GE VERNOVA

8 Series

Protective Relay Platform

850 - 845 - 869 - 889

Communications Guide

8 Series version: 2.9x

Publication reference: 1601-0702-AD

CE

RoHS Compliant

WORLDWIDE 10 YEAR WARRANTY

REGISTERED ISO 9001

GE Vernova 8 Series Protective Relay Platform Communications Guide for revision 2.9x.

Part number: 1601-0702-AD (December 2022)

Disclaimer

It is the responsibility of the user to verify and validate the suitability of all GE Vernova products. This equipment must be used within its design limits. The proper application including the configuration and setting of this product to suit the power system assets is the responsibility of the user, who is also required to ensure that all local or regional safety guidelines are adhered to. Incorrect application of this product could risk damage to property/the environment, personal injuries or fatalities and shall be the sole responsibility of the person/entity applying and qualifying the product for use.

The content of this document has been developed to provide guidance to properly install, configure and maintain this product for its intended applications. This guidance is not intended to cover every possible contingency that may arise during commissioning, operation, service, or maintenance activities. Should you encounter any circumstances not clearly addressed in this document, please contact your local GE Vernova service site.

The information contained in this document is subject to change without notice.

IT IS THE SOLE RESPONSIBILITY OF THE USER TO SECURE THEIR NETWORK AND ASSOCIATED DEVICES AGAINST CYBER SECURITY INTRUSIONS OR ATTACKS. GE VERNOVA AND ITS AFFILIATES ARE NOT LIABLE FOR ANY DAMAGES AND/OR LOSSES ARISING FROM OR RELATED TO SUCH SECURITY INTRUSION OR ATTACKS.

Table of Contents

8 Series Protective Relay Platform

Chapter 1: Introduction

The Multilin 8 Series protective relay platform includes four different relays, the 850, 845, 869, and 889. Information in this manual applies to all 8 series relays unless otherwise indicated.

The Multilin 850 relay is a microprocessor-based unit intended for the management and primary protection of distribution feeders, as well as for the management and backup protection of buses, transformers, and transmission lines. The 850 relay is particularly suited to overhead feeders, where automatic reclosing is normally applied.

The Multilin 869 relay is a microprocessor-based unit intended for the management and primary protection of medium and large sized motors. Base relay models provide thermal overload and overcurrent protection plus a number of current and voltage based backup functions.

The Multilin 845 relay is a microprocessor-based unit intended for the management and primary protection of the medium to large size medium voltage (MV) and high voltage (HV) power transformers. Both 2-winding and 3-winding transformers are supported. The 845 relay provides a number of primary and backup current and voltage based protection functions. This system allows for control of the circuit breakers at each winding plus a number of monitoring and control functions are also provided.

The Multilin 889 relay is a microprocessor-based unit intended for the primary protection of small, medium and large sized generators. Base relay models provide standard generator protection functions plus a number of current and voltage based backup functions.

Communications

8 Series relays have a two-stage communications capability. The base CPU supports Modbus protocol through the Ethernet, USB, serial and WiFi port. In addition, the base CPU also supports IEC 103, DNP serial, DNP TCP/IP, and TFTP protocol. Once the communications module option is added to the base, the base Ethernet port becomes disabled but the two Ethernet ports on the communications module have enhanced communications capabilities such as IEC61850 Ed.2, IEC62439 parallel redundancy protocol (PRP) and IEEE 1588 Precision Time Protocol (PTP version 2). The communications CPU also supports Modbus TCP, IEC 104, DNP TCP, TFTP, SFTP, and SNTP protocol.

For Further Assistance

For current manuals and software go to:
Website: www.gegridsolutions.com/multilin/ProductListing.htm
For product support, contact the information and call center as follows:

GE Vernova
650 Markland Street
Markham, Ontario
Canada L6C 0M1
Worldwide telephone: +1 905 927 7070
Europe/Middle East/Africa telephone: +34 94 485 88 54
North America toll-free: 1 800 547 8629
Fax: +1 905 927 5098
Worldwide e-mail: multilin.tech@ge.com
Europe e-mail: multilin.tech.euro@ge.com
Website: http://www.gegridsolutions.com/multilin

8 Series Protective Relay Platform

Chapter 2: Communication Ports

8 Series protective relays have four communications ports: RS485, WiFi, USB, and Ethernet.

RS485 Port

SERIAL

RS485 port:	Isolated
Baud rates:	Supports 9600, 19200, 38400, 57600, and 115200 kbps
Baud rates:	Supports 300, 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 kbps
Response time:	10 ms typical
Parity:	None, Odd, Even
Protocol:	Modbus RTU, DNP 3.0, IEC 60870-5-103
Maximum distance:	1200 m (4000 feet)
Isolation:	2 kV
Cable:	Belden 9841 or similar 24 AWG stranded, shielded twisted-pair

RS485

On the rear, the 8 Series relay is equipped with one RS485 serial communication port and one 10/100 Mbps Ethernet port. The RS485 port has settings for baud rate and parity. It is important that these parameters agree with the settings used on the computer or other equipment connected to this port. A maximum of 32 relays can be daisy-chained and connected to a DCS, PLC or a PC using the RS485 port.

Path: Setpoints > Device > Communications > RS485

BAUD RATE

Range: 9600, 19200, 38400, 57600, 115200
Default: 115200

PARITY

Range: None, Odd, Even
Default: None

PORT PROTOCOL

Range: Modbus, DNP 3.0, IEC 60870-5-103

Default: Modbus

Wi-Fi

Wi-Fi refers to Wireless Local Area Networks (WLANs) that are based on the 802.11 set of standards. WLANs are essentially providing Local Area Network (LAN) type of connectivity but without the need of cables, which makes them more convenient for use in limited spaces. Wi-Fi works on top of the TCP/IP stack, the same as Ethernet. The signal strength and its range is determined by the wireless device's antenna technology and standard, the best being IEEE 802.11n.

Wi-Fi defines two modes of operation, namely ad-hoc, used for small deployments, and infrastructure mode, which supports more robust types of security and better capabilities for centralized management. The infrastructure mode requires an access point (AP). Devices operating in this mode pass all data through the AP.

The Wi-Fi module integrated on the 8 Series products conforms to IEEE 802.11b/g/n standards. The 8 Series devices operate in infrastructure mode. Security is optional, but enabled by default and it is advisable that it is left on, as wireless traffic is very susceptible to cyber-attacks.

The security technology used is WPA2 (Wireless Protected Access version 2), based on the IEEE 802.11i standard for data encryption. WPA2 is a second version of WPA technology, designed to solve known security limitations found in one of the encryption algorithms used by WPA, namely TKIP (Temporal Key Integrity Protocol). WPA2 uses CCMP (Counter Mode with Cipher Block Chaining Message Authentication Code Protocol), which provides an enhanced data cryptographic encapsulation mechanism based on AES (Advanced Encryption Standard). CCMP makes WPA2 much stronger and secure than its predecessors, WPA and WEP.

Several forms of WPA2 security keys exist. The 8 Series supports WPA2 PSK (Pre-Shared Key), which utilizes 64 hexadecimal digits. The key may actually be entered as a string of 64 hexadecimal digits or as a passphrase of 8 to 32 printable ASCII characters. For user convenience, the settings accept the key in the form of a passphrase. Internally the ASCII passphrase is used for deriving a 256-bit key.

The following are the Wi-Fi network settings for the 8 Series product. Only an Administrator has the rights to change them.

Path: Setpoints > Device > Communications > Wi-Fi

WiFi Enable

This setting switches Wi-Fi functionality on/off. By default Wi-Fi is enabled in the basic offering, but it is disabled in software options that offer CyberSentry.

WiFi IP Address / Subnet Mask

The default IP address is 192.168.0.x, where x is calculated as:

X = (modulo 242 of the last 3 digits of the serial number) + 12
Example: A unit has a serial number of MJ3A16000405, the default IP address would be 192.168.0.175 (where 405 mod 242 = 163 + 12 = 175).

This is to ensure uniqueness of the default IP address for all 8 Series devices present on one wireless network and it creates a usable address space from 192.168.0.12 to 192.168.0.253 for 8 Series devices.


NOTE

From the remaining range of unicast addresses 192.168.0.1 to 192.168.0.253, at least two are going to be used for the AP and a laptop installed with the EnerVista software, which will be used to configure the 8 Series devices. The AP should be configured with the

address 192.168.0.1 and mask 255.255.255.0 and have DHCP enabled with a DHCP range from 192.168.0.2 to 192.168.0.253. This allows laptops, iPads and any other devices to connect to the local network without the need to statically configure their own IP address and mask.

WiFi GWY IP Address

The setting specifies the address of the access point AP which the 8 Series device uses for communicating over Wi-Fi.

WiFi Security

The setting enables Wi-Fi security. If set to "None", there is no security and all traffic is open. By default WiFi Security is set to WPA2-PSK.

WiFi SSID

The SSID is the public name of a wireless network. All of the wireless devices on a WLAN must use the same SSID in order to communicate with each other. The default for the SSID is provided by the vendor with the shipment of any new 8 Series device. It is recommended that the customer modifies this name as needed after initial startup, to ensure unique SSIDs if several WLANs are configured.

SSID broadcast should be disabled on AP. This provides some extra protection by requiring an SSID before connecting to the device and making it harder for casual outsiders looking for wireless networks to find the device and attempt to connect.

WiFi WPA2 Passphrase

The WPA2 Passphrase is used for generating the encryption key. The same passphrase must be set on AP and on all devices communicating on the same WLAN. The 8 Series device supports a string of up to 14 printable ASCII characters. Internally a 256-bit key is calculated by applying the PBKDF2 key derivation function to this passphrase, using the SSID as the salt and 4096 iterations of HMAC-SHA1.

The 8 Series devices are configured with a default passphrase, which is provided by the vendor with the shipment of any new 8 Series device.

When choosing a new passphrase, the password complexity rules of CyberSentry must be used (see CyberSentry details in the relay Instruction manual).

This field is visible only if the security is set to WPA2-PSK.

Ideally the passphrase should be set through EnerVista and not directly from the Keypad, where there are limitations in terms of space and types of characters supported. However, for convenience, the passcode setting is available from the Keypad as well.

WiFi Status

A Wi-Fi symbol is displayed in the caption area of the 8 Series product front panel. The following table lists all possibilities for this icon:

Wi-Fi State	Wi-Fi Icon Color
Disabled	Icon is grey and crossed by a red line
Disconnected	Grey
Connecting	Yellow
Connected	Green

Wi-Fi Events

Event	Description
Wi-Fi Connected	This event is recorded to indicate a network connect.
Wi-Fi Disconnected	This event is recorded to indicate a network disconnect.

NOTE

If the relay is in service mode and the settings are default a minor error is triggered.

Wi-Fi Quick Start Procedure

The following provides the settings information and instructions to quickly setup Wi-Fi.

Required Equipment

- 8 Series Relay with Wi-Fi functionality
- PC with Wi-Fi
- Access Point

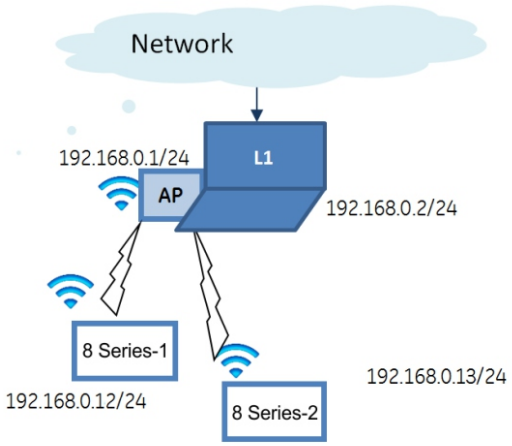
Quick Start Procedure

1. The PC Wi-Fi Network Settings are as follows:
   Passphrase: provided with the 8 Series relay
2. The Access Point Settings are given below:

IP address:	192.168.0.1
Subnet Mask:	255.255.255.0
SSID:	same as entered on the PC (SSID provided with the 8 Series relay)
Broadcast	disabled
Security type:	WPA2-PSK (WPA2-Personal)
Encryption:	AES
Passphrase:	same as entered on the PC (Passphrase provided with the 8 Series relay)
DHCP enabled	range of 192.168.0.12 to 192.168.0.253

3. Any 8 Series relays in range are automatically connect to the configured Access Point.
4. Start EnerVista on a PC and use the Discover function, all relays within range appear and are populated in EnerVista for initial configuration and commissioning.
5. Once the relay is configured, change the 8 Series relay default Wi-Fi SSID and Passphrase settings before the relay goes into service.

Figure 2-1: Example of Wi-Fi Deployment



USB

The USB parameters are as follows:

IP Address: 172.16.0.2

IP Subnet Mask: 255.255.255.0

IP GWY IP Address: 172.16.0.1

NOTICE

Whenever the device is rebooted, the USB cable needs to be unplugged and plugged in again for proper communication to be established over USB.

NOTICE

Connecting multiple 8 Series relays over USB to a single PC is not possible because in the case of USB, the IP address of the device 172.16.0.2 is constant.

Using the Quick Connect Feature via the USB Port

From the EnerVista 8 Series Setup software the **Quick Connect** button can be used to establish a fast connection through the front panel USB port of an 8 Series relay.

Before starting, verify that the standard USB cable is properly connected from the laptop computer to the front panel USB port.

1. Verify that the latest version of the EnerVista 8 Series Setup software is installed (available from the GE EnerVista CD or online from http://www.gegridsolutions.com/multilin). See the software installation section in the*relay*Instruction Manual for installation details.
2. Open the 8-Series Setup.
3. Select the device to start EnerVista 8 Series Setup.
4. Click the **Quick Connect** button to open the Quick Connect dialog box.

5. Set the **Interface** to USB, then click **Connect**.
6. The EnerVista 8 Series Setup software creates a site named "Quick Connect" with a corresponding device also named "Quick Connect" and displays them on the upper-left corner of the screen. Expand the sections to view data directly from the device.

Ethernet Ports

The following communication offerings are available.

Base Offering

Modes: 10/100 Mbps

One Port: RJ45

Protocol: Modbus TCP

Communications Card Option "C" - 2x Copper (RJ45) Ports

Modes: 10/100 MB

Two Ports: RJ45 (with this option both enabled ports are on the communications card; the Ethernet port located on the base CPU is disabled)

Protocols: Modbus TCP, DNP 3.0, IEC 60870-5-104, IEC 61850 GOOSE, IEEE 1588, SNTP, IEC 62439-3 clause 4 (PRP)

Communications Card Option "S" - 2x ST Fiber Ports

Modes: 100 MB

Two Ports: ST (with this option both enabled ports are on the communications card; the Ethernet port located on the base CPU is disabled)

Protocols: Modbus TCP, DNP 3.0, IEC 60870-5-104, IEC 61850 GOOSE, IEEE 1588, SNTP, IEC 62439-3 clause 4 (PRP)

Wavelength: 1300 nm

Typical link distance: 4 km

Network Settings Menu

The following are the network settings menu of the 8 Series relay to accommodate the features of the 8 Series relay product. If the communications card is installed network port 1 is no longer available. When using more than one Ethernet port, configure each to belong to a different network or subnet using the IP addresses and mask, else communication becomes unpredictable when more than one port is configured to the same subnet.

The softkeys and Down/Up key can be used to enter an IP address. When entering an IP address you must press the "Back" key first to switch between softkey mode and the Down/Up key mode.

NETWORK 1, 4, 5, PRT1(4,5) IP ADDRESS

Range: Standard IPV4 Address format

Default: 169.254.3.3 (Port 1)

Default: 127.0.0.1 (Port 4, 5)

The setting sets the port's IPV4 address in standard IPV4 format.

The setting is valid on Port 1 if the optional communications card is not present.

The setting is valid on Port 5 if Port 4's OPERATION is set to INDEPENDENT.

PRT1(4,5) SUBNET IP MASK

Range: Standard IPV4 mask format

Default: 255.255.255.0 (Port 1)

Default: 0.0.0.0 (Port 4, 5)

This setting specifies the IPv4 mask associated with the corresponding port IP address.

PRT1 GWY ADDRESS

This setting sets the ports IPv4 GATEWAY address in standard IPv4 format.

This setting is only valid on port 1.

This setting is not present on port 4 and 5, which are available on the communications card.

The communications card comes with the capability of setting a number of static routes and one default route, which is used instead of default gateways.

- The fiber optic ports support only 100 Mbps.

- Changes to the Ethernet communications settings take effect only after rebooting the relay.
- All Ethernet ports have flex operands associated with them. A failure of one of the Ethernet ports will trigger an event, a target message and the corresponding operand set.

PRT4 OPERATION

Range: Independent, LLA, PRP
Default: Independent

This setting determines the mode of operation for ports 4 and 5: Independent, LLA or PRP.

INDEPENDENT operation: ports 4 and 5 operate independently with their own MAC and IP address.

LLA operation: the operation of ports 4 and 5 are as follows:

Ports 4 and 5 use port 4's MAC and IP address settings while port 5 is in standby mode in that it does not actively communicate on the Ethernet network but monitors its link. If Port 4 is active and the link loss problem is detected, communications is switched to Port 5 immediately. Port 5 is, in effect, acting as a redundant or backup link to the network for port 4.

LLA (Link Loss Alert) is a proprietary feature supported by the 8 Series relay fiber optic ports. When enabled on an 8 Series fiber optic port, this feature is able to detect a failure of the fiber link. If port 4's **OPERATION** is set to LLA, the detection of a link failure by this feature triggers the transfer of communications from Port 4 to Port 5. If LLA is enabled on a port with a non-fiber SFP, the target message "LLA not supported by Prt (4 or 5)" is displayed on the keypad and an event is logged.

PRP (Parallel Redundancy Protocol) operation: ports 4 and 5 use the same MAC 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 (8 Series relay) 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. Ports of PRP devices operating with the same Internet Protocol (IP) addresses for traffic that uses IP Management protocols such as Address Resolution Protocol (ARP) must operate correctly.

Duplicate Discard mode (only mode supported by the 8 Series). This is the normal setting for PRP operation and once set it allows the sender LRE to append a six-octet field that contains a sequence number, the Redundancy Control Trailer (RCT) to both frames it sends. The receiver LRE uses the sequence number of the RCT and the source MAC address to detect duplicates. It forwards only the first frame of a pair to its upper layers.

Routing

When the configuration card is present, a default route and a maximum number of 6 static routes can be configured. The default route is used as the last choice, if no other route towards a given destination is found.

Path:Setpoints > Device > Communications > Routing > Default Route

GATEWAY ADDRESS

Range: Standard IPV4 unicast address format (0.0.0.1 to 223.255.255.254)

Default: 127.0.0.1

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.

This setting is available only if the communications card is present.

Path:Setpoints > Device > Communications > Routing > Static RT1 (2 to 6)

RT1 (2,3,4,5,6) DESTINATION

Range: Standard IPV4 network address format (0.0.0.1 to 223.255.255.254)

Default: 127.0.0.1

This setting sets the destination IPv4 route. This setting is available only if the communications card is present.

RT1 (2,3,4,5,6) MASK

Range: Standard IPV4 network mask format

Default: 255.0.0.0

This setting sets the IP mask associated with the route. This setting is available only if the communications card is present.

RT1 (2,3,4,5,6) GATEWAY

Range: Standard IPV4 unicast address format (0.0.0.1 to 223.255.255.254)

Default: 127.0.0.1

This setting sets the destination IP route. This setting is available only if the communications card is present.

ADDING AND DELETING STATIC ROUTES

Defaults:

Rule #1.
By default, the value of the destination field is 127.0.0.1 for all static routes (1 to 6). This is equivalent to saying that the static routes are not configured. When the destination address is 127.0.0.1, the mask and gateway must also be kept as default values.

Rule #2.
By default, the value of the default route gateway address is 127.0.0.1. This means the default route is not configured.

Adding a route:

Rule #3.
Use any of the static network route entries numbered 1 to 6 to configure a static network route. Once a route destination is configured for any of the entries 1 to 6, that entry becomes a static route and it must meet all the rules listed in *Important Notes* below.

Rule #4.
To configure the default route, enter a default gateway address. A default gateway address configured must be validated against Rule #5, the next rule.

Deleting a route:

Rule #5.
Routes are deleted by replacing the route destination with the default address (127.0.0.1). When deleting a route, the mask and gateway must also be put back to their default values.

Rule #6.
The default route is deleted by replacing the default gateway with the default value 127.0.0.1.

Important Notes:

1. Host routes are not supported at present.
2. The route mask has IPv4 mask format. In binary this is 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.

4. Item #3, above, can be verified by checking that RtDestination & RtMask == RtDestination
5. This is an example of a good configuration: RtDestination= 10.1.1.0; Rt Mask= 255.255.255.0
6. This is an example of a bad configuration: RtDestination = 10.1.1.1; Rt Mask= 255.255.255.0
7. The route destination must not be a connected network.
8. The route gateway must be on a connected network. This rule applies to the gateway address of the default route as well.
9. Item #8, above, can be verified by checking that:
   RtGwy & Prt4Mask) == (Prt4IP & Prt4Mask) || (RtGwy & Prt5Mask) == (Prt5IP & Prt5Mask)

TARGETS

WRONG ROUTE CONFIG

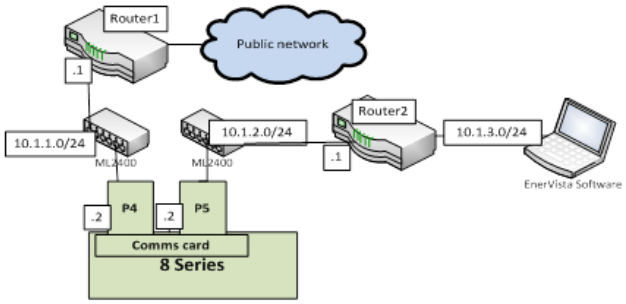
Description: A route with mismatched destination and mask has been configured.

Message: "Wrong route configuration.

"What to do: Rectify the IP address and mask of the mis-configured route.

TOPOLOGY EXAMPLE

Figure 2-2: Topology Example



In the Topology Example above, the 8 Series device is connected through the two Ethernet ports available on the communications card.

- Port 4 (IP address 10.1.1.2) connects to LAN 10.1.1.0/24 and to the Internet through Router1. Router 1 has an interface on 10.1.1.0/24 and the IP address of this interface is 10.1.1.1.
- Port 5 (IP address 10.1.2.2) connects to LAN 10.1.2.0/24 and to EnerVista setup program through Router 2. Router 2 has an interface on 10.1.2.0/24 and the IP address of this interface is 10.1.2.1.

Configuration

Network addresses:

PRT54IP ADDRESS = 10.1.1.2PRT4 SUBNET IP MASK = 255.255.255.0PRT5 IP ADDRESS = 10.1.2.2PRT5 SUBNET IP MASK = 255.255.255.0

Routing Settings:

IPV4 DEFAULT ROUTE: GATEWAY ADDRESS = 10.1.1.1

STATIC NETWORK ROUTE 1:

- RT1 DESTINATION = 10.1.3.0/24RT1 NET MASK = 255.255.255.0RT1 GATEWAY = 10.1.2.1

Behavior: One static network route was added to the destination 10.1.3.0/24, where a laptop running EnerVista is located. This static route uses a different gateway (10.1.2.1) than the default route. This gateway is the address of Router 2, which is “aware” of destination 10.1.3.0 and is able to route packets coming from the 8 Series device and destined to EnerVista.

Status

TCP Connections Status

These values specify the maximum and the remaining number of TCP connections still available for each protocol. Depending on the order code, some protocols may be hidden.

Each time a connection is used, the remaining number of connections decrements. When a connection is released, the remaining number of connections increments. If no connection is made over the specific protocol, the number remaining equals the maximum number available for the specific protocol.

For example, the maximum number of Modbus TCP connections is 5. Once an EnerVista session is opened on a computer connected to the 8series over Ethernet, the Modbus TCP status shows 4. If the EnerVista application is closed, the Modbus TCP status shows 5.

The following are the Maximum TCP connections per protocols for the “SE” communications order code option:

Modbus TCP - Maximum	3*
DNP TCP - Maximum	2 (Depends on number of configured channels)

* With USB or WiFi connections, this number decreases as follows:

- 1 USB or 1 WiFi connection: Modbus TCP - Maximum = 2
- 1 USB and 1 WiFi connection: Modbus TCP - Maximum = 1

The following are the Maximum TCP connections per protocols for the Advanced communications order code options:

MMS TCP - Maximum	8
Modbus TCP - Maximum	5
DNP TCP - Maximum	2 (Depends on the number of configured channels)
IEC-104 TCP -Maximum	2 (Depends on the number of configured channels)
OPC-UA - Maximum	3
SFTP - Maximum*	8 (2 x 1 Administrator, 2 x 3 Observers)

* SFTP is only available with the Advanced security option.

Path:Status > Communications > Connections

MMS TCP - Maximum

Default: 0 (SE), 8 (Advanced)

MMS TCP - Remaining

Modbus TCP - Maximum

Default: 3 (SE), 5 (Advanced)

For the "SE" communications option, a USB or WiFi connection decreases the number of remaining Modbus TCP connections, by up to two (one for USB and one for WiFi).

Modbus TCP - Remaining

DNP TCP - Maximum

Default: 2 (Depends on the number of configured channels)

DNP TCP - Remaining

IEC - 104 - Maximum

Default: 0 (SE), 2 (Advanced. Depends on the number of configured channels)

IEC - 104 - Remaining

OPC - UA - Maximum

Default: 0 (SE), 3 (Advanced)

OPC - UA - Remaining

SFTP - Maximum

Default: 0 (SE), 8 (Advanced. 2 x 1 Administrator, 2 x 3 Observers)

SFTP is only available with the Advanced security option.

SFTP - Remaining

Activity Status

The communication state for each enabled communication type is shown by its value. The main CPU and Comms software sets/resets the active bits for all enabled communication types. The communication state bits are not latched.

Path:Status > Communications > Activity Status

SERIAL MODBUS

Range: NONE, ACTIVE
Default: NONE

SERIAL DNP

Range: NONE, ACTIVE
Default: NONE

SERIAL IEC103

Range: NONE, ACTIVE
Default: NONE

ETHERNET MODBUS

Range: NONE, ACTIVE
Default: NONE

ETHERNET DNP

Range: NONE, ACTIVE
Default: NONE

ETHERNET IEC104
Range: NONE, ACTIVE
Default: NONE

ETHERNET IEC61850
Range: NONE, ACTIVE
Default: NONE

ETHERNET GOOSE
Range: NONE, ACTIVE
Default: NONE

ETHERNET DEVICENET
Range: NONE, ACTIVE
Default: NONE

ETHERNET PROFIBUS
Range: NONE, ACTIVE
Default: NONE

8 Series Protective Relay Platform

Chapter 3: Time Protocols

Real-time Clock

Path: Setpoints > Device > Real Time Clock

The 8 Series relay 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 8 Series relay supports an internal clock, SNTP, IRIG-B, and PTP IEEE 1588 (version 2)as potential time references.

If two or more time sources are available, the time source with the higher priority shown in Time Sources table is used where 1 is considered to be the highest priority. Please note that the time source priority of PTP and IRIG-B can be swapped. If both PTP and IRIG-B are available to the 8 Series relay, by default the 8 Series relay clock syncs to PTP over IRIG-B. If PTP is not available the 8 Series relay CPU syncs the internal clock to IRIG-B.

Table 3-1: Time Sources

Time Source	Priority
PTP (IEEE1588)	1*
IRIG-B	2*
SNTP	3
Internal Clock	4

* The priority of IRIG-B and PTP can be swapped.

NOTICE

Synchronization by IEC103, DNP, Modbus and IEC104 is not going to be issued if there is a sync source from IRIG-B, SNTP or PTP.

IEEE 1588 Precision Time Protocol (PTP version 2)

PTP Status

The present values of the PTP protocol are displayed here.

Path:Status > PTP

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.

RTC Accuracy is the estimated maximum time difference at present in the Real Time Clock (RTC), considering the quality information imbedded 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 difference is one second or more, or that the difference cannot be estimated.

Port 4 (5) PTP State is the present state of the port's PTP clock. The PTP clock state is:

- DISABLED
  If the port's function setting is Disabled
- NO SIGNAL
  If enabled but no signal from an active master has been found and selected
- CALIBRATING
  If an active master has been selected but lock is not at present established
- SYNCH'D (NO PDELAY)
  If the port is synchronized, but the peer delay mechanism is non-operational
- SYNCHRONIZED
  If the port is synchronized

PTP Configuration

Path: Setpoints > Device > Real Time Clock > Precision Time

PORT 4(5) PTP FUNCTION

Range: Disabled, Enabled

Default: Enabled

When the port setting is selected as "Disabled," PTP is disabled on the port. The relay does not generate, or listen to, PTP messages on the port.

PORT 4(5) PATH DELAY ADDER

Range: 0 to 60000 ns in steps of 1 ns

Default: 0 ns

The time delivered by PTP is advanced by the time value in the setting prior to the time being used to synchronize the relay's real time clock. This is to compensate for time delivery delays not compensated for in the network. In a fully compliant Power Profile (PP) network, the peer delay and the processing delay mechanisms compensate for all the delays between the grandmaster and the relay. In such networks, the setting is 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. The setting can be used to approximately compensate for the delay. Since the relay is not aware of network switching that dynamically changes the amount of uncompensated delay, there is no setting that always completely corrects for uncompensated delay. A setting can be chosen that reduces worst-case error to half of the range between minimum and maximum uncompensated delay if these values are known.

PORT 4(5) PATH DELAY ASYMMETRY

Range: -1000 to +1000 ns in steps of 1 ns

Default: 0 ns

The setting corresponds to "Delay Asymmetry" 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 the setting is set to zero.

In unusual cases where the length of link is different in different directions, the setting is to be set to the number of nanoseconds longer the Ethernet propagation delay is to the relay compared with 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 9000 ns and that the delay from the switch to the relay is 11000 ns, then the mean delay is 10000 ns, and the path delay asymmetry is +1000 ns.

STRICT POWER PROFILE

Range: Enabled, Disabled

Default: Enabled

Power profile (IEEE Std C37.238™ 2011) requires that the grandmaster clock be power profile compliant, that the delivered time have a worst-case error of ±1 µs, and that the peer delay mechanism be implemented. With the strict power profile setting enabled, the relay selects as master only 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.

The setting applies to all of the relay's PTP-capable ports.

PTP DOMAIN NUMBER

Range: 0 to 255

Default: 0

The setting is set to the domain number of the grandmaster-capable clock(s) to which they can be synchronized. 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.

The setting applies to all of the relay's PTP-capable ports.

PTP VLAN PRIORITY

Range: 0 to 7

Default: 4

The 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 (Power Profile) 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.

The setting applies to all of the relay's PTP-capable ports.

PTP VLAN ID

Range: 0 to 4095
Default: 0

The 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 (Power Profile). 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.

The setting applies to all of the relay's PTP-capable ports.

PTP PRIORITY

Range: 1, 2
Default: 1

The setting sets the priority of PTP time for the relay. If set to 1 and IRIG-B is available, the relay syncs the relay's time reference to the PTP time. If set to 2 and IRIG-B is available, the relay syncs its reference to IRIG-B time.

Clock

Path:Setpoints > Device > Real Time Clock > Clock

DATE

Format: Month/Day/Year
Range: Month: 1 to 12; Day: 1 to 31; Year: 2008 to 2094
Default: 01/01/2008

TIME

Range: 0 to 23: 0 to 59:0 to 59
Default: 00:00:00

LOCAL TIME OFFSET FROM UTC

Range: –24.0 to 24.0 hrs in steps of 0.5 hrs
Default: 0.0 hrs

REAL TIME CLOCK EVENTS

Range: Disabled, Enabled
Default: Enabled

IRIG-B

Range: Disabled, Enabled
Default: Disabled

DAYLIGHT SAVINGS TIME

Range: Disabled, Enabled
Default: Disabled

DST START MONTH

Range: January to December (all months)
Default: Not Set

DST START DAY

Range: SUN to SAT (all days of the week)
Default: Not Set

DST START WEEK

Range: 1st, 2nd, 3rd, 4th, Last
Default: Not Set

DST START HOUR
Range: 0 to 23
Default: 2

DST END MONTH
Range: January to December (all months)
Default: Not Set

DST END WEEK
Range: 1st, 2nd, 3rd, 4th, Last
Default: Not Set

DST END DAY
Range: SUN to SAT (all days of the week)
Default: Not Set

DST END HOUR
Range: 0 to 23
Default: 2

IRIG-B

IRIG-B is available in all 8 Series relays. A failure on IRIG-B triggers an event and a target message.

NOTICE

Note that IRIG-B is auto detected. The signal type is detected in the hardware, so there are no configurable options.

8 Series Protective Relay Platform

Chapter 4: DNP Protocol

Path: Setpoints > Device > Communications > DNP protocol

DNP Channel 1(2) Port

Range: NONE, NETWORK - TCP, NETWORK - UDP
Default: NONE

The **DNP Channel 1 Port** and **DNP Channel 2 Port** settings select the communications port assigned to the DNP protocol for each channel. When this setting is set to "Network - TCP", the DNP protocol can be used over TCP/IP on channels 1 or 2. When this value is set to "Network - UDP", the DNP protocol can be used over UDP/IP.

DNP Address

Range: 0 to 65519 in steps of 1
Default: 65519

The DNP address sets the DNP slave address. This number identifies the 8 Series relay on a DNP communications link. Each DNP slave must be assigned a unique address.

DNP Client Address 1(2)

Range: standard IP address
Default: 0.0.0.0

The DNP Client Address settings can force the 8 Series relay to respond to a maximum of two specific DNP masters.

DNP TCP/UDP Port 1(2)

Range: 1 to 65535 in steps of 1
Default: 2000


NOTE

"DNP Channel 1 Port" will take the "**DNP TCP/UDP Port 1**" and "**DNP Client Address 1**" to allow/reject connections. The same relation is used by channel 2.

DNP Unsol Resp Function

Range: Enabled, Disabled
Default: Disabled

This setting will take effect for Ethernet communication only if the main card is present or a comms card is available in the device. This setting enables/disables the unsolicited response functionality. It is disabled for RS485 applications since there is no collision avoidance mechanism.

DNP Unsol Resp Timeout

Range: 0 to 60 s in steps of 1

Default: 5 s

Sets the time the 8 Series relay waits for a DNP master to confirm an unsolicited response.

Unsol Resp Max Retries

Range: 1 to 255 in steps of 1

Default: 10

Sets the number of times the 8 Series relay retransmits an unsolicited response without receiving confirmation from the master; a value of "255" allows infinite re-tries.

DNP Unsol Resp Dest Addr

Range: 1 to 65519 in steps of 1

Default: 1

Sets the DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the 8 Series relay from the current TCP connection or the most recent UDP message.

DNP Time Sync IIN Period

Range: 1 to 10080 min. in steps of 1

Default: 1440 min

This setting determines how often the Need Time Internal Indication (IIN) bit is set by the 8 Series relay. Changing this time allows the DNP master to send time synchronization commands more or less often, as required.

If the requirement for synchronization is more than a couple of seconds, consider synchronization via other means such as IRIGB or 1588. Given network asymmetry, the consistency of the network latency, clock drift, and additional delays due to routers located between the client and the 8 Series relay all contribute error.

DNP Message Fragment Size

Range: 30 to 2048 in steps of 1

Default: 240

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.

DNP OBJECT 1(32) Default Variation

These settings allow selection of the DNP default variation number for object types 1, 2, 20, 21, 22, 23, 30, and 32. The default variation refers to the variation response when variation 0 is requested and/or in class 0, 1, 2, or 3 scans.

TCP Connection Timeout

Range: 10 to 300 s in steps of 1

Default: 120 s

This setting specifies a time delay for the detection of dead network TCP connections. If there is no data traffic on a DNP TCP connection for greater than the time specified by this setting, the connection will be aborted by the 8 Series relay. This frees up the connection to be re-used by a client.

DNP communication

The 8 Series relay supports Distributed Network Protocol (DNP) version 3.0. and the 8 Series relay operates as a DNP slave device. Two DNP masters can actively communicate with the 8 Series relay at one time as the 8 Series relay maintains two sets of DNP data change buffers and connection information. The following is a detailed explanation of the 8 Series relay 's DNP 3 implementation.

NOTICE

Both DNP and IEC104 protocol can work at the same time, but the user has to consider that there is only one point map. So, the two protocols will use the same data mapping, i.e. the same point index and same point source.

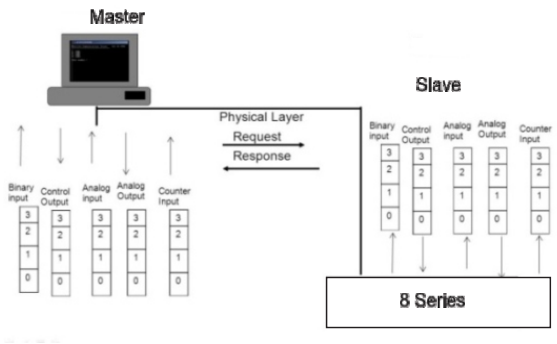
NOTICE

The 8 Series relay supports two DNP3.0 client connections simultaneously.

NOTICE

When configuring DNP do not use port 20057 since it is reserved for internal purposes by the unit itself.

Figure 4-1: DNP Data Types



DATA TYPES

Binary input data: Binary input data is used to monitor two-state device operations such as the position of a circuit breaker. The user can configure up to 96 Binary inputs. All binary inputs are configured from FlexLogic operands. For a complete list, see Format Code FC142.

Binary output data: Binary output data is used to control two-state devices such as the tripping or circuit closing of a circuit breaker. The 8 Series relay can be configured to support up to 16 Binary outputs. The slave's Binary outputs are automatically mapped into the 8 Series relay virtual inputs starting at virtual input 1. Please note that the number of Binary/ Control outputs is configurable. The user can configure a subset that supports dual point control. This subset starts at address 0.

Analog input data: Analog input data is used to monitor analog signals such as voltages, currents, and power. Up to 32 analog points can be mapped to the master.

Analog output data: Not supported in the 8 Series relay .

Time stamps

Count input data: Count input data could represent a cumulative quantity such as kilowatt-hours of energy. Up to 16 counter points can be mapped to the master.

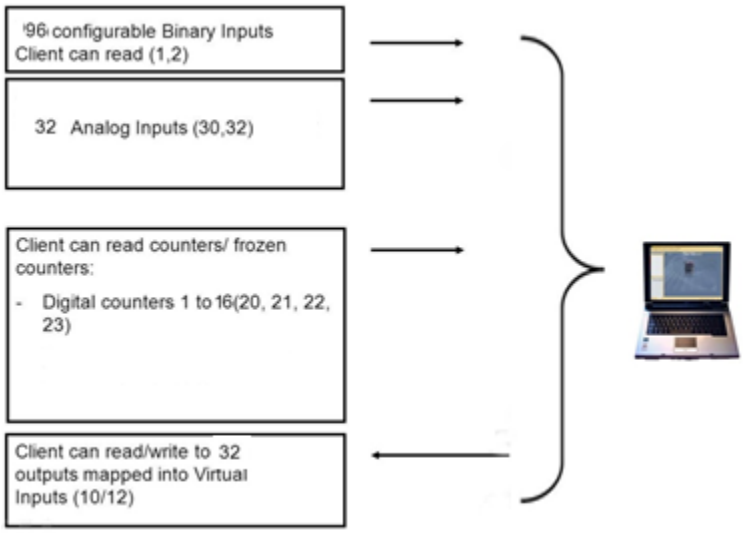


Table 4-1: Supported Object Numbers

Object	DNP Data Type	8 Series relay
1	Binary Input Status	User Assigned FlexLogic Operands
2	Binary Input Change since last read	
10	Binary Output Status for monitoring	User assigned Virtual Inputs and/ or Commands (client looks at status only)
12	Control Relay Output Block	User assigned Virtual inputs and/ or Commands (client can write to the user specified number of control relay outputs)
20	Counter Value	Digital counters 1 through 16.
21	Frozen Counter Value	
22	Counter Value Change since last read	
23	Frozen Counter Value Change since last read by client	
30	User configured Analog Input value	
32	User configured Analog Input value changed since last time read by client	

Analog Variation Numbers	Data Format
1	32-bit integer value with flag
2	16-bit integer value with flag
3	32-bit integer value without flag
4	16-bit integer value without flag
5	32-bit floating point value with flag

The following setpoints are in the **PATH**: SETPOINTS > DEVICE > COMMUNICATIONS > DNP PROTOCOL

DNP CHANNEL 1 PORT

Range: NONE, NETWORK - TCP, NETWORK- UDP
Default: NONE

DNP CHANNEL 2 PORT

Range: NONE, NETWORK - TCP, NETWORK- UDP
Default: NONE

The DNP Channel 1 Port and DNP Channel 2 Port settings select the communications port assigned to the DNP protocol for each channel. When this setting is set to "Network - TCP," the DNP protocol can be used over TCP/IP on channels 1 or 2. When this value is set to "Network - UDP," the DNP protocol can be used over UDP/IP.

NOTICE

If the additional communication module is not present, only RS485 is a possible option. The Network options are hidden in this case and the DNP channel is assigned to the RS485 port by default.

DNP ADDRESS

Range: 0 to 65519 in steps of 1
Default: 65519

Sets the DNP slave address. This number identifies this 8 Series relay on a DNP communications link. Each DNP slave should be assigned a unique address.

DNP NETWORK CLIENT ADDRESS 1(2)

Range: Standard IP Address
Default: 0.0.0.0

The DNP Network Client Address settings can force the 8 Series relay to respond to a maximum of two specific DNP masters.

DNP TCP/UDP PORT NUMBER 1 (2)

Range: 1 to 65535 in steps of 1
Default: 20000

The DNP NETWORK CLIENT ADDRESS 1(2) and DNP TCP/UDP PORT NUMBER 1(2) settings are available only if the communications card is present. "DNP Channel 1 Port" takes the "Port Number 1" and "Client Address 1" to allow or reject connections. The same relation is used by channel 2.

DNP UNSOL RESPONSE FUNCTION

Range: Enabled, Disabled
Default: Disabled

Should be "Disabled" for RS485 applications since there is no collision avoidance mechanism. Unsolicited response settings is hidden if the communication card is not present, as DNP runs only on RS485 in this case.

DNP UNSOL RESPONSE TIMEOUT

Range: 0 to 60 s in steps of 1 s
Default: 5 s

Sets the time the 8 Series relay waits for a DNP master to confirm an unsolicited response.

DNP UNSOL RESPONSE MAX RETRIES

Range: 1 to 255 in steps of 1
Default: 10

Sets the number of times the 8 Series relay retransmits an unsolicited response without receiving confirmation from the master; a value of "255" allows infinite re-tries.

DNP UNSOL RESPONSE DEST ADDRESS

Range: 0 to 65519 in steps of 1
Default: 1

Sets the DNP address to which all unsolicited responses are sent. The IP address to which unsolicited responses are sent is determined by the 8 Series relay from the current TCP connection or the most recent UDP message.

DNP TIME SYNC IIN PERIOD

Range: 1 to 10080 min in steps of 1 min
Default: 1440 min

This setting determines how often the Need Time Internal Indication (IIN) bit is set by the 8 Series relay . Changing this time requires the DNP master to send time synchronization commands more or less often, as this setting time period.

NOTICE

If the requirement for time synchronization is more than a couple of seconds the user is advised to consider time-sync via other means such as IRIG-B or 1588, given network asymmetry, the consistency of the network latency, clock drift and additional delays due to routers located between the client and the 8 Series relay , all of which contribute errors.

DNP MESSAGE FRAGMENT SIZE

Range: 30 to 2048 in steps of 1
Default: 240

This setting determines the size (maximum length of frame), 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.

DNP OBJECT 1(2) DEFAULT VARIATION

Range: 1, 2
Default: 2

These settings allow the user to select the DNP default variation number for object types 1, 2, 20, 21, 22, 23, 30, and 32. The default variation refers to the variation response when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. The DNP binary outputs typically map one-to-one to IED data points. That is, each DNP binary output controls a single physical or virtual control point in an IED. In the 8 Series relay, DNP binary outputs are mapped to virtual inputs.

DNP OBJECT 20(22) DEFAULT VARIATION

Range: 1, 2, 5, 6
Default: 1

For explanation, see above.

DNP OBJECT 21 DEFAULT VARIATION

Range: 1, 2, 9, 10
Default: 1

For explanation, see above.

DNP OBJECT 23 DEFAULT VARIATION

Range: 1, 2, 5, 6
Default: 2

For explanation, see above.

DNP OBJECT 30 DEFAULT VARIATION

Range: 1, 2, 3, 4, 5
Default: 1

For explanation, see above.

DNP OBJECT 32 DEFAULT VARIATION

Range: 1, 2, 3, 4, 5, 7

Default: 1

For explanation, see above.

DNP TCP CONNECTION TIMEOUT

Range: 10 to 300 s in steps of 1 s

Default: 120 s

The setting specifies a time delay for the detection of failed network TCP connections. If there is no data traffic on a DNP TCP connection for greater than the time specified by the setting, the connection is aborted by the 8 Series relay. This frees up the resource for the connection and allows another DNP TCP connection request.

DNP device profile

DNP 3.0 Device Profile	
(Also see the IMPLEMENTATION TABLE in the following section)	
Vendor Name: **General Electric Multilin**	
Device Name: **8 Series relay**	
Highest DNP Level Supported: For Requests: **Level 2** For Responses: **Level 2**	
Device Function: ☐Master ☒ **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 Input Changes (Object 2)** **Binary Outputs (Object 10)** **Control Relay Output Block (Object 12)** **Binary Counters (Object 20)** **Frozen Counters (Object 21)** **Counter Change Event (Object 22)** **Frozen Counter Event (Object 23)** **Analog Inputs (Object 30)** **Analog Input Changes (Object 32)** **Analog Deadbands (Object 34)**	
Time and Date (Object 50) **Time Delay Fine (Object 52)** **Class Data (Object 60)** **Internal Indications (Object 80)**	
Maximum Data Link Frame Size (octets):	**Maximum Application Fragment Size (octets):**
Transmitted: **292**	Transmitted: **configurable up to 2048**
Received: **292**	Received: **2048**
Maximum Data Link Re-tries:	**Maximum Application Layer Re-tries:**
☒**None**	☒ **None**
☐Fixed at 3	☐ Configurable
☐Configurable	

DNP 3.0 Device Profile	
Requires Data Link Layer Confirmation: ☒ **Never** ☐ Always ☐Sometimes ☐Configurable	
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 ☐Variable ☐ Configurable Complete Appl. Fragment: ☒ **None** ☐Fixed ☐Variable ☐Configurable Application Confirm: ☐ None ☒ **Fixed at 10 s** ☐Variable ☐Configurable Complete Appl. Response: ☒ **None**☐Fixed at ___ ☐Variable ☐ Configurable	
Others: Transmission Delay: **No intentional delay** Need Time Interval: **Configurable (default = 24 hrs.)** Select/Operate Arm Timeout: **10 s** Binary input change scanning period: **8 times per power system cycle** Analog input change scanning period: **500 ms** Counter change scanning period: **500 ms** Frozen counter event scanning period: **500 ms**	
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	
Explanation of 'Sometimes': Object 12 points are mapped to Virtual Inputs and Commands (Force Coils). Both "Pulse On" and "Latch On" operations perform the same function in the 8 Series relay ; that is, the appropriate Virtual Input or Coil is put into the "On" state. The On/Off times and Count value are ignored. "Pulse Off" and "Latch Off" operations put the appropriate Virtual Input or Coil into the "Off" state. "Trip" and "Close" operations both put the appropriate Virtual Input or coil into the "On" state if a paired mapping is set, otherwise "Trip" will put into "Off" and "Close" will put into "On".	
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** ☒**ENABLE/DISABLE** unsolicited Function codes supported	**Sends Static Data in Unsolicited Responses:** ☒**Never** ☐ When Device Restarts ☐ When Status Flags Change No other options are permitted.

DNP 3.0 Device Profile	
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 Counter Object/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	

DNP implementation

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	**VARIATION NO.**	**DESCRIPTION**	**FUNCTION CODES (DEC)**	**QUALIFIER CODES (HEX)**	**FUNCTION CODES (DEC)**	**QUALIFIER CODES (HEX)**
1	0	Binary Input (Variation 0 is used to request default variation)	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	---	---
	1	Binary Input	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	2	Binary Input with Status	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
2	0	Binary Input Change (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	---	---
	1	Binary Input Change without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	Binary Input Change with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	3	Binary Input Change with Relative Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	---	---
10	0	Binary Output Status (Variation 0 is used to request default variation)	1 (read)	00, 01(start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	---	---
	2	Binary Output Status	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 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 quantity) 17, 28 (index)	129 (response)	echo of request

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
20	0	Binary Counter (Variation 0 is used to request default variation)	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	---	---
	1	32-Bit Binary Counter	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	2	16-Bit Binary Counter	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	5	32-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	6	16-Bit Binary Counter without Flag	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
21	0	Frozen Counter(Variation 0 is used to request defaultvariation)	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	---	---
	1	32-Bit Frozen Counter	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	2	16-Bit Frozen Counter	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	9	32-Bit Frozen Counter without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	10	16-Bit Frozen Counter without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
22	0	Counter Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	---	---
	1	32-Bit Counter Change Event	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	16-Bit Counter Change Event	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	5	32-Bit Counter Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
	6	16-Bit Counter Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
23	0	Frozen Counter Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	---	---
	1	32-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	16-Bit Frozen Counter Event	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	5	32-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	6	16-Bit Frozen Counter Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
30	0	Analog Input (Variation 0 is used to request default variation)	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	---	---
	1	32-Bit Analog Input	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	2	16-Bit Analog Input	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	3	32-Bit Analog Input without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	4	16-Bit Analog Input without Flag	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
	5	short floating point	1 (read) 22 (assign class)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
32	0	Analog Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	---	---
	1	32-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	2	16-Bit Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	3	32-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	4	16-Bit Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	5	short floating point Analog Change Event without Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
	7	short floating point Analog Change Event with Time	1 (read)	06 (no range, or all) 07, 08 (limited quantity)	129 (response) 130 (unsol. resp.)	17, 28 (index)
34	0	Analog Input Reporting Deadband (Variation 0 is used to request default variation)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	---	---
	1	16-bit Analog Input Reporting Deadband (default - see Note 1)	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
			2 (write)	00, 01 (start-stop) 07, 08 (limited quantity) 17, 28 (index)	---	---
	2	32-bit Analog Input Reporting Deadband	1 (read)	00, 01 (start-stop) 06 (no range, or all) 07, 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
			2 (write)	00, 01 (start-stop) 07, 08 (limited quantity) 17, 28 (index)	---	---
50	1	Time and Date (default - see Note 1)	1 (read) 2 (write)	00, 01 (start-stop) 06 (no range, or all) 07 (limited qty=1) 08 (limited quantity) 17, 28 (index)	129 (response)	00, 01 (start-stop) 17, 28 (index) (see Note 2)
52	2	Time Delay Fine (quantity = 1)	129 (response)	07 (limited quantity)	---	---
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)	---	---
	1	Class 0 Data	1 (read) 22 (assign class)	06 (no range, or all)	---	---
	2	Class 1 Data	1 (read) 20 (enable unsol)	06 (no range, or all) 07, 08 (limited quantity)	---	---
	3	Class 2 Data	21 (disable unsol)		---	---
	4	Class 3 Data	22 (assign class)		---	---
80	1	Internal Indications	1 (read)	00, 01 (start-stop) (index =7)	129 (response)	00, 01 (start-stop)

OBJECT			REQUEST		RESPONSE	
OBJECT NO.	VARIATION NO.	DESCRIPTION	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)	FUNCTION CODES (DEC)	QUALIFIER CODES (HEX)
			2 (write) (see Note 3)	00 (start-stop) (index =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.)	---	---	---

NOTICE

1. A default variation refers to the variation response when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. The default variations for object types 1, 2, 20, 21, 22, 23, 30, and 32 are selected via relay settings. This optimizes the class 0 poll data size.
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, will be responded with qualifiers 00 or 01 (for changeevent objects, qualifiers 17 or 28 are always responded.)

Cold restarts are implemented the same as warm restarts – the 8 Series relay is not restarted, but the DNP process is restarted.

8 Series Protective Relay Platform

Chapter 5: DNP / IEC104 Point Lists

The menu path for the DNP/IEC104 point lists is shown below.

Path: Setpoints > Device > Communications > DNP/IEC104 Point Lists

Binary Input / MSP Points
Analog Input / MME Points
Binary Outp / CSC / CDC Pnts

Binary input points (DNP) or MSP points (IEC 60870-5-104)

The binary inputs points for the DNP protocol, or the MSP points for IEC 60870-5-104 protocol, can be configured to a maximum of 96 points. The data source for each point is user-programmable and can be configured by assigning FlexLogic operands. For a complete list, see Format Code FC142.

The menu path for the binary input points (DNP) or MSP points (IEC 60870-5-104) is shown below.

Path: Setpoints > Device > Communications > DNP/IEC104 Point Lists > Binary Input/MSP Points

Point 0 Entry
...
Point 255 Entry

Analog input points (DNP) or MME points (IEC 60870-5-104)

Up to 255 analog input points can be configured for the DNP or IEC 60870-5-104 protocols. The menu path for the analog input point (DNP) or MME points (IEC 60870-5-104) is shown below.

Path: Setpoints > Device > Communications > DNP/IEC104 Point Lists > Analog Input / MME Points

Analog IP Point 0 Entry
Point 0 Scale Factor
Point 0 Deadband

DNP ANALOG INPUT POINT 0(255) SCALE FACTOR

Range: / 0.001, / 0.01, / 0.1, / 1, / 10, / 100, / 1000, / 10000, / 100000
Default: /1

These are numbers used to scale analog input point values. Each setting represents the scale factor for the analog input point. For example, if the DNP PHASE A VOLTAGE SCALE FACTOR setting is set to "/ 1000", and the Phase A voltage is 72000 V, the Phase A voltage sent on to the 8 Series relay is 72 V. The settings are useful when analog input values must be adjusted to fit within certain ranges in DNP masters.

NOTICE

Note that a scale factor of "/ 0.1" is equivalent to a multiplier of 10.

DNP ANALOG INPUT POINT 0(255) DEADBAND

Range: 1 to 100000000 in steps of 1
Default: 30000

The setting is the threshold value to define the condition to trigger unsolicited responses containing analog input data. Each setting represents the default deadband value for the associated analog input. For example, to trigger unsolicited responses from the 8 Series relay when phase A current changes by 15 A, the DNP CURRENT DEADBAND for Phase A current should be set to "15". Note that these settings are the deadband default values. 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 8 Series relay the new deadbands are in effect.

Binary output points (DNP) or CSC/CDC points (IEC 60870-5-104)

The binary output points for the DNP protocol, or the CSC/CDC points for IEC 60870-5-104 protocol, can be configured to a maximum of 16 points. The data source for each point is user-programmable and can be configured by assigning FlexLogic operands. The menu path for the binary output points (DNP) or CSC/CDC points (IEC 60870-5-104) is shown below.

Path: Setpoints > Device > Communications > DNP/IEC104 Point Lists > Binary Output / CSC/CDC Points

Binary Output Point 0 ON
Binary Output Point 0 OFF
...
Binary Output Point 31 ON
Binary Output Point 31 OFF

NOTICE

The DNP / IEC 60870-5-104 point lists always begin with point 0 and end at the first "Off" value. Since DNP / IEC 60870-5-104 point lists must be in one continuous block, any points assigned after the first "Off" point are ignored.

BINARY INPUT POINTS

The DNP binary input data points are configured through the **DNP / IEC104 POINT LISTS BINARY INPUT / MSP POINTS** menu. When a freeze function is performed on a binary counter point, the frozen value is available in the corresponding frozen counter point.

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 with status), Configurable**
Change Event Variation reported when variation 0 requested: **2 (Binary Input Change with Time), Configurable**
Change Event Scan Rate: **8 times per power system cycle**
Change Event Buffer Size: **1024**
Default Class for All Points: **1**

POINT NAME/DESCRIPTION COUNTERS

The following details 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. 8 Series relay Digital Counter values are represented as 16 or 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 noack), 9 (freeze and clear), 10 (freeze and clear, noack), 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)**
Change Event Buffer Size: **10**
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 Counter Change Event without time)**
Change Event Buffer Size: **10**
Default Class for all points: **3**

BINARY AND FROZEN COUNTERS POINT INDEX NAME/DESCRIPTION

0 Digital Counter 1
1 Digital Counter 2
2 Digital Counter 3
3 Digital Counter 4
4 Digital Counter 5
5 Digital Counter 6
6 Digital Counter 7
7 Digital Counter 8
8 Digital Counter 9
9 Digital Counter 10
10 Digital Counter 11
11 Digital Counter 12
12 Digital Counter 13
13 Digital Counter 14
14 Digital Counter 15
15 Digital Counter 16

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 for 16-bit values and 2147483647 for 32-bit values. 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. 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.

NOTICE

1. A default variation refers to the variation response when variation 0 is requested and/or in class 0, 1, 2, or 3 scans. The default variations for object types 1, 2, 20, 21, 22, 23, 30, and 32 are selected via relay settings. This optimizes the class 0 poll data size.
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 with qualifiers 00 or 01. For change event objects, qualifiers 17 or 28 are always responded.

Cold restarts are implemented the same as warm restarts – the 8 Series relay is not restarted, but the DNP process is restarted.

8 Series Protective Relay Platform

Chapter 6: IEC 60870-5-104

The IEC 60870-5-104 communications protocol is supported on Ethernet ports 4 and 5 only. Setting changes become active after rebooting.

NOTICE

In 8 Series relay both DNP and IEC104 protocol can work at the same time, but consider that there is only one point map. So, the two protocols use the same data mapping, i.e., same point index and same point source.

NOTICE

The 8 Series relay supports up to two IEC104 client connections simultaneously.

Path: Setpoints > Device > Communications > IEC 60870-5-104

- Channel 1 Port
- Channel 2 Port
- Common Address of ASDU
- Client Address 1
- Client Address 2
- TCP Port Number 1
- TCP Port Number 2
- Cyclic Data Period
- Object Info Addrs Bnry
- Object Info Addrs Analog
- Object Info Addrs Countrs
- Object Info Addrs Cmnd
- Object Info Analog Param

By default the Object Information Address for the different data is as follows:

- M_SP (Single Points) = 1000
- M_ME (Measured value) = 2000
- M_IT (Integrated Totals) = 3000
- C_SC or C_DC (Single or Double Command) = 4000
- P_ME_NB (Parameter of measured value) = 5000

Each Measured value has a Parameter of measured value (P_ME_NB) associated to its threshold.

The IEC 60870-5-104 Deadbands settings are used to determine when to trigger spontaneous responses containing M_ME_NB_1 analog data. Each setting represents the threshold value for each M_ME_NB_1 analog point.

For example, to trigger spontaneous responses from the 8 Series relay when a current value changes by 15 A, the "Analog Point xx Deadband" setting should be set to 15. Note that these settings are the default values of the deadbands. P_ME_NB_1 (parameter of measured value, scaled value) points can be used to change threshold values, from the default, for each individual M_ME_NB_1 analog point. There are three ways to send the measurands to the Master station. The measurands are part of the General Group and Group 2, so when a general interrogation or group 2 interrogation takes place all the measurands are included in the response. Also, there is a cyclic data period setting where it is configured in the scan period to send the measurands to the Master. And the last way, is by sending spontaneously when a deadband overflow takes place. The IEC104 Channels sub-menu information is shown below.

Commands are executed over the Binary Outputs. The first 8 Binary Outputs are configured to receive Select/Operate Commands and the next 8 Binary Outputs are configured to receive Direct Execute Commands.

The **IEC104 CHANNEL 1 PORT** and **IEC104 CHANNEL 2 PORT** settings select the communications port assigned to the IEC104 protocol for each channel. When this setting is set to "Network - TCP", the IEC104 protocol can be used over TCP/IP on channels 1 or 2. The **IEC104 NETWORK CLIENT ADDRESS** settings can force the 8 Series relay to respond to a maximum of two specific IEC104 masters which own the configured IP Addresses. The settings in this sub-menu are shown below.

NOTICE

"IEC104 Channel 1 Port" takes the "Port Number 1" and "Client Address 1" to allow or reject connections. The same method is used by channel 2.

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 is set by the 96 Single Points (M_SP).
Group 2 is set by the 32 Measured values (M_ME).
Group 3 is set by the 32 Measured thresholds (P_ME).

These 96 Single Points and 32 Measured Values are also sent as a response to a General Interrogation.

The Integrated Totals (M_IT) has its own Counter Group 1, and it is sent as a response to a General Request Counter.

Interoperability

This document is adapted from the IEC 60870-5-104 standard. For this section the boxes indicate the following: ⊠ – used in the standard direction; □– not used.

IEC 60870-5-104 Interoperability Document

System or device:

□ System definition.

□ Controlling station definition (master).

⊠ Controlled station definition (slave).

Application layer:Transmission mode for application data:Mode 1 (least significant octet first), as defined in Clause 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.Common address of ASDU:

⊠ Two octets.Information object address:

☒ Three octets.
☒ Structured
☒ Unstructured

Cause of transmission:
☒ Two octets (with originator address). Originator address is set to zero if not used.Maximum length of APDU.253 in both directions (the maximum length is a fixed system parameter).Selection of standard ASDUs.For the following lists, the boxes indicate the following:☒ – used in standard direction;
☐ – not used.

Process information in monitor direction:

Table 6-1: Process information in monitor direction

Number / description	Mnemonic
☒ <1> := Single-point information	M_SP_NA_1
☐ <3> := Double-point information	M_DP_NA_1
☐ <5> := Step position information	M_ST_NA_1
☐ <7> := Bitstring of 32 bits	M_BO_NA_1
☐ <9> := Measured value, normalized value	M_ME_NA_1
☒ <11> := Measured value, scaled value	M_ME_NB_1
☐ <13> := Measured value, short floating point value	M_ME_NC_1
☒ <15> := Integrated totals	M_IT_NA_1
☐ <20> := Packed single-point information with status change detection	M_SP_NA_1
☐ <21> := Measured value, normalized value without quantity descriptor	M_ME_ND_1
☒ <30> := Single-point information with time tag CP56Time2a	M_SP_TB_1
☐ <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 bits 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
☐ <36> := Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☒ <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

Table 6-2: Process information in control direction

Number / description	Mnemonic
☒ <45> := Single command	C_SC_NA_1
☒ <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 bits	C_BO_NA_1
☒ <58> := Single command with time tag CP56Time2a	C_SC_TA_1
☒ <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

Number / description	Mnemonic
☐ <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 bits with time tag CP56Time2a	C_BO_TA_1

Either the ASDUs of the set <45> to <51> or of the set <58> to <64> are used.

Table 6-3: System information in monitor direction

Number / description	Mnemonic
☒ <70> := End of initialization	M_EI_NA_1

Table 6-4: System information in control direction

Number / description	Mnemonic
☒ <100> := Interrogation command	C_IC_NA_1
☒ <101> := Counter interrogation command	C_CI_NA_1
☒ <102> := Read command	C_RD_NA_1
☒ <103> := Clock synchronization command (see Clause 7.6 in standard)	C_CS_NA_1
☒ <105> := Reset process command	C_RP_NA_1
☒ <107> := Test command with time tag CP56Time2a	C_TS_TA_1

Table 6-5: Parameter in control direction

Number / description	Mnemonic
☐ <110> := Parameter of measured value, normalized value	PE_ME_NA_1
☒ <111> := Parameter of measured value, scaled value	PE_ME_NB_1
☐ <112> := Parameter of measured value, short floating point value	PE_ME_NC_1
☐ <113> := Parameter activation	PE_AC_NA_1

Table 6-6: File transfer

Number / description	Mnemonic
☐ <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, available only 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) are shown in the following tables. In these tables, shaded boxes (▒) are not required, black boxes (■) are not permitted in the companion standard, empty cells indicate the functions or ASDU are not used, and a cross (╳) indicates availability only in the standard direction.

Table 6-7: Cause of transmission numbers

Number	Cause of transmission
1	Periodic, cyclic
2	Background scan
3	Spontaneous
4	Initialized
5	Request or requested
6	Activation

Number	Cause of transmission
7	Activation confirmation
8	Deactivation
9	Deactivation confirmation
10	Activation termination
11	Return information caused by a remote command
12	Return information caused by a local command
13	File transfer
20	Interrogated by station interrogation
21 to 36	Interrogated by group <number> interrogation
37	Requested by general counter request
38 to 41	Requested by group <number> counter request
44	Unknown type of identification
45	Unknown cause of transmission
46	Unknown command address of ASDU
47	Unknown information object address

Table 6-8: Cause of transmission assignments

Type identification		Cause of transmission																	
No.	Mnemonic	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	▒			▒		▒	▒	▒	▒	▒			▒		▒	▒	▒	▒	▒
<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	X			▒	X	▒	▒	▒	▒	▒	▒	▒	▒	X	▒	▒	▒	▒	▒
<12>	M_ME_TB_1	▒	▒	■	▒	■	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
<13>	M_ME_NC_1				▒		▒	▒	▒	▒	▒	▒	▒	▒		▒	▒	▒	▒	▒
<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	▒	▒	X	▒		▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒

Type identification		Cause of transmission																	
No.	Mnemonic	1	2	3	4	5	6	7	8	9	10	11	12	13	20 to 36	37 to 41	44	45	46	47
<36>	M_ME_TF_1	▒	▒		▒		▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒	▒
<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	▒	▒	▒	▒	▒						▒	▒	▒	▒	▒				
<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	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	▒	▒	▒	▒	▒	X	X	▒	▒	▒	▒	▒	▒	X	▒				
<112>	P_ME_NC_1	▒	▒	▒	▒	▒			▒	▒	▒	▒	▒	▒		▒				
<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*)	▒	▒	▒	▒		▒	▒	▒	▒	▒	▒	▒		▒	▒				

NOTICE

"*" blank or X only

Basic application functions:

Station initialization:

☒ Remote initialization.

Cyclic data transmission:

☒ Cyclic data transmission.

Read procedure:

☒ Read procedure.

Spontaneous transmission:

☒ Spontaneous transmission.

Double transmission of information objects with cause of transmission spontaneous:

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 bits: 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:

☒ Group 1.

☒ Group 2.

☒ Group 3.

☒ Group 4.

☒ Group 5.

☒ Group 6.

☒ Group 7.

☒ Group 8.

☒ Group 9.

☒ Group 10.

☒ Group 11.

☒ Group 12.

☒ Group 13.

☒ Group 14.

☒ Group 15.

☒ Group 16.

☒ Global.

Clock synchronization:

☒ Clock synchronization (optional, see Clause 7.6).

☐ Day of week used.

☐ RESI, GEN (time tag substituted/not substituted)

☐ SU-bit (summertime) used.

Command transmission:

☒ Direct command transmission.

☐ Direct setpoint command transmission.

☒ Select and execute command.

☐ Select and execute setpoint command.

☒ C_SE ACTTERM used.
☒ No additional definition.
☒ Short pulse duration (duration determined by a system parameter in the outstation).
☒ Long pulse duration (duration determined by a system parameter in the outstation).
☒ Persistent output.
☒ Supervision of maximum delay in command direction of commands and setpoint commands.
Maximum allowable delay of commands and setpoint commands: 5 s.
Transmission of integrated totals:
☒ Mode A: Local freeze with spontaneous transmission.
☒ Mode B: Local freeze with counter interrogation.
☒ Mode C: Freeze and transmit by counter-interrogation commands.
☒ Mode D: Freeze by counter-interrogation command, frozen values reported simultaneously.
☒ Counter read.
☒ Counter freeze without reset.
☒ Counter freeze with reset.
☒ Counter reset.
☒ General request counter.
☒ Request counter group 1.
☒ Request counter group 2.
☒ Request counter group 3.
☒ Request counter group 4.
Parameter loading:
☒ Threshold value.
☐ Smoothing factor.
☐ Low limit for transmission of measured values.
☐ High limit for transmission of measured values.
Parameter activation:
☐ Activation/deactivation of persistent cyclic or periodic transmission of the addressed object.
Test procedure:
☐ Test procedure.
File transfer in monitor direction:
☐ Transparent file.
☐ Transmission of disturbance data of protection equipment.
☐ Transmission of sequences of events.
☐ Transmission of sequences of recorded analog values.
File transfer in control direction:
☐ Transparent file.
Background scan:
☐ Background scan.
Definition of timeouts:

Parameter	Default value	Remarks	Selected value
t_0		Timeout of connection establishment	N/A

Parameter	Default value	Remarks	Selected value
t_1	15 s	Timeout of send or test APDUs	15 s
t_2	10 s	Timeout for acknowledgements in case of no data messages $t_2 < t_1$	10 s
t_3	20 s	Timeout for sending test frames in case of a long idle state	20 s

Maximum range of values for all time outs: 1 to 255 s, accuracy 1 s.

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 ($2^{15} - 1$) 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*.

Port number:

Parameter	Value	Remarks
Port number	2404	In all cases

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 given projects has to be chosen by the user of this standard.

☒ Ethernet 802.3.

☐ Serial X.21 interface.

☐ Other selection(s) from RFC 2200 (list below if selected).

8 Series Protective Relay Platform

Chapter 7: IEC 60870-5-103

The point map for the 103 is different from the one shared by the IEC104 and DNP protocols. IEC 60870-5-103 serial communications protocol is supported on the rear RS485 port only.

The DNP, IEC 103 and Modbus cannot be enabled simultaneously. Only one instance of DNP 3.0, IEC 103 or Modbus can run on the RS485 serial port.

Path:SETPOINTS > DEVICE > COMMUNICATIONS > IEC 60870-5-103 PROTOCOL

IEC103 Common ASDU Addrs

Range: 0 to 254 in steps of 1

Default: 0

IEC103 Sync Timeout

Range: 0 to 1440 minutes in steps of 1 min

Default: 0 min

All binary inputs are configured from FlexLogic operands. For a complete list, see Format Code FC142.

NOTICE

Pay attention when configuring the function type and information number of the different points, because they must be unique. There is no mechanism in the EnerVista 8 Series Setup software or the front panel HMI to detect duplication of the information index.

NOTICE

The IEC 60870-5-103 point lists always begin with point 0 and end at the first "Off" value. Since IEC 60870-5-103 point lists must be in one continuous block, any points assigned after the first "Off" point are ignored.

Cause of Transmission

The cause of transmission is an unsigned integer which takes one of the values specified in the following tables.

Table 7-1: Cause of Transmission in the Monitor Direction

Value	Description
<1>	Spontaneous
<2>	Cyclic
<3>	Reset frame count bit (FCB)
<4>	Reset communications unit (CU)
<5>	Start/Restart
<6>	Power on
<8>	Time synchronization
<9>	General interrogation
<10>	Termination of general interrogation
<20>	Positive ack of command
<21>	Nack of command

Table 7-2: Cause of Transmission in the Control Direction

Value	Description
<8>	Time synchronization
<9>	Initiation of general interrogation
<20>	General command

IEC 60870-5-103 Menus

PATH: SETPOINTS > DEVICE > COMMUNICATIONS > IEC103 POINT LISTS > BINARY INPUTS

BINARY INPUT POINT X

FUNC TYPE

Range: 0 to 255 in steps of 1
Default: 0

INFO NUM

Range: 0 to 255 in steps of 1
Default: 0

POINT X

Range: 0 to 255 in steps of 1
Default: 0

PRESENT IN GEN INTERROGATION

Range: YES, NO
Default: NO

Select YES to send the binary input in response to a general interrogation request. By default, the binary input is not sent.

There are five measurand ASDUs available. The Fifth ASDU supports more metering values as shown below.

PATH:SETPOINTS > DEVICE > COMMUNICATIONS > IEC103 POINT LISTS > MEASURANDS > FIRST ASDU...FIFTH ASDU

IDENT TYPE

Range: 3, 9

Default: 3

First/Second/Third/Fourth ASDU:

If Ident Type=3 , 4 Measurands are sent to the master

If Ident Type=9, 4 Measurands are sent to the master

Fifth ASDU:

If Ident Type=3 , 4 Measurands are sent to the master

If Ident Type=9 , 16 Measurands are sent to the master

PATH: SETPOINTS > DEVICE > COMMUNICATIONS > IEC103 POINT LISTS > COMMANDS

The IEC 60870-5-103 Disturbance Recorder supports disturbance data transmission. For full functionality, the 64 Digital Channels need to be configured according to the Digital Inputs configured in the Transient Recorder.

PATH:SETPOINTS > DEVICE > COMMUNICATIONS > IEC103 DISTURBANCE RECORDER

DIGITAL CHANNEL 1...64

FUNC TYPE

Range: 0 to 255 in steps of 1

Default: 0

INFO NUM

Range: 0 to 255 in steps of 1

Default: 0

Interoperability

Physical layer

Electrical interface

☒	EIA RS-485
32	Number of loads for one protection equipment

Optical interface

☐	Glass fibre
☐	Plastic fibre
☐	F-SMA type connector
☐	BFOC/2,5 type connector

Transmission speed

☒	9600 bits/s
☒	19200 bits/s

Link layer

There are no choices for the Link Layer.

Application layer

Transmission mode for application data

Mode 1 (least significant octet first), is used exclusively in this companion standard.

Common address of ASDU

☒	One COMMON ADDRESS OF ASDU (identical with station address)
	More than one COMMON ADDRESS OF ASDU

Selection of standard information numbers in monitor direction

Table 7-3: System functions in monitor direction

	INF	Semantics
☒	<0>	End of general interrogation
☒	<0>	Time synchronization
☒	<2>	Reset FCB
☒	<3>	Reset CU
☒	<4>	Start/restart
☒	<5>	Power on

Table 7-4: Status indications in monitor direction

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<16>	Auto-recloser active		
☐	<17>	Teleprotection active		
☐	<18>	Protection active		
☐	<19>	LED reset		
☐	<20>	Monitor direction blocked		
☐	<21>	Test mode		
☐	<22>	Local parameter setting		
☐	<23>	Characteristic 1		
☐	<24>	Characteristic 2		
☐	<25>	Characteristic 3		
☐	<26>	Characteristic 4		
☐	<27>	Auxiliary input 1		
☐	<28>	Auxiliary input 2		
☐	<29>	Auxiliary input 3		
☐	<30>	Auxiliary input 4		

Table 7-5: Supervision indications in monitor direction

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<32>	Measurand supervision I		
☐	<33>	Measurand supervision V		
☐	<35>	Phase sequence supervision		
☐	<36>	Trip circuit supervision		

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<37>	I>> back-up operation		
☐	<38>	VT fuse failure		
☐	<39>	Teleprotection disturbed		
☐	<46>	Group warning		
☐	<47>	Group alarm		

Table 7-6: Earth fault indications in monitor direction

	INF	Semantics	8 Series relay Identifier	8 Series relay 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		

Table 7-7: Fault indications in monitor direction

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<64>	Start / pick-up L1		
☐	<65>	Start / pick-up L2		
☐	<66>	Start / pick-up L3		
☐	<67>	Start / pick-up N		
☐	<68>	General trip		
☐	<69>	Trip L1		
☐	<70>	Trip L2		
☐	<71>	Trip L3		
☐	<72>	Trip I>> (back-up operation)		
☐	<73>	Fault location X in ohms		
☐	<74>	Fault forward / line		
☐	<75>	Fault reverse / busbar		
☐	<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		
☐	<84>	General start / pick-up		
☐	<85>	Breaker failure		
☐	<86>	Trip measuring system L1		
☐	<87>	Trip measuring system L2		
☐	<88>	Trip measuring system L3		
☐	<89>	Trip measuring system E		
☐	<90>	Trip I>		

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<91>	Trip I>>		
☐	<92>	Trip IN>		
☐	<93>	Trip IN>>		

Table 7-8: Auto-reclosure indications in monitor direction

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<128>	CB 'on' by AR		
☐	<129>	CB 'on' by long-time AR		
☐	<130>	AR blocked		

Table 7-9: Measurands in monitor direction

	INF	Semantics	8 Series relay Identifier	8 Series relay Data Text
☐	<144>	Measurand I		
☐	<145>	Measurands I, V		
☐	<146>	Measurands I, V, P, Q		
☐	<147>	Measurands In, Ven		
☐	<148>	Measurands IL123, VL123, P, Q, f		

Table 7-10: 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

Table 7-11: System functions in control direction

	INF	Semantics
☒	<0>	Initiation of general interrogation
☒	<0>	Time synchronization

Table 7-12: 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

Table 7-13: General 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>	General interrogation of generic data
☐	<248>	Write entry
☐	<249>	Write entry with confirmation
☐	<250>	Write entry with execution
☐	<251>	Write entry abort

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	☐		☒
Current L2	☐		☒
Current L3	☐		☒
Voltage L1-E	☐		☒
Voltage L2-E	☐		☒
Voltage L3-E	☐		☒
Active power P	☐		☒
Reactive power Q	☐		☒
Frequency f	☐		☒
Voltage L1-L2	☐		☒

8 Series Protective Relay Platform

Chapter 8: IEC 61850

The optional communications processor supports both the IEC61850 GOOSE and IEC 61850 MMS Server service as per IEC 61850 standard Ed. 2. The GOOSE messaging service provides the 8 Series relay unit the ability to Publish/Subscribe Digital Input and other element statuses and its Quality and Timestamp to/from other IEDs with supporting GOOSE messaging service. Server support allows remote 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 8 Series relay configuration software, EnerVista 8 Series Setup software.

General

IEC61850 SERVER

The IEC 61850 Server (i.e., 8 Series 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.

Appendix B lists the implementation details of IEC 61850, including the logical nodes and number of instances for each that are supported within the 8 Series relay.

Data Obj	data attribute	Type	FC	Name	Description
PhyHealth		ENS			This physical device's health
	stVal	ENUMERATED	ST		3 when ANY MAJOR ERROR ==On; 2 when ANY MINOR ERROR==On; 1 otherwise

Functionality

CLIENT CONNECTIONS

The 8 Series relay supports up to eight IEC61850 concurrent client connections.

LOGICAL DEVICES AND REPORTS

Supported buffered and un-buffered report, the **report triggers** are shown in the *Supported Triggers* list.

Supported Triggers

- Data-change
- Integrity
- General-interrogation

Supported buffered and un-buffered **report option** fields are shown in the *Field* list.

Field

- Sequence number
- Report time stamp
- Reason for inclusion
- Data set name
- Data-ref
- Buffer-overflow (Buffered reports only)
- Entry id (Buffered reports only)
- Conf- revision

Report control block configuration settings are modified from IEC61850 advanced 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 can not be updated from the Modbus settings.

Status

IEC 61850 Status

Path:Status > Communications > IEC 61850 Status

COMMS NOT VALIDATED OK

Range: NO, YES
Default: NO

COMMS NOT VALIDATED DONE

Range: YES, NO
Default: YES

COMMS VALIDATED OK

Range: YES, NO
Default: YES

COMMS VALIDATED DONE

Range: YES, NO
Default: YES

MAIN NOT VALIDATED OK

Range: NO, YES
Default: NO

MAIN NOT VALIDATED DONE

Range: YES, NO
Default: YES

MAIN VALIDATED OK
Range: YES, NO
Default: YES

MAIN VALIDATED DONE
Range: YES, NO
Default: YES

NOT RUNNING.ERROR CID
Range: NO, YES
Default: NO

RUNNING.DEFAULT CID
Range: NO, YES
Default: NO

RUNNING.SAVING CID TO FLASH
Range: NO, YES
Default: NO

CID HANDLING DONE
Range: YES, NO
Default: YES

NUMBER OF CONNECTED CLIENTS
Default: 0

CLIENT 1(8) IP ADDRESS
Range: 0, 0XFFFFFFFF
Default: 0

GOOSE Status

GGIO1 INDICATIONS

Path: Status > Communications > GGIO1 Indications

The present state of the 32 GGIO1 Indications are shown here. There are up to 32 GGIO indications that can be used to map any FlexLogic operand into the IED 61850 information model. Default value is Off.

GOOSE STATUS

Path:Status > Communications > GOOSE Status

GOOSE 1 to 64 Status
Range: OFF, ON
Default: OFF

This setting indicates GOOSE communications are being received. A GOOSE STATUS of ON indicates successful receipt of the last GOOSE packet. A GOOSE STATUS of OFF indicates the communications link has failed, with the speed this setting changes determined by the Update Time setting configured under GOOSE Transmission.

GOOSE HEADER

Path:Status > Communications > GOOSE HDR Status

GOOSE 1 to 64 H.Status

Range: OFF, ON

Default: OFF

This setting validates the GOOSE packet structure. A GOOSE HEADER STATUS of ON indicates that the structure of the last GOOSE packet was valid.

GOOSE ANALOG

Path:Status > Communications > GOOSE Analog AV

FLOAT 1 to 24

Range:

Default: 0.0

SINT32 1 to 8

Range:

Default: 0

IEC 61850 STATUS

Path:Status > Communications > IEC 61850 Status

COMMS NOT VALIDATED OK

Range: NO, YES

Default: NO

COMMS NOT VALIDATED DONE

Range: YES, NO

Default: YES

COMMS VALIDATED OK

Range: YES, NO

Default: YES

COMMS VALIDATED DONE

Range: YES, NO

Default: YES

MAIN NOT VALIDATED OK

Range: NO, YES

Default: NO

MAIN NOT VALIDATED DONE

Range: YES, NO

Default: YES

MAIN VALIDATED OK

Range: YES, NO

Default: YES

MAIN VALIDATED DONE

Range: YES, NO

Default: YES

NOT RUNNING.ERROR CID

Range: NO, YES

Default: NO

RUNNING.DEFAULT CID

Range: NO, YES

Default: NO

RUNNING.SAVING CID TO FLASH
Range: NO, YES
Default: NO

CID HANDLING DONE
Range: YES, NO
Default: YES

NUMBER OF CONNECTED CLIENTS
Default: 0

CLIENT 1(8) IP ADDRESS
Range: 0, 0XFFFFFFFF
Default: 0

The IEC 61850 Configurator

The 8 Series relay supports the IEC 61850 protocol which is identified by order code option "**2A**" or"**2E**".

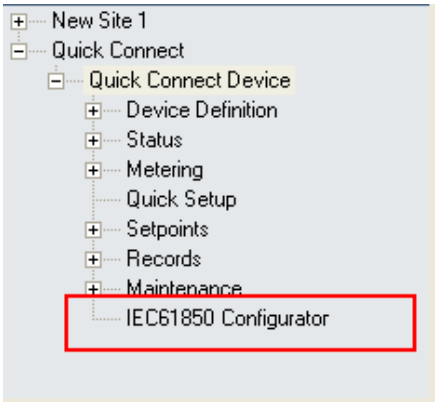
The IEC 61850 configurator is found in both the online and offline section of the EnerVista 8 Series Setup software for configuring the online 8 Series relay and offline 8 Series relay settings file respectively.

Online and Offline Setup

ONLINE SETTINGS FILE

Two options are available to configure the relay's online settings file.

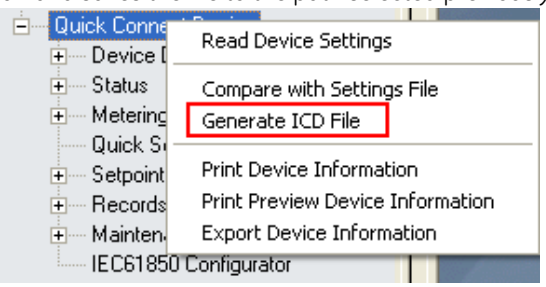
1. Configuration
   - Configure the 8 Series relay (having order code option: IEC 61850) through the Device Setup or Quick connect screen.
   - The IEC 61850 Configurator "tree" item is displayed after Maintenance. See figure below.



   - Launch the online IEC 61850 configurator screen, by double-clicking on the **IEC61850 Configurator** "tree" item.
   - Select the required settings from the different tab displays (in the configurator screen) to complete the IEC 61850 configuration.
2. Online right-click option
   - Select any online relay and right click on the selected "tree" item. More options become available for selection, as shown in the next examples.

Example of Additional Options

Generate ICD file: The menu option generates a default ICD file with the respective order code option and saves the file to the path selected previously.



Read Device Settings: The menu option reads all the settings from the relay by TFTP and creates an 8 Series relay file with extension *.CID. The created *.CID file consists of two sections. A private section where all non IEC 61850 settings are available, and a public section in which IEC 61850 related settings are implemented.

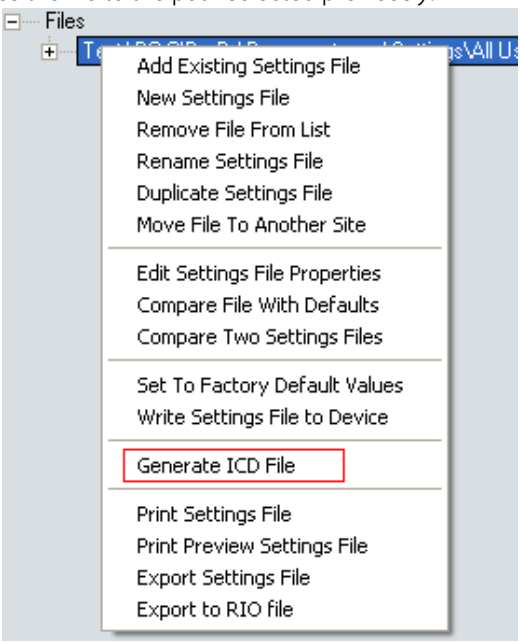
NOTICE

When creating a CID file using a 3rd party ICT/SCL tool, ensure the following:

- The order code in the CID file must match the device order code if writing the CID file directly into the relay (without using the EnerVista software). The "Desc" value in communication settings of the CID file must match the relay's order code.
- The maximum allowed services must be equal or below the specified limits as in ICD/CID.
- Configure Datasets only in "LLN0" logical node.
- Creating new LD, LN, and communication-AP settings is not recommended.

OFFLINE SETTINGS FILE

The Generate ICD file menu option generates a default ICD file with the respective order code option and saves the file to the path selected previously.



IEC 61850 Configurator Details

The IEC61850 Configurator allows editing of all sections of the IEC61850 CID and ICD file. No other operations can be performed in the EnerVista 8 Series Setup software if the IEC 61850 Configurator is open. Close the IEC61850 session to perform other operations in the EnerVista software.

NOTICE

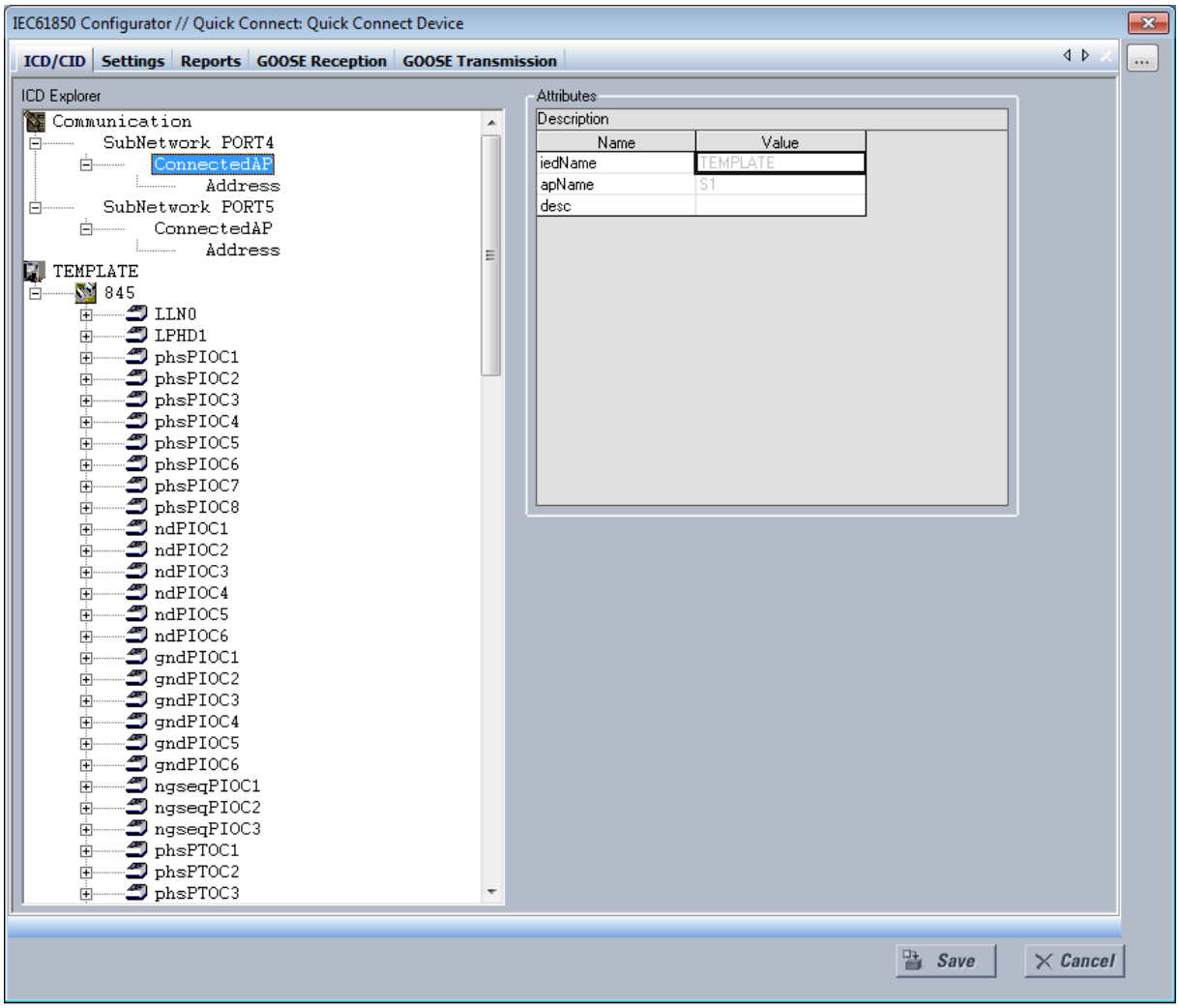
When the IEC 61850 configuration is saved while online, the DEVICE IN SERVICE state (**Setpoints > Device > Installation**) switches to Not Ready for the duration of the upload. This ensures that all new settings are applied before the device is operational.

The IEC 61850 configurator consists of five sections:

- ICD/CID
- Settings
- Reports
- GOOSE Reception
- GOOSE Transmission

ICD/CID

Select the ICD/CID tab in the IEC 61850 Configurator window. The ICD/CID tab consists of the ICD Explorer window to the left side of the view. The ICD Explorer window allows the user to navigate through the data model of the relay and change desired IEC 61850 parameters such as the Logical Device Name, MMS port and others.

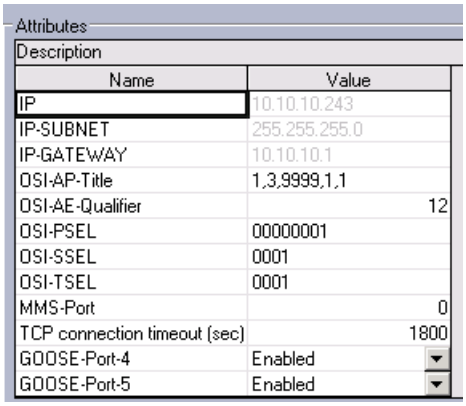


To Modify the Parameters

1. Select a parameter in the ICD Explorer window to open the Attributes window in the right part of the screen.
2. In the Attributes window, double click in the Value column of the table and enter the new value for that parameter.
   For example, from the Attributes window the user can set the IED name, description, and configuration version for the Logical Device, see preceding figure.

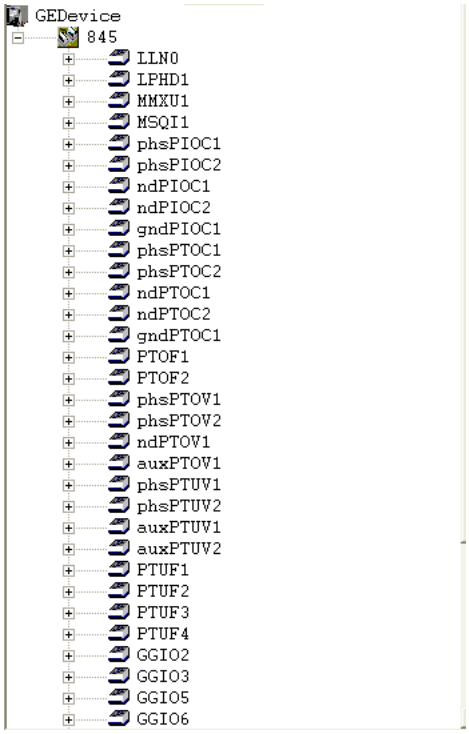
Parameters

- IP, IP-Subnet, IP-Gateway: The parameters are the configured IP details in the device.
- OSI parameters: The parameters must be configured according to the IEC 61850 standard.
- MMS TCP Port Number: 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.
- TCP Connection timeout: The range of the setting is 10 to 1800 s, in steps of 10. 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 TCP connection for more than this setting time, the connection is disconnected from the server.



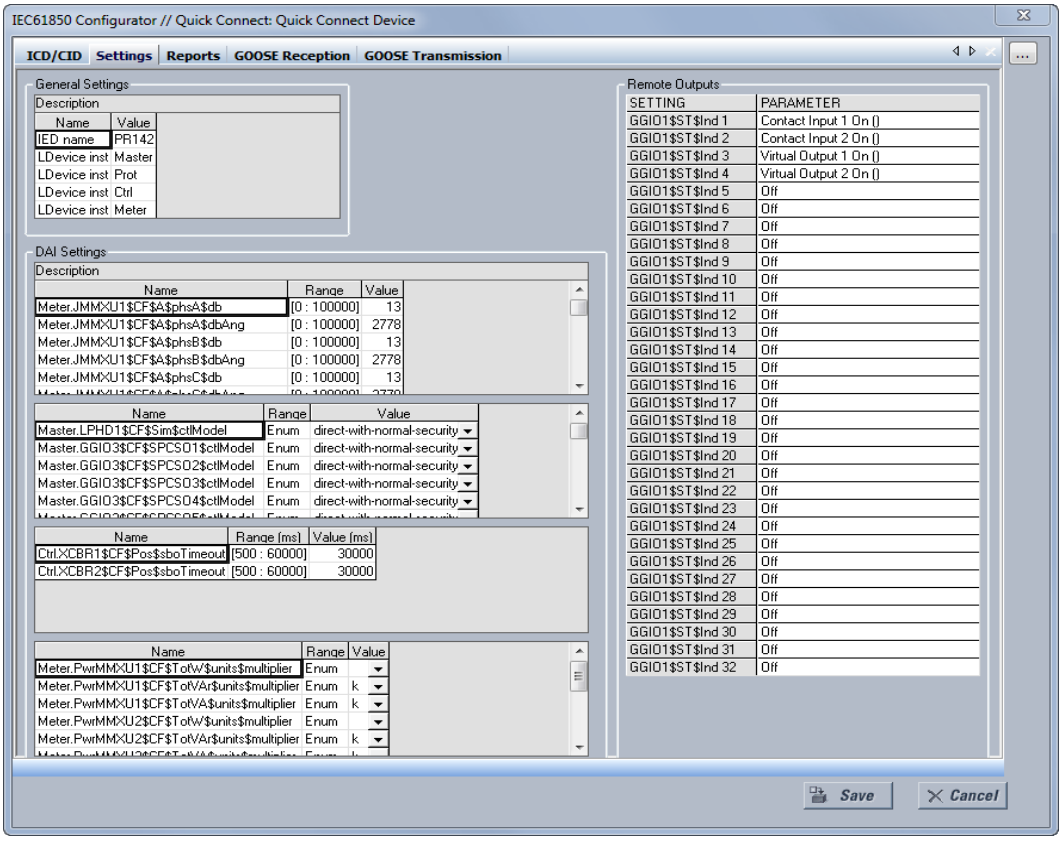
GOOSE Transmission on port -4 and port-5 (which are the 2 advanced communication optic ports available) is configurable. Choose either port or both of the ports for GOOSE transmission and reception. The logical nodes displayed under the **GEDevice > 8 Series relay** tree (see figure below) are shown based on the order code.

If a particular order code does not support certain protection and control functions, the respective logical node is not shown in the list.



Settings

The Settings tab consists of General Settings, DAI Settings, and Remote Outputs.



General Settings

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.

LDevice inst

Range: Up to 64 alphanumeric characters

This setting 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. The first character in the string must be a number or letter.

DAI Settings

DAI settings contains features for configuration including: MMXU & MSQI logical nodes, GGIO3 logical node, XCBR logical node.

MMXU & MSQI Logical nodes

Range: 1 to 100.000 %

The MMXU & MSQI 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.

MIN/MAX VALUES FOR MMXU NODES

The equations to calculate minimum (min) and maximum (max) values in the MMXU nodes are as follows:

Table 8-1: Calculate Min/Max MMXU Node Values

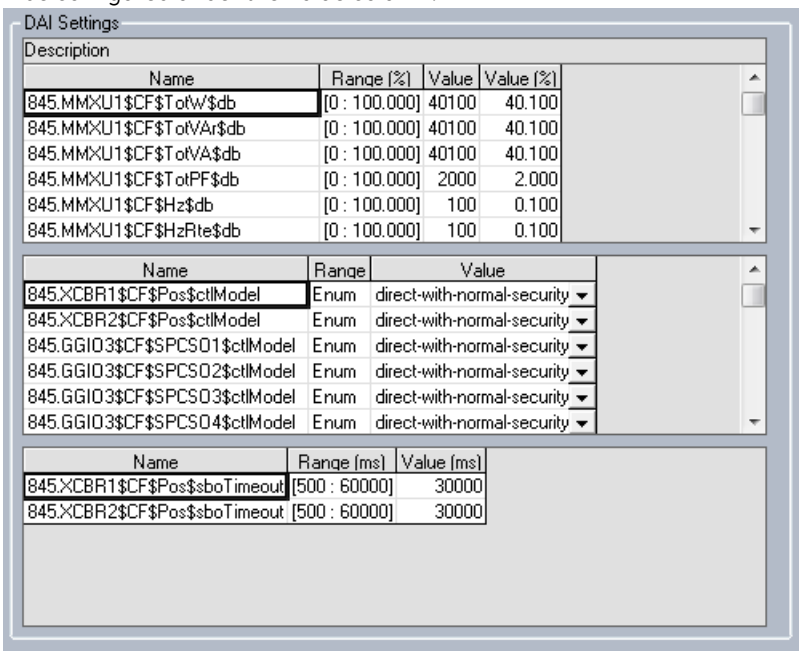
MMXU Node Value	To Calculate
TotW	max = ((Phase CT primary *4)* (VT Secondary * VT Ratio)* 1.5)/1000 min = -max Note that the max is divided by 1000 to convert from W to kW
TotVar	max = ((Phase CT primary *4)* (VT Secondary * VT Ratio) * 1.5)/1000 min = -max Note that the max is divided by 1000 to convert from Var to kVar
TotVA	max = ((Phase CT primary *4)* (VT Secondary * VT Ratio)* 1.5)/1000 min = -max Note that the max is divided by 1000 to convert from VA to kVA
TotPF	max = 1 min = -1
Hz	max = 90 min = 0
HzRte	max = 15 min = -15
PPV	when the VT connection is WYE:max = Phase VT Ratio * 240 * SQR(3) when the VT connection is DELTA:max = Phase VT Ratio * 240 min = 0
PhV	max = Phase VT Ratio * 240 min = 0
A$phsA, phsB, phsC	max = (Phase CT Primary * 46) min = 0

MMXU Node Value	To Calculate
A$neut	max = (Ground CT Primary * 46) min = 0
A$net	max = (Phase CT Primary * 46) min = 0
A$res	max = (Sens. Ground CT Primary * 3) min = 0
AuxV	max = Aux. VT Ratio * 240 min = 0
SeqA$c1, c2 ,c3	max = (Phase CT Primary * 46) min = 0
SeqV$c1, c2, c3	max = (Phase VT Ratio * 240) min = 0
dbAng	angle dB = (DB percentage* 360)

GGIO3 Logical Node

Range: Enum

These are the control models supported: (0) status only, (1) direct-with-normal-security. They can be configured under the Value column.



XCBR Logical Node

Range: the sboTimeout setting range is 500 to 60000 msec

The XCBR1 Pos sboTimeout setting is used to select SBO timeout value. To be successful, the IEC 61850 "operate" command must be executed after the "select" command within the time set by XCBR1 Pos sboTimeout.

XCBR-POS can be configured for status only, Direct operate, Select before operate, Direct operate with enhanced, SBO enhanced.

Remote Outputs (GGIO 1 Indications) (FlexLogic Operand Interface)

GGIO1 is a workaround that allows any 8 Series relay FlexLogic operands to be mapped into the IED 61850 information model. Once in the model, the operand status is visible via MMS services and may be added to datasets for GOOSE and reports.

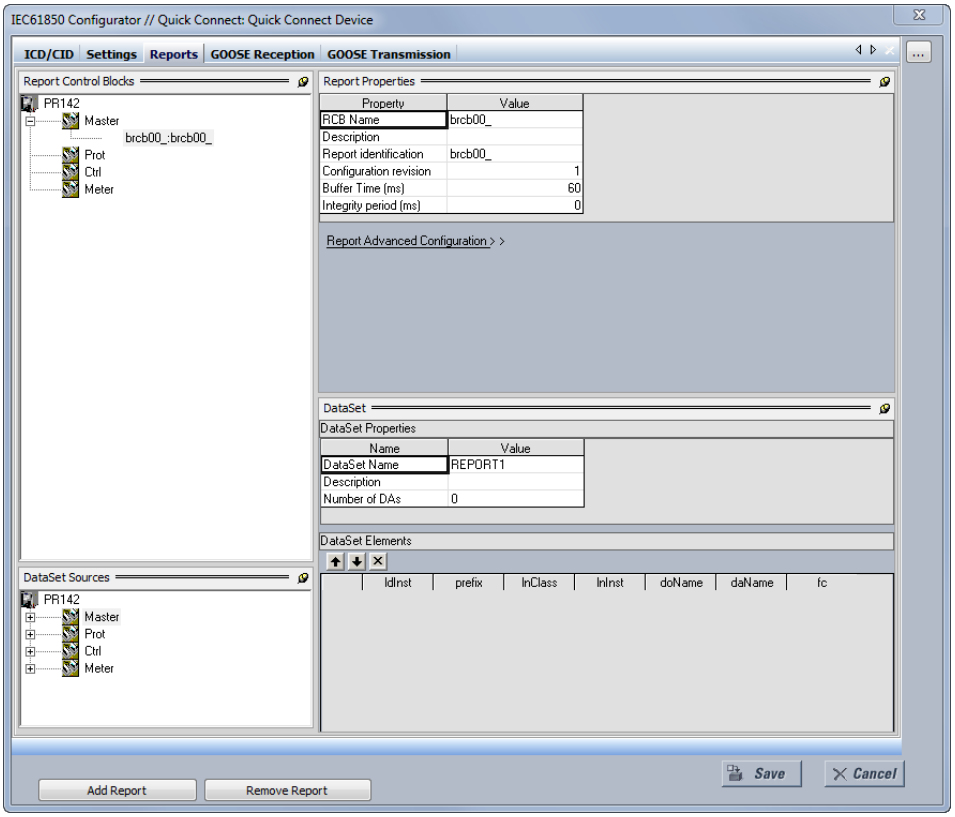
There are up to 32 GGIO1 indications that can be used to map those digital values.

These GGIO1 indications are assigned by the corresponding setpoint that can be modified in the Settings Tab screen of the 61850 configurator where the mapping element can be selected from the FlexLogic operand list similar to the DNP or IEC104 binary input point configuration.

Reports

The Reports tab in IEC 61580 Configurator permits configuration of data sets and report control blocks for buffered and unbuffered reports.

Figure 8-1: Reports Screen

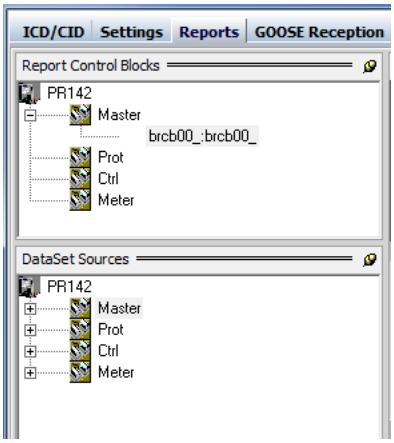


The screen helps the user to create, modify and delete Report Control Blocks (RCBs) and Datasets. Each Report Control Block must have a maximum of 4 different clients with up to a maximum of 8 Report Control Blocks linked to their Datasets. Each dataset must have a maximum of 64 elements in total.

There are two screens available in the Report tab window:

- Report Control Blocks: Report control blocks can be added as required.
  - **RCB 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 2 more characters indicating the number of the instance of the RCB depending on the number of IEC61850 clients configured.
  - **Description:** The maximum number of characters allowed is 32.
- Dataset Sources: Each report control block can be appended with dataset items in the screen using a drag and drop operation.

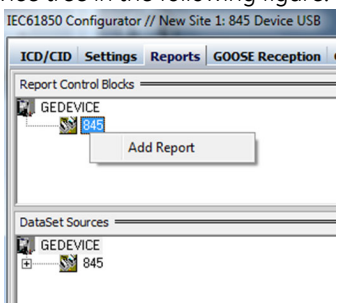
Figure 8-2: Report Control Blocks and DataSet Sources Screen



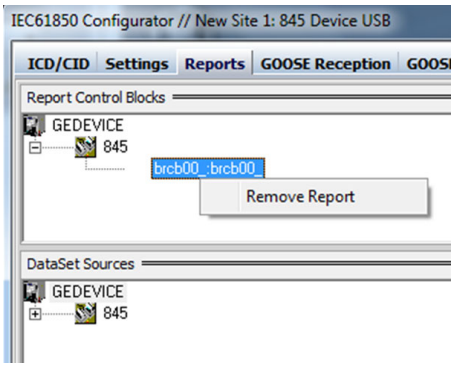
The following buttons are available in the Reports window.

- **Add Report** and **Remove Report** buttons: Both buttons are on the lower left of the screen.

- Note that a Report control block can also be added by right-clicking the relay name which is under the GEDevice tree in the following figure.



The **Remove Report** button deletes an existing Report control block.
Note that the Report can also be deleted by right clicking the configured existing report.



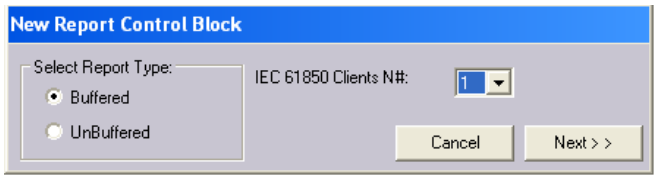
- **Save** and **Cancel** buttons: Click the **Save** button to save all configured settings. Click the **Cancel** button to discard the modifications just made to the configuration.

Add Report Control Block

1. Click on the "Add Report" button.

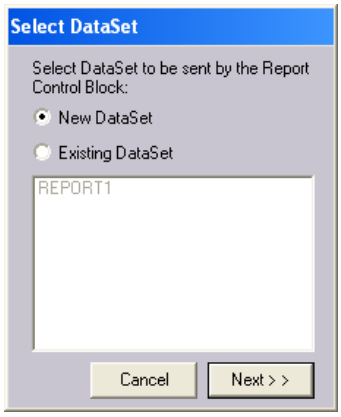
The button is available in the lower side of the screen and is used to add a report control block. (A Report can also be added by right clicking the relay name.)
The **New Report Control Block** window appears.

Figure 8-3: New Report Control Block Window



2. Select a buffered or unbuffered report type.
3. In the "IEC61850 Clients N#" dropdown list, select 1 or any other available number.
4. Click **Next** to proceed with further configuration (or click **Cancel** to discard the new configuration).
5. In the **Select DataSet** window, select **New DataSet** or **Existing DataSet**.

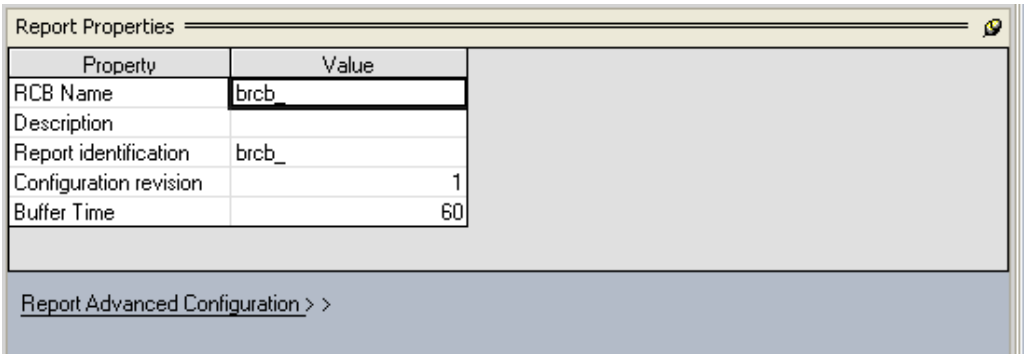
Figure 8-4: Select DataSet Window



Report Properties

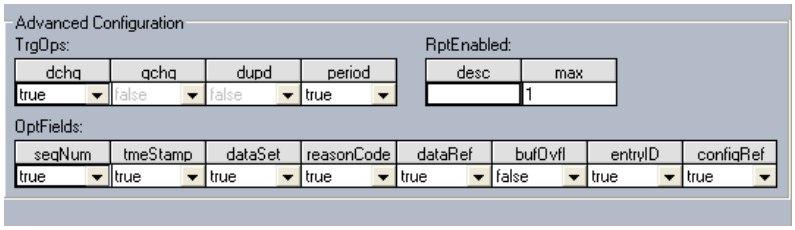
The report properties section can be viewed when any configured available report available is selected.

Figure 8-5: Report Properties Window



Click Report Advanced Configuration to see all the available parameters of the Report control block. Respective OptFields, TrgOps can be configured by selecting true or false. Buffer time is given in milliseconds.

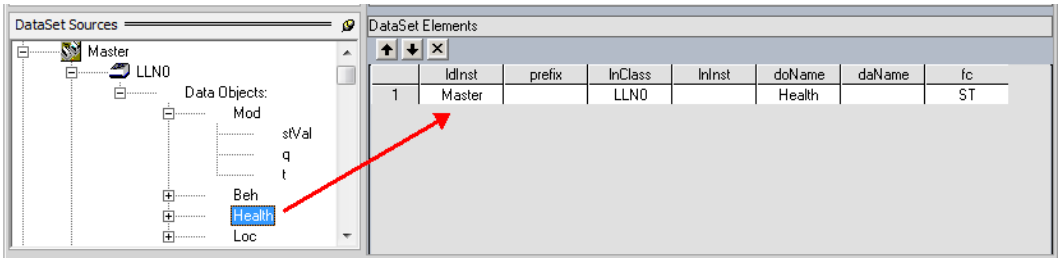
Figure 8-6: Advanced Configuration



Configure Dataset Items

1. Select the required logical node under GEDevice > 8 Series relay tree.
2. Go to the required dataset item.
3. Drag and drop the item to the DataSet Elements section, see the following DataSet Sources/DataSet figure.

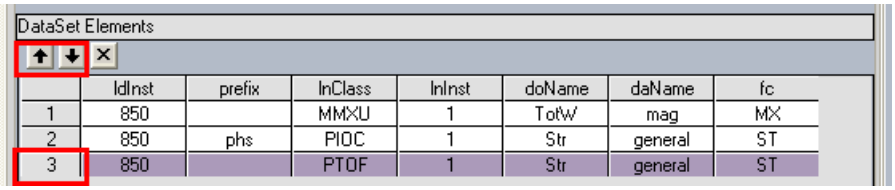
Figure 8-7: DataSet Sources Window



Change the Order of Configured Dataset Items

1. Select the row in which the order is to be changed.
2. Use the "up" arrow if you want to shift the row to the top. Use the "down" arrow to shift the row down.

Figure 8-8: Re-order DataSet Items

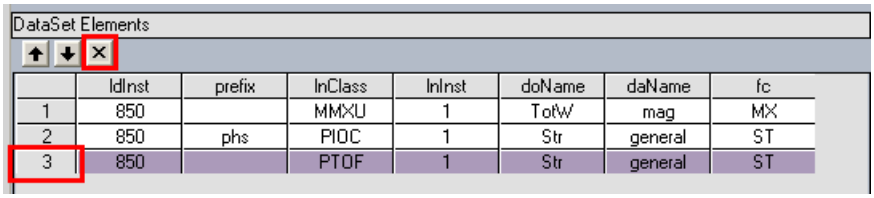


Delete a Dataset Item

The following list gives the two methods that can be used to delete a dataset item.

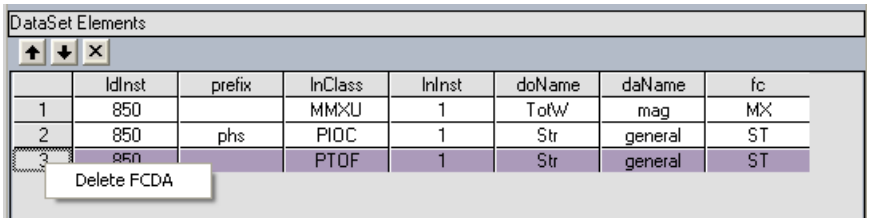
- Select the row in which the dataset item is to be deleted and click the "x" button.

Figure 8-9: Delete a Dataset Item



- Select the row in which the dataset item is to be deleted then right click and select the displayed "Delete FCDA" option.

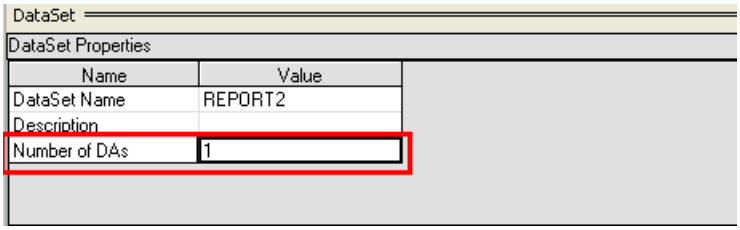
Figure 8-10: Delete FCDA Option



Number of DAs Counter

Depending on the configured dataset items, the "Number of DAs" counter increases automatically.

Figure 8-11: Dataset Properties



Maximum Report Control Blocks

The 8 Series relay supports a maximum of 8 report control blocks. Buffered and unbuffered reports are both included in the maximum. The user can configure reports based on the Report Configurations Supported table as follows.

Table 8-2: Report Configurations Supported

Buffered Report	Unbuffered Report	Total Reports
7	1	8
...	...	8
1	7	8

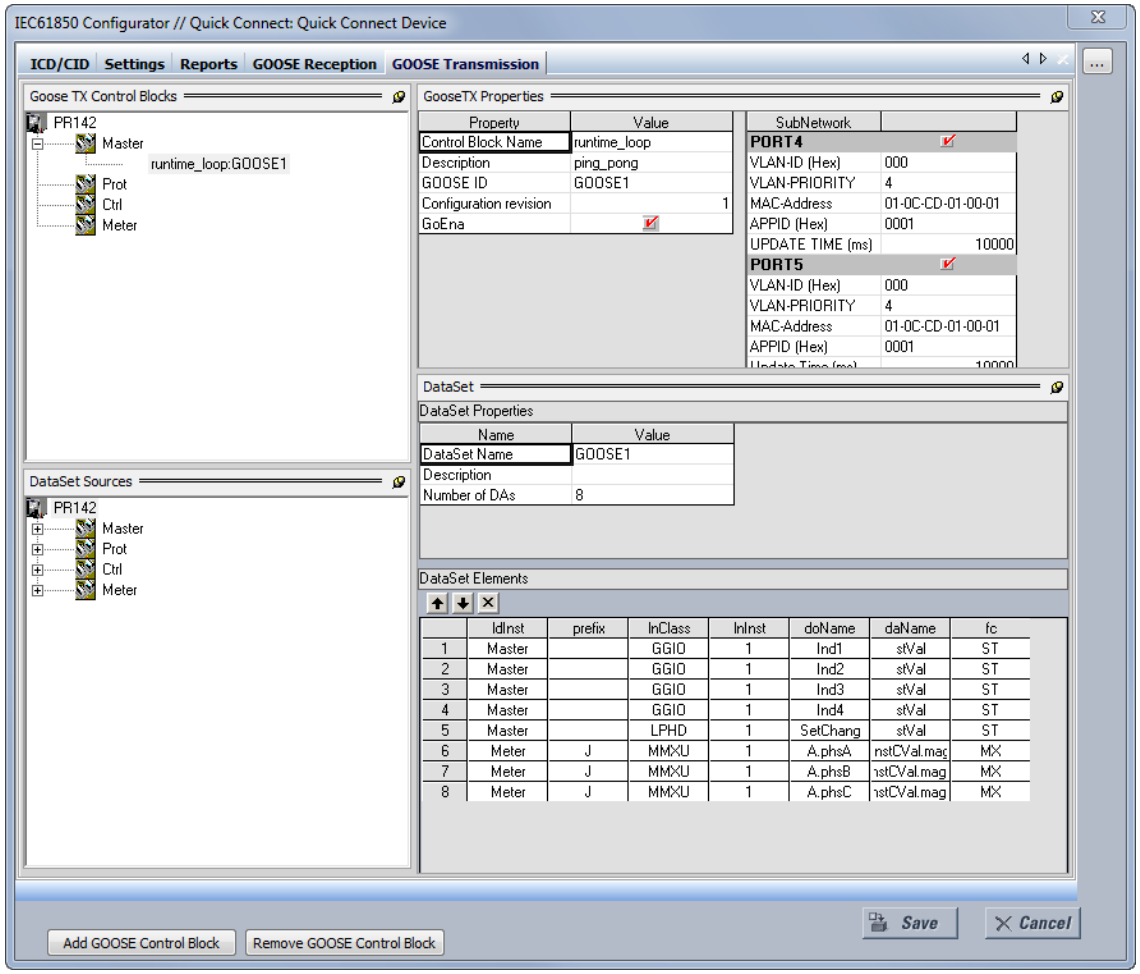
Goose Transmission

The 8 Series relay has an IEC 61850 server and supports the GOOSE message scheme. A maximum of 16 GOOSE control blocks can be added. The GOOSE Configuration has two sections:

- Transmission
- Reception

GOOSE transmission configuration is described in this section.

Figure 8-12: Goose Transmission Screen

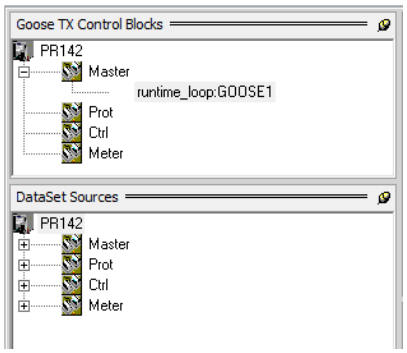


The GOOSE Transmission window has two screens.

- GOOSE Tx control blocks: The user can add the required GOOSE control block.
  - **Control Block 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.
  - **Description:** The maximum number of characters allowed is 32.
  - **GOOSE ID:** The maximum number of characters allowed is 129.
  - **Ethertype App ID:** 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).
  - **Multicast MAC:** 6 pairs of letters (from A to F, upper case or lower case) or numbers separated by colons.
  - **VLAN priority:** A number from 0 to 7.
  - **VLAN identifier:** 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).
- Dataset sources: Each GOOSE control block can be appended with dataset items in this screen using a drag and drop operation.

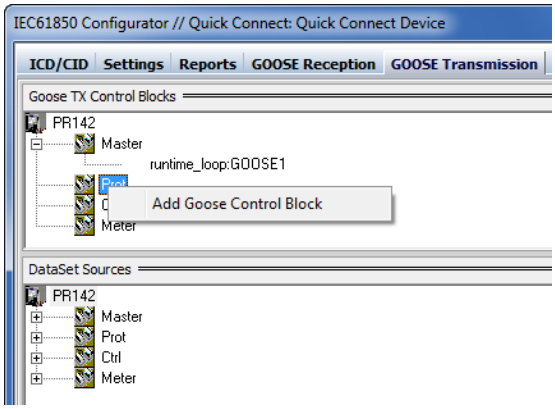
- **DataSet Name**: The first character in the value of this attribute must be a letter (upper or lower case). The rest of the characters must be a number, a letter (upper or lower case) or a "_". The maximum number of characters allowed is 32.
- **Description:** The maximum number of characters allowed is 32.

Figure 8-13: Goose TX Control Blocks and DataSet Sources Screen

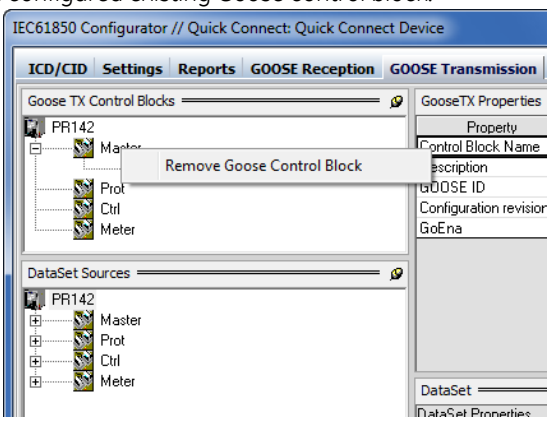


The following buttons are available in the Goose Transmission window:

- The **Add GOOSE Control Block** button or right-clicking the relay name under the Goose TX Control Block tree adds a new Goose control block.



The **Remove Goose Control Block**button or right-clicking an existing Goose control block deletes a configured existing Goose control block.



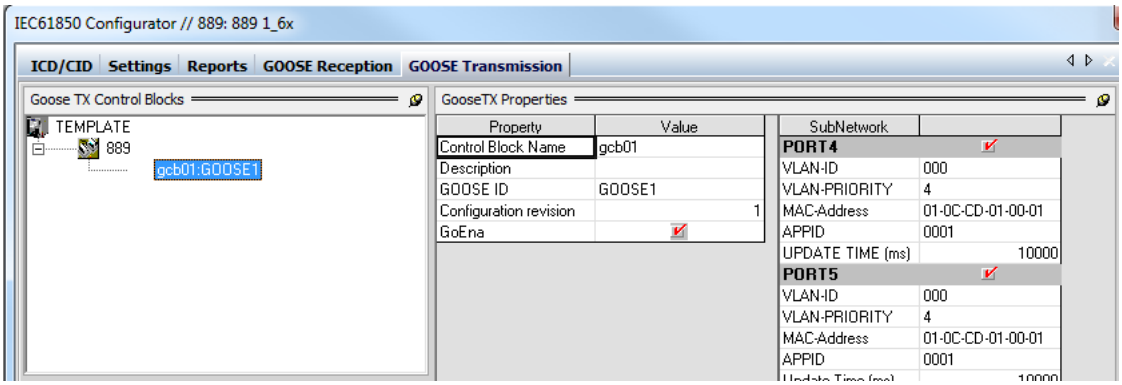
- Click the **Save** button to save all configured settings. Click the **Cancel** button to discard the modifications just made to the configuration.

Add a GOOSE Transmission Control Block

1. Click the **Add GOOSE Control Block** button.

2. The Tx GOOSE control block is added under the relay name tree node with a default Control block name.

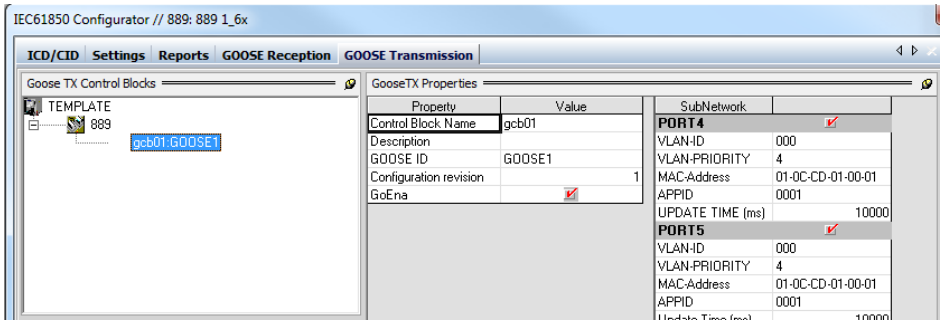
Figure 8-14: Goose TX Control Blocks



Goose Tx Properties

The properties section can be viewed on selecting any configured GOOSE block available.

Figure 8-15: Goose TX Properties Screen



Parameters for Goose TX

- GOOSE ID: The range of the setting is 129-characters
- Time to live (ms): The range of the setting is 1000 to 60000 in steps of 1000
- Multicast MAC: The standard MAC address limit. 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
- VLAN priority: The range of the setting is 0 to 7 in steps of 1
- VLAN identifier: The range of the setting is 0 to 4095 in steps of 1

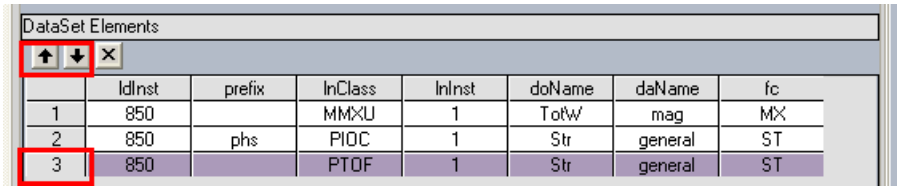
Goose Transmission Dataset Items

The following provides details for working with dataset items.

Change the Order of Configured Dataset Items

1. Select the row in which the order is to be changed.
2. Use the “up” arrow if you want to shift the row to the top. Use the “down” arrow to shift the row down.

Figure 8-16: Re-order DataSet Items

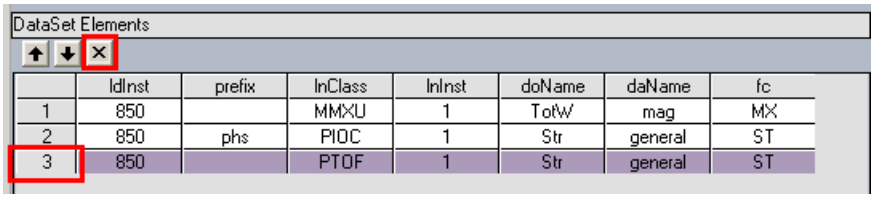


Delete a Dataset Item

The following list gives the two methods that can be used to delete a dataset item.

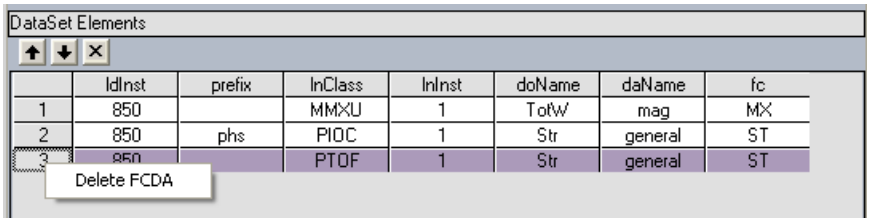
- Select the row in which the dataset item is to be deleted and click the **x** button.

Figure 8-17: Delete a Dataset Item



- Select the row in which the dataset item is to be deleted then right click and select the displayed **Delete FCDA** option.

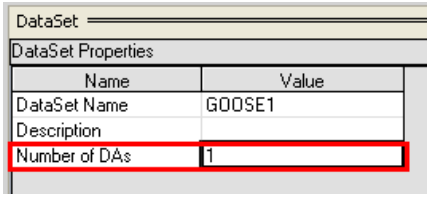
Figure 8-18: Delete FCDA Option



Number of DAs

Depending on the configured dataset items, the **Number of DAs** counter increases automatically.

Figure 8-19: Dataset Properties



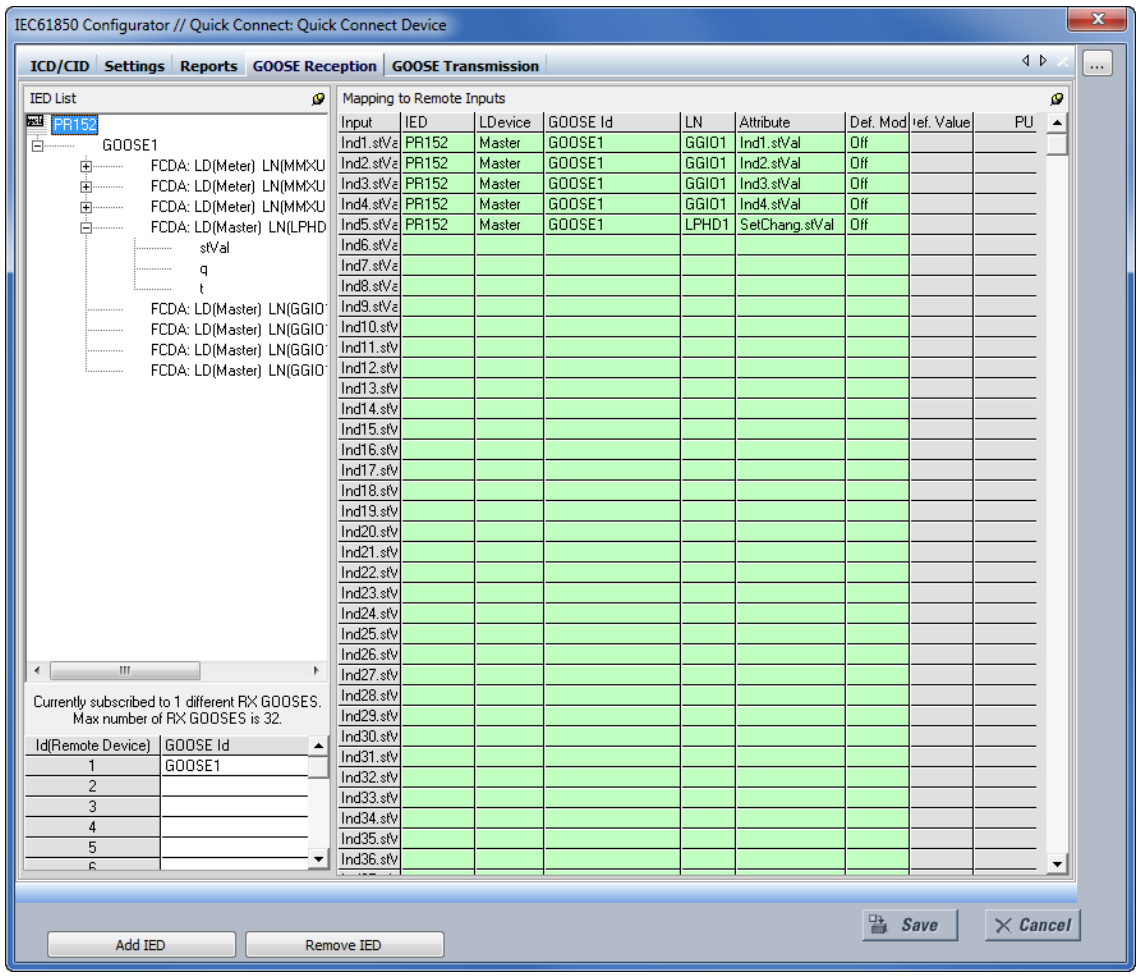
Goose Reception

The 8 Series relay can receive Transmitted GOOSE from any IED in "GOOSE Reception". For proper GOOSE reception the relay must be configured as described in this section. A maximum of 64 IEDs can be added.

GOOSE Reception has two sections:

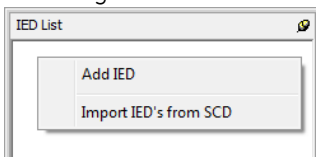
- IED list: add IEDs to subscribe to additional GOOSE transmissions.
- Mapping to Remote Inputs: Each subscribed GOOSE dataset item can be added to the screen using the drag and drop method.

Figure 8-20: Goose Reception Screen



The following buttons are available in the Goose Reception window:

- The **Add IED** button or right-clicking in the **IED List** section adds an IED.



  The **Remove IED** button deletes a configured IED.
- Click the **Save** button to save all configured settings. Click the **Cancel** button to discard the modifications just made to the configuration.

Configure Dataset Items

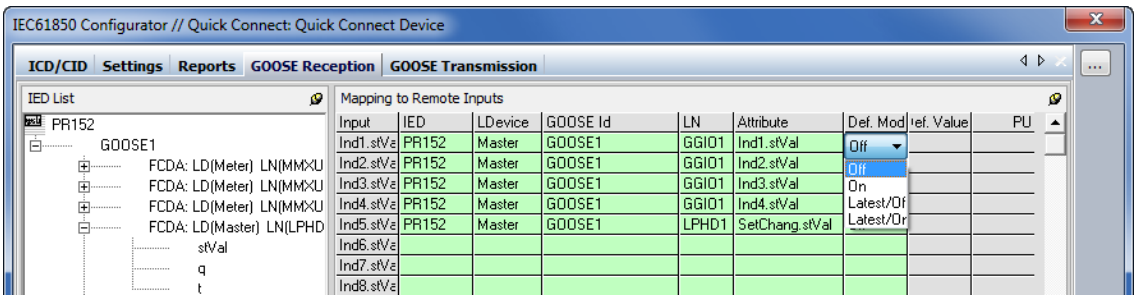
1. Select the dataset item being subscribed under the required IED which is available in the **Template > LDInst > GOOSEOut 1** tree (these names are the default settings and may have been changed).
2. Locate the required dataset item.
3. Drag and drop the chosen dataset item to the **Mapping to Remote Inputs** section.

Configure Default Mode (Def. Mode)

Def. Mode 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. When communications resume, the input becomes fully operational. Left-click on a value in the Def. Mode column to set the value. The following choices are available:

- On: the value defaults to Logic 1.
- Off: the value defaults to Logic 0.
- Latest/Off: The value freezes to the latest known state. It the latest state is not known, such as after relay power-up but before the first communication exchange, the value defaults to Logic 0.
- Latest/On: The value freezes to the latest known state. It the latest state is not known, such as after relay power-up but before the first communication exchange, the value defaults to Logic 1.

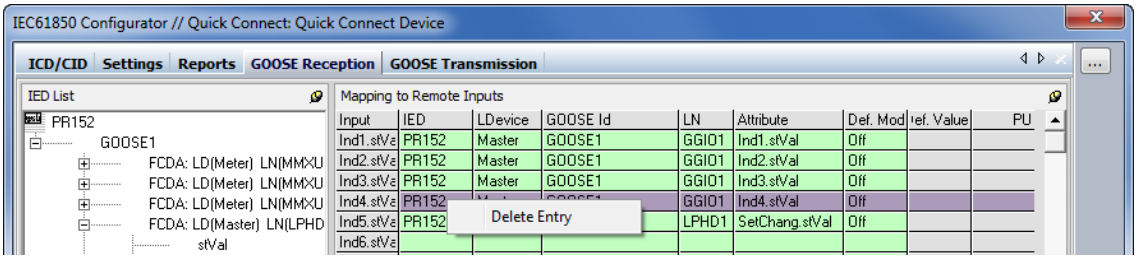
Figure 8-21: GOOSE Reception tab, Def. Mode



Delete a Dataset Item

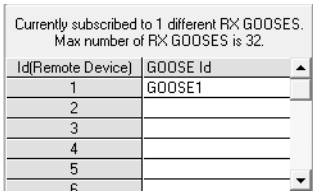
- Select the row in which the dataset item is being deleted then right click and select **Delete Entry**.

Figure 8-22: Delete Dataset Entry



IED Count

Depending on the configured dataset items for IEDs, the IED count on the bottom left of the screen increases automatically. In addition, the GOOSE Id field is updated with the GOOSE ID of the subscriber relay.



IEC 61850 MMS File Transfer

8 Series relays support MMS file transfer services based on IEC-61850-7-2. The following files are available for transfer:

- Motor Start Records: Ms1.cf, ms1.dat. (Comtrade format)

- Oscillography Records: Osc1.cfg, Osc1.dat, Osc1.hdr (Comtrade format)
- Event File: Evt.txt
- Device Configuration File: Default.CID
- Snapshot File: Snapshot.txt

8 Series Protective Relay Platform

Chapter 9: OPC–UA Communication Standard

This chapter describes the implementation process for the OPC-UA (OLE for Process Control – Unified Architecture) in the 8 Series relays.

Definitions and Acronyms

- OPC-UA – OLE for Process Control - Unified Architecture
- OLE – Object Linking and Embedding
- SOA – Service Oriented Architecture
- DA – Data Access
- AE – Alarms and Events
- SDK – Software Development Kit
- CTT – Compliance Test Tool

OPC–UA Architecture

OPC-UA is a platform-independent standard through which various systems and devices can communicate by sending messages between Clients and Servers. It supports robust, secure communication that assures the identity of Clients and Servers and resists attacks. OPC-UA defines sets of Services that Servers may provide, and individual Servers specify to Clients which Service sets they support. Information is conveyed using OPC-UA-defined and vendor-defined data types, and Servers define object models that Clients can dynamically discover. Servers can provide access to both current and historical data, as well as Alarms and Events to notify Clients of important changes. OPC UA can be mapped onto a variety of communication protocols and data can be encoded in various ways to trade off portability and efficiency.

The OPC communication is done through Client-Server architecture. In the case of the 8 Series relays, the relay is implemented as the Server.

NOTE

An OPC-UA Server is only available in 8 Series relays with an Advanced Communications option.

The parts that are supported are:

- OPC-UA DA
  - Read and write actions of the data service. The data service deals with real-time data only, not historical data.
- OPC-UA AE
  - Alarms and events service.
- OPC-UA Methods
  - Commands service.

OPC–UA Server Configuration

For order code options including OPC-UA communications, the OPC-UA server is always available in the 8 Series relay. It does not need to be turned on or enabled in any way.

The 8 Series OPC-UA server internal configuration data includes the following:

- OPC-UA connection port: 4840
- Maximum number of client connections:3
- The server has the following data types:
  - Double - used for Analog Values
  - Boolean - used for Digital, Logic, Input and Output data
- The response time increases proportional to the number of nodes being read.

There are many OPC-UA client software applications that can be used to validate the OPC-UA server. Some options are listed below:

- Iconics: Genesis64
- Indusoft: Web Studio
- HB-Softsolution: Comet UA Browser
- OPC UA: Sample Client
- Unified Automation: UaExpert

To view OPC-UA data, configure the OPC-UA client that will be connected to the relay, and add the 8 Series relay as a server.

OPC–UA Point Lists

- Modeling for the following:

Events
All digital signals available generate an event with a change of value or status.

Alarms
Operate element from Protection functions generate an alarm when the status value changes.

Commands
The Open&Close breaker and Reset commands have been implemented as Method services.

For Virtual Inputs, these signals are directly writable from the DA view instead of Method services.

To view the full points list, configure the OPC-UA client that will be connected to the relay, and add the 8 Series relay as a server.

8 Series Protective Relay Platform

Chapter 10: File Transfer Protocols

The base offering of 8 Series relay supports Trivial File Transfer Protocol (TFTP). The default port 69 is always used. No configuration setting is available. When the communications module is present, SSH File Transfer Protocol (SFTP) is also available. The default TCP port 22 for SSH is used for SFTP as well.

Reading Event Recorder

To read the entire event recorder contents (the only available format), use the following filename:

Evt.txt

Event Record retrieval example:

tftp -i 172.16.0.2 get evt.txt

Reading Transient Recorder

Familiarity with the Transient recorder feature is required to understand the following description.

The Oscillography_ Number_of_Triggers register is incremented by one every time a new oscillography file is triggered (captured) and cleared to zero when oscillography data is cleared. When a new trigger occurs, the associated oscillography file is assigned a file identifier number equal to the incremented value of the register; the newest file number is equal to the Oscillography_Number_of_Triggers register. This register can be used to determine if any new data has been captured by periodically reading it to see if the value has changed; if the number has increased then new data is available.

The Oscillography Number of Records register specifies the maximum number of files (and the number of cycles of data per file) that can be stored in the memory of the relay.

The Oscillography Available Records register specifies the actual number of files that are stored and still available to be read out of the relay. Writing “Yes” (i.e. the value 1) to the Oscillography Clear Data register clears oscillography data files, clears both the Oscillography Number of Triggers and Oscillography Available Records registers to zero, and sets the Oscillography Last Cleared Date to the present date and time.

To read binary COMTRADE oscillography files, read the following filenames:

OSCnnnn.CFG and OSCnnn.DAT

Transient Record retrieval example:

tftp -i 172.16.0.2 get osc1.cfg

tftp -i 172.16.0.2 get osc1.dat

The COMTRADE Version used on 8 Series relays is C37.111-1999.

Reading Fault Reports

Fault report data is available via the file retrieval mechanism in each8 Series relay. The filename is **FaultReport1_#####.txt** and the **#####** refers to the fault report record number.

The fault report number is a counter that indicates how many fault reports have ever occurred. Only the last fifteen fault reports are available for retrieval; a request for a non-existent fault report file yields a null file.

The total amount of available reports since the last clear command is found in "Number of Reports", Modbus register (32690).

Report retrieval example:

tftp -i 172.16.0.2 get FaultReport1_1.txt

8 Series Protective Relay Platform

Chapter 11: Modbus Protocol

All Ethernet ports and serial communication ports support the Modbus protocol. The only exception is if the serial port has been configured for DNP or IEC 60870-5-103 operation (see descriptions below). This allows the EnerVista 8 Series Setup software (which is a Modbus master application) to communicate to the 8 Series relay.

The 8 Series relay implements a subset of the Modicon Modbus RTU serial communication standard. The Modbus protocol is hardware-independent. That is, the physical layer can be any of a variety of standard hardware configurations. This includes USB, RS485, fiber optics, etc. Modbus is a single master/multiple slave type of protocol suitable for a multi-drop configuration.

The 8 Series relay is always a Modbus slave with a valid slave address range 1 to 254.

DATA FRAME FORMAT AND DATA RATE

One data frame of an asynchronous transmission to or from an 8 Series relay typically consists of 1 start bit, 8 data bits, and 1 stop bit. This produces a 10-bit data frame. This is important for transmission through modems at high bit rates. Modbus protocol can be implemented at any standard communication speed. The 8 Series relay supports operation at 9600, 19200, 38400, 57600, and 115200 bps baud rate. The USB interface supports ModBus TCP/IP.

FUNCTION CODE SUPPORTED

The following functions are supported by the 8 Series relay:

- FUNCTION CODE 03H - Read Setpoints
- FUNCTION CODE 04H - Read Actual Values
- FUNCTION CODE 05H - Execute Operation
- FUNCTION CODE 06H - Store Single Setpoint
- FUNCTION CODE 07H - Read Device Status
- FUNCTION CODE 08H - Loopback Test
- FUNCTION CODE 10H - Store Multiple Setpoints
- FUNCTION CODE 42H - Group Settings Read
- FUNCTION CODE 43H - Group Settings Write

When a ModBus master such as the EnerVista 8 Series Setup software communicates to the 8 Series relay over Ethernet, the 8 Series relay slave address, TCP port number and the 8 Series relay IP address for the associated port must be configured and are also configured within the Master for this device. The default ModBus TCP port number is 502.

The following ModBus parameters are configurable:

Path:Setpoints > Device > Communications > Modbus Protocol

MODBUS SLAVE ADDRESS

Range: 1 to 254 in steps of 1

Default: 254

For the RS485 ports each 8 Series relay must have a unique address from 1 to 254. Address 0 is the broadcast address to which all Modbus slave devices listen. Addresses do not have to be sequential, but no two devices can have the same address, otherwise conflicts resulting in errors occur. Generally, each device added to the link uses the next higher address starting at 1.

MODBUS TCP PORT NUMBER

Range: 1 to 65535 in steps of 1

Default: 502

The TCP port number used with Modbus over Ethernet. Note that the maximum number of simultaneous Modbus connections supported over Ethernet is:

- three for an 8 Series relay without the communications card,
- five for an 8 Series relay with the communications card.

COMPATIBILITY

Range: Disabled, SR750 or SR469, FlexMap

Default: Disabled

The **COMPATIBILITY** mode changes the Modbus actual value registers to emulate an SR relay (SR735, SR750 or SR469). The emulation supports typical actual value data for common data items.

Starting in version 2.90, choose "FlexMap" for SR750 or SR469 support to include support for additional SR750 registers and SR469 registers.

See the *8 Series Protective Relay Communications guide* for the list.

When the device is programmed in **COMPATIBILITY** mode, 8 Series relay actual values cannot be retrieved from Modbus.

FLEXMAP FILE

Range: Up to 13 alphanumeric characters

Default: SR735XA290.000, SR750XA290.000 or SR469XA290.000

The **FLEXMAP FILE** describes the translation from the 8Series Modbus memory map to the target Modbus memory map.

For SR750 support enter the filename "SR750XA290.000".

For SR735 support enter the filename "SR735XA290.000".

For SR469 support enter the filename "SR469XA290.000".

MODBUS 485 READ ACTUALS

Range: Function Code 03h, Function Code 04h

Default: Function Code 04h

The Modbus 485 Read Actuals setting configures the Function Code that the relay responds to from a Modbus Master when Actual Values are requested. Use this setting in scenarios where the Modbus Master can only communicate using Function Code 03h for requesting Actual Values.

NOTE

This setting applies only to the RS485 connection.

NOTE

When this setting is changed to Function Code 03h, retrieving configuration settings through the RS485 port is not possible.

MODBUS ACTIVITY TIMEOUT

Range: 0 to 3600 s in steps of 1 s

Default: 0 s

The Modbus Activity Timeout specifies the minimum time without Modbus communication. This timeout is used to declare the Modbus 'Loss of Communication' state.

The Modbus state is always Active if the Modbus Activity Timeout is 0 s.

MODBUS ERROR RESPONSES

The following exception response codes are implemented.

Error ID	Exception	Description
01	ILLEGAL FUNCTION	The function code transmitted is not one of the functions supported by the 8 Series relay.
02	ILLEGAL DATA ADDRESS	The address referenced in the data field transmitted by the master is not an allowable address for the 8 Series relay.
03	ILLEGAL DATA VALUE	The value referenced in the data field transmitted by the master is not within range for the selected data address.

Function Code 03H (Read Setpoints)

Modbus Implementation: Read Holding Registers

8 Series relay Implementation: Read Setpoints

For the 8 Series relay implementation of Modbus, the function code can be used to read any setpoints ("holding registers"). Holding registers are 16 bit (two byte) values transmitted high order byte first. As a result all 8 Series relay Setpoints are sent as two bytes. The maximum number of registers that can be read in one transmission is 125.

The slave response to this function code is the slave address, function code, a count of the number of data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first.

For example, consider a request for slave 17 to respond with 3 registers starting at address 006B. For this example the register data in these addresses is as follows:

Address	Data
006B	022B
006C	0000
006D	0064

The master/slave packets have the following format:

Table 11-1: Master Packet Format for Function Code 03H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	03	read registers
DATA STARTING ADDRESS	2	4A 8A	data starting at 4A8A
NUMBER OF SETPOINTS	2	00 04	4 registers = 8 bytes total
CRC (low, high)	2	67 F4	CRC error code

Table 11-2: Slave Packet Format for Function Code 03H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 254
FUNCTION CODE	1	03	read registers
BYTE COUNT	1	08	4 registers = 8 bytes total
DATA 1	2	00 00	value in address 4A8A (16-bit)
DATA 2	2	04 B0	value in address 4A8B (16-bit)
DATA 3	2	00 00	value in address 4A8C (32-bit)
DATA 4	2	00 64	
CRC (low, high)	2	E7 75	CRC error code

ASE 2000 V2 Example

```
--> 00 00 00 00 00 06 FE 03 4A 8A 00 04
--> 00 00 00 00 00 0B FE 03 08 00 00 04 B0 00 00 00 64
```

Function Code 04H (Read Actual Values)

Modbus Implementation: Read Input Registers

8 Series relay Implementation: Read Actual Values

For the 8 Series relay implementation of Modbus, the function code can be used to read any actual values ("input registers"). Input registers are 16 bit (two byte) values transmitted high order byte first. Thus all 8 Series relay Actual Values are sent as two bytes. The maximum number of registers that can be read in one transmission is 125.

The slave response to this function code is the slave address, function code, a count of the data bytes to follow, the data itself and the CRC. Each data item is sent as a two byte number with the high order byte sent first.

For example, request slave 17 to respond with 1 register starting at address 0008. For this example the value in this register (0008) is 0000.

Table 11-3: Master Packet Format for Function Code 04H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	04	read registers
DATA STARTING ADDRESS	2	05 95	data starting at 0595
NUMBER OF ACTUAL VALUES	2	00 02	2 registers = 4 bytes total
CRC (low, high)	2	75 24	CRC error code

Table 11-4: Slave Packet Format for Function Code 04H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 254
FUNCTION CODE	1	04	read registers
BYTE COUNT	1	04	2 register = 4 bytes total
DATA 1	2	00 00	value in address 0595 (32-bit)
DATA 2	2	27 0F	
CRC (low, high)	2	AF 7F	CRC error code

ASE 2000 V2 Example

```
--> 00 00 00 00 00 06 FE 04 05 95 00 02
--> 00 00 00 00 00 07 FE 04 04 00 00 27 0F
```

Function Code 05H (Execute Operation)

Modbus Implementation: Force Single Coil

8 Series relay Implementation: Execute Operation

The function code allows the master to request an 8 Series relay to perform specific command operations.

For example, to request slave 17 to execute operation code 1 (reset), we have the following master/slave packet format:

Table 11-5: Master Packet Format for Function Code 05H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	05	execute operation
OPERATION CODE	2	00 01	operation code 1
CODE VALUE	2	FF 00	perform function
CRC (low, high)	2	C9 F5	CRC error code

Table 11-6: Slave Packet Format for Function Code 05H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 17
FUNCTION CODE	1	05	execute operation
OPERATION CODE	2	00 01	operation code 1
CODE VALUE	2	FF 00	perform function
CRC (low, high)	2	C9 F5	CRC error code

ASE 2000 V2 Example

```
--> 00 00 00 00 00 06 FE 05 00 01 FF 00
--> 00 00 00 00 00 06 FE 05 00 01 FF 00
```

Function Code 06H (Store Single Setpoint)

Modbus Implementation: Preset Single Register

8 Series relay Implementation: Store Single Setpoint

The command allows the master to store a single setpoint into the memory of an 8 Series relay. The slave response to this function code is to echo the entire master transmission.

For example, request slave 17 to store the value 2 in setpoint address 04 5C. After the transmission in this example is complete, setpoints address 04 5C contains the value 0002. The master/slave packet format is shown next.

Table 11-7: Master Packet Format for Function Code 06H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	06	store single setpoint
DATA STARTING ADDRESS	2	4A 44	setpoint address 4A 44
DATA	2	03 E8	data for setpoint address 4A 44
CRC (low, high)	2	CB 76	CRC error code

Table 11-8: Slave Packet Format for Function Code 06H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 254
FUNCTION CODE	1	06	store single setpoint
DATA STARTING ADDRESS	2	4A 44	setpoint address 4A 44
DATA	2	03 E8	data for setpoint address 04A 44
CRC (low, high)	2	CB 76	CRC error code

ASE 2000 V2 Example

```
--> 00 00 00 00 00 06 FE 06 4A 44 03 E8
--> 00 00 00 00 00 06 FE 06 4A 44 03 E8
```

Function Code 07H (Read Device Status)

Modbus Implementation: Read Exception Status

8 Series relay Implementation: Read Device Status

The function used to quickly read the status of a selected device. A short message length allows for rapid reading of status. The status byte returned has individual bits set to 1 or 0 depending on the status of the slave device. For this example, consider the following 8 Series relay general status byte:

Table 11-9: Master Packet Format for Function Code 07H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	07	read device status
CRC (low, high)	2	00 12	CRC error code

Table 11-10: Slave Packet Format for Function Code 07H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 254
FUNCTION CODE	1	07	read device status
DEVICE STATUS (see following table)	1	28	status = 00101000 (in binary)
CRC (low, high)	2	12 1E	CRC error code

ASE 2000 V2 Example

--> 00 00 00 00 00 02 FE 07

--> 00 00 00 00 00 03 FE 07 28

Function code 07H includes the following bit masks:

Table 11-11: Device Table Status

Bit mask	Description
Bit 0	SP Group 3 Active
Bit 1	SP Group 2 Active
Bit 2	Pickup State
Bit 3	Breaker Connected
Bit 4	Breaker Closed
Bit 5	Breaker Tripped
Bit 6	Alarm
Bit 7	Trip

Function Code 08H (Loopback Test)

Modbus Implementation: Loopback

8 Series relay Implementation: Loopback Test

The function is used to test the integrity of the communication link. The 8 Series relay echos the request.

For example, consider a loopback test from slave 254:

Table 11-12: Master Packet Format for Function Code 08H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	08	loopback test
DIAGNOSTICS CODE	2	00 00	must be 00 00
DATA	2	00 00	must be 00 00
CRC (low, high)	2	F4 04	CRC error code

Table 11-13: Slave Packet Format for Function Code 08H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 17
FUNCTION CODE	1	08	loopback test
DIAGNOSTICS CODE	2	00 00	must be 00 00
DATA	2	00 00	must be 00 00
CRC (low, high)	2	F4 04	CRC error code

ASE 2000 V2 Example

--> 00 00 00 00 00 06 FE 08 00 00 00 00

--> 00 00 00 00 00 06 FE 08 00 00 00 00

Function Code 10H (Store Multiple Setpoints)

Modbus Implementation: Preset Multiple Registers

8 Series relay Implementation: Store Multiple Setpoints

The function code allows multiple Setpoints to be stored into the 8 Series relay memory. Modbus "registers" are 16-bit (two byte) values transmitted high order byte first. Thus all 8 Series relay setpoints are sent as two bytes. The maximum number of Setpoints that can be stored in one transmission is dependent on the slave device. Modbus allows up to a maximum of 60 holding registers to be stored. The 8 Series relay response to this function code is to echo the slave address, function code, starting address, the number of Setpoints stored, and the CRC.

For example, consider a request for slave 254 to store the value 00 0A to setpoint address 41 DB and the value 00 64 to setpoint address 41 DC. After the transmission in this example is complete, 8 Series relay slave 254 will have the following setpoints information stored:

Address	Data
41 DB	00 0A
41 DC	00 64

Table 11-14: Master Packet Format for Function Code 10H

MASTER TRANSMISSION	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message for slave 254
FUNCTION CODE	1	10	store setpoints
DATA STARTING ADDRESS	2	41 DB	setpoint address 41 DB
NUMBER OF SETPOINTS	2	00 02	2 setpoints – 4 bytes total
BYTE COUNT	1	04	4 bytes of data
DATA 1	2	00 0A	data for setpoint address 41 DB
DATA 2	2	00 64	data for setpoint address 41 DC
CRC (low, high)	2	91 ED	CRC error code

Table 11-15: Slave Packet Format for Function Code 10H

SLAVE RESPONSE	BYTES	EXAMPLE	DESCRIPTION
SLAVE ADDRESS	1	FE	message from slave 254
FUNCTION CODE	1	10	store setpoints
DATA STARTING ADDRESS	2	41 DB	setpoint address 41 DB
NUMBER OF SETPOINTS	2	00 02	2 setpoints
CRC (low, high)	2	31 C0	CRC error code

ASE 2000 V2 Example

```
--> 00 00 00 00 00 0B FE 10 41 DB 00 02 04 00 0A 00 64
--> 00 00 00 00 00 06 FE 10 41 DB 00 02
```

Administrator Login and Commands via Modbus for 8 Series Relays

Logging in as Administrator

Logging in as Administrator is demonstrated in the example below. The process requires writing 44 bytes which consist of the Role ID and Password. Password characters are 22 bytes and role characters are also 22 bytes. The logging in must be done using a single Modbus command using Function 10H (Store Multiple Setpoints).

The following table shows data to be written to the relay to login as Administrator. The relay password in this example is 0.

Table 11-16: Data Written to Relay to Login as Administrator

Description	Memory Map Address		Value to be written	
	DEC	HEX	DEC	HEX
Role Characters 1 and 2	62242	F322	16740	4164
Role Characters 3 and 4	62243	F323	28009	6D69
Role Characters 5 and 6	62244	F324	28265	6E69
Role Characters 7 and 8	62245	F325	29556	7374
Role Characters 9 and 10	62246	F326	29281	7261
Role Characters 11 and 12	62247	F327	29807	746F
Role Characters 13 and 14	62248	F328	29184	7200
Role Characters 15 and 16	62249	F329	0	0000
Role Characters 17 and 18	62250	F32A	0	0000
Role Characters 19 and 20	62251	F32B	0	0000
Role Characters 21 and 22	62252	F32C	0	0000
Password Characters 1 and 2	62253	F32D	12288	3000
Password Characters 3 and 4	62254	F32E	0	0000
Password Characters 5 and 6	62255	F32F	0	0000
Password Characters 7 and 8	62256	F330	0	0000
Password Characters 9 and 10	62257	F331	0	0000
Password Characters 11 and 12	62258	F332	0	0000
Password Characters 13 and 14	62259	F333	0	0000
Password Characters 15 and 16	62260	F334	0	0000
Password Characters 17 and 18	62261	F335	0	0000
Password Characters 19 and 20	62262	F336	0	0000
Password Characters 21 and 22	62263	F337	0	0000

Table 11-17: Login as Administrator Function Format

Slave#	Function	Data Starting Address	Number of Setpoints	Byte Count	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7	Data 8	Data 9
FE	10	F322	0016	2C	4164	6D69	6E69	7374	7261	746F	7200	0	0

Table 11-18: Login as Administrator Function Format continued

Data 10	Data 11	Data 12	Data 13	Data 14	Data 15	Data 16	Data17	Data 18	Data 19	Data 20	Data 21	Data 22
0	0	3000	0	0	0	0	0	0	0	0	0	0

Commands using Modbus Function 10H (Store Multiple Setpoints)

Sending commands requires writing 4 bytes to the Command address register using the Modbus Function 10H (Store Multiple Setpoints). The 4 bytes are the function and the command values. The function value is always 05.

Table 11-19: Modbus Commands registers

Description	Memory Map Address	
	DEC	HEX
Command Register	40129	0x0080
Command Function Register	40130	0x0081

Table 11-20: Examples of Command values

Command Value	Value Description
1	Reset
96	Clear All Records
98	Clear Events
105	Clear Energy Use Data
4096	Force Virtual Input 1

A complete list of Modbus Commands is found at the end of chapter 12.

Function Format for "Clear All" command:

Table 11-21: Function Format for "Clear All" command

Slave #	Function	Data Starting Address	Number of Setpoints	Byte count	Data 1	Data 2
FE	10	0080	0002	04	0005	0060

Table 11-22: Function Format for "Clear Energy Use Data" command

Slave #	Function	Data Starting Address	Number of Setpoints	Byte count	Data 1	Data 2
FE	10	0080	0002	04	0005	0069

Table 11-23: Function Format for "Force Virtual Input 1" command

Slave #	Function	Data Starting Address	Number of Setpoints	Byte count	Data 1	Data 2
FE	10	0080	0002	04	0005	1000

Commands using Modbus Function 05H (Execute Operation)

Specific command operations such as described above can also be performed using function code 05H.

Table 11-24: Format for Function Code 05H

Master Transmission	Byte#	Example	Description
Slave Address	1	FE	message for slave # 254
Function Code	1	05	execute operation
Operation Code	2	00 01	operation code
Code Value	2	FF 00	perform function
CRC	2	DF 6A	CRC error code

Table 11-25: Examples of Command values

Command Value	Value Description
1	Reset
96	Clear All Records
98	Clear Events
105	Clear Energy Use Data
4096	Force Virtual Input 1

Table 11-26: Function Format for Reset command

Slave #	Function	Operation Code	Code Value
FE	05	0001	FF00

8 Series Protective Relay Platform

Chapter 12: About the Modbus Memory Map

Refer to the Modbus Maps spreadsheet package located online under Support Documents on the webpage for each 8 Series relay:

www.gegridsolutions.com/multilin/ProductListing.htm

NOTICE

Modbus Maps and Format Codes for all 8 Series relays are included in the same package. There are several versions of the Modbus Map and corresponding Format Codes available, and the one matching the relay firmware version should be used.

Accessing Data via the User Map

The 8 Series relay has a powerful feature, called the User Map, which allows a computer to read up to 125 non-consecutive data registers (setpoints or actual values) by using one Modbus packet. It is often necessary for a master computer to continuously poll various values in each of the connected slave relays. If these values are scattered throughout the memory map, reading them would require numerous transmissions and would burden the communication link. The User Map can be programmed to join any memory map address to one in the block of consecutive User Map locations, so that they can be accessed by reading these consecutive locations.

The 8 Series relay contains a user-definable area in the Modbus memory map. This area allows re-mapping of the addresses of any Actual Values registers. The User Definable area has two sections.

1. A Register Index area (40524 to 40648) that contains 125 Actual Values register addresses
2. A Register area (30524 to 30648) that contains the data at the addresses in the Register Index

Register data that is separated in the rest of the memory map may be re-mapped to adjacent register addresses in the user-definable registers area. This is accomplished by writing to register addresses in the user-definable register index area. This allows for improved throughput of data and can eliminate the need for multiple read command sequences. The user-definable register index is stored as a setpoint and therefore it is "remembered" even when the power is removed.

Default User Map

Common actual values have been defaulted for the user. Below are the default registers. (This is the general Default User Map; some features are not supported in all relays resulting in some blank addresses. View the Modbus User Map in the Enervista 8 Series Setup software for specific relays.)

Table 12-1: Default User Map

User Map Address	Description	Modbus Address	
User Map Address 1,2	Device Status	30714	30715
User Map Address 3,4	LED1 1-16	30710	30711
User Map Address 5,6	Contact Inputs 1-32	30700	30701
User Map Address 7,8	Contact Outputs 1-32	30708	30709
User Map Address 9,10	Virtual Inputs 1-32	30716	30717
User Map Address 11, 12	Virtual Outputs 1-32	30724	30725
User Map Address 13,14	Remote Inputs 1-32	30736	30737
User Map Address 15,16	GGIO1 Indications 1-32	30752	30753
User Map Address 17,18	J1 Ia	34420	34421
User Map Address 19,20	J1 Ib	34422	34423
User Map Address 21,22	J1 Ic	34424	34425
User Map Address 23,24	J1 In	34428	34429
User Map Address 25,26	J1 I AVG	34445	34446
User Map Address 27,28	J1 Ig	34426	34427
User Map Address 29,30	J2 Van RMS	34646	34647
User Map Address 31,32	J2 Vbn RMS	34648	34649
User Map Address 33,34	J2 Vcn RMS	34650	34651
User Map Address 35,36	J2 Vab RMS	34652	34653
User Map Address 37,38	J2 Vbc RMS	34654	34655
User Map Address 39,40	J2 Vca RMS	34656	34657
User Map Address 41,42	J2 V AVG L-L	34670	34671
User Map Address 43,44	J2 V AVG L-N	34672	34673
User Map Address 45,46	Pwr1 Real	35690	35691
User Map Address 47,48	Pwr1 Apparent	35694	35695
User Map Address 49	Pwr1 PF	35714	
User Map Address 50	Product Code	30001	
User Map Address 51	J2-CT Frq Rate of Chge	34931	
User Map Address 52,53	Sync1 Line Volts Magnitude	35585	35586
User Map Address 54	Sync1 Line Volts Angle	35587	
User Map Address 55,56	Sync1 Line Volts Frequency	35588	35589
User Map Address 57,58	Pwr1 Pos WattHours	35854	35855
User Map Address 59,60	Pwr1 Ph A Real	35696	35697
User Map Address 61,62	Pwr1 Ph A Apparent	35708	35709
User Map Address 63	Pwr1 Ph A PF	35715	
User Map Address 64,65	Pwr1 Ph B Real	35698	35699
User Map Address 66,67	Pwr1 Ph B Apparent	35710	35711
User Map Address 68	Pwr1 Ph B PF	35716	
User Map Address 69,70	Pwr1 Ph C Real	35700	35701
User Map Address 71,72	Pwr1 Ph C Apparent	35712	35713
User Map Address 73	Pwr1 Ph C PF	35717	
User Map Address 74,75	Pwr1 Reactive	35692	35693

User Map Address	Description	Modbus Address	
User Map Address 76,77	Pwr1 Ph A Reactive	35702	35703
User Map Address 78,79	Pwr1 Ph B Reactive	35704	35705
User Map Address 80,81	Pwr1 Ph C Reactive	35706	35707

The 8 Series relay supports 32-bit Modbus items to be configured in the user map. When such an address is configured in the user map for example at user map address 1, user map address 2 is also consumed by the same item irrespective of the address assigned in address 2.

Memory Map Organization

The 8 Series relay Memory Map describes all the data registers that can be accessed via serial communications. The Memory Map address range is grouped into several categories as outlined in the following table. All memory map locations are two byte (16 bit) values. The remaining pages of this chapter list all locations of the Memory Map. Addresses for all locations are shown in hexadecimal. Consult the range, step, units, and the data format (listed after the memory map) to interpret register values.

NOTE

Many Modbus drivers add 40001 (for settings) or 30001 (for actual values) to the actual address of the register addresses. For example, if settings address 0h was to be read, then 40001d would be the address required by the Modbus communications driver; similarly, if settings address 320h (800d) was to be read, then 40801d would be the address required by the Modbus communications driver.

Table 12-2: Memory Map Organization

Memory Map Section	Address Range	Description
Product ID	30001 to 30104	Identification and revision information.
Actual Values	30193 to 30391	Actual values. Read Only.
	30660 to 38923	
User Map Values	30524 to 30648	User Map Values. See the previous section for details.
Setpoints	40001 to 40008	Setpoints data. Read and Write.
	40230 to 40477	
	40660 to 95523	
Commands	40129 to 40140	Substitute command locations. Read and write.
User Map Setpoints	40524 to 40648	User map setpoints. Configures user map values
Simulation	102550 to 102896	Simulation

Compatibility Mode

The 8 Series relay supports emulation of the SR750/SR735/SR469 Modbus memory map for retrofit applications. The emulation supports typical actual value data for common data items. When enabled, the 8 Series relay responds to Modbus packets from a PLC as if it were a legacy SR relay.

The compatibility mode is only available for RS485 and rear Ethernet ports. (The USB and Wifi always respond using the 8 Series memory map.)

When in compatibility mode the rear RS485 port and the rear Ethernet ports are not accessible via EnerVista 8 Series Setup so it is not possible to change any settings, view actual values or retrieve records. When in compatibility mode the actual values supported can be read via the rear RS485 or rear Ethernet Ports using Modbus Master e.g. PLC or DCS. The front USB port should be used for connection and EnerVista 8 Series Setup activities.

User Map

When using the default user map in compatibility mode, the user is required to enter the Modicon format for the address that is being read in the user map. The Modicon format has an offset of 30001, and thus is different from the values found in the SR publications. For convenience, the translated values have been included in the tables below. The user map can only be entered in an offline file, and the compatibility mode must be set to SR469 or SR750, depending on the product being used.

The user map implementation is the same function as covered in the section *Accessing Data via the User Map*. The only difference is that the read function starts at 0100h (256 Dec) to correspond to the SR469/SR750 map.Range: User Map #1 (0100h) to User Map #125 (017Ch)

Example:

PLC requests Phase A current from SR469 = 0300h (HEX) using User Map #1 = 0100h

Default User Map #1 in 8 Series PC SW = 30769 (Dec) => SR469 = 768 (Dec) = 0300h(HEX)

The following tables list the addresses supported in compatibility mode for both SR469 and SR750. The SR Hex and decimal values are provided with the corresponding 8 Series value.

Table 12-3: SR469 Addresses supported in Compatibility Mode

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
0000	0	30001	Product Code	30001
0001	1	30002	Hardware Revision	30002
0002	2	30003	Firmware Version	30003
0010	16	30017	Boot 1 Version	30005
00F0	240	30241	Time	30241
00F2	242	30243	Date	30243
0100	256	30257	User Map Value 1	30524
0101	257	30258	User Map Value 2	30525
0102	258	30259	User Map Value 3	30526
0103	259	30260	User Map Value 4	30527
0104	260	30261	User Map Value 5	30528
0105	261	30262	User Map Value 6	30529
0106	262	30263	User Map Value 7	30530
0107	263	30264	User Map Value 8	30531
0108	264	30265	User Map Value 9	30532
0109	265	30266	User Map Value 10	30533
010A	266	30267	User Map Value 11	30534
010B	267	30268	User Map Value 12	30535
010C	268	30269	User Map Value 13	30536
010D	269	30270	User Map Value 14	30537
010E	270	30271	User Map Value 15	30538
010F	271	30272	User Map Value 16	30539
0110	272	30273	User Map Value 17	30540
0111	273	30274	User Map Value 18	30541
0112	274	30275	User Map Value 19	30542
0113	275	30276	User Map Value 20	30543

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
0114	276	30277	User Map Value 21	30544
0115	277	30278	User Map Value 22	30545
0116	278	30279	User Map Value 23	30546
0117	279	30280	User Map Value 24	30547
0118	280	30281	User Map Value 25	30548
0119	281	30282	User Map Value 26	30549
011A	282	30283	User Map Value 27	30550
011B	283	30284	User Map Value 28	30551
011C	284	30285	User Map Value 29	30552
011D	285	30286	User Map Value 30	30553
011E	286	30287	User Map Value 31	30554
011F	287	30288	User Map Value 32	30555
0120	288	30289	User Map Value 33	30556
0121	289	30290	User Map Value 34	30557
0122	290	30291	User Map Value 35	30558
0123	291	30292	User Map Value 36	30559
0124	292	30293	User Map Value 37	30560
0125	293	30294	User Map Value 38	30561
0126	294	30295	User Map Value 39	30562
0127	295	30296	User Map Value 40	30563
0128	296	30297	User Map Value 41	30564
0129	297	30298	User Map Value 42	30565
012A	298	30299	User Map Value 43	30566
012B	299	30300	User Map Value 44	30567
012C	300	30301	User Map Value 45	30568
012D	301	30302	User Map Value 46	30569
012E	302	30303	User Map Value 47	30570
012F	303	30304	User Map Value 48	30571
0130	304	30305	User Map Value 49	30572
0131	305	30306	User Map Value 50	30573
0132	306	30307	User Map Value 51	30574
0133	307	30308	User Map Value 52	30575
0134	308	30309	User Map Value 53	30576
0135	309	30310	User Map Value 54	30577
0136	310	30311	User Map Value 55	30578
0137	311	30312	User Map Value 56	30579
0138	312	30313	User Map Value 57	30580
0139	313	30314	User Map Value 58	30581
013A	314	30315	User Map Value 59	30582
013B	315	30316	User Map Value 60	30583
013C	316	30317	User Map Value 61	30584
013D	317	30318	User Map Value 62	30585
013E	318	30319	User Map Value 63	30586
013F	319	30320	User Map Value 64	30587
0140	320	30321	User Map Value 65	30588
0141	321	30322	User Map Value 66	30589

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
0142	322	30323	User Map Value 67	30590
0143	323	30324	User Map Value 68	30591
0144	324	30325	User Map Value 69	30592
0145	325	30326	User Map Value 70	30593
0146	326	30327	User Map Value 71	30594
0147	327	30328	User Map Value 72	30595
0148	328	30329	User Map Value 73	30596
0149	329	30330	User Map Value 74	30597
014A	330	30331	User Map Value 75	30598
014B	331	30332	User Map Value 76	30599
014C	332	30333	User Map Value 77	30600
014D	333	30334	User Map Value 78	30601
014E	334	30335	User Map Value 79	30602
014F	335	30336	User Map Value 80	30603
0150	336	30337	User Map Value 81	30604
0151	337	30338	User Map Value 82	30605
0152	338	30339	User Map Value 83	30606
0153	339	30340	User Map Value 84	30607
0154	340	30341	User Map Value 85	30608
0155	341	30342	User Map Value 86	30609
0156	342	30343	User Map Value 87	30610
0157	343	30344	User Map Value 88	30611
0158	344	30345	User Map Value 89	30612
0159	345	30346	User Map Value 90	30613
015A	346	30347	User Map Value 91	30614
015B	347	30348	User Map Value 92	30615
015C	348	30349	User Map Value 93	30616
015D	349	30350	User Map Value 94	30617
015E	350	30351	User Map Value 95	30618
015F	351	30352	User Map Value 96	30619
0160	352	30353	User Map Value 97	30620
0161	353	30354	User Map Value 98	30621
0162	354	30355	User Map Value 99	30622
0163	355	30356	User Map Value 100	30623
0164	356	30357	User Map Value 101	30624
0165	357	30358	User Map Value 102	30625
0166	358	30359	User Map Value 103	30626
0167	359	30360	User Map Value 104	30627
0168	360	30361	User Map Value 105	30628
0169	361	30362	User Map Value 106	30629
016A	362	30363	User Map Value 107	30630
016B	363	30364	User Map Value 108	30631
016C	364	30365	User Map Value 109	30632
016D	365	30366	User Map Value 110	30633
016E	366	30367	User Map Value 111	30634
016F	367	30368	User Map Value 112	30635

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
0170	368	30369	User Map Value 113	30636
0171	369	30370	User Map Value 114	30637
0172	370	30371	User Map Value 115	30638
0173	371	30372	User Map Value 116	30639
0174	372	30373	User Map Value 117	30640
0175	373	30374	User Map Value 118	30641
0176	374	30375	User Map Value 119	30642
0177	375	30376	User Map Value 120	30643
0178	376	30377	User Map Value 121	30644
0179	377	30378	User Map Value 122	30645
017A	378	30379	User Map Value 123	30646
017B	379	30380	User Map Value 124	30647
017C	380	30381	User Map Value 125	30648
0200	512	30513	Motor Status	30960
0201	513	30514	Motor Thermal Capacity Used	30961
0202	514	30515	Estimated Trip Time on OL	30962
0204	516	30517	Motor Speed	30968
0210	528	30529	Motor Status	30960
0211	529	30530	CO Outputs	30708
0220	544	30545	Cause of Last Trip[1]	31220
0221	545	30546	Cause of Last Trip - Date	31224
0223	547	30548	Cause of Last Trip - Time	31224
026E	622	30623	Element Status 149 (Thermal Alarm)	38048
026F	623	30624	Element Status 169 (Overload)	38068
0270	624	30625	Element Status 153 (Undercurrent 1 Alarm)	38052
0271	625	30626	Element Status 150 (Current Unbalance Alarm)	38049
0272	626	30627	Element Status 172 (Ground Fault Alarm)	38071
0273	627	30628	Element Status 657 (RTD 1 Alarm)	38556
0274	628	30629	Element Status 658 (RTD 2 Alarm)	38557
0275	629	30630	Element Status 659 (RTD 3 Alarm)	38558
0276	630	30631	Element Status 660 (RTD 4 Alarm)	38559
0277	631	30632	Element Status 661 (RTD 5 Alarm)	38560
0278	632	30633	Element Status 662 (RTD 6 Alarm)	38561
0279	633	30634	Element Status 663 (RTD 7 Alarm)	38562
027A	634	30635	Element Status 664 (RTD 8 Alarm)	38563
027B	635	30636	Element Status 665 (RTD 9 Alarm)	38564
027C	636	30637	Element Status 666 (RTD 10 Alarm)	38565

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
027D	637	30638	Element Status 667 (RTD 11 Alarm)	38566
027E	638	30639	Element Status 668 (RTD 12 Alarm)	38567
0281	641	30642	Element Status 364 (Phase UV 1)	38263
0282	642	30643	Element Status 406 (Phase OV 1)	38305
0284	644	30645	Element Status 591 (Power Factor Alarm (Motor Generator))	38490
0285	645	30646	Element Status 462 (Reactive Power Alarm)	38361
0286	646	30647	Element Status 176 (Underpower Alarm)	38075
0289	649	30650	Element Status 592 (Current Dmd 1)	38491
028A	650	30651	Element Status 596 (Real Power Demand 1)	38495
028B	651	30652	Element Status 600 (Reactive Power Demand 1)	38499
028C	652	30653	Element Status 604 (Apparent Power Demand 1)	38503
028D	653	30654	Element Status 124 (Analog Input 1 Alarm)	38023
028E	654	30655	Element Status 125 (Analog Input 2 Alarm)	38024
028F	655	30656	Element Status 126 (Analog Input 3 Alarm)	38025
0290	656	30657	Element Status 127 (Analog Input 4 Alarm)	38026
0292	658	30659	Element Status 639 (RTD 1 Trip)	38538
0293	659	30660	Element Status 640 (RTD 2 Trip)	38539
0294	660	30661	Element Status 641 (RTD 3 Trip)	38540
0295	661	30662	Element Status 642 (RTD 4 Trip)	38541
0296	662	30663	Element Status 643 (RTD 5 Trip)	38542
0297	663	30664	Element Status 644 (RTD 6 Trip)	38543
0298	664	30665	Element Status 645 (RTD 7 Trip)	38544
0299	665	30666	Element Status 646 (RTD 8 Trip)	38545
029A	666	30667	Element Status 647 (RTD 9 Trip)	38546
029B	667	30668	Element Status 648 (RTD 10 Trip)	38547
029C	668	30669	Element Status 649 (RTD 11 Trip)	38548
029D	669	30670	Element Status 650 (RTD 12 Trip)	38549
02B0	688	30689	Thermal Lockout Time	30963
02B1	689	30690	Total Motor Lockout Time	30967
02B2	690	30691	Max Start Rate LO Time	30964
02B3	691	30692	Time Btwn Starts LO Time	30965
02B4	692	30693	Restart Delay LO Time	30966
02D0	720	30721	Access switch status	30700
02D1	721	30722	Test switch status	30700

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
02D2	722	30723	Starter switch status	30700
02D3	723	30724	Emergency restart switch status	30700
02D4	724	30725	Remote reset switch status	30700
02D5	725	30726	Assignable switch #1 status	30700
02D6	726	30727	Assignable switch #2 status	30700
02D7	727	30728	Assignable switch #3 status	30700
02D8	728	30729	Assignable switch #4 status	30700
02D9	729	30730	Trip Coil 1	31041
02FC	764	30765	Time	30241
02FE	766	30767	Date	30243
0300	768	30769	J1 Ia RMS	34430
0302	770	30771	J1 Ib RMS	34432
0304	772	30773	J1 Ic RMS	34434
0306	774	30775	J1 I AVG	34445
0308	776	30777	Motor Load	33800
0309	777	30778	Motor Current Unbalance	33801
030A	778	30779	Therm Model Biased Load	33802
030B	779	30780	J1 Ig RMS	34436
030D	781	30782	Ia Diff	33720
030E	782	30783	Ib Diff	33722
030F	783	30784	Ic Diff	33724
0320	800	30801	Hottest Stator RTD Temp (°C)	36591
0321	801	30802	RTD 1 (°C)	36610
0322	802	30803	RTD 2 (°C)	36611
0323	803	30804	RTD 3 (°C)	36612
0324	804	30805	RTD 4 (°C)	36613
0325	805	30806	RTD 5 (°C)	36614
0326	806	30807	RTD 6 (°C)	36615
0327	807	30808	RTD 7 (°C)	36616
0328	808	30809	RTD 8 (°C)	36617
0329	809	30810	RTD 9 (°C)	36618
032A	810	30811	RTD 10 (°C)	36619
032B	811	30812	RTD 11 (°C)	36620
032C	812	30813	RTD 12 (°C)	36621
0330	816	30817	Hottest Stator RTD Temp (°F)	36591
0331	817	30818	RTD 1 (°F)	36610
0332	818	30819	RTD 2 (°F)	36611
0333	819	30820	RTD 3 (°F)	36612
0334	820	30821	RTD 4 (°F)	36613
0335	821	30822	RTD 5 (°F)	36614
0336	822	30823	RTD 6 (°F)	36615
0337	823	30824	RTD 7 (°F)	36616
0338	824	30825	RTD 8 (°F)	36617
0339	825	30826	RTD 9 (°F)	36618
033A	826	30827	RTD 10 (°F)	36619

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
033B	827	30828	RTD 11 (°F)	36620
033C	828	30829	RTD 12 (°F)	36621
0340	832	30833	J2 Vab	34636
0341	833	30834	J2 Vbc	34638
0342	834	30835	J2 Vca	34640
0343	835	30836	J2 V AVG L-L	34670
0344	836	30837	J2 Van	34630
0345	837	30838	J2 Vbn	34632
0346	838	30839	J2 Vcn	34634
0347	839	30840	J2 V AVG L-N	34672
0348	840	30841	Frequency	34891
0370	880	30881	Pwr1 PF	35714
0371	881	30882	Pwr1 Real	35690
0374	884	30885	Pwr1 Reactive	35692
0376	886	30887	Pwr1 Apparent	35694
0377	887	30888	Pwr1 Pos WattHours	35854
0379	889	30890	Pwr1 Pos VarHours	35862
037B	891	30892	Pwr1 Neg VarHours	35864
0390	912	30913	Cur1 Ph A Demand	35974
0392	914	30915	Pwr1 Real Dmd	36134
0394	916	30917	Pwr1 Reactive Dmd	36142
0396	918	30919	Pwr1 Apparent Dmd	36150
0397	919	30920	Cur1 Max Ph A Demand	35980
0399	921	30922	Pwr1 Max Real Dmd	36136
039B	923	30924	Pwr1 Max Reactive Dmd	36144
039D	925	30926	Pwr1 Max Apparent Dmd	36152
03B0	944	30945	Analog Input 1	36830
03B2	946	30947	Analog Input 2	36832
03B4	948	30949	Analog Input 3	36834
03B6	950	30951	Analog Input 4	36836
03E0	992	30993	RTD 1 Max (°C)	36640
03E1	993	30994	RTD 2 Max (°C)	36643
03E2	994	30995	RTD 3 Max (°C)	36646
03E3	995	30996	RTD 4 Max (°C)	36649
03E4	996	30997	RTD 5 Max (°C)	36652
03E5	997	30998	RTD 6 Max (°C)	36655
03E6	998	30999	RTD 7 Max (°C)	36658
03E7	999	31000	RTD 8 Max (°C)	36661
03E8	1000	31001	RTD 9 Max (°C)	36664
03E9	1001	31002	RTD 10 Max (°C)	36667
03EA	1002	31003	RTD 11 Max (°C)	36670
03EB	1003	31004	RTD 12 Max (°C)	36673
03F0	1008	31009	RTD 1 Max (°F)	36640
03F1	1009	31010	RTD 2 Max (°F)	36643
03F2	1010	31011	RTD 3 Max (°F)	36646
03F3	1011	31012	RTD 4 Max (°F)	36649

469 HEX	469 Decimal	Modicon Format (Needed for User Map)	Description	869 Source Modbus Address
03F4	1012	31013	RTD 5 Max (°F)	36652
03F5	1013	31014	RTD 6 Max (°F)	36655
03F6	1014	31015	RTD 7 Max (°F)	36658
03F7	1015	31016	RTD 8 Max (°F)	36661
03F8	1016	31017	RTD 9 Max (°F)	36664
03F9	1017	31018	RTD 10 Max (°F)	36667
03FA	1018	31019	RTD 11 Max (°F)	36670
03FB	1019	31020	RTD 12 Max (°F)	36673
0500	1280	31281	J2 Vab Angle	34665
0501	1281	31282	J2 Vbc Angle	34666
0502	1282	31283	J2 Vca Angle	34667
0503	1283	31284	J1 Ia Angle	34440
0504	1284	31285	J1 Ib Angle	34441
0505	1285	31286	J1 Ic Angle	34442

1.Please note that the following last trip causes are supported: Overload Trip (Thermal Trip), Current Unbalance Trip, Mechanical Jam Trip, Ground Fault Trip, Acceleration Trip, Phase UV Trip, Phase OV Trip, Voltage Frequency Trip (Overfrequency Trip and Underfrequency Trip), Differential Trip, Single Phasing trip, Tachometer Trip, Short Circuit Trip, Phase Reversal trip, Reverse Power Trip, Undercurrent Trip, Power Factor Trip.

Table 12-4: SR750 Addresses supported in Compatibility Mode

750 HEX	750 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
0000	0	30001	Product Code	30001
0001	1	30002	Hardware Revision	30002
0002	2	30003	Firmware Version	30003
0004	4	30005	Boot 1 Version	30005
0091	145	30146	Virtual Input 1	30716
0092	146	30147	Virtual Input 2	30716
0093	147	30148	Virtual Input 3	30716
0094	148	30149	Virtual Input 4	30716
0095	149	30150	Virtual Input 5	30716
0096	150	30151	Virtual Input 6	30716
0097	151	30152	Virtual Input 7	30716
0098	152	30153	Virtual Input 8	30716
0099	153	30154	Virtual Input 9	30716
009A	154	30155	Virtual Input 10	30716
009B	155	30156	Virtual Input 11	30716
009C	156	30157	Virtual Input 12	30716
009D	157	30158	Virtual Input 13	30716
009E	158	30159	Virtual Input 14	30716
009F	159	30160	Virtual Input 15	30716
00A0	160	30161	Virtual Input 16	30716
00A1	161	30162	Virtual Input 17	30716
00A2	162	30163	Virtual Input 18	30716
00A3	163	30164	Virtual Input 19	30716
00A4	164	30165	Virtual Input 20	30716

750 HEX	750 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
00A5	165	30166	Virtual Input 21	30716
00F0	240	30241	Time	30241
00F2	242	30243	Date	30243
0100	256	30257	User Map Value 1	30524
0101	257	30258	User Map Value 2	30525
0102	258	30259	User Map Value 3	30526
0103	259	30260	User Map Value 4	30527
0104	260	30261	User Map Value 5	30528
0105	261	30262	User Map Value 6	30529
0106	262	30263	User Map Value 7	30530
0107	263	30264	User Map Value 8	30531
0108	264	30265	User Map Value 9	30532
0109	265	30266	User Map Value 10	30533
010A	266	30267	User Map Value 11	30534
010B	267	30268	User Map Value 12	30535
010C	268	30269	User Map Value 13	30536
010D	269	30270	User Map Value 14	30537
010E	270	30271	User Map Value 15	30538
010F	271	30272	User Map Value 16	30539
0110	272	30273	User Map Value 17	30540
0111	273	30274	User Map Value 18	30541
0112	274	30275	User Map Value 19	30542
0113	275	30276	User Map Value 20	30543
0114	276	30277	User Map Value 21	30544
0115	277	30278	User Map Value 22	30545
0116	278	30279	User Map Value 23	30546
0117	279	30280	User Map Value 24	30547
0118	280	30281	User Map Value 25	30548
0119	281	30282	User Map Value 26	30549
011A	282	30283	User Map Value 27	30550
011B	283	30284	User Map Value 28	30551
011C	284	30285	User Map Value 29	30552
011D	285	30286	User Map Value 30	30553
011E	286	30287	User Map Value 31	30554
011F	287	30288	User Map Value 32	30555
0120	288	30289	User Map Value 33	30556
0121	289	30290	User Map Value 34	30557
0122	290	30291	User Map Value 35	30558
0123	291	30292	User Map Value 36	30559
0124	292	30293	User Map Value 37	30560
0125	293	30294	User Map Value 38	30561
0126	294	30295	User Map Value 39	30562
0127	295	30296	User Map Value 40	30563
0128	296	30297	User Map Value 41	30564
0129	297	30298	User Map Value 42	30565
012A	298	30299	User Map Value 43	30566

750 HEX	750 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
012B	299	30300	User Map Value 44	30567
012C	300	30301	User Map Value 45	30568
012D	301	30302	User Map Value 46	30569
012E	302	30303	User Map Value 47	30570
012F	303	30304	User Map Value 48	30571
0130	304	30305	User Map Value 49	30572
0131	305	30306	User Map Value 50	30573
0132	306	30307	User Map Value 51	30574
0133	307	30308	User Map Value 52	30575
0134	308	30309	User Map Value 53	30576
0135	309	30310	User Map Value 54	30577
0136	310	30311	User Map Value 55	30578
0137	311	30312	User Map Value 56	30579
0138	312	30313	User Map Value 57	30580
0139	313	30314	User Map Value 58	30581
013A	314	30315	User Map Value 59	30582
013B	315	30316	User Map Value 60	30583
013C	316	30317	User Map Value 61	30584
013D	317	30318	User Map Value 62	30585
013E	318	30319	User Map Value 63	30586
013F	319	30320	User Map Value 64	30587
0140	320	30321	User Map Value 65	30588
0141	321	30322	User Map Value 66	30589
0142	322	30323	User Map Value 67	30590
0143	323	30324	User Map Value 68	30591
0144	324	30325	User Map Value 69	30592
0145	325	30326	User Map Value 70	30593
0146	326	30327	User Map Value 71	30594
0147	327	30328	User Map Value 72	30595
0148	328	30329	User Map Value 73	30596
0149	329	30330	User Map Value 74	30597
014A	330	30331	User Map Value 75	30598
014B	331	30332	User Map Value 76	30599
014C	332	30333	User Map Value 77	30600
014D	333	30334	User Map Value 78	30601
014E	334	30335	User Map Value 79	30602
014F	335	30336	User Map Value 80	30603
0150	336	30337	User Map Value 81	30604
0151	337	30338	User Map Value 82	30605
0152	338	30339	User Map Value 83	30606
0153	339	30340	User Map Value 84	30607
0154	340	30341	User Map Value 85	30608
0155	341	30342	User Map Value 86	30609
0156	342	30343	User Map Value 87	30610
0157	343	30344	User Map Value 88	30611
0158	344	30345	User Map Value 89	30612

750 HEX	750 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
0159	345	30346	User Map Value 90	30613
015A	346	30347	User Map Value 91	30614
015B	347	30348	User Map Value 92	30615
015C	348	30349	User Map Value 93	30616
015D	349	30350	User Map Value 94	30617
015E	350	30351	User Map Value 95	30618
015F	351	30352	User Map Value 96	30619
0160	352	30353	User Map Value 97	30620
0161	353	30354	User Map Value 98	30621
0162	354	30355	User Map Value 99	30622
0163	355	30356	User Map Value 100	30623
0164	356	30357	User Map Value 101	30624
0165	357	30358	User Map Value 102	30625
0166	358	30359	User Map Value 103	30626
0167	359	30360	User Map Value 104	30627
0168	360	30361	User Map Value 105	30628
0169	361	30362	User Map Value 106	30629
016A	362	30363	User Map Value 107	30630
016B	363	30364	User Map Value 108	30631
016C	364	30365	User Map Value 109	30632
016D	365	30366	User Map Value 110	30633
016E	366	30367	User Map Value 111	30634
016F	367	30368	User Map Value 112	30635
0170	368	30369	User Map Value 113	30636
0171	369	30370	User Map Value 114	30637
0172	370	30371	User Map Value 115	30638
0173	371	30372	User Map Value 116	30639
0174	372	30373	User Map Value 117	30640
0175	373	30374	User Map Value 118	30641
0176	374	30375	User Map Value 119	30642
0177	375	30376	User Map Value 120	30643
0200	512	30513	Device Status	30714
0204	516	30517	CI Inputs 1-32	30700
0206	518	30519	CO Outputs	30708
0207	519	30520	Time	30241
0209	521	30522	Date	30243
020B	523	30524	Active Group	30756
02FE	766	30767	J2 Vn RMS	34658
02FF	767	30768	K1 Ig RMS	34486
0300	768	30769	J1 Ia RMS	34430
0301	769	30770	J1 Ib RMS	34432
0302	770	30771	J1 Ic RMS	34434
0303	771	30772	J1 Load	34459
0304	772	30773	J1 Ig RMS	34436
0305	773	30774	J2 Van	34630
0306	774	30775	J2 Vbn	34632

750 HEX	750 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
0307	775	30776	J2 Vcn	34634
0308	776	30777	J2 Vab	34636
0309	777	30778	J2 Vbc	34638
030A	778	30779	J2 Vca	34640
030C	780	30781	J1 I AVG	34445
030D	781	30782	J2 V AVG L-L	34670
030E	782	30783	J2 V AVG L-N	34672
030F	783	30784	J1 In RMS	34438
0310	784	30785	Pwr1 Real	35690
0311	785	30786	Pwr1 Reactive	35692
0312	786	30787	Pwr1 Apparent	35694
0313	787	30788	Pwr1 PF	35714
0314	788	30789	Frequency	34891
0315	789	30790	Frequency ROC	34893
0316	790	30791	Auto Scale Factor	
0318	792	30793	Sync1 Bus Volts Magnitude	35580
0319	793	30794	Sync1 Bus Volts Frequency	35583
031A	794	30795	Sync1 Voltage Difference	35590
031B	795	30796	Sync1 Angle Difference	35592
031C	796	30797	Sync1 Frequency Difference	35593
031D	797	30798	Sync1 Bus Volts Angle	35582
0320	800	30801	Pwr1 Pos WattHours	35854
0322	802	30803	Pwr1 Pos WattHours Cost	35856
0324	804	30805	Pwr1 Neg WattHours	35858
0326	806	30807	Pwr1 Neg WattHours Cost	35860
0328	808	30809	Pwr1 Pos VarHours	35862
032A	810	30811	Pwr1 Neg VarHours	35864
0330	816	30817	Cur1 Ph A Demand	35974
0331	817	30818	Cur1 Ph B Demand	35976
0332	818	30819	Cur1 Ph C Demand	35978
0333	819	30820	Pwr1 Real Dmd	36134
0334	820	30821	Pwr1 Reactive Dmd	36142
0335	821	30822	Pwr1 Apparent Dmd	36150
0340	832	30833	Cur1 Max Ph A Demand	35980
0345	837	30838	Cur1 Max Ph B Demand	35982
034A	842	30843	Cur1 Max Ph C Demand	35984
034F	847	30848	Pwr1 Max Real Dmd	36136
0354	852	30853	Pwr1 Max Reactive Dmd	36144
0359	857	30858	Pwr1 Max Apparent Dmd	36152
0360	864	30865	Pwr1 Ph A Real	35696
0361	865	30866	Pwr1 Ph A Reactive	35702
0362	866	30867	Pwr1 Ph A Apparent	35708
0363	867	30868	Pwr1 Ph A PF	35715
0364	868	30869	Pwr1 Ph B Real	35698
0365	869	30870	Pwr1 Ph B Reactive	35704
0366	870	30871	Pwr1 Ph B Apparent	35710

750 HEX	750 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
0367	871	30872	Pwr1 Ph B PF	35716
0368	872	30873	Pwr1 Ph C Real	35700
0369	873	30874	Pwr1 Ph C Reactive	35706
036A	874	30875	Pwr1 Ph C Apparent	35712
036B	875	30876	Pwr1 Ph C PF	35717
0370	880	30881	Analog Input	35714
0400	1024	31025	J1 Ia Angle	34440
0401	1025	31026	J1 Ib Angle	34441
0402	1026	31027	J1 Ic Angle	34442
0403	1027	31028	J1 In Angle	34444
0404	1028	31029	J1 Ig Angle	34443
0406	1030	31031	K1 Ig Angle	34493
0410	1040	31041	J2 Van Angle	34662
0411	1041	31042	J2 Vbn Angle	34663
0412	1042	31043	J2 Vcn Angle	34664
0413	1043	31044	J2 Vab Angle	34665
0414	1044	31045	J2 Vbc Angle	34666
0415	1045	31046	J2 Vca Angle	34667
0416	1046	31047	J2 Vn Angle	34668
0420	1056	31057	J1 I_0	34447
0421	1057	31058	J1 I_0 Angle	34453
0422	1058	31059	J1 I_1	34449
0423	1059	31060	J1 I_1 Angle	34454
0424	1060	31061	J1 I_2	34451
0425	1061	31062	J1 I_2 Angle	34455
0426	1062	31063	J2 V0	34674
0427	1063	31064	J2 V0 Angle	34680
0428	1064	31065	J2 V1	34676
0429	1065	31066	J2 V1 Angle	34681
042A	1066	31067	J2 V2	34678
042B	1067	31068	J2 V2 Angle	34682
0629	1577	31578	Trip Coil Monitor	38447
062A	1578	31579	Close Coil Monitor	38543

Table 12-5: SR735 Addresses supported in Compatibility Mode

735 HEX	735 Decimal	Modicon Format (Needed for User Map)	Description	850 Source Modbus Address
0000	0	30001	Product Code	30001
0001	1	30002	Hardware Revision	30002
0003	2	30003	Firmware Version	30003
0010	16	30017	J1 Ia	34420
0011	17	30018	J1 Ib	34422
0012	18	30019	J1 Ic	34424
0013	19	30020	J1 Ig	34426

Using the Memory Map

Refer to the Modbus Maps spreadsheet package located online under Manuals on the webpage for each 8 Series relay:

www.gegridsolutions.com/multilin/ProductListing.htm

NOTICE

Modbus Maps and Format Codes for all 8 Series relays are included in the same package. There are several versions of the Modbus Map and corresponding Format Codes available, and the one matching the relay firmware version should be used.

Reading Device Status Register Bits

Values in this Communications Guide show bit position by hexadecimal value, for example '0x00100000 In Service'. The following tables show equivalent 32-bit assignments, using Device Status values as an example.

Table 12-6: Modbus Map entry, Device Status

Modbus Address	Hex Address	Description	Min	Max	Step	Units	Format Code	Factory Default	Size in Words	850	869	889	845
30714	0x02C9	Device Status	0	0xFFFFFFFF	1		FC135	0	2	Y	Y	Y	Y

Table 12-7: Format Code entries, Device Status (FC 135)

Code	Type	Definition	850	869	889	845
FC135	unsigned 32 bits	Device Status				
	0x00040000	Self-Test Fault	Y	Y	Y	Y
	0x00080000	Maintenance	Y	Y	Y	Y
	0x00100000	In Service	Y	Y	Y	Y
	0x00200000	SP Group 6 Active	Y	Y	Y	Y
	0x00400000	SP Group 5 Active	Y	Y	Y	Y
	0x00800000	SP Group 4 Active	Y	Y	Y	Y
	0x01000000	SP Group 3 Active	Y	Y	Y	Y
	0x02000000	SP Group 2 Active	Y	Y	Y	Y
	0x04000000	Pickup State	Y	Y	Y	Y
	0x40000000	Alarm	Y	Y	Y	Y
	0x80000000	Trip	Y	Y	Y	Y

The following figure shows a Modbus Read from Device of two registers, starting with 02C9.

MODBUS - READ FROM DEVICE

Address (HEX)	Modbus Type	# of ...	Selection	Modbus Group	Values
02C9	Actual Value	2	Binary	None	1010-1100-0001-0000, 0000-0000-0000-0000,
	Actual Value		Hex	None	32 21 16 1

The following table gives the equivalent 32-bit values.

2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000001	Bit 1
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000002	Bit 2
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000004	Bit 3
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000008	Bit 4
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000010	Bit 5

2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000020	Bit 6
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000040	Bit 7
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000080	Bit 8
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000100	Bit 9
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000200	Bit 10
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000400	Bit 11
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00000800	Bit 12
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00001000	Bit 13
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00002000	Bit 14
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00004000	Bit 15
2nd 16 bits	Low Order Word of Long Value	0x02CA	0x00008000	Bit 16
1st 16 bits	High Order Word of Long Value	0x02C9	0x00010000	Bit 17
1st 16 bits	High Order Word of Long Value	0x02C9	0x00020000	Bit 18
1st 16 bits	High Order Word of Long Value	0x02C9	0x00040000	Bit 19
1st 16 bits	High Order Word of Long Value	0x02C9	0x00080000	Bit 20
1st 16 bits	High Order Word of Long Value	0x02C9	0x00100000	Bit 21
1st 16 bits	High Order Word of Long Value	0x02C9	0x00200000	Bit 22
1st 16 bits	High Order Word of Long Value	0x02C9	0x00400000	Bit 23
1st 16 bits	High Order Word of Long Value	0x02C9	0x00800000	Bit 24
1st 16 bits	High Order Word of Long Value	0x02C9	0x01000000	Bit 25
1st 16 bits	High Order Word of Long Value	0x02C9	0x02000000	Bit 26
1st 16 bits	High Order Word of Long Value	0x02C9	0x04000000	Bit 27
1st 16 bits	High Order Word of Long Value	0x02C9	0x08000000	Bit 28
1st 16 bits	High Order Word of Long Value	0x02C9	0x10000000	Bit 29
1st 16 bits	High Order Word of Long Value	0x02C9	0x20000000	Bit 30
1st 16 bits	High Order Word of Long Value	0x02C9	0x40000000	Bit 31
1st 16 bits	High Order Word of Long Value	0x02C9	0x80000000	Bit 32

Reading CO Outputs

CO Outputs are used to show the state of the output relays in the 8-Series device (internal to the device). For example, on the 869 relay the Trip and Close contacts have voltage monitoring inputs. The Trip and Close Circuit Monitoring feature uses the voltage input to monitor the trip and to close coil circuit integrity.

To read the output relay status for all relays, use Modbus address 30708 (0x02C3) where each bit corresponds to a different output relay as described in format code FC198.

Table 12-8: Modbus Map entry, CO Outputs

Modbus Address	Hex Address	Description	Min	Max	Step	Units	Format Code	Factory Default	Size in Words	850	869	889	845
30708	0x02C3	CO Outputs	0	0xFFFFFFFF	1		FC198	0	2	Y	Y	Y	Y

Table 12-9: Format Code entries, CO Outputs

Code	Type	Definition	850	869	889	845
FC126A	unsigned 16 bits	Off / On Selection				
	0	Off	Y	Y	Y	Y
	1	On	Y	Y	Y	Y
FC198	unsigned 32 bits	Output Relay Operation				
Each bit corresponds to a particular output relay, and uses format FC126A						

Code	Type	Definition	850	869	889	845
	0x00000004	Output Relay 3	Y	Y	Y	Y
	0x00000008	Output Relay 4	Y	Y	Y	Y
	0x00000010	Output Relay 5	Y	Y	Y	Y
	0x00000020	Output Relay 6	Y	Y	Y	Y
	0x00000040	Output Relay 7	Y	Y	Y	Y

Interpreting Element Status for Breaker Contacts

Element Status items with formats FE020 - FE025 are used to sense/verify the state of the breaker contacts, external to the 8 Series device.

The following Modbus registers are assigned to Breaker Contact Element Status:

- 38005 (0x1F44) Element Status 106 (Output Relay 1)
- 38006 (0x1F45) Element Status 107 (Output Relay 2)
- 38007 (0x1F46) Element Status 108 (Output Relay 3)
- 38008 (0x1F47) Element Status 109 (Output Relay 4)
- 38009 (0x1F48) Element Status 110 (Output Relay 5)
- 38010 (0x1F49) Element Status 111 (Output Relay 6)
- 37951 (0x1F0E) Element Status 52 (Critical Fail)

These Modbus Registers are listed in the Modbus memory map table as follows:

Table 12-10: Modbus Map entries, Element Status Register for Breaker Control Relays

Modbus Address	Hex Address	Description	Min	Max	Step	Units	Format Code	Factory Default	Size in Words	850	869	889	845
38005	0x1F44	Element Status 106 (Output Relay 1)	0	65535	1		FE106	0		Y	Y	Y	Y
38006	0x1F45	Element Status 107 (Output Relay 2)	0	65535	1		FE107	0		Y	Y	Y	Y
38007	0x1F46	Element Status 108 (Output Relay 3)	0	65535	1		FE108	0		Y	Y	Y	Y
38008	0x1F47	Element Status 109 (Output Relay 4)	0	65535	1		FE109	0		Y	Y	Y	Y
38009	0x1F48	Element Status 110 (Output Relay 5)	0	65535	1		FE110	0		Y	Y	Y	Y
38010	0x0301	Element Status 111 (Output Relay 6)	0	65535	1		FE111	0		Y	Y	Y	Y
37951	0x1F0E	Element Status 52 (Critical Fail)	0	65535	1		FE052	0		Y	Y	Y	Y

The format code used for each Modbus register is listed in the Format Code column. In this case, the format codes used are FE052 and FE106 through FE111.

These format codes are described in the Format Code table as follows:

Table 12-11: Format Code entries, Element Status Register for Breaker Control Relays

Code	Type	Definition	850	869	889	845
FE106	unsigned 16 bits	Element Status: Output Relay 1				
	0x0002	Von	Y	Y	Y	Y
	0x0004	Voff	Y	Y	Y	Y
FE107	unsigned 16 bits	Element Status: Output Relay 2				
	0x0002	Von	Y	Y	Y	Y
	0x0004	Voff	Y	Y	Y	Y
FE108	unsigned 16 bits	Element Status: Output Relay 3				
	0x0002	Von				Y
	0x0004	Voff				Y
FE109	unsigned 16 bits	Element Status: Output Relay 4				
	0x0002	Von				Y

Code	Type	Definition	850	869	889	845
	0x0004	Voff				Y
FE110	unsigned 16 bits	Element Status: Output Relay 5				
	0x0002	Von				Y
	0x0004	Voff				Y
FE111	unsigned 16 bits	Element Status: Output Relay 6				
	0x0002	Von				Y
	0x0004	Voff				Y
FE052	unsigned 16 bits	Element Status: Critical Fail				
	0x0002	Critical Fail OP	Y	Y	Y	Y

From the notes preceding the full Format Code table, notice that Element Status Format Codes (FE1 onwards) contain values that should be masked with 0x01FF to match the bit field values shown in the table.

Element Status 106 monitors the state of the voltage monitor for Output Relay 1.

When the voltage is present on the Trip Contact voltage monitor (Von), the Element Status 106 register will read: 0x2002 (8194). The masked value is then 0x0002, corresponding to Von in the preceding table.

When the voltage is not present on the Trip Contact voltage monitor (Voff), the Element Status 106 register will read: 0x2004 (8196). The masked value is then 0x0004, corresponding to Voff in the preceding table.

Element Status 107 monitors the state of the voltage monitor for Output Relay 2.

When the voltage is present on the Trip Contact voltage monitor (Von), the Element Status 107 register will read: 0x2002 (8194). The masked value is then 0x0002, corresponding to Von in the preceding table.

When the voltage is not present on the Trip Contact voltage monitor (Voff), the Element Status 107 register will read: 0x2004 (8196). The masked value is then 0x0004, corresponding to Voff in the preceding table.

Element Status 52 is used to monitor the Critical Fail contact.

When the relay is in service, the "IN SERVICE" LED on the front panel is green.

The Element Status 52 (Critical Fail) register reads: 0x2000 (8192). The masked value is then 0x0000, indicating Critical Fail Op is not present.

When the relay is not service, the "IN SERVICE" LED on the front panel is orange.

The Element Status 52 (Critical Fail) register reads: 0x2002 (8194). The masked value is then 0x0002, corresponding to Cristical Fail Op in the preceding table.

Reading Phase Current Values

In this example a PLC is accessing the 6 sequential values beginning at Modbus address 34420 (Phase A current) in an 850 relay.

The following Modbus registers are assigned to Phase Currents:

- 34420 (0x1143) J1 Ia - Phase A current
- 34422 (0x1145) J1 Ib - Phase B current
- 34424 (0x1147) J1 Ic - Phase C current

These Modbus Registers are listed in the Modbus memory map table as follows:

Table 12-12: Modbus Map entries for Phase Currents

Modbus Address	Hex Address	Description	Min	Max	Step	Units	Format Code	Factory Default	Size in Words	850	869	889	845
34420	0x1143	J1 Ia	0	0xFFFFFFFF	1	A	F13	0	2	Y	Y	Y	Y
34422	0x1145	J1 Ib	0	0xFFFFFFFF	1	A	F13	0	2	Y	Y	Y	Y
34424	0x1147	J1 Ic	0	0xFFFFFFFF	1	A	F13	0	2	Y	Y	Y	Y

In this case the format code used is F13, which is described in the Format Code table as follows:

Table 12-13: Format Code entries for Phase Current

Code	Type	Definition	850	869	889	845
F13	unsigned 32 bits	Unsigned Long Value, 3 Decimal Places				
1st 16 bits		High Order Word of Long Value	Y	Y	Y	Y
2nd 16 bits		Low Order Word of Long Value	Y	Y	Y	Y

The phase current metering values read by the PLC should match the values shown on the relay. Validating the received values in the PLC against the real values observed on the 850 relay front panel or read via 8 Series EnerVista Setup is recommended.

PLCs can use two different word orders for reading 32-bit registers. As a result, a 32 bit value of aabbccdd may be read as aabb ccdd, or as ccdd aabb.

A word-swap may be necessary to read the proper data from 850 relay current registers.

Once the correct word order is set, the obtained value needs to be divided by 1000 to get the decimal point.

Register: 34420	Register: 34421
1st 16 bits High Order Word of Long Value	2nd 16 bits Low Order Word of Long Value
unsigned 32 bits Unsigned Long Value	
unsigned 32 bits Unsigned Long Value, 3 Decimal Places	

For example:

Phase A Current value on relay display: 183.594 A

Phase current values read from Phase A Current Modbus registers:

04F5 (34420): 0002

04F6 (34421): CD2A

Combine the two 16 bit values into a 32 bit unsigned value: 183594

Apply the decimal point rule (divide by 1000): 183.594 A

Register: 34420	Register: 34421
0002	CD2A
183594	
183.594	

Reading Last Trip Target Messages

Target messages are read through the Modbus Target Message registers.

Table 12-14: Modbus Map entries, Targets

Modbus Address	Hex Address	Description	Min	Max	Step	Units	Format Code	Factory Default	Size in Words	850	869	889	845
30273	0x0110	Target Count	0	256	1		F0	0	1	Y	Y	Y	Y
30274	0x0111	Target Cause	0	0xFFFFFFFF	1		FC134	0	2	Y	Y	Y	Y

Follow these steps to obtain the Last Trip message:

1. Read address 30273 (0x0110) to obtain the Target Count.
2. Write the value obtained from Target Count register to select the Target Index register at address, for example: 40230 (0x00E5). This will position the Target Message Index at newest Target Message.
3. Read the Target Cause register for the newest Target Message to obtain the Target Message cause.

For example, here are 3 Target Messages, with a Target Count of 3.

Target Index # 3	GND IOC 1 OP
Target Index # 2	GND IOC 1 PKP
Target Index # 1	Link Error Primary

In this example, the following values are read from the Target Registers:

Target Index # 3 Value:	0x00CO, 0xF202
Target Index # 2 Value:	0x00CO, 0xF201
Target Index # 1 Value:	0x0000, 0x0037

In order to interpret the target messages, we need to refer to the appropriate function codes:

For Target Index #1: Link Error Primary

The value in Target Message Register 0111(hex) is 0x0000.

The value in Target Message Register 0112(hex) is 0x0037. 0x0037 = Decimal 55 - Link Error Primary (As per format FC134)

Table 12-15: Format FC134 (See full description in Format Code Table)

Code	Type	Definition
FC134	Unsigned 32 bits	Cause of Event
	...	
	54	FLASH Error
	55	**Link Error Primary**
	56	Traffic Error Primary
	...	

For Target Index #2: GND IOC 1 Trip PKP

The value in Target Message Register 0111(hex) is 0x00C0. In the FC134 table below, this corresponds to Trip.

The value in Target Message Register 0112(hex) is 0xF201. In the FC134 table below, F2 corresponds to IOC 1, and 01 corresponds to Pickup.

Table 12-16: Format FC134 Byte Assignments

0x00A0 - Alarm
0x00C0 - Trip
0x0080 - Configurable

0xF2xx - IOC 1
0xF4xx - IOC 2
0xF6xx - IOC 3
0xXX01 - Pickup
0xXX02 - Operate
0xXX04 - Dropout

For Target Index #3 - Last Trip: GND IOC 1 Trip OP

In this example, we see the GND IOC 1 Trip OP event logged as the last trip.

Las Trip Data Cause: GND IOC 1 Trip OPEvent Number: 768

Details about the Last Trip can be found in the Last Trip Modbus Registers:

Table 12-17: Modbus Map entries, Last Trip

Modbus Address	Hex Address	Description	Min	Max	Step	Units	Format Code	Factory Default	Size in Words	850	869	889	845
31220	0x04C3	Cause	0	0xFFFFFFFF	1		FC134	0	2	Y	Y	Y	Y
31222	0x04C5	Event	0	4294967295	1		F10	0	2	Y	Y	Y	Y

Follow these steps to obtain information about the Last Trip:

1. Read address 31220 (0x04C3) to obtain the Last trip Data Cause. (32 bit).
2. Read address 31222 (0x04C5) to find the Event Number. (32 bit)

In this example, the value in Last Trip Cause Register 0x04C3(hex) is x00C0. In the FC134 table below, this corresponds to Trip.

The value in Last Trip Cause Register 0x04C4(hex) is 0xF202. In the FC134 table below, F2 corresponds to IOC 1, and 02 corresponds to Operate.

Table 12-18: Format FC134 Byte Assignments

0x00A0 - Alarm
0x00C0 - Trip
0x0080 - Configurable
0xF2xx - IOC 1
0xF4xx - IOC 2
0xF6xx - IOC 3
0xXX01 - Pickup
0xXX02 - Operate
0xXX04 - Dropout

The value in Last Trip Event Register 0x04C5(hex) is 0x0000.

The value in Last Trip Event Register 0x04C6(hex) is 0x0300. 0x0300 = Decimal 768 - Event Number 768 (As per format F10)

Table 12-19: Format F10 (See full description in Format Code Table)

Code	Type	Definition
F10	unsigned 32 bits	Unsigned Long Value
1st 16 bits		High Order Word of Long Value
2nd 16 bits		Low Order Word of Long Value

Modbus Commands

Command Value	Description	850	869	889	845
0	None	Y	Y	Y	Y
1	Reset	Y	Y	Y	Y
3	Open	Y	Y	Y	Y
4	Close	Y	Y	Y	Y
5	Open2	Y		Y	Y
6	Close2	Y		Y	Y
7	Open3				Y
8	Close3				Y
9	ChangeToSetpointGroup1	Y	Y	Y	Y
10	ChangeToSetpointGroup2	Y	Y	Y	Y
11	ChangeToSetpointGroup3	Y	Y	Y	Y
12	ChangeToSetpointGroup4	Y	Y	Y	Y
13	ChangeToSetpointGroup5	Y	Y	Y	Y
14	ChangeToSetpointGroup6	Y	Y	Y	Y
15	Active Group	Y	Y	Y	Y
18	Local	Y	Y	Y	Y
19	Remote	Y	Y	Y	Y
96	Clear All Records	Y	Y	Y	Y
97	Clear Targets	Y	Y	Y	Y
98	Clear Events	Y	Y	Y	Y
99	Clear Transient Records	Y	Y	Y	Y
100	Clear DataLogger	Y	Y	Y	Y
101	Clear Max Current Demand	Y	Y	Y	Y
102	Clear Min/Max Real Power Demand	Y	Y	Y	Y
103	Clear Min/Max Reactive Power Demand	Y	Y	Y	Y
104	Clear Min/Max Apparent Power Demand	Y	Y	Y	Y
105	Clear Energy Use Data	Y	Y	Y	Y
106	Clear Thermal Capacity	Y			
107	Clear Digital Counters	Y	Y	Y	Y
108	Clear BKR1 Arcing Current	Y	Y	Y	Y
109	Clear BKR1 Health Data	Y	Y	Y	Y
110	Clear BKR2 Arcing Current	Y		Y	Y
111	Clear BKR2 Health Data	Y		Y	Y
112	Clear BKR3 Arcing Current				Y
113	Clear BKR3 Health Data				Y
122	Reset Motor Info		Y		
123	RTD Maximums		Y	Y	Y
124	Reset Unauthorized Access	Y	Y	Y	Y
126	Clear Fault Reports	Y	Y	Y	Y
134	USER PushButton 1	Y	Y	Y	Y
135	USER PushButton 2	Y	Y	Y	Y
136	USER PushButton 3	Y	Y	Y	Y

Command Value	Description	850	869	889	845
137	Start Inhibit		Y		
199	MotorDLogClear		Y		
200	MotorDLogStart		Y		
201	MotorDLogStop		Y		
202	Trigger Waveform	Y	Y	Y	Y
210	Clear Autoreclose 1	Y			
211	Clear Broken Rotor Bar Data		Y		
213	Clear Motor Start Statistics		Y		
214	Clear Motor Learned Data		Y		
215	Clear Xfmr Loss of Life				Y
216	Clear Xfmr Learned Data				Y
217	Clear Xfmr Energization Records				Y
218	Clear Xfmr DFR Records				Y
219	Clear Xfmr Historic Max Record				Y
220	Clear DGA History				Y
222	Clear Running Hours			Y	
223	Clear Last Trip Data	Y	Y	Y	Y
224	Clear Stator Inter-Turn Fault		Y		
227	Clear Autoreclose 2	Y			
229	Clear Energy Log Data	Y	Y	Y	Y
230	Clear PwrQuality Data	Y	Y	Y	Y
240	USER PushButton 4	Y	Y	Y	Y
241	USER PushButton 5	Y	Y	Y	Y
242	USER PushButton 6	Y	Y	Y	Y
243	USER PushButton 7	Y	Y	Y	Y
244	USER PushButton 8	Y	Y	Y	Y
245	USER PushButton 9	Y	Y	Y	Y
246	USER PushButton 10	Y	Y	Y	Y
247	Reset Annunciator	Y	Y	Y	Y
248	TabPbNavBtn1Pressed	Y	Y	Y	Y
249	TabPbNavBtn2Pressed	Y	Y	Y	Y
250	TabPbNavBtn3Pressed	Y	Y	Y	Y
251	TabPbNavBtn4Pressed	Y	Y	Y	Y
252	TabPbNavBtnReleased	Y	Y	Y	Y
253	Acknowledge Annunciator	Y	Y	Y	Y
254	SW Cmd Open 1	Y	Y	Y	Y
255	SW Cmd Close 1	Y	Y	Y	Y
256	SW Cmd Open 2	Y	Y	Y	Y
257	SW Cmd Close 2	Y	Y	Y	Y
258	SW Cmd Open 3	Y	Y	Y	Y
259	SW Cmd Close 3	Y	Y	Y	Y
260	SW Cmd Open 4	Y	Y	Y	Y
261	SW Cmd Close 4	Y	Y	Y	Y
262	SW Cmd Open 5	Y	Y	Y	Y
263	SW Cmd Close 5	Y	Y	Y	Y
264	SW Cmd Open 6	Y	Y	Y	Y
265	SW Cmd Close 6	Y	Y	Y	Y

Command Value	Description	850	869	889	845
266	SW Cmd Open 7	Y	Y	Y	Y
267	SW Cmd Close 7	Y	Y	Y	Y
268	SW Cmd Open 8	Y	Y	Y	Y
269	SW Cmd Close 8	Y	Y	Y	Y
270	SW Cmd Open 9	Y	Y	Y	Y
271	SW Cmd Close 9	Y	Y	Y	Y
278	Clear OHSW Arcing Current	Y			
279	Clear OHSW Health Data	Y			
280	Clear RCL Arcing Current	Y			
281	Clear RCL Health Data	Y			
282	Clear RCL Wear Data	Y			
283	Clear Auto Sectionalizer	Y			
284	Clear Auto Reclose	Y			
4096	Force Virtual Input 1	Y	Y	Y	Y
4097	Force Virtual Input 2	Y	Y	Y	Y
4098	Force Virtual Input 3	Y	Y	Y	Y
4099	Force Virtual Input 4	Y	Y	Y	Y
4100	Force Virtual Input 5	Y	Y	Y	Y
4101	Force Virtual Input 6	Y	Y	Y	Y
4102	Force Virtual Input 7	Y	Y	Y	Y
4103	Force Virtual Input 8	Y	Y	Y	Y
4104	Force Virtual Input 9	Y	Y	Y	Y
4105	Force Virtual Input 10	Y	Y	Y	Y
4106	Force Virtual Input 11	Y	Y	Y	Y
4107	Force Virtual Input 12	Y	Y	Y	Y
4108	Force Virtual Input 13	Y	Y	Y	Y
4109	Force Virtual Input 14	Y	Y	Y	Y
4110	Force Virtual Input 15	Y	Y	Y	Y
4111	Force Virtual Input 16	Y	Y	Y	Y
4112	Force Virtual Input 17	Y	Y	Y	Y
4113	Force Virtual Input 18	Y	Y	Y	Y
4114	Force Virtual Input 19	Y	Y	Y	Y
4115	Force Virtual Input 20	Y	Y	Y	Y
4116	Force Virtual Input 21	Y	Y	Y	Y
4117	Force Virtual Input 22	Y	Y	Y	Y
4118	Force Virtual Input 23	Y	Y	Y	Y
4119	Force Virtual Input 24	Y	Y	Y	Y
4120	Force Virtual Input 25	Y	Y	Y	Y
4121	Force Virtual Input 26	Y	Y	Y	Y
4122	Force Virtual Input 27	Y	Y	Y	Y
4123	Force Virtual Input 28	Y	Y	Y	Y
4124	Force Virtual Input 29	Y	Y	Y	Y
4125	Force Virtual Input 30	Y	Y	Y	Y
4126	Force Virtual Input 31	Y	Y	Y	Y
4127	Force Virtual Input 32	Y	Y	Y	Y

8 Series Protective Relay Platform

Appendix A: Radius Server and Certificates

Appendix A includes information about the RADIUS server and certificates followed by an example of how to set up a simple RADIUS server and certificate management.

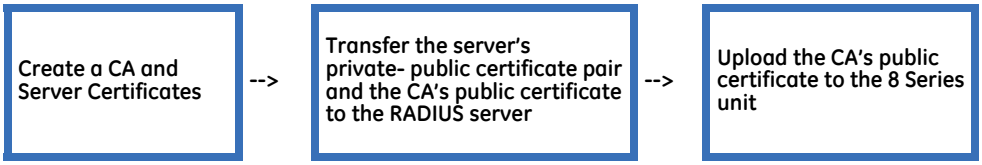
Simple RADIUS Server and Certificate Management

The 8 Series unit can act as a RADIUS client and has the ability to authenticate users with a RADIUS server using the EAP-TTLS protocol. Authentication is performed with the help of certificates.

Any cryptography application such as OpenSSL etc. can be used to create certificates. First, a private key and certificate request are created for the server. The certificate request contains the public key, and the server's information (name, email, organization etc.) The certificate request is then sent to a certificate authority (CA) for the authority's digital signature. If the request is sent to a well-known CA, then upon receiving payment from the RADIUS server's administrator, the CA verifies the information and signs the certificate. The administrator can choose not to use an external well-known CA's services and create a local CA instead.

The signed certificate of the server along with CA's public certificate are then sent back to the RADIUS server administrator. Finally, the CA's public certificate is uploaded to the relay.

In this example, a local CA is created and used to sign the server's certificate request.



Authentication:

The user initiates the authentication process by providing user credentials. The 8 Series unit then tries to establish a trust relationship with the RADIUS server. The RADIUS server identifies itself via a certificate which it sends to the 8 Series unit. This certificate holds the server's information:

- version
- public key
- subject
- serial number
- valid from
- valid until
- key-usage
- signature algorithm
- "issuer" (i.e. CA) etc.

The 8 Series unit then validates the server's identity by verifying the server's certificate against the CA certificate that it has. If both the server and CA certificates are signed by the same trusted authority (CA), a client side trust relationship is successfully established.

Setting Up a Simple RADIUS Server

The following example demonstrates how to set up a test bench RADIUS server. A proper RADIUS server is only to be deployed by qualified IT professionals. The third party tools and services mentioned below are only for demonstration purposes and do not imply endorsement by GE Vernova.

This example uses FreeRADIUS as the RADIUS server.

Download and install FreeRADIUS.net (Windows™ version) from the following location:

http://freeradius.net/

Radius Server Certificate Management

The activities described here are required for certificate management.

Create a Private Key for the Server

To create a private key by using the command:

```
openssl genrsa -out server.key 4096
```

The RSA based private key is generated.

NOTE

The RSA based private key is not a password protected key.

Create a Certificate Request for the Server

To create a certificate request by using the command:

```
openssl req -new -key server.key -out server.csr
```

While using the command, you are asked to enter the following information that is incorporated into the certificate request.

- Country Name
- State or Province Name
- Locality Name
- Organizational Unit Nae
- Common Name
- Email Address

What you enter here is called a Distinguished Name or a DN. All this information is sent with the certificate request, see figure A-1. The two 'extra' attributes ("A challenge password" and "An optional company name") are left blank for this example.

Figure A-1: Enter DN information for Certificate request

```
Country Name (2 letter code) [AU]:CA
State or Province Name (full name) [Some-State]:Ontario
Locality Name (eg, city) []:Markham
Organization Name (eg, company) [Internet Widgits Pty Ltd]:Example Company
Organizational Unit Name (eg, section) []:XYZ Department
Common Name (e.g. server FQDN or YOUR name) []:PDC Radius Server
Email Address []:xyz@xyz.xyz

Please enter the following 'extra' attributes
to be sent with your certificate request
A challenge password []:
An optional company name []:
```

Create a Signed Certificate for the Server

CA certificates (assuming it to be your root certificate from CA) are created and later used to sign the server's certificate request.

1. Create a private key for the root CA by using the command:

```
openssl genrsa -out ca.key 4096
```

2. Create a public certificate and self-sign it, by using the command:

```
openssl req -new -x509 -days 3650 -key ca.key -out ca.crt
```

While using the above command, you are asked to enter information that is incorporated into your certificate. Please make sure that while entering this information (as depicted in the previous step) that the Common Name (CN) of the CA and the Server certificate do NOT match. This avoids naming collisions and other related errors later on.

3. Use the server's certificate request (server.csr) that was created as described in the previous section (see *Create a Certificate Request for the Server*) and sign it with the CA. Use the following command:

```
openssl x509 –req –days 3650 –in server.csr –CA ca.crt –CAkey
ca.key –set_serial 01 –out server.crt
```

Definitions	
x509	This term is used to add a digital signature to the certificate.
-req	With this option, a certificate request is expected instead of the certificate (by default).
-in	Specifies the input file from which the certificate is read.
-CA	Specifies the CA certificate to be used for signing. When the **-CA** option is present, **x509** behaves like a "mini CA". The input file is signed by this CA using this option. The issuer name is set to the subject name of the CA and it is digitally signed using the CA's private key. This option is normally combined with the **–req** option. Without the **–req** option, the input is a certificate which must be self-signed.
-CAkey	When the **-CA** option is used to sign a certificate, it uses a serial number specified in a file. This file consists of one line containing an even number of hex digits with the serial number to use. After each use, the serial number is incremented and written out to the file again.
-set_serial	Specifies the serial number to use.
-out	Specifies the output file to write to.
–days	Specifies the number of days the certificate is valid.

Transfer Certificates to Server

Copy the following files,

- server.key
- server.crt
- ca.crt

onto the FreeRADIUS.net server under the directory containing the certificates.

In this example the directory is located under the path:
<Path_to_Radius>\etc\raddb\certs\FreeRADIUS.net\DemoCerts>

Radius Server Configuration

Modify the following **.GE and .CONF** files to configure the RADIUS server.

RADIUSD.CONF

Locate the "bind_address" field and set it to your RADIUS server's IP address in the radiusd.conf file.

USERS.CONF

Add the users in the users.conf file.

The file is available under the **<Path_to_Radius>\etc\raddb** directory.

Adding the following text configures a user "Tester" which has an "Administrator" role.

Tester:

```
->User-Password == "Testing1!1"

->GE-UR-Role = Administrator
```

CLIENTS.CONF

Add the clients in the clients.conf file.

The file is available under the **<Path_to_Radius>\etc\raddb** directory.

The following text defines a RADIUS client 8 Series unit with the assumption that its IP-address is 10.0.0.2 and subnet mask is 255.255.255.0. The "secret" that is specified here is also configured on the 8 Series unit for successful authentication. The "shortname" is a short alias that can be used in place of the IP address and it is optional.

```
client 10.0.0.2/24 {

secret = testing123

shortname = private-network-1

}
```

DICTIONARY.GE

Create a file called "dictionary.ge" under the **<Path_to_Radius>\etc\raddb** directory and add the following content to it:

```
# ############################################################

#     GE VSA's

############################################################

VENDOR     GE     2910

# Management authorization

BEGIN-VENDOR     GE

# Role ID

ATTRIBUTE     GE-UR-Role     1     integer

# GE-UR-ROLE values

VALUE     GE-UR-Role     Administrator     1
```

```
VALUE      GE-UR-Role      Supervisor      2

VALUE      GE-UR-Role      Engineer      3

VALUE      GE-UR-Role      Operator      4

VALUE      GE-UR-Role      Observer      5

END-VENDOR     GE

#############################################################

DICTIONARY
```

Add the following line to the "dictionary" file present under **<Path_to_Radius>\etc\raddb**.

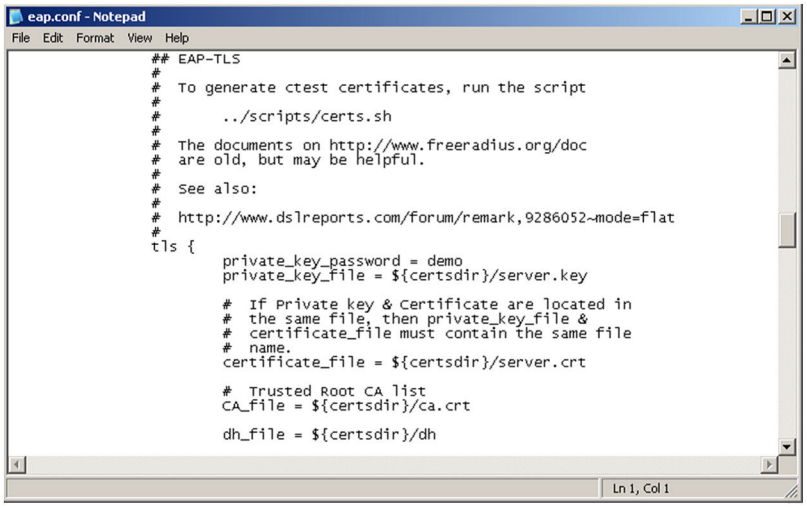
```
$INCLUDE dictionary.ge
```

EAP.CONF

The eap.conf file is available under the **<Path_to_Radius>\etc\raddb** directory.

Locate the "tls" block and add the respective entries as shown in figure A-2 to the "private_key_file", "certificate_file" and "CA_file" fields.

Figure A-2: EAP.CONF file



Start the Server

The **<Path_to_Radius>/start_radiusd_debug.bat** file can be used to start the RADIUS server in debug mode.

It is recommended to first run the RADIUS server in debug mode, otherwise, you cannot see what is going on and cannot correct any problems.

Radius Client Configuration (8 Series Unit)

Radius settings are configured under **Setpoints > Device > Security** on the EnerVista 8 Series Setup software.

Configure the IP address and ports for the Radius server.

Enter the vendor ID for GE Vernova in the field dedicated for this purpose. The GE Vernova vendor ID is 2910 and the field is set to this value by default.

The CA's public certificate needs to be transferred to the 8 Series unit . Since the 8 Series unit accepts the certificates in DER format, the signed certificate must first be converted from PEM format to DER by using the command:

```
openssl x509 -in ca.crt -inform PEM -out ca.der -outform DER
```

Move the DER file (ca.der) to the 8 Series unit by using SFTP.

The path on the 8 Series unit is "/net/MainShare"

Finally, update the Remote RADIUS shared secret (as set up in clients.conf) using the EnerVista 8 Series Setup software.

8 Series Protective Relay Platform

Appendix B: IEC 61850 Implementation Details

MICS

This section contains the combined Model Implementation Conformance Statement (MICS) for the IEC 61850 interface in the 8 Series family of protective relays with firmware 2.9x.

- September, 2022 version 1.01

1. Introduction

This model implementation conformance statement is applicable for 8 Series Family, with firmware 2.9x:

This MICS document specifies the modeling extensions compared to IEC 61850 Edition 2. For the exact details on the standardized model please compare the ICD substation configuration file: 845.icd, 850.icd, 869.icd and 889.icd, version 2.9x.

- Clause 2 contains the list of implemented logical nodes.
- Clause 3 describes the new and extended logical nodes.
- Clause 4 describes the new and extended common data classes.

2. Logical Nodes

The following table is a list of the logical nodes and maximum number of instances supported* within the 8 Series relays:

*Note: Depending on the relay order code, the number of available logical nodes may change.

LOGICAL NODES

L: System Logical Nodes	Description	ANSI	850	869	845	889
LPHD1	Physical device information	-	Yes	Yes	Yes	Yes
LLN0	Logical node zero	-	Yes	Yes	Yes	Yes
LGOS	Goose subscription		Yes	Yes	Yes	Yes
C: Logical Nodes for control						
CSWI	Switch controller		Yes(9)	Yes(9)	Yes(9)	Yes(9)
RCLCSWI	Recloser controller		Yes	No	No	No
F: Logical Nodes for functional blocks						
TurnFltFXOT	Stator Inter-Turn Fault		No	Yes	No	No
RunHrsFXOT	Generator Run Hours		No	No	No	Yes
DigCntFCNT	Digital Counters		Yes(16)	Yes(16)	Yes(16)	Yes(16)
G: Logical nodes for generic references						
GGIO1	Remote Outputs					
GGIO2	Contact Inputs		Yes	Yes	Yes	Yes
GGIO3	Virtual Inputs		Yes	Yes	Yes	Yes
GGIO4	Virtual Outputs		Yes	Yes	Yes	Yes
GGIO5	Remote Inputs		Yes	Yes	Yes	Yes
GGIO6	Contact Outputs		Yes	Yes	Yes	Yes
GGIO7	Analog Inputs		Yes	Yes	Yes	Yes
ColdLodGAPC	Cold Load		Yes(2)	No	No	No
SwOntoFltGAPC	Switch Onto Fault		Yes(3)	No	No	No
PoleDscGAPC	Pole Discordance		Yes(3)	No	No	No
CTSupGAPC	CT Supervision		Yes(3)	No	No	No
BrknCondGAPC	Broken Conductor		Yes(3)	No	No	No
FldBkrDspGAPC	Field Bkr.Discrepancy		No	No	No	Yes
I: Logical nodes for interfacing and archiving						
LEDsIHMI	LED status		Yes	Yes	Yes	Yes
M: Logical nodes for metering and measurement						

L: System Logical Nodes	Description	ANSI	850	869	845	889
J1MHAI	Harmonics		Yes(1)	Yes(1)	Yes(1)	Yes(1)
J2MHAI	Harmonics		Yes(1)	Yes(1)	Yes(1)	Yes(1)
K1MHAI	Harmonics		Yes(1)	Yes(1)	Yes(1)	Yes(1)
K2MHAI	Harmonics		Yes(1)	Yes(1)	Yes(1)	Yes(1)
JKMHAI	Harmonics		Yes(1)	Yes(1)	Yes(1)	Yes(1)
MMTR	Energy counters		Yes(4)	Yes(1)	Yes(1)	Yes(3)
EnrLogMMTR	Energy log metering		Yes(4)	Yes(1)	Yes(1)	Yes(2)
PwrDmdMMTR	Pwr Dmd metering		Yes(4)	Yes(1)	Yes(1)	Yes(1)
CurDmdMMTR	Cur Dmd metering		Yes(4)	Yes(1)	Yes(3)	Yes(1)
MMXU1	J metering		Yes	Yes	Yes	Yes
MMXU2	Sens. Gnd. current		Yes	Yes	No	Yes
K1MMXU1 (869, 845, 889)	K1 currents		No	Yes	Yes	Yes
K2MMXU1 (845, 889)	K2 currents		No	No	Yes	Yes
JMMXU1	Currents		Yes	No	No	No
K1MMXU1	K1 currents		Yes	Yes	Yes	Yes
K2MMXU1	K2 currents		Yes	No	Yes	Yes
JKMMXU1	JK currents		Yes	No	No	No
K2MMXU1 (850)	K2 currents		Yes	No	No	No
K2MMXU2 (850)	K2 currents		Yes	No	No	No
K_MMXU1	K metering		No	No	No	Yes
LeaMMXU1	LEA voltages		Yes	No	No	No
LeaMMXU2	LEA voltages		Yes	No	No	No
FastUFMMXU1	Fast Under Freq.		Yes	No	No	No
CTSupMMXU1	CT Supervision		Yes	No	No	No
MSQI1	Sequence metering		Yes	Yes	Yes	Yes
K1MSQI1	K1Seq. metering		No	Yes	Yes	Yes
K2MSQI1	K2 Seq. metering		No	No	Yes	Yes
K_MSQI1	K Seq. metering		No	No	No	Yes
PwrMMXU	Power metering		Yes(4)	Yes(4)	Yes(4)	Yes(4)
P: Logical Nodes for protection functions						
PDOP	Directional power		Yes(4)	Yes(2)	Yes(2)	Yes(2)
RctPwrTripPDUP	Reactive power Trip		No	Yes	No	Yes
RctPwrAlmPDUP	Reactive power Alm.		No	Yes	No	Yes
tripPDUP	Underpower Trip		No	Yes	No	No
almPDUP	Underpower Alarm		No	Yes	No	No
SeqShtdnPDUP	Sequence Shutdown		No	No	No	Yes
PwrLosPDUP	Power Loss		Yes(2)	No	No	No
phsPIOC	Ph. Inst. overcurrent		Yes(16)	Yes(2)	Yes(6)	Yes(6)
ndPIOC	Neut. Inst. Overcurrent		Yes(16)	Yes(2)	Yes(6)	Yes(3)
gndPIOC	Gnd. Inst. Overcurrent		Yes(12)	Yes	Yes(6)	Yes(2)
hsePIOC	Sen. Gnd. Inst. Overc.		Yes(4)	No	No	Yes
ngseqPIOC	Neg. Seq. Inst Overc.		Yes(16)	No	Yes(3)	Yes(3)
jamPIOC	Mechanical Jam		No	Yes	No	No
scPIOC	Short Circuit		No	Yes	No	No
OfflinePIOC	Offline Overcurrent		No	No	No	Yes

L: System Logical Nodes	Description	ANSI	850	869	845	889
InadvEnergPIOC	Inadvertent Energiz.		No	No	No	Yes
phsPTOC	Ph. Tim. Overcurrent		Yes(8)	Yes	Yes(3)	Yes(2)
ndPTOC	Neut. Tim. Overcur.		Yes(8)	Yes	Yes(3)	Yes(2)
gndPTOC	Gnd. Tim. Overcur.		Yes(6)	Yes	Yes(3)	Yes(2)
hsePTOC	Sen. Gnd. Tim Overc.		Yes(2)	No	No	Yes
ngseqPTOC	Neg.Seq.Tim. Overc.		Yes(8)	Yes	Yes(3)	No
unbalalmPTOC	Current Unbal. Alm.		No	Yes	No	Yes
unbaltripPTOC	Current Unbal. Trip		No	Yes	No	Yes
accelPTOC	Acceleration Time		No	Yes	No	No
ldincPTOC	Load Increase alarm		No	Yes	No	Yes
PTOF	OverFrequency		Yes(12)	Yes(2)	Yes(4)	Yes(2)
phsPTOV	Phase Overvoltage		Yes(4)	No	Yes(2)	Yes(2)
ndPTOV	Neutral Overvoltage		Yes(4)	No	Yes	Yes
ngseqPTOV	Neg.Seq. OverV.		Yes(4)	No	No	Yes
auxPTOV	Aux. Overvoltage		Yes(4)	No	Yes	Yes(2)
phrevPTOV	Ph.Reversal OverV.		No	Yes	No	Yes
PTUF	UnderFrequency		Yes(12)	Yes(4)	Yes(6)	Yes(4)
FastPTUF	Fast UnderFreq.		Yes(8)	No	No	No
HzBndPTUF	Freq. OOB Accum.		No	No	Yes(7)	Yes(7)
phsPTUV	Phase Undervoltage		Yes(8)	Yes(2)	Yes(2)	Yes(2)
auxPTUV	Aux. Undervoltage		Yes(4)	Yes(2)	Yes(2)	Yes(2)
RctPwrPTUV	React. Pwr. UV.		Yes(4)	No	No	No
TmPTUV	Time Dep.UV		Yes(4)	No	No	No
ThHaNeutPTUV	3rd Ha Neut UV.		No	No	No	Yes
ThHaNeutAlmPTUV	3rd Ha Neut Alm UV.		No	No	No	Yes
RestPTUV	Restoration		Yes(2)	No	No	No
ThmOvlPTTR	Thermal Model		Yes(2)	No	No	No
MotThmPTTR	Thermal Model		No	Yes	No	No
curPTTR	Xfmr. Thrm. Overload		No	No	Yes	No
GenThmPTTR	Gen. Thrm. Overload		No	No	No	Yes
PFRC	Freq. ROC		Yes(12)	Yes(2)	Yes(4)	Yes(2)
trbusPTRC	Trip Bus		Yes(6)	Yes(6)	Yes(6)	Yes(6)
WatPSDE	Wattmetric Gnd. Fault		Yes(4)	No	No	No
NeutAdmPSDE	Neutral Admittance		Yes(3)	No	No	No
PVPH	Volts per Hertz		No	Yes	Yes(2)	Yes(2)
PTUC	UnderCurrent		Yes(3)	No	No	No
tripPTUC	UnderCurrent Trip		No	Yes	No	No
almPTUC	UnderCurrent Alarm		No	Yes	No	No
PMRI	Thermal Inhibit		No	Yes	No	No
instPDIF	Instant. Differential		No	No	Yes	No
pcntPDIF	Xrfm. Percent. Diff.		No	No	Yes	No
PcntPDIF	Percent. Diff.		No	Yes	No	Yes
OvrlPcntPDIF	Overall Percent. Diff.		No	No	No	Yes
RGFPDIF	Restricted Gnd. Fault		Yes(3)	No	Yes(3)	Yes
LodEncPDIS	Load Encroachment		Yes(2)	No	No	No
LosExtPDIS	Loss of Exc. Circle		No	Yes	No	Yes

L: System Logical Nodes	Description	ANSI	850	869	845	889
ThHaVPHIZ	3rd Har. Volt. Diff.		No	No	No	Yes
HaDetPHAR	Harmonic Detection		Yes(6)	Yes(6)	Yes(6)	Yes(6)
OOSPPAM	Out of Step		No	No	No	Yes
PTEF	TEFD		Yes(2)	No	No	No
Q: Logical Nodes for power quality events						
PQQVVR	power quality events		Yes	Yes	No	No
R: Logical Nodes for protection related functions						
phsRDIR	Ph. Dir. Overcurrent		Yes(4)	Yes	Yes	Yes
ndRDIR	Neut. Dir. Overcurrent		Yes(4)	Yes	Yes	Yes
gndRDIR	Gnd. Dir. Overcurrent		Yes(2)	No	Yes	Yes
ngseqRDIR	Neg.Seq.Dir. OverC.		Yes(2)	No	No	Yes
hseRDIR	Sens.Gnd.Dir. OverC.		Yes	No	No	Yes
RREC	Autoreclosing		Yes(2)	No	No	No
RCLRREC	Autoreclosing		Yes	No	No	No
RBRF	Breaker failure		Yes(3)	Yes	Yes(3)	Yes(2)
RCLRRBRF	Breaker failure		Yes	No	No	No
RptRFLO	Fault locator		Yes(15)	No	No	No
SynChkRSYN	Synchrocheck		Yes(2)	No	Yes	Yes
MtrStrtRDRE	Motor Start records		No	Yes	No	No
TransRcdRDRE	Transient records		Yes	Yes	Yes	Yes
S: Logical Nodes for supervision and monitoring						
ArcFlsSARC	Arc Flash		Yes(3)	Yes(3)	Yes(3)	Yes(3)
RtdSTMP	RTD Inputs		Yes(13)	Yes(13)	Yes(13)	Yes(13)
RemRtdSTMP	Remote RTD Inputs		Yes(12)	Yes(12)	Yes(12)	Yes(12)
RtdMaxSTMP	Max RTD		Yes(13)	Yes(13)	Yes(13)	Yes(13)
RRtdMaxSTMP	Max Remote RTD		Yes(12)	Yes(12)	Yes(12)	Yes(12)
HotRtdSTMP	Hottest RTD		Yes	Yes	Yes	Yes
RemHotRtdSTMP	Remote Hottest RTD		Yes	Yes	Yes	Yes
SPTR	Winding Hottest Spot		No	No	Yes	No
DgaSIML	DGA		No	No	Yes	No
BknRotSVBR	Broken Rotor Bar		No	Yes	No	No
T: Logical nodes for instrument transformers and sensors						
TVTR	Fuse Failure		Yes(2)	Yes	Yes	Yes
X: Logical nodes for switchgear						
XCBR	Breaker		Yes(2)	Yes	Yes(3)	Yes(2)
XSWI	Switchgear status		Yes(9)	Yes(9)	Yes(9)	Yes(9)
OHSWXSWI	Overhead Sw. health		Yes	No	No	No
RCLXCBR	Reclose breaker		Yes	No	No	No
Y: Logical nodes for power transformers						
XfmrYPTR	Harmonic Derating		No	No	Yes	No
XfmrYLTC	Tap Changer		No	No	Yes	No
Z: Logical nodes for further power system equipment						
GnStZGEN	Generator Status		No	No	No	Yes
ZMOT	Motor Status		No	Yes	No	No
ZBAT	Battery Monitoring		Yes	No	No	No

The tables in this section use the following abbreviations:

- M: Data is mandatory in the IEC 61850-7-4 ED.2
- O: Data is optional in the IEC 61850-7-4 ED.2 and is used in the device.
- E: Data is an extension to the IEC 61850-7-4 ED.2
- C: Data is conditional in the IEC 61850-7-4 ED.2 and is used in the device.

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	DPL_0	Physical device name plate	M	
PhyHealth	ENS_11	Physical device health	M	
Proxy	SPS_0	Indicates if this LN is a proxy	M	
Sim	SPC_1	Receive Simulated GOOSE	O	
SetChang	SPS_2	Setting Change	O	
NotInServ	SPS_2	Device out of service	O	
SetFilRjct	SPS_2	Settings file rejected	O	
MajorErr	SPS_2	Major error	O	
MinorErr	SPS_2	Minor error	O	
Port4EthFail	SPS_2	Port 4 fails	O	
Port5EthFail	SPS_2	Port 5 fails	O	
FWSuccess	SPS_2	Firmware updated	O	

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	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_0	Name plate	M	
GoCB (ACSI class GOOSE control block)				
GoCB	GoCB			

2.1.3 LGOS (GOOSE subscription)

LGOS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
LGOS		Logical node zero		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_2	Name plate	M	
St	SPS_0	Status of the subscription	M	
LastStNum	INS_0	Last state number received	O	
ConfRevNum	INS_0	Expected conf revision num.	O	
GoCBRef	ORG_0		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	

2.2 Logical Nodes for control functions. LN Group: C

a) CSWI Switchgear controller

CSWI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
CSWI_0				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Controls				
Pos	DPC_0		M	

b) CSWI Recloser controller

CSWI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
CSWI_1				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Controls				
Pos	DPC_0		M	
PosA	DPC_1		O	
PosB	DPC_1		O	
PosC	DPC_1		O	
HlthStr	ACD_3	Switch health pickup	O	
HlthOpnStr	ACD_3	Open time sw. health pkp.	O	
HlthClsStr	ACD_3	Close time sw. health pkp.	O	
ArcPhAStr	ACD_3	Arc time PhA sw. health pkp.	O	
ArcPhBStr	ACD_3	Arc time PhB sw. health pkp.	O	
ArcPhCStr	ACD_3	Arc time PhC sw. health pkp.	O	
EngyPhAStr	ACD_3	Arc energy PhA sw. health pkp.	O	
EngyPhBStr	ACD_3	Arc energy PhB sw. health pkp.	O	
EngyPhCStr	ACD_3	Arc energy PhC sw. health pkp.	O	
HlthFail	SPS_2	Sw.open or close failed	O	
ArcFail	SPS_2	Sw. arc time failed	O	

2.3 Logical Nodes for the functional block. LN Group: F

2.3.1 FXOT (Action at over threshold)

a) TurnFltFXOT: Stator inter-turn fault

FXOT class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
TurnFltFXOT		Stator inter-turn fault		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	O	

Op	ACT_2	Operate	M	
Str2	ACD_3	Start	O	
Op2	ACT_3	Operate	O	

b) RunHrsFXOT: Generator Running Hours

FXOT class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RunHrsFXOT		Generator running hours		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Op	ACT_2	Level of action reached	M	
OpTmh	INS_0	Operation Time	O	

2.3.2 FCNT (Counter)

a) DigCntFCNT: Digital counters

FCNT class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
FCNT_DIGCNT				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
HiLim	SPS_0	High limit OP	O	
EqLimOp	SPS_2	Equal Limit OP	O	
LoLim	SPS_0	Low Limit OP	O	
CntRs	BCR_0	Accumulated Value	M	
FrznCnt	BCR_1	Frozen Value	O	

2.4 Logical Nodes for generic references. LN Group: G

2.4.1 GGIO (Generic process I/O)

a) GGIO1: Remote Outputs

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/**	**Notes**
GGIO_RO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Ind1	SPS_0	General Indication (binary input)	O	Remote Output 1
Ind2	SPS_0	General Indication (binary input)	O	Remote Output 2
..	..	..	..	
Ind32	SPS_0	General Indication (binary input)	O	Remote Output 32

b) GGIO2: Contact Inputs

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_CI		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Ind1	SPS_0	General Indication	O	Contact input 1
Ind2	SPS_0	General Indication	O	Contact input 2
..	..	..	..	
Ind32	SPS_0	General Indication	O	Contact input 32

c) GGIO3: Virtual Inputs

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_VI		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	

Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Controls				
SPCSO1	SPC_1	Single point controllable status output	O	Virtual Input 1
SPCSO2	SPC_1	Single point controllable status output	O	Virtual Input 2
..	..	..	..	
SPCSO64	SPC_1	Single point controllable status output	O	Virtual Input 64

d) GGIO4: Virtual Outputs logical node.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_VO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Ind1	SPS_0	General Indication	O	Virtual Output 1
Ind2	SPS_0	General Indication	O	Virtual Output 2
..	..	..	..	
Ind96	SPS_0	General Indication	O	Virtual Output 96

e) GGIO5: Remote Inputs (GOOSE) logical node for 3A/3E option.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_RI		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Ind1	SPS_0	General Indication	O	Remote input 1
Ind2	SPS_0	General Indication	O	Remote input 2
..	..	..	..	
Ind256	SPS_0	General Indication	O	Remote input 256
AnIn1	MV_2	Analog Input	O	Float type
..	..	..	..	
AnIn24	MV_2	Analog Input	O	Float type

AnIn25	MV_4	Analog Input	O	Integer type
..	..	..	..	
AnIn32	MV_4	Analog Input	O	Integer type

f) GGIO5: Remote Inputs (GOOSE) for 2A/2E option.

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_RI		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Ind1	SPS_0	General Indication	O	Remote input 1
Ind2	SPS_0	General Indication	O	Remote input 2
..	..	..	..	
Ind128	SPS_0	General Indication	O	Remote input 128
AnIn1	MV_2	Analog Input	O	Float type
..	..	..	..	
AnIn6	MV_2	Analog Input	O	Float type
AnIn7	MV_4	Analog Input	O	Integer type
AnIn8	MV_4	Analog Input	O	Integer type

g) GGIO6: Contact Outputs

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_CO		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Ind1	SPS_0	General Indication	O	Contact Output 1
Ind2	SPS_0	General Indication	O	Contact Output 2
Ind3	SPS_0	General Indication	O	
Ind4	SPS_0	General Indication	O	
Ind8	SPS_0	General Indication	O	
Ind9	SPS_0	General Indication	O	
Ind10	SPS_0	General Indication	O	
Ind11	SPS_0	General Indication	O	
Ind12	SPS_0	General Indication	O	
Ind16	SPS_0	General Indication	O	
Ind17	SPS_0	General Indication	O	

Ind18	SPS_0	General Indication	O	
Ind19	SPS_0	General Indication	O	
Ind20	SPS_0	General Indication	O	
Ind24	SPS_0	General Indication	O	

h) GGIO7: Analog Inputs

GGIO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GGIO_AI		Generic process I/O		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
AnIn1	SPS_0	General Indication	O	Analog Input 1
AnIn2	SPS_0	General Indication	O	Analog Input 2
AnIn3	SPS_0	General Indication	O	
AnIn4	SPS_0	General Indication	O	

2.4.2 GAPC (Generic automatic process control)

a) ColdLodGAPC: Cold load

b) SwOntoFlt: Switch Onto Fault

c) FldBkrDspGAPC: Field Breaker Discrepancy

d) BrknConGAPC: Broken Conductor

GAPC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/**	**Notes**
ColdLodGAPC **SwOntoFltGAPC** **FldBkrDspGAPC** **BrknConGAPC**		Generic Automatic process control		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Str	ACD_2		O	
Op	ACT_2		O	

e) PoleDscGAPC: Pole Discordance

GAPC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/**	**Notes**
PoleDscGAPC		Generic Automatic process control		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Dsc	ACT_2		O	
DscEx	ACT_3		O	
DscCon	ACT_3		O	
DscCur	ACT_3		O	
DscPhsAFailOpn	SPS_2		O	
DscPhsBFailOpn	SPS_2		O	
DscPhsCFailOpn	SPS_2		O	
DscPhsAFailCls	SPS_2		O	
DscPhsBFailCls	SPS_2		O	
DscPhsCFailCls	SPS_2		O	

f) CTSupGAPC: CT Supervision

GAPC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/**	**Notes**
CTSupGAPC		Generic Automatic process control		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
Str	ACD_2		O	
Op	ACT_2		O	
StrSeqChk	ACD_3		O	
OpSeqChk	ACT_3		O	
StrDiffChk	ACD_3		O	
OpDiffChk	ACT_3		O	
StrSymChk	ACD_3		O	
OpSymChk	ACT_3		O	

2.5 Logical Nodes for interfacing and archiving. LN Group: I

2.5.1 IHMI (Human Machine Interface)

a) LEDsIHMI: Status of the LEDs

IHMI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
IHMI		Human Machine Interface		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
InService	SPS_2	In Service LED	O	
TripInd	SPS_2	Trip LED	O	
AlmInd	SPS_2	Alarm LED	O	
StrInd	SPS_2	Pickup LED	O	
UsrPrgmLED5	SPS_2	User-programmable LED 5	O	
...	SPS_2		O	
UsrPrgmLED17	SPS_2	User-programmable LED 17	O	
...	SPS_2		O	
UsrPrgmLED24	SPS_2	User-programmable LED 24	O	

The number of user-programmable LEDs available depends on the order code Faceplet Option:

- M (basic): UserPrgmLED 5 - UsrPrgmLED17
- G (standard): UserPrgmLED 5 - UsrPrgmLED17
- A (advanced): UserPrgmLED 5 - UsrPrgmLED24

2.6 Logical Nodes for metering and measurement. LN Group: M

2.6.1 MHAI (Harmonics or Interharmonics)

a) J1MHAI1

b) J2MHAI1

c) K1MHAI1

d) K2MHAI1

e) JKMHAI1

MHAI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MHAI		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
ThdA	WYE_5		O	
HA2	WYE_4	2nd harmonic	O	
...	WYE_4		O	
HA25	WYE_4	25th harmonic	O	

2.6.2 MMXU (Measurement)

a) MMXU1: Measurement

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_1		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
Hz	MV_0	Line Frequency	O	VLFREC
HzRte	MV_1	Frequency Rate of Change	O	
Hz3VT	MV_1		O	
Hz3VTRte	MV_1		O	
HzVx	MV_1		O	
HzVxRte	MV_1		O	
PPV	DEL_0	Phase to phase voltages (VL1L2,...)	O	Phase Voltage

PhV	WYE_0	Phase to ground voltages (VL1ER, ...)	O	Ground Voltage
A	WYE_1	Phase currents (IL1, ...)	O	Currents
AuxV	CMV_1	Auxiliary Phase Voltage	O	Aux Voltage
AvAPhs	MV_0	Average Phase Current	O	

b) MMXU2: Measurements (sensitive ground)

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_2		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
A	WYE_2	Phase currents (IL1, ...)	O	Currents
AvAPhs	MV_0	Average Phase Current	O	

c) K1MMXU1 (869, 845, 889)

d) K2MMXU1 (845, 889)

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_SLOT_K		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
Hz	MV_0	Line Frequency	O	VLFREC
HzRte	MV_1	Frequency Rate of Change	O	VLFREC
A	WYE_2	Phase currents (IL1, ...)	O	Currents
AvAPhs	MV_0	Average Phase Current	O	

e) JMMXU1: Slot J Currents

f) K1MMXU1: K1 Currents

g) K2MMXU1: K2 Currents

h) JKMMXU1: JK Currents

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_SLOT_K_2		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
A	WYE_1	Phase currents (IL1, ...)	O	Currents
AvAPhs	MV_0	Average Phase Current	O	

i) K2MMXU1 (850)

j) K2MMXU2 (850)

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_SLOT_K_3		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	

Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
Hz3VT	MV_1		O	
HzVx	MV_1		O	
PPV	DEL_0			
AuxV	CMV_1			

k) LeaMMXU: Lea Voltages

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_LEA		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
PPV	DEL_0	Phase to Phase Voltages	O	
PhV	WYE_6	Phase to Ground Voltages	O	

l) CTSupMMXU: CT Supervision Metering

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_CTS		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
CTS1SymImin	MV_1	CTS1 Symmetric Min. Current	O	
CTS1SymImax	MV_1	CTS1 Symmetric Max. Current	O	
CTS1SymQuot	MV_1	CTS1 Symmetric Quotient	O	
CTS1DiffCur	MV_1	CTS1 Differential Current	O	
CTS2SymImin	MV_1	CTS2 Symmetric Min. Current	O	
CTS2SymImax	MV_1	CTS2 Symmetric Max. Current	O	
CTS2SymQuot	MV_1	CTS2 Symmetric Quotient	O	
CTS2DiffCur	MV_1	CTS2 Differential Current	O	
CTS3SymImin	MV_1	CTS3 Symmetric Min. Current	O	

CTS3SymImax	MV_1	CTS3 Symmetric Max. Current	O	
CTS3SymQuot	MV_1	CTS3 Symmetric Quotient	O	
CTS3DiffCur	MV_1	CTS3 Differential Current	O	

m) FastUFMMXU: Fast UnderFrequency Metering

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_FAST_UF		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
Hz	MV_0	Fast Frequency	O	
HzRte	MV_1	Fast Rate of Change	O	

n) PwrMMXU: Power Metering

MMXU class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMXU_POWER		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
TotW	MV_0	Total active power (P)	O	Real Power
TotVAr	MV_0	Total reactive power (Q)	O	Reactive Power
TotVA	MV_0	Total apparent power (S)	O	Apparent Power
TotPF	MV_0	Average power factor (PF)	O	Power Factor
W	WYE_3	Phase active power	O	Real Power
VAr	WYE_3	Phase reactive power	O	Reactive Power
VA	WYE_3	Phase apparent power	O	Apparent Power
PF	WYE_3	Phase power factor	O	Power Factor

2.6.3 MSQI Sequence and Imbalance

a) MSQI1: Sequence Metering

b) K_MSQI: K Sequence Metering

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/C**	**Notes**
MSQI_1		Sequence and imbalance		

Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
SeqA	SEQ_0	Pos, Neg and Zero seq Current	C	I0_P, I1_P, I2_P
SeqV	SEQ_0	Pos, Neg and Zero seq Voltage	C	V0_P, V1_P, V2_P

c) K1MSQI1: K1 Sequence Metering

d) K2MSQI1: K2 Sequence Metering

MSQI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/C**	**Notes**
MSQI_2		Sequence and imbalance		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
SeqA	SEQ_0	Pos, Neg and Zero seq Current	C	I0_P, I1_P, I2_P

2.6.4 MMTR

a) MMTR: Energy Counters

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR_1		Metering		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
CntPsWh	MV_1	Power Pos. WHrs	O	
CntPsWhCst	MV_3	Power Pos. WHrs Cost	O	
CntNgWh	MV_1	Power Neg. WHrs	O	
CntNgWhCst	MV_3	Power Neg. WHrs Cost	O	
CntPsVArh	MV_1	Power Pos. VArHours	O	
CntNgVArh	MV_1	Power Neg. VArHours	O	
RsEnrDT	INS_1	Reset Energy D/T	O	

b) EnrLogMMTR: Energy Log Metering

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR_2		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
PosLEWh	MV_3	Power Last Event Pos. WattHours	O	
NegLEWh	MV_3	Power Last Event Neg. WattHours	O	
PosLEVArh	MV_3	Power Last Event Pos. VarHours	O	
NegLEVArh	MV_3	Power Today Neg. VarHours	O	
PosTdyWh	MV_3	Power Today Pos. WattHours	O	
NegTdyWh	MV_3	Power Today Neg. WattHours	O	
PosTdyVArh	MV_3	Power Today Pos. VarHours	O	
NegTdyVArh	MV_3	Power Yesterday Neg. VarHours	O	
PosYdyWh	MV_3	Power Yesterday Neg. VarHours	O	
NegYdyWh	MV_3	Power Yesterday Pos. WattHours	O	
PosYdyVArh	MV_3	Power Yesterday Neg. WattHours	O	
NegYdyVArh	MV_3	Power Yesterday Pos. VarHours	O	
RsEnrDT	INS_1	Reset Energy Log D/T	O	

c) PwrDmdMMTR: Power Demand Metering

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR_3		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
PwrRsDmdDT	INS_1	Power Reset Demand D/T	O	

WDmd	MV_1	Power Real Demand	O	
WMaxDmd	MV_3	Power Max Real Demand	O	
WMinDmd	MV_3	Power Min Real Demand	O	
VArDmd	MV_1	Power Reactive Demand	O	
VArMaxDmd	MV_3	Power Max Reactive Demand	O	
VarMinDmd	MV_3	Power Min Reactive Demand	O	
VADmd	MV_1	Power Apparent Demand	O	
VAMaxDmd	MV_3	Power Max Apparent Demand	O	
VAMinDMD	MV_3	Power Min Apparent Demand	O	

d) CurDmdMMTR: Current Demand Metering

MMTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MMTR_4		Measurement		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
CurRsDmdDT	INS_1	Current Reset Demand D/T	O	
Aamd	MV_1	Current PhA Demand	O	
AbDmd	MV_1	Current PhB Demand	O	
AcDmd	MV_1	Current PhC Demand	O	
AaMaxDmd	MV_3	Current Max PhA Demand	O	
AbMaxDmd	MV_3	Current Max PhB Demand	O	
AcMaxDmd	MV_3	Current Max PhC Demand	O	

2.7 Logical Nodes for protection functions. LN Group: P

2.7.1 PDOP (Directional Overpower)

a) PDOP: Directional overpower

PDOP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDOP		Directional Overpower		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	

Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

2.7.2 PDUP (Directional Underpower)

a) RctPwrTripPDUP: Reactive power trip

b) RctPwrAlmPDUP: Reactive power alarm

PDUP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RctPwrTripPDUP RctPwrAlmPDUP		Directional Underpower		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	
StrPos	ACD_3	Positive pickup	O	
OpPos	ACT_3	Negative pickup	O	
StrNeg	ACD_3	Positive Operate	O	
OpNeg	ACT_3	Negative Operate	O	

c) SeqShtdnPDUP: Sequential Shutdown

PDUP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
SeqShtdnPDUP		Directional Underpower		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

d) PwrLosPDUP: Power Loss

PDUP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDUP_2		Directional Underpower		

Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	M	
Op	ACT_0	Operate	M	

2.7.3 PIOC (Instantaneous overcurrent)

a) phsPIOC: Phase IOC

b) OfflinePIOC: Offline IOC

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
phsPIOC **Offline PIOC**		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	O	
Op	ACT_0	Operate	M	

c) ndPIOC: neutral IOC

d) gndPIOC: ground IOC

e) hsePIOC: Sensitive Ground IOC

g) jamPIOC: Mechanical Jam

h) scPIOC: Short Circuit

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ndPIOC/ **gndPIOC/** **hsePIOC/** **jamPIOC/** **scPIOC**		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	

Status Information				
Str	ACD_1	Start	O	
Op	ACT_1	Operate	M	

f) ngseqPIOC: Negative Sequence IOC

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
NgSeqPIOC		Instantaneous overcurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	O	Neq Seq IOC PKP
Op	ACT_2	Operate	M	Neq Seq IOC OP

i) InadvEnergPIOC: Inadvertent Energization

PIOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
InadvEnergPIOC		Inadvertent Energization		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Op	ACD_2	Operate	M	
Armed	ACT_3	Armed	O	

2.7.4 PTOC (Time Overcurrent)

a) phsPTOC: Phase TOC

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PhsPTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	

Status Information				
Str	ACD_0	Start	O	TOC PKP
Op	ACT_0	Operate	M	TOC OP

b) ndPTOC: neutral TOC

c) gndPTOC: ground TOC

d) hsePTOC: sensitive ground TOC

f) unbalalmPTOC: Current unbalance alarm

g) unbaltripPTOC: Current unbalance trip

h) accelPTOC: Acceleration

i) ldincPTOC: Load Increase alarm

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ndPTOC/ gndPTOC/ hsePTOC/ unbalalmPTOC/ unbaltripPTOC/ accelPTOC/ ldincPTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_1	Start	O	PKP
Op	ACT_1	Operate	M	OP

e) ngseqPTOC: Negative Sequence TOC

PTOC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
NgSeqPTOC		Time overcurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	O	
Op	ACT_2	Operate	M	

2.7.5 PTOF (OverFrequency)

a) PTOF: Overfrequency

PTOF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTOF		OverFrequency		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	PTOF PKP
Op	ACT_2	Operate	M	PTOF OP

2.7.6 PTOV (Overvoltage)

a) phsPTOV: Phase overvoltage

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
phsPTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	M	Phase TOV PKP
Op	ACT_0	Operate	O	Phase TOV OP

b) ndPTOV: Neutral overvoltage

c) ngseqPTOV: negative sequence overvoltage

d) auxPTOV: Auxiliary overvoltage

e) phsrevPTOV: Phase reversal overvoltage

PTOV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
auxPTOV/ ndPTOV/ ngseqPTOV/ phsrevPTOV		Overvoltage		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	

NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

2.7.7 PTUF (Underfrequency)

a) PTUF: Underfrequency

b) FastPTUF: Fast Underfrequency

PTUF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUF		UnderFrequency		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	PTUF PKP
Op	ACT_2	Operate	M	PTUF OP

c) HzBndPTUF: Frequency out of band accumulation

PTUF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
HzBndPTUF		UnderFrequency		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACD_2	Operate	M	
Measured and metered values				
HzObAccum	MV_3	Frequency OOB Accum	O	

2.7.8 PTUV (Undervoltage)

a) phsPTUV: Phase undervoltage

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
phsPTUV		Undervoltage		
Data				
Common Logical Node Information				

Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	M	Phase PTUV PKP
Op	ACT_0	Operate	M	Phase PTUV OP

b) auxPTUV: Auxiliary undervoltage

c) ThHaNeutPTUV: Third harmonic neutral undervoltage

d) ThHaNeutAlmPTUV: Third harmonic neutral undervoltage

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
auxPTUV/ ThHaNeutPTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

e) RctPwrPTUV: Reactive Power undervoltage

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RectPwrPTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	
Restore	SPS_2		O	

f) TmPTUV: Time dependent undervoltage

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
TimedPTUV		Undervoltage		
Data				
Common Logical Node Information				

Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	
TmCrv	SPS_2	Curve	O	
Cnt	SPS_2	Counter	O	

g) RestPTUV: Restoration undervoltage

PTUV class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RestorationPTUV		Undervoltage		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	
StrAux	ACD_3	Start	O	
OpAux	ACT_3	Operate	O	
Init	SPS_2	Initiate	O	

2.7.9 PTTR (Thermal overload)

a) PTTR: Thermal O/L

b) MotThmPTTR: Thermal mode node

PTTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTTR/ MotThmPTTR		Thermal Overload		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	M	
Op	ACT_0	Operate	M	

c) curPTTR: Transformer O/L

PTTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
curPTTR		Thermal Overload		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	O	
StrW1	ACT_3	Start W1	O	
StrW2	ACT_3	Start W2	O	
StrW3	ACT_3	Start W3	O	
Op	ACT_2	Operate	M	

d) GenThmPTTR: Thermal O/L

PTTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
tmpPTTR/ GenThmPTTR		Thermal Overload		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	O	
Op	ACT_2	Operate	M	

2.7.10 PFRC (Rate of change of frequency)

a) PFRC: Rate of change of frequency

PFRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PFRC		Rate of change of frequency		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	

Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

2.7.11 PTRC (Protection trip conditioning)

a) PTRC: Trip Bus

PTRC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PFRC		Trip bus		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

2.7.12 PSDE (Sensitive directional Earth fault)

a) WatPSDE: Wattmetric Ground fault

b) NeutAdm: Neutral admittance

PSDE class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
WatPSDE/ NeutAdm		Sensitive directional earth fault (/Neutral admittance)		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	O	

2.7.13 PVPH (Volts per Hertz)

a) PVPH: Volts per Hertz

PVPH class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PVPH		Volts per Hertz		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	

Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

2.7.14 PTUC (Undercurrent)

a) tripPTUC: Undercurrent trip

b) almPTUC: Undercurrent alarm

PTUC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUC		Undercurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

c) PTUC: Undercurrent

PTUC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTUC_2		Undercurrent		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	
StrAlm	ACD_3	Start aux	O	
OpAlm	ACT_3	Operate aux	O	

2.7.15 PMRI (Start inhibit)

a) PMRI: Start Inhibit

PMRI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PMRI		Start inhibit		

Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
StrInh	SPS_0	Start inhibited	O	

2.7.16 PDIF (Differential protection)

a) instPDIF: Instantaneous Differential

PDIF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDIF_2		Differential protection		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Op	ACT_2	Operate	M	

b) PcntPDIF: Transformer Percent Differential

e) OvrlPcntPDIF: Overall Percent Differential

PDIF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PERC_PDIF_1		Differential protection		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	o	
Op	ACT_0	Operate	M	
DifACLc	WYE_3	Differential Current	O	
RstA	WYE_3	Restraint Current	O	
Ha2ndA	WYE_4	2nd Harmonic Current	O	
Ha5thA	WYE_4	5th Harmonic Current	O	

c) PcntPDIF: Generator Percent Differential

d) PcntPDIF: Motor Percent Differential

PDIF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PERC_PDIF_0		Differential protection		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	O	
Op	ACT_0	Operate	M	
DifACLc	WYE_3	Differential Current	O	
RstA	WYE_3	Restraint Current	O	

f) RGFPDIF: Restricted Ground Fault

PDIF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RGFPDIF		Differential protection		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_0	Start	O	
Op	ACT_0	Operate	M	
SupervOn	SPS_2	Supervision	O	

2.7.17 PDIS (Differential Protection)

a) LodEcrPDIS: Load Encroachment

PDIS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDIS_0		Differential Protection		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	

Status Information				
Str	ACD_2	Start	M	
Op	ACT_2	Operate	M	

b) LosExtPDIS: Loss of Excitation

PDIS class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PDIS_1		Differential Protection		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start Circle 1	M	
Op	ACT_2	Operate Circle 1	M	
StrC2	ACD_2	Start Circle 2	O	
OpC2	ACT_2	Operate Circle 2	O	
Z1ResC1	MV_3	Z1 Resistance Circle 1	O	
Z1ReaC1	MV_3	Z1 Reactance Circle 1	O	
Z1MagC1	MV_3	Z1 Magnitude Circle 1	O	
Z1AngC1	MV_3	Z1 Angle Circle 1	O	
Z1ResC2	MV_3	Z1 Resistance Circle 2	O	
Z1ReaC2	MV_3	Z1 Reactance Circle 2	O	
Z1MagC2	MV_3	Z1 Magnitude Circle 2	O	
Z1AngC2	MV_3	Z1 Angle Circle 2	O	

2.7.18 PHIZ (Ground detector)

a) ThHaVPHIZ: Third harmonic Voltage difference

PHIZ class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ThHaVTripPHIZ/ ThHaVAlmpPHIZ		Ground detector		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start Trip	O	
Op	ACT_2	Operate Trip	M	
StrAlm	ACD_3	Start Alarm	O	
OpAlm	ACT_3	Operate Alarm	O	

2.7.19 PHAR (Harmonic restraint)

a) HaDetPHAR: Harmonic detection

PHAR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
HaDetPHAR		Harmonic restraint		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	O	
Op	ACT_2	Operate	M	

2.7.20 PPAM (Out of Step)

a) OOSPPAM: Out of step

PPAM class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
OOSPPAM		Out of step		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Start	M	
StrLftBld	ACT_3	Left blinder pickup	O	
StrRgtBld	ACT_3	Right blinder pickup	O	
StrTimer	ACT_3	Timer pickup	O	
Op	ACT_2	Operate	M	

2.7.21 PTEF (Transient Earth/Ground Fault))

a) PTEF: Transient earth/ground fault detection

PPAM class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PTEF		Transient earth/ground fault		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Str	ACD_2	Enabled	M	
TrRv	SPS_2	Reverse	O	
TrFw	SPS_2	Forward	O	
Measured values				
TrReactPwr	MV_3	Transient Reactive Power	M	
TrActPwr	MV_3	Transient Active Power	O	
DyThrPosQ	MV_3	Dynam. Threshold Pos Q	O	
DyThrNegQ	MV_3	Dynam. Threshold Neg Q	O	
DyThrPosP	MV_3	Dynam. Threshold Pos P	O	
DyThrNegQ	MV_3	Dynam. Threshold Pos P	O	

2.8 Logical Nodes for power quality events. LN Group: Q

2.8.1 QVVR (Voltage Variation)

a) PQQVVR: Power Quality Events

QVVR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
QVVR_VD		Voltage variation		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
VarStr	SPS_0		M	
DipStr	SPS_0		O	
SwlStr	SPS_0		O	
Measured and metered values				
RcdSncClr	INS_1		O	
RsTms	INS_1		O	
SrcPh	ENS_8		O	
EvtTyp	ENS_9		O	
EvtInst	ENS_10		O	
VVa	MV_2		O	
VVaTm	MV_2		O	
EvtDt	INS_1		O	

2.9 Logical Nodes for protection related functions. LN Group: R

2.9.1 RDIR (Directional element)

a) phsRDIR: Phase directional overcurrent

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
PhsRDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Dir	ACD_0	Direction	M	
Op	ACT_0	Operate	O	

b) ndRDIR: Neutral directional element

c) gndRDIR: Ground directional element (845, 850, 889)

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ndRDIR/ gndRDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Dir	ACD_1	Direction	M	
Op	ACT_3	Operate	O	

d) ngseqRDIR: Negative sequence directional element (850,889)

e) hseRDIR: ground directional overcurrent (850, 889)

RDIR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ngseqRDIR/ hseRDIR		Directional Element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Dir	ACD_2	Directions	M	
Op	ACT_2	Directions	O	

2.9.2 RREC (Autoreclosing)

a) RREC: Autoreclose elements

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RREC		Autoreclosing element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	

Status Information				
OpCls	ACT_2		M	
AutoRecSt	ENS_3	Operate	M	

b) RREC: Autoreclose for 850-R

RREC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RREC_1		Autoreclosing element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
OpCls	ACT_2	Operate	M	
OpClsA	ACT_3	Operate Phase A	O	
OpClsB	ACT_3	Operate Phase B	O	
OpClsC	ACT_3	Operate Phase C	O	
AutoRecSt	ENS_3	AutoReclosing Status	M	
AutoRecStA	ENS_12	AutoReclosing Status Phase A	O	
AutoRecStB	ENS_12	AutoReclosing Status Phase B	O	
AutoRecStC	ENS_12	AutoReclosing Status Phase C	O	

2.9.3 RBRF (Breaker failure)

a) RBRF: breaker failure

RBRF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RBRF		Breaker failure element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
OpEx	ACT_2	Breaker failure trip	M	
OpIn	ACT_2	Breaker failure operate	M	

a) RCLRBRF: breaker failure for 850-R

RBRF class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RBRF_2		Breaker failure element		

Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
OpEx	ACT_2	Breaker failure trip	M	
OpIn	ACT_2	Breaker failure operate	M	
OpExA	ACT_3	Breaker failure trip PhA	O	
OpInA	ACT_3	Breaker failure operate PhA	O	
OpExB	ACT_3	Breaker failure trip PhB	O	
OpInB	ACT_3	Breaker failure operate PhB	O	
OpExC	ACT_3	Breaker failure trip PhC	O	
OpInC	ACT_3	Breaker failure operate PhC	O	

2.9.4 RFLO (Fault locator)

a) rptRFLO: Fault report

RFLO class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
rptRFLO		Fault locator element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured Values				
FltZ	CMV_2	Fault Impedance	M	
FltDiskm	MV_2	Fault Distance in KM	O	
FltLoop	ENS_4	Fault Type	O	
RecCyc	INS_1	Fault Reclose Shot	O	

2.9.5 RSYN (Synchronism-check)

a) SynChkRSYN: Synchrocheck

RSYN class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
SynChkRSYN		Synchronism-check		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	

NamPlt	LPL_1	Name plate	M	
Status Information				
Rel	SPS_0		M	
LivBus	SPS_2		O	
LivLin	SPS_2		O	
DeaBus	SPS_2		O	
DeaLin	SPS_2		O	
ClsPerm	SPS_2		O	
Measured values				
DifVClc	MV_2		O	
DifHzClc	MV_2		O	
DifAngClc	MV_2		O	
BusVMag	MV_3		O	
BusVHz	MV_3		O	
BusVAng	MV_3		O	
LinVMag	MV_3		O	
LinVHz	MV_3		O	
LinVAng	MV_3			

2.9.6 RDRE (Disturbance Recorder)

a) MtrStrtRDRE: Motor Start Records

RDRE class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDRE_MOTOR_START		Motor Start Records		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
RcdMade	SPS_0	Start Records	M	If FltNum>0 true, else false
FltNum	INS_0	Fault number	M	
RsTms	INS_1	Last CLear D/T	O	

b) TransRcdRDRE: Transient Records

RDRE class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
RDRE_TRANSIENTS		Transient Recorder		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	

Status Information				
RcdMade	SPS_0	Transient Records	M	If NumRcd>0 true, else false
FltNum	INS_0	Records since last clear	M	
NumRcd	INS_1	Records available	O	
RsTms	INS_1	Last Clear D/T	O	

2.10 Logical Nodes for supervision and monitoring. LN Group: S

2.10.1 SARC (Monitoring and diagnostics for arcs)

a) ArcFlsSARC: Arc Flash

SARC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O/**	**Notes**
ArcFlsSARC		Arc Flash element		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status information				
FADet	SPS_0		M	
FADetS1	SPS_2		O	
FADetS2	SPS_2		O	
FADetS3	SPS_2		O	
FADetS4	SPS_2		O	
LT1PKP	SPS_2		O	
LT2PKP	SPS_2		O	
LT3PKP	SPS_2		O	
LT4PKP	SPS_2		O	
HsPhAIOCStr	ACD_3			
HsPhBIOCStr	ACD_3		O	
HsPhCIOCStr	ACD_3		O	
HsGndIOCStr	ACD_3		O	
LTFail	SPS_2		O	
LT1Fail	SPS_2		O	
LT2Fail	SPS_2		O	
LT3Fail	SPS_2		O	
LT4Fail	SPS_2		O	
Measured values				
HSIa	MV_3		O	
HSIb	MV_3		O	
HSIc	MV_3		O	
HSIg	MV_3		O	
Controls				
FACntRs	INC_1		M	

2.10.2 STMP (Temperature supervision)

a) RtdSTMP: RTD Temperature supervision

b) RemRtdSTMP: Remote RTD Temperature supervision

STMP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
STMP		temperature sensor		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
Alm	SPS_0		O	
Trip	SPS_0		O	
Str	ACD_3		O	
StrAlm	ACD_3		O	
OpnCirc	SPS_2		O	
ShrtCirc	SPS_2		O	
Measured values				
Tmp	MV_4	Temperature	O	

c) RtdMaxSTMP: RTD Max Temperature

d) RRtdMaxSTMP: Remote RTD Max Temperature

STMP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
MAX_TEMP_STMP		temperature supervision		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
ShrtCirc	SPS_2		O	
Measured values				
Tmp	MV_4		O	
RtdRsDt	INS_1		O	

e) HotRtdSTMP: Hottest RTD

f) RemHotRtdSTMP: Remote Hottest RTD

STMP class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
HOTTEST_STMP		temperature sensor		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
ShrtCirc	SPS_2		O	
Measured values				
HotStaIn	MV_5	Rem. Hot. Sta. RTD Input	O	
HotStaTmp	MV_5	Rem. Hot. Sta. RTD Temp	O	
HotBeaIn	MV_5	Rem.Hot. Bea. RTD Input	O	
HotBeaTmp	MV_5	Rem.Hot.Bea. RTD Temp	O	

2.10.3 SPTR (Power transformer supervision)

a) XfmrSPTR: Winding hottest spot (845)

SPTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XfmrSPTR		Insulation medium supervision		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
HPTmpOp	SPS_0		O	
HPTmpStr	SPS_2		O	
AgeRteStr	SPS_2		O	
AgeRteOp	SPS_2		O	
LOLStr	SPS_2		O	
LOLOp	SPS_2		O	
Measured values				
AgeRte	MV_2		O	
HPTmpClc	MV_2		O	
DlyRatLOL	MV_3		O	
XfmrLfLst	MV_3		O	
TopOilTmp	MV_3		O	
AmbTmp	MV_3		O	

2.10.4 SIML (Insulation medium supervision)

a) DgaSIML: Insulation medium supervision (liquid) (845)

SIML class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
SIML_DGA		Insulation medium supervision		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Measured values				
H2ppm	MV_2	Hydrogen in ppm	O	
N2ppm	MV_2	N2 in ppm	O	
COppm	MV_2	CO in ppm	O	
CO2ppm	MV_2	CO2 in ppm	O	
CH4ppm	MV_2	CH4 in ppm	O	
C2H2ppm	MV_2	C2H2 in ppm	O	
C2H4ppm	MV_2	C2H4 in ppm	O	
C2H6ppm	MV_2	C2H6 in ppm	O	
O2ppm	MV_2	O2 in ppm	O	
MstH2Oppm	MV_3	Moisture H2O in ppm	O	
TDCG	MV_3	TDCG	O	
AmbTmp	MV_5	Ambient temperature	O	
HyH2ppm	MV_5	Hydran H2 in ppm	O	
HyH2HrlTrnd	MV_5	Hydran Hourly Trend	O	
HyH2DlyTrnd	MV_5	Hydran Daily Trend	O	
RHLev	MV_3	Percent RH Level	O	
RHrlAv	MV_3	Percent RH Hourly Average	O	
H2OppmLev	MV_5	H2O ppm Level	O	
H2OppmHrlAv	MV_5	H2O ppm Hourly Average	O	

2.10.5 SVBR (Vibration supervision)

a) BknRotSVBR: Broken Rotor Bar

SVBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
SVBR		Vibrationsupervision		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	

NamPlt	LPL_1	Name plate	M	
Status Information				
Alm	SPS_0	Broken Rotor Bar PKP	O	
Trip	SPS_0	Broken Rotor Bar OP	O	
Measured values				
CompLev	MV_3	Component level	O	
CompHz	MV_3	Component frequency	O	
MotLodBRBClc	MV_3	Motor load at BRB	O	
LodDevBRBClc	MV_3	Load Dev. at BRB	O	
MaxCompLev	MV_3	Calculation	O	
MaxCompHz	MV_3	Max. Component frequency	O	
MotLodBRBMax	MV_3	Max. Motor load at BRB Calc.	O	
LodDevBRBMax	MV_3	Max. Load Dev. at BRB Calc.	O	

2.11 Logical Nodes for instrument transformers and sensors. LN Group: T

2.11.1 TVTR (Voltage Transformer)

a) TVTR: Fuse Failure

TVTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
TVTR		Voltage transformer		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
FuFail	SPS_0	Fuse failure	O	

2.12 Logical Nodes for switchgear. LN Group: X

2.12.1 XCBR (Circuit breaker)

a) XCBR: circuit breaker

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Loc	SPS_0	Local operation	M	Local / Remote
OpCnt	INS_0	Operation counter	M	Breaker openings
Controls				
Pos	DPC_0	Switch position	M	Breaker open, close
BlkOpn	SPC_2	Remote Block opening	M	
BlkCls	SPC_2	Remote Block closing	M	
LocBlkOpn	SPC_3	Local Block opening	O	
LocBlkCls	SPC_3	Local Block closing	O	
Status information				
CBOpCap	ENS_2	Circuit breaker operating capability	M	(BKR Openings Cnt - BREAKER Openings)*2

a) RCLXCBR: circuit breaker

XCBR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XCBR		Circuit breaker		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Loc	SPS_0	Local operation	M	Local / Remote
OpCnt	INS_0	Operation counter	M	Breaker openings
Controls				
Pos	DPC_1	3PH Reclose position	M	
PosA	DPC_2	Single Phase A reclose position	O	
PosB	DPC_2	Single Phase B reclose position	O	
PosC	DPC_2	Single Phase C reclose position	O	
BlkOpn	SPC_2	Remote Block opening	M	

BlkCls	SPC_2	Remote Block closing	M	
LocBlkOpn	SPC_3	Local Block opening	O	
LocBlkCls	SPC_3	Local Block closing	O	

2.12.2 XSWI (Circuit Switch)

a) XSWI: circuit breaker (850)

XSWI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XSWI_0		Circuit switch		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Loc	SPS_0	Local operation	M	
OpCnt	INS_0	Operation counter	M	
Controls				
Pos	DPC_1	Switch position	M	
BlkOpn	SPC_2	Block opening	M	
BlkClr	SPC_2	Block closing	M	
Status information				
SwTyp	ENS_7	Switch type	M	

b) OHSHXSWI: circuit breaker (850)

XSWI class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XSWI_1		Circuit switch		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Loc	SPS_0	Local operation	M	
OpCnt	INS_0	Operation counter	M	
Controls				
Pos	DPC_1	Switch position	M	
BlkOpn	SPC_2	Block opening	M	
BlkClr	SPC_2	Block closing	M	
Status information				
SwTyp	ENS_7	Switch type	M	
HlthStr	ACD_3	Switch health pickup	O	

HlthOpnStr	ACD_3	Open time sw. health pkp.	O	
HlthClsStr	ACD_3	Close time sw. health pkp.	O	
ArcPhAStr	ACD_3	Arc time PhA sw. health pkp.	O	
ArcPhBStr	ACD_3	Arc time PhB sw. health pkp.	O	
ArcPhCStr	ACD_3	Arc time PhC sw. health pkp.	O	
EngyPhAStr	ACD_3	Arc energy PhA sw. health pkp.	O	
EngyPhBStr	ACD_3	Arc energy PhB sw. health pkp.	O	
EngyPhCStr	ACD_3	Arc energy PhC sw. health pkp.	O	
HlthFail	SPS_2	Sw.open or close failed	O	
ArcFail	SPS_2	Sw. arc time failed	O	
OpnLmtRch	SPS_2	Max.number of Open reached	O	
ClsLmtRch	SPS_2	Max.number of Close reached	O	

2.13 Logical Nodes for power transformers. LN Group: Y

2.13.1 WfmrYRTR (Power Transformer)

a) XfmrYPTR: Harmonic Derating

YPTR class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XfmrYPTR				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
W1HaDeratStr	ACD_3	W1 Harmonic Derating PKP	O	
W1HaDeratOp	ACT_3	W1 Harmonic Derating OP	O	
W2HaDeratStr	ACD_3	W2 Harmonic Derating PKP	O	
W2HaDeratOp	ACT_3	W2 Harmonic Derating OP	O	
W3HaDeratStr	ACD_3	W3 Harmonic Derating PKP	O	
W3HaDeratOp	ACT_3	W3 Harmonic Derating OP	O	
LodLimRed	SPS_2	Load Limit Reduced	O	
Measured values				
W1LodFact	MV_3	W1 Load Factor	O	

W1AvPhCur	MV_3	W1 Average Phase Current	O	
W1HaDerat	MV_3	W1 Harmonic Derating Factor	O	
W2LodFact	MV_3	W2 Load Factor	O	
W2AvPhCur	MV_3	W2 Average Phase Current	O	
W2HaDerat	MV_3	W2 Harmonic Derating Factor	O	
W3LodFact	MV_3	W3 Load Factor	O	
W3AvPhCur	MV_3	W3 Average Phase Current	O	
W3HaDerat	MV_3	W3 Harmonic Derating Factor	O	

2.13.2 XfmrYLTC (Tap Changer)

b) XfmrYLTC: Tap Changer

YLTC class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
XfmrYLTC				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
EndPosR	SPS_0	Tap Changer at Max. Tap	M	
EndPosL	SPS_0	Tap Changer at Min. Tap	O	
TapPos	ISC_0	Tap Position	O	
Measured values				
OhmsIn1	MV_3	Ohms in 1	O	
WndgV	MV_3	Winding Voltage	O	
DltVMinTapV	MV_3	Delta V Above Min. Tap V	O	

2.14 Logical Nodes for further power system equipment. LN Group: Z

2.14.1 ZGEN (Generator)

a) GnStZGEN: Generator status

ZGEN class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
GnStZGEN		Generator		
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	

Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
GnSt	ENS_5	Generator state	M	
OpNoLod	SPS_0	Operation at no load (N/A)	M	
RotDir	ENS_6	Phase rotation	M	
OpUnExt	SPS_0	Operation at under excitation (N/A)	M	
OpOvExt	SPS_0	Operation at over excitation (N/A)	M	

2.14.2 ZMOT (Motor)

a) ZMOT: Motor status

ZMOT class				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ZMOT				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
MotSt	ENS_5		O	Included in Tissue 808
Measured values				
MotThCapUsed	MV_5		O	
EstTrTmOL	MV_5		O	
ThLockTm	MV_5		O	
MxStrRteLOTm	MV_5		O	
TmBtwStrLOTm	MV_5		O	
ReStrDlyLOTm	MV_5		O	
TotMotLockTm	MV_5		O	
MotSpeed	MV_5		O	
MotRunHours	MV_5		O	
MotLoad	MV_1		O	
MotCurrUnb	MV_1		O	
ThModBsdLoad	MV_1		O	
FltdMotLoad	MV_1		O	
FltdRMSCurA	MV_1		O	
FltdRMSCurB	MV_1		O	
FltdRMSCurC	MV_1		O	
FltdMagCurA	MV_1		O	
FltdMagCurB	MV_1		O	
FltdMagCurC	MV_1		O	
LastStrCur	MV_3		O	

LastMotStrTrm	INS_1		O	
LastAccelTm	MV_3		O	
MotStrNum	MV_5		O	

2.14.3 ZBAT (Battery)

a) ZBat: Battery Health Monitoring

ZBAT				
Attribute Name	**Attr. Type**	**Explanation**	**M/O**	**Notes**
ZBAT				
Data				
Common Logical Node Information				
Mod	ENC_0	Mode	M	
Beh	ENS_0	Behavior	M	
Health	ENS_1	Health	M	
NamPlt	LPL_1	Name plate	M	
Status Information				
BatTestInit	SPS_2	Battery test Initiation	O	
BatTestPass	SPS_2	Battery test pass	O	
BatTestFail	SPS_2	Battery test fail	O	
BatCheck	SPS_2	Battery check	O	
BatChaDis	SPS_2	Battery charger disabled	O	
BatRep	SPS_2	Replace battery	O	
BatTestBlk	SPS_2	Battery test blocked	O	
BatFullChg	SPS_2	Battery full charged	O	
Measured values				
Vol	MV_0	DC Supply volt	O	
Amp	MV_0	DC Supply current	O	
PwrAvg	MV_1	DC Supply Average power	O	
PwrMax	MV_1	DC Supply Maximum power	O	
PwrMin	MV_1	DC Supply Minimum power	O	

3 COMMON DATA CLASS

The tables in this section use the following abbreviations:

- 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.
- C: Data is conditional in the IEC 61850-7-4 and is used in the device.
- GC_1: At least one of the attributes shall be present for a given instance of DataObject/SubDataObject.
- GC_2: All or none of the data attributes belonging to the same group (n) shall be present for a given instance of DataObject/SubDataObject.
- AC_CO_M: The attribute is mandatory, if the controllable status class supports control.
- AC_CO_O: The attribute is optional, if the controllable status class supports control.
- AC_ST: The attribute is mandatory, if the controllable status class supports status information.
- AC_LN0_M: The attribute shall be present if the data NamPlt belongs to LLN0.

3.1 Common data class specifications for status information

3.1.1 Single Point Status (SPS)

SPS_0					
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

SPS_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
SPS_2					
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			O

3.1.2 Integer Status (INS)

INS_0					
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
d	Vstring255	DC			O
INS_1					
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
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.1.3 Enumerated Status (ENS)

ENS_0 (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

ENS_1 (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

ENS_2 (CBOpCap)					
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
d	Vstring255	DC			O

ENS_3 (AutoRecSt)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	1 - Ready 'AR Enabled 2 - InProgress 'AR in Progress 3 - Successful ' Not mapped 4 - Waiting for trip 'AR Initiated 5 - Trip issues by protection 'Not mapped 6 - Fault disappeared ' Not mapped 7 - Wait to complete ' Not mapped 8 - Circuit breaker close ' AR Close 9 - Cycle unsuccessful ' AR Lockout 10 - Unsuccessful ' AR Disabled 11 - Aborted ' Not mapped	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O

ENS_4 (Fault Type)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	1, 2, 3, 4, 5, 6, other	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O
dataNs	Vstring255	EX			

ENS_5 (GeneratorSt)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	Stopped, Stopping, Started...	M

q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O

ENS_6 (RotDir)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	Clockwise, Counter-Clockwise...	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O

ENS_7 (SwType)					
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

ENS_8 (SourcePhase)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None, Va, Vb, Vc, Vab, Vbc, Vca	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

ENS_9 (EventType)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	None, Volt Sag, Volt Swell	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

ENS_10 (ElementInstance)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	VD1, VD2, VD3	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

ENS_11 (Health)					
Attribute					
Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enumerated	ST	dchg	OK, Warning, Alarm	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
d	Vstring255	DC			O

3.1.4 Protection activation information (ACT)

ACT_0					
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
configuration, description and extension					
d	Vstring255	DC			O

ACT_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
configuration, description and extension					
d	Vstring255	DC			O

ACT_2					
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

ACT_3					
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			M

3.1.5 Directional protection activation information (ACD)

ACD_0					
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

ACD_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
neut	Boolean	ST	dchg		GC_2(4)
dirNeut	Enumerated (Byte)	ST	dchg	unknown | forward | backward	GC_2(4)
q	Bvstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
d	Vstring255	DC			O

ACD_2					
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

ACD_3					
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			M

3.2 Common data class specifications for measurand information

3.2.1 Measured Value (MV)

MV_0					
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	INT32U				
d	Vstring255	DC			O

MV_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
ILim	FloatAnalogueValue				
f	FLOAT32				GC_1
IILim	FloatAnalogueValue				
f	FLOAT32				GC_1
min	FloatAnalogueValue				
f	FLOAT32				GC_1
max	FloatAnalogueValue				
f	FLOAT32				GC_1
limDb	INT32U				
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

MV_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

MV_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
dataNs	Vstring255	EX			M

MV_4					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	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
d	Vstring255	DC			O

MV_5					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
mag	FloatAnalogueValue	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
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

3.2.2 Complex Measured Value (CMV)

CMV_0					
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
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
d	Vstring255	DC			O

CMV_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
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
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

CMV_2					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				

q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
d	Vstring255	DC			O

CMV_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
d	Vstring255	DC			O

CMV_4					
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
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
zeroDb	INT32U	CF			O
rangeC	RangeConfig	CF			O
d	Vstring255	DC			O

CMV_5					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
q	BVstring13	MX	qchg		M
t	Utctime	MX			M
configuration, description and extension					
units	Unit	CF			O
SIUnit	Byte				M
Multiplier	Byte				O
d	Vstring255	DC			O
dataNs	Vstring255	EX			M

CMV_5					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
measured attributes					
cVal	FloatVector	MX	dchg		M
mag	FloatAnalogueValue				
f	FLOAT32				
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
d	Vstring255	DC			O

3.2.3 Phase to ground related measured values of a three phase system (WYE)

WYE_0					
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

WYE_1					
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

WYE_2					
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
neut	CMV_0				GC_1
net	CMV_0				GC_1
configuration, description and extension					
d	Vstring255	DC			O

WYE_3					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_4				GC_1
phsB	CMV_4				GC_1
phsC	CMV_4				GC_1
configuration, description and extension					
d	Vstring255	DC			O

WYE_4					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_4				GC_1
phsB	CMV_5				GC_1
phsC	CMV_4				GC_1
configuration, description and extension					
d	Vstring255	DC			O

WYE_5					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
Data					
phsA	CMV_6				GC_1
phsB	CMV_6				GC_1
phsC	CMV_6				GC_1
configuration, description and extension					
d	Vstring255	DC			O

WYE_6					
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
configuration, description and extension					
d	Vstring255	DC			O

3.2.4 Phase to phase related measured values of a three phase system (DEL)

DEL_0					
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_0					
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_0						
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
control and status						
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

SPC_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
control and status						
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_1	M
operTimeout	INT32U	CF			AC_CO_O
d	Vstring255	DC			O

SPC_2					
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	M
d	Vstring255	DC			O

SPC_3					
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	M
d	Vstring255	DC			O
dataNs	Vstring255	EX			O

3.3.2 Controllable double point (DPC)

DPC_0						
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
stSeld	Boolean	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

DPC_1					
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

DPC_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
dataNs	Vstring255	EX			O

DPC_3						
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
stSeld		Boolean	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

3.3.3 Controllable integer status (INC)

INC_0					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dcgh	On, blocked, test, test/ blocked, Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
ctlModel	ENUMERATED	CF			M

INC_1					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					
stVal	Enum	ST	dcgh	On, blocked, test, test/ blocked, Off	M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
ctlModel	ENUMERATED	CF			M

3.3.4 Integer controller step position information (ISC)

ISC_0					
Attribute Name	**Attribute Type**	**FC**	**TrgOp**	**Value/Value Range**	**M/O/C**
DataAttribute					
status					

valWTr	ValWithTrans	ST	dcgh		M
q	BVstring13	ST	qchg		M
t	Utctime	ST			M
configuration, description and extension					
ctlModel	ENUMERATED	CF			M
d	Vstring255	DC			O

3.3.5 Controllable enumerated status (ENC)

ENC_0 (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		ctlmodel	M

ENC_1 (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		cntmodel 1	M

3.4 Common data class specifications for description information

3.4.1 Device name plate (DPL)

DPL_0 (type Mod)					
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
location	Vstring255	DC			O
d	Vstring255	DC			M

3.4.2 Logical node name plate (LPL)

LPL_0 (type Mod)					
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

LPL_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

TICS Template for Server

This section contains a template for the TISSUES (Technical Issues) Implementation Conformance Statement (TICS). According to the UCA IUG QAP (Quality Assurance Plan) the Tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

1 Introduction

This tissues conformance statement template is applicable to the 8 Series relays.

Version 1.0

Date: July 23, 2015

2 Mandatory Edition 2 TISSUES

The following table gives an overview of the applicable mandatory Tissues.

Part 6 Tissue	Description	Implemented Y / N/A
658	Tracking related features	N/A
663	FCDA element cannot be a "functionally constrained logical node"	Y
668	Autotransformer modeling	N/A
687	SGCB ResvTms	N/A
719	ConfDataSet - maxAttributes definition is confusing	Y
721	Log element name	N/A
768	bType VisString65 is missing	Y
770	Goose ID max. length is 129 characters	Y
779	object references	Y
788	SICS S56 from optional to mandatory	N/A
789	ConfLdName as services applies to both server and client	Y
804	valKind and IED versus System configuration	N/A
806	Max length of log name inconsistent between -6 and -7-2	N/A
807	Need a way to indicate if "Owner" present in RCB	N/A
822	Extension of IED capabilities	N/A
823	ValKind for structured data attributes	N/A
824	Short addresses on structured data attributes	N/A
825	Floating point value	N/A
845	SGCB ResvTms	N/A
853	SBO and ProtNs	N/A
855	Recursive SubFunction	N/A
857	Function/SubFunction for ConductingEquipment	N/A
886	Missing 8-1 P-types	N/A
901	tServices as AP or as IED element	N/A
936	SupSubscription parameter usage is difficult	N/A
1168	doName and daName of ExtRef; doName may have one dot (DO.SDO)	N/A
1175	IPv6 address lowercase only	N/A

Part 7-1 Tissue	Description	Implemented Y / N/A
828	Data model namespace revision IEC 61850-7-4:2007[A]	Y
1151	simulated GOOSE disappears after 1st appearance when LPHD.Sim = TRUE	N/A
1196	Extensions to standardized LN classes made by third parties	N/A

Part 7-2 Tissue	Description	Implemented Y / N/A
778	AddCause values – add value not-supported	Y
780	What are unsupported trigger option at a control block?	Y
783	TimOper Resp- ; add Authorization check	N/A
786	AddCause values 26 and 27 are switched	Y
820	Mandatory ACSI services (use for PICS template)	N/A
858	typo in enumeration ServiceType	N/A
861	dchg of ConfRev attribute	N/A
876	GenLogicINodeClass and SGCB, GoCB, MsvCB, UsvCB	N/A
1038	Loss of Info Detection After Resynch	N/A
1050	GTS Phycomaddr definition in SCL	N/A
1062	Entrytime not used in CDC	N/A
1071	Length of DO name	Y
1091	The sentence "The initial value of EditSG shall be 0", has to be stated in part 7.2 not in 8.1	N/A
1127	Missing owner attribute in BTS and UTS	N/A
1163	Old report in URCB	N/A
1202	GI not optional	Y

Part 7-3 Tissue	Description	Implemented Y / N/A
697	persistent command / PulseConfig	N/A
698	Wrong case is BAC.dB attribute	N/A
722	Units for 'h' and 'min' not in UnitKind enumeration.	N/A
919	Presence Condition for sVC	N/A
925	Presence of i or f attribute - Problem with writing	N/A
926	Presence Conditions within RangeConfig	Y

Part 7-4 Tissue	Description	Implemented Y / N/A
671	mistake in definition of Mod & Beh	N/A
674	CDC of ZRRC.LocSta is wrong	N/A
675	SIML LN	N/A
676	Same data object name used with different CDC	N/A
677	MotStr is used with different CDC in PMMS and SOPM LN classes	N/A
679	Remove CycTrMod Enum	N/A
680	SI unit for MHYD.Cndct	N/A
681	Enum PIDAlg	N/A
682	ANCR.ParColMod	N/A
683	Enum QVVR.IntrDetMth	N/A
685	Enum ParTraMod	N/A
686	New annex H - enums types in XML	N/A
694	Data object CmdBlk	N/A
696	LSVS.St (Status of subscription)	N/A
712	interpretation of quality operatorBlocked	N/A
713	DO Naming of time constants in FFIL	N/A
724	ANCR.Auto	N/A
725	Loc in LN A-group	N/A
734	LLN0.OpTmh vs. LPHD.OpTmh	N/A
735	ISAF.Alm and ISAF.AlmReset	N/A
736	PFSign	N/A
742	GAPC.Str, GAPC.Op and GAPC.StrVal	N/A
743	CCGR.PmpCtl and CCGR.FanCtl	N/A
744	LN STMP, EEHealth and EEName	N/A
772	LPHD.PwrUp/PwrDn shall be transient	N/A
773	Loc, LocKey and LocSta YPSH and YLTC	N/A
774	ITCI.LocKey	N/A
775	KVLV.ClsLim and OpnLim	N/A
776	LPHD.OutOv/InOv and LCCH.OutOv/InOv	N/A
800	Misspelling in CSYN	N/A
802	CCGR and Harmonized control authority	N/A
808	Presence condition of ZMOT.DExt and new DOs	N/A
831	Setting of ConfRevNum in LGOS	N/A
838	Testing in Beh=Blocked	N/A
844	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE	N/A
849	Presence conditions re-assessing in case of derived statistical calculation	N/A
877	QVUB -settings should be optional	N/A
909	Remove ANCR.ColOpR and ColOpL	N/A
920	Resetable Counter is NOT resetable	N/A
932	Rename AVCO.SptVol to AVCO.VolSpt	N/A
939	Change CDC for ANCR.FixCol	N/A
991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory	N/A
1007	PTRC as fault indicator - Update of description required	Y
1044	TapChg in AVCO	N/A

Part 7-4 Tissue	Description	Implemented Y / N/A
1077	Rename DOnames within LTIM	N/A

Part 8-1 Tissue	Description	Implemented Y / N/A
784	Tracking of control (CTS)	N/A
817	Fixed-length GOOSE float encoding	N/A
834	File dir name length 64	Y
951	Encoding of Owner attribute	N/A
1040	More associate error codes	N/A
1178	Select Response+ is non-null value	Y

Compare the TISSUE database for more details: w ww.tissues.iec61850.com

PICS

This section contains the Protocol Implementation Conformance Statement (PICS) for the IEC 61850 interface in the 8 Series relays.

Version 1.0

Date: July 23, 2015

1 General

The following ACSI conformance statements are used to provide an overview and details about 8 Series relays, with firmware 1.80:

- 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 B.1.

Table B.1: 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			
- = not applicable Y = supported N or empty = not supported				

3 ACSI models conformance statement

The ACSI models conformance statement is defined in Table B.2.

Table B.2: 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**			
	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

		Client/ Subscriber	Server/ Publisher	Value/ Comments
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 B.3 (depending on the statements in Table B.1).

Table B.3: 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			
S14	1,2	CreateDataSet	TP			
S15	1,2	DeleteDataSet	TP			
S16	1,2	GetDataSetDirectory	TP		Y	
Substitution						
S17	1	SetDataValues	TP			Ed1 only

	Ed	ACSI Service	AA: TP/MC	Client Sub (C)	Server Pub (S)	Comments
Setting group control						
S18	1,2	SelectActiveSG	TP			
S19	1,2	SelectEditSG	TP			
S20	1,2	SetEditSGValues	TP			
S21	1,2	ConfirmEditSGValues	TP			
S22	1,2	GetEditSGValues	TP			
S23	1,2	GetSGCBValues	TP			
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)			
S24-3	1,2		data-update (dupd)			
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)			
S27-3	1,2		data-update (dupd)			
S28	1,2	GetURCBValues	TP		Y	
S29	1,2	SetURCBValues	TP		Y	
Logging						
Log control						
S30	1,2	GetLCBValues	TP			
S31	1,2	SetLCBValues	TP			
Log						
S32	1,2	QueryLogByTime	TP			
S33	1,2	QueryLogAfter	TP			
S34	1,2	GetLogStatusValues	TP			
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	

	Ed	ACSI Service	AA: TP/MC	Client Sub (C)	Server Pub (S)	Comments
S39	1,2	SetGoCBValues	TP		Y	
GSSE (Ed2:61850-7-2 Annex C)						
S40	1,2	SendGSSEMessage	MC			Deprecated
GSSE Control Block (Ed2:61850-7-2 Annex C)						
S41	1,2	GetGsReference	TP			Deprecated
S42	1,2	GetGSSEDataOffset	TP			Deprecated
S43	1,2	GetGsCBValues	TP			Deprecated
S44	1,2	SetGsCBValues	TP			Deprecated
Transmission of sampled value model (SVC)						
Multicast SV						
S45	1,2	SendMSVMessage	MC			Use for 9-2LE or IEC 61869-9
Multicast Sampled Value Control Block						
S46	1,2	GetMSVCBValues	TP			
S47	1,2	SetMSVCBValues	TP			
Unicast SV						
S48	1,2	SendUSVMessage	TP			
Unicast Sampled Value Control Block						
S49	1,2	GetUSVCBValues	TP			
S50	1,2	SetUSVCBValues	TP			
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			
File transfer						
S57	1,2	GetFile	TP		Y	
S58	1,2	SetFile	TP			
S59	1,2	DeleteFile	TP			
S60	1,2	GetFileAttributeValues	TP			
S61	1,2	GetServerDirectory (FILE)	TP		Y	
Time						
T1	1,2	Time resolution of internal clock	-		2 ms	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		-			T5 (µs) (<= 1 µs), T3 >= 20)
T3	1,2	Supported TimeStamp resolution	-		1 µs	nearest negative power of 2 in seconds

PIXIT

This section contains the Protocol Implementation eXtra Information for Testing (PIXIT) for the IEC 61850 interface in the 8 Series relays.

Version 1.0

Date: July 23, 2015

Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in 8 Series relays.

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.

PIXIT for Association model

ID	Ed	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	4
As2	1,2	TCP_KEEPALIVE value. The recommended range is 1...20s	7200 seconds but if no application message is detected within the As3 value, the device will close 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	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N
As6	1,2	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
As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size 120000 Min MMS PDU size 32000.
As8	1,2	What is the maximum start up time after a power supply interrupt	180 seconds

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, N Invalid, N Reserved, N Questionable N Overflow N OutofRange N BadReference N Oscillatory N 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, N Invalid, N Reserved, N Questionable N BadReference N Oscillatory N Failure N OldData N Inconsistent N Inaccurate Source: N Process N Substituted N 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*	On Y [On-]Blocked N Test N Test/Blocked N Off N

* 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

PIXIT for Data set model

ID	Ed	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	64
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

PIXIT for Substitution model

ID	Ed	Description	Value / Clarification
Sb1	1	Are substituted values stored in volatile memory	NOT SUPPORTED

PIXIT for Setting group control model

ID	Ed	Description	Value / Clarification
Sg1	1	What is the number of supported setting groups for each logical device	NOT SUPPORTED
Sg2	1,2	What is the effect of when and how the non-volatile storage is updated **(compare IEC 61850-8-1 $16.2.4)**	NOT SUPPORTED
Sg3	1	Can multiple clients edit the same setting group	NOT SUPPORTED
Sg4	1	What happens if the association is lost while editing a setting group	NOT SUPPORTED
Sg5	1	Is EditSG value 0 allowed	NOT SUPPORTED
Sg6	2	When ResvTms is not present how long is an edit setting group locked	NOT SUPPORTED

PIXIT for Reporting model

ID	Ed	Description	Value / Clarification
Rp1	1	The supported trigger conditions are (compare PICS)	integrity Y data change Y quality change N data update N general interrogation Y
Rp2	1	The supported optional fields are	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 Y
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	May the reported data set contain: - structured data objects - data attributes	 Y Y
Rp10	1,2	What is the scan cycle for binary events Is this fixed, configurable	Event Driven Fixed
Rp11	1	Does the device support to pre-assign a 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

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

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 will be published).
Gp4	1,2	What is the slow retransmission time Is it fixed or configurable	Configured by SCL on GoCB MaxTime
Gp5	1,2	What is the fastest retransmission time Is it fixed or configurable	Fixed. MinTime = 5 ms
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	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	 Y Y (timestamp attributes are not supported)
Gp9	2	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* x 4 - sqNum = 5 -> Update time* later with TAL = Update time* x 4 - sqNum = 6-> Update time* later with TAL = Update time* x 4 - sqNum = 7 ..... - ..... ***Update time** is configured in the EnerVista 8 Series Setup

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 N 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 will be ignored, but when the next correct message will be received, it will be proceed as normal.
Gs4	1,2	What is the Behavior when a subscribed GOOSE message is out-of-order	Message will be proceeded
Gs5	1,2	What is the Behavior when a subscribed GOOSE message is duplicated	Message will be ignored
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May 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 will be 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 hasn't the expected data structure.	The message will be ignored. The mechanism applies where the new GOOSE message is not received within a TAL.

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 & 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	What is the Behavior of the DUT when the check conditions are set Is this Behavior fixed, configurable, 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 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
Ct10	1,2	How to force a "test-not-ok" respond with SelectWithValue request	Device in local mode
Ct11	1,2	How to force a "test-not-ok" respond with Select request	
Ct12	1,2	How to force a "test-not-ok" respond 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

ID	Ed	Description	Value / Clarification
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	DOns: N SBOns: N DOes: N SBOes: N Configurable: N
Ct16	1,2	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	DOns: N SBOns: N DOes: N SBOes: N
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	SBOns: N SBOes: N
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	SBOns: N DOns: N
Ct22	2	How to force a "parameter-change-in-execution	SBOns: N/A SBOes: N/A

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 60 seconds
Tm3	1,2	How long does it take to take over the new time from 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 Origination 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 and is this configurable	Local N

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 and 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	
Ft6	1	Is the requested file path included in the MMS fileDirectory respond file name	Y
Ft7	1	Is the wild char supported MMS fileDirectory request	No
Ft8	1,2	Is it allowed that 2 clients get a file at the same time	Y same file Y different files
Ft9	1,2	Which files can be deleted	Not Applicable

PIXIT for Service tracking model

ID	Ed	Description	Value / Clarification
Tr1	2	Which ACSI services are tracked by LTRK.GenTrk	Not Applicable

8 Series Protective Relay Platform

Appendix C: Revision History

Revision history

Table C-1: Revision History

MANUAL P/N	RELEASE DATE
1601-0702-A1	March 2016
1601-0702-A2	April 2016
1601-0702-A3	December 2016
1601-0702-A4	August 2017
1601-0702-A5	March 2018
1601-0702-A6	December 2018
1601-0702-A7	February 2019
1601-0702-A8	May 2019
1601-0702-A9	November 2019
1601-0702-AA	August 2020
1601-0702-AB	November 2020
1601-0702-AC	June 2021
1601-0702-AD	December 2022

Major Updates

For information on the updates included in this release of the 8 Series Communications Guide, please refer to the latest release notes for the 8 Series 2.9 version online.

NOTE

This manual replaces the following individual product Communications Guides:

- 850 Feeder Protection System Communications Guide (1601-0299-A5)
- 845 Transformer Protection System Communications Guide (1601-0409-A2)
- 869 Motor Protection System Communications Guide (1601-0451-A3)

GE VERNOVA

GE Vernova
650 Markland Street
Markham, Ontario
Canada L6C 0M1
Worldwide telephone: +1 905 927 7070
Europe/Middle East/Africa telephone: +34 94 485 88 54
North America toll-free: 1 800 547 8629
Fax: +1 905 927 5098
Worldwide e-mail: GA.support@gevernova.com
Website: https://www.gevernova.com/grid-solutions/multilin/