767]
0x38E0		Data Logger Chnl 11	F004	1	R/W	1	[0 , 32767]
0x38E1		Data Logger Chnl 12	F004	1	R/W	1	[0 , 32767]
0x38E2		Data Logger Chnl 13	F004	1	R/W	1	[0 , 32767]
0x38E3		Data Logger Chnl 14	F004	1	R/W	1	[0 , 32767]
0x38E4		Data Logger Chnl 15	F004	1	R/W	1	[0 , 32767]
0x38E5		Data Logger Chnl 16	F004	1	R/W	1	[0 , 32767]
0x38F9		Confirmation address			W	1	
Ajustes unidad direccional de potencia Grupo 1 - Directional Power 1 Settings							
0x38FA		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x38FB		Blk Time After Close	F003	1	R/W	2	[0,00 , 900,00] s
0x38FD		Dir Power Angle 1	F003	1	R/W	2	[0,00 , 359,99] Deg
0x38FF		Stage 1 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3901		Stage 1 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3903		Dir Power Angle 2	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3905		Stage 2 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3907		Stage 2 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3909		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x391C		Confirmation address			W	1	
Ajustes unidad direccional de potencia Grupo 2 - Directional Power 2 Settings							
0x391D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x391E		Blk Time After Close	F003	1	R/W	2	[0,00 , 900,00] s
0x3920		Dir Power Angle 1	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3922		Stage 1 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3924		Stage 1 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3926		Dir Power Angle 2	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3928		Stage 2 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x392A		Stage 2 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x392C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x393F		Confirmation address			W	1	
Ajustes unidad direccional de potencia Grupo 3 - Directional Power 3 Settings							
0x3940		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3941		Blk Time After Close	F003	1	R/W	2	[0,00 , 900,00] s
0x3943		Dir Power Angle 1	F003	1	R/W	2	[0,00 , 359,99] Deg
0x3945		Stage 1 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x3947		Stage 1 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x3949		Dir Power Angle 2	F003	1	R/W	2	[0,00 , 359,99] Deg
0x394B		Stage 2 Tap	F003	1	R/W	2	[-10000,00 , 10000,00] MW
0x394D		Stage 2 Time	F003	1	R/W	2	[0,00 , 900,00] s
0x394F		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3962		Confirmation address			W	1	
Ajustes unidad Rotor Bloqueado Grupo 1 - Locked Rotor 1 Settings							
		Locked Rotor 1					
0x3963		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3964		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x3965		Full Load Current	F003	1	R/W	2	[0.10 , 10.00] KA
0x3967		Pickup Level	F003	1	R/W	2	[1.01 , 109.00]
0x3969		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x396B		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x396D		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3977		Confirmation address			W	1	
Ajustes unidad Rotor Bloqueado Grupo 2 - Locked Rotor 2 Settings							
		Locked Rotor 2					
0x3978		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3979		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x397A		Full Load Current	F003	1	R/W	2	[0.10 , 10.00] KA
0x397C		Pickup Level	F003	1	R/W	2	[1.01 , 109.00]
0x397E		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x3980		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x3982		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x398C		Confirmation address			W	1	
Ajustes unidad Rotor Bloqueado Grupo 3 - Locked Rotor 3 Settings							
		Locked Rotor 3					
0x398D		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x398E		Input	F012	1	R/W	1	0=PHASOR(DFT)
							1=RMS
0x398F		Full Load Current	F003	1	R/W	2	[0.10 , 10.00] KA
0x3991		Pickup Level	F003	1	R/W	2	[1.01 , 109.00]
0x3993		Trip Delay	F003	1	R/W	2	[0.00 , 900.00] s
0x3995		Reset Delay	F003	1	R/W	2	[0.00 , 900.00] s

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3997		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x39A1		Confirmation address			W	1	
Ajustes Comunicaciones Remotas - Remote Communications Settings							
0x3A76		Remote Comms	F012	1	R/W	1	0=DISABLED
							1=GSSE
							2=GOOSE
0x3A77		F650 ID	F009	1	R/W	33	
0x3A98		Hold Time	F005	1	R/W	2	[1000 , 60000] ms
0x3A9A		Events Remote Out	F012	1	R/W	1	0=DISABLED
							1=ENABLED
Ajustes Entradas Remotas (32 elementos) - Remote Inputs Settings (32 items) [Only Configurable for GSSE]							
0x3A9B		Remote Device 1	F009	1	R/W	33	
0x3ABC		Bit Pair 1	F012	1	R/W	1	0=NONE
							1=DNA-1
							2=DNA-2

							32=DNA-32
							33=UserSt-1
							34=UserSt-2

							96=UserSt-64
0x3ABD		Default Value 1	F012	1	R/W	1	0=OFF
							1=ON
							2=Latest OFF
							3=Latest ON
Ajustes Entradas Remotas (32 elementos) - Remote Inputs Settings (32 items) [Only Configurable for GSSE] (cont.)							
0x3ABE		Remote Device 2	F009	1	R/W	33	
0x3ADF		Bit Pair 2	F012	1	R/W	1	0=NONE
							1=DNA-1
							2=DNA-2

							32=DNA-32
							33=UserSt-1
							34=UserSt-2

							96=UserSt-64
0x3AE0		Default Value 2	F012	1	R/W	1	0=OFF
							1=ON
							2=Latest OFF
							3=Latest ON
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...
0x3ED8		Remote Device 32	F009	1	R/W	33	
0x3EF9		Bit Pair 32	F012	1	R/W	1	0=NONE
							1=DNA-1
							2=DNA-2

							32=DNA-32

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							33=UserSt-1
							34=UserSt-2

							96=UserSt-64
0x3EFA		Default Value 32	F012	1	R/W	1	0=OFF
							1=ON
							2=Latest OFF
							3=Latest ON
0x3EFB		Events Remote Inp	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x3EFC		Destination MAC Data1	F004	1000	R/W	1	
0x3EFD		Destination MAC Data2	F004	1000	R/W	1	
0x3EFE		Destination MAC Data3	F004	1000	R/W	1	
0x3EFF		GSSE RemDevice01 MAC Data1	F004	1000	R/W	1	
0x3F00		GSSE RemDevice01 MAC Data2	F004	1000	R/W	1	
0x3F01		GSSE RemDevice01 MAC Data3	F004	1000	R/W	1	
0x3F02		GSSE RemDevice02 MAC Data1	F004	1000	R/W	1	
0x3F03		GSSE RemDevice02 MAC Data2	F004	1000	R/W	1	
0x3F04		GSSE RemDevice02 MAC Data3	F004	1000	R/W	1	
0x3F05		GSSE RemDevice03 MAC Data1	F004	1000	R/W	1	
0x3F06		GSSE RemDevice03 MAC Data2	F004	1000	R/W	1	
0x3F07		GSSE RemDevice03 MAC Data3	F004	1000	R/W	1	
0x3F08		GSSE RemDevice04 MAC Data1	F004	1000	R/W	1	
0x3F09		GSSE RemDevice04 MAC Data2	F004	1000	R/W	1	
0x3F0A		GSSE RemDevice04 MAC Data3	F004	1000	R/W	1	
0x3F0B		GSSE RemDevice05 MAC Data1	F004	1000	R/W	1	
0x3F0C		GSSE RemDevice05 MAC Data2	F004	1000	R/W	1	
0x3F0D		GSSE RemDevice05 MAC Data3	F004	1000	R/W	1	
0x3F0E		GSSE RemDevice06 MAC Data1	F004	1000	R/W	1	
0x3F0F		GSSE RemDevice06 MAC Data2	F004	1000	R/W	1	
0x3F10		GSSE RemDevice06 MAC Data3	F004	1000	R/W	1	
0x3F11		GSSE RemDevice07 MAC Data1	F004	1000	R/W	1	
0x3F12		GSSE RemDevice07 MAC Data2	F004	1000	R/W	1	
0x3F13		GSSE RemDevice07 MAC Data3	F004	1000	R/W	1	
0x3F14		GSSE RemDevice08 MAC Data1	F004	1000	R/W	1	
0x3F15		GSSE RemDevice08 MAC Data2	F004	1000	R/W	1	
0x3F16		GSSE RemDevice08 MAC Data3	F004	1000	R/W	1	
0x3F17		GSSE RemDevice09 MAC Data1	F004	1000	R/W	1	
0x3F18		GSSE RemDevice09 MAC Data2	F004	1000	R/W	1	
0x3F19		GSSE RemDevice09 MAC Data3	F004	1000	R/W	1	
0x3F1A		GSSE RemDevice10 MAC Data1	F004	1000	R/W	1	
0x3F1B		GSSE RemDevice10 MAC Data2	F004	1000	R/W	1	
0x3F1C		GSSE RemDevice10 MAC Data3	F004	1000	R/W	1	
0x3F1D		GSSE RemDevice11 MAC Data1	F004	1000	R/W	1	
0x3F1E		GSSE RemDevice11 MAC Data2	F004	1000	R/W	1	
0x3F1F		GSSE RemDevice11 MAC Data3	F004	1000	R/W	1	
0x3F20		GSSE RemDevice12 MAC Data1	F004	1000	R/W	1	
0x3F21		GSSE RemDevice12 MAC Data2	F004	1000	R/W	1	
0x3F22		GSSE RemDevice12 MAC Data3	F004	1000	R/W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3F23		GSSE RemDevice13 MAC Data1	F004	1000	R/W	1	
0x3F24		GSSE RemDevice13 MAC Data2	F004	1000	R/W	1	
0x3F25		GSSE RemDevice13 MAC Data3	F004	1000	R/W	1	
0x3F26		GSSE RemDevice14 MAC Data1	F004	1000	R/W	1	
0x3F27		GSSE RemDevice14 MAC Data2	F004	1000	R/W	1	
0x3F28		GSSE RemDevice14 MAC Data3	F004	1000	R/W	1	
0x3F29		GSSE RemDevice15 MAC Data1	F004	1000	R/W	1	
0x3F2A		GSSE RemDevice15 MAC Data2	F004	1000	R/W	1	
0x3F2B		GSSE RemDevice15 MAC Data3	F004	1000	R/W	1	
0x3F2C		GSSE RemDevice16 MAC Data1	F004	1000	R/W	1	
0x3F2D		GSSE RemDevice16 MAC Data2	F004	1000	R/W	1	
0x3F2E		GSSE RemDevice16 MAC Data3	F004	1000	R/W	1	
0x3F2F		GSSE RemDevice17 MAC Data1	F004	1000	R/W	1	
0x3F30		GSSE RemDevice17 MAC Data2	F004	1000	R/W	1	
0x3F31		GSSE RemDevice17 MAC Data3	F004	1000	R/W	1	
0x3F32		GSSE RemDevice18 MAC Data1	F004	1000	R/W	1	
0x3F33		GSSE RemDevice18 MAC Data2	F004	1000	R/W	1	
0x3F34		GSSE RemDevice18 MAC Data3	F004	1000	R/W	1	
0x3F35		GSSE RemDevice19 MAC Data1	F004	1000	R/W	1	
0x3F36		GSSE RemDevice19 MAC Data2	F004	1000	R/W	1	
0x3F37		GSSE RemDevice19 MAC Data3	F004	1000	R/W	1	
0x3F38		GSSE RemDevice20 MAC Data1	F004	1000	R/W	1	
0x3F39		GSSE RemDevice20 MAC Data2	F004	1000	R/W	1	
0x3F3A		GSSE RemDevice20 MAC Data3	F004	1000	R/W	1	
0x3F3B		GSSE RemDevice21 MAC Data1	F004	1000	R/W	1	
0x3F3C		GSSE RemDevice21 MAC Data2	F004	1000	R/W	1	
0x3F3D		GSSE RemDevice21 MAC Data3	F004	1000	R/W	1	
0x3F3E		GSSE RemDevice22 MAC Data1	F004	1000	R/W	1	
0x3F3F		GSSE RemDevice22 MAC Data2	F004	1000	R/W	1	
0x3F40		GSSE RemDevice22 MAC Data3	F004	1000	R/W	1	
0x3F41		GSSE RemDevice23 MAC Data1	F004	1000	R/W	1	
0x3F42		GSSE RemDevice23 MAC Data2	F004	1000	R/W	1	
0x3F43		GSSE RemDevice23 MAC Data3	F004	1000	R/W	1	
0x3F44		GSSE RemDevice24 MAC Data1	F004	1000	R/W	1	
0x3F45		GSSE RemDevice24 MAC Data2	F004	1000	R/W	1	
0x3F46		GSSE RemDevice24 MAC Data3	F004	1000	R/W	1	
0x3F47		GSSE PORT	F012	1000	R/W	1	0=PORT A
							1=PORT B
							2=BOTH
0x3F5B		Confirmation address					
Ajustes Sincronizacion SNTP - SNTP synchronization Settings (Do not apply to C650 models)							
		SNTP					
0x3F5C		Function	F012	1	R/W	1	0=DISABLED
							1=UNICAST
							2=BROADCAST
							3=ANYCAST
0x3F5D		UDP Port	F005	1	R/W	2	[1 , 65535]
0x3F5F		Server IP Oct 1	F004	1	R/W	1	[0 , 255]
0x3F60		Server IP Oct 2	F004	1	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3F61		Server IP Oct 3	F004	1	R/W	1	[0 , 255]
0x3F62		Server IP Oct 4	F004	1	R/W	1	[0 , 255]
0x3F66		Confirmation address					
0x3F67		Server2 UDP Port	F004	1	R/W	1	[0 , 255]
0x3F69		Server2 IP Oct 1	F004	1	R/W	1	[0 , 255]
0x3F6A		Server2 IP Oct 2	F004	1	R/W	1	[0 , 255]
0x3F6B		Server2 IP Oct 3	F004	1	R/W	1	[0 , 255]
0x3F6C		Server2 IP Oct 4	F004	1	R/W	1	[0 , 255]
0x3F87		Confirmation address			W	1	
Contador de Pulsos-Pulse Counters							
0x3F88		PulseCntr Enabled 1	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3F89		PulseCntr Name 1	F009	1,000	R/W	16	
0x3F99		PulseCntr Factor 1	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3F9B		PulseCntr Overflow 1	F005	1,000	R/W	2	[0 , 1000000]
0x3F9D		PulseCntr Board Origin 1	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3F9E		PulseCntr Input Origin 1	F004	1,000	R/W	1	[1 , 32]
0x3F9F		PulseCntr Enabled 2	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FA0		PulseCntr Name 2	F009	1,000	R/W	16	
0x3FB0		PulseCntr Factor 2	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FB2		PulseCntr Overflow 2	F005	1,000	R/W	2	[0 , 1000000]
0x3FB4		PulseCntr Board Origin 2	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FB5		PulseCntr Input Origin 2	F004	1,000	R/W	1	[1 , 32]
0x3FB6		PulseCntr Enabled 3	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FB7		PulseCntr Name 3	F009	1,000	R/W	16	
0x3FC7		PulseCntr Factor 3	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FC9		PulseCntr Overflow 3	F005	1,000	R/W	2	[0 , 1000000]
0x3FCB		PulseCntr Board Origin 3	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FCC		PulseCntr Input Origin 3	F004	1,000	R/W	1	[1 , 32]
0x3FCD		PulseCntr Enabled 4	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FCE		PulseCntr Name 4	F009	1,000	R/W	16	
0x3FDE		PulseCntr Factor 4	F003	1,000	R/W	2	[0.000 , 65000.000]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x3FE0		PulseCntr Overflow 4	F005	1,000	R/W	2	[0 , 1000000]
0x3FE2		PulseCntr Board Origin 4	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FE3		PulseCntr Input Origin 4	F004	1,000	R/W	1	[1 , 32]
0x3FE4		PulseCntr Enabled 5	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
Contador de Pulsos-Pulse Counters (cont.)							
0x3FE5		PulseCntr Name 5	F009	1,000	R/W	16	
0x3FF5		PulseCntr Factor 5	F003	1,000	R/W	2	[0.000 , 65000.000]
0x3FF7		PulseCntr Overflow 5	F005	1,000	R/W	2	[0 , 1000000]
0x3FF9		PulseCntr Board Origin 5	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x3FFA		PulseCntr Input Origin 5	F004	1,000	R/W	1	[1 , 32]
0x3FFB		PulseCntr Enabled 6	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x3FFC		PulseCntr Name 6	F009	1,000	R/W	16	
0x400C		PulseCntr Factor 6	F003	1,000	R/W	2	[0.000 , 65000.000]
0x400E		PulseCntr Overflow 6	F005	1,000	R/W	2	[0 , 1000000]
0x4010		PulseCntr Board Origin 6	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x4011		PulseCntr Input Origin 6	F004	1,000	R/W	1	[1 , 32]
0x4012		PulseCntr Enabled 7	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4013		PulseCntr Name 7	F009	1,000	R/W	16	
0x4023		PulseCntr Factor 7	F003	1,000	R/W	2	[0.000 , 65000.000]
0x4025		PulseCntr Overflow 7	F005	1,000	R/W	2	[0 , 1000000]
0x4027		PulseCntr Board Origin 7	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x4028		PulseCntr Input Origin 7	F004	1,000	R/W	1	[1 , 32]
0x4029		PulseCntr Enabled 8	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x402A		PulseCntr Name 8	F009	1,000	R/W	16	
0x403A		PulseCntr Factor 8	F003	1,000	R/W	2	[0.000 , 65000.000]
0x403C		PulseCntr Overflow 8	F005	1,000	R/W	2	[0 , 1000000]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x403E		PulseCntr Board Origin 8	F012	1,000	R/W	1	0=F
							1=G
							2=H
							3=J
0x403F		PulseCntr Input Origin 8	F004	1,000	R/W	1	[1 , 32]
0x4052		Confirmation address			W	1	
Comparadores Analógicos-Analog comparators							
0x4053		Analog Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4054		Analog Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4055		Analog Input 01	F004	1,000	R/W	1	
0x4056		Analog Maximum 01	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4058		Analog Minimum 01	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x405A		Analog Delay 01	F003	1,000	R/W	2	[0.00 , 900.00] s
0x405C		Analog Hysteresis 01	F003	1,000	R/W	2	[0.0 , 50.0]
0x405E		Analog Direction 01	F012	1,000	R/W	1	0=OUT
							1=IN
0x405F		Analog Input 02	F004	1,000	R/W	1	
0x4060		Analog Maximum 02	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4062		Analog Minimum 02	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4064		Analog Delay 02	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4066		Analog Hysteresis 02	F003	1,000	R/W	2	[0.0 , 50.0]
0x4068		Analog Direction 02	F012	1,000	R/W	1	0=OUT
							1=IN
0x4069		Analog Input 03	F004	1,000	R/W	1	
0x406A		Analog Maximum 03	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x406C		Analog Minimum 03	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x406E		Analog Delay 03	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4070		Analog Hysteresis 03	F003	1,000	R/W	2	[0.0 , 50.0]
0x4072		Analog Direction 03	F012	1,000	R/W	1	0=OUT
							1=IN
0x4073		Analog Input 04	F004	1,000	R/W	1	
0x4074		Analog Maximum 04	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4076		Analog Minimum 04	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4078		Analog Delay 04	F003	1,000	R/W	2	[0.00 , 900.00] s
0x407A		Analog Hysteresis 04	F003	1,000	R/W	2	[0.0 , 50.0]
0x407C		Analog Direction 04	F012	1,000	R/W	1	0=OUT
							1=IN
0x407D		Analog Input 05	F004	1,000	R/W	1	
0x407E		Analog Maximum 05	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4080		Analog Minimum 05	F003	1,000	R/W	2	[-100000.000 , 100000.000]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4082		Analog Delay 05	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4084		Analog Hysteresis 05	F003	1,000	R/W	2	[0.0 , 50.0]
0x4086		Analog Direction 05	F012	1,000	R/W	1	0=OUT
							1=IN
0x4087		Analog Input 06	F004	1,000	R/W	1	
0x4088		Analog Maximum 06	F003	1,000	R/W	2	[-100000.000 , 100000.000]
Comparadores Analógicos-Analog comparators (cont.)							
0x408A		Analog Minimum 06	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x408C		Analog Delay 06	F003	1,000	R/W	2	[0.00 , 900.00] s
0x408E		Analog Hysteresis 06	F003	1,000	R/W	2	[0.0 , 50.0]
0x4090		Analog Direction 06	F012	1,000	R/W	1	0=OUT
							1=IN
0x4091		Analog Input 07	F004	1,000	R/W	1	
0x4092		Analog Maximum 07	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4094		Analog Minimum 07	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4096		Analog Delay 07	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4098		Analog Hysteresis 07	F003	1,000	R/W	2	[0.0 , 50.0]
0x409A		Analog Direction 07	F012	1,000	R/W	1	0=OUT
							1=IN
0x409B		Analog Input 08	F004	1,000	R/W	1	
0x409C		Analog Maximum 08	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x409E		Analog Minimum 08	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40A0		Analog Delay 08	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40A2		Analog Hysteresis 08	F003	1,000	R/W	2	[0.0 , 50.0]
0x40A4		Analog Direction 08	F012	1,000	R/W	1	0=OUT
							1=IN
0x40A5		Analog Input 09	F004	1,000	R/W	1	
0x40A6		Analog Maximum 09	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40A8		Analog Minimum 09	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40AA		Analog Delay 09	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40AC		Analog Hysteresis 09	F003	1,000	R/W	2	[0.0 , 50.0]
0x40AE		Analog Direction 09	F012	1,000	R/W	1	0=OUT
							1=IN
0x40AF		Analog Input 10	F004	1,000	R/W	1	
0x40B0		Analog Maximum 10	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40B2		Analog Minimum 10	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40B4		Analog Delay 10	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40B6		Analog Hysteresis 10	F003	1,000	R/W	2	[0.0 , 50.0]
0x40B8		Analog Direction 10	F012	1,000	R/W	1	0=OUT
							1=IN
0x40B9		Analog Input 11	F004	1,000	R/W	1	
0x40BA		Analog Maximum 11	F003	1,000	R/W	2	[-100000.000 , 100000.000]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x40BC		Analog Minimum 11	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40BE		Analog Delay 11	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40C0		Analog Hysteresis 11	F003	1,000	R/W	2	[0.0 , 50.0]
0x40C2		Analog Direction 11	F012	1,000	R/W	1	0=OUT
							1=IN
0x40C3		Analog Input 12	F004	1,000	R/W	1	
Comparadores Analógicos-Analog comparators (cont.)							
0x40C4		Analog Maximum 12	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40C6		Analog Minimum 12	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40C8		Analog Delay 12	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40CA		Analog Hysteresis 12	F003	1,000	R/W	2	[0.0 , 50.0]
0x40CC		Analog Direction 12	F012	1,000	R/W	1	0=OUT
							1=IN
0x40CD		Analog Input 13	F004	1,000	R/W	1	
0x40CE		Analog Maximum 13	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40D0		Analog Minimum 13	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40D2		Analog Delay 13	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40D4		Analog Hysteresis 13	F003	1,000	R/W	2	[0.0 , 50.0]
0x40D6		Analog Direction 13	F012	1,000	R/W	1	0=OUT
							1=IN
0x40D7		Analog Input 14	F004	1,000	R/W	1	
0x40D8		Analog Maximum 14	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40DA		Analog Minimum 14	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40DC		Analog Delay 14	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40DE		Analog Hysteresis 14	F003	1,000	R/W	2	[0.0 , 50.0]
0x40E0		Analog Direction 14	F012	1,000	R/W	1	0=OUT
							1=IN
0x40E1		Analog Input 15	F004	1,000	R/W	1	
0x40E2		Analog Maximum 15	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40E4		Analog Minimum 15	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40E6		Analog Delay 15	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40E8		Analog Hysteresis 15	F003	1,000	R/W	2	[0.0 , 50.0]
0x40EA		Analog Direction 15	F012	1,000	R/W	1	0=OUT
							1=IN
0x40EB		Analog Input 16	F004	1,000	R/W	1	
0x40EC		Analog Maximum 16	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40EE		Analog Minimum 16	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40F0		Analog Delay 16	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40F2		Analog Hysteresis 16	F003	1,000	R/W	2	[0.0 , 50.0]
0x40F4		Analog Direction 16	F012	1,000	R/W	1	0=OUT
							1=IN
0x40F5		Analog Input 17	F004	1,000	R/W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x40F6		Analog Maximum 17	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40F8		Analog Minimum 17	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x40FA		Analog Delay 17	F003	1,000	R/W	2	[0.00 , 900.00] s
0x40FC		Analog Hysteresis 17	F003	1,000	R/W	2	[0.0 , 50.0]
0x40FE		Analog Direction 17	F012	1,000	R/W	1	0=OUT
							1=IN
Comparadores Analógicos-Analog comparators (cont.)							
0x40FF		Analog Input 18	F004	1,000	R/W	1	
0x4100		Analog Maximum 18	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4102		Analog Minimum 18	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4104		Analog Delay 18	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4106		Analog Hysteresis 18	F003	1,000	R/W	2	[0.0 , 50.0]
0x4108		Analog Direction 18	F012	1,000	R/W	1	0=OUT
							1=IN
0x4109		Analog Input 19	F004	1,000	R/W	1	
0x410A		Analog Maximum 19	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x410C		Analog Minimum 19	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x410E		Analog Delay 19	F003	1,000	R/W	2	[0.00 , 900.00] s
0x4110		Analog Hysteresis 19	F003	1,000	R/W	2	[0.0 , 50.0]
0x4112		Analog Direction 19	F012	1,000	R/W	1	0=OUT
							1=IN
0x4113		Analog Input 20	F004	1,000	R/W	1	
0x4114		Analog Maximum 20	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4116		Analog Minimum 20	F003	1,000	R/W	2	[-100000.000 , 100000.000]
0x4118		Analog Delay 20	F003	1,000	R/W	2	[0.00 , 900.00] s
0x411A		Analog Hysteresis 20	F003	1,000	R/W	2	[0.0 , 50.0]
0x411C		Analog Direction 20	F012	1,000	R/W	1	0=OUT
							1=IN
0x412F		Confirmation address			W	1	
Ajustes Derivada de Frecuencia 1-Frequency Rate of Change 1 Settings							
0x4130		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4131		Freq. Rate Trend	F012	1,000	R/W	1	0=INCREASING
							1=DECREASING
							2=BI-DIRECTIONAL
0x4132		Freq. Rate Pickup	F003	1,000	R/W	2	[0.10 , 10.00] Hz/s
0x4134		Freq. Rate OV Supv	F003	1,000	R/W	2	[0.00 , 110.00] %
0x4136		Freq. Rate Min	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x4138		Freq. Rate Max	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x413A		Freq. Rate Delay	F003	1,000	R/W	2	[0.00 , 60.00] s
0x413C		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x414F		Confirmation address			W	1	
Ajustes Derivada de Frecuencia 2-Frequency Rate of Change 2 Settings							
0x4150		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4151		Freq. Rate Trend	F012	1,000	R/W	1	0=INCREASING
							1=DECREASING
							2=BI-DIRECTIONAL
0x4152		Freq. Rate Pickup	F003	1,000	R/W	2	[0.10 , 10.00] Hz/s
0x4154		Freq. Rate OV Supv	F003	1,000	R/W	2	[0.00 , 110.00] %
0x4156		Freq. Rate Min	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x4158		Freq. Rate Max	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x415A		Freq. Rate Delay	F003	1,000	R/W	2	[0.00 , 60.00] s
0x415C		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x416F		Confirmation address			W	1	
Ajustes Derivada de Frecuencia 3-Frequency Rate of Change 3 Settings							
0x4170		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4171		Freq. Rate Trend	F012	1,000	R/W	1	0=INCREASING
							1=DECREASING
							2=BI-DIRECTIONAL
0x4172		Freq. Rate Pickup	F003	1,000	R/W	2	[0.10 , 10.00] Hz/s
0x4174		Freq. Rate OV Supv	F003	1,000	R/W	2	[0.00 , 110.00] %
0x4176		Freq. Rate Min	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x4178		Freq. Rate Max	F003	1,000	R/W	2	[20.00 , 80.00] Hz
0x417A		Freq. Rate Delay	F003	1,000	R/W	2	[0.00 , 60.00] s
0x417C		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x418F		Confirmation address			W	1	
Inversión de carga 1-Load Encroachment 1							
0x4190		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x4191		Min. Voltage	F003	1,000	R/W	2	[0.00 , 300.00] V
0x4193		Reach	F003	1,000	R/W	2	[0.02 , 250.00] Ohm
0x4195		Angle	F003	1,000	R/W	2	[5 , 50] Deg
0x4197		Pickup Delay	F003	1,000	R/W	2	[0.000 , 65.535] s
0x4199		Reset Delay	F003	1,000	R/W	2	[0.000 , 65.535] s
0x419B		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x41AE		Confirmation address			W	1	
Inversión de carga 2-Load Encroachment 2							
0x41AF		Function	F012	1,000	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x41B0		Min. Voltage	F003	1,000	R/W	2	[0.00 , 300.00] V
0x41B2		Reach	F003	1,000	R/W	2	[0.02 , 250.00] Ohm
0x41B4		Angle	F003	1,000	R/W	2	[5 , 50] Deg
0x41B6		Pickup Delay	F003	1,000	R/W	2	[0.000 , 65.535] s
0x41B8		Reset Delay	F003	1,000	R/W	2	[0.000 , 65.535] s
0x41BA		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x41CD		Confirmation address			W	1	
Inversión de carga 3-Load Encroachment 3							
0x41CE		Function	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x41CF		Min. Voltage	F003	1,000	R/W	2	[0.00 , 300.00] V
0x41D1		Reach	F003	1,000	R/W	2	[0.02 , 250.00] Ohm
0x41D3		Angle	F003	1,000	R/W	2	[5 , 50] Deg
0x41D5		Pickup Delay	F003	1,000	R/W	2	[0.000 , 65.535] s
0x41D7		Reset Delay	F003	1,000	R/W	2	[0.000 , 65.535] s
0x41D9		Snapshot Events	F012	1,000	R/W	1	0=DISABLED
							1=ENABLED
0x41EC		Confirmation address			W	1	
Max. Number of Starts							
0x41ED		Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x41EE		Full Load Amps	F003	1000	R/W	2	[0,5 , 10,0] A
0x41F0		Breaker Supervision	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x41F1		Min. Stop Time	F003	1000	R/W	2	[0,0 , 900,0] s
0x41F3		Number of starts	F004	1000	R/W	1	[0 , 10]
0x41F4		Time to restart	F004	1000	R/W	1	[0 , 100] min
0x41F5		Reset counter	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x41F6		Snapshot Events	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4209		Confirmation address			W	1	
Ajustes Protocolo PROCOME - PROCOME Protocol Communication Settings							
0x420A		COMM Port	F012	1	R/W	1	0=NONE
							1=COM 1
0x420B		Slave Number	F004	1	R/W	1	[0 , 254]
0x4210		Confirmation address			W	1	
32N1 High - wattmetric Ground Fault High Level Group 1 Settings							
0x44A0		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44A1		Voltage Pickup Level	F003	1	R/W	2	[2.00 , 70.00] V
0x44A3		Current Selection	F012	1	R/W	1	0=IN
							1=IG
0x44A4		OC Pickup Level	F003	1	R/W	2	[0.005 , 0.400] A

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x44A6		OC Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44A8		Power Pickup	F003	1	R/W	2	[0.01 , 4.50] W
0x44AA		MTA	F004	1	R/W	1	[0 , 360] Deg
0x44AB		Power Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44AD		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
							2=USER CURVE A
							3=USER CURVE B
							4=USER CURVE C
							5=USER CURVE D
0x44AE		Multiplier	F003	1	R/W	2	[0.02 , 2.00] s
0x44B0		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44BA		Confirmation address			W	1	
32N2 High - wattmetric Ground Fault High Level Group 2 Settings							
0x44BB		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44BC		Voltage Pickup Level	F003	1	R/W	2	[2.00 , 70.00] V
0x44BE		Current Selection	F012	1	R/W	1	0=IN
							1=IG
0x44BF		OC Pickup Level	F003	1	R/W	2	[0.005 , 0.400] A
0x44C1		OC Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44C3		Power Pickup	F003	1	R/W	2	[0.01 , 4.50] W
0x44C5		MTA	F004	1	R/W	1	[0 , 360] Deg
0x44C6		Power Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44C8		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
32N2 High - wattmetric Ground Fault High Level Group 2 Settings (cont.)							
							2=USER CURVE A
							3=USER CURVE B
							4=USER CURVE C
							5=USER CURVE D
0x44C9		Multiplier	F003	1	R/W	2	[0.02 , 2.00] s
0x44CB		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44D5		Confirmation address			W	1	
32N3 High - wattmetric Ground Fault High Level Group 3 Settings							
0x44D6		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44D7		Voltage Pickup Level	F003	1	R/W	2	[2.00 , 70.00] V
0x44D9		Current Selection	F012	1	R/W	1	0=IN
							1=IG
0x44DA		OC Pickup Level	F003	1	R/W	2	[0.005 , 0.400] A
0x44DC		OC Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44DE		Power Pickup	F003	1	R/W	2	[0.01 , 4.50] W
0x44E0		MTA	F004	1	R/W	1	[0 , 360] Deg
0x44E1		Power Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44E3		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
							2=USER CURVE A

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							3=USER CURVE B
							4=USER CURVE C
							5=USER CURVE D
0x44E4		Multiplier	F003	1	R/W	2	[0.02 , 2.00] s
0x44E6		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44F0		Confirmation address			W	1	
32N1 Low - wattmetric Ground Fault Low Level Group 1 Settings							
0x44F1		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x44F2		Voltage Pickup Level	F003	1	R/W	2	[2.00 , 70.00] V
0x44F4		Current Selection	F012	1	R/W	1	0=IN
							1=IG
0x44F5		OC Pickup Level	F003	1	R/W	2	[0.005 , 0.400] A
0x44F7		OC Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44F9		Power Pickup	F003	1	R/W	2	[0.01 , 4.50] W
0x44FB		MTA	F004	1	R/W	1	[0 , 360] Deg
0x44FC		Power Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x44FE		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
							2=USER CURVE A
							3=USER CURVE B
							4=USER CURVE C
							5=USER CURVE D
0x44FF		Multiplier	F003	1	R/W	2	[0.02 , 2.00] s
0x4501		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x450B		Confirmation address			W	1	
32N2 Low - wattmetric Ground Fault Low Level Group 2 Settings							
0x450C		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x450D		Voltage Pickup Level	F003	1	R/W	2	[2.00 , 70.00] V
0x450F		Current Selection	F012	1	R/W	1	0=IN
							1=IG
0x4510		OC Pickup Level	F003	1	R/W	2	[0.005 , 0.400] A
0x4512		OC Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x4514		Power Pickup	F003	1	R/W	2	[0.01 , 4.50] W
0x4516		MTA	F004	1	R/W	1	[0 , 360] Deg
0x4517		Power Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x4519		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
							2=USER CURVE A
							3=USER CURVE B
							4=USER CURVE C
							5=USER CURVE D
0x451A		Multiplier	F003	1	R/W	2	[0.02 , 2.00] s
0x451C		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4526		Confirmation address			W	1	
32N3 Low - wattmetric Ground Fault Low Level Group 3 Settings							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4527		Function	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4528		Voltage Pickup Level	F003	1	R/W	2	[2.00 , 70.00] V
0x452A		Current Selection	F012	1	R/W	1	0=IN
							1=IG
0x452B		OC Pickup Level	F003	1	R/W	2	[0.005 , 0.400] A
0x452D		OC Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x452F		Power Pickup	F003	1	R/W	2	[0.01 , 4.50] W
0x4531		MTA	F004	1	R/W	1	[0 , 360] Deg
0x4532		Power Pickup Delay	F003	1	R/W	2	[0.00 , 600.00] s
0x4534		Curve	F012	1	R/W	1	0=DEFINITE TIME
							1=INVERSE TIME
							2=USER CURVE A
							3=USER CURVE B
							4=USER CURVE C
							5=USER CURVE D
0x4535		Multiplier	F003	1	R/W	2	[0.02 , 2.00] s
0x4537		Snapshot Events	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4541		Confirmation address			W	1	
Ajustes IEC 870-5-103 - IEC 870-5-103 Settings							
0x4542		COMM Port	F012	1	R/W	1	0=NONE
							1=COM 1
0x4543		Slave Number	F004	1	R/W	1	[0 , 254]
0x4544		Synchronization Timeout	F004	1	R/W	1	[0 , 1440] min
0x454E		Confirmation address			W	1	
Ajustes de Fecha y Hora - Time Settings							
0x454F		LOC TIME OFFS. UTC	F003	1	R/W	2	[-24.0 , 24.0]
0x4551		DAYLIG. SAVINGS TIME	F012	1	R/W	1	0=DISABLED
							1=ENABLED
0x4552		DST START MONTH	F012	1	R/W	1	0=JAN
							1=FEB
							2=MAR
							3=APR
							4=MAY
							5=JUN
							6=JUL
							7=AUG
							8=SEP
							9=OCT
							10=NOV
							11=DEC
0x4553		DST START WEEKDAY	F012	1	R/W	1	0=Monday
							1=Tuesday
							2=Wednesday
							3=Thursday
							4=Friday
							5=Saturday
							6=Sunday
0x4554		DST START DAY INST	F012	1	R/W	1	0=First

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=Second
							2=Third
							3=Fourth
							4=Last
0x4555		DST START HOUR	F004	1	R/W	1	[0 , 23]
0x4556		DST STOP MONTH	F012	1	R/W	1	0=JAN
							1=FEB
							2=MAR
							3=APR
							4=MAY
							5=JUN
							6=JUL
							7=AUG
							8=SEP
							9=OCT
							10=NOV
							11=DEC
0x4557		DST STOP WEEKDAY	F012	1	R/W	1	0=Monday
							1=Tuesday
							2=Wednesday
							3=Thursday
							4=Friday
							5=Saturday
							6=Sunday
0x4558		DST STOP DAY INST	F012	1	R/W	1	0=First
							1=Second
							2=Third
							3=Fourth
							4=Last
Ajustes de Fecha y Hora - Time Settings (cont.)							
0x4559		DST STOP HOUR	F004	1	R/W	1	[0 , 23]
0x455A		IRIG-B LOCAL TIME	F012	1	R/W	1	0=OFF
							1=ON
0x455B		IRIGB Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x455C		PTP IRIGB Priority	F012	1000	R/W	1	0=PTP-1588
							1=IRIG-B
0x4564		Confirmation address			W	1	
Digital Counters							
0x48B8		DigCnt 1 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x48B9		DigCnt 1 Name	F009	1000	R/W	16	
0x48C9		DigCnt 1 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48CB		DigCnt 1 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48CD		DigCnt 2 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x48CE		DigCnt 2 Name	F009	1000	R/W	16	
0x48DE		DigCnt 2 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48E0		DigCnt 2 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48E2		DigCnt 3 Function	F012	1000	R/W	1	0=DISABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
							1=ENABLED
0x48E3		DigCnt 3 Name	F009	1000	R/W	16	
0x48F3		DigCnt 3 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48F5		DigCnt 3 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x48F7		DigCnt 4 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x48F8		DigCnt 4 Name	F009	1000	R/W	16	
0x4908		DigCnt 4 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x490A		DigCnt 4 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x490C		DigCnt 5 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x490D		DigCnt 5 Name	F009	1000	R/W	16	
0x491D		DigCnt 5 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x491F		DigCnt 5 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4921		DigCnt 6 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4922		DigCnt 6 Name	F009	1000	R/W	16	
0x4932		DigCnt 6 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4934		DigCnt 6 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4936		DigCnt 7 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4937		DigCnt 7 Name	F009	1000	R/W	16	
0x4947		DigCnt 7 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4949		DigCnt 7 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x494B		DigCnt 8 Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x494C		DigCnt 8 Name	F009	1000	R/W	16	
0x495C		DigCnt 8 Preset	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x495E		DigCnt 8 Compare	F005	1000	R/W	2	[-2147483648 , 2147483647]
0x4960		Snapshot Events	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x496A		Confirmation address			W	1	
PTP 1588							
0x4975		PTP FUNCTION	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4976		PORTA DELAY ADDER	F005	1000	R/W	2	[0 , 60000] ns
0x4978		PORTA DELAY ASYM	F004	1000	R/W	1	[-1000 , 1000] ns
0x497A		PORTB DELAY ADDER	F005	1000	R/W	2	[0 , 60000] ns
0x497C		PORTB DELAY ASYM	F004	1000	R/W	1	[-1000 , 1000] ns
0x497D		STRICT POWER PROFILE	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x497E		PTP DOMAIN NUMBER	F004	1000	R/W	1	[0 , 255]
0x497F		PTP VLAN PRIORITY	F004	1000	R/W	1	[0 , 7]
0x4980		PTP VLAN ID	F004	1000	R/W	1	[0 , 4095]
0x4981		PTP EPOCH	F012	1000	R/W	1	0=UTC_SINCE_2000
							1=UTC_SINCE_1900
							2=UTC_SINCE_1970
0x4988		Confirmation address			W	1	
Routing							

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4989		Default RT GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x498A		Default RT GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x498B		Default RT GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x498C		Default RT GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x498D		Static RT1 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x498E		Static RT1 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x498F		Static RT1 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x4990		Static RT1 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x4991		Static RT1 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x4992		Static RT1 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x4993		Static RT1 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x4994		Static RT1 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x4995		Static RT1 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x4996		Static RT1 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x4997		Static RT1 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x4998		Static RT1 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x4999		Static RT2 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x499A		Static RT2 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x499B		Static RT2 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x499C		Static RT2 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x499D		Static RT2 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x499E		Static RT2 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x499F		Static RT2 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49A0		Static RT2 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49A1		Static RT2 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49A2		Static RT2 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49A3		Static RT2 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49A4		Static RT2 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49A5		Static RT3 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49A6		Static RT3 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49A7		Static RT3 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49A8		Static RT3 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49A9		Static RT3 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49AA		Static RT3 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49AB		Static RT3 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49AC		Static RT3 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49AD		Static RT3 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49AE		Static RT3 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49AF		Static RT3 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49B0		Static RT3 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49B1		Static RT4 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49B2		Static RT4 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49B3		Static RT4 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49B4		Static RT4 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49B5		Static RT4 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49B6		Static RT4 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49B7		Static RT4 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49B8		Static RT4 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49B9		Static RT4 GWY Oct1	F004	1000	R/W	1	[0 , 255]

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x49BA		Static RT4 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49BB		Static RT4 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49BC		Static RT4 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49BD		Static RT5 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49BE		Static RT5 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49BF		Static RT5 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49C0		Static RT5 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49C1		Static RT5 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49C2		Static RT5 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49C3		Static RT5 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49C4		Static RT5 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49C5		Static RT5 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49C6		Static RT5 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49C7		Static RT5 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49C8		Static RT5 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49C9		Static RT6 IP Oct1	F004	1000	R/W	1	[0 , 255]
0x49CA		Static RT6 IP Oct2	F004	1000	R/W	1	[0 , 255]
0x49CB		Static RT6 IP Oct3	F004	1000	R/W	1	[0 , 255]
0x49CC		Static RT6 IP Oct4	F004	1000	R/W	1	[0 , 255]
0x49CD		Static RT6 Mask Oct1	F004	1000	R/W	1	[0 , 255]
0x49CE		Static RT6 Mask Oct2	F004	1000	R/W	1	[0 , 255]
0x49CF		Static RT6 Mask Oct3	F004	1000	R/W	1	[0 , 255]
0x49D0		Static RT6 Mask Oct4	F004	1000	R/W	1	[0 , 255]
0x49D1		Static RT6 GWY Oct1	F004	1000	R/W	1	[0 , 255]
0x49D2		Static RT6 GWY Oct2	F004	1000	R/W	1	[0 , 255]
0x49D3		Static RT6 GWY Oct3	F004	1000	R/W	1	[0 , 255]
0x49D4		Static RT6 GWY Oct4	F004	1000	R/W	1	[0 , 255]
0x49EC		Confirmation address			W	1	
Network (Ethernet) E Settings							
0x49ED		IP Address Oct1	F004	1000	R/W	1	[0 , 255]
0x49EE		IP Address Oct2	F004	1000	R/W	1	[0 , 255]
0x49EF		IP Address Oct3	F004	1000	R/W	1	[0 , 255]
0x49F0		IP Address Oct4	F004	1000	R/W	1	[0 , 255]
0x49F1		Netmask Oct1	F004	1000	R/W	1	[0 , 255]
0x49F2		Netmask Oct2	F004	1000	R/W	1	[0 , 255]
0x49F3		Netmask Oct3	F004	1000	R/W	1	[0 , 255]
0x49F4		Netmask Oct4	F004	1000	R/W	1	[0 , 255]
0x4A05		Confirmation address			W	1	
Redundancy settings							
0x4A06		REDUNDANCY MODE	F012	1000	R/W	1	0=INDEPENDENT
							1=LLA
							2=PRP
							3=HSR
							4=RSTP
							5=DAISY_CHAIN
0x4A07		LLA Priority	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4A08		LLA Timeout	F005	1000	R/W	2	[0 , 600000] ms

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4A0A		RSTP BRIDGE PRIORITY	F005	1000	R/W	2	[0 , 61440]
0x4A0C		RSTP PORTA PRIORITY	F005	1000	R/W	2	[0 , 240]
0x4A0E		RSTP PORTA PATHCOST	F005	1000	R/W	2	[0 , 2000000]
0x4A10		RSTP PORTB PRIORITY	F005	1000	R/W	2	[0 , 240]
0x4A12		RSTP PORTB PATHCOST	F005	1000	R/W	2	[0 , 2000000]
0x4A1E		Confirmation address			W	1	
Cold Load Pickup							
0x4A1F		Cold Load Function	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4A20		Cold Outage Time	F004	1000	R/W	1	[1 , 1000] min
0x4A21		Cold Blocking Time	F004	1000	R/W	1	[1 , 1000] s
0x4A22		Cold Load Events	F012	1000	R/W	1	0=DISABLED
							1=ENABLED
0x4A28		Confirmation address			W	1	
Ajustes de unidad de Sobrefrequencia Grupo 4- Overfrequency 4 Settings							
0x39DD		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x39DE		Pickup Level	F003	1.000	R/W	2	[20
0x39E0		Trip Delay	F003	1.000	R/W	2	[0
0x39E2		Reset Delay	F003	1.000	R/W	2	[0
0x39E4		Minimum Voltage	F003	1.000	R/W	2	[10
0x39E6		Snapshot Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x39E7		Frequency Source	F012	1.000	R/W	1	0=LINE FRQ
							1=BUS FRQ
0x39F9		Confirmation address			W	1	
Ajustes de unidad Subfrencuencia Grupo4- Underfrequency 4 Settings							
0x39FA		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x39FB		Pickup Level	F003	1.000	R/W	2	[20
0x39FD		Trip Delay	F003	1.000	R/W	2	[0
0x39FF		Reset Delay	F003	1.000	R/W	2	[0
0x3A01		Minimum Voltage	F003	1.000	R/W	2	[10
0x3A03		Snapshot Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x3A04		Frequency Source	F012	1.000	R/W	1	0=LINE FRQ
							1=BUS FRQ
0x3A16		Confirmation address			W	1	
Ajustes unidad Sobrefrequencia 5- Overfrequency 5 Settings							
0x4A29		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A2A		Pickup Level	F003	1.000	R/W	2	[20
0x4A2C		Trip Delay	F003	1.000	R/W	2	[0
0x4A2E		Reset Delay	F003	1.000	R/W	2	[0
0x4A30		Minimum Voltage	F003	1.000	R/W	2	[10
0x4A32		Snapshot Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A33		Frequency Source	F012	1.000	R/W	1	0=LINE FRQ
							1=BUS FRQ
0x4A37		Confirmation address			W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
Ajustes de unidad de Subfrecuencia 5- Underfrequency 5 Settings							
0x4A38		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A39		Pickup Level	F003	1.000	R/W	2	[20
0x4A3B		Trip Delay	F003	1.000	R/W	2	[0
0x4A3D		Reset Delay	F003	1.000	R/W	2	[0
0x4A3F		Minimum Voltage	F003	1.000	R/W	2	[10
0x4A41		Snapshot Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A42		Frequency Source	F012	1.000	R/W	1	0=LINE FRQ
							1=BUS FRQ
0x4A46		Confirmation address			W	1	
Ajustes de unidad de sobrefrequencia 6- Overfrequency 6 Settings							
0x4A47		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A48		Pickup Level	F003	1.000	R/W	2	[20
0x4A4A		Trip Delay	F003	1.000	R/W	2	[0
0x4A4C		Reset Delay	F003	1.000	R/W	2	[0
0x4A4E		Minimum Voltage	F003	1.000	R/W	2	[10
0x4A50		Snapshot Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A51		Frequency Source	F012	1.000	R/W	1	0=LINE FRQ
							1=BUS FRQ
0x4A55		Confirmation address			W	1	
Ajustes de unidad de subfrequencia 6- Underfrequency 6 Settings							
0x4A56		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A57		Pickup Level	F003	1.000	R/W	2	[20
0x4A59		Trip Delay	F003	1.000	R/W	2	[0
0x4A5B		Reset Delay	F003	1.000	R/W	2	[0
0x4A5D		Minimum Voltage	F003	1.000	R/W	2	[10
0x4A5F		Snapshot Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A60		Frequency Source	F012	1.000	R/W	1	0=LINE FRQ
							1=BUS FRQ
0x4A64		Confirmation address			W	1	
Ajustes de unidad de 60CTs- 60CTS Failure Settings							
0x4A65		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A66		3IO Current PKP	F003	1.000	R/W	2	[0
0x4A68		3VO Voltage Inhibit	F003	1.000	R/W	2	[0
0x4A6A		GND Current Inhibit	F003	1.000	R/W	2	[0
0x4A6C		SGND Current Inhibit	F003	1.000	R/W	2	[0
0x4A6E		Time Delay	F003	1.000	R/W	2	[0
0x4A70		Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A78		Confirmation address			W	1	
Ajustes de unidad de bloqueo por 2nd armónico-2nd HRMC Inhibit Settings							
0x4A79		Function	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0x4A7A		Pickup	F003	1.000	R/W	2	[1
0x4A7C		Delay	F003	1.000	R/W	2	[0
0x4A7E		Minimum Current	F003	1.000	R/W	2	[0
0x4A80		Phases For Operation	F012	1.000	R/W	1	0=ANY ONE
							1=ANY TWO
							2=ALL THREE
							3=AVERAGE
0x4A81		Events	F012	1.000	R/W	1	0=DISABLED
							1=ENABLED
0x4A87		Confirmation address			W	1	
Datos Ecuaciones PLC - PLC Data							
0x6000		PLC equations	F009		R	15360	
Datos Display Gráfico - LCD Data							
0x9C00		LCD configuration			R	768	
Bits de Maniobra (24 bits) - Commands							
0xAFFE	0x0001	Operation 1	F001		W	1	
0xAFFE	0x0002	Operation 2	F001		W	1	
0xAFFE	0x0004	Operation 3	F001		W	1	
0xAFFE	0x0008	Operation 4	F001		W	1	
0xAFFE	0x0010	Operation 5	F001		W	1	
0xAFFE	0x0020	Operation 6	F001		W	1	
0xAFFE	0x0040	Operation 7	F001		W	1	
0xAFFE	0x0080	Operation 8	F001		W	1	
0xAFFE	0x0100	Operation 9	F001		W	1	
0xAFFE	0x0200	Operation 10	F001		W	1	
0xAFFE	0x0400	Operation 11	F001		W	1	
0xAFFE	0x0800	Operation 12	F001		W	1	
0xAFFE	0x1000	Operation 13	F001		W	1	
0xAFFE	0x2000	Operation 14	F001		W	1	
0xAFFE	0x4000	Operation 15	F001		W	1	
0xAFFE	0x8000	Operation 16	F001		W	1	
0xAFFF	0x0001	Operation 17	F001		W	1	
0xAFFF	0x0002	Operation 18	F001		W	1	
0xAFFF	0x0004	Operation 19	F001		W	1	
0xAFFF	0x0008	Operation 20	F001		W	1	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0xAFFF	0x0010	Operation 21	F001		W	1	
0xAFFF	0x0020	Operation 22	F001		W	1	
0xAFFF	0x0040	Operation 23	F001		W	1	
0xAFFF	0x0080	Operation 24	F001		W	1	
Identificación del Equipo - Relay Identification							
0xB000		Relay model	F009		R	8	
0xB008		Firmware version	F009		R	2	
0xB018		Year(0=2000,1=2001,...) and part of firmware compilation	F001		R	1	
0xB019		Day and month of firmware compilation	F001		R	1	
0xB020		Address of PLC equations	F005		R	2	
0xB022		Address of LCD configuration	F005		R	2	
0xB027		MAC Address	F009		R	6	
0xB02D		Serial Number	F009		R	4	
0xB031		Manufacturing Date	F009		R	8	
Eventos de Control y Panel de Alarmas - Control Events & Alarm Panel							
0xF000		Status and acknowledge of the 192 control events	F001		R	24	Status = 24 first bytes
							1st byte: 1st eight control events (First event=bit less significant)
							2nd byte: 2nd eight control events (Ninth event=bit less significant)
							. . .
							Ack = 24 second bytes
							25th byte: 1st eight control events (First event=bit less significant)
							26th byte: 2nd eight control events (Ninth event=bit less significant)
							. . .
0xF018		Indicate which control events are configured as alarm	F001		R	12	1st byte: 1st eight control events (First event=bit less significant)
							2nd byte: 2nd eight control events (Ninth event=bit less significant)
							. . .
0xF024		Date/Time of the 1-16 alarms	F011		R	64	
0xF064		Date/Time of the 17-32 alarms	F011		R	64	
0xF0A4		Date/Time of the 33-48 alarms	F011		R	64	
0xF0E4		Date/Time of the 49-64 alarms	F011		R	64	
0xF124		Date/Time of the 65-80 alarms	F011		R	64	
0xF164		Date/Time of the 81-96 alarms	F011		R	64	
0xF1A4		Date/Time of the 97-112 alarms	F011		R	64	
0xF1E4		Date/Time of the 113-128 alarms	F011		R	64	
0xF224		Date/Time of the 129-144 alarms	F011		R	64	
0xF264		Date/Time of the 145-160 alarms	F011		R	64	
0xF2A4		Date/Time of the 161-176 alarms	F011		R	64	

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
0xF2E4		Date/Time of the 177-192 alarms	F011		R	64	
0xF324		Alarm acknowledge	F001		W	12	1st byte: 1st eight alarms (First alarm=bit less significant)
							2nd byte: 2nd eight alarms (Ninth alarm=bit less significant)
							. . .
Entradas Virtuales - Virtual Inputs							
0xF430		64 Virtual Inputs (32 Latched + 32 Self Reset)	F001		R/W	4	2nd byte: 1st eight virtual inputs (First virtual input=bit less significant)
							1st byte: 2nd eight virtual inputs (Ninth virtual input=bit less significant)
							. . .
Nombre Fichero de Eventos - Events File Name							
0xFE00		Name of the events file to read	F009		W		EVE.TXT: all snapshot-events are sent in ASCII format
							NEW_EVE.TXT: the new snapshot-events are sent in ASCII format
							EVE.BIN: all snapshot-events are sent in BINARY format
							NEW_EVE.BIN: the new snapshot-events are sent in BINARY format
Forzado de Salidas por Comunicaciones - Forcing Outputs							
0xFE20		Opening force output file	F004		W	3	Write "OUTPUT"
0xFE28		Closing force output file	F004		W	3	Write "OUTPUT"
0xFF20		Forcing outputs	F004		W	5	First word = Board number;
Ficheros Oscilografía y Reporte de Faltas - Oscillography and Fault Report Files							
0xFE40		Name of the oscillography/fault report file to read	F009		W		OSCXXX.DAT, OSCXXX.CFG, OSCXXX.HDR
							FLTXXX.TXT (where XXX=001 to 999)
Sucesos - Snapshot events							
0xFF00		Character position of current block within events file	F005		R	2	
0xFF02		Size of currently-available data block of events file	F004		R	1	
0xFF03		Block of data requested events file (122 items)	F004		R	1	
Ficheros Oscilografía y Reporte de Faltas - Oscillography and Fault Report Files							
0xFF40		Character position of current block within osc file	F005		R	2	
0xFF42		Size of currently-available data block of osc file	F004		R	1	
0xFF43		Block of data requested osc file (122 items)	F004		R	1	
Sincronización Horaria - Synchronization							
0xFFF0		Synchronization (milliseconds from 01/01/2000)	F011		R/W	4	
DESCRIPCIÓN FORMATO DE DATOS - FORMATS DESCRIPTION							
	F001	UNSIGNED INT 16 BIT (BITMASK)					
	F002	SIGNED INT 32 BIT					
	F003	FLOAT 32 BIT					
	F004	SIGNED INT 16 BIT					
	F005	SIGNED INT 32 BIT					
	F006	DOUBLE 64 BIT					

ADDRESS	BIT	NAME	FORMAT	STEP	MODE	LENGTH	MISCELLANEOUS
	F007	UNSIGNED INT 8 BIT					
	F008	SIGNED INT 8 BIT					
	F009	STRING					
	F011	UNSIGNED INT 64 BIT (MILISECONDS FROM 01/01/2000)					
	F012	UNSIGNED INT 16 BIT (ENUMERATED)					

F650 Digital Bay Controller

Appendix C: DNP 3.0 protocol for F650

C.1 DNP 3.0 protocol settings

F650 units enable the programming of certain parameters related to DNP3 protocol. These parameters are called DNP3 protocol settings and can be modified from the front panel or from the Level 2 software. The F650 relay supports communication with multiple masters (3) and maintains three separate groups of DNP3 settings. Each group of DNP3 settings is related to a single **logical DNP3 slave device**. The F650 relay is able to communicate simultaneously with up to three different DNP3 master stations. Each master communicates with a different **logical DNP3 slave**, these logical slaves appearing as separate physical DNP3 slaves. This is achieved by keeping separate set of settings, event queues and set of states for each logical device.

Notice that it is necessary to set different **DNP Address** and **TCP/UDP Port** for each **logical DNP3 slave device**.

Time synchronization through DNP protocol is available from all three DNP masters that can communicate with F650. However the date & time are taken from only one master at the same moment. It is recommended to use only one master to do time sync through DNP.

Setting No	Setting Name	Default Value	Range
1	Physical Port	NONE	NONE, COM1, COM2, NETWORK
2	Address	255	0 to 65534, step 1
3	IP Addr Client1 Oct1	0	0 to 255 step 1
4	IP Addr Client1 Oct2	0	0 to 255 step 1
5	IP Addr Client1 Oct3	0	0 to 255 step 1
6	IP Addr Client1 Oct4	0	0 to 255 step 1
7	IP Addr Client2 Oct1	0	0 to 255 step 1
8	IP Addr Client2 Oct2	0	0 to 255 step 1
9	IP Addr Client2 Oct3	0	0 to 255 step 1
10	IP Addr Client2 Oct4	0	0 to 255 step 1
11	IP Addr Client3 Oct1	0	0 to 255 step 1
12	IP Addr Client3 Oct2	0	0 to 255 step 1
13	IP Addr Client3 Oct3	0	0 to 255 step 1
14	IP Addr Client3 Oct4	0	0 to 255 step 1
15	IP Addr Client4 Oct1	0	0 to 255 step 1
16	IP Addr Client4 Oct2	0	0 to 255 step 1

Setting No	Setting Name	Default Value	Range
17	IP Addr Client4 Oct3	0	0 to 255 step 1
18	IP Addr Client4 Oct4	0	0 to 255 step 1
19	IP Addr Client5 Oct1	0	0 to 255 step 1
20	IP Addr Client5 Oct2	0	0 to 255 step 1
21	IP Addr Client5 Oct3	0	0 to 255 step 1
22	IP Addr Client5 Oct4	0	0 to 255 step 1
23	TCP/UDP Port	20000	1 to 65535, step 1
24	Unsol Resp Function	DISABLED	DISABLED, ENABLED
25	Unsol Resp TimeOut	5 s	0 to 60 sec, step 1
26	Unsol Resp Max Ret	10	1 to 255, step 1
27	Unsol Resp Dest Adr	200	0 to 65519, step 1
28	Current Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
29	Voltage Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
30	Power Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
31	Energy Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
32	Other Scale Factor	1	0.00001, 0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000
33	Current Deadband	30000	0 to 65535, step 1
34	Voltage Deadband	30000	0 to 65535, step 1
35	Power Deadband	30000	0 to 65535, step 1
36	Energy Deadband	30000	0 to 65535, step 1
37	Other Deadband	30000	0 to 65535, step 1
38	Msg Fragment Size	240	30 to 2048, step 1
39	Binary Input Block1	CTL EVENTS 1-16	See the explanation below
40	Binary Input Block2	CTL EVENTS 17-32	See the explanation below
41	Binary Input Block3	CTL EVENTS 33-48	See the explanation below
42	Binary Input Block4	CTL EVENTS 49-64	See the explanation below
43	Binary Input Block5	CTL EVENTS 65-80	See the explanation below
44	Binary Input Block6	CTL EVENTS 81-96	See the explanation below
45	Binary Input Block7	CTL EVENTS 97-112	See the explanation below
46	Binary Input Block8	CTL EVENTS 113-128	See the explanation below
47	Binary Input Block9	SWITCHGEAR 1-8	See the explanation below
48	Binary Input Block10	SWITCHGEAR 9-16	See the explanation below
49	Default analog Map	Disabled	See the explanation below
50	Analog Input Point 0	End Of List	See the explanation below
51	Analog Input Point 1	End Of List	See the explanation below
52	Analog Input Point 2	End Of List	See the explanation below
53	Analog Input Point 3	End Of List	See the explanation below
54	Analog Input Point 4	End Of List	See the explanation below
55	Analog Input Point 5	End Of List	See the explanation below
56	Analog Input Point 6	End Of List	See the explanation below
57	Analog Input Point 7	End Of List	See the explanation below
58	Analog Input Point 8	End Of List	See the explanation below
59	Analog Input Point 9	End Of List	See the explanation below
60	Analog Input Point 10	End Of List	See the explanation below
61	Analog Input Point 11	End Of List	See the explanation below
62	Analog Input Point 12	End Of List	See the explanation below
63	Analog Input Point 13	End Of List	See the explanation below

Setting No	Setting Name	Default Value	Range
64	Analog Input Point 14	End Of List	See the explanation below
65	Analog Input Point 15	End Of List	See the explanation below
66	Analog Input Point 16	End Of List	See the explanation below
67	Analog Input Point 17	End Of List	See the explanation below
68	Analog Input Point 18	End Of List	See the explanation below
69	Analog Input Point 19	End Of List	See the explanation below
70	Analog Input Point 20	End Of List	See the explanation below
71	Analog Input Point 21	End Of List	See the explanation below
72	Analog Input Point 22	End Of List	See the explanation below
73	Analog Input Point 23	End Of List	See the explanation below
74	Analog Input Point 24	End Of List	See the explanation below
75	Analog Input Point 25	End Of List	See the explanation below
76	Analog Input Point 26	End Of List	See the explanation below
77	Analog Input Point 27	End Of List	See the explanation below
78	Analog Input Point 28	End Of List	See the explanation below
79	Analog Input Point 29	End Of List	See the explanation below
80	Analog Input Point 30	End Of List	See the explanation below
81	Analog Input Point 31	End Of List	See the explanation below
82	Time Sync IIN Period	1440	1 to 10080 min

1. **Physical Port**: The F650 supports the Distributed Network Protocol (DNP) version 3.0. The F650 can be used as a DNP slave device connected up to three DNP masters (usually RTUs or SCADA master stations). The Physical Port setting is used to select the communications port assigned to the DNP protocol for a specific logical DNP slave device of F650. When this setting is set to NETWORK, the DNP protocol can be used over either TCP/IP or UDP/IP.

2. **Address**: This setting is the DNP slave address. This number identifies the F650 on a DNP communications link. Each logical DNP slave should be assigned a unique address.

3-22. **IP Addr Client x Oct x:** this setting is one of four octets of an IP address. The F650 relay can respond to a maximum of 5 specific DNP masters (not in the same time). To set the IP address of DNP master it is necessary to set four octets (e.g. to set the IP address of the first DNP master to 192.168.48.125, you should set **IP Addr Client1 Oct1** = 192, **IP Addr Client1 Oct2** = 168, **IP Addr Client1 Oct3** = 48, **IP Addr Client1 Oct4** = 125).

23. **TCP/UDP Port**: TCP/UDP port number for the case of DNP3 communication being performed through the Ethernet.

24. **Unsol Resp Function**: ENABLED, if unsolicited responses are allowed, and DISABLED otherwise.

25. **Unsol Resp TimeOut**: sets the time the F650 waits for a DNP master to confirm an unsolicited response.

26. **Unsol Resp Max Ret**: This setting determines the number of times the F650 retransmits an unsolicited response without receiving a confirmation from the master. Once this limit has been exceeded, the unsolicited response is sent at a larger interval. This interval is called the unsolicited offline interval and is fixed at 10 minutes.

27. **Unsol Resp Dest Adr**: This setting is DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the F650 from either the current DNP TCP connection or the most recent UDP message.

28-32. **Scale Factor**: These settings are numbers used to scale Analog Input point values. These settings group the F650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **Voltage Scale Factor** is set to a value of 1000, all DNP Analog Input points that are voltages are returned with the values 1000 times smaller (e.g. a value 72000 V on the F650 is returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in DNP masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10 times larger).

33-37. Deadband: These settings are the values used by the F650 to determine when to trigger unsolicited responses containing Analog Input data. These settings group the F650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, in order to trigger unsolicited responses from the F650 when any current values change by 15 A, the **Current Deadband** setting should be set to 15. Note that these settings are the default values of the deadbands. DNP object 34 points can be used to change deadband values, from the default, for each individual DNP Analog Input point. Whenever power is removed and re-applied to the F650, the default deadbands are in effect.

38. Msg Fragment Size: This setting determines the size, in bytes, at which message fragmentation occurs. Large fragment sizes allow for more efficient throughput; smaller fragment sizes cause more application layer confirmations to be necessary which can provide for more robust data transfer over noisy communication channels

39-48. Binary Input Block x: These settings allow customization and change of the size of DNP Binary Inputs point list. The default Binary Inputs point list contains 160 points representing binary states that are configured using ***Setpoint > Relay Configuration*** in the EnerVista 650 Setup program. These 160 binary states are grouped in 10 blocks of 16 points each. There are 128 bits (8 blocks of 16) called *Control Events* and 32 bits (2 blocks of 16) corresponding to the states of 16 *switchgears* available in F650 relay. If not all of the 160 points are required in the DNP master, a custom Binary Inputs point list can be created by selecting up to 10 blocks of 16 points. Each block represents 16 Binary Input points. Block 1 represents Binary Input points 0-15, block 2 represents Binary Input points 16- 31, block 3 represents Binary Input points 32-47, etc. The minimum number of Binary Input points that can be selected is 16 (1 block). If all of the **Binary Input Block x** settings are set to “NOT USED”, the default list of 160 points is in effect. The F650 forms the Binary Inputs points list from the **Binary Input Block x** settings up to the first occurrence of a setting value “NOT USED”. Permitted values for these settings are: NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48, CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112, CTL EVENTS 113-128, SWITCHGEAR 1-8, SWITCHGEAR 9-16,BOARD F 1-16,BOARD F 17-32, BOARD G 1-16, BOARD G 17-32,BOARD H 1-16, BOARD H 17-32, BOARD J 1-16,BOARD J 17-32.

49-81. Default analog Map: This setting allows selection between predefined Analog Input Points or choosing preferred Analog Input Points (from 50 to 81).

82. DNP Time Sync IIN Period: This setting has a range of between 1 and 10080 minutes in steps of 1 minute and the default value is “1440 min”. It determines how often the Need Time Internal Indication (IIN) bit is set by the F650 relay. Changing this time allows the DNP master to send time synchronization commands more or less often, as required.

C.2 DNP 3.0 device profile document

The following table provides a “Device Profile Document” in the standard format defined in the DNP 3.0 Subset Definitions Document.

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 1 of 3)

(Also see the IMPLEMENTATION TABLE in the following section)	
Vendor Name: **General Electric Multilin**	
Device Name: **F650 Relay**	
Highest DNP Level Supported:	**Device Function:**
For Requests: **Level 2**	☐ Master
For Responses: **Level 2**	✓ **Slave**

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): **Binary Inputs (Object 1)** **Binary Inputs Changes (Object 2)** **Binary Outputs (Object 10)** **Binary Counters (Object 20)** **Frozen Counters (21)** **Binary Counters Change (Object 22)** **Frozen Counter Change (23)** **Analog Inputs (Object 30)** **Analog Input Changes (Object 32)** **Analog Deadbands (Object 34)**	
Maximum Data Link String Size (octets): Transmitted: 292 Received: 292	**Maximum Application Fragment Size (octets):** Transmitted: Configurable up to 2048 Received: 2048
Maximum Data Link Re-tries: ☐ None ✓ **Fixed at 2** ☐ Configurable	**Maximum Application Layer Re-tries:** ✓ **None** ☐ Configurable
Requires Data Link Layer Confirmation: ✓ **Never** ☐ Always ☐ Sometimes ☐ Configurable	

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 2 of 3)

Requires Application Layer Confirmation:

- ☐ Never
- ☐ Always
- ✓ **When reporting Event Data**
- ✓ **When sending multi-fragment responses**
- ☐ Sometimes
- ☐ Configurable

Timeouts while waiting for:

Data Link Confirm:	☐ None	✓ **Fixed at 3 s**	☐ Variable	☐ Configurable
Complete Appl. Fragment:	✓ **None**	☐ Fixed at	☐ Variable	☐ Configurable
Application Confirm:	☐ None	✓ **Fixed at 4 s**	☐ Variable	☐ Configurable
Complete Appl. Response	✓ **No0ne**	☐ Fixed at	☐ Variable	☐ Configurable

Others:

Transmission Delay:	**No intentional delay**
Need Time Delay:	**10 min.**
Select/Operate Arm Timeout:	**10 s**
Binary Input change scanning period:	**1 ms**
Packed binary change process period:	**1 s**
Analog Input change scanning period:	**500 ms**
Unsolicited response notification delay:	**500 ms**
Unsolicited response retry delay:	**Configurable 0 to 60 s**
Unsolicited offline interval:	**10 min.**

Sends/Executes Control Operations:

WRITE Binary Outputs	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	✓ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	✓ **Always**	☐ Sometimes	☐ Configurable
DIRECT OPERATE – NO ACK	☐ Never	✓ **Always**	☐ Sometimes	☐ Configurable
Count > 1	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	✓ **Always**	☐ Sometimes	☐ Configurable
Pulse Off	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch On	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Latch Off	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Queue	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	✓ **Never**	☐ Always	☐ Sometimes	☐ Configurable

DNP V3.00 DEVICE PROFILE DOCUMENT (Sheet 3 of 3)

Reports Binary Input Change Events when no specific variation requested: ☐ Never ✓ **Only time-tagged** ☐ Only non-time-tagged ☐ Configurable	***Reports time-tagged Binary Input Change Events when no specific variation requested:*** ☐ Never ✓ **Binary Input Change With Time** ☐ Binary Input Change With Relative Time ☐ Configurable (attach explanation)
Sends Unsolicited Responses: ☐ Never ☐ Configurable ☐ Only certain objects ✓ **Sometimes (attach explanation)** ✓ **ENABLE/DISABLE** unsolicited Function codes supported	***Sends Static Data in Unsolicited Responses:*** ✓ **Never** ☐ When Device Restarts ☐ When Status Flag Change No other options permitted
Explanation of 'Sometimes': It will be disabled for RS-485 applications, since there is no collision avoidance mechanism. For ethernet communication it will be available and it can be disabled or enabled with the proper function code.	
Default CounterObject/Variation: ☐ No Counters Reported ☐ Configurable (attach explanation) ✓ **Default Object: 20.** **Default Variation: 1** ✓ **Point-by-point list attached**	***Counters Roll Over at:*** ☐ No Counters Reported ☐ Configurable (attach explanation) ☐ 16 Bits ✓ **32 Bits** ☐ Other Value: _____ ✓ **Point-by-point list attached**
Sends Multi-Fragment Responses: ✓ **Yes** ☐ No	

C.3 Implementation table

The following table shows objects, variations, function codes and qualifiers supported by F650 units, both in requests and responses for DNP3 protocol. For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07 or 08, are responded to with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 are responded to with qualifiers 17 or 28. For change-event objects, qualifiers 17 or 28 are always responded.

Text in ***bold and italic*** indicates functionality higher than DNP3 implementation level 2.

IMPLEMENTATION TABLE (Sheet 1 out of 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read) ***22 (assign class)***	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
1	1	Binary Input	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
1	2	Binary Input with Status (default – see Note 1)	1 (read) ***22 (assign class)***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
2	0	Binary Input Change - All Variations See Note 1	1 (read)	06 (no range, or all) 07,08 (limited qty)		
2	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol. resp.)	17, 28 (index)
2	2	Binary Input Change with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol. resp.)	17, 28 (index)
10	0	Binary Output - All Variations	1 (read)	06 (no range, or all) ***00,01 (start-stop)*** ***07,08 (limited qty)*** ***17,28 (index)***		
10	2	Binary Output Status See Note 1	***1 read***	***00,01 (start-stop)*** ***06 (no range, or all)*** ***07,08 (limited qty)*** ***17,28 (index)***	129 (response)	00, 01 (start-stop) ***17,28 (index)*** See Note 2
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir.op, noack)	***00,01 (start-stop)*** ***07,08 (limited qty)*** 17, 28 (index)	129 (response)	echo of request
20	0	Binary Counter - All Variations	1 (select) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz.cl. noack)	06 (no range, or all)		

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded to with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The F650 is not restarted, but the DNP process is restarted.

IMPLEMENTATION TABLE (Sheet 2 out of 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
21	0	Frozen Counter - All Variations	1 (read)	06 (no range, or all)		
22	0	Counter Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
23	0	Frozen Counter Change Event	1 (read)	06 (no range, or all) 07,08 (limited qty)		
30	0	Analog Input - All Variations	1 (read) 22 (assign class)	06 (no range, or all) 00,01 (start-stop) 07,08 (limited qty) 17,28 (index)		
30	1	32-Bit Analog Input See Note 1	1 (read) 22 (assign class)	000,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
30	2	16-Bit Analog Input	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
30	3	32-Bit Analog Input without Flag	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
30	4	16-Bit Analog Input without Flag	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
30	5	Analog Short Float	1 (read) 22 (assign class)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00, 01 (start-stop) 17,28 (index) See Note 2
32	0	Analog Change Event - All Variations	1 (read)	06 (no range, or all) 07,08 (limited qty)		
32	1	32-Bit Analog Change Event without Time See Note 1	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17, 28 (index)
32	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17, 28 (index)
32	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17,28 (index)
32	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17,28 (index)
32	5	Analogs (Short-float) without time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17,28 (index)
32	7	Analogs (Short-float) with time	1 (read)	06 (no range, or all) 07,08 (limited qty)	129 (response) 130 (unsol.resp)	17,28 (index)
34	0	Analog Input Reporting Deadband	1 (read)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)		
34	1	16-Bit Analog Input Reporting Deadband See Note 1	1 (read)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00,01 (start-stop) 17,28 (index) See Note 2

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded to with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The F650 is not restarted, but the DNP process is restarted.

IMPLEMENTATION TABLE (Sheet 3 out of 3)

OBJECT			REQUEST		RESPONSE	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes	Qualifier Codes (hex)
34	2	32-Bit Analog Input Reporting Deadband See Note 1	2 (write)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)		
50	0	Time and Date - All Variations	1 (read)	00,01 (start-stop) 06 (no range, or all) 07,08 (limited qty) 17,28 (index)	129 (response)	00,01 (start-stop) 17,28 (index) See Note 2
50	1	Time and Date See Note 1	1 (read) 2 (write)	00,01 (start-stop) 06 (no range, or all) 07 (limited qty=1) 08 (limited qty) 17,28 (index)	129 (response)	00,01 (start-stop) 17,28 (index) See Note 2
52	2	Time Delay Fine	1 (read) 2 (write)		129 (response)	07 (limited qty) quantity=1
60	0	Class 0, 1, 2, and 3 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all)		
60	1	Class 0 Data		06 (no range, or all)		
60	2	Class 1 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07,08 (limited qty)		
60	3	Class 2 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07,08 (limited qty)		
60	4	Class 3 Data	1 (read) 20 (enable unsol) 21 (disable unsol) 22 (assign class)	06 (no range, or all) 07,08 (limited qty)		
80	1	Internal Indications	2 (write)	00 (start-stop) (index must =7)		
		No Object (function code only) See Note 3	13 (cold restart)			
		No Object (function code only)	14 (warm restart)			
		No Object (function code only)	23 (delay meas.)			

Note 1: A default variation refers to the variation responded when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

Note 2: For static (non-change-event) objects, qualifiers 17 or 28 are only responded when a request is sent with qualifiers 17 or 28, respectively. Otherwise, static object requests sent with qualifiers 00, 01, 06, 07, or 08, are responded to with qualifiers 00 or 01 (for change-event objects, qualifiers 17 or 28 are always responded).

Note 3: Cold restarts are implemented the same as warm restarts – The F650 is not restarted, but the DNP process is restarted.

C.4 Binary input points

The F650 relay has a configurable Map of DNP Binary Input points. This map can be formed by up to 10 blocks of 16 binary states that are configured using ***Setpoint > Relay Configuration*** in the EnerVista 650 Setup program. The minimum number of DNP Binary Input points is 16 and the maximum number is 160. Within these 160 DNP points, 128 bits (8 blocks of 16) are mapped to *Control Events* (***Setpoint > Relay Configuration > Control Events***) and 32 bits (2 block of 16) are mapped to contacts A, B of 16 *Switchgears* (***Setpoint > Relay Configuration > Switchgear***). Each *Switchgear* in F650 is mapped into two DNP Binary Input points. Lets say the setting Binary Input Block1 has been set the value Switchgear 1-8, it means that DNP Binary Input point 0 = Switchgear 1Contact A, DNP Binary Input point 1 = Switchgear 1 Contact B, DNP Binary Input point 2 = Switchgear 2 Contact A, etc.

To each *Control Event* or *Switchgear Contact*, assign any of the binary states of the F650 relay. These states are contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. DNP Points that correspond to *Control Events* or *Switchgear Contacts* that are not configured have a zero value in the response.

Using the PLC-Editor, through the EnerVista 650 Setup program select ***Setpoint > Logic Configuration*** to implement complex logic, more than simple OR and NOT previous functions. To accomplish this, under ***Setpoint > Relay Configuration > Control Events,*** assign a Virtual Output to a selected point, and then implement wished logic with the PLC-Editor.

BINARY INPUT POINTS

Static (Steady-State) Object Number: **1**

Change Event Object Number: **2**

Request Function Codes supported: **1 (read), 22 (assign class)**

Static Variation Reported when variation 0 requested: **2 (Binary Input Change with status)**

Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time)**

Default Class for all points: **1**

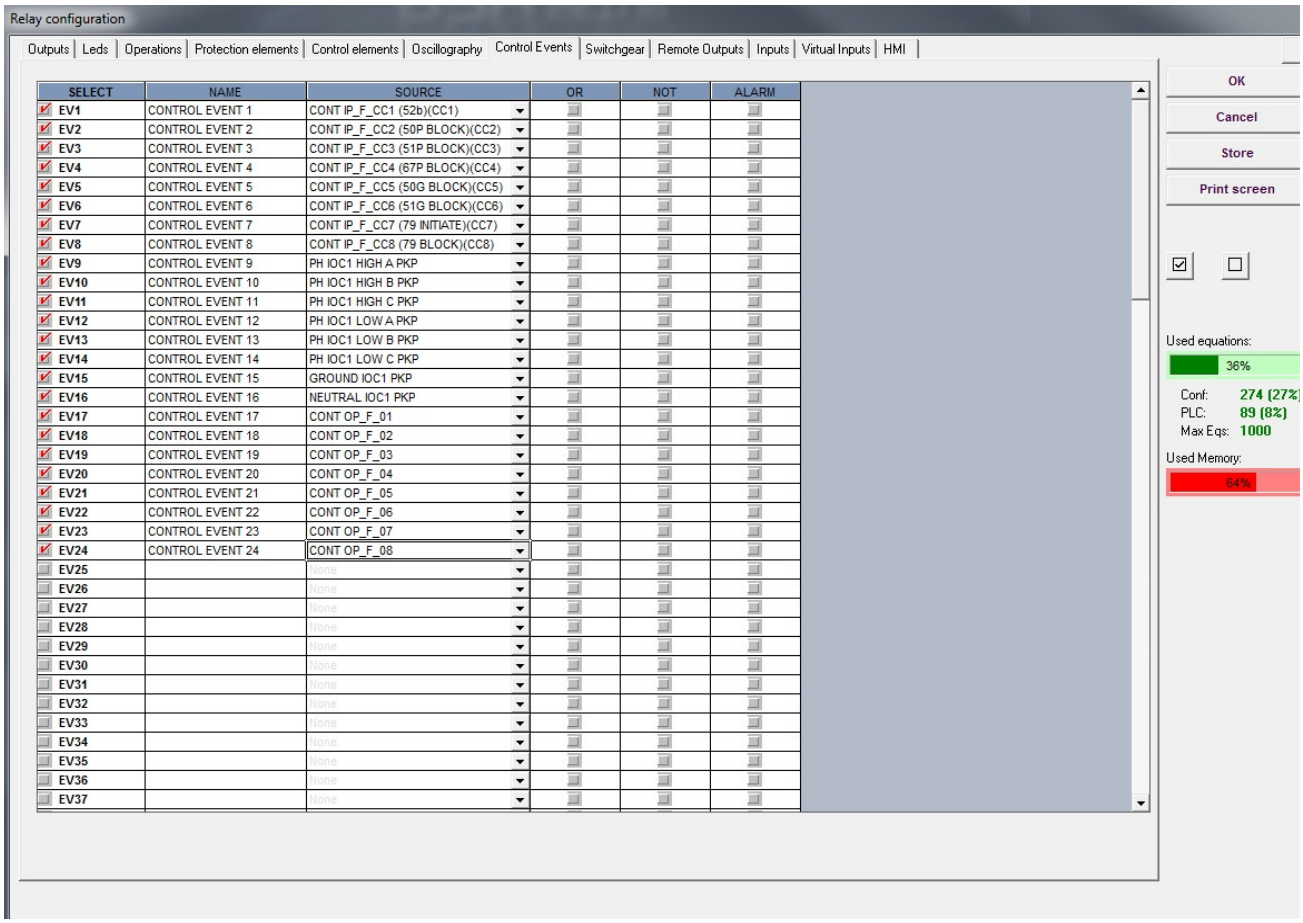
DEFAULT BINARY INPUT POINTS MAP

POINT INDEX	NAME/DESCRIPTION		POINT INDEX	NAME/DESCRIPTION
0-127	Control Events 1-128		145	Switchgear 9 Contact B
128	Switchgear 1 Contact A		146	Switchgear 10 Contact A
129	Switchgear 1 Contact B		147	Switchgear 10 Contact B
130	Switchgear 2 Contact A		148	Switchgear 11 Contact A
131	Switchgear 2 Contact B		149	Switchgear 11 Contact B
132	Switchgear 3 Contact A		150	Switchgear 12 Contact A
133	Switchgear 3 Contact B		151	Switchgear 12 Contact B
134	Switchgear 4 Contact A		152	Switchgear 13 Contact A
135	Switchgear 4 Contact B		153	Switchgear 13 Contact B
136	Switchgear 5 Contact A		154	Switchgear 14 Contact A
137	Switchgear 5 Contact B		155	Switchgear 14 Contact B
138	Switchgear 6 Contact A		156	Switchgear 15 Contact A
139	Switchgear 6 Contact B		157	Switchgear 15 Contact B
140	Switchgear 7 Contact A		158	Switchgear 16 Contact A
141	Switchgear 7 Contact B		159	Switchgear 16 Contact B
142	Switchgear 8 Contact A			
143	Switchgear 8 Contact B			
144	Switchgear 9 Contact A			

C.5 DNP configuration examples

C.5.1 Configuring DNP user map

For example, consider configuring DNP Binary Inputs Map with 8 Contact Inputs, 8 Protection states, 8 Contact Outputs and 2 Switchgears. This configuration can be done in two steps. In first step, select **Setpoint > Relay Configuration** from the EnerVista 650 Setup program and then configure the **Control Events** bits and **Switchgear** bits. This is shown in figures 9.1 and 9.2. In the second step, select **Setpoint > System Setup > Communication settings > DNP** in order to change the DNP Binary Input Block settings. Set the values of the first three Binary Input blocks, Binary Input Block1 = CTL EVENTS 1-16, Binary Input Block2 = CTL EVENTS 17-32, Binary Input Block3 = SWITCHGEAR 1-8. This is shown in Figure C-1: Configuration of Control Events bits 13-1



SELECT	NAME	SOURCE	OR	NOT	ALARM
EV1	CONTROL EVENT 1	CONT IP_F_CC1 (52b)(CC1)			
EV2	CONTROL EVENT 2	CONT IP_F_CC2 (50P BLOCK)(CC2)			
EV3	CONTROL EVENT 3	CONT IP_F_CC3 (51P BLOCK)(CC3)			
EV4	CONTROL EVENT 4	CONT IP_F_CC4 (67P BLOCK)(CC4)			
EV5	CONTROL EVENT 5	CONT IP_F_CC5 (50G BLOCK)(CC5)			
EV6	CONTROL EVENT 6	CONT IP_F_CC6 (51G BLOCK)(CC6)			
EV7	CONTROL EVENT 7	CONT IP_F_CC7 (79 INITIATE)(CC7)			
EV8	CONTROL EVENT 8	CONT IP_F_CC8 (79 BLOCK)(CC8)			
EV9	CONTROL EVENT 9	PH IOC1 HIGH A PKP			
EV10	CONTROL EVENT 10	PH IOC1 HIGH B PKP			
EV11	CONTROL EVENT 11	PH IOC1 HIGH C PKP			
EV12	CONTROL EVENT 12	PH IOC1 LOW A PKP			
EV13	CONTROL EVENT 13	PH IOC1 LOW B PKP			
EV14	CONTROL EVENT 14	PH IOC1 LOW C PKP			
EV15	CONTROL EVENT 15	GROUND IOC1 PKP			
EV16	CONTROL EVENT 16	NEUTRAL IOC1 PKP			
EV17	CONTROL EVENT 17	CONT OP_F_01			
EV18	CONTROL EVENT 18	CONT OP_F_02			
EV19	CONTROL EVENT 19	CONT OP_F_03			
EV20	CONTROL EVENT 20	CONT OP_F_04			
EV21	CONTROL EVENT 21	CONT OP_F_05			
EV22	CONTROL EVENT 22	CONT OP_F_06			
EV23	CONTROL EVENT 23	CONT OP_F_07			
EV24	CONTROL EVENT 24	CONT OP_F_08			
EV25		None			
EV26		None			
EV27		None			
EV28		None			
EV29		None			
EV30		None			
EV31		None			
EV32		None			
EV33		None			
EV34		None			
EV35		None			
EV36		None			
EV37		None			

Figure C-1: Configuration of Control Events bits

Relay configuration

Outputs | Leds | Operations | Protection elements | Control elements | Oscillography | Control Events | Switchgear | Remote Outputs | Inputs | Virtual Inputs | HMI

SELECT	Contacts	Opening time(ms)	Closing time(ms)	Contact A	OR	NOT	Contact B
Switchgear 1	52a + 52t	1000	1000	CONT IP_F_CC13(O7_SEAL)			CONT IP_F_CC15(SUP_COIL1)
Switchgear 2	52a + 52t	1000	1000	CONT IP_F_CC15(SUP_COIL1)			CONT IP_F_CC16(SUP_COIL2)
Switchgear 3	NONE	1000	1000	None			None
Switchgear 4	NONE	1000	1000	None			None
Switchgear 5	NONE	1000	1000	None			None
Switchgear 6	NONE	1000	1000	None			None

Figure C-2: CONFIGURATION OF SWITCHGEAR

Product Setup -> Communication Settings -> DNP3 Slave

DNP3 Slave 1 | DNP3 Slave 2 | DNP3 Slave 3

Name	Value	
Voltage Scale Factor	1	
Power Scale Factor	0.01	
Energy Scale Factor	1	
Other Scale Factor	0.1	
Current Deadband	1	[0 : 65535]
Voltage Deadband	30000	[0 : 65535]
Power Deadband	30000	[0 : 65535]
Energy Deadband	1	[0 : 65535]
Other Deadband	30000	[0 : 65535]
Msg Fragment Size	240	[30 : 2048]
Binary Input Block 1	BOARD F 1-16	
Binary Input Block 2	BOARD F 17-32	
Binary Input Block 3	BOARD G 1-16	
Binary Input Block 4	BOARD G 17-32	
Binary Input Block 5	BOARD H 1-16	
Binary Input Block 6	BOARD H 17-32	
Binary Input Block 7	BOARD J 1-16	
Binary Input Block 8	BOARD J 17-32	
Binary Input Block 9	NOT USED	
Binary Input Block 10	NOT USED	
Default Analog Map	ENABLED	[0.00:1.00]
Analog Input Point 0	Pos MWatthour Freeze	
Analog Input Point 1	Neg MWatthour Freeze	
Analog Input Point 2	Pos MVarhour Freeze	
Analog Input Point 3	Neg MVarhour Freeze	
Analog Input Point 4	Positive MWatthour	
Analog Input Point 5	Negative MWatthour	
Analog Input Point 6	Positive MVarhour	
Analog Input Point 7	Negative MVarhour	
Analog Input Point 8	End of list	
Analog Input Point 9	3 Phase Power Factor	
Analog Input Point 10	Line Frequency	
Analog Input Point 11	Bus Frequency	
Analog Input Point 12	df/dt	
Analog Input Point 13	Line Frequency Primary	

OK | Cancel | Store | >> | << | Print screen

Figure C-3: CONFIGURATION OF DNP BINARY INPUT BLOCKS

In the example presented in this chapter the F650 relay has 48 Binary Input points, as shown in the table below.

C.5.2 Example of custom binary input points map

POINT INDEX	NAME/DESCRIPTION		POINT INDEX	NAME/DESCRIPTION
0	CONT_IP_F_CC1(CC1)		24	Not Configured
1	CONT_IP_F_CC2(CC2)		25	Not Configured
2	CONT_IP_F_CC3(CC3)		26	Not Configured
3	CONT_IP_F_CC4(CC4)		27	Not Configured
4	CONT_IP_F_CC5(CC5)		28	Not Configured
5	CONT_IP_F_CC6(CC6)		29	Not Configured
6	CONT_IP_F_CC7(CC7)		30	Not Configured
7	CONT_IP_F_CC8(CC8)		31	Not Configured
8	PH IOC1 HIGH A PKP		32	CONT_IP_F_CC13 (CC13)
9	PH IOC1 HIGH B PKP		33	CONT_IP_F_CC14(CC14)
10	PH IOC1 HIGH C PKP		34	CONT_IP_F_CC15(CC15)
11	PH IOC1 LOW A PKP		35	CONT_IP_F_CC16(CC16)
12	PH IOC1 LOW B PKP		36	Not Configured
13	PH IOC1 LOW C PKP		37	Not Configured
14	GROUND IOC1 PKP		38	Not Configured
15	NEUTRAL IOC1 PKP		39	Not Configured
16	CONT OP_F_01		40	Not Configured
17	CONT OP_F_02		41	Not Configured
18	CONT OP_F_03		42	Not Configured
19	CONT OP_F_04		43	Not Configured
20	CONT OP_F_05		44	Not Configured
21	CONT OP_F_06		45	Not Configured
22	CONT OP_F_07		46	Not Configured
23	CONT OP_F_08		47	Not Configured

C.5.3 Multiple DNP 3.0 masters communication with F650

Typical architecture of multi-master communication using DNP 3.0.

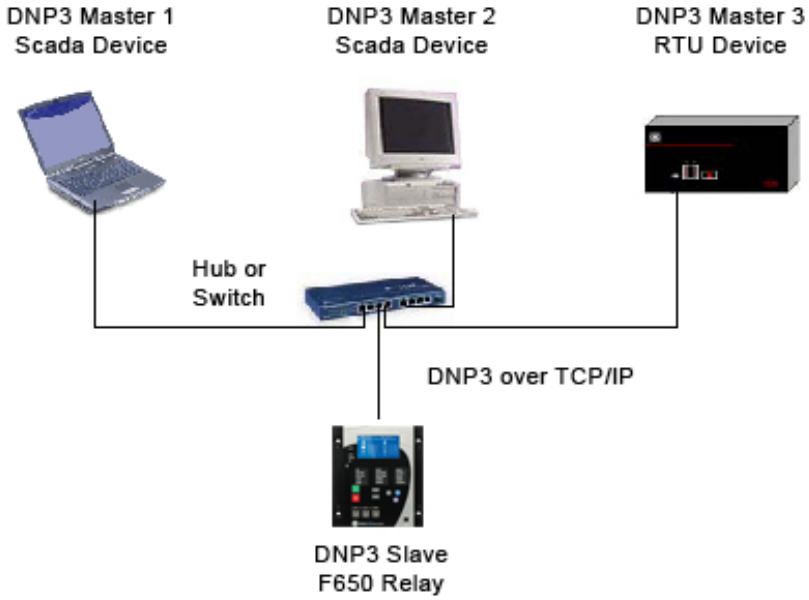


Figure C-4: Multiple DNP3.0 masters communicating with F650

DNP 3.0 Slave – F650	DNP 3.0 Master 1	DNP 3.0 Master 2	DNP 3.0 Master 3
Ethernet Config IP Addr: 192.168.37.20 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.1 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.2 Netmask: 255.255.255.0	Ethernet Config IP Addr: 192.168.37.3 Netmask: 255.255.255.0
DNP 3.0 slave 1 Physical Port: Network Address: 255 IP Addr Cli1: 192.168.37.1 TCP/UDP Port : 20000 Unsol Dest Addr: 200	DNP3 over TCP/IP DNP Addr: 200 DNP Dest Addr: 255 IP Dest: 192.168.37.20 TCP Dest Port: 20000	DNP3 over TCP/IP DNP Addr: 201 DNP Dest Addr: 256 IP Dest : 192.168.37.20 TCP Dest Port: 20001	DNP3 over TCP/IP DNP Addr: 202 DNP Dest Addr: 257 IP Dest: 192.168.37.20 TCP Dest Port: 20002
DNP 3.0 slave 2 Physical Port: Network Address: 256 IP Addr Cli1: 192.168.37.2 TCP/UDP Port : 20001 Unsol Dest Addr: 201			
DNP 3.0 slave 3 Physical Port: Network Address: 257 IP Addr Cli1: 192.168.37.3 TCP/UDP Port : 20002 Unsol Dest Addr: 202			

Figure C-5: SETTINGS FOR DNP3.0 MULTI-master communications with F650

C.6 Binary output and control relay output

Supported Control Relay Output Block fields: Pulse On.

The F650 relay provides 24 DNP Binary/Control Output points. These outputs are mapped to the first 24 commands configured in the F650. Executing a command is equal to activate the PLC equation that was attached to this command. Thus all of the 24 DNP Binary/Control Output points are pulsed points. It means that only Pulse On flag is accepted in DNP control operations on those points. All commands have configurable names. Changing the command's name can be done using the EnerVista 650 Setup program.

BINARY OUTPUT STATUS POINTS

Object Number: **10**

Request Function Codes supported: **1 (read)**

Default Variation Reported when variation 0 requested: **2 (Binary Output Status)**

CONTROL RELAY OUTPUT BLOCKS

Object Number: **12**

Request Function Codes supported: **3 (select), 4 (operate), 5 (direct operate), 6 (direct operate, no ack.)**

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
0	OPERATION1
1	OPERATION2
2	OPERATION3
3	OPERATION4
4	OPERATION5
5	OPERATION6
6	OPERATION7
7	OPERATION8
8	OPERATION9
9	OPERATION10
10	OPERATION11
11	OPERATION12
12	OPERATION13
13	OPERATION14
14	OPERATION15
15	OPERATION16
16	OPERATION17
17	OPERATION18
18	OPERATION19
19	OPERATION20
20	OPERATION21
21	OPERATION22
22	OPERATION23
23	OPERATION24
24-55	VI latched 1-32
56	VI Self Reset 1-2
57	VI Self Reset 3-4
58	VI Self Reset 5-6

BINARY/CONTROL OUTPUT POINTS	
POINT INDEX	NAME/DESCRIPTION
59	VI Self Reset 7-8
60	VI Self Reset 9-10
61	VI Self Reset 11-12
62	VI Self Reset 13-14
63	VI Self Reset 15-16
64	VI Self Reset 17-18
65	VI Self Reset 19-20
66	VI Self Reset 21-22
67	VI Self Reset 23-24
68	VI Self Reset 25-26
69	VI Self Reset 27-28
70	VI Self Reset 29-30
71	VI Self Reset 31-32

C.7 Binary counters

The following table lists both Binary Counters (Object 20) and Frozen Counters (Object 21). When a freeze function is performed on a Binary Counter point, the frozen value is available in the corresponding Frozen Counter point.

Digital Counter values are represented as 32-bit integers. The DNP 3.0 protocol defines counters to be unsigned integers. Care should be taken when interpreting negative counter values.

BINARY COUNTERS

Static (Steady-State) Object Number: **20**
Change Event Object Number: **22**
Request Function Codes supported: **1 (read), 7 (freeze), 8 (freeze no ack), 9 (freeze and clear), 10 (freeze and clear, no ack), 22 (assign class)**
Static Variation reported when variation 0 requested: **1 (32-Bit Binary Counter with Flag)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Counter Change Event without time)**
Default Class for all points: **3**

FROZEN COUNTERS

Static (Steady-State) Object Number: **21**
Change Event Object Number: **23**
Request Function Codes supported: **1 (read)**
Static Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter with Flag)**
Change Event Variation reported when variation 0 requested: **1 (32-Bit Frozen Counter Event without time)**
Default Class for all points: **3**

BINARY AND FROZEN COUNTERS POINT INDEX NAME/DESCRIPTION:

0 Pulse Counter 1	16 Pos MWatthour
1 Pulse Counter 2	17 Neg MWatthour
2 Pulse Counter 3	18 Pos MVatthour
3 Pulse Counter 4	19 Neg MVatthour
4 Pulse Counter 5	
5 Pulse Counter 6	
6 Pulse Counter 7	
7 Pulse Counter 8	
8 Digital Counter 1	
9 Digital Counter 2	
10 Digital Counter 3	
11 Digital Counter 4	
12 Digital Counter 5	
13 Digital Counter 6	
14 Digital Counter 7	
15 Digital Counter 8	

C.8 Analog inputs

It is important to note that 16-bit and 32-bit variations of Analog Inputs are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum positive representation is 32767. This is a DNP requirement.

The deadbands for all Analog Input points are in the same units as the Analog Input quantity. For example, an Analog Input quantity measured in volts has a corresponding deadband in units of volts. This is in conformance with DNP Technical Bulletin 9809-001 Analog Input Reporting Deadband. The scale factors apply also to deadbands. For example if Current Scale Factor is set to 0.001, and it is desired that a specific Analog Input point (that is of type current) trigger an event when its value changes by 1 kA, then the deadband for this point should be set to 1000. Relay settings are available to set default deadband values according to data type. Deadbands for individual Analog Input Points can be set using DNP Object 34.

ANALOG INPUT POINTS

Static (Steady-State) Object Number: **30**

Change Event Object Number: **32**

Request Function Codes supported: **1 (read), 2 (write, deadbands only), 22 (assign class)**

Static Variation Reported when variation 0 requested: **1 (32-Bit Analog Input)**

Change Event Variation reported when variation 0 requested: 1 **(Analog Change event without Time)**

Change Event Scan Rate: defaults to **500ms.**

Default Class for all points: **1**

Units for Analog Input points are as follows:

Current:	kA/A	Apparent Power:	MVA/KVA
Voltage:	kV/V	Energy:	MWh, MVArh/ kWh, kVArh
Real Power:	MW/KV	Frequency:	Hz
Reactive Power:	MVAr/kVAr	Angle:	degrees

ANALOG INPUT POINTS

POINT	DESCRIPTION	UNIT
0	Phasor Ia Primary	kA / A
1	Phasor Ib Primary	kA / A
2	Phasor Ic Primary	kA / A
3	Phasor Ig Primary	kA / A
4	Phasor Isg Primary	kA / A
5	Phasor In Primary	kA / A
6	RMS Ia Primary	kA / A
7	RMS Ib Primary	kA / A
8	RMS Ic Primary	kA / A
9	RMS Ig Primary	kA / A
10	RMS Isg Primary	kA / A
11	I0 Primary	kA / A
12	I1 Primary	kA / A
13	I2 Primary	kA / A
14	V0 Primary	kV / V
15	V1 Primary	kV / V
16	V2 Primary	kV / V

POINT	DESCRIPTION	UNIT
17	Vab Primary	kV / V
18	Vbc Primary	kV / V
19	Vca Primary	kV / V
20	Vn Primary	kV / V
21	Va Primary	kV / V
22	Vb Primary	kV / V
23	Vc Primary	kV / V
24	VL Primary	kV / V
25	VBB Primary	kV / V
26	Phase A Reactive Pwr	MVAr / kVAr
27	Phase A Apparent Pwr	MVA / kVA
28	Phase A Real Pwr	MW / kW
29	Phase B Reactive Pwr	MVAr / kVAr
30	Phase B Apparent Pwr	MVA / kVA
31	Phase B Real Pwr	MW / kW
32	Phase C Reactive Pwr	MVAr / kVAr
33	Phase C Apparent Pwr	MVA / kVA
34	Phase C Real Pwr	MW / kW
35	3 Phase Reactive Pwr	MVAr / kVAr
36	3 Phase Apparent Pwr	MVA / kVA
37	3 Phase Real Pwr	MW / kW
38	Phase A Power Factor	
39	Phase B Power Factor	
40	Phase C Power Factor	
41	3 Phase Power Factor	
42	Line Frequency Primary	Hz
43	Bus Frequency Primary	Hz
44	Vx Primary	kV / V
45	Pos MVarhour Freeze	MVArh / kVArh
46	Neg MVarhour Freeze	MVArh / kVArh
47	Pos MWatthour Freeze	MWh / kWh
48	Pos MWatthour Freeze	MWh / kWh
49	Positive MVarhour	MVArh / kVArh
50	Negative MVarhour	MVArh / kVArh
51	Positive MWatthour	MWh / kWh
52	Negative MWatthour	MWh / kWh
53	Fault 1 Prefault Phase A Current Magnitude	kA / A
54	Fault 1 Prefault Phase A Current Angle	degrees
55	Fault 1 Prefault Phase B Current Magnitude	kA / A
56	Fault 1 Prefault Phase B Current Angle	degrees
57	Fault 1 Prefault Phase C Current Magnitude	kA / A
58	Fault 1 Prefault Phase C Current Angle	degrees
59	Fault 1 Prefault Phase AB Voltage Magnitude	kV / V
60	Fault 1 Prefault Phase AB Voltage Angle	degrees
61	Fault 1 Prefault Phase BC Voltage Magnitude	kV / V
62	Fault 1 Prefault Phase BC Voltage Angle	degrees
63	Fault 1 Prefault Phase CA Voltage Magnitude	kV / V
64	Fault 1 Prefault Phase CA Voltage Angle	degrees
65	Fault 1 Postfault Phase A Current Magnitude	kA / A
66	Fault 1 Postfault Phase A Current Angle	degrees

POINT	DESCRIPTION	UNIT
67	Fault 1 Postfault Phase B Current Magnitude	kA / A
68	Fault 1 Postfault Phase B Current Angle	degrees
69	Fault 1 Postfault Phase C Current Magnitude	kA / A
70	Fault 1 Postfault Phase C Current Angle	degrees
71	Fault 1 Postfault Phase AB Voltage Magnitude	kV / V
72	Fault 1 Postfault Phase AB Voltage Angle	degrees
73	Fault 1 Postfault Phase BC Voltage Magnitude	kV / V
74	Fault 1 Postfault Phase BC Voltage Angle	degrees
75	Fault 1 Postfault Phase CA Voltage Magnitude	kV / V
76	Fault 1 Postfault Phase CA Voltage Angle	degrees
77	Fault 1 Type	Enum
78	Fault 1 Location	km
79	Fault 1 Prefault Ground Current Magnitude	kA / A
80	Fault 1 Prefault Ground Current Angle	degrees
81	Fault 1 Prefault Sensitive Ground Current Magnitude	kA / A
82	Fault 1 Prefault Sensitive Ground Current Angle	degrees
83	Fault 1 Postfault Ground Current Magnitude	kA / A
84	Fault 1 Postfault Ground Current Angle	degrees
85	Fault 1 Postfault Sensitive Ground Current Magnitude	kA / A
86	Fault 1 Postfault Sensitive Ground Current Angle	degrees
87	% of Load to Trip	%
88	Board F - Analog 1	
89	Board F - Analog 2	
90	Board F - Analog 3	
91	Board F - Analog 4	
92	Board F - Analog 5	
93	Board F - Analog 6	
94	Board F - Analog 7	
95	Board F - Analog 8	
96	Board G - Analog 1	
97	Board G - Analog 2	
98	Board G - Analog 3	
99	Board G - Analog 4	
100	Board G - Analog 5	
101	Board G - Analog 6	
102	Board G - Analog 7	
103	Board G - Analog 8	
104	Board H - Analog 1	
105	Board H - Analog 2	
106	Board H - Analog 3	
107	Board H - Analog 4	
108	Board H - Analog 5	
109	Board H - Analog 6	
110	Board H - Analog 7	
111	Board H - Analog 8	
112	Board J - Analog 1	
113	Board J - Analog 2	
114	Board J - Analog 3	
115	Board J - Analog 4	
116	Board J - Analog 5	

POINT	DESCRIPTION	UNIT
117	Board J - Analog 6	
118	Board J - Analog 7	
119	Board J - Analog 8	

The “Fault Type” is represented by enumeration value. The table below shows values with DNP3 setting “Other Scale Factor = 1".

ENUM VALUE	FAULT TYPE
0	GROUND
1	PHASE
2	TRIPH
3	AG
4	ABG
5	AB
6	BG
7	BCG
8	BC
9	CG
10	CAG
11	CA
12	NAF

If the DNP3 setting “Other Scale Factor” has a value different from “1” then “Enum Value” is scaled by the adjusted factor. For example if “Other Scale Factor = 0.001", then the value corresponding to “TRIPH” fault type is 2000.

NAF indicates that the type of fault has not been calculated.

F650 Digital Bay Controller

Appendix D: IEC 60870-5-104 protocol

D.1 Introduction

The F650 implements functionality of an IEC 60870-5-104 server. The devices responds to client requests or can send spontaneous transmissions. F650 implementation of 60870-5-104 provides analog metering and states.

The IEC 60870-5-104 communications protocol is supported on Ethernet ports A and B only.

D.2 Technical description

ASDU is the information unit used for data transmission. An ASDU may have data inside or not. The ASDU is encapsulated in another package of the link layer. ASDU address takes up 2 bytes.

Communication frames can be control or data frames. Control strings do not have ASDU inside.

A frame is consisting of 3 parts. (2 of them are not always present):

Link data + [ASDU header+ [ASDU data]]

The data between brackets can be omitted.

In IEC104 communication is made by TCP/IP protocols. Actually, it is a TCP communication. The default port is the 2404.

The F650 is listening as a server and supports up to two different IEC60870-5-104 masters simultaneously.

D.3 Basic application functions

Cyclic data transmission

Cyclic data transmission is used to send measured values to the IEC 60870-5-104 master.

Spontaneous Transmission:

Information objects may be transmitted without a specific request from the IEC 60870-5-104 master.

The data that can be sent spontaneously are:

- Measured values when a deadband overflow takes place.
- Single points in the time the event is produced.
- Double points in the time the event is produced.
- Integrated Totals

Clock synchronization

F650 supports clock synchronization from IEC 60870-5-104 master.

If IRIG-B, PTP-1588 or SNTP is being used for time synchronization, the IEC 60870-5-104 clock synchronization command does not set the F650 real time clock.

Command transmission

F650 is allowed to accept single commands and double commands.

D.4 IEC 104 settings

The Communication settings for IEC 60870-5-104 protocol are the following:

Product Setup > Communication Settings > IEC 870-5-104			
Name	Value	Units	Range
Function	DISABLED		
TCP Port	2404		[0:65535]
Common Addr of ASDU	255		[0:65535]
Cyclic Meter Period	0	Seconds	[0:3600]
Synchronization Event	0	Minutes	[0:1400]
IEC104 NET1 CLI1 OCTET1	0		[0 : 255]
IEC104 NET1 CLI1 OCTET2	0		[0 : 255]
IEC104 NET1 CLI1 OCTET3	0		[0 : 255]
IEC104 NET1 CLI1 OCTET4	0		[0 : 255]
IEC104 NET1 CLI2 OCTET1	0		[0 : 255]
IEC104 NET1 CLI2 OCTET2	0		[0 : 255]
IEC104 NET1 CLI2 OCTET3	0		[0 : 255]
IEC104 NET1 CLI2 OCTET4	0		[0 : 255]
Function 2	DISABLED		
TCP Port 2	2404		[0:65535]
Common Addr of ASDU 2	255		[0:65535]
IEC104 NET2 CLI1 OCTET1	0		0 : 255]
IEC104 NET2 CLI1 OCTET2	0		0 : 255]
IEC104 NET2 CLI1 OCTET3	0		0 : 255]
IEC104 NET2 CLI1 OCTET4	0		0 : 255]
IEC104 NET2 CLI2 OCTET1	0		0 : 255]
IEC104 NET2 CLI2 OCTET2	0		0 : 255]
IEC104 NET2 CLI2 OCTET3	0		0 : 255]

IEC104 NET2 CLI2 OCTET4	0		0 : 255]
IEC104 SCALE CURRENT	1		
IEC104 SCALE VOLTAGE	1		
IEC104 SCALE POWER	1		
IEC104 SCALE ENERGY	1		
IEC104 SCALE OTHER	1		
IEC104 DEADBAND CURRENT	30000		[0:65535]
IEC104 DEADBAND VOLTAGE	30000		[0:65535]
IEC104 DEADBAND POWER	30000		[0:65535]
IEC104 DEADBAND ENERGY	30000		[0:65535]
IEC104 DEADBAND OTHER	30000		[0:65535]
IEC104 IOA BINARIES	1000		[0:65535]
IEC104 IOA DOUBLE POINTS	1500		[0:65535]
IEC104 IOA ANALOGS	2000		[0:65535]
IEC104 IOA COUNTERS	4000		[0:65535]
IEC104 IOA COMMANDS	3000		[0:65535]
IEC104 IOA ANALOG PARAMETERS	5000		[0:65535]

Function: Enable or disable the protocol operation for the first IEC 60870-5-104 connection.

TCP Port: Listening TCP port in the relay. Default value is 2404.

Common Addr of ASDU: Address in the ASDU header. Default value is 255.

Cyclic Meter Period: Number of seconds for cyclical data sending, 0 means no spontaneous meterings.

Synchronization event: Period of time (in minutes) for which timestamps are considered valid after receiving a clock synchronization command.

IEC104 NET1 CLI1 OCTET1 to 4: These four octets define the IP address of the first client that is accepted in the first connection. The F650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.

EC104 NET1 CLI2 OCTET1 to 4: These four octets define the IP address of the second client that is accepted in the first connection. The F650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.

Function 2: Enable or disable the protocol operation for the second connection.

TCP Port 2: Listening TCP port in the relay. Default value is 2404.

Common Addr of ASDU2: Address in the ASDU header. Default value is 255.

IEC104 NET2 CLI1 OCTET1 to 4: These four octets define the IP address of the first client that is accepted in the second connection. The F650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.

IEC104 NET2 CLI2 OCTET1 to 4: These four octets define the IP address of the second client that is accepted in the second connection. The F650 relay can respond to a maximum of 2 IEC 60870-5-104 masters (not at the same time) in this connection.

IEC104 SCALE CURRENT, VOLTAGE,

POWER, ENERGY, OTHER: These settings are numbers used to scale Analog Input point values. These settings group the F650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the scale factor for all Analog Input points of that type. For example, if the **IEC104 SCALE VOLTAGE** is set to a value of 1000, all IEC104 Analog Input points that are voltages are returned with the values 1000 times smaller (e.g. a value 72000 V on the F650 is returned as 72). These settings are useful when Analog Input values must be adjusted to fit within certain ranges in IEC 60870-5-104 masters. Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10 times larger).

IEC104 DEADBAND CURRENT, VOLTAGE, POWER, ENERGY, OTHER: These settings are the values used by the F650 to determine when to trigger spontaneous responses containing Analog Input data.

These settings group the F650 Analog Input data into types: current, voltage, power, energy, and other. Each setting represents the default deadband value for all Analog Input points of that type. For example, in order to trigger spontaneous responses from the F650 when any current values change by 15 A, the **IEC104 DEADBAND CURRENT** setting should be set to 15. Note that these settings are the default values of the deadbands. Parameter of measured value ASDU can be used to change deadband values, from the default, for each individual IEC104 Analog Input point. Whenever power is removed and re-applied to the F650, the default deadbands are in effect.

IEC104 IOA BINARIES: Starting Information Object Address for Single Points.

IEC104 IOA DOUBLE POINTS: Starting Information Object Address for Double Points.

IEC104 IOA ANALOGS: Starting Information Object Address for Analog Inputs.

IEC104 IOA COUNTERS: Starting Information Object Address for Counters.

IEC104 IOA COMMANDS: Starting Information Object Address for Single or Double Commands.

IEC104 IOA ANALOG PARAMETERS: Starting Information Object Address for Parameter of measured value. Each

Measured value has a Parameter of measured value associated with its threshold.

The F650 relay has a custom Binary Inputs points list, called User Map; it is common for any protocol. In the case of IEC 104 Protocol, those points are GROUP1 and GROUP2.

The IEC 104 User Map can be configured using the **EnerVista 650 Setup** software in ***Setpoint > Relay Configuration > Control Events***.

The User Map contains 128 Binary Inputs. To each point of the User Map, assign any of the binary states of the F650 relay. It is also possible to combine those states using OR and NOT functions. These states are: contact inputs and outputs, virtual outputs, protection element states, PLC states, etc. The User Map always has a size of 128 Binary Inputs. Points in the User Map that are not configured have a zero value in the answer.

It is possible to implement more complex logic than simple OR and NOT using the **PLC Editor** tool in **EnerVista 650 Setup** in the menu ***Setpoint > Logic Configuration.*** These complex signals (Virtual Outputs) can be assigned to the binary points in the Control Events configuration for the IEC 104 user map.

Groups of Data

The data is organized into groups in order to provide values when the controlling station requests them by a general or group interrogation.

Group 1, 2 & 4 are set by the 256 Single Points (M_SP_NA_1).

Group 3 is set by the 16 Double Points (M_DP_NA_1).

Group 5 and 6 are set by the120 Analog Inputs, short floating-point (M_ME_NC_1).

Group 7 is set by the 120 Parameter of measured value, short floating-point (P_ME_NC_1).

These 256 Single Points, 16 Double points and 120 Measured Values are also sent as a response to a General Interrogation.

The 20 Integrated Totals (M_IT_NA_1) has its own Counter Group and it is sent as a response to a General Request Counter.

Group 1 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1000-1063	CONTROL EVENTS 1-64

Group 2 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1064-1127	CONTROL EVENTS 65-128

Group 3 Status	
POINT	DESCRIPTION
M_DP_NA_1	
1500-1515	SWITCHGEAR EVENTS

Group 4 Status	
POINT	DESCRIPTION
M_SP_NA_1	
1128-1255	BOARD F 1-32, G 1-32, H 1-32, J 1-32

Group 5 Single point	
POINT	DESCRIPTION
M_ME_NC_1	
2000	Phasor Ia Primary
2001	Phasor Ib Primary
2002	Phasor Ic Primary
2003	Phasor Ig Primary
2004	Phasor Isg Primary
2005	Phasor In Primary
2006	RMS Ia Primary
2007	RMS Ib Primary
2008	RMS Ic Primary
2009	RMS Ig Primary
2010	RMS Isg Primary
2011	I0 Primary

Group 5 Single point	
2012	I1 Primary
2013	I2 Primary
2014	V0 Primary
2015	V1 Primary
2016	V2 Primary
2017	Vab Primary
2018	Vbc Primary
2019	Vca Primary
2020	Vn Primary
2021	Va Primary
2022	Vb Primary
2023	Vc Primary
2024	VL Primary
2025	VBB Primary
2026	Phase A Reactive Pwr
2027	Phase A Apparent Pwr
2028	Phase A Real Pwr
2029	Phase B Reactive Pwr
2030	Phase B Apparent Pwr
2031	Phase B Real Pwr
2032	Phase C Reactive Pwr
2033	Phase C Apparent Pwr
2034	Phase C Real Pwr
2035	3 Phase Reactive Pwr
2036	3 Phase Apparent Pwr
2037	3 Phase Real Pwr
2038	Phase A Power Factor
2039	Phase B Power Factor
2040	Phase C Power Factor
2041	3 Phase Power Factor
2042	Line Frequency Primary
2043	Bus Frequency Primary
2044	Vx Primary
2045	Pos Mvarhour Freeze
2046	Neg Mvarhour Freeze
2047	Pos MWatthour Freeze
2048	Neg MWatthour Freeze
2049	Positive MVarhour
2050	Negative MVarhour
2051	Positive MWatthour
2052	Negative MWatthour
2053	Fault 1 Prefault Phase A Current Magnitude
2054	Fault 1 Prefault Phase A Current Angle
2055	Fault 1 Prefault Phase B Current Magnitude
2056	Fault 1 Prefault Phase B Current Angle
2057	Fault 1 Prefault Phase C Current Magnitude
2058	Fault 1 Prefault Phase C Current Angle
2059	Fault 1 Prefault Phase AB Voltage Magnitude

Group 6 Metering	
POINT	DESCRIPTION
M_ME_NC_1	
2060	Fault 1 Prefault Phase AB Voltage Angle
2061	Fault 1 Prefault Phase BC Voltage Magnitude
2062	Fault 1 Prefault Phase BC Voltage Angle
2063	Fault 1 Prefault Phase CA Voltage Magnitude
2064	Fault 1 Prefault Phase CA Voltage Angle
2065	Fault 1 Postfault Phase A Current Magnitude
2066	Fault 1 Postfault Phase A Current Angle
2067	Fault 1 Postfault Phase B Current Magnitude
2068	Fault 1 Postfault Phase B Current Angle
2069	Fault 1 Postfault Phase C Current Magnitude
2070	Fault 1 Postfault Phase C Current Angle
2071	Fault 1 Postfault Phase AB Voltage Magnitude
2072	Fault 1 Postfault Phase AB Voltage Angle
2073	Fault 1 Postfault Phase BC Voltage Magnitude
2074	Fault 1 Postfault Phase BC Voltage Angle
2075	Fault 1 Postfault Phase CA Voltage Magnitude
2076	Fault 1 Postfault Phase CA Voltage Angle
2077	Fault 1 Type
2078	Fault 1 Location
2079	Fault 1 Prefault Ground Current Magnitude
2080	Fault 1 Prefault Ground Current Angle
2081	Fault 1 Prefault Sensitive Ground Current Magnitude
2082	Fault 1 Prefault Sensitive Ground Current Angle
2083	Fault 1 Postfault Ground Current Magnitude
2084	Fault 1 Postfault Ground Current Angle
2085	Fault 1 Postfault Sensitive Ground Current Magnitude
2086	Fault 1 Postfault Sensitive Ground Current Angle
2087	% of Load to Trip
2088	Board F – Analog 1
2089	Board F – Analog 2
2090	Board F – Analog 3
2091	Board F – Analog 4
2092	Board F – Analog 5
2093	Board F – Analog 6
2094	Board F – Analog 7
2095	Board F – Analog 8
2096	Board G – Analog 1
2097	Board G – Analog 2
2098	Board G – Analog 3
2099	Board G – Analog 4
2100	Board G – Analog 5
2101	Board G – Analog 6
2102	Board G – Analog 7
2103	Board G – Analog 8
2104	Board H – Analog 1
2105	Board H – Analog 2
2106	Board H – Analog 3

Group 6 Metering	
2107	Board H – Analog 4
2108	Board H – Analog 5
2109	Board H – Analog 6
2110	Board H – Analog 7
2111	Board H – Analog 8
2112	Board J – Analog 1
2113	Board J – Analog 2
2114	Board J – Analog 3
2115	Board J – Analog 4
2116	Board J – Analog 5
2117	Board J – Analog 6
2118	Board J – Analog 7
2119	Board J – Analog 8

Group 7 Deadband	
POINT	DESCRIPTION
P_ME_NC_1	
5000-5119	Analog Input Deadbands 2000-2119

Integrated Totals	
POINT	DESCRIPTION
M_IT_NA_1	
4000-4007	Pulse Counter 1-8
4008-4015	Digital Counters 1-8
4016-4019	Energy Counters

D.5 IEC 60870-5-104 point list

OPERATIONS IN IEC 60870-5-104 FOR F650

The two standard procedures for command transmission are accepted, Direct command or Select and Execute command.

The following table determines how a command can be executed in F650

Commands		
POINT	DESCRIPTION	COMMAND MODE
3000	Operation 1 (ON) + Operation 2(OFF)	Select and Execute Double Command
---	---	---
3005	Operation 11 (ON) + Operation 12(OFF)	Select and Execute Double Command
3006	Operation 13 (ON) + Operation 14(OFF)	Direct Double Command
---	---	---
3011	Operation 23 (ON) + Operation 24(OFF)	Direct Double Command
3012	Virtual Self Reset 1 (ON) + Virtual Self Reset 2(OFF)	Direct Double Command
---	---	---
3027	Virtual Self Reset 31 (ON) + Virtual Self Reset 32(OFF)	Direct Double Command
3028-3059	Virtual Latched 1-32	Direct Single Command

There are 24 available operation in F650 device; they must be configured using EnerVista 650 Setup in ***Setting***

> Relay Configuration > Operations.

ASDU address must start with 3000; the addresses for operation are from 3000 to 3011. The operations go from 0 to 23.

D.6 IEC 60870-5-104 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets must be selected to implement particular telecontrol systems. Certain parameter values, such as the choice of "structured" or "unstructured" fields of the INFORMATION OBJECT ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications. This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers, it is necessary that all partners agree on the selected parameters.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. The text descriptions of parameters which are not applicable to this companion standard are strike-through (corresponding check box is marked black).

NOTEIn addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The selected parameters should be marked in the white boxes as follows

	Function or ASDU is not used
X	Function or ASDU is used as standardized (default)
R	Function or ASDU is used in reverse mode
B	Function or ASDU is used in standard and reverse mode

The possible selection (blank, X, R, or B) is specified for each specific clause or parameter.

A black check box indicates that the option cannot be selected in this companion standard.

System or device

(system-specific parameter, indicate definition of a system or a device by marking one of the following with “**X**”)

	System definition
X	Controlling station definition (Master)
R	Controlled station definition (Slave)

Network configuration

(network-specific parameter, all configurations that are used are to be marked "**X**")

~~Point-to-point~~	~~Multipoint-partyline~~
~~Multiple point-to-point~~	~~Multipoint-star~~

Physical layer
(network-specific parameter, all interfaces and data rates that are used are to be marked "**X**")

Transmission speed (control direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange	
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27	
StandardRecommended if >1 200 bit/s			
~~100 bit/s~~	~~2 400 bit/s~~	~~2 400 bit/s~~	~~56 000 bit/s~~
~~200 bit/s~~	~~4 800 bit/s~~	~~4 800 bit/s~~	~~64 000 bit/s~~
~~300 bit/s~~	~~9 600 bit/s~~	~~9 600 bit/s~~	
~~600 bit/s~~		~~19 200 bit/s~~	
~~1 200 bit/s~~		~~38 400 bit/s~~	

Transmission speed (monitor direction)

Unbalanced interchange	Unbalanced interchange	Balanced interchange	
Circuit V.24/V.28	Circuit V.24/V.28	Circuit X.24/X.27	
StandardRecommended if >1 200 bit/s			
~~100 bit/s~~	~~2 400 bit/s~~	~~2 400 bit/s~~	~~56 000 bit/s~~
~~200 bit/s~~	~~4 800 bit/s~~	~~4 800 bit/s~~	~~64 000 bit/s~~
~~300 bit/s~~	~~9 600 bit/s~~	~~9 600 bit/s~~	
~~600 bit/s~~		~~19 200 bit/s~~	
~~1 200 bit/s~~		~~38 400 bit/s~~	

Link layer
(network-specific parameter, all options that are used are to be marked “X”. Specify the maximum frame length. If a non-standard assignment of class 2 messages is implemented for unbalanced transmission, indicate the Type ID and COT of all messages assigned to class 2.)

~~Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.~~

Link transmission

- ■ ~~Balanced transmission~~
- ■ ~~Unbalanced transmission~~

Frame length

- ■ ~~Balanced transmission~~
- ■ ~~Unbalanced transmission~~

Address field of the link

- ■ ~~not present (balanced transmission only)~~
- ■ ~~One octet~~
- ■ ~~Two octets~~
- ■ ~~Structured~~
- ■ ~~Unstructured~~

When using an unbalanced link layer, the following ASDU types are returned in class 2 messages (low priority) with the indicated causes of transmission:

■ ~~The standard assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission
9, 11, 13, 21	<1>

■ ~~A special assignment of ASDUs to class 2 messages is used as follows:~~

Type identification	Cause of transmission

~~Note: (In response to a class 2 poll, a controlled station may respond with class 1 data when there is no class 2 data available).~~

Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

(system-specific parameter, all configurations that are used are to be marked "**X**")

- [ ] ~~One octet~~
- [X] Two octets

Information object address
(system-specific parameter, all configurations that are used are to be marked "**X**")

- [ ] ~~One octet~~
- [ ] ~~Two octets~~
- [X] Three octets
- [X] Structured
- [X] Unstructured

Cause of transmission
(system-specific parameter, all configurations that are used are to be marked "**X**")

- [ ] ~~One octet~~
- [X] Two octets (with originator address). Originator address is set to zero if not used

Length of APDU
(system-specific parameter, specify the maximum length of the APDU per system)

The maximum length of APDU for both directions is 253. It is a fixed system parameter.

- [ ] Maximum length of APDU per system in control direction
- [ ] Maximum length of APDU per system in monitor direction

Selection of standard ASDUs

Process information in monitor direction
(station-specific parameter, mark each Type ID “X” if it is only used in the standard direction, "**R**" if only used in the reverse direction, and “B” if used in both directions).

X	<1>	:= Single-point information	M_SP_NA_1
■	~~<2> := Single-point information with time tag~~		~~M_SP_TA_1~~
X	<3>	:= Double-point information	M_DP_NA_1
■	~~<4> := Double-point information with time tag~~		~~M_DP_TA_1~~
	<5>	:= Step position information	M_ST_NA_1
■	~~<6> := Step position information with time tag~~		~~M_ST_TA_1~~
	<7>	:= Bitstring of 32 bit	M_BO_NA_1
■	~~<8> := Bitstring of 32 bit with time tag~~		~~M_BO_TA_1~~
	<9>	:= Measured value, normalized value	M_ME_NA_1
■	~~<10>:= Measured value, normalized value with time tag~~		~~M_ME_TA_1~~
	<11> :=	Measured value, scaled value	M_ME_NB_1
■	~~<12> := Measured value, scaled value with time tag~~		~~M_ME_TB_1~~
X	<13>:=	Measured value, short floating point value	M_ME_NC_1
■	~~<14> := Measured value, short floating point value with time tag~~		~~M_ME_TC_1~~
X	<15> :=	Integrated totals	M_IT_NA_1
■	~~<16> := Integrated totals with time tag~~		~~M_IT_TA_1~~
■	~~<17> := Event of protection equipment with time tag~~		~~M_EP_TA_1~~
■	~~<18> := Packed start events of protection equipment with time tag~~		~~M_EP_TB_1~~
■	~~<19> := Packed output circuit information of protection equipment with time tag~~		~~M_EP_TC_1~~
	<20> :=	Packed single-point information with status change detection	M_SP_NA_1
	<21> :=	Measured value, normalized value without quality descriptor	M_ME_ND_1
X	<30> :=	Single-point information with time tag CP56Time2a	M_SP_TB_1
X	<31> :=	Double-point information with time tag CP56Time2a	M_DP_TB_1
	<32> :=	Step position information with time tag CP56Time2a	M_ST_TB_1
	<33> :=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
	<34> :=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
	<35> :=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
X	<36> :=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
X	<37> :=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
	<38> :=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
	<39> :=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
	<40> :=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

In this companion standard only the use of the set <30> – <40> for ASDUs with time tag is permitted.

Process information in control direction
(station-specific parameter, mark each Type ID “X” if it is only used in the standard direction, "**R**" if only used in the reverse direction, and “**B**” if used in both directions).

X	<45> :=	Single command	C_SC_NA_1
X	<46> :=	Double command	C_DC_NA_1
	<47> :=	Regulating step command	C_RC_NA_1
	<48> :=	Set point command, normalized value	C_SE_NA_1
	<49> :=	Set point command, scaled value	C_SE_NB_1
	<50> :=	Set point command, short floating point value	C_SE_NC_1
	<51> :=	Bitstring of 32 bit	C_BO_NA_1
X	<58> :=	Single command with time tag CP56Time2a	C_SC_TA_1
X	<59> :=	Double command with time tag CP56Time2a	C_DC_TA_1
	<60> :=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
	<61> :=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
	<62> :=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
	<63> :=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
	<64> :=	Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> – <51> or of the set <58> – <64> are used.

System information in monitor direction
(station-specific parameter, mark with an "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<70> :=	End of initialization	M_EI_NA_1

System information in control direction
(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	<100>:=	Interrogation command	C_IC_NA_1
X	<101>:=	Counter interrogation command	C_CI_NA_1
X	<102>:=	Read command	C_RD_NA_1
X	<103>:=	Clock synchronization command (option see 7.6)	C_CS_NA_1
	~~<104>:=~~	~~Test command~~	~~C_TS_NA_1~~
X	<105>:=	Reset process command	C_RP_NA_1
	~~<106>:=~~	~~Delay acquisition command~~	~~C_CD_NA_1~~
X	<107>:=	Test command with time tag CP56Time2a	C_TS_TA_1

Parameter in control direction

(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐	<110>:=	Parameter of measured value, normalized value	P_ME_NA_1
☐	<111>:=	Parameter of measured value, scaled value	P_ME_NB_1
X	<112>:=	Parameter of measured value, short floating point value	P_ME_NC_1
☐	<113>:=	Parameter activation	P_AC_NA_1

File transfer
(station-specific parameter, mark each Type ID "**X**" if it is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐	<120>:=	File ready	F_FR_NA_1
☐	<121>:=	Section ready	F_SR_NA_1
☐	<122>:=	Call directory, select file, call file, call section	F_SC_NA_1
☐	<123>:=	Last section, last segment	F_LS_NA_1
☐	<124>:=	Ack file, ack section	F_AF_NA_1
☐	<125>:=	Segment	F_SG_NA_1
☐	<126>:=	Directory {blank or X, only available in monitor (standard) direction}	F_DR_TA_1
☐	<127>:=	Query Log – Request archive file	F_SC_NB_1

Type identifier and cause of transmission assignments
(station-specific parameters)

Shaded boxes: option not required.

Black boxes: option not permitted in this companion standard

Blank: functions or ASDU not used.

Mark Type Identification/Cause of transmission combinations:

"**X**" if only used in the standard direction;

"**R**" if only used in the reverse direction;

"**B**" if used in both directions.

Type identification		Cause of transmission																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<1>	M_SP_NA_1					X									X					
~~<2>~~	~~M_SP_TA_1~~																			
<3>	M_DP_NA_1					X									X					
~~<4>~~	~~M_DP_TA_1~~																			
<5>	M_ST_NA_1																			
~~<6>~~	~~M_ST_TA_1~~																			

<7>	M_BO_NA_1																			
~~<8>~~	~~M_BO_TA_1~~																			
<9>	M_ME_NA_1																			
~~<10>~~	~~M_ME_TA_1~~																			
<11>	M_ME_NB_1																			
~~<12>~~	~~M_ME_TB_1~~																			
<13>	M_ME_NC_1	X				X									X					
~~<14>~~	~~M_ME_TC_1~~																			
<15>	M_IT_NA_1															X				
~~<16>~~	~~M_IT_TA_1~~																			
~~<17>~~	~~M_EP_TA_1~~																			
~~<18>~~	~~M_EP_TB_1~~																			
~~<19>~~	~~M_EP_TC_1~~																			
<20>	M_PS_NA_1																			
<21>	M_ME_ND_1																			
<30>	M_SP_TB_1			X																
<31>	M_DP_TB_1																			
<32>	M_ST_TB_1																			
<33>	M_BO_TB_1																			
<34>	M_ME_TD_1																			
<35>	M_ME_TE_1																			
<36>	M_ME_TF_1			X																
<37>	M_IT_TB_1			X																
<38>	M_EP_TD_1																			
<39>	M_EP_TE_1																			
<40>	M_EP_TF_1																			
<45>	C_SC_NA_1						X	X	X	X	X									
<46>	C_DC_NA_1						X	X	X	X	X									
<47>	C_RC_NA_1																			
<48>	C_SE_NA_1																			
<49>	C_SE_NB_1																			
<50>	C_SE_NC_1																			
<51>	C_BO_NA_1																			
<58>	C_SC_TA_1						X	X	X	X	X									
<59>	C_DC_TA_1						X	X	X	X	X									
<60>	C_RC_TA_1																			
Type identification		**Cause of transmission**																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<61>	C_SE_TA_1																			
<62>	C_SE_TB_1																			
<63>	C_SE_TC_1																			
<64>	C_BO_TA_1																			
<70>	M_EI_NA_1*				X															
<100>	C_IC_NA_1						X	X	X	X	X									
<101>	C_CI_NA_1						X	X			X									
<102>	C_RD_NA_1					X														

<103>	C_CS_NA_1						X	X												
~~<104>~~	~~C_TS_NA_1~~																			
<105>	C_RP_NA_1						X	X												
~~<106>~~	~~C_CD_NA_1~~																			
<107>	C_TS_TA_1																			
<110>	P_ME_NA_1																			
<111>	P_ME_NB_1																			
<112>	P_ME_NC_1						X	X							X					
<113>	P_AC_NA_1																			
<120>	F_FR_NA_1																			
<121>	F_SR_NA_1																			
<122>	F_SC_NA_1																			
<123>	F_LS_NA_1																			
<124>	F_AF_NA_1																			
<125>	F_SG_NA_1																			
<126>	F_DR_TA_1*																			
<127>	F_SC_NB_1*																			
* Blank or X only																				

Basic application functions

Station initialization
(station-specific parameter, mark "**X**" if function is used)

X	Remote initialization

Cyclic data transmission
(station-specific parameter, mark “X” if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	Cyclic data transmission

Read procedure
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions)

X	Read procedure

Spontaneous transmission
(station-specific parameter, mark “X” if function is only used in the standard direction, "**R**" if only used in the reverse direction, and “B” if used in both directions)

X	Spontaneous transmission

Double transmission of information objects with cause of transmission spontaneous

(station-specific parameter, mark each information type "**X**" where both a Type ID without time and corresponding Type ID with time are issued in response to a single spontaneous change of a monitored object)

The following type identifications may be transmitted in succession caused by a single status change of an information object. The particular information object addresses for which double transmission is enabled are defined in a project-specific list.

- [ ] Single-point information M_SP_NA_1, M_SP_TA_1, M_SP_TB_1 and M_PS_NA_1
- [ ] Double-point information M_DP_NA_1, M_DP_TA_1 and M_DP_TB_1
- [ ] Step position information M_ST_NA_1, M_ST_TA_1 and M_ST_TB_1
- [ ] Bitstring of 32 bit M_BO_NA_1, M_BO_TA_1 and M_BO_TB_1 (if defined for a specific project)
- [ ] Measured value, normalized value M_ME_NA_1, M_ME_TA_1, M_ME_ND_1 and M_ME_TD_1
- [ ] Measured value, scaled value M_ME_NB_1, M_ME_TB_1 and M_ME_TE_1
- [ ] Measured value, short floating point number M_ME_NC_1, M_ME_TC_1 and M_ME_TF_1

Station interrogation

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

- [X] global
- [X] group 1
- [X] group 2
- [X] group 3
- [X] group 4
- [X] group 5
- [X] group 6
- [X] group 7
- [X] group 8
- [X] group 9
- [X] group 10
- [X] group 11
- [X] group 12
- [X] group 13
- [X] group 14
- [X] group 15
- [X] group 16

Information object addresses assigned to each group must be shown in a separate table.

Clock synchronization

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Spontaneous transmission
	Day of week used
	RES1, GEN (time tag substituted/ not substituted) used
	SU-bit (summertime) used

optional, see 7.6

Command transmission

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Direct command transmission
	Direct set point command transmission
X	Select and execute command
	Select and execute set point command
X	C_SE ACTTERM used

X	No additional definition
X	Short-pulse duration (duration determined by a system parameter in the outstation)
X	Long-pulse duration (duration determined by a system parameter in the outstation)
X	Persistent output

X	Supervision of maximum delay in command direction of commands and set point commands

10s	Maximum allowable delay of commands and set point commands

Transmission of integrated totals
(station- or object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Mode A: Local freeze with spontaneous transmission
X	Mode B: Local freeze with counter interrogation
X	Mode C: Freeze and transmit by counter-interrogation commands
X	Mode D: Freeze by counter-interrogation command, frozen values reported

X	Counter read
X	Counter freeze without reset
X	Counter freeze with reset
X	Counter freeze with reset

X	General request counter
X	Request counter group 1
X	Request counter group 2
X	Request counter group 3
	Request counter group 4

Parameter loading

(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

X	Threshold value
	Smoothing factor
	Low limit for transmission of measured values
	Low limit for transmission of measured values

Parameter activation
(object-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Act/deact of persistent cyclic or periodic transmission of the addressed object

Test procedure
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Test procedure

File transfer
(station-specific parameter, mark "**X**" if function is used).

File transfer in monitor direction

	Transparent file
	Transmission of disturbance data of protection equipment
	Transmission of sequences of events
	Transmission of sequences of recorded analogue values

File transfer in control direction

	Transparent file

Background scan
(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

	Background scan

Acquisition of transmission delay

(station-specific parameter, mark "**X**" if function is only used in the standard direction, "**R**" if only used in the reverse direction, and "**B**" if used in both directions).

☐ ~~Acquisition of transmission delay~~

Definition of time outs

Parameter	Default value	Remarks	Selected value
t0	30 s	Time-out of connection establishment	**N/A**
t1	15 s	Time-out of send or test APDUs	**15 s**
t2	10 s	Time-out for acknowledges in case of no data messages t2 < t1	**10 s**
t3	20 s	Time-out for sending test frames in case of a long idle state	**20 s**

Maximum range for timeouts t0 to t2: 1 s to 255 s, accuracy 1 s.
Recommended range for timeout t3: 1 s to 48 h, resolution 1 s.
Long timeouts for t3 may be needed in special cases where satellite links or dialup connections are used (for instance to establish connection and collect values only once per day or week).

Maximum number of outstanding I format APDUs *k* and latest acknowledge APDUs (*w*)

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	**12 APDUs**
w	8 APDUs	Latest acknowledge after receiving *w* I format APDUs	**8 APDUs**

Maximum range of values *k*: 1 to 32767 (215–1) APDUs, accuracy 1 APDU

Maximum range of values *w*: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: *w* should not exceed two-thirds of *k*).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

Redundant connections

☐ Number N of redundancy group connections used

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for a given projects has to be chosen by the user of this standard.

X	Ethernet 802.3
	Serial X.21 interface
	Other selection from RFC 2200:

List of valid documents from RFC 2200

1.....

2.....

3.....

4.....

5.....

6.....

7. etc.

F650 Digital Bay Controller

Appendix E: PROCOME protocol

E.1 PROCOME protocol

Procome is an communication protocol focused on control operations. Commands to read data as status, measurements, events and counters have been implemented together with commands to perform operations and synchronization.

This procome implementation has a subset of the basic application functions, asdus and services of the whole procome profile. The protection functionality for procome has not been implemented.

Application functions and ASDUS:

The implemented profile is the following:

a) Secondary station initialization

- ASDU 5 Identification

b) Control Functions - Control requests

- Primary to Secondary:
  - ASDU 100 Control data request
- Secondary to Primary:
  - ASDU 100 Measurements and digital changes transmission
  - ASDU 101 Counters transmission

c) Control Functions - Digital signals status refresh

- Primary to Secondary.
  - ASDU 103 Digital status data request
- Secondary to Primary.
  - ASDU 103 Digital status data transmission

d) Control Functions - Overflow

e) Control Functions - Commands

- Primary to Secondary.

  ASDU 121 Commands

- Secondary to Primary.

  ASDU 121 Commands

f) Clock Synchronization

- Primary to Secondary.

  ASDU 6 Clock Synchronization

-Secondary to Primary:

  ASDU 6 Clock Synchronization

Procome Settings:

Product Setup > Communication Settings > PROCOME			
Name	**Default Value**	**Step**	**Range**
COMM Port	NONE		[NONE - COM1]
Slave Number	0		
			[0 : 254]

When value NONE is selected in the COMM Port setting the protocol is not enabled. The COM1 selection enables PROCOME for the COM1 (remote) serial port.

Slave Number:is the PROCOME slave number.

Baud rate and parity for COM1 must be set in ***Setpoint > Communications > Serial Ports***.

Procome Configuration:

The procome data configuration is performed through the **Setpoint > Procome Configuration** tool when communicating via Ethernet with the device. The procome configuration file can be retrieved and sent to the relay easily. The relay must be switched off and on to start working with the new procome configuration set by the user. The relay by default has no procome configuration. For more information about procome configuration see 5.13 IEC 60870-5-103 configuration.

F650 Digital Bay Controller

Appendix F: IEC 60870-5-103 protocol

F.1 IEC 60870-5-103 protocol

F.1.1 Interoperability document

The F650 implements functionality of an IEC 60870-5-103 server.

This section describes the protocol IEC 60870-5-103 implementation in the unit.

1. PHYSICAL LAYER

Electrical interface

X	EIA RS-485
32	Number of loads for one protection equipment

Optical interface

X	Glass fiber
X	Plastic fiber
	F-SMA type connector
X	BFOC/2,5 type connector

Transmission speed

X	9600 bits/s
X	19200 bits/s

2. LINK LAYER

There are no choices for the link layer.

3. APPLICATION LAYER

Transmission mode for application data

Mode 1 (least significant octet first), as defined in 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU

X	One COMMON ADDRESS OF ASDU (identical with station address)
	More than one COMMON ADDRESS OF ASDU

Selection of standard information numbers in monitor direction

System functions in monitor direction

	INF	Semantics
X	<0>	End of general interrogation
X	<0>	Time synchronization
X	<2>	Reset FCB
X	<3>	Reset CU
X	<4>	Start/restart
X	<5>	Power on

Status indications in monitor direction

	INF	Semantics	F650 Identifier	F650 Data Text
X	<16>	Auto-recloser active	4591	AR READY
X	<17>	Teleprotection active	3895	LOCAL
	<18>	Protection active		
X	<19>	LED reset	6839	RESET LEDS
	<20>	Monitor direction blocked		
	<21>	Test mode		
	<22>	Local parameter setting		
X	<23>	Characteristic 1	4875	GROUP 1 ACT ON
X	<24>	Characteristic 2	4876	GROUP 2 ACT ON
X	<25>	Characteristic 3	4877	GROUP 3 ACT ON
	<26>	Characteristic 4		
	<27>	Auxiliary input 1		
	<28>	Auxiliary input 2		
	<29>	Auxiliary input 3		
	<30>	Auxiliary input 4		

Supervision indications in monitor direction

	INF	Semantics	F650 Identifier	F650 Data Text
	<32>	Measurand supervision I		

	<33>	Measurand supervision V		
	<35>	Phase sequence supervision		
X	<36>	Trip circuit supervision	4539	BREAKER FAIL SUPERVISION
	<37>	I>> back-up operation		
X	<38>	VT fuse failure	4545	VT FUSE FAILURE
	<39>	Teleprotection disturbed		
	<46>	Group warning		
	<47>	Group alarm		

Earth fault indications in monitor direction

	INF	Semantics	F650 Identifier	F650 Data Text
	<48>	Earth fault L1		
	<49>	Earth fault L2		
	<50>	Earth fault L3		
	<51>	Earth fault forward, i.e. line		
	<52>	Earth fault reverse, i.e. busbar		

Fault indications in monitor direction

	INF	Semantics	F650 Identifier	F650 Data Text
X	<64>	Start / pick-up L1	3997|4013|4029|4045|4061|4077|4164|4182|4200|5651|5669|5687	PH IOC/TOC 1/2/3 H/L A PKP
X	<65>	Start / pick-up L2	3999|4015|4031|4047|4063|4079|4166|4184|4202|5653|5671|5689	PH IOC/TOC 1/2/3 H/L B PKP
X	<66>	Start / pick-up L3	4001|4017|4033|4049|4065|4081|4168|4186|4204|5655|5673|5691	PH IOC/TOC 1/2/3 H/L C PKP
X	<67>	Start / pick-up N	4112|4120|4128|4239|4248|4257	GROUND IOC/ TOC 1/2/3 PKP
X	<68>	General trip	4004|4020|4036|4052|4068|4084|4171|4189|4207|5658|5676|5694	PH IOC/TOC 1/2/3 H/L OP
X	<69>	Trip L1	3998|4014|4030|4046|4062|4078|4165|4183|4201|5652|5670|5688	PH IOC/TOC 1/2/3 H/L A OP
X	<70>	Trip L2	4000|4016|4032|4048|4064|4080|4167|4185|4203|5654|5672|5690	PH IOC/TOC 1/2/3 H/L B OP
X	<71>	Trip L3	4002|4018|4034|4050|4066|4082|4169|4187|4205|5656|5674|5692	PH IOC/TOC 1/2/3 H/L C OP
	<72>	Trip I>> (back-up operation)		
	<73>	Fault location X in ohms		
	<74>	Fault forward / line		
	<75>	Fault forward / lbusbar		

	<76>	Teleprotection signal transmitted		
	<77>	Teleprotection signal received		
	<78>	Zone 1		
	<79>	Zone 2		
	<80>	Zone 3		
	<81>	Zone 4		
	<82>	Zone 5		
	<83>	Zone 6		
X	<84>	General start / pick-up	4003|4019|4035|4051|4067|4083|4170|4188|4206|5657|5675|5693|4112|4120|4128|4239|4248|4257	PH H/L / GND IOC/ TOC 1/2/3 PKP
X	<85>	Breaker failure	4537	BKR FAIL INITIATE
	<86>	Trip measuring system L1		
	<87>	Trip measuring system L2		
	<88>	Trip measuring system L3		
	<89>	Trip measuring system E		
X	<90>	Trip I>	4004|4020|4036|4052|4068|4084	PH IOC 1/2/3 H/L OP
X	<91>	Trip I>>	4171|4189|4207|5658|5676|5694	PH TOC 1/2/3 H/L OP
X	<92>	Trip IN>	4113|4121|4129	GND IOC 1/2/3 OP
X	<93>	Trip IN>>	4240|4249|4258	GND TOC 1/2/3 OP

Auto-reclosure indications in monitor direction

	INF	Semantics	F650 Identifier	F650 Data Text
X	<128>	CB 'on' by AR	4586	AR CLOSE BREAKER
	<129>	CB 'on' by long-time AR		
X	<130>	AR blocked	4593	AR BLOCK

Measurands in monitor direction

	INF	Semantics	F650 Identifier	F650 Data Text
X	<144>	Measurand I	5064	Ib Primary
X	<145>	Measurands I, V	5064-5080	Ib,Vab Primary
X	<146>	Measurands I, V, P, Q	5064-5080-5099-5100	Ib,Vab,P,Q Primary

X	<147>	Measurands In, Vn	5066-5086	Ig Primary, Vn Primary
X	<148>	Measurands IL123, VL123, P, Q, f	5063-5064-5065-5083-5084-5085-5099-5100-3969	Ia,Ib,Ic,Va,Vb,Vc,P, Q Primary ,Line Frequency

Generic functions in monitor direction

	INF	Semantics
	<240>	Read headings of all defined groups
	<241>	Read values or attributes of all entries of one group
	<243>	Read directory of a single entry
	<244>	Read value or attribute of a single entry
	<245>	End of general interrogation of generic data
	<249>	Write entry with confirmation
	<250>	Write entry with execution
	<251>	Write entry aborted

Selection of standard information numbers in control direction

System functions in control direction

	INF	Semantics
X	<0>	Initiation of general interrogation
X	<0>	Time synchronization

General commands in control direction

	INF	Semantics
	<16>	Auto-recloser on / off
	<17>	Teleprotection on / off
	<18>	Protection on / off
	<19>	LED reset
	<23>	Activate characteristic 1
	<24>	Activate characteristic 2
	<25>	Activate characteristic 3
	<26>	Activate characteristic 4

Generic functions in control direction

	INF	Semantics
	<240>	Read headings of all defined groups
	<241>	Read values or attributes of all entries of one group

	<243>	Read directory of a single entry
	<244>	Read value or attribute of a single entry
	<245>	End of general interrogation of generic data
	<248>	Write entry
	<249>	Write entry with confirmation
	<250>	Write entry with execution
	<251>	Write entry aborted

Basic application functions

	Test mode
	Blocking of monitor direction
	Disturbance data
	Generic services
	Private data

Miscellaneous

Measurand	**Max. MVAL = times rated value**		
	1,2	**or**	**2,4**
Current L1			**X**
Current L2			**X**
Current L3			**X**
Voltage L1-E			**X**
Voltage L2-E			**X**
Voltage L3-E			**X**
Active power P			**X**
Reactive power Q			**X**
Frequency f			**X**
Voltage L1-L2			**X**

F.1.2 Application level

1. Application Functions

The unbalanced transmission mode of the protocol is used to avoid the possibility that more than one protection equipment attempts to transmit on the channel at the same time, over the RS485 backside port.

Data is transferred to the primary or control station (master) using the "data acquisition by polling" principle. Cyclically, the master requests class 2 data to the secondary station (slave). When slave has class 1 data (high

priority) pending, the ACD control bit is set to 1 demanding the master to request for that data. Periodically, the master can send a General Interrogation in order to update the complete database.

The measurands are sent to the primary station as a response to a class 2 request. There is a setting (0-60 min) in order to configure the desired interval, where 0 means transmission as fast as possible.

The following functions are supported:

- Initialization
- General Interrogation
- Synchronization
- Commands transmission

2. Type identification

The implemented Type Identification values are listed below:

TYPE IDENTIFICATION UI8[1..8] <1..255>

<1..31> := definitions of this companion standard (compatible range)

<32..255>:= for special use (private range)

Information in monitor direction:

<1>:= time-tagged message

<3>:= measurands I

<5>:= identification

<6>:= time synchronization

<8>:= general interrogation termination

<9>:= measurands II

Information in control direction:

<6>:= time synchronization

<7>:= general interrogation

<20>:= general command

3. Function Type

FUNCTION TYPE UI8 [1..8] <0..255>

<0..127>:= private range

<128..129>:= compatible range

<130..143>:= private range

<144..145>:= compatible range

<146..159>:= private range

<160..161>:= compatible range

<162..175>:= private range

<176..177>:= compatible range

<178..191>:= private range

<192..193>:= compatible range

<194..207>:= private range

<208..209>:= compatible range

<210..223>:= private range

<224..225>:= compatible range

<226..239>:= private range

<240..241>:= compatible range

<242..253>:= private range

<254..255>:= compatible range

The F650 device is identified at the protocol level as "overcurrent protection", so the Function Type <160> is used for all the digital and analogue points proposed by the standard and mapped in this profile. For the other data supported by the device, the number can be set from the private range.

4. Information Number

INFORMATION NUMBER := UI8 [1..8] <0..255>

Monitor direction := <0..255>

<0..15>:=system functions

<16..31>:= status

<32..47>:=supervision

<48..63>:=earth fault

<64..127>:=short circuit

<128..143>:=auto-reclosure

<144..159>:=measurands

<160..239>:=not used

<240..255>:=generic functions

Control direction:=<0..255>

<0..15>:=system functions

<16..31>:=general commands

<240..255>:=generic functions

F650 Digital Bay Controller

Appendix G: Redundancy protocol

G.1 PRP and HSR Ethernet protocols

Industrial real-time Ethernets typically demand much higher availability and uninterrupted operation than office Ethernet solutions can provide. Even a short loss of connectivity can result in loss of functionality, as for example in some automation, vehicular, power generation, and power distribution systems.

To recover from a network failure, different standard redundancy schemes are applied such as Parallel Redundancy Protocol (PRP), High-availability Seamless Redundancy (HSR) and others.

The basic concept of both protocols, PRP and HSR, is to send practically identical frames over different paths and discard one of the copies in reception, at best. If an error occurs or one of the paths is down, the frame traveling through that path does not reach the destination, but its copy does.

If the node to be attached to a redundant network has not the capability to do it (e.g. has only one port), it can be connected through a Redundancy Box (RedBox). This type of node allows single attached nodes connect transparently to a redundant network. An example can be seen in Figures 1.

PRP operates on two independent networks. Each frame is replicated on the sending node and transmitted over both networks. The receiving node processes the frame arriving first and discards the subsequent copy. The PRP layer is responsible for this replicate/discard function and hides the two networks from the upper layers. This scheme works without explicit reconfiguration and switchover and therefore does not show a period of unavailability.

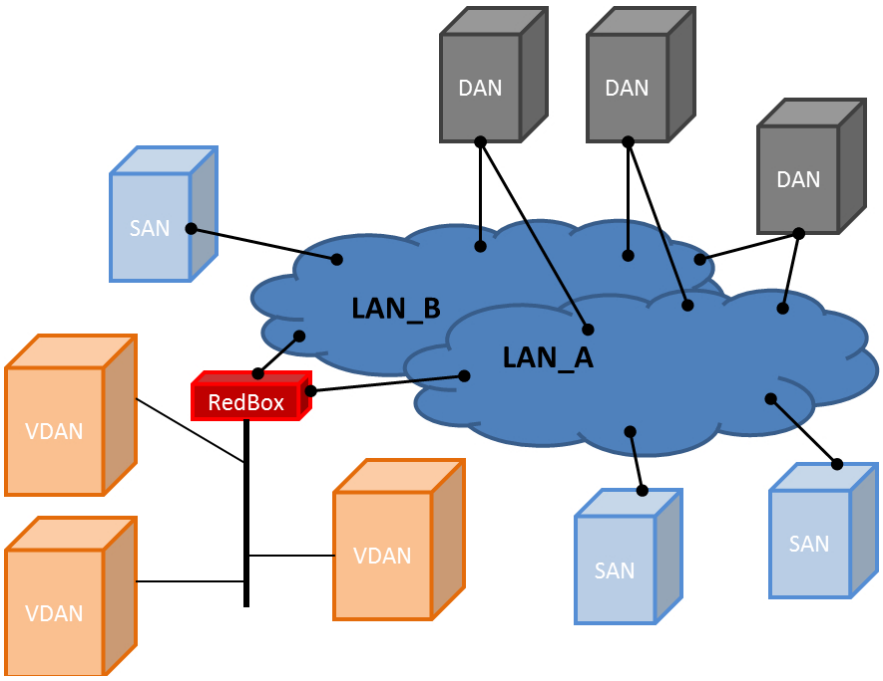


Figure G-1: Example of PRP with two LANs (LAN A and LAN B)

The two LANs, named LAN_A and LAN_B, are identical in protocol at the MAC level, but they can differ in performance and topology. Transmission delays can also be different. The LANs have no direct connection among them and they are assumed to be fail independent.

In some applications, only availability-critical nodes need a double attachment, while others do not. In order to meet the specific requirements, PRP defines different kinds of end nodes.

- The Dual Attached Node (DAN) is connected to both LANs.
- Uncritical nodes can be attached to only one LAN and are therefore called Single Attached Nodes (SAN). SANs that need to communicate with each other are on the same LAN.
- The Redundancy Box (RedBox) is used when a single interface node has to be attached to both networks. Such a node can communicate with all other nodes. Since a node behind a RedBox appears for other nodes like a DAN, it is called Virtual DANs (VDAN). The RedBox itself is a DAN and acts as a proxy on behalf of its VDANs. The RedBox has its own IP address for management purposes

Similarly to PRP, HSR is based in the duplication of every frame sent, but in a ring topology. Each copy of the frame is injected in a different direction of the ring. If any of the links between nodes is down, all nodes are still reachable. This topology forces every node in the net to be HSR aware because they have to forward every message until it reaches its destination. With that purpose, the redundancy information is located at the beginning of the frame allowing a faster forwarding, see next figure.

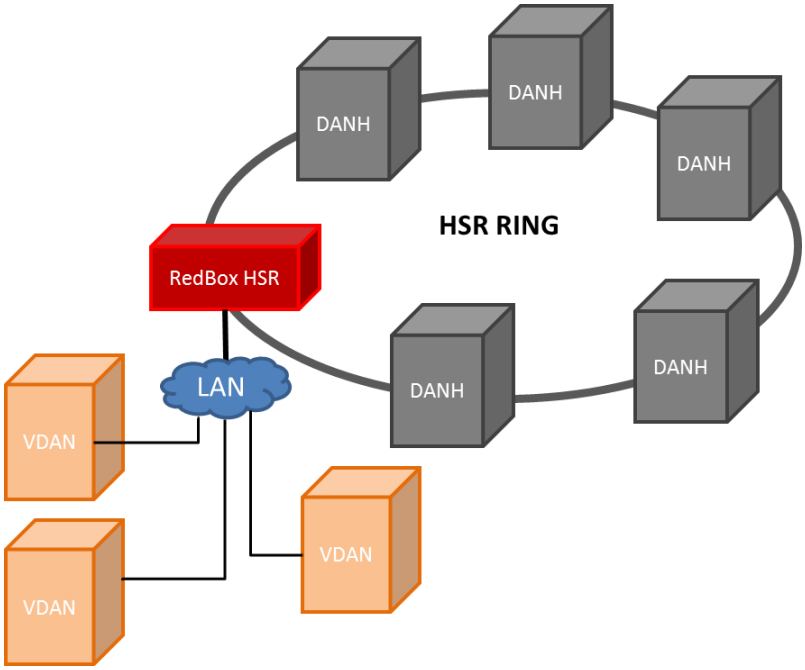


Figure G-2: Example of HSR with HSR ring

Definitions:

- PRP – Parallel Redundancy Protocol - redundancy protocol for high availability in substation automation networks based on IEC 62439-3 Clause 4 and applicable to networks based on Ethernet technology (ISO/IEC 8802-3).
- OSI - Open Systems Interconnection - model defined by the International Organization for Standardization (ISO) for standardizing the functions of a communication system in terms of abstraction layers. Similar communication functions are grouped into logical layers. A layer serves the layer above it and is served by the layer below it. There are 7 layers: physical, data link, network, transport, session, presentation, application.
- DANP – Doubly Attached Node running PRP – a node that has two ports which operate in parallel and are attached to the upper layers of the OSI communications stack through a Link Redundancy Entity module.
- DANH – Doubly Attached Node with HSR protocol.
- LRE - Link Redundancy Entity – module operating at the link layer of the OSI stack and responsible for handling duplicates and managing redundancy.
- SAN – Singly Attached Node – regular nodes with non-redundant network adapters
- RedBox – device attaching singly attached nodes (SANs) to a redundant network.

- RCT – Redundancy Check Trailer – PRP trailer added to frames and consisting of the following fields:
  - 16-bit sequence number (SeqNr);
  - 4-bit LAN identifier (LanId);
  - 12 bit frame size (LSDUsize)
  - 16-bit suffix (PRPsuffix).

G.1.1 PRP

PRP defines a redundancy protocol for high availability in substation automation networks. It is applicable to networks based on Ethernet technology (ISO/IEC 8802-3).

PRP is designed to provide seamless recovery in case of a single failure in the network, by using a combination of LAN duplication and frame duplication technique. Identical frames are sent on two completely independent networks that connect source and destination, see next figure.

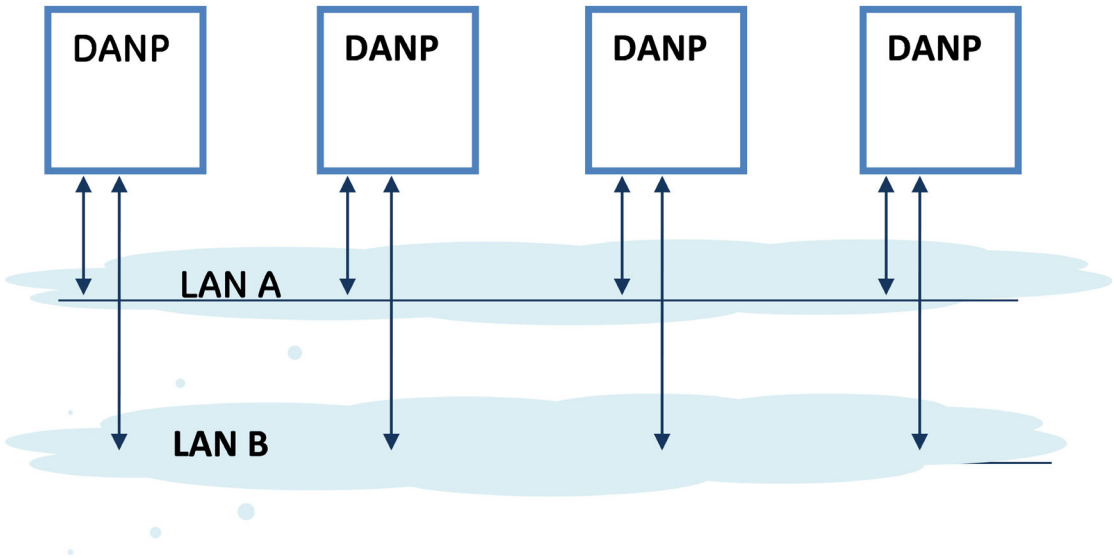


Figure G-3: Example of PRP Redundant Network

Under normal circumstances both frames reach their destination and one of them is sent up the OSI stack to the destination application, while the second one is discarded. If an error occurs in one of the networks and traffic is prevented from flowing on that path, connectivity is still be provided through the other network to ensure continuous communication. However, care must be taken when designing the two LANs, so that no single point of failure (such as a common power supply) is encountered, as such scenarios can bring down both LANs simultaneously.

PRP uses specialized nodes called doubly attached nodes (DANPs) for handling the duplicated frames. DANPs devices have an additional module at the link layer level, called the Link Redundancy Entity (LRE). LRE is responsible for duplicating frames and adding the specific PRP trailer when sending the frames out on the LAN, as well as making decisions on received frames as to which one is sent up the OSI stack to the application layer and which one is discarded. In essence LRE is responsible for making PRP transparent to the higher layers of the stack. There is a second type of specialized device used in PRP networks, called RedBox, with the role of connecting Single Attached Nodes (SANs) to a redundant network.

F650 relays implement only the DANP functionality. The RedBox functionality is not implemented.

The original standard IEC 62439-3 (2010) was amended to align PRP with the High availability Seamless Redundancy (HSR) protocol. To achieve this, the original PRP was modified at the cost of losing compatibility with the PRP 2010 version. The revised standard IEC 62439-3 (2012) is commonly referred to as PRP-1, while the original standard is PRP-0. The F650 relays support only PRP-1.

PRP can be enabled in configuration through a setting available on the network configuration menu (Product Setup? Communication Settings? Network (Ethernet), REDUNDANCY, which already has the capability of enabling Failover redundancy. When REDUNDANCY is set to PRP, the ports dedicated for PRP operate in redundant mode.

The rights associated with configuring PRP follow the security requirements for network configuration.

PRP management through SNMP MIB is not supported, as F650 doesn't currently support SNMP for configuration. Settings and actual values are only available through the front panel and through EnerVista.

The PRP solution to implement must ensure that performance requirements stated in IEC 61850-5 Clause 13 are still met. It is specified under Clause 13 (Message performance requirements) that messages of type 1A must meet the performance class P2/3, which is 3ms (See 3.7.1.1).

G.1.2 HSR

HSR defines a redundancy protocol for high availability in substation automation networks, based on PRP principles, provides the property of zero recovery time, typically used in ring topology but applicable to any topology.

In the F650 relay, HSR is implemented in devices with communication option number K (for Fiber; 100 Base Fx) and M (for cooper; Base 100 Tx). A frame is sent over both ports. A destination should receive, in the fault-free state, two identical frames within a certain time skew, forward the first frame to the application and discard the second frame when (and if) it comes. A sequence number is used to recognize such duplicates.

In contrast to PRP (IEC 62439-3- Clause 4), with which it shares the operating principle, HSR nodes are arranged into a ring, which allows the network to operate without dedicated switches, since every node is able to forward frames from port to port. HSR originally meant "High-availability Seamless Ring", but HSR is not limited to a simple ring topology.

Redundant connections to other HSR rings and to PRP networks are possible.

G.2 RSTP (IEEE 802.1D-2004) and daisy chain

G.2.1 RSTP description

The Rapid Spanning Tree Protocol (RTSP), like STP, was designed to avoid loops in an Ethernet network. Rapid Spanning Tree Protocol (RSTP) (IEEE 802.1w) is an evolution of the Spanning Tree Protocol (STP) (802.1d standard) and provides for faster spanning tree convergence after a topology change.

G.2.2 RSTP concepts

The IEEE 802.1d Spanning Tree Protocol (STP) was developed to allow the construction of robust networks that incorporate redundancy while pruning the active topology of the network to prevent loops. While STP is effective, it requires that frame transfer must halt after a link outage until all bridges in the network are sure to be aware of the new topology.

Using STP (IEEE 802.1d) recommended values, this period lasts 30 seconds. The Rapid Spanning Tree Protocol (IEEE 802.1w) is a further evolution of the 802.1d Spanning Tree Protocol. It replaces the settling period with an active handshake between switches (bridges) that guarantees topology information to be rapidly propagated through the network. RSTP converges in less than one second. RSTP also offers a number of other significant innovations. These include:

- Topology changes in STP must be passed to the root bridge before they can be propagated to the network. Topology changes in RSTP can be originated from and acted upon by any designated switch (bridge), leading to more rapid propagation of address information
- STP recognizes one state - blocking for ports that should not forward any data or information. RSTP explicitly recognizes two states or blocking roles - alternate and backup port including them in computations of when to learn and forward and when to block
- STP relays configuration messages received on the root port going out of its designated ports. If an STP switch (bridge) fails to receive a message from its neighbor it cannot be sure where along the path to the root a failure occurred. RSTP switches (bridges) generate their own configuration messages, even if they fail to receive one from the root bridge. This leads to quicker failure detection
- RSTP offers edge port recognition, allowing ports at the edge of the network to forward frames immediately after activation while at the same time protecting them against loops
- An improvement in RSTP allows configuration messages to age more quickly preventing them from “going around in circles” in the event of a loop RSTP has three states. They are discarding, learning and forwarding.

The discarding state is entered when the port is first taken into service. The port does not learn addresses in this state and does not participate in frame transfer. The port looks for STP traffic in order to determine its role in the network. When it is determined that the port plays an active part in the network, the state changes to learning. The learning state is entered when the port is preparing to play an active member of the network. The port learns addresses in this state but does not participate in frame transfer. In a network of RSTP switches (bridges) the time spent in this state is usually quite short. RSTP switches (bridges) operating in STP compatibility mode spend between 6 to 40 seconds in this state. After 'learning' the bridge places the port in the forwarding state. While in this state the port both learn addresses and participates in frame transfer while in this state. The result of these enhanced states is that the IEEE 802.1d version of spanning tree (STP) can take a fairly long time to resolve all the possible paths and to select the most efficient path through the network. The IEEE 802.1w Rapid reconfiguration of Spanning Tree significantly reduces the amount of time it takes to establish the network path. The result is reduced network downtime and improved network robustness. In addition to faster network reconfiguration, RSTP also implements greater ranges for port path costs to accommodate the higher connection speeds that are being implemented.

Proper implementations of RSTP (by switch vendors) is designed to be compatible with IEEE 802.1d STP. GE recommends that you employ RSTP or STP in your network.

G.2.3 Use in meshed networks

One great strength of RSTP is its support for all kinds of meshed topologies. The resulting flexibility regarding the installation is a clear advantage over the stringent restrictions that are imposed by ring protocols such as MRP and ring installations. However, this flexibility harbors one great disadvantage, namely the reconfiguration time, which for an interconnected network depends – among other things – on the complexity of the network topology and the location in the network at which the failure occurred. Since RSTP is a decentralized protocol, it may also provoke highly unpredictable race conditions in the establishment of new communications paths, particularly when choosing a new root bridge. This gives rise to network reconfiguration times that can be estimated only very roughly, and this does restrict the use of RSTP, particularly in meshed networks. In the case of meshed networks with very little complexity (such as ring networks with two or three additional loops or subrings), a detailed analysis can make it possible to determine upper limits, but these always need to be worked out individually. Unlike with the protocols MRP, HSR and PRP, it is not possible to make a general statement.

G.2.4 Daisy chain

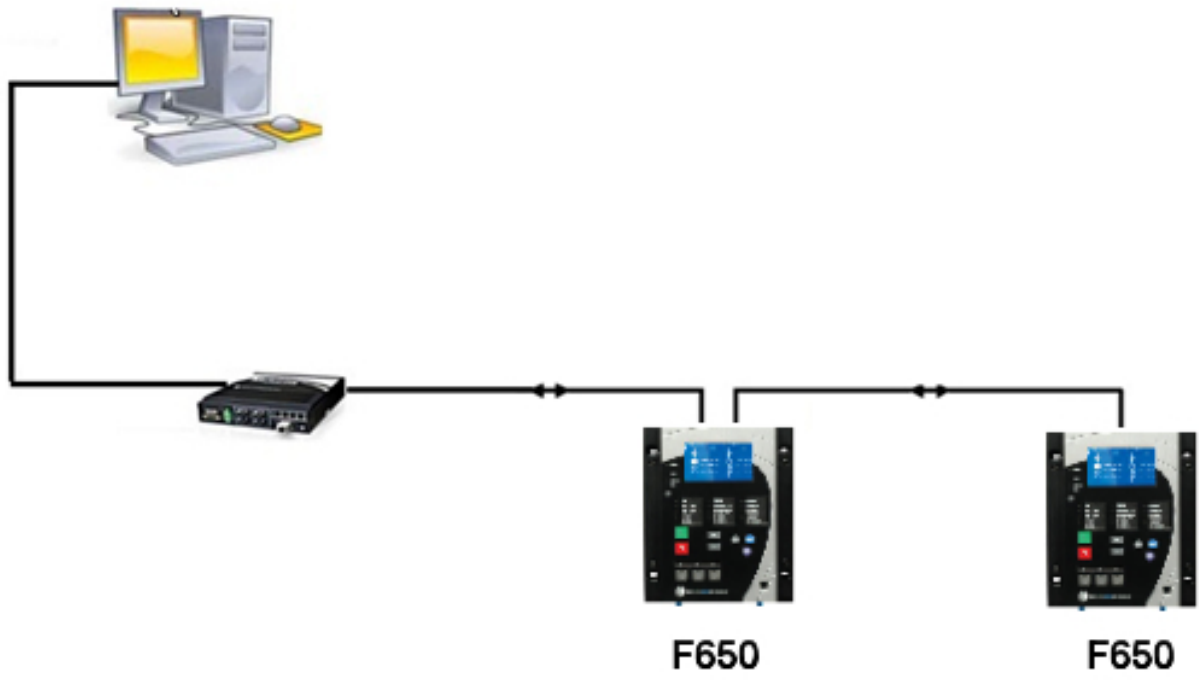
A daisy chain is an interconnection of devices where each device is connected in series to the next.

With an Ethernet daisy-chain redundancy selected, the F650 has two Ethernet ports and it is working as an Ethernet unmanaged switch. The two Ethernet ports are used for connecting each device to the ports of its two neighboring devices.

Each device in the daisy chain forwards the message until it reaches the destination.

Ports A and B use the same MAC (physical device) address and operate by chaining one device with the next one.

Note: It is important not to create a loop in this topology. Both ends of the chain can be connected to different networks. The device operates only with one IP address through these 2 ports.



G.3 Link loss alert (LLA)

G.3.1 LLA

(Link Loss Alert) operation: The operation of ports A and B are as follows:

Ports A and B use port A's MAC and IP address settings while port B is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link.

G.3.2 LLA priority

If this setting is set to enabled, the port A has the priority. If PORTA's LLA detects a problem with the link, communications is switched to Port B. Port B is, in effect, acting as a redundant or backup link to the network for port A.

G.3.3 LLA timeout

This setting is active only when the LLA PRIORITY is set to ENABLED. When the link on primary port is detected again after it fails, there is LLA TIMEOUT (ms) monitoring time for the health of the network. During this time, the secondary port remains active. If primary network is healthy for more than LLA TOIMEOUT value, the switch over to primary port is automatic.

If the setting LLA PRIORITY is enabled:

- The primary port is port A while secondary (redundant) port is port B.
- The primary port is always used if available.
- If the link on primary port is lost switch over to secondary port occurs immediately.
- When the link on primary port is detected again, there is a monitoring timeout (LLA TIMEOUT) for the health of the network. After that period the communication switch over to primary port automatically.

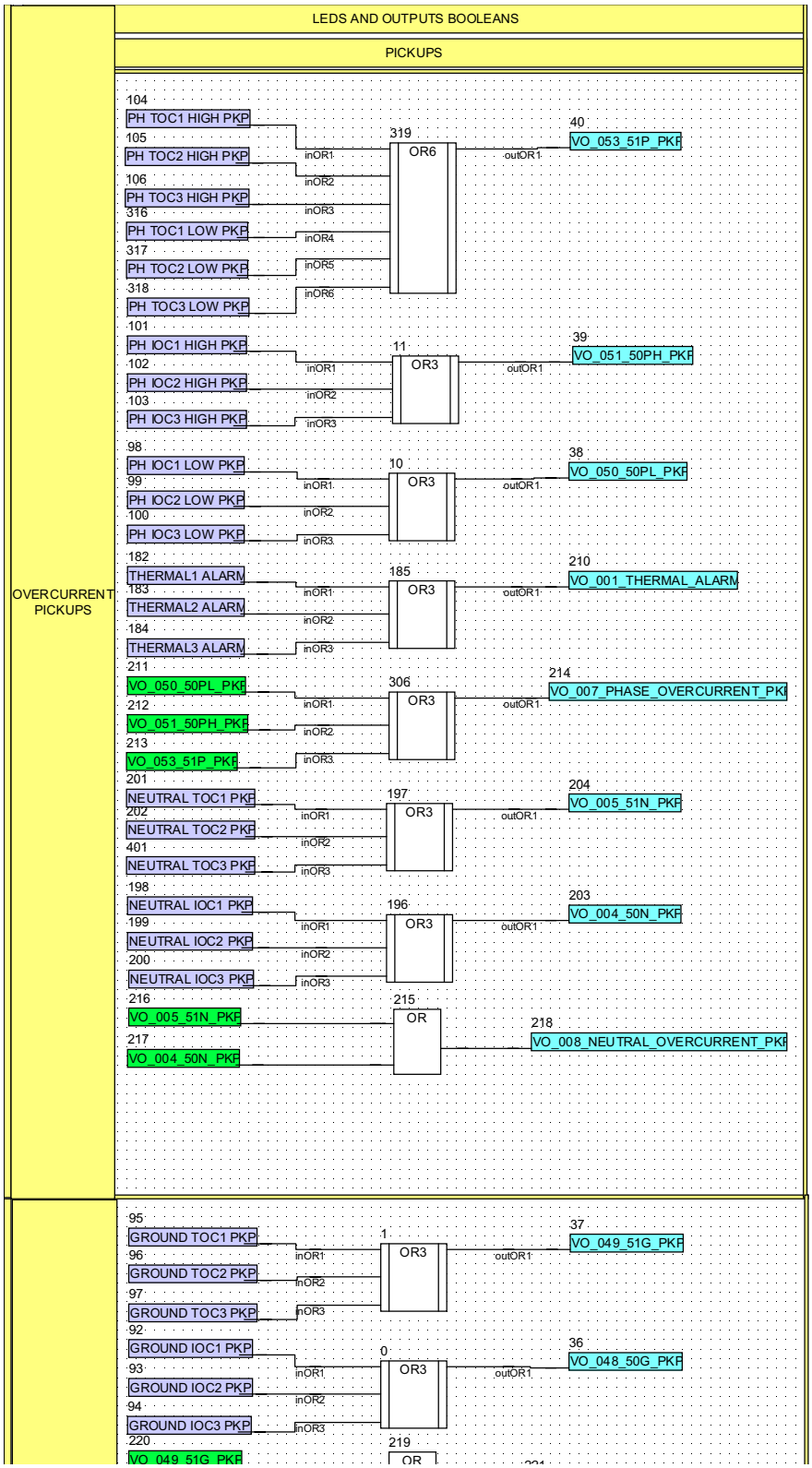
If the setting LLA PRIORITY is disabled:

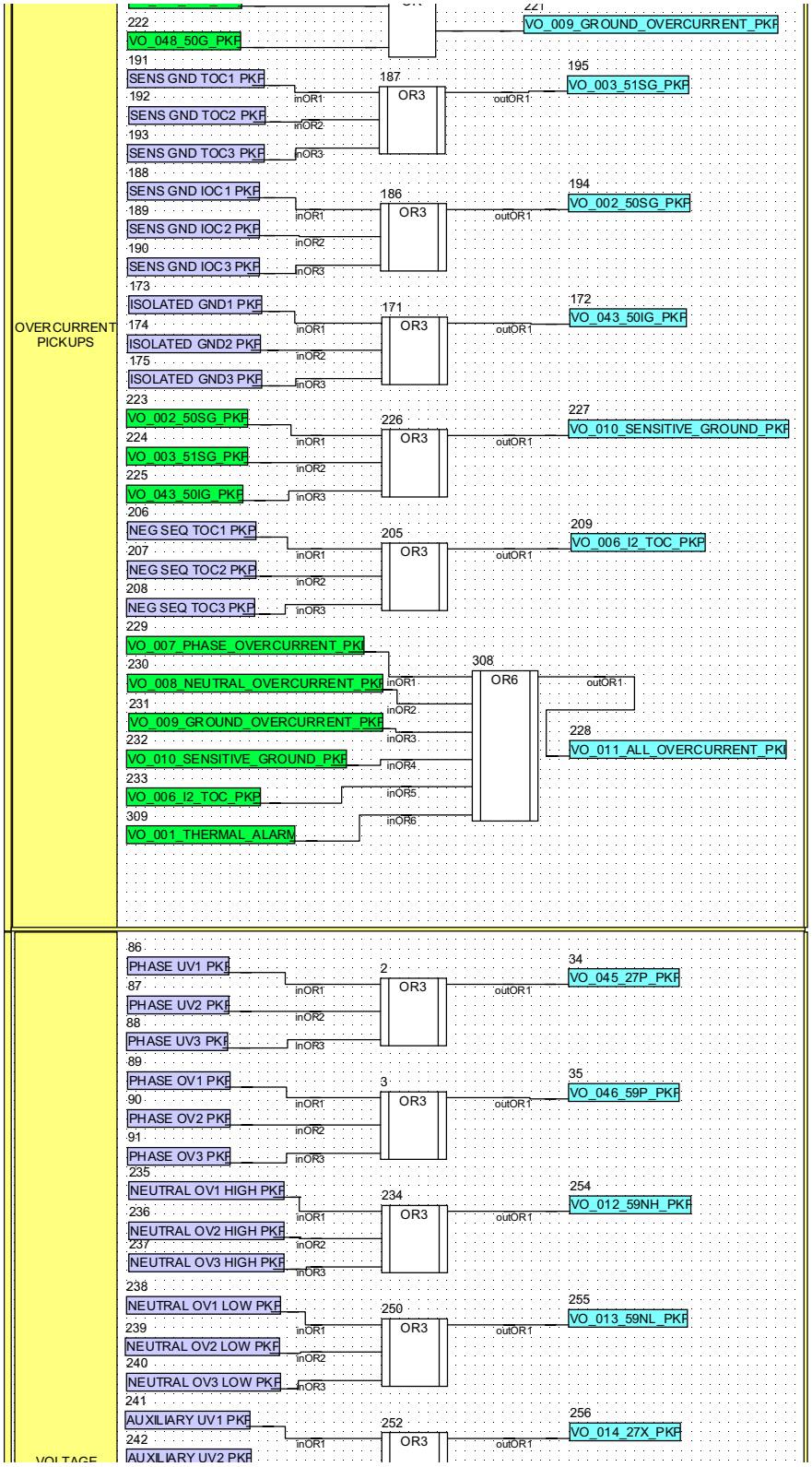
- There is no priority, therefore there is no primary port. The communication switch over from one Port to the other occurs when the link fails.
- In this case the LLA TIMEOUT setting does not act.

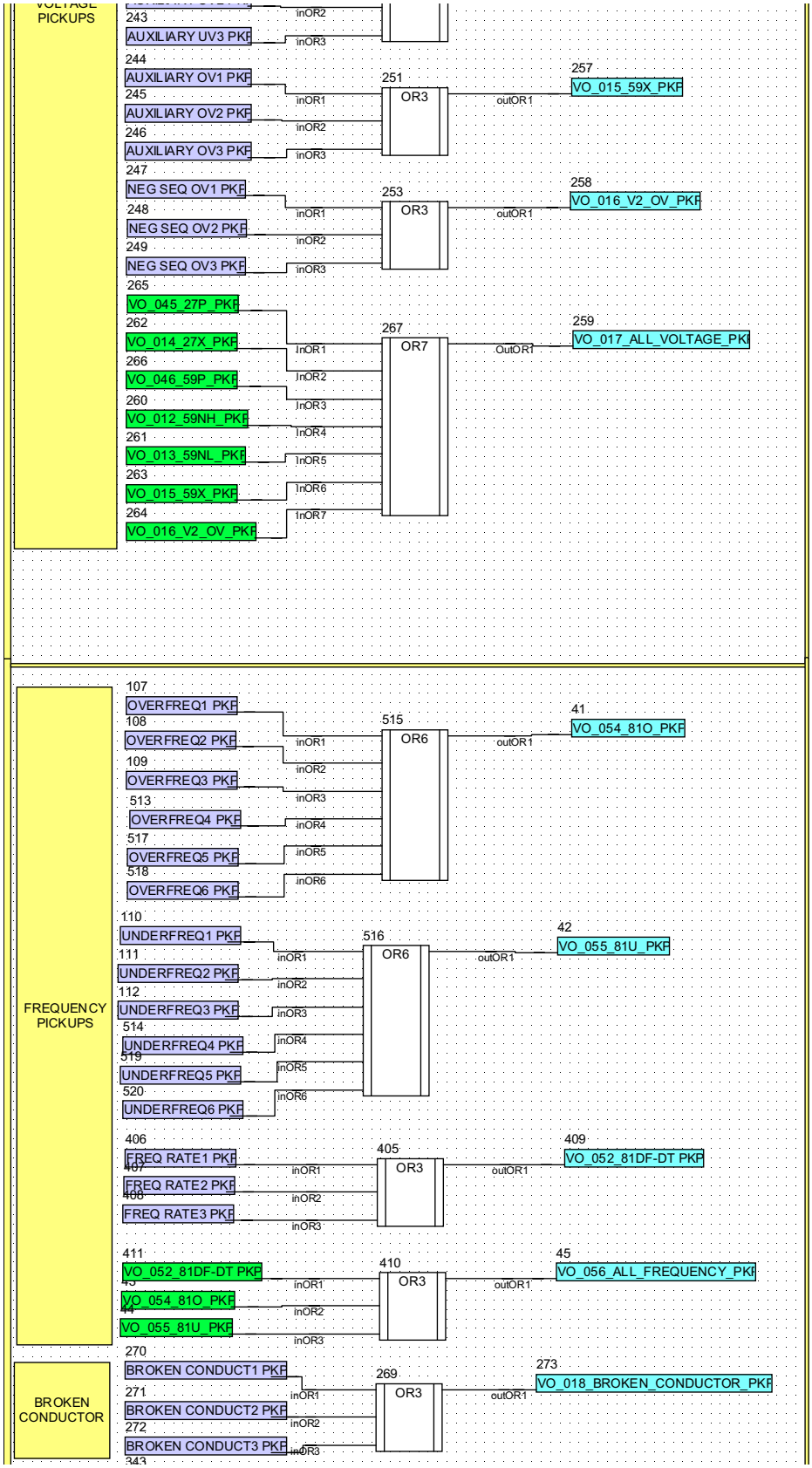
F650 Digital Bay Controller

Appendix H: Factory default logic

H.1 Factory default logic




OVERCURRENT PICKUPS
222
VO_048_50G_PKP
221
VO_009_GROUND_OVERCURRENT_PKP
191
SENS GND TOC1 PKP
192
SENS GND TOC2 PKP
193
SENS GND TOC3 PKP
187
OR3
inOR1
inOR2
inOR3
outOR1
195
VO_003_51SG_PKP
188
SENS GND IOC1 PKP
189
SENS GND IOC2 PKP
190
SENS GND IOC3 PKP
186
OR3
194
VO_002_50SG_PKP
173
ISOLATED GND1 PKP
174
ISOLATED GND2 PKP
175
ISOLATED GND3 PKP
171
OR3
172
VO_043_50IG_PKP
223
VO_002_50SG_PKP
224
VO_003_51SG_PKP
225
VO_043_50IG_PKP
226
OR3
227
VO_010_SENSITIVE_GROUND_PKP
206
NEG SEQ TOC1 PKP
207
NEG SEQ TOC2 PKP
208
NEG SEQ TOC3 PKP
205
OR3
209
VO_006_I2_TOC_PKP
229
VO_007_PHASE_OVERCURRENT_PKP
230
VO_008_NEUTRAL_OVERCURRENT_PKP
231
VO_009_GROUND_OVERCURRENT_PKP
232
VO_010_SENSITIVE_GROUND_PKP
233
VO_006_I2_TOC_PKP
309
VO_001_THERMAL_ALARM
308
OR6
inOR4
inOR5
inOR6
228
VO_011_ALL_OVERCURRENT_PKP
86
PHASE UV1 PKP
87
PHASE UV2 PKP
88
PHASE UV3 PKP
2
OR3
34
VO_045_27P_PKP
89
PHASE OV1 PKP
90
PHASE OV2 PKP
91
PHASE OV3 PKP
3
OR3
35
VO_046_59P_PKP
235
NEUTRAL OV1 HIGH PKP
236
NEUTRAL OV2 HIGH PKP
237
NEUTRAL OV3 HIGH PKP
234
OR3
254
VO_012_59NH_PKP
238
NEUTRAL OV1 LOW PKP
239
NEUTRAL OV2 LOW PKP
240
NEUTRAL OV3 LOW PKP
250
OR3
255
VO_013_59NL_PKP
241
AUXILIARY UV1 PKP
242
AUXILIARY UV2 PKP
252
OR3
256
VO_014_27X_PKP


VOLTAGE PICKUPS
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AUXILIARY UV3 PKP
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AUXILIARY OV1 PKP
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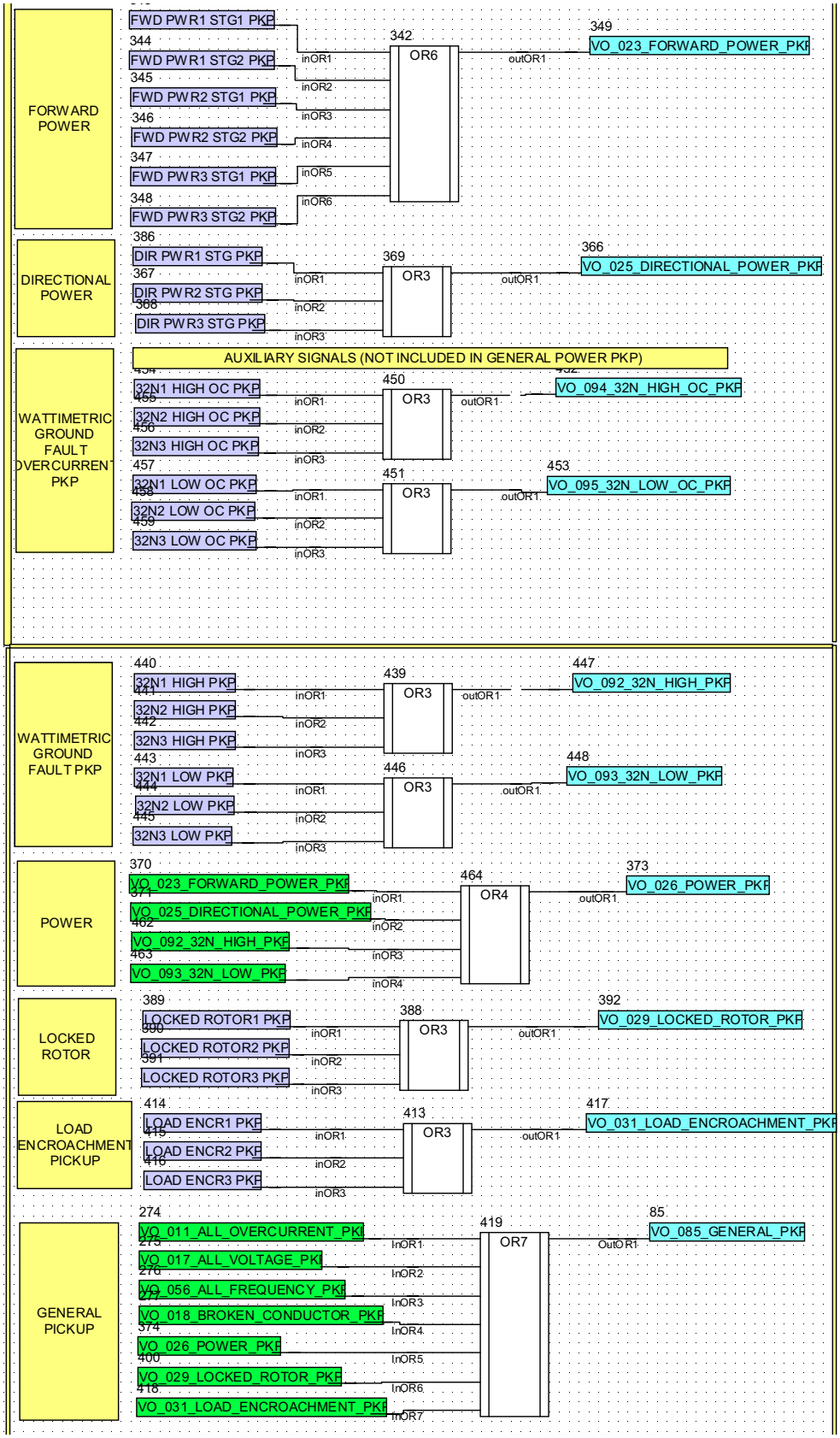
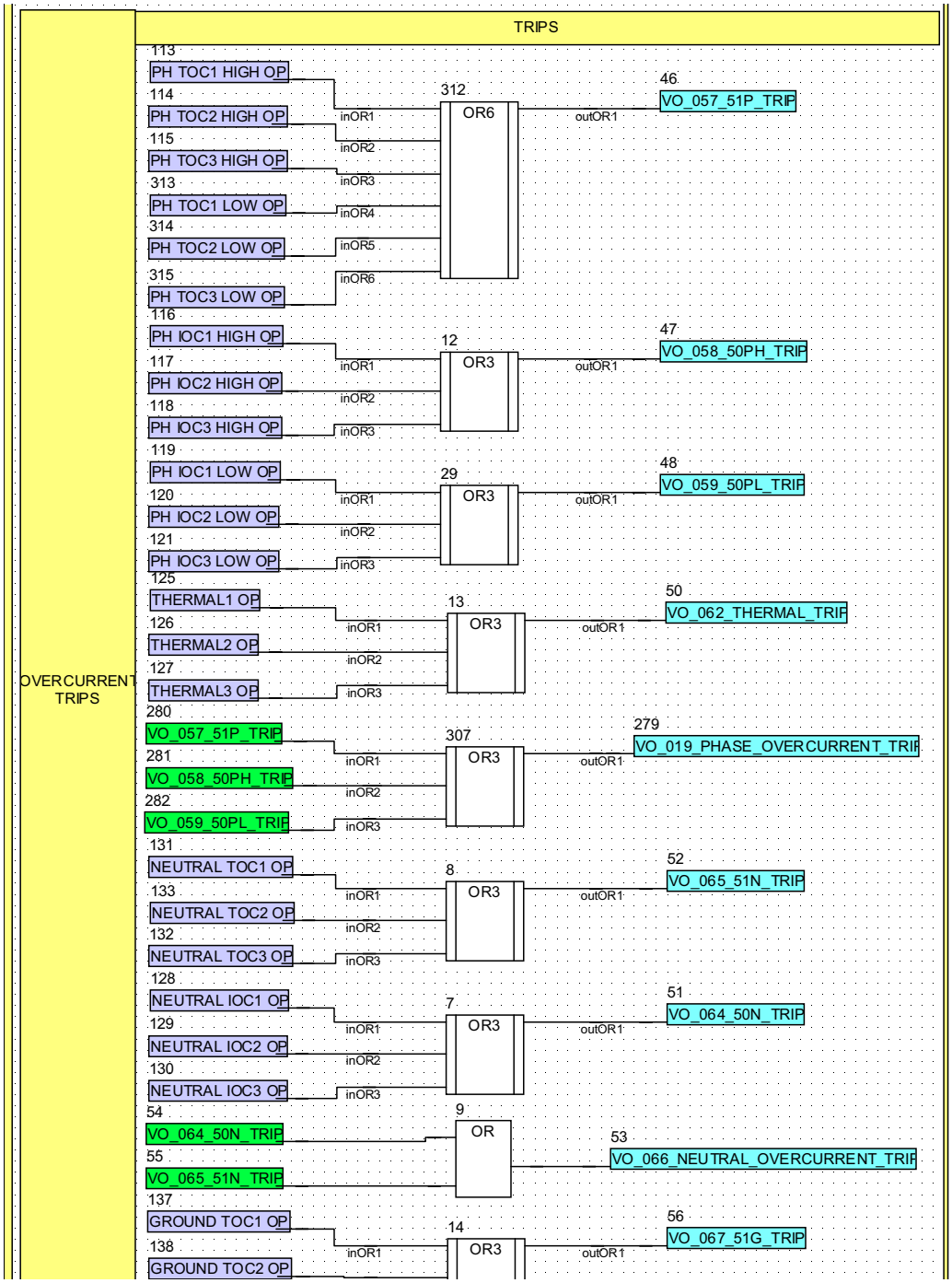
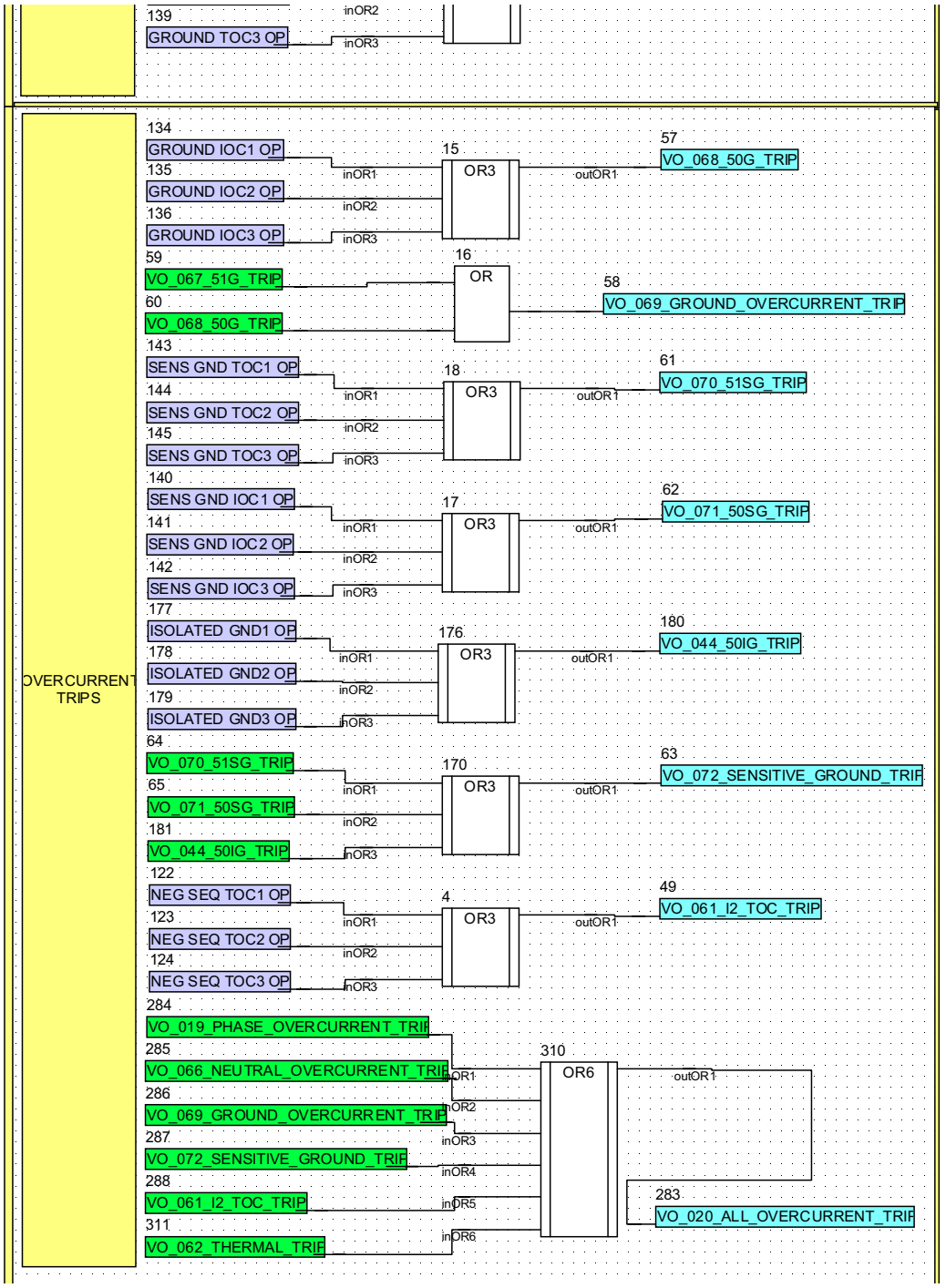
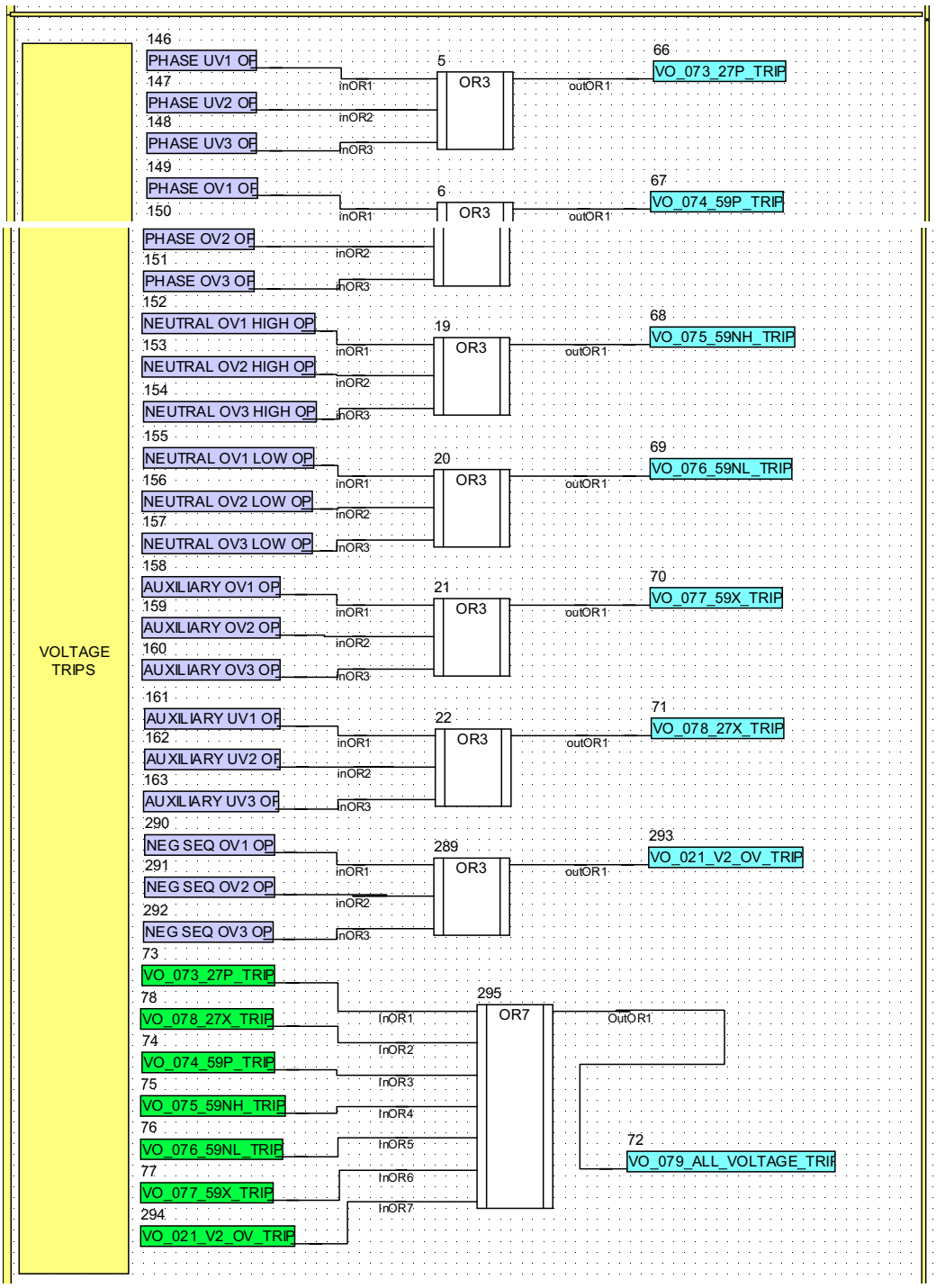
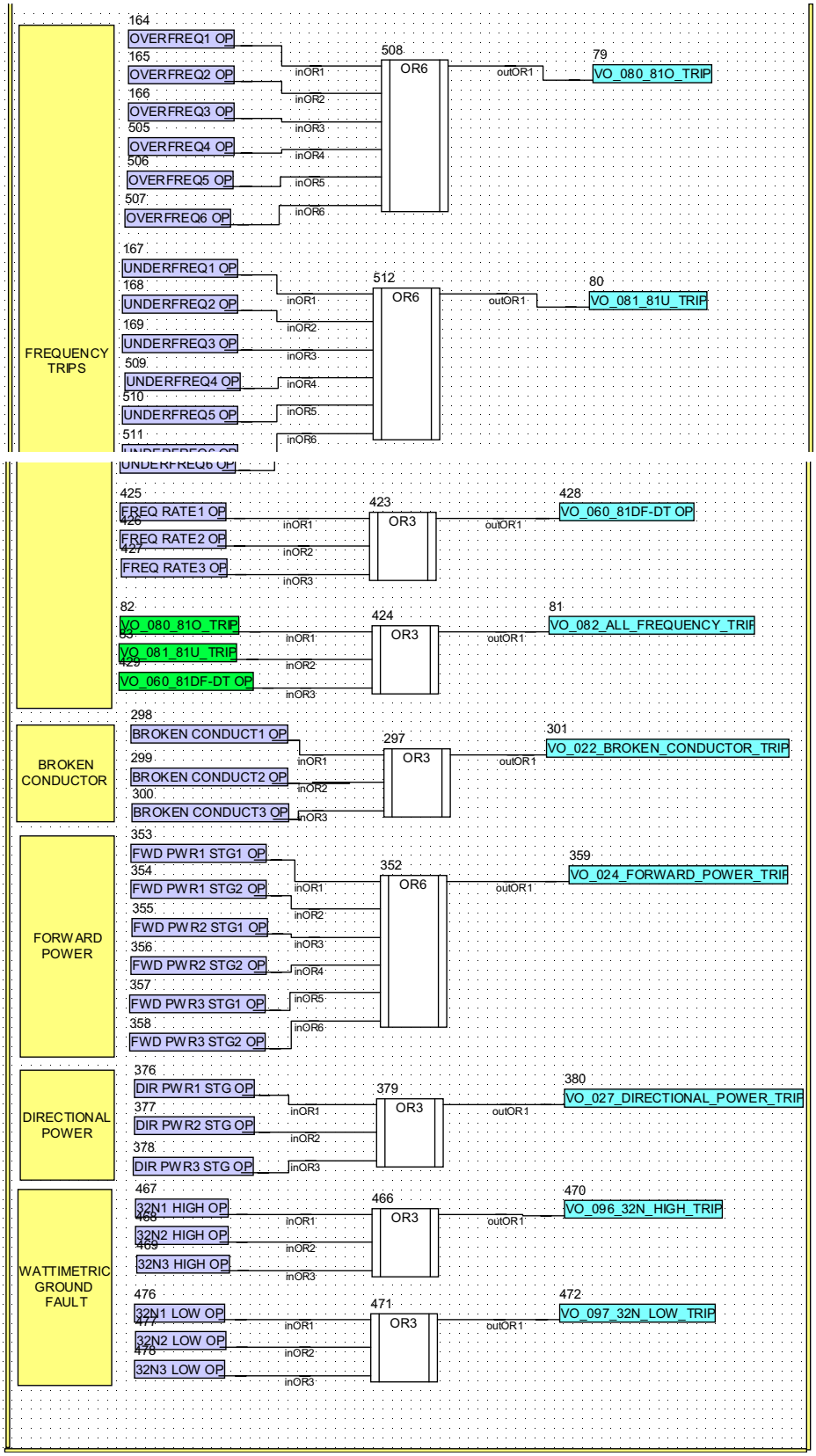
AUXILIARY OV2 PKP
246
AUXILIARY OV3 PKP
247
NEG SEQ OV1 PKP
248
NEG SEQ OV2 PKP
249
NEG SEQ OV3 PKP
265
VO_045_27P_PKP
262
VO_014_27X_PKP
266
VO_046_59P_PKP
260
VO_012_59NH_PKP
261
VO_013_59NL_PKP
263
VO_015_59X_PKP
264
VO_016_V2_OV_PKP
inOR1
inOR2
inOR3
251
OR3
outOR1
257
VO_015_59X_PKP
253
OR3
258
VO_016_V2_OV_PKP
267
OR7
inOR4
inOR5
inOR6
inOR7
259
VO_017_ALL_VOLTAGE_PKP
FREQUENCY PICKUPS
107
OVERFREQ1 PKP
108
OVERFREQ2 PKP
109
OVERFREQ3 PKP
513
OVERFREQ4 PKP
517
OVERFREQ5 PKP
518
OVERFREQ6 PKP
515
OR6
41
VO_054_81O_PKP
110
UNDERFREQ1 PKP
111
UNDERFREQ2 PKP
112
UNDERFREQ3 PKP
514
UNDERFREQ4 PKP
519
UNDERFREQ5 PKP
520
UNDERFREQ6 PKP
516
OR6
42
VO_055_81U_PKP
406
FREQ RATE1 PKP
407
FREQ RATE2 PKP
408
FREQ RATE3 PKP
405
OR3
409
VO_052_81DF-DT PKP
411
VO_052_81DF-DT PKP
43
VO_054_81O_PKP
44
VO_055_81U_PKP
410
OR3
45
VO_056_ALL_FREQUENCY_PKP
BROKEN CONDUCTOR
270
BROKEN CONDUCT1 PKP
271
BROKEN CONDUCT2 PKP
272
BROKEN CONDUCT3 PKP
269
OR3
273
VO_018_BROKEN_CONDUCTOR_PKP

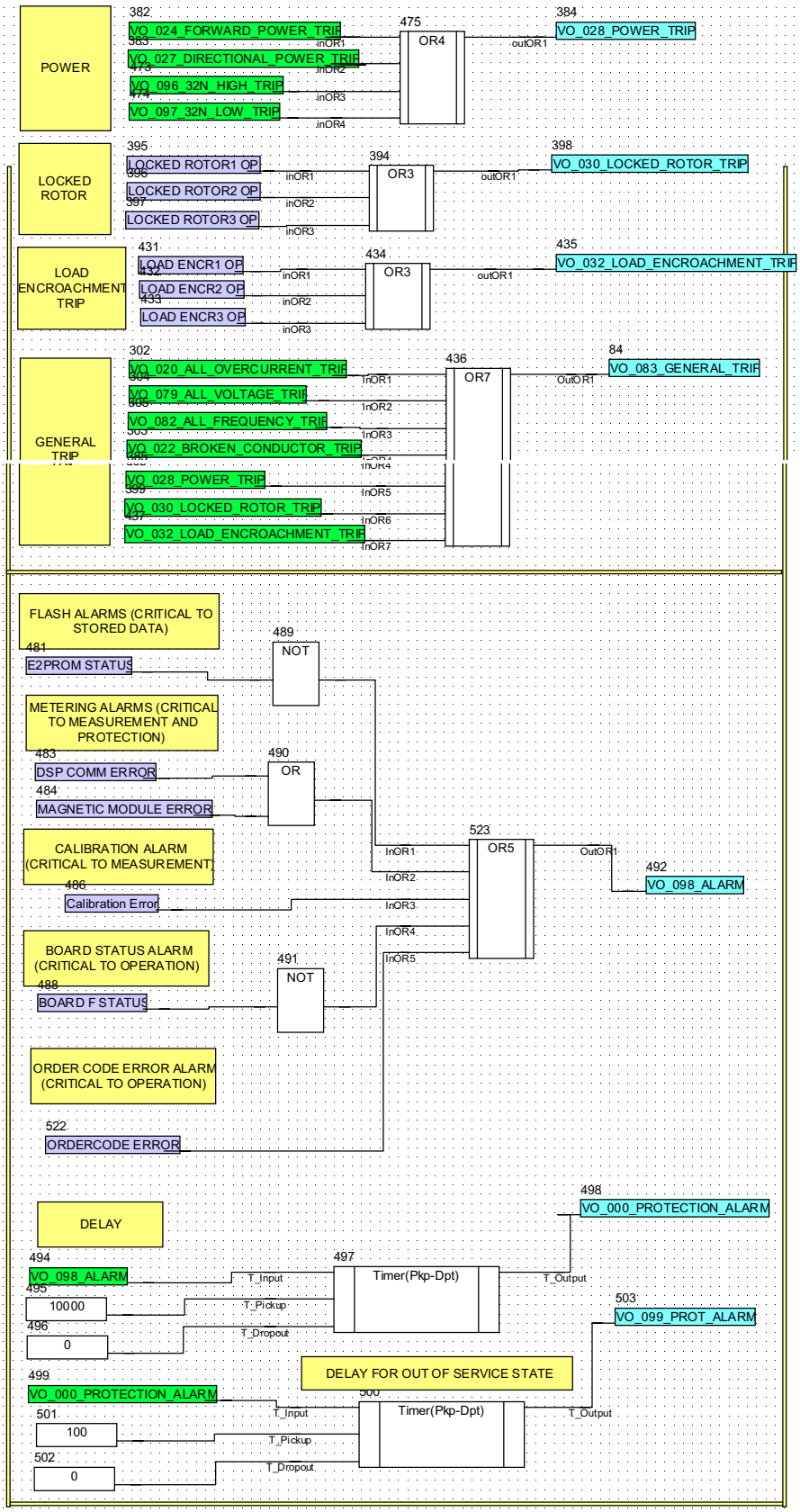

FORWARD POWER
FWD PWR1 STG1 PKP
344
FWD PWR1 STG2 PKP
345
FWD PWR2 STG1 PKP
346
FWD PWR2 STG2 PKP
347
FWD PWR3 STG1 PKP
348
FWD PWR3 STG2 PKP
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
342
OR6
outOR1
349
VO_023_FORWARD_POWER_PKP
DIRECTIONAL POWER
386
DIR PWR1 STG PKP
367
DIR PWR2 STG PKP
368
DIR PWR3 STG PKP
369
OR3
366
VO_025_DIRECTIONAL_POWER_PKP
WATTIMETRIC GROUND FAULT OVERCURRENT PKP
AUXILIARY SIGNALS (NOT INCLUDED IN GENERAL POWER PKP)
32N1 HIGH OC PKP
32N2 HIGH OC PKP
32N3 HIGH OC PKP
450
VO_094_32N_HIGH_OC_PKP
457
32N1 LOW OC PKP
32N2 LOW OC PKP
32N3 LOW OC PKP
451
453
VO_095_32N_LOW_OC_PKP
WATTIMETRIC GROUND FAULT PKP
440
32N1 HIGH PKP
441
32N2 HIGH PKP
442
32N3 HIGH PKP
439
447
VO_092_32N_HIGH_PKP
443
32N1 LOW PKP
444
32N2 LOW PKP
445
32N3 LOW PKP
446
448
VO_093_32N_LOW_PKP
POWER
370
VO_023_FORWARD_POWER_PKP
371
VO_025_DIRECTIONAL_POWER_PKP
462
VO_092_32N_HIGH_PKP
463
VO_093_32N_LOW_PKP
464
OR4
373
VO_026_POWER_PKP
LOCKED ROTOR
389
LOCKED ROTOR1 PKP
390
LOCKED ROTOR2 PKP
391
LOCKED ROTOR3 PKP
388
392
VO_029_LOCKED_ROTOR_PKP
LOAD ENCROACHMENT PICKUP
414
LOAD ENCR1 PKP
415
LOAD ENCR2 PKP
416
LOAD ENCR3 PKP
413
417
VO_031_LOAD_ENCROACHMENT_PKP
GENERAL PICKUP
274
VO_011_ALL_OVERCURRENT_PKP
275
VO_017_ALL_VOLTAGE_PKP
276
VO_056_ALL_FREQUENCY_PKP
277
VO_018_BROKEN_CONDUCTOR_PKP
374
VO_026_POWER_PKP
400
VO_029_LOCKED_ROTOR_PKP
418
VO_031_LOAD_ENCROACHMENT_PKP
419
OR7
85
VO_085_GENERAL_PKP


TRIPS
OVERCURRENT TRIPS
113 PH TOC1 HIGH OP
114 PH TOC2 HIGH OP
115 PH TOC3 HIGH OP
313 PH TOC1 LOW OP
314 PH TOC2 LOW OP
315 PH TOC3 LOW OP
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
312 OR6
outOR1
46 VO_057_51P_TRIP
116 PH IOC1 HIGH OP
117 PH IOC2 HIGH OP
118 PH IOC3 HIGH OP
12 OR3
47 VO_058_50PH_TRIP
119 PH IOC1 LOW OP
120 PH IOC2 LOW OP
121 PH IOC3 LOW OP
29 OR3
48 VO_059_50PL_TRIP
125 THERMAL1 OP
126 THERMAL2 OP
127 THERMAL3 OP
13 OR3
50 VO_062_THERMAL_TRIP
280 VO_057_51P_TRIP
281 VO_058_50PH_TRIP
282 VO_059_50PL_TRIP
307 OR3
279 VO_019_PHASE_OVERCURRENT_TRIP
131 NEUTRAL TOC1 OP
133 NEUTRAL TOC2 OP
132 NEUTRAL TOC3 OP
8 OR3
52 VO_065_51N_TRIP
128 NEUTRAL IOC1 OP
129 NEUTRAL IOC2 OP
130 NEUTRAL IOC3 OP
7 OR3
51 VO_064_50N_TRIP
54 VO_064_50N_TRIP
55 VO_065_51N_TRIP
9 OR
53 VO_066_NEUTRAL_OVERCURRENT_TRIP
137 GROUND TOC1 OP
138 GROUND TOC2 OP
14 OR3
56 VO_067_51G_TRIP


139
GROUND TOC3 OP
inOR2
inOR3
OVERCURRENT TRIPS
134
GROUND IOC1 OP
135
GROUND IOC2 OP
136
GROUND IOC3 OP
15
OR3
inOR1
inOR2
inOR3
outOR1
57
VO_068_50G_TRIP
59
VO_067_51G_TRIP
60
VO_068_50G_TRIP
16
OR
58
VO_069_GROUND_OVERCURRENT_TRIP
143
SENS GND TOC1 OP
144
SENS GND TOC2 OP
145
SENS GND TOC3 OP
18
OR3
61
VO_070_51SG_TRIP
140
SENS GND IOC1 OP
141
SENS GND IOC2 OP
142
SENS GND IOC3 OP
17
OR3
62
VO_071_50SG_TRIP
177
ISOLATED GND1 OP
178
ISOLATED GND2 OP
179
ISOLATED GND3 OP
176
OR3
180
VO_044_50IG_TRIP
64
VO_070_51SG_TRIP
65
VO_071_50SG_TRIP
181
VO_044_50IG_TRIP
170
OR3
63
VO_072_SENSITIVE_GROUND_TRIP
122
NEG SEQ TOC1 OP
123
NEG SEQ TOC2 OP
124
NEG SEQ TOC3 OP
4
OR3
49
VO_061_I2_TOC_TRIP
284
VO_019_PHASE_OVERCURRENT_TRIP
285
VO_066_NEUTRAL_OVERCURRENT_TRIP
286
VO_069_GROUND_OVERCURRENT_TRIP
287
VO_072_SENSITIVE_GROUND_TRIP
288
VO_061_I2_TOC_TRIP
311
VO_062_THERMAL_TRIP
310
OR6
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
outOR1
283
VO_020_ALL_OVERCURRENT_TRIP


VOLTAGE TRIPS
146 PHASE UV1 OP
147 PHASE UV2 OP
148 PHASE UV3 OP
149 PHASE OV1 OP
150 PHASE OV2 OP
151 PHASE OV3 OP
152 NEUTRAL OV1 HIGH OP
153 NEUTRAL OV2 HIGH OP
154 NEUTRAL OV3 HIGH OP
155 NEUTRAL OV1 LOW OP
156 NEUTRAL OV2 LOW OP
157 NEUTRAL OV3 LOW OP
158 AUXILIARY OV1 OP
159 AUXILIARY OV2 OP
160 AUXILIARY OV3 OP
161 AUXILIARY UV1 OP
162 AUXILIARY UV2 OP
163 AUXILIARY UV3 OP
290 NEG SEQ OV1 OP
291 NEG SEQ OV2 OP
292 NEG SEQ OV3 OP
73 VO_073_27P_TRIP
78 VO_078_27X_TRIP
74 VO_074_59P_TRIP
75 VO_075_59NH_TRIP
76 VO_076_59NL_TRIP
77 VO_077_59X_TRIP
294 VO_021_V2_OV_TRIP
5 OR3
6 OR3
19 OR3
20 OR3
21 OR3
22 OR3
289 OR3
295 OR7
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
inOR7
outOR1
OutOR1
66 VO_073_27P_TRIP
67 VO_074_59P_TRIP
68 VO_075_59NH_TRIP
69 VO_076_59NL_TRIP
70 VO_077_59X_TRIP
71 VO_078_27X_TRIP
293 VO_021_V2_OV_TRIP
72 VO_079_ALL_VOLTAGE_TRIP


FREQUENCY TRIPS
164 OVERFREQ1 OP
165 OVERFREQ2 OP
166 OVERFREQ3 OP
505 OVERFREQ4 OP
506 OVERFREQ5 OP
507 OVERFREQ6 OP
508 OR6
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
outOR1
79 VO_080_81O_TRIP
167 UNDERFREQ1 OP
168 UNDERFREQ2 OP
169 UNDERFREQ3 OP
509 UNDERFREQ4 OP
510 UNDERFREQ5 OP
511 UNDERFREQ6 OP
512 OR6
80 VO_081_81U_TRIP
425 FREQ RATE1 OP
426 FREQ RATE2 OP
427 FREQ RATE3 OP
423 OR3
428 VO_060_81DF-DT OP
82 VO_080_81O_TRIP
83 VO_081_81U_TRIP
429 VO_060_81DF-DT OP
424 OR3
81 VO_082_ALL_FREQUENCY_TRIP
BROKEN CONDUCTOR
298 BROKEN CONDUCT1 OP
299 BROKEN CONDUCT2 OP
300 BROKEN CONDUCT3 OP
297 OR3
301 VO_022_BROKEN_CONDUCTOR_TRIP
FORWARD POWER
353 FWD PWR1 STG1 OP
354 FWD PWR1 STG2 OP
355 FWD PWR2 STG1 OP
356 FWD PWR2 STG2 OP
357 FWD PWR3 STG1 OP
358 FWD PWR3 STG2 OP
352 OR6
359 VO_024_FORWARD_POWER_TRIP
DIRECTIONAL POWER
376 DIR PWR1 STG OP
377 DIR PWR2 STG OP
378 DIR PWR3 STG OP
379 OR3
380 VO_027_DIRECTIONAL_POWER_TRIP
WATTIMETRIC GROUND FAULT
467 32N1 HIGH OP
468 32N2 HIGH OP
469 32N3 HIGH OP
466 OR3
470 VO_096_32N_HIGH_TRIP
476 32N1 LOW OP
477 32N2 LOW OP
478 32N3 LOW OP
471 OR3
472 VO_097_32N_LOW_TRIP


POWER
382
VO_024_FORWARD_POWER_TRIP
383
VO_027_DIRECTIONAL_POWER_TRIP
473
VO_096_32N_HIGH_TRIP
474
VO_097_32N_LOW_TRIP
475
OR4
inOR1
inOR2
inOR3
inOR4
outOR1
384
VO_028_POWER_TRIP
LOCKED ROTOR
395
LOCKED ROTOR1 OP
396
LOCKED ROTOR2 OP
397
LOCKED ROTOR3 OP
394
OR3
398
VO_030_LOCKED_ROTOR_TRIP
LOAD ENCROACHMENT TRIP
431
LOAD ENCR1 OP
432
LOAD ENCR2 OP
433
LOAD ENCR3 OP
434
OR3
435
VO_032_LOAD_ENCROACHMENT_TRIP
GENERAL TRIP
302
VO_020_ALL_OVERCURRENT_TRIP
304
VO_079_ALL_VOLTAGE_TRIP
305
VO_082_ALL_FREQUENCY_TRIP
303
VO_022_BROKEN_CONDUCTOR_TRIP
436
OR7
inOR1
inOR2
inOR3
inOR4
inOR5
inOR6
inOR7
OutOR1
84
VO_083_GENERAL_TRIP
FLASH ALARMS (CRITICAL TO STORED DATA)
481
E2PROM STATUS
489
NOT
METERING ALARMS (CRITICAL TO MEASUREMENT AND PROTECTION)
483
DSP COMM ERROR
484
MAGNETIC MODULE ERROR
490
OR
CALIBRATION ALARM (CRITICAL TO MEASUREMENT)
486
Calibration Error
523
OR5
OutOR1
492
VO_098_ALARM
BOARD STATUS ALARM (CRITICAL TO OPERATION)
488
BOARD F STATUS
491
NOT
ORDER CODE ERROR ALARM (CRITICAL TO OPERATION)
522
ORDERCODE ERROR
DELAY
494
VO_098_ALARM
495
10000
496
0
497
Timer(Pkp-Dpt)
T_Input
T_Pickup
T_Dropout
T_Output
498
VO_000_PROTECTION_ALARM
503
VO_099_PROT_ALARM
DELAY FOR OUT OF SERVICE STATE
499
VO_000_PROTECTION_ALARM
501
100
502
0
500
Timer(Pkp-Dpt)
T_Input
T_Pickup
T_Dropout
T_Output

F650 Digital Bay Controller

Appendix I: Factory default configuration

I.1 Factory default settings

Product Setup > Communication Settings > Serial Ports					
Setting Description	Name	Default Value	Step	Range	User Value
Baud rate for COM1	COM1 Baud Rate	19200	N/A	[300 : 115200]	
Baud rate for COM2	COM2 Baud Rate	19200	N/A	[300 : 115200]	
Parity for COM1	COM1 Parity	NONE	N/A	[NONE:ODD:EVEN]	
Parity for COM2	COM2 Parity	NONE	N/A	[NONE:ODD:EVEN]	

Product Setup > Communication Settings > Network (Ethernet)					
Network (Ethernet)1 > Network (Ethernet)2					
Setting Description	Name	Default Value	Step	Range	User Value
1st octet of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octet of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octet of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octet of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octet of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octet of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octet of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octet of Netmask	Netmask Oct4	0	N/A	[0 : 255]	
1st octet of Gateway	Gateway IP Oct1	0	N/A	[0 : 255]	
2nd octet of Gateway	Gateway IP Oct2	0	N/A	[0 : 255]	
3rd octet of Gateway	Gateway IP Oct3	0	N/A	[0 : 255]	
4th octet of Gateway	Gateway IP Oct4	0	N/A	[0 : 255]	
**For firmware versions 7.00 or higher; the Network settings are the ethernet communication parameters are as follow					

Product Setup > Communication Settings > Network (Ethernet)					
Network (Ethernet)1 > Network (Ethernet)					
Setting Description	Name	Default Value	Step	Range	User Value
1st octet of IP address	IP Address Oct1	0	N/A	[0 : 255]	
2nd octet of IP address	IP Address Oct2	0	N/A	[0 : 255]	
3rd octet of IP address	IP Address Oct3	0	N/A	[0 : 255]	
4th octet of IP address	IP Address Oct4	0	N/A	[0 : 255]	
1st octet of Netmask	Netmask Oct1	0	N/A	[0 : 255]	
2nd octet of Netmask	Netmask Oct2	0	N/A	[0 : 255]	
3rd octet of Netmask	Netmask Oct3	0	N/A	[0 : 255]	
4th octet of Netmask	Netmask Oct4	0	N/A	[0 : 255]	
**For firmware versions 7.00 or higher; on the Network settings are also located the settings for Redundancy.					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	REDUNDANCY MODE	INDEPENDENT	N/A	[INDEPENDENT; LLA; PRP; HSR; RSTP; DAISY_CHAIN]	
Establish priority for Port A	LLA Priority	DISABLED	N/A	[ENABLED; DISABLED]	
Switch over time from port B to port A	LLA Timeout	5000	N/A	[0 : 600000]	
Switch (bridge) priority value	RSTP BRIDGE PRIORITY	32768	N/A	[0 : 61440]	
determine which ports are used for forwarding	RSTP PORT A PRIORITY	128	N/A	[0 : 240]	
assigned port cost value used for the switch	RSTP PORT A PATHCOST	200000	N/A	[0 : 2000000]	
Determine which ports are used for forwarding	RSTP PORT B PRIORITY	128	N/A	[0 : 240]	
Assigned port cost value used for the switch	RSTP PORT B PATHCOST	200000	N/A	[0 : 2000000]	

Product Setup > Communication Settings > Modbus Protocol					
Setting Description	Name	Default Value	Step	Range	User Value
Slave address for COM1	Modbus Address COM1	254	N/A	[1 : 255]	
Slave address for COM2	Modbus Address COM2	254	N/A	[1 : 255]	
Modbus port number for Modbus TCP/IP	Modbus Port Number	502	N/A	[0 : 65535]	

Product Setup > Communication Settings > DNP3 Slave					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	Name	Default Value	Step	Range	User Value
Communications port assigned to the DNP protocol	Physical Port	NONE	N/A	[COM1:COM2:NETWORK]	
DNP slave address	Address	255	N/A	[0 : 65534]	
1st Octect of IP address of DNP master 1	IP Addr Client1 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 1	IP Addr Client1 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 1	IP Addr Client1 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 1	IP Addr Client1 Oct4	0	N/A	[0 : 255]	

1st Octect of IP address of DNP master 2	IP Addr Client2 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 2	IP Addr Client2 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 2	IP Addr Client2 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 2	IP Addr Client2 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 3	IP Addr Client3 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 3	IP Addr Client3 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 3	IP Addr Client3 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 3	IP Addr Client3 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client4 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client4 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client4 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client4 Oct4	0	N/A	[0 : 255]	
1st Octect of IP address of DNP master 4	IP Addr Client5 Oct1	0	N/A	[0 : 255]	
2nd Octect of IP address of DNP master 4	IP Addr Client5 Oct2	0	N/A	[0 : 255]	
3nd Octect of IP address of DNP master 4	IP Addr Client5 Oct3	0	N/A	[0 : 255]	
4th Octect of IP address of DNP master 4	IP Addr Client5 Oct4	0	N/A	[0 : 255]	
TCP/UDP port number for DNP over Ethernet	TCP/UDP Port	20000	N/A	[0 : 65535]	
Unsolicited responses permission	Unsol Resp Function	DISABLED	N/A	[DISABLED – ENABLED]	
Time out to confirm an unsolicited response	Unsol Resp TimeOut	5	1 s	[0 : 60]	
Number of retransmissions of an unsol resp w/o confirmation	Unsol Resp Max Ret	10	N/A	[0 : 255]	
Address to which all unsolicited responses are sent	Unsol Resp Dest Adr	200	N/A	[0 : 65519]	
Scale for currents	Current Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for voltages	Voltage Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Product Setup > Communication Settings > DNP3 Slave (CONT.)					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Scale for power	Power Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Scale for energy	Energy Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Other Scale factor	Other Scale Factor	1	N/A	[0.00001-0.0001-0.001-0.01-0.1-1-10-100-1000]	
Default deadband for Current Analog Input points to trigger unsolicited responses	Current Deadband	30000	N/A	[0 : 65535]	
Default deadband for Voltage Analog Input points to trigger unsolicited responses	Voltage Deadband	30000	N/A	[0 : 65535]	
Default deadband for Power Analog Input points to trigger unsolicited responses	Power Deadband	30000	N/A	[0 : 65535]	
Default deadband for Energy Analog Input points to trigger unsolicited responses	Energy Deadband	30000	N/A	[0 : 65535]	
Default deadband for Other Analog Input points to trigger unsolicited responses	Other Deadband	30000	N/A	[0 : 65535]	
Size (in bytes) for message fragmentation	Msg Fragment Size	240	1 byte	[30 : 2048]	

Product Setup > Communication Settings > DNP3 Slave (CONT.)					
DNP3 Slave 1 > DNP3 Slave 2 > DNP3 Slave 3					
Setting Description	Name	Default Value	Step	Range	User Value
Size customization and change of DNP Binary Inputs point list	Binary Input Block 1	CTL EVENTS 1-16	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 2	CTL EVENTS 17-32	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 3	CTL EVENTS 33-48	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 4	CTL EVENTS 49-64	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 5	CTL EVENTS 65-80	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 6	CTL EVENTS 81-96	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 7	CTL EVENTS 97-112	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 8	CTL EVENTS 113-128	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 9	SWITCHGEAR 1-8	N/A	[See DNP note2]	
Size customization and change of DNP Binary Inputs point list	Binary Input Block 10	SWITCHGEAR 9-16	N/A	[See DNP note2]	
Default Analog Map permission	Default Analog Map	ENABLED	N/A	[ENABLED; DISABLE]	
DNP Analog Input Points point list	Analog Input Point 0	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 1	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 2	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 3	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 4	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 5	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 6	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 7	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 8	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 9	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 10	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 11	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 12	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 13	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 14	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 15	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 16	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 17	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 18	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 19	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 20	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 21	End of list	N/A		

DNP Analog Input Points point list	Analog Input Point 22	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 23	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 24	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 25	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 26	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 27	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 28	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 29	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 30	End of list	N/A		
DNP Analog Input Points point list	Analog Input Point 31	End of list	N/A		

DNP Notes	
Note 1: Scale Factor	Note that a scale factor of 0.1 is equivalent to a multiplier of 10 (i.e. the value is 10
Note 2: Binary Input Block Selection:	[NOT USED, CTL EVENTS 1-16, CTL EVENTS 17-32, CTL EVENTS 33-48,CTL EVENTS 49-64, CTL EVENTS 65-80, CTL EVENTS 81-96, CTL EVENTS 97-112,

Product Setup > Communication Settings > IEC 870-5-104					
Setting Description	Name	Default Value	Step	Range	User Value
Enable or disable the protocol operation	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Listening TCP port in the relay	TCP Port	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU	255	N/A	[0 : 65535]	
Number of seconds for instantaneous metering	Cyclic Meter Period	0	1 s	[0 : 3600]	
Synchronization Event	Synchronization Event	0	0 N/A	[0 : 3600]	
1st Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 1	IEC104 NET1 CLI1 OCTET4	0	N/A	[0 : 255]	
1st Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 2	IEC104 NET1 CLI2 OCTET4	0	N/A	[0 : 255]	
Enable or disable the protocol operation	Function 2	DISABLED	N/A		
Listening TCP port in the relay	TCP Port 2	2404	N/A	[0 : 65535]	
Address in the ASDU header	Common Addr of ASDU 2	255	N/A	[0 : 65535]	
1st Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET2	0	N/A	[0 : 255]	

Product Setup > Communication Settings > IEC 870-5-104 (CONT.)					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
3nd Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 1	IEC104 NET2 CLI1 OCTET4	0	N/A	[0 : 255]	
1st Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET1	0	N/A	[0 : 255]	
2nd Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET2	0	N/A	[0 : 255]	
3nd Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET3	0	N/A	[0 : 255]	
4th Octect of IP address of 104 master 2	IEC104 NET2 CLI2 OCTET4	0	N/A	[0 : 255]	
IEC104 SCALE CURRENT	IEC104 SCALE CURRENT	1		[0,00001; 0,0001; 0,001; 0,01; 0,1; 1; 10; 100; 1000; 10000]	
IEC104 SCALE VOLTAGE	IEC104 SCALE VOLTAGE	1			
IEC104 SCALE POWER	IEC104 SCALE POWER	1			
IEC104 SCALE ENERGY	IEC104 SCALE ENERGY	1			
IEC104 SCALE OTHER	IEC104 SCALE OTHER	1			
IEC104 DEADBAND CURRENT	IEC104 DEADBAND CURRENT	30000		[0 : 65535]	
IEC104 DEADBAND VOLTAGE	IEC104 DEADBAND VOLTAGE	30000		[0 : 65535]	
IEC104 DEADBAND POWER	IEC104 DEADBAND POWER	30000		[0 : 65535]	
IEC104 DEADBAND ENERGY	IEC104 DEADBAND ENERGY	30000		[0 : 65535]	
IEC104 DEADBAND OTHER	IEC104 DEADBAND OTHER	30000		[0 : 65535]	
IEC104 IOA BINARIES	IEC104 IOA BINARIES	1000		[0 : 65535]	
IEC104 IOA DOUBLE POINTS	IEC104 IOA DOUBLE POINTS	1500		[0 : 65535]	
IEC104 IOA ANALOGS	IEC104 IOA ANALOGS	2000		[0 : 65535]	
IEC104 IOA COUNTERS	IEC104 IOA COUNTERS	4000		[0 : 65535]	
IEC104 IOA COMMANDS	IEC104 IOA COMMANDS	3000		[0 : 65535]	
IEC104 IOA ANALOG PARAMETERS	IEC104 IOA ANALOG PARAMETERS	5000		[0 : 65535]	

IEC 870-5-104 Notes	
Note 1: Cyclic Meter Period	0 value means no spontaneous metering

Product Setup > Communication Settings > sntp					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Port used	UDP port	123	1	[1 : 65535]	
IP Address OCT 1	Server IP Oct 1	0	1	[1 : 255]	
IP Address OCT 2	Server IP Oct 2	0	1	[1 : 255]	
IP Address OCT 3	Server IP Oct 3	0	1	[1 : 255]	
IP Address OCT 4	Server IP Oct 4	0	1	[1 : 255]	

Product Setup > Communication Settings > procome					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Serial Remote Com Port selection	COMM Port	NONE		[NONE – COM1]	
Slave number for procome	Slave Number	0		[0 : 254]	

Product Setup > Communication Settings > ptp 1588					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	PTP FUNCTION	DISABLE		[DISABLE; ENABLE]	
Port A, B Path Delay Adder	PORTA DELAY ADDER	0		ns [0 : 60000]	
Port A Path Delay Asymmetry	PORTA DELAY ASYM	0		ns [-1000 : 1000]	
Port B Path Delay Adder	PORTB DELAY ADDER	0		ns [0 : 60000]	
Port B Path Delay Asymmetry	PORTB DELAY ASYM	0		ns [-1000 : 1000]	
Strict Power Profile	STRICT POWER PROFILE	DISABLED		DISABLED/ENABLED	
PTP domain number	PTP DOMAIN NUMBER	0		[0 : 255]	
PTP VLAN Priority	PTP VLAN PRIORITY	4		[0 : 7]	
PTP VLAN Identification	PTP VLAN ID	0		[0 : 4095]	
Reference time defining the origin of a time scale is termed the epoch.	PTP EPOCH	UTC SINCE 2000		UTC SINCE 2000; UTC SINCE 1970; UTC SINCE 1900	

Product Setup > Communication Settings > Routing					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
1st octet of Gateway	Default RT GWY Oct1	0	1	[0 : 255]	
2nd octet of Gateway	Default RT GWY Oct2	0	1	[0 : 255]	
3nd octet of Gateway	Default RT GWY Oct3	0	1	[0 : 255]	
4th octet of Gateway	Default RT GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct2	0	1	[0 : 255]	

sets the destination IPv4 route	Static RT1 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT1 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT1 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT1 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT2 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT2 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT2 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT3 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT3 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct2	0	1	[0 : 255]	

sets the gateway to reach the destination IP route	Static RT3 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT3 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT4 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT4 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT4 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT5 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct3	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT5 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT5 GWY Oct4	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct1	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct2	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct3	0	1	[0 : 255]	
sets the destination IPv4 route	Static RT6 IP Oct4	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct1	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct2	0	1	[0 : 255]	
sets the IP mask associated with the route	Static RT6 Mask Oct3	0	1	[0 : 255]	

sets the IP mask associated with the route	Static RT6 Mask Oct4	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct1	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct2	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct3	0	1	[0 : 255]	
sets the gateway to reach the destination IP route	Static RT6 GWY Oct4	0	1	[0 : 255]	
SETPOINT > Product Setup > Modbus User Map					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Address 00 for Modbus user map	Address 00	0	N/A	[0000 : FFFF]	
Address 01 for Modbus user map	Address 01	0	N/A	[0000 : FFFF]	
	...	...		...	
Address 254 for Modbus user map	Address 254	0	N/A	[0000 : FFFF]	
Address 255 for Modbus user map	Address 255	0	N/A	[0000 : FFFF]	
SETPOINT > PRODUCT SETUP > FAULT REPORT					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Positive sequence impedance module	Pos Seq Module	3.00	0.01 Ohm	[0.01 : 250.00]	
Positive sequence impedance angle	Pos Seq Angle	75	1 Deg	[25 : 90]	
Zero sequence impedance module	Zero Seq Module	9.00	0.01 Ohm	[0.01 : 750.00]	
Zero sequence impedance angle	Zero Seq Angle	75	1 Deg	[25 : 90]	
Line length	Line Length	100.0	0.1	[0.0 : 2000.0]	
Display fault on HMI	Show Fault On HMI	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
CT Direction	CT Direction	REVERSE	NA	REVERSE; FORWARD	
Setpoint > Product Setup > Oscillography					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function Permission	Function	ENABLED	N/A	[DISABLED – ENABLED]	
Prefault	Trigger Position	30	1%	[5 : 95]	
Samples per cycle	Samples/Cycle	64	N/A	[4 – 8 – 16 –32 – 64]	
Maximum number of oscillos	Max. Number Osc.	4	1 oscillo	[1 : 20]	
Automatic oscillography overwrite	Automatic Overwrite	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Setpoint > Product Setup > Data Logger					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Data logger Rate	Data Logger Rate	1 s	N/A	[1 s, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min.]	
Data Logger analog channels X	Data Logger Chnl X	None	N/A	[1 to 16]	

Setpoint > Product Setup > Demand					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Demand Function	DISABLED	N/A	[DISABLED – ENABLED]	
Demand method for current values	CRNT Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand method for Power values	POWER Demand Method	THERMAL EXPONENTIAL	N/A	[BLOCK INTERVAL -	
				ROLLING DEMAND -	
				THERMAL EXPONENTIAL]	
Demand interval	Demand Interval	5 Minutes	N/A	[5 – 10 – 15 – 20– 30–60]	
Trigger Enabled	Trigger Enabled	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Product Setup > time settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Local time zone offset Universal Coordinated Time	LOC. TIME OFFS. UTC	0	1	[-24,0 : 24,0]	
To follow DST rules	DAYLIG. SAVINGS TIME	DISABLED	NA	[DISBLED; ENABLED]	
Set the start month of the DST	DST START MONTH	MAR	MONTH	January to December	
Set the start weekday of the DST	DST START WEEKDAY	SUNDAY	DAY	Monday to Sunday	
Set the start day instance	DST START DAY INST	LAST	NA	First; Second; Third; Fourth; Last	
Set the starting hour of the DST	DST START HOUR	2	1	[0 : 23]	
Set the Stop month of the DST	DST STOP MONTH	OCT	Month	January to December	
Set the stop weekday of the DST	DST STOP WEEKDAY	SUNDAY	Day	Monday to Sunday	
Set the stop day instance	DST STOP DAY INST	LAST	NA	First; Second; Third; Fourth; Last	
Set the stop hour of the DST	DST STOP HOUR	2	1	[0 : 23]	
IRIG-B local time	IRIG-B LOCAL TIME	OFF	NA	[ON; OFF]	
Function permission	IRIGB Function	DISABLED	NA	ENABLLED; DISABLED	
Establish the sync priority	PTP IRIGB Priority	PTP-1588	NA	PTP-1588; IRIG_B	

Setpoint > System Setup > General Settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Phase CT ratio	Phase CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Ground CT ratio	Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Sensitive ground CT ratio	Stv Ground CT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT ratio	Phase VT Ratio	1.0	0.1	[1.0 : 6000.0]	
Phase VT connection	Phase VT Connection	WYE	N/A	[WYE – DELTA]	
Rated voltage	Nominal Voltage	100.0	0.1	[1.0 : 250.0]	
Rated Frequency	Nominal Frequency	50 Hz	Hz	[50-60]	
Phase rotation	Phase Rotation	ABC	N/A	[ABC – ACB]	

Frequency reference	Frequency Reference	VI	N/A	[VI-VII-VIII]	
Auxiliary Voltage	Auxiliary Voltage	VX	N/A	[VX – VN]	
Snapshot Event generation	Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Primary meter units	Primary meter units	kA_kV	NA	A_V; kA_kV	
Device name	Device name	NA	NA	NA	

Setpoint > System Setup > Flex Curves					
Flex Curves A > Flex Curves B > Flex Curves C > Flex Curves D					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Values for reset points 0.00 pkp	Time 0.00xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.05 pkp	Time 0.05xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
…	…	…	0.001 s	[0.000 : 65.535]	
Values for reset points 0.97 pkp	Time 0.97xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for reset points 0.98 pkp	Time 0.98xPKP [RST]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.03 pkp	Time 1.03xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 1.05 pkp	Time 1.05xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
…	…	…	0.001 s	[0.000 : 65.535]	
Values for operation points 19.50 pkp	Time 19.50xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Values for operation points 20.00 pkp	Time 20.00xPKP [OP]	0.000	0.001 s	[0.000 : 65.535]	
Setpoint > System Setup > Breaker > Breaker Settings					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Number of Switchgear selected as breaker	Number of Switchgear	1	1	[1 : 16]	
Maximum value of KI2t	Maximum KI2t	9999.99	0.01(KA)2 s	[0.00 : 9999.99]	
KI2t integration time	KI2t Integ. Time	0.03	0.01s	[0.03 : 0.25]	
Maximum number of openings	Maximum Openings	9999	1	[0 : 9999]	
Maximum Openings in one hour	Max.Openings 1 hour	40	1	[1 : 60]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > System Setup > Breaker > Breaker Maintenance					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
KI2t Counter Phase A	KI2t BKR Ph A Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
KI2t Counter Phase B	KI2t BKR Ph B Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
KI2t Counter Phase C	KI2t BKR Ph C Cnt	0.00	0.01 (KA)2 s	[0.00 : 9999.99]	
Openings counter	BKR Openings Cnt	0	1	[0 : 9999]	
Closings counter	BKR Closings Cnt	0	1	[0 : 9999]	

Setpoint > System Setup > Switchgear					
Setting Description	Name	Default Value	Step	Range	User Value
Snapshot Event generation for switchgear #1	Snapshot Events SWGR 1	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #2	Snapshot Events SWGR 2	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #3	Snapshot Events SWGR 3	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #4	Snapshot Events SWGR 4	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #5	Snapshot Events SWGR 5	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #6	Snapshot Events SWGR 6	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #7	Snapshot Events SWGR 7	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #8	Snapshot Events SWGR 8	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #9	Snapshot Events SWGR 9	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #10	Snapshot Events SWGR 10	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #11	Snapshot Events SWGR 11	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #12	Snapshot Events SWGR 12	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #13	Snapshot Events SWGR 13	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #14	Snapshot Events SWGR 14	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #15	Snapshot Events SWGR 15	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation for switchgear #16	Snapshot Events SWGR 16	DISABLED	N/A	[DISABLED – ENABLED]	
Setpoint > system setup > miscellaneous >					
Setting Description	Name	Default Value	Step	Range	User Value
Relay out of service status	Relay Out Of Service	ENABLED	N/A	[DISABLED – ENABLED]	
Set to local or remote	Local/Remote Blocked	OFF	N/A	ON; OFF	
Active language on the relay	Active Language	0	N/A	[0 : 1]	

Setpoint > Protection Elements > Phase Current >					
> Phase TOC High > Phase TOC High 1 > Phase TOC High 2 > Phase TOC High 3					
> Phase TOC Low > Phase TOC Low 1 > Phase TOC Low 2 > Phase TOC Low 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	

Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Voltage Restraint	Voltage Restraint	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Phase Current >					
> Phase IOC High > Phase IOC High 1 > Phase IOC High 2 > Phase IOC High 3					
> Phase IOC Low > Phase IOC Low 1 > Phase IOC Low 2 > Phase IOC Low 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Phase Current > Phase Directional >					
Phase Directional 1> Phase Directional 2 > Phase Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	40	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Voltage Memory	Voltage Memory	0,00 s	0,01 s	[0,00 : 3,00]	

Setpoint > Protection Elements > Phase Current > Thermal Model >					
Thermal Model 1 > Thermal Model 2 > Thermal Model 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Heating constant	Heat Time Constant	6.0	0.1 min	[3.0 : 600.0]	
Cooling constant	Cool Time Constant	2.00	0.01 times Heat Time Ct.	[1.00 : 6.00]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Alarm level	Alarm Level	80.0	0.10%	[1.0 : 110.0]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Setpoint > Protection Elements > Neutral Current > Neutral TOC					
Neutral TOC 1> Neutral TOC 2 > Neutral TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	

Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Neutral Current > Neutral IOC					
Neutral IOC 1 > Neutral IOC 2 > Neutral IOC 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Neutral Current > Neutral Directional >					
Neutral Directional 1 > Neutral Directional 2 > Neutral Directional 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Ground Current > Ground TOC					
Ground TOC 1 > Ground TOC 2 > Ground TOC 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Ground Current > Ground IOC					
Ground IOC 1 > Ground IOC 2 > Ground IOC 3					
Setting Description	Name	Default Value	Step	Range	User Value

Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	30.00	0.01 A	[0.05 : 160.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Ground Current > Ground Directional > Ground Directional 1 > Ground Directional 2 > Ground Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Polarization type	Polarization	VO	N/A	[V_0 – I_P – V_0+I_P – V_0*I_P]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Sensitive Ground TOC Sensitive Ground TOC 1 > Sensitive Ground TOC 2 > Sensitive Ground TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.050	0.001 A	[0.005 : 16.000]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Sensitive Ground IOC Sensitive Ground IOC 1 > Sensitive Ground IOC 2 > Sensitive Ground IOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Pickup level	Pickup Level	0.100	0.001 A	[0.005 : 16.000]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Isolated Ground IOC Isolated Ground IOC 1 > Isolated Ground IOC 2 > Isolated Ground IOC 3

Setting Description	Name	Default Value	Step	Range	User Value
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
High Voltage level	Vh Level	20	1 V	[2 : 70]	
Low Current level	Il LEVEL	0.005	0.001 A	[0.005 : 0.400]	
Low Voltage level	Vl LEVEL	2	1 V	[2 : 70]	
High Current level	Ih LEVEL	0.025	0.001 A	[0.005 : 0.400]	
Operation time	Delay	0.00	0.01 s	[0.00 : 900.00]	
Deviation time to instantaneous	Time to inst	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Sensitive Ground Current > Sensitive Ground Directional > Sensitive Ground Directional 1 > Sensitive Ground Directional 2 > Sensitive Ground Directional 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Torque Angle	MTA	-45	1 Deg	[-90 : +90]	
Operation Direction	Direction	FORWARD	N/A	[FORWARD – REVERSE]	
Block logic type	Block Logic	PERMISSION	N/A	[BLOCK – PERMISSION]	
Polarization voltage threshold	Pol V Threshold	10	1 V	[0 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Negative Sequence Current > Negative Sequence TOC > Negative Sequence TOC 1 > Negative Sequence TOC 2 > Negative Sequence TOC 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	1.00	0.01 A	[0.05 : 160.00]	
Curve shape	Curve	IEEE Ext Inv	N/A	[See list of curves]	
Time Dial	TD Multiplier	1.00	0.01 s	[0.00 : 900.00]	
Reset type	Reset	INSTANTANEOUS	N/A	[INSTANTANEOUS – LINEAR]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Voltage Elements > Phase UV > Phase UV 1 > Phase UV 2 > Phase UV 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input mode	Mode	PHASE-PHASE	N/A	[PHASE-PHASE, PHASE-GROUND]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	
Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Minimum Voltage Threshold	Minimum Voltage	5	1 V	[0 : 300]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Supervision by breaker status	Supervised by 52	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Voltage Elements > Phase OV >					
Phase OV 1 > Phase OV 2 > Phase OV 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Operation logic	Logic	ANY PHASE	N/A	[ANY PHASE – TWO PHASES – ALL PHASES]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Voltage Elements >					
>Neutral OV High > Neutral OV High 1 > Neutral OV High 2 > Neutral OV High 3					
>Neutral OV Low > Neutral OV Low 1 > Neutral OV Low 2 > Neutral OV Low 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > voltage elements > Negative Sequence OV >					
Negative Sequence OV 1 > Negative Sequence OV 2 > Negative Sequence OV 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements >voltage elements > Auxiliary oV					
Auxiliary oV 1 > Auxiliary oV 2 > Auxiliary oV 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Trip Time	Trip Delay	10.00	0.01 s	[0.00 : 900.00]]	
Reset Time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements >voltage elements > Auxiliary UV					
Auxiliary UV 1 > Auxiliary UV 2 > Auxiliary UV 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup Level	Pickup Level	10	1 V	[3 : 300]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME – INVERSE TIME]	

Time Dial	Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Power > Forward Power					
Forward Power 1 > Forward Power 2 > Forward Power 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[0.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Power > Directional Power>					
Directional Power 1 > Directional Power 2 > Directional Power 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Block from offline	Blk Time After Close	0.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 1	Dir Power Angle 1	0.00	0.01 Deg	[0.00 : 359.99]	
Pickup level for stage 1	Stage 1 Tap	10.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 1	Stage 1 Time	60.00	0.01 s	[0.00 : 900.00]	
Directional Angle for stage 2	Dir Power Angle 2	0.00	1 Deg	[0.00 : 359.99]	
Pickup level for stage 2	Stage 2 Tap	20.00	0.01MW	[-10000.00 : 10000.00]	
Trip time for stage 2	Stage 2 Time	60.00	0.01 s	[0.00 : 900.00]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Protection Elements > Power					
WATT GND FLT HIGH 1 > WATT GND FLT HIGH 2 > WATT GND FLT HIGH 3 WATT GND FLT LOW 1 > WATT GND FLT LOW 2 > WATT GND FLT LOW 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	Function	DISABLED	N/A	[DISABLED-ENABLED]	
Supervision minimum voltage	Voltage Pickup Level	2	0.01 V	[2.00 : 70.00]	
Source of operating current.	Current selection	IN	N/A	[IN-IG]	
Pickup Level for Overcurrent	OC Pickup Level	0,005	0.001A	[0.005 : 0.400]	
Pickup Delay for Overcurrent	OC Pickup Delay	0,2	0.01 s	[0.00 : 600.00]	
Pickup Level for operating Power	Power Pickup	0,01	0.01 W	[0.01 : 4.50]	
Max torque angle	MTA	0	1 Deg	[0 : 360]	
Pickup Delay for Operating Power	Power Pickup Delay	0,2	0.01 s	[0.00 : 600.00]	
Curve shape	Curve	DEFINITE TIME	N/A	[DEFINITE TIME - INVERSE TIME - USER CURVE A - USER CURVE B - USER CURVE C - USER CURVE D]	
Multiplier	Multiplier	1	0.01 s	[0.02 : 2.00]	
Snapshot event generation	Snapshot Event	DISABLED	N/A	[DISABLED-ENABLED]	

Setpoint > Control Elements > Setting Group					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Setting Grouping Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Active Group	Active Group	GROUP 1	N/A	[GROUP 1 – GROUP 2 – GROUP 3]	
Snapshot Event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Underfrequency					
Underfrequency 1 > Underfrequency 2 > Underfrequency 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	49.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[10 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Overfrequency					
Overfrequency 1 > Overfrequency 2 > Overfrequency 3					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Pickup level	Pickup Level	50.50	0.01 Hz	[20.00 : 65.00]	
Trip time	Trip Delay	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	0.01 s	[0.00 : 900.00]	
Minimum voltage threshold	Minimum Voltage	30	1 V	[10 : 300]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Synchrocheck					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead bus voltage level	Dead Bus Level	10.00	0.01 V	[0.00 : 300.00]	
Live bus voltage level	Live Bus Level	50.00	0.01 V	[0.00 : 300.00]	
Dead line voltage level	Dead Line Level	10.00	0.01 V	[0.00 : 300.00]	
Live line voltage level	Live Line Level	50.00	0.01 V	[0.00 : 300.00]	
Voltage Difference	Max Volt Difference	10.00	0.01 V	[2.00 : 300.00]	
Angle Difference	Max Angle Difference	10.0	0.1 Deg	[2.0 : 80.0]	
Frequency Slip	Max Freq Difference	20	10 mHz	[10 : 5000]	
Breaker Closing time	Time	0.50	0.01 s	[0.01 : 600.00]	
Dead Line – Dead Bus Function permission	DL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Live Line – Dead Bus Function permission	LL-DB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Dead Line – Live Bus Function permission	DL-LB Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Autoreclose					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Maximum Number of shots	Max Number Shots	1	N/A	[1 : 4]	
Dead time 1	Dead Time 1	0.00	0.01 s	[0.00 : 900.00]	
Dead time 2	Dead Time 2	0.00	0.01 s	[0.00 : 900.00]	
Dead time 3	Dead Time 3	0.00	0.01 s	[0.00 : 900.00]	
Dead time 4	Dead Time 4	0.00	0.01 s	[0.00 : 900.00]	
Reclaim time or reset lockout delay	Reclaim Time	0.00	0.01 s	[0.00 : 900.00]	
Reclose conditions permission	Cond. Permission	DISABLED	N/A	[DISABLED – ENABLED]	
Hold time	Hold Time	0.00	0.01 s	[0.00 : 900.00]	
Reset time	Reset Time	0.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > Breaker Failure					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Supervision (retrip) pickup level	Supervision Pickup	1.00	0.01 A	[0.05 : 160.00]	
Hiset pickup level	Hiset Pickup	5.00	0.01 A	[0.05 : 160.00]	
Lowset pickup level	Lowset Pickup	2.00	0.01 A	[0.05 : 160.00]	
Internal arc pickup level	Internal Arc Pickup	0.10	0.01 A	[0.05 : 160.00]	
Internal arc time delay	Internal Arc Delay	10.00	0.01 s	[0.00 : 900.00]	
Retrip time delay	Supervision Delay	10.00	0.01 s	[0.00 : 900.00]	
Hiset time delay	HiSet Delay	10.00	0.01 s	[0.00 : 900.00]	
Lowset time delay	LowSet Delay	10.00	0.01 s	[0.00 : 900.00]	
Second stage time delay	2nd Step Delay	10.00	0.01 s	[0.00 : 900.00]	
WITHOUT current element time delay	No Current Delay	10.00	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > VT Fuse Failure)					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Setpoint > Control Elements > BROKEN CONDUCTOR					
Broken Conductor 1 > Broken Conductor 2 > Broken Conductor 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Tap Level in percentage of I2/I1	Tap	20	0.10%	[20.0 : 100.0]	
Trip Time	Trip Delay	60	0.01 s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	
Current Inhibition Level setting	Operation Threshold	0.005	0.001 A	[0.000 : 1.000]	

Setpoint > Control Elements > Locked Rotor					
Locked Rotor 1 > Locked Rotor 2 > Locked Rotor 3					
Setting Description	Name	Default Value	Step	Range	User Value
Function permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Input type	Input	PHASOR(DFT)	N/A	[PHASOR – RMS]	
Full load current	Full Load Current	0.50	KA	[0.10 : 10.00]	
Pickup level	Pickup Level	1.01	N/A	[1.01 : 109.00]	
Trip time	Trip Delay	0.00	s	[0.00 : 900.00]	
Reset time	Reset Delay	0.00	s	[0.00 : 900.00]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > PULSE COUNTERS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Pulse counter enabling setting	CntPulses Enabled X	DISABLED	N/A	[DISABLED – ENABLED]	
Name of the pulse counter	CntPulses Name X	Pulse Counter 1	N/A	N/A	
Multiplier factor for the pulse counter	CntPulses Factor X	1.000	0.001	[0.000 : 65000.000]	
Overflow value for the pulse counter	CntPulses Overflow X	65535	1	[0 : 1000000]	
Board selection for the pulse counter	CntPulses Board Origin X	F	N/A	[F,G,H,I]	
Input index inside the selected board	CntPulses Input Origin X	1	1	[1 : 32]	
Note: X is the pulse counter index, up to 8.					

SETPOINT > CONTROL ELEMENTS > ANALOG COMPARATORS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Generic Analog Function Permission	Analog Function	DISABLED	N/A	[DISABLED – ENABLED]	
Generic Snapshot Events Generation	Analog Snapshot Events	DISABLED	N/A	[DISABLED – ENABLED]	
Analog Input Value Selection	Analog Input X	None	N/A	[All available analog values]	
Analog Maximum Threshold Value	Analog Maximum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Minimum Threshold Value	Analog Minimum X	1.000	0.001	[-100000.000 : 100000.000]	
Analog Delay for Activation Signal	Analog Delay X	0.00	0.01 s	[0.00 : 900.00]	
Analog Hysteresis for the Deadband	Analog Hysteresis X	1.0	0.1	[0.0 : 50.0]	
Analog Direction for Activation Inside or Outside the Deadband	Analog Direction X	OUT	N/A	[IN-OUT]	
Note: X is the analog comparator index, up to 20					

SETPOINT > CONTROL ELEMENTS > FREQUENCY RATE OF CHANGE					
FREQUENCY RATE OF CHANGE 1 > FREQUENCY RATE OF CHANGE 2 > FREQUENCY RATE OF CHANGE 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	

Direction of the frequency change	Freq. Rate Trend	INCREASING	N/A	[INCREASING - DECREASING - BI-DIRECTIONAL]	
Operation Value in Hz/s	Freq. Rate Pickup	0.50	0.01 Hz/s	[0.10 : 10.00]	
Minimum required voltage in % nominal voltage	Freq. Rate OV Supv	40.00	0.01%	[0.00 : 110.00]	
Minimum Frequency Threshold	Freq. Rate Min	45.00	0.01 Hz	[20.00 : 80.00]	
Maximum Frequency Threshold	Freq. Rate Max	65.00	0.01 Hz	[20.00 : 80.00]	
Frequency rate Trip Delay	Freq. Rate Delay	0.00	0.01 s	[0.00 : 60.00]	
Snapshot Events Generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > LOAD ENCROACHMENT					
LOAD ENCROACHMENT 1 > LOAD ENCROACHMENT 2 > LOAD ENCROACHMENT 3					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function	DISABLED	N/A	[DISABLED – ENABLED]	
Minimum positive-sequence voltage required	Min. Voltage	25.00	0.01 V	[0.00 : 300.00]	
Impedance reach of the element	Reach	1.00	0.01 Ohm	[0.02 : 250.00]	
Angle (Size of the blocking region)	Angle	5	1 Deg	[5 : 50]	
Trip Time	Pickup Delay	0.000	0.001 s	[0.000 : 65.535]	
Reset Time	Reset Delay	0.000	0.001 s	[0.000 : 65.535]	
Snapshot Events Generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

SETPOINT > CONTROL ELEMENTS > MAX. NUMBERS OF STARTS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function Permission	Function	DISABLED	N/A	[DISABLED- ENABLED]	
Motor Full Load Current	Full Load Amps	5.0	0.1 A	[0.5: 10.0]	
Stop condition supervised by breaker	Breaker Supervision	DISABLED	N/A	[DISABLED- ENABLED]	
	Min. Stop Time	0.0	0.1s	[0.0: 900.0]	
Number of Starts per tour	Number of Starts	5	1	[0: 100]	
Reset counter setting	Reset Counter	DISABLED	N/A	[DISABLED- ENABLED]	
Snapshot Event Generation	Snapshot Events	ENABLED	N/A	[DISABLED- ENABLED]	

SETPOINT > CONTROL ELEMENTS > DIGITAL COUNTERS					
SETTING DESCRIPTION	NAME	DEFAULT VALUE	STEP	RANGE	USER VALUE
Function permission	DigCnt 1 Function	DISABLED	NA		
Digital Counter 1 name	DigCnt 1 Name		NA		
Digital counter 1 Preset	DigCnt 1 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 1 Compare	DigCnt 1 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 2 Function	DISABLED	NA		
Digital Counter 2 name	DigCnt 2 Name		NA		
Digital counter 2 Preset	DigCnt 2 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 2 Compare	DigCnt 2 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 3 Function	DISABLED	NA		
Digital Counter 3 name	DigCnt 3 Name		NA		

Digital counter 3 Preset	DigCnt 3 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 3 Compare	DigCnt 3 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 4 Function	DISABLED	NA		
Digital Counter 4 name	DigCnt 4 Name		NA		
Digital counter 4 Preset	DigCnt 4 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 4 Compare	DigCnt 4 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 5 Function	DISABLED	NA		
Digital Counter 5 name	DigCnt 5 Name		NA		
Digital counter 5 Preset	DigCnt 5 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 5 Compare	DigCnt 5 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 6 Function	DISABLED	NA		
Digital Counter 6 name	DigCnt 6 Name		NA		
Digital counter 6 Preset	DigCnt 6 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 6 Compare	DigCnt 6 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 7 Function	DISABLED	NA		
Digital Counter 7 name	DigCnt 7 Name		NA		
Digital counter 7 Preset	DigCnt 7 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 7 Compare	DigCnt 7 Compare	0	1	[-2147483648 : 2147483647]	
Function permission	DigCnt 8 Function	DISABLED	NA		
Digital Counter 8 name	DigCnt 8 Name		NA		
Digital counter 8 Preset	DigCnt 8 Preset	0	1	[-2147483648 : 2147483647]	
Digital counter 8 Compare	DigCnt 8 Compare	0	1	[-2147483648 : 2147483647]	
Snapshot Event Generation	Snapshot Events	ENABLED	NA	[ENABLED; DISABLED]	
SETPOINT > CONTROL ELEMENTS > COLD LOAD PICK UP					
SETTING DESCRIPTION	**NAME**	**DEFAULT VALUE**	**STEP**	**RANGE**	**USER VALUE**
Function permission	Cold Load Function	DISABLED	NA	[ENABLED; DISABLED]	
Cold Load Pickup Outage Time	Cold Outage Time	20	min	[1 : 1000]	
Cold Load Pickup Blocking Time	Cold Blocking Time	5	s	[1 : 1000]	
Snapshot Event Generation	Cold Load Events	ENABLED	NA	[ENABLED; DISABLED]	

Setpoint > Inputs/Outputs > Contact I/O >					
Board F > Board G > Board H > Board J					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
I/O board type (available only for CIO modules)	I/O Board Type_**X**	NONE	N/A	[NONE, 16 INP + 8OUT, 8 INP + 8OUT + SUPV 32 INP 16 INP + 8 ANA]	

Input activation voltage threshold Group A	Voltage Threshold A_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group B	Voltage Threshold B_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group C	Voltage Threshold C_**X**	80	1 V	[10 : 230]	
Input activation voltage threshold Group D	Voltage Threshold D_**X**	80	1 V	[10 : 230]	
Debounce time for Group A	Debounce Time A_**X**	15	1 ms	[1 : 50]	
Debounce time for Group B	Debounce Time B_**X**	15	1 ms	[1 : 50]	
Debounce time for Group C	Debounce Time C_**X**	15	1 ms	[1 : 50]	
Debounce time for Group D	Debounce Time D_**X**	15	1 ms	[1 : 50]	
Input type	Input Type_**X**_CC**Y** (CC**Y**)	POSITIVE	N/A	[POSITIVE-EDGE, NEGATIVE-EDGE, POSITIVE, NEGATIVE]	
Input signal time delay	Delay Input Time_**X**_CC**Y** (CC**Y**)	0	1 ms	[0 : 60000]	
Output logic type	Output Logic_**X**_0**Z**	POSITIVE	N/A	[POSITIVE, NEGATIVE]	
Output type	Output Type_**X**_0**Z**	NORMAL	N/A	[NORMAL, PULSE, LATCH]	
Output pulse length	Pulse Output Time_**X**_0**Z**	10000	1 ms	[0 : 60000]	
Analog Inputs Range	Range_**X**_0**Z**	NONE	N/A	[NONE, -1 to 0mA, 0 to 1 mA, -1 to 1 mA, 0 to 5 mA, 0 to 10 mA]	
Minimum Value	Min_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]	
Maximum Value	Max_Value_**X**_0**Z**	0.00	0.01	[-9999.99 : 9999.99]	
Snapshot event generation	Snapshot Events	ENABLED	N/A	[DISABLED – ENABLED]	

Note 2: Description of X, Y and Z in input/output boards			
X	F, G, H or J, the I/O board name, depending on the Relay model.		
	F and G are internal Relay boards, and H and J are additional boards available in CIO modules (remote Bus CAN I/O module)		
For the I/O board selection in the relay model:	I/O BOARD TYPE		
	ASSOCIATED DIGIT	ENERVISTA 650 SETUP BOARD SETTINGS	BOARD TYPE
	0	NONE	None
	1	16 INP+ 8 OUT	Mixed
	2	8 INP +8 OUT +SUPV	Supervision
	4	32 INP	32 digital inputs
	5	16 INP + 8 ANA	16 digital inputs + 8 analog inputs
CC**Y**	Is the name used for inputs in I/O boards		
	Mixed, 16 digital inputs: CC1….CC16		
	Supervision: 8 digital inputs: CC1,..., CC8		
	32 INP: 32 digital inputs; CC1,...,CC32		

0**Z**	Is the name used for the different outputs in I/O boards, 8 outputs available for any of the two types of board (01,…., 08)

Setpoint > Inputs/Outputs > Remote Comms					
Setting Description	**Name**	**Default Value**	**Step**	**Range**	**User Value**
Remote comms selection	Remote Comms	NONE	N/A	[NONE – GSSE – GOOSE]	
SETTING DESCRIPTION FOR GSSE					
Remote comms selection	Remote Comms	GSSE	N/A	[NONE – GSSE – GOOSE]	
Device Identification	650 ID	F650	N/A		
Hold time signal send by the transmitting device	Hold Time	10000	1 ms	[1000 : 60000]	
Snapshot Events Generation	Snapshot Events Remote Out	DISABLED	N/A	[DISABLED – ENABLED]	
Remote Device Description	Remote Device X	Remote Device X	N/A		
Bit Pair Selection	Bit Pair X	None	N/A	[DNA-1 to DNA-32 – UserSt-1 to UserSt-64]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	
SETTING DESCRIPTION FOR GOOSE					
Remote comms selection	Remote Comms	GOOSE	N/A	[NONE – GSSE – GOOSE]	
Default Value Selection	Default Value X	OFF	N/A	[OFF – ON – LATEST OFF – LATEST ON]	
Note: X is the Remote Device index, up to 32					

LIST OF TIME OVERCURRENT CURVES AVAILABLE IN F650
IEEE extremely/very/moderately inverse
IEC Curve A/B/C/Long-Time Inverse/ Short-Time Inverse
IAC extremely/very/normally/moderately inverse
ANSI extremely/very/normally/moderately inverse
I2t
Definite time
Rectifier curve
User Curve - FlexCurve™ A/B/C/D

Note:

SOURCE COLUMN

This column allows the user to select the simple or complex (OR signal/virtual output) operand that activates the selected elements for configuration of the relay.

If more than one operand is selected, the relay performs an OR gate to activate the selected element.

SIGNAL LOGIC COLUMN

This refers to each individual signal selected on its left. NOT legend means that the signal is inverted.

SOURCE LOGIC COLUMN

This refers to the whole SOURCE signal selected on its left. NOT legend means that the signal is inverted. If more than one operand is selected, the OR gate output is inverted.

SETPOINT > RELAY CONFIGURATION > OUTPUTS			
OUTPUT	SOURCE	SOURCE LOGIC	LOGIC
CONT OP OPER_F_01	VO_000_PROTECTION_ALARM		-
CONT OP OPER_F_02	VO_046_59P_PKP		-
	VO_045_27P_PKP	-	
CONT OP OPER_F_03	VO_048_50G_PKP		-
CONT OP OPER_F_04	VO_049_51G_PKP		-
CONT OP OPER_F_05	VO_051_50PH_PKP		-
	VO_050_50PL_PKP	-	
CONT OP OPER_F_06	VO_053_51P_PKP		-
CONT OP OPER_F_07	OPERATION BIT 1		-
	AR CLOSE BREAKER	-	
CONT OP OPER_F_08	OPERATION BIT 2		-
	VO_083_GENERAL_TRIP	-	

SETPOINT > RELAY CONFIGURATION > LEDS				
LED	SOURCE	SOURCE LOGIC	LOGIC	LED NAME
LED01	VO_000_PROTECTION ALARM		-	PROT ALARM
LED02	VO_083_GENERAL_TRIP		-	TRIP
LED03	VO_019_PHASE_OVERCURRENT_TRIP		-	50/51P TRIP
LED04	VO_069_GROUND_OVERCURRENT_TRIP		-	50/51G TRIP
LED05	VO_074_59P_TRIP	-	-	27/59 TRIP
	VO_073_27P_TRIP			
LED06	VO_085_GENERAL_PKP		-	PICKUP
LED07	VO_007_PHASE_OVERCURRENT_PKP		-	50/51P PICKUP
LED08	VO_009_GROUND_OVERCURRENT_PKP		-	50/51G PICKUP
LED09	VO_045_27P_PKP		-	27 PICKUP
LED10	VO_046_59P_PKP		-	59 PICKUP
LED11	AR READY		-	79 READY
LED12	AR RCL IN PROGRESS		-	79 IN-PROG
LED13	AR BLOCK		-	79 BLOCK

SETPOINT > RELAY CONFIGURATION > LEDS				
LED	SOURCE	SOURCE LOGIC	LOGIC	LED NAME
LED14	AR CONDS INPUT		NOT	79 INHIBIT
LED15	AR LOCKOUT		-	79 LOCKOUT

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
LED RESET INPUT	OPERATION BIT 3		
CHANGE LOCAL-REMOTE	Not Configured		
CHANGE OP BLOCKED	Not Configured		
HMI BACKLIGHT ON	Not Configured		
HMI BACKLIGHT OFF	Not Configured		
PH IOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 1		
PH IOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 1		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
PH IOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 2		
PH IOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC2 (50P BLOCK)(CC2)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 2		
NEUTRAL IOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL IOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL IOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND IOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 3		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
GROUND IOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 3		
GROUND IOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC5 (50G BLOCK)(CC5)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 3		
SENS GND IOC1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 4		
SENS GND IOC3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 4		
PH TOC1 HIGH A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC1 HIGH C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC2 HIGH C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 5		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
PH TOC3 HIGH B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 5		
PH TOC3 HIGH C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 5		
NEUTRAL TOC1 BLOCK	GROUP 1 BLOCKED		
	NEUTRAL DIR1 OP	NOT	
NEUTRAL TOC2 BLOCK	GROUP 2 BLOCKED		
	NEUTRAL DIR2 OP	NOT	
NEUTRAL TOC3 BLOCK	GROUP 3 BLOCKED		
	NEUTRAL DIR3 OP	NOT	
GROUND TOC1 BLOCK	GROUP 1 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR1 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC2 BLOCK	GROUP 2 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR2 OP	NOT	
	LATCHED VIRT IP 7		
GROUND TOC3 BLOCK	GROUP 3 BLOCKED		
	CONT IP_F_CC6 (51G BLOCK)(CC6)		
	GROUND DIR3 OP	NOT	
	LATCHED VIRT IP 7		
SENS GND TOC1 BLOCK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC2 BLOCK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
	LATCHED VIRT IP 8		
SENS GND TOC3 BLOCK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
	LATCHED VIRT IP 8		
PHASE UV1 BLOCK	GROUP 1 BLOCKED		
PHASE UV2 BLOCK	GROUP 2 BLOCKED		
PHASE UV3 BLOCK	GROUP 3 BLOCKED		
NEG SEQ OV1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ OV2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ OV3 BLOCK	GROUP 3 BLOCKED		
THERMAL1 BLOCK	GROUP 1 BLOCKED		
THERMAL2 BLOCK	GROUP 2 BLOCKED		
THERMAL3 BLOCK	GROUP 3 BLOCKED		
PHASE DIR1 BLK INP	GROUP 1 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
PHASE DIR2 BLK INP	GROUP 2 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
PHASE DIR3 BLK INP	GROUP 3 BLOCKED		
	CONT IP_F_CC4 (67P BLOCK)(CC4)		
	LATCHED VIRT IP 9		
NEUTRAL DIR1 BLK INP	GROUP 1 BLOCKED		
NEUTRAL DIR2 BLK INP	GROUP 2 BLOCKED		
NEUTRAL DIR3 BLK INP	GROUP 3 BLOCKED		
GROUND DIR1 BLK INP	GROUP 1 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR2 BLK INP	GROUP 2 BLOCKED		
	LATCHED VIRT IP 10		
GROUND DIR3 BLK INP	GROUP 3 BLOCKED		
	LATCHED VIRT IP 10		
NEUTRAL OV1 HIGH BLK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV2 HIGH BLK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV3 HIGH BLK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 12		
NEUTRAL OV1 LOW BLK	GROUP 1 BLOCKED		
NEUTRAL OV2 LOW BLK	GROUP 2 BLOCKED		
NEUTRAL OV3 LOW BLK	GROUP 3 BLOCKED		
AUXILIARY UV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY UV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY UV3 BLOCK	GROUP 3 BLOCKED		
PHASE OV1 BLOCK	GROUP 1 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV2 BLOCK	GROUP 2 BLOCKED		
	LATCHED VIRT IP 11		
PHASE OV3 BLOCK	GROUP 3 BLOCKED		
	LATCHED VIRT IP 11		
AUXILIARY OV1 BLOCK	GROUP 1 BLOCKED		
AUXILIARY OV2 BLOCK	GROUP 2 BLOCKED		
AUXILIARY OV3 BLOCK	GROUP 3 BLOCKED		
NEG SEQ TOC1 BLOCK	GROUP 1 BLOCKED		
NEG SEQ TOC2 BLOCK	GROUP 2 BLOCKED		
NEG SEQ TOC3 BLOCK	GROUP 3 BLOCKED		
OVERFREQ1 BLOCK	GROUP 1 BLOCKED		
OVERFREQ2 BLOCK	GROUP 2 BLOCKED		
OVERFREQ3 BLOCK	GROUP 3 BLOCKED		
UNDERFREQ1 BLOCK	GROUP 1 BLOCKED		
UNDERFREQ2 BLOCK	GROUP 2 BLOCKED		
UNDERFREQ3 BLOCK	GROUP 3 BLOCKED		
SETT GROUPS BLOCK	Not Configured		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
BROKEN CONDUCT1 BLK	GROUP 1 BLOCKED		
BROKEN CONDUCT2 BLK	GROUP 2 BLOCKED		
BROKEN CONDUCT3 BLK	GROUP 3 BLOCKED		
ISOLATED GND1 BLK	GROUP 1 BLOCKED		
	SENS GND DIR1 OP	NOT	
ISOLATED GND2 BLK	GROUP 2 BLOCKED		
	SENS GND DIR2 OP	NOT	
ISOLATED GND3 BLK	GROUP 3 BLOCKED		
	SENS GND DIR3 OP	NOT	
SENS GND DIR1 BLK IP	GROUP 1 BLOCKED		
SENS GND DIR2 BLK IP	GROUP 2 BLOCKED		
SENS GND DIR3 BLK IP	GROUP 3 BLOCKED		
FWD PWR1 BLOCK	GROUP 1 BLOCKED		
FWD PWR2 BLOCK	GROUP 2 BLOCKED		
FWD PWR3 BLOCK	GROUP 3 BLOCKED		
PH TOC1 LOW A BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW B BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC1 LOW C BLK	GROUP 1 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR1 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW A BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 A OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW B BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC2 LOW C BLK	GROUP 2 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR2 C OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW A BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 A OP	NOT	
	LATCHED VIRT IP 6		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
PH TOC3 LOW B BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 B OP	NOT	
	LATCHED VIRT IP 6		
PH TOC3 LOW C BLK	GROUP 3 BLOCKED		
	CONT IP_F_CC3 (51P BLOCK)(CC3)		
	PHASE DIR3 C OP	NOT	
	LATCHED VIRT IP 6		
DIR PWR1 BLOCK	GROUP 1 BLOCKED		
DIR PWR2 BLOCK	GROUP 2 BLOCKED		
DIR PWR3 BLOCK	GROUP 3 BLOCKED		
LOCKED ROTOR1 BLK	GROUP 1 BLOCKED		
LOCKED ROTOR2 BLK	GROUP 2 BLOCKED		
LOCKED ROTOR3 BLK	GROUP 3 BLOCKED		
FREQ RATE1 BLOCK	GROUP 1 BLOCKED		
FREQ RATE2 BLOCK	GROUP 2 BLOCKED		
FREQ RATE3 BLOCK	GROUP 3 BLOCKED		
LOAD ENCR1 BLOCK	GROUP 1 BLOCKED		
LOAD ENCR2 BLOCK	GROUP 2 BLOCKED		
LOAD ENCR3 BLOCK	GROUP 3 BLOCKED		
32N1 HIGH BLOCK	GROUP 1 BLOCKED		
32N2 HIGH BLOCK	GROUP 2 BLOCKED		
32N3 HIGH BLOCK	GROUP 3 BLOCKED		
32N1 LOW BLOCK	GROUP 1 BLOCKED		
32N2 LOW BLOCK	GROUP 2 BLOCKED		
32N3 LOW BLOCK	GROUP 3 BLOCKED		
THERMAL1 A RST	OPERATION BIT 4		
THERMAL1 B RST	OPERATION BIT 4		
THERMAL1 C RST	OPERATION BIT 4		
THERMAL2 A RST	OPERATION BIT 4		
THERMAL2 B RST	OPERATION BIT 4		
THERMAL2 C RST	OPERATION BIT 4		
THERMAL3 A RST	OPERATION BIT 4		
THERMAL3 B RST	OPERATION BIT 4		
THERMAL3 C RST	OPERATION BIT 4		
Synchrocheck BLK INP	Not Configured		
AR LEVEL BLOCK	CONT IP_F_CC8 (79 BLOCK)(CC8)		
	LATCHED VIRT IP 14		
AR PULSE BLOCK	Not Configured		
AR PULSE UNBLOCK	Not Configured		
AR INITIATE	VO_083_GENERAL_TRIP		
	CONT IP_F_CC7 (79 INITIATE)(CC7)		
	LATCHED VIRT IP 13		
AR CONDS INPUT	SYNCHK CLOSE PERM	NOT	NOT
	LATCHED VIRT IP 15		
BKR FAIL INITIATE	Not Configured		
GROUP 1 ACT ON	Not Configured		
GROUP 2 ACT ON	Not Configured		

SETPOINT > RELAY CONFIGURATION > PROTECTION ELEMENTS			
PROTECTION ELEMENT	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
GROUP 3 ACT ON	Not Configured		
FAULT REPORT TRIGG	VO_083_GENERAL_TRIP		
CLEAR FAULT REPORTS	Not Configured		
DEMAND TRIGGER INP	Not Configured		
DEMAND RESET INP	OPERATION BIT 7		
FREEZE ENERGY CNT	Not Configured		
UNFREEZE ENERGY CNT	Not Configured		
RESET ENERGY CNT	OPERATION BIT 6		
RESET KI2t COUNTERS	OPERATION BIT 5		
RESET BKR COUNTERS	OPERATION BIT 5		

SETPOINT > RELAY CONFIGURATION > OSCILLOGRAPHY				
DIGITAL CHANNEL	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
DIG_CHANNEL#1	TRIP	VO_083_GENERAL_TRIP		
DIG_CHANNEL#2	50/51P TRIP	VO_019_PHASE_OVERCURRENT_TRIP		
DIG_CHANNEL#3	50/51G TRIP	VO_069_GROUND_OVERCURRENT_TRIP		
DIG_CHANNEL#4	27 TRIP	VO_073_27P_TRIP		
DIG_CHANNEL#5	59 TRIP	VO_074_59P_TRIP		
DIG_CHANNEL#6	PICKUP	VO_085_GENERAL_PKP		
DIG_CHANNEL#7	50/51P PICKUP	VO_007_PHASE_OVERCURRENT_PKP		
DIG_CHANNEL#8	50/51G PICKUP	VO_009_GROUND_OVERCURRENT_PKP		
DIG_CHANNEL#9	27 PICKUP	VO_045_27P_PKP		
DIG_CHANNEL#10	59 PICKUP	VO_046_59P_PKP		
DIG_CHANNEL#11	79 READY	AR READY		
DIG_CHANNEL#12	79 IN-PROG	AR RCL IN PROGRESS		
DIG_CHANNEL#13	79 BLOCK	AR BLOCK		
DIG_CHANNEL#14	79 INHIBIT	AR CONDS INPUT	NOT	
DIG_CHANNEL#15	79 LOCKOUT	AR LOCKOUT		
DIG_CHANNEL#16	Not Configured			
OSCILLO TRIGGER	OSCILLO TRIGGER	OPERATION BIT 8		
		VO_083_GENERAL_TRIP		

SETPOINT > RELAY CONFIGURATION > OPERATIONS			
OPERATION	OPERATION TEXT	SETTINGS	VALUE/SOURCE
Operation1	CLOSE BREAKER	INTERLOCK (LOGIC)	SYNC CLOSE PERM
		FINAL STATES AND LOGIC	BREAKER CLOSED
		FRONT KEY	I Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL

SETPOINT > RELAY CONFIGURATION > OPERATIONS			
OPERATION	OPERATION TEXT	SETTINGS	VALUE/SOURCE
Operation2	OPEN BREAKER	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	BREAKER OPEN
		FRONT KEY	O Key
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	1000
		CHANNELS	ALL
Operation3	LEDS RESET	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation4	THERMAL RESET	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation5	BRK COUNTERS RESET	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation6	ENERGY RESET	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation7	DEMAND RESET	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL
Operation8	TRIGGER OSCILLO	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	500
		CHANNELS	ALL

SETPOINT > RELAY CONFIGURATION > OPERATIONS			
OPERATION	OPERATION TEXT	SETTINGS	VALUE/SOURCE
Operation9	Not configured	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
.....	.....	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured
Operation24	Not configured	INTERLOCK (LOGIC)	Not configured
		FINAL STATES AND (LOGIC)	Not configured
		FRONT KEY	Not configured
		INPUT	Not configured
		VIRTUAL OUTPUT	Not configured
		TIMEOUT	Not configured
		CHANNELS	Not configured

SETPOINT > RELAY CONFIGURATION > EVENTS				
EVENT	NAME	SOURCE	SIGNAL LOGIC	SOURCE LOGIC
EV1	Not Configured			
EV2	Not Configured			
...	...			
EV128	Not Configured			

SETPOINT > RELAY CONFIGURATION > SWITCHGEAR				
SWITCHGEAR	SETTING	VALUE/SOURCE	SIGNAL LOGIC	SOURCE LOGIC
SWITCHGEAR 1	CONTACTS	52b		
	OPENING TIME	1000		
	CLOSING TIME	1000		
	CONTACT A SOURCE	N/A		
	CONTACT B SOURCE	CONT IP_F_CC1 (52b)(CC1)		
	OPEN TEXT	52 OPEN		
	ALARM	NO		
	CLOSED TEXT	52 CLOSE		
	ALARM	NO		
	ERROR 00 TEXT	52 ERROR		
	ALARM	N/A		
	ERROR 11 TEXT	52 UNDEFINED		
	ALARM	N/A		
	OPENING INIT	OPERATION BIT 2		
	CLOSING INIT	OPERATION BIT 1		

SETPOINT > RELAY CONFIGURATION > SWITCHGEAR				
SWITCHGEAR	SETTING	VALUE/SOURCE	SIGNAL LOGIC	SOURCE LOGIC
SWITCHGEAR 2	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		
...	...	...	...	...
SWITCHGEAR 16	CONTACTS	Not Configured		
	OPENING TIME	Not Configured		
	CLOSING TIME	Not Configured		
	CONTACT A SOURCE	Not Configured		
	CONTACT B SOURCE	Not Configured		
	OPEN TEXT	Not Configured		
	ALARM	Not Configured		
	CLOSED TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 00 TEXT	Not Configured		
	ALARM	Not Configured		
	ERROR 11 TEXT	Not Configured		
	ALARM	Not Configured		
	OPENING INIT	Not Configured		
	CLOSING INIT	Not Configured		

F650 Digital Bay Controller

Appendix J: Miscellaneous

J.1 Warranty

For products shipped as of 1 October 2013, GE VERNOVA warrants most of its GE VERNOVA manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at:

https://www.gevernova.com/grid-solutions/multilin/warranty.htm

For products shipped before 1 October 2013, the standard 24-month warranty applies.

MANUAL P/N	RELEASE DATE
GEK-106310-AF	June 2017
GEK-106310-AG	November 2017
GEK-106310-AH	April 2018
1601-0800-A1	November 2020
1601-0800-A2	March 2021
1601-0800-A3	October 2022
1601-0800-A4	April 2024
1601-0800-A5	February 2025

J.1.1 Major Updates

For information on the updates included in this release of the F650 Digital Bay Controller, please refer to the latest release notes for Firmware version 9.0x, EnerVista F650 Setup version 9.0x online.