



GE VERNOVA

MM300E

Technical Manual Motor Management System

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Major changes

For information on the updates included in this release of the manual, please refer to the latest release notes.



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CHAPTER 1

INTRODUCTION

1.1 **CHAPTER OVERVIEW**

This chapter provides a general introduction to the instruction manual.

This chapter contains the following sections:

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Cautions, warnings and notes	5
For Further Assistance	8

1.2 FOREWORD

This technical manual provides a functional and technical description of the relay, as well as a comprehensive set of instructions for using it. The level at which this manual is written assumes that you are already familiar with protection engineering and have experience in this discipline. The description of principles and theory is limited to that which is necessary to understand the product. For further details on general protection engineering theory, we refer you to the publication, Protection and Automation Application Guide, which is available online.

We have attempted to make this manual as accurate, comprehensive and user-friendly as possible. However we cannot guarantee that it is free from errors. Nor can we state that it cannot be improved. We would therefore be very pleased to hear from you if you discover any errors, or have any suggestions for improvement. Our policy is to provide the information necessary to help you safely specify, engineer, install, commission, maintain, and eventually dispose of this product. We consider that this manual provides the necessary information, but if you believe that more details are needed, please contact us.

1.2.1 TARGET AUDIENCE

This manual is aimed towards all professionals charged with installing, commissioning, maintaining, troubleshooting, or operating any of the products within the specified product range. This includes installation and commissioning personnel as well as engineers who will be responsible for operating the product.

The level at which this manual is written assumes that installation and commissioning engineers have knowledge of handling electronic equipment. Also, system and protection engineers have a thorough knowledge of protection systems and associated equipment.

1.2.2 TYPOGRAPHICAL CONVENTIONS

The following typographical conventions are used throughout this manual.

- Description of software menu items, buttons, labels or hardware keys and buttons written in bold type and colored in Vernova dark green.
For example: Select **Save** from the file menu
- The names for special keys, appear in in upper case bold type and colored in Vernova dark green.
For example: **ENTER**
- Filenames, paths, code, and text that appears on a command line interface use the courier font
For example: `Example\File.text`
- Special terminology is written with leading capitals
For example: Line Differential Relay
- If reference is made to the relay's internal settings database on the relay's LCD screen, the menu items are written in bold italics
For example: ***SECURITY*** (on the relay's LCD screen), or ***Security*** (in the EnerVista D&I Setup software)
- Menu paths are shown with > separators. This applies to both software menu paths and relay menu paths
For example: ***SETTINGS > SYSTEM SETUP > AC INPUTS*** (for relay path), or **File > Save** (for software path)
- Setting values are written with the courier font and are italicized
For example: `Enabled`
- The products, use Flexlogic operands. Flexlogic operands are written in dark Vernova green uppercase courier font
For example: `PUSHBUTTON 1 ON`
- Sometimes it is beneficial to emphasize some words. Depending on the case in question, this may be done with bold, italic or upper case font attributes.
- Notes are written in italic in, and are surrounded by a border.
For example:

Note:
This is a note

1.2.3 NOMENCLATURE

Due to the technical nature of this manual, many special terms, abbreviations and acronyms are used throughout the manual. Some of these terms are well-known industry-specific terms while others may be special product-specific terms used by GE Vernova. The first instance of any acronym or term used in a particular chapter is explained.

We would like to highlight the following changes of nomenclature however:

- The word *relay* and *IED* (Intelligent Electronic Device) are both used to describe the protection device. The term *IED* is associated with the IEC61850 standard, whereas the term *relay* is the long-used traditional term. It may also be referred to simply as the *device* or the *product*.
- American English and spelling is used throughout this manual.
- The term 'Earth' and American term 'Ground' are equivalent. You may find either used in the manual.
- When depicting a generic instance of a number of items, this manual uses <n> where n can be any integer.

1.3 CAUTIONS, WARNINGS AND NOTES

Before attempting to install or use the device, review all safety indicators in this document to help prevent injury, equipment damage, or downtime.

1.3.1 GENERAL CAUTIONS AND WARNINGS

The following general safety precautions and warnings apply.



Caution:

Before attempting to use the equipment, it is important that all danger and caution indicators are reviewed.
If the equipment is used in a manner not specified by the manufacturer or functions abnormally, proceed with caution. Otherwise, the protection provided by the equipment may be impaired and can result in impaired operation and injury.



Warning:

Hazardous voltages can cause shock, burns or death.



Caution:

Installation/service personnel must be familiar with general device test practices, electrical awareness and safety precautions must be followed.
Before performing visual inspections, tests, or periodic maintenance on this device or associated circuits, isolate or disconnect all hazardous live circuits and sources of electric power.



Warning:

Failure to shut equipment off prior to removing the power connections could expose you to dangerous voltages causing injury or death.
Ensure that all connections to the product are correct so as to avoid accidental risk of shock and/or fire, for example from high voltage connected to low voltage terminals.



Caution:

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

Use the device only for its intended purpose and application.

Ensure that all ground paths are un-compromised for safety purposes during device operation and service.

All recommended equipment that should be grounded and must have a reliable and un-compromised grounding path for safety purposes, protection against electromagnetic interference and proper device operation.

Equipment grounds should be bonded together and connected to the facility's main ground system for primary power.

Keep all ground leads as short as possible.

In addition to the safety precautions mentioned all electrical connections made must respect the applicable local jurisdiction electrical code.

It is recommended that a field external switch, circuit breaker be connected near the equipment as a means of power disconnect. The external switch or circuit breaker is selected in accordance with the power rating.

This product itself is not Personal Protective Equipment (PPE). However, it can be used in the computation of site specific Arc Flash analysis when the arc flash option is ordered. If a new appropriate Hazard Reduction Category code for the installation is determined, user should follow the cautions mentioned in the arc flash installation section.

The critical failure relay must be connected to annunciate the status of the device for ALL applications. This is particularly important for when the Arc Flash option is ordered.

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

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



Warning:

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

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



Caution:

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

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



Warning:

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

Note:

To ensure the settings file inside the relay is updated, wait 30 seconds after a setpoint change before cycling power. This product is rated to Class A emissions levels and is to be used in Utility, Substation Industrial environments. Not to be used near electronic devices rated for Class B levels.

1.4 FOR FURTHER ASSISTANCE

For product support, contact us 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: ga.support@gevernova.com

Website: <https://www.gevernova.com>

1.4.1 REPAIRS

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

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

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

Use the detailed return procedure outlined at

<https://www.gevernova.com/grid-solutions/return-procedures>

The current warranty and return information are outlined at

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

CHAPTER 2

PRODUCT DESCRIPTION

2.1 CHAPTER OVERVIEW

This chapter contains the following sections:

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2.2 DESCRIPTION

The MM300 Enhanced can be equipped with either of two control panels, or with no control panel. Features

- Basic control panel: includes pushbuttons for Stop, Start A, Start B, Auto, Manual, and Reset, and 12 LED status indicators.
- Graphical control panel: includes a 3.5-inch 320 by 240 pixel backlit color LCD screen, 14 pushbuttons and 10 LED indicators, which provide access to actual values, trip and alarm lists, event records, and setting configuration. A USB port is provided for laptop computer connection.

The MM300 Enhanced includes the following input/output capabilities:

- 2 to 18 contact outputs
- 6 to 30 contact inputs

The following additional functions are available:

- Ten process interlocks configurable for trip, stop, or alarm.
- Passcode for up to three security levels.
- Eight pre-defined starter types.
- Start inhibits.
- Time between starts.
- Restart block timer.
- Starts per hour.
- Optional undervoltage restart.

The thermal model uses a standard overload curve with multiplier or IEC Trip Class curve, and incorporates hot/cold biasing, unbalance biasing, RTD biasing, and exponential cooling.

A single-line diagram for the MM300 Enhanced is shown below.

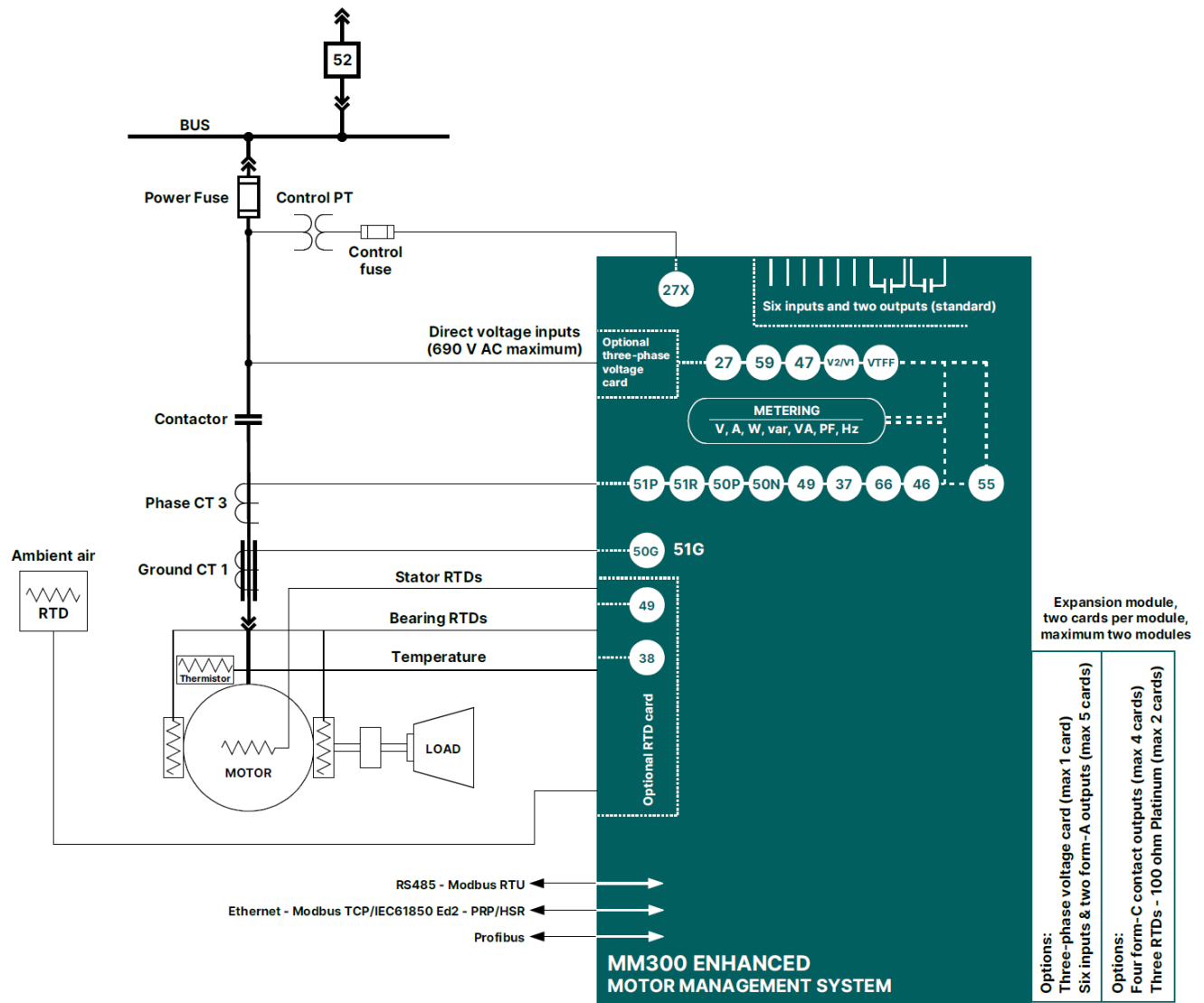


Figure 1: Single line diagram

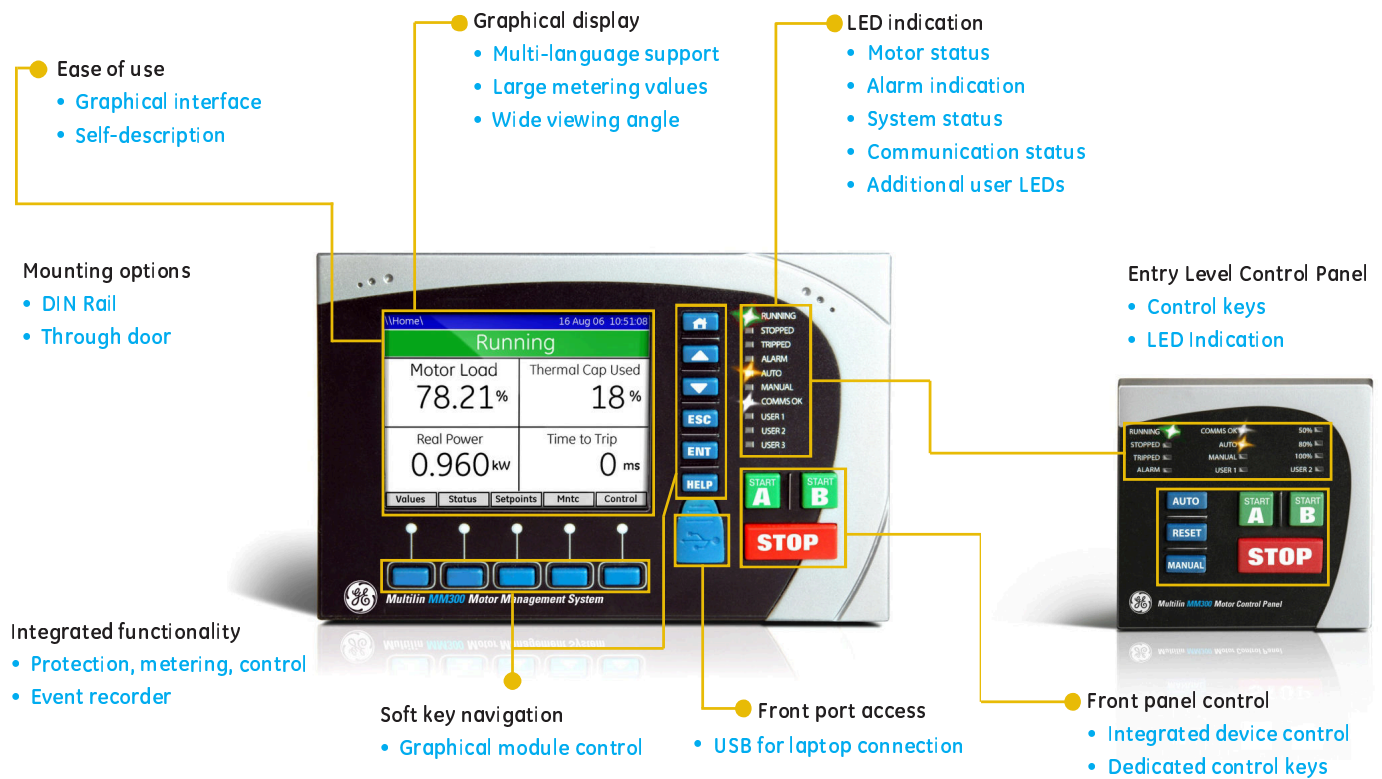
Protection functions

ANSI device	Description
27X	Undervoltage, auxiliary input
27	Undervoltage, three-phase
37	Undercurrent and underpower
38	Bearing temperature RTD
46	Current unbalance
47	Voltage phase reversal
49	Thermal overload
50G	Ground instantaneous overcurrent
50N	Neutral overcurrent
51P	Phase time overcurrent
50R	Locked/stalled rotor, mechanical jam
59	Overvoltage, three-phase

ANSI device	Description
66	Starts per hour and time between starts
86	Start inhibits
VTFF	Voltage transformer fuse failure

Other device functions

Acceleration time	Output Relays
Data logger	Overload Alarm
Digital counters	Process Interlocks
Event recorder	Real Time Clock (PTP, SNTP)
Fault recorder	Relay Self-Test Monitoring
FlexCurves	Relay Testing Mode
FlexLogic Equations	Remote Outputs
IEC 61850 Communication	Restart Inhibit
Input Functions	RTD Sensor
Last Trip Data	Starter Types
Manual and Auto Control	Starts/Hr Inhibit
Metering: current, voltage, power, PF, energy, frequency	Thermal Inhibit
Motor Health Report	Thermistor Sensor
Motor Learned Data	Time Between Starts
Motor Start and Stop Control	Undervoltage Restart
Motor Start Control	Virtual Inputs (128)
Motor Start Records	Virtual Outputs (128)
Motor Start Statistics	Voltage Unbalance
Non-volatile Latched	Waveform Recorder



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Figure 2: feature overview

2.3 MM300 ENHANCED ORDER CODES

The information to specify an MM300 Enhanced relay is provided in the following order code figure.

		Base						Expanded				Enh.				
		MM300	–	*	E	*	*	*	*	A	*	*	*	*	*	E
Interface	MM300														MM300 Enhanced Motor Management System	
Control panel	X														No control panel	
	B														Basic control panel, no USB	
	G														Graphical control panel with USB	
Power supply		H													High: 80 to 250 V DC (Standard); 60 to 300 V AC	
		L													Low*: 24 V DC (24 to 48 V DC Nominal)	
Communications		C													Standard communication: 1xRS485 (Modbus RTU) + 1x RJ45 (Modbus TCP)**	
		E													Standard + Profibus DP Slave + IEC61850 ED2	
		R													Standard + 1x RJ45 (Modbus TCP/IEC61850 Ed2- PRP/HSR)** + Profibus DP Slave	
Options		S													Standard: Starter control and event recorder	
		1													Option 1: Standard plus undervoltage autorestart	
Base unit input/output		C													Two (2) 10A form-A relays and six (6) 60 to 300V AC digital Inputs	
		M													Two (2) 10A form-A relays and six (6) 20 to 60V DC digital input (Dry or 24V DC wetting configurable)	
Current inputs		A													3 Phase and Ground Standard CT (1A/5A) + 1 Core Balance CT	
Protection & expansion input/output		X	X	X	X	X									No additional protection	
		B													Three-phase voltage metering and three-phase underpower, undervoltage, overvoltage, phase reversal	
		C	C	C	C										Two (2) 10A form-A relays and six (6) 60 to 300V AC digital Inputs	
		D	D	D	D										Four (4) 10A form-C relays	
		M	M	M	M										Two (2) 10A form-A relays and six (6) 20 to 60V DC digital input (Dry or 24V DC wetting configurable)	
		G	G	G	G										Bank of three (3) RTDs: 100PT (maximum of 2 banks)	
Cybersecurity		B													Basic	
		A													Advanced	

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NOTES:

- *The UV Restart feature is not supported with the Low-Voltage power supply option
- ** ETH 1 will be also dedicated for maintenance purposes.
- Expansion I/O slots must be chosen sequentially.
- Maximum 2 'G' module options.
- If the ordered unit does not include Graphical Control Panel (GCP), RS232 to RJ45 to cable is required to be ordered for future upgrading purposes.

Figure 3: order codes

2.3.1 EXAMPLE OF AN ORDER CODE

MM300-GEHC1CAXXXA: MMM300 with graphical control panel and USB port, English language display, high voltage 84 to 250 V DC and 60 to 300 V AC power supply, 1xRS485 (Modbus RTU) + 1x RJ45 (Modbus TCP) communications, starter control, event recorder, undervoltage autorestart, three-phase current, thermal overload, undercurrent, single phase underpower, two 10 A form-A contact output relays, and six digital inputs, with 3 Phase and Ground Standard CT (1A/5A) + 1 Core Balance CT and Advanced Cybersecurity.

CHAPTER 3

INSTALLATION

3.1 CHAPTER OVERVIEW

This chapter contains the following sections:

Chapter Overview	17
Mechanical installation	18
Electrical installation	26
Starter Types	44

3.2 MECHANICAL INSTALLATION

This section describes the mechanical installation of the MM300 Enhanced system, including dimensions for mounting and information on module withdrawal and insertion.

3.2.1 DIMENSIONS

The MM300 Enhanced is packaged in a modular arrangement.

The dimensions of the relay are shown below. Additional dimensions for mounting and panel cutouts are shown in the following sections.

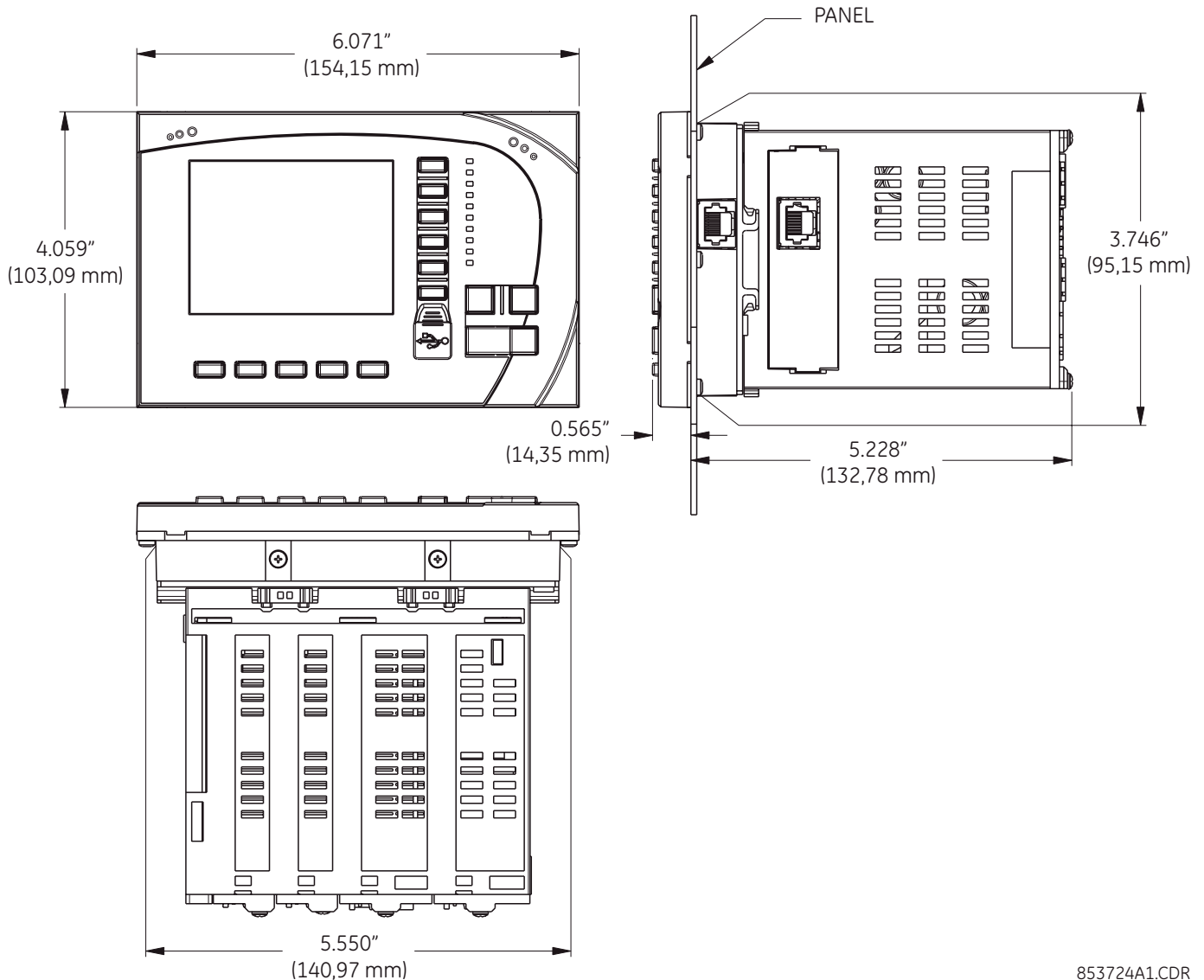


Figure 4: Dimensions

3.2.2 PRODUCT IDENTIFICATION

The product identification label is located on the side panel of the relay. This label indicates the product model, serial number, firmware revision, and date of manufacture.

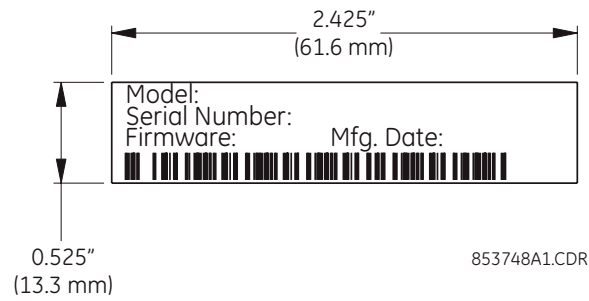


Figure 5: MM300 Enhanced label

3.2.3 MOUNTING

The MM300 Enhanced can be mounted three ways: standard panel mount, DIN rail mount, and screw mount for high vibration environments.

The standard panel mount and cutout dimensions are illustrated below.

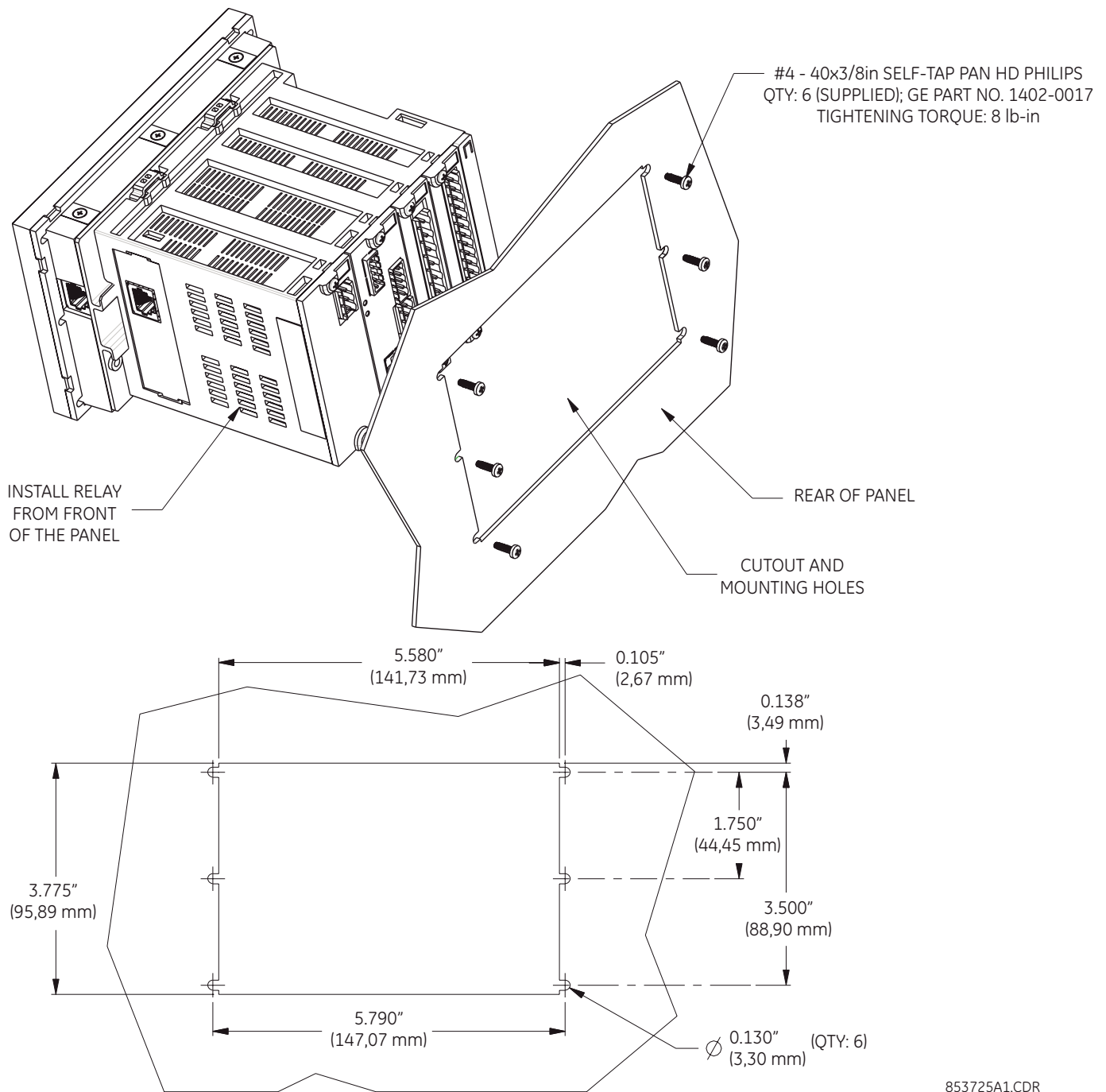


Figure 6: Base Unit standard panel mounting and cutout dimensions

The DIN rail mounting is illustrated below. The DIN rail conforms to EN 50022.



Caution:
To avoid the potential for personal injury due to fire hazards, ensure the unit is mounted in a safe location and/or within an appropriate enclosure.

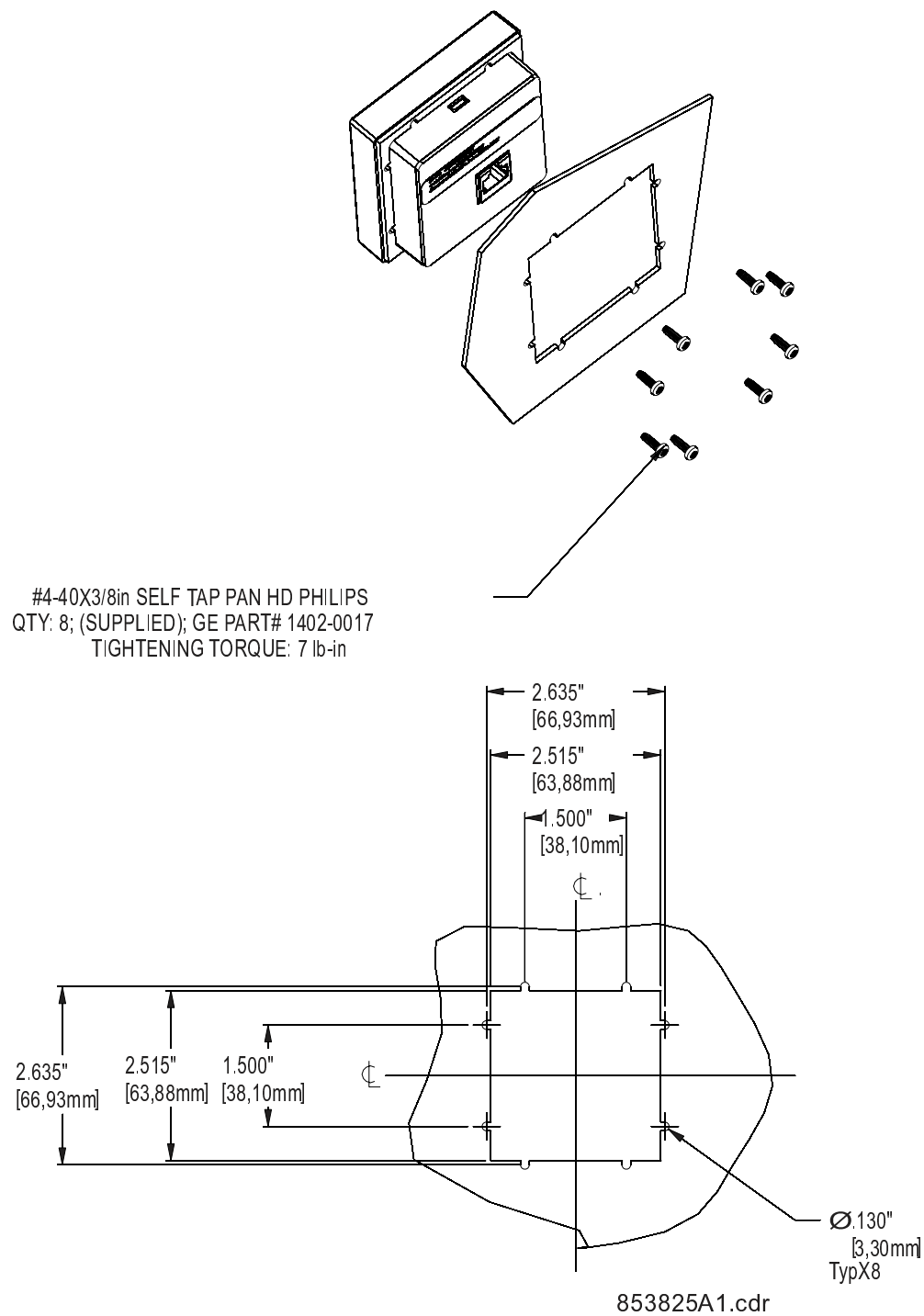


Figure 7: Basic Control Panel mounting and cutout dimensions

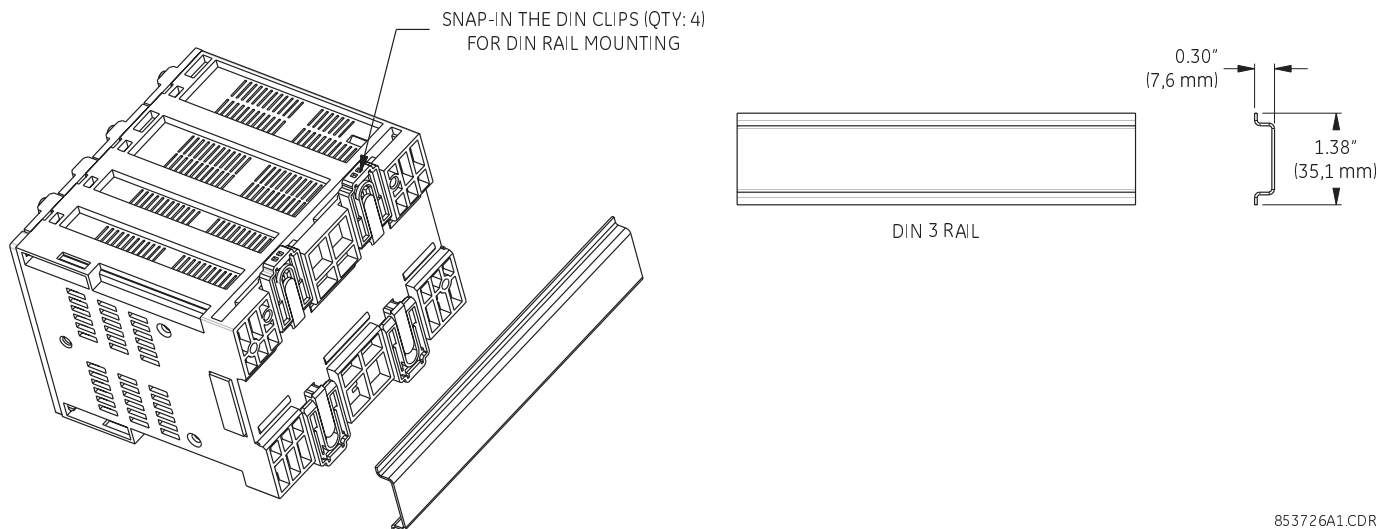


Figure 8: DIN rail mounting - Base and Expansion units

Screw mounts for high vibration environments are illustrated below.

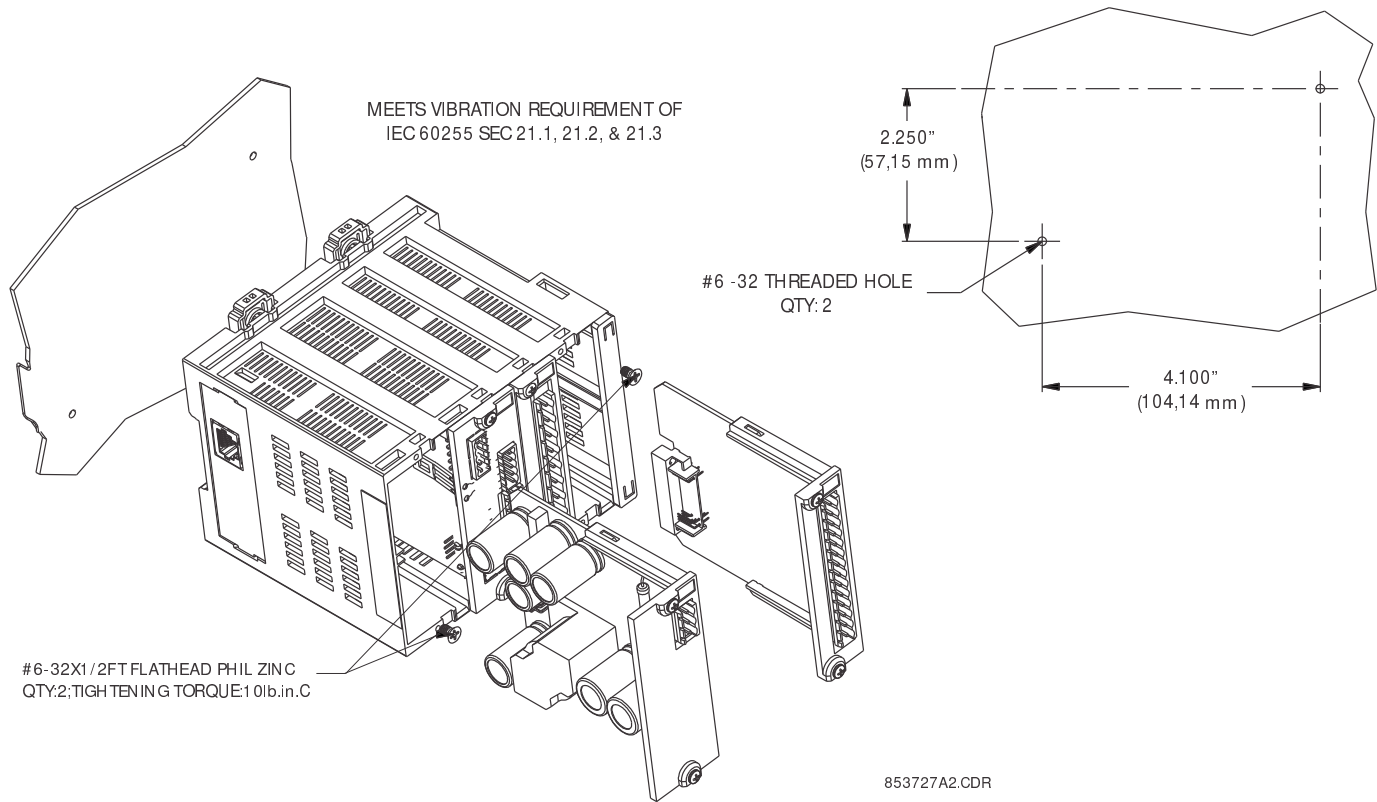


Figure 9: Base Unit screw mounting

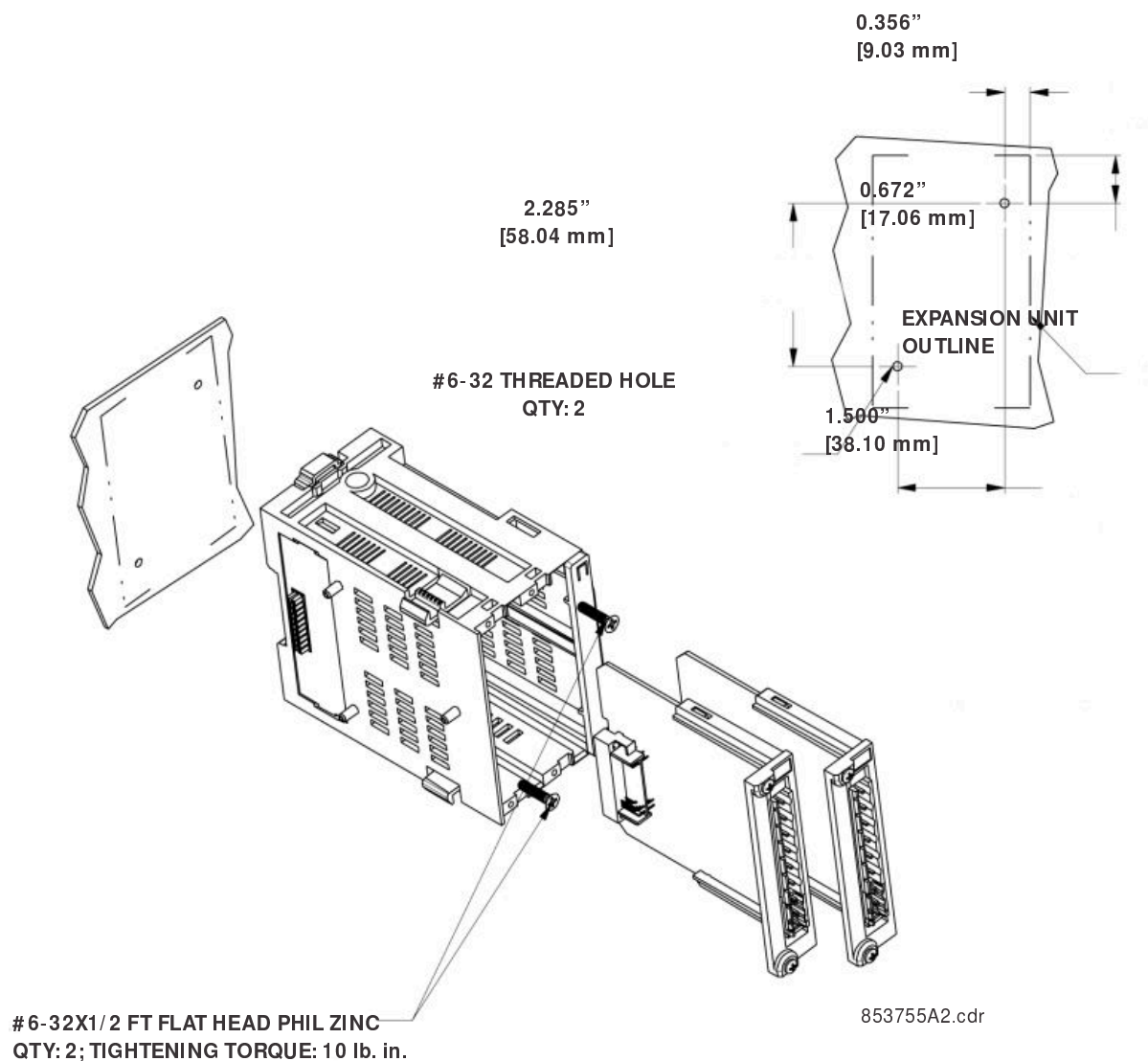


Figure 10: Expansion Unit screw mounting

3.2.4 MODULE WITHDRAWAL AND INSERTION



Warning:

Module withdrawal and insertion may only be performed when control power has been removed from the unit. Inserting an incorrect module type into a slot may result in personal injury, damage to the unit or connected equipment, or undesired operation!



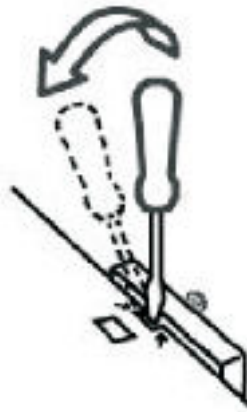
Caution:

Proper electrostatic discharge protection (for example, a static strap) must be used when coming into contact with modules while they are removed from the MM300 Enhanced.

The MM300 Enhanced is a modular protection system. This allows for easy withdrawal and insertion of modules for fast replacement. Modules must only be replaced in their original factory configured slots.

Use the following procedure to withdraw a module.

1. Ensure that control power has been removed from the MM300 Enhanced.
2. Record the slot location of the module to ensure that the same or replacement module is inserted into the correct slot.
3. Remove the two captive screws at the top and bottom of the module.
4. Slide a flat-blade screwdriver into the opening above the module marked by the two arrows on top of the MM300 Enhanced case.
5. Press down on the screwdriver and pivot towards the unit to unlatch the module from the MM300 Enhanced case.

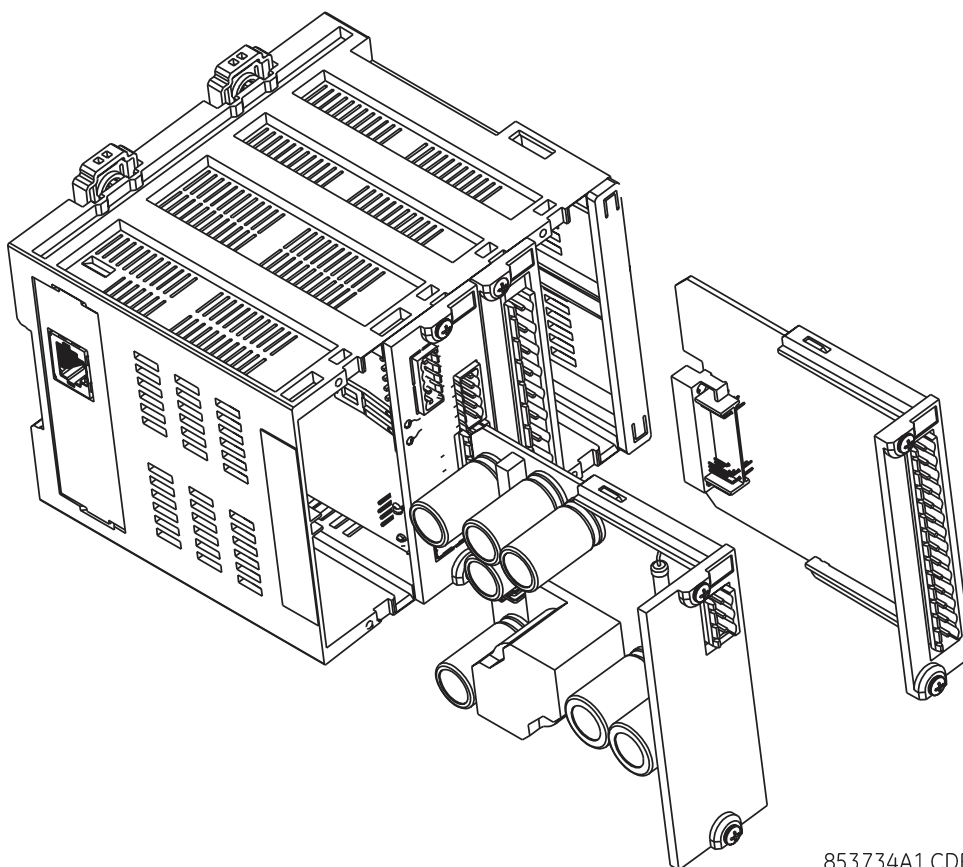


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Figure 11: Removing a module from the MM300 Enhanced

Use the following procedure to insert a module.

1. Ensure that control power has been removed from the MM300 Enhanced.
2. Ensure that the module is being inserted into the correct slot.
3. Align the module card edges with the slot track as shown in the diagram below.



4. Gently slide the modules into the slot until the modules latch into the opening marked by the two arrows on top of the MM300 Enhanced case.
5. Attach the two captive screws to anchor the module to the case (use a tightening torque of 3.5 lb.-in.)

3.2.5 MODULE AND TERMINAL IDENTIFICATION

The relay's input/output and protection modules are labeled with the "IO_" prefix followed by a one-character identifier as follows.

Input/output module nomenclature

Module	Description
IO_A	CT module
IO_B	VT module
IO_C	Two 10 A form-A relays, six 60 to 300 V AC digital inputs, and Aux VT input module.
IO_D	Four 10 A form-C relays module.
IO_M	Two 10 A form-A relays, six 20 to 60 V DC digital inputs (Dry or 24V wetting configurable).
IO_G	3 RTD module.

The MM300 Enhanced terminals are labeled with a three-character identifier. The first character identifies the module slot position and the second character identifies the terminals within the module. For example, the first terminal in a module in slot C is identified as "C1".

Note:

Do not confuse the slot designation with the module ordering designation. That is, terminal "C1" does not imply an IO_C module. Rather, it indicates the first terminal of whatever module is in slot C.

3.3 ELECTRICAL INSTALLATION

This section describes the electrical installation of the MM300 Enhanced system. An overview of the MM300 Enhanced terminal connections is shown below.



Caution:
The MM300 Enhanced is not to be used in any way other than described in this manual.

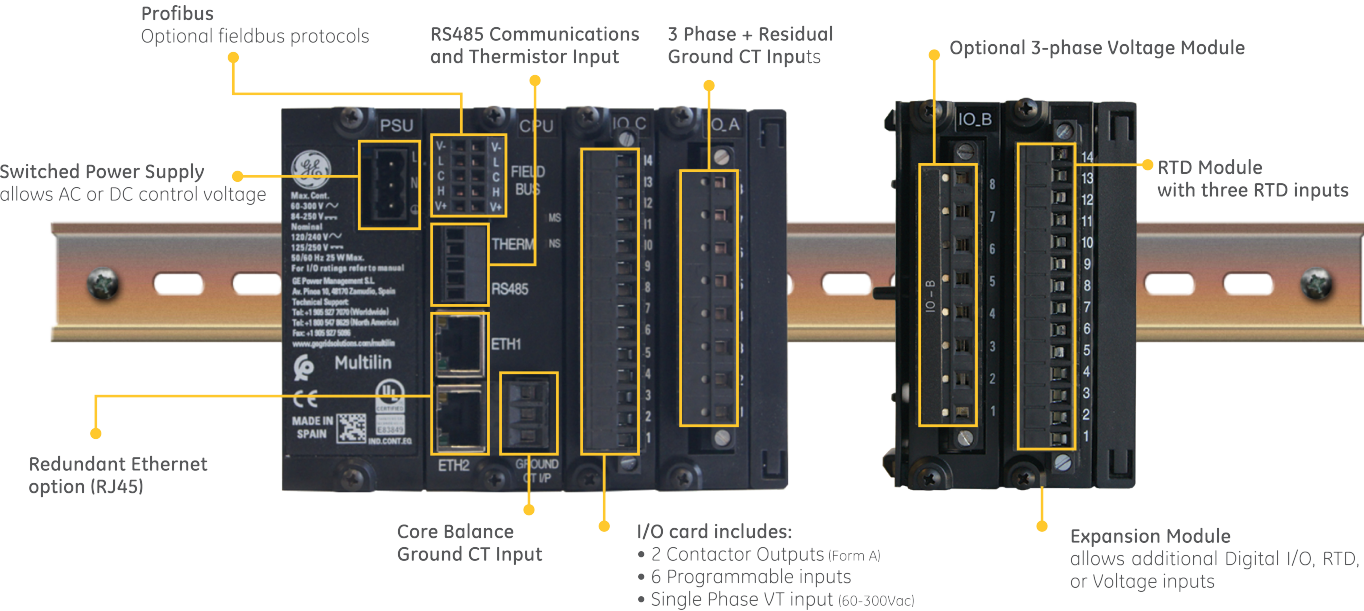


Figure 12: terminal connection overview

The MM300 Enhanced can contain up to eight modules. The first four modules (slots A through D) comprise the base unit, and the next four modules (slots E through H) comprise the optional expanded unit.

Module slot position

	Slot	Module types
Base Unit	A	Power supply module (High or Low)
	B	CPU module with communications (1 of 3 Comm Types)
	C	IO_C or IO_M module
	D	IO_A module
Expansion Modules	E	IO_B or IO_C or IO_D or IO_M or IO_G module
	F	IO_C or IO_D or IO_M or IO_G module
	G	IO_C or IO_D or IO_M or IO_G module
	H	IO_C or IO_D or IO_M or IO_G module

The following figure shows a typical module arrangement for an expanded unit.



Caution:
Use gauge size appropriate for the voltage and current draw of the device.

Gauge Sizes

Card	Wiring
CPU Card: Thermistor, RS485 and Fieldbus	16 AWG (3.50mm pitch terminals)The uncovered communications cable shield connected to the common terminal should not exceed 1" (2.5 cm) for proper EMC shielding of the communications cable.
PSU / CBCT / IO_C / IO_M / IO_D / IO_G	12 AWG (5.00mm pitch terminals)Wire gauge size remains constant; increased pitch distance reflects higher voltage rating.
IO_A / IO_B	12 AWG (7.62mm pitch terminals) ²

1.The uncovered communications cable shield connected to the common terminal should not exceed 1" (2.5 cm) for proper EMC shielding of the communications cable.

2.Wire gauge size remains constant; increased pitch distance reflects higher voltage rating.

Note:
It is recommended that you install a circuit disconnection system for control power, near the device, which should be easily accessible after installation of the unit. This is in case an emergency power shut-down of the unit is required.

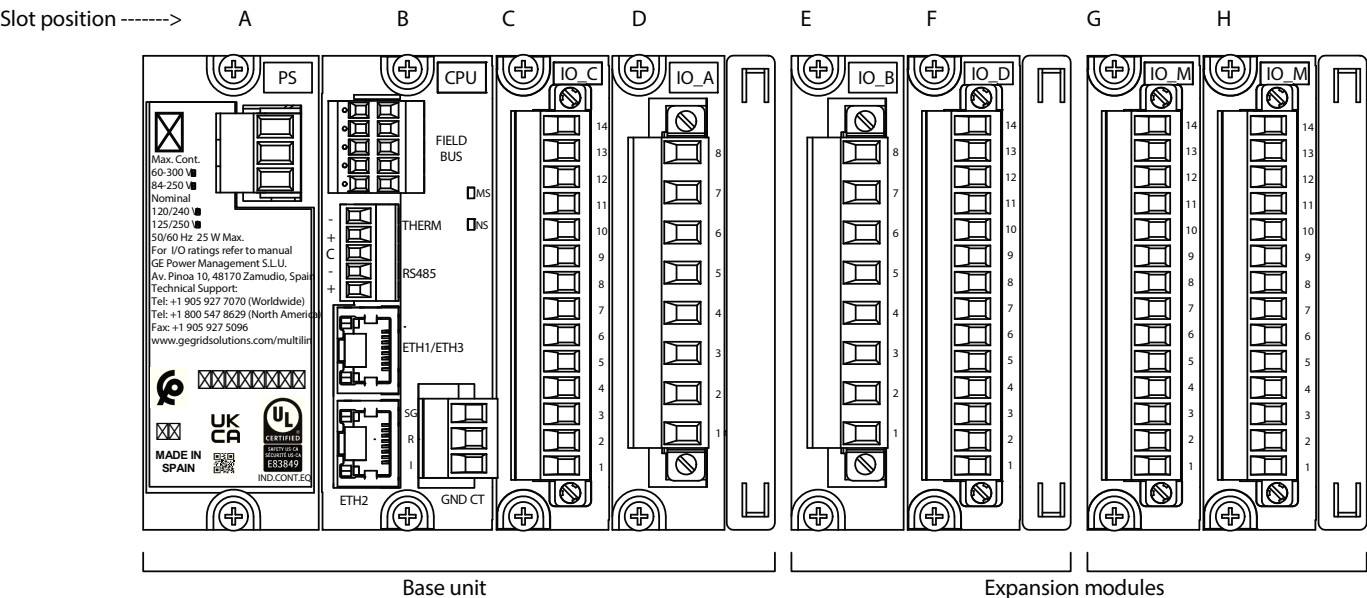


Figure 13: Example of module arrangement

3.3.1 POWER SUPPLY MODULE

The power supply module in slot A supplies control power to the MM300 Enhanced system. For the high voltage version, a supply voltage between 60 to 300 V AC or 80 to 250 V DC is required to power the MM300 Enhanced. For the low voltage version, 24 V DC to 48 V DC is required to power the MM300 Enhanced.

**Caution:**

Check the voltage rating of the unit before applying control power! Control power outside of the operating range of the power supply will damage the MM300 Enhanced

3.3.2 CPU MODULE

The main CPU module and optional communications board is contained in slot B. This module provides a Modbus RTU RS485 port, a thermistor input, and a 50:0.025 CBCT input. The optional communications board provides Fieldbus and Ethernet ports.

3.3.2.1 GROUND CURRENT INPUT

The MM300 Enhanced CPU module has a sensitive ground input suitable for a 50:0.025 CT. There is also a 1/5A ground input on the CT module (IO_A) with the configurable primary rating. Only one ground CT input (either CBCT described here, or a 1/5A ground connection) can be used at any time. Refer to Phase current inputs (IO_A module) for more information on 1/5A ground connection.

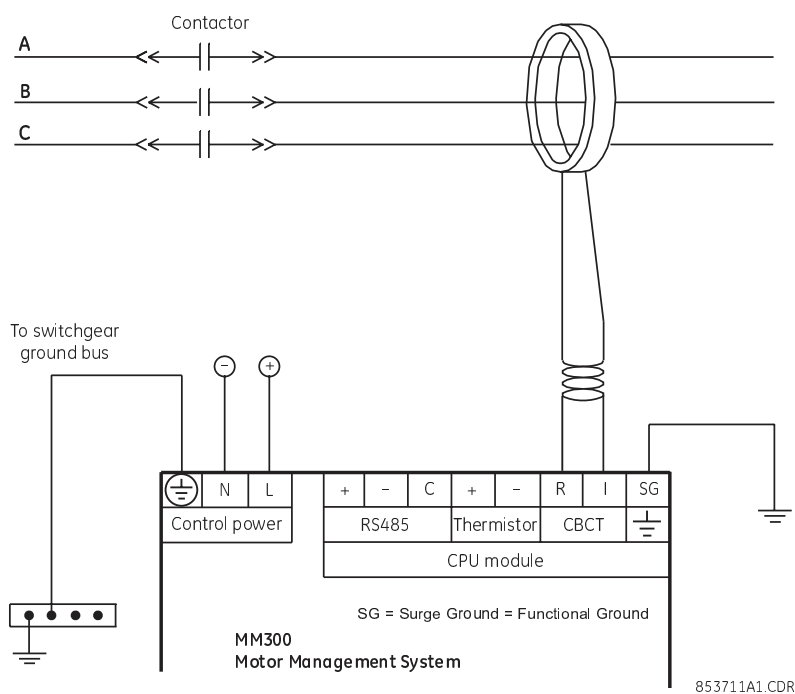


Figure 14: CBCT connection

**Caution:**

The zero-sequence connection is recommended. Unequal saturation of CTs, size and location of motor, resistance of power system, motor core saturation density, and other factors, may cause false readings in the residually connected ground fault circuit.

Note:

Only one ground input should be wired; the other input should be unconnected.

The exact placement of a zero-sequence CT to detect only ground fault current is shown below. If the core balance CT is placed over shielded cable, capacitive coupling of phase current into the cable shield during motor starts may be detected as ground current unless the shield wire is also passed through the CT window. Twisted-pair cabling on the zero-sequence CT is recommended.

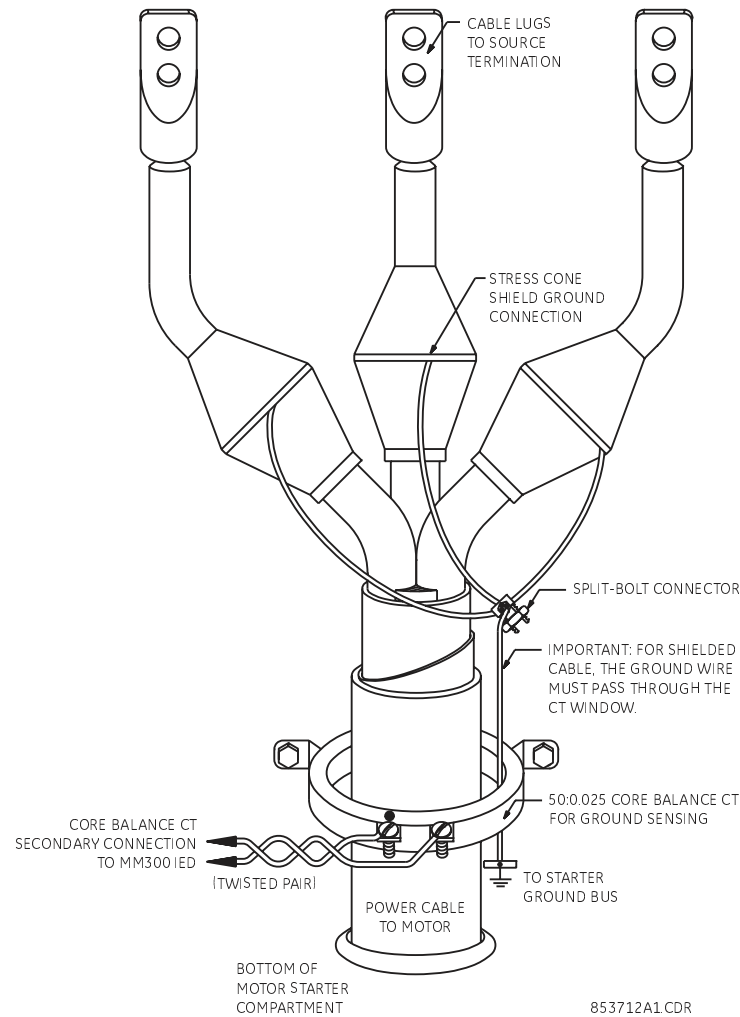


Figure 15: Core balance ground CT installation, shielded cable

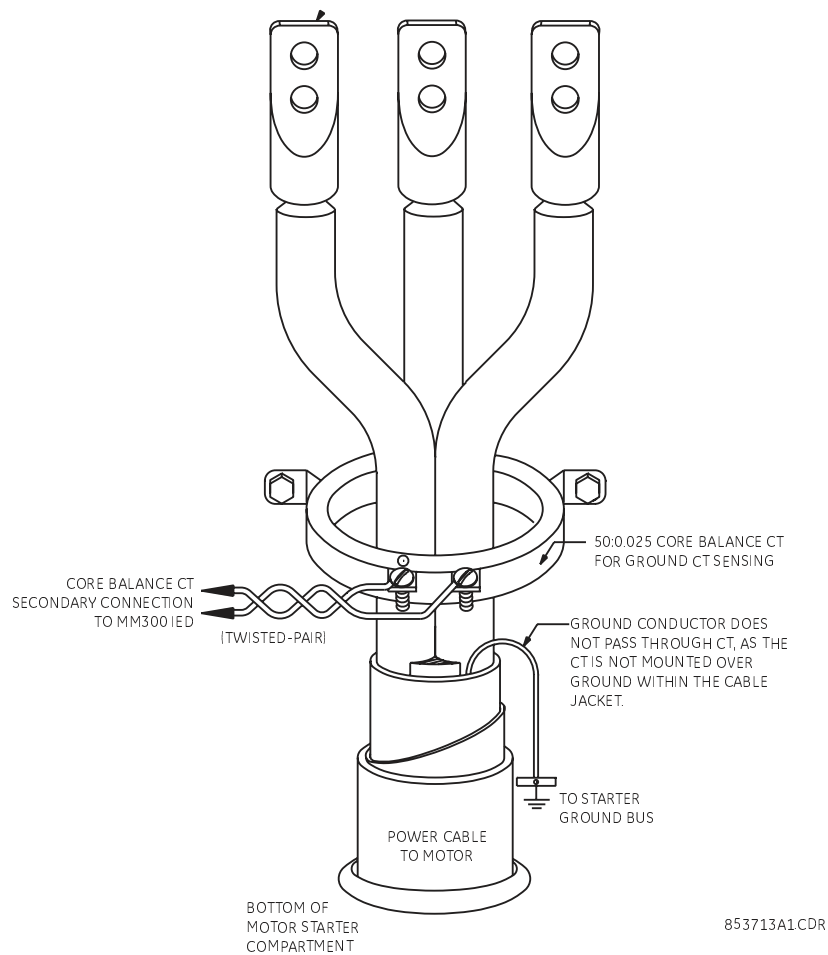


Figure 16: Core balance ground CT installation, unshielded cable

3.3.2.2 THERMISTOR CONNECTIONS

Either a positive temperature coefficient (PTC) or negative temperature coefficient (NTC) thermistor may be directly connected to the + and - terminals on the CPU module. By specifying the hot and cold thermistor resistance, the MM300 Enhanced automatically determines the thermistor type as NTC or PTC. Use thermistors with hot and cold resistance values in the range 100 to 30000 Ω . If no thermistor is connected, the **THERMISTOR ALARM** and **THERMISTOR TRIP** settings must be set to *Disabled*.

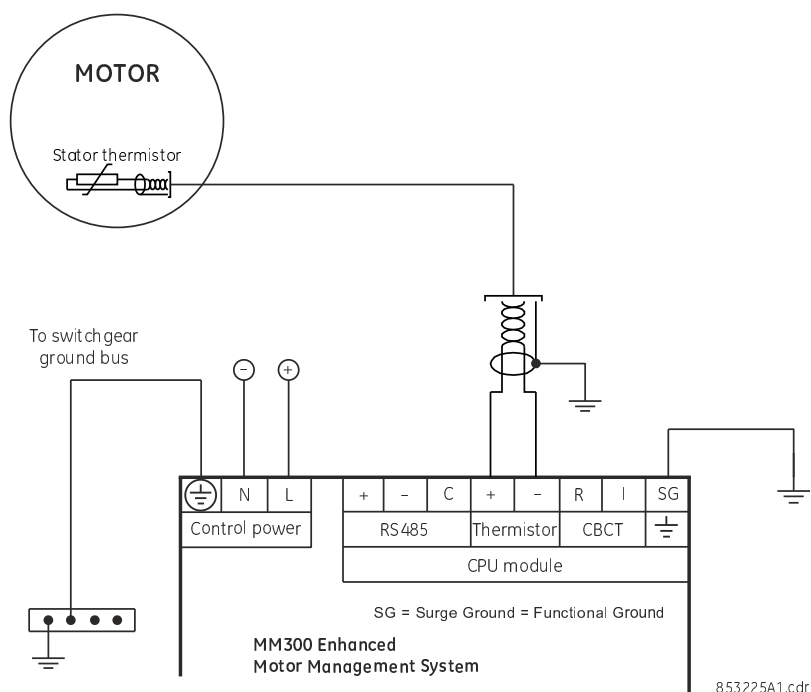


Figure 17: Typical thermistor connection

3.3.3 PROTECTION MODULES

The following protection modules are available for the MM300 Enhanced.

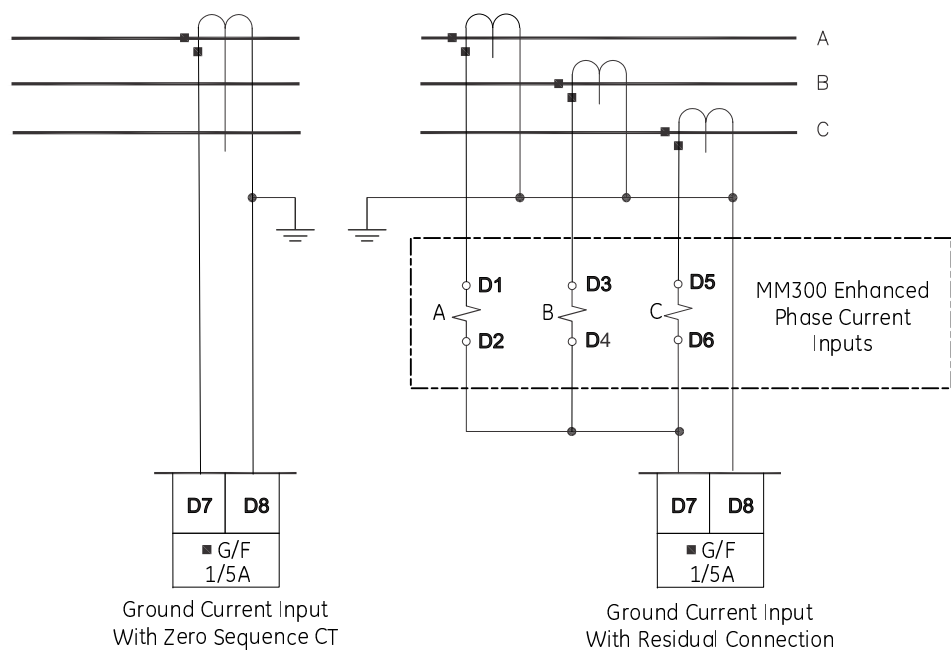
Protection Modules

Module	Slots	Description
IO_A	D	Three-phase current metering and thermal overload, undercurrent, and single-phase underpower protection.
IO_B	E	Three-phase voltage metering and three-phase underpower, undervoltage, overvoltage, power factor and phase reversal protection.
IO_G	E, F, G, H	Bank of three (3) RTDs: 100PT (maximum of 2 banks).

Note:

The recommended torque is 0.44N/m for the protection modules.

There are two dedicated ground inputs as the 1/5A secondary Ground Current (IO_A module) and the 50:0.025 sensitive ground inputs (CPU module). Ground input to protection module IO_A can either be a 1/5A residual connection or a 1/5A zero sequence CT input.

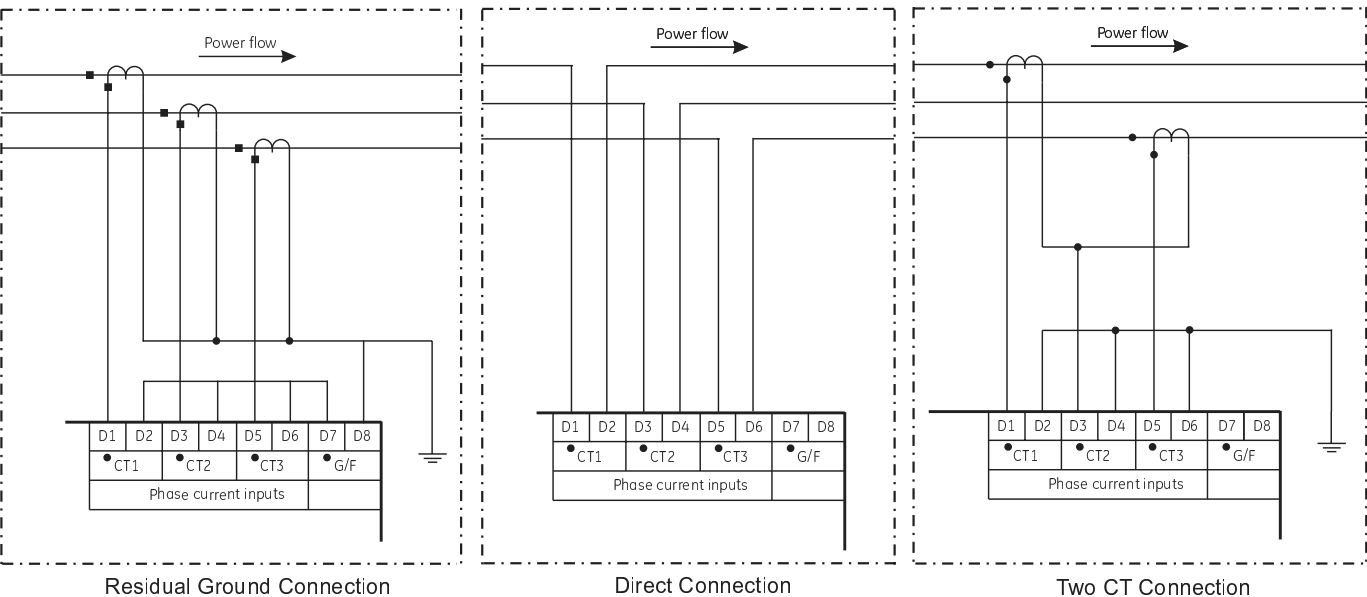


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Figure 18: Zero sequence connection

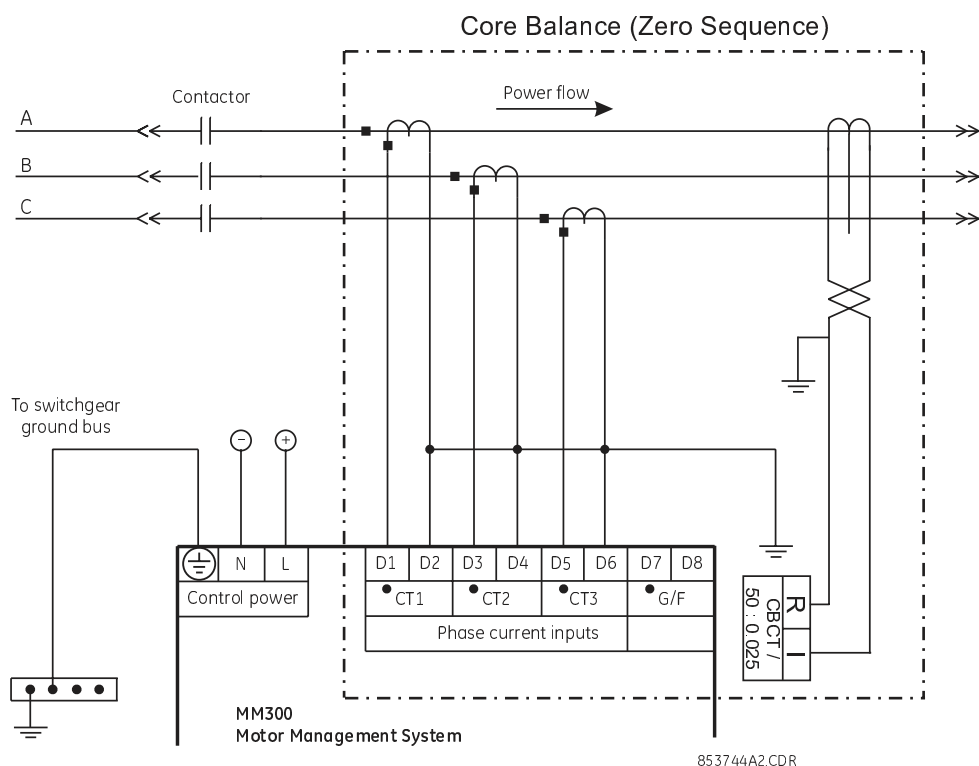
The zero sequence connection as shown in the diagram above is recommended. Unequal saturation of CTs, CT mismatch, size and location of motor, resistance of the power system, motor core saturation density, etc. may cause false readings in the residually connected ground fault circuit. Refer to Ground current input for CBCT connection. Note that if residual ground connection is selected, the **CT PRIMARY** setpoint used by the Phase CT's will also be used by the residual ground calculations. Polarity of the phase CTs is critical for negative-sequence unbalance calculation, power measurement, and 1/5A ground current detection (if used).

3.3.4 PHASE CURRENT INPUTS (IO_A MODULE)



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Figure 19: Typical phase current input connections



The MM300 Enhanced has three channels for phase current inputs, each with an isolating transformer. The phase CTs should be chosen so the FLA is not less than 50% of the rated phase CT primary. Ideally, the phase CT primary should be chosen such that the FLA is 100% of the phase CT primary or slightly less, never more. This will ensure maximum accuracy for the current measurements. The maximum phase CT primary current is 1000 A.

The ground CT connection can either be a zero sequence (core balance) installation or a residual connection. Note that only 1 A and 5 A secondary CTs may be used for the residual connection. The zero sequence connection is shown in the diagram above, and this is recommended. Unequal saturation of CTs, CT mismatch, size and location of motor, resistance of the power system, motor core saturation density, etc. may cause false readings in the residually connected ground fault circuit. CPU module for further information.

Note that if residual ground connection is selected, the **CT PRIMARY** setpoint used by the Phase CT's will also be used by the residual ground calculations.



Caution:

Polarity of the phase CTs is critical for negative-sequence unbalance calculation, power measurement, and residual ground current detection (if used).

3.3.4.1 TWO CT CONFIGURATION

Each of the two CTs acts as a current source. The current that comes out of the CT on phase A flows into the interposing CT on the relay marked CT1. From there, the current sums with the current that is flowing from the CT on phase C which has just passed through the interposing CT on the relay marked CT3. This summed current flows through the interposing CT marked CT2 and from there, the current splits up to return to its respective source (CT).

Polarity is very important since the value of phase B must be the negative equivalent of A + C in order for the sum of all the vectors to equate to zero.

Only one ground connection should be made as shown. If two ground connections are made, a parallel path for current has been created.

In the two CT configuration, the currents will sum vectorially at the common point of the two CTs. The diagram illustrates the two possible configurations. If one phase is reading high by a factor of 1.73 on a system that is known to be balanced, simply reverse the polarity of the leads at one of the two phase CTs (taking care that the CTs are still tied to ground at some point). Polarity is important.

Note:
Change CT wiring only if the system is de-energized!

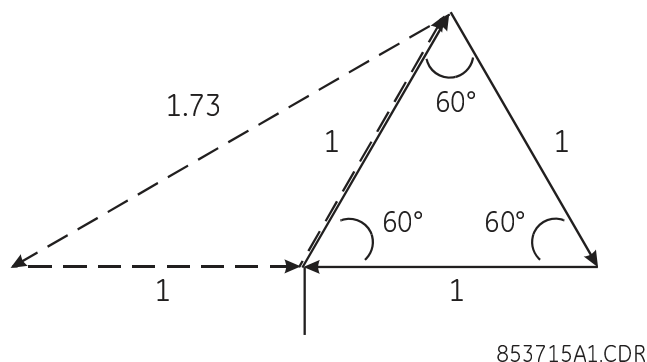


Figure 20: Two CT connection vector diagram

To illustrate the point further, the following diagram shows how the current in phases A and C sum up to create phase B.

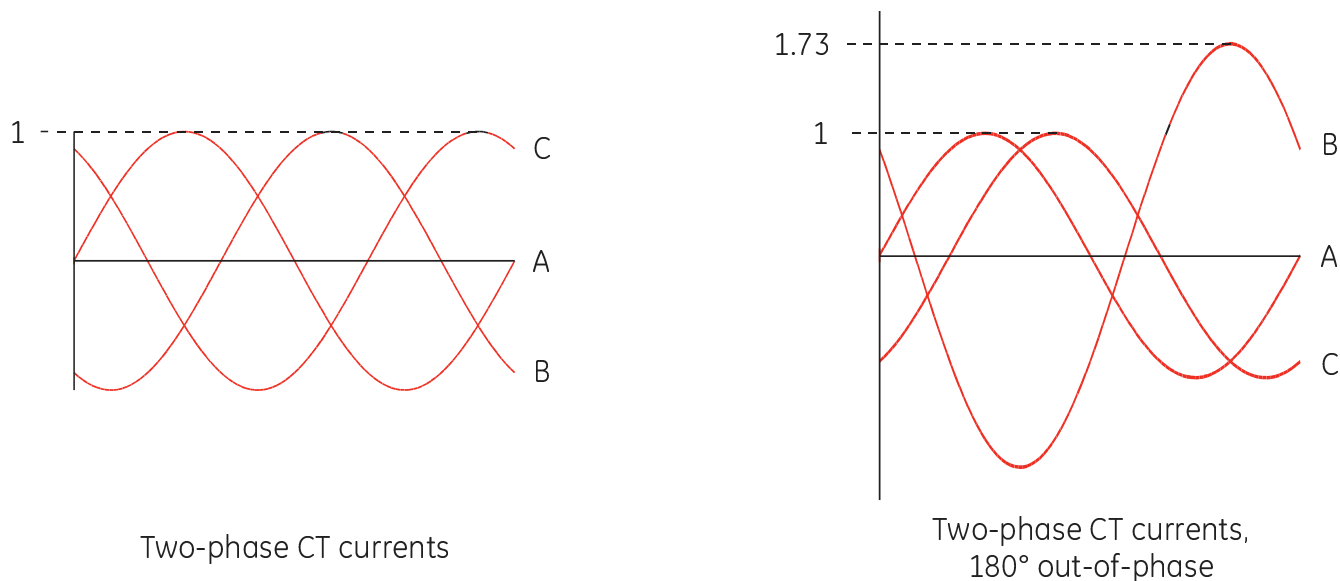


Figure 21: Two CT connection currents

Once again, if the polarity of one of the phases is out by 180°, the magnitude of the resulting vector on a balanced system will be out by a factor of 1.73.

On a three-wire supply, this configuration will always work and unbalance will be detected properly. In the event of a single phase, there will always be a large unbalance present at the interposing CTs of the relay. If for example phase A was lost, phase A would read zero while phase B and C would both read the magnitude of phase C. If on the other hand, phase B was lost, at the supply, phase A would be 180° out-of-phase with phase C and the vector addition would equal zero at phase B.

3.3.5 PHASE VOLTAGE INPUTS (IO_B MODULE)

The MM300 Enhanced has three channels for AC voltage inputs. There are no internal fuses or ground connections on the voltage inputs. Polarity is critical for correct power measurement and voltage phase reversal operation.

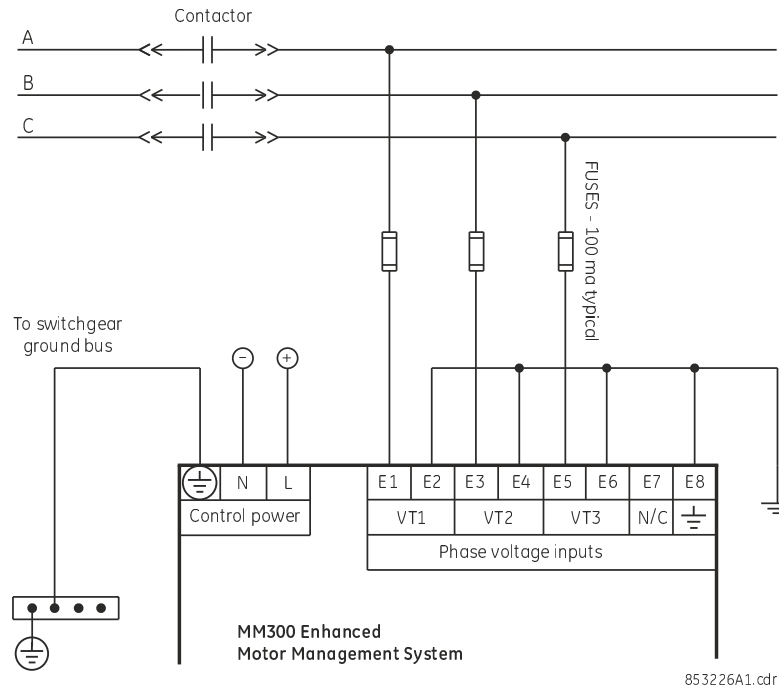


Figure 22: Wye voltage connection

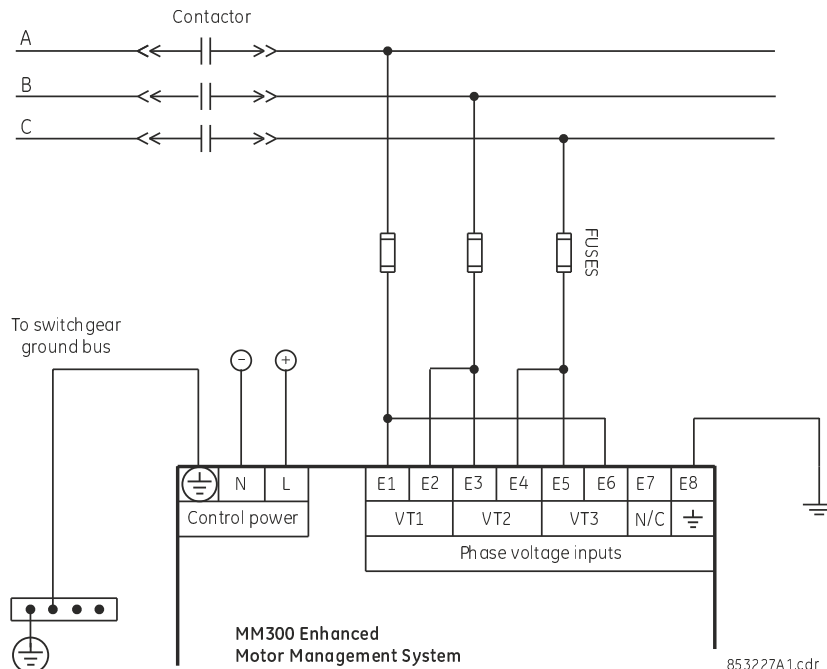


Figure 23: Delta voltage connection

3.3.6 RTD SENSOR CONNECTIONS (IO_G MODULE)

The type IO_G module contains three PT100 RTDs and associated protection functionality.

The MM300 Enhanced monitors up to six RTD inputs for stator, bearing, ambient, or other temperature monitoring types. The type of each RTD is 100 Ω platinum (DIN 43760). RTDs must be three-wire type.

The RTD circuitry compensates for lead resistance, provided that each of the three leads is the same length. Lead resistance should not exceed 25 Ω per lead. Shielded cable should be used to prevent noise pickup in industrial environments. RTD cables should be kept close to grounded metal casings and away from areas of high electromagnetic or radio interference. RTD leads should not be run adjacent to or in the same conduit as high current carrying wires.

The uncovered communications cable shield connected to the common terminal should not exceed 1" (2.5 cm) for proper EMC shielding of the communications cable.

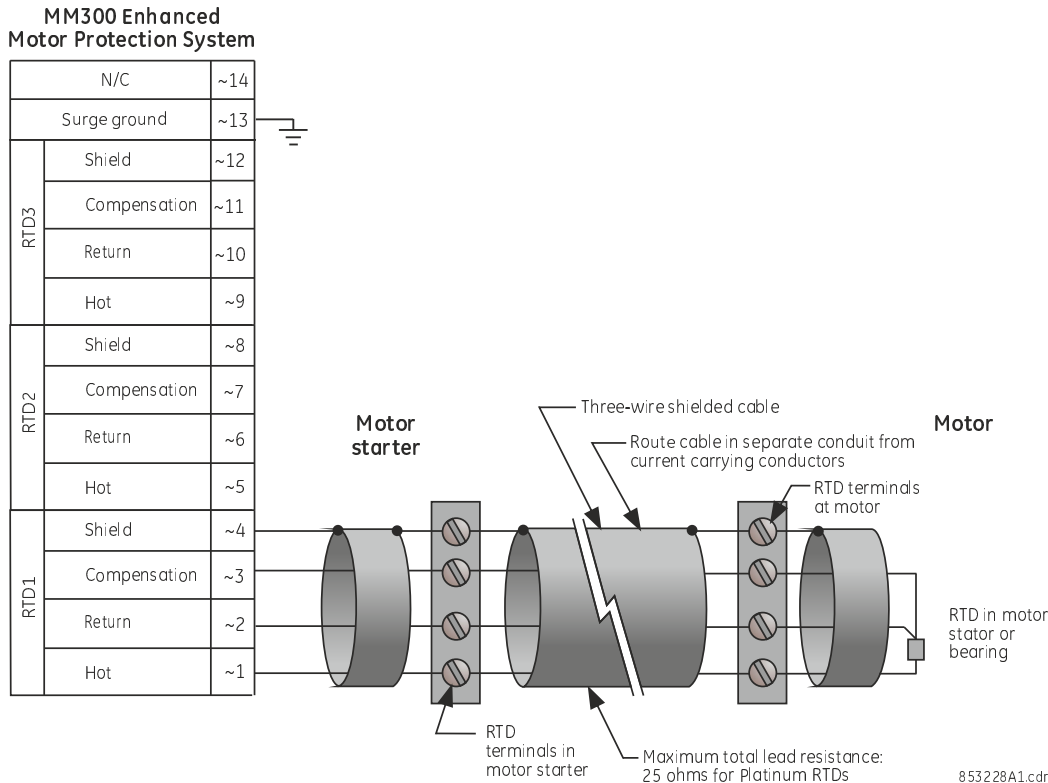


Figure 24: RTD wiring

3.3.7 INPUT/OUTPUT MODULES

The following input and output modules are available for the MM300 Enhanced.

MM300 Enhanced input and output modules

Module	Slots	Description
IO_C	C, E, F, G, H	Two 10 A form-A relays and six 60 to 300 V AC digital inputs
IO_D	E, F, G, H	Four 10 A form-C relays
IO_M	C, E, F, G, H	Two 10 A relay N/O, six DI 20 to 60 DC (dry or 24 V DC wet configurable)

Note:
The recommended torque is 0.44N/m for the protection modules.

3.3.7.1 TYPE IO_C MODULE CONNECTIONS

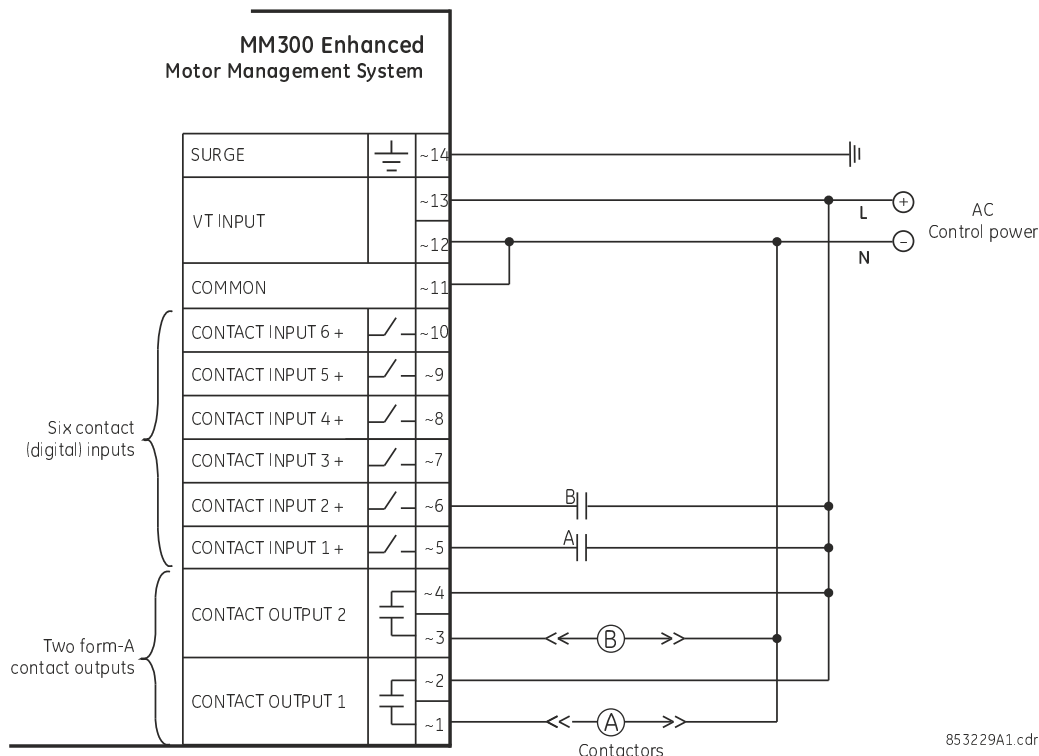


Figure 25: Typical wiring for type IO_C module

The IO_C module contains two form-A contact output relays, six digital inputs and control voltage input.

Contact inputs can be programmed to any of the input functions, such as field stop or process interlock. The exception is that contactor A status is fixed as the first contact input, and contactor B status (where used) is fixed as the second contact input.

An AC auxiliary supply must be connected to terminals 12 and 13. This auxiliary voltage (from slot C only) is also used for actual value indication, for auxiliary undervoltage, and for undervoltage restart. When three-phase voltages are not available, it is also used to calculate power quantities and is used as a phase angle reference.

When the IO_C module, **located in slot C**, senses an interruption to its auxiliary supply, it raises an AC Low Aux Voltage Inhibit.

The two contact outputs can be programmed to follow any one of the digital signals developed by the MM300 Enhanced, such as alarms and status signals. The exception is that the contactor A relay is fixed as the first contact output, and contactor B relay is fixed as the second contact output (where used).

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and readings of inputs.

Note:

All IO_C cards must have the auxiliary input VT wired for proper input sensing. If the auxiliary voltage on any IO_C module is too low, the contact inputs states for the affected module will be forced to OFF.

Note:

Substitute the slot position of the input/output module (C, E, F, G, H) wherever the tilde symbol "~" appears in the diagrams above.

3.3.7.2 TYPE IO_D MODULE CONNECTIONS

The IO_D module contains four form-C contact output relays.

In general, contact outputs can be programmed to follow any one of the digital signals developed by the MM300 Enhanced, such as alarms and status signals.

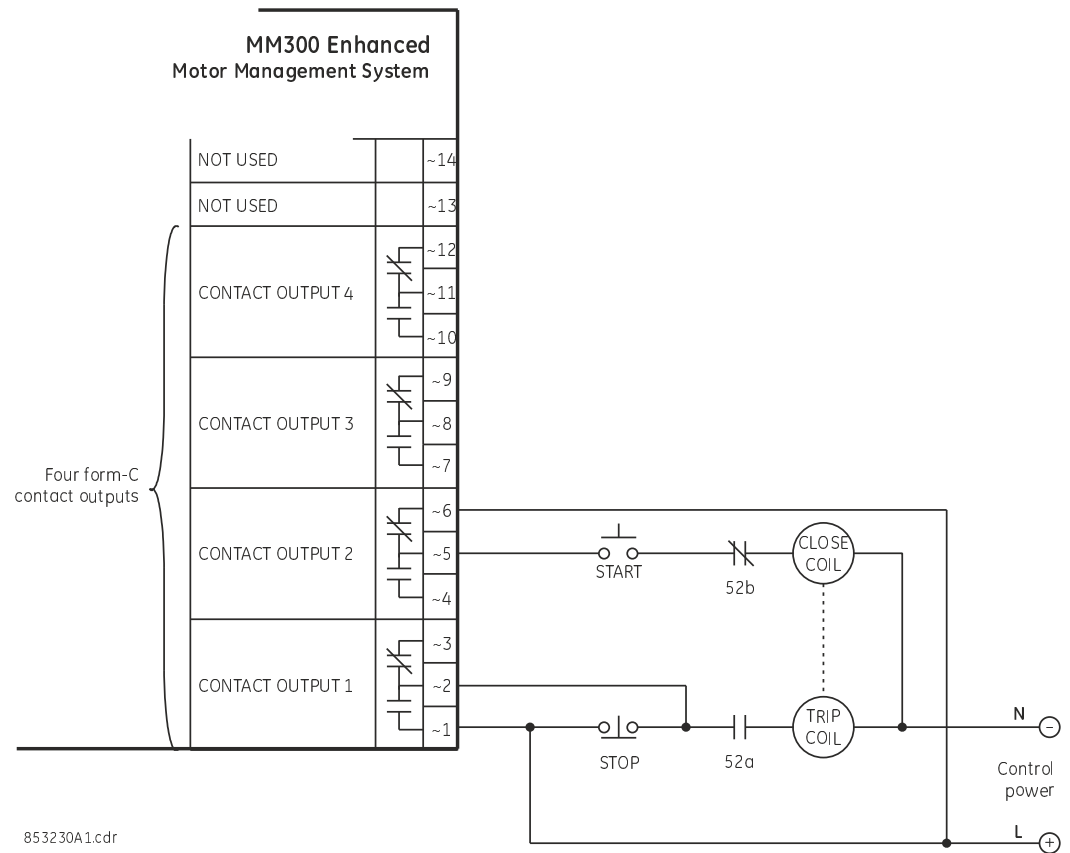


Figure 26: Typical wiring for type IO_D contact output module

Note:

Substitute the slot position of the input/output module (E, F, G, or H) wherever the tilde symbol “~” appears in the diagrams above.

3.3.7.3 TYPE IO_M MODULE CONNECTIONS

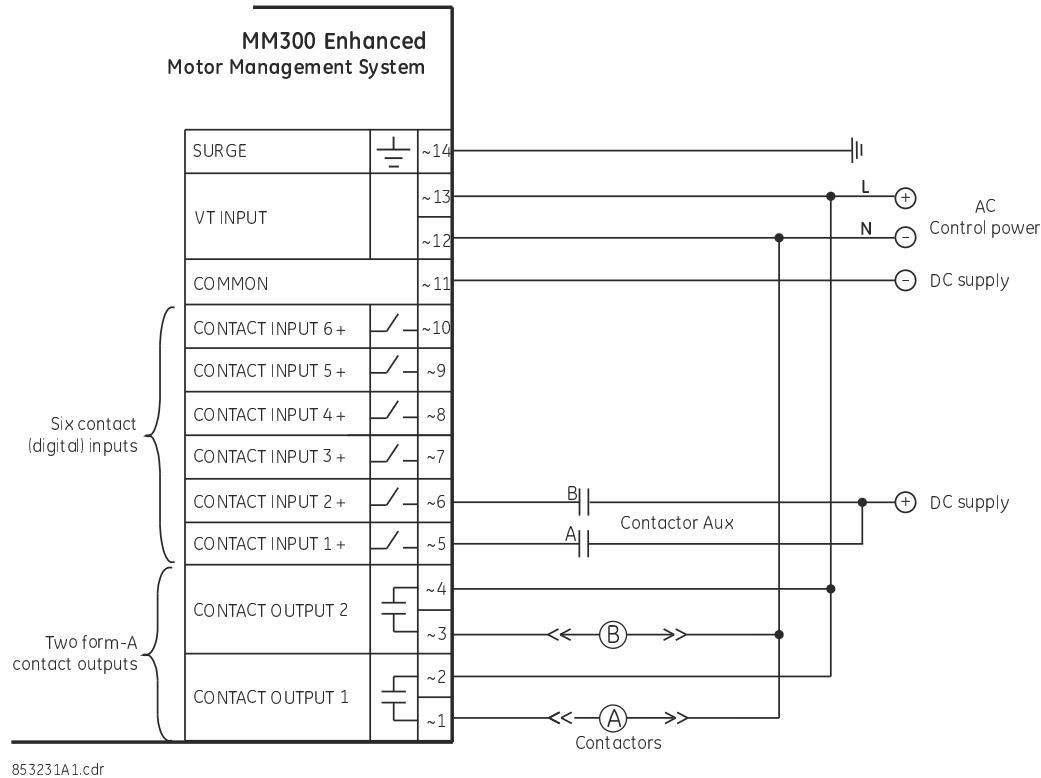


Figure 27: Typical wiring for type IO_M module - wet input contact example

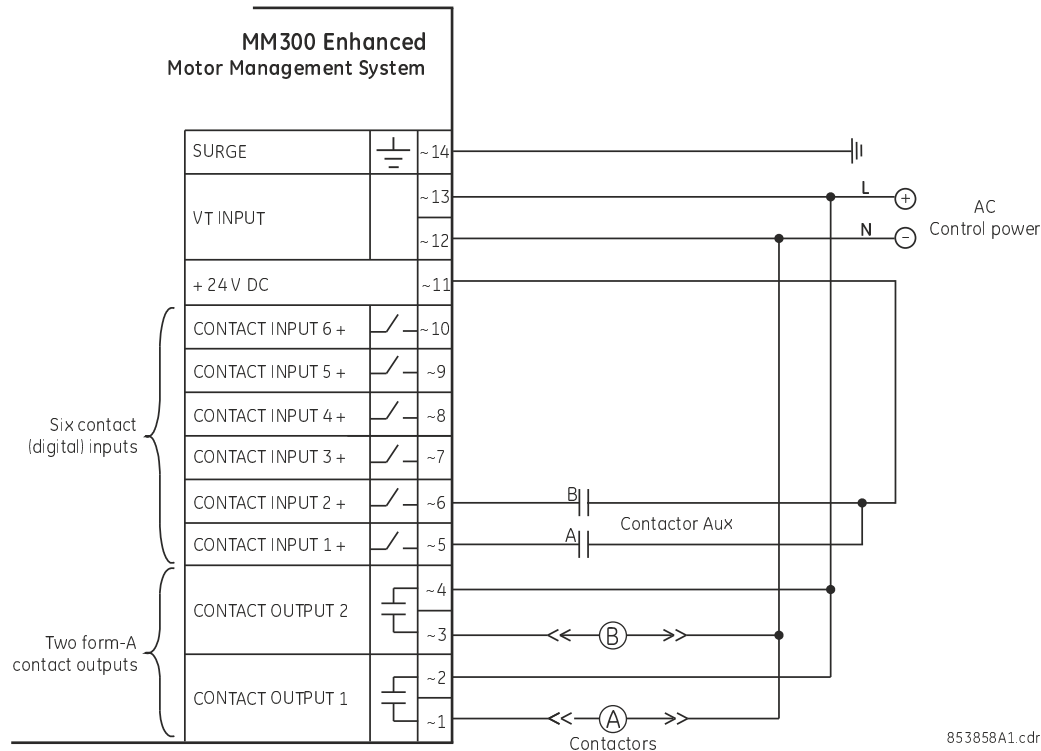


Figure 28: Typical wiring for type IO_M module - dry input contact example

The IO_M module contains two form-A contact output relays, six digital inputs and a voltage input, which is a required connection. Contact inputs can be programmed to any of the input functions, such as field stop or process

interlock. The exception is that contactor A status is fixed as the first contact input, and contactor B status (where used) is fixed as the second contact input.

An AC auxiliary supply must be connected to terminals 12 and 13 of the IO_M module in slot C. This auxiliary voltage from slot C is used for actual value indication, for auxiliary undervoltage, and for undervoltage restart. When three-phase voltages are not available, it is also used to calculate power quantities and is used as a phase angle reference.

Note:

The auxiliary voltage connection is required on all IO_M modules, both in slot C and in expansion slots.

Note:

From v2.20 onwards, in case no IOC boards are mounted and as long as the UVR functionality is disabled, Low Aux Voltage condition will not be applied in case no auxiliary voltage is applied in the Vaux inputs of the IOM mounted on Slot C.

IO_M input type can be configured as Dry-type or Wet-type using the configurable software option 'Input Signal Type'. Wet or Dry input signal types can be connected to contact input terminals as shown in the above figures. Dry inputs use an internal +24V that is supplied by the MM300 Enhanced.

Note:

Software option 'Input Signal Type' configured as Wet or Dry applies to all the inputs contacts of IO_M card. For instance, when 'Input Signal Type' is configured as Wet, the user must ensure that external DC supply is applied to all the contact inputs. When 'Input Signal Type' is configured as Dry, the user must ensure that inputs are wired as shown in the dry input contact example figure above, to an internal +24V that is supplied by the MM300 Enhanced.

The two contact outputs can be programmed to follow any one of the digital signals developed by the MM300 Enhanced, such as alarms and status signals. The exception is that the contactor A relay is fixed as the first contact output, and contactor B relay is fixed as the second contact output (where used).

Note:

Substitute the slot position of the input/output module (C, E, F, G, H) wherever the tilde symbol “~” appears in the diagrams above.

Card Terminal Number	Option C2 x 10A Relay N/O6 x DI 60-300 AC	Option D4 x 10A Relay Form C	Option M2 x 10A Relay N/O6 x DI 20-60 DC
14	Not connected	Not connected	Not connected
13	Auxiliary VT - Input/Live	Not connected	Auxiliary VT - Input/Live
12	Auxiliary VT - Return/Neutral	Relay 4 - N.C.	Auxiliary VT - Return/Neutral
11	Contact Input Common	Relay 4 - COM	Common OR +24 V DC
10	Contact Input 6 - (+)	Relay 4 - N.O.	Contact Input 6 - (+)
9	Contact Input 5 - (+)	Relay 3 - N.C.	Contact Input 5 - (+)
8	Contact Input 4 - (+)	Relay 3 - COM	Contact Input 4 - (+)
7	Contact Input 3 - (+)	Relay 3 - N.O.	Contact Input 3 - (+)
6	Contact Input 2 - (+)	Relay 2 - N.C.	Contact Input 2 - (+)
5	Contact Input 1 - (+)	Relay 2 - COM	Contact Input 1 - (+)
4	Relay 2 - COM	Relay 2 - N.O.	Relay 2 - COM
3	Relay 2 - N.O.	Relay 1 - N.C.	Relay 2 - N.O.

Card Terminal Number	Option C2 x 10A Relay N/O6 x DI 60-300 AC	Option D4 x 10A Relay Form C	Option M2 x 10A Relay N/O6 x DI 20-60 DC
2	Relay 1 - COM	Relay 1 - COM	Relay 1 - COM
1	Relay 1 - N.O.	Relay 1 - N.O.	Relay 1 - N.O.

3.3.8 DIELECTRIC STRENGTH TESTING

It may be required to test a complete motor starter for dielectric strength (“flash” or “HI-POT”) with the MM300 Enhanced installed.

The MM300 Enhanced with the I/O Module type C installed (see below) is rated for 1.9 kV AC for 1 second, or 1.6 kV AC for 1 minute (per UL 508) isolation between relay contacts, CT inputs, VT inputs and the surge ground terminal SG. Some precautions are required to prevent damage to the MM300 Enhanced during these tests.

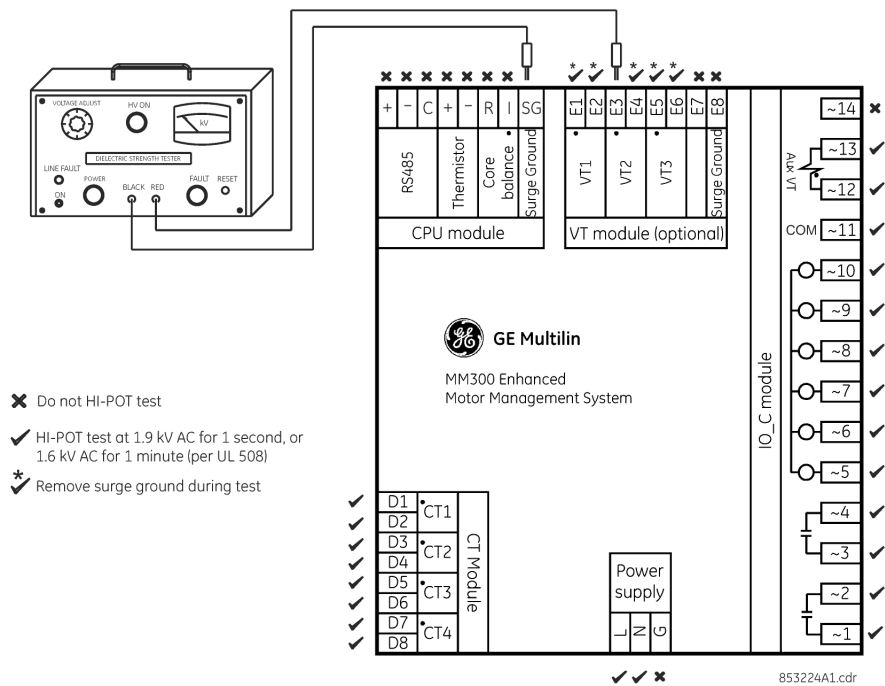


Figure 29: Testing for dielectric strength - with IO_C module

The MM300 Enhanced with the I/O Module type E installed (see below) is rated for 550 V AC for 1 second, or 500 V AC for 1 minute (per UL 508) isolation between relay contacts, CT inputs, VT inputs and the surge ground terminal SG. Some precautions are required to prevent damage to the MM300 Enhanced during these tests.

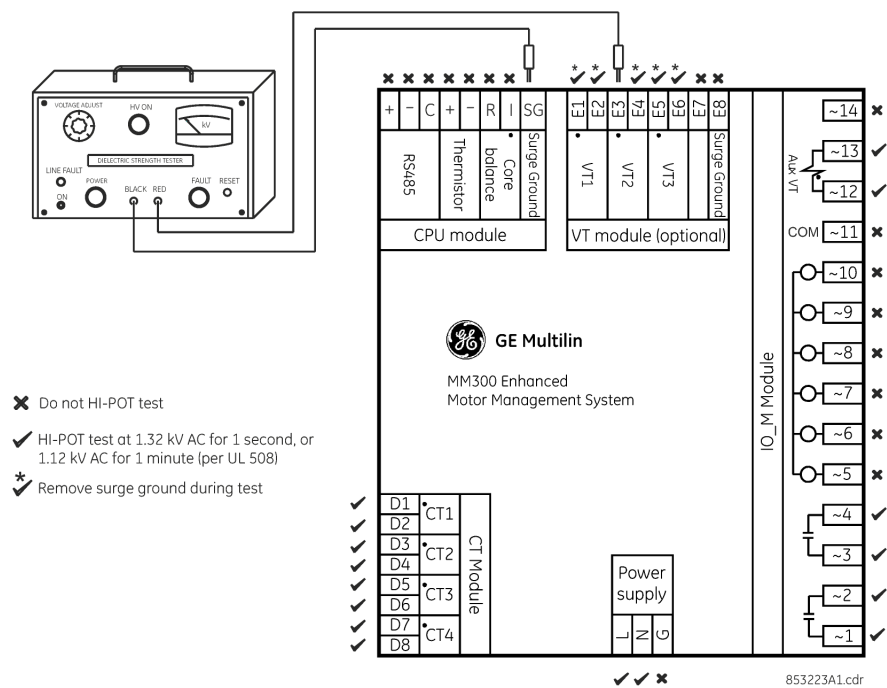


Figure 30: Testing for dielectric strength - with IO_M module

Filter networks and transient protection clamps are used between VT input and the surge ground terminal. This is intended to filter out high voltage transients, radio frequency interference (RFI), and electromagnetic interference (EMI). The filter capacitors and transient suppressors may be damaged by continuous high voltage. Disconnect the surge ground terminal (E8) during testing of VT inputs. The CT inputs, control power, and output relays do not require any special precautions. Low voltage inputs (less than 30 volts), RTDs, and RS485 communication ports are not to be tested for dielectric strength under any circumstance (see above).

Note:

Substitute the slot position of the Input/Output module (M, F, G, or H) wherever the tilde symbol “~” appears in the diagram above.

3.3.9 THERMAL RECOMMENDATIONS

In order to avoid excessive heat inside the relay, please follow recommendations below:

- There must be around 2” or 6 cm around the relay to allow air circulation. It has been tested and the CPU internal temperature is reduced 9°C:

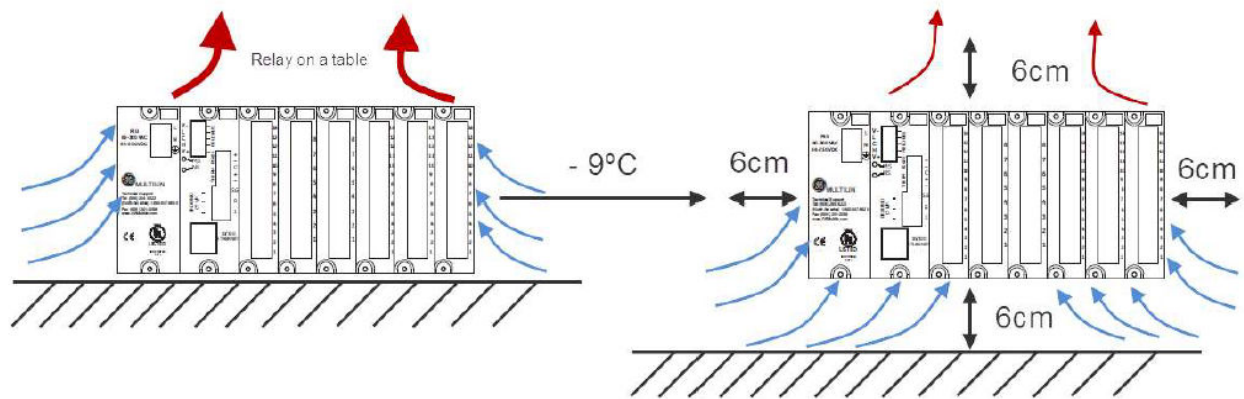


Figure 31: Temperature reduces around 9°C when leaving 6cm around the relay

- Relay can be installed in vertical or horizontal position. However, in vertical mode internal temperature is around 5°C more.
- Avoid installing heat sources below the relay.
- There are 3 mechanism for heat dissipation:
 - a. Conduction. In the case of MM300 is limited as the base unit housing is made of plastic.
 - b. Convection. This is the most relevant mechanism for MM300 thanks to its slots in the housing.
 - c. Radiation. This is only applicable for very high temperatures as it goes with the fourth power of the temperature in Kelvin scale and is not relevant in MM300 cooling.

Everything done to ensure convection will reduce hot spots within the product and will ensure longer reliability.

3.4 STARTER TYPES

3.4.1 FULL-VOLTAGE NON-REVERSING STARTER

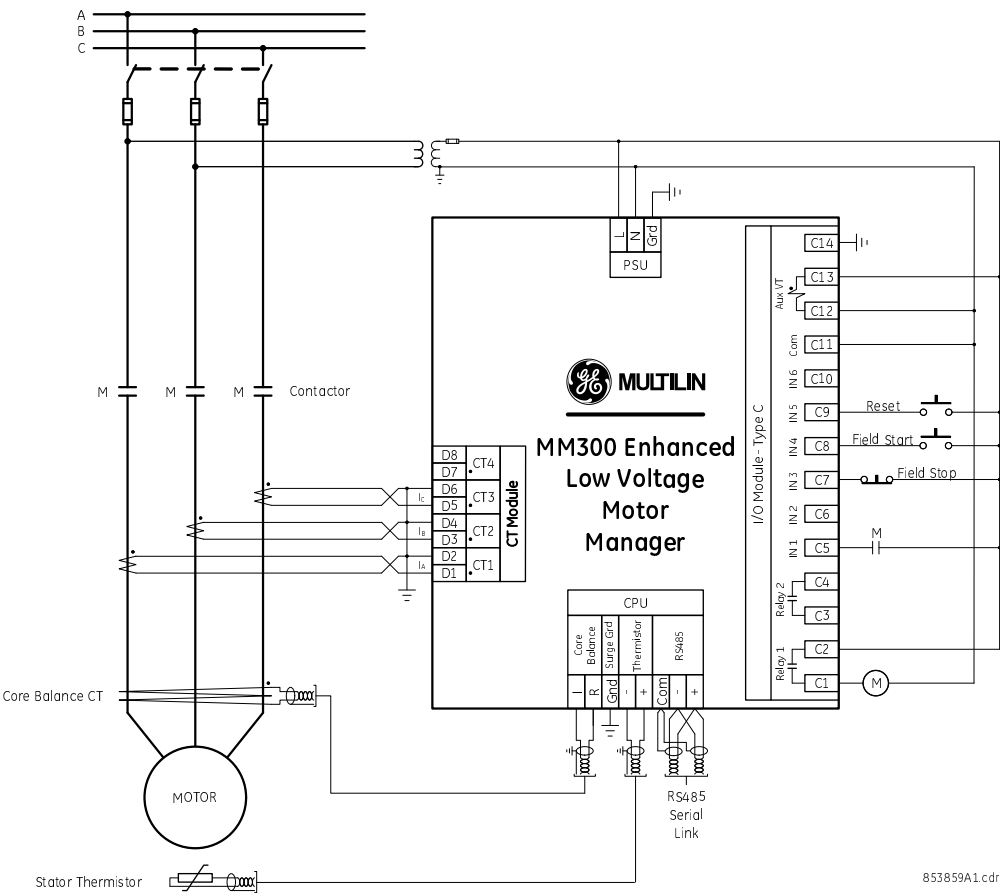
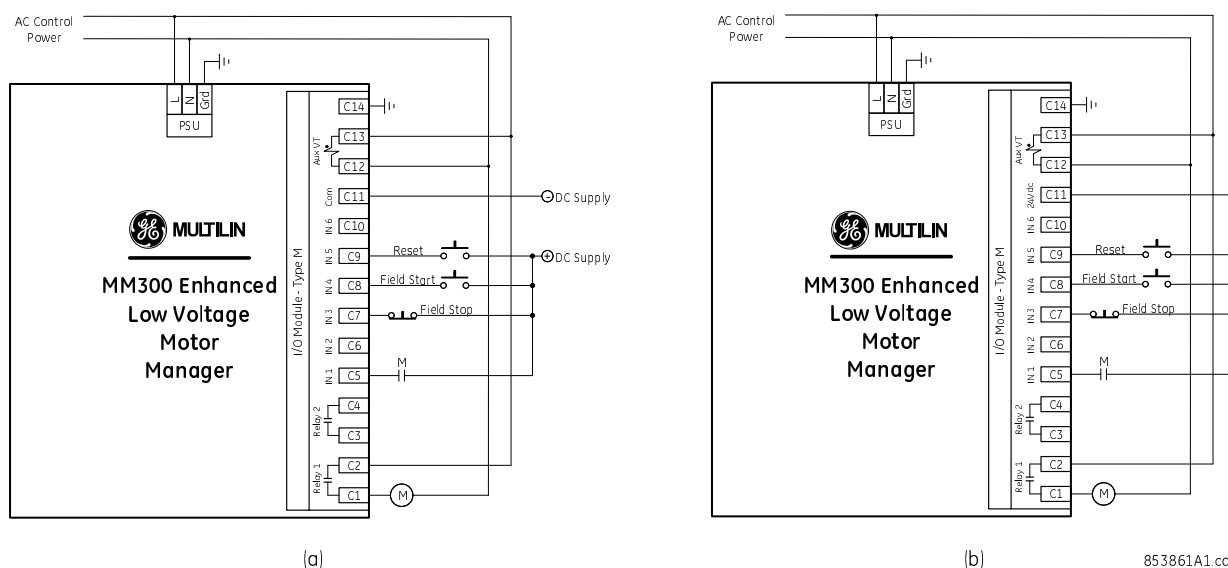


Figure 32: Full-voltage non-reversing starter typical wiring - IO_C



853861A1.cdr

Figure 33: Full-voltage non-reversing starter typical wiring - IO_M(a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

The full-voltage non-reversing starter type is a full voltage or across-the-line non-reversing starter.

When a start control is received, the pre-contactor relay (if any) is picked up for the set pre-contactor time. When the pre-contactor timer times out, relay1 picks up and seals-in, picking up contactor M, which starts the motor. When a stop control is received, relay1 drops out, contactor M drops out, and the motor stops. The pre-contactor is omitted on forced starts (for example, UVR Immediate, External Start).

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

3.4.2 FULL-VOLTAGE REVERSING STARTER

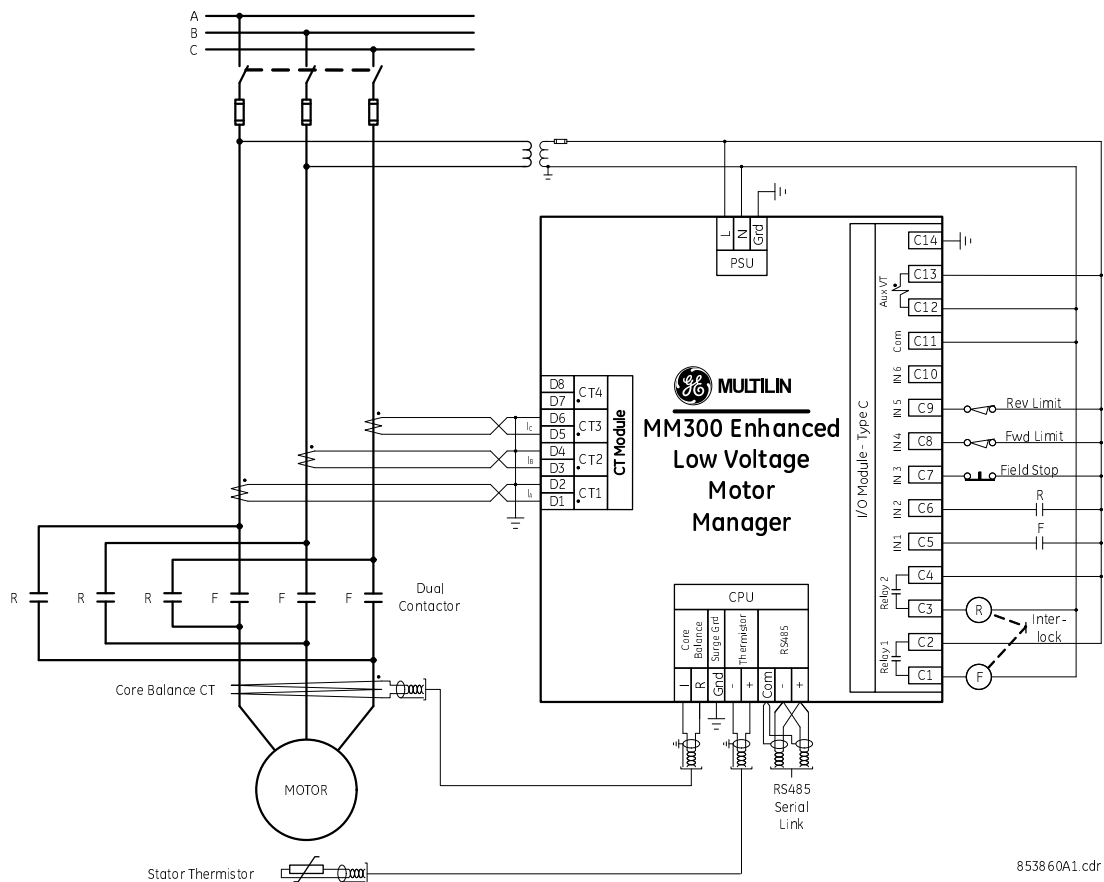


Figure 34: Full-voltage reversing starter typical wiring - IO_C

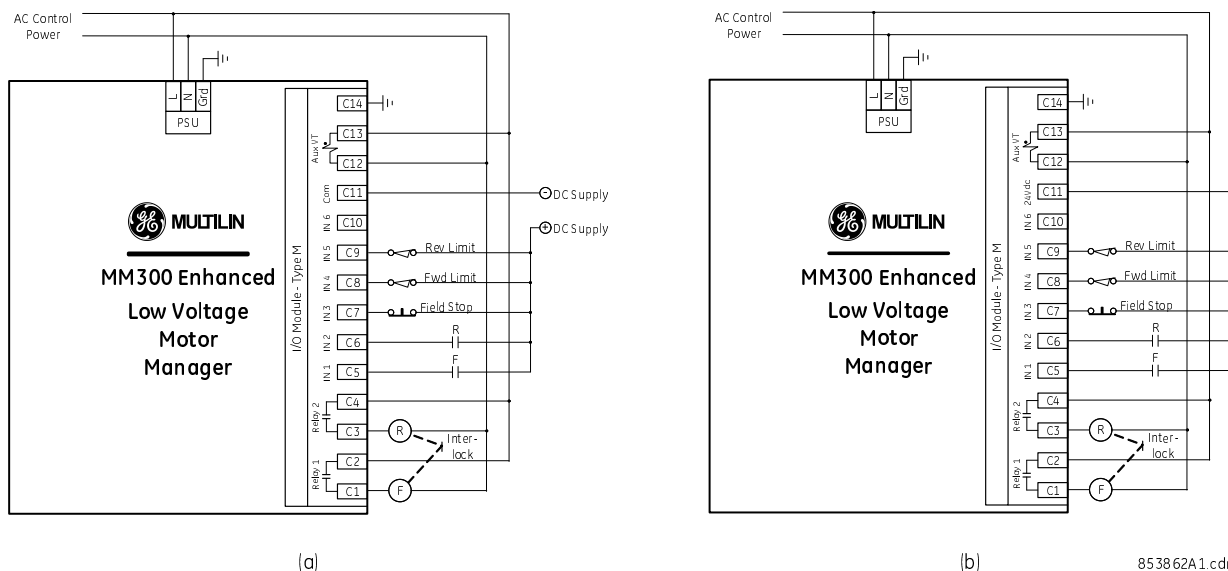


Figure 35: Full-voltage reversing starter typical wiring - IO_M (a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

The full-voltage reversing starter type is a full voltage or across-the-line reversing starter.

When a start A (forward) control is received, the pre-contactor relay (if any) is picked up for the set pre-contactor time. When the pre-contactor timer times out, relay1 picks up and seals-in, picking up contactor F, which starts the motor in the forward direction. When a start B (reverse) control is received, relay1 drops out, and contactor F drops out. When the contactor F Off status is received, the starter waits for the set transfer time to allow the motor to slow or stop. When the transfer time timer times out, relay2 picks up and seals-in, picking up contactor R, which starts the motor in the reverse direction. When a stop control is received, relays 1 and 2 drop out, contactor F and R drop out, and the motor stops. The starter logic is fully symmetrical between forward and reverse.

When a contact input has its function set to forward limit, and that contact closes, relay1 will drop out, stopping any forward rotation. When a contact input has its function set to reverse limit, and that contact closes, relay2 will drop out, stopping any reverse rotation. The pre-contactor is omitted on forced starts (for example, UVR Immediate, External Start). Forced starts are not supervised by this starter transfer timer – any external starting circuit must itself respect fast direction change restrictions.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

3.4.3 TWO-SPEED STARTER

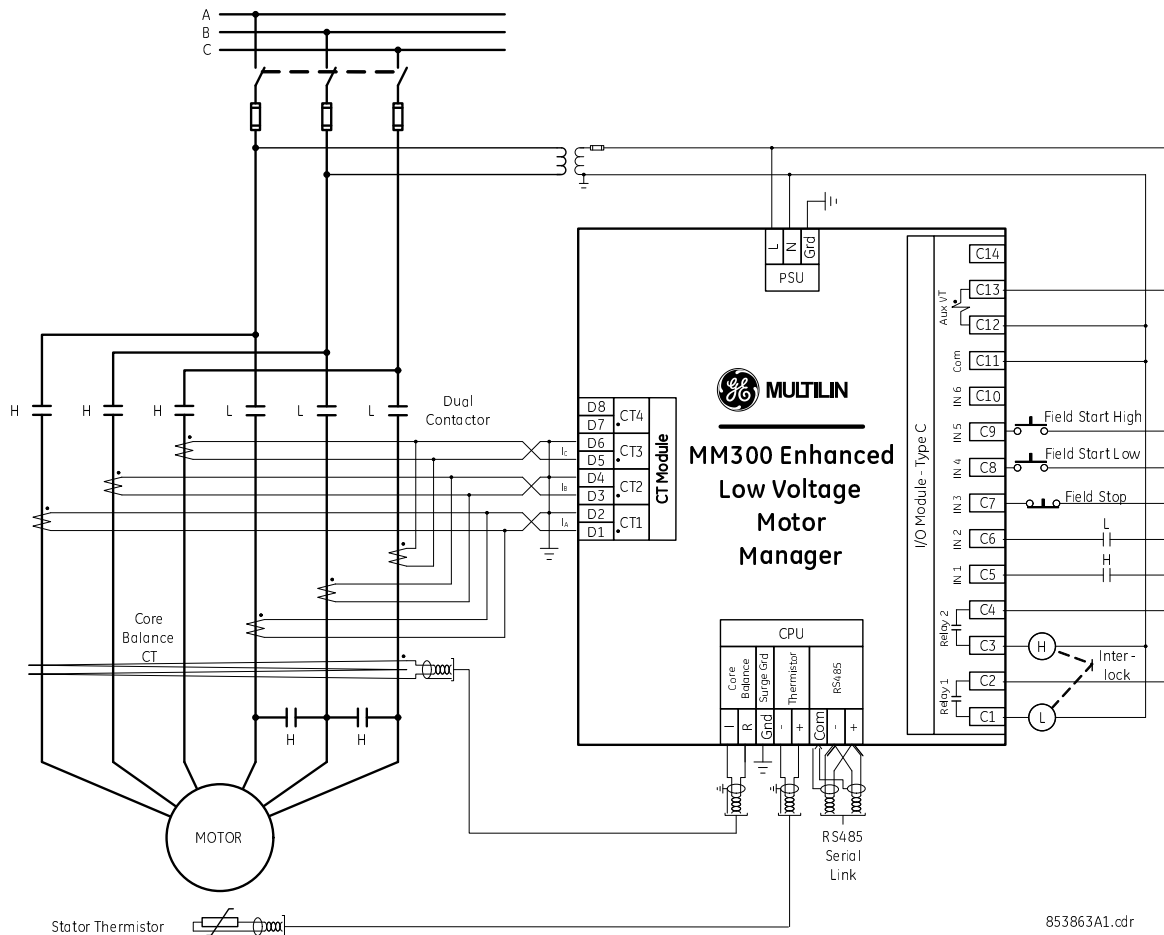


Figure 36: Two-speed starter typical wiring - IO_C

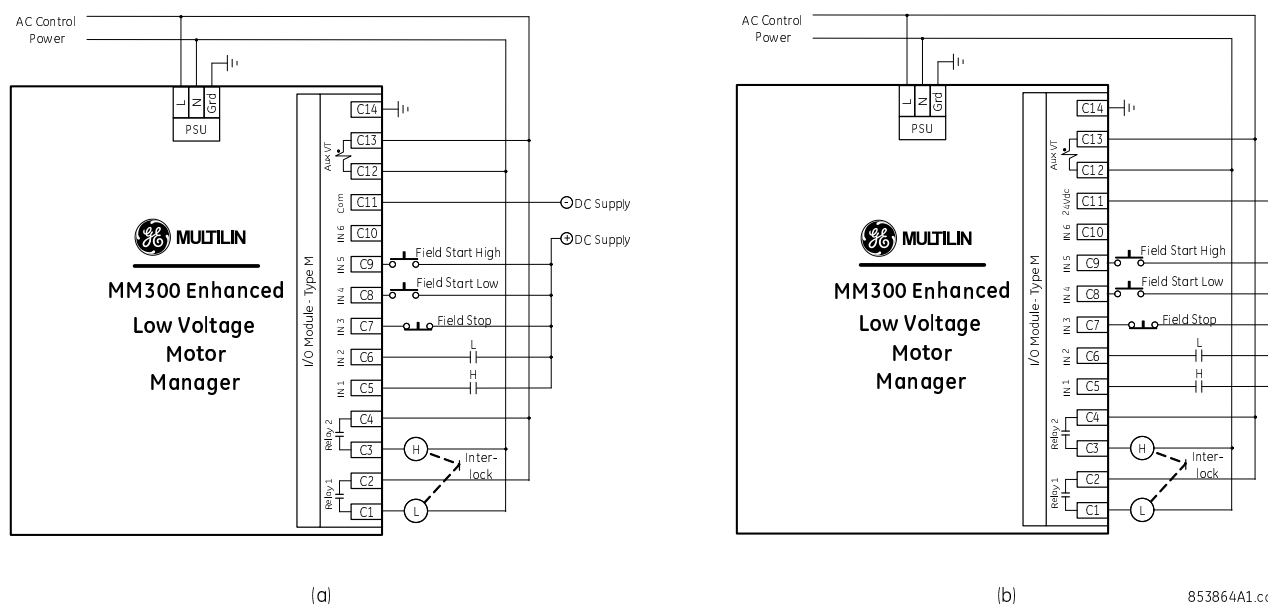


Figure 37: Two-speed starter typical wiring IO_M(a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

This starter type is a full voltage or across-the-line two speed starter.

When a start A (low speed) control is received, the pre-contactor relay (if any) is picked up for the set pre-contactor time. When the pre-contactor timer times out, relay1 picks up and seals-in, picking up contactor L, which starts the motor in low speed. When a start B (high speed) control is received, the relay1 drops out, and contactor L drops out. When contactor L Off status is received, the relay2 picks up and seals-in, picking up contactor H, which starts the motor in high speed. Should a start A (low speed) control be received when relay2 is picked up, relay2 is drops out, and contactor H drops out. When contactor H Off status is received, the starter waits for the set transfer time to allow the motor to slow. When the transfer time timer times out, the relay1 picks up and seals-in, picking up contactor L, which starts the motor in low speed. When a stop control is received, the relays 1 and 2 drop out, contactors L and H drop out, and the motor stops. If the **HIGH SPEED START BLOCK** setting is *Enabled*, this starter will not allow a start B (high speed) control unless already running at low speed.

The pre-contactor is omitted on forced starts (for example, UVR Immediate, External Start). Forced starts are not supervised by the starter transfer timer – any external starting circuit must itself respect high to low speed transition restrictions and starting in high speed restrictions.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

3.4.4 WYE-DELTA OPEN TRANSITION STARTER

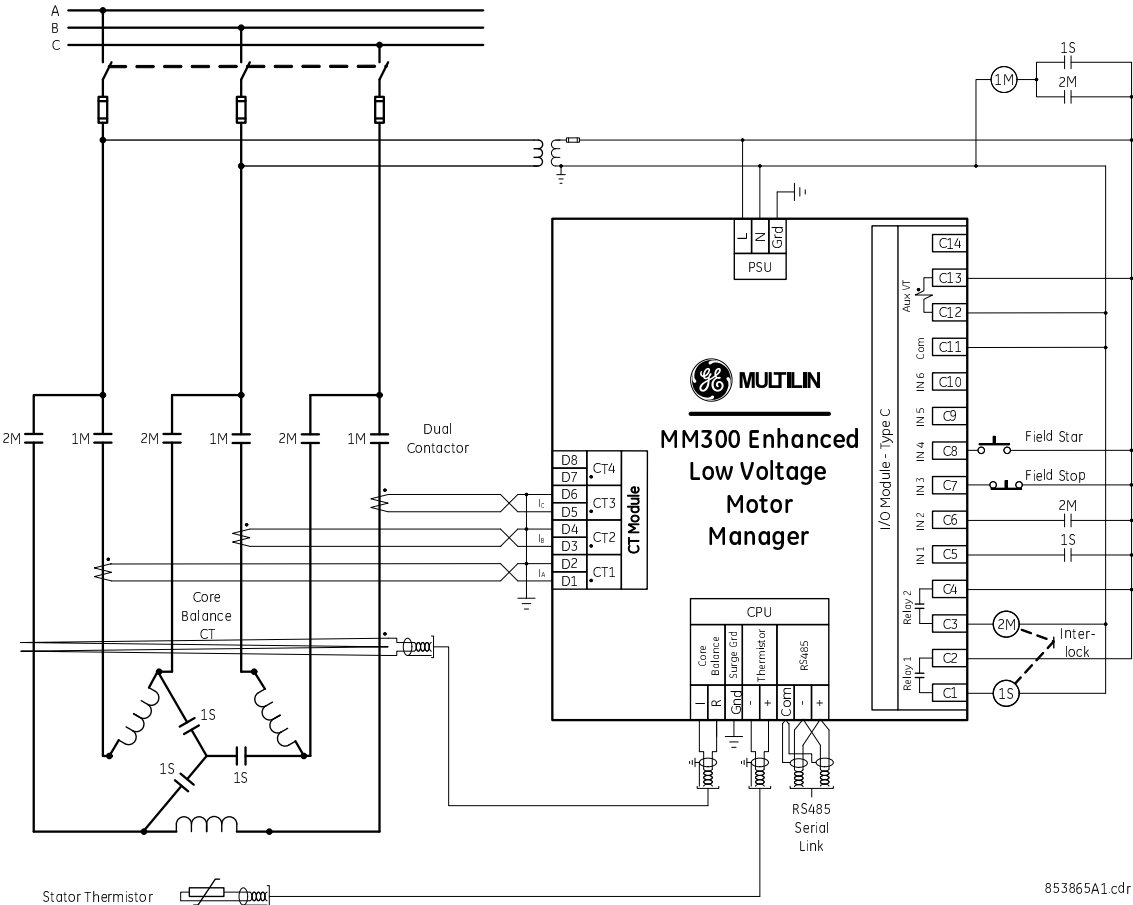


Figure 38: Wye-delta open transition starter typical wiring - IO_C

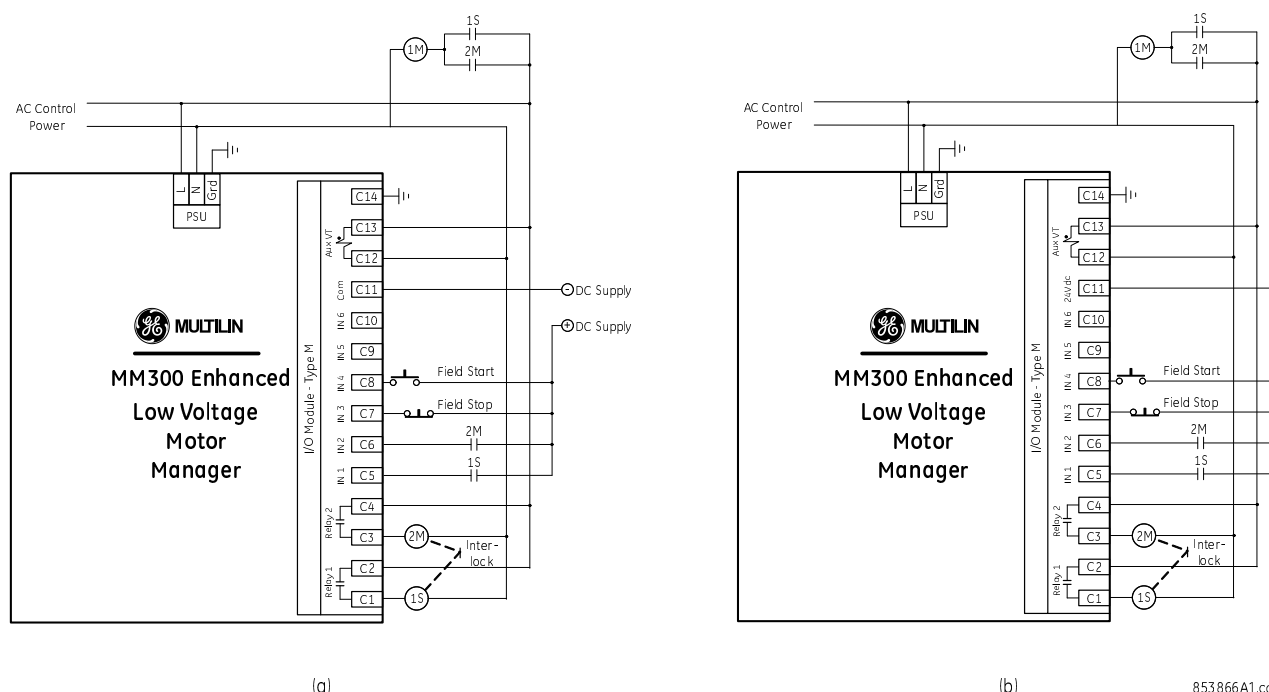


Figure 39: Wye-delta open transition starter typical wiring - IO_M(a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

The wye-delta open transition starter is a reduced voltage starter.

When a start A control is received, the pre-contactor relay (if any) is picked up for the set pre-contactor time. When the pre-contactor timer times out, relay1 picks up and seals-in, picking up the 1S contactor, which connects the motor in wye configuration. The 1S contactor in turn picks up the 1M contactor, which connects the motor to the supply. The motor is now starting at 58% voltage. When the transfer time timer expires, the relay1 is de-energized, contactor 1S drops out, opening the wye and disconnecting the motor from the supply. When the contactor 1S Off status is received, relay2 picks up and seals-in, picking up the 2M contactor, which connects the motor in delta configuration. The 2M contactor in turn picks up the 1M contactor, which connects the motor to the supply. The motor is now running at full voltage. When a stop control is received, relays 1 and 2 drop out, contactor 1S and 2M drop out, contactor 1M drops out, and the motor stops.

Pre-contactor is omitted on forced starts (for example, UVR Immediate, External Start). Otherwise, type A forced starts operate in the same fashion as other type A starts, with the transfer to full voltage occurring when the transfer time expires. Type B forced starts are not supervised by this starter transfer timer – any external type B starting circuit must itself respect full voltage starting restrictions.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

3.4.5 INVERTER STARTER

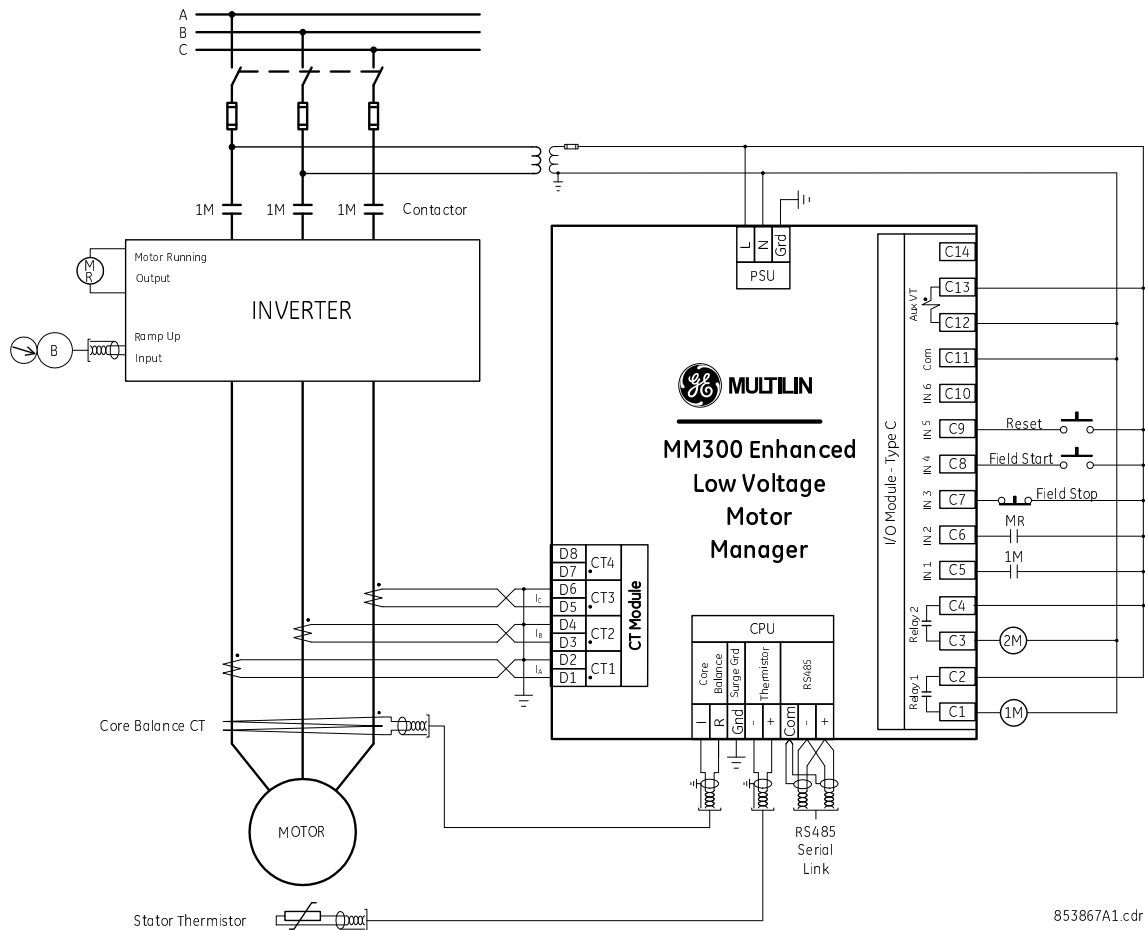


Figure 40: Inverter starter typical wiring - IO_C

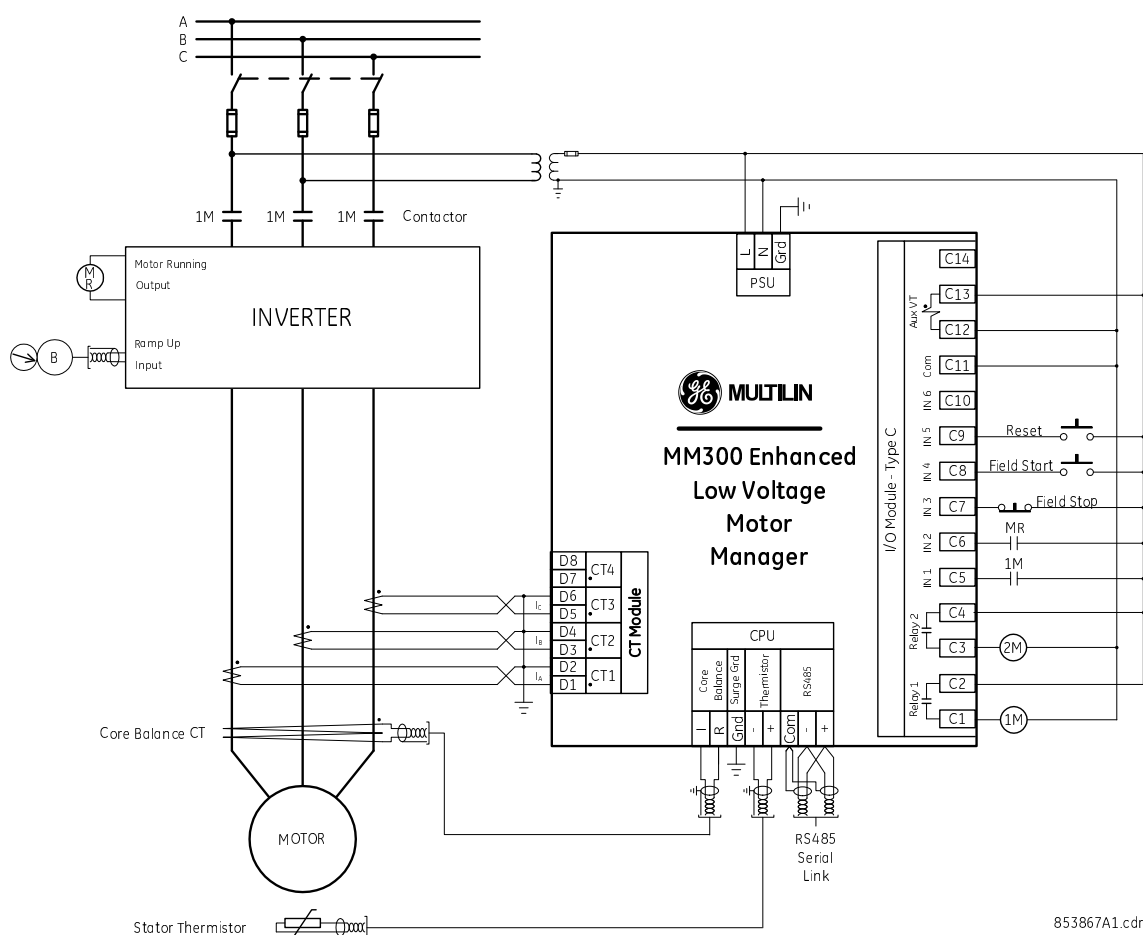


Figure 41: Inverter starter typical wiring - IO_M(a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

The inverter starter is used with an external inverter that ramps the motor speed up on start and ramps it down on stop.

The B Open Contactor Control Circuit and B Welded Contactor alarms are defeated when the inverter starter is selected.

When a start A control is received, the pre-contactor (if any) is picked up for the set delay, then relay1 picks up and seals-in, picking up contactor 1M. This provides power for the inverter to start up. Relay2 closes after a 1 second delay, and seals in, which signals the inverter to ramp up the motor. When a stop control is received, the relay2 drops out, and the inverter ramps down. When the ramp down time timer has expired, relay1 is opened, contactor 1M drops out, cutting power to the inverter and motor.

The inverter signals the relay that it is up-to-speed by closing auxiliary relay MR. If the auxiliary relay MR unexpectedly opens while running, signaling a possible inverter problem, relay2 drops out, and the inverter ramps down if it has not done so already. An Inverter alarm is issued, but relay1 remains closed, so contactor 1M stays picked up, and the supply to the inverter is maintained. This is done so that the inverter has power to retain its event records for subsequent diagnosis of the problem. Relay1 is opened removing power to the inverter when a stop control is received, and the alarm is reset on the next start.

Forced starts (for example, External Start) operate in the same fashion as other starts, with relay1 not picking up until the pre-contactor timer times out. Then, after 1 second, relay2 picks up. If up-to-speed feedback is not received from auxiliary relay MR within the RAMP UP TIME setting during a start, a Drive Start Failed alarm is generated. If

up-to-speed feedback is not seen before a stop control, an Inverter Fail alarm is generated, and relay2 opens as described above. If inverter speed feedback remains when the ramp down time expires during a stop, a Drive Stop Fail alarm is generated. Neither results in a trip or a stop. The Drive Start Failed alarm is latched until reset or cleared by a stop control. The Inverter Fail alarm is cleared at next start.

The Undervoltage Autorestart feature is disabled for the Inverter Starter.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

Note:

Ensure inverter is located before contactor.

3.4.6 SOFT STARTER TYPE

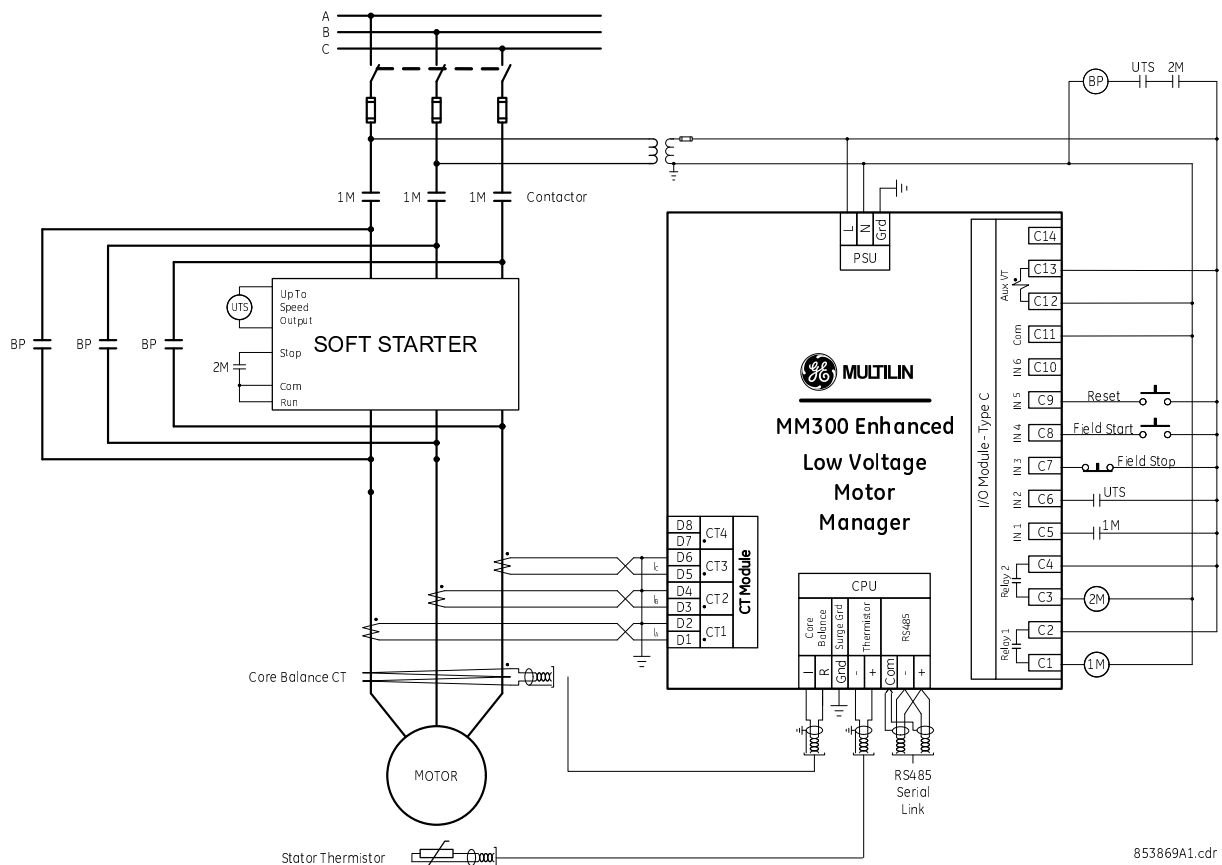


Figure 42: Soft starter typical wiring - IO_C

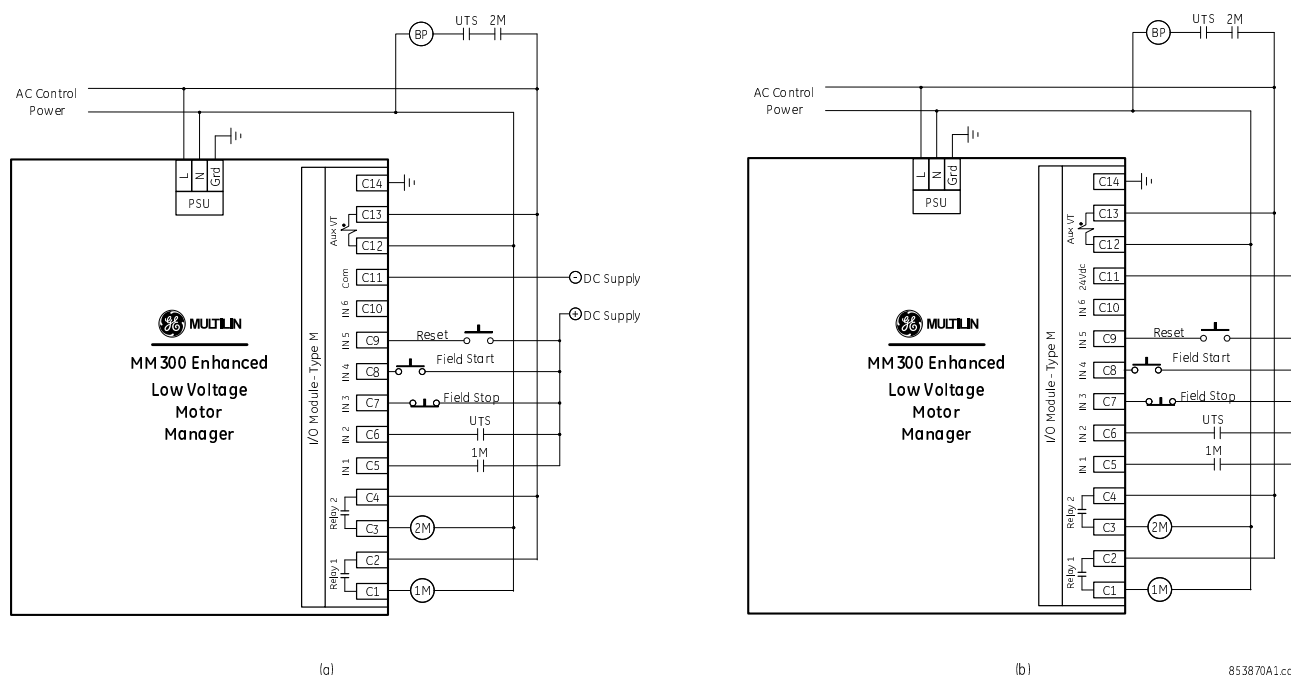


Figure 43: Soft starter typical control wiring - IO_M(a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

The soft starter type is used with an external soft starter that ramps the motor speed up on start and down on stop. Once the motor is ramped up, the soft starter can be bypassed.

When a start A control is received, the pre-contactor (if any) is picked up for the set delay, then relay1 picks up and seals-in, picking up contactor 1M. This provides power for the soft starter to start up and to drive the motor. Relay2 closes after a 1 second delay, and seals in, which signals the soft starter to ramp up the motor, then relay 2M signals the soft starter to ramp the motor up. When the soft starter signals up-to-speed by picking up auxiliary relay UTS, the starter generates the soft starter bypass signal. When a stop control is received, relay2 drops out, signaling the soft starter to ramp down. When the ramp down time timer has expired, relay1 is opened, M1 drops out, cutting power to the soft starter and motor.

Forced starts (for example, External Start) operate in the same fashion as other starts; relay2 closes after a 1 second delay. If up-to-speed feedback is not received from auxiliary relay UTS within the RAMP UP TIME setting during a start, a Drive Start Failed alarm is generated. If soft starter speed feedback remains when the ramp down time expires during a stop, a Drive Stop Fail alarm is generated. Neither results in a trip or a stop. The Drive Start Failed alarm is cleared by a stop control.

The B Open Contactor Control Circuit and B Welded Contactor alarms implemented in the start/stop control element are defeated when the soft starter is selected.

The Undervoltage Autorestart feature is disabled for the Soft Starter.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

Note:

Ensure soft starter is located before contactor.

3.4.7 AUTOTRANSFORMER OPEN TRANSITION STARTER

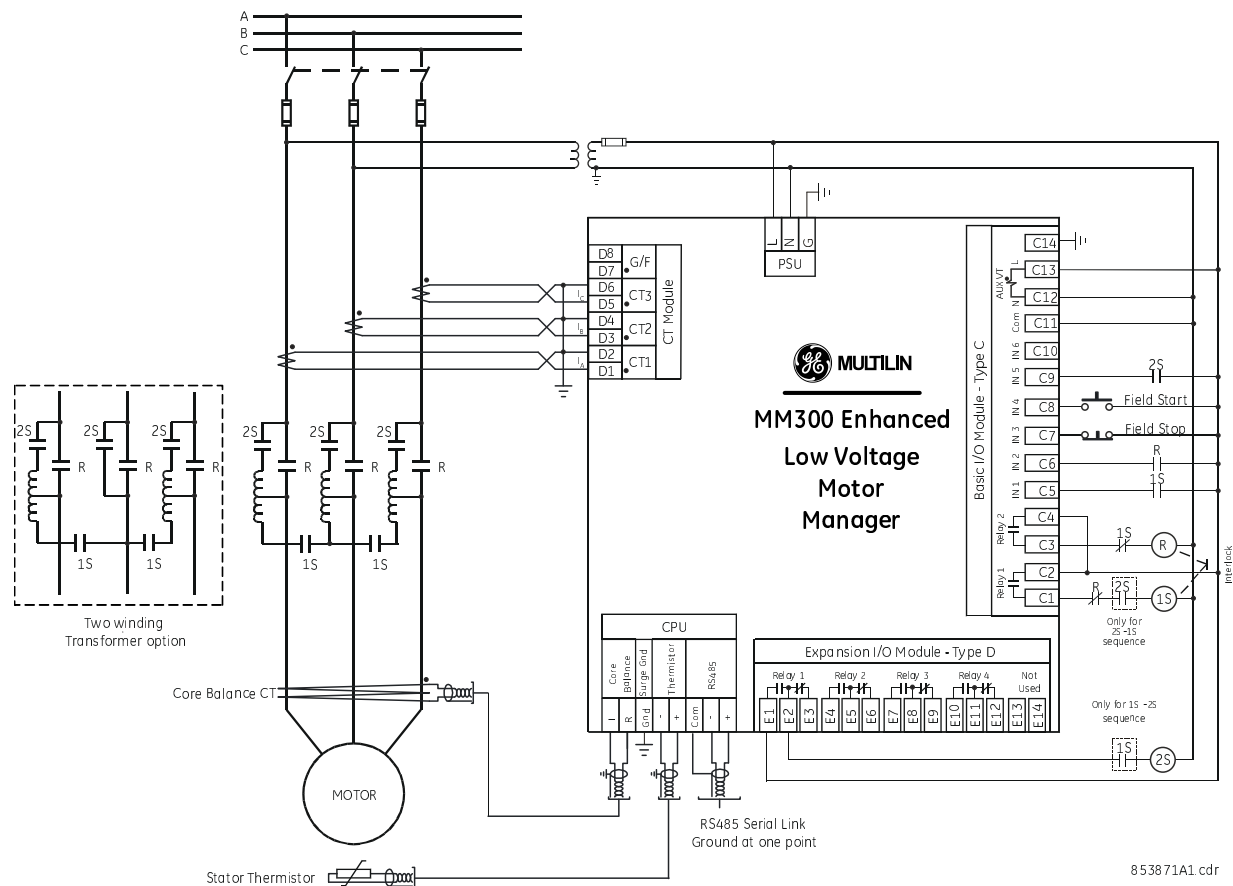


Figure 44: Autotransformer open transition starter typical wiring - IO_C

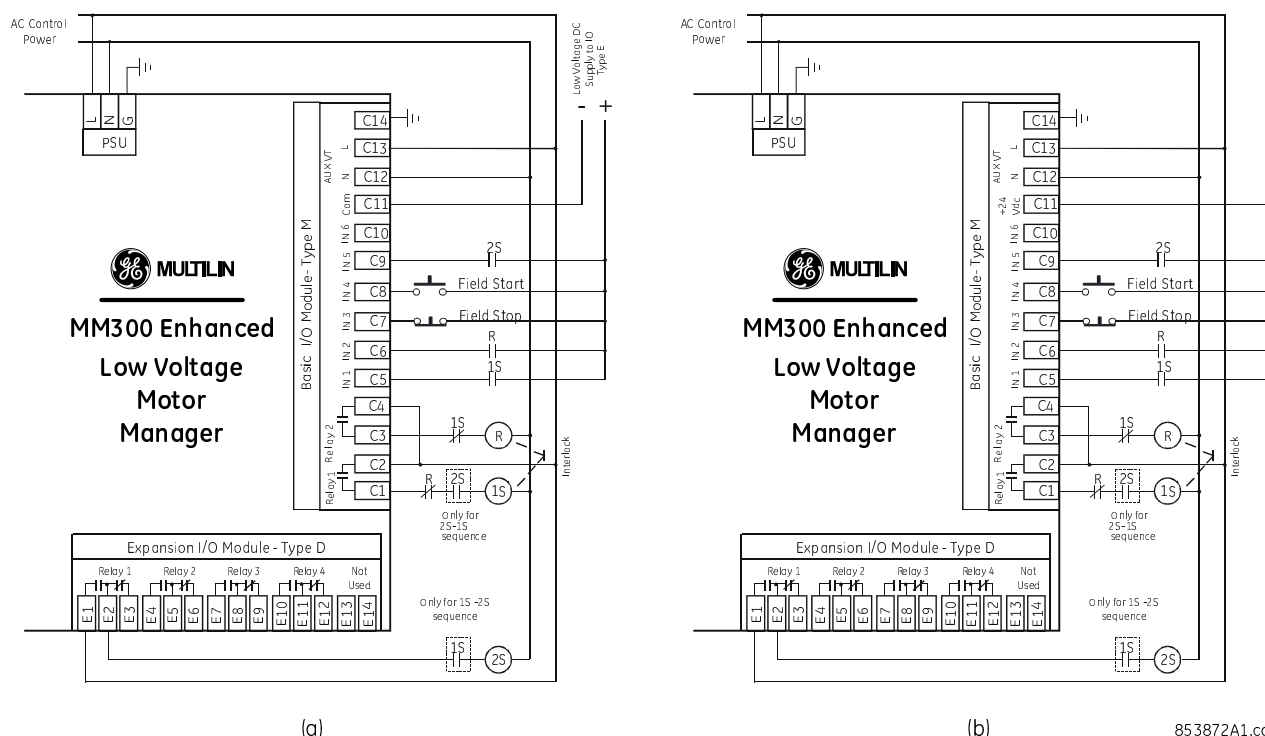


Figure 45: Autotransformer open transition starter typical control wiring - IO_M(a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

Autotransformer open transition starter is a reduced voltage starter. Three motor contactors R, 1S and 2S each controlled by a separate relay output relay are used to perform this function. There are two options of this starter: 1S-2S and 2S-1S. For more details please refer to Autotransformer open transition starter.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

3.4.8 AUTOTRANSFORMER CLOSED TRANSITION STARTER

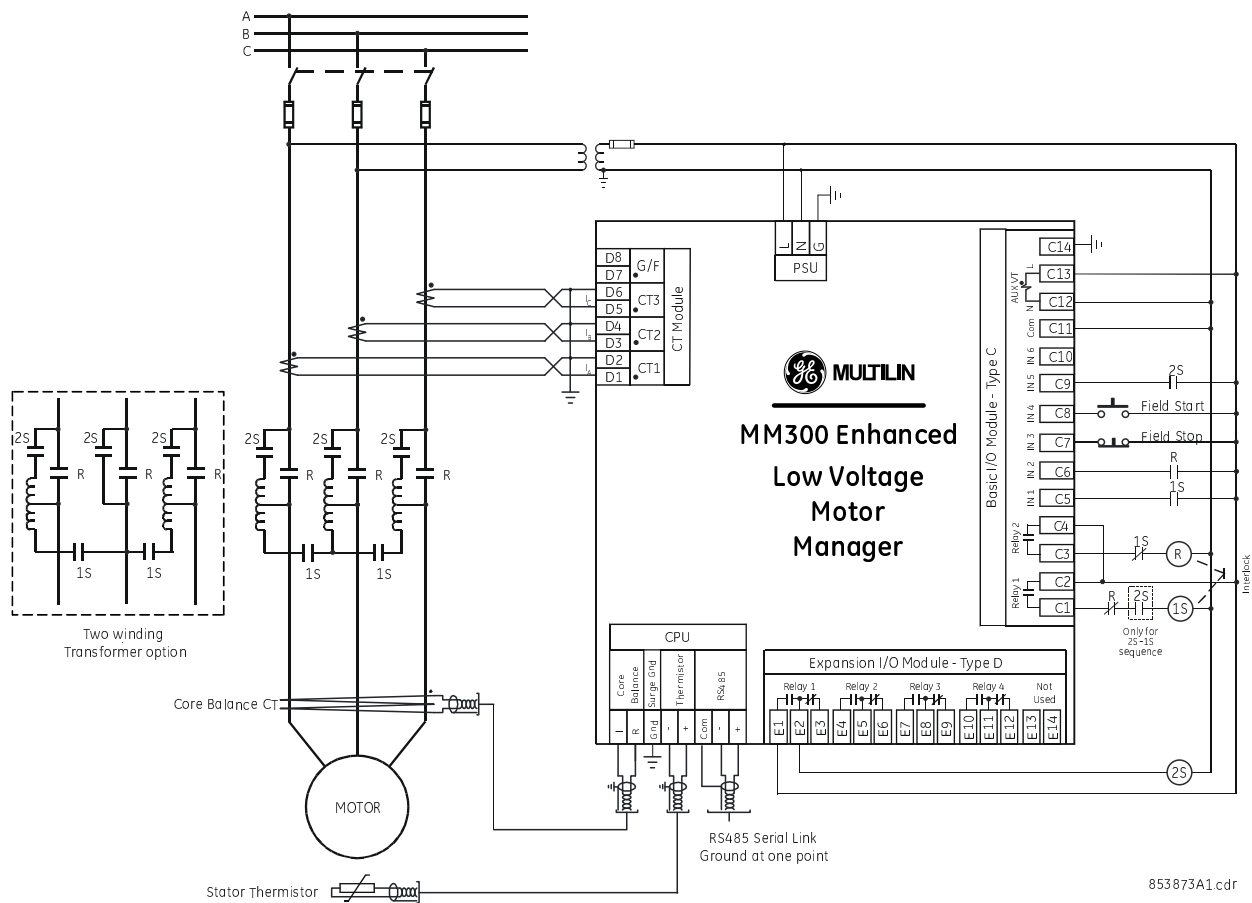


Figure 46: Autotransformer closed transition starter typical wiring - IO_C

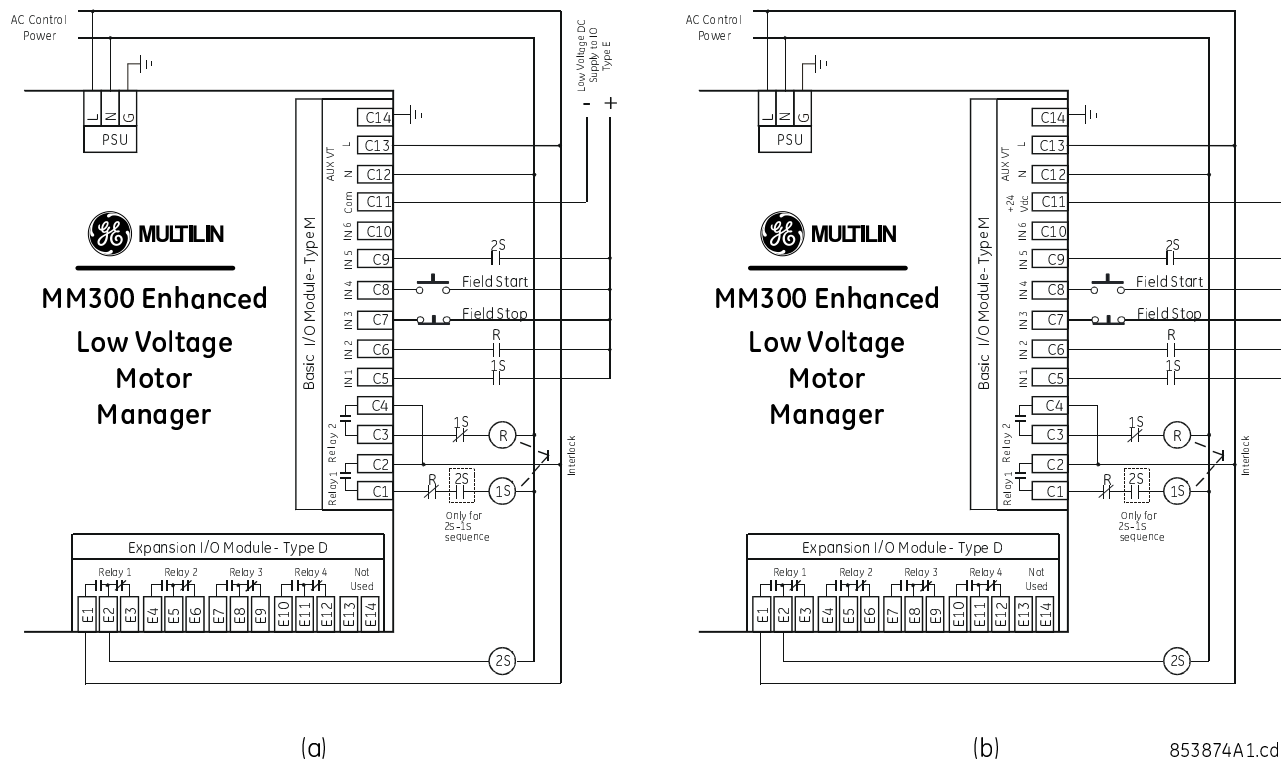


Figure 47: Autotransformer closed transition starter typical control wiring - IO_M (a) wet input contacts (b) dry input contacts

Note:

The above drawing applies only to a high-voltage power supply. If a low-voltage (DC) power supply is used, an appropriate DC voltage source must be used for this power supply.

Autotransformer closed transition starter is a reduced voltage starter. Three motor contactors R, 1S and 2S each controlled by a separate 859 output relay are used to perform this function. There are two options of this starter: 1S-2S and 2S-1S. For more details please refer to Autotransformer closed transition starter.

Note:

Connect AUX VT to the Control Supply for correct operation of the UV Restart feature and correct input readings.

CHAPTER 4

FRONT PANEL

4.1 **CHAPTER OVERVIEW**

This chapter contains the following sections:

Chapter Overview	60
Interfaces	61

4.2 INTERFACES

There are three methods of interfacing with the MM300 Enhanced Motor Management System .

- Interfacing via the graphical control panel.
- Interfacing via the basic control panel.
- Interfacing via the EnerVista Flex software.

This section provides an overview of the interfacing methods available with the relay using the Graphical and Basic control panels. For additional details on interface parameters (for example, settings, actual values, etc.), refer to the individual chapters.

4.2.1 GRAPHICAL CONTROL PANEL

The MM300 Enhanced graphical control panel provides the operator with rapid access to relevant information and controls using intuitive sequences. It also provides all available information and setting control, again with intuitive sequences.

4.2.1.1 INTRODUCTION TO THE GRAPHICAL CONTROL PANEL

The central feature of the graphical control panel is a 3.5-inch 320 by 240 pixel backlit color LCD screen. The panel also contains keys (pushbuttons) that control the display and perform commands. In addition, the interface contains START A, START B, and STOP direct acting control pushbuttons.

The display also contains several LED indicators that provide a summary of the machine status. Details are displayed on the screen when the user navigates to the appropriate page.



Figure 48: Front panel with example default display

4.2.1.1.1 GRAPHICAL DISPLAY

Each display page consists of the following three components:

HEADER BAR

The header bar displays the hierarchical path name, the date and time in 24-hour format, and the current password access level. The hierarchical path is always displayed on the left top side of the graphical display. The present time is displayed on the right top side. If the test switch is on, the time is replaced with the text `TEST MODE` in red.

SOFT-KEY LABELS

These are indicated on the bottom line. The soft-keys are used for navigation, performing functions, and for acknowledgment.

- Navigation: soft-keys can be used to traverse across and down the hierarchy of pages.
- Functional: soft-keys can be used to perform page-specific functions.
- Acknowledgment: soft keys can be used to acknowledge popup windows.

Soft-key labels change to show relevant selections for the displayed screen. The color of each soft-key label indicates its functionality. Soft-keys are highlighted for the displayed page, unauthorized keys are grayed-out, and unused keys are not displayed.

SELECTED PAGE

The remainder of the screen shows the selected page. Pages are organized in a hierarchical or tree-based menu structure. To improve readability, some pages are labeled with rectangular outlines or colored backgrounds. Some pages contain too many fields to display at once. These pages display arrows bars at the right edge to indicate that the page continues below the screen. When recalled, scrolled pages are re-positioned at the top of the page.

Fields display actual value or setting information, and have behaviors that allow help display, editing, and control.

Each Actual Value analog field displayed on the home page has an associated alarm limit and changes color to orange when that limit is exceeded. Fields with an associated trip limit change their color to red when that limit has tripped. Fields that are disabled or unavailable are grayed-out.

4.2.1.1.2 KEYPAD

The function keys perform the labeled functionality. The summary of function key operation is shown below.

Summary of function key operations

Key	Operation
HOME	Single press recalls the home page; double press recalls the default display
UP	Scroll up page, select field, tab to next field, increment value
DOWN	Scroll down page, select field, tab to previous field, decrement value
ESC	Single press closes pop-up, cancels editing, deselects field, moves to previous page; sustained press logs out (cancels security passcode entry)
ENTER	Single press freezes scrolling and selects field, edits selected field, saves edited value; double press sets the selected field/page as default; sustained press logs in (enter security passcode)
HELP	Displays context sensitive help and Modbus address

The HOME key always recalls the root or home page. The home page allows access to all sub-pages and also contains a status and process values summary. Double pressing the HOME key recalls the default display. Like a screen-saver, the default display appears after a period of inactivity and displays user-selected information.

The UP and DOWN keys function in different ways depending on their context.

- Where a scroll bar is displayed, the UP and DOWN keys scroll the page up and down.
- Where there is no scroll bar or it is grayed-out, the first press of the UP and DOWN keys selects the first field. Subsequent presses tab up and down through the fields, scrolling as required.
- When a field is open for editing, the UP and DOWN keys increment/decrement the value of that field.

The ENTER key functions in different ways depending on its context.

- If there are no selected fields, the ENTER key will freeze any scroll bars and select the first field on the display.
- If a field is selected, pressing ENTER will attempt to open it for editing.
- If a field is opened for editing, pressing enter will exit the edit sequence.
- Double pressing the ENTER key at any time selects the displayed page as the default display.
- A sustained press on ENTER prompts the security passcode and displays a dialog box that allows passcode entry.

For example, pressing and holding the ENTER key, or attempting a control where a password is required, displays the **PASSCODE ENTRY** dialog box.

The ESC key functions in different ways depending on its context.

- If a pop-up dialog box is displayed, the ESC key closes it.
- If an edit sequence is in progress, the ESC key cancels the edit.
- If a field is selected, the ESC key de-selects it.
- In all other instances, the ESC key moves back one page in the menu structure.
- A sustained press on the ESC key clears the security passcode and prompts for confirmation.

The HELP key functions in different ways depending on its context.

- If a field is selected, the HELP key displays a help window for the field.
- If a help window is displayed, the HELP key closes it.

Help windows are also closed when any other key is pressed.

Pressing an invalid key displays a message explaining the problem and recommending a solution. Where the key-press is invalid because a security passcode is required, the dialog window will be a passcode entry window.

When a lockout occurs that clears when a count-down timer expires or when the thermal capacity recovers for a restart, the **Status > Message** page is displayed indicating timer value or thermal capacity.

4.2.1.1.3 CONTROL KEYS

The MM300 Enhanced has three large direct control keys: START A, START B, and STOP.

- STOP: The STOP key allows the user to stop the motor directly from the MM300 Enhanced faceplate interface. Pressing this key causes the contactor A and contactor B output relays to de-energize, therefore dropping out the motor contactor.



Warning:
The STOP button on the control panel cannot be used as an E-Stop switch. An external series Emergency push button should be installed.

- START A and START B: Pressing these keys initiates the programmed start sequence. The START A and START B keys are used to start the motor from the MM300 Enhanced faceplate (if MCC control is enabled). The start A and start B sequences can also be initiated via communications, field control, or hardwired input.

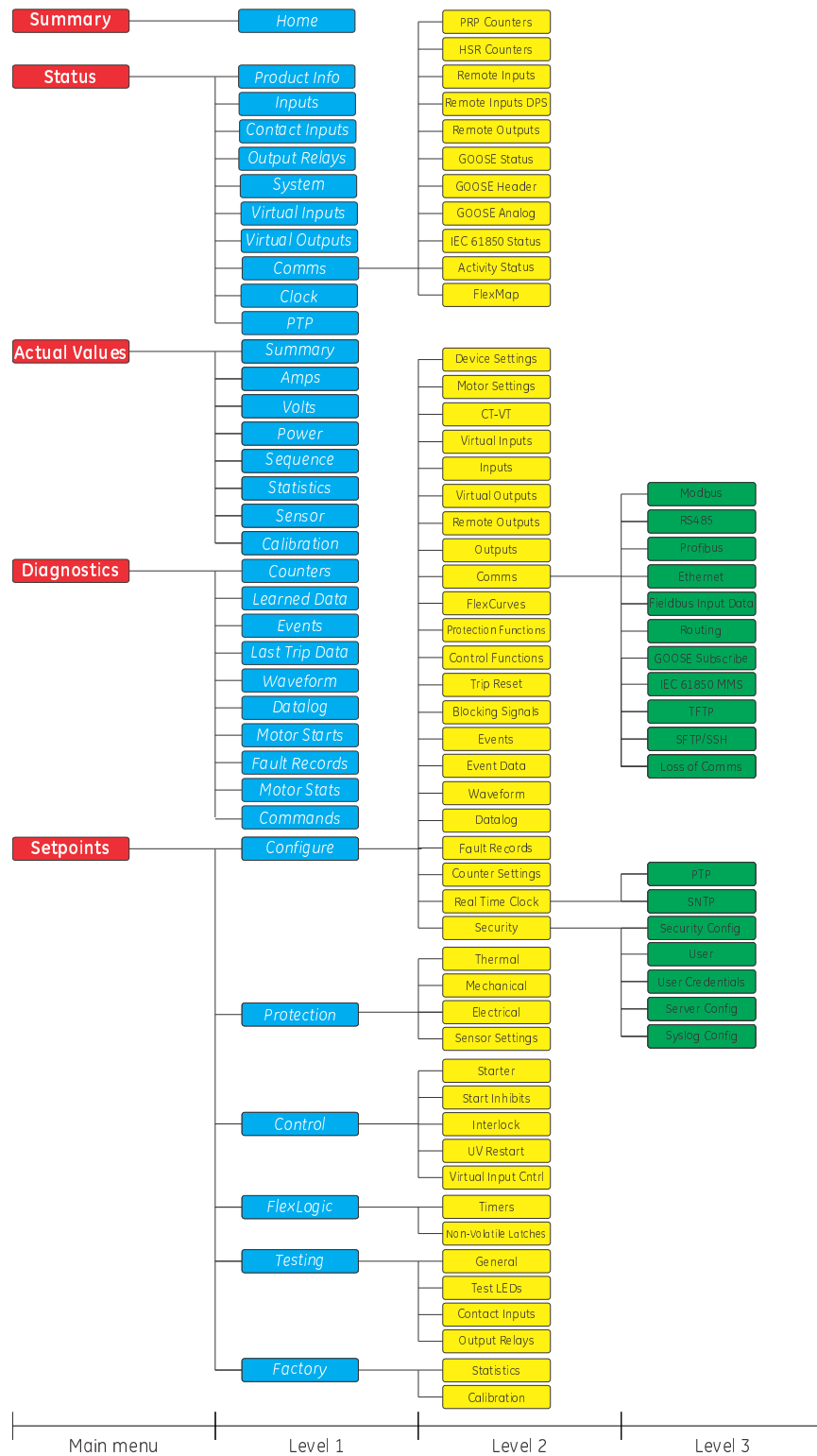
4.2.1.1.4 LED INDICATORS

The control panel LEDs summarize the status of the device and up to three user-programmable parameters. The LED colors can be independently configured by the user to display either red, orange, or green, as required by local operating conventions. The following LEDs are available for the MM300 Enhanced.

- Running LED: Indicates that the motor is running. It will be on whenever the contactor A or B relays are closed and the contactor status inputs acknowledge the correct state. Current flow does not affect the indicator.
- Stopped LED: Indicates that the motor is stopped based on both contactors A and B being de-energized.
- Tripped LED: Indicates that the A and B contactor relays are de-energized. The motor cannot be restarted as long as this indicator remains on.
- Alarm LED: Indicates that an alarm condition is present.
- Auto LED: Indicates if the MM300 Enhanced is in auto control mode.
- Manual LED: Indicates if the MM300 Enhanced is in manual control mode.
- Comms OK LED: Indicates the status of communication interface activity. If interfaces are communicating, then the LED is green. If interfaces are failed, then the LED is red. If one of the interfaces are failed, then this LED is orange.
- User 1 to User 3 LEDs: These LEDs can be programmed by the user to indicate any digital condition.

4.2.1.2 GRAPHICAL DISPLAY PAGES

A summary of the MM300 Enhanced page hierarchy is shown below.



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Figure 49: MM300 Enhanced display page hierarchy

4.2.1.2.1 HOME DISPLAY PAGE

The home page represents the root of the entire menu structure. An overview of the system status is displayed which includes the following items.

- Locked out, tripped, blocked, stopped, pre-contactor, starting, running status, and inhibit.
- Motor load, thermal capacity used, and power.
- Estimated time to trip (if motor is loaded above its service factor).
- The longest current timeout from any of the pre-contactor time, time to overload, time to reset, starts/hour block, time between starts, transfer time, undervoltage restart time, and restart block timers.
- Temperature of the hottest stator RTD (if there is an RTD and the two previous items are not applicable).
- Average line-to-line voltage (if there is no RTD).

The VALUES, STATUS, SETPOINTS, DIAG, and CONTROL soft-keys are displayed on the home page. The STATUS soft-key will be highlighted red if any trip conditions are active, orange if relay is not tripped and any alarm conditions are present. Otherwise it will be gray. If the **TRIPPED LED FLASHER** setpoint is set to “ON”, the soft-key will flash red if there is a trip or lockout.

Pressing any of the soft-keys displays the first sub-page in the hierarchy. Pressing the ESC key within any of these sub-pages returns directly to the home page.

4.2.1.2.2 DEFAULT DISPLAY

The default display is automatically shown when no control key has been pressed for five minutes. It can also be recalled at any time by double-clicking the HOME key.

The default display can be set to the home page, any actual values page, or any status page. A page can be set to be the default display by navigating to that page and double-pressing the ENTER key. The default display setting is saved in non-volatile memory.

If a page is set as the default display, the soft-keys will be those of the selected page.

4.2.1.2.3 STATUS PAGES

The status pages provide the user with up-to-date information on the current status of the MM300 Enhanced.

Status pages are divided into ten sections.

- Product Info
- Inputs (displays the present state of assigned contact inputs).
- Contact Inputs
- Output Relays
- System (displays the present state of the communications interface).
- Virtual Inputs
- Virtual Outputs
- Comms
- Clock
- PTP

Message types are classified by color and associated icon type, as follows:

- Red Triangle = Trip
- Orange Square = Alarm
- Blue Circle = Stop
- Black Text = Information Message

Message can have an associated countdown timer.

When the relay is first powered up, the status page lists why the relay is not available for service. This is not an exhaustive list of setpoints to be configured, but is a list of key items such as **FLA**, **CT TYPE**, **STARTER TYPE** and **CONTROL SOURCE**, that must be configured before the unit will be available for use. Protection values must still be configured for the motor to be protected correctly.

Stops

These include Process Interlock Stop, and Field Stop.

Trips/Alarms

These trigger depending on the protection setpoints. A typical example would be; **OVERLOAD TRIPS**.

Information Messages

Information pages are split into two groups:

- With navigation (an ENTER symbol is shown on the right side of the display)
- Without navigation

When a line showing a message (with navigation) is highlighted, pressing ENTER will navigate directly to the page in question, so that the situation can be quickly resolved. A typical example would be `FLA not set`. Selecting this entry on the page will take you to the **Setpoints > Config > Motor** page.

4.2.1.2.4 ACTUAL VALUES PAGES

The actual values pages are divided into eight sections.

- Summary (overview of primary actual values)
- Amps (metered current values)
- Volts (metered voltage values)
- Power (metered power values)
- Sequence
- Statistics
- Sensor (metered temperature and thermistor values)
- Calibration

The actual values summary page displays a summary of the analog actual values. The above pages are accessible from the summary page through the corresponding soft-keys at the bottom of the screen.

4.2.1.2.5 DIAGNOSTICS PAGES

The diagnostic pages are divided into ten sections.

- Counters (accumulated system counter data)
- Learned Data (learned values based upon metered data)
- Events (event recorder data for up to 256 events)
- Last Trip Data
- Waveform (waveform parameters)
- Datalog (datalog parameters)
- Motor Starts
- Fault Records
- Commands

Pressing ENTER on a highlighted line on one of the above pages will take you directly into the detailed event analysis screen. Only ID and date/time will be displayed for event information on the Graphical Control Panel. For detailed information on events, the user needs to connect via EnerVista Flex.

4.2.1.2.6 SETPOINTS PAGES

The setpoints pages are divided into five sections.

- Configure (contains basic configuration setpoints)
- Protection (contains the protection setpoints)
- Control (contains the control setpoints)
- FlexLogic
- Testing
- Factory (contains settings used by for testing and calibration purposes.)

The setpoints page displays a warning message concerning unexpected performance if setpoints are improperly changed. It is recommended that all relay outputs capable of causing damage or harm be blocked before a setpoints change is made and it is clear the relay is performing as intended with the new setpoints.

To streamline the setpoint entry process, the graphical control panel will not display setpoints that are not relevant at the specific instance. For instance, if a process interlock function is disabled, the six setpoints associated with that interlock function will not be displayed. If all ten process interlock functions are disabled, the MM300 Enhanced will display only 10 successive *Disabled* list items. If one of the interlock functions were then enabled, then room is made on the display for the six setpoints which are now functional.

The setpoint pages are in a common format of twelve rows and two columns displaying setpoint name, value, and units.

4.2.1.2.7 POPUP WINDOWS

There are three types of popup windows:

- Setpoint editor popup windows.
- Help popup windows.
- Invalid operation popup windows.

Refer to Setpoints for details on setpoint editor popup windows.

Help popup windows are initiated by pressing the HELP key. Refer to Keypad for more information about help popup windows.

Invalid operation popups explain the problem and provide direction on how to rectify it. This may also include invalid features or uninstalled options (for example, accessing the undervoltage restart page when undervoltage restart option is not ordered). Where a key-press is illegal because a security passcode is required, the popup is a passcode entry dialog box.

Help and illegal action popup windows remain open until they are acknowledged by clicking any soft or hard key, or until a pre-determined period of inactivity has passed.

4.2.1.3 PROGRAMMING TECHNIQUES

To streamline the setting entry process, the graphical control panel omits non-functional settings from the display.



Caution:

Settings may be changed while the motor is running. However, appropriate measures must be taken to limit the consequences of entering unintended or misunderstood setting values. Consequences of inappropriate settings to the specific application at hand include loss of protection, loss of control, and undesired starting or stopping.

4.2.1.3.1 ENUMERATION SETPOINTS

Enumeration settings select from a limited set of values (for example, enabled or disabled). The following procedure describes how to edit an enumeration setting:

1. Use the soft-keys to select the relevant setting page.
2. Use the UP and DOWN keys to select the relevant setting field.
3. Press the ENTER key. A popup window will appear with a list of available values.
4. Use the UP and DOWN keys to select from the available values. If there are more than seven available values, then an arrow indicator will appear on the lower right of the popup to indicate additional selections.
5. Press the ENTER key when complete to exit the edit sequence. The selection will be automatically saved.
6. Press ESC to cancel the edit and leave the setpoint unchanged.

4.2.1.3.2 NUMERIC SETPOINTS

Numeric setpoints accept a numerical value within a specific range. The numeric setpoint editor is a numeric input panel, with the current value shown on the number display. The minimum, maximum, step, and default values are shown on the left of the keypad, and the label of the setpoint being edited is displayed on the menu bar of the setpoint editor.

The navigational soft keys change the numeric key in focus, which is highlighted in orange. There are also five functional soft-buttons in the popup window.

- BkSpc: This key performs the backspace function, clearing the last digit or decimal from the display.
- CLR: This key clears the field's value from the display
- Default: This key returns the setpoint value to its default value.
- OFF: This key disables the setpoint and is visible only for setpoints that can be disabled.

In order to activate the functions offered by these buttons, the user has to highlight the appropriate button and press Select.

The UP and DOWN front panel keys can also be used to increment and decrement the setpoint by its step value. Clicking the ENTER key verifies the displayed value. If the setpoint value is valid, it is stored as the new setpoint value and the editor is closed. Otherwise, an error statement is displayed and the DEFAULT soft-button is brought to focus. Clicking HOME before the value is stored cancels the edit sequence and recalls the home page.

The following procedure describes how to edit a numeric setting.

1. Use the navigation keys to select the relevant setting page.
2. Use the navigation keys to select the relevant setting field.
3. Press the ENTER key to open the numeric setpoint editor.
4. Use the navigational soft-keys to highlight the first digit of the new setpoint value.
5. Press the Select soft-key to select the highlighted digit.
6. Use the navigational soft-keys to highlight the next digit, then press Select.
7. When the new value has been fully entered, press the ENTER key to store the value and close the window.

4.2.1.3.3 ALPHANUMERIC SETPOINTS

Alphanumeric setpoints accept any alphanumeric value of a specified size and are generally used for labeling and identification purposes. When an alphanumeric setpoint is selected, the MM300 Enhanced displays an alphanumeric setpoint editor window.

A flashing underline marks the current character. The "<" and ">" soft-keys shift the cursor left and right. When the cursor is at the extreme right hand side of the field and the field has not reached its maximum length of string input, the ">" key shifts the cursor to the right and sets the selected character to the space character. Up to 20 characters can be stored for alphanumeric setpoints. A long click of the "<" and ">" soft keys move the cursor to the first or last character in the string.

The up and down soft-keys increment and decrement the selected character through the character set. A long click of the up or down soft-keys sets the selected character to “a” and “Z”, respectively. The shift soft-key toggles the case of the character set. Pressing ENTER stores the selected value, while pressing ESC cancels the editing sequence and closes the popup editor.

The following procedure describes how to edit an alphanumeric setting.

1. Use the soft-keys to select the relevant setting page.
2. Use the arrow soft-keys to select the relevant alphanumeric setpoint field.
3. Press the ENTER key to open the alphanumeric setpoint editor.
4. The first character of the alphanumeric setting value will be marked with a flashing cursor (underline).
5. Use the up, down, left, right, shift, and space soft-keys to change the indicated character.
6. Use the left and right arrow soft-keys to select and change more characters.
7. Press the ENTER key when complete to exit the edit sequence. The changes are automatically saved.

4.2.1.3.4 DATE, TIME, AND IP ENTRY

The entry process for date, time, and IP setpoints follows the same convention as numeric setpoints, where the day, month, year, hour, minute, second, and each octet of the IP address are entered as separate fields. Input verification is performed for all fields of the setpoint when the ENTER key is pressed. As these are standard formats, the minimum, maximum and step value displays are removed. For date and time setpoints, a format string of DD/MM/YYYY or HH:MM:SS is included as a part of the setpoint label for reference when entering a new value.

4.2.1.3.5 SECURITY ACCESS

Depending on the order code selected for the product, (Basic or Advanced) there are different security access levels. Please see Cyber-security for more detailed information.

In order to allow the modification of settings via the Graphical Control Panel, navigate to **Setpoints > Configure > Security**, and with **Login** highlighted, press the ENTER button.

After selecting **Login**, pop up windows for either Basic or Advanced Cyber-security, according to the product's order code, will be displayed:

- Basic - Available roles for selection
- Advanced - Username entry field

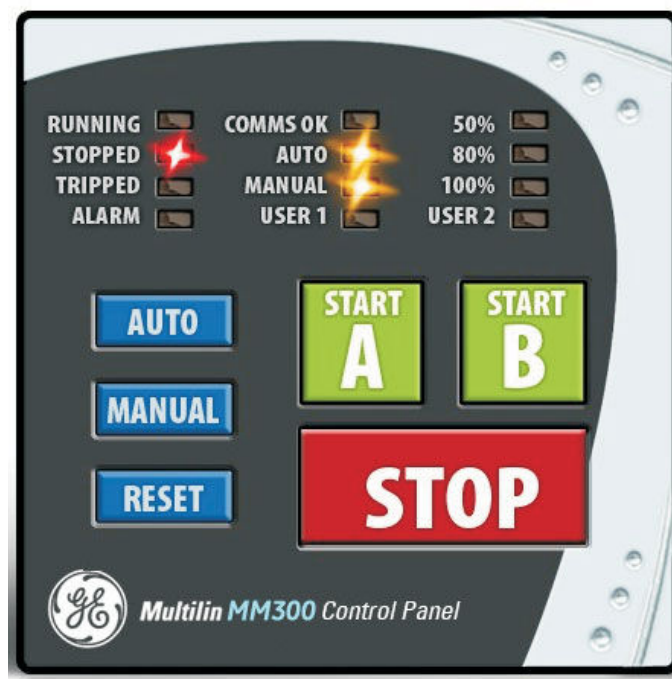
Once the relevant action has been taken, a password will be required.

Note:

For models with Advanced cyber-security, any logout that occurs when using the Graphical Control Panel will be reported to Syslog as a Manual Timeout.

4.2.2 BASIC CONTROL PANEL

The MM300 Enhanced Basic control panel includes pushbuttons for Stop, Start A, Start B, Auto, Manual, and Reset, and 12 LED status indicators.



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Figure 50: Basic control panel

DIRECT CONTROL PUSHBUTTONS

The MM300 Enhanced basic control panel has three large direct control keys: START A, START B, and STOP. The STOP key allows the user to stop the motor directly from the MM300 Enhanced faceplate interface. Pressing this key causes the contactor A and contactor B output relays to de-energize, therefore dropping out the motor contactor. The START A and START B keys are used to start the motor from the MM300 Enhanced faceplate if MCC control is enabled.

AUTO AND MANUAL PUSHBUTTONS

When a switch contact is configured for auto/manual, the front panel auto/manual pushbuttons are inoperative. When no switch contacts are configured, but the **MCC AUTO/MANUAL KEY** setpoint is “Enabled”, the control panel auto and manual keys will switch the mode between auto and manual. When no input is configured for auto or manual, and the **MCC AUTO/MANUAL KEY** setpoint is “Disabled”, both auto and manual modes are set on.

RESET PUSHBUTTON

When the Reset button is pressed, a reset command is sent. The BCP reset key will perform a non-lockout and lockout reset if **RESET LOCKOUT USING RESET KEY** option is “Enabled”.

LED INDICATORS

The following LEDs are provided:

- **Running LED** Indicates that the motor is running. It will be on whenever the contactor A or B relays are closed, and the contactor status inputs acknowledge the correct state. Current flow does not affect the indicator.
- **Stopped LED** Indicates that the motor is stopped based on both contactors A and B being de-energized.
- **Tripped LED** Indicates that the A and B contactor relays are de-energized. The motor cannot be restarted as long as this indicator remains on.
- **Alarm LED** Indicates that an alarm condition is present.
- **Auto LED** Indicates if the MM300 Enhanced is in auto control mode.

- **Manual LED** Indicates if the MM300 Enhanced is in manual control mode.
- **Comms OK LED** Indicates the status of communication interface activity. If interfaces are communicating, then the LED is green. If interfaces are failed, then the LED is red. If one of the interfaces are failed, then this LED is orange.
- **User 1 and User 2 LEDs** These LEDs can be programmed by the user to indicate any digital condition.
- 50%/80%/100% - showing motor load.



Warning:

The **STOP** button on the MM300 Enhanced control panel cannot be used as an E-Stop switch. An external Emergency push button should be installed.

CHAPTER 5

ENERVISTA FLEX

5.1 CHAPTER OVERVIEW

The settings application software used in this range of IEDs is called EnerVista Flex. It is a collection of software tools, which is used for managing all aspects of the IEDs. This chapter provides a brief description of each software tool.

This chapter contains the following sections:

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5.2 INSTALL ENERVISTA FLEX

Installation of the EnerVista Flex software requires system administrator access to the computer.

Note:

If there is a previous version of the EnerVista Flex software installed on the computer, it must be uninstalled before installing a new software version.

1. Download the EnerVista Flex installer from the GE web page.
2. Launch the installer by right-clicking on the .exe and selecting the option to **Run as administrator**.
3. When the initial installer screen opens, click **Yes** and then click **Next** in the following screen to continue.
4. Read and accept the terms in the license agreement by selecting the **I accept the terms in the license agreement** radio button, click **Next** to continue.
5. Click **Install** to start the installation. To review any information in previous steps, click Back. To stop the installation, click **Cancel**.
6. Wait for the installation to finish. Progress is indicated by the Status bar.
7. After installation, click **Finish** to close the window.

The software installation process creates the following folder:

C:\Program Files (x86)\GE Power Management\EnerVista Flex

5.3 UNINSTALL ENERVISTA FLEX

To uninstall the software:

1. Access the Control Panel in Windows® and click the ***Uninstall or change a program*** option from ***Programs and Features***.
2. Select EnerVista Flex from the list of installed software and click ***Uninstall***.
3. Confirm the uninstall, if necessary.
4. Wait for the software removal process to complete. This can take a few minutes.
5. Confirm the software has been removed by viewing the list of installed software in the Windows® Control Panel.

5.4 CONFIGURE COMMUNICATION PORTS

Communication using EnerVista Flex can be established through three different port types. To set proper communication parameters, the user selects the communication channel they will be using when communicating through EnerVista Flex.

- USB - Allows communication via the Graphical control Panel USB
- Serial - Allows communication via the RS485 port
- Ethernet - Allows communication via EnerVista Flex when using the RJ45 ports available in the relay

For large file transfers such as the Motor health report or Disturbance Records, for example, Ethernet communication is recommended for a faster user experience.

Firmware upgrade can only be done using Ethernet communication

Note:

USB slave address need to set to 1 when communicating via front USB port with MM300 Enhanced.

5.5 ACCESS MANAGEMENT

User roles are used to control access to the EnerVista Flex software.

There are five default users provided within the EnerVista Flex software, one for each user role. The table below describes the user roles, default user names, and permission levels within the EnerVista Flex software. Use these accounts as a starting point for your installation. Additional accounts can be created by logging in to the Admin or UserAdmin account.

Note:

Default accounts for all but Guest have the initial password set to **Welcome#123**.

Guest default password is **Guest#1234**.

The names and email addresses associated with each account should be changed to reflect the actual user information, with passwords changed on first login.

User Role	Default User Name*	Permissible Actions
Administrator	Admin	All access, firmware upload.
Engineer	Engg	Everything except user management and firmware upload
Operator	Oper	Connect to online devices only
Guest	Guest	Open Project, Receive CID, View Settings Open, Receive and Refresh Disturbance Recorder Open Device, View IEC 61850 Print and View PSL
Cyber-Security	UserAdmin	User management only

User account information (other than the user password) can only be changed by users with Administrator or Cyber-Security user roles.

5.5.1 PASSWORD REQUIREMENTS

Passwords used for user authentication have the following requirements:

- 9 characters minimum
- Must include at least 3 of the following: uppercase, lowercase, numeric and special characters (@, !, #, {, etc).
- The password is encrypted and saved in the database

5.6 LOGIN

The login screen of the EnerVista Flex software allows the selection of five language alternatives: English, French, Spanish, Russian and Turkish.

Select a language and enter a valid username and password to login.

Note:

Username and passwords, as well as user profiles are set by the system administrator. User Profile settings allow or block access to different parts of the EnerVista Flex software.

After login, the Main Screen of EnerVista Flex opens

The main screen includes the following areas:

Software Name – GE EnerVista Flex

Welcome

This area can be used to create a new project or open an existing project. Previously viewed projects are listed so they can be re-opened quickly, and sample projects which can be used and reamed are also included.

Modules

Used to Navigate to the Project View to Quick connect a device.

Other Apps

Used to launch the EnerVista 8Series and EnerVista UR software applications.

User

This area includes software version information, user preferences, and user logout controls.

Each area on the main screen is detailed in the following sections.

5.7 USER SETTINGS

The User area on the main screen is described below.

From left to right, the options available are:

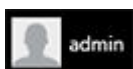
- **Settings**
- **About**
- **admin**
- Window controls (minimize, maximize and close)



Settings



About



admin

The Settings button provides access to the **My Preferences Setting** dialog box, with the following options:

- **Appearance**
 - Choose from the six colour scheme options
- **Setting Preferences**
 - Setting File Transfer--Edit communications settings for offline device
 - Poll Cycle Setting--Enable poll cycle

The **About** button shows the EnerVista Flex version and release dialog box.

Information is required should you need to contact GE customer support.

The **admin** button allows access to the **Manage Role Based Access** dialog box, with tools to configure, **User Accounts**, **User Groups** and **Roles**.

5.7.1 EDIT MY PROFILE

Use the **Edit Profile** menu under **MANAGED ROLE BASED ACCESS\USER ACCOUNTS** path in EnerVista Flex to change your password, user profile picture, or the first and last name associated with your account. Other changes to user accounts require Administrator or Cyber-Security access.

To change your password:

1. Click the edit icon to the right of the password field.
2. Enter a new password.
3. Confirm the new password by entering it in the second password field and click **Save** to save your changes.

Note:

Passwords must be a minimum of 9 characters including at least three of the following: uppercase, lowercase, numeric, and special characters.

5.8 QUICK CONNECT

Click the **Quick Connect** button to quickly connect to a device using USB or ethernet connection by entering and selecting appropriate interface (USB or Ethernet) IP address, Slave Address and Port. The Device Type selected is P40Agile-Enh for P40 Agile Enhanced IEDs. The model number and version info may be obtained from the device by clicking the **Read Model Number** button. Click the **Connect** button and connection will be established with the device if the rest of the parameters are ok.



Quick Connect

Figure 51: The quick connect dialog box

Once connected using Quick Connect, the Device name, model number, version and IP address are listed in the Quick Connect pane. Mouseover the device entry in the Quick connect pane and click the **Service Report** button to open the Generate Service Report dialog box to download the service report (used for technical support purposes) from the device, and click the **Firmware Update** button to open the Firmware Update dialog box to update the IED firmware and click the **Go to device view** button to configure the device, settings, logic designer and IEC 61850 (if available according to the Cortec).



Service Report

Clicking the **Service Report** option will open the Authenticate dialog box. Enter the device password for the appropriate IED role and click the **Connect** button.

When connected to the IED, a Generate Service Report window will open where the user can choose the file location in the computer for saving the Service Report Zip file. After selecting the file path to generate the service report, the user should click on the **Generate** button and the service report files (if available in the device) will be downloaded from the device in zip format. The files provided (if available) are:

- CID device file
- Events device files
- Disturbance records device (Comtrade) files

- Fault Reports device files
- Data Logger device (Comtrade) files
- Target messages device file
- Last 5 EnerVista Flex Debug logs



Firmware Update

The **Firmware Update** dialog box allows the selection of a firmware file from a user defined file location accessible via the PC running EnerVista Flex. The Firmware Update dialog box is only available for the EnerVista Flex role of Administrator.

To update the device firmware, click on the **Go to device view** option that will open the Authenticate dialog box. Enter the device password for the appropriate IED role and click the **Connect** button.

After authenticating, a Firmware update window will open. This window has three sections: Device Status, New Firmware file, View Details. In the Device Status section, the user can see the current device firmware version model number, serial number and type of connection to the device. In the New Firmware File section, the user can select the new firmware file to be updated on the device. After selecting the new firmware file by clicking on the folder icon, the user should click on the **Read Firmware** button and the new firmware version to be updated will appear. After that click on the **Upload** button and the firmware update process will start. The firmware update process will take some time to complete. Do not power OFF the device until the process is complete. After the process will be complete the user can close the Firmware Update window. In the View Details section, the user can see all the details of the firmware update process.

Note:

The relay reboots after the firmware update. Wait at least 6 minutes to allow all I/O boards to complete their updates before powering off the relay.



Go to device view

Clicking the **Go to device view** option will open the **Authenticate** dialog box. Enter the device password for the appropriate IED role and click the **Connect** button. The **Required Access Level** roles in the **Authenticate** dialog box are the IED access roles (not the EnerVista Flex access roles). Refer to the User Configuration section in this chapter for more information.

When connected to the IED, the following device specific second-level tab options are available:

- Profile
- Setting
- Logic
- Monitor
- Records
- IEC 61850 Configuration
- User Configuration

For information about Profile, Setting, Logic and Records, refer to the Configuration section.

5.8.1 MONITOR

The IED **Monitor** menu ribbon contains the following items:

- Poll Status
- Commands

The **Poll Status** indicator shows a colour-coded device poll state; green if the poll cycle is being executed, red if not. The **Poll Cycle** setting can be configured under **SETTINGS\MY PREFERENCES SETTING** path in the User area of the main screen. Refer to the User Settings section in this chapter for more information.

The **Commands** button opens a **Commands** dialog box, allowing various commands to be sent to the device.

The **Monitor** pane may be docked and has five status category tabs at the bottom of the pane:

- Device Status
- Measurement
- Records
- Testing
- Virtual Inputs

Each of the Status pane tabs contains a filterable list of monitor items, with each selected item available as a tab at the top of the main workspace pane, with the attributes for the currently selected item shown in the main workspace. The path to the selected monitor item is shown at the bottom of the main workspace pane.

5.8.2 USER CONFIGURATION

The **User Configuration** pane allows device User type, Username, password and user rights to be modified and saved to the connected IED.

The IED roles are Administrator, Engineer, Operator and Viewer. Administrator, Engineer and Operator roles are password protected, 0 being the default password. Viewer requires no password. Refer to the Cyber-Security chapter for more information.

5.9 ERROR LIST

The **Error List** button at the bottom of the main screen provides access to a filtered/searchable list of device errors. The **Error List** menu ribbon has the following options:

- **Error**—Hides/unhides error items in the Error List workspace
- **Warning**—Hides/unhides warning items in the Error List workspace
- **Info**—Hides/unhides info items in the Error List workspace

The **Error List** may be pinned or minimised, as required.

5.10 IED CONFIGURATION

In order to configure an IED using the EnerVista Flex software, a project must be created and opened with at least one IED added, or an IED connected using Quick Connect.

If using a project for IED configuration, double-click the IED icon in the Project Topology view to open the IED Profile.

If connecting to an IED using Quick Connect the IED profile will open directly after authenticating to the device. The name of the IED CID file will be displayed at the top-level tab for both project based or Quick Connect IED configuration.

Note:

It is good practice to download the CID file from the IED and use it as the base for configuration changes.

The top-level IED tab comprises second-level items:

- Profile
- Setting
- Logic
- Records
- IEC 61850 Configuration

5.10.1 PROFILE TAB

The IED **Profile** tab provides device information and allows access to the device's language setting. **Device Language** setting options available are English(UK), English(US), Spanish, French, Russian and Turkish.

5.10.2 SETTING TAB

The IED **Setting** tab provides access to set the device settings, with device setting menu ribbon items:

- **Save**
- **Summary**
- **Export**
- **Close All**

The **Save** button saves all the setting changes done in the IED. The changes can be saved for every dedicated setting menu by clicking the **Save** button for each menu when the changes are done, or all the changes can be saved at once by clicking the higher level **Save** button on the **Setting** menu ribbon.

The **Summary** button opens a **Protection Summary** screen that displays the summarized information of settings from the Protection, Monitoring and Control setting in the IED. For more details on this subject, refer to the Protection Summary section within this chapter.

The **Export** button opens an **Export Device Settings** dialog box, allowing the setting data to be exported to XRIO, PDF, CSV and Excel file formats, with setting group data selected or deselected as required.

In the **Export Device Settings** dialog box, the **Copy Details** button copies the file export process details to the PC's copy/paste buffer.

The **Close All** button will close all the opened settings windows (including the Protection Summary) on the setting workspace.

To alter device settings, navigate in the **Settings** pane device tree to the desired setting name and double-click to modify the required parameters in each case.

A tab for each selected setting allows access at the top of the setting parameter workspace.

Note:

Hover over value fields for a menu tip showing the maximum, minimum and step values for each.

Note:

The selected setting path is shown at the bottom of the parameter workspace area.

Send CID File and **Receive CID File** buttons are provided (bottom right of main workspace) to send and receive CID data to/from the device. These buttons are only available when opening the IED CID file from a **Project**. If connected using **Quick Connect** they will not be available.



Send CID File



Receive CID File

5.10.2.1 PROTECTION SUMMARY

The Protection Summary screen displays the summarised information of settings from Protection, Monitoring and Control Elements. This window can be viewed by opening a device and clicking on the **Setting** tab where it is opened by default. This window can be closed using the **Close All** button in **Setting** tab toolbar or by clicking at the x at the **Protection Summary** tab name.

Protection Summary window is divided into three sections:

Toolbar

This has **Default**, **Restore**, **Refresh** and **Save** buttons, **Element Search** control and **Show Filters** expander control which shows/hides the Filter section which is open by default.

- **Default** sets the **Relays** (configurable relay outputs, Relay O/P X) and **Function** (Disabled, Trip, Alarm, Latched Alarm, Configurable) settings of all elements to Defaults. This button is always Enabled.
- **Restore** reverts the settings to saved values. This button is enabled when modifying any setting but is disabled by default.
- **Refresh** fetches the latest setting values from an online device. This is available for online devices only and is always enabled.
- **Save** will save setting values to device for online and to CID for offline devices. This button is enabled upon the modification of any setting including Active Setting.
- **Element Search** can be used to search for any Element.

Filter

This has different filters to narrow down the results displayed in Settings Data section.

- Using the **Relays** filter, the user can select the required Relays (configurable relay outputs, Relay O/P X) for viewing where all configurable relay outputs are selected by default.
- **Allow Column Filtering** is used to enable/disable column level filtering, which is unselected by default.
- **Groups** filter can be used to show/hide the available **Groups**, which are selected by default. Group 1 is always visible and cannot be hidden.
- **Active Settings** has the current Active Group selected in Device settings and can be changed and saved. The selected Active Group is highlighted in the Settings Data section and cannot be hidden using Groups filter.

Settings Data

This has **Settings** grouped in to three sections **Protection Elements**, **Monitoring Elements** and **Control Elements**. These three sections have Expander controls, with which the user can expand/collapse sections and view only the relevant element(s).

Each Elements section has three buttons: **Relays**, **Function Settings** and **Navigate to screen**.

- **Relays** (configurable relay outputs, Relay O/P X) are shown as radio buttons which have three states: Disabled (if **Function** setting is set to *Disabled*), On and Off. Elements which don't have configurable relay outputs are displayed as empty, which indicates that the Element has no **Relays (Relay O/P X)** settings to configure.
- **Function Settings** is shown as drop down and with current value selected.
- **Navigate to screen** opens a new tab/focuses already opened tab of the respective Element screen.

5.10.3 LOGIC DESIGNER

An external logic designer is opened when selecting the IED **Logic** tab. Logic may be created/edited and saved in the tool as required.

Once closed, the main Logic workspace contains a list of the logic command lines in tabular form.

The logic designer may be reopened by selecting the Logic Editor item in the Logic menu ribbon.

Note:

For detailed instructions, refer to the logic designer section.

5.10.4 RECORDS

The IED **Records** tab contains the following **Records** menu ribbon items:

- Open
- Import
- Export
- Email (Share)
- Print (Share)
- Application Cache (Show Records)
 - show/hide application cache records
- Device Cache (Show Records)
 - show/hide device cache records
- Imported Files
 - show/hide imported cache records
- Delete
- Refresh

The main **Records** workspace contains a filtered list of available records, with any open records selectable as tabs at the bottom of the workspace window.

Send CID File and **Receive CID File** buttons are provided (bottom right of main workspace) to send and receive CID data to or from the device.



Send CID File



Receive CID File

5.10.5 IEC 61850 CONFIGURATION

An external ***IEC 61850 Configuration*** tool is opened when selecting the IED ***IEC 61850 Configuration*** tab. The IED IEC 61850 configuration may be created, edited and saved in the tool as required.

Note:
For detailed instructions, refer to the IEC 61850 Configuration section.

Send CID File and ***Receive CID File*** buttons are provided (bottom right of main workspace) to send and receive CID data to or from the device.



Send CID File



Receive CID File

5.11 CREATE A NEW PROJECT

A project needs to be created and devices (one or more) added to it, in order to begin configuring individual settings, PSL logic and IEC 61850 (Cortec dependent feature) for each device. In order to create a project, do the following:

1. Click **New Project** in the Main Screen Welcome area (left side) or in the **Project** item in the **Modules** pane to manage Projects.
2. Enter a Project Name and Description and click **Create Project** when done.

The Project window opens to the **Topology View**, which is empty until IED devices are added.

The Project management space can be used to configure an extended system, such as a substation or bay with various substation elements and devices if desired.

Project View is selectable on the top row of tab items, this allows projects to be viewed.

Project Name is selectable on the top row. This is the user-defined project name.

Topology View is selectable on the second row. This view is empty until IED devices are added to the workspace.

The next step is to add one or more devices to the project, either by dragging and dropping a device into the workspace—the central region of the screen, or by using the **Quick Download** option (communicating directly with an IED) or by importing an existing CID file into the project by using the **Import** option available in the ribbon that contains the **Save**, **Import/Export**, **Send/Receive**, **Connection**, **Sync**, **Mode (Offline, Online)** and **Compare** options.

5.12 MANAGE PROJECTS

Select the **Open Project**, **New Project**, **Recent Project** or **Sample** item in the **Welcome** pane or the **Project** item in the **Modules** pane to manage Projects. The project may also be managed at any time in the project views, by selecting the top-level **Project** tab.



Project item in the **Modules** pane



Project tab

The **Project** page comprises a horizontal menu ribbon with:

- **My Computer**
- **Keyword Search**
- **Import**
- **Export**
- **Delete**

Projects may be created, opened and closed using the vertical menu ribbon on the left. Projects may be sorted, filtered, searched and selected via a project list in the main project management workspace.

Projects may be opened by double-clicking the desired project item listed.

5.13 PROJECT CONFIGURATION

5.13.1 TOPOLOGY VIEW

The **Topology View** comprises a **Toolbox** window at the left of the main workspace containing the **Substation Elements** and **IED Devices**, and a **Topology** window at the right of the main workspace.

Toolbox window elements and devices may be dragged into the project workspace window (main screen area). Right-clicking in the workspace window, or on selected substation elements or IEDs provides more options.

Topology window selections may be added, Imported, Exported, Edited and deleted as required, using the appropriate buttons.

The Topology View menu ribbon has options to:

- **Save**
- **Import** (CID or SCD)
- **Export** (CID or SCD)
- **Send CID**
- **Receive CID**
- **Quick Download**
- **Connection** (Associate, Disassociate)
- **Sync**
- **Mode** (Select **Offline** and **Online** modes)
- **Compare** topology elements (**Compare with Default**, **Compare across Projects**, **Compare with external device file**)

The movable (and dockable either left or right) **Toolbox** pane contains **Substation Elements** and **IED Devices**, which may be dragged to the main Topology workspace as required.

The movable (and dockable either left or right) **Topology** pane contains the project items in the main Topology workspace in a hierarchical tree view. The Topology pane also has options to:

- **Add Substation**
- **Add Voltage**
- **Add Bay**
- **Add Device**
- **Import** (CID or SCD)
- **Export** (CID or SCD)
- **Edit** (project, device, element name and description)
- **Delete** (Substation, Voltage and Bay items)

Topology pane project items are colour coded to indicate device/element, with the colour code key at the bottom of the Topology pane.

5.13.2 IEC 61850 CONFIGURATION

The **IEC 61850 Configuration** view comprises a **Publisher** pane, a **Dataset** pane a **Control Block** pane and a **Subscriber** pane.

The IEC 61850 Configuration menu ribbon has options to:

- **Open**
- **Save**
- **Manage Data Model** (connected device only)

- **Measurement Setting** (connected device only)
- **Control Setting** (connected device only)
- **Add Dataset**
- **Edit Dataset**
- **Delete Dataset**
- **Hide/Unhide Datasets**
- **Add GOOSE Control Block**
- **Edit GOOSE Control Block**
- **Delete GOOSE Control Block**
- **Hide/Unhide GOOSE Control Blocks**
- **Add Report Control Block**
- **Edit Report Control Block**
- **Delete Report Control Block**
- **Hide/Unhide Report Control Blocks**
- **Add Sample Value Block**
- **Edit Sample Value Block**
- **Delete Sample Value Block**
- **Hide/Unhide Sample Value Blocks**
- **Edit Subscribe Parameter**
- **Unmap (Subscribe)**
- **Unsubscribe All**
- **Graphical View (Summary View)**
- **Table View (Summary View)**
- **Hide and Unhide Connections**
- **User-friendly Name/IEC Name**

Added Datasets appear as blocks within the Dataset pane—Publisher items may then be dragged and dropped into the blocks as required. Added GOOSE, Report and Sample Value Control Blocks appear in the Control Block pane—Publisher items from Dataset blocks may be connected to required GOOSE, Report and Sample Value blocks as required.

Dataset connected Control Block items may be connected to appropriate Subscriber items.

Note:

Connected items are shown using arrowed lines, with control block to Subscriber lines selectable to Edit, Unmap and Unsubscribe, and Publisher to Dataset lines selectable to Unsubscribe. Dataset items may be removed within Dataset blocks, by selecting the ☒ for each Publisher item.

5.13.3 ADD A NEW DEVICE

To add a new IED device to a project, follow these steps:

1. From the project topology view, click to expand the **IED Devices** menu in the toolbox on the left.
2. Drag and drop a device from the toolbox to project area (the central grid).
When the new device is dropped, an **Add Device** window opens.
3. Enter a Name and Description for the device.
4. Select **Model Type** corresponding to the device Cortec.
5. To select the required IED device Cortec, select each element in turn and choose the required option for each digit from the choices in the corresponding list. Ensure that this matches the order code of the actual device.

Elements added to the project appear in the right-hand Topology panel, in a tree structure. The next step is to download the device CID file as a basis for configuring the device.

Note:

The device Name field only accepts alphanumeric characters. Do not use spaces or other special characters other than underscore _.

5.13.4 EDIT A DEVICE

1. Right-click the corresponding device graphic in the Topology workspace, or the required device in the Topology pane tree and select Edit or select Edit in the Topology Pane menu ribbon.
2. Edit the name and description for the device.
3. The **Model Type** selection is only available when adding a new IED Device. Once it has been added, only the name and description can be updated.

Note:

The **IED Device Name** field only accepts alphanumeric characters. Do not use spaces or other special characters.

5.13.5 RECEIVE CID FROM DEVICE

After creating an IED Device within the EnerVista Flex software, the CID file can be downloaded from the physical device. Ensure that the order code for the created IED Device in the project matches the order code of the actual physical device. The CID can also be downloaded directly from the physical device by using the **Quick Download** option in the project menu ribbon. When doing that the CID file will be downloaded directly from the connected physical device and the corresponding IED device will be created in the project.

Only the Engineer and Administrator EnerVista Flex user roles can access the **Send/Receive CID File** and **Quick Download** (CID File) functionalities in the EnerVista Flex software. The Guest user role can only access the **Receive CID File** functionality. The Operator user role has no access to any of these functionalities.

Note:

It is important to ensure that the IED Device Name is correct.

1. Double-click the **IED Device** icon in the **Project Topology View** to open the **IED Device Profile**.
2. Click the **Receive CID File** button located in the bottom right corner of the **IED Device Profile** window.
3. Click **Yes** to confirm that unsaved configuration changes made in the offline file can be overwritten.
4. In the **Receive CID File – Device Information** window, enter the Interface used for the connection and Ethernet IP Address, Slave Address and Port of the device and click **Continue**.
5. A Serial Number mismatch message may appear, click **Yes** to continue with the download process.
6. The Schema is validated once the status bar indicates the CID file transfer is successfully completed. Click **Finish** to complete the CID file download process.
7. Click **OK** to acknowledge the completed CID file transfer and return to the device view.

Note:

Only accounts with the Engineer or Administrator EnerVista Flex user roles can access the Send/Receive CID File and Quick Download (CID File) functionalities in the EnerVista Flex software.

5.13.6 EDIT DEVICE CONFIGURATION SETTINGS

Note:

It is good practice to download the CID file from the device and use it as the basis for configuration changes.

1. Double-click the **IED Device** button, in the **Project Topology View** to open the **IED Device Profile**.
2. Click **Setting** on the **IED Device** menu bar. The **IED Device Name** will be the one assigned to the CID file when it is created or when it is added to the **Project Topology View**.

The Setting tab opens showing the configuration options.

5.13.7 SEND CID FILE TO DEVICE

Once configuration changes are complete, update the P40 Agile Enhanced IED configuration by sending the CID file back to the device.

Note:

It is good practice to download the CID file from the device and use it as the basis for configuration changes.

1. Double-click the **IED Device** icon in the **Project Topology View** to open the **IED Device Profile**.
2. Click the **Send CID File** button located in the bottom right corner of the **IED Device Profile** window.
3. Click **Yes** to confirm that unsaved configuration changes made in the offline file can be overwritten.
4. In the **Send CID File – Device Information** window, enter the Interface used for the connection, the Ethernet IP Address of the device, the Slave Address and Port, then click **Continue**.
5. A Serial Number mismatch message may appear, click **Yes** to continue with the upload process.
6. In the **Send CID File – User Authentication** window, enter the IED User Name and Password.
7. The status bar indicates when the file transfer is complete. When the "CID public and private sections validated" message appears, click **Finish** to acknowledge the completed CID file transfer and return to the **IED Device Profile** view.

Note:

*The EnerVista Flex user account must have the appropriate user role assigned (Administrator or Engineer) in order to access the **Send CID File** functionality in the EnerVista Flex software. Account settings can be changed by the Administrator.*

5.13.8 SET DEVICE LANGUAGE

Select the **Language** setting for the device HMI, using the **Device Language** drop-down list available in the **IED Device Profile** tab in EnerVista Flex software. MM300E language available is English only.



EnerVista Flex language is selectable at login. It may be different to the device language if desired.

5.14 LOGIC DESIGNER

5.14.1 MENU SYSTEM

Menu system

5.14.1.1 ONLINE TREE

The EnerVista Flex software has child nodes under the FlexLogic branch in the online window called Logic Designer and Logic Monitor.

5.14.1.2 OFFLINE TREE

The EnerVista Flex software has a child node under the FlexLogic branch in the offline window called Logic Designer.

Note:

The Logic Monitor does not exist for EnerVista Flex offline.

5.14.2 PREFERENCES

Preferences

5.14.2.1 GENERAL

The following preferences are available for the General configuration of EnerVista Flex software Logic Designer.

The General tab contains all preferences which are used at the PC Setup level.

The Settings Screens section defines the way the User Interface has to be present and behave with regular usage.

The Settings File Transfer section is where the user can choose to include or exclude communication settings present while performing file transfer operations.

5.14.2.2 MESSAGE COLORS

The following Output window background and text color parameters can be configured in the EnerVista Flex software Logic Designer.

- Message Background
- Regular Messages
- Compiler - Minor Warnings
- Compiler - Major Warnings
- Compiler - Errors
- Compiler - Results
- Monitoring - Timing

5.14.2.3 LOGIC DESIGNER SETUP

SIZE AND UNITS

EnerVista Flex software Logic Designer allows you to alter the canvas size. Follow the instructions below to change the canvas size of the workbook.

1. Select **File > Preferences > Workbook Setup** from the menu.
2. Select the Size and Units tab. The option is present when the Logic Designer screen is open.
3. Enter the desired width and height for the workbook.
4. Click OK to confirm your changes.

Note:

Currently the canvas size is limited to 1000 x 1000 inches.

WORKBOOK

The user can print the contents of the viewer by selecting **File > Print** from the menu.

It is also possible to alter the printing options. Select **File > Workbook Setup** from the menu and a window containing the printing format parameters is displayed.

The user can select the Print Scale for the workbook, or select Fit to Page to print the entire workbook on one page.

Enabling Orphan Protection when printing will prevent Virtual Output circuits from spanning more than a single page. The largest Virtual Output circuit is scaled to fit on a single page and all remaining Virtual Output circuits are printed using the same scale.

The choice of whether to Show Title Block is also available.

Note:

There may be instances when a printer configuration alters the appearance of the symbols and objects used in the design document. To produce a printout that better matches the displayed version of the design document, output the document using a tool that produces a PDF document and then use a PDF viewer to print the document.

FILE INFORMATION

Each printed page can include a Title Block located in the bottom right corner of the printed page. Information for the title block is entered in the File Information screen.

If a graphic logo is to be included in the title block, ensure the image is no larger than 36 pixels wide by 35 pixels high.

5.14.2.3.1 DISPLAY

The following options are available for the Display configuration of the Logic Designer.

SYMBOL STYLE

The Logic Designer is configured to display FlexLogic in three symbol styles (IEC, ISO, and EnerVista).

Each of the three symbol styles can be displayed in either Color or Black & White.

SYMBOL CREATION

There are two options available when placing symbols onto the canvas:

- **Drop Single Symbol** - After selecting a symbol from the toolbar, this option allows the user to add one symbol to the workbook by clicking in the workbook where to add the symbol. Only the first click after selecting the symbol adds a symbol to the workbook.
- **Repeat Symbol** - After selecting a symbol from the toolbar, this option allows the user to add the selected symbol to the workbook by clicking in the workbook where to add the symbol. Subsequent clicks will add the same selected symbol.

ZOOM OPERATION

If Sheet Only is selected, each sheet of a document will maintain its own zoom level. If Workbook is selected, then all sheets will have the same zoom level.

5.14.2.3.2 EDITOR

The Auto-Save function is by default enabled and set to auto-save information every 5 minutes. The time interval can be changed from a minimum of 5 minutes to a maximum of 30 minutes.

When the time interval elapses, Auto-Save will check if there are any unsaved changes in the Logic Designer.

- If the document is unchanged or the document has not changed since the last Auto-Save, then Auto-Save will wait until the next time interval.
- If a change has occurred, Auto-Save will save using the settings file path but with the extension `.auto` instead of `.CID`.

When the user successfully saves a Logic Designer document, EnerVista Flex permanently deletes any auto-saved file, if it exists, as it is no longer necessary.

EnerVista Flex permanently deletes any auto-saved file, if it exists, as it is no longer necessary.

Note:

The Auto-Save option in the Logic Designer Preferences window is only used for an offline settings file. The option is not applicable to an online device.

5.14.2.3.3 AUTO-POPULATE

When an existing settings file is opened in the Logic Designer, the Logic Designer will populate the canvas and attempt to evenly distribute the Virtual Output circuits across multiple sheets. A value of `100` will place all FlexLogic equations on a single sheet. A value of `1` will place each Virtual Output circuit on a separate sheet.

5.14.2.3.4 COMPILER

There are three options available to the user in the Compiler screen:

- **Show Warnings** - The user can choose to show any combination of Minor, Major, or Setting related warnings.
- **Automatically Sort VOs** - Virtual Output circuits can be set to be automatically ordered in the compiler output. When this option is selected, an algorithm is implemented to give the best results and quickest performance. The capability to reorder the Virtual Outputs is also disabled with this selection
- **Optimize Compiled Output** - Selecting this option triggers the compiler to take a second pass through the equations looking for areas where equations can be optimized/reduced. The results from the compiler will indicate the results of the optimization. After successfully compiling the logic design the FlexLogic equations are then copied into the existing settings file.

5.14.3 LOGIC DESIGNER

5.14.3.1 OVERVIEW

The Logic Designer is a tool that allows the operator to graphically edit and represent the information that is currently edited through the spreadsheet data entry.

Key features of this tool are:

- Open and edit multiple screens simultaneously.
- Cut, copy, or paste equations between sheets of the same settings file.
- Print the contents of the EnerVista Flex Logic Designer.
- Basic drawing functionality in the viewer includes: Text, Lines, Boxes, Circles

The Logic Designer is one of two available options for a user to configure FlexLogic. The other one being the FlexLogic Equation Editor.

Three timestamp variables: Logic Design Last Saved, Logic Design Last Compiled, and FlexLogic Editor Last Saved, are visible in the compiler window, making it easy to see the latest one that has been used.

In order to maintain synchronization with the FlexLogic Editor, update rules are defined as follows if the user tries to open the Logic Designer:

- If the FlexLogic Equation Editor is already open and in edit mode, the user is prompted by a message to save any changes. Logic Designer is not launched.
- If the FlexLogic Equation Editor is open and any changes have been saved, the FlexLogic Equation Editor is made Read-only and Logic Designer launch is initiated.

Note:

A maximum of five Logic Designer windows can be open at any one time.

5.14.3.1.1 INITIAL AUTO-POPULATE

When a settings file is opened in the Logic Designer and there is no design document associated with the settings file, the Logic Designer will examine the information in the original FlexLogic Editor and create a new design document based on the FlexLogic Editor. The FlexLogic Editor has to be error free and compiled in order for the Auto Populate to work properly.

Any lines of FlexLogic placed after the first *EndOfList* line is ignored.

5.14.3.2 EDITING A DESIGN DOCUMENT

5.14.3.2.1 VIEWING FEATURES

ZOOM

The amount of Logic that can be viewed on the screen can be adjusted by right clicking in an empty spot on the sheet and selecting Zoom from the context menu. By default the zoom level is set to 75%, which offers the most displayed information while still maintaining readability.

The zoom levels can also be customized from the View menu.

SHOW UNUSED PINS

This feature is selected by default, but when this feature is unchecked, any output connections leaving the Contact Input and Contact Output symbol that are not being used will become invisible.

This feature can be used to clean up the Logic Design Document before printing.

5.14.3.2.2 EDITING FEATURES

While editing a Design Document there are some extended features available to the use.

- **Undo** - Select to remove previous editing actions.
- **Cut - Copy - Paste - Delete** - Single or multiple symbols can have simple actions performed on them to help design the Logic Document. When an object is selected holding the Control key (CTRL) will allow the dragging object to be copied, leaving the original object in its original location.
- **Copy Sheet** - This command is used to create a bitmap image from the active sheet and place the bitmap image onto the clipboard. This bitmap image can then be pasted into other applications.
- **Clear Sheet** - Select to clear the contents of the active sheet.
- **Clear Workbook** - Select this command to clear the contents of the entire active Design Document. The user will then be prompted to auto-populate the cleared workbook using the given preferences.

5.14.3.2.3 SEARCH

Type in text and press the Search button to perform a search on the current Logic Design Document. All results matching the search text will appear in the results window. Double click on any result to switch the document so that the result match comes into view. The search field keeps a history of the last 32 searches performed. The newest search will be at the top of the list and the oldest will be at the bottom.

Note:

While in the Logic Designer, double-clicking on a result causes the document to bring the selected symbol into view. The symbol will also become selected, so that further action may be taken on the symbol.

5.14.3.3 TOOLBARS

5.14.3.3.1 INTRODUCTION

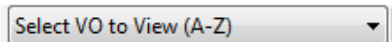
There are four toolbars associated with the Logic Designer:

1. **Logic Designer Toolbar** - contains general tools for the design document
2. **Basic Actions Toolbar** - contains tools used to navigate around the canvas, align components and adjust the size of the components
3. **Advanced Actions Toolbar** - used to rotate, flip, group/ungroup and move components between the viewable layers on the canvas
4. **Token Toolbox** - contains basic objects and symbols used to design the FlexLogic Document

5.14.3.3.2 LOGIC DESIGNER TOOLBAR

EnerVista Flex software Logic Designer has a toolbar specifically designed for FlexLogic, which provides the user with access to all the symbols and functionality needed.

Each button is described below:

	New	Create a new settings file
	Open	Open an existing settings file.
	Save	Save the current Logic Design Document
	PDF Document	Create a PDF document based from the current Logic Design Document.
	Toggle Compile/Message Window	Display/hide the Compile/Message window.
	Sort Order	Select to change the sort order for the Virtual Output used list. Virtual Output's can be sorted numerically in ascending and descending order based on the Virtual Output index. Virtual Output's can also be sorted alphabetically in ascending and descending order based on the Virtual Output name.
	Jump To	User can select a currently used Virtual Output to jump to in the workbook. Each Virtual Output listed also contains the name of the sheet where the Virtual Output is located.
	Logic Designer	Switch to Logic Designer mode.
	Logic Monitor	Switch to Logic Monitor mode.
	Master Communications ON	Turn ON all communications to all Logic Design Documents that are in the monitoring mode.
	Master Communications OFF	Turn OFF all communications to all Logic Design Documents that are in the monitoring mode.

5.14.3.3.3 BASIC ACTIONS TOOLBAR

The Drawing icons are used to adjust vertices on basic objects and to edit component properties.

The Zoom icons are used to resize, zoom and pan around the document.

The Align icons are used to align two or more components in a variety of ways.

The Layout icons are used to space components and size components with relation to each other.

SELECTING COMPONENTS

Select multiple components by holding the CTRL key down and selecting each of the components with the mouse button. The last component selected will be considered to be the reference component. When multiple components are selected, each component is outlined with a series of empty boxes. The last component selected, the reference component, is outlined with a series of solid boxes.

5.14.3.3.4 ADVANCED ACTIONS TOOLBAR

The Nudge tools are used to move components by small lengths.

The Rotate tools are used to move components by small lengths.

Note:

Only basic objects (lines, rectangles, ellipses) can be rotated and flipped.

Note:

The Structure tools are used to group/ungroup components and to move components in between the viewable layers of your document (i.e.: visually show a component to be behind another overlapping component).

Note:

Only objects from the Drawing Toolbar can have their structure adjusted.

5.14.3.3.5 TOKEN TOOLBOX

DRAWING TOOLS

The Boolean Tokens are used to create FlexLogic Equations. These symbols are used as intermediate logic for the Virtual Output equations.

OR Gate	Place a OR Gate in the Design Document.
AND Gate	Place a AND Gate in the Design Document.
NOR Gate	Place a NOR Gate in the Design Document.
NAND Gate	Place a NAND Gate in the Design Document.
XOR Gate	Place a XOR Gate in the Design Document.
NOT Gate	Place a NOT Gate in the Design Document.
Latch(16)	Place a Latch symbol in the Design Document.
Positive One Shot	Place a Positive One Shot symbol in the Design Document.
Negative One Shot	Place a Negative One Shot symbol in the Design Document.
Dual One Shot	Place a Dual One Shot symbol in the Design Document.
Timer(32)	Place a Timer symbol in the Design Document.

I/O TOOLS

The I/O Tools are used to create FlexLogic Equations. These symbols are used as inputs and outputs of the Virtual Output equations.

Input	Place an Input Symbol which can be configured to any FlexLogic Operand value.
FlexAnalog	The FlexAnalog Symbol can be used as the input to a FlexElement or use the FlexAnalog symbol to monitor an actual value when in Logic Monitoring mode.

Virtual Output (32)	Place a Virtual Output symbol in the Design Document. The left side of the symbol is used to assign a logic equation result to the virtual output. The right side of the symbol can be used as an Input Gate to another equation.
Tag Out	A Tag Out can be used in 1 of 2 ways. The first use of the Tag Out is to break up logic that needs to span several sheets. The second use of the Tag Out is to associate a frequently used block of code with the Tag Out and then repeatedly use the same block of code using a Tag In. When a Tag Out is referenced more than once, the Tag Out is replaced with a Virtual Output during the compile phase.
Tag In	A Tag-In can be used to reference an existing Tag-Out.

BOOLEAN TOKENS

The Boolean Tokens are used to create FlexLogic Equations. These symbols are used as intermediate logic for the Virtual Output equations.

OR Gate	Place a OR Gate in the Design Document.
AND Gate	Place a AND Gate in the Design Document.
NOR Gate	Place a NOR Gate in the Design Document.
NAND Gate	Place a NAND Gate in the Design Document.
XOR Gate	Place a XOR Gate in the Design Document.
NOT Gate	Place a NOT Gate in the Design Document.
Latch(16)	Place a Latch symbol in the Design Document.
Positive One Shot	Place a Positive One Shot symbol in the Design Document.
Negative One Shot	Place a Negative One Shot symbol in the Design Document.
Dual One Shot	Place a Dual One Shot symbol in the Design Document.
Timer(32)	Place a Timer symbol in the Design Document.

5.14.3.4 LOGIC SYMBOLS

5.14.3.4.1 I/O TOKENS

INPUT

Properties

The Input property page contains 2 list boxes and a link button.

From the first list box, the user selects the Input Family from the following types:

Off	Targets
On	Relay Service
Virtual Inputs On	Testing
Virtual Outputs On	Self-Test Error
Contact Inputs On	Output Relay Voltage Monitoring
Contact Inputs Off	Critical Failure Relay
Virtual Inputs Off	Protection/Currents
Output Relays	Protection/Voltage
Any Trip	Protection/Frequency
Any Alarm	Control Elements
Any PKP	Monitoring Elements

Any OP	Non-Volatile Latches
Resetting	Programmable Pushbuttons
Setpoint Access	Data Logger

After selecting the Input Family, the second list box will dynamically adjust to show the available selections from the specific Family.

VIRTUAL OUTPUT

Properties

There is a maximum of 32 Virtual Outputs. Each Virtual Output must be given an assigned identifier. No two Virtual Outputs can share the same identifier.

- The user can select from a list of available Virtual Outputs. None is the first selection in the list to allow the user to deselect the identifier.
- The Virtual Output symbol contains an output connection that can be used as an input into a separate logic block. Using this connection is equivalent to using an Input symbol assigned to the Virtual Output state.

TAG IN/TAG OUT

Properties

The Tag Out has a single name property. By default, the name will be set to *Tag n*, where *n* represents an index indicating the number of Tag Outs used in the editor. This value will increment as each Tag Out is created.

If a user were to change the name of the Tag Out, then the associated Tag In should also get re-referenced using the new name.

The Tag In has a single selection property. The selection will consist of a list of Tag Out name's that have not been already selected by existing Tag Ins. The first selection in the list will be None so that the user can deselect a Tag so that it can be used elsewhere.

Usage

Tag In's and Tag Outs are used to make logical links between two locations within the FlexLogic design document. These locations can be on the same sheet or on separate sheets. The same Tag Out can be referenced by multiple Tag Ins but be aware that for each Tag In instance of the FlexLogic block represented by the Tag Out will be replicated. If using a Tag Out more than once, be sure to enable the compile optimization.

5.14.3.4.2 BOOLEAN TOKENS

OR

Properties

The user can change the Gate type by means of a selection list. The user does not have to specify the number of inputs. Each gate requires a minimum of 2 inputs. The user can dynamically add 2 empty inputs to the gate until 16 inputs are available after the user adds the 2nd input.

A text field on the gate will indicate how many inputs are being used.

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: OR: Minimum two inputs required

Each gate must have a minimum of 2 valid inputs and a maximum of 16 valid inputs.

AND

Properties

The user can change the Gate type by means of a selection list. The user does not have to specify the number of inputs. Each gate requires a minimum of 2 inputs. The user can dynamically add 2 empty inputs to the gate until 16 inputs are available after the user adds the 2nd input.

A text field on the gate will indicate how many inputs are being used.

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: AND: Minimum two inputs required

Each gate must have a minimum of 2 valid inputs and a maximum of 16 valid inputs.

NOR

Properties

The user can change the Gate type by means of a selection list. The user does not have to specify the number of inputs. Each gate requires a minimum of 2 inputs. The user can dynamically add 2 empty inputs to the gate until 16 inputs are available after the user adds the 2nd input.

A text field on the gate will indicate how many inputs are being used.

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: NOR: Minimum two inputs required

Each gate must have a minimum of 2 valid inputs and a maximum of 16 valid inputs.

NAND

Properties

The user can change the Gate type by means of a selection list. The user does not have to specify the number of inputs. Each gate requires a minimum of 2 inputs. The user can dynamically add 2 empty inputs to the gate until 16 inputs are available after the user adds the 2nd input.

A text field on the gate will indicate how many inputs are being used.

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: NAND: Minimum two inputs required

Each gate must have a minimum of 2 valid inputs and a maximum of 16 valid inputs.

XOR

Properties

The user can change the Gate type by means of a selection list. The user does not have to specify the number of inputs. Each gate requires 2 inputs.

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: XOR: Minimum two inputs required

Each gate must have 2 valid inputs.

NOT

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: NOT: Minimum two inputs required

This Input must be connected to another symbol's Output.

TIMER

Properties

There is a maximum of 32 Timers. Each Timer must be given an assigned identifier from 1 to 32. No two Timers can share the same identifier. The user can select from a list of available Timers. None is the first selection in the list to allow the user to deselect the identifier.

Compiler Messages

The following compiler messages are associated with this symbol.

ERROR: Symbol not connected (SYMBOL_ID, Name, SheetReference)

If the output of the symbol completes a path to a Virtual Output, but the input of the symbol is not connected, an error is produced.

ERROR: Timer used more than once (SYMBOL_ID, SheetReference)

A Timer is being used by at least two virtual output equations.

Warning: Symbol not connected (SYMBOL_ID, Name, SheetReference)

If the output of the symbol is not connected, a non-critical warning is produced.

5.14.3.5 COMPILER

5.14.3.5.1 COMPILING

Pressing the Toggle Compile Window toolbar button allows the user to view the compile window. This dialog can be resized. Also, from this dialog the user can change the Compile Order of the virtual outputs from the VOut Order tab.

This window also contains a results window that shows all error messages, warning messages, and results when the compiler is executed as seen below.

Compile Messages

If the compile is successful, a message will indicate the number of Logic Lines that the compile will occupy.

The FlexLogic equations can be compiled into FlexLogic settings in three ways:

1. Press the Compile button.
2. Select Compile from the Edit menu.
3. Press 'F7'.

The compiling message now displays options being set in preferences for the compile option. Example: compiling (Auto sort VOx on, Optimization off)

Three variables are introduced to capture the timestamp operations performed on FlexLogic, either from the FlexLogic Editor or Logic Designer. One can depict which of the two options is the latest and in use.

All compile messages in the output window are hyperlinked to the graphical document. By double clicking on a warning or error message the symbol associated with the warning or error will get selected and be placed into the viewable area of the screen.

Memory Used - displays the memory used in the adjacent window.

The variables in the compiler window have the following set of properties:

1. When no Logic (New file creation) is present, these timestamps are not present.
2. Timestamp is displayed in the format 'Mon DD YYYY HH:MM:SS' [Jun 22 1981 14:20:00]
3. On each compilation done in Logic Designer the timestamps get updated
4. On pressing Save, only the *Logic Designer Last Saved* gets updated.
5. Based on the values present at each launch of Logic Designer, Internal validation prompts respective user messages, which are also displayed as compiler messages.

Exclude From Compile

While designing the FlexLogic equations, entire sheets can be removed from the compile logic. This allows the user to test various schemes by placing schemes on separate sheets and including either sheet at compile time.

To exclude a sheet from the compiling, select the sheet to exclude and press the right mouse button and select Exclude from Compile.

The sheet name will be contained within the characters < and > to indicate the sheet is excluded.

Any FlexLogic on a compiled sheet that makes reference to VO's or TagOut symbols on an excluded sheet will produce compile errors.

5.14.3.5.2 COMPILER MESSAGES

When Warnings are set to *All* (see Interfaces), Critical warnings are also included.

Warning Category	Gate Affected	Message	Description
Critical	Input	Input set to unused VO (SYMBOL_ID,Name,SheetReference)	An Input symbol is using an unassigned Virtual Output
Critical	Tag-Out	Tag-out not connected (TAG_ID,SheetReference)	A Tag-Out symbol has no input
Critical	All	Symbol not connected (SYMBOL_ID,Name,SheetReference)	A symbols output is not connected and is not part of a VO block
All	=VO	Virtual Output n has default name (VO_ID,SheetReference)	An Assigned Virtual Output is using the default name
All	Input	Input using default name (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a Contact Input set to the default name
All	Input	Input using default name (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a Virtual Input set to the default name
All	Input	Input using default name (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a Contact Output's set to the default name
All	Input	Input using default name (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a Digital Element set to the default name

Warning Category	Gate Affected	Message	Description
All	Input	Input using default name (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a FlexElement set to the default name
All	Input	Input using default name (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a Digital Counter set to the default name
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Virtual Input
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Contact Input
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Digital Element
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled FlexElement
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Digital Counter
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Control Pushbutton
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Programmable Pushbutton
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Contact Output
Critical	Input	Input using disabled feature (SYMBOL_ID,Name,SheetReference)	An Input symbol is using a disabled Protection/Monitoring Element
Critical	Input	Input set to OFF (SYMBOL_ID,SheetReference)	An Input symbol is set to OFF
Critical	Input	Input set to ON (SYMBOL_ID,SheetReference)	An Input symbol is set to ON

Error Category	Gate Affected	Message	Description
ERROR	All	Number of lines (nnn) exceeds maximum limit of 1024	The compiled result exceeds the limit of 1024.
ERROR	Tag-In	Tag-in not configured (TAG_ID, SheetReference)	A Tag-In is connected to a circuit but the Tag-In is not referencing an existing Tag-Out.
ERROR	=VO	VO has no inputs (VO_ID, SheetReference)	An Assigned Virtual Output is located within the FlexLogic diagram and there is no block connected to the Virtual Output.

Error Category	Gate Affected	Message	Description
ERROR	All	Symbol not connected (SYMBOL_ID, SheetReference)	A symbol that is connected to a Virtual Output block has at least one of it's inputs open and requires a connection to be made to complete the circuit.
ERROR	Timer	Timer used more than once (TIMER_ID, SheetReference)	The same timer is used in more than one place in the editor. This means either the circuit that the Timer belongs to has been branched, or the Timer has been duplicated.
ERROR	Input	Unrecognized Parameter (SYMBOL_ID,Name, SheetReference)	An Input symbol is configured to an item that is not recognized by the current order code and version. Possible cause: The order code and/or version of the settings file was converted causing the input parameter to become unavailable.

5.15 IEC 61850 CONFIGURATION

IEC 61850 feature is Cortec dependant for MM300 Enhanced IEDs.

IEC 61850 configuration can be done through the IEC 61850 Configuration tool, which is available when connected to the device or when working on a Project configuration offline.

Refer to IEC 61850 Configuration in the Project Configuration section of this chapter for more information.

5.16 OPEN DEVICE

The Open Device feature enables the user to work with any settings file (CID) of the device which is supported by EnerVista Flex, without creating a project. The user can quickly open a P40 Agile Enhanced device Settings file (CID) from any location on their computer and make the necessary changes straight away.

The Open Device feature is available in a place holder on the Modules dashboard.

Click on this option and a file selection window will pop up asking the user to select "CID" file. The user can choose any P40 Agile Enhanced device CIDs from any location on a local computer or from any shared drive or remote computer with Read and Write access.

Once the File is selected, the EnerVista Flex opens a new tab for the device and shows all the device information.

The user can open any supported device CID without creating a project. Only one CID can be opened at a time. With a CID opened with Open Device, the user is able to do all the operations that would be available for a device created inside a project.

The possible actions are:

- Modify Settings, Protection summary screen, IEC 61850 configuration and Logic for the device for the items that are supported for that Cortec. These changes are saved directly into the CID file.
- The CID file changes can be transferred to a device with same Cortec and version using **Send CID File** option (icon in the bottom right-hand corner).
- The CID can also be updated from a device with same Cortec and version using **Receive CID File** option to sync the device (icon in the bottom right-hand corner).
- Export Settings to CSV, Excel and PDF is also supported in the Settings tab.

5.17 SETTINGS CONVERSION

The Settings Conversion feature enables the user to convert any MM300 Enhanced device settings file (CID File) from an earlier version to a more recent version. This conversion module is necessary to allow users to upload their settings file into the latest firmware version of the device when they were originally created in an older version of the firmware.

This module will only allow the version to be upgraded where the model number or Cortec remains unchanged during the conversion process. This module does not allow the user to downgrade from a more recent version to an older version. The Settings Conversion module will migrate the 61850 data, Modbus Settings values, and Scheme Logic section in the device to the higher version without impacting the configuration. Any values not applicable in the more recent version of the device will be defaulted.

At the end of the conversion process a report is generated indicating the Newly added, Removed or Modified data during conversion from older to newer version.

The Settings Conversion feature is available inside the Projects. The user can access to the CID files to be converted by launching the EnerVista Flex software application and logging into it. After that the user should access to the Project module and either create a new project or open an existing project. Once inside a project the user should select a MM300 Enhanced device CID. If no CID exists in the project, any MM300 Enhanced CID file can be imported into the project or quickly downloaded from a connected device. (See Create a New Project, Manage Projects and Project configuration sections for more details in projects handling).

The settings conversion feature is accessed using the **Convert** option available when right clicking on a MM300 Enhanced CID file, either using the Canvas view or the Topology view.

After clicking on the **Convert** option, a **Convert Device Settings file** pop up window will appear, providing the Device Name, the Model Number and the Current Version of the original CID file from an older version that is going to be converted to a newer version. Select the required new version in the **Convert Version** drop down list available and click on the **Convert** button. The conversion process will be initiated. When finished and if successful, a version update success message will appear in green, the existing file in the project is updated to the version selected and the old file is saved on the location available in the **Original File Backup** path.

After a successful conversion the **Show Log** button is enabled. By clicking on it, the user can access to the conversion report in a separate window. The conversion window will close when the user opens the conversion log, so make sure that the path to the conversion backup file is saved, if required, before accessing the log.

CHAPTER 6

SETPOINTS

6.1 CHAPTER OVERVIEW

This chapter contains the following sections:

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6.2 CONFIGURE

The configuration setpoints contain data on motor configuration as well as system setup, inputs, outputs, communications, CTs, and VTs. The following sub-pages are available.

- System (setpoints related to MM300 Enhanced system configuration, such as the faceplate LEDs)
- Motor (setpoints related to motor configuration).
- CT-VT (setpoints related to CT and VT configuration).
- Inputs (setpoints related to digital input configuration)
- Outputs (setpoints related to digital output configuration)
- Comms (setpoints related to communications configuration)
- Events (setpoints related to the event recorder)
- Counters (setpoints related to the digital counters)

6.2.1 DEVICE SETTINGS

The following setpoints are available.

LED Color Invert

Range: Red/Green, Green/Red

Default: Green/Red

When set to “Red/Green”, the color of Running LED is red, and the color of the Stopped LED is green. When set to “Green/Red” the color of the Running LED is green, and the color of the Stopped LED is red.

Tripped LED Flasher

Range: On/Yes, Off/No

Default: Off/No

This setpoint determines whether the Tripped LED flashes or is steadily illuminated when there is a trip or lockout condition.

Maj Self-Test Err Func

Range: Alarm, Trip

Default: Trip

This setpoint defines the relay self-test function upon detection of a Major Problem. Upon detection of a Major Error, relay operates the Trip output relay when set to Trip.

Note:

This setting is not applicable to a Minor Problem. Upon detection of a Minor Problem, the relay automatically takes the default self-test action by generating a target message, flash Alarm LED and record in the event recorder.

Internal Temp Alarm

Range: Off (max.), 50 to 91°C in steps of 1°C

Default: 70°C

When the relay's internal temperature exceeds the set level, relay self-test declares it as a minor problem and takes the appropriate action.

Internal Temp Trip

Range: Off (max.), 50 to 91°C in steps of 1°C

Default: Off

When the relay's internal temperature exceeds the set trip level, relay self-test declares it as a major problem and takes the appropriate action.

Note:

When setting this feature, be aware that the internal relay temperature is typically 20°C above the relay's ambient temperature. If an alarm or trip is required at a particular internal temperature of the starter in which the relay is mounted, the setting should be that much higher than the starter temperature.

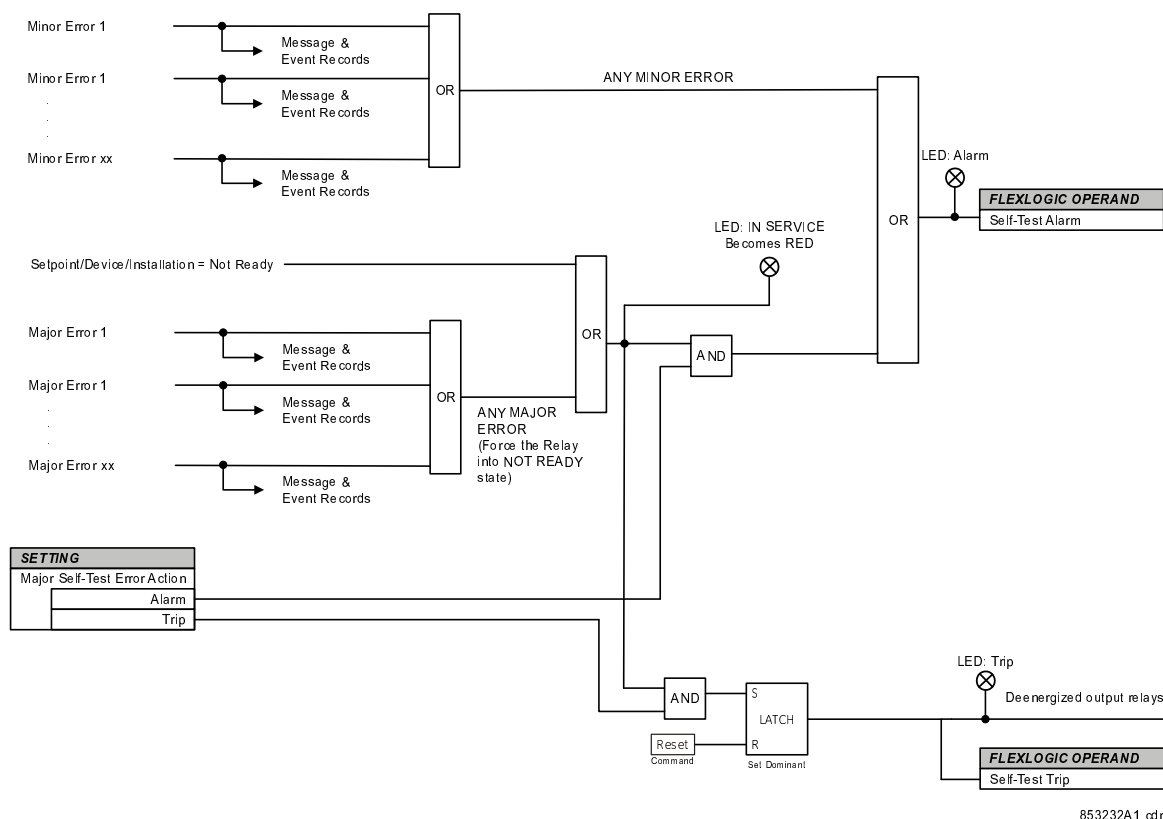


Figure 52: Major problems self-test trip and alarm monitoring

Ignore PRT in Test Mode

Range: Disabled/Enabled

Default: Disabled

If set to “Enabled” the undervoltage, undercurrent and underpower protection functions are blocked in Test Mode.

RST TCU Using RST Key

Range: Disabled/Enabled

Default: Enabled

If set to “Enabled”, when a Lockout Reset is used to reset a Thermal Overload, the Thermal Capacity% will be reset to zero.

The RESET button on the GCP and BCP can be used to send a *Lockout Reset* command or a *Thermal Capacity Reset* command. If the RESET button is pressed for less than 10 seconds, a *Lockout Reset* or *Non-Lockout Reset* is sent. However, by pressing the RESET button for more than 10 seconds, a *Thermal Capacity Reset* command is sent.

Note:

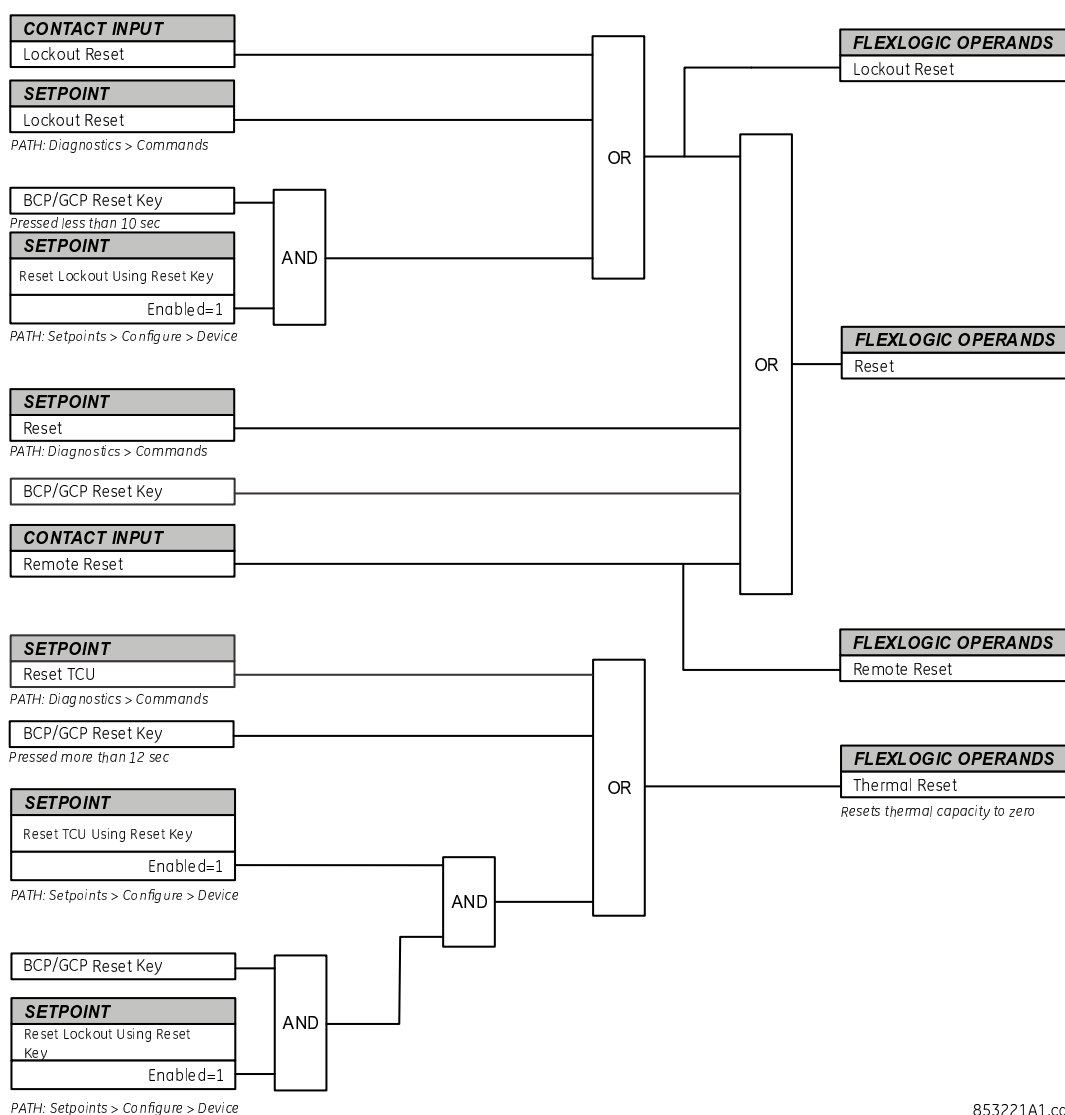
When a GCP/BCP RESET key is pressed continuously for longer than 12 seconds the Thermal Capacity% will be reset to zero, independently of the **RST TCU USING RST KEY** setting configuration.

Reset Lockout Using Reset Key

Range: Disabled/Enabled

Default: Disabled

If set to “Enabled”, the GCP/BCP RESET key will perform a non-lockout and lockout reset.



853221A1.cdr

Figure 53: Reset function logic

Set Date

Range: Format (MM/DD/YY HH:MM:SS) Min:01/01/2000 Max:12/31/2099

Default: 01/01/2000

Set to program today's date.

Set Time

Range: Format (HH:MM:SS:hh) 00:00:00:00 to 23:59:59:99

Default: 00:00:00:00

Set to program current time.

Note:

There will be a 2-3 second discrepancy with the computer if the Sync Device to Computer button available in EnerVista Flex is used. For better timestamp accuracy, the use of sources such as PTP or SNTP are recommended. For available settings, please see Digital inputs.

Time Offset from UTC

Range: -24 to +24 in steps of 0.50

Default: 0.00

Enter the time in hours that your zone is offset from Universal Time.

Daylight Savings

Range: Disabled/Enabled

Default: Disabled

Set to enable automatic time change based on the DS time setpoints.

Note:

Once this setting is "Enabled" all the following Daylight Savings (DST) settings need to be configured to valid values.

DST Start Month

Range: Not Set, (List of months) January to December

Default: Not Set

DST Start Week

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

Default: Not Set

DST Start Weekday

Range: Not Set, SUN, MON, TUE, WED, THU, FRI, SAT

Default: Not Set

DST End Month

Range: Not Set, (List of months) January to December

Default: Not Set

DST End Week

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

Default: Not Set

DST End Weekday

Range: Not Set, SUN, MON, TUE, WED, THU, FRI, SAT

Default: Not Set

Orange LED Intensity

Range: Level 1 to 6

Default: Level 1

Selects brightness level (1 to 6) for Control Panel LEDs.

Green LED Intensity

Range: Level 1 to 6

Default: Level 3

Selects brightness level (1 to 6) for Control Panel LEDs.

Red LED Intensity

Range: Level 1 to 6

Default: Level 1

Selects brightness level (1 to 6) for Control Panel LEDs.

User 1 LED Assignment, User 2 LED Assignment, User 3 LED Assignment

Range: any FlexLogic™ operand

Default: Off

Set to program the GC P/BCP user LEDs to follow an internal element.

USER 1 LED Color

Range: None, Red, Green, Orange

Default: Red

Selects the color of the USER 1 LED.

USER 2 LED Color

Range: None, Red, Green, Orange

Default: Red

Selects the color of the USER 2 LED.

USER 3 LED Color

Range: None, Red, Green, Orange

Default: Red

Selects the color of the USER 3 LED.

Screen Saver Feature

Range: Off, On

Default: On

Screen saver will become active after five minutes of LCD inactivity. The LCD will switch off after this time interval. Timing is fixed.

Phasor Display

Range: Leading, Lagging

Default: Lagging

The user has the choice to display either lagging or leading phasor quantities.

Current Cutoff Level

Range: 0.0 A to 1.0 A in steps of 0.1 A

Default: 0.2 A

Sets the level of current below which any current readings are considered to be noise, and below which the value measured is substituted with zero.

The cut-off operation applies to quantities used for metering, protection and control, as well as those used for communications. Raw current samples available via oscillography are not subject to cut-off.

Voltage Cutoff Level

Range: 1 V to 30 V in steps of 1 V

Default: 20 V

Sets the level of voltage below which any voltage readings are considered to be noise, and below which the value measured is substituted with zero. The cut-off operation applies to quantities used for metering, protection and control, as well as those used for communications. Raw current samples available via oscillography are not subject to cut-off.

6.2.1.1 SELF-TEST ERRORS

The relay performs self-diagnostics at initialization (after power up), and continuously as a background task to ensure that the hardware and software are functioning correctly. There are two types of self-test warnings indicating either a minor or major problem. Minor problems indicate a problem with the relay that does not compromise protection of the power system. Major errors indicate a problem with the relay which takes it out of service.

Note:

Self-test warnings may indicate a serious problem with the relay hardware.

Upon detection of a minor problem, the relay will:

- Display the detailed description of the error on the relay display as a target message.
- Record the minor self-test error in the event recorder.
- Flash the ALARM LED

When *Trip* is selected as an action, upon detection of a major problem, the relay will:

- De-energize all output relays
- Block protection and control elements
- Assert Self-Test Trip FlexLogic operand
- Display *Major Self-test error* as a target message
- Record the major self-test failure in the event recorder

When *Alarm* is selected as an action, upon detection of a major problem, the relay will:

- Flash the ALARM LED
- Assert Self-Test Alarm FlexLogic operand
- Display *Major Self-test error* as a target message
- Record the major self-test failure in the event recorder

The targets cannot be cleared under either condition if the error is still active.

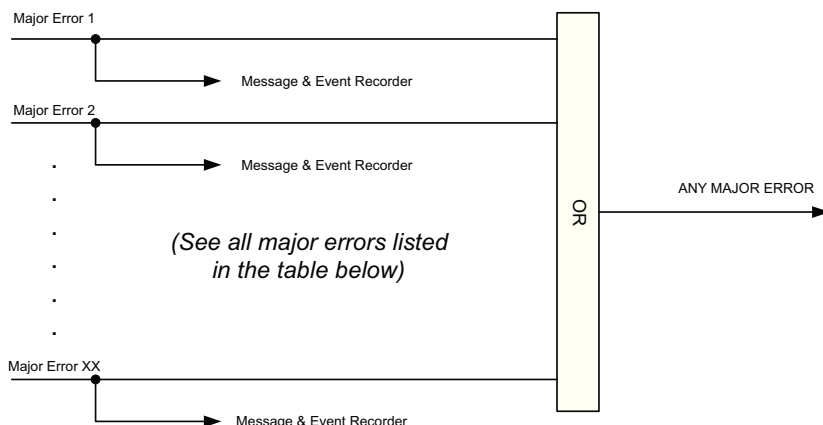


Figure 54: Major errors

Major Self-Test				
Self-Test Message	Latched Target Message	Description	How often the test is performed	What should you do
Relay Not Ready	No	PRODUCT SETUP INSTALLATION setting indicates relay is not in a programmed state.	On power up and whenever the PRODUCT SETUP INSTALLATION setting is altered.	Program all required settings and then set the PRODUCT SETUP INSTALLATION setting to <i>Ready</i> .
Major Self-Test (failure code)	Yes	Unit hardware failure detected	Every 1(1) or 2,5(2)(3) seconds	Contact the factory and supply the failure code as noted on the display.
Internal Temperature Trip	Yes	If the internal temperature rises above the set temperature	Every 1 second	

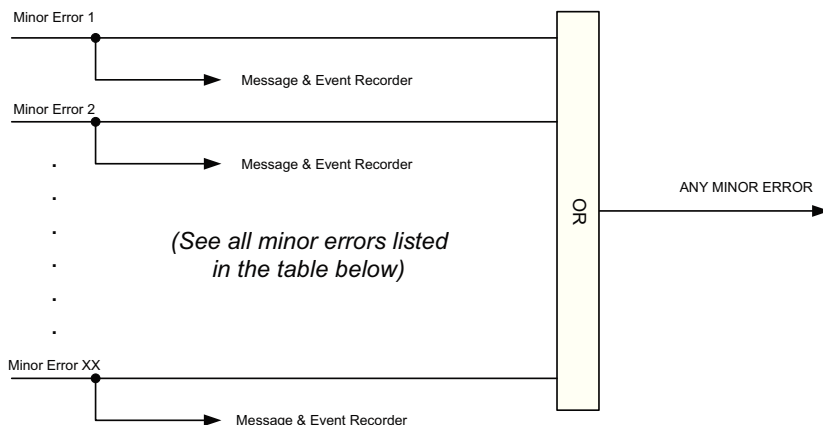


Figure 55: Minor errors

Minor Self-Test			
Self-Test Message	Description	How often the test is performed	What should you do
Internal Temperature Alarm	If the internal temperature rises above the set temperature	Every 1 second	If alert doesn't self-reset then contact factory. Otherwise monitor recurrences as a momentary error that was detected but recovered.
Order Code Error	Hardware doesn't match order code	Every 2.5 seconds	
CPU S/N Invalid	CPU card doesn't have valid data to match the order code.	Every 2.5 seconds	
Slot "\$""\$ is the slot ID (i.e. C, D, E, F, G H)IO S/N Invalid	IO card located in slot "\$" doesn't have valid data to match the order code.	Every 2.5 seconds	
PSU S/N Invalid	Power Supply Unit doesn't have valid data to match the order code.	Every 2.5 seconds	
RTC Error	The CPU cannot read the time from the real time clock	Every 2.5 seconds	
Product Serial Invalid	The product serial number doesn't match the product type	Every 2.5 seconds	
Serial Comm1 Error	Errors when initializing or accessing serial port 1.	Every 2.5 seconds	
Serial Comm2 Error	Errors when initializing or accessing serial port 2.	Every 2.5 seconds	
Serial Comm3 Error	Errors when initializing or accessing serial port 3.	Every 2.5 seconds	
FLASH Error	The permanent storage memory has been corrupted	Every 2.5 seconds	
SPI Error	Communication error between CPU and LEDs, Keypad or peripheral memory devices	Every 2.5 seconds	
Invalid MAC Address	MAC address is not in the product range	Every 2.5 seconds	
Invalid MAC Address 1	MAC address 1 is not in the product range	Every 2.5 seconds	
Invalid MAC Address 2	MAC address 2 is not in the product range	Every 2.5 seconds	
Clock Not Set	The clock has the default time	Every 2.5 seconds	Set clock to current time
Link Error Primary	Port 1 is not connected	Every 2.5 seconds	Ensure Ethernet cable is connected, check cable functionality (i.e. physical damage or perform continuity test), and ensure master or peer device is functioning. If none of these apply, contact the factory.
Link Error Secondary	Port 2 is not connected	Every 2.5 seconds	Ensure Ethernet cable is connected, check cable functionality (i.e. physical damage or perform continuity test), and ensure master or peer device is functioning. If none of these apply, contact the factory.
Traffic Error Primary	Abnormally high amount of Broadcast and Uni-cast traffic on port 1 or port 4	Every 2.5 seconds	Contact site IT department to check network for malfunctioning devices

Minor Self-Test			
Ambient Temperature >80°C	The ambient temperature surrounding the product has exceeded 80°C	Every 2.5 seconds	Inspect mounting enclosure for unexpected heat sources (i.e. loose primary cables) and remove accordingly
IO Boards CAN Error	CAN driver errors.	Every 2.5 seconds	If alert doesn't self-reset then contact factory. Otherwise monitor re-occurrences as a momentary error was detected but recovered.
SNTP Failure	Synchronization from a SNTP server failed.	Every 2.5 seconds	Ensure Ethernet connection, check cable functionality (i.e. physical damage) and ensure SNTP server configuration is correct. If none of these apply, contact the factory.
PTP Failure	Synchronization from a PTP master failed.	Every 2.5 seconds	Ensure Ethernet connection, check cable functionality (i.e. physical damage) and ensure PTP settings are correct. If none of these apply, contact the factory.
SelfTestFWUpdate	The updating of the firmware failed	Every 2.5 seconds	Re-try uploading firmware. If the upload doesn't work a second time contact factory
IO Overvoltage Error	This function should check overvoltage error flag in status register of Slot C and Slot E boards.	Every 2.5 seconds	Check that voltage channels applied (to either auxiliary voltage or IO_B board phases) do not exceed maximum limits (690V). If alarm persists then contact the factory.
Frequency Error	This function checks if system frequency is above the upper bound or not.	Every 2.5 seconds	Check voltage IO_B board external connection and auxiliary IO_C board internal connection. Check that power system frequency is within measuring range. Check power system harmonic currents and voltages, they should meet IEEE 519 1992, IEC 61000. If alarm persists then contact the factory.
Slot "\$" Comms Error	This function checks the status of communications of all IO boards from Slot C to Slot J, except from IO_A and IO_B boards.	Every 2.5 seconds	Check that boards are well inserted in their slots, and expansion modules are correctly connected. If alarm persists then contact the factory.

1. "\$" is the slot ID (i.e. C, D, E, F, G H)

6.2.2 MOTOR SETTING

6.2.2.1 COMMON MOTOR SETPOINTS

Motor Name

Range: up to 20 ASCII characters

Default: Motor Name

Enter a motor name that will appear in the Actual Values message and various reports. In the Chinese version of this product this field will instead accept 10 Unicode characters.

Motor FLA

Range: 0.5 to 1000.0 A in steps of 0.1 A

Default: Off

Sets maximum continuous phase current. If set to *Not Programmed*, the relay will not assert any contact outputs, so the motor will not run.

Motor Nameplate Voltage

Range: 100 to 690 V in steps of 1 V

Default: 690 V

This setpoint specifies the rated motor nameplate voltage. This value represents the base phase-to-phase voltage, and is used by the undervoltage and overvoltage protection elements.

Supply Frequency

Range: 50 Hz, 60 Hz

Default: 60 Hz

This setpoint specifies the nominal system frequency.

Motor Rating

Range: Off, 0.3 to 1100.0 kW in steps of 0.1 kW

Default: Off

This setpoint specifies the Motor Nominal rating setting, which is used as reference for Under Power Alarm/Trip.

of Starts to Learn

Range: 1 to 5 in steps of 1

Default: 3

This setpoint specifies the number of motor start and stop records used to calculate the learned data presented in **Diagnostics > Learned Data**.

Load Avg Calc. Period

Range: 1 to 90 min in steps of 1 min

Default: 15 min

This setpoint adjusts the period of time over which the average motor load and power is calculated. The calculation is ignored during motor starting.

The following sections provide additional information for each starter type.

6.2.2.2 STARTER CONFIGURATIONS

The MM300 Enhanced starter function is responsible for executing the motor startup sequence, including the pre-contactor start warning. The MM300 Enhanced provides eight predefined starters.

- Full-voltage non-reversing
- Full-voltage reversing
- Two-speed

- Wye-delta open transition
- Inverter
- Soft start
- Autotransformer open transition
- Autotransformer closed transition

Note:

By selecting a predefined starter, inputs and outputs are automatically assigned. Select the **Setpoints > Configure > Motor Settings** page to edit the motor data settings.

6.2.2.3 COMMON STARTER SETPOINTS

Starter Type

Range: None, FV Nonreversing, FV Reversing, Two-Speed, Wye-Delta, Inverter, Soft Starter, Autotr Open Trans, Autotr Closed Trans

Default: None

This setpoint selects the starter type. The relay is essentially disabled when the value is set to *None*. The following figure illustrates typical starter timing beginning from the stopped state for all starter types.

Pre-contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

Sets the amount of time after a start command before the motor is started. Most starters do not use this delay for forced starts such as UVR Immediate and External Start. This setpoint is also used by the inverter starter and the soft start starter to set the amount of time between powering up an inverter or soft starter and sending the ramp-up command. An audible or other warning signal can be activated in this interval by connecting the signal to a contact output set to the pre-contactor function.

Transfer Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

Sets the amount of time between stopping and starting in a new direction for the reversing starter, the time between running at high speed and starting at low speed for the two-speed starter, and the time between starting and transferring to full voltage for the wye-delta starter. It has no function for the full voltage non-reversing starter, for the inverter starter and for the soft starter.

Ramp Up Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

In the inverter and soft start starters, this setpoint sets the amount of time after signaling the inverter or soft starter to ramp up that the up to speed feed back can be delayed without issuing a Drive Start Fail alarm.

Ramp Down Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

In the inverter and soft start starters, this setpoint sets the amount of time after signaling the inverter or soft starter to ramp down before the main contactor is opened cutting power to the inverter/soft starter. If speed feed back is still on when this time expires, a Drive Stop Fail alarm is issued.

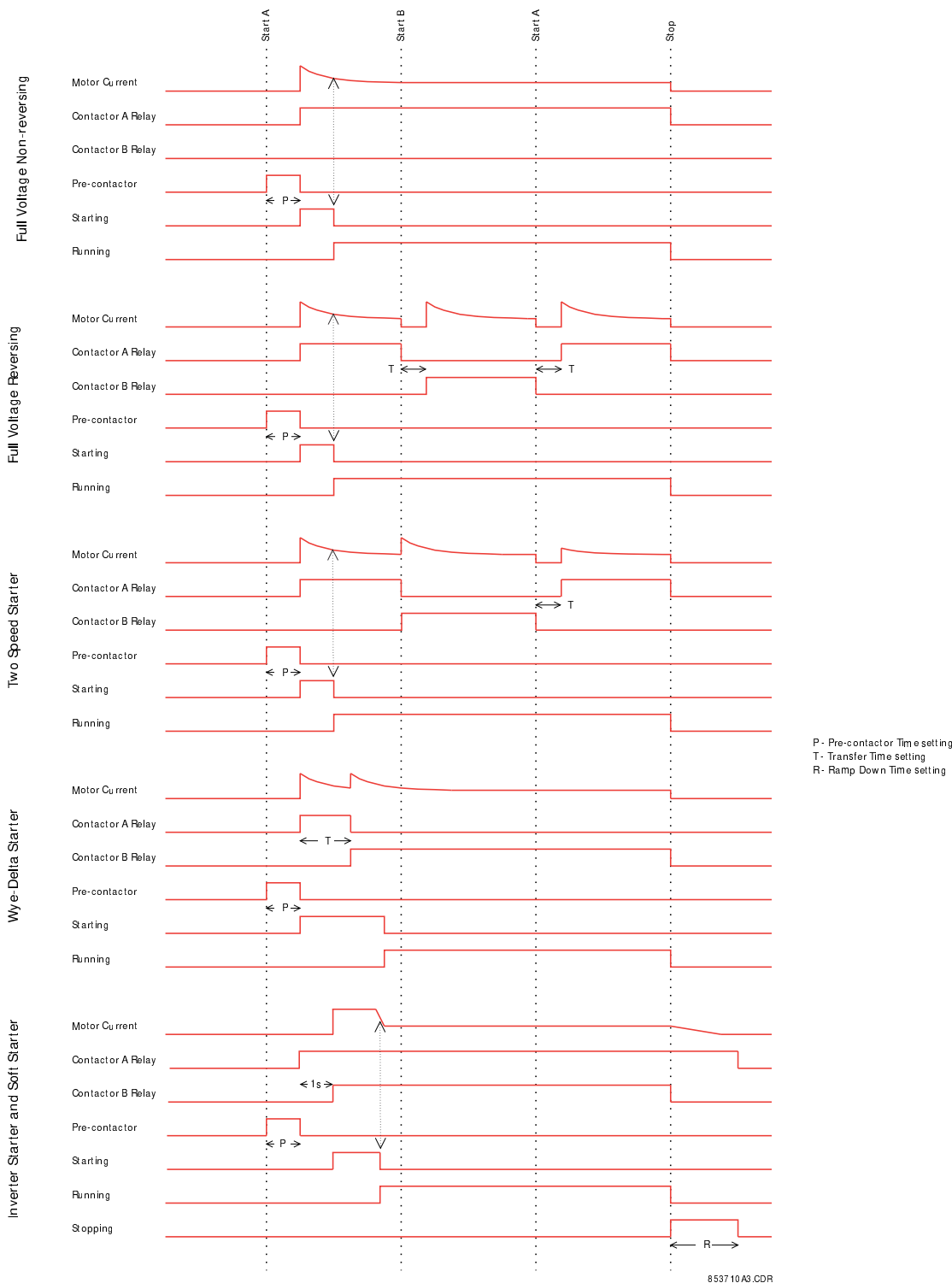


Figure 56: Typical starter timing (1 of 2)

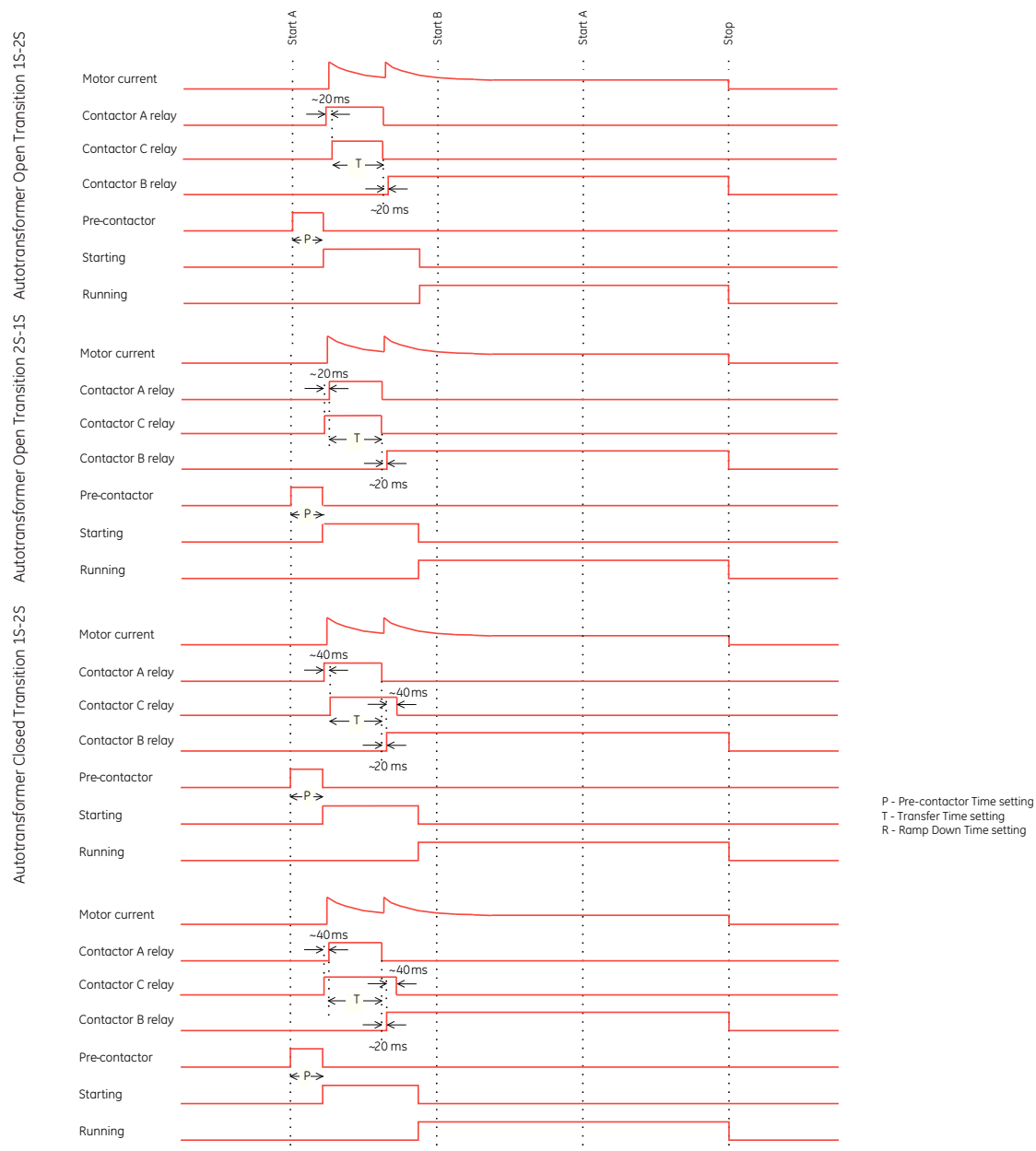


Figure 57: Typical starter timing (2 of 2)

6.2.2..1 FULL-VOLTAGE NON-REVERSING STARTER

If the **STARTER TYPE** setpoint is programmed to *FV Non-Reversing*, the pre-contactor relay (if any) is picked up for the set **PRE-CONTACTOR TIME** when a start control is received. When the pre-contactor timer times out, the contactor A relay picks up and seals-in, starting the motor. When a stop control is received, the contactor A relay is dropped out and the motor stops.

The following figure illustrates typical starter timing beginning from the stopped state.

This starter type is a full voltage or across-the-line non-reversing starter.

When a start control is received, the pre-contactor relay (if any) is picked up for the set **PRE-CONTACTOR TIME**. When the Pre-contactor Timer times out, the contactor A relay picks up and seals-in, closing D1-D2 and picking up

contactor M, which starts the motor. When a stop control is received, the contactor A relay is dropped out, Relay 1 opens, contactor M drops out, and the motor stops.

Pre-contactor is omitted on forced starts (e.g. UVR Immediate, External Start).

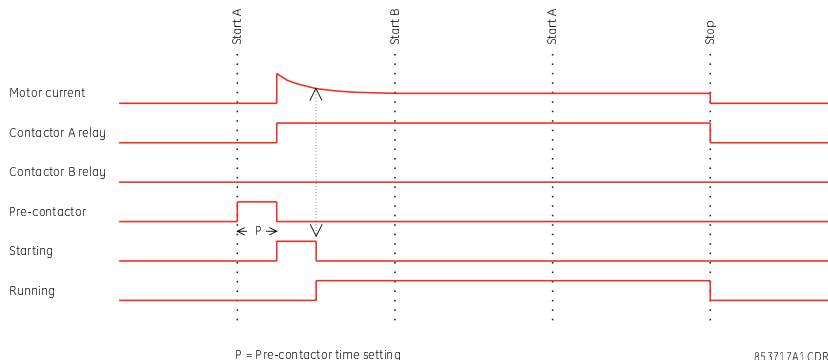


Figure 58: Typical starter timing for full-voltage non-reversing starter

The following additional setpoint is available for the full-voltage non-reversing starter.

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

This setpoint represents the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as undervoltage restart immediate and external start.

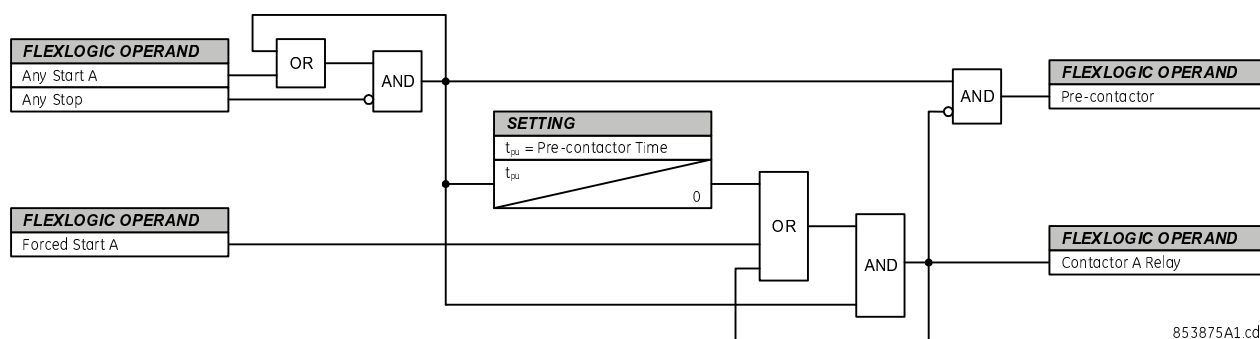


Figure 59: Full-voltage non-reversing starter logic diagram

6.2.2.2 FULL-VOLTAGE REVERSING STARTER

The full-voltage reversing starter type is a full-voltage or across-the-line reversing starter.

When a start A (forward) control is received, the pre-contactor relay (if any) is picked up for the set **PRE-CONTACTOR TIME**. When the pre-contactor timer times out, the contactor A relay picks up and seals-in, starting the motor in the forward direction. When a start B (reverse) control is received, the A contactor is dropped out. When contactor A status off is received, the starter waits for the set **TRANSFER TIME** to allow the motor to slow or stop. When the transfer time timer times out, the contactor B relay picks up and seals-in, starting the motor in the reverse direction. When a stop control is received, the contactor A and B relays are dropped out and the motor stops. The starter logic is fully symmetrical between forward and reverse.

When a contact input has its function set to *Forward Limit*, and that contact closes, the contactor A relay will drop out. When a contact input has its function set to *Reverse Limit*, and that contact closes, the contactor B relay will drop out.

The pre-contactor is omitted on forced starts (for example, undervoltage restart immediate or external start). Forced starts are not supervised by this starter transfer timer – any external starting circuit must itself respect fast direction change restrictions.

The following figure illustrates typical starter timing beginning from the stopped state.

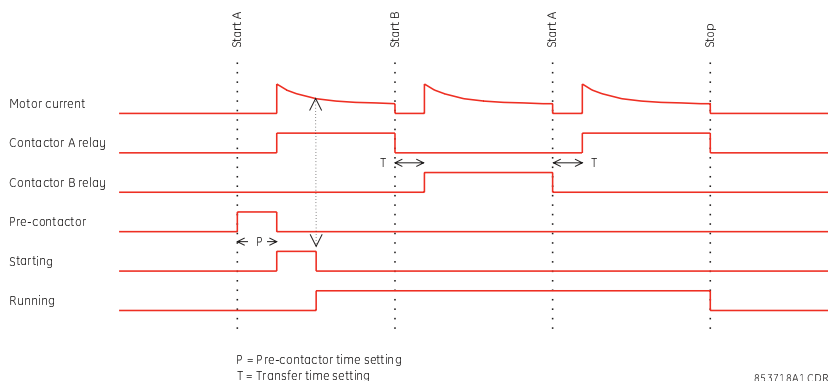


Figure 60: Typical starter timing for full-voltage reversing starter

The following additional setpoints are available for the full-voltage reversing starter.

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

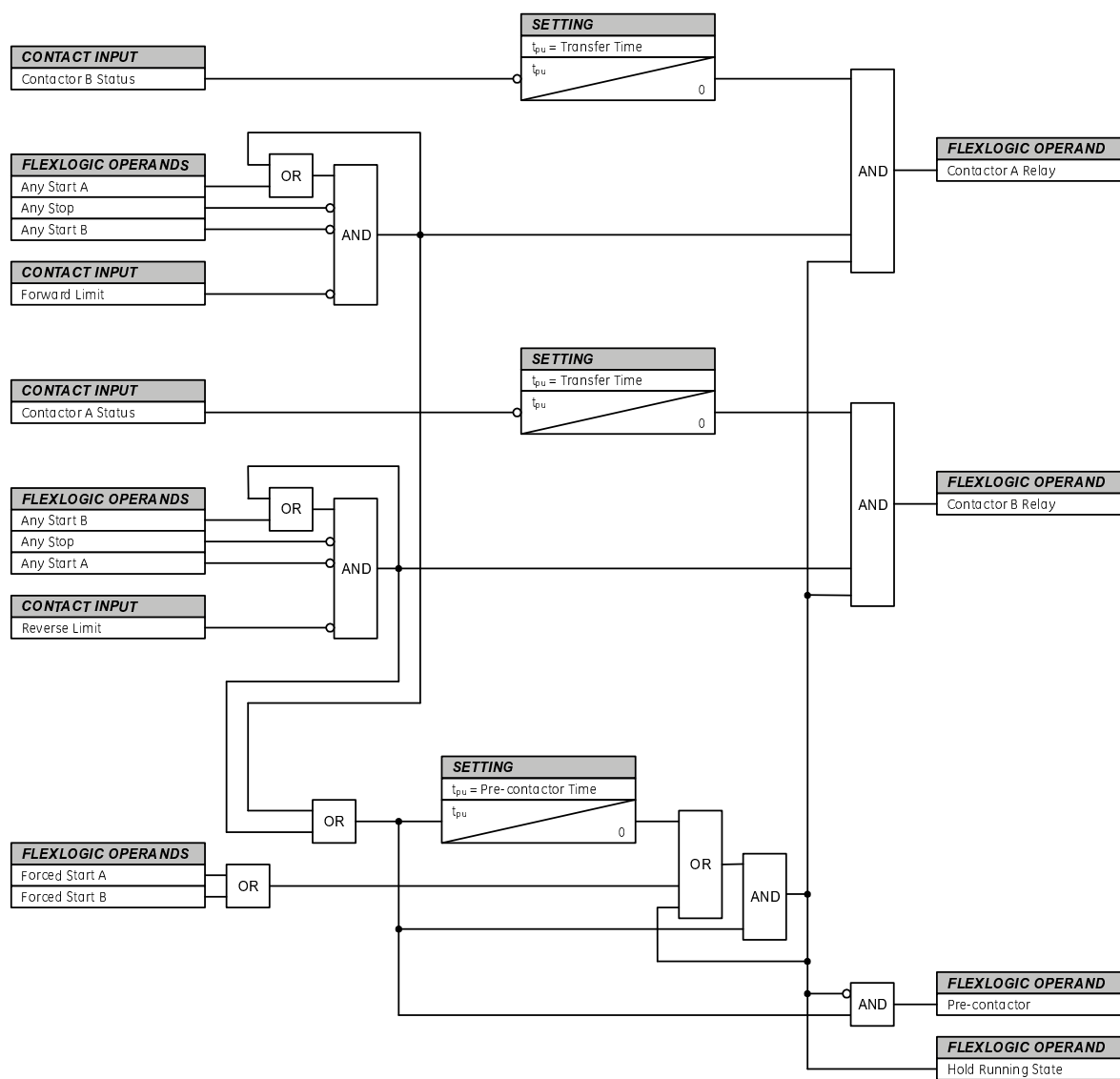
This setpoint represents the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as undervoltage restart immediate and external start.

Transfer Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

This setpoint represents the time between stopping and starting in a new direction for the reversing starter.



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Figure 61: Full-voltage reversing starter logic diagram

6.2.2.3 TWO-SPEED STARTER

The two-speed starter type is a full-voltage or across-the-line two-speed starter.

When a start A (low speed) control is received, the pre-contactor relay (if any) is picked up for the set **PRE-CONTACTOR TIME**. When the pre-contactor timer times out, the contactor A relay picks up and seals-in, starting the motor in low speed. When a start B (high speed) control is received, the A contactor is dropped out. When contactor A status Off is received, the contactor B relay picks up and seals-in, starting the motor in high speed. Should a start A (low speed) control be received when the high speed contactor B is picked up, contactor B is dropped out. When contactor B status Off is received, the starter waits for the set **TRANSFER TIME** to allow the motor to slow. When the transfer time timer times out, the contactor A relay picks up and seals-in, starting the motor in low speed. When a stop control is received, the contactor A and B relays are dropped out and the motor stops.

If the **HIGH SPEED START BLOCK** setpoint is *Enabled*, this starter will not allow a start B (high speed) control unless already running on contactor A (low speed).

The pre-contactor is omitted on forced starts (for example, undervoltage restart immediate or external start). Forced starts are not supervised by this starter transfer timer – any external starting circuit must itself respect high to low speed transition restrictions and starting in high speed restrictions.

The following figure illustrates typical starter timing beginning from the stopped state.

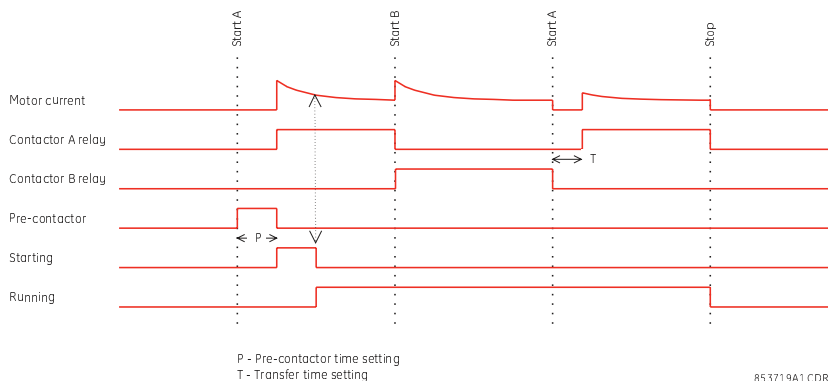


Figure 62: Typical starter timing for two-speed starter

The following additional setpoints are available for the two-speed starter.

High Spd FLA

Range: Off (Max.), 0.5 to 1000.0 A in steps of 0.1 A

Default: Off

This setpoints specifies the maximum continuous phase current when running in high speed.

Note:

The **HIGH SPD FLA** setpoint is seen only if motor's **STARTER TYPE** is set to "Two-Speed".

High Spd Motor Rating

Range: Off (Max.), 0.3 to 1100.0 kW in steps of 0.1 kW

Default: Off

This setpoint specifies the motor nominal rating setting and is used as reference for Under Power Alarm/Trip.

Note:

The **HIGH SPD MOTOR RATING** setpoint is seen only if motor's **STARTER TYPE** is set to "Two-Speed".

High Spd Start Block

Range: Enabled, Disabled

Default: Enabled

This setpoint is only available when **STARTER TYPE** is set to "Two-Speed".

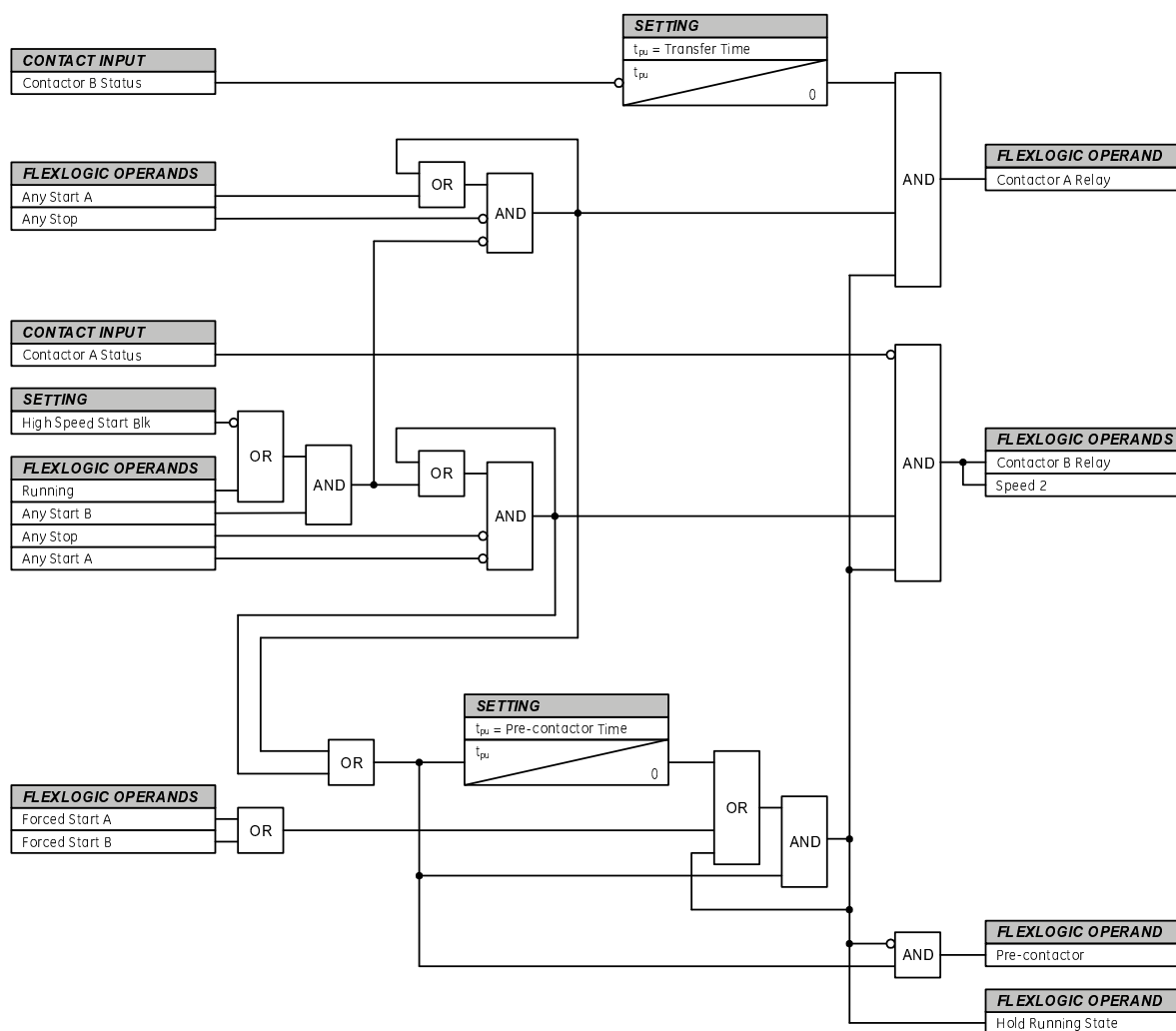
When this setpoint is programmed as *Disabled*, the relay allows the motor to be started directly to high speed. When programmed as *Enabled*, the motor must be running in low-speed before switching to high-speed.

Transfer Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

This setpoint represents the time between running at high speed and starting at low speed for the two-speed starter.



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Figure 63: Two-speed starter logic diagram

6.2.2..4 WYE-DELTA OPEN TRANSITION STARTER

The wye-delta open transition starter is a reduced voltage starter.

When a start A control is received, the pre-contactor relay (if any) is picked up for the set **PRE-CONTACTOR TIME**. When the pre-contactor timer times out, the contactor A relay picks up and seals-in, picking up the 1S contactor, which connects the motor in wye configuration. The 1S contactor in turn picks up the 1M contactor, which connects the motor to the supply. The motor is now starting at 58% voltage. When the transfer time timer expires, the contactor A relay is de-energized, contactor 1S drops out, opening the wye and disconnecting the motor from the supply. When the contactor 1S status off is received, the contactor B relay picks up and seals-in, picking up the 2M contactor, which connects the motor in delta configuration. The 2M contactor in turn picks up the 1M contactor, which connects the motor to the supply. The motor is now running at full voltage. When a stop control is received, the contactor A and B relays are dropped out, contactor 1S and 2M drop out, contactor 1M drops out, and the motor stops.

Pre-contactor is omitted on forced starts (for example, undervoltage restart immediate or external start). Otherwise, contactor A forced starts operate in the same fashion as other contactor A starts, with the transfer to full voltage occurring when the transfer time expires. Contactor B forced starts are not supervised by this starter transfer timer – any external contactor B starting circuit must itself respect full voltage starting restrictions.

The following figure illustrates typical starter timing beginning from the stopped state.

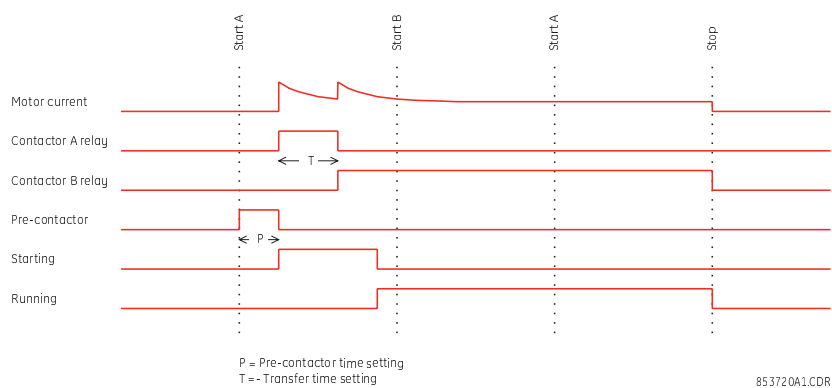


Figure 64: Typical starter timing for wye-delta open transition starter

The following additional setpoints are available for the wye-delta open transition starter.

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

This setpoint represents the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as undervoltage restart immediate and external start.

Transfer Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

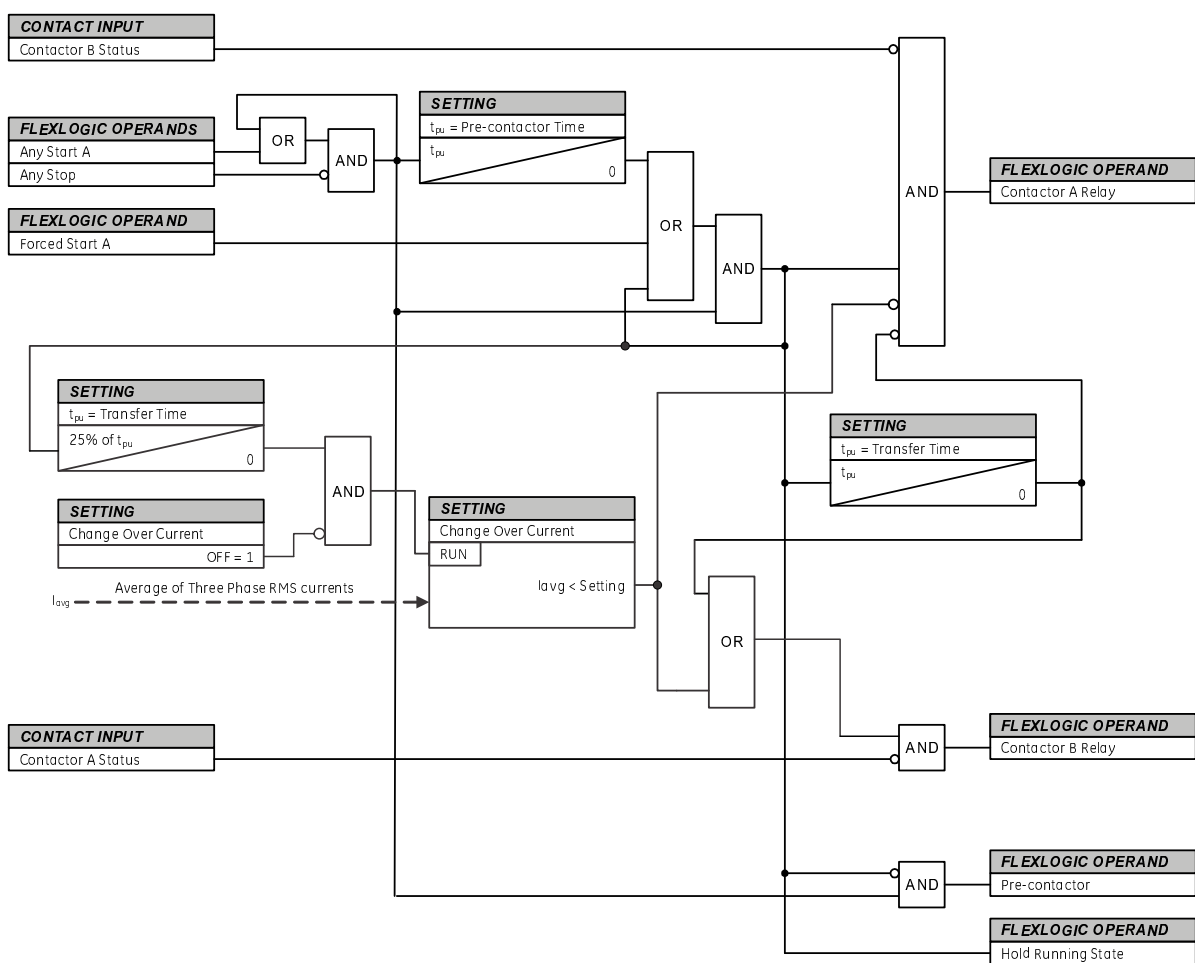
If the value specified by this setpoint has expired, the transition from wye (contactor A) to delta (contactor B) will occur.

Change Over Current

Range: Off (Max.), 1.0 to 5.1 x FLA in steps of 0.1 x FLA

Default: 1.5 x FLA.

If the average of the three phase currents has dropped below the value specified by this setpoint and 25% of the value specified by the **TRANSFER TIME** setpoint has expired, then the transition from wye (contactor A) to delta (contactor B) will occur. If the **CHANGE OVER CURRENT** setting is set to "Off", the transition from Wye to Delta will occur after expiration of the Transfer Time.



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Figure 65: Wye-delta open transition starter logic diagram

6.2.2..5 INVERTER STARTER

The Inverter starter type is used with an external inverter that ramps the motor speed up on start and ramps it down on stop.

The B Open Contactor Control Circuit and B Welded Contactor alarms are defeated when the inverter starter is selected.

When a start A control is received, the pre-contactor (if any) is picked up for the set delay, then relay1 picks up and seals-in, picking up contactor 1M. This provides power for the inverter to start up. Relay2 closes after a 1 second delay, and seals in, which signals the inverter to ramp up the motor. When a stop control is received, the relay2 drops out, and the inverter ramps down. When the ramp down time timer has expired, relay1 is opened, contactor 1M drops out, cutting power to the inverter and motor.

The inverter signals the relay that it is up-to-speed by closing auxiliary relay MR. If the auxiliary relay MR unexpectedly opens while running, signaling a possible inverter problem, relay2 drops out, and the inverter ramps down if it has not done so already. An Inverter alarm is issued, but relay1 remains closed, so contactor 1M stays picked up, and the supply to the inverter is maintained. This is done so that the inverter has power to retain its event records for subsequent diagnosis of the problem. Relay1 is opened removing power to the inverter when a stop control is received, and the alarm is reset on the next start.

Forced starts (for example, External Start) operate in the same fashion as other starts, with relay1 not picking up until the pre-contactor timer times out. Then, after 1 second, relay2 picks up. If up-to-speed feedback is not received from auxiliary relay MR within the **RAMP UP TIME** setting during a start, a Drive Start Failed alarm is generated. If

up-to-speed feedback is not seen before a stop control, an Inverter Fail alarm is generated, and relay2 opens as described above.

If inverter speed feedback remains when the ramp down time expires during a stop, a Drive Stop Fail alarm is generated. Neither results in a trip or a stop. The Drive Start Failed alarm is latched until reset or cleared by a stop control. The Inverter fail alarm is cleared at next start.

The Undervoltage Autorestart feature is disabled for the Inverter Starter.

Note:

Ensure the inverter is located before the contactor.

The following figure illustrates typical starter timing beginning from the stopped state.

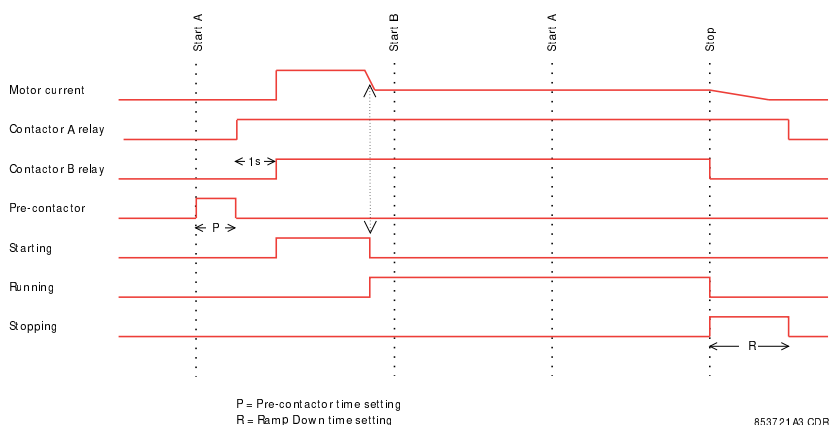


Figure 66: Typical starter timing for the inverter starter

The following additional setpoints are available for the inverter starter.

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

This setpoint specifies the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as external start. This setpoint is also used by the inverter starter and the soft start starter to set the amount of time between powering up an inverter or soft starter and sending the ramp-up command. An audible or other warning signal can be activated in this interval by connecting the signal to a contact output set to the pre-contactor function.

Ramp Up Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

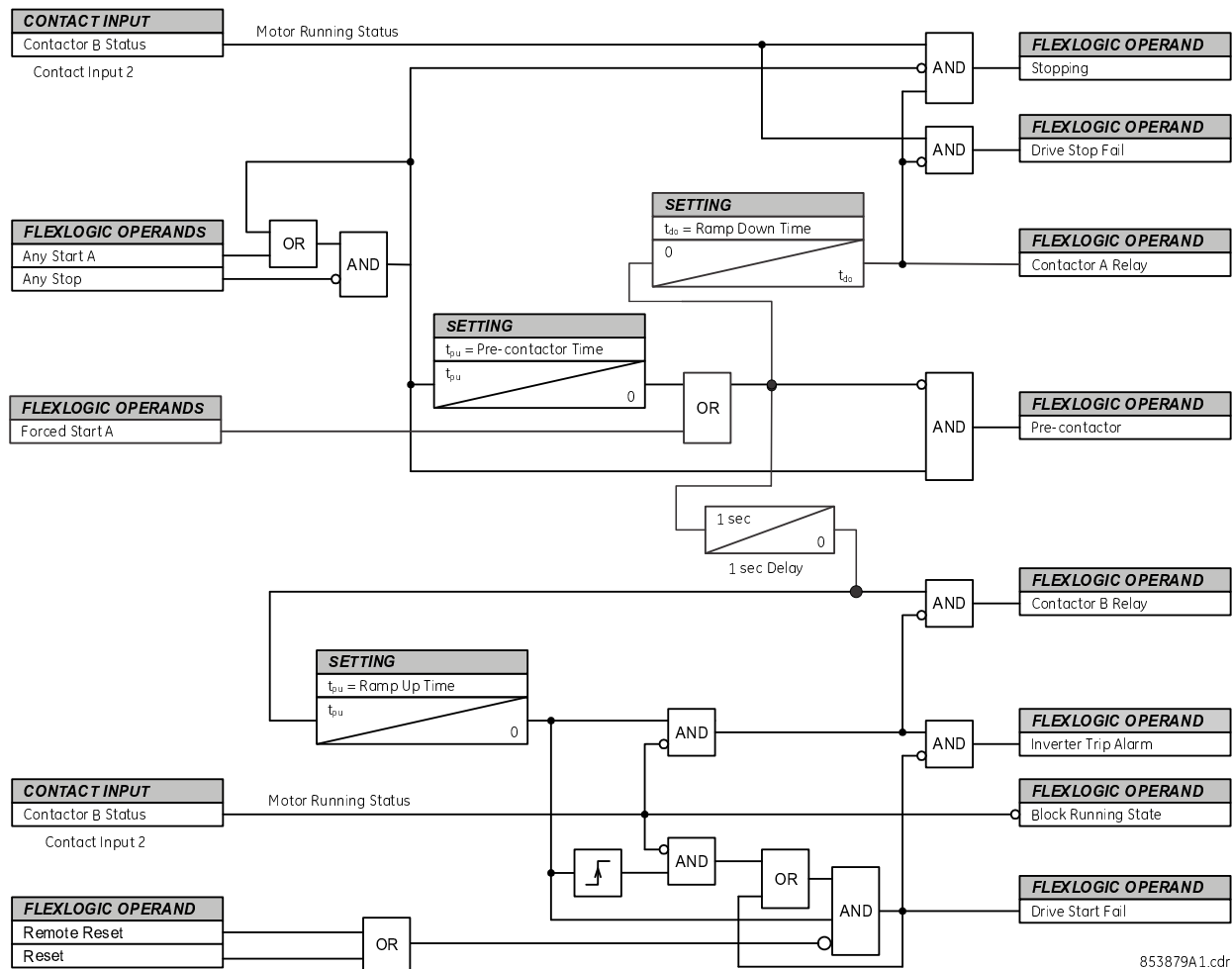
This setpoint specifies the time after signaling the inverter starter to ramp up that the up-to-speed feedback can be delayed without issuing a Drive Start Fail alarm.

Ramp Down Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

This setpoint specifies the time after signaling the inverter starter to ramp down before the main contactor is opened, cutting power to the starter. If speed feed back is still on when this time expires, a Drive Stop Fail alarm is issued.



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Figure 67: Inverter starter logic diagram

6.2.2.6 SOFT STARTER

The soft starter type is used with an external soft starter that ramps the motor speed up on start and down on stop. Once the motor is ramped up, the soft starter can be bypassed.

When a start A control is received, the pre-contactor (if any) is picked up for the set delay, then relay1 picks up and seals-in, picking up contactor 1M. This provides power for the Soft Starter to start up. Relay2 closes after a 1 second delay, and seals in, which signals the soft starter to ramp up the motor. When a stop control is received, the relay2 drops out, and the soft starter ramps down. When the ramp down time timer has expired, relay1 is opened, contactor 1M drops out, cutting power to the soft starter and motor.

Forced starts (for example, external start) operate in the same fashion as other starts, with the B contactor not calling for the soft starter to ramp until the pre-contactor timer times out.

If up to speed feedback is not received from the soft starter via the contactor B status within the **RAMP UP TIME** setpoint during a start, a Drive Start Failed alarm is generated. If soft starter speed feedback remains when the **RAMP DOWN TIME** expires during a stop, a Drive Stop Fail alarm is generated. Neither results in a trip or a stop. The Drive Start Failed alarm is latched until reset.

The B Open Contactor Control Circuit and B Welded Contactor alarms implemented in the start/stop control element are defeated when the soft starter is selected.

If the soft starter does not provide an up to speed feedback signal, the contactor B relay contact or an auxiliary contact of the B contactor should be connected to the up to speed feedback contact input to suppress spurious Drive Failed To Start alarms.

The Undervoltage Autorestart feature is disabled for the Soft Starter.

The following figure illustrates typical starter timing beginning from the stopped state.

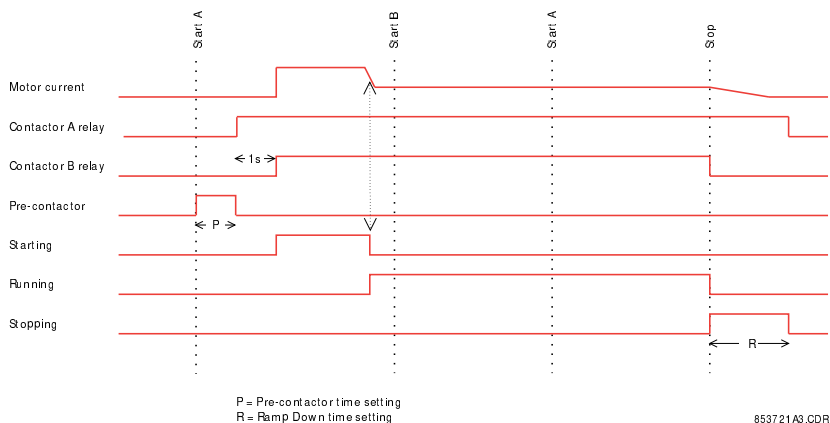


Figure 68: Typical starter timing for the soft starter

The following additional setpoints are available for the soft starter.

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

This setpoint specifies the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as external start. This setpoint is also used by the inverter starter and the soft start starter to set the amount of time between powering up an inverter or soft starter and sending the ramp-up command. An audible or other warning signal can be activated in this interval by connecting the signal to a contact output set to the pre-contactor function.

Ramp Up Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

This setpoint specifies the time after signaling the soft starter to ramp up that the up-to-speed feedback can be delayed without issuing a Drive Start Fail alarm.

Ramp Down Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

This setpoint specifies the time after signaling the soft starter to ramp down before the main contactor is opened, cutting power to the starter. If speed feedback is still on when this time expires, a Drive Stop Fail alarm is issued.

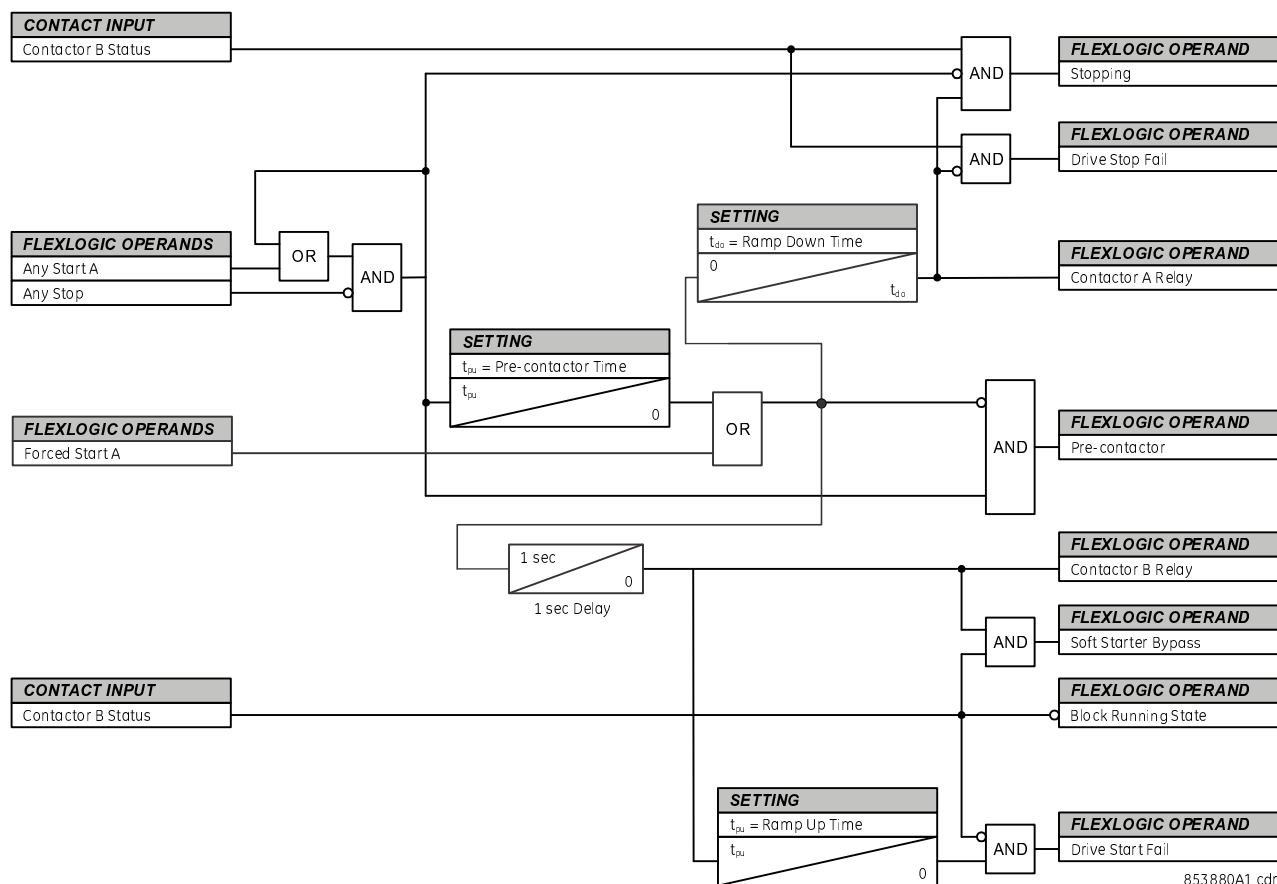


Figure 69: Soft start starter logic diagram

6.2.2..7 AUTOTRANSFORMER OPEN TRANSITION STARTER

The following table shows the I/O names used in Autotransformer open transition starter. It also shows connections between contactor, inputs/outputs and internal flags/operands driving these outputs.

FlexLogic operand	Contact output	Contactor	Status contact input
Contactor A Relay	C1	1S	C5
Contactor B Relay	C3	R	C6
Contactor C Relay	Assignable (default: N/A)	2S	Assignable (default: N/A)

Autotransformer open transition starter is a reduced voltage starter.

The expansion I/O module type C, D or E must be properly installed when the Autotransformer open transition starter is used. Three motor contactors R, 1S and 2S, each controlled by a separate MM300 Enhanced output relay are used to perform this function. There are two options of this starter: 1S-2S and 2S-1S. Each one offers a slightly different sequence of contactors operation. The description of both sequences is given as follows:

1S-2S start sequence:

1. Start A command received by the MM300 Enhanced (serial, digital input or faceplate).
2. Wait for the time set in the **PRE-CONTACTOR TIME** setpoint.
3. Close and maintain contactor 1S.
4. Wait until contactor 1S closed status is received, then close and maintain contactor 2S. Reduced voltage is applied to the motor.
5. Wait for the time set in the **TRANSFER TIME** setpoint.

6. Open Contactors 1S and 2S.
7. Wait until contactor 1S open status is received.
8. Close and maintain contactor R. Full voltage is applied to the motor.

2S-1S start sequence:

1. Start A command received by the MM300 Enhanced (serial, digital input or faceplate).
2. Wait for the time set in **PRE-CONTACTOR TIME** setpoint.
3. Close and maintain contactor 2S. Reduced voltage is applied to the motor.
4. Wait until contactor 2S closed status is received, then close and maintain contactor 1S.
5. Wait for the time set in the **TRANSFER TIME** setpoint.
6. Open contactors 1S and 2S.
7. Wait until contactor 1S open status is received.
8. Close and maintain contactor R. Full voltage is applied to the motor.

Stop/trip sequence:

1. Stop command received by the MM300 Enhanced or a trip occurs.
2. Open Contactor R.
3. Open Contactors 1S and 2S if they are not already opened.

The following figures illustrate typical starter timing beginning from the stopped state.

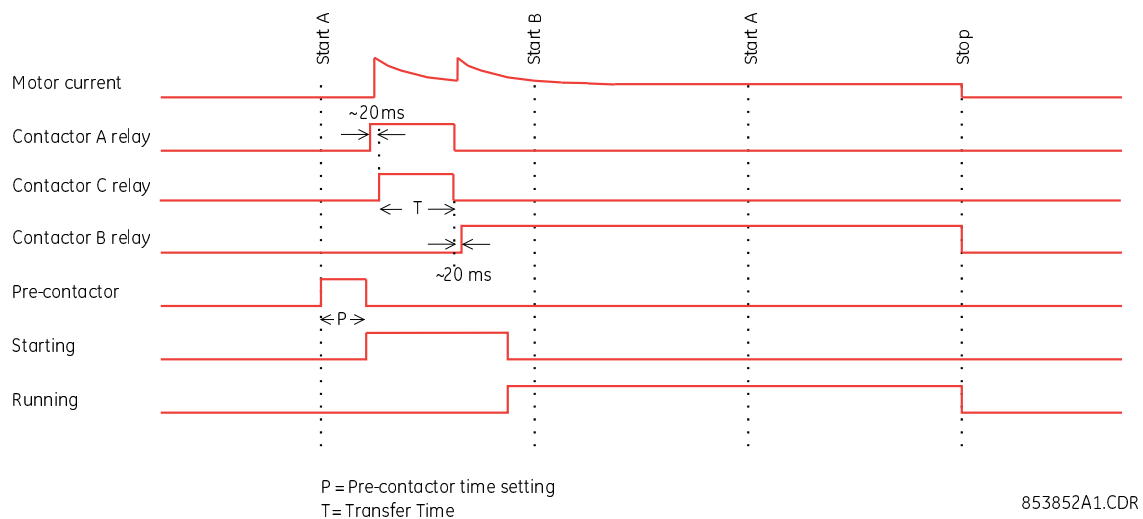


Figure 70: Typical starter timing for autotransformer open transition starter 1S-2S

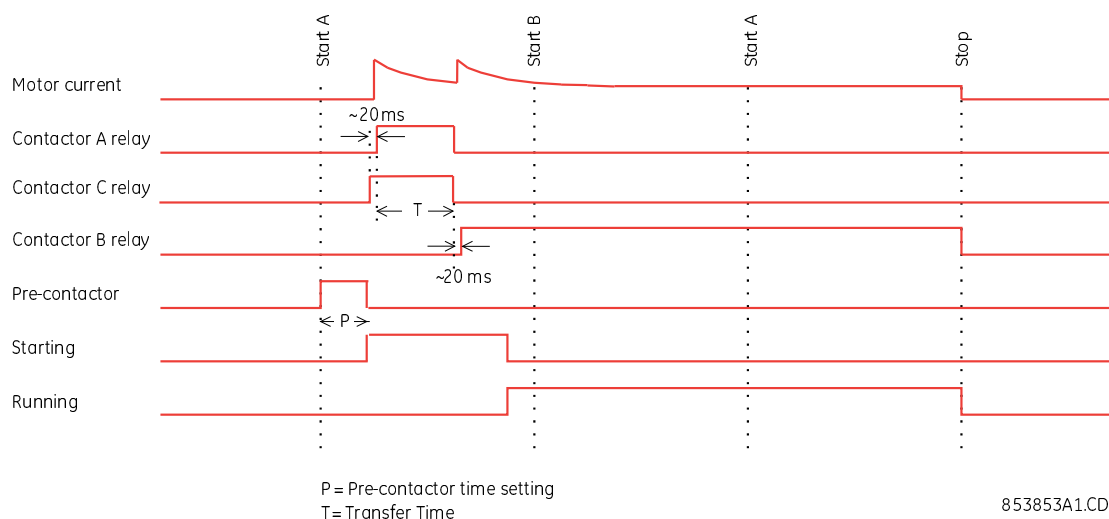


Figure 71: Typical starter timing for autotransformer open transition starter 2S-1S

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

This setpoint represents the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as undervoltage restart immediate and external start. This setpoint is also used by the inverter starter and the soft start starter to set the amount of time between powering up an inverter or soft starter and sending the ramp-up command. An audible or other warning signal can be activated in this interval by connecting the signal to a contact output set to the pre-contactor function.

Transfer Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

The value specified by this setpoint is the time during which, the motor will be supplied with the reduced voltage through an autotransformer. When this time expires, contactor B will close and supply the full voltage to the motor.

Contactor Sequence

Range: 1S-2S, 2S-1S

Default: 1S-2S

Contactors 1S and 2S are closed in a sequence with a 20 millisecond delay. **CONTACTOR SEQUENCE** setpoint selects the order of closing.

An additional two setpoints have to be configured in order to make the element work properly: **CONTACTOR C STATUS** and **CONTACTOR C**. Refer to Digital inputs and Output relays. The selections made there also assign two system messages `Open Ctrl Cct` and `Welded Contactor` to the status of contactor 2S.

Note:

*It is recommended to check the specifications of the autotransformer used for this application and adjust the MM300 Enhanced setpoint **STARTS/HOUR LIMIT** if necessary [Path: **Setpoints > Control > Start Inhibits**].*

Note:

Pre-contactor is omitted on forced starts (for example, UVR Immediate, External Start). Otherwise, type A forced starts operate in the same fashion as other type A starts, with the transfer to full voltage occurring when the transfer time expires. Type B forced starts are not supervised by this starter transfer timer - any external type B starting circuit must itself respect full voltage starting restrictions.

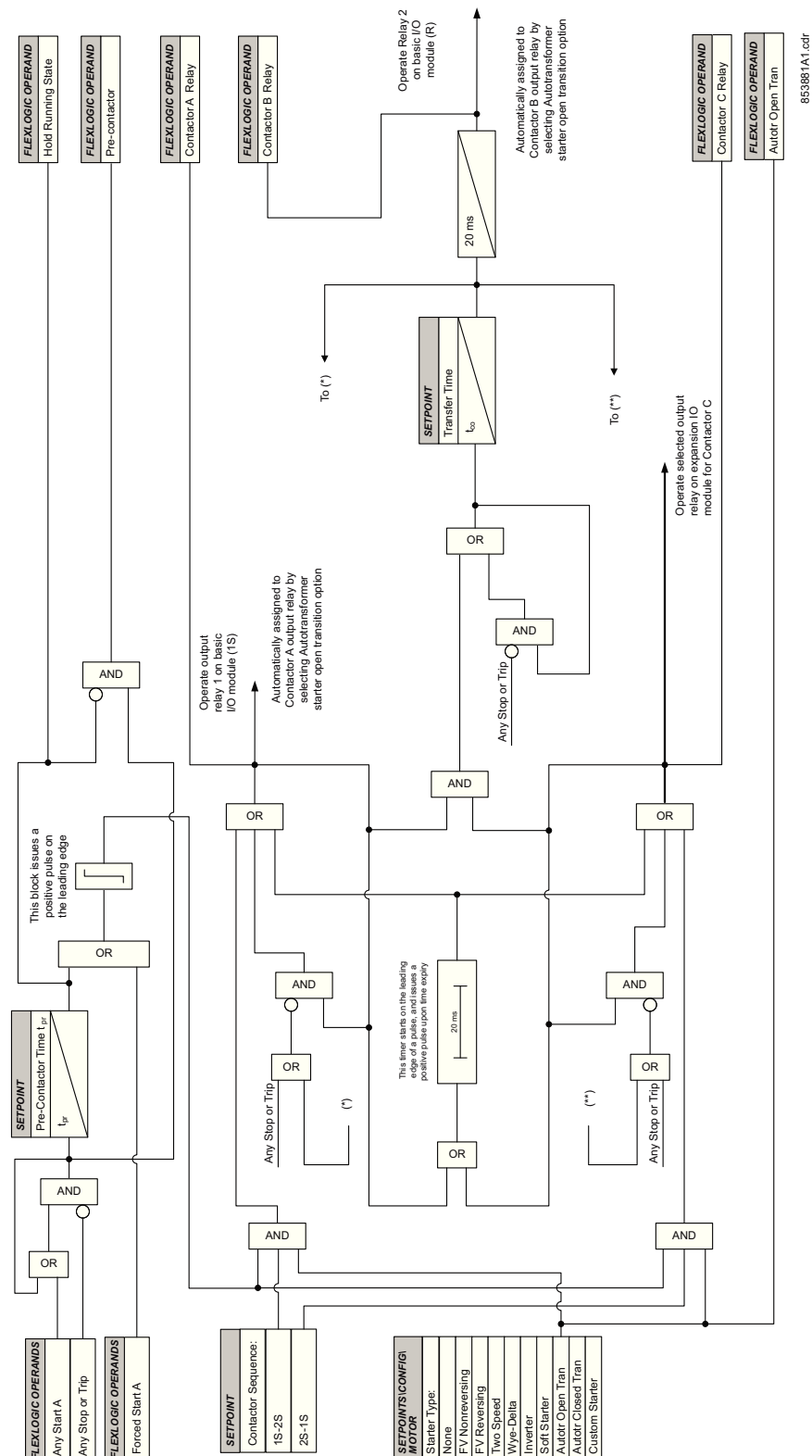


Figure 72: Autotransformer starter open transition logic diagram

6.2.2..8 AUTOTRANSFORMER CLOSED TRANSITION STARTER

The following table shows the I/O names used in Autotransformer closed transition starter. It also shows connections between contactor, inputs/outputs and internal flags/operands driving these outputs.

FlexLogic operand	Contact output	Contactor	Status contact input
Contactor A Relay	C1	1S	C5
Contactor B Relay	C3	R	C6
Contactor C Relay	Assignable (default: N/A)	2S	Assignable (default: N/A)

Autotransformer closed transition starter is a reduced voltage starter.

The expansion I/O module type C, D or E must be properly installed when the Autotransformer closed transition starter is used. Three motor contactors R, 1S and 2S each controlled by a separate MM300 Enhanced output relay are used to perform this function. There are two options of this starter: 1S-2S and 2S-1S. Each one offers a slightly different sequence of contactors operation. The description of both sequences is given as follows:

1S-2S start sequence:

1. Start A command received by the MM300 Enhanced (serial, digital input or faceplate).
2. Wait for the time set in **PRE-CONTACTOR TIME** setpoint.
3. Close and maintain contactor 1S.
4. Wait until contactor 1S closed status is received, then close and maintain contactor 2S. Reduced voltage is applied to the motor.
5. Wait for the time set in the **TRANSFER TIME** setpoint.
6. Open Contactors 1S.
7. Wait until contactor 1S open status is received.
8. Close and maintain contactor R. Full voltage is applied to the motor.
9. Wait until contactor R closed status is received.
10. Open contactor 2S.

2S-1S start sequence:

1. Start A command received by the MM300 Enhanced (serial, digital input or faceplate).
2. Wait for the time set in **PRE-CONTACTOR TIME** setpoint.
3. Close and maintain contactor 2S. Reduced voltage is applied to the motor.
4. Wait until contactor 2S closed status is received, then close and maintain contactor 1S.
5. Wait for the time set in the **TRANSFER TIME** setpoint.
6. Open contactors 1S.
7. Wait until contactor 1S open status is received.
8. Close and maintain contactor R. Full voltage is applied to the motor.
9. Wait until contactor R closed status is received.
10. Open contactor 2S.

Stop/trip sequence:

1. Stop command received by the MM300 Enhanced or a trip occurs.
2. Open Contactor R.
3. Open Contactors 1S and 2S if they are not already opened.

The following figures illustrate typical starter timing beginning from the stopped state.

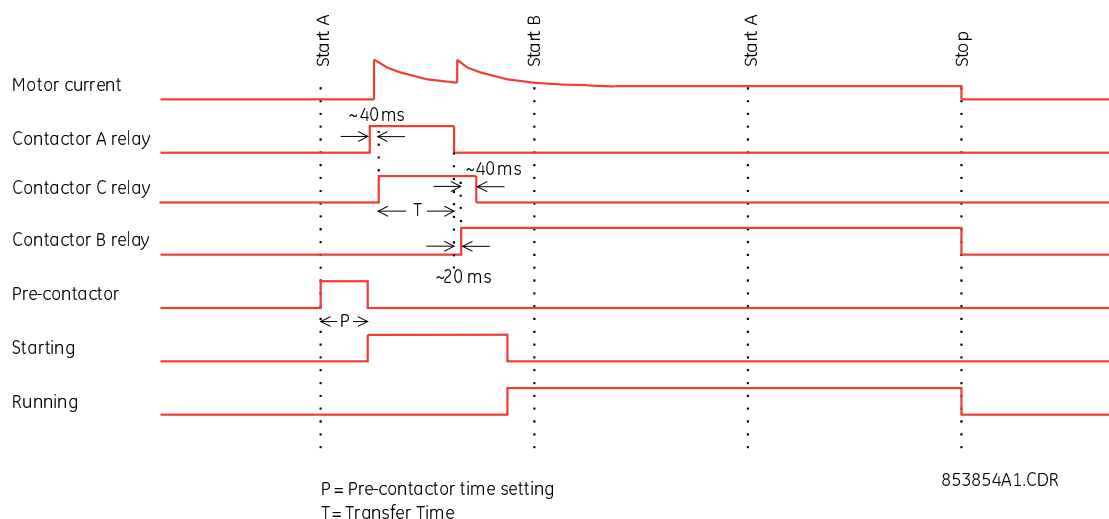


Figure 73: Typical starter timing for autotransformer closed transition starter 1S-2S

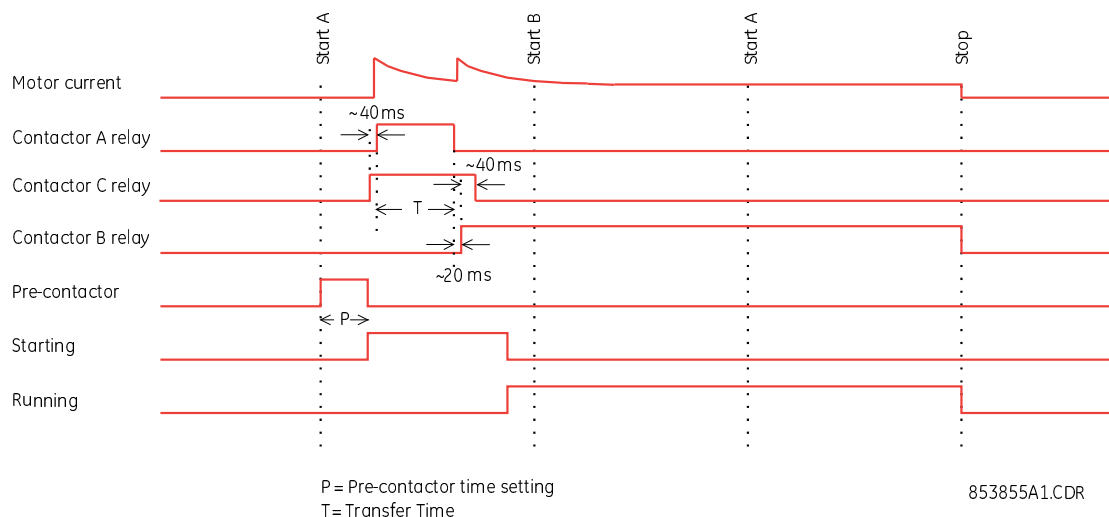


Figure 74: Typical starter timing for autotransformer closed transition starter 2S-1S

Pre-Contactor Time

Range: 0 to 60 s in steps of 1 s

Default: 0 s

This setpoint represents the time after a start command before the motor is started. Most starters do not use this delay for forced starts such as undervoltage restart immediate and external start. This setpoint is also used by the inverter starter and the soft start starter to set the amount of time between powering up an inverter or soft starter and sending the ramp-up command. An audible or other warning signal can be activated in this interval by connecting the signal to a contact output set to the pre-contactor function.

Transfer Time

Range: 0 to 125 s in steps of 1 s

Default: 1 s

The value specified by this setpoint is the time during which, the motor will be supplied with the reduced voltage through an autotransformer. When this time expires, contactor B will close and supply the full voltage to the motor.

Contactor Sequence

Range: 1S-2S, 2S-1S

Default: 1S-2S

Contactors 1S and 2S are closed in a sequence with a 40 millisecond delay. **CONTACTOR SEQUENCE** setpoint selects the order of closing.

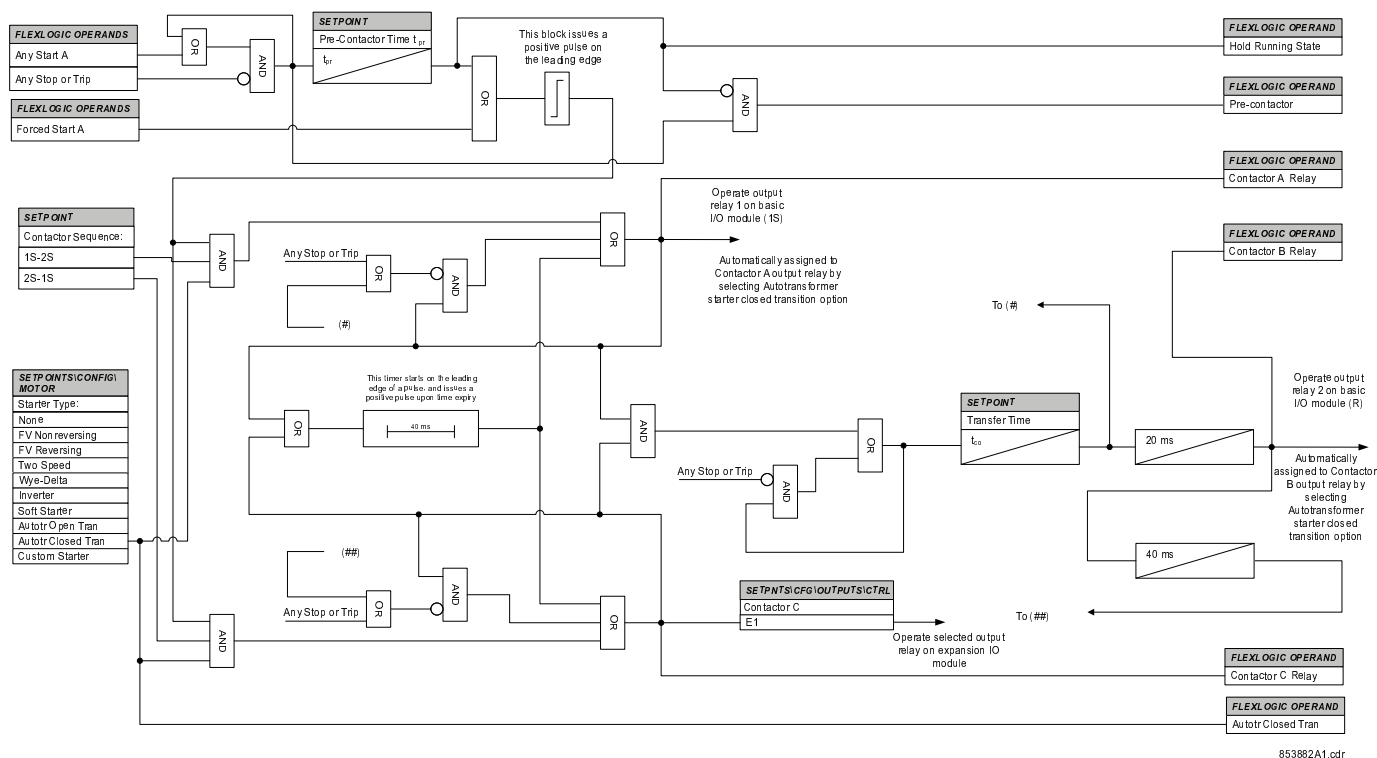
An additional two setpoints have to be configured in order to make the element work properly: **CONTACTOR C STATUS** and **CONTACTOR C**. Refer to Digital inputs and Output relays. The selections made there also assigns two system messages `Open Ctrl Cct` and `Welded Contactor` to the status of contactor 2S.

Note:

It is recommended to check the specifications of the autotransformer used for this application and adjust the MM300 Enhanced setpoint **STARTS/HOUR LIMIT** if necessary [Path: **Setpoints > Control > Start Inhibits**].

Note:

Pre-contactor is omitted on forced starts (for example, UVR Immediate, External Start). Otherwise, type A forced starts operate in the same fashion as other type A starts, with the transfer to full voltage occurring when the transfer time expires. Type B forced starts are not supervised by this starter transfer timer - any external type B starting circuit must itself respect full voltage starting restrictions.



853882A1.cdr

Figure 75: Autotransformer starter closed transition logic diagram

6.2.3 CURRENT AND VOLTAGE TRANSFORMERS

Path: **Setpoints > Configure > CT-VT**

The following setpoints are available to configure the current and voltage transformers.

Phase CT Type

Range: None, Direct Connect, 1 A Secondary, 5 A Secondary

Default: None

Direct Connect specifies that no Phase CTs are used, that motor phase current passes directly through the relay. *Direct Connect* should never be used where full load amps is greater than 5.0 amps.

Note:

If "Direct Connect" is selected and the FLA is set >5 A, an *FLA too high* message will be displayed on the Status page.

CT Primary

Range: 5 to 1000 A in steps of 1 A

Default: 5 A

This setpoint specifies the phase CT primary current. It should never be less than the full load amps, and preferably no more than twice full load amps.

Standard cut-off default is 20% (0.2pu) of CT primary. At CT primary less than 0.2pu, primary CT turns are required and an appropriate current cut-off setpoint.

For example: using a 30:1 CT with 6A FLA gives 0.2A CT secondary @ FLA, the cut-off must be lowered to 0.1A and a minimum of 3 primary turns are required.

Note:

This setpoint is displayed only if the phase CT type is set to 1 A secondary or 5 A secondary.

High Spd CT Primary

Range: 5 to 1000 A in steps of 1 A

Default: 5 A

This setpoint is used to determine the CT ratio needed when running at high speed. It should never be less than the high speed full load current, and preferably no greater than twice than the high speed full load current.

Note:

This setpoint is displayed only if the phase CT type is set to 1 A secondary or 5 A secondary and the motor starter type is two-speed.

CT Primary Turns

Range: 1 to 10

Default: 1

The value of this setting should equal the number of turns on the CT Primary to display the correct current value. Internally the current measurement will be divided by this setting. For smaller motors where the drawn current is very low, the motor leads may be wrapped through the CT Primary with several turns, increasing the current seen by the 859 and increasing the accuracy of the measurement as a result.

Standard cut-off default is 20% (0.2pu) of CT primary. At CT primary less than 0.2pu, primary CT turns are required and an appropriate current cut-off setpoint.

For example: using a 30:1 CT with 6A FLA gives 0.2A CT secondary @ FLA, the cut-off must be lowered to 0.1A and a minimum of 3 primary turns are required.

Ground CT Type

Range: None, 1A Secondary, 5A Secondary, CBCT 2000:1

Default: CBCT 2000:1

With “None” selected, the ground fault remains disabled.

If the fourth CT input (ground input) is connected to the residual of the phase CTs, this setpoint should have the same value as that of the Phase CT Type. For high resistance grounded systems, sensitive ground current detection is possible if the 2000:1 (50:0.025) ground input is used. To use the 2000:1 input, select “2000:1” for the Ground CT Type. On solidly grounded systems where fault currents can be quite large, the 1A Secondary, 5A Secondary ground CT type must be used for either zero-sequence or residual ground sensing. If the connection is residual, the Ground CT secondary and primary values must be the same as the phase CT. If however, the connection is zero-sequence, the Ground CT primary value must be entered.

Ground CT Primary

Range: 5 to 1000 A in steps of 1 A

Default: 5 A

Enter the primary rating of the ground CT wired to the relay ground CT terminals.

When the ground input is used for measuring the residual 3I0 current, the primary current must be the same as the one selected for the phase CTs.

3 Ph V Connection

Range: Wye, Delta

Default: Wye

The method in which the IO_B voltage inputs are connected must be entered here. Note that phase reversal is disabled for single VT operation. All voltages are assumed balanced.

Auxiliary Voltage Connection

Range: Vab VT, Vbc VT, Vca VT, Van VT, Vbn VT, Vcn VT, Van Direct, Vbn Direct, Vcn Direct

Default: Vab VT

This is the connection of the control transformer to the motor's supply voltage, used in shifting and scaling the auxiliary voltage signal up to motor terminal voltage for undervoltage restart and when the three-phase voltage option is not present, calculating various metering quantities such as watts.

Auxiliary VT Primary

Range: 110 to 690 V in steps of 1 V

Default: 415 V

This setpoint specifies the primary voltage rating of the control transformer used in scaling the auxiliary voltage signal up to motor terminal voltage. If the motor supply voltage permits the direct connection of the auxiliary VT input and a control transformer is not used, enter the same value as the **AUXILIARY VT SECONDARY** setpoint.

Auxiliary VT Secondary

Range: 110 to 300 V in steps of 1 V

Default: 110 V

This setpoint specifies the secondary voltage rating of the control transformer, used in scaling the auxiliary voltage signal up to motor terminal voltage.

It is also used to set the contact input sensing threshold. If motor supply voltage permits direct connection of the auxiliary VT input and a control transformer is not used, enter the normal voltage that the auxiliary VT input will experience.

6.2.4 DIGITAL INPUTS

Path: **Setpoints > Configure > Digital Inputs**

The MM300 Enhanced digital (contact) inputs are programmed in this menu.

Input Signal Type/Slot C

Range: Wet-type, Dry-type

Default: Wet-type

Note:

This setting is only available and applicable when slot C is ordered with module IO_M, otherwise this setting remains hidden.

Input Signal Type/Slot E

Range: Wet-type, Dry-type

Default: Wet-type

Note:

This setting is only available and applicable when slot E is ordered with module IO_M, otherwise this setting remains hidden.

Input Signal Type/Slot F

Range: Wet-type, Dry-type

Default: Wet-type

Note:

This setting is only available and applicable when slot F is ordered with module IO_M, otherwise this setting remains hidden.

Input Signal Type/Slot G

Range: Wet-type, Dry-type

Default: Wet-type

Note:

This setting is only available and applicable when slot G is ordered with module IO_M, otherwise this setting remains hidden.

Input Signal Type/Slot H

Range: Wet-type, Dry-type

Default: Wet-type

Contact input type can be configured as Dry-type or Wet-type using this setting. Dry inputs use an internal +24V that is supplied by the MM300 Enhanced.

Selection of the input type (wet or dry) applies to all the contact inputs of the associated slot. For instance, when setpoint **INPUT SIGNAL TYPE/SLOT C** is configured as Wet-type, user must ensure that external DC supply is applied to all the contact inputs of slot C. And when setpoint **INPUT SIGNAL TYPE/SLOT C** is configured as Dry-

type, user must ensure that all the slot C inputs are wired to an internal +24V that is supplied by the MM300 Enhanced.

Note:

This setting is only available and applicable when slot H is ordered with module IO_M, otherwise this setting remains hidden.

Access Switch

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This setting allows an open contact to disable security access of at selected levels.

The value *N/A* indicates that the function has no assigned Contact Input.

Note:

This setting is only available and applicable when slot H is ordered with module IO_M, otherwise this setting remains hidden.

Auto/Manual Switch

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

The “Close” value sets the Auto mode and “Open” sets the Manual mode.

Comms Permissive

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This setting allows an open contact to disable communications control. Used by the auto/manual control element.

Contactor Status A

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents the normally open auxiliary contact of contactor A. It is used by the starters, the stop/start control element, and the system trouble function. Automatically assigned to the first input when a starter type is selected, but not otherwise user-programmable.

Contactor Status B

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents the normally open auxiliary contact of contactor A. It is used by the starters, the stop/start control element, and the system trouble function. Automatically assigned to the second input when reversing, two-speed starter, autotransformer open transition, or autotransformer closed transition type is selected, and when the custom I/O which uses this input is selected, but it is not otherwise user-programmable.

Contactor Status C

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents the normally open auxiliary contact of contactor 2S. It is used by the Autotransformer Open Transition and Autotransformer Closed Transition starters, the stop/start control element, and the system trouble function.

Field Permissive

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents an open contact which disables field control. Used by the auto/manual control element.

Field Start A

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a field-located manual switch requesting contactor A pickup. Used by the auto/manual control element.

Field Start B

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a field-located manual switch requesting contactor B pickup. Used by the auto/manual control element.

Field Stop

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a field-located manual switch where an open position requests a stop. Used by the auto/manual control element.

Forward Limit

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a contact which opens at the forward travel limit. Used by the reversing starter type.

Hard Wired Permissive

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents an open contact that disables hard-wired control. Used by the auto/manual control element.

Hard Wired Start A

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents an auto contact (typically from a PLC) requesting contactor A pickup. Used by the auto/manual control element.

Hard Wired Start B

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents an auto contact (typically from a PLC) requesting contactor B pickup. Used by the auto/manual control element.

Hard Wired Stop

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents an auto contact (typically from a PLC) where the open position requests a stop. Used by the auto/manual control element.

Interlock A (J)

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents the contact inputs used by process interlocks A through J, respectively.

Lockout Reset

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a contact input used to reset lockout trips.

MCC Permissive

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents an open contact that disables MCC control. Used by the auto/manual control element.

Remote Reset

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a contact input used to resets non-lockout trips and alarms.

Reverse Limit

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a contact which opens at the reverse travel limit. Used by the reversing starter type.

Test Switch

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a contact input used to suspend collection of selected data items, override auto/manual modes, and cause interlocks to be ignored. When **TEST SWITCH** is kept asserted, the device enters into Test Mode. While MM300 Enhanced is in Test Mode, the starting inhibit counters are bypassed. Undercurrent, undervoltage and underpower functions can also be blocked in Test Mode by enabling the setting **PRT FUNC IGNORE IN TEST MODE**. While in the test position, if the test switch is switched from Closed to Open while the motor is in the Running state, an internal stop is generated to stop the motor.

UVR Inhibit

Range: N/A, Contact Input 1 to Contact Input X, Virtual Output 1 to Virtual Output 128

Default: N/A

This value represents a contact that disables undervoltage restart feature when closed, and allows undervoltage restarts to take place when open.

Note:

*The thermal capacity% will be reset to zero after a Lockout Reset, if the **RESET TCU USING RESET KEY** setting is set to Enabled.*

6.2.5 VIRTUAL INPUTS

The MM300 Enhanced is equipped with 128 virtual inputs that can be individually programmed to respond to input signals from the keypad or communications protocols. This has the following advantages over Contact Inputs only.

- The number of logic inputs can be increased without introducing additional hardware.
- Logic functions can be invoked from a remote location over a single communication channel.
- The same logic function can be invoked both locally via contact input or front panel keypad, and/or remotely via communications.
- Panel switches can be replaced entirely by virtual switches to save cost and wiring.

All virtual input operands are defaulted to “Off” (logic 0) unless the appropriate input signal is received.

Path: *Setpoints > Configure > Virtual Inputs > Virtual Input 1 (128)*

Function

Range: Disabled, Enabled

Default: Disabled

If this setting is set to “Disabled” the input will be forced to OFF (logic 0) regardless of any attempt to alter the input. If set to “Enabled” the input operates as shown on the logic diagram below and generates output FlexLogic™ operands in response to received input signals and the applied settings.

Name

Range: up to 13 alphanumeric characters

Default: VI 1

An alphanumeric name may be assigned to a virtual input for diagnostic, setting, and event recording purposes.

Type

Range: Latched, Self-reset

Default: Latched

There are two types of operation: self-reset and latched. If **VIRTUAL INPUT x TYPE** is “Self-Reset”, when the input signal transits from OFF to ON the output operand will be set to ON for only one evaluation of the FlexLogic™ equations, then return to OFF. If set to “Latched” the virtual input sets the state of the output operand to the same state as the most recent received input.

Note:

The self-reset operating mode generates the output operand for a single evaluation of the FlexLogic™ equations (i.e., a pulse of one protection pass). If the operand is to be used anywhere other than internally in a FlexLogic™ equation, it will likely have to be lengthened in time. A FlexLogic™ timer with a delayed reset time can perform this function.

Events

Range: Enabled, Disabled

Default: Enabled

Selecting “Enabled” means that every change in the contact input state will trigger an event.

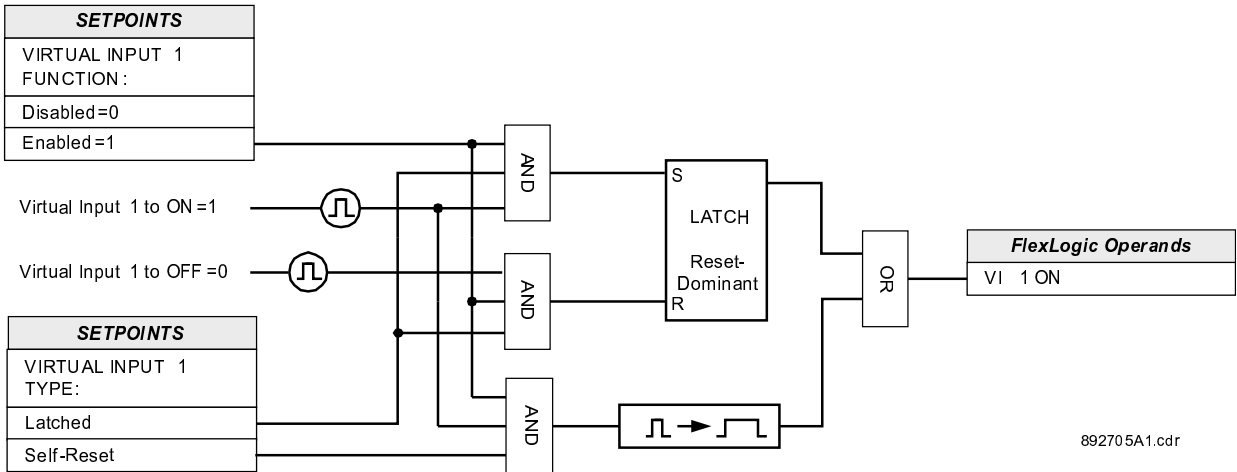


Figure 76: Virtual inputs scheme logic

6.2.6 OUTPUT RELAYS

Path: **Setpoints** > **Configure** > **Output relays**

Contact inputs are designated by their card slot letter appended with their card terminal number. Contact outputs, which have two or three terminals, use the first of their terminal numbers. This is the same scheme as is used to form the relay terminal designation. A typical contact output setpoint page is shown below. Contact inputs/outputs setpoints

The terminal designation is indicated under the “Terminal” column. The values in the first column are determined from the installed option cards and cannot be edited.

When a starter type is selected, the first equipped contact output and the first equipped contact input are forced to the contactor A relay function and the contactor A status function, respectively. When the two-speed, reversing starter, autotransformer open transition, or autotransformer closed transition type is selected, the second equipped contact output and the second equipped contact input are forced to the contactor B relay **FUNCTION** and the contactor B status **FUNCTION**, respectively. Any prior values for these setpoints are erased, and the setpoint becomes non-editable.

A function associated with an enabled element will be displayed in black. If the element is disabled, it will be displayed in red. Pre-defined functions are also displayed in red.

For contact outputs the **FUNCTION** setpoint determines which internal signal turns the output on and off. A list of the setpoints options with descriptions is shown below. For more information on a particular option, see the appropriate section in this manual.

- *Contactor A Relay*: This value represents an output contact that energizes contactor A. It is used by the starters, the stop/start control element, and the system trouble function, and automatically assigned to the first output when a starter type is selected. Not otherwise user assignable.
- *Contactor B Relay*: This value represents an output contact that energizes contactor B. It is used by the starters, the stop/start control element, and the system trouble function, and automatically assigned to the second output when a reversing, two-speed, inverter, soft starter, autotransformer open transition or

autotransformer closed transition type is selected, and when the custom I/O is selected and uses this output. Not otherwise user assignable.

- *Contactor C Relay*: This value represents an output contact that energizes contactor 2S. The related contact output is assigned by the user. It is used by the Autotransformer Open Transition and Autotransformer Closed Transition starters, the stop/start control element, and the system trouble function.
- FlexLogic™ operands: Any FlexLogic™ operand can be assigned to a contact output.

Output relays function options

Function	Description
Contactor A Relay	Output contact that energizes contactor A. Used by the starters, the Stop/Start control element, and System Troubles. Automatically assigned to the first output when a starter type is selected. Not otherwise user assignable.
Contactor B Relay	Output contact that energizes contactor B. Used by the starters, the Stop/Start control element, and System Troubles. Used by the starters, the Stop/Start control element, and System Troubles. Automatically assigned to the second output when a reversing, two speed, inverter or soft starter type is selected. Not otherwise user assignable.
Selected FlexLogic Operands, to be determined	See FlexLogic Operands

6.2.7 VIRTUAL OUTPUTS

The MM300 Enhanced is equipped with 128 virtual outputs (that may be assigned via FlexLogic. If not assigned, the output will be forced to *Off* (Logic 0). An ID may be assigned to each virtual output. Virtual outputs are resolved in each protection pass through the evaluation of the FlexLogic equations. Any change of state of a virtual output can be logged as an event if programmed to do so. For example, if Virtual Output 1 is the trip signal from FlexLogic and the trip relay is used to signal events, the settings would be programmed as follows:

VIRTUAL OUTPUT 1 ID: "Trip"

VIRTUAL OUTPUT 1 EVENTS: "Enabled"

Path: *Setpoints > Configure > Virtual Outputs > Virtual Output 1(X)*

Virtual Output # Name

Range: up to 13 alphanumeric characters

Default: VO 1

An alphanumeric name may be assigned to a virtual input for diagnostic, setting, and event recording purposes.

Events

Range: Enabled, Disabled

Default: Disabled

Selecting "Enabled" means that every change in the virtual output state will trigger an event.

6.2.8 REMOTE OUTPUTS

Path: *Setpoints > Configure > Remote Outputs*

6.2.9 COMMS

6.2.9.1 MODBUS

Path: *Setpoints > Configure > Comms > Modbus*

Slave Address

Range: 1 to 254 in steps of 1

Default: 254

TCP Port

Range: 0 to 65535 in steps of 1

Default: 502

Modbus Activity Timeout

Range: 0 to 3600 s in steps of 1 s

Default: 0 s

This setting 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 **MODBUS ACTIVITY TIMEOUT** is 0 s.

Compatibility

Range: Disabled, FlexMap

Default: Disabled

Note:

When set to FlexMap, the relay will stop communication with EnerVista Flex when using RS485 and Eth1/Eth2/Eth3. The user will only be able to communicate using EnerVista Flex through the Graphical Control Panel USB port or through the lateral RS485 port, where the Graphical Control Panel is usually connected. To connect through this lateral RS485 port, an MM300/MM200 1Ft. RS232-RJ45, PN: 0804-0180 cable must be used. Do not connect to the lateral RS485 port via the RJ45 from a laptop. Only serial connection is allowed to this port.

FlexMapFile

Range: MM300XAFlexMap.000,MM2XAFlexMap.00

This shows the name of the FlexMap file that is available when *FlexMap* is selected. The FlexMapFile must be typed in, it is not in the pulldown list.

6.2.9.2 RS485

Path: *Setpoints > Configure > Comms > RS485*

RS485 Baud Rate

Range: 9600, 19200, 38400, 57600 and 115200

Default: 115200

RS485 Parity

Range: None, Odd, Even

Default: Even

6.2.9.3 PROFIBUS

Path: *Setpoints > Configure > Comms > Profibus*

Profibus Address

Range: 1 to 125 in steps of 1

Default: 125

Specifies the Profibus slave address for this node.

Profibus Baud Rate

Range: 9600, 19200, 31250, 45450, 93750, 187500, 500K, 1.5M, Autodetect

Default: Autodetect

Specifies the speed of communication for the Profibus interface.

Profibus Activity Timeout

Range: 0 to 3600 s in steps of 1 s

Default: 0 s

This setting specifies the minimum time without fieldbus communication. This timeout is used to declare the Profibus *Loss of Communication* state. The Profibus state is always *Active* if **PROFIBUS ACTIVITY TIMEOUT** is 0 s.

6.2.9.4 ETHERNET

Path: *Setpoints > Configure > Comms > Ethernet > Ethernet [X]*

Note:

[X] represents the element number where the setting is applicable to Ethernet 1, 2 and 3. Ethernet 1 is only available for communications order code option C and E. Ethernet 2 and 3 are only available for communications order code option R.

ETH[X] Function

Range: Enabled, Disabled

Default: Disabled

This setting enables or disables network communication on the respective port. When **ETH[X] FUNCTION** is *Disabled*, the network traffic on that port is disabled.

ETH[X] IP Addr

Range: Standard IPv4 address format

Default: 169.254.3.3 (ETH1), 127.0.0.1 (ETH2/3)

This sets the port's IPv4 address in standard IPv4 format.

Note:

This setting is only valid for Ethernet 3 if **ETH2 OPERATION** is set to *Independent*.

ETH[X] Subnet Mask

Range: Standard IPv4 subnet mask format

Default: 255.255.255.0

This sets the port's IPv4 subnet mask in standard IPv4 format.

Note:

*This setting is only valid for Ethernet 3 if **ETH2 OPERATION** is set to *Independent*.*

ETH1 Gtway Addr

Range: Standard IPv4 address format

Default: 169.254.3.1

This sets the port's IPv4 gateway address in standard IPv4 format.

Note:

Gateway address must be on the same subnet as the IP address.

ETH2 Operation

Range: Independent, LLA, PRP, HSR

Default: Independent

This specifies the mode of operation between Ethernet 2 and 3. When set to *Independent*, Ethernet 2 and 3 operate independently with their own MAC and IP addresses.

6.2.9.4.1 REDUNDANCY

Path: *Setpoints > Configure > Comms > Ethernet > Redundancy*

PRP/HSR McstAddr

Range: 01-15-4E-00-01-00 to 01-15-4E-00-01-FF

Default: 01-15-4E-00-01-00

This setting allows the user to change the multicast address used by the PRP supervision frames. All devices attached to the PRP and HSR networks need to use the same multicast address for the network supervision to operate properly.

LLA Link Timeout

Range: 50 to 60000 ms in steps of 1 ms

Default: 100 ms

This specifies the link scan interval. The link status is scanned at the selected interval and when the link status on an active port is detected as having failed, communication is switched to an alternative port within the configured interval. For fast switching, the interval needs to be configured to lower values.

6.2.9.5 ROUTING

When the configuration card is present, a default route and a maximum number of 6 static routes may be configured. The default route (**GATEWAY ADDRESS**) is only used if no other route towards a given IP destination is found.

Path: *Setpoints > Configure > Comms > Routing*

Gateway Address

Range: Standard IPv4 unicast address format (0.0.0.1 to 223.255.255.254)

Default: 127.0.0.1

This sets the gateway of the default route to be used by IP traffic sent from the relay if no other route is found.

Rt1...6 Destination

Range: Standard IPv4 network address format (0.0.0.1 to 223.255.255.254)

Default: 127.0.0.1

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

Rt1...6 Mask

Range: Standard IPv4 network mask format

Default: 255.0.0.0

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

Rt1...6 Gateway

Range: Standard IPv4 unicast address format (0.0.0.1 to 223.255.255.254)

Default: 127.0.0.1

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

ADDING AND DELETING STATIC ROUTES

- By default the value of the destination field is 127.0.0.1 for all static routes (1 to 6). This is equivalent with saying that the static routes are not configured. When the destination address is 127.0.0.1 the mask and gateway must be also kept on default values.
- By default the value of the default route gateway address is 127.0.0.1. This means the default route is not configured.
- 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 the notes below.
- To configure the default route, enter a default gateway address. A default gateway address configured must be validated against the last rule listed in the notes below.
- 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 be also brought back to default values.
- The default route is deleted by replacing the default gateway with the default value 127.0.0.1.

Note:

Host routes are not supported at present.

Note:

The route mask has IPv4 mask format. In binary this should be a set of contiguous bits of 1 from left to right, followed by one or more contiguous bits of 0.

Note:

The route destination and mask must match. This can be verified by checking that $RtDestination \& RtMask == RtDestination$
Example of good configuration: $RtDestination = 10.1.1.0$; $RtMask = 255.255.255.0$
Example of bad configuration: $RtDestination = 10.1.1.1$; $RtMask = 255.255.255.0$

Note:
The route destination must not be a connected network.

Note:
The route gateway must be on a connected network. This rule applies to the gateway address of the default route as well. This can be verified by checking that: $(RtGwy \& \text{Prt4Mask}) == (\text{Prt4IP} \& \text{Prt4Mask}) \parallel (RtGwy \& \text{Prt5Mask}) == (\text{Prt5IP} \& \text{Prt5Mask})$

6.2.9.6 IEC61850 MMS

Path: *Setpoints > Configure > Comms > IEC61850 MMS*

MMS Protocols

Range: Enabled, Disabled

Default: Enabled

This setting allows the MMS protocol communication to be enabled or disabled.

6.2.9.7 GOOSE SUBSCRIBE

Path: *Setpoints > Configure > Comms > GOOSE Subscribe*

6.2.9.7.1 REMOTE INPUTS

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > Remote Inputs*

REMOTE IP BOOLEAN X

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > Remote Inputs > Remote IP Boolean X*

Name

Range: 13 alphanumeric characters

Default: RI[X]

Note:
[X] ranges from 1 to 128.

Default State

Range: Off, On, Latest/Off, Latest/On

Default: Off

6.2.9.7.2 REMOTE INPUTS DPS

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > Remote Inputs DPS*

REMOTE INPUTS DPS X

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > Remote Inputs > Remote Inputs DPS X*

Name

Range: 13 alphanumeric characters

Default: RI DPS [X]

Note:
[X] ranges from 1 to 16.

Default State

Range: Intermediate-state, Off, On, Bad-state, Latest

Default: Latest

6.2.9.7.3 GOOSE ANALOGS

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > GOOSE Analogs*

REMOTE IP FLOAT 1 TO 24

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > GOOSE Analogs > Remote IP Float 1 to 24*

Float Name

Range: 13 alphanumeric characters

Default: GOOSE Float[X]

Note:
[X] ranges from 1 to 24.

Float ID

Range: 6 alphanumeric characters

Default: Empty string

Default Mode

Range: Default value, Last known

Default: Default value

Default Value

Range: -1000000.000 to 1000000.000 in steps of 0.001

Default: 1000.000

Units

Range: 4 alphanumeric characters

Default: Empty string

PU Base

Range: 0.001 to 1000000.000 in steps of 0.001

Default: 1.000

REMOTE IP SINT32 1 TO 8

Path: *Setpoints > Configure > Comms > GOOSE Subscribe > GOOSE Analogs > Remote IP SINT32 1 to 8*

SINT32 Name

Range: 13 alphanumeric characters

Default: GOOSE SINT[X]

Note:
[X] ranges from 1 to 8.

SINT32 ID

Range: 6 alphanumeric characters

Default: Empty string

Default Mode

Range: Default value, Last known

Default: Default value

Default Value

Range: -1000000 to 1000000 in steps of 1

Default: 1000

Units

Range: 4 alphanumeric characters

Default: Empty string

PU Base

Range: 0.001 to 1000000.000 in steps of 0.001

Default: 1.000

6.2.9.8 TFTP

Path: *Setpoints > Configure > Comms > TFTP*

TFTP Protocols

Range: Enabled, Disabled

Default: Enabled

This setting allows the TFTP communication to be enabled or disabled.

6.2.9.9 SFTP/SSH

Path: *Setpoints > Configure > Comms > SFTP/SSH*

SFTP/SSH Protocols

Range: Enabled, Disabled

Default: Enabled

This setting allows the SFTP/SSH communication to be enabled or disabled.

6.2.9.10 LOSS OF COMMS

Path: *Setpoints > Configure > Comms > Loss of Comms*

Function

Range: Disabled, Trip, Latched trip, Alarm, Configurable

Default: Disabled

Interface

Range: Serial, Serial + Ethernet, Serial + Fieldbus, Ethernet, Fieldbus, Ethernet + Fieldbus, All

Default: Serial

Modbus

Range: Off, On

Default: Off

Profibus

Range: Off, On

Default: Off

Pickup Delay

Range: 0 to 600 s in steps of 1 s

Default: 2 s

6.2.10 FLEXCURVES

The MM300 Enhanced has four programmable FlexCurves™ - FlexCurve A, B, C, D.

The points for FlexCurves A through D are defined by the user in EnerVista Flex software. User-defined curves can be used for Time Overcurrent protection in the same way as IEEE, IAC, ANSI and IEC curves. Each of the four FlexCurves™ have 120-point settings for entering times to reset and operate, 40 points for reset (from 0 to 0.98 times the Pickup value) and 80 for operate (from 1.03 to 20 times the Pickup).

This data is converted into two continuous curves by linear interpolation between data points.

Path: *Setpoints > Configure > FlexCurves > FlexCurve (X)*

FlexCurve Name

Range: FlexCurve A, FlexCurve B, FlexCurve C, FlexCurve D

Default: FlexCurve A

Reference Curve

Range: None, IEC Standard/Very/Extremely Inverse, UK Long Time Inverse, Rectifier, FR Short Time Inverse, Standard Inverse (1.3s), RI, IEEE Moderately/Very/Extremely Inverse, US Inverse, US Short Time Inverse, ANSI Extremely/Very/Normally/Moderately Inverse, IAC Extremely/Very/Normally/Moderately Inverse, I2t, I4t, FlexCurves™ A, B, C and D

Default: IEEE Extremely Inverse

Formula (Reset)

Range: None, IEC Standard/Very/Extremely Inverse, UK Long Time Inverse, Rectifier, FR Short Time Inverse, Standard Inverse (1.3s), RI, IEEE Moderately/Very/Extremely Inverse, US Inverse, US Short Time Inverse, ANSI Extremely/Very/ Normally/Moderately Inverse, IAC Extremely/Very/Normally/Moderately Inverse, I2t, I4t, FlexCurves™ A, B, C and D

Default: IEEE Extremely Inverse

Formula (Operative)

Range: Numerical value

Default: None

CURVE POINTS

For FlexCurves A through D, the following table details the 120 points as well as the characteristic for each of them, and a blank cell where the user can write the time value when the operation (for $I > I_{pickup}$) or the reset (for $I < I_{pickup}$) is required.

FlexCurves™ table

RESET (xPKP)	TIME ms	RESET (xPKP)	TIME ms	RESET (xPKP)	TIME ms	RESET (xPKP)	TIME ms	RESET (xPKP)	TIME ms	RESET (xPKP)	TIME ms
0		0.68		1.03		2.9		4.9		10.5	
0.05		0.7		1.05		3		5		11	
0.1		0.72		1.1		3.1		5.1		11.5	
0.15		0.74		1.2		3.2		5.2		12	
0.2		0.76		1.3		3.3		5.3		12.5	
0.25		0.78		1.4		3.4		5.4		13	
0.3		0.8		1.5		3.5		5.5		13.5	
0.35		0.82		1.6		3.6		5.6		14	
0.4		0.84		1.7		3.7		5.7		14.5	
0.45		0.86		1.8		3.8		5.8		15	
0.48		0.88		1.9		3.9		5.9		15.5	
0.5		0.9		2		4		6		16	
0.52		0.91		2.1		4.1		6.5		16.5	
0.54		0.92		2.2		4.2		7		17	
0.56		0.93		2.3		4.3		7.5		17.5	
0.58		0.94		2.4		4.4		8		18	
0.6		0.95		2.5		4.5		8.5		18.5	
0.62		0.96		2.6		4.6		9		19	
0.64		0.97		2.7		4.7		9.5		19.5	
0.66		0.98		2.8		4.8		10		20	

The first two columns (40 points) correspond to the RESET curve. The other 4 columns, with 80 points in total, correspond to the OPERATE curve. The reset characteristic values are between 0 and 0.98, and the operation values are between 1.03 and 20.

The final curve will be created by means of a linear interpolation from the points defined by the user. This is a separate process for the RESET and OPERATE curves.

These points are defined in a separate module from the relay, using a configuration program included in EnerVista Flex software, which incorporates a graphical environment for viewing the curve, making it easy for the user to create.

Note:

An IED using a given FlexCurve™ applies linear approximation for times between the user-entered points. Special care must be taken when setting two points that are close to a Pickup multiple of 1; that is, $0.98 \cdot I_{pickup}$ and $1.03 \cdot I_{pickup}$. It is recommended to set the two times to a similar value, otherwise the linear approximation may result in undesired behavior for the operating quantity that is close to $1.00 \cdot I_{pickup}$.

FLEXCURVE CONFIGURATION WITH SOFTWARE

EnerVista Flex software allows for easy configuration and management of FlexCurves™ and their associated data points. FlexCurves™ can be configured from a selection of standard curves to provide the best approximate fit, then specific data points can be edited afterwards. Alternatively, curve data can be imported from a specified file (.csv format) by selecting *Import Data* from the EnerVista Flex setting.

Curves and data can be exported, viewed and cleared by clicking the appropriate buttons.

FlexCurves™ are customized by editing the operating time (ms) values at pre-defined per-unit current multiples. Note that the pickup multiples start at zero (implying the reset time), operating time below Pickup, and operating time above Pickup.

6.2.11 PROTECTION FUNCTIONS

Path: *Setpoints > Configure > Protection*

Protection **FUNCTION** setpoint determines the operational characteristic of the following protection features.

Thermal Capacity Trip Function, Thermal Capacity Alarm Function, Mechanical Jam Function, Undercurrent Alarm Function, Undercurrent Trip Function, Underpower Alarm Function, Underpower Trip Function, Acceleration Trip Function, Acceleration Alarm Function, Thermistor Trip Function, Thermistor Alarm Function, Open Control Circuit Function, Welded Contact Function, Load Increase Alarm Function, Auxiliary U/V Trip Function, Aux U/V Alarm Function, Ground Alarm Function, Ground Trip Function, Current Unbalance Alarm Function, Current Unbal Trip Function, Undervoltage Alarm Function, Undervoltage Trip Function, Overvoltage Alarm Function, Overvoltage Trip Function, Phase Reversal Function, Fuse Fail Function, RTD 1/6 Alarm Function, RTD 1/6 Trip Function, V2/V1 1/2 Function, Phase IOC 1/2 Function, Phase TOC 1/2 Function, PF 1/2 Function

Range: Disabled, Trip, Latched Trip, Alarm, Configurable

6.2.12 CONTROL FUNCTIONS

Path: *Setpoints > Configure > Control*

Control **FUNCTION** setpoint is required to enable or disable the following control functions:

IL A/J Function, UVR Function

Range: Enabled, Disabled

6.2.13 TRIP RESET

Path: *Setpoints > Configure > Trip Reset*

Any FlexLogic operand can be selected to reset the Trip or Latched Trip function. The list of the trip functions are as follows:

Mechanical Jam Trip Reset, Undercurrent Trip Reset, Underpower Trip Reset, Acceleration Trip Reset, Thermistor Trip Reset, IL A...J Trip Reset, Loss of Comms Trip Reset, Aux U/V Trip Reset, Ground Trip Reset, Current Unbal Trip Reset, Undervoltage Trip Reset, Overvoltage Trip Reset, Phase Reversal Trip

Reset, Fuse Fail Trip Reset, RTD 1/6 Trip Reset, V2/V1 1/2 Trip Reset, Phase IOC 1/2 Trip Reset, Phase TOC 1/2 Trip Reset, PF 1/2 Trip Reset

Range: Off, FlexLogic operand

Default: Off

6.2.14 BLOCKING SIGNALS**Path:** *Setpoints > Configure > Blocking signals*

Any of the following functions can be blocked when the configured FlexLogic operand is asserted. In Thermal Protection, while the blocking signal is applied the element remains running and updates the thermal memory, but the states of the thermal Trip and Alarm operands will reset. When the element blocking signal is removed, the element logic is based on the new value of the thermal capacity and updates the status of the Thermal Trip OP and Thermal Alarm OP operands.

Thermal Block, Mechanical Jam Block, Undercurrent Block, Underpower Block, Acceleration Block, Thermistor Block, Open/Welded Contact Block, Load Increase Alarm Block, Aux U/V Block, Ground Block, Current Unbal Block, Undervoltage Block, Overvoltage Block, Phase Reversal Block, Fuse Fail Block, RTD 1/6 Block, V2/V1 1/2 Block, Phase IOC 1/2 Block, Phase TOC 1/2 Block, PF 1/2 Block, UVR Short Cct Block, Counters Alarm Block, Loss of Comms Block

Range: Off, FlexLogic operand

Default: Off

6.2.15 EVENTS**Path:** *Setpoints > Configure > Events*

This setpoint can be set to *Enabled*, or *Disabled*. If set to *Enabled*, the events associated with the pickup, operation, or other conditions of the feature are recorded in the Event Recorder.

Thermal Events, Mechanical Jam Events, Undercurrent Events, Underpower Events, Acceleration Events, Thermistor Events, Open/Welded Contact Events, Load Increase Alarm Events, Aux U/V Events, Ground Events, Current Unbalance Events, Undervoltage Events, Overvoltage Events, Phase Reversal Events, Fuse Fail Events, RTD 1/6 Events, V2/V1 1/2 Events, Phase IOC 1/2 Events, Phase TOC 1/2 Events, PF 1/2 Events, IL A/J Events, Undervoltage Restart Events, Counters Alarm Events, Loss of Comms Events

Range: Enabled, Disabled

Default: Enabled

6.2.16 EVENT DATA

The Event Data stores 64 FlexAnalog quantities each time an event occurs. The behavior will match that of the Event Recorder. When changes are made to the Event Data settings, the Event data will be cleared and the Snapshot.txt file will be deleted. The Event Record will remain as is and will not be cleared.

Path: *Setpoints > Configure > Event Data***Parameter 1 - 64**

Range: Off, any FlexAnalog parameter

Default: Off

6.2.17 WAVEFORM**Path:** *Setpoints > Configure > Waveform*

Waveforms are captured at the same sampling rate as the other relay data at the point of trigger. By default, data is captured for all AC current and voltage inputs available on the relay as ordered.

A waveform is generated upon the change of state of at least one of the assigned triggers: “Trigger Source”, “Trigger on Pickup”, “Trigger on Operate”, “Trigger on Alarm”, or “Trigger on Trip”.

The number of cycles captured in a single transient record varies based on number of records, sample rate, and number of selected channels. There is a fixed amount of data storage for the Transient Recorder: the more data captured, the less the number of cycles captured per record. Since the 9 analog channels are captured in the record by default, and the number of digital channels will minimally affect the length of the record, the cycles per record are well approximated in the following table. A maximum of 320 cycles (at 32 samples per cycle) can be captured per record and the trigger point can be adjusted to anywhere within the set cycles. If the trigger mode is set to “One-Shot”. Then the trace memory is triggered once; if it is set to “Retrigger”, then it automatically re-triggers and overwrites the previous data.

The following setpoints are available:

Number of Records

Range: 1 to 16 in steps of 1

Default: 5

Selects the desired number of records.

Sample per Cycle

Range: 32 /c, 16 /c, 8 /c

Default: 32 /c

Selects the number of samples per cycle used to represent the waveform.

Trigger Mode

Range: Retrigger, One-shot

Default: Retrigger

Determines whether or not the trigger data is overwritten with new trigger data. “Retrigger” will overwrite the previous trigger data with the new trigger data. One-shot mode will keep the current trigger data until a manual Clear command is sent.

Trigger Position

Range: 0 to 100% step 1%

Default: 20%

Percentage of the sample buffer used for pre-trigger samples.

Trigger Source

Range: Off, Any FlexLogic operand

Default: Command

Selects a trigger source. Command is always active. FlexLogic can be used to create combinations of trigger sources.

Trigger on Any Pickup

Range: Off, On

Default: Off

The selection of *On* triggers the recorder whenever the pickup condition is detected by any of the protection or control elements.

Trigger on Any Operate

Range: Off, On

Default: Off

The selection of *On* triggers the recorder whenever the operate state of any of the enabled protection or control elements.

Trigger on Trip

Range: Off, On

Default: Off

The selection of *On* triggers the recorder whenever any of the protection elements configured as *Trip* function operate, or the state of the operand assigned to operate the #1 Trip output relay changes to high.

Trigger on Alarm

Range: Off, On

Default: Off

The selection of *On* triggers the recorder whenever any of the protection elements configured as *Alarm* or *Latched Alarm* function operate, or the state of the operand assigned to trigger the Alarm LED changes to high.

Digital Input 1 to 64

Range: Off, Any FlexLogic operand

Default: Off

Analog Input 1 to 16

Range: Off, Any analog FlexLogic operand

Default: Off

6.2.18 DATALOG

The datalog samples and records up to 16 analog parameters at rate defined by the user. All data is stored in non-volatile memory, where the information will be retained upon relay control power lost.

The datalog can be configured with a few channels over a long period of time, or with larger number of channels for a shorter period of time. The relay automatically partitions the available memory between the channels in use.

The selection of the rate for logging data also affects the duration of recorded data. The datalog will have longer duration for sampling rates at longer periods of time ("1 minute", "30 minutes", "1 hour"), as compared to sampling rates at short periods ("per cycle", or "per second").

The recorded data can be downloaded to EnerVista Flex and displayed with parameters on the vertical axis and time on the horizontal axis.

Path: *Setpoints > Configure > Datalog*

Function

Range: Disabled, Continuous, Triggered

Default: Disabled

This setting configures the mode in which the datalog will operate.

When set to “Continuous”, the datalog will actively record any configured channels at the rate as defined in the datalog **SAMPLE RATE** setting. The datalog will be idle in this mode if no channels are configured.

When set to “Triggered”, the datalog will begin to record any configured channels at the instance of the rising edge of the trigger (FlexLogic operand). The datalog will ignore all subsequent triggers and will continue to record data until the active record is full. Once the datalog is full, a Clear Data Logger command is required to clear the datalog record, before a new record can be started. Performing the Clear Data Logger command will also stop the current record and reset the datalog to be ready for the next trigger. The Clear Data Logger command is located under **Diagnostics > Commands**.

The table below shows an example of the dependency of the datalog storage capacity with respect to the selected number of channels, and the selected rate (time interval) at which the logged values are taken.

The datalog buffer space can be monitored to produce an alarm when the logged data occupy 80% of the datalog storage space. Target message, and operand `Data Logger Alrm` is generated at this time.

Trigger Source

Range: Off, Any FlexLogic operand

Default: Off

This setting selects the signal used to trigger the start of a new datalog record. Any FlexLogic operand can be used as a trigger source. This setting only applies when the datalog **FUNCTION** is set to “Triggered”.

Trigger Position

Range: 0 to 100% steps of 1%

Default: 25%

This setpoint defines the percentage of buffer space that will be used for recording pre-trigger samples.

Sample Rate

Range: 1 cycle, 1 second, 30 seconds, 1 minute, 15 minutes, 30 minutes, 1 hour, 6 hours, 8 hours, 12 hours, 24 hours

Default: 1 minute

This setting selects the time interval at which the actual value will be recorded.

Channel 1(16) Source

Range: Off, Any FlexLogic operand

Default: Off

This setpoint selects the metering analog value that is to be recorded in Channel 1(16) of the datalog.

The parameters available in a given relay are dependent on the type of relay, the type and number of CT/VT hardware installed, and the type and number of Analog Inputs hardware installed. Upon startup, the relay will automatically prepare the parameter list. A list of all possible analog metering actual value parameters is shown in the latest [Modbus Maps - Industrial Products](#) document online. The parameter index numbers are used to avoid scanning through the entire list of parameters on the relay display; entering the relevant index number on the relay keypad will immediately display the required parameter.

Ch 1(16) Mode

Range: Sample, Min, Max, Mean

Default: Sample

This setpoint defines the type of sample to be logged in the datalog record with respect to the selected rate.

The selected rate is the time interval selected under the setpoint **SAMPLE RATE**.

While enabled the Datalog will execute every protection pass and each of the four modes - Sample, Max, Min or Mean. The flex-analog values are updated at protection-pass rate:

In “Sample” mode the datalog records the flex-analog value updated in the first protection-pass from the time interval selected under setpoint **SAMPLE RATE**.

In “Max” mode the datalog records the maximum protection pass value of the selected flex-analog parameter from all protection pass values from the time interval selected under setpoint **SAMPLE RATE**.

In “Min” mode the datalog records the minimum protection pass value of the selected flex-analog parameter from all protection pass values from the time interval selected under setpoint **SAMPLE RATE**.

In “Mean” mode, the datalog records the average value among all the values at protection-pass rate, from the time interval selected under setpoint **SAMPLE RATE**. The mean (average) is calculated by simply dividing the sum of all the values by their number over the time interval.

Datalog storage capacity

Sampling rate [sec]		Number of channels	Time window covered			
			[sec]	[min]	[hour]	[day]
1 cycle	50Hz	1	1310.7	21.8	0.4	0.0
		8	546.1	9.1	0.2	0.0
		16	327.7	5.5	0.1	0.0
	60Hz	1	1092.3	18.2	0.3	0.0
		8	455.1	7.6	0.1	0.0
		16	273.1	4.6	0.1	0.0
1		1	65536.0	1092.3	18.2	0.8
		8	27306.0	455.1	7.6	0.3
		16	16384.0	273.1	4.6	0.2
30		1	1966080.0	32768.0	546.1	22.8
		8	819180.0	13653.0	227.6	9.5
		16	491520.0	8192.013	136.5	5.7

Sampling rate [sec]	Number of channels	Time window covered			
		[sec]	[min]	[hour]	[day]
60	1	3932160.0	65536.0	1092.3	45.5
	8	1638360.0	27306.0	455.1	19.0
	16	983040.0	16384.0	273.1	11.4
900	1	58982400.0	983040.0	16384.0	682.7
	8	24575400.0	409590.0	6826.5	284.4
	16	14745600.0	245760.0	4096.0	170.7
1800	1	117964800.0	1966080.0	32768.0	1365.3
	8	49150800.0	819180.0	13653.0	568.9
	16	29491200.0	491520.0	8192.0	341.3
3600	1	235929600.0	3932160.0	65536.0	2730.7
	8	98301600.0	1638360.0	27306.0	1137.8
	16	58982400.0	983040.0	16384.0	682.7

6.2.19 FAULT RECORDS

The EnerVista Flex supports up to 15 user-programmable fault reports and an associated fault locator before overwriting the oldest one. The trigger conditions and the characteristics of the feeder, as well as the analog quantities to be stored, are entered in this menu.

When enabled, this function monitors the pre-fault trigger. The pre-fault data are stored in the memory for prospective creation of the fault report on the rising edge of the pre-fault trigger. The element waits for the fault trigger as long as the pre-fault trigger is asserted, but not shorter than 1 second. When the fault trigger occurs, the fault data is stored, and the complete report is created. If the fault trigger does not occur within 1 second after the pre-fault trigger drops out, the element resets and no record is created.

Each fault report contains a header with the following information:

- Relay model
- Device name
- Firmware revision
- Date and time of trigger
- Name of pre-fault trigger (FlexLogic operand)

- Name of Fault trigger (FlexLogic operand)
- Active setting group at the time of pre-fault trigger
- Active setting group at the time of fault trigger

The main body of the fault report contains the following information:

- All current and voltage phasors (Four cycles after the fault trigger)
- Pre-fault values for all programmed analog channels (one cycle before pre-fault trigger)
- Fault values of all programmed analog channels (one cycle after the fault trigger)

Each Fault Report is created as a text file viewed using EnerVista Flex software. The files are numbered sequentially as they are created.

The trigger can be any FlexLogic operand, but in most applications, it is expected to be the same operand, usually a virtual output, that is used to drive an output relay to trip a breaker. A FAULT RPT TRIG event is automatically created when the report is triggered.

If a number of protection elements, such as overcurrent elements, are “OR’d” to create a fault report trigger, the first operation of any element causing the OR gate output to become high triggers the fault report. However, if other elements operate during the fault and the first operated element has not been reset (the OR gate output is still high), the fault report is not triggered again. Considering the reset time of protection elements, there is very little chance that fault report can be triggered twice in this manner. As the fault report must capture a usable amount of pre- and post-fault data, it cannot be triggered faster than every 20 ms.

The fault report stores data, in non-volatile memory, pertinent to an event when triggered. Each fault report is stored as a file to a maximum capacity of fifteen files. A sixteenth trigger overwrites the oldest file.

The EnerVista Flex software is required to view all captured data. The relay faceplate display can be used to view the date and time of trigger, the fault type and the distance location of the fault.

Path: *Setpoints > Configure > Fault Records*

Function

Range: Disabled, Enabled

Default: Disabled

This setpoint will enable or disable the function of the fault report.

Pre-Fault Trigger

Range: Off, Any FlexLogic operand

Default: Any trip

This setpoint specifies the FlexLogic operand to capture the pre-fault data. The rising edge of this operand stores one-cycle-old data for subsequent reporting. The element waits for the fault trigger to create a record, provided that the operand selected as **PRE-FAULT TRIGGER** is “On”. If the operand remains “Off” for 1 second, the element resets and no record is created.

Fault Trigger

Range: Off, Any FlexLogic operand

Default: Any trip

This setpoint specifies the FlexLogic operand to capture the fault data. The rising edge of this operand stores the data as fault data, which results in a new report. The trigger (not the pre-fault trigger) controls the date and time of the report. The distance to fault calculations are initiated by this signal.

Analog Channels 1 to 16

Range: Off, Any FlexLogic operand

Default: Off

These settings specify an actual value. Values such as voltage or current magnitude, true RMS, phase angle, frequency, temperature, etc., to be stored should a report be created. Up to 16 analog channels can be configured.

6.2.20 COUNTER SETTINGS

Path: *Setpoints > Configure > Counter Settings*

Counters Alarm Function

Range: Disabled, Alarm

Default: Disabled

This setting enables the Counters functionality.

Drive Greasing Interval

Range: Off (Max.), 100 to 50,100 hours in steps of 100 hours

Default: Off

Enter the interval at which the motor bearings must be lubricated. When the motor running time exceeds this setpoint, a motor greasing interval alarm is generated. To clear the “Motor Running Hours” use the “Clear Maintenance Timers” command and start the motor. If this feature is not required, set to “Off”.

Contactors Inspection Interval

Range: Off (Max.), 100 to 65,000 operations in steps of 100 operations

Default: Off

Enter the interval after which the contactor contacts must be inspected for wear. When the Number of Starts counter exceeds this setpoint, a contactor inspection interval alarm is generated. To clear the “Number of Motor Starts” use the “Clear Counters” command. If this feature is not required, set this setpoint to “Off”.

Max Motor Stopped Time

Range: Off (Max.), 10 to 10,010 hours in steps of 10 hours

Default: Off

Enter the maximum interval during which the motor can be left not running. When the “Motor Stopped Time” exceeds this setpoint, a maximum motor stopped time alarm is generated. To clear the “Motor Stopped Hours” use the “Clear Maintenance Timers” command, and stop the motor. If this feature is not required, set this setpoint to “Off”.

6.2.21 REAL-TIME CLOCK

The MM300 Enhanced 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 IED. The accuracy of the time stamp is based on the time reference that is used. It supports an internal clock, SNTP and 1588 as potential time references.

If two or more time sources are setup the time source with the higher priority shown in the table below is used where 1 is considered to be the highest priority.

Time Source	Accuracy	Priority
1588		1
SNTP		2
Internal clock		3

6.2.21.1 PTP

Path: *Setpoints > Configure > Real Time Clock > PTP*

PTP Domain Num

Range: 0 to 255 in steps of 1

Default: 0

6.2.21.2 SNTP

Path: *Setpoints > Configure > Real Time Clock > SNTP*

SNTP Server1 IP Addr

Range: 0.0.0.0 to 223.255.255.254 in steps of 1

Default: 0. 0. 0. 0

SNTP Server1 UDP Port Num

Range: 0 to 65535 in steps of 1

Default: 123

SNTP Server2 IP Addr

Range: 0.0.0.0 to 223.255.255.254 in steps of 1

Default: 0. 0. 0. 0

SNTP Server2 UDP Port Num

Range: 0 to 65535 in steps of 1

Default: 123

6.2.22 SECURITY

The MM300 Enhanced has two security options that the user can choose between based on their application and setup requirements:

- Basic Security - The basic security feature present in the default offering of the product.
- Advanced Cyber-security - The feature refers to the advanced security options available as a software option. When this option is purchased, it is automatically enabled and Basic Security is disabled.

For more information, please refer to Cyber-security

Path: *Setpoints > Configure > Security*

6.2.22.1 BASIC SECURITY

Login

Range: Administrator, Engineer, Operator, Viewer

Default: Viewer

This setting allows a user to login with a specific role.

1. Whenever a user attempts to connect to a MM300 Enhanced IED, EnerVista Flex will prompt for a username and password. All the available roles are listed in a drop-down. The role name also serves as the username.
2. The default role, *Viewer*, does not require a password.
3. If the user enters the wrong password, *Authentication Failed!* message is displayed.
4. If the authentication is successful, a successful login banner is displayed; *You have successfully logged in with role "Engineer"! for example.*

Logout

Range: Yes, No

Default: No

When logging out the current user, this setting will log back in as a *Viewer*. If the user was already a *Viewer*, no action is taken.

Bypass Access

Range: Disabled, Local, HMI only

Default: Disabled

The **BYPASS ACCESS** feature allows to bypass user authentication. Once this setting is other than *Disabled*, then the user is granted Administrator access rights on the configured interface. If configured as *Local* then no user authentication is needed for accessing the device over USB or HMI.

The use of this feature should be restricted only in commissioning phase or when it is considered safe.

Pswd Complexity

Range: Enabled, Disabled

Default: Disabled

When set to *Enabled*, this setting allows the user to configure password strings which adhere to complexity rules defined in Communications. When configured as *Disabled*, the user can change the password to any string with a maximum length of 20 characters.

Note:

*When the value of **PSWD COMPLEXITY** is changed from *Disabled* to *Enabled* the device will validate all passwords subsequently created in accordance with the password complexity rules. Passwords created before enabling **PSWD COMPLEXITY** do not have to be reconfigured to adhere to the password complexity rules.*

Access Lockout

Range: 0 to 99 in steps of 1

Default: 3

This sets the number of failed authentications allowed before the device blocks all subsequent authentication attempts for the **ACCESS LOCKOUT TIME** set. A value of 0 means **ACCESS LOCKOUT** is disabled.

Access Lockout Time

Range: 0 to 9999 min in steps of 1 min

Default: 3 min

This is the duration of lockout in minutes. After configured number of failed authentications, that particular role gets locked out for configured **ACCESS LOCKOUT TIME**. After this period, the user will be allowed to login again for that role.

Access Timeout HMI

Range: 2 to 999 min in steps of 1 min

Default: 5 min

When logged in through the HMI, the user can be inactive for the period configured as **ACCESS TIMEOUT HMI** before being automatically logged out.

Note:

This setting is valid for MM300 Enhanced with Graphical Control Panel option G, but not for those with options X and B.

Access Timeout Other

Range: 2 to 999 min in steps of 1 min

Default: 5 min

This setting specifies the time an authorized user can be inactive, before automatically getting logged out. This applies to all users and roles, independent of the communication channel (serial, Ethernet or USB), except HMI users.

Restore Defaults

Range: Yes, No

Default: No

Upon the selection of *Yes* the IED restores the factory default settings, including security related configurations, user credentials and communication. All logs will also be cleared from the IED.

This is to facilitate NERC CIP compliance requirements for decommissioning critical cyber devices. Users logged in as Administrator can change this setting.

Factory Service

Range: Enabled, Disabled

Default: Disabled

Only users logged in as Administrator can change this setting and would normally only be used by GE personnel in order to service the device.

Require PW for D/T Change

Range: Enabled, Disabled

Default: Enabled

The date and time can be set by any role, if this setting is *Disabled*. If this setting is *Enabled* the date and time can only be set by the Administrator.

Require PW for Control

Range: Enabled, Disabled

Default: Enabled

If this setting is *Disabled*, Operator controls do not require a password. If this setting is *Enabled*, the Operator password is required.

In MM300 Enhanced this setting only applies for Start A, Start B and Stop push buttons of the GCP.

Bypass PW for Remote Control

Range: Enabled, Disabled

Default: Disabled

If this setting is *Enabled*, controls do not require a password. If this setting is only applicable to Basic Cyber-security order code option.

User

Range: 8 to 20 ASCII characters

Default: 0

This allows the user to configure the password for various roles.

- A user connected to the device with Administrator privileges can modify passwords for all other roles.
- A user with any other role can only change the password for their own account on both the HMI and in EnerVista Flex.

6.2.22.2 ADVANCED SECURITY

Authent Method

Range: Device, Server/Device, Device/Server

Default: Device/Server

This setting allows the user to configure the priority for authentication method for each authentication attempt. If user selects *Device*, then only Local authentication will be utilized. The relay will not communicate with the RADIUS server for authentication. If *Server/Device* is selected, then the relay will first connect with remote RADIUS server for authentication but if that is not reachable then it will authenticate user based on local database of credentials. If user chooses *Device/Server*, then priority for authentication will be given to device credentials database driven. If that fails, then the relay will try to connect to remote RADIUS server for authentication.

User

Range: 8 to 20 ASCII characters

Default: ChangeMe1#

Allows the user to change the password on their account. Only if the user is logged in as an Administrator can they change other users' passwords.

All other configuration settings are the same as for Basic security.

SERVER CONFIGURATION

The below table shows the settings used to configure the RADIUS server in the device, which enables remote authentication.

Setting Name	Description	Min	Max	Default
RADIUS IP Prim	IP address of primary Radius server. Default value indicates no Primary Radius server is configured, and hence Radius is disabled.	0.0.0.0	223.255.255.254	0.0.0.0
RADIUS IP Sec	IP address of secondary Radius server. Default value indicates no secondary Radius server is configured, and hence Radius is disabled.	0.0.0.0	223.255.255.254	0.0.0.0

Setting Name	Description	Min	Max	Default
RADIUS Authentication Port	Radius authentication port	1	65535	1812
Vendor ID	An identifier that specifies Radius vendor specific attributes used with the protocol.	1	65535	Value that represents GE: 2910
Radius Authentication Method	Authentication method used by Radius server. Currently fixed to EAP-TTLS.	EAP-TTLS	EAP-TTLS	EAP-TTLS
Timeout	Timeout in seconds in between re-transmission requests	2	600	5
Retries	Number of retries before giving up	1	10	3
Radius Authentication (Shared) Secret	Shared Secret used in authentication. It is only displayed as asterisks. This setting must meet the CyberSentry™ password requirements.	See Cyber-security for requirements	245 characters	N/A
Confirm Radius Authentication (Shared) Secret	Confirmation of the shared secret. Only display as asterisks.	See Cyber-security for requirements	245 characters	N/A

SYSLOG CONFIGURATION

An MM300 Enhanced with the Advanced cyber-security option allows the user to configure Syslog servers. The device supports the configuration of up to two Syslog servers for redundancy.

The MM300 Enhanced device communicates with the configured Syslog servers over UDP in compliance with RFC-5428.

USER CONFIGURATION

There can be up to 20 user accounts in an IED with advanced security, allowing the following to be configured:

- Username
- Password
- User role (Administrator, Engineer, Operator, Viewer)

It is strongly recommended that more than one Administrator account is created.

6.3 UNDERSTANDING SETPOINTS

Any of the motor trip and alarm setpoints may be viewed or altered by pressing the SETPOINTS soft-key. Setpoints data is divided into four pages.

- Configuration page: Information about the motor configuration as well as system setup, inputs, outputs, communications, CTs, and VTs.
- Protection page: Information about the protection features.
- Control page: Information about the process control features.
- Security page: Information about the security and password features.

Press the SETPOINTS soft-key to scroll through the setpoints pages.

The soft-keys on the **Home > Setpoints** page open pages two levels down, since the pages immediately below this page are blank. For example, the CONFIG soft-key opens the **Home > Setpoints > Configure > Motor Setting** page.

The pages containing setpoint fields, except for the inputs and outputs pages, are in a common format. This is a simple tabular format with two columns: setpoint name and units, and setpoint value. Setpoints for features that are not enabled are omitted from the page.



Caution:

Setpoints may be changed while the motor is running; however it is not recommended to change important protection parameters without first stopping the motor.

Setpoints will remain stored indefinitely in the internal non-volatile memory even when control power to the unit is removed. Protection parameters are based on the entered data. This data must be complete and accurate for the given system for reliable protection and operation of the motor.

6.3.1 COMMON SETPOINTS

To make the application of this device as simple as possible, similar methods of operation and similar types of setpoints are incorporated in various features. Rather than repeat operation descriptions for this class of setpoint throughout the manual, a general description is presented in this overview. Details that are specific to a particular feature are included in the discussion of the feature. The form and nature of these setpoints is described below.

FUNCTION

Any of the protection elements can be enabled by the **<ELEMENT_NAME> FUNCTION** setpoint located in **Setpoints > Configure > Protection Functions**. Similarly, controls elements can be enabled by the **<ELEMENT_NAME> FUNCTION** setpoint located in **Setpoints > Configure > Control Functions**.

The **FUNCTION** setpoint determines the operational characteristic of each feature. The range for this setpoint is: *Disabled, Trip, Latched Trip, Alarm, Latched Alarm* and *Configurable*.

If **FUNCTION** is set to *Disabled*, then the feature is not operational.

If **FUNCTION** is set to *Trip*, then the feature is operational. When the “Trip” function is selected and the feature operates, the trip output remains latched even after the trip condition is gone.

If **FUNCTION** is set to *Latched Trip* then the feature is operational. When this function is selected, and the feature operates, the trip output remains latched even after the trip condition is gone. The main difference between the Trip and Latched Trip function lies in the Reset mechanics. The Latched Trip function can only be reset from **LOCKOUT RESET** or **<ELEMENT_NAME> TRIP RESET**. The Trip function can be reset from any of the reset inputs such as **<ELEMENT_NAME> TRIP RESET, LOCKOUT RESET, REMOTE RESET**, the Graphic/Basic

Control Panel RESET key or a Reset command. For more details on Reset function logic, see Device settings. The Trip or Latched Trip function, when operated, also asserts the trip operands, and the Tripped LED is lit.

If the **FUNCTION** setpoint is selected as *Alarm*, then the feature is operational. When this function is selected, and the feature operates, the Alarm LED is lit, and any assigned auxiliary output relay operates. The “Trip” output relay does not operate, and the Trip LED is not lit. The Alarm LED can be reset by issuing reset command.

If **FUNCTION** is set to *Configurable*, the feature is fully operational but Trip or Alarms specific outputs are not driving any action. Operands from this element must be programmed to a desirable action which may be as simple as the auxiliary output relay or used in FlexLogic.

TRIP RESET

The **<ELEMENT_NAME> TRIP RESET** setpoint selects an operand from the list of FlexLogic operands, which when active, resets the Trip outputs after the trip condition is gone. The **<ELEMENT_NAME> TRIP RESET** setpoint can be programmed from **Setpoints > Configure > Trip Reset**.

BLOCK

The **<ELEMENT_NAME> BLOCK** setpoint selects an operand from the list of FlexLogic operands, which when active, blocks the feature from running. When set to *On* the feature is always blocked; when set to *Off*, block is disabled. The **<ELEMENT_NAME> BLOCK** setpoint can be programmed from **Setpoints > Configure > Blocking Signal**.

EVENTS

The **<ELEMENT_NAME> EVENT** setpoint can be set to *Enabled* or *Disabled*. If set to *Enabled*, the events associated with the pickup, operation, or other conditions of the feature are recorded in the Event Recorder. The **<ELEMENT_NAME> EVENT** setpoint can be programmed from **Setpoints > Configure > Events**.

6.4 PROTECTION

6.4.1 THERMAL

The primary protective function of the MM300 Enhanced is the thermal model. It integrates stator and rotor heating into a single model. The rate of motor heating is gauged by measuring the terminal currents. The present value of the accumulated motor heating is maintained in the Thermal Capacity Used actual value register. When the motor is in overload, the motor temperature and thermal capacity used will rise. A trip occurs when the thermal capacity used reaches 100%. When the motor is stopped and is cooling to ambient, the thermal capacity used decays to zero. If the motor is running normally, the motor temperature will eventually stabilize at some steady state temperature, and the thermal capacity used increases or decreases to some corresponding intermediate value, which accounts for the reduced amount of thermal capacity left to accommodate transient overloads.

The thermal model consists of six key elements.

- Unbalance current biasing that accounts for negative-sequence heating.
- Hot/cold biasing that accounts for normal temperature rise.
- RTD biasing that accounts for ambient variation and cooling problems
- An overload curve that accounts for the rapid heating that occurs during stall, acceleration, and overload.
- Cooling rate that accounts for heat dissipation.
- Thermal protection reset that controls recovery from thermal trips and lockouts.

Each of these categories are described in the following sub-sections.

6.4.1.1 UNBALANCE BIASING

Unbalanced phase currents (that is, negative-sequence currents) cause rotor heating in addition to the normal heating caused by positive-sequence currents. When the motor is running, the rotor rotates in the direction of the positive-sequence MMF wave at near synchronous speed. The induced rotor currents are at a frequency determined by the difference between synchronous speed and rotor speed, typically 2 to 4 Hz. At these low frequencies the current flows equally in all parts of the rotor bars, right down to the inside portion of the bars at the bottom of the slots. On the other hand, negative-sequence stator current causes an MMF wave with a rotation opposite to rotor rotation, which induces rotor current with a frequency approximately two times the line frequency (100 Hz for a 50 Hz system or 120 Hz for a 60 Hz system.) The skin effect at this frequency restricts the rotor current to the outside portion of the bars at the top of the slots, causing a significant increase in rotor resistance and therefore significant additional rotor heating. This extra heating is not accounted for in the thermal limit curves supplied by the motor manufacturer, as these curves assume only positive-sequence currents from a perfectly balanced supply and balanced motor construction.

To account for this additional heating, the MM300 Enhanced allows for the thermal model to be biased with negative-sequence current. This biasing is accomplished by using an equivalent motor heating current rather than the simple motor terminal current (I_{avg}). This equivalent current is calculated as shown in the following equation.

$$I_{eq} = I_{avg} \times \sqrt{1 + k \times \left(\frac{I_2}{I_1} \right)^2}$$

In the above equation:

- I_{eq} represents the equivalent motor heating current in per-unit values on an FLA base.
- I_{avg} represents the average RMS current at each motor terminals in per-unit values on an FLA base.
- I_2 / I_1 represents the negative-sequence to positive-sequence current ratio.
- k represents the value of the **UNBALANCE K FACTOR** setpoint, used to adjust the degree of unbalance biasing.

The value for k may be estimated as follows.

$$k = \frac{175}{I_{LR}^2} \text{ (typical estimate); } k = \frac{230}{I_{LR}^2} \text{ (conservative estimate)}$$

In the above equation, I_{LR} represents the locked rotor current in per-unit values on an FLA base.

If a k value of 0 is entered, the unbalance biasing is defeated and the overload curve will time out against the average per-unit motor current.

The following figure shows recommended motor derating as a function of voltage unbalance recommended by NEMA (the National Electrical Manufacturers Association). To illustrate the MM300 Enhanced unbalance biasing, assume a typical induction motor with an inrush of $6 \times \text{FLA}$ and a negative-sequence impedance of 0.167. With this impedance, voltage unbalances of 1, 2, 3, 4, and 5% on the motor terminals will result in current unbalances of 6, 12, 18, 24, and 30%, respectively. Based on these assumptions, the derating resulting from the MM300 Enhanced unbalance biasing for different values of k is as illustrated in the GE Multilin curve below. Note that the curve for $k = 8$ is almost identical to the NEMA derating curve.

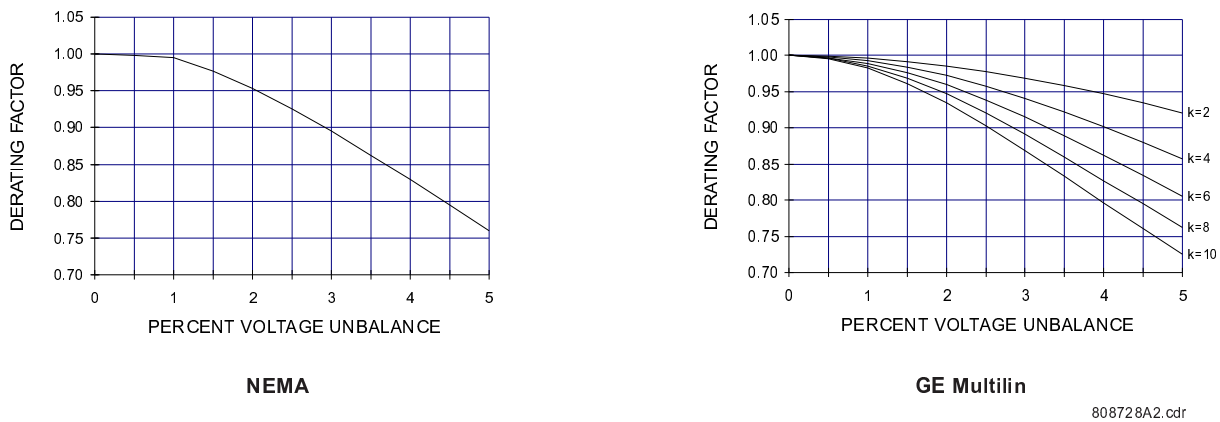


Figure 77: Motor derating factor due to unbalanced voltage

6.4.1.2 HOT/COLD BIASING

When the motor is running with a constant load below the overload level, the motor will eventually reach a steady state temperature, which corresponds to a particular steady-state thermal capacity used. As some thermal capacity is used, there is less thermal capacity left in the motor to cover transient overloads than is available when the motor is cold. Typically, the extent of this effect is calculated by taking the ratio of the motor's rated hot safe stall time to its rated cold safe stall time. The safe stall time (also known as locked rotor time) is the time taken with the rotor not turning for the motor to heat to a temperature beyond which motor damage occurs at an unacceptable rate. The term 'cold' refers to starting off with the motor at ambient temperature, while 'hot' refers to starting off with the motor at the temperature reached when running at rated load. The method the thermal model uses to account for the pre-overload state is thus known as hot/cold biasing.

The MM300 Enhanced calculates the steady-state thermal capacity used according to the following equation.

$$TCU_{SS} = I_{eq}^2 \times (100\% - HCR)$$

In the above equation:

- TCU_{SS} represents the steady-state thermal capacity used expressed as a percentage.
- I_{eq} represents the equivalent motor heating current in per-unit values on an FLA base. Refer to Unbalance biasing for additional details.
- HCR represents the value of the **HOT/COLD SAFE STALL RATIO** setpoint expressed as a percentage.

For example, a motor with a safe stall time hot of 7 seconds, and a safe stall time cold of 10 seconds would typically have the **HOT/COLD SAFE STALL RATIO** set to $7/10 \times 100\% = 70\%$. If the motor current is 0.8pu, the steady state thermal capacity used is:

$$TCU_{SS} = (0.8)^2 \times (100\% - 70\%) = 19.2\%$$

If a **HOT/COLD SAFE STALL RATIO** value of 100% is entered, the hot/cold biasing is defeated, and unless RTD biasing is deployed, the thermal model will operate as if the motor was cold prior to overload.

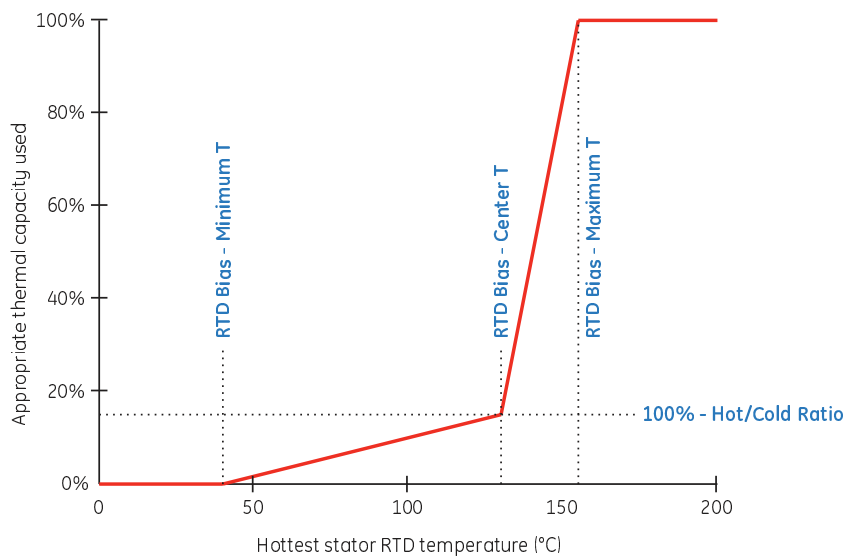
6.4.1.3 RTD BIASING

The thermal model can operate based solely on measured current and the assumption of rated ambient and normal motor cooling, as described earlier. However, if the ambient temperature is unusually high, or motor cooling is blocked, the motor will have a non-modeled temperature increase. The RTD biasing feature can correct for this by forcing the Thermal Capacity Used register up to the value appropriate to the temperature of the hottest stator RTD. Since RTDs are relatively slow, the rest of the thermal model is still required during starting and heavy overload conditions when motor heating is relatively fast. The RTD bias feature does not therefore prevent the thermal capacity used value from rising above the value appropriate to the RTD temperature.

The value of the Thermal Capacity Used register appropriate to the RTD temperature is determined by the straight line segmented curve shown in the following figure. This curve is characterized by minimum, center, and maximum temperature values, and by the **HOT/COLD SAFE STALL RATIO** value.

Note:

The RTD bias feature alone cannot create a trip. If the RTD bias forces thermal capacity used to 100%, the motor current must be above FLA before an overload trip can occur.



853730A1.CDR

Figure 78: RTD bias curve

6.4.1.4 STANDARD OVERLOAD CURVE

The overload curve accounts for the rapid motor heating that occurs during stall, acceleration, and overload. Specifically, the overload curve controls the rate of increase of Thermal Capacity Used whenever the equivalent motor heating current is greater than 1.01 times the **MOTOR FLA** setpoint. The curve is defined by the following equation and reflects that overload heating largely swamps the cooling, and this heating is primarily due to resistive losses in the stator and the rotor windings (said losses being proportional to the square of the current).

$$\text{Trip Time} = \left(\text{Curve Multiplier} \times \frac{87.46}{I_{eq}^2 - 1}, 1200 \right)_{\text{MIN}}$$

In the above equation,

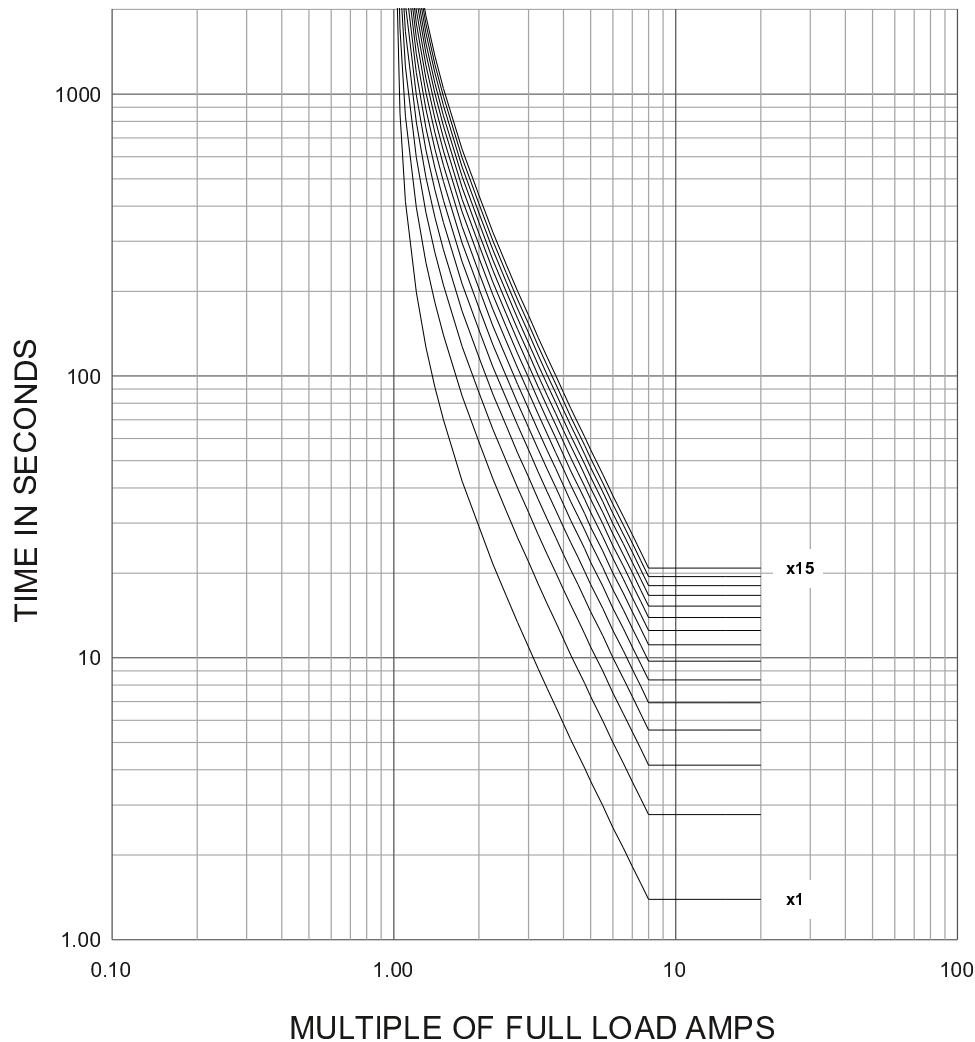
- *Trip Time* represents the time (in seconds) for the MM300 Enhanced to trip, given the motor starts cold and the current is constant.
- *Curve Multiplier* represents the value of the **STANDARD OVERLOAD CURVE** setpoint. This setpoint can be used to adjust the curve to match the thermal characteristics of the motor.
- *Ieq* represents the equivalent motor heating current in per-unit values on a full load current base. The value of *Ieq* is limited in this equation to 8.0 to prevent the overload from acting as an instantaneous element and responding to short circuits. Equivalent motor heating current is discussed in Unbalance biasing.

For example, a motor with a stall current (also known as locked rotor current) of 8 times its FLA, with a standard overload curve of 7, if stalled from a cold state, trips in the following amount of time.

$$\text{Trip Time} = 7 \times \frac{87.46}{8^2 - 1} = 9.7 \text{ seconds}$$

This would respect a safe stall cold time of 10 seconds.

The standard overload curves are displayed below.



853731A4.cdr

Figure 79: Standard overload curve trip time s

The trip times for the standard overload curves are tabulated below.

Standard overload curve trip times (in seconds)

PICKUP (× FLA)	STANDARD CURVE MULTIPLIERS														
	× 1	× 2	× 3	× 4	× 5	× 6	× 7	× 8	× 9	× 10	× 11	× 12	× 13	× 14	× 15
1.01	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
1.05	853	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
1.10	416	833	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
1.20	198.8	398	596	795	994	1193	1200	1200	1200	1200	1200	1200	1200	1200	1200
1.30	126.8	254	380	507	634	761	887	1014	1141	1200	1200	1200	1200	1200	1200
1.40	91.1	182.2	273	364	456	547	638	729	820	911	1002	1093	1184	1200	1200
1.50	70.0	139.9	210	280	350	420	490	560	630	700	770	840	910	980	1050
1.75	42.4	84.8	127.2	169.6	212	254	297	339	382	424	466	509	551	594	636
2.00	29.2	58.3	87.5	116.6	145.8	174.9	204	233	262	292	321	350	379	408	437
2.25	21.5	43.1	64.6	86.1	107.6	129.2	150.7	172.2	193.8	215	237	258	280	301	323
2.50	16.66	33.3	50.0	66.6	83.3	100.0	116.6	133.3	149.9	166.6	183.2	200	217	233	250
2.75	13.33	26.7	40.0	53.3	66.6	80.0	93.3	106.6	119.9	133.3	146.6	159.9	173.3	186.6	199.9
3.00	10.93	21.9	32.8	43.7	54.7	65.6	76.5	87.5	98.4	109.3	120.3	131.2	142.1	153.1	164.0
3.25	9.15	18.29	27.4	36.6	45.7	54.9	64.0	73.2	82.3	91.5	100.6	109.8	118.9	128.0	137.2
3.50	7.77	15.55	23.3	31.1	38.9	46.6	54.4	62.2	70.0	77.7	85.5	93.3	101.1	108.8	116.6
3.75	6.70	13.39	20.1	26.8	33.5	40.2	46.9	53.6	60.3	67.0	73.7	80.3	87.0	93.7	100.4
4.00	5.83	11.66	17.49	23.3	29.2	35.0	40.8	46.6	52.5	58.3	64.1	70.0	75.8	81.6	87.5
4.25	5.13	10.25	15.38	20.5	25.6	30.8	35.9	41.0	46.1	51.3	56.4	61.5	66.6	71.8	76.9
4.50	4.54	9.09	13.63	18.17	22.7	27.3	31.8	36.3	40.9	45.4	50.0	54.5	59.1	63.6	68.2
4.75	4.06	8.11	12.17	16.22	20.3	24.3	28.4	32.4	36.5	40.6	44.6	48.7	52.7	56.8	60.8
5.00	3.64	7.29	10.93	14.58	18.22	21.9	25.5	29.2	32.8	36.4	40.1	43.7	47.4	51.0	54.7
5.50	2.99	5.98	8.97	11.96	14.95	17.94	20.9	23.9	26.9	29.9	32.9	35.9	38.9	41.9	44.9
6.00	2.50	5.00	7.50	10.0	12.49	14.99	17.49	19.99	22.5	25.0	27.5	30.0	32.5	35.0	37.5
6.50	2.12	4.24	6.36	8.48	10.60	12.72	14.84	16.96	19.08	21.2	23.3	25.4	27.6	29.7	31.8
7.00	1.82	3.64	5.47	7.29	9.11	10.93	12.75	14.58	16.40	18.22	20.0	21.9	23.7	25.5	27.3
7.50	1.58	3.17	4.75	6.33	7.91	9.50	11.08	12.66	14.25	15.83	17.41	19.00	20.6	22.2	23.7
8.00	1.39	2.78	4.16	5.55	6.94	8.33	9.72	11.11	12.49	13.88	15.27	16.66	18.05	19.44	20.8
10.00	1.39	2.78	4.16	5.55	6.94	8.33	9.72	11.11	12.49	13.88	15.27	16.66	18.05	19.44	20.8
15.00	1.39	2.78	4.16	5.55	6.94	8.33	9.72	11.11	12.49	13.88	15.27	16.66	18.05	19.44	20.8
20.00	1.39	2.78	4.16	5.55	6.94	8.33	9.72	11.11	12.49	13.88	15.27	16.66	18.05	19.44	20.8

6.4.1.5 IEC TRIP CLASS

According to IEC 60947-4-1, Trip Class specifies the maximum trip time (in sec) from the cold state when the motor is running at current level of $7.2 \times \text{FLA}$. The standard also specifies the tripping time when the motor load current reaches 1.2 and 1.5 times the FLA, as shown in the table below.

Relay trip time according to IEC 60947-4-1 trip class

Motor Current (× FLA)	Trip Class 5	Trip Class 10	Trip Class 20	Trip Class 30	Trip Class 40
1.2	ttrip < 7200 s				

Motor Current (x FLA)	Trip Class 5	Trip Class 10	Trip Class 20	Trip Class 30	Trip Class 40
1.5	ttrip < 120 s	ttrip < 240 s	ttrip < 480 s	ttrip < 720 s	ttrip < 960 s
7.2	3s < ttrip ≤ 5s	3s < ttrip ≤ 10s	3s < ttrip ≤ 20s	3s < ttrip ≤ 30s	3s < ttrip ≤ 40s

When IEC Trip Class is selected, the MM300 Enhanced calculates the time to trip using the below curve established based on motor running conditions as defined in the above table. Time determined by these curves is the time to trip in seconds the relay will take to trip given that the motor starts cold and the current is constant. Time to trip is used to determine the thermal capacity used. If the overload disappears or the motor is tripped (stopped), then the thermal capacity used decreases as per the cooling rate, to simulate motor cooling, depending on the motor status and the values programmed for the COOL TIME CONST RUNNING and COOL TIME CONST STOPPED settings.

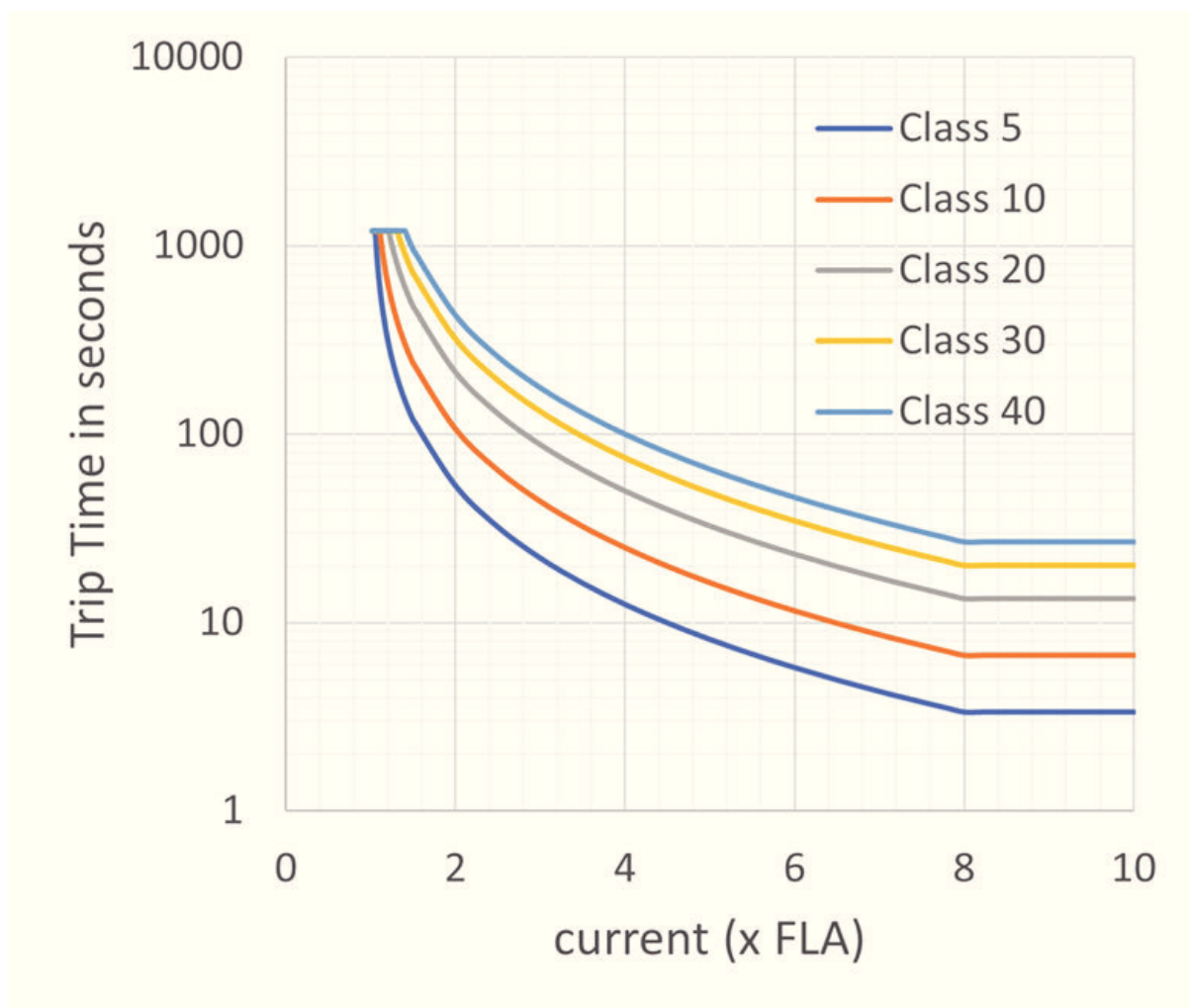


Figure 80: Overload Curves for Trip Class 5, 10, 20, 30 and 40

6.4.1.6 COOLING RATE

The model causes the thermal capacity used to decrease exponentially when the steady-state thermal capacity used value is less than the actual thermal capacity used. This simulates motor cooling. As a stopped motor normally cools significantly slower than a running motor, the relay has two cooling time constant setpoints, one used when

the motor is off (stopped, tripped, locked out, pre-contactor, etc.), the other used when the motor is on (starting, running, stopping). In each case, the time constant is time in minutes for the motor temperature to cool by 63% of the difference between the initial temperature and ambient temperature.

When the steady state Thermal Capacity Used is higher than the actual value of the Thermal Capacity Used, but the equivalent motor heating current is below the level where the overload curve controls the Thermal Capacity Used, the model increases the Thermal Capacity Used at a rate of 5% per minute.

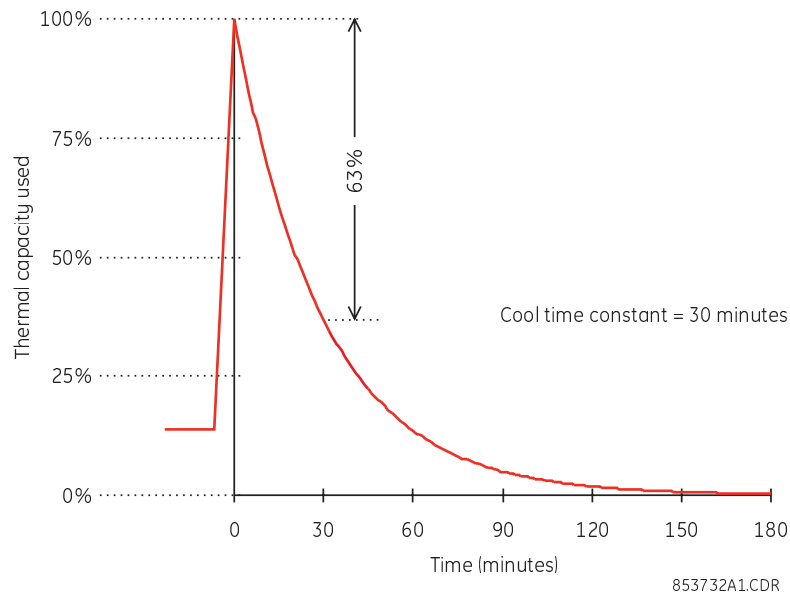


Figure 81: Thermal model cooling following a trip at $t = 0$

6.4.1.7 THERMAL PROTECTION RESET

Operating at the thermal model protection limit is a serious event, and results in a lockout that cannot be reset until the motor has cooled, except with an *Engineer* or *Administrator* security login. The **MINIMIZE RESET TIME** setpoint controls whether lockout persists until the motor has cooled until the thermal capacity used reaches 15% (approximately twice the **COOL TIME CONST STOPPED** setpoint), or until the relay estimates based on learned thermal capacity used on start that the motor has cooled sufficiently for a successful restart. For the latter, a 2% safety margin is included. While in lockout, the motor can not be started via the MM300 Enhanced. Refer to Start inhibits for details.

A second setpoint controls whether once the motor has cooled as described above, the lockout is replaced with a trip that can be manually reset without security login, or alternatively the condition is fully reset allowing immediate restart.

As illustrated in figure below, **THERMAL CAPACITY USED** quantity can be reset to zero by the following means:

- When Reset TCU command is issued, **THERMAL CAPACITY USED** will reset to zero. This command is available at **Diagnostics > Commands**.
- When the GCP/BCP RESET key is pressed continuously for more than 12 seconds, the **THERMAL CAPACITY USED** will be reset to zero.
- When the **RESET LOCKOUT USING RESET KEY** and **RST TCU USING RST KEY** setpoints are set to *Enabled*, the GCP/BCP RESET key, when pressed, can reset **THERMAL CAPACITY USED** to zero.

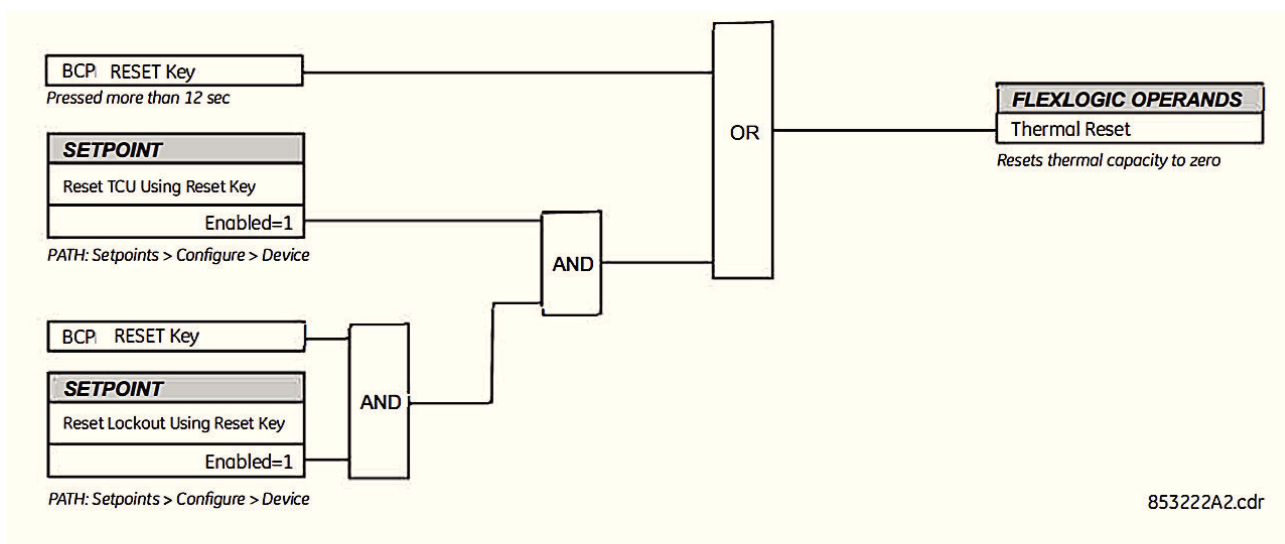


Figure 82: Thermal reset logic

6.4.1.8 TWO-SPEED APPLICATION

In two-speed motor application the thermal protection function provides dedicated thermal overload load curve settings (**HI-SPD OVERLOAD CURVE**, **HI-SPD THERMAL TRIP CLASS**, **HI-SPD STANDARD CURVE**, **HI-SPD TRIP CLASS MULTIPLIER**) to properly configure the high speed motor overload curve. When the motor is switched from low speed to high speed or when it is started at high speed, the MM300 Enhanced thermal model provides the flexibility to configure as required.

The MM300 Enhanced uses the same thermal protection function that integrates the heating at each speed into one thermal model using a common thermal capacity used to register values for both speeds.

Note:

Setpoints **HI-SPD OVERLOAD CURVE**, **HI-SPD THERMAL TRIP CLASS**, **HI-SPD STANDARD CURVE**, **HI-SPD TRIP CLASS MULTIPLIER** are only available when the motor **STARTER TYPE** is configured as *Two-Speed*, otherwise these setting are hidden. These settings are only applicable when the motor is switched from low speed to high speed or when the motor is started at high speed.

6.4.1.9 THERMAL PROTECTION SETPOINTS

Path: **Setpoints > Protection > Thermal Overload**

Overload Curve

Range: Standard Curve, IEC Trip Class

Default: Standard Curve

The overload curve determines the thermal limit overload conditions that can damage the motor. This curve accounts for the motor heating during stall, acceleration, and running conditions.

Hi-Spd Overload Curve

Range: Standard Curve, IEC Trip Class

Default: Standard Curve

Thermal protection function uses this curve to determine the thermal limit overload condition when motor is running at high-speed. This setpoint is only available when motor setpoint **STARTER TYPE** is configured as *Two-Speed*, otherwise this setting is hidden.

Thermal Cap Trip Class

Range: 5, 10, 20, 30, 40

Default: 20

Note:

*This setting and **HI-SPD THERMAL TRIP CLASS** are only available when setpoints **OVERLOAD CURVE** and **HI-SPD OVERLOAD CURVE** are configured as *IEC Trip Class*.*

Hi-Spd Thermal Trip Class

Range: 5, 10, 20, 30, 40

Default: 20

In two-speed motor starter application, thermal trip class is specified using this setting when motor is running at high speed.

Standard Overload Curve

Range: 1 to 15 in steps of 1

Default: 4

Fits the standard overload curve to the thermal characteristics of the protected motor.

Note:

*This setting and **HI-SPD STANDARD CURVE** are only available when setpoints **OVERLOAD CURVE** and **HI-SPD OVERLOAD CURVE** are configured as *Standard Curve*.*

Hi-Speed Standard Curve

Range: 1 to 15 in steps of 1

Default: 4

Fits the standard overload curve to the thermal characteristics of the protected motor.

Overload Pickup Level

Range: 1.01 to 1.25 x FLA in steps of 0.01 x FLA

Default: 1.01 x FLA

This setpoint dictates where the overload curve begins as the motor enters an overload condition. This is useful for service factor motors as it allows the pickup level to be defined. The curve is effectively cut off at current values below this pickup.

Trip Class Multiplier

Range: 0.50 to 1.50 in steps of 0.01

Default: 1.00

The MM300 Enhanced provides the flexibility of shifting the default Trip Class curves on the time axis to best match the thermal characteristics of the protected motor.

Note:

*This setting and **HI-SPEED TRIP CLASS MULTIPLIER** are only available when setpoint **OVERLOAD CURVE** is configured as *IEC Trip Class*.*

Hi-Speed Trip Class Multiplier

Range: 0.50 to 1.50 in steps of 0.01

Default: 1.00

In two-speed starter type application, thermal protection uses trip class multiplier specified by this setting when motor is running or started at high speed.

H/C Safe Stall Ratio

Range: 1 to 100% in steps of 1%

Default: 75%

Controls the Hot/Cold Bias and RTD Bias features. Enter the ratio of the rated Safe Stall Time Hot to the rated Safe Stall Time Cold as a percentage. 100% disables Hot/Cold Bias.

Cool Time Const Running

Range: 1 to 1000 min in steps of 1 min

Default: 15 min

Sets the cooling time constant used by the thermal model when the motor is on. Enter the time in minutes for the temperature to cool by 63% of the difference between the initial value and ambient when the motor is at speed.

Cool Time Const Stopped

Range: 1 to 1000 min in steps of 1 min

Default: 30 min

Sets the cooling time constant used by the thermal model when the motor is off. Enter the time in minutes for the temperature to cool by 63% of the difference between the initial value and ambient when the motor is stationary.

Unbal K Factor

Range: 0 to 19 in steps of 1

Default: 0

Sets the degree of unbalance biasing used by the thermal model. 0 disables unbalance bias. It has no function on single phase motor applications.

Minimize Reset Time

Range: Disabled, Enabled

Default: Disabled

When set to *Disabled*, the lockout condition following a thermal protection operation will persist till the Thermal Capacity Used has dropped to 15%. When set to *Enabled*, the lockout persists until the available thermal capacity is more than the learned thermal capacity used at start, plus an additional margin of 2%. Learned TCU quantity is described in Start inhibits.

For example, if the thermal capacity used for the last three starts is 34, 31, and 37% respectively, the learned starting capacity used at start is the maximum of the three, i.e. 37%. The lockout will reset when TCU drops below $(100\% - 37\% - 2\%) = 61\%$.

Overload Reset Mode

Range: Manual, Auto

Default: Manual

When set to *Auto*, an automatic reset of overload lockouts occurs after the motor has cooled as described under **MINIMIZE RESET TIME**.

When set to *Manual*, the lockouts are replaced with trips when the motor cools. The trips must be reset via the control panel, by remote contact or by comms before the motor can be re-started.

RTD Bias

Range: Disabled, Enabled

Default: Disabled

RTD Bias - Minimum T

Range: Off (Max.), 0 to 251°C in steps of 1°C

Default: Off

This setting is hidden when **RTD BIAS** is set as *Disabled*. It sets the stator RTD temperature appropriate for a Thermal Capacity Used value of 0. If **RTD BIAS** is to be deployed, enter the rated ambient temperature. 0 or a value greater than **RTD BIAS - CENTER T** disables **RTD BIAS**.

RTD Bias - Center T

Range: Off (Max.), 0 to 251°C in steps of 1°C

Default: Off

This setting is hidden when **RTD BIAS** is set as *Disabled*. It sets the stator RTD temperature appropriate for a Thermal Capacity Used value of 100% **HOT/COLD SAFE STALL RATIO**. If **RTD BIAS** is to be deployed, enter the rated full load motor running temperature. 0 or a value greater than **RTD BIAS - MAXIMUM T** disables **RTD BIAS**.

RTD Bias - Maximum T

Range: Off (Max.), 0 to 251°C in steps of 1°C

Default: Off

This setting is hidden when **RTD BIAS** is set as *Disabled*. It sets the stator RTD temperature appropriate for a Thermal Capacity Used value of 100%. If **RTD BIAS** is to be deployed, enter the stator insulation temperature rating. 0 or a value greater than **RTD BIAS - CENTER T** disables **RTD BIAS**.

Thermal Capacity Alarm Function

Range: Disabled, Alarm

Default: Disabled

This setting enables the thermal model alarm functionality.

Thermal Capacity Alarm Level

Range: 10 to 100% in steps of 1%

Default: 75%

This sets the amount of Thermal Capacity Used above which the Thermal Level Alarm is issued.

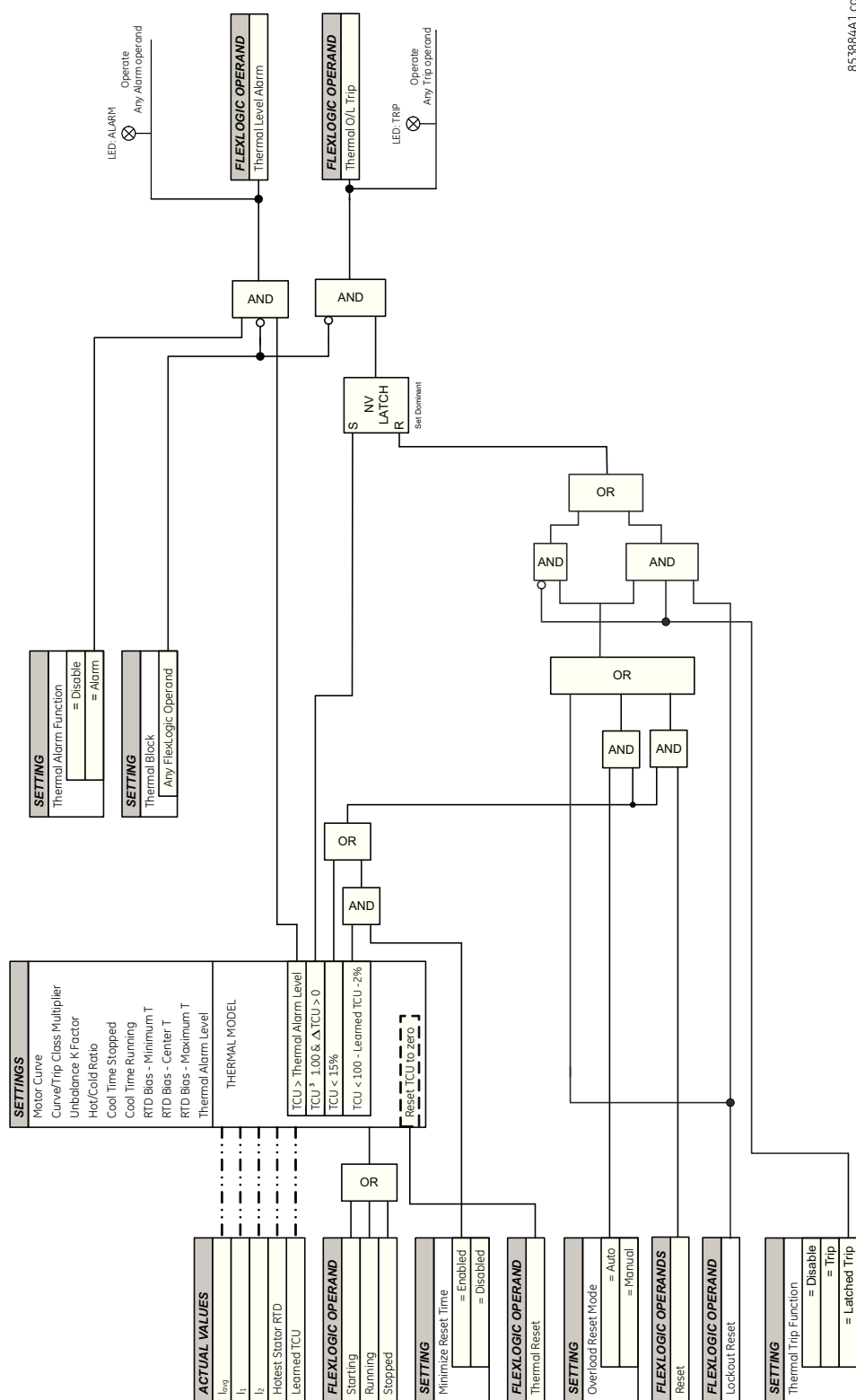


Figure 83: Thermal model protection logic diagram

6.4.2 MECHANICAL

6.4.2.1 MECHANICAL JAM

After the motor has started and reached a running state, the mechanical jam element (if enabled) produces a trip when the magnitude of I_a , I_b , or I_c reaches or exceeds the pickup level for the time specified by the **MECHANICAL JAM DELAY** setpoint. This feature may be used to indicate a stall condition when running. Not only does it protect the motor by taking it off-line faster than the thermal model (overload curve), it may also prevent or limit damage to the driven equipment if motor starting torque persists on jammed or broken equipment. Mechanical jam setpoints

The **MECHANICAL JAM LEVEL** should be set higher than motor loading during normal operation, but lower than the motor stall level. Normally the delay is set to the minimum time delay or to avoid nuisance trips due to momentary load fluctuations.

When 2-speed motor protection functionality is employed, the MM300 Enhanced will block mechanical jam protection during the acceleration time from Speed 1 to Speed 2 until the motor current has dropped below overload pickup level ($OL \times FLA$) or the Accel Time Fr. Lo-Hi Spd has expired. At the point of time when the motor reaches the high-speed running stage, mechanical jam will be re-enabled using the setpoint **HIGH SPD FLA** set under **Setpoints > Configure > Motor Settings**. The pickup level should be set higher than motor loading during normal operation, but lower than the motor stall level for both speeds. Normally the delay is set to the minimum time delay or set so that no nuisance trips occur due to momentary load fluctuations.

Path: Setpoints > Protection > Mechanical > Mechanical Jam

Mechanical Jam Level

Range: 1.01 to $4.50 \times FLA$ in steps of 0.01

Default: $3.00 \times FLA$

This setpoint sets the current pickup level.

Mechanical Jam Delay

Range: 0.1 to 30.0 s in steps of 0.1 s

Default: 0.1 s

This setpoint sets the amount of time motor current must exceed pickup to generate a trip.

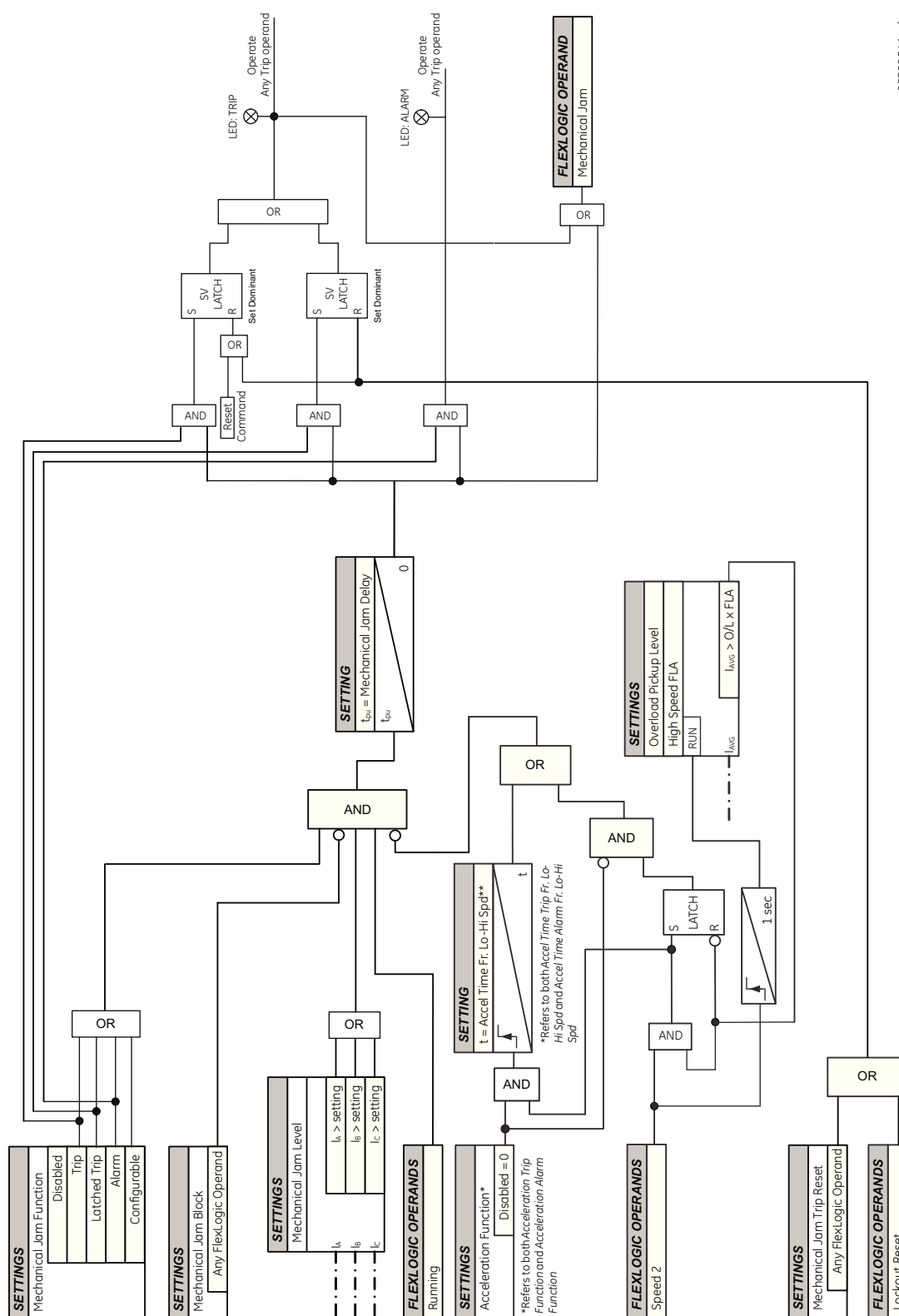


Figure 84: Mechanical jam logic diagram

6.4.2.2 UNDERCURRENT

When the motor is in the running state, a trip or alarm will occur should the magnitude I_a , I_b , or I_c fall below the pickup level for the time specified by the **UNDERCURRENT ALARM DELAY**. The pickup levels should be set lower than the lowest motor loading during normal operations. Undercurrent setpoints

For example, if a pump is cooled by the liquid it pumps, loss-of-load may mean that the pump overheats. In this case, the undercurrent feature is enabled. To prevent motor loading from falling below $0.75 \times \text{FLA}$, even for short durations, the **UNDERCURRENT TRIP LEVEL** could be set to 70% and the **UNDERCURRENT ALARM LEVEL** to 75%. The **UNDERCURRENT TRIP DELAY** and **UNDERCURRENT ALARM DELAY** setpoints are typically set as quick as possible i.e. 1 second.

Path: *Setpoints > Protection > Mechanical > Undercurrent*

Undercurrent Trip Level

Range: 1 to 100% FLA in steps of 1%

Default: 10% FLA

This setpoint specifies the undercurrent trip pickup level.

Undercurrent Trip Delay

Range: 1 to 60 s in steps of 1 s

Default: 1 s

This sets the amount of time the motor current must exceed pickup to generate a trip.

Undercurrent Alarm Level

Range: 1 to 100% FLA in steps of 1%

Default: 15% FLA

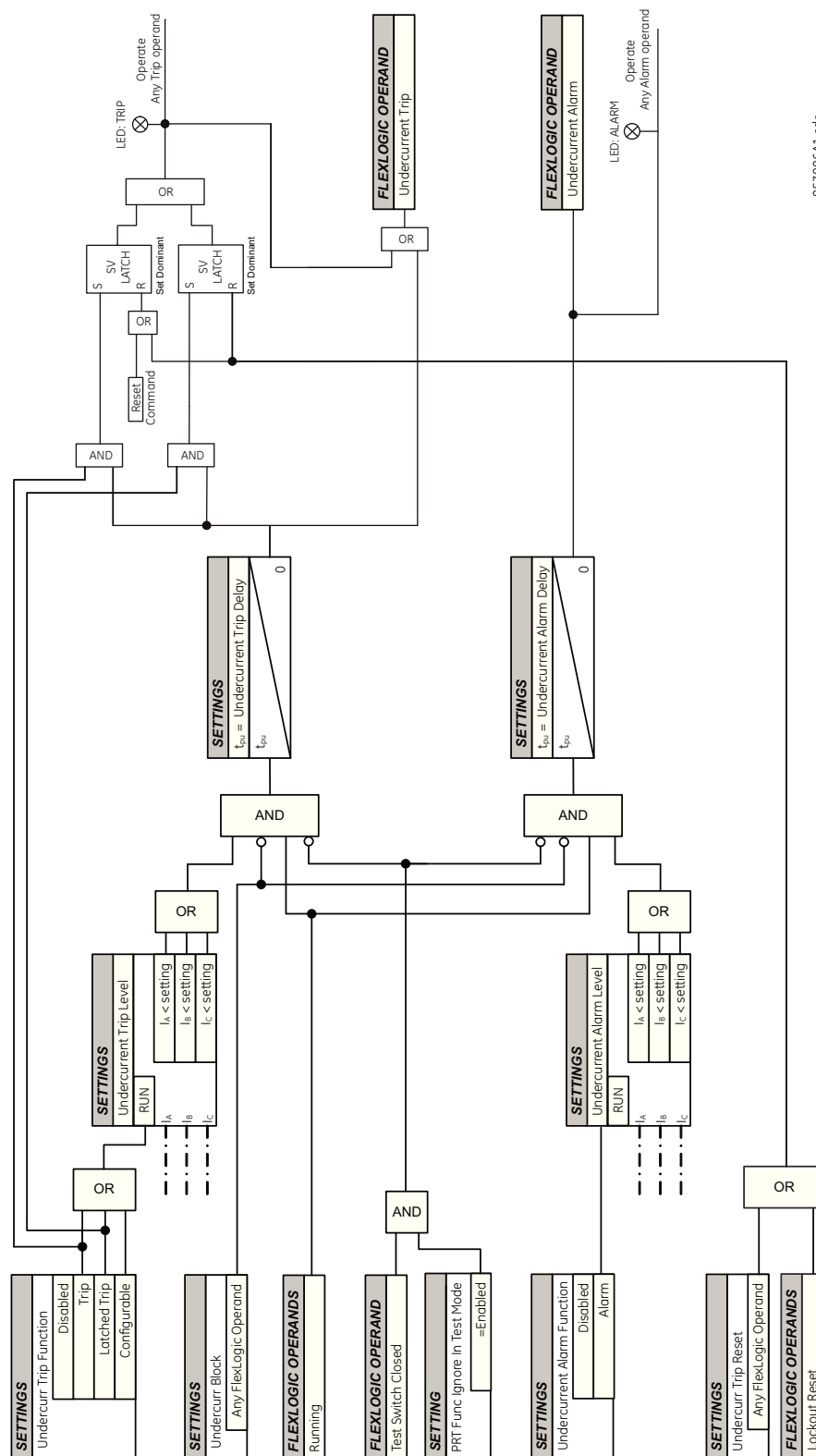
This sets the undercurrent alarm pickup level.

Undercurrent Alarm Delay

Range: 1 to 60 s in steps of 1 s

Default: 1 s

This sets the amount of time the motor current must exceed pickup to generate an alarm.



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Figure 85: Undercurrent logic diagram

6.4.2.3 UNDERPOWER

Underpower protection is available whether a type I0_B module (3 x VT) is included in the order code or not. When this option is included, the power is calculated using the voltages connected to this card. When this option is not

included, the power is calculated using the auxiliary voltage and assumes that the missing voltages are balanced. Underpower setpoints

When the motor is in the running state, a trip or alarm will occur if the magnitude of the real power falls below the pickup level for the time specified by the **UNDERPOWER ALARM DELAY** setpoint. The pickup levels should be less than the lowest motor loading during normal operations.

Setpoint levels are a percentage of MNR, where MNR is the **MOTOR RATING** setpoint.

The following setpoints are available for the underpower protection feature.

Path: Setpoints > Protection > Mechanical > Underpower

Underpower Trip Mode

Range: Single Phase, Three Phase

Default: Three Phase

With type B card (3 x VTs) order code option, when this setpoint is:

- configured as *Three Phase*, the element uses three phase active power (kW) calculated using the voltages connected to this card. configured as *Single Phase*, the element uses single phase active power (kW) using the Phase A Current and Phase A voltage.

Without type B card (3 x VTs) order code option, when this setpoint is:

- configured as *Three Phase*, the element uses three phase active power (kW) calculated using the auxiliary voltage, under the assumption that missing voltages are balanced. configured as *Single Phase*, the element uses single phase active power (kW) using the Phase A Current and Auxiliary voltage as specified under setpoint **AUXILIARY VOLTAGE CONNECTION**.

Underpower Trip Level

Range: 1 to 100% MNR in steps of 1%

Default: 20%

This setpoint specifies the underpower trip pickup level. The set pickup level is programmed as percentage of MNR. MNR is the Rated kW specified by the setpoint **MOTOR RATING** configured under **Setpoints > Configure > Motor**.

Underpower Trip Delay

Range: 1 to 60 s in steps of 1 s

Default: 1 s

The setpoint specifies the amount of time the motor current must exceed the trip pickup level to generate a trip.

Underpower Alarm Level

Range: 1 to 100% MNR in steps of 1%

Default: 20%

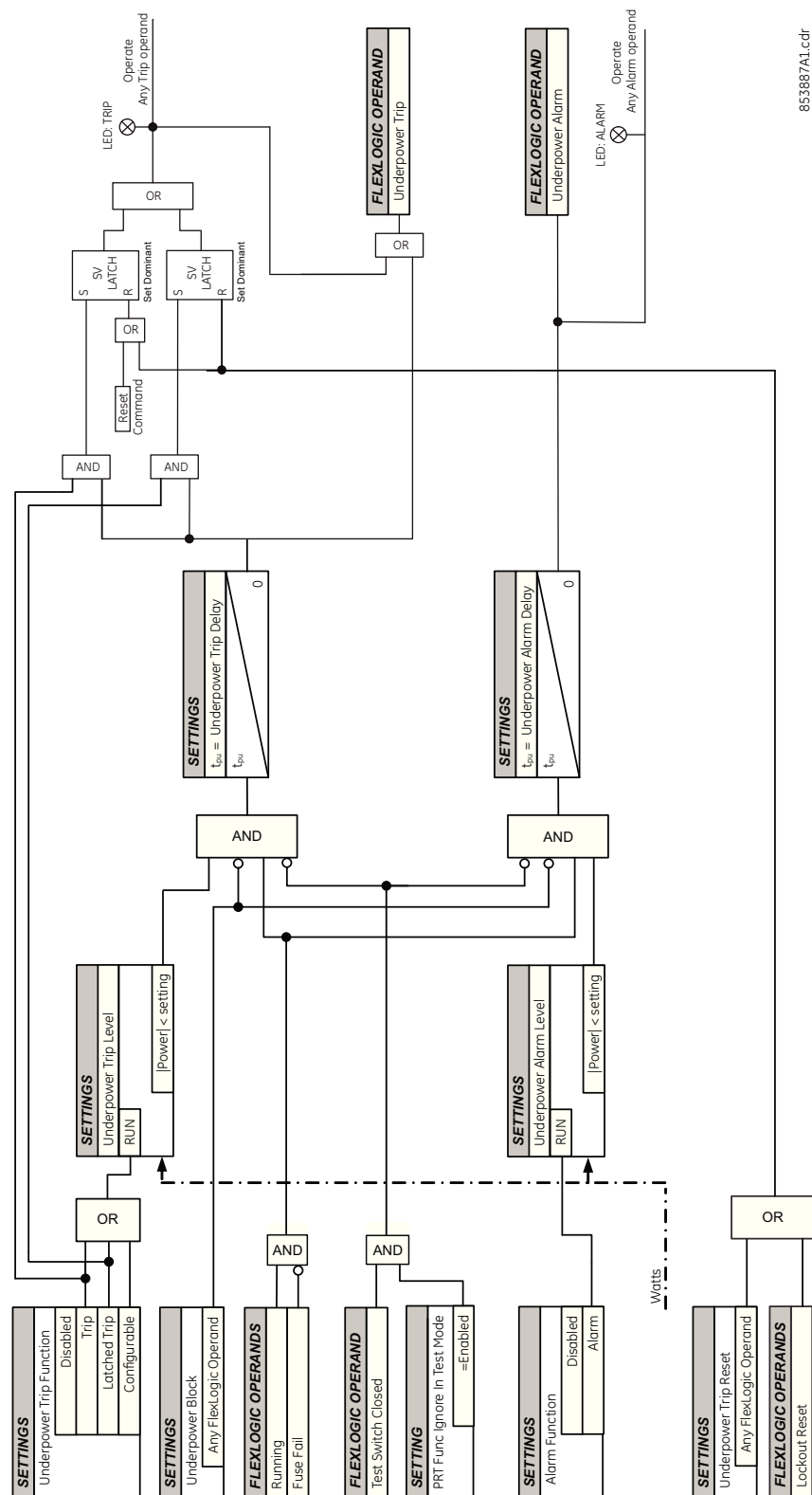
This setpoint specifies the underpower alarm pickup level.

Underpower Alarm Delay

Range: 1 to 60 s in steps of 1 s

Default: 1 s

The setpoint specifies the amount of time the motor current must exceed the alarm pickup level to generate an alarm.



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Figure 86: Underpower logic diagram

6.4.2.4 ACCELERATION TIME

The thermal model protects the motor under both starting and overload conditions. The acceleration timer trip may be used to complement this protection. For example, if the motor always starts in 2 seconds, but the safe stall time

is 8 seconds, there is no point letting the motor remain in a stall condition for the 7 or 8 seconds it would take for the thermal model to operate. Furthermore, the starting torque applied to the driven equipment for that period of time could cause severe damage. Acceleration protection setpoints

If enabled, the acceleration protection will trip if the motor stays in the starting state and does not reach the running state by the set acceleration time. Detection of starting and running is as described in Stop/start control.

The learned acceleration time is the longest acceleration time measured over the last five successful starts or all available starts if there are less than five records, plus margin. The margin is 25% of the longest time or 1 second, whichever is greater. A successful motor start is one in which the motor reaches the running state. If the relay does not contain records of five successful starts, the acceleration protection will not operate.

In two-speed motor application, setpoints **HI-SPD ACCEL TRIP TIMER**, **HI-SPD ACCEL ALARM TIMER**, **ACCEL TRIP TIME FR. L-H SPD** and **ACCEL ALARM TIME FR. L-H SPD** must be configured. A two-speed motor is usually started at a low speed and then switched to a higher speed when required. When the motor starts at high speed, the **HI-SPD ACCEL TRIP TIMER** setting specifies the maximum acceleration time at high speed. When motor is switched from a low-to-high speed, setting **ACCEL TRIP TIME FR. L-H SPD** specifies the acceleration time.

Note:

Setpoints **HI-SPD ACCEL TRIP TIMER** and **ACCEL TRIP TIME FR. L-H SPD** are only available when motor starter type is configured as two-speed, otherwise these settings are hidden. These settings are only applicable when motor is switched from low speed to high speed or when motor is started at high speed.

Path: Setpoints > Protection > Mechanical > Acceleration Protection

Acceleration Trip Timer

Range: 0.5 to 250.0 s in steps of 0.1 s

Default: 7.0 s

This sets the maximum acceleration time before tripping. Uses the learned acceleration time from the last five successful starts.

Hi-Spd Accel Trip Timer

Range: 0.5 to 250.0 s in steps of 0.1 s

Default: 7.0 s

This setting specifies the maximum acceleration trip time when the motor is started at high speed in two-speed motor application. The setting is only available when motor setpoint **STARTER TYPE** is configured as *Two-Speed*, otherwise it is hidden.

Accel Trip Time Fr. L-H Spd

Range: 0.5 to 250.0 s in steps of 0.1 s

Default: 7.0 s

This setting is provided to select maximum accelerating trip time from low speed to high speed when motor is switched from low to high speed. The setting is only available when motor setpoint **STARTER TYPE** is configured as *Two-Speed*, otherwise it is hidden.

Acceleration Alarm Timer

Range: 0.5 to 250.0 s in steps of 0.1 s

Default: 5.0 s

This sets the maximum acceleration time before tripping. Uses the learned acceleration time from the last five successful starts.

Hi-Spd Accel Alarm Timer

Range: 0.5 to 250.0 s in steps of 0.1 s

Default: 5.0 s

This setting specifies maximum acceleration alarm time when motor is directly started at high speed in two-speed motor application. The setting is only available when motor setpoint **STARTER TYPE** is configured as *Two-Speed*, otherwise it is hidden.

Accel Alarm Time Fr. L-H Spd

Range: 0.5 to 250.0 s in steps of 0.1 s

Default: 5.0 s

This setting is provided to select maximum accelerating alarm time from low speed to high speed when motor is switched from low to high speed. The setting is only available when motor setpoint **STARTER TYPE** is configured as *Two-Speed*, otherwise it is hidden.

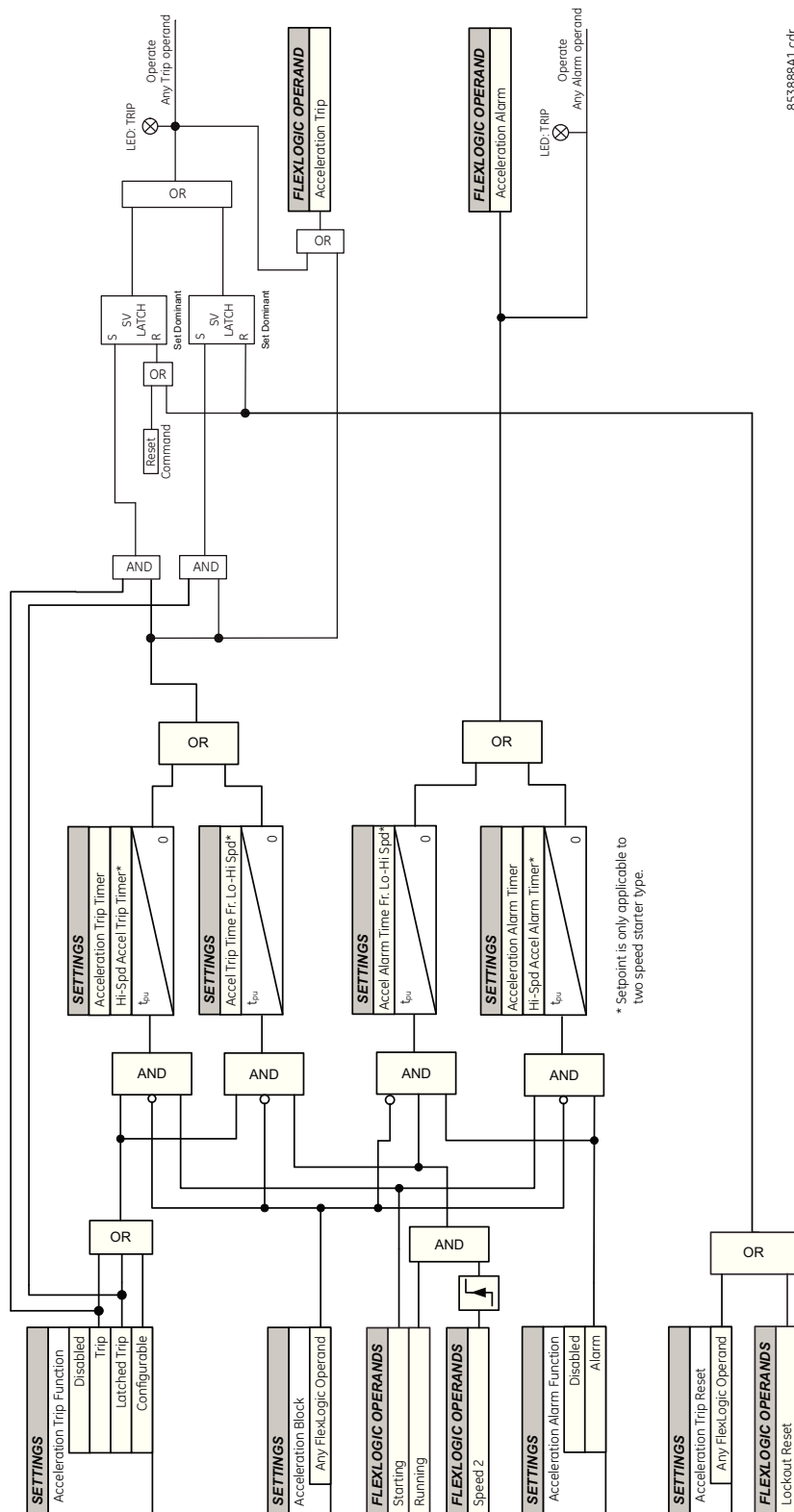


Figure 87: Acceleration logic diagram

6.4.2.5 CONTACTOR MONITORING

Contactor A, B and C status inputs are monitored to ensure that the contactor(s) correctly follow the relay's output contact(s). If the appropriate contactor does not close within the set time delay (**CONTROL CIRCUIT DELAY**), an

Open Control Circuit Alarm or Trip is generated. If a contactor does not open within **CONTROL CIRCUIT DELAY**, a Welded Contactor Alarm or Trip is generated, depending on the **WELDED CONTACT FUNCTION** setting. The trip is sealed in till a reset command is issued.

Note:

Contactor B monitoring is disabled for starter types that use the contactor B contact inputs and outputs for other than interfacing to a contactor, e.g. the Inverter starter.

In addition, the presence of contactor current is compared to expectations - if any current is detected when the contactors should be open, or no current is detected when the contactors should be closed and the motor running, an Inconsistent Inputs alarm is generated. This monitoring can be disabled by the simulator for bench testing for example, where the contactors are not connected.

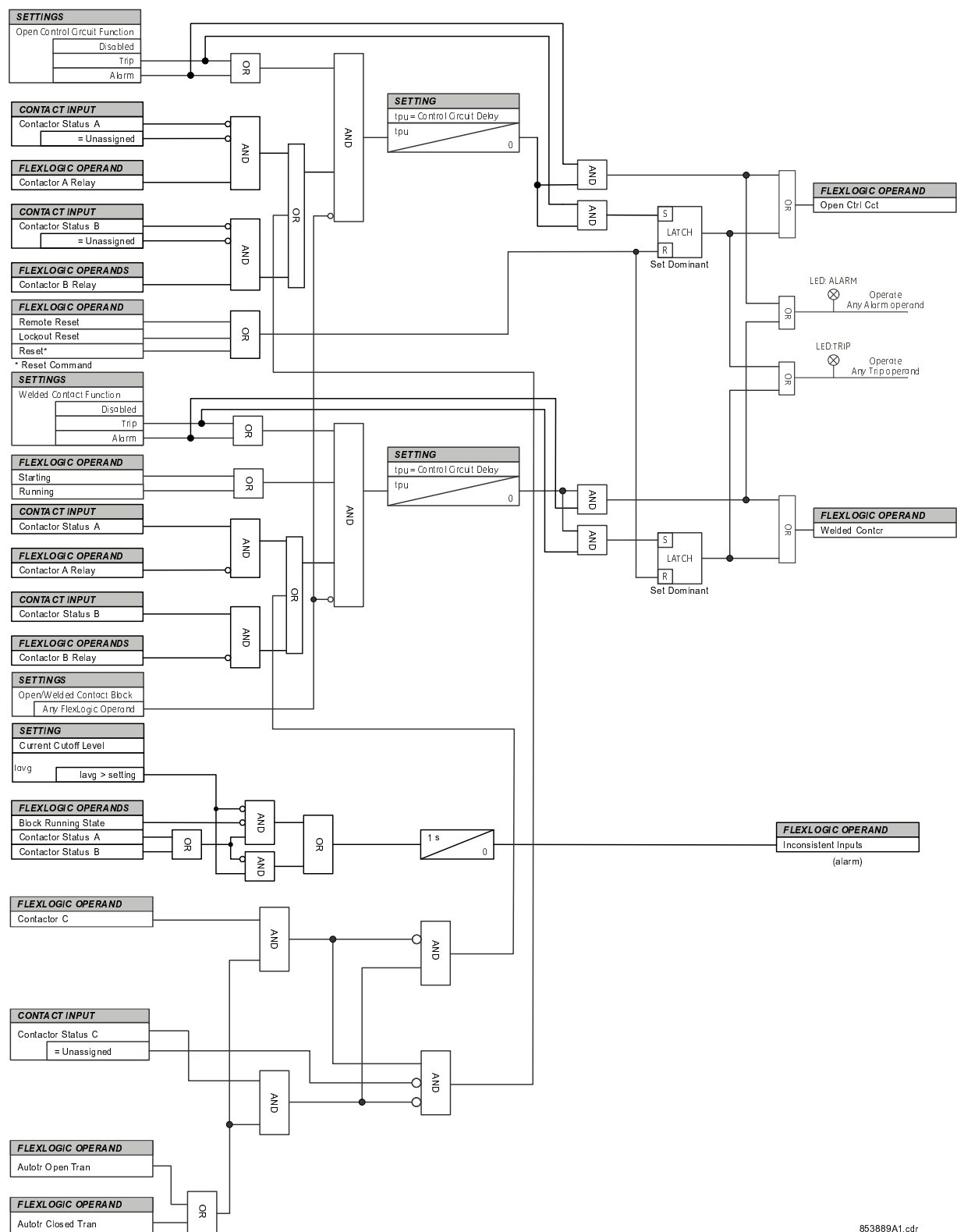
Path: Setpoints > Protection > Mechanical > Contactor Monitoring

Control Circuit Delay

Range: 0.2 to 2.0 s in steps of 0.1 s

Default: 1.0 s

This setting specifies the time within which the contactor must close. If the contactor does not close in this time, an Open Control Circuit Alarm or Trip is generated. Similarly, if the contactor does not open within the set time, a Welded Contactor Alarm or Trip is generated.



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Figure 88: Contactor monitoring logic diagram

6.4.3 ELECTRICAL

6.4.3.1 LOAD INCREASE ALARM

The load increase alarm is used to alarm abnormal load increases that may indicate problems with the process. An alarm is enabled only after the acceleration phase is complete and the motor has entered the running phase. The alarm is generated when the current exceeds the set pickup level after the set time delay, and automatically resets when the current has subsided.

Path: *Setpoints > Protection > Electrical > Load Increase Alarm*

Load Increase Alarm Level

Range: 50 to 150% FLA in steps of 1%

Default: 105

This setting specifies the alarm pickup threshold.

Load Increase Alarm Delay

Range: 0.1 to 180.0 s in steps of 0.1 s

Default: 5.0 s

This sets the amount of time that the motor current must exceed pickup to generate a trip.

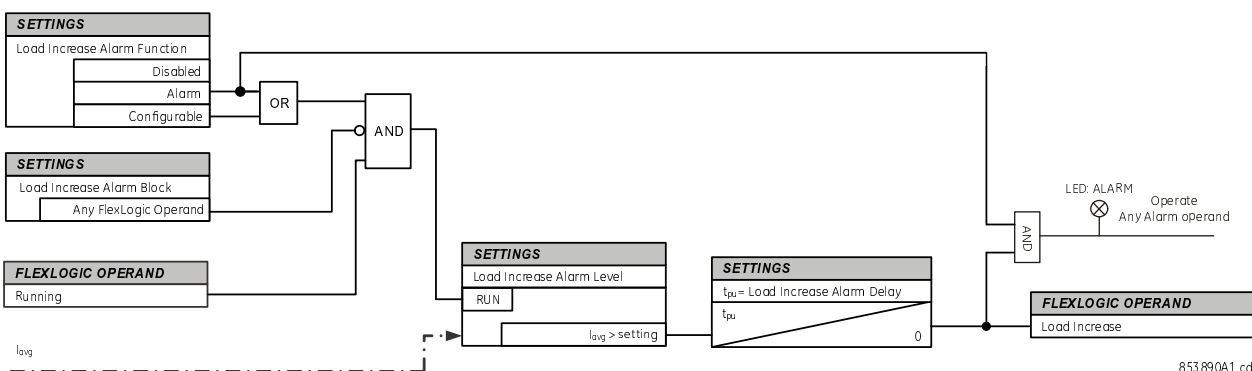


Figure 89: Load increase alarm logic diagram

6.4.3.2 AUXILIARY UNDERVOLTAGE

As discussed in Phase undervoltage, undervoltage on the motor supply can present problems for both starting and running the motor. the phase undervoltage element may be used to protect against these problems, however it requires a 3 x VT Inputs option B card to be installed. Where there is no option B card, where the relay's auxiliary VT input is derived from the motor's supply, and where the errors introduced by the control power transformer can be tolerated, the auxiliary undervoltage element may be used.

Path: *Setpoints > Protection > Electrical > Auxiliary Undervoltage*

Aux U/V Trip Level

Range: 60 to 90% in steps of 1%

Default: 60%

Sets the auxiliary overvoltage trip level according to percentage of nominal control voltage.

Note:

NCV - Nominal Control Voltage - is calculated depending on Aux VT connection:

Note:

*If Aux VT is set for Direct: **NCV = MNV** / $\sqrt{3}$*

Note:

*If Aux VT is set for VabVT, VbcVT, VcaVT, VanVT, VbnVT, VcnVT: **NCV = Aux VT secondary***

Aux U/V Trip Delay

Range: 1 to 60 s in steps of 1 s

Default: 5 s

This setpoint specifies the auxiliary undervoltage trip delay.

Aux U/V Alarm Level

Range: 60 to 90% NCV in steps of 1%

Default: 65%

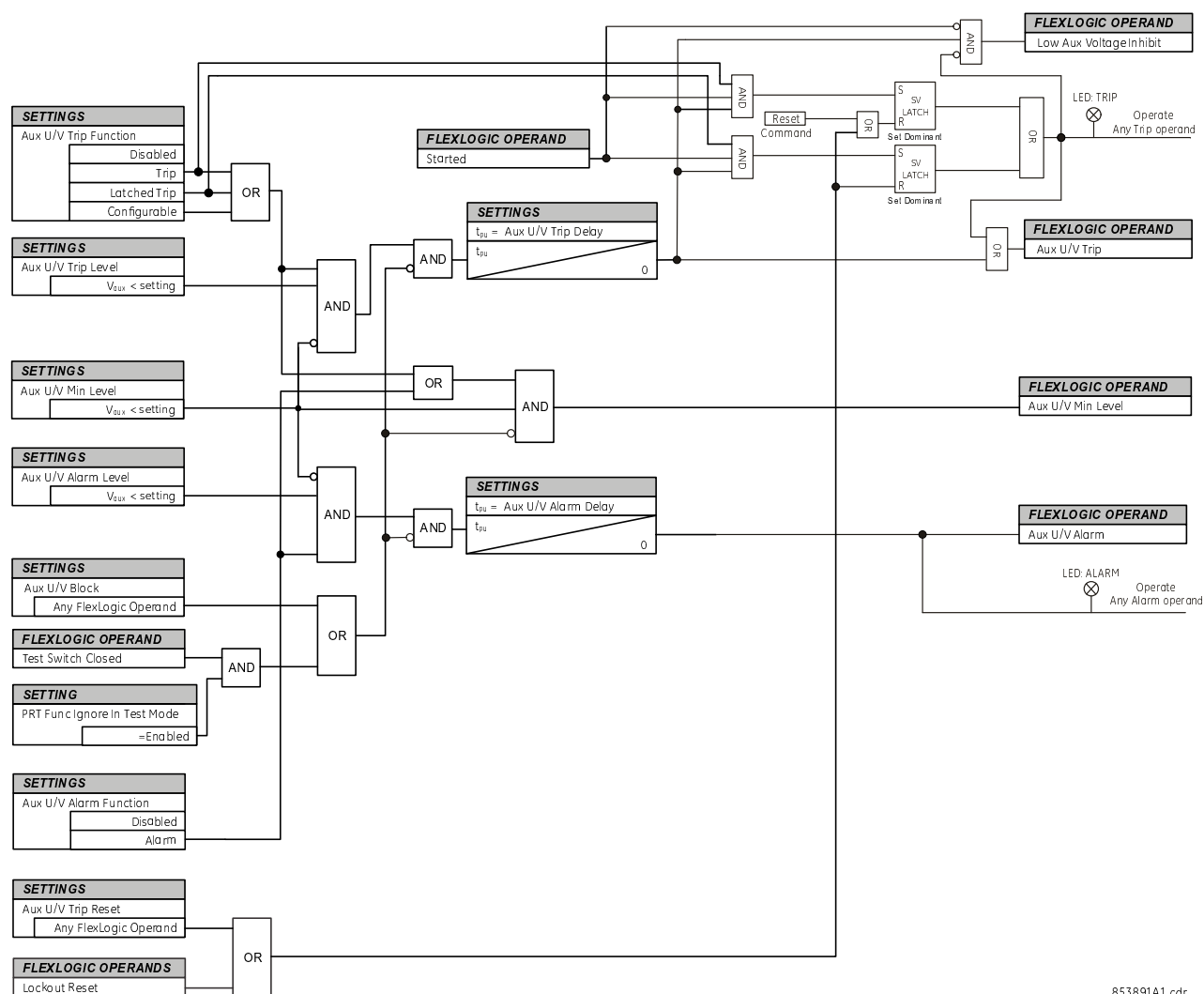
This sets the auxiliary undervoltage alarm level according to the percentage of nominal control voltage.

Aux U/V Alarm Delay

Range: 1 to 60 s in steps of 1 s

Default: 5 s

This sets the auxiliary undervoltage alarm delay.



853891A1.cdr

Figure 90: Auxiliary undervoltage protection logic diagram

6.4.3.3 GROUND FAULT

When motor stator windings become wet or otherwise suffer insulation deterioration, low magnitude leakage currents often precede complete failure and resultant destructive fault currents. Ground fault protection provides early detection of such leakage current, allowing the motor to be taken offline in time to limit motor damage. However, if a high magnitude ground fault occurs that is beyond the capability of the contactor to interrupt, it is desirable to wait for the fuses or an upstream device to provide the interruption.

The ground fault protection will alarm or trip when the ground current magnitude meets or exceeds the pickup for the specified time, provided that the maximum phase current is less than $8 \times \text{FLA}$.

Depending on the value chosen for the **GROUND CT TYPE** setting, the current measured by this element is either the core balance CT current, the fourth CT input current, or the sum of the first three CT inputs' currents. When used with a core-balance CT, this protection becomes a sensitive ground fault protection.

A ground fault trip is a serious event, and therefore results in a lockout that cannot be reset until the motor has cooled except with an *Engineer* or *Administrator* security login.

Note:

*The ground fault protection pickup setpoints are entered in a multiple of Full Load Amperes (x FLA) if the **GROUND CT TYPE** setpoint is selected as **1A Secondary**, **5A Secondary** or in units of primary amps if a 50:0.025 core balance CT is used and the ground CT is selected as **50:0.025**.*

Various situations (for example, contactor bounce) may cause transient ground currents during motor starting that exceed the ground fault pickup levels for a very short period of time. The delay can be fine-tuned to an application so it still responds very quickly, but rides through normal operational disturbances. Normally, the ground fault time delays are set as short as possible, that is, 0 ms. Time may have to be increased if nuisance tripping occurs.

Special care must be taken when the ground input is wired to the phase CTs in a residual connection. When a motor starts, the starting current (typically $6 \times \text{FLA}$ for an induction motor) has an asymmetrical or DC component. This momentary DC component will cause each of the phase CTs to react differently, and cause a net current into the ground input of the relay. A 20 ms block of the ground fault elements when the motor starts normally enables the relay to ride through this momentary ground current signal.

Path: Setpoints > Protection > Electrical > Ground Fault

Ground Trip Level (GROUND CT TYPE = 1A, 5A)

Range: 10 to 100% FLA in steps of 1%

Default: 20% FLA

This setpoint specifies the ground fault trip pickup level.

Ground Trip Level (with core balance CT when GROUND CT TYPE = 2000:1)

Range: 0.5 to 15.0 A in steps of 0.1 A

Default: 10.0 A

This setpoint specifies the ground fault trip pickup level.

Ground Trip Delay on Start

Range: 0.0 to 10.0 s in steps of 0.1 s

Default: 0.0 s

This setpoint specifies the time that the motor ground fault current must meet or exceed pickup to generate a ground fault trip when the motor is in a starting condition.

Ground Trip Delay on Run

Range: 0.0 to 5.0 s in steps of 0.1 s

Default: 0.0 s

This setpoint specifies the time that the motor ground fault current must meet or exceed pickup to generate a ground fault trip when the motor is in a running condition.

Ground Trip Dropout Delay

Range: 0.0 to 10.0 s in steps of 0.1 s

Default: 0.0 s

This setting specifies a time delay to reset the trip command. This delay should be set long enough to allow the breaker or contactor to disconnect the motor.

Ground Alarm Level (GROUND CT TYPE = None, 1A, 5A)

Range: 10 to 100% FLA in steps of 1%

Default: 20% FLA

This setpoint specifies the ground fault alarm level.

Ground Trip Level (with core balance CT when *GROUND CT TYPE* = 2000:1)

Range: 0.5 to 15.0 A in steps of 0.1 A

Default: 10.0 A

This setpoint specifies the ground fault alarm level.

Ground Alarm Delay on Start

Range: 0 to 60 s in steps of 1 s

Default: 10 s

This setpoint specifies the amount of time motor ground fault current must exceed pickup to generate an alarm when the motor is in a starting condition.

Ground Alarm Delay on Run

Range: 0 to 60 s in steps of 1 s

Default: 10 s

This setpoint specifies the amount of time motor ground fault current must exceed pickup to generate an alarm when the motor is in a running condition.

Ground Alarm Dropout Delay

Range: 0.0 to 10.0 s in steps of 0.1 s

Default: 0 s

This setpoint specifies a time delay to reset the alarm command.

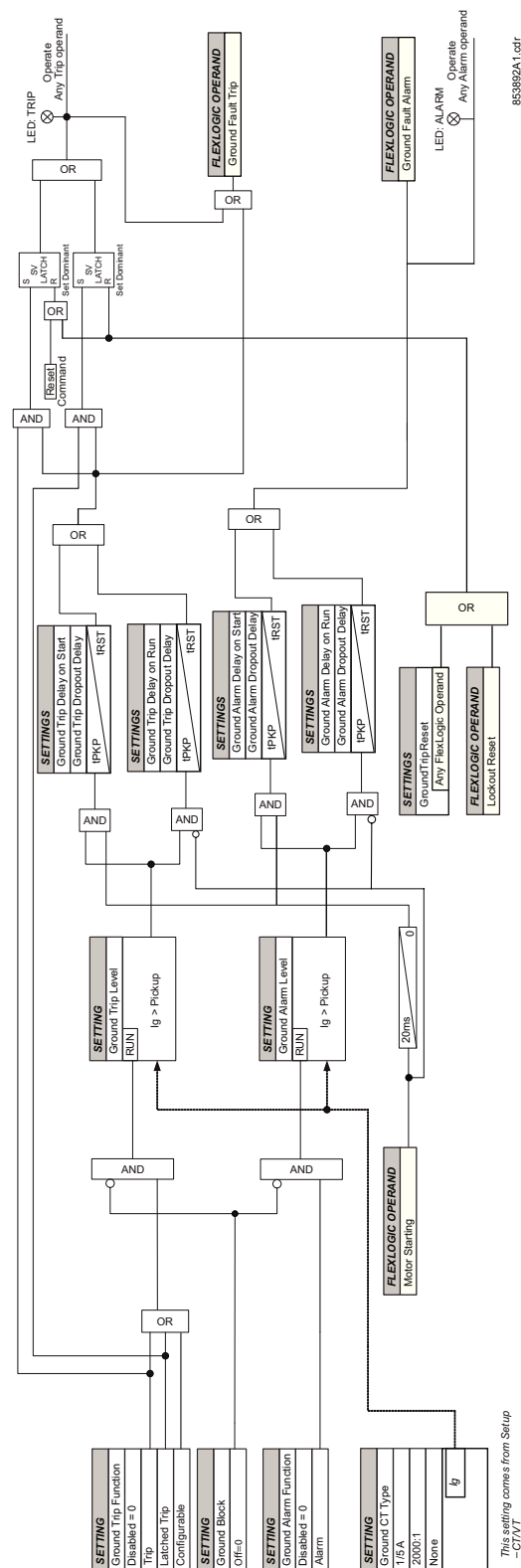


Figure 91: Ground fault protection logic diagram

6.4.3.4 CURRENT UNBALANCE

Unbalance current, also known as negative sequence current or I_2 , results in disproportionate rotor heating. If the thermal overload protection's unbalance bias feature has been enabled, the thermal overload protection will protect

the motor against this by tripping when the motor's thermal capacity is exhausted. However, the current unbalance protection can detect this condition and alarm or trip before the motor has heated substantially.

For the MM300 Enhanced unbalance is defined as the ratio of negative-sequence to positive-sequence current, I_2 / I_1 if the motor is operating at a load greater than FLA ($I_{avg} > 1$). If the motor is less than FLA, unbalance is defined as $I_2 / I_1 \times I_{avg}$. This desensitizing is necessary to prevent nuisance alarms when a motor is lightly loaded. If enabled, a trip and/or alarm occurs once the unbalance magnitude equals or exceeds the set pickup for the set period of time. If the unbalance level equals or exceeds 40%, or when $I_{avg} \geq 0.25$ and current in any one phase is less than the **CURRENT CUTOFF LEVEL** setting, the motor is considered to be single phasing and a trip occurs within 2 seconds. Single phasing protection is disabled if the unbalance trip feature is turned *Off*.

When setting the pickup level, note that a 1% voltage unbalance typically translates into a 6% current unbalance. To prevent nuisance trips or alarms, the pickup level should not be set too low. Also, since short term unbalances are common, a reasonable delay should be set to avoid nuisance trips or alarms.

Note:

Unusually high unbalance levels may be caused by incorrect phase CT wiring.

For example, if the supply voltage is normally unbalanced up to 2%, the current unbalance seen by a typical motor is $2 \times 6 = 12\%$. In this case, set the current unbalance alarm pickup to 15 and the current unbalance trip pickup to 20 to prevent nuisance tripping; 5 or 10 seconds is a reasonable delay

Path: Setpoints > Protection > Electrical > Current Unbalance

Current Unbal Trip Level

Range: 4 to 40%, in steps of 1%

Default: 30%

This setpoint specifies the current unbalance trip pickup level.

Current Unbal Trip Delay

Range: 1 to 60 s in steps of 1 s

Default: 1 s

This setpoint specifies the time the motor unbalance current must meet or exceed pickup to generate a trip.

Current Unbal Alarm Level

Range: 4 to 40%, in steps of 1%

Default: 15%

This setpoint specifies the current unbalance alarm pickup level.

Current Unbal Alarm Delay

Range: 1 to 60 s in steps of 1 s

Default: 1 s

This setpoint specifies the time the motor unbalance current must meet or exceed pickup to generate an alarm.

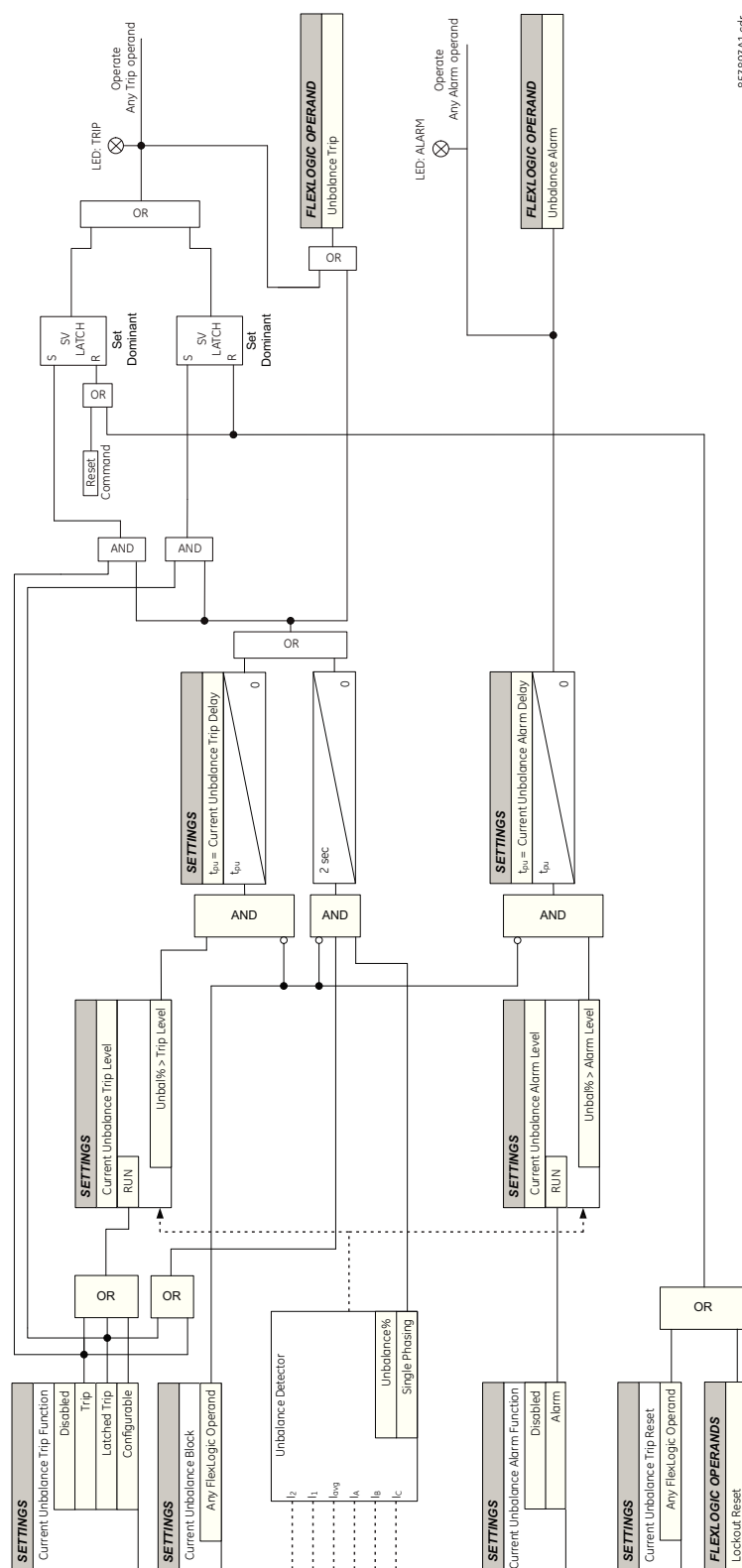


Figure 92: Current unbalance logic diagram

6.4.3.5 PHASE UNDERVOLTAGE

Note:

Phase undervoltage protection is available only when a type B option card (3 × VT) is included in the order code.

An undervoltage on a running motor with a constant load, results in increased current. The relay thermal model typically picks up this condition and provides adequate protection. However, the phase undervoltage element may be used to provide for an advance warning alarm and/or for tripping before the motor has heated. Phase undervoltage setpoints

Attempting to start a large motor when the supply voltage is down may also be undesirable. An undervoltage of significant proportion that persists while starting a motor may prevent the motor from reaching rated speed. This may be especially critical for a synchronous motor. If the undervoltage condition is due to a weak supply such as being from undersized backup generation, the backup could collapse if additional load is applied. To cover these situations, this feature may also be used to provide protection for undervoltage conditions before and during starting.

The MM300 Enhanced uses the undervoltage restart element to handle loss of supply, and the fuse fail element to cover main and VT fuse failure.

The element generates alarms or trips when any of the three phase-to-phase voltages meets or falls below the pickup level. To prevent nuisance alarms and trips resulting from loss of supply, the element is blocked when any phase-to-phase voltage is less than minimum undervoltage level.

Path: *Setpoints > Protection > Electrical > Phase Undervoltage*

Undervoltage Trip Level

Range: 60 to 99% of MNV in steps of 1%

Default: 60%

This setpoint specifies the phase undervoltage trip pickup level as a percentage of the rated voltage.

Undervoltage Trip Delay

Range: 1 to 60 s in steps of 1 s

Default: 30 s

This setpoint specifies the undervoltage trip delay time.

Undervoltage Alarm Level

Range: 60 to 99% of MNV in steps of 1%

Default: 70%

This setpoint specifies the phase undervoltage alarm pickup level as a percentage of the rated voltage.

Undervoltage Alarm Delay

Range: 1 to 60 s in steps of 1 s

Default: 30 s

This setpoint specifies the undervoltage alarm delay time.

Undervoltage Min Level

Range: Off (Max.), 5 to 40% of MNV in steps of 1%

Default: Off

This setpoint specifies the phase undervoltage minimum level as a percentage of the rated voltage. Selecting *Off* enables the undervoltage function to detect the undervoltage condition at zero voltage.

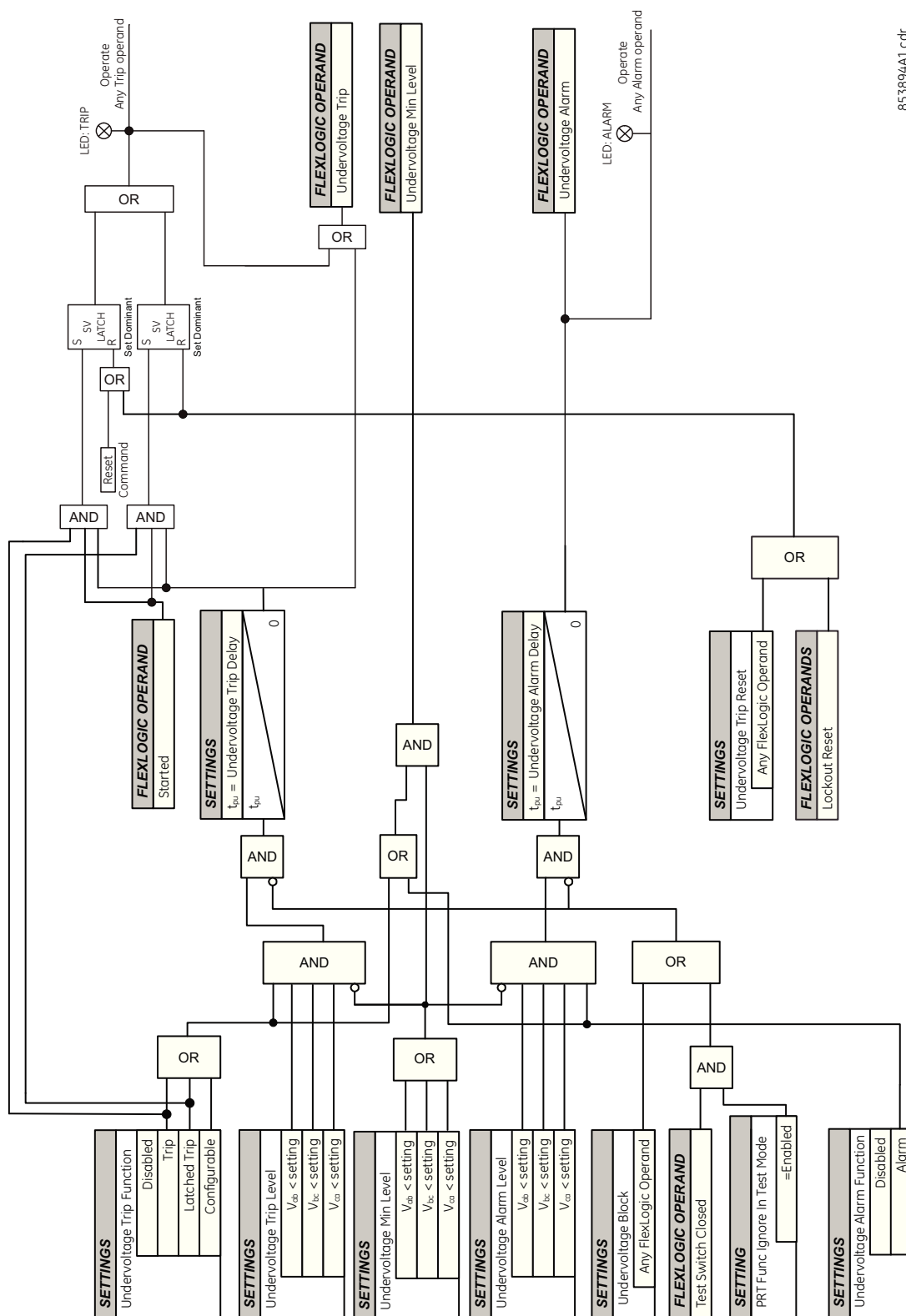


Figure 93: Phase undervoltage protection logic diagram

6.4.3.6 PHASE OVERVOLTAGE

Note:

Phase overvoltage protection is available only when a type B option card (3 × VT) is specified in the order code.

An overvoltage on a running motor with a constant load, results in decreased current. However, iron losses increase, causing an increase in motor temperature. The current overload element will not pickup this condition and provide adequate protection. Therefore, the overvoltage element may be useful for protecting the motor in the event of a sustained overvoltage condition.

If this element is enabled, a trip or alarm will occur once the magnitude of either V_{ab} , V_{bc} or V_{ca} meets or rises above the pickup level for a user-specified period of time.

Path: *Setpoints > Protection > Electrical > Phase Overvoltage*

Overvoltage Trip Level

Range: 101 to 120% of MNV in steps of 1%

Default: 110%

This setpoint specifies the overvoltage trip pickup level as a percentage of the rated voltage.

Overvoltage Trip Delay

Range: 1 to 60 s in steps of 1 s

Default: 30 s

This setpoint specifies the time that the voltage must meet or exceed the overvoltage trip pickup level to generate a trip.

Overvoltage Alarm Level

Range: 101 to 120% of MNV in steps of 1%

Default: 105%

This setpoint specifies the overvoltage alarm pickup level as a percentage of the rated voltage.

Overvoltage Alarm Delay

Range: 1 to 60 s in steps of 1 s

Default: 30 s

This setpoint specifies the time that the voltage must meet or exceed the overvoltage alarm pickup level to generate an alarm.

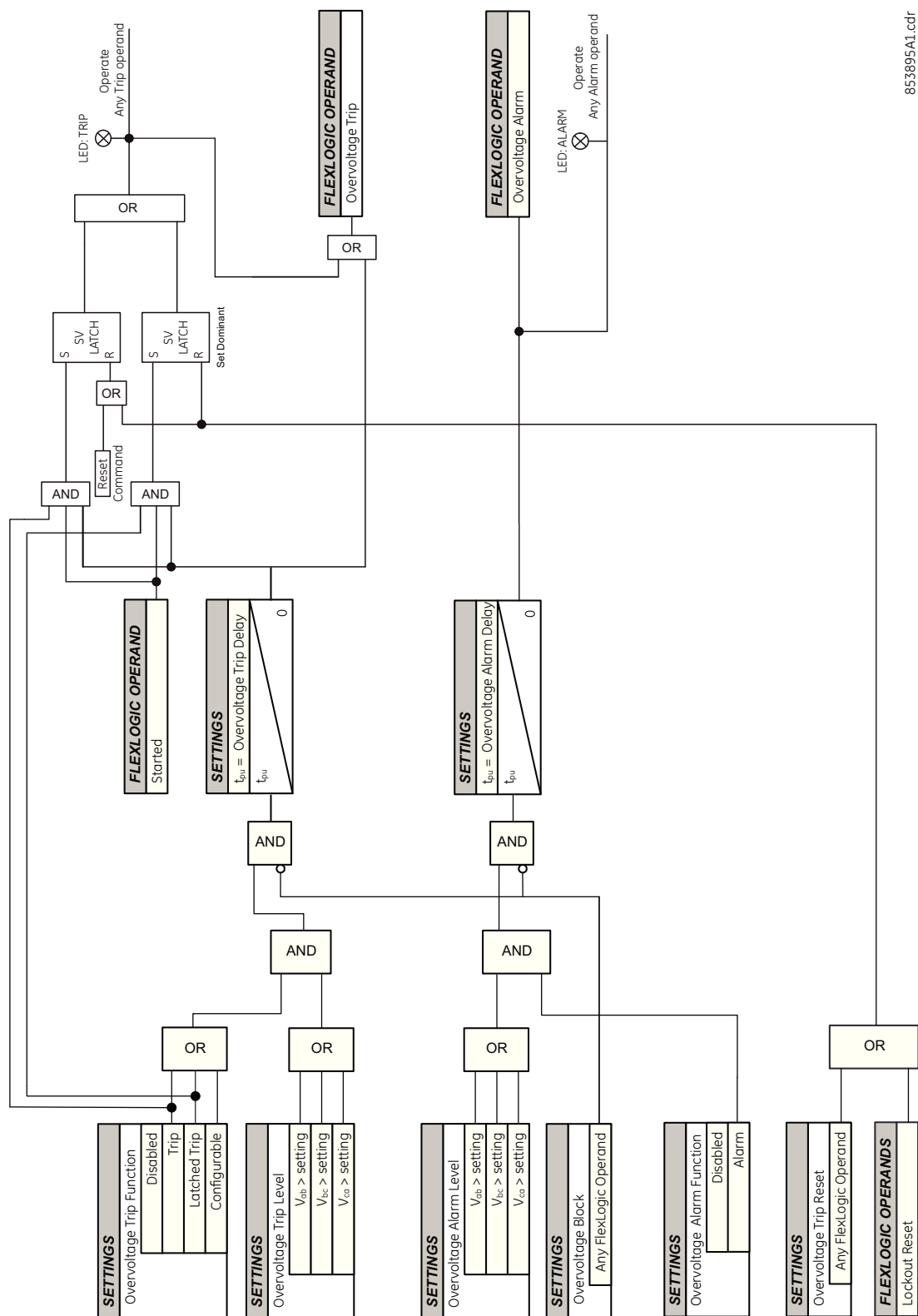


Figure 94: Phase overvoltage protection logic diagram

6.4.3.7 PHASE REVERSAL

The MM300 Enhanced can detect the phase rotation of the three phase voltages based on the motor starter type. When all three phase-to-phase voltages (V_{ab}, V_{bc} and V_{ca}) are greater than 50% of V_T, if the phase rotation of the

three phase voltages is not the same as the phase rotation or reverse starter and there is no fuse failure, either an alarm or a trip will occur within programmed pickup delay time. Upon detection of the phase reversal, this element will also issue a Phase Reversal Inhibit operand to inhibit starting of a motor. Polarity is critical for voltage phase reversal operation.

Note:

*VT is the voltage programmed under **Setpoints > Configure > CT-VT**. Phase reversal is *Disabled* for single VT operation.*

Path: Setpoints > Protection > Electrical > Phase Reversal

Phase Reversal Pickup Delay

Range: 0.00 to 180.00 s in steps of 0.01 s

Default: 1.00 s

This setpoint specifies the pickup delay of the element.

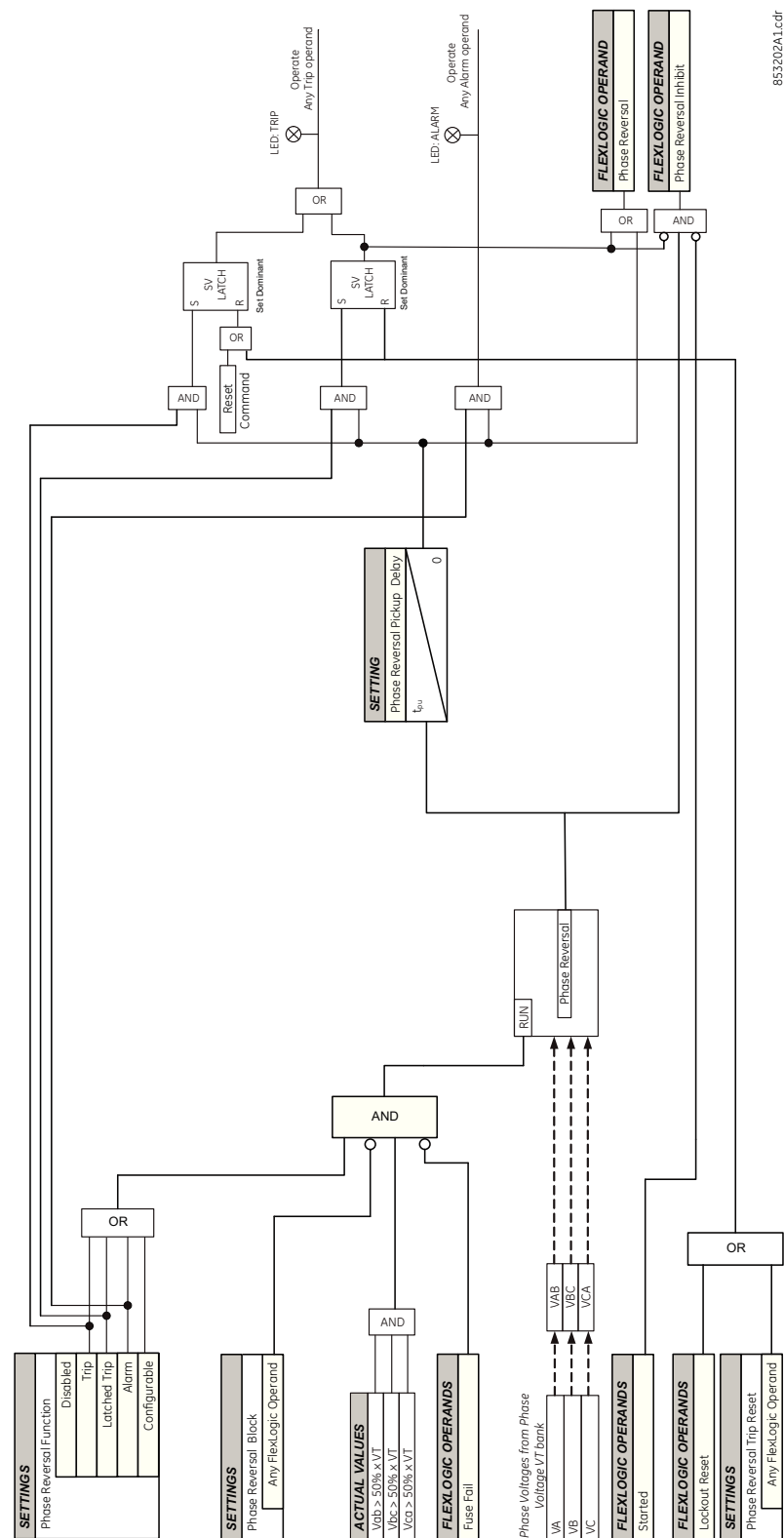


Figure 95: Phase reversal logic diagram

6.4.3.8 VOLTAGE UNBALANCE

Unbalanced operating conditions can damage power system equipment. Distribution system operators strive to maintain balanced voltages by equally distributing load demands on all three phases of distribution feeders. Voltage

unbalance arises from asymmetric operation leading to phase voltages with unequal magnitudes, phase shifts that are not equal to 120 degrees, or a combination of both. The voltage unbalance element can be used to detect asymmetrical system voltage conditions, loss of one or two phases of the source, or reversed phase sequence of voltages.

The element responds based on the relative magnitudes of the negative and positive sequence voltages i.e., V_2/V_1 . The settings of this function are applied to calculated V_2/V_1 to produce a trip flag. The voltage unbalance trip flag is asserted if the element stays picked up for the time defined by pick-up time delay. The element drops from pickup without operation if the calculated V_2/V_1 drops below 97-98% of the pickup value, before the time for operation is reached.

Note:

[X] represents the stage (X=1 for stage 1).

Path: Setpoints > Protection > Electrical > Voltage Unbalance

V2/V1 [X] Pickup

Range: 4 to 40% in steps of 1%

Default: 30%

This setpoint specifies the voltage unbalance pickup level as a percentage.

V2/V1 [X] Time Delay

Range: 0.1 to 60.0 s in steps of 0.1 s

Default: 1.0 s

This setpoint specifies the time that the voltage must meet or exceed the voltage unbalance trip pickup level to generate a trip or alarm.

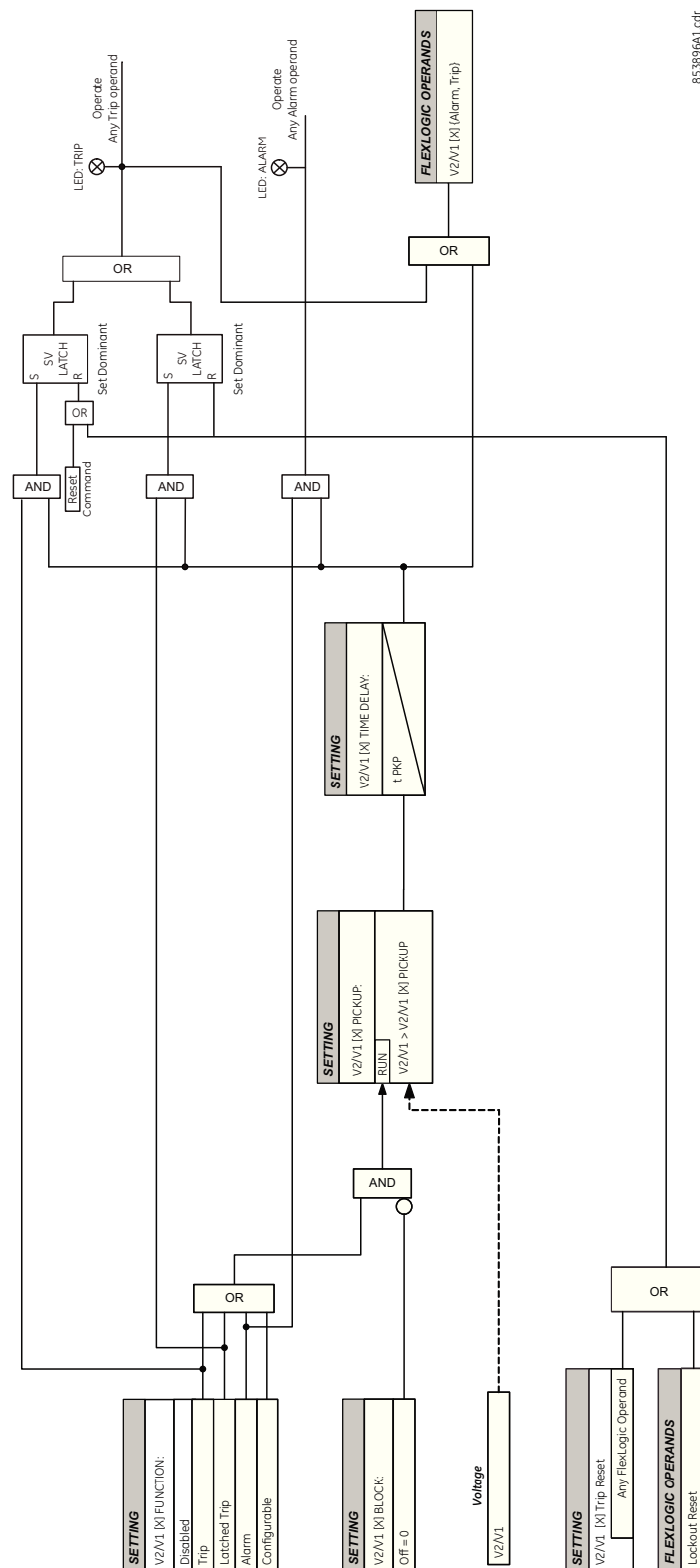


Figure 96: Voltage unbalance protection logic diagram

6.4.3.9 PHASE INSTANTANEOUS OVERCURRENT

Phase current faults occur when fault current flows between two or more phases of a power system. The fault current may be between the phase conductors only, or between two or more phase conductors and earth. Although not as common as earth faults (single phase to earth), phase faults are typically more severe.

The settings of this function are applied to each of the three phases to produce a trip flag. The IOC trip flag is asserted if the element stays picked up for the time and magnitude of the current defined. The element drops from pickup without operation if the measured current drops below 97-98% of the pickup value, before the time for operation is reached.

Note:
[X] represents the element number.

Path: *Setpoints > Protection > Electrical > Phase IOC*

Phase IOC [X] Pickup

Range: 0.20 to 8.00 x CT in steps of 0.01 x CT

Default: 1.00 x CT

This setpoint specifies the pickup threshold of the phase instantaneous overcurrent element.

Phase IOC [X] Time Delay

Range: 0.1 to 60.0 s in steps of 0.1 s

Default: 1.0 s

This setpoint specifies the time that the current must meet or exceed the phase instantaneous overcurrent pickup level before operating.

Phase IOC [X] tReset

Range: 0.1 to 60.0 s in steps of 0.1 s

Default: 1.0 s

This setpoint specifies the reset time.

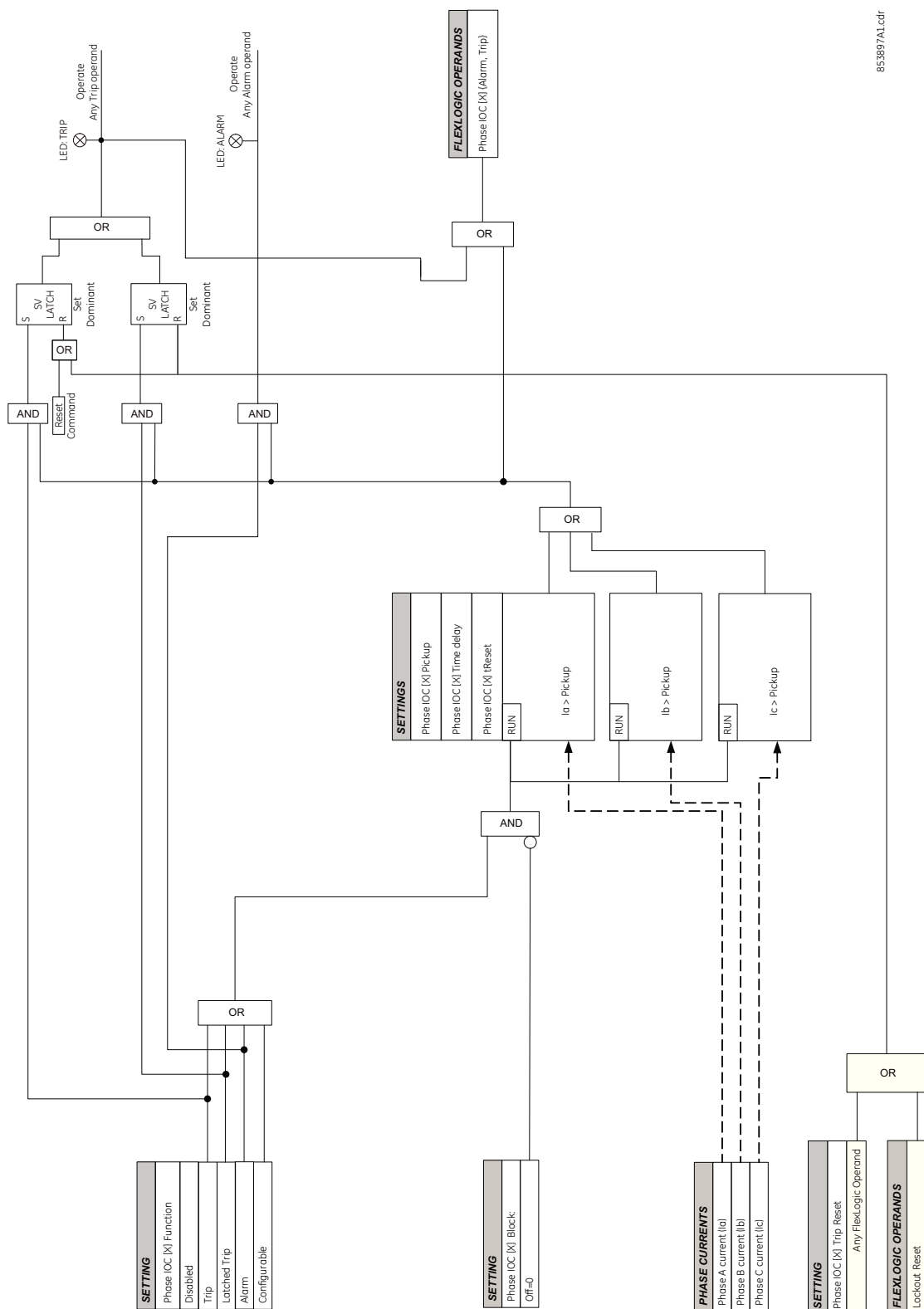


Figure 97: Phase instantaneous overcurrent protection logic diagram

6.4.3.10 PHASE TIME OVERCURRENT

The inverse time overcurrent curves used by the time overcurrent elements are the IEEE, IEC, GE Type IAC, ANSI, I²t and I⁴t standard curve shapes. This allows for simplified coordination with downstream devices.

If none of these curve shapes is adequate, FlexCurves may be used to customize the inverse time curve characteristics. The definite time curve is also an option that may be appropriate if only simple protection is required.

Overcurrent curve types

IEEE	ANSI	IEC	GE TYPE IAC	OTHER
IEEE Extremely Inverse	ANSI Extremely Inverse	IEC Standard Inverse	IAC Extremely Inverse	I^2t
IEEE Very Inverse	ANSI Very Inverse	IEC Very Inverse	IAC Very Inverse	I^4t
IEEE Moderately Inverse	ANSI Normally Inverse	IEC Extremely Inverse	IAC Inverse	FlexCurves A, B, C and D
US Inverse	ANSI Moderately Inverse	UK Long Time Inverse	IAC Short Inverse	Definite Time
US Short Time Inverse		Rectifier		RI
		FR Short Time Inverse		
		Standard Inverse (1.3s)		

A time dial multiplier setting allows the selection of a multiple of the base curve shape (where the time dial multiplier = 1) with the curve shape setting. Unlike the electromechanical time dial equivalent, operate times are directly proportional to the time multiplier (**TD MULTIPLIER**) setting value. For example, all times for a multiplier of 10 are 10 times the multiplier 1 or base curve values. Setting the multiplier to zero results in an instantaneous response to all current levels above pickup.

Time overcurrent time calculations are made with an internal energy capacity memory variable. When this variable indicates that the energy capacity has reached 100%, a time overcurrent element will operate. If less than 100% energy capacity is accumulated in this variable and the current falls below the dropout threshold of 97 to 98% of the pickup value, the variable must be reduced.

Two types of this resetting operation are available: *DT* and *Inverse*. The *Inverse* selection can be used where the relay must coordinate with electromechanical relays. The *DT* selection is intended for applications with other relays, such as most static relays, which set the energy capacity directly to zero or some fixed time delay when the current falls below the reset threshold or when inverse curve coordination is not available.

Note:

In IEEE, ANSI, IAC, I^2t and I^4t curves, the multiplier setting *TDM* value is provided by **TIME DIAL** setting.

IEEE CURVES

The IEEE time overcurrent curve shapes conform to industry standards and the IEEE C37.112-1996 curve classifications for extremely, very, and moderately inverse. The IEEE curves are derived from the following formula:

$$T = TDM \times \left[\frac{A}{(I/I_{pickup})^p - 1} + B \right], T_{RESET} = TDM \times \left[\frac{t_r}{1 - (I/I_{pickup})^2} \right]$$

Where:

- T = operate time (in seconds)
- **TDM** = multiplier setting
- I = input current
- I_{pickup} = pickup current setting

- A, B, p = constants
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)
- t_r = characteristic constant

IEEE inverse time curve constants

IEEE Curve Shape	A	B	P	t_r
IEEE Extremely Inverse	28.2	0.1217	2.000	29.1
IEEE Very Inverse	19.61	0.491	2.000	21.6
IEEE Moderately Inverse	0.0515	0.1140	0.02000	4.85
US Inverse	5.95	0.180	2.000	5.95
US Short Time Inverse	0.16758	0.11858	0.02000	2.261

IEEE curve trip times (in seconds)

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2	3	4	5	6	7	8	9	10
IEEE EXTREMELY INVERSE										
0.5	11.341	4.761	1.823	1.001	0.648	0.464	0.355	0.285	0.237	0.203
1	22.682	9.522	3.647	2.002	1.297	0.927	0.709	0.569	0.474	0.407
2	45.363	19.043	7.293	4.003	2.593	1.855	1.418	1.139	0.948	0.813
4	90.727	38.087	14.587	8.007	5.187	3.71	2.837	2.277	1.897	1.626
6	136.09	57.13	21.88	12.01	7.78	5.564	4.255	3.416	2.845	2.439
8	181.454	76.174	29.174	16.014	10.374	7.419	5.674	4.555	3.794	3.252
10	226.817	95.217	36.467	20.017	12.967	9.274	7.092	5.693	4.742	4.065
IEEE VERY INVERSE										
0.5	8.09	3.514	1.471	0.899	0.654	0.526	0.45	0.401	0.368	0.345
1	16.179	7.028	2.942	1.798	1.308	1.051	0.9	0.802	0.736	0.689
2	32.358	14.055	5.885	3.597	2.616	2.103	1.799	1.605	1.472	1.378
4	64.716	28.111	11.769	7.193	5.232	4.205	3.598	3.209	2.945	2.756
6	97.074	42.166	17.654	10.79	7.849	6.308	5.397	4.814	4.417	4.134
8	129.432	56.221	23.538	14.387	10.465	8.41	7.196	6.418	5.889	5.513
10	161.79	70.277	29.423	17.983	13.081	10.513	8.995	8.023	7.361	6.891
IEEE MODERATELY INVERSE										
0.5	3.22	1.902	1.216	0.973	0.844	0.763	0.706	0.663	0.63	0.603
1	6.439	3.803	2.432	1.946	1.688	1.526	1.412	1.327	1.26	1.207
2	12.878	7.606	4.864	3.892	3.377	3.051	2.823	2.653	2.521	2.414
4	25.756	15.213	9.729	7.783	6.753	6.102	5.647	5.307	5.041	4.827
6	38.634	22.819	14.593	11.675	10.13	9.153	8.47	7.96	7.562	7.241
8	51.512	30.426	19.458	15.567	13.507	12.204	11.294	10.614	10.083	9.654
10	64.39	38.032	24.322	19.458	16.883	15.255	14.117	13.267	12.604	12.068
US INVERSE										
0.5	2.47	1.082	0.462	0.288	0.214	0.175	0.152	0.137	0.127	0.12
1	4.94	2.163	0.924	0.577	0.428	0.35	0.304	0.274	0.254	0.24
2	9.88	4.327	1.848	1.153	0.856	0.7	0.608	0.549	0.509	0.48
4	19.76	8.653	3.695	2.307	1.712	1.4	1.216	1.098	1.018	0.96

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2	3	4	5	6	7	8	9	10
6	29.64	12.98	5.543	3.46	2.568	2.1	1.824	1.647	1.526	1.441
8	39.52	17.307	7.39	4.613	3.423	2.8	2.432	2.196	2.035	1.921
10	49.4	21.633	9.238	5.767	4.279	3.5	3.04	2.744	2.544	2.401
US SHORT TIME INVERSE										
0.5	10.35	6.062	3.831	3.04	2.621	2.356	2.171	2.032	1.924	1.837
1	20.7	12.123	7.662	6.079	5.241	4.712	4.341	4.065	3.849	3.674
2	41.4	24.247	15.324	12.159	10.483	9.423	8.683	8.13	7.698	7.349
4	82.8	48.493	30.648	24.317	20.966	18.847	17.365	16.259	15.395	14.698
6	124.2	72.74	45.972	36.476	31.448	28.27	26.048	24.389	23.093	22.046
8	165.6	96.987	61.296	48.635	41.931	37.694	34.73	32.519	30.791	29.395
10	207.001	121.233	76.62	60.793	52.414	47.117	43.413	40.648	38.489	36.744

ANSI CURVES

The ANSI time overcurrent curve shapes conform to industry standards and the ANSI C37.90 curve classifications for extremely, very, and moderately inverse. The ANSI curves are derived from the following formula:

$$T = TDM \times \left[A + \frac{B}{(I/I_{pickup}) - C} + \frac{D}{((I/I_{pickup}) - C)^2} + \frac{E}{((I/I_{pickup}) - C)^3} \right], T_{RESET} = TDM \times \left[\frac{t_r}{1 - (I/I_{pickup})^2} \right]$$

Where:

- T = operate time (in seconds)
- **TDM** = multiplier setting
- I = input current
- I_{pickup} = pickup current setting
- A to E = constants
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)
- t_r = characteristic constant

ANSI inverse time curve constants

ANSI CURVE SHAPE	A	B	C	D	E	t_r
ANSI Extremely Inverse	0.0399	0.2294	0.5000	3.0094	0.7222	5.67
ANSI Very Inverse	0.0615	0.7989	0.3400	-0.2840	4.0505	3.88
ANSI Normally Inverse	0.0274	2.2614	0.3000	-4.1899	9.1272	5.95
ANSI Moderately Inverse	0.1735	0.6791	0.8000	-0.0800	0.1271	1.08

ANSI curve trip times (in seconds)

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
ANSI EXTREMELY INVERSE										
0.5	2.000	0.872	0.330	0.184	0.124	0.093	0.075	0.063	0.055	0.049
1.0	4.001	1.744	0.659	0.368	0.247	0.185	0.149	0.126	0.110	0.098
2.0	8.002	3.489	1.319	0.736	0.495	0.371	0.298	0.251	0.219	0.196

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
4.0	16.004	6.977	2.638	1.472	0.990	0.742	0.596	0.503	0.439	0.393
6.0	24.005	10.466	3.956	2.208	1.484	1.113	0.894	0.754	0.658	0.589
8.0	32.007	13.955	5.275	2.944	1.979	1.483	1.192	1.006	0.878	0.786
10.0	40.009	17.443	6.594	3.680	2.474	1.854	1.491	1.257	1.097	0.982
ANSI VERY INVERSE										
0.5	1.567	0.663	0.268	0.171	0.130	0.108	0.094	0.085	0.078	0.073
1.0	3.134	1.325	0.537	0.341	0.260	0.216	0.189	0.170	0.156	0.146
2.0	6.268	2.650	1.074	0.682	0.520	0.432	0.378	0.340	0.312	0.291
4.0	12.537	5.301	2.148	1.365	1.040	0.864	0.755	0.680	0.625	0.583
6.0	18.805	7.951	3.221	2.047	1.559	1.297	1.133	1.020	0.937	0.874
8.0	25.073	10.602	4.295	2.730	2.079	1.729	1.510	1.360	1.250	1.165
10.0	31.341	13.252	5.369	3.412	2.599	2.161	1.888	1.700	1.562	1.457
ANSI NORMALLY INVERSE										
0.5	2.142	0.883	0.377	0.256	0.203	0.172	0.151	0.135	0.123	0.113
1.0	4.284	1.766	0.754	0.513	0.407	0.344	0.302	0.270	0.246	0.226
2.0	8.568	3.531	1.508	1.025	0.814	0.689	0.604	0.541	0.492	0.452
4.0	17.137	7.062	3.016	2.051	1.627	1.378	1.208	1.082	0.983	0.904
6.0	25.705	10.594	4.524	3.076	2.441	2.067	1.812	1.622	1.475	1.356
8.0	34.274	14.125	6.031	4.102	3.254	2.756	2.415	2.163	1.967	1.808
10.0	42.842	17.656	7.539	5.127	4.068	3.445	3.019	2.704	2.458	2.260
ANSI MODERATELY INVERSE										
0.5	0.675	0.379	0.239	0.191	0.166	0.151	0.141	0.133	0.128	0.123
1.0	1.351	0.757	0.478	0.382	0.332	0.302	0.281	0.267	0.255	0.247
2.0	2.702	1.515	0.955	0.764	0.665	0.604	0.563	0.533	0.511	0.493
4.0	5.404	3.030	1.910	1.527	1.329	1.208	1.126	1.066	1.021	0.986
6.0	8.106	4.544	2.866	2.291	1.994	1.812	1.689	1.600	1.532	1.479
8.0	10.807	6.059	3.821	3.054	2.659	2.416	2.252	2.133	2.043	1.972
10.0	13.509	7.574	4.776	3.818	3.324	3.020	2.815	2.666	2.554	2.465

IEC CURVES

The IEC 60255 IDMT Operate equation is:

$$T = TMS \times \left[\frac{K}{(I/I_{pickup})^E - 1} \right], \quad T_{RESET} = TMS \times \left[\frac{t_r}{1 - (I/I_{pickup})^f} \right]$$

Where:

- T = operate time (in seconds)
- TMS = multiplier setting
- I = input current
- I_{pickup} = pickup current setting

- K, E = constants
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)
- t_r = characteristic constant

IEC (BS) inverse time curve constants

IEC (BS) CURVE SHAPE	K	E	t_r	f
IEC Standard Inverse	0.140	0.020	8.2	6.45
IEC Very Inverse	13.500	1.000	50.92	2.4
IEC Extremely Inverse	80.000	2.000	44.1	3.03
UK Long Time Inverse	120	1	-	-
Rectifier	45900	5.6	-	-
FR Short Time Inverse	0.050	0.040	-	-
Standard Inverse (1.3s)	0.0607	0.02	3.55	6.45

Note:

When using UK Long Time Inverse, Rectifier or FR Short Time Inverse for the Operate characteristic, DT (Definite Time) is always used for the Reset characteristic.

IEC curve trip times (in seconds)

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IEC STANDARD INVERSE										
0.05	0.860	0.501	0.315	0.249	0.214	0.192	0.176	0.165	0.156	0.149
0.10	1.719	1.003	0.630	0.498	0.428	0.384	0.353	0.330	0.312	0.297
0.20	3.439	2.006	1.260	0.996	0.856	0.767	0.706	0.659	0.623	0.594
0.40	6.878	4.012	2.521	1.992	1.712	1.535	1.411	1.319	1.247	1.188
0.60	10.317	6.017	3.781	2.988	2.568	2.302	2.117	1.978	1.870	1.782
0.80	13.755	8.023	5.042	3.984	3.424	3.070	2.822	2.637	2.493	2.376
1.00	17.194	10.029	6.302	4.980	4.280	3.837	3.528	3.297	3.116	2.971
IEC VERY INVERSE										
0.05	1.350	0.675	0.338	0.225	0.169	0.135	0.113	0.096	0.084	0.075
0.10	2.700	1.350	0.675	0.450	0.338	0.270	0.225	0.193	0.169	0.150
0.20	5.400	2.700	1.350	0.900	0.675	0.540	0.450	0.386	0.338	0.300
0.40	10.800	5.400	2.700	1.800	1.350	1.080	0.900	0.771	0.675	0.600
0.60	16.200	8.100	4.050	2.700	2.025	1.620	1.350	1.157	1.013	0.900
0.80	21.600	10.800	5.400	3.600	2.700	2.160	1.800	1.543	1.350	1.200
1.00	27.000	13.500	6.750	4.500	3.375	2.700	2.250	1.929	1.688	1.500
IEC EXTREMELY INVERSE										
0.05	3.200	1.333	0.500	0.267	0.167	0.114	0.083	0.063	0.050	0.040
0.10	6.400	2.667	1.000	0.533	0.333	0.229	0.167	0.127	0.100	0.081
0.20	12.800	5.333	2.000	1.067	0.667	0.457	0.333	0.254	0.200	0.162
0.40	25.600	10.667	4.000	2.133	1.333	0.914	0.667	0.508	0.400	0.323
0.60	38.400	16.000	6.000	3.200	2.000	1.371	1.000	0.762	0.600	0.485
0.80	51.200	21.333	8.000	4.267	2.667	1.829	1.333	1.016	0.800	0.646

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
1.00	64.000	26.667	10.000	5.333	3.333	2.286	1.667	1.270	1.000	0.808
UK LONG TIME INVERSE										
0.05	12.000	6.000	3.000	2.000	1.500	1.200	1.000	0.857	0.750	0.667
0.10	24.000	12.000	6.000	4.000	3.000	2.400	2.000	1.714	1.500	1.333
0.20	48.000	24.000	12.000	8.000	6.000	4.800	4.000	3.429	3.000	2.667
0.40	96.000	48.000	24.000	16.000	12.000	9.600	8.000	6.857	6.000	5.333
0.60	144.000	72.000	36.000	24.000	18.000	14.400	12.000	10.286	9.000	8.000
0.80	192.000	96.000	48.000	32.000	24.000	19.200	16.000	13.714	12.000	10.667
1.00	240.000	120.000	60.000	40.000	30.000	24.000	20.000	17.143	15.000	13.333
RECTIFIER										
0.05	264.241	48.313	4.896	0.976	0.280	0.101	0.042	0.020	0.010	0.006
0.10	528.482	96.626	9.792	1.952	0.559	0.201	0.085	0.040	0.021	0.012
0.20	1056.964	193.251	19.583	3.904	1.119	0.403	0.170	0.080	0.042	0.023
0.40	2113.928	386.502	39.167	7.808	2.237	0.806	0.340	0.161	0.083	0.046
0.60	3170.891	579.754	58.750	11.712	3.356	1.209	0.510	0.241	0.125	0.069
0.80	4227.855	773.005	78.334	15.615	4.474	1.612	0.680	0.322	0.166	0.092
1.00	5284.819	966.256	97.917	19.519	5.593	2.015	0.850	0.402	0.208	0.115
FR SHORT TIME INVERSE										
0.05	0.153	0.089	0.056	0.044	0.038	0.034	0.031	0.029	0.027	0.026
0.10	0.306	0.178	0.111	0.088	0.075	0.067	0.062	0.058	0.054	0.052
0.20	0.612	0.356	0.223	0.175	0.150	0.135	0.124	0.115	0.109	0.104
0.40	1.223	0.711	0.445	0.351	0.301	0.269	0.247	0.231	0.218	0.207
0.60	1.835	1.067	0.668	0.526	0.451	0.404	0.371	0.346	0.327	0.311
0.80	2.446	1.423	0.890	0.702	0.602	0.538	0.494	0.461	0.435	0.415
1.00	3.058	1.778	1.113	0.877	0.752	0.673	0.618	0.576	0.544	0.518
STANDARD INVERSE (1.3s)										
0.05	0.373	0.217	0.137	0.108	0.093	0.083	0.076	0.071	0.068	0.064
0.10	0.745	0.435	0.273	0.216	0.186	0.166	0.153	0.143	0.135	0.129
0.20	1.491	0.870	0.546	0.432	0.371	0.333	0.306	0.286	0.270	0.258
0.40	2.982	1.739	1.093	0.864	0.742	0.665	0.612	0.572	0.540	0.515
0.60	4.473	2.609	1.639	1.295	1.113	0.998	0.918	0.858	0.811	0.773
0.80	5.964	3.479	2.186	1.727	1.484	1.331	1.224	1.144	1.081	1.030
1.00	7.455	4.348	2.732	2.159	1.856	1.664	1.530	1.429	1.351	1.288

IAC CURVES

The curves for the General Electric type IAC relay family are derived from the formula:

$$T = TDM \times \left[A + \frac{B}{(I/I_{pickup}) - C} + \frac{D}{((I/I_{pickup}) - C)^2} + \frac{E}{((I/I_{pickup}) - C)^3} \right], \quad T_{RESET} = TDM \times \left[\frac{t_r}{1 - (I/I_{pickup})^2} \right]$$

Where:

- T = operate time (in seconds)
- **TDM** = multiplier setting
- I = input current
- I_{pickup} = pickup current setting
- A to E = constants
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)
- t_r = characteristic constant

GE type IAC inverse time curve constants

IAC CURVE SHAPE	A	B	C	D	E	t_r
IAC Extremely Inverse	0.0040	0.6379	0.6200	1.7872	0.2461	6.008
IAC Very Inverse	0.0900	0.7965	0.1000	-1.2885	7.9586	4.678
IAC Inverse	0.2078	0.8630	0.8000	-0.4180	0.1947	0.990
IAC Short Inverse	0.0428	0.0609	0.6200	-0.0010	0.0221	0.222

IAC curve trip times (in seconds)

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
IAC EXTREMELY INVERSE										
0.5	1.699	0.749	0.303	0.178	0.123	0.093	0.074	0.062	0.053	0.046
1.0	3.398	1.498	0.606	0.356	0.246	0.186	0.149	0.124	0.106	0.093
2.0	6.796	2.997	1.212	0.711	0.491	0.372	0.298	0.248	0.212	0.185
4.0	13.591	5.993	2.423	1.422	0.983	0.744	0.595	0.495	0.424	0.370
6.0	20.387	8.990	3.635	2.133	1.474	1.115	0.893	0.743	0.636	0.556
8.0	27.183	11.987	4.846	2.844	1.966	1.487	1.191	0.991	0.848	0.741
10.0	33.979	14.983	6.058	3.555	2.457	1.859	1.488	1.239	1.060	0.926
IAC VERY INVERSE										
0.5	1.451	0.656	0.269	0.172	0.133	0.113	0.101	0.093	0.087	0.083
1.0	2.901	1.312	0.537	0.343	0.266	0.227	0.202	0.186	0.174	0.165
2.0	5.802	2.624	1.075	0.687	0.533	0.453	0.405	0.372	0.349	0.331
4.0	11.605	5.248	2.150	1.374	1.065	0.906	0.810	0.745	0.698	0.662
6.0	17.407	7.872	3.225	2.061	1.598	1.359	1.215	1.117	1.046	0.992
8.0	23.209	10.497	4.299	2.747	2.131	1.813	1.620	1.490	1.395	1.323
10.0	29.012	13.121	5.374	3.434	2.663	2.266	2.025	1.862	1.744	1.654
IAC INVERSE										
0.5	0.578	0.375	0.266	0.221	0.196	0.180	0.618	0.160	0.154	0.148
1.0	1.155	0.749	0.532	0.443	0.392	0.360	0.337	0.320	0.307	0.297
2.0	2.310	1.499	1.064	0.885	0.784	0.719	0.674	0.640	0.614	0.594
4.0	4.621	2.997	2.128	1.770	1.569	1.439	1.348	1.280	1.229	1.188
6.0	6.931	4.496	3.192	2.656	2.353	2.158	2.022	1.921	1.843	1.781
8.0	9.242	5.995	4.256	3.541	3.138	2.878	2.695	2.561	2.457	2.375
10.0	11.552	7.494	5.320	4.426	3.922	3.597	3.369	3.201	3.072	2.969
IAC SHORT INVERSE										

MULTIPLIER (TDM)	CURRENT (I/I _{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.5	0.072	0.047	0.035	0.031	0.028	0.027	0.026	0.026	0.025	0.025
1.0	0.143	0.095	0.070	0.061	0.057	0.054	0.052	0.051	0.050	0.049
2.0	0.286	0.190	0.140	0.123	0.114	0.108	0.105	0.102	0.100	0.099
4.0	0.573	0.379	0.279	0.245	0.228	0.217	0.210	0.204	0.200	0.197
6.0	0.859	0.569	0.419	0.368	0.341	0.325	0.314	0.307	0.301	0.296
8.0	1.145	0.759	0.559	0.490	0.455	0.434	0.419	0.409	0.401	0.394
10.0	1.431	0.948	0.699	0.613	0.569	0.542	0.524	0.511	0.501	0.493

I²T CURVES

The curves for the I²t are derived from the following formula:

$$T = TDM \times \left[\frac{100}{(I/I_{pickup})^2} \right], \quad T_{RESET} = TDM \times \left[\frac{100}{(I/I_{pickup})^2} \right]$$

Where:

- T = operate time (in seconds)
- **TDM** = multiplier setting
- I = input current
- I_{pickup} = pickup current setting
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)

I²T curve trip times (in seconds)

MULTIPLIER (TDM)	CURRENT (I/I _{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.01	0.44	0.25	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01
0.10	4.44	2.50	1.11	0.63	0.40	0.28	0.20	0.16	0.12	0.10
1.00	44.44	25.00	11.11	6.25	4.00	2.78	2.04	1.56	1.23	1.00
10.00	444.44	250.00	111.11	62.50	40.00	27.78	20.41	15.63	123.5	10.00
100.00	4444.44	2500.00	1111.1	625.00	400.00	277.78	204.08	156.25	123.46	100.00
600.00	26666.7	15000.0	6666.7	3750.0	2400.0	1666.7	1224.5	937.50	740.74	600.00

I⁴T CURVES

The curves for the I⁴t are derived from the following formula:

$$T = TDM \times \left[\frac{100}{(I/I_{pickup})^4} \right], \quad T_{RESET} = TDM \times \left[\frac{100}{(I/I_{pickup})^4} \right]$$

Where:

- T = operate time (in seconds)
- **TDM** = multiplier setting

- I = input current
- I_{pickup} = pickup current setting
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)

I4T curve trip times (in seconds)

MULTIPLIER (TDM)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.01	0.1975	0.0625	0.0123	0.0039	0.0016	0.0008	0.0004	0.0002	0.00015	0.0001
0.10	1.9753	0.6250	0.1235	0.0391	0.0160	0.0077	0.0042	0.0024	0.0015	0.0010
1.00	19.753	6.250	1.235	0.391	0.160	0.077	0.042	0.024	0.015	0.010
10.00	197.531	62.500	12.346	3.906	1.600	0.772	0.416	0.244	0.152	0.100
100.00	1975.31	625.00	123.46	39.06	16.00	7.72	4.16	2.44	1.52	1.00
600.00	11851.9	3750.0	740.7	234.4	96.00	46.3	25.0	14.65	9.14	6.00

RI (RAPID INVERSE) CHARACTERISTIC

The RI operate curve is represented by the following formula:

$$T = k(RI) \times \left[\frac{1}{0.339 - \frac{0.236}{(I/I_{pickup})}} \right]$$

Where:

- T = operate time (in seconds)
- $k(RI)$ = time multiplier setting
- I = input current
- I_{pickup} = pickup current setting

Note:

When using RI for the operate characteristic, DT (Definite Time) is always used for the reset characteristic.

RI curve trip times (in seconds)

MULTIPLIER ($k(RI)$)	CURRENT (I/I_{pickup})									
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
0.1	0.550	0.452	0.384	0.357	0.343	0.334	0.328	0.323	0.320	0.317
0.2	1.101	0.905	0.768	0.714	0.685	0.667	0.655	0.646	0.639	0.634
0.4	2.202	1.810	1.536	1.429	1.371	1.335	1.310	1.292	1.279	1.268
0.6	3.303	2.715	2.305	2.143	2.056	2.002	1.965	1.939	1.918	1.902
0.8	4.404	3.620	3.073	2.857	2.742	2.670	2.620	2.585	2.558	2.536
1.0	5.505	4.525	3.841	3.571	3.427	3.337	3.276	3.231	3.197	3.171

FLEXCURVES

The custom FlexCurves are described in detail in Interfaces. The curve shapes for the FlexCurves are derived from the following formulae:

$$T = TDM \times \left[\text{FlexCurve Time at } (I / I_{pickup}) \right] \text{ when } (I / I_{pickup}) \geq 1.00$$

$$T_{RESET} = TDM \times \left[\text{FlexCurve Time at } (I / I_{pickup}) \right] \text{ when } (I / I_{pickup}) \leq 0.98$$

Where:

- T = operate time (in seconds)
- **TDM** = time multiplier setting
- I = input current
- I_{pickup} = pickup current setting
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)

DEFINITE TIME CURVES

The definite time curve shape operates as soon as the pickup level is exceeded for a specific period of time. The base definite time curve delay is in seconds. The curve multiplier of 0.05 to 600.00 makes this delay adjustable from 50 to 600000 milliseconds:

$$T = TDM \text{ in seconds, when } I / I_{pickup}$$

$$T_{RESET} = TDM \text{ in seconds}$$

Where:

- T = operate time (in seconds)
- **TDM** = time multiplier setting
- I = input current
- I_{pickup} = pickup current setting
- T_{RESET} = reset time in seconds (assuming energy capacity is 100% and reset is timed)

6.4.3.11 POWER FACTOR

Once the power factor is less than either the Lead or Lag level, for the specified delay, a trip or alarm will occur indicating a Lead or Lag condition.

The relay calculates the average power factor in the three phases as follows:

$$\text{Average Power Factor} = \frac{\text{Total 3 Phase Real Power}}{\text{Total 3 Phase Apparent Power}}$$

The following figure illustrates the conventions, where the negative value means the lead power factor, and the positive value means the lag power factor.

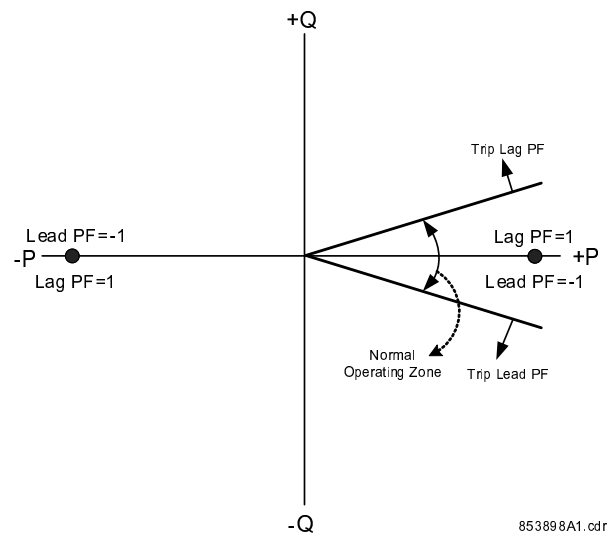


Figure 98: Conventions for power factor

Path: *Setpoints > Protection > Electrical > Power Factor*

PF [X] Lead Level

Range: 0.05 to 0.99 in steps of 0.01

Default: 0.95

This setpoint specifies the power factor lead level.

PF [X] Lag Level

Range: 0.05 to 0.99 in steps of 0.01

Default: 0.95

This setpoint specifies the power factor lag level.

PF [X] Pickup Delay

Range: 1.0 to 60.0 s in steps of 0.1 s

Default: 1.0 s

This setpoint specifies the time delay for the power factor function.

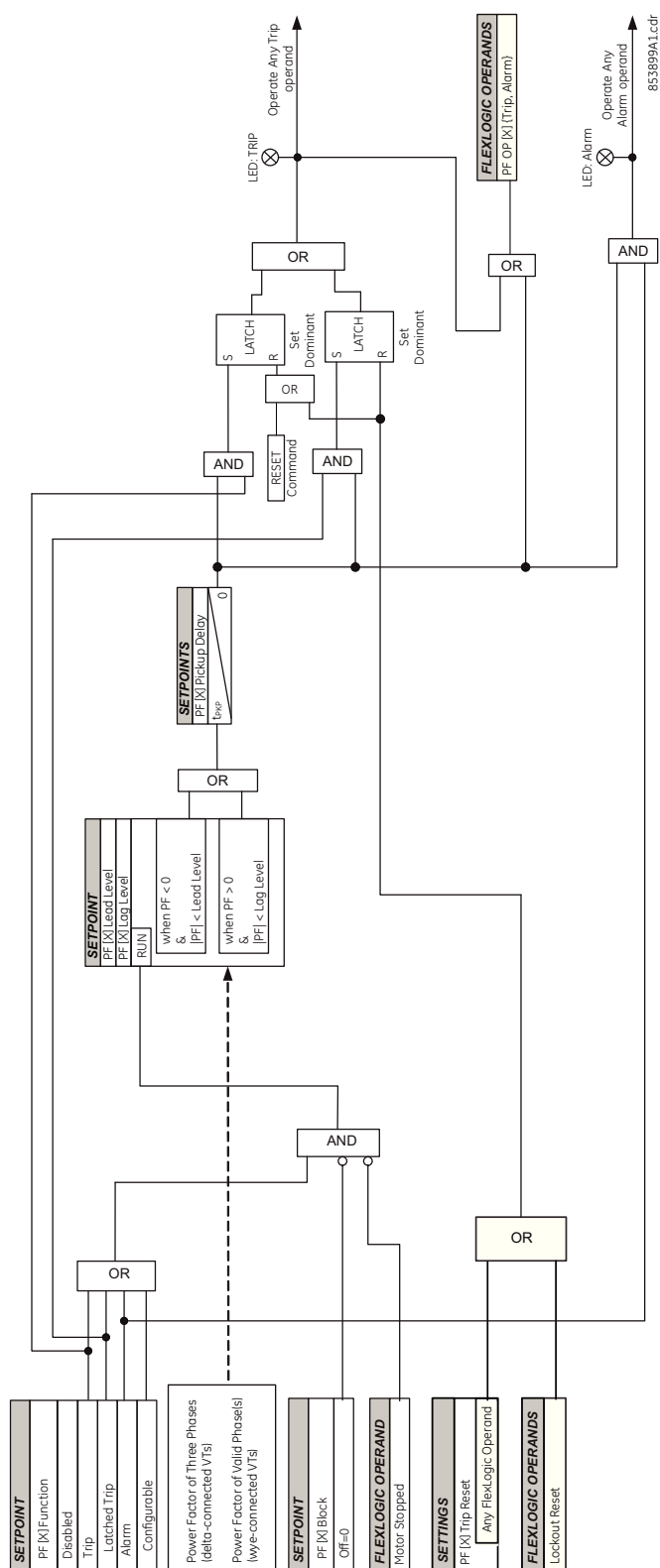


Figure 99: Power factor logic diagram

6.4.4 SENSOR SETTINGS

6.4.4.1 THERMISTOR PROTECTION

Either a Positive Temperature Coefficient (PTC) or Negative Temperature Coefficient (NTC) thermistor may be directly connected to the MM300 Enhanced. By specifying the hot and cold thermistor resistance, the MM300 Enhanced automatically determines the thermistor type as NTC or PTC. Use thermistors with hot and cold resistance values in the range 100 to 30000 Ω . If no thermistor is connected, the **THERMISTOR TRIP FUNCTION** and **THERMISTOR ALARM FUNCTION** must be set to *Disabled*.

Path: *Setpoints > Protection > Sensor > Thermistor*

Thermistor Hot Resist

Range: 0.1 to 30.0 k Ω in steps of 0.1 k Ω

Default: 5.0 k Ω

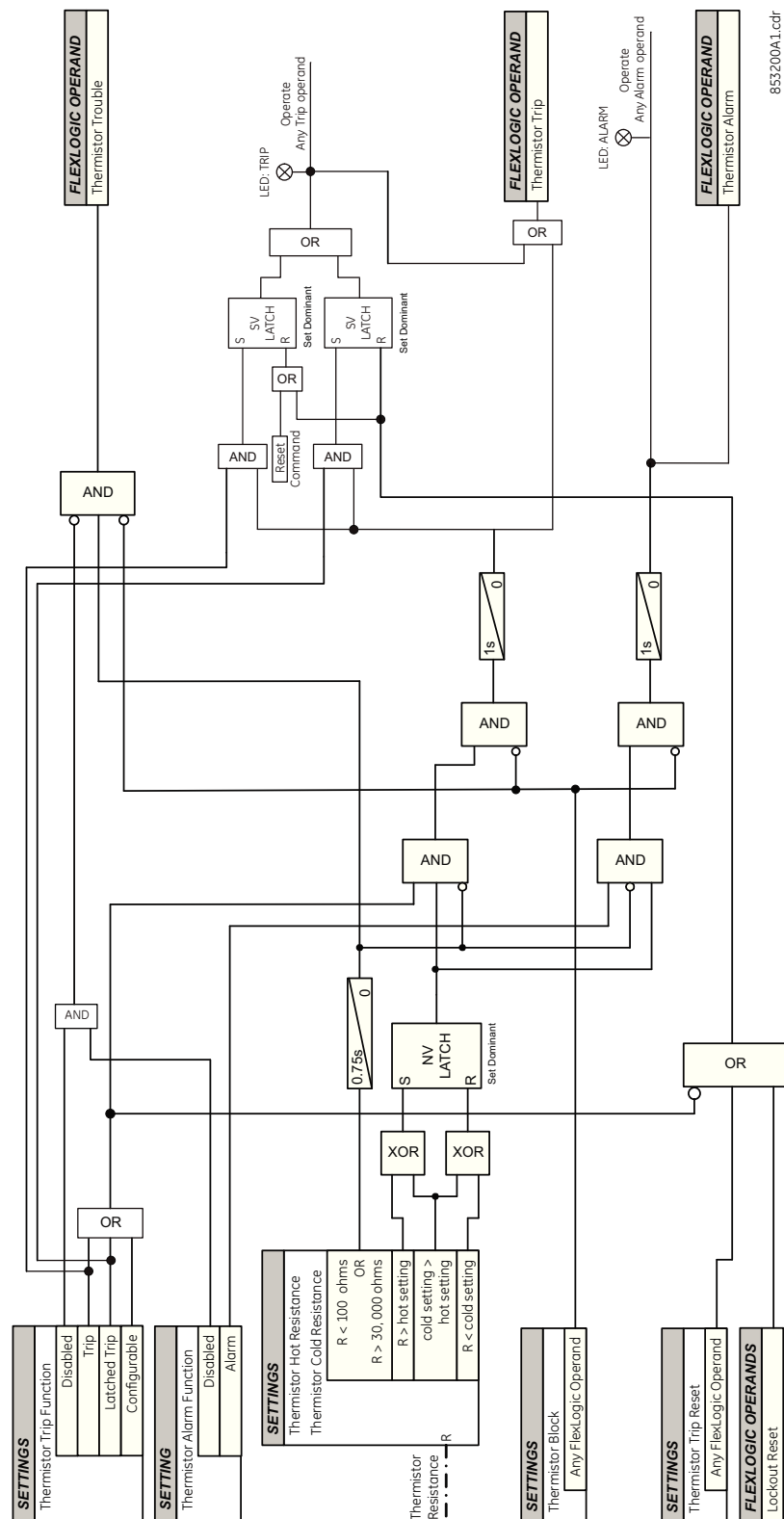
For a PTC thermistor, enter the resistance that the thermistor must rise above before a thermistor trip or alarm can be cleared. For an NTC thermistor, enter the resistance that the thermistor must drop below before a thermistor trip or alarm can be cleared.

Thermistor Cold Resist

Range: 0.1 to 30.0 k Ω in steps of 0.1 k Ω

Default: 0.1 k Ω

For a PTC thermistor, enter the resistance that the thermistor must drop below before a thermistor trip or alarm can be cleared. For an NTC thermistor, enter the resistance that the thermistor must rise above before a thermistor trip or alarm can be cleared.



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Figure 100: Thermistor protection logic diagram

6.4.4.2 RTD PROTECTION

The MM300 Enhanced can support up to six 100-R RTDs, each of which may be configured to have a trip temperature and an alarm temperature. The alarm temperature is normally set slightly greater than normal running

temperature, and the trip temperature is normally set at the insulation rating. Trip voting has been added for extra security in the event of RTD malfunction. If enabled, a second RTD must also exceed the trip temperature of the RTD being checked before a trip will be issued. If the RTD is chosen to vote with itself, or *OFF*, the voting feature is disabled. RTD protection setpoints

The following table shows the RTD resistance versus temperature. RTDs configured as stator types are also used by the thermal model for determining the RTD bias.

RTD temperature vs. resistance

Temperature		Resistance (in ohms)
°C	°F	100 Pt
-50	-58	80.31
-40	-40	84.27
-30	-22	88.22
-20	-4	92.16
-10	14	96.09
0	32	100.00
10	50	103.90
20	68	107.79
30	86	111.67
40	104	115.54
50	122	119.39
60	140	123.24
70	158	127.07
80	176	130.89
90	194	134.70
100	212	138.50
110	230	142.29
120	248	146.06
130	266	149.82
140	284	153.58
150	302	157.32
160	320	161.04
170	338	164.76
180	356	168.47
190	374	172.46
200	392	175.84
210	410	179.51
220	428	183.17
230	446	186.82
240	464	190.45
250	482	194.08

All RTDs programmed with an alarm or a trip are monitored for sensor failure. When the measured temperature is greater than 250°C, the RTD is declared failed and a common RTD open circuit alarm is issued. When the measured temperature is less than -50°C, a common RTD short circuit/low temperature alarm is issued.

Path: *Setpoints > Protection > Sensor Settings > RTD Protection*

RTD Open/Short Alarm

Range: Enabled, Disabled

Default: Disabled

Enable to generate an alarm if RTD is opened or shorted.

RTD [X] Application

Range: None, Stator, Bearing, Ambient, Other

Default: None

This setting allows each individual RTD to be assigned to a group application. This is useful for some applications, which require group measurement. Selecting *None* means that the RTD will operate individually and not will be a part of any RTD group.

RTD [X] Name

Range: Max. of 20 characters

Default: RTD 1(6)

RTD [X] Trip Temp

Range: -50 to 250°C in steps of 1°C

Default: 155°C

This setpoint specifies the trip temperature for the RTDs.

RTD [X] Alarm Temp

Range: -50 to 250°C in steps of 1°C

Default: 130°C

This setpoint specifies the alarm temperature for the RTDs.

RTD [X] Trip Voting

Range: Off, RTD 1...6

Default: Off

This setpoint selects the redundant RTD that must also exceed this RTD's trip temperature for a trip to occur.

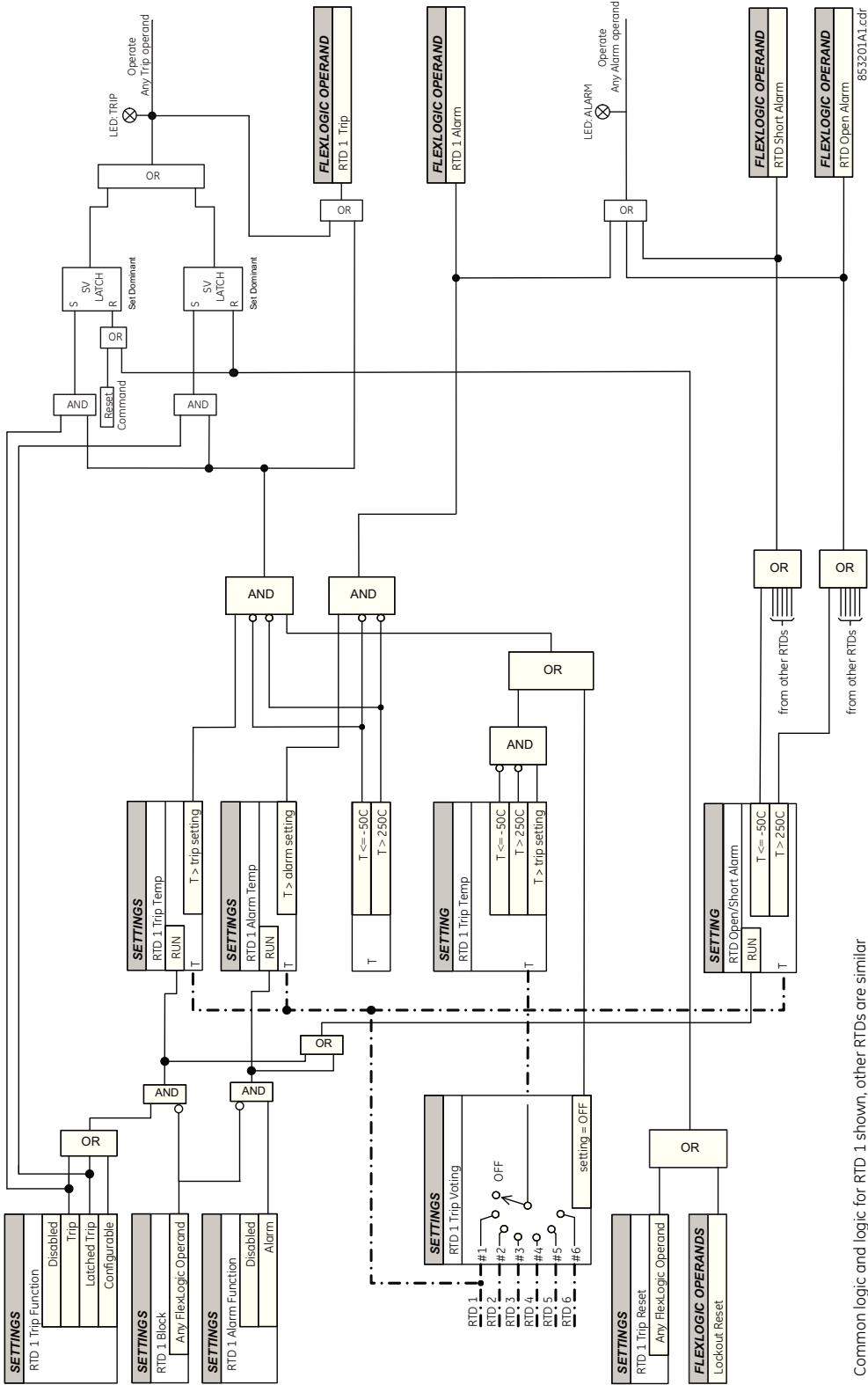


Figure 101: RTD protection logic diagram

6.5 CONTROL

6.5.1 STARTER SETPOINTS

Navigate to the **Setpoints > Control > Starter** page to edit the starter setpoints.

6.5.1.1 AUTO/MANUAL CONTROL

The auto/manual control element manages the auto/manual control mode, consolidates the start A, start B and stop controls from their various sources, and applies auto/manual, test switch and permissive supervision.

The MM300 Enhanced has four possible sources of start A, start B and stop controls:

- Communications: Controls received over a serial data link - Modbus, Profibus and/or Modbus TCP. Communications controls are not differentiated based on port or protocol.
- Hard-wired: Controls received typically via contact inputs from a PLC or DCS.
- Field: Controls received typically via contact inputs from pushbuttons or switches located adjacent to the controlled equipment.
- MCC: controls received from the control panel of the MM300 Enhanced.

Communications and hard-wired controls are considered to be auto controls and are inhibited unless auto mode is on. Field and MCC controls are considered to be manual controls and are inhibited unless manual mode is on. Each source may also have a contact input assigned to permissive supervision, which enables that source when on.

Auto/manual control sources

Control source	Supervision	
Communications	Auto	Comms permissive
Hard-wired	Auto	Hard-wired permissive
Field	Manual	Field permissive
MCC	Manual	MCC permissive

The MM300 Enhanced may also be set to always honor stop controls, regardless of auto/manual mode and permissive supervision (default).

The auto/manual control element also drives a control source active indicator for each source on the front panel display (if equipped) that shows the user exactly which control sources have both the correct auto/manual mode on and have their permissive configured and on.

The auto/manual control element includes non-volatile latches that hold the auto and manual mode states. Besides supervising controls from the sources, the latches drive auto and manual indicators on the MM300 Enhanced control panel. The latches can be controlled either by an external auto switch contact or by the control panel.

- When configured for Auto/Man switch contact, auto is on when the contact is closed energizing the input, and manual is on when the contact is open.
- When a switch contact is configured for auto/manual, the front panel auto/manual pushbuttons are inoperative. When no switch contacts are configured, but the **MCC AUTO/MANUAL KEY** setpoint is *Enabled*, the control panel auto and manual keys will switch the mode between auto and manual.
- When no input is configured for auto or manual, and the **MCC AUTO/MANUAL KEY** setpoint is *Disabled*, both auto and manual modes are set on.

The Auto and Manual modes are temporarily forced to settable states when the test switch is on.

Path: **Setpoints > Control > Starter > Auto/Manual Control**

Auto/Manual Key

Range: Enabled, Disabled

Default: Disabled

When no switch contacts are configured, but the MCC **AUTO/MANUAL KEY** setpoint is *Enabled*, the control panel auto and manual keys will switch the mode between auto and manual. When no input is configured for auto or manual, and the MCC **AUTO/MANUAL KEY** setpoint is *Disabled*, both auto and manual modes are set on.

Comms Start Control

Range: Enabled, Disabled

Default: Disabled

Sets whether start commands are accepted via comms.

Comms Stop Mode

Range: Always Enabled, Follow Ctrl Mode

Default: Always Enabled

If set to *Always Enabled*, communication stops will always be honored, irrespective of the **COMMS START CTRL** setpoint and auto/manual mode. If set to *Follow Ctrl Mode*, communication stops will be supervised by auto/manual and by communication permissive in the same manner as the starts.

Comms Stop Action

Range: Stop, Trip

Default: Stop

Defines whether comms control trips (reset required to clear) or stops (no reset required).

Hard Wired Start Control

Range: Enabled, Disabled

Default: Disabled

Sets whether start commands are accepted from hard wired start contact inputs.

Hard Wired Stop Mode

Range: Always Enabled, Follow Ctrl Mode

Default: Always Enabled

If set to *Always Enabled*, hard-wired stops will always be honored, irrespective of the **HARD WIRED START CONTROL** setpoint, auto/manual mode and permissive. If set to *Follow Ctrl Mode*, hard-wired stops will be supervised by auto/manual and by hard-wired permissive in the same manner as the starts.

Hard Wired Stop Action

Range: Stop, Trip

Default: Stop

Defines whether hard wired stop control trips (reset required to clear) or stops (no reset required).

Hard Wired 2W/3W

Range: 2W, 3W

Default: 3W

The setpoint is for two-wire or three-wire control selection. If in the two-wire mode, all hard-wired start contact inputs being open will be treated as a hard-wired stop control. For reversing and two-speed starter configurations, both start inputs open is treated as a hard-wired stop control.

Field Start Control

Range: Enabled, Disabled

Default: Disabled

Sets whether start commands are accepted from field start contact inputs.

Field Stop Mode

Range: Always Enabled, Follow Ctrl Mode

Default: Always Enabled

If set to *Always Enabled*, field stops will always be honored, irrespective of the **FIELD START CONTROL** setpoint, auto/manual mode, and permissive. If set to *Follow Ctrl Mode*, field stops will be supervised by auto/manual and by field permissive in the same manner as the starts.

Field Stop Action

Range: Stop, Trip

Default: Stop

Defines whether field control trips (reset required to clear) or stops (no reset required).

Field 2W/3W

Range: 2W, 3W

Default: 3W

Two-wire or three-wire controls selection. If in the two-wire mode, all field start contact inputs being open will be treated as a field stop control. For reversing and two-speed starter configurations, both start inputs open is treated as a field stop control.

MCC Start Control

Range: Enabled, Disabled

Default: Enabled

Sets whether start commands are accepted from the control panel.

MCC Stop Mode

Range: Always Enabled, Follow Ctrl Mode

Default: Always Enabled

If set to *Always Enabled*, control panel stops will always be honored, irrespective of the **MCC START CONTROL** setpoint, auto/manual mode, and permissive. If set to *Follow Ctrl Mode*, control panel stops will be supervised by auto/manual and by MCC permissive in the same manner as the starts.

MCC Stop Action

Range: Stop, Trip

Default: Stop

Defines whether MCC control trips (reset required to clear) or stops (no reset required).

Test Auto Mode

Range: On, Off, Unaffected

Default: Off

Sets whether, when the test switch is on, the auto mode is forced on, forced off, or is unaffected.

Test Manual Mode

Range: On, Off, Unaffected

Default: On

When the test switch is on, this setpoint determines if the manual mode is forced on, forced off, or is unaffected.

Change Mode on Comm Alarm

Range: Enabled, Disabled

Default: Disabled

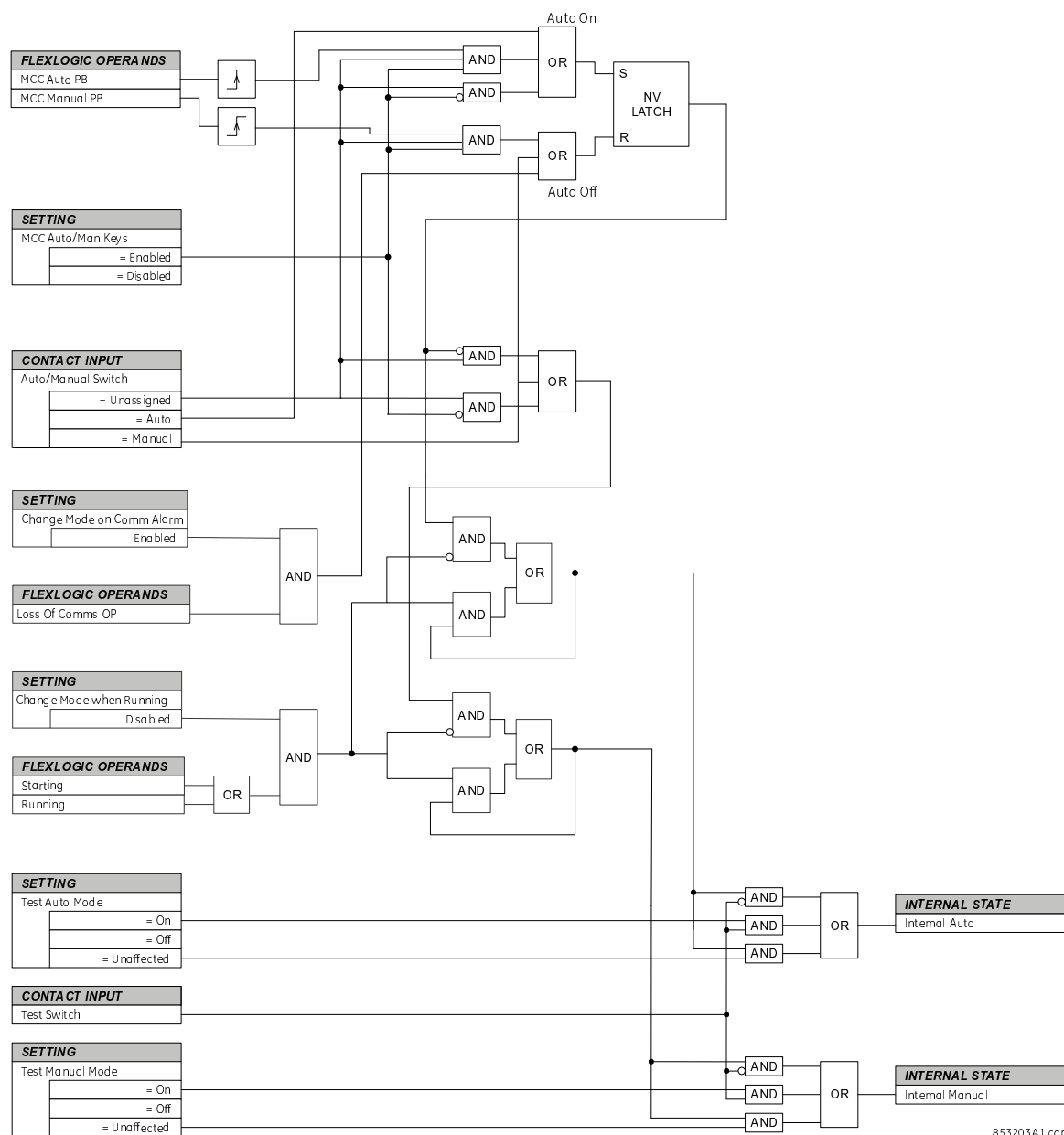
Allows the command mode to automatically switch from auto to manual when the serial comms failure alarm is active. If the motor is running when the alarm occurs it will be stopped and will restart based on manual start inputs only. When serial communication is restored, the MM300 Enhanced will remain in manual command mode.

Change Mode When Running

Range: Enabled, Disabled

Default: Disabled

Allows the active command mode to be changed while the motor is running. When set to *Disabled*, the motor must first be stopped before the command mode can be changed.



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Figure 102: Auto/manual control logic diagram - 1 of 4

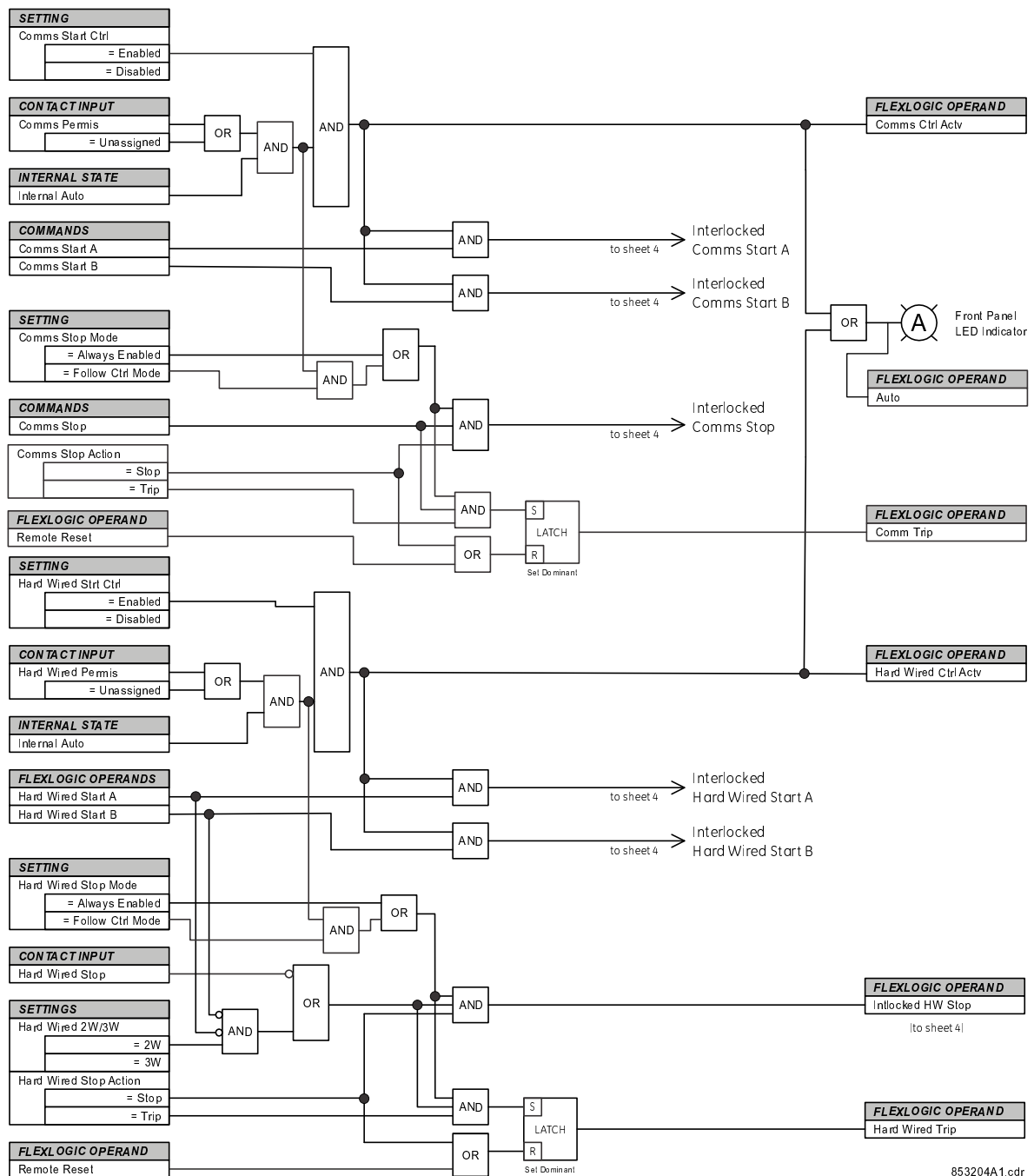


Figure 103: Auto/manual control logic diagram - 2 of 4

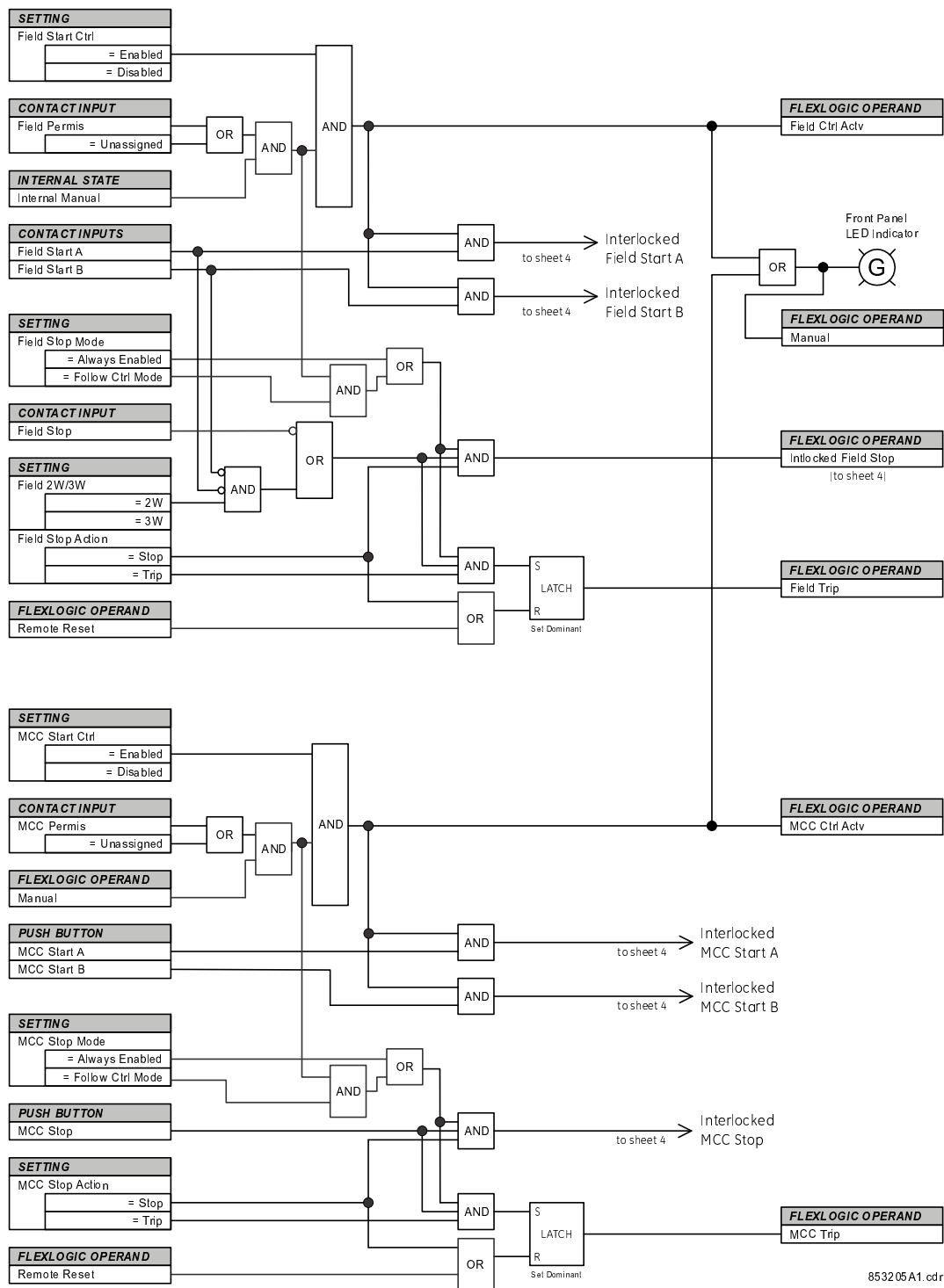


Figure 104: Auto/manual control logic diagram - 3 of 4

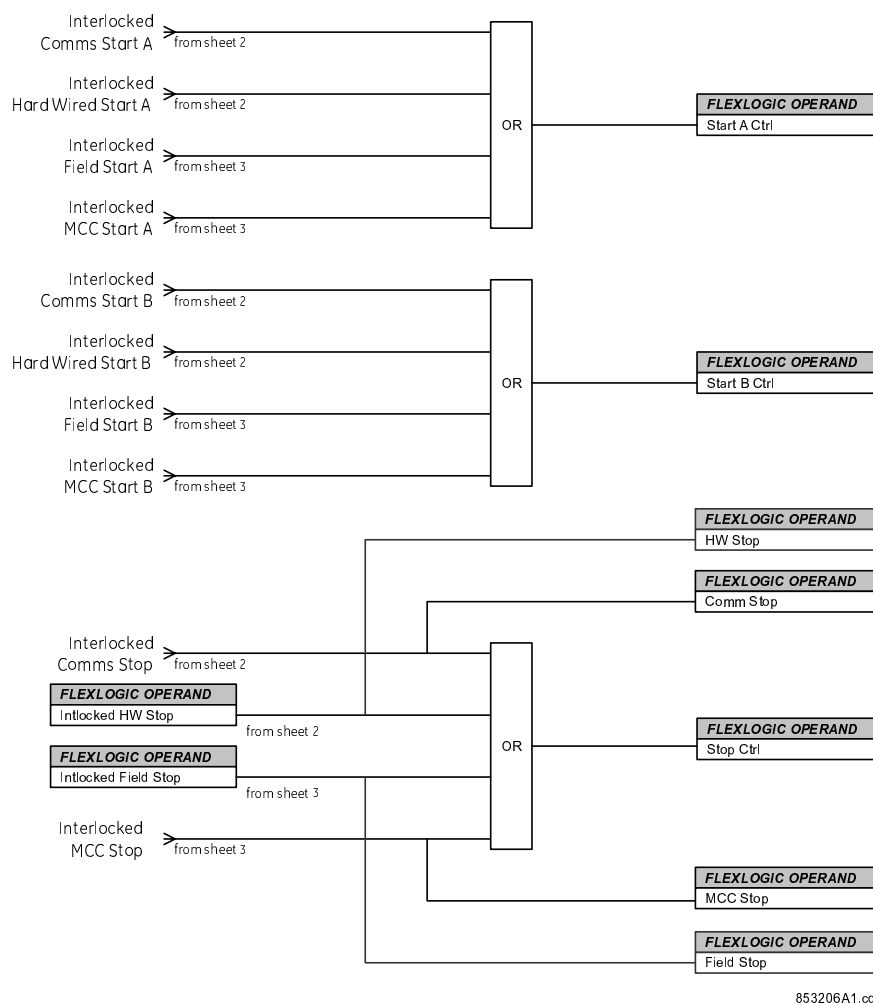


Figure 105: Auto/manual control logic diagram - 4 of 4

6.5.1.2 STOP/START CONTROL

An external stop sequence has occurred if the relay detects that either contactor A or contactor B has dropped out without receiving a stop command. If the **EXTERNAL STOP ACTION** setpoint is programmed as *Stop*, the relay will accept this as a stop control and display the `External Stop` message. If this setpoint is set to *Trip*, the relay will treat this as an emergency stop trip. This trip condition must be reset before the motor can be restarted.

Most protection and control elements in this relay are sensitive to whether the motor is stopped, starting, or running. These include the thermal overload model, jam, acceleration, undercurrent, underpower, overvoltage, and undervoltage protection, the process interlocks, and the thermal start inhibit and undervoltage restart elements.

Traditionally, the motor is deemed to have entered the starting state when the motor current changes from zero to some measurable value, and to have entered the running state when the current having increased above FLA then subsides below FLA. This algorithm is satisfactory for most applications. The current profile of full voltage across-the-line starters for instance typically goes from zero to $6 \times \text{FLA}$ within a cycle of the contactor closing, and then decays exponentially until it reaches $1 \times \text{FLA}$ just before reaching normal operating speed.

However, some starter types implemented in the 859 have significantly different current profiles. For instance, with an inverter starter, the inverter may ramp the motor speed up so slowly that the current never exceeds FLA. Alternatively, the current may initially exceed $1 \times \text{FLA}$, but subside well before reaching normal operating speed. The traditional algorithm could either not declare the motor reaching the running state, or declare it much too soon.

Another problem can develop when there is a brief supply interruption for which the immediate undervoltage restart feature recloses the contactor so quickly that there is little or no inrush current. The traditional algorithm would

detect the start (if it is fast enough), but may or may not detect the running state that follows. Even if it does detect the running state, as it is an atypical start, the learned values such as learned acceleration time would be corrupted.

The MM300 Enhanced employs an improved starting and running state detection algorithm. Normally, it declares starting when either contactor A or contactor B closes. Running is declared when either contactor has been closed for one second, and then current is found to be below $1 \times \text{FLA}$. This provides equivalent functionality to the traditional algorithm. However, the advanced algorithm also accepts Starting Status Block and Running Status Block signals. Most starter types leave these signals in their default off state, where they have no effect on the starting and running declarations. Where required however, the starters can manipulate these signals to correct the above described problems with the traditional algorithm. The inverter starter for instance asserts the Starting Status Block signal when it powers up the inverter, and then allows the starting state to be declared by turning it off only when the ramp up command is issued. The inverter starter also asserts the Running Status Block signal and then allows the running state to be declared by turning it off only when the inverter signals up-to-speed.

In addition, the advanced algorithm accepts a UVR Short Dip signal from the undervoltage restart element. This signal will carry the running status through short dips followed by immediate reclose.

If an A or B motor contactor is externally energized, the relay will treat this as a start A or B control, and display an `External Start A Alarm` or an `External Start B Alarm` message.

The stop/start control element also consolidates the various start and stop signals for the convenience of other elements.

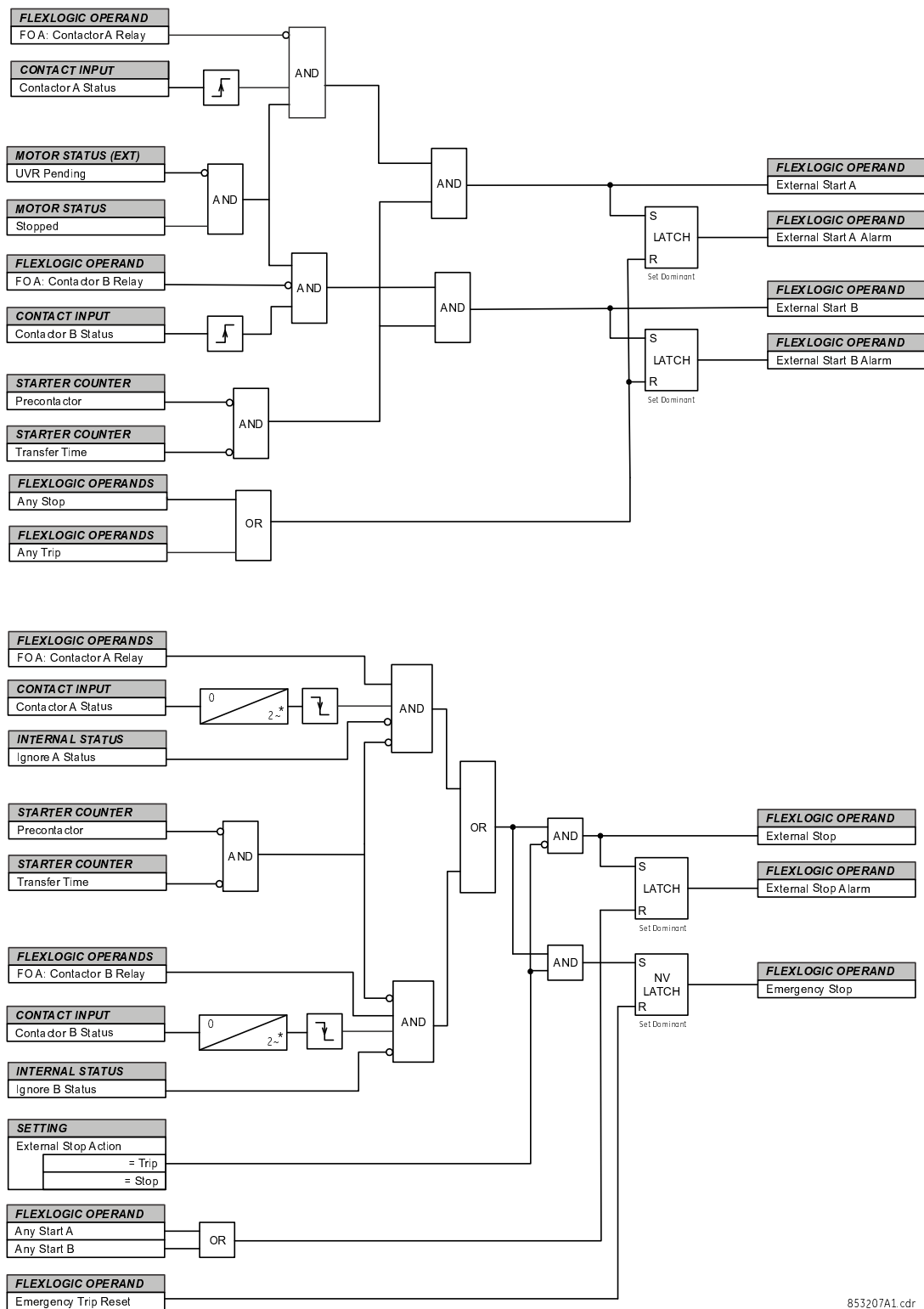
Path: *Setpoints > Control > Starter > Start/Stop Control*

External Stop Action

Range: Stop, Trip

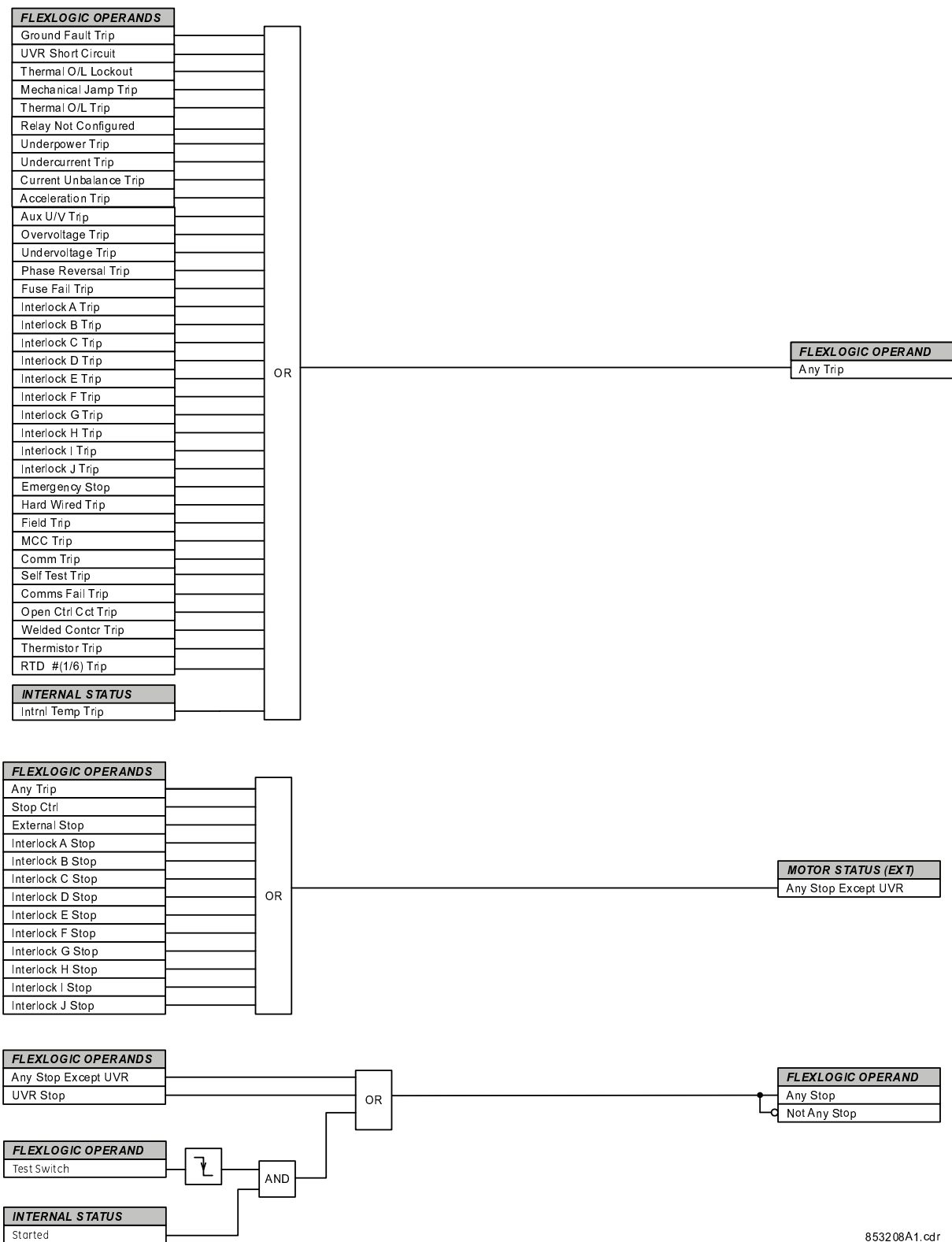
Default: Stop

This setpoints selects whether an external stop is considered to be an emergency stop (reset required to clear) or a stop control (no reset required).



* - delays coordination with the undervoltage restart element

Figure 106: External stop/start logic diagram



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Figure 107: Trip/stop logic diagram

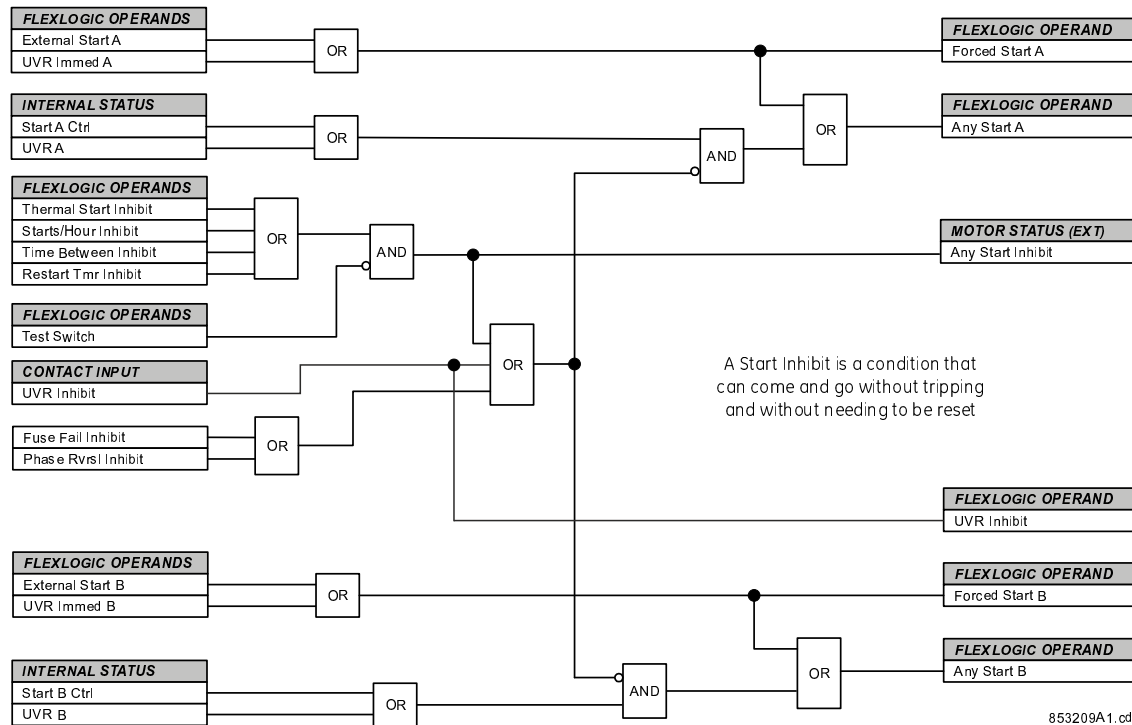


Figure 108: Start logic diagram

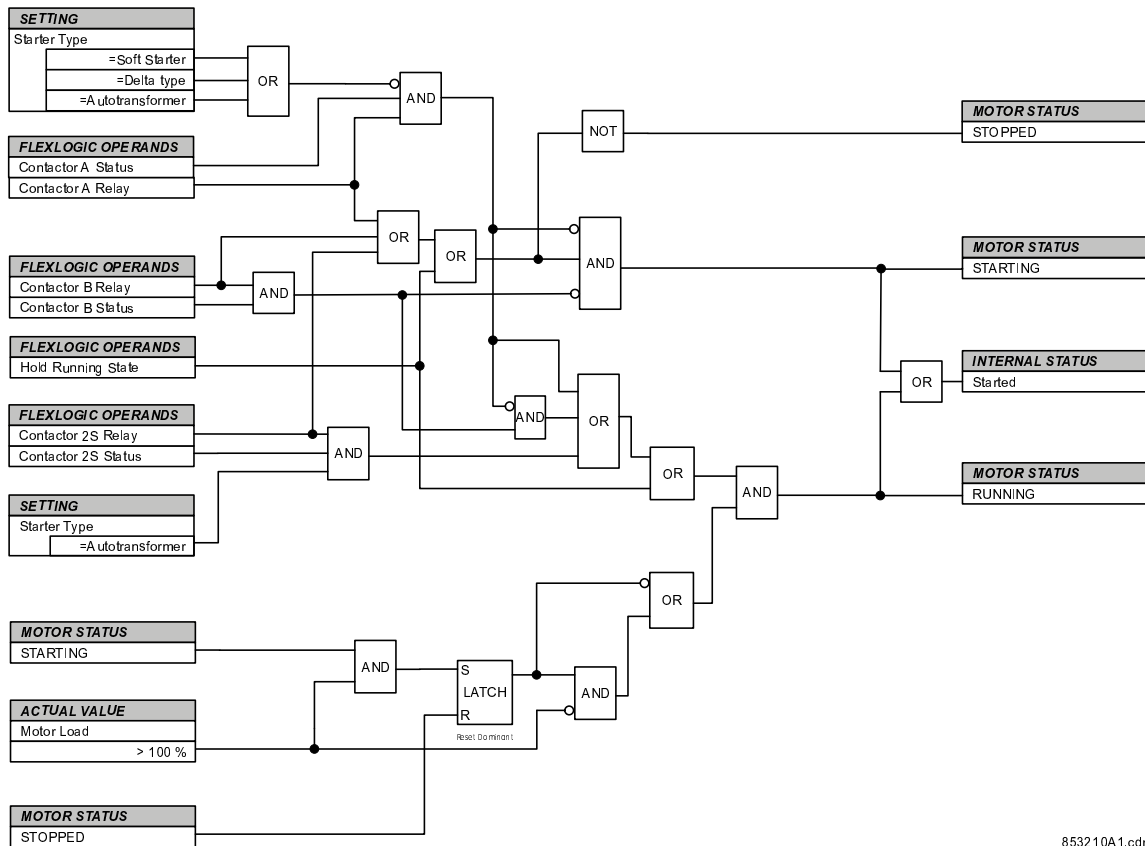
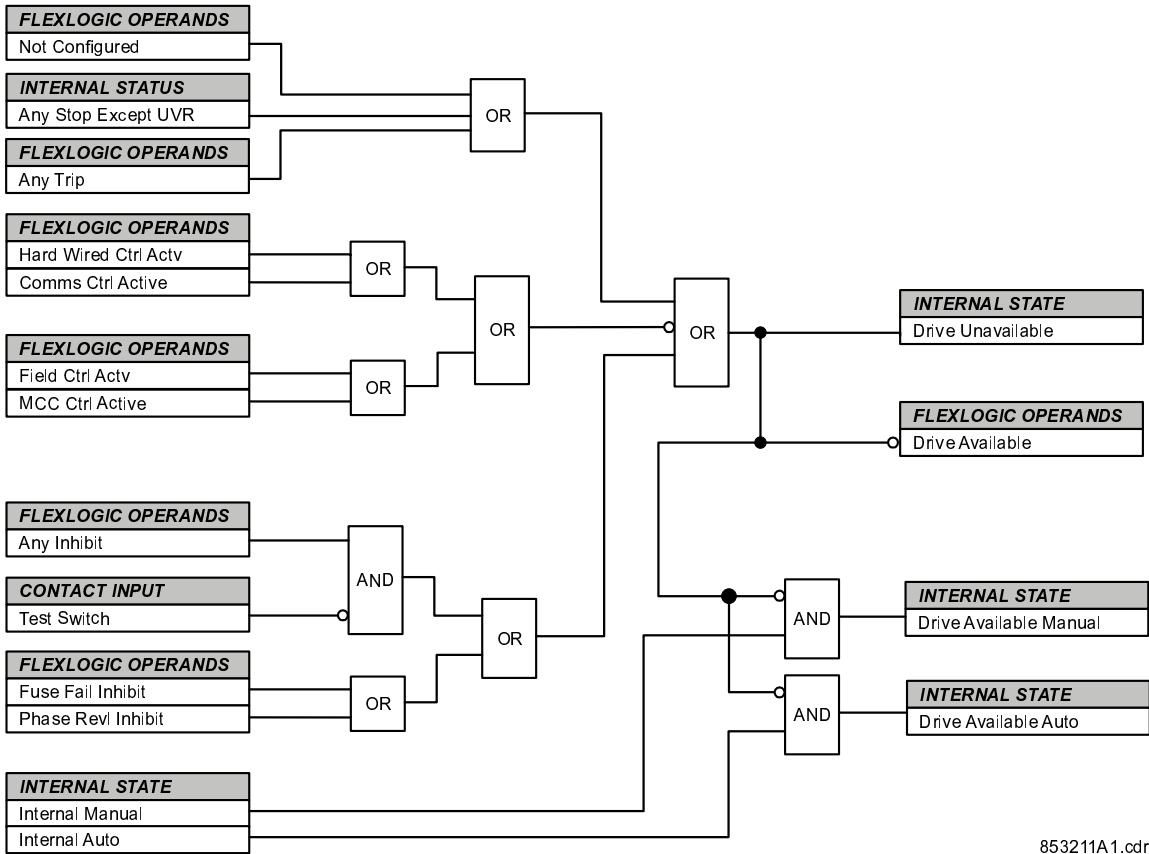


Figure 109: Motor status diagram



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Figure 110: Drive available logic diagram

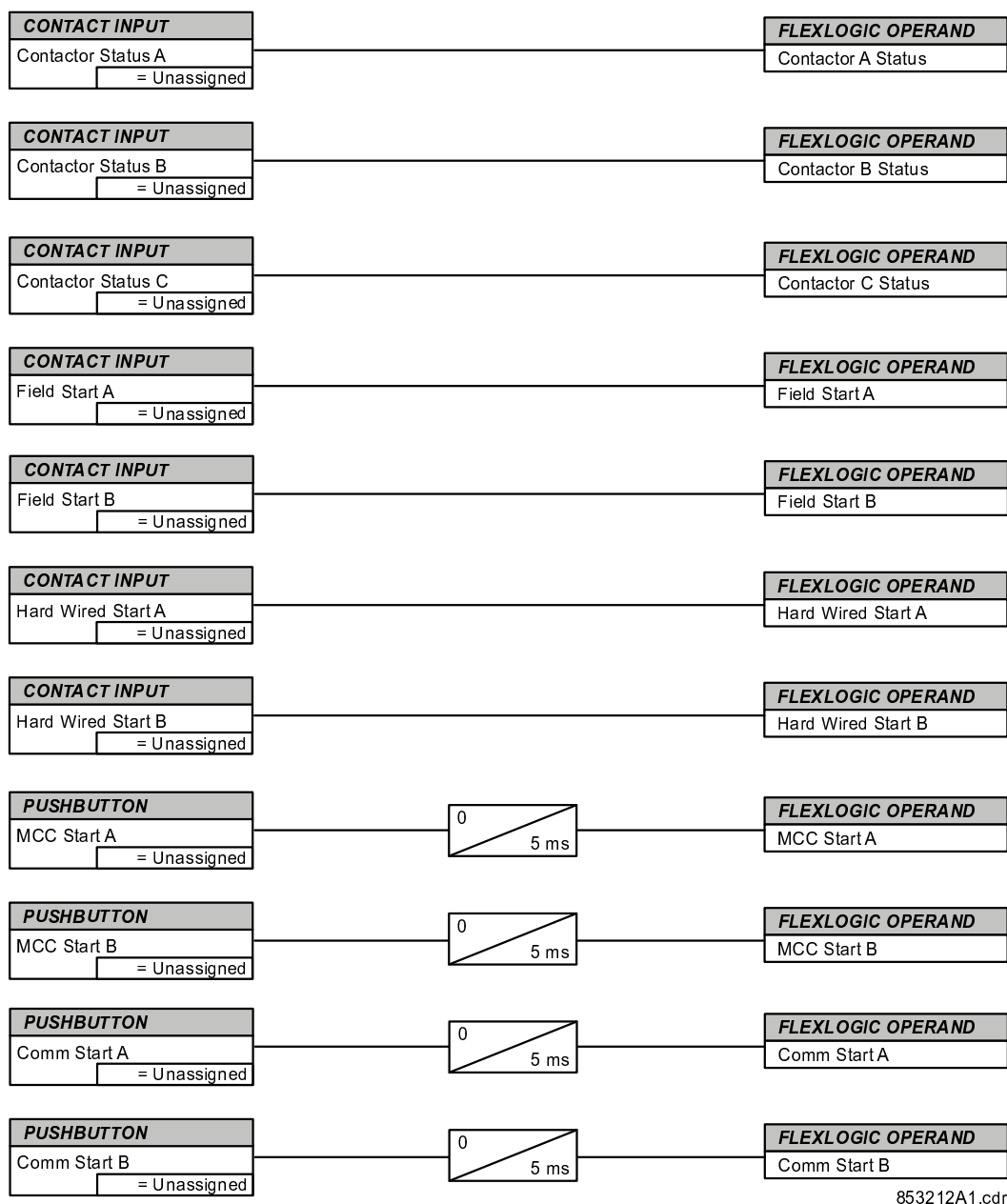


Figure 111: Start initiation logic diagram

6.5.2 START INHIBITS

The MM300 Enhanced provides four elements that guard against excessive starting duty:

- Thermal start inhibit
- Starts per hour inhibit
- Time between starts inhibit
- Restart inhibit

THERMAL START INHIBIT

This function is provided to inhibit the starting of a motor if there is insufficient thermal capacity available for a successful start. The motor start inhibit logic algorithm is defined by the **START INHIBIT MARGIN** setpoint. If this

value is 0, starts are inhibited until thermal capacity used decays to a level of 15%. If this setpoint is greater than zero, starts are inhibited while the available thermal capacity is less than the learned thermal capacity used at start.

Note:

The margin should be set to zero if the load varies for different starts.

The learned thermal capacity used at start is the largest value of thermal capacity used calculated by the thermal model from the last five successful starts, plus a user-defined margin. The margin is a percentage of this largest of five. A successful motor start is one in which the motor reaches the running state. See Stop/start control for a description of running state logic. If the relay does not contain records of five successful starts, a value of 85% is used for the learned thermal capacity used, which requires the thermal capacity used to decay to the same 15% level required when the margin setpoint is zero.

For example, if the thermal capacity used for the last 5 starts is 24, 23, 27, 22 and 21% respectively, the learned starting capacity used at start is the maximum value: $(24\%+23\%+27\%+26\%+20\%) = 27\%$. If the set margin is 25%, the adjusted thermal capacity learned is calculated as $27\% \times (1+25\%/100\%) = 33.75\%$. If the motor stops with a thermal capacity used of 90%, a start inhibit will be issued till the motor cools to $100\% - 33.75\% = 66.25\%$. If the stopped cool time constant is set to 30 minutes, the inhibit time will be:

$$30 \times \ln(90\% / 66.25\%) = 9.2 \text{ minutes}$$

If the margin is set to zero instead, the inhibit time will be:

$$30 \times \ln(90\% / 15\%) = 54 \text{ minutes}$$

STARTS PER HOUR INHIBIT

This element defines the number of start attempts allowed in any 60 minute interval. Once the set number of starts has occurred in the last 60 minutes, start controls are inhibited until the oldest start contributing to the inhibit is more than 60 minutes old.

TIME BETWEEN STARTS INHIBIT

The time between starts element enforces a programmable minimum time duration between two successive starts attempts. A time delay is initiated with every start and a restart is not allowed until the specified interval has elapsed. This timer feature may be useful in enforcing the duty limits of starting resistors or starting autotransformers. It may also be used to restrict jogging.

RESTART INHIBIT

This element may be used to ensure that a certain amount of time passes between the time a motor is stopped and the restarting of that motor. This timer is useful for many process applications and motor considerations. If a motor is on a down-hole pump, the liquid may fall back down the pipe and spin the rotor backwards after the motor stops. It would be very undesirable to start the motor at this time. This feature is bypassed by undervoltage immediate restart and by external start.

For each of these features, non-volatile memory is used to make them behave as if they continue to operate while control power is lost.

Note:

The starts per hour inhibit, time between starts inhibit and restart inhibit elements assume that a motor start is occurring when the relay measures the transition of no motor current to some value of motor current.

Path: Setpoints > Control > Start Inhibits

Start Inhibit Margin

Range: 0 to 11% in steps of 1%, Off (Max.)

Default: Off

This setpoint specifies the start inhibit margin. A value of *OFF* disables start inhibits. A value of *0%* causes starts to be inhibited until the thermal capacity used value calculated by the thermal model drops to 15% or less. Setpoint values in the range of 1 to 10% specify the margin to be included in the calculation of the learned thermal capacity used at start value, and cause starts to be inhibited until the present thermal capacity used value drops to the learned thermal capacity used at start value or less.

Starts/Hour Limit

Range: 1 to 6 in steps of 1, Off (Max.)

Default: Off

This setpoint specifies the number of starts in the last 60 minutes at which count start control is inhibited. A value of *OFF* disables this feature.

Time Between Starts

Range: 1 to 3601 s in steps of 1 s, Off (Max.)

Default: Off

This setpoint specifies the time following a start before a start control is permitted to prevent restart attempts in quick succession (jogging). A value of *OFF* disables this feature.

Restart Block Delay

Range: 1 to 50001 s in steps of 1 s, Off (Max.)

Default: Off

This setpoint specifies the time following stop before a start control is permitted. A value of *OFF* disables this feature.

Note:

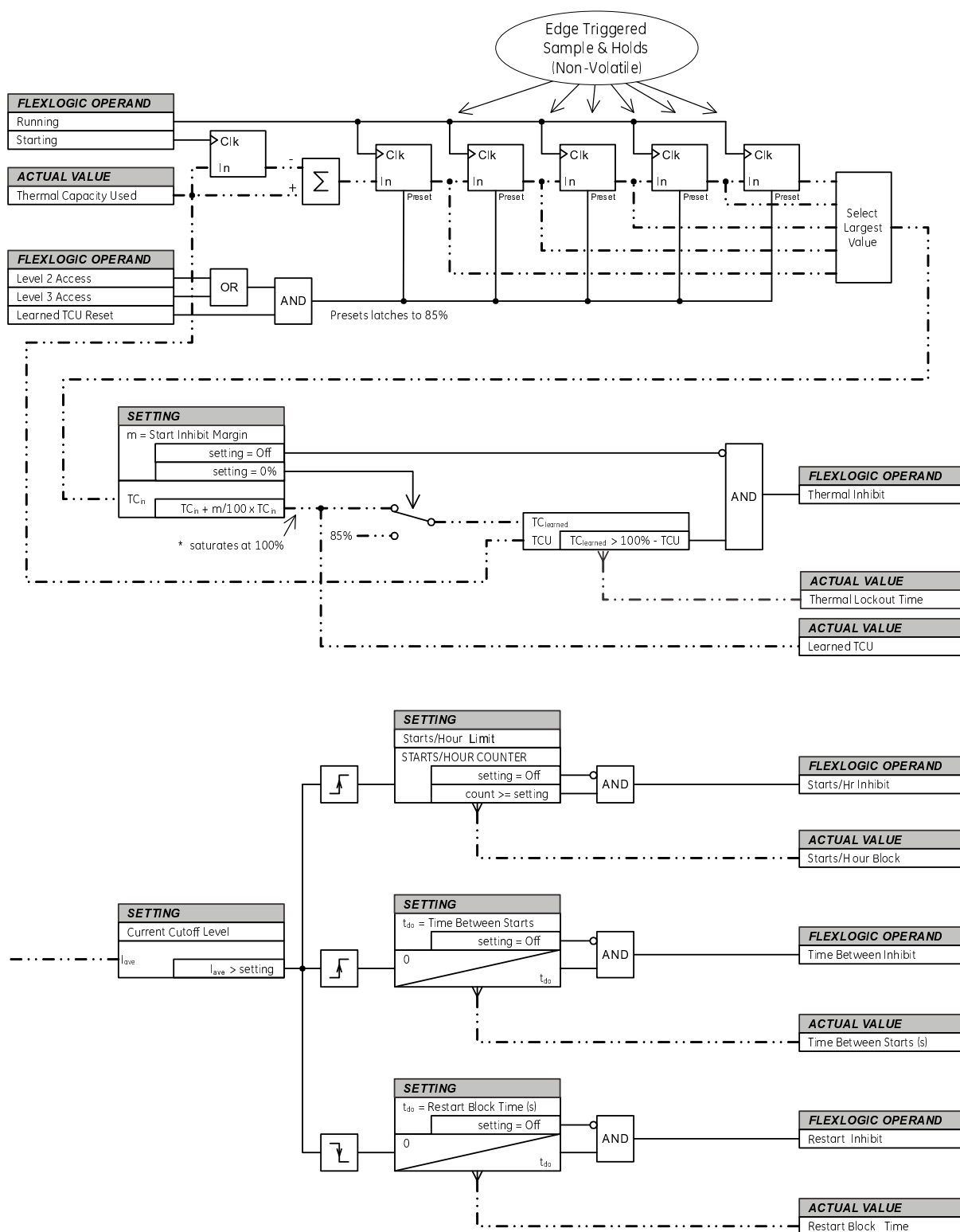
The start inhibit, start per hours, time between start and restart timer functions are bypassed when the MM300 Enhanced enters test mode.

Note:

The remaining time counters and the thermal capacity used continues counting down and drops by also taking into account the period of time the MM300 Enhanced is in test mode.

Note:

*When the motor is forced to stay in test mode, neither the **NUMBER OF MOTOR STARTS** nor the **MOTOR RUNNING HOURS** counters are incremented.*



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Figure 112: Start inhibit, starts per hour, time between starts and restart inhibit logic diagram

6.5.3 PROCESS INTERLOCKS

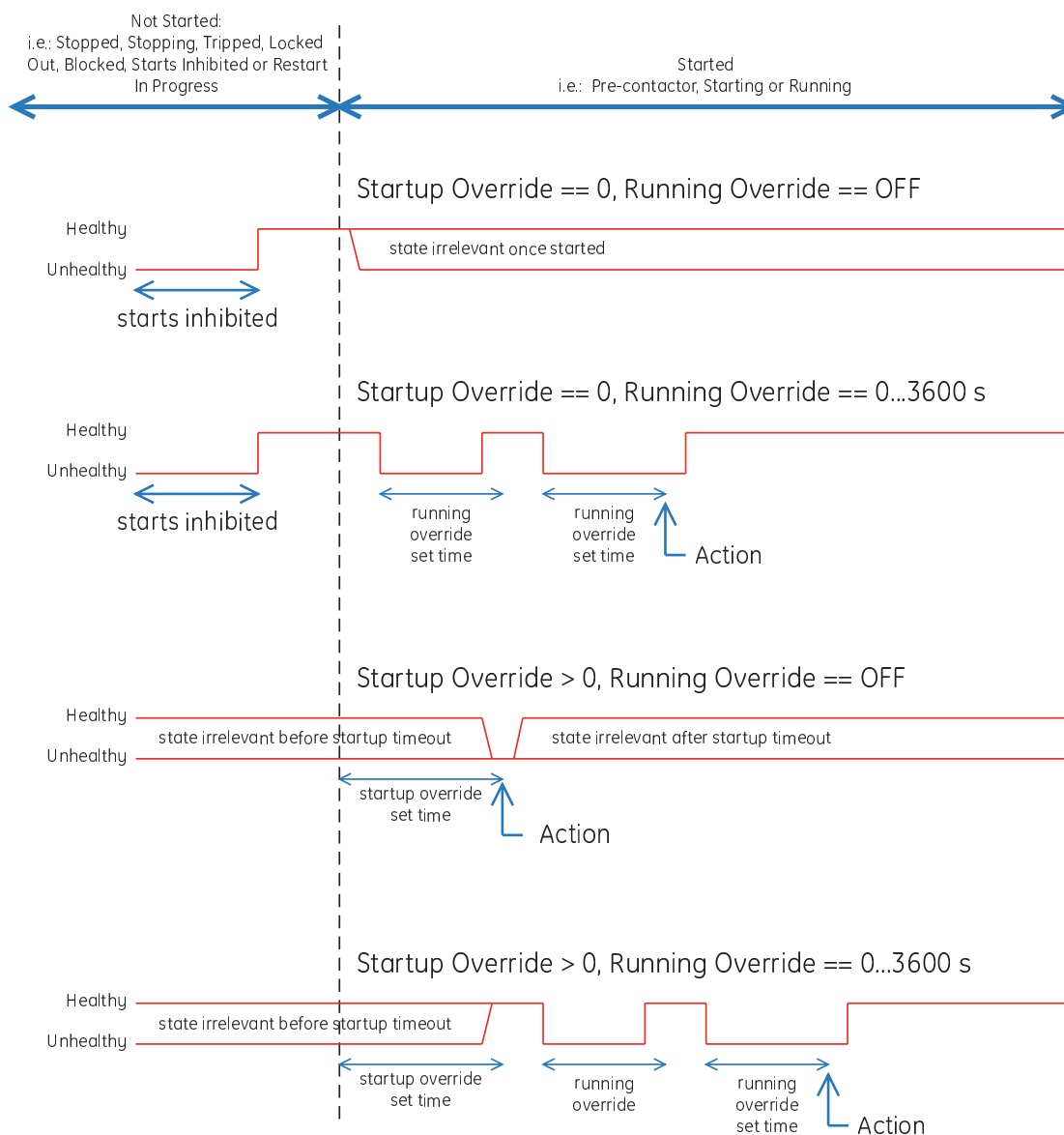
Ten independent process interlocks A through J (abbreviated as **IL A...J** on the display) are used to provide trip, stop or alarm actions based on a contact input.

The contact input for utilized process interlocks is assigned in the contact inputs setpoints page. The healthy state of the contact driving the input, the state wherein there is no trip, stop or alarm action taken by the interlock, may be set to either open or closed.

Each process interlock has a startup override timer that sets the time given for the process interlock switch to reach the healthy state (measured from the moment a start control is received). If the input is unhealthy at the moment this timer expires, the interlock function performs its configured action. If the startup override delay setpoint is set to zero, the switch must be healthy for the motor to start.

Each process interlock also has a running override timer that sets the time the switch can remain unhealthy during normal running. If the startup override timer has expired and the switch then goes unhealthy for longer than the **IL A(J) RUNNING OVERRIDE** delay setpoint, the interlock performs its configured action. If the **IL A(J) RUNNING OVERRIDE** is *Off* and the switch goes unhealthy after the startup override has expired, no action will occur.

The process interlocks may also be set such that no action is performed when the test switch is closed. This allows the control circuit to be tested.



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Figure 113: Process interlock timing

The setpoints and logic for interlock A shown below applies to all interlocks A through J.

Path: *Setpoints* > *Control* > *Interlock*

IL Ignore in Test

Range: Enabled, Disabled

Default: Disabled

When this setpoint is *Enabled*, all process interlocks are ignored when the test switch is on.

IL A...J Name

Range: 20 alphanumeric characters

Default: Process Interlock A

This setpoint represents the interlock description that appears in the event record and on the status message page.

IL A...J Inst Alarm

Range: Enabled, Disabled

Default: Disabled

When this setpoint is *Enabled*, a process interlock alarm is issued without delay. This is in addition to the trip, stop, or alarm selected by the **IL A...J FUNCTION** setpoint.

IL A...J Startup Override

Range: 0 to 3600 s in steps of 1 s

Default: 0 s

This setpoint specifies the time provided for the process interlock switch to reach the healthy state, measured from the moment a start control is received. This includes any pre-contactor time. A value of 0 inhibits starts if the switch state is unhealthy.

IL A Running Override

Range: 0 to 3601 s in steps of 1 s, Off (Max.)

Default: 0 s

This setpoint specifies the time the switch can remain unhealthy during normal running. A value of *Off* renders the interlock inoperative during normal running.

IL A Healthy State

Range: Open, Closed

Default: Closed

This setpoint allows the user to configure the process interlock contact input as either healthy open or healthy closed. The switch state is healthy when no action is taken by this interlock.

When set to *Open* the process interlock's contact input is in a healthy state if it is energized. If the contact input is not energized, it is declared as being in an unhealthy state.

With this setpoint value at *Closed*, the process interlock's contact input is in an unhealthy state if it is energized. If the contact input is not energized, it is declared as being in a healthy state.

Contact input "Process Interlock A(J)"	Setpoint "IL A(J) Healthy State"	Switch State
On	Open	Healthy
Off	Open	Unhealthy
On	Closed	Unhealthy

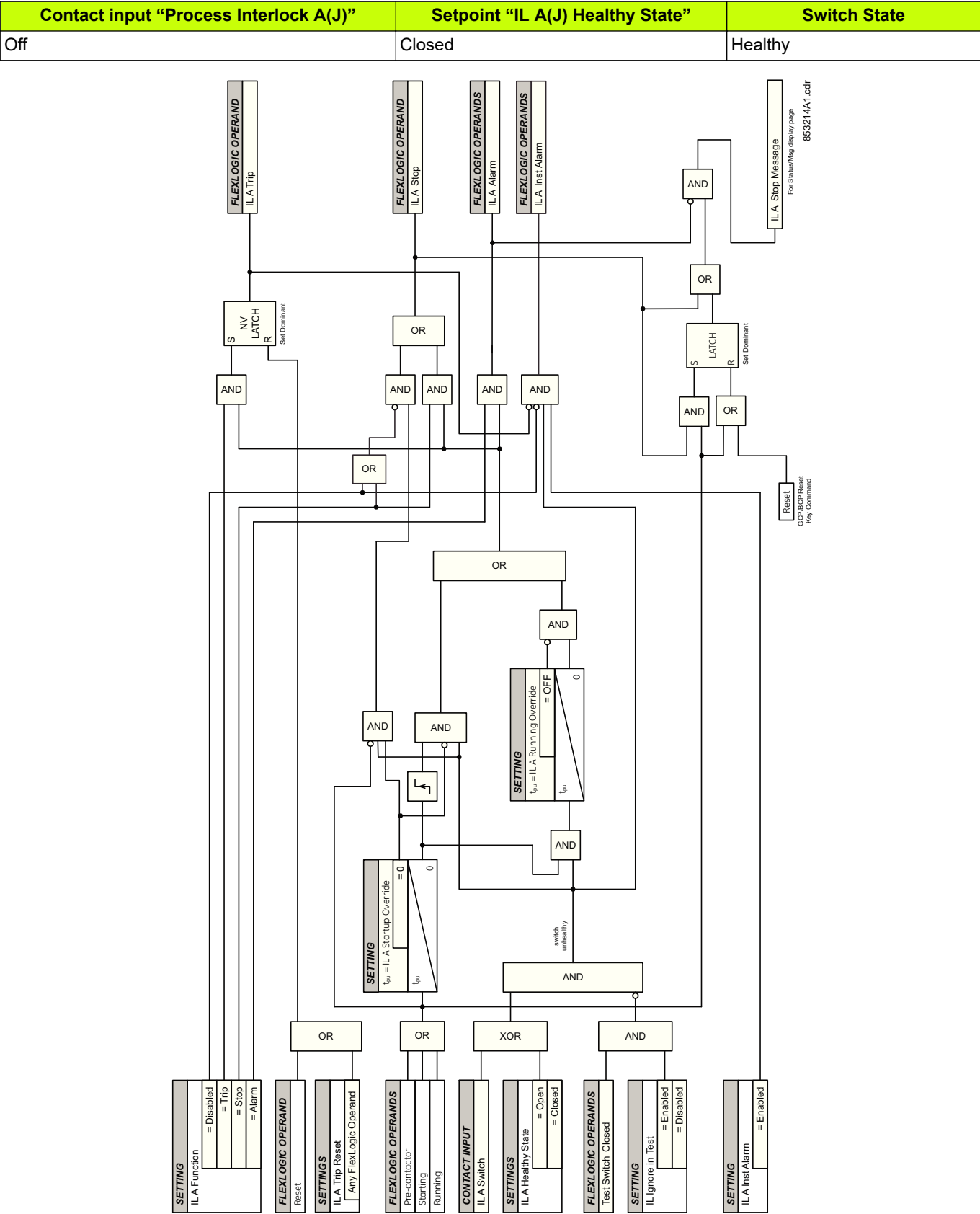


Figure 114: Process interlock A functional logic diagram

6.5.4 UNDERVOLTAGE RESTART

The undervoltage restart element (UVR) provides for relay-initiated undervoltage motor restart after a momentary power loss (dip). In addition, this element provides for controlling the timing of both controlled starts and undervoltage restarts following interruptions.

When the auxiliary voltage supply drops below the dropout voltage level, the motor contactor(s) are de-energized until the dip is over as indicated by supply recovery to the pickup level. The duration of the dip is classified as short, medium, or long, based on settable time thresholds.

- Short dips are intended to cover situations where it is appropriate to immediately close the contactors back in on voltage recovery.
- Medium dips are for where it is appropriate to restart the motor with any staged startup sequence the starter type might provide.
- Long dips (interruptions) are intended to cover cases where restoration is from backup power, and there must be substantial intervals between starting different motors to maintain stability, and/or only critical motors can be started.
- Very long dips are intended to cover shutdowns, after which automatic undervoltage restart is not required.

During power loss, the UVR element provides a *Power Loss Time* value to indicate the total time that power is lost. If the motor was running at the time a short dip occurred, and the supply had been healthy for a programmable time prior to the dip, a forced restart will occur as soon as the relay detects healthy auxiliary voltage. A forced restart bypasses any pre-contactor and staged startup sequence the starter type might otherwise provide.

If the motor was running at the time a medium or long dip occurred, after a programmable medium or long delay, a normal start will be performed.

If the motor was not running at the start of the dip, no restart sequence will be initiated. Start controls are ignored while the UVR delay is timing out. While the UVR timer is counting down, the status will change to "UVR Pending". During UVR Pending, any stop or trip will immediately cancel the restart sequence.

With control voltage derived from the incoming motor supply, the MM300 Enhanced will experience the same interruption as the motor. The MM300 Enhanced is designed to ride through power outages of up to 200 ms, so that the undervoltage restart function is unaffected. For longer outages the relay saves critical data to non-volatile memory just before shutting down. While the relay is shut down, a backup timer continues to keep time without external power by using stored energy.

Path: Setpoints > Control > Undervoltage restart

Note:

When modifying any of the settings listed under this path, a reboot is required for all internal cores to be properly synchronized.

UVR Dropout Level

Range: 60 to 100% of MNV in steps of 1%

Default: 65%

Sets the motor voltage level below which the undervoltage restart element is triggered. This setting is a percentage of the **MOTOR NAMEPLATE VOLTAGE**. The value programmed must be set lower than the **UVR PICKUP LEVEL**.

UVR Pickup Level

Range: 60 to 100% of MNV in steps of 1%

Default: 90%

Sets the motor voltage level above which the undervoltage restart element is triggered. This setting is a percentage of the **MOTOR NAMEPLATE VOLTAGE**. The value programmed must be set higher than the **UVR DROPOUT LEVEL**.

UVR Short Dip Time

Range: 100 to 510 ms in steps of 10 ms, Off (Max.)

Default: 200 ms

This setpoint specifies the maximum duration of short dips, which result in immediate restarts. A value of *Off* disables immediate restarts.

UVR Med Dip Time

Range: 0.1 to 10.0 s in steps of 0.1 s

Default: 2.0 s

This setpoint represents the maximum duration of medium dips.

UVR Long Dip Time

Range: 0.5 to 60.5 min in steps of 0.5 min, Off (Max.)

Default: Off

This setpoint represents the maximum duration of long dips. A value of *Off* disables restarts after long dips.

UVR Med Dip Delay

Range: 0.2 to 90.0 seconds in steps of 0.2 seconds

Default: 2.0 s

This setpoint represents the undervoltage restart medium delay.

UVR Long Dip Delay

Range: 1.0 to 1200.0 s in steps of 1.0 seconds

Default: 10.0 s

This setpoint represents the undervoltage restart long delay.

UVR BACKUP PROTECTION

When supply voltage to the MM300 Enhanced is derived from the incoming motor supply, the relay will experience the same interruption as the motor. After the power supply is recovered and motor is restarted by the **UVR FUNCTION**, the device can take up to 60 seconds to initialize. During the boot-up process, short circuit, thermal overload or mechanical jam can damage the motor if undetected. The relay provides backup protection against short circuit (phase and ground), thermal overload and mechanical jam during the boot-up process when the motor is restarted by the **UVR FUNCTION**.

UVR Ph Short Cct Level

Range: 1.01 to 6.00 x FLA in steps of 0.01 x FLA, Off (Min.)

Default: Off

UVR Grd Short Cct Level (for 1/5A Ground CT Type)

Range: 1.01 to 10.00 x CT in steps of 0.01 x CT, Off (Min.)

Default: Off

UVR Grd Short Cct Level (for 50:0.025 Ground CT Type)

Range: 0.50 to 15.00 A in steps of 0.01 A, Off (Min.)

Default: Off

UVR MechJam Level

Range: 1.01 to 4.50 x FLA in steps of 0.01, Off (Min.)

Default: Off

UVR Ph Short Cct Delay

Range: 0.20 to 60.0 s in steps of 0.1 s

Default: 5.0 s

UVR Grd Short Cct Delay

Range: 0.20 to 60.0 s in steps of 0.1 s

Default: 10.0 s

UVR MechJam Delay

Range: 0.1 to 30.0 s in steps of 0.1 s

Default: 1.0 s

Note:

When the undervoltage restart feature is enabled, the contact inputs of the IO_C & M modules are considered valid only when the auxiliary voltage is higher than the **UVR PICKUP LEVEL**. When the voltage drops below the **UVR DROPOUT LEVEL**, the input status are frozen to avoid possible issues with the contactor A/B/C status and HW/Field Stops inputs.

Note:

When undervoltage restart is disabled, the contact inputs of the IOM board work regardless of the voltage level of the auxiliary voltage.

Note:

When using medium and long dip, ensure that the delay setting is greater than the **UVR INHIBIT** time (if used).

Note:

The undervoltage restart feature requires a minimum of 2.5 s between successive dips, to ensure correct operation.

Note:

If Aux VT is set for Direct then the voltage levels (Pickup and Dropout) are set as a percentage of $MNV \wedge 3$, where MNV is motor nominal rated voltage.

Note:

If Aux VT is set for VabVT, VbcVT, VcaVT, VanVT, VbnVT, VcnVT the voltage levels (Pickup and Dropout) are set as a percentage of Aux VT secondary.

Note:

For UV Restart element to work, the relevant inputs like contactor status, start signal and stop signal etc must be configured and wired to the contact inputs of slot C IO board. Virtual Output should not be used in the configuration of hardware signals.

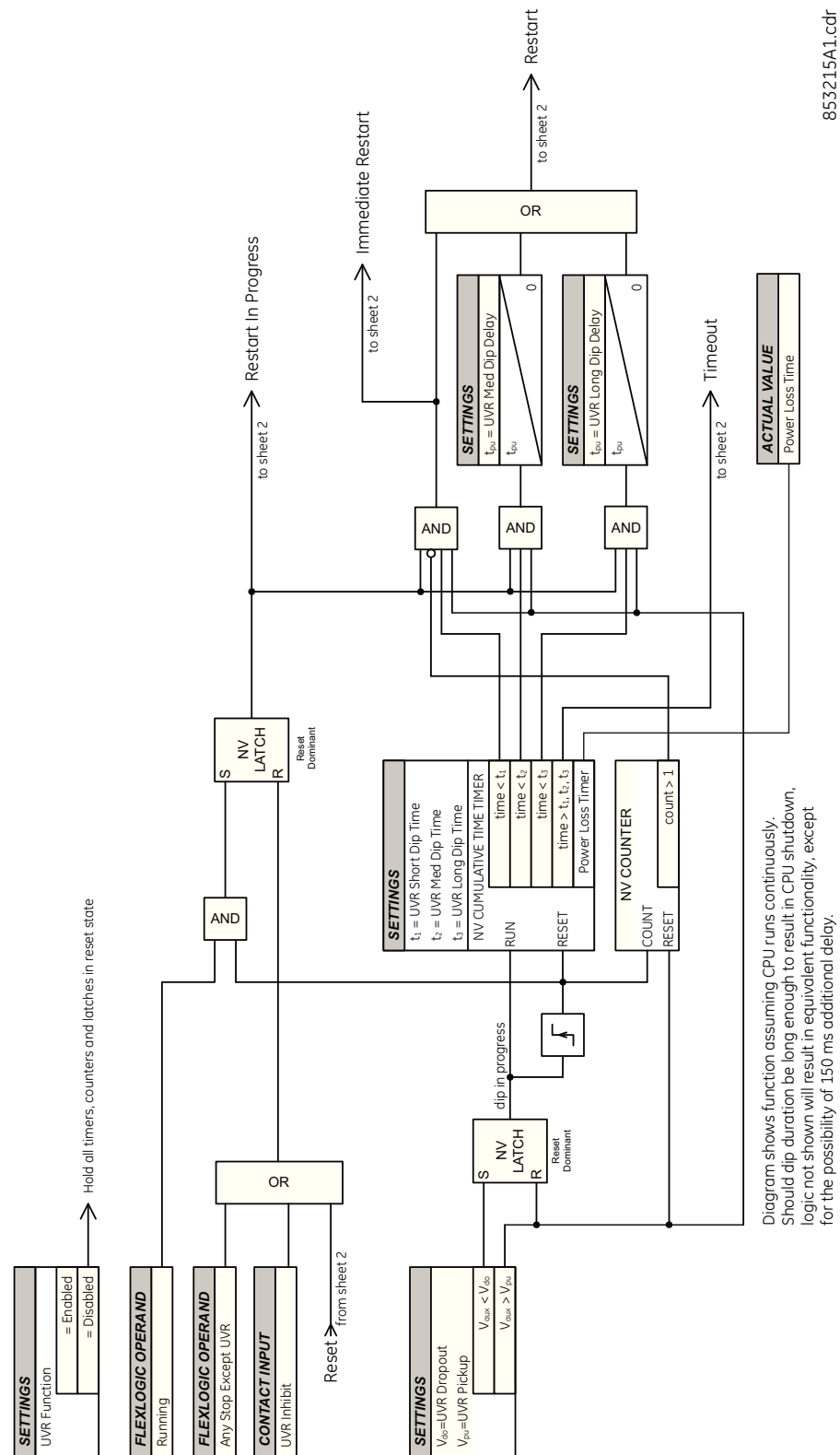


Figure 115: Undervoltage restart control logic diagram - 1 of 3

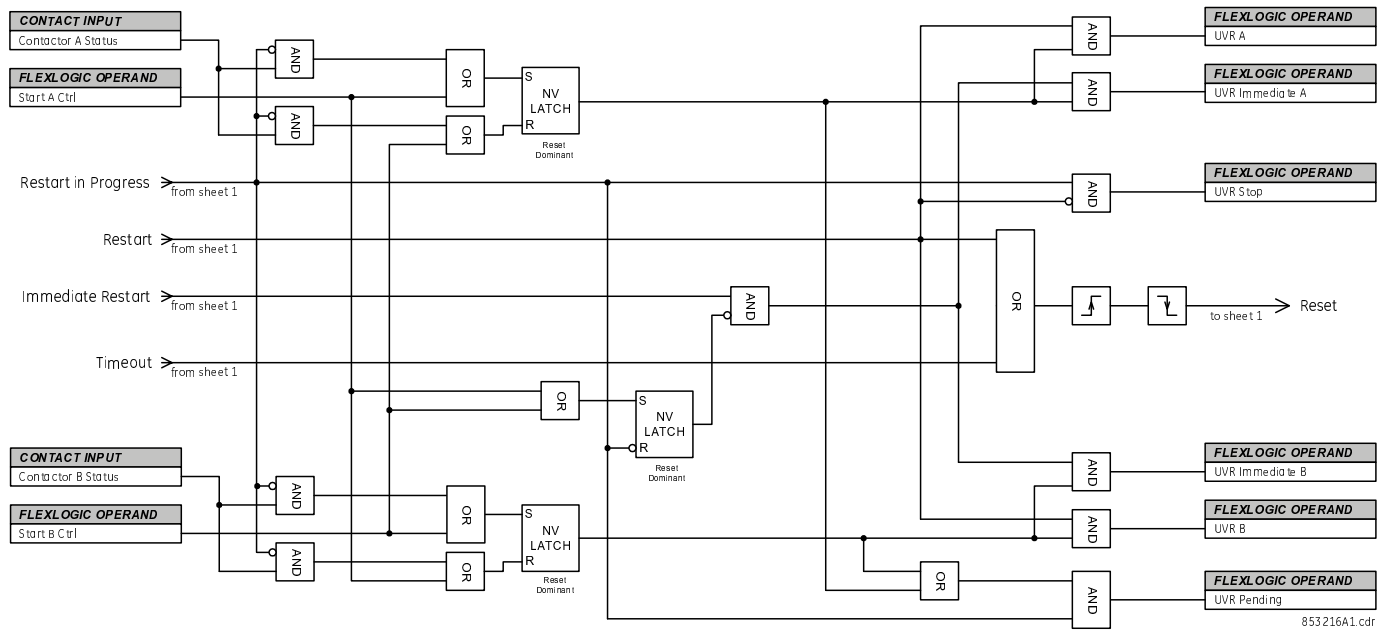


Figure 116: Undervoltage restart control logic diagram - 2 of 3

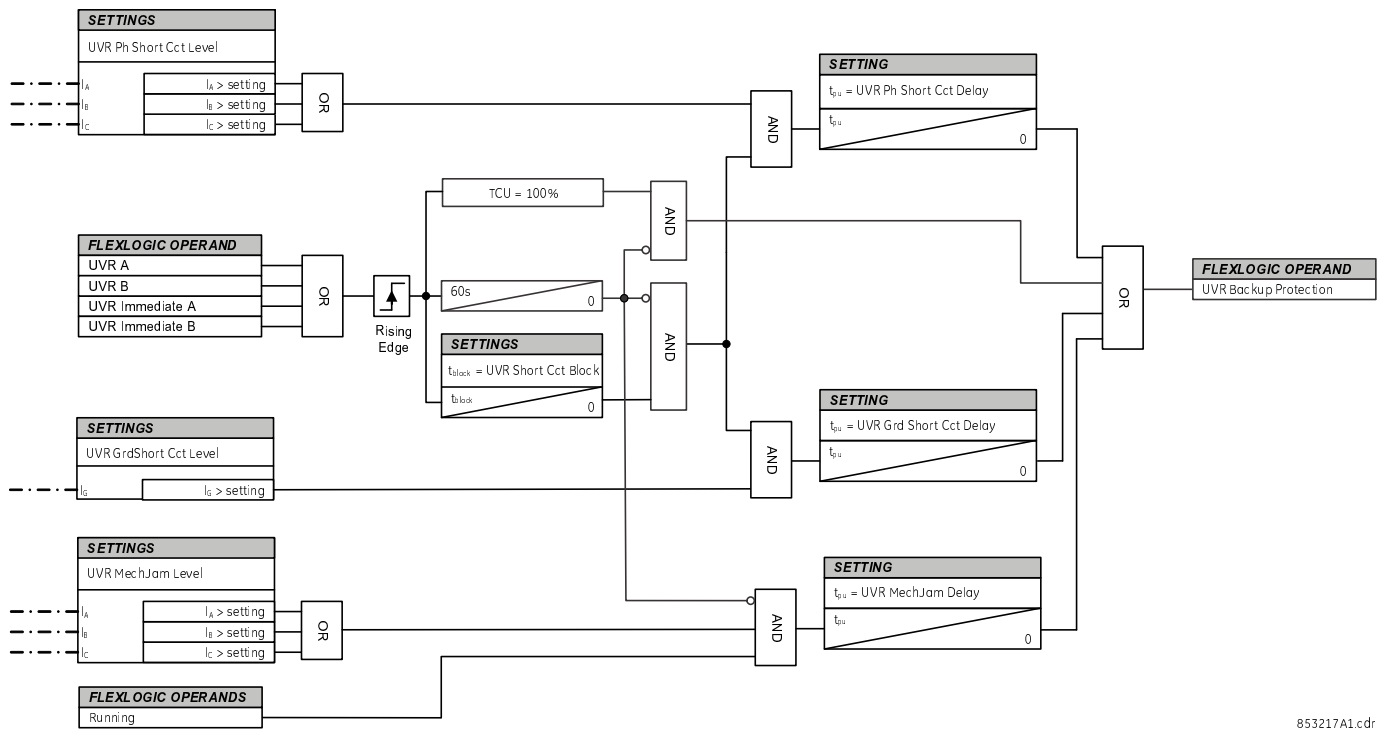


Figure 117: Undervoltage restart control logic diagram - 3 of 3

6.5.5 VIRTUAL INPUT CONTROL

The states of up to 128 virtual inputs can be changed at the following path:

Path: *Setpoints > Control > Virtual Input Control*

Force Virtual Input 1(128)

Range: Off, On

Default: Off

The status will either be *Off* (logic 0) or *On* (logic 1). If the corresponding virtual input selected under **Setpoints > Configure > Virtual Inputs > Virtual Input 1 (128)** is set to *Latched*, the command *On* initiated from this menu will remain *On* and the status of this virtual input will also be *On* until the command *Off* is received. If the virtual input type is *Self-reset*, the command and status of this virtual input will revert to *Off* after one evaluation of the FlexLogic equations.

6.6 FLEXLOGIC

6.6.1 INTRODUCTION

To provide maximum flexibility to the user, the arrangement of internal digital logic combines fixed and user-programmed parameters. Logic upon which individual features are designed is fixed and all other logic, from digital input signals through to elements or combinations of elements to digital outputs is variable. The user has complete control of all variable logic through FlexLogic. In general, the system receives analog and digital inputs, which are then used to produce analog and digital outputs.

The states of all digital signals used in the MM300 Enhanced are represented by flags (FlexLogic operands). A digital 1 is represented by a set flag. Any external contact change-of-state can be used to block an element from operating, as an input to a control feature in a FlexLogic equation, or to operate an output relay. The state of the contact input can be displayed locally or viewed remotely via the communications facilities provided. If a simple scheme where a contact input is used to block an element is desired, this selection is made within the menu of the element. This applies to other features that set flags: elements, virtual inputs, remote inputs, schemes and human operators.

Traditionally, protective relay logic has been relatively limited. Any unusual applications involving interlocks, blocking, or supervisory functions had to be hard-wired using contact inputs and outputs. FlexLogic minimizes the requirement for auxiliary components and wiring whilst making more complex schemes possible.

When more complex logic than the one presented above is required, FlexLogic tool should be used. For example, if the user needs to block the operation of a phase time overcurrent element by the closed state of a contact input, and the operated state of a phase under-voltage element, the two input states need be programmed in a FlexLogic equation. This equation ANDs the two inputs to produce a virtual output which then needs be programmed within the menu of the phase time overcurrent as a blocking input. Virtual outputs can only be created by FlexLogic equations.

The logic that determines the interaction of inputs, elements, schemes and outputs is field-programmable through the use of logic equations that are sequentially processed. The use of virtual inputs and outputs in addition to hardware is available internally and on the communication ports for other relays to use (distributed FlexLogic).

FlexLogic allows users to customize the relay through a series of equations that consist of operators and operands. The operands are the states of inputs, elements, schemes and outputs. The operators are logic gates, timers and latches (with set and reset inputs). A system of sequential operations allows any combination of specified operands to be assigned as inputs to specified operators to create an output. The final output of an equation is a numbered register called a virtual output. Virtual outputs can be used as an input operand in any equation, including the equation that generates the output, as a seal-in or other type of feedback.

A FlexLogic equation consists of parameters that are either operands or operators. Operands have a logic state of 1 or 0. Operators provide a defined function, such as an AND gate or a Timer. Each equation defines the combinations of parameters to be used to set a Virtual Output flag. Evaluation of an equation results in either a 1 (=ON, i.e. flag set) or 0 (=OFF, i.e. flag not set). Each equation is evaluated at least 4 times every power system cycle. Some types of operands are present in the relay in multiple instances; e.g. contact and remote inputs. These types of operands are grouped together (for presentation purposes only) on the faceplate display. The characteristics of the different types of operands are listed in the table below.

FlexLogic™ operands

Element Name	Operands	Event Description
Acceleration	Acceleration Acceleration Alarm	Acceleration Protection trip has operated Acceleration Protection alarm has operated.
Any Alarm	Any Alarm	Any operated element with Function selected as "Alarm"
Any Block	Any Block	Any block signal has operated

Element Name	Operands	Event Description
Any Major Error	Any Major Error	See the Relay Major Self-Test errors table
Any Minor Error	Any Minor Error	See the Relay Minor Self-Test errors table
Any OP	Any OP	Any enabled protection or control element operated
Any PKP	Any PKP	Any enabled protection or control element picked up
Any Starts	Start A CtrlStart B CtrlForced Start AForced Start BAny Start AAny Start B	Asserted when a start A command is received from any control source with all required supervision enabledAsserted when a start B command is received from any control source with all required supervision enabledOn when a start A that bypasses the staged start sequence is presentOn when a start B that bypasses the staged start sequence is presentOn when any start A is presentOn when any start B is present
Any Trip	Any Trip	Any operated element with Function selected as "Trip"
Auto Manual Mode	AutoManual	Asserted when auto mode is enabled.Asserted when manual mode is enabled.
AutoMan Ctrl Stop	Comm StopMCC Stop	Asserted when a Comm stop command is asserted and it is accepted by control mode.Asserted when a MCC stop command is asserted and it is accepted by control mode.
Auxiliary Undervoltage	Aux U/VAux U/V AlarmAux U/V Min LevelUndervoltage Min Level	Asserted when auxiliary undervoltage trip condition exists.Asserted when auxiliary undervoltage alarm condition existsAsserted when auxiliary voltage is below minimum levelAsserted when voltage is below minimum level.
Contactors Status	Pre- contactorContactor A RelayContactor B RelayContactor C RelayContactor A StatusContactor B StatusContactor C Status	Asserted during a pre-contactor warningExpected by several control elements to be asserted to close contactor AExpected by several control elements to be asserted to close contactor BExpected by several control elements to be asserted to close contactor COn when the input associated with the status of contactor A is raisedOn when the input associated with the status of contactor B is raisedOn when the input associated with the status of contactor C is raised
Control Trips	Hard Wired TripField TripMCC TripComm TripEmergency Stop	Asserted when a trip resulting from a hard-wired control contact input has yet to be resetAsserted when a trip resulting from a field control contact input has yet to be resetAsserted when a trip resulting from a motor control center (MCC) stop has yet to be resetAsserted when a Comm Trip command is receivedOn when external stop action is to trip, and an external start has occurred
CounterAlarm	Drive Greasing AlarmContactor Inspect AlarmMax Stopped Alarm	Asserted when the running hours exceed the alarm levelAsserted when the number of starts exceeds the alarm levelAsserted when the stopped hours exceed the alarm level
Ctrl Active	Comms Ctrl ActvHard Wired Ctrl ActvField Ctrl ActvMCC Ctrl ActvNo Control Source	Asserted when the communication start controls have all required supervision enabledAsserted when the hard-wired start controls have all required supervision enabledAsserted when the field start controls have all required supervision enabledAsserted when motor control center (MCC) start controls have all required supervision enabledAsserted when non of the control elements (Comms, Hard Wired, Field and MCC) is enabled
Ctrl Starts	Field Start AField Start BHard Wired Start AMCC Start AComm Start AHard Wired Start BMCC Start BComm Start B	On when the input associated with Field Start A is raisedOn when the input associated with Field Start B is raisedOn when the input associated with Hard Wired Start A is raisedOn when the Start A button is pressed in the GCP or BCPOn when the Start A command is recognized by communicationsOn when the input associated with Hard Wired Start B is raisedOn when the Start B button is pressed in the GCP or BCPOn when the Start B command is recognized by communications
Ctrl Stops	Stop CtrlHW StopField Stop	Asserted when a stop command is receivedAsserted when a hard-wired control contact input is holding the motor stoppedAsserted when a field control contact input is holding the motor stopped
Current Unbalance	UnbalanceUnbalance Alarm	Current Unbalance trip has operatedCurrent Unbalance alarm has operated

Element Name	Operands	Event Description
Data Logger	Data Logger Alarm	Data Logger buffer filled 80%
Drive Available	Drive Available Drive Start Fail Drive Stop Fail	On when motor is on or at least one start is active Expected to be assigned On within the Ramp Up Time during a start Expected to be assigned On when the Ramp Down Time expires during a stop
Fuse Fail	Fuse Fail Fuse Fail Inst	Asserted when a fuse failure trip/alarm function operates after the fixed 1 sec delay Asserted when fuse failure trip/alarm function operates instantaneously
Ground Fault	Ground Fault Ground Fault Alarm	Ground Fault Trip has operated Ground Fault Alarm has operated
In Serv.	In-Service	The relay is in-Service
Inconsistent Inputs	Inconsistent Inputs	Asserted when Inconsistent Inputs conditions exist.
Inhibits	Any Start Inhibit Low Aux Voltage Inhibit Thermal Inhibit Restart Inhibit Starts/Hr Inhibit Time Between Inhibit Fuse Fail Inhibit Phase Reversal Inhibit UVR Inhibit	On when any start inhibit is present Asserted when an auxiliary undervoltage condition inhibits starting Asserted when the motor is too hot to be started Asserted when the minimum restart time has not expired since the last motor start Asserted when the number of starts in the last 60 minutes has reached the set maximum Asserted when the minimum time between starts has not expired since the last motor start Asserted when a fuse fail condition inhibits starting Asserted when a phase reversal condition inhibits starting Asserted when the input associated with the UVR Inhibit is raised
Load Increase Alarm	Load Increase	Asserted when a load increase alarm condition exists
Loss of Comms	Loss Of Comms PKP Loss Of Comms OP	Loss Of Comms has picked up Loss Of Comms has operated
Mechanical Jam	Mechanical Jam	Mechanical Jam has operated
Motor Status	Running Starting Stopped	On when motor is running (finished starting) On when motor is coming up to speed, not yet running On when motor has stopped
Open Ctrl Cct	Open Ctrl Cct	Asserted when Open Control Circuit conditions exist
Phase IOC	Phase IOC 1 Phase IOC 2	At least one phase of phase IOC 1 has operated At least one phase of phase IOC 2 has operated
Phase Overvoltage	Overvoltage Overvoltage Alarm	Asserted when an overvoltage trip condition exists Asserted when an overvoltage alarm condition exists
Phase Reversal	Phase Reversal	Asserted when a phase reversal condition exists
Phase TOC	Phase TOC 1 Phase TOC 2	At least one phase of phase TOC 1 has operated At least one phase of phase TOC 2 has operated
Phase Undervoltage	Undervoltage Undervoltage Alarm	Asserted when an undervoltage trip condition exists Asserted when an undervoltage alarm condition exists
Power Factor	PF OP 1 PF OP 2	Power Factor 1 has operated Power Factor 2 has operated.

Element Name	Operands	Event Description
Process Interlock	IL AIL BIL CIL DIL EIL FIL GIL HIL IIL A Inst AlarmIL B Inst AlarmIL C Inst AlarmIL D Inst AlarmIL E Inst AlarmIL F Inst AlarmIL G Inst AlarmIL H Inst AlarmIL I Inst AlarmIL J Inst AlarmIL JIL A StopIL B StopIL C StopIL D StopIL E StopIL F StopIL G StopIL H StopIL I StopIL J Stop	Asserted upon a process interlock A command Asserted upon a process interlock B command Asserted upon a process interlock C command Asserted upon a process interlock D command Asserted upon a process interlock E command Asserted upon a process interlock F command Asserted upon a process interlock G command Asserted upon a process interlock H command Asserted upon a process interlock I command Asserted upon a process interlock A Instantaneous alarm command Asserted upon a process interlock B Instantaneous alarm command Asserted upon a process interlock C Instantaneous alarm command Asserted upon a process interlock D Instantaneous alarm command Asserted upon a process interlock E Instantaneous alarm command Asserted upon a process interlock F Instantaneous alarm command Asserted upon a process interlock G Instantaneous alarm command Asserted upon a process interlock H Instantaneous alarm command Asserted upon a process interlock I Instantaneous alarm command Asserted upon a process interlock J Instantaneous alarm command Asserted upon a process interlock J command Asserted upon a process interlock A stop command Asserted upon a process interlock B stop command Asserted upon a process interlock C stop command Asserted upon a process interlock D stop command Asserted upon a process interlock E stop command Asserted upon a process interlock F stop command Asserted upon a process interlock G stop command Asserted upon a process interlock H stop command Asserted upon a process interlock I stop command Asserted upon a process interlock J stop command
Remote GOOSE Rx Offline	Remote GOOSE Rx Offline	Asserts when any of configured GOOSE receptions are not being received and reset if all configured GOOSE receptions are received.
Reset	Lockout ResetRemote ResetThermal ResetReset	Lockout Reset contact input or Lockout Reset command is closed to reset lockout and non-lockout latches trips and alarms Remote reset contact input is closed to reset non-lockout trips and alarms BCP/GCP 'Reset' key is used to reset thermal capacity % to zero Lockout reset or Remote Reset is initiated
RTD	RTD 1RTD 1 AlarmRTD 2RTD 2 AlarmRTD 3RTD 3 AlarmRTD 4RTD 4 AlarmRTD 5RTD 5 AlarmRTD 6RTD 6 AlarmRTD Open AlarmRTD Short Alarm	RTD 1 trip function has operated RTD 1 alarm function has operated RTD 2 trip function has operated RTD 2 alarm function has operated RTD 3 trip function has operated RTD 3 alarm function has operated RTD 4 trip function has operated RTD 4 alarm function has operated RTD 5 trip function has operated RTD 5 alarm function has operated RTD 6 trip function has operated RTD 6 alarm function has operated RTD sensor is detected open RTD sensor is detected shorted
Security	Authentication LockoutAuthenticatio n FailUnauth Change AttemptLoginLogoutP rim Radius Srv UnavailableSec Radius Srv Unavailable	The authentication lockout has occurred because of too many failed authentication attempts Operand set for Failed Authentication self test and alarm Operand set for unauthorized setting change action An event meant to indicate when a certain role logged in An event meant to indicate when a certain role logged out or timed out Primary Radius server is unavailable Secondary Radius server is unavailable
Self-Test Monitor	Self-Test AlarmSelf- Test TripSNTP Failure PTP Failure	Self-Test Alarm is asserted when a minor or a major self-test condition exists Self-Test Trip is asserted when a major self-test condition exists Synchronization from a SNTP server failed Synchronization from a PTP master failed
Setpoint Access	Setting Change	An event to indicate setting change(s)
Starter Types Additional	Inverter Trip AlarmStopping	Expected to be assigned On when contactor B status unexpectedly opens while running Expected to be assigned On during speed ramp down

Element Name	Operands	Event Description
Starters Running Flags	Soft Starter BypassSpeed 2Hold Running StateBlock Running StateAutotr Open TranAutotr Closed Tran	Expected to be assigned On when the motor is ramped upAsserted when motor is running at high speedAsserted during the transfer time when both Contactor A Relay and Contactor B Relay are Off, but the motor is still considered to be runningExpected to be assigned On when even though Contactor A Relay or Contactor B Relay is On, the motor is not actually runningAutotransformer Open Transition Starter is selectedAutotransformer Closed Transition Starter is selected
Start-Stop	Any Stop Except UVRAny StopNot Any StopExternal Stop AlarmExternal Start A AlarmExternal Start B AlarmExternal Start AExternal Start BExternal Stop	On when any lockout, trip or stop other than UVR Stop is OnOn when any lockout, trip or stop is OnOn when no lockout, trip or stop is OnTurned On when stopped following an external stopTurned On when operating following an external A startTurned On when operating following an external B startPulsed On when external start A detectedPulsed On when external start B detectedPulsed On when external stop set to stop only is detected
Syslog	Clear EventsClear TransientClear Fault Records	Command is issued to clear eventsCommand is issued to clear transient recordsCommand is issued to clear fault records
Targets Active	Active Target	At least one target is detected active
Test Mode	Testing ON	Testing is enabled
Thermal OL	Thermal O/L TripThermal Level Alarm	Asserted when the thermal model has operated and the motor has cooled, but the trip has not yet been reset or locked outAsserted when the thermal capacity used alarm condition exists
Thermistor	ThermistorThermistor AlarmThermistor Trouble	Asserted when a thermistor trip condition existsAsserted when a thermistor alarm condition existsAsserted when a thermistor sensor is open or short circuit
Undercurrent	UndercurrentUndercu rent Alarm	Undercurrent trip has operatedUndercurrent alarm has operated
Underpower	UnderpowerUnderpo wer Alarm	Underpower trip has operatedUnderpower alarm has operated
UV Restart	UVR PendingUVR Backup ProtectionUVR AUVR BUVR Immediate AUVR Immediate BUVR Stop	Asserted when UVR pending condition existsAsserted when short circuit or thermal overload or mechanical jam condition exists when motor is restarted by UVR functionAsserted when any of the UV Restart conditions exists to close contactor AAsserted when any of the UV Restart conditions exists to close contactor BAsserted when immediate restart conditions exist to close contactor AAsserted when immediate restart conditions exist to close contactor BAsserted when UVR does not initiate Restart while the restart is in progress
Voltage Unbalance	V2/V1 1V2/V1 2	Voltage Unbalance 1 OperatedVoltage Unbalance 2 Operated
Welded Contact	Welded Contcr	Asserted when Welded Contract conditions exist

Some operands can be re-named by the user. These are the names of the breakers in the breaker control feature and the ID of contact inputs, virtual inputs and virtual outputs. If the user changes the default name or ID of any of these operands, the assigned name will appear in the relay list of operands. The default names are shown in the FlexLogic™ operands table above.

FlexLogic operators

TYPE	SYNTAX	DESCRIPTION	NOTES
Editor	INSERT	Insert a parameter in an equation list.	
	DELETE	Delete a parameter from an equation list.	
End	END	The first END encountered signifies the last entry in the list of processed FlexLogic™ parameters.	
Logic gate	NOT	Logical NOT	Operates on the previous parameter.

TYPE	SYNTAX	DESCRIPTION	NOTES
	OR(2)↓ OR(16)	2 input OR gate↓ 16 input OR gate	Operates on the 2 previous parameters.↓ Operates on the 16 previous parameters.
	AND(2)↓ AND(16)	2 input AND gate↓ 16 input AND gate	Operates on the 2 previous parameters.↓ Operates on the 16 previous parameters.
	NOR(2)↓ NOR(16)	2 input NOR gate↓ 16 input NOR gate	Operates on the 2 previous parameters.↓ Operates on the 16 previous parameters.
	NAND(2)↓ NAND(16)	2 input NAND gate↓ 16 input NAND gate	Operates on the 2 previous parameters.↓ Operates on the 16 previous parameters.
	XOR(2)	2 input Exclusive OR gate	Operates on the 2 previous parameters.
	LATCH (S,R)	Latch (set, reset): reset-dominant	The parameter preceding LATCH(S,R) is the reset input. The parameter preceding the reset input is the set input.
	Positive One Shot	1	The output value is On for one processing cycle following an Off to On transition of the input value.
	Negative One Shot	1	The output value is On for one processing cycle following an On to Off transition of the input value.
	Dual One Shot	1	The output value is On for one processing cycle following either an On to Off or an Off to On transition of the input value.
Timer	TIMER 1↓ TIMER 32	Timer set with FlexLogic™ timer 1 settings.↓ Timer set with FlexLogic™ timer 32 settings.	The timer is started by the preceding parameter. The output of the timer is TIMER #.
Assign virtual output	= Virt Op 1↓ = Virt Op 128	Assigns previous FlexLogic™ operand to virtual output 1.↓ Assigns previous FlexLogic™ operand to virtual output 96.	The virtual output is set by the preceding parameter

FlexLogic™ gate characteristics

GATES	NUMBER OF INPUTS	OUTPUT IS '1' (= ON) IF...
NOT	1	input is '0'
OR	2 to 16	any input is '1'
AND	2 to 16	all inputs are '1'
NOR	2 to 16	all inputs are '0'
NAND	2 to 16	any input is '0'
XOR	2	only one input is '1'

FLEXLOGIC™ RULES

When forming a FlexLogic equation, the sequence in the linear array of parameters must follow these general rules:

1. Operands must precede the operator which uses the operands as inputs.
2. Operators have only one output. The output of an operator must be used to create a virtual output if it is to be used as an input to two or more operators.
3. Assigning the output of an operator to a virtual output terminates the equation.
4. A timer operator (for example, TIMER 1) or virtual output assignment (for example, = Virt Op 1) may only be used once. If this rule is broken, a syntax error will be declared.

FLEXLOGIC™ EVALUATION

Each equation is evaluated in the order in which the parameters have been entered.

FlexLogic™ provides latches, which by definition have a memory action, remaining in the set state after the set input has been asserted. However, they are volatile; that is, they reset on the re-application of control power. When making changes to settings, all FlexLogic™ equations are re-compiled whenever any new setting value is entered, so all latches are automatically reset. If it is necessary to re-initialize FlexLogic™ during testing, for example, it is good practice to power the unit down and then back up.

6.6.2 TIMERS

There are 32 identical FlexLogic™ timers available. These timers can be used as operators for FlexLogic™ equations.

Path: *Setpoints > FlexLogic > Timers > Timer 1(X)*

Timer 1 Mode

Range: Pickup, Dropoff, Dwell, Pulse, Pickup/Dropoff

Default: Pickup

Timer 1 Pickup Delay

Range: 0 to 14,400,000 ms in steps of 1 ms

Default: 0 ms

Timer 1 Dropoff Delay

Range: 0 to 14,400,000 ms in steps of 1 ms

Default: 0 ms

6.6.3 NON-VOLATILE LATCHES

The purpose of a non-volatile latch is to provide a permanent logical flag that is stored safely and does not reset when the relay reboots after being powered down. Typical applications include sustaining operator commands or permanently blocking relay functions such as autorecloser, until a deliberate HMI action resets the latch.

Operation of the element is summarized in the following table:

Non-volatile latch logic

LATCH 1 TYPE	LATCH 1 SET	LATCH 1 RESET	LATCH 1 ON	LATCH 1 OFF
Reset Dominant	On	Off	On	Off
	Off	Off	Previous State	Previous State
	On	On	Off	On
	Off			
Set Dominant	On	Off	On	Off
		On		
	Off	Off	Previous State	Previous State
	Off	On	Off	On

Path: *Setpoints > FlexLogic > Non-volatile Latches > Non-Volatile Latch 1(X)*

NV Latch 1 Name

Range: Any combination of 13 alphanumeric characters

Default: NV Latch 1

NV Latch 1 Type

Range: Reset-Dominant, Set-Dominant

Default: Reset-Dominant

The setting characterizes NV Latch 1 to be set- or reset-dominant.

NV Latch 1 Set

Range: Any FlexLogic operand

Default: Off

NV Latch 1 is SET when the specified FlexLogic operand is asserted.

NV Latch 1 Reset

Range: Any FlexLogic operand

Default: Off

NV Latch 1 is RESET when the specified FlexLogic operand is asserted.

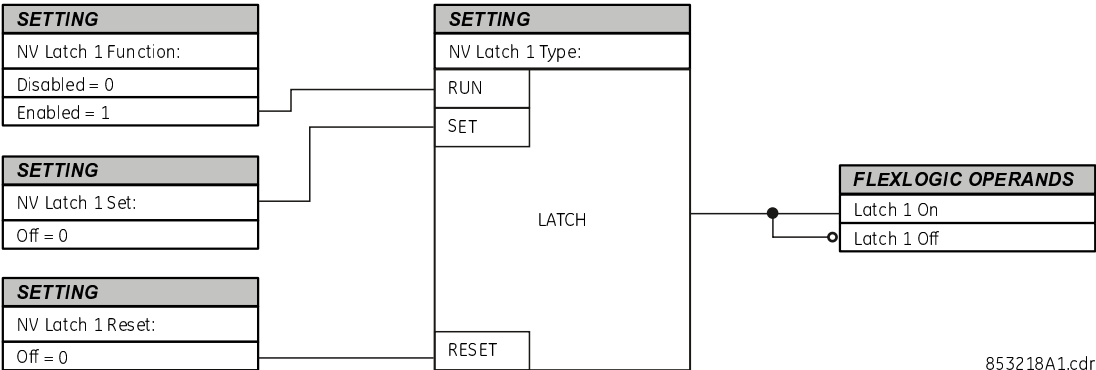


Figure 118: Non-volatile latch logic diagram

6.7 TESTING

The MM300 Enhanced Testing feature can be used to test LEDs, Contact Inputs and Contact Output Relays.

6.7.1 SETPOINTS

6.7.1.1 GENERAL

The relay enters into test mode when any of the test operations (Simulation, Contact Inputs, Contact Output Relays, LEDs or Analog Outputs) is programmed to “Enabled”. The actual system parameters are not monitored, including Current, Voltage, and Contact Inputs.

Path: *Setpoints > Testing > General*

Force LEDs

Range: Enabled, Disabled

Default: Disabled

When “Enabled”, the relay enters into test mode and LED states and colors can be forced from the **Setpoints > Testing > Force LEDs** menu. This will override the normal operation of the LEDs. When “Disabled”, the LED states and colors will maintain their normal operation.

Force Contact Inputs

Range: Enabled, Disabled

Default: Disabled

When **FORCE CONTACT INPUTS** is “Enabled”, the relay enters into test mode and contact inputs states can be forced from the **Setpoints > Testing > Force Contact Inputs** menu. This will override the normal operation of the input contacts. When **FORCE CONTACT INPUTS** is “Disabled”, the relay states will maintain their normal operation.

Force Relays

Range: Enabled, Disabled

Default: Disabled

When **FORCE RELAYS** is “Enabled”, the relay enters into test mode and contact inputs states can be forced from the **Setpoints > Testing > Force Output Relays** menu. This will override the normal operation of the output contacts. When **FORCE RELAYS** is “Disabled”, the relay states will maintain their normal operation. .

6.7.1.2 TEST LEDs

This function is used to program the state and color of each LED when **FORCE LEDs** is “Enabled”.

Note:

Test LEDs setpoints will revert to default values at power-up.

Path: *Setpoints > Testing > Test LEDs*

LED 1(12)

Range: Off, Red, Green, Orange

Default: Off

6.7.1.3 CONTACT INPUTS

This function is used to program the state of each contact input when **FORCE CONTACT INPUTS** is “Enabled”. The number of Contact Inputs available is dependent on the installed Order Code options.

Note:
Contact Inputs setpoints will revert to default values at power-up.

Path: *Setpoints > Testing > Contact Inputs*

CI 1(X)

Range: Off, On

Default: Off

The item name will display the user-configurable name for the Contact Input.

6.7.1.4 OUTPUT RELAYS

This function is used to program the state of each output relay when **FORCE RELAYS** is “Enabled”. Select “Off” to force the output relay to the de-energized state, or select “On” to force the output relay to the energized state. The number of Output Relays available is dependent on the installed Order Code options.

Note:
Output Relays setpoints will revert to default values at power-up.

Path: *Setpoints > Testing > Output Relays*

Output Relay 1(X)

Range: Off, On

Default: Off

CHAPTER 7

STATUS AND ACTUAL VALUES

7.1 **CHAPTER OVERVIEW**

This chapter contains the following sections:

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7.2 SUMMARY

Path: **Summary** > **Home**

Extended Status

Range: Stopped, Pre-contactor, Starting, Running, UVR Pending, Blocked, Inhibit, Self-Test Fault, Alarm, Forward, Reverse, Low Speed, High Speed

Default: Stopped

Stopped: State is changed to Stopped when motor stops.

Pre-contactor: This status remains asserted during time between the start command initiation and before the motor is started. The time duration is defined by setpoint **PRE-CONTACTOR TIME**.

Starting: The MM300 Enhanced declares the *Starting* state when either contactor A or contactor B closes.

Running: This state is asserted when motor is successfully started and finishes starting condition. Running is declared when either contactor has been closed for one second, and then current is found to be below $1 \times \text{FLA}$.

UVR Pending: This status is asserted whilst the UVR timer is counting down. During UVR Pending, any stop or trip will immediately cancel the restart sequence.

Blocked: This is the status when any block is asserted.

Inhibit: This state is asserted when any of the start inhibits (Thermal Start Inhibit, Starts/Hour Inhibit, Time Between Starts Inhibit, and Restart Delay Inhibit) are true.

Self-Test Fault: Status is changed to Self-Test Fault when either Self-test Alarm or Self-test Trip is true.

Alarm: This is the state when any alarm is asserted.

Forward: In *FV Reversing STARTER TYPE* application, this will be the status when contactor A relay picks up and starts the motor in forward direction.

Reverse: In *FV Reversing STARTER TYPE* application, this will be the status when contactor A relay drops out and the set **TRANSFER TIME** times out, the contactor B relay picks up and seals-in, starting the motor in the reverse direction.

Low Speed: In two-speed motor application, the state is changed to *Low Speed* when any Start A command is initiated.

High Speed: In two-speed motor application, the state is changed to *High Speed* when any Start B command is initiated.

Drive Status

Range: Drive Unavailable, Available Auto, Available Manual, Available, Running, ESD Trip/Stop

Default: 0

Motor Load

Range: 0 to 2000% in steps of 1%

Default: 0%

Thermal Cap Used

Range: 0 to 100% in steps of 1%

Default: 0%

3ph Active Power

Range: -50,000.0 to 50,000.0 kW in steps of 0.1 kW

Default: 0.0 kW

Pre-Contactor Timer

Range: 0 to 65,535 s in steps of 1 s

Default: 0 s

Time to Overload Trip

Range: 0 to 65,000 s in steps of 1 s

Default: 0 s

Thermal Lockout Time

Range: 0 to 600 min in steps of 1 min

Default: 0 min

Time to Reset

Range: 0 to 65,000 s in steps of 1 s

Default: 0 min

Starts/Hr Block

Range: 0 to 60 s in steps of 1 s

Default: 0 s

Time Between Starts

Range: 0 to 3600 s in steps of 1 s

Default: 0 s

Transfer Timer

Range: 0 to 65,535 s in steps of 1 s

Default: 0 s

UVR Timer

Range: 0 to 65,535 s in steps of 1 s

Default: 0 s

Power Loss Time

Range: 0 to 65,535 s in steps of 1 s

Default: 0 s

Restart Block Time

Range: 0 to 30,000 s in steps of 1 s

Default: 0 s

Average Line Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

7.3 STATUS

7.3.1 PRODUCT INFORMATION

Path: *Status > Product Information*

The above path displays the fixed system information, including the Order Code, Product Serial #, Hardware Revision, Firmware Status, Firmware Version, Firmware Date, Firmware Time, Boot Version, Boot Date, Boot Time, IEC61850 Version, MAC Address, Database Version, Database Data, and Database Time

- Order Code: The installed Order Code
- Product Serial #: The relay serial number
- Hardware Revision: The hardware revision of the relay
- Firmware Version: The firmware version of the Main CPU
- Firmware Date: The Main CPU firmware build date in the format mm/dd/yyyy
- Firmware Time: The Main CPU firmware build time
- Boot Version: The boot code version of the Main CPU
- Boot Date: The Main CPU boot code build date in the format mm/dd/yyyy
- Boot Time: The Main CPU boot code build time
- Database Version: The database version of the Main CPU
- Database Data: The database version date in the format mm/dd/yyyy
- Database Time: The database time IEC61850 Version
- MAC Address 1/2: The MAC address for copper Ethernet port 1 and 2

7.3.2 DIGITAL INPUT FUNCTIONS

Path: *Status > Inputs*

The page accessed via the above path displays status messages of the following digital input functions:

Access Switch, Auto/Manual Switch, Comms Permissive, Contactor Status A/B/C, Field Permissive, Field Start A/B, Field Stop, Forward Limit, Hard Wired Permissive, Hard Wired Start A/B, Hard Wired Stop, Process Interlock A/J, Lockout Reset, MCC Permissive, Remote Reset, Reverse Limit, Test Switch, UVR Inhibit

Range: Off, On

Default: Off

7.3.3 CONTACT INPUT STATUS

Path: *Status > Contact Inputs*

The page accessed via the above path displays the contact input status.

Contact Input 1 to 30

Range: Off, On

Default: Off

7.3.4 OUTPUT RELAY STATUS

Path: *Status > Output relays*

The page accessed via the above path displays the status of the output relays.

Output Relay 1 to 18

Range: Off, On

Default: Off

7.3.5 VIRTUAL INPUT STATUS

Path: *Status > Virtual Inputs*

The page accessed via the above path displays the status of the virtual inputs.

Virtual Inputs 1 to 128

Range: Off, On

Default: Off

7.3.6 VIRTUAL OUTPUT STATUS

Path: *Status > Virtual Outputs*

The page accessed via the above path displays the status of the virtual outputs.

Virtual Outputs 1 to 128

Range: Off, On

Default: Off

7.3.7 COMMUNICATIONS

7.3.7.1 PRP COUNTERS

Path: *Status > Comms > PRP Counters*

Total Rx PortA

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received on Port A.

Total Rx PortB

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received on Port B.

Total Err PortA

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received with an error on Port A.

Total Err PortB

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received with an error on Port B.

7.3.7.2 HSR COUNTERS

Path: *Status > Comms > HSR Counters*

Total Rx PortA

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received on Port A.

Total Rx PortB

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received on Port B.

Total Err PortA

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received with an error on Port A.

Total Err PortB

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Counter for the total messages received with an error on Port B.

7.3.7.3 REMOTE INPUTS

Path: *Status > Comms > Remote Inputs*

Remote Input 1/128

Range: Off, On

Default: Off

7.3.7.4 REMOTE INPUTS DPS

Path: *Status > Comms > Remote Inputs DPS*

RI DPS 1/16

Range: Intermediate, Off, On, Bad-State

Default: Intermediate

7.3.7.5 REMOTE OUTPUTS

Path: *Status > Comms > Remote Outputs*

Remote O/P 1/64

Range: Off, On

Default: Off

7.3.7.6 GOOSE STATUS

Path: *Status > Comms > GOOSE status*

GOOSE Status 1/32

Range: Off, On

Default: Off

7.3.7.7 GOOSE HEADER

Path: *Status > Comms > GOOSE header*

GOOSE Header 1/32

Range: Off, On

Default: Off

7.3.7.8 GOOSE ANALOG

Path: *Status > Comms > GOOSE Analog*

GOOSE Float 1/24

Range: ?

Default: 0

GOOSE SINT32 1/8

Range: ?

Default: 0

7.3.7.9 IEC 61850 STATUS

Path: *Status > Comms > IEC 61850 Status*

Comms NV OK

Range: No, Yes

Default: No

Comms NV Done

Range: No, Yes

Default: No

Comms V OK

Range: No, Yes

Default: No

Comms V Done

Range: No, Yes

Default: No

Main NV OK

Range: No, Yes

Default: No

Main NV Done

Range: No, Yes

Default: No

Main V OK

Range: No, Yes

Default: No

Main V Done

Range: No, Yes

Default: No

NR. Error CID

Range: No, Yes

Default: No

R. Default CID

Range: No, Yes

Default: No

R. Saving CID to Flash

Range: No, Yes

Default: No

CID Handling Done

Range: No, Yes

Default: No

Number of Connected Clients

Range: 0 to 8 in steps of 1

Default: 0

Client 1/8 IP Address

Range: 0 to 0xFFFFFFFF

Default: 0

IEC61850 Version

Range: 0 to 65535 in steps of 1

Default: 0

7.3.7.10 ACTIVITY STATUS

Path: *Status > Comms > Activity Status*

Serial Modbus

Range: None, Active

Default: None

Ethernet Modbus

Range: None, Active

Default: None

Profibus

Range: None, Active

Default: None

7.3.7.11 FLEXMAP

Path: *Status > Communications > FlexMap*

Device Name

Range: 32 Alphanumeric characters

Default: 0

Client 1/8 IP Address

Range: No file, File error, File OK

Default: No file

7.3.8 REAL TIME CLOCK

Path: *Status > Real Time Clock*

RTC Sync Source

Range: None, ETH1 PTP Clock, ETH2 PTP Clock, ETH3 PTP Clock, SNTP Server 1, SNTP Server 2

Default: None

Date

Range: 01/01/2000 to 12/31/2099

Default: 01/01/2000

Time

Range: 00:00:00:00 to 23:59:59:99

Default: 00:00:00:00

Weekday

Range: SUN, MON, TUE, WED, THU, FRI, SAT

Default: SUN

Daylight Saving Active

Range: Disabled, Enabled

Default: Disabled

7.3.9 PTP

Path: **Status** > **PTP**

Grandmaster ID

Range: 8 alphanumeric characters

Default: None

ETH1 PTP State

Range: Disabled, No Signal, Calibrating, Synchronized

Default: No signal

ETH2 PTP State

Range: Disabled, No Signal, Calibrating, Synchronized

Default: No signal

ETH3 PTP State

Range: Disabled, No Signal, Calibrating, Synchronized

Default: No signal

7.4 STATUS AND ACTUAL VALUES

7.4.1 SUMMARY

Path: *Actual Values* > *Summary*

Ph Ia/Ib/Ic RMS

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Current Unbal

Range: 0.0 to 100.0% in steps of 0.1%

Default: 0.0%

Vab/Vbc/Vca Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Frequency

Range: 0.00 to 120.00 Hz

Default: 0.0 Hz

3ph Active Power

Range: -2,000.0 to 2,000.0 kW in steps of 0.1 kW

Default: 0.0 kW

3ph Apparent Power

Range: 0.0 to 2,500.0 kVA in steps of 0.1 kVA

Default: 0.0 kVA

3ph Reactive Power

Range: -2,000.0 to 2,000.0 kvar in steps of 0.1 kvar

Default: 0.0 kvar

3ph Power Factor

Range: -0.99 to 1.00 in steps of 0.01

Default: 0.00

7.4.2 AMPS

Path: *Actual Values* > *Amps*

Ph Ia/Ib/Ic DFT

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Gn Ig DFT

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Ph Ia/Ib/Ic Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Gnd Ig Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Ph Ia/Ib/Ic RMS

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Gnd Ig RMS

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Ph Average RMS

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Motor Load

Range: 0 to 2000% of FLA in steps of 1%

Default: 0% of FLA

7.4.3 VOLTS

Path: *Actual Values* > *Volts*

Ph Va/Vb/Vc Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Auxiliary Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Ph Va/Vb/Vc Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Vaux Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Vab/Vbc/Vca Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Average Ph Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Average Line Voltage

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Voltage Unbal

Range: 0.0 to 100% in steps of 1%

Default: 0.0%

7.4.4 POWER

Path: *Actual Values* > *Power*

Ph A/B/C Active Power

Range: -2,000.0 to 2,000.0 kW in steps of 0.1 kW

Default: 0.0 kW

Ph A/B/C Apparent Power

Range: 0.0 to 2,500.0 kVA in steps of 0.1 kVA

Default: 0.0 kVA

Ph A/B/C Reactive Power

Range: -2,000.0 to 2,000.0 kvar in steps of 0.1 kvar

Default: 0.0 kvar

Ph A/B/C Power Factor

Range: -0.99 to 1.00 in steps of 0.01

Default: 0.00

3ph Active Power

Range: -2,000.0 to 2,000.0 kW in steps of 0.1 kW

Default: 0.0 kW

3ph Apparent Power

Range: 0.0 to 2,500.0 kVA in steps of 0.1 kVA

Default: 0.0 kVA

3ph Reactive Power

Range: -2,000.0 to 2,000.0 kvar in steps of 0.1 kvar

Default: 0.0 kvar

3ph Power Factor

Range: -0.99 to 1.00 in steps of 0.01

Default: 0.00

MWh Consumption

Range: 0.000 to 999,999.999 Mwh in steps of 0.001 Mwh

Default: 0.000 Mwh

MVarh Consumption

Range: 0.000 to 999,999.999 Mvarh in steps of 0.001 Mvarh

Default: 0.000 Mvarh

7.4.5 SEQUENCE

Path: *Actual Values* > *Sequence*

Current Unbal

Range: 0.0 to 100.0% in steps of 0.1%

Default: 0.0%

Positive Seq (I1)

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Negative Seq (I2)

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Zero Seq (I0)

Range: 0.0 to 50,000.0 A in steps of 0.1 A

Default: 0.0 A

Positive Seq (I1) Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Negative Seq (I2) Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Zero Seq (I0) Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Voltage Unbal

Range: 0.0 to 100.0% in steps of 0.1%

Default: 0.0%

Positive Seq (V1)

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Negative Seq (V2)

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Zero Seq (V0)

Range: 0 to 20,000 V in steps of 1 V

Default: 0 V

Positive Seq (V1) Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Negative Seq (V2) Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

Zero Seq (V0) Angle

Range: 0.0 to 359.9 in steps of 0.1

Default: 0.0

7.4.6 SENSOR

Path: *Actual Values* > *Sensor*

Internal Temp

Range: -40 to 125° C in steps of 1° C

Default: 0° C

Hottest Stator RTD#

Range: 0 to 6 in steps of 1

Default: 0

Hottest Stator RTD Temp

Range: -50 to 251° C in steps of 1° C

Default: 0° C

RTD 1/2/3/4/5/6 Temp

Range: -50 to 251° C in steps of 1° C

Default: 0° C

RTD 1/2/3/4/5/6 Max Temp

Range: -50 to 251° C in steps of 1° C

Default: 0° C

Thermistor

Range: 0 to 65,535 Ω in steps of 1 Ω

Default: 0 Ω

7.4.7 CALIBRATION

Path: *Actual Values* > *Calibration*

Original Calibration Date

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Original Calibration Time

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Last Calibration Date

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Last Calibration Time

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

CHAPTER 8

DIAGNOSTICS

8.1 **CHAPTER OVERVIEW**

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8.2 **DIAGNOSTICS**

The Diagnostics pages display typical diagnostic information, including the event recorder, learned data, phasors, system counters, and system information. In the event of a trip or alarm, the Diagnostic pages are often very helpful in diagnosing the cause of the condition.

8.3 COUNTERS

Path: *Diagnostics* > *Counters*

This page displays the values of the various MM300 Enhanced digital counters.

The total number of trips by type are displayed on this screen. Trip counters are typically used for scheduling inspections on equipment, performing qualitative analysis of system problems and spotting trends. Several general counters are also available.

Total Number of Trips, Overload Trips, Mechanical Jam Trips, Undercurrent Trips, Current Unbalance Trips, Ground Fault Trips, Motor Acceleration Trips, Undervoltage Trips, Overvoltage Trips, Voltage Phase Reversal Trips, Underpower Trips

Range: 0 to 65,535 trips in steps of 1 trip

These values display a breakdown of number of trips by type. When the total number of trips for any counter exceeds 65,535, that counter is reset to 0. To clear this value, use the clear counters command.

Number of Motor Starts

Range: 0 to 65,535 starts in steps of 1 start

This value displays the number of accumulated motor starts or start attempts. This value may be useful information when troubleshooting a motor failure. When this counter exceeds 65,535 starts, it will reset to 0. To clear this value, use the clear maintenance timers command.

Motor Running Hours

Range: 0 to 100,000 hours in steps of 1 hour

The motor running hours timer accumulates the total running time for the motor. This value may be useful for scheduling routine maintenance. Counter will roll over to zero after range is exceeded. To clear this value, use the clear maintenance timers command and start the motor.

Motor Stopped Hours

Range: 0 to 65,535 hours in steps of 1 hour

The motor stopped hours timer accumulates the total stopped time for the motor. This value may be useful for scheduling routine maintenance. To clear this value, use the clear maintenance timers command and stop the motor.

Note:

*The above clear commands can also be sent directly from the Graphical Control Panel, by highlighting the value then pressing **Clear**. Setpoint access *Engineer* is required.*

8.4 LEARNED DATA

Path: *Diagnostics* > *Learned Data*

The MM300 Enhanced measures and records individual data records. The latest individual data record set can be viewed using the learned data feature. The data, when input cumulatively to the learned data recorder can be used to evaluate changes or trends over time. Note that learned values are calculated even when the features requiring them are disabled.

The learned data recorder measures and records up to 250 data record sets, all from actual motor operation. The recorder can only be retrieved using EnerVista Flex software.

Clearing learned data (*Diagnostics* > *Commands* > *Clear Learned Data*) resets all these values to their minimum values and clears the stored file. The date and time are recorded when clearing and a Clear Learned Record event is sent to the event recorder. The next record will be captured after N successful starts.

Note:

Each of the learned features discussed below should not be used until at least N successful motor starts and stops have occurred, where N is defined by the **NUMBER OF STARTS TO LEARN** setting in *Setpoints* > *Configure* > *Motor Settings*.

Note:

Any motor start that is initiated by the MM300 Enhanced undervoltage restart function is not taken into account when calculating the start learned data such as **LEARNED ACCELERATION TIME**, **LEARNED STARTING CURRENT**, **LEARNED STARTING CAPACITY**, **LAST ACCELERATION TIME**, **LAST STARTING CURRENT**, and **LAST START TCU**.

Records Since Clear

This setting shows the number of records since the last clear.

Last Clear Date/Time

Range: MM/DD/YY HH:MM:SS

This setting shows the date and time on which the record was last cleared.

Learned Acceleration Time

Range: 0.0 to 200.0 s in steps of 0.1 s

If motor load during starting is relatively consistent, the learned acceleration time may be used to fine tune the acceleration protection. Learned acceleration time will be the greatest time of the last N successful starts where N is defined by the **# OF STARTS TO LEARN** setting. The time is measured from the transition of motor current from zero to greater than overload pickup, until line current falls below the overload pickup level.

Learned Starting Current

Range: 0.00 to 20.00 x FLA in steps of 0.01 x FLA

The learned starting current is measured 200 ms after the transition of motor current from zero to greater than overload pickup. This should ensure that the measured current is symmetrical. The value displayed is the average of the last N successful starts where N is defined by the **# OF STARTS TO LEARN** setting. If there are less than five starts, a value of 0 seconds will be averaged in for the full five starts.

Learned Starting Capacity

Range: 0 to 100% in steps of 1%

The learned starting capacity is used to determine if there is enough thermal capacity to permit a start. If there is not enough thermal capacity available for a start, a start inhibit will be issued. Starting will be blocked until there is

sufficient thermal capacity available. The learned start thermal capacity is the largest start thermal capacity used value calculated by the thermal model over the last N successful starts, where N is defined by the setting # **OF STARTS TO LEARN**. Start thermal capacity used is the amount of thermal capacity used during starting. A successful motor start is the one in which the motor reaches the running state.

If the thermal capacity used during starting is relatively consistent, the learned start thermal capacity used value plus suitable margin may be used to manually fine-tune the thermal start inhibit margin. See Start inhibits for a description of how the learned start thermal capacity used is calculated. The learned start thermal capacity used value should not be used until at least N successful motor starts have occurred.

Last Acceleration Time

Range: 0.0 to 250.0 s in steps of 0.1 s

The last acceleration time is measured after a successful motor start.

Last Starting Current

Range: 0.00 to 20.00 x FLA in steps of 0.01 x FLA

The last starting current is measured after a successful motor start.

Last Start TCU

Range: 0 to 100% in steps of 1%

The last start thermal capacity used is measured after a successful motor start.

Last Start Date/Time

Range: MM/DD/YY HH:MM:SS

This setting specifies the date and time of the last start.

Last Run Time (Days)

Range: 0 to 100,000 in steps of 1

Last Run Time (Hr/Min)

Range: 00:00 to 23:59

When the motor status transitions from starting to running, this time is recorded. Then, another time is recorded when the motor transitions from running to stopped. **LAST RUN TIME** is the difference between these two times.

Learned Average Load

Range: 0.00 to 20.00 x FLA in steps of 0.01 x FLA

The MM300 Enhanced can learn the average motor load over a period of time. This setting is the average motor current, expressed as a multiple of FLA over a period of time, when the motor status is *Running*. The period of data window is t_{AVER} , specified in the **LOAD AVERAGE CALC. PERIOD** setting, which is programmed under **Setpoints > Configure > Motor Settings**. If the run time of a start/stop sequence is less than t_{AVER} , the **LEARNED AVERAGE LOAD** will average all available samples. The calculation is ignored during motor starting. The data will be updated every t_{AVER} minutes once the motor status is *Running*. In the case of two-speed motors with different FLA values for the two speeds, the FLA used for each current sample is the one in effect at the time that sample was taken.

Learned Average kW

Range: 0.0 to 100,000.0 kW in steps of 0.1 kW

This setting provides the average motor real power when the motor status is *Running*. The period of data window is t_{AVER} , specified by **LOAD AVERAGE CALC. PERIOD**. If the run time of a start/stop sequence is less than t_{AVER} , the **LEARNED AVERAGE KW** will average all available samples. The calculation is ignored whilst the motor is starting. The data will be updated every t_{AVER} minutes once the motor status is *Running*.

Learned Average kVar

Range: 0.0 to 100,000.0 kVar in steps of 0.1 kVar

This setting provides the average motor reactive power when the motor status is *Running*. The method used is the same as for the **LEARNED AVERAGE KW** setting.

Learned Average PF

Range: -0.99 to 1.00 in steps of 0.01

This setting provides the average motor power factor when the motor status is *Running*. The method used is the same as for the **LEARNED AVERAGE KW** setting.

Average Run Time (Days)

Range: 0 to 100,000 in steps of 1

Average Run Time (Hr/Min)

Range: 00:00 to 23:59

This setting uses the time the last N start record is saved, where N is defined by the setting **NUMBER OF STARTS TO LEARN**. If the number of minutes' run time exceeds 59, the **AVERAGE RUN TIME (HR/MIN)** is increased by one, and this value rolls over to zero and starts again. If the number of hours exceeds 23, the **AVERAGE RUN TIME (DAYS)** is increased by one, and this value also rolls over to zero and starts again.

RTD 1(X) Max Temp

Range: -50 to 250°C in steps of 1°C

This setting records the maximum temperature experienced by each of the RTDs. Once per second, each of the RTD temperature values is captured. For each RTD, if the RTD temperature value is greater than the RTD maximum temperature already stored, the RTD maximum temperature is set to this latest value. The RTD maximum temperature values are maintained in non-volatile memory to carry over a relay power interruption. RTD elements shall be configured accordingly.

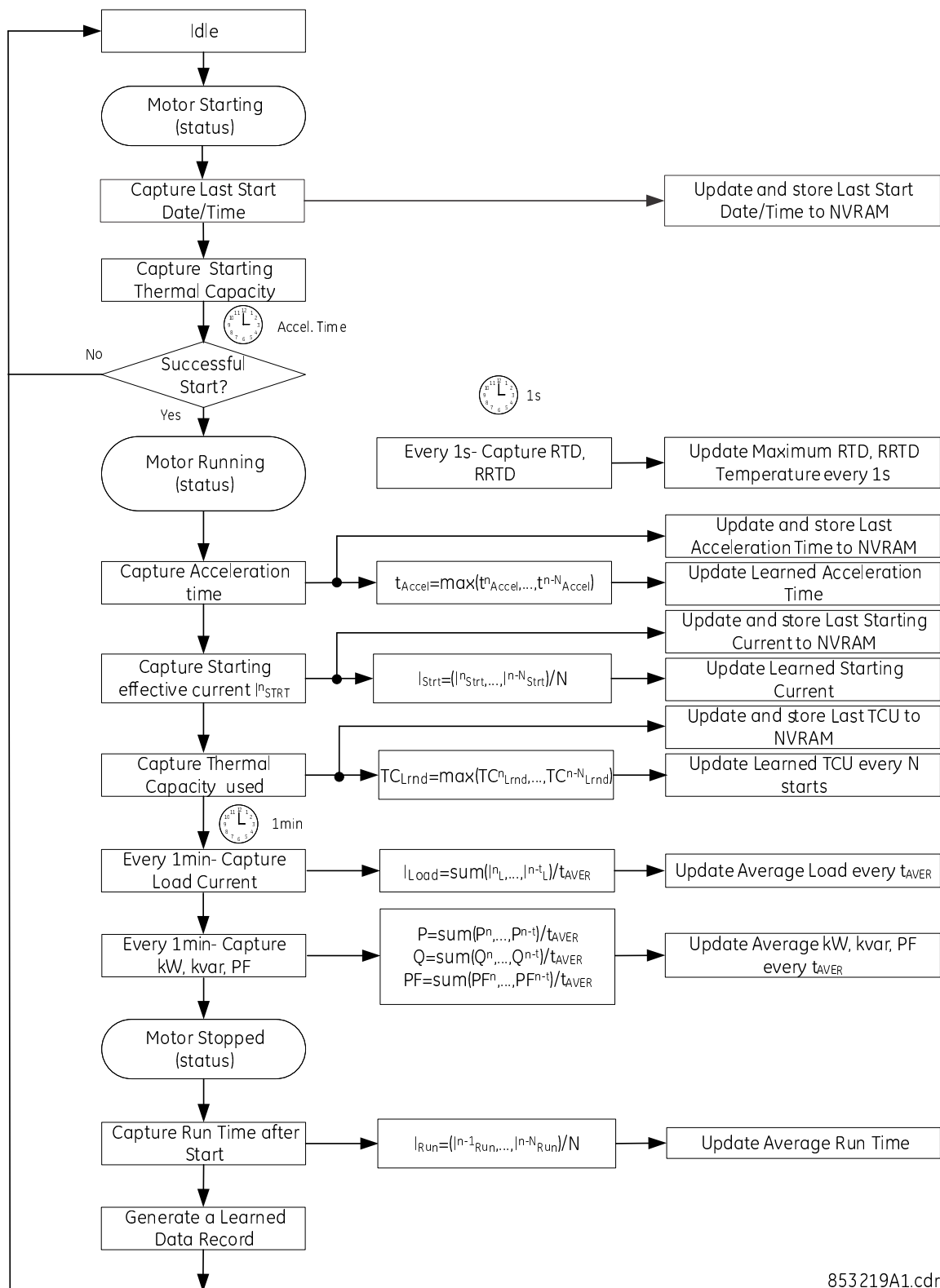


Figure 119: Motor learned data function

8.5 EVENTS

Path: *Diagnostics > Events*

When this page is accessed, the EnerVista Flex will load and format an event list from the event recorder. After a short length of time (depending on the number of recorded events), the green `Loading...Complete` indicator will become active, and an event list will be loaded with the most recent event placed at the top of the list, and the oldest at the bottom. The most recent event is automatically selected. If a new event occurs while viewing the event page, the event list will automatically reorganize itself and place the newest event first. The addition of new events while the event list is being viewed will not reset the event screen to the top of the page unless the newest event is being viewed. If there are no events in the event recorder, then this page will be empty.

On the front panel, individual events are selected by using the UP and DOWN keys to highlight the event then pressing the ENTER key. This will display a pop-up window with the event details.

8.6 LAST TRIP DATA

Path: *Diagnostics > Last Trip Data*

Cause

Range: None to date, Any FlexLogic operand

Default: None to date

Event

Range: 0 to 4,294,967,295 in steps of 1

Default: 0

Date

Range: MM/DD/YY HH:MM:SS

Default: 01/01/08 00:00:00

Parameter 1 - 64

Range: -2,147,483,648 to 2,147,483,647 in steps of 1

Default: 0

8.7 WAVEFORM

Path: *Diagnostics* > *Waveform*

The waveform page displays the MM300 Enhanced waveform parameters.

Transient Records Since Last Clear

Range: 0 to 65,565 in steps of 1

This setting gives a count of waveform triggers since the Clear Waveform command was sent.

Transient Records Available

Range: 1 to 16 in steps of 1

Date

Range: MM/DD/YY HH:MM:SS

8.8 DATALOG

Path: *Diagnostics* > *Datalog*

The datalog page displays typical diagnostic information.

Note:
Not all the diagnostic parameters are shown in this manual.

of Triggers Since Clear

Range: 0 to 65,565 in steps of 1

This setting gives a count of datalog triggers since the Clear Data Logger command was sent.

of Datalog Samples Stored

Range: 0 to 80,000 in steps of 1

This provides a count of samples stored in the datalog for the current trigger cause.

Trigger Cause

Range: Any FlexLogic operand

This provides the date of the current trigger.

Trigger Date

This provides the date of the current trigger.

Trigger Time

This provides the time of the current trigger.

Datalog Status

Range: Stopped, Started, Triggered, Pre trigger, Post trigger

Indicates the present status of the datalog feature. *Stopped* and *Started* are only used in *Continuous* mode. *Triggered*, *Pre trigger* and *Post trigger* are only used in *Triggered* mode.

8.9 MOTOR START RECORDS

Path: *Diagnostics* > *Motor Start Records*

When the MM300 Enhanced declares motor starting status, a start data record is triggered and begins to sample and record the following parameters at a rate of one sample every 100 ms.

Motor start record parameters

Values	Type
True RMS values of the phase A current (Ia)	FlexAnalog
True RMS values of the phase B current (Ib)	
True RMS values of the phase C current (Ic)	
Average of true RMS values of the three-phase currents (Iavg)	
True RMS value of the ground current (Ig)	
Current unbalance (%)	
True RMS values of the phase A-N, B-N, and C-N voltages (Van, Vbn, and Vcn) if Three Phase Voltage Connection is Wye or phase A-B, B-C and C-A voltages (Vab, Vbc, and Vca) if Three Phase Voltage Connection is delta connected.)	
Average of the three-phase Voltage (V Avg L-N if VT is Wye Connected or V Avg L-L if VT is Delta Connected)	
Real power	
Reactive power	
Power factor	
Thermal capacity used (%)	
Frequency	
Motor Status (Stopped, Starting, Running, Tripped)	FlexLogic Operand

One pre-trigger sample and 29 second post-trigger samples are recorded. The data record ignores all subsequent triggers and continues to record data until the active record is finished.

A total of six records are stored in the relay. Record 1 is the baseline record; it is written to only by the first start that occurs after the user clears the motor start records. Records 2 to 6 are a rolling buffer of the last five motor starts. A new record automatically shifts the rolling buffer and overwrites the oldest record; 2.

The record files are formatted using the COMTRADE file format. The files can be downloaded and displayed via EnerVista Flex software. All the files are stored in non-volatile memory, so that information is retained when power to the relay is lost.

The viewing, customizing and saving the motor start records is the same as the transient records.

The Clear Motor Start Records command (under *Diagnostics* > *Commands*) clears the stored files. The date and time are recorded at the time of clearing, when a Clear Start Rec event is sent to the event record. Records can also be cleared using EnerVista Flex software.

Records Since Clear

Range: 0 to max 32-bit unsigned integer in steps of 1

This setting shows the number of records since the last clear.

Last Clear Date/Time

Range: MM/DD/YY HH:MM:SS

This provides the date and time on which the record was cleared.

8.10 MOTOR START STATISTICS

Path: *Diagnostics > Motor Start Statistics*

Start Date/Time

Range: MM/DD/YY HH:MM:SS

Default: 01/01/08 00:00:00

Start Acceleration Time

Range: 0.000 to 250.000 s in steps of 0.001 s

Default: 0.000 s

8.11 FAULT RECORDS

Path: *Diagnostics* > *Fault Records*

The latest fifteen fault locator records can be displayed. The most recent fault location calculation (when applicable) is displayed in this menu, along with the date and time stamp of the fault trigger.

Number Of Reports

Range: 0 to 65,535 in steps of 1

This setting shows the number of reports since the last clear.

Last Trip Date/Time

Range: MM/DD/YY HH:MM:SS

This setting shows the date and time on which the last report was generated.

Last Clear Date/Time

Range: MM/DD/YY HH:MM:SS

This setting shows the date and time on which the last record was cleared.

Fault Report X Time

Range: MM/DD/YY HH:MM:SS

This setting shows the date and time on which the specified fault report was generated.

8.12 COMMANDS

Path: *Diagnostics* > *Commands*

Reset

Range: Yes, No

Default: No

Issues a Non-Lockout Reset command.

Lockout Reset

Range: Yes, No

Default: No

Issues a Lockout Reset command.

Reset TCU

Range: Yes, No

Default: No

Issues a Reset TCU command to reset Thermal TCU to zero.

Stop

Range: Yes, No

Default: No

Stops the motor.

Start A

Range: Yes, No

Default: No

Initiates the programmed Start A sequence to start the motor.

Start B

Range: Yes, No

Default: No

Initiates the programmed Start B sequence to start the motor.

Clear Last Trip Data

Range: Yes, No

Default: No

Clears all information from the last trip.

Reset MWh and MVarh Meters

Range: Yes, No

Default: No

Clears the MWh and MVarh metering values.

Clear Trip Counters

Range: Yes, No

Default: No

Clears the following counters: Total Number of Trips, Overload Trips, Mechanical Jam Trips, Undercurrent Trips, Current Unbalance Trips, Ground Fault Trips, Motor Acceleration Trips, Underpower Trips, and Number of UV Restarts.

Clear Maintenance Timer

Range: Yes, No

Default: No

Clears maintenance information timers, including **MOTOR RUNNING HOURS**, **MOTOR STOPPED HOURS**, and **NUMBER OF MOTOR STARTS**.

Clear RTD Maximums

Range: Yes, No

Default: No

Clears learned RTD Maximums.

Reset Motor Information

Range: Yes, No

Default: No

Clears all motor information, such as **LEARNED ACCELERATION TIME**, **LEARNED STARTING CAPACITY**, **LEARNED STARTING CURRENT**, **MOTOR LOAD LEARNED** and **THERMAL CAPACITY**.

Clear Motor Start Statistics

Range: Yes, No

Default: No

This command clears all the motor start statistics records.

Clear Motor Start Records

Range: Yes, No

Default: No

This command clears all the stored motor start records. The date and time of when they are cleared is recorded.

Clear Learned Data

Range: Yes, No

Default: No

This resets all the learned values to their minimum values and clears the stored file. The date and time of when they are cleared is recorded. A 'Clear Learned Record' event is sent to the event record. The next record is captured after N successful starts.

Clear Waveform

Range: Yes, No

Default: No

This command clears all the stored waveform records.

Clear Event Record

Range: Yes, No

Default: No

This command clears all the stored event records.

Clear Fault Records

Range: Yes, No

Default: No

This command clears all the fault reports and records the date and time that they were last cleared.

Clear All Records

Range: Yes, No

Default: No

This command clears all the stored records.

CHAPTER 9

COMMUNICATIONS

9.1 **CHAPTER OVERVIEW**

This chapter contains the following sections:

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9.2 INTRODUCTION

This chapter specifies the detailed communications specifications for the MM300 Enhanced. The IED has a two-stage communications capability. The base CPU supports Modbus protocol through the Ethernet, USB and serial ports. Once the communications processor option is added to the base, the Ethernet port becomes disabled but the two Ethernet ports on the communications module have enhanced communications capabilities such as 61850, IEC62439 parallel redundancy protocol and 1588.

9.3 COMMUNICATIONS INTERFACES

The MM300 Enhanced has a number of standard and optional communication interfaces.

Device	Port	Availability	Terminal type	Use	Data protocols
Graphical control panel	Front	Standard	Mini USB	Local settings File transference	Modbus RTU
MM300 Enhanced	Rear RS485	Standard	RS485	SCADA Remote setting File transference	Modbus RTU
	Rear Ethernet 1- ETH1/ Rear Ethernet 3- ETH3(**)	Standard- ETH1 / Optional- ETH3(*)	RJ45 Copper	SCADA Remote setting File transference Firmware upgrade Configurable Independent/PRP/HS R/LLA- Only for ETH3 (*)	Modbus TCP, IEC 61850 Ed. 2 (*)PTPSNTPTFTP(*)S FTP(*)SSH(*)
	Rear Ethernet 2 - ETH2	Optional (*)	RJ45 Copper	SCADA Remote setting File transference Firmware upgrade Configurable Independent/PRP/HS R/LLA (*)	Modbus TCP, IEC 61850 Ed. 2 (*)PTPSNTPTFTP(*)S FTP(*)SSH(*)
	Fieldbus	Optional (*)	5-pin connector	SCADA	Profibus

Note:

(*) are options which are order code dependent.

Note:

The rest of the options are available for all order codes. See order codes for more information.

Note:

Rear Ethernet 1(**) becomes Rear Ethernet 3 when Communications is selected as R in the order code, but it is the same physical port.

9.4 SERIAL COMMUNICATION

9.4.1 RS485 CONNECTIONS

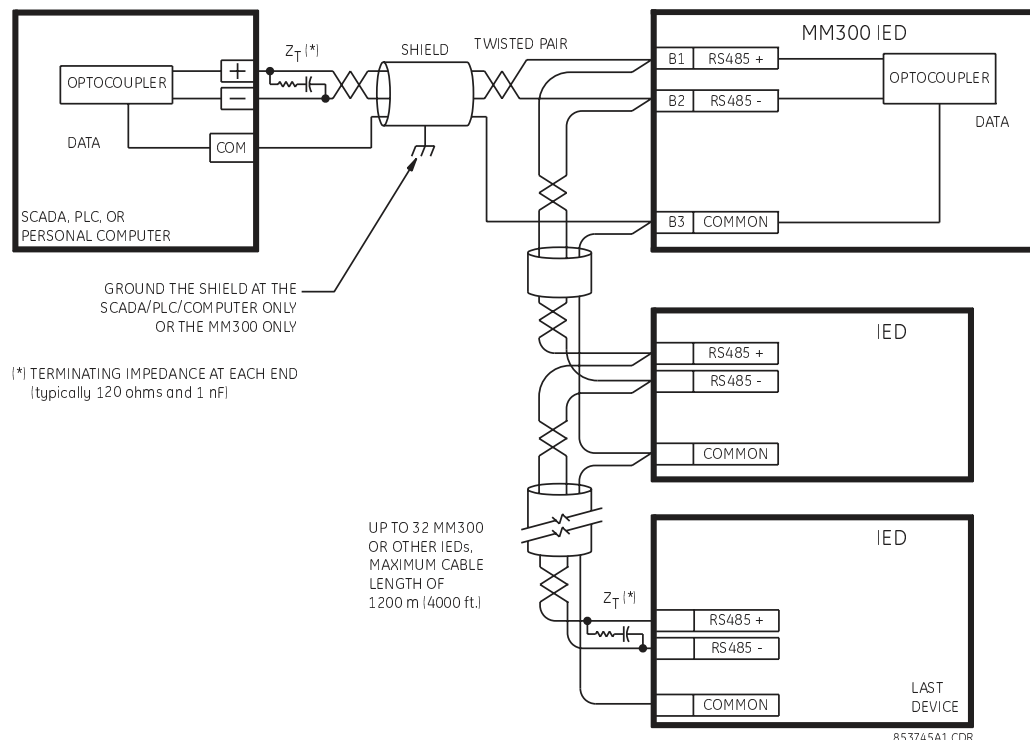


Figure 120: Typical RS485 connection

One two-wire RS485 port is provided. Up to 32 MM300 Enhanced IEDs can be daisy-chained together on a communication channel without exceeding the driver capability. For larger systems, additional serial channels must be added. Commercially available repeaters can also be used to add more than 32 relays on a single channel. Suitable cable should have a characteristic impedance of 120 Ω and total wire length should not exceed 1200 meters (4000 ft). Commercially available repeaters will allow for transmission distances greater than 1200 meters.

Voltage differences between remote ends of the communication link are not uncommon. For this reason, surge protection devices are internally installed across all RS485 terminals. Internally, an isolated power supply with an optocoupled data interface is used to prevent noise coupling.



Caution:

To ensure that all devices in a daisy-chain are at the same potential, it is imperative that the common terminals of each RS485 port are tied together and grounded only once, at the master or at the MM300 Enhanced. Failure to do so may result in intermittent or failed communications.

The source computer/PLC/SCADA system should have similar transient protection devices installed, either internally or externally. Ground the shield at one point only, as shown in the figure above, to avoid ground loops.

Correct polarity is also essential. The MM300 Enhanced IEDs must be wired with all the positive (+) terminals connected together and all the negative (–) terminals connected together. Each relay must be daisy-chained to the next one. Avoid star or stub connected configurations. The last device at each end of the daisy-chain should be terminated with a 120 Ω ¼ watt resistor in series with a 1 nF capacitor across the positive and negative terminals. Observing these guidelines will ensure a reliable communication system immune to system transients.

The uncovered communications cable shield connected to the common terminal should not exceed 1" (2.5 cm) for proper EMC shielding of the communications cable.

9.4.1.1 RS485 INTERFACE (MODBUS RTU)

The RS485 interface is a serial two-wire port intended for use as a Modbus RTU slave. The RS485 port has the following characteristics.

- Address: 1 to 254
- Baud rate: 9600 to 115200 bps
- Supported Modbus function codes: 03H, 04H, 05H, 06H, 07H, 08H, 10H

The MM300 Enhanced 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 RS232, RS422, RS485, fiber optics, etc. Modbus is a single master/multiple slave type of protocol suitable for a multi-drop configuration as provided by RS485 hardware. The MM300 Enhanced Modbus implementation employs two-wire RS485 hardware. Using RS485, up to 32 IEDs can be daisy-chained together on a single communication channel.

The MM300 Enhanced is always a Modbus slave. It can not be programmed as a Modbus master. Computers or PLCs are commonly programmed as masters.

Both monitoring and control are possible using read and write register commands. Other commands are supported to provide additional functions.

9.5 STANDARD ETHERNET COMMUNICATION

The Ethernet interface is required for IEC 61850 (IEC 61850 protocol availability must be selected at the time of order). With this protocol, the Ethernet interface also offers communication with Modbus TCP for remote configuration and record extraction.

ETH1 port selection between fiber and copper (RJ45) hardware options is done when ordering the device.

Fiber optic connection is recommended for use in permanent connections in a substation environment, as it offers advantages in terms of noise rejection. The fiber optic port provides 100 Mbps communication and uses type LC connectors.

The device can also be connected to either a 10Base-T or a 100Base-TX Ethernet hub or switch using the RJ45 port. The port automatically senses which type of hub is connected. Due to noise and interference reasons, this connection type is only recommended for short-term connections over a short distance.

The pins on the RJ45 connector are as follows:

Pin	Signal Name	Signal Definition
1	TXP	Transmit (positive)
2	TXN	Transmit (negative)
3	RXP	Receive (positive)
4	-	Not used
5	-	Not used
6	RXN	Receive (negative)
7	-	Not used
8	-	Not used

Note:

The update of the Network Port settings at **Setpoints > Configure > Comms** should not be done offline in the CID and sent to the IED. The Ethernet settings update should be done on line directly in the IED, either entering the settings manually through the HMI, or by communications through the front USB port.

9.6 REDUNDANT ETHERNET COMMUNICATION

Redundancy is required where a single point of failure cannot be tolerated. It is required in critical applications such as substation automation. The redundancy interface in the device provides two Ethernet ports (ETH2, ETH3) with order code option R.

PRP addresses the need for seamless switchover and zero recovery time in case of single network failure in substation automation networks. PRP achieves redundancy by using a combination of LAN duplication and frame duplication technique. Identical frames are sent on two completely independent networks that connect source and destination. Under normal circumstances both frames will reach destination and one of them will be sent up the OSI stack to the destination application, while the second one will be discarded.

HSR functionality, like PRP, addresses the need for seamless switchover and zero recovery time in case of single network failure in substation automation networks. A source node in HSR ring receives a frame from its upper layer and sends it over its two ports in different directions. Under normal circumstances (fault-free state) both identical frames will reach destination node within a certain interval and the first frame will be sent up the OSI stack to the destination application, while the second one will be discarded.

LLA (Link Loss Alert) detects a failure in the fiber link. When the link failure is detected, communication is switched to the standby port. When the primary port link detected is good, the communication is switched back to primary and the backup port goes back into standby mode.

9.6.1 PARALLEL REDUNDANCY PROTOCOLS (PRP)

PRP (Parallel Redundancy Protocol) is defined in IEC 62439-3. PRP provides bump-less redundancy and meets the most demanding needs of substation automation. The PRP implementation between the paired ports is compatible with any standard PRP device.

PRP uses two independent Ethernet networks operating in parallel. PRP systems are designed so that there should be no common point of failure between the two networks, so the networks have independent power sources and are not connected together directly. Devices designed for PRP applications have two ports attached to two separate networks and are called Doubly Attached Nodes (DAN). A DAN has two ports, one MAC address and one IP address. The sending node replicates each frame and transmits them over both networks. The receiving node processes the frame that arrives first and discards the duplicate. Therefore, there is no distinction between the working and backup path. The receiving node checks that all frames arrive in sequence and that frames are correctly received on both ports.

In a DAN, both ports share the same MAC address so it does not affect the way devices talk to each other in an Ethernet network (Address Resolution Protocol at layer 2). Every data frame is seen by both ports. When a DAN sends a frame of data, the frame is duplicated on both ports and therefore on both LAN segments. This provides a redundant path for the data frame if one of the segments fails. Under normal conditions, both LAN segments are working and each port receives identical frames. The selection of PRP in the device can be done by selecting PRP at the ETH2 Operation setting at path: **Setpoints > Configure > Comms > Ethernet > Ethernet 2**

When set to *PRP*, ETH2 (PortA) and ETH3 (PortB) are the paired ports and use the same MAC address of ETH2 and combine information at the link layer. In this mode of operation both ports are connected two different switches on LANA and LANB. The relay processes the first received frame by forwarding the packet to upper layers and discards the duplicate frame, using the Link Redundancy Entity (LRE) service at layer 2. When received a frame from the network, LRE forwards the first received frame of a pair to the upper layers after removing the RCT and discards the duplicate. When receiving a frame from the upper layers of the node, LRE appends the RCT and sends the frame through both ports. PRP main mode of operation is Duplicate Discard Mode and Duplicate Accept Mode is not supported.

9.6.2 HIGH-AVAILABILITY SEAMLESS REDUNDANCY (HSR)

HSR is standardized in IEC 62439-3 (clause 5) for use in ring topology networks. Similar to PRP, HSR provides bump less redundancy and meets the most demanding needs of substation automation. HSR has become the

reference standard for ring-topology networks in the substation environment. The HSR implementation between the device paired ports is compatible with any standard HSR device.

HSR works on the premise that each device connected in the ring is a doubly attached node running HSR (referred to as DANH). The selection of HSR in the device can be done by selecting HSR at the ETH2 Operation setting at path: **Setpoints > Configure > Comms > Ethernet > Ethernet 2**

When set to *HSR*, ETH2 (PortA) and ETH3 (PortB) are the paired ports and use the same MAC address of ETH2. In this mode, all the participating devices are connected in ring topology and in normal condition (fault-free state) both identical frames will reach destination device within a certain interval and the first frame will be sent up the OSI stack to the destination application, while the second one will be discarded. When received a frame that is destined to the relay from network, the relay processes the first received packet by removing the HSR tag and discards the duplicate.

9.6.3 LINK LOSS ALERT FUNCTIONALITY (LLA)

LLA detects a failure in the network link. When the link failure is detected, communication is switched to the standby port. When the primary port link detected is good, the communication is switched back to primary and the backup port goes back into standby mode. The selection of LLA in the device can be done by selecting LLA at the ETH2 Operation setting at path: **Setpoints > Configure > Comms > Ethernet > Ethernet 2**

When set to *LLA*, ETH2 and ETH3 will use ETH2's MAC and IP address settings. In this mode ETH3 is in standby mode and is not actively communicate on the Ethernet network but will monitor its link. If ETH2's LLA detects a problem with the link, communication is switched to ETH3. ETH3 is, in effect, acting as a redundant or backup link to the network for ETH2. Once ETH2 detects that the link is good, communications automatically switches back to ETH2 and ETH3 switches back into standby mode.

9.7 DATA PROTOCOLS

9.7.1 MODBUS RTU

The RS485 interface is a serial two-wire port intended for use as a Modbus RTU slave. The RS485 port has the following characteristics:

Modbus Address: 1 to 254

Baud Rate: 9600 to 115200 bps

Supported Modbus Function Codes:

- 03H - Read Holding Registers
- 04H - Read Input Registers
- 05H - Write Single Coil
- 06H - Write Single Holding Register
- 07H - Read Execution status
- 08H - Loopback
- 10H - Write multiple registers

DATA PACKET FORMAT

Modbus RTU protocol's Master/Slave request/response sequence consists of the following bytes (transmitted as separate data frames):

Address: 1 byte

This is the first byte of every transmission. This byte represents the user- assigned address of the slave device that is to receive the message sent by the master.

Each slave device must be assigned a unique address and only the addressed slave will respond to a transmission that starts with its address. In a master request transmission, the address represents the address of the slave to which the request is being sent. In a slave response transmission, it represents the address of the slave that is sending the response.

Function Code: 1 byte

This is the second byte of every transmission. Modbus defines function codes 1 to 127.

Data: variable number of bytes depending on function code

This may be actual values, setpoints or addresses sent by the master to the slave or by the slave to the master.

CRC: 2 bytes

This is an error-checking code.

ERROR CHECKING

The Modbus RTU version includes a two-byte CRC-16 (16-bit cyclic redundancy check) with every transmission. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (11000000000000101B). The 16-bit remainder of the division is appended to the end of the transmission, MS Byte first. The resulting message including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred.

If a Modbus slave device receives a transmission in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the transmission. A CRC-16 error indicates that one or more bytes of the transmission were received incorrectly and thus the entire transmission should be ignored in order to avoid the MM300 Enhanced

performing any incorrect operation. The CRC-16 calculation is an industry standard method used for error detection. An algorithm is included here to assist programmers in situations where no standard CRC-16 calculation routines are available.

For more details, see the latest *Modbus Maps - Industrial Products* spreadsheet available at MM300 Motor Management System Support Documents.

9.7.2 MODBUS TCP

The MM300 Enhanced Ethernet interface is configured as a Modbus RTU slave and has the following characteristics:

Network Configuration: using IP address, Subnet Mask and gateway

Ethernet Port: 502

Supported Virtual Connections: 5

Supported Modbus Function Codes:

- 03H - Read Holding Registers
- 04H - Read Input Registers
- 05H - Write Single Coil
- 06H - Write Single Holding Register
- 10H - Write multiple registers

DATA PACKET FORMAT

Modbus TCP protocol's Master/Slave request/response sequence consists of the following bytes:

Transaction Identifier: 2 bytes

This identification field is used for transaction pairing when multiple messages are sent along the same TCP connection by a client without waiting for a prior response.

Protocol Identifier: 2 bytes

This field is always 0 for Modbus services.

Length: 2 bytes

This field is a byte count of the remaining fields, including the unit identifier byte, function code byte, and the data fields.

Unit Identifier: 1 byte

This field is used to identify a remote server located on a non-TCP/IP network for serial bridging. In a typical Modbus TCP/IP server application, the unit ID is set to 00 or FF, ignored by the server, and simply echoed back in the response.

Function Code: 1 byte

This is the second byte of every transmission. Modbus defines function codes 1 to 127.

Data: variable number of bytes depending on function code

This may be actual values, setpoints or addresses sent by the master to the slave or by the slave to the master.

The complete Modbus TCP/IP Application Data Unit is embedded into the data field of a standard TCP frame and sent via TCP to system port 502, which is specifically reserved for Modbus applications. Modbus TCP/IP clients and servers receive Modbus data via port 502.

Note:

The Ethernet interface has the same memory map layout as the serial Modbus RTU interface.

For more details, see the latest *Modbus Maps - Industrial Products* spreadsheet available at [MM300 Motor Management System Support Documents](#).

9.7.3 ADMINISTRATOR LOGIN AND COMMANDS VIA MODBUS

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.

Data Written to Relay to Login as Administrator

Description	Memory Map Address		Values 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

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

Login as Administrator Function Format continued

Data 10	Data 11	Data 12	Data 13	Data 14	Data 15	Data 16	Data 17	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.

Modbus Commands Registers

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

Examples of Command Values

Command Value	Value Description
1	Reset
96	Clear All Records
98	Clear Event Records
105	Clear Energy Use Data
4096	Force Vir I/P 1

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

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

Function Format for "Force Vir I/P 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.

Format for Function Code 05H

Master Transmission	Byte#	Example	Description
Slave Address	1	FE	Message for slave # 254
Function Code	1	05	Execute operation

Master Transmission	Byte#	Example	Description
Operation Code	2	00 01	Operation code
Code Value	2	FF 00	Perform function
CRC	2	DF 6A	CRC error code

Examples of Command Values

Command Value	Value Description
1	Reset
96	Clear All Records
98	Clear Event Records
105	Clear Energy Use Data
4096	Force Vir I/P 1

Function Format for Reset Command

Slave #	Function	Operation Code	Code Value
FE	05	0001	FF00

9.7.4 IEC 61850

This section describes how the IEC 61850 standard is applied to the MM300 Enhanced IED. It is not a description of the standard itself. The level at which this section is written assumes that the reader is already familiar with the IEC 61850 standard.

IEC 61850 is the international standard for Ethernet-based communication in substations. It enables integration of all protection, control, measurement and monitoring functions within a substation, and additionally provides the means for interlocking and inter-tripping. It combines the convenience of Ethernet with the security that is so essential in substations today.

The MM300 Enhanced IEDs support both the IEC 61850 GOOSE and IEC 61850 MMS Server service as per IEC 61850 standard Ed. 2. The GOOSE messaging service provides the MM300 Enhanced IED 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 IED for monitoring and control. The configuration of IEC 61850 services is accomplished using the EnerVista Flex software.

9.7.4.1 BENEFITS OF IEC 61850

The standard provides:

- Standardized models for IEDs and other equipment within the substation
- Standardized communication services (the methods used to access and exchange data)
- Standardized formats for configuration files
- Peer-to-peer communication

The standard adheres to the requirements laid out by the ISO OSI model and therefore provides complete vendor interoperability and flexibility on the transmission types and protocols used. This includes mapping of data onto

Ethernet, which is becoming more and more widely used in substations, in favor of RS485. Using Ethernet in the substation offers many advantages, most significantly including:

- Ethernet allows high-speed data rates (currently 100 Mbps, rather than tens of kbps or less used by most serial protocols)
- Ethernet provides the possibility to have multiple clients
- Ethernet is an open standard in every-day use
- There is a wide range of Ethernet-compatible products that may be used to supplement the LAN installation (hubs, bridges, switches)

9.7.4.2 IEC 61850 INTEROPERABILITY

A major benefit of IEC 61850 is interoperability. IEC 61850 standardizes the data model of substation IEDs, which allows interoperability between products from multiple vendors.

An IEC 61850-compliant device may be interoperable, but this does not mean it is interchangeable. You cannot simply replace a product from one vendor with that of another without reconfiguration. However the terminology is pre-defined and anyone with prior knowledge of IEC 61850 should be able to integrate a new device very quickly without having to map all of the new data. IEC 61850 brings improved substation communications and interoperability to the end user, at a lower cost.

9.7.4.3 THE IEC 61850 DATA MODEL

The data model of any IEC 61850 IED can be viewed as a hierarchy of information, whose nomenclature and categorization is defined and standardized in the IEC 61850 specification.

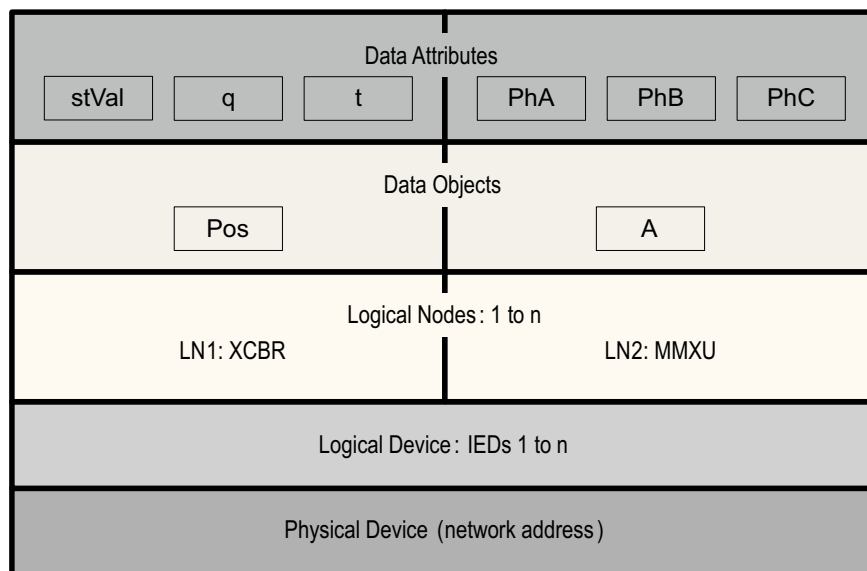


Figure 121: Data model layers in IEC 61850

The levels of this hierarchy can be described as follows:

Data frame format

Layer	Description
Physical Device	Identifies the actual IED within a system. Typically the device's name or IP address can be used (for example Feeder_1 or 10.0.0.2).
Logical Device	Identifies groups of related Logical Nodes within the Physical Device. For 859 5 Logical Devices exist: Control, Measurements, Protection, Records, System.

Layer	Description
Logical Node Instance	The IEC 61850 Logical Device top-level data model consists of instances of Logical Nodes. The data model name for a Logical Node instance is constructed from an optional prefix (known as the wrapper), the Logical Node name, and an instance ID (or suffix). For example, XCBR1 (CB Control), MMXU1 (measurements), PTOF2 (overfrequency protection, stage 2).
Data Object	This next layer is used to identify the type of data you will be presented with. For example, Pos (position) of Logical Node type XCBR.
Data Attribute	This is the actual data (measurement value, status, description, etc.). For example, stVal (status value) indicating actual position of circuit breaker for Data Object type Pos of Logical Node type XCBR.

9.7.4.4 IEC 61850 DATA MODEL IMPLEMENTATION

The data model is described in the Model Implementation Conformance Statement (MICS) document, which is available as a separate document.

9.7.4.5 IEC 61850 COMMUNICATION SERVICES IMPLEMENTATION

The IEC 61850 communication services implemented in the IEDs are described in the Protocol Implementation Conformance Statement (PICS) document, which is available as a separate document.

9.7.4.6 IEC 61850 PEER-TO-PEER (GOOSE) COMMUNICATIONS

The implementation of IEC 61850 Generic Object Oriented Substation Event (GOOSE) enables faster communication between IEDs offering the possibility for a fast and reliable system-wide distribution of input and output data values. The GOOSE model uses multicast services to deliver event information. Multicast messaging means that messages are sent to selected devices on the network. The receiving devices can specifically accept frames from certain devices and discard frames from the other devices. It is also known as a publisher-subscriber system. When a device detects a change in one of its monitored status points it publishes a new message. Any device that is interested in the information subscribes to the data it contains.

9.7.4.7 MAPPING GOOSE MESSAGES TO REMOTE INPUTS

Each GOOSE signal contained in a subscribed GOOSE message can be mapped to any of the remote inputs within the IEC 61850 configuration. The remote inputs allow the mapping to internal logic functions for protection control, directly to output contacts or LEDs for monitoring.

An IED can subscribe to all GOOSE messages but only the following data types can be decoded and mapped to a remote input:

- BOOLEAN
- INT16
- INT32
- INT8
- UINT16
- UINT32
- UINT8

IEC 61850 GOOSE CONFIGURATION

All GOOSE configuration is performed using the software application.

9.7.4.8 ETHERNET DISCONNECTION

IEC 61850 associations are unique and made between the client and server. If Ethernet connectivity is lost for any reason, the associations are lost, and will need to be re-established by the client. The IED has a TCP_KEEPALIVE function to monitor each association, and terminate any which are no longer active.

9.7.4.9 LOSS OF POWER

The IED allows the re-establishment of associations without disruption of its operation, even after its power has been removed. As the IED acts as a server in this process, the client must request the association. Uncommitted settings are canceled when power is lost, and reports requested by connected clients are reset. The client must re-enable these when it next creates the new association to the IED.

9.7.4.10 IEC 61850 CONFIGURATION

The EnerVista Flex settings application software provides an IEC 61850 configurator tool, which allows the pre-configured IEC 61850 configuration file to be imported and transferred to the IED. It is also possible to manually create configuration files for all products, based on their original IED capability description (ICD file).

Other features include:

- The extraction of configuration data for viewing and editing.
- A sophisticated error-checking sequence to validate the configuration data before sending to the IED.

Note:

Measurements Deadband changes in IEC 61850 settings take effect only after rebooting the IED.

9.8 INDUSTRIAL PROTOCOL

Note:

5 to 24 VDC external power is required for this interface to operate. A GSE file is provided on the GE Grid Solutions website: [MM300 Motor Management System](#).

9.8.1 PROFIBUS

The MM300 Enhanced Fieldbus interface supports both Profibus DPV0 or DPV1 functionality. The typical Profibus-DP network has one DP master and one or more DP slaves. In a typical bus segment up to 32 stations can be connected (a repeater is used if more than 32 stations operate on a bus). The end nodes on a Profibus-DP network must be terminated to avoid reflections on the bus line.

The Profibus slave supports a configurable address, which ranges from 1 to 126. Address 126 is used only for commissioning purposes and should not be used to exchange user data.

The MM300 Enhanced has autobaud support. The available baud rates and other slave specific information needed for configuration are contained in the GSE file, which is used by a network configuration program.

As a DP slave, the IED transfers fast process data to the DP master according to master-slave principle, supporting up to 96 words of input data and 1 word of output (command) data.

The MM300 Enhanced also supports mandatory parametrization. It keeps its user parameter data/setpoints in a non-volatile memory and does not need device related parametrization during start-up of the DP master.

In addition to the default user map, the Input data available to the Profibus master is configurable using Fieldbus user map page.

9.8.1.1 PROFIBUS DP PHYSICAL INTERFACE

5 to 24 VDC external power is required for this interface to operate. The external connections through the Fieldbus interface are as follows:

Fieldbus interface external connections (Profibus)

Pin	Connection (external device)
V-	Pin 5
L	Pin 8, line A (negative TX/RX)
C	Common drain
H	Pin 3, line B (positive TX/RX)
V+	Pin 6

The MM300 Enhanced can accept an external voltage level up to 24 VDC on its V- and V+ terminals. Specifically for termination, the voltage must be reduced to 5V; refer to the Profibus Termination section below.

The Modbus status (MS) and network status (NS) LEDs indicate the status of the Fieldbus interface.

Profibus LED indications

LED	Color	Description
MS	Green	Profibus READY
	Red	Profibus NOT READY
NS	Green	Communication to Master OK
	Red	Communication to Master FAIL

When used for Profibus, the Fieldbus port has the following characteristics:

- Baud rate: 9600, 19200, 31250, 45450, 93750, 187500, 500000, and 1.5M bps (auto-detect)*
- Address: 1 to 126
- Vendor ID: 4D20 (hex)
- Data table size: inputs = 174 bytes, outputs = 2 bytes
- To be actioned, output bit must be 1 for a minimum time of 100 ms

Note:

* Profibus communications will operate only in 1.5 Mbps or auto-detect with the present implementation. Auto-detect includes baud rates 19.2 Kbps, 187.5 Kbps, 500 Kbps, and 1.5 Mbps.

The Profibus DP Master must read the GSE (Device Master Data) file of the 859 for the purposes of configuration and parameterization.

9.8.1.2 PROFIBUS TERMINATION

Profibus segments should be terminated by a bus termination. The MM300 Enhanced termination voltage is +5V and the connections are as illustrated below.

If the bus voltage level is higher, such as 24V, an external device must be used to drop the voltage to the required +5V termination level. The Procentec T1 Terminator or equivalent is suitable to provide proper termination to the MM300 Enhanced from a 24V level.

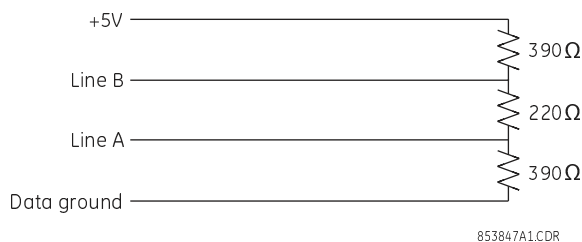


Figure 122: Profibus termination

9.8.1.3 PROFIBUS DPV0

The 853847A1.eps supports DPV0 cyclic data exchange and diagnostics as per the below mapping.

9.8.1.3.1 PROFIBUS INPUT DATA

Motor status, voltage and current metering and last trip actual values are mapped to the Profibus input data.

Category	Address (By Bytes)	Length in Bytes	Description	Format
Status-Motor	0	2	Motor Status	FC614
	2	2	Extended Status	FC615
	4	2	Thermal Cap Used	F0
	6	2	Time to Overload Trip	F0
Start Blocks	8	2	Starts/Hour Block	F0
	10	2	Time Between Starts Lockout	F0
	12	2	Restart Block Lockout	F0
Learned	14	2	Average Motor Load Learned	F2
	16	4	Learned Acceleration Time	F13
	20	2	Learned Starting Current	F2

Category	Address (By Bytes)	Length in Bytes	Description	Format
Counters	22	2	Number of Motor Starts	F0
	24	2	Number of UV Restarts	F0
	26	4	Motor Running Hours	F10
	30	4	Motor Stopped Hours	F10
Current Metering	34	4	Ia	F10
	38	4	Ib	F10
	42	4	Ic	F10
	46	4	Iavg	F10
	50	4	Igrd	F10
	54	2	Motor Load	F1
	56	2	Current Unbalance (I Unb)	F1
Voltage Metering	58	2	Vab	F0
	60	2	Vbc	F0
	62	2	Vca	F0
	64	2	Va1 Angle	F1
	66	2	Vb1 Angle	F1
	68	2	Vc1 Angle	F1
	70	2	Van	F0
	72	2	Vbn	F0
	74	2	Vcn	F0
	76	2	VAux	F0
	78	2	Frequency	F2
Power Metering	80	2	Power Factor	F22
	82	4	Real Power	F31
	86	4	Reactive Power	F31
	90	4	Apparent Power	F11
	94	4	MWh Consumption	F13
	98	4	Mvarh Consumption	F13
Sensor Metering	102	2	Hottest Stator RTD	F0
	104	2	Hottest Stator RTD Temp	F20B
	106	2	RTD 1 Temp	F20B
	108	2	RTD 2 Temp	F20B
	110	2	RTD 3 Temp	F20B
	112	2	RTD 4 Temp	F20B
	114	2	RTD 5 Temp	F20B
	116	2	RTD 6 Temp	F20B

Category	Address (By Bytes)	Length in Bytes	Description	Format
Last Trip Data	118	4	Cause of Last Trip	FC134
	122	4	Last Trip Date Time	F50
	126	4	Last Trip Time uSeconds	F51
	130	4	Pre Trip Ia	F30
	134	4	Pre Trip Ib	F30
	138	4	Pre Trip Ic	F30
	142	2	Pre Trip Motor Load	F30
	144	2	Pre Trip Current Unbalance	F30
	146	4	Pre Trip Igrd	F30
	150	2	Pre Trip Vab	F30
	152	2	Pre Trip Vbc	F30
	154	2	Pre Trip Vca	F30
	156	2	Pre Trip Van	F30
	158	2	Pre Trip Vbn	F30
	160	2	Pre Trip Vcn	F30
	162	2	Pre Trip System Frequency	F30
	164	4	Pre Trip Real Power	F30
	168	4	Pre Trip Reactive Power	F30
	172	2	Pre Trip Apparent Power	F30
	174	2	Pre Trip Power Factor	F30
Contact Inputs	176	4	Contact Input 32-1 (Bit Field)	FC194
Contact Outputs	180	4	Contact Output 32-1 (Bit Field)	FC198
Virtual Inputs	184	4	Virtual Input 32-1 (Bit Field)	FC524
Virtual Outputs	188	4	Virtual Output 32-1 (Bit Field)	FC524D

9.8.1.3.2 PROFIBUS OUTPUT DATA

The capability to reset, stop, and start the motor has been made available via the Profibus output data. As polled output data is continuously written to the slave device, the MM300 Enhanced looks for a change in the value to execute any command.

Byte	Value		Description
	Dec	Hex	
0	0	0x00	Reserved Byte
1	1	0x01	Reset
	2	0x02	Lockout Reset
	3	0x03	Stop
	4	0x04	Start A
	5	0x05	Start B
	6	0x06	Clear Last Trip Data Prompt
	7	0x07	Reset MWh and Mvarh Meters
	8	0x08	Clear Counters
	9	0x09	Clear Event Records
	10	0x0A	Clear Waveform Data

Byte	Value		Description
	Dec	Hex	
	11	0x0B	Clear Maintenance Timer
	12	0x0C	Clear RTD Maximums
	13	0x0D	Reset Motor Information
	14	0x0E	Auto Mode
	15	0x0F	Manual Mode
	16	0x10	Trigger Waveform Capture

9.8.1.3.3 DIAGNOSTICS

The MM300 Enhanced supports both slave mandatory (6 bytes system-wide standardized) and slave specific extended diagnostic data. If the diagnostics are considered high priority, the PLC/host program will be informed of the fault (alarm, trip, command, or message) and can call a special error routine. When no extended diagnostic information is available and the master initiates a diagnostic read, only the six standard slave mandatory bytes are read, formatted as follows:.

System standard diagnostics bytes 1 to 6

Byte	Description	Measured Value
1	Station Status 1	0x08
2	Station Status 2	0x0C
3	Station Status 3	0x00
4	Diagnostic Master Address	0x7D
5	Identification Number (High Byte)	0x0C
6	Identification Number (Low Byte)	0x52

DPV0 diagnostic alarms

		Byte	Bit	GSE Bit #		Ext. Diag Byte
	Standard Diagnosis	0			Station Status 1	
		1			Station Status 2	
		2			Station Status 3	
		3			Master Address	
		4			Man Id	
		5			Man Id	
		6			Length	0
		7	0	0	Reserved	1
		7	1	1	Reserved	1
		7	2	2	Reserved	1
		7	3	3	Reserved	1
		7	4	4	Reserved	1
		7	5	5	Reserved	1
		7	6	6	Reserved	1
		7	7	7	Reserved	1

		Byte	Bit	GSE Bit #		Ext. Diag Byte
		8	0	8	Reserved	2
		8	1	9	Reserved	2
		8	2	10	Reserved	2
		8	3	11	Reserved	2
		8	4	12	Reserved	2
		8	5	13	Reserved	2
		8	6	14	Reserved	2
		8	7	15	Reserved	2
		9	0	16	Reserved	3
		9	1	17	Reserved	3
		9	2	18	Reserved	3
		9	3	19	Reserved	3
		9	4	20	Reserved	3
		9	5	21	Reserved	3
		9	6	22	Reserved	3
		9	7	23	Reserved	3
0		10	0	24	Reserved	4
1		10	1	25	Reserved	4
2		10	2	26	Reserved	4
3		10	3	27	Reserved	4
4		10	4	28	Reserved	4
5		10	5	29	Reserved	4
6		10	6	30	Reserved	4
7		10	7	31	Reserved	4
8		11	0	32	Reserved	5
9		11	1	33	Reserved	5
10		11	2	34	Reserved	5
11		11	3	35	Reserved	5
12		11	4	36	Reserved	5
13		11	5	37	Reserved	5
14		11	6	38	Reserved	5
15		11	7	39	Reserved	5
16		12	0	40	Reserved	6
17		12	1	41	Reserved	6
18		12	2	42	Reserved	6
19		12	3	43	Reserved	6
20		12	4	44	Reserved	6
21		12	5	45	Reserved	6
22		12	6	46	Reserved	6

		Byte	Bit	GSE Bit #		Ext. Diag Byte
23		12	7	47	Reserved	6
24		13	0	48	Reserved	7
25		13	1	49	Reserved	7
26		13	2	50	Reserved	7
27		13	3	51	Reserved	7
28		13	4	52	Reserved	7
29		13	5	53	Reserved	7
30		13	6	54	Reserved	7
31		13	7	55	Reserved	7
32		14	0	56	Reserved	8
33		14	1	57	Reserved	8
34		14	2	58	Reserved	8
35		14	3	59	Reserved	8
36		14	4	60	Reserved	8
37		14	5	61	Reserved	8
38		14	6	62	Reserved	8
39		14	7	63	Reserved	8
40		15	0	64	Reserved	9
41		15	1	65	Reserved	9
42		15	2	66	Reserved	9
43		15	3	67	Reserved	9
44		15	4	68	Reserved	9
45		15	5	69	Reserved	9
46		15	6	70	Reserved	9
47		15	7	71	Reserved	9
48		16	0	72	Reserved	10
49		16	1	73	Reserved	10
50		16	2	74	Reserved	10
51		16	3	75	Reserved	10
52		16	4	76	Reserved	10
53		16	5	77	Reserved	10
54		16	6	78	Reserved	10
55		16	7	79	Reserved	10
56		17	0	80	Aux U/V Trip	11
57		17	1	81	Emergency Stop	11
58		17	2	82	Fuse Fail Trip	11
59		17	3	83	OpenControl Circuit	11
60		17	4	84	Thermistor Trip	11
61		17	5	85		11

		Byte	Bit	GSE Bit #		Ext. Diag Byte
62		17	6	86		11
63		17	7	87	Self Test Trip	11
64		18	0	88	Process ILock F Trip	12
65		18	1	89	Process ILock G Trip	12
66		18	2	90	Process ILock H Trip	12
67		18	3	91	Process ILock I Trip	12
68		18	4	92	Process ILock J Trip	12
69		18	5	93	Hard Wired Trip	12
70		18	6	94	Field Trip	12
71		18	7	95	MCC Trip	12
72		19	0	96	RTD 6 Trip	13
73		19	1	97	Comm Fail Trip	13
74		19	2	98	Relay Not Configured	13
75		19	3	99	Process ILock A Trip	13
76		19	4	100	Process ILock B Trip	13
77		19	5	101	Process ILock C Trip	13
78		19	6	102	Process ILock D Trip	13
79		19	7	103	Process ILock E Trip	13
80		20	0	104	Mechanical Jam Trip	14
81		20	1	105	UnderCurrent Trip	14
82		20	2	106	Unbalance Trip	14
83		20	3	107	RTD 1 Trip	14
84		20	4	108	RTD 2 Trip	14
85		20	5	109	RTD 3 Trip	14
86		20	6	110	RTD 4 Trip	14
87		20	7	111	RTD 5 Trip	14
88		21	0	112	Any Trip	15
89		21	1	113	Thermal O/L Trip	15
90		21	2	114	Ground Fault Trip	15
91		21	3	115	Acceleration Trip	15
92		21	4	116	Phase Reversal Trip	15
93		21	5	117	UnderPower Trip	15
94		21	6	118	UnderVoltage Trip	15
95		21	7	119	OverVoltage Trip	15
96		22	0	120	Reserved	16
97		22	1	121	Reserved	16
98		22	2	122	Reserved	16
99		22	3	123	Reserved	16
100		22	4	124	Reserved	16

		Byte	Bit	GSE Bit #		Ext. Diag Byte
101		22	5	125	Reserved	16
102		22	6	126	Reserved	16
103		22	7	127	Reserved	16
104		23	0	128	Reserved	17
105		23	1	129	Reserved	17
106		23	2	130	Reserved	17
107		23	3	131	Reserved	17
108		23	4	132	Reserved	17
109		23	5	133	Reserved	17
110		23	6	134	Reserved	17
111		23	7	135	Reserved	17
112		24	0	136	Reserved	18
113		24	1	137	Reserved	18
114		24	2	138	Reserved	18
115		24	3	139	Reserved	18
116		24	4	140	Reserved	18
117		24	5	141	Reserved	18
118		24	6	142	Reserved	18
119		24	7	143	Reserved	18
120		25	0	144	Reserved	19
121		25	1	145	Reserved	19
122		25	2	146	Reserved	19
123		25	3	147	Reserved	19
124		25	4	148	Reserved	19
125		25	5	149	Reserved	19
126		25	6	150	Reserved	19
127		25	7	151	Reserved	19
128		26	0	152	Reserved	20
129		26	1	153	Reserved	20
130		26	2	154	Reserved	20
131		26	3	155	Reserved	20
132		26	4	156	Reserved	20
133		26	5	157	Reserved	20
134		26	6	158	Reserved	20
135		26	7	159	Reserved	20
136		27	0	160	Reserved	21
137		27	1	161	Self Test Alarm	21
138		27	2	162	Comm Fail Alarm	21
139		27	3	163	Reserved	21

		Byte	Bit	GSE Bit #		Ext. Diag Byte
140		27	4	164	Reserved	21
141		27	5	165	Reserved	21
142		27	6	166	Reserved	21
143		27	7	167	Reserved	21
144		28	0	168	Welded Contactor	22
145		28	1	169	Reserved	22
146		28	2	170	Reserved	22
147		28	3	171	Reserved	22
148		28	4	172	Load Increase Alarm	22
149		28	5	173	Drive Greasing Alarm	22
150		28	6	174	Contactor Inspect Alarm	22
151		28	7	175	Max Stopped Alarm	22
152		29	0	176	Aux U/V Alarm	23
153		29	1	177	External Stop Alarm	23
154		29	2	178	Fuse Fail Alarm	23
155		29	3	179	Open Ctrl Cct Alarm	23
156		29	4	180	Thermistor Alarm	23
157		29	5	181	Reserved	23
158		29	6	182	External Start A Alarm	23
159		29	7	183	External Start B Alarm	23
160		30	0	184	Process ILock F Alarm	24
161		30	1	185	Process ILock G Alarm	24
162		30	2	186	Process ILock H Alarm	24
163		30	3	187	Process ILock I Alarm	24
164		30	4	188	Process ILock J Alarm	24
165		30	5	189	Drive Failed to Start	24
166		30	6	190	Inverter Failed	24
167		30	7	191	Drive Stop Failed	24
168		31	0	192	RTD 6 Alarm	25
169		31	1	193	RTD Open Alarm	25
170		31	2	194	RTD Short Alarm	25
171		31	3	195	Process ILock A Alarm	25
172		31	4	196	Process ILock B Alarm	25
173		31	5	197	Process ILock C Alarm	25
174		31	6	198	Process ILock D Alarm	25
175		31	7	199	Process ILock E Alarm	25
176		32	0	200	Reserved	26
177		32	1	201	UnderCurrent Alarm	26
178		32	2	202	Unbalance Alarm	26

		Byte	Bit	GSE Bit #		Ext. Diag Byte
179		32	3	203	RTD 1 Alarm	26
180		32	4	204	RTD 2 Alarm	26
181		32	5	205	RTD 3 Alarm	26
182		32	6	206	RTD 4 Alarm	26
183		32	7	207	RTD 5 Alarm	26
184		33	0	208	Any Alarm	27
185		33	1	209	Thermal Level Alarm	27
186		33	2	210	Ground Fault Alarm	27
187		33	3	211	Acceleration Alarm	27
188		33	4	212	Phase Reversal Alarm	27
189		33	5	213	UnderPower Alarm	27
190		33	6	214	UnderVoltage Alarm	27
191		33	7	215	OverVoltage Alarm	27
192		34	0	216	Reserved	28
193		34	1	217	Reserved	28
194		34	2	218	Reserved	28
195		34	3	219	Reserved	28
196		34	4	220	Reserved	28
197		34	5	221	Reserved	28
198		34	6	222	Reserved	28
199		34	7	223	Reserved	28
200		35	0	224	Reserved	29
201		35	1	225	Reserved	29
202		35	2	226	Reserved	29
203		35	3	227	Reserved	29
204		35	4	228	Reserved	29
205		35	5	229	Reserved	29
206		35	6	230	Reserved	29
207		35	7	231	Reserved	29
208		36	0	232	Reserved	30
209		36	1	233	Reserved	30
210		36	2	234	Reserved	30
211		36	3	235	Reserved	30
212		36	4	236	Reserved	30
213		36	5	237	Reserved	30
214		36	6	238	Reserved	30
215		36	7	239	Reserved	30
216		37	0	240	Reserved	31
217		37	1	241	Reserved	31

		Byte	Bit	GSE Bit #		Ext. Diag Byte
218		37	2	242	Reserved	31
219		37	3	243	Reserved	31
220		37	4	244	Reserved	31
221		37	5	245	Reserved	31
222		37	6	246	Reserved	31
223		37	7	247	Reserved	31
224		38	0	248	Reserved	32
225		38	1	249	Reserved	32
226		38	2	250	Reserved	32
227		38	3	251	Reserved	32
228		38	4	252	Reserved	32
229		38	5	253	Reserved	32
230		38	6	254	Reserved	32
231		38	7	255	Reserved	32
232		39	0	256	Reserved	33
233		39	1	257	Reserved	33
234		39	2	258	Reserved	33
235		39	3	259	Comm Stop	33
236		39	4	260	Fuse Fail Inhibit	33
237		39	5	261	Phase Reversal Inhibit	33
238		39	6	262	Low Aux Voltage Inhibit	33
239		39	7	263	UV Restart Inhibit	33
240		40	0	264	Reserved	34
241		40	1	265	Reserved	34
242		40	2	266	Reserved	34
243		40	3	267	Reserved	34
244		40	4	268	Reserved	34
245		40	5	269	Reserved	34
246		40	6	270	Reserved	34
247		40	7	271	Reserved	34
248		41	0	272	Reserved	35
249		41	1	273	Reserved	35
250		41	2	274	Reserved	35
251		41	3	275	Reserved	35
252		41	4	276	Reserved	35
253		41	5	277	Reserved	35
254		41	6	278	Reserved	35
255		41	7	279	Reserved	35
256		42	0	280	Process I Lock F Stop	36

		Byte	Bit	GSE Bit #		Ext. Diag Byte
257		42	1	281	Process I Lock G Stop	36
258		42	2	282	Process I Lock H Stop	36
259		42	3	283	Process I Lock I Stop	36
260		42	4	284	Process I Lock J Stop	36
261		42	5	285	HW Stop	36
262		42	6	286	Field Stop	36
263		42	7	287	MCC Stop	36
264		43	0	288	Reserved	37
265		43	1	289	Reserved	37
266		43	2	290	Reserved	37
267		43	3	291	Process I Lock A Stop	37
268		43	4	292	Process I Lock B Stop	37
269		43	5	293	Process I Lock C Stop	37
270		43	6	294	Process I Lock D Stop	37
271		43	7	295	Process I Lock E Stop	37
272		44	0	296	Forward Limit	38
273		44	1	297	Reverse Limit	38
274		44	2	298	Starts/Hr Inhibit	38
275		44	3	299	Time Between Inhibit	38
276		44	4	300	Reserved	38
277		44	5	301	Reserved	38
278		44	6	302	Reserved	38
279		44	7	303	Reserved	38
280		45	0	304	Any Stop	39
281		45	1	305	Thermal Inhibit	39
282		45	2	306	Reserved	39
283		45	3	307	Reserved	39
284		45	4	308	Reserved	39
285		45	5	309	Restart Inhibit	39
286		45	6	310	Reserved	39
287		45	7	311	Reserved	39
288		46	0	312	Reserved	40
289		46	1	313	Reserved	40
290		46	2	314	Reserved	40
291		46	3	315	Reserved	40
292		46	4	316	Reserved	40
293		46	5	317	Reserved	40
294		46	6	318	Reserved	40
295		46	7	319	Reserved	40

		Byte	Bit	GSE Bit #		Ext. Diag Byte
296		47	0	320	Reserved	41
297		47	1	321	Reserved	41
298		47	2	322	Reserved	41
299		47	3	323	Reserved	41
300		47	4	324	Reserved	41
301		47	5	325	Reserved	41
302		47	6	326	Reserved	41
303		47	7	327	Reserved	41
304		48	0	328	Reserved	42
305		48	1	329	Reserved	42
306		48	2	330	Reserved	42
307		48	3	331	Reserved	42
308		48	4	332	Reserved	42
309		48	5	333	Reserved	42
310		48	6	334	Reserved	42
311		48	7	335	Reserved	42
312		49	0	336	Reserved	43
313		49	1	337	Reserved	43
314		49	2	338	Reserved	43
315		49	3	339	Reserved	43
316		49	4	340	Reserved	43
317		49	5	341	Reserved	43
318		49	6	342	Reserved	43
319		49	7	343	Reserved	43
320		50	0	344	Reserved	44
321		50	1	345	Reserved	44
322		50	2	346	Reserved	44
323		50	3	347	Reserved	44
324		50	4	348	Reserved	44
325		50	5	349	Reserved	44
326		50	6	350	Reserved	44
327		50	7	351	Reserved	44
328		51	0	352	Reserved	45
329		51	1	353	Reserved	45
330		51	2	354	Reserved	45
331		51	3	355	Reserved	45
332		51	4	356	Reserved	45
333		51	5	357	Reserved	45
334		51	6	358	Reserved	45

		Byte	Bit	GSE Bit #		Ext. Diag Byte
335		51	7	359	Reserved	45
336		52	0	360	Reserved	46
337		52	1	361	Reserved	46
338		52	2	362	Reserved	46
339		52	3	363	Reserved	46
340		52	4	364	Reserved	46
341		52	5	365	Reserved	46
342		52	6	366	Reserved	46
343		52	7	367	Reserved	46
344		53	0	368	Reserved	47
345		53	1	369	Reserved	47
346		53	2	370	Reserved	47
347		53	3	371	Reserved	47
348		53	4	372	Reserved	47
349		53	5	373	Reserved	47
350		53	6	374	Reserved	47
351		53	7	375	Reserved	47
352		54	0	376	Reserved	48
353		54	1	377	Reserved	48
354		54	2	378	Reserved	48
355		54	3	379	Reserved	48
356		54	4	380	Reserved	48
357		54	5	381	Reserved	48
358		54	6	382	Reserved	48
359		54	7	383	Reserved	48
360		55	0	384	Reserved	49
361		55	1	385	Reserved	49
362		55	2	386	Reserved	49
363		55	3	387	Reserved	49
364		55	4	388	Reserved	49
365		55	5	389	Reserved	49
366		55	6	390	Reserved	49
367		55	7	391	Reserved	49
368		56	0	392	Reserved	50
369		56	1	393	Reserved	50
370		56	2	394	Reserved	50
371		56	3	395	IO Input Overvoltage	50
372		56	4	396	IO Frequency Error	50
373		56	5	397	Reserved	50

		Byte	Bit	GSE Bit #		Ext. Diag Byte
374		56	6	398	Reserved	50
375		56	7	399	Reserved	50
376		57	0	400	Internal Temperature High	51
377		57	1	401	IO Communication Failure	51
378		57	2	402	Metering Failure	51
379		57	3	403	Reserved	51
380		57	4	404	Clock Error	51
381		57	5	405	Calibration Error	51
382		57	6	406	EEPROM Error	51
383		57	7	407	IO Input Read Error	51
384		58	0	408	Reserved	52
385		58	1	409	Reserved	52
386		58	2	410	Reserved	52
387		58	3	411	Reserved	52
388		58	4	412	Reserved	52
389		58	5	413	Reserved	52
390		58	6	414	Reserved	52
391		58	7	415	Reserved	52
392		59	0	416	Reserved	53
393		59	1	417	Reserved	53
394		59	2	418	Reserved	53
395		59	3	419	Reserved	53
396		59	4	420	Reserved	53
397		59	5	421	Reserved	53
398		59	6	422	Reserved	53
399		59	7	423	Reserved	53
400		60	0	424	Reserved	54
401		60	1	425	Reserved	54
402		60	2	426	Reserved	54
403		60	3	427	Reserved	54
404		60	4	428	Reserved	54
405		60	5	429	Reserved	54
406		60	6	430	Reserved	54
407		60	7	431	Reserved	54
408		61	0	432	Reserved	55
409		61	1	433	Transfer Timer	55
410		61	2	434	FLA Not Set	55
411		61	3	435	CT Type Not Set	55
412		61	4	436	Starter Type Not Set	55

		Byte	Bit	GSE Bit #		Ext. Diag Byte
413		61	5	437	No Control Source	55
414		61	6	438	Clock Not Set	55
415		61	7	439	FLA Too High	55

Note:

The extended diagnostic data is only provided when one of the states listed in the above extended diagnostic table has become true.

9.8.1.4 PROFIBUS DPV1

The MM300 Enhanced also supports DPV1 extensions. The device supports Class 1 and Class 2 acyclic reads and writes as well as DPV1 Diagnostics.

9.8.1.4.1 ACYCLIC READ/WRITE DATA

The motor status data can be read acyclically by retrieving the byte lengths indicated below from the relevant Object, Slot, Index.

DPV1 acyclic read data

Category	Object	Slot	Index	Length (in Bytes)	Data Item	Format
Status-Motor	0	0	0	2	Motor Status	FC614
	0	0	2	2	Extended Status	FC615
	0	0	4	2	Thermal Cap Used	F0
	0	0	6	2	Time to Overload Trip	F0
Start Blocks	0	0	8	2	Starts/Hour Block	F0
	0	0	10	2	Time Between Starts Lockout	F0
	0	0	12	2	Restart Block Lockout	F0
Learned	0	0	14	2	Average Motor Load Learned	F2
	0	0	16	4	Learned Acceleration Time	F13
	0	0	20	2	Learned Starting Current	F2
Counters	0	0	22	2	Number of Motor Starts	F0
	0	0	24	2	Number of UV Restarts	F0
	0	0	26	4	Motor Running Hours	F10
	0	0	30	4	Motor Stopped Hours	F10
Current Metering	0	0	34	4	Ia	F10
	0	0	38	4	Ib	F10
	0	0	42	4	Ic	F10
	0	0	46	4	Iavg	F10
	0	0	50	4	Igrd	F10
	0	0	54	2	Motor Load	F1
	0	0	56	2	Current Unbalance (I Unb)	F1

Category	Object	Slot	Index	Length (in Bytes)	Data Item	Format
Voltage Metering	0	0	58	2	Vab	F0
	0	0	60	2	Vbc	F0
	0	0	62	2	Vca	F0
	0	0	64	2	Va1 Angle	F1
	0	0	66	2	Vb1 Angle	F1
	0	0	68	2	Vc1 Angle	F1
	0	0	70	2	Van	F0
	0	0	72	2	Vbn	F0
	0	0	74	2	Vcn	F0
	0	0	76	2	VAux	F0
	0	0	78	2	Frequency	F2
	0	0	78	2	Frequency	F2
Power Metering	0	0	80	2	Power Factor	F22
	0	0	82	4	Real Power	F31
	0	0	86	4	Reactive Power	F31
	0	0	90	4	Apparent Power	F11
	0	0	94	4	MWh Consumption	F13
	0	0	98	4	Mvarh Consumption	F13
Sensor Metering	0	0	102	2	Hottest Stator RTD	F0
	0	0	104	2	Hottest Stator RTD Temp	F20B
	0	0	106	2	RTD 1 Temp	F20B
	0	0	108	2	RTD 2 Temp	F20B
	0	0	110	2	RTD 3 Temp	F20B
	0	0	112	2	RTD 4 Temp	F20B
	0	0	114	2	RTD 5 Temp	F20B
	0	0	116	2	RTD 6 Temp	F20B

Category	Object	Slot	Index	Length (in Bytes)	Data Item	Format
Last Trip Data	0	0	118	2	Cause of Last Trip	FC134
	0	0	122	4	Last Trip Date Time	F50
	0	0	126	4	Last Trip Time uSeconds	F51
	0	0	130	4	Pre Trip Ia	F30
	0	0	134	4	Pre Trip Ib	F30
	0	0	138	4	Pre Trip Ic	F30
	0	0	142	2	Pre Trip Motor Load	F30
	0	0	144	2	Pre Trip Current Unbalance	F30
	0	0	146	4	Pre Trip Igrd	F30
	0	0	150	2	Pre Trip Vab	F30
	0	0	152	2	Pre Trip Vbc	F30
	0	0	154	2	Pre Trip Vca	F30
	0	0	156	2	Pre Trip Van	F30
	0	0	158	2	Pre Trip Vbn	F30
	0	0	160	2	Pre Trip Vcn	F30
	0	0	162	2	Pre Trip System Frequency	F30
	0	0	164	4	Pre Trip Real Power	F30
	0	0	168	4	Pre Trip Reactive Power	F30
	0	0	172	2	Pre Trip Apparent Power	F30
	0	0	174	2	Pre Trip Power Factor	F30
Contact Inputs	0	0	176	4	Contact Input 32-1 (Bit Field)	FC194
Contact Outputs	0	0	180	4	Contact Output 32-1 (Bit Field)	FC198
Virtual Inputs	0	0	184	4	Virtual Input 32-1 (Bit Field)	FC524
Virtual Outputs	0	0	188	4	Virtual Output 32-1 (Bit Field)	FC524D

DPV1 acyclic write data

Object	Slot	Index	Value		Description
			Dec	Hex	
0	0	0	1	0x01	Reset
0	0	0	2	0x02	Lockout Reset
0	0	0	3	0x03	Stop
0	0	0	4	0x04	Start A
0	0	0	5	0x05	Start B
0	0	0	6	0x06	Clear Last Trip Data Prompt
0	0	0	7	0x07	Reset MWh and Mvarh Meters
0	0	0	8	0x08	Clear Counters
0	0	0	9	0x09	Clear Event Records
0	0	0	10	0x0A	Clear Waveform Data
0	0	0	11	0x0B	Clear Maintenance Timer
0	0	0	12	0x0C	Clear RTD Maximums
0	0	0	13	0x0D	Reset Motor Information
0	0	0	14	0x0E	Auto Mode

Object	Slot	Index	Value		Description
			Dec	Hex	
0	0	0	15	0x0F	Manual Mode
0	0	0	16	0x10	Trigger Waveform Capture

9.8.1.4.2 DIAGNOSTICS

DPV1 diagnosis data consists of standard and extended diagnoses, the latter of which is split into process alarms and diagnostic alarms.

Trip, Alarm and Control status are categorized as Process Alarms, as these provide information pertaining to the motor health that the MM300 Enhanced is controlling and monitoring.

Messages are categorized as Diagnostic Alarms as these provide detailed diagnostic information regarding the MM300 Enhanced.

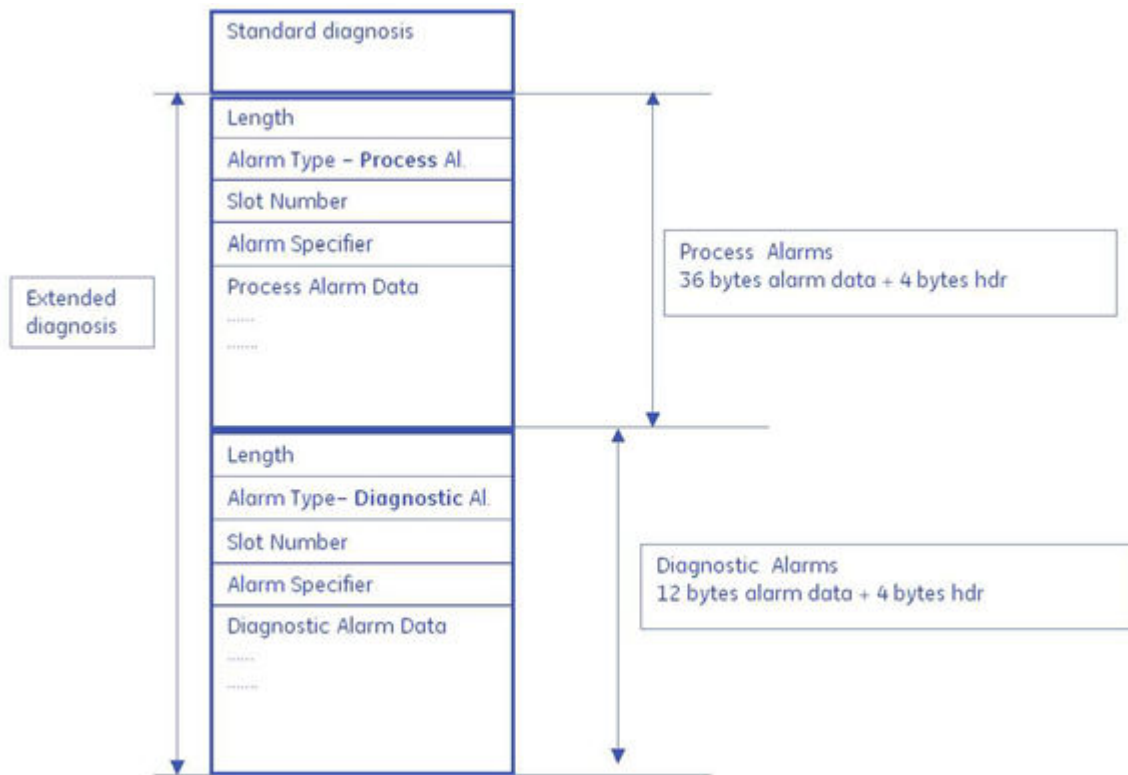


Figure 123: DPV1 diagnosis data structure

DPV1 diagnostic alarms

		Byte	Bit	GSE Bit #		Ext. Diag Byte
	Standard Diagnosis	0			Station Status 1	
		1			Station Status 2	
		2			Station Status 3	
		3			Master Address	
		4			Man Id	
		5			Man Id	

		Byte	Bit	GSE Bit #		Ext. Diag Byte
	Length	6	0	0	Length	0
		6	1	1		0
		6	2	2		0
		6	3	3		0
		6	4	4		0
		6	5	5		0
		6	6	6		0
		6	7	7		0
	Alarm Type	7	0	0	Alarm Type - Process Alarm	1
		7	1	1		1
		7	2	2		1
		7	3	3		1
		7	4	4		1
		7	5	5		1
		7	6	6		1
		7	7	7		1
	Slot Number	8	0	8	Slot Number	2
		8	1	9		2
		8	2	10		2
		8	3	11		2
		8	4	12		2
		8	5	13		2
		8	6	14		2
		8	7	15		2
	Alarm Specifier	9	0	16	Alarm Specifier	3
		9	1	17		3
		9	2	18		3
		9	3	19		3
		9	4	20		3
		9	5	21		3
		9	6	22		3
		9	7	23		3
0		10	0	24	Reserved	4
1		10	1	25	Reserved	4
2		10	2	26	Reserved	4
3		10	3	27	Reserved	4
4		10	4	28	Reserved	4
5		10	5	29	Reserved	4
6		10	6	30	Reserved	4

		Byte	Bit	GSE Bit #		Ext. Diag Byte
7		10	7	31	Reserved	4
8		11	0	32	Reserved	5
9		11	1	33	Reserved	5
10		11	2	34	Reserved	5
11		11	3	35	Reserved	5
12		11	4	36	Reserved	5
13		11	5	37	Reserved	5
14		11	6	38	Reserved	5
15		11	7	39	Reserved	5
16		12	0	40	Reserved	6
17		12	1	41	Reserved	6
18		12	2	42	Reserved	6
19		12	3	43	Reserved	6
20		12	4	44	Reserved	6
21		12	5	45	Reserved	6
22		12	6	46	Reserved	6
23		12	7	47	Reserved	6
24		13	0	48	Reserved	7
25		13	1	49	Reserved	7
26		13	2	50	Reserved	7
27		13	3	51	Reserved	7
28		13	4	52	Reserved	7
29		13	5	53	Reserved	7
30		13	6	54	Reserved	7
31		13	7	55	Reserved	7
32		14	0	56	Reserved	8
33		14	1	57	Reserved	8
34		14	2	58	Reserved	8
35		14	3	59	Reserved	8
36		14	4	60	Reserved	8
37		14	5	61	Reserved	8
38		14	6	62	Reserved	8
39		14	7	63	Reserved	8
40		15	0	64	Reserved	9
41		15	1	65	Reserved	9
42		15	2	66	Reserved	9
43		15	3	67	Reserved	9
44		15	4	68	Reserved	9
45		15	5	69	Reserved	9

		Byte	Bit	GSE Bit #		Ext. Diag Byte
46		15	6	70	Reserved	9
47		15	7	71	Reserved	9
48		16	0	72	Reserved	10
49		16	1	73	Reserved	10
50		16	2	74	Reserved	10
51		16	3	75	Reserved	10
52		16	4	76	Reserved	10
53		16	5	77	Reserved	10
54		16	6	78	Reserved	10
55		16	7	79	Reserved	10
56		17	0	80	Aux U/V Trip	11
57		17	1	81	Emergency Stop	11
58		17	2	82	Fuse Fail Trip	11
59		17	3	83	OpenControl Circuit	11
60		17	4	84	Thermistor Trip	11
61		17	5	85		11
62		17	6	86		11
63		17	7	87	Self Test Trip	11
64		18	0	88	Process ILock F Trip	12
65		18	1	89	Process ILock G Trip	12
66		18	2	90	Process ILock H Trip	12
67		18	3	91	Process ILock I Trip	12
68		18	4	92	Process ILock J Trip	12
69		18	5	93	Hard Wired Trip	12
70		18	6	94	Field Trip	12
71		18	7	95	MCC Trip	12
72		19	0	96	RTD 6 Trip	13
73		19	1	97	Comm Fail Trip	13
74		19	2	98	Relay Not Configured	13
75		19	3	99	Process ILock A Trip	13
76		19	4	100	Process ILock B Trip	13
77		19	5	101	Process ILock C Trip	13
78		19	6	102	Process ILock D Trip	13
79		19	7	103	Process ILock E Trip	13
80		20	0	104	Mechanical Jam Trip	14
81		20	1	105	UnderCurrent Trip	14
82		20	2	106	Unbalance Trip	14
83		20	3	107	RTD 1 Trip	14
84		20	4	108	RTD 2 Trip	14

		Byte	Bit	GSE Bit #		Ext. Diag Byte
85		20	5	109	RTD 3 Trip	14
86		20	6	110	RTD 4 Trip	14
87		20	7	111	RTD 5 Trip	14
88		21	0	112	Any Trip	15
89		21	1	113	Thermal O/L Trip	15
90		21	2	114	Ground Fault Trip	15
91		21	3	115	Acceleration Trip	15
92		21	4	116	Phase Reversal Trip	15
93		21	5	117	UnderPower Trip	15
94		21	6	118	UnderVoltage Trip	15
95		21	7	119	OverVoltage Trip	15
96		22	0	120	Reserved	16
97		22	1	121	Reserved	16
98		22	2	122	Reserved	16
99		22	3	123	Reserved	16
100		22	4	124	Reserved	16
101		22	5	125	Reserved	16
102		22	6	126	Reserved	16
103		22	7	127	Reserved	16
104		23	0	128	Reserved	17
105		23	1	129	Reserved	17
106		23	2	130	Reserved	17
107		23	3	131	Reserved	17
108		23	4	132	Reserved	17
109		23	5	133	Reserved	17
110		23	6	134	Reserved	17
111		23	7	135	Reserved	17
112		24	0	136	Reserved	18
113		24	1	137	Reserved	18
114		24	2	138	Reserved	18
115		24	3	139	Reserved	18
116		24	4	140	Reserved	18
117		24	5	141	Reserved	18
118		24	6	142	Reserved	18
119		24	7	143	Reserved	18
120		25	0	144	Reserved	19
121		25	1	145	Reserved	19
122		25	2	146	Reserved	19
123		25	3	147	Reserved	19

		Byte	Bit	GSE Bit #		Ext. Diag Byte
124		25	4	148	Reserved	19
125		25	5	149	Reserved	19
126		25	6	150	Reserved	19
127		25	7	151	Reserved	19
128		26	0	152	Reserved	20
129		26	1	153	Reserved	20
130		26	2	154	Reserved	20
131		26	3	155	Reserved	20
132		26	4	156	Reserved	20
133		26	5	157	Reserved	20
134		26	6	158	Reserved	20
135		26	7	159	Reserved	20
136		27	0	160	Reserved	21
137		27	1	161	Self Test Alarm	21
138		27	2	162	Comm Fail Alarm	21
139		27	3	163	Reserved	21
140		27	4	164	Reserved	21
141		27	5	165	Reserved	21
142		27	6	166	Reserved	21
143		27	7	167	Reserved	21
144		28	0	168	Welded Contactor	22
145		28	1	169	Reserved	22
146		28	2	170	Reserved	22
147		28	3	171	Reserved	22
148		28	4	172	Load Increase Alarm	22
149		28	5	173	Drive Greasing Alarm	22
150		28	6	174	Contactor Inspect Alarm	22
151		28	7	175	Max Stopped Alarm	22
152		29	0	176	Aux U/V Alarm	23
153		29	1	177	External Stop Alarm	23
154		29	2	178	Fuse Fail Alarm	23
155		29	3	179	Open Ctrl Cct Alarm	23
156		29	4	180	Thermistor Alarm	23
157		29	5	181	Reserved	23
158		29	6	182	External Start A Alarm	23
159		29	7	183	External Start B Alarm	23
160		30	0	184	Process I Lock F Alarm	24
161		30	1	185	Process I Lock G Alarm	24
162		30	2	186	Process I Lock H Alarm	24

		Byte	Bit	GSE Bit #		Ext. Diag Byte
163		30	3	187	Process ILock I Alarm	24
164		30	4	188	Process ILock J Alarm	24
165		30	5	189	Drive Failed to Start	24
166		30	6	190	Inverter Failed	24
167		30	7	191	Drive Stop Failed	"24
168		31	0	192	RTD 6 Alarm	"25
169		31	1	193	RTD Open Alarm	25
170		31	2	194	RTD Short Alarm	25
171		31	3	195	Process ILock A Alarm	25
172		31	4	196	Process ILock B Alarm	25
173		31	5	197	Process ILock C Alarm	25
174		31	6	198	Process ILock D Alarm	25
175		31	7	199	Process ILock E Alarm	25
176		32	0	200	Reserved	26
177		32	1	201	UnderCurrent Alarm	26
178		32	2	202	Unbalance Alarm	26
179		32	3	203	RTD 1 Alarm	26
180		32	4	204	RTD 2 Alarm	26
181		32	5	205	RTD 3 Alarm	26
182		32	6	206	RTD 4 Alarm	26
183		32	7	207	RTD 5 Alarm	26
184		33	0	208	Any Alarm	27
185		33	1	209	Thermal Level Alarm	27
186		33	2	210	Ground Fault Alarm	27
187		33	3	211	Acceleration Alarm	27
188		33	4	212	Phase Reversal Alarm	27
189		33	5	213	UnderPower Alarm	27
190		33	6	214	UnderVoltage Alarm	27
191		33	7	215	OverVoltage Alarm	27
192		34	0	216	Reserved	28
193		34	1	217	Reserved	28
194		34	2	218	Reserved	28
195		34	3	219	Reserved	28
196		34	4	220	Reserved	28
197		34	5	221	Reserved	28
198		34	6	222	Reserved	28
199		34	7	223	Reserved	28
200		35	0	224	Reserved	29
201		35	1	225	Reserved	29

		Byte	Bit	GSE Bit #		Ext. Diag Byte
202		35	2	226	Reserved	29
203		35	3	227	Reserved	29
204		35	4	228	Reserved	29
205		35	5	229	Reserved	29
206		35	6	230	Reserved	29
207		35	7	231	Reserved	29
208		36	0	232	Reserved	30
209		36	1	233	Reserved	30
210		36	2	234	Reserved	30
211		36	3	235	Reserved	30
212		36	4	236	Reserved	30
213		36	5	237	Reserved	30
214		36	6	238	Reserved	30
215		36	7	239	Reserved	30
216		37	0	240	Reserved	31
217		37	1	241	Reserved	31
218		37	2	242	Reserved	31
219		37	3	243	Reserved	31
220		37	4	244	Reserved	31
221		37	5	245	Reserved	31
222		37	6	246	Reserved	31
223		37	7	247	Reserved	31
224		38	0	248	Reserved	32
225		38	1	249	Reserved	32
226		38	2	250	Reserved	32
227		38	3	251	Reserved	32
228		38	4	252	Reserved	32
229		38	5	253	Reserved	32
230		38	6	254	Reserved	32
231		38	7	255	Reserved	32
232		39	0	256	Reserved	33
233		39	1	257	Reserved	33
234		39	2	258	Reserved	33
235		39	3	259	Comm Stop	33
236		39	4	260	Fuse Fail Inhibit	33
237		39	5	261	Phase Reversal Inhibit	33
238		39	6	262	Low Aux Voltage Inhibit	33
239		39	7	263	UV Restart Inhibit	33
240		40	0	264	Reserved	34

		Byte	Bit	GSE Bit #		Ext. Diag Byte
241		40	1	265	Reserved	34
242		40	2	266	Reserved	34
243		40	3	267	Reserved	34
244		40	4	268	Reserved	34
245		40	5	269	Reserved	34
246		40	6	270	Reserved	34
247		40	7	271	Reserved	34
248		41	0	272	Reserved	35
249		41	1	273	Reserved	35
250		41	2	274	Reserved	35
251		41	3	275	Reserved	35
252		41	4	276	Reserved	35
253		41	5	277	Reserved	35
254		41	6	278	Reserved	35
255		41	7	279	Reserved	35
256		42	0	280	Process ILock F Stop	36
257		42	1	281	Process ILock G Stop	36
258		42	2	282	Process ILock H Stop	36
259		42	3	283	Process ILock I Stop	36
260		42	4	284	Process ILock J Stop	36
261		42	5	285	HW Stop	"36
262		42	6	286	Field Stop	"36
263		42	7	287	MCC Stop	"36
264		43	0	288	Reserved	37
265		43	1	289	Reserved	37
266		43	2	290	Reserved	37
267		43	3	291	Process ILock A Stop	37
268		43	4	292	Process ILock B Stop	37
269		43	5	293	Process ILock C Stop	37
270		43	6	294	Process ILock D Stop	37
271		43	7	295	Process ILock E Stop	37
272		44	0	296	Forward Limit	38
273		44	1	297	Reverse Limit	38
274		44	2	298	Starts/Hr Inhibit	38
275		44	3	299	Time Between Inhibit	38
276		44	4	300	Reserved	38
277		44	5	301	Reserved	38
278		44	6	302	Reserved	38
279		44	7	303	Reserved	38

		Byte	Bit	GSE Bit #		Ext. Diag Byte
280		45	0	304	Any Stop	39
281		45	1	305	Thermal Inhibit	39
282		45	2	306	Reserved	39
283		45	3	307	Reserved	39
284		45	4	308	Reserved	39
285		45	5	309	Restart Inhibit	39
286		45	6	310	Reserved	39
287		45	7	311	Reserved	39
288	Length	46	0	312	Length	40
289		46	1	313		40
290		46	2	314		40
291		46	3	315		40
292		46	4	316		40
293		46	5	317		40
294		46	6	318		40
295		46	7	319		40
296	Alarm Type	47	0	320	Alarm Type - Diagnostic alarm	41
297		47	1	321		41
298		47	2	322		41
299		47	3	323		41
300		47	4	324		41
301		47	5	325		41
302		47	6	326		41
303		47	7	327		41
304	Slot Number	48	0	328	Slot Number	42
305		48	1	329		42
306		48	2	330		42
307		48	3	331		42
308		48	4	332		42
309		48	5	333		42
310		48	6	334		42
311		48	7	335		42

		Byte	Bit	GSE Bit #		Ext. Diag Byte
312	Alarm Specifier	49	0	336	Alarm Specifier	43
313		49	1	337		43
314		49	2	338		43
315		49	3	339		43
316		49	4	340		43
317		49	5	341		43
318		49	6	342		43
319		49	7	343		43
320		50	0	344	Reserved	44
321		50	1	345	Reserved	44
322		50	2	346	Reserved	44
323		50	3	347	Reserved	44
324		50	4	348	Reserved	44
325		50	5	349	Reserved	44
326		50	6	350	Reserved	44
327		50	7	351	Reserved	44
328		51	0	352	Reserved	45
329		51	1	353	Reserved	45
330		51	2	354	Reserved	45
331		51	3	355	Reserved	45
332		51	4	356	Reserved	45
333		51	5	357	Reserved	45
334		51	6	358	Reserved	45
335		51	7	359	Reserved	45
336		52	0	360	Reserved	46
337		52	1	361	Reserved	46
338		52	2	362	Reserved	46
339		52	3	363	Reserved	46
340		52	4	364	Reserved	46
341		52	5	365	Reserved	46
342		52	6	366	Reserved	46
343		52	7	367	Reserved	46
344		53	0	368	Reserved	47
345		53	1	369	Reserved	47
346		53	2	370	Reserved	47
347		53	3	371	Reserved	47
348		53	4	372	Reserved	47
349		53	5	373	Reserved	47
350		53	6	374	Reserved	47

		Byte	Bit	GSE Bit #		Ext. Diag Byte
351		53	7	375	Reserved	47
352		54	0	376	Reserved	48
353		54	1	377	Reserved	48
354		54	2	378	Reserved	48
355		54	3	379	Reserved	48
356		54	4	380	Reserved	48
357		54	5	381	Reserved	48
358		54	6	382	Reserved	48
359		54	7	383	Reserved	48
360		55	0	384	Reserved	49
361		55	1	385	Reserved	49
362		55	2	386	Reserved	49
363		55	3	387	Reserved	49
364		55	4	388	Reserved	49
365		55	5	389	Reserved	49
366		55	6	390	Reserved	49
367		55	7	391	Reserved	49
368		56	0	392	Reserved	50
369		56	1	393	Reserved	50
370		56	2	394	Reserved	50
371		56	3	395	IO Input Overvoltage	50
372		56	4	396	IO Frequency Error	50
373		56	5	397	Reserved	50
374		56	6	398	Reserved	50
375		56	7	399	Reserved	50
376		57	0	400	Internal Temperature High	51
377		57	1	401	IO Communication Failure	51
378		57	2	402	Metering Failure	51
379		57	3	403	Reserved	51
380		57	4	404	Clock Error	51
381		57	5	405	Calibration Error	51
382		57	6	406	EEPROM Error	51
383		57	7	407	IO Input Read Error	51
384		58	0	408	Reserved	52
385		58	1	409	Reserved	52
386		58	2	410	Reserved	52
387		58	3	411	Reserved	52
388		58	4	412	Reserved	52
389		58	5	413	Reserved	52

		Byte	Bit	GSE Bit #		Ext. Diag Byte
390		58	6	414	Reserved	52
391		58	7	415	Reserved	52
392		59	0	416	Reserved	53
393		59	1	417	Reserved	53
394		59	2	418	Reserved	53
395		59	3	419	Reserved	53
396		59	4	420	Reserved	53
397		59	5	421	Reserved	53
398		59	6	422	Reserved	53
399		59	7	423	Reserved	53
400		60	0	424	Reserved	54
401		60	1	425	Reserved	54
402		60	2	426	Reserved	54
403		60	3	427	Reserved	54
404		60	4	428	Reserved	54
405		60	5	429	Reserved	54
406		60	6	430	Reserved	54
407		60	7	431	Reserved	54
408		61	0	432	Reserved	55
409		61	1	433	Transfer Timer	55
410		61	2	434	FLA Not Set	55
411		61	3	435	CT Type Not Set	55
412		61	4	436	Starter Type Not Set	55
413		61	5	437	No Control Source	55
414		61	6	438	Clock Not Set	55
415		61	7	439	FLA Too High	55

9.8.1.4.3 I&M (IDENTIFICATION & MAINTENANCE) RECORDS

The MM300 Enhanced supports only the mandatory I&M0 record. It does not support the optional I&M1, I&M2, I&M3, I&M4 or I&M5 records., so requests for these I&M records would result in an error response.

I&M records can be read using the following sequence of reads and writes from the Profibus master.

Send a Write Call-REQ-PDU i.e., DPV1 write request (MS1 and MS2) to the IED, on slot 0, index 255 and FI_Index = 65000:

	Content	Size	Coding	Notes
DPV1 Header	Function Number	1 Octet	5Fh	fixed
	Slot Number	1 Octet	0	variable
	Index	1 Octet	255	fixed
	Length	1 Octet	04	Call Header
Call Header	Extended Function Number	1 Octet	08h	fixed

	Content	Size	Coding	Notes
	Reserved	1 Octet	00h	fixed
	FI_ Index	2 Octets	65000	sub index

The MM300 Enhanced will reply with a Write Call-Res-PDU:

	Content	Size	Coding	Notes
DPV1 Header	Function Number	1 Octet	5Fh	fixed
	Slot Number	1 Octet	0	variable (same as that in request)
	Index	1 Octet	255	fixed
	Length	1 Octet	04	Call Header

Send a Read-REQ-PDU i.e., DPV1 Read request (MS1 and MS2) to the MM300 Enhanced, on slot 0, index 255 and Length = 68:

	Content	Size	Coding	Notes
DPV1 Header	Function Number	1 Octet	5Eh	fixed
	Slot Number	1 Octet	0	variable
	Index	1 Octet	255	fixed
	Length	1 Octet	68	Call Header & Body

The MM300 Enhanced will reply with a Read-Res-PDU:

	Content	Size	Coding	Notes
DPV1 Header	Function Number	1 Octet	5Eh	fixed
	Slot Number	1 Octet	0	variable
	Index	1 Octet	255	fixed
	Length	1 Octet	68	Call Header & Body
Call Header	Extended Function Number	1 Octet	08h	fixed
	Reserved	1 Octet	00h	fixed
	FI_ Index	2 Octets	65000	sub index
Body	IM Function	64 Octets		I&M record

The 64 octets of I&M record in I&M0 response structure are formatted as follows:

Structure Element	Size in Bytes	Example Retrieved Data
Manufacture Specific Data (10 Bytes)	10	00 00 00 00 00 00 00 00 00 00
Manufacture ID (2 Bytes, Provided by PNO)	2	0x01A7
Order ID (20 Bytes, Order Code of device)	20	MM300-GEHP3CABD
Serial No. (16, Bytes, Serial No. of MM300 device)	16	50-GEHE3BBAK
Hardware Revision (2 Bytes, Hardware Revision of MM300 device)	2	0X00041
Software Revision (4 Bytes, Comms Firmware Revision)	4	V1.50.0
Revision Counter (2 Bytes, Profibus Library revision)	2	0x0166
Profile ID (2 Bytes, Generic for MM300)	2	0xF600
Profile Specific Type (2 Bytes, No Profile Specific type for MM300)	2	0x0000
IM Version (2 Bytes)	2	V1.1
IM Supported (2 Bytes, Currently only I&M0)	2	0x0000

9.8.2 TIME SYNCHRONIZATION

9.8.2.1 IEEE 1588 PRECISION TIME PROTOCOL (PTP VERSION 2)

9.8.2.1.1 FEATURE SUMMARY

The IED implements PTP functionality on each of its Ethernet ports independently, and automatically selects the port with the best time using the Best Master Clock Algorithm. Depending on the order code selection, the device will have one Ethernet port (ETH1) or two (ETH2 and ETH3), which are used for redundancy..

The IED may use PTP or SNTP time sources based on the user configuration or it may free-run if none of the time sources are available.

PTP version 2 is supported and only the transport over IEEE 802.3/Ethernet PTP option is supported. PTP Version 1 is not supported. Only the slave-only operation option is supported, master operation is not implemented.

The MM300 Enhanced IED supports both 1-step and 2-step synchronization on ingress. As the IED operates only in slave mode, it doesn't egress any synchronization messages except peer delay request.

The peer delay mechanism is implemented, but in the requester mode, responder mode is not supported. The end-to-end delay mechanism is not implemented as it is forbidden by both Power and Power Utility Profiles.

The IED supports synchronizing to the grandmasters with either Power Profile (IEEE C37.238: 2017) or Power Utility Profile (IEC61850 9-3).

The MM300 Enhanced IED synchronizes (meets the time accuracy requirements) within 15 seconds, given an error-free PP input and stable temperature.

The ALTERNATE_TIME_OFFSET_INDICATOR TLV in PP is not used to calculate local time zone.

9.8.2.1.1.1 SYSTEM OPERATION

The IED supports the Precision Time Protocol (PTP) specified in IEEE Std 1588TM 2008 (PTP v2). This enables the IED to synchronize to the international time standard over an Ethernet network that implements both the Power Profile (PP) specified in IEEE Std C37.238TM 2017 and Power Utility profile (PU) specified in IEC61850 9-3.

Power profile specifies PTP message extensions that includes two TLVs (type, length, and values) as given below: IEEE_C37_238 TLV - providing additional information to monitor clock performance in real time

- IEEE_C37_238 TLV - providing additional information to monitor clock performance in real time
- ALTERNATE_TIME_OFFSET_INDICATOR TLV - providing local time zone information

However, the usage of TLVs is made optional in IEEE Std C37.238 2017. The IED doesn't use the information provided in optional TLVs and tolerates the missing TLVs. When a master clock with power profile and power utility profile are available in network, the IED can synchronize to best master based on best master clock algorithm.

When the ETH1/2/3 PTP Function is enabled, Slave-only operation is supported, where a grandmaster is available on the port communication path, the Best Master Clock Algorithm selects the best master clock out of all the enabled ports, and the respective port state is set to *Slave*. The IED implements the state machine for slave-only implementation specified in PTP clause 9.2 independently on each Ethernet port.

9.8.2.2 SNTP

The MM300 Enhanced accepts time synchronization from up to two different SNTP servers. In order to define number of SNTP servers to be used, different settings for each SNTP server must be configured.

If only one SNTP server is used to synchronize the relay, the **SNTP SERVER1 IP ADDR** and **SNTP SERVER1 UDP PORT NUM** settings must be configured.

If two SNTP server are to be used, then in addition to the above settings for the main server, **SNTP SERVER2 IP ADDR** and **SNTP SERVER2 UDP PORT NUM** need to be configured for the back-up server.

9.8.2.3 TIME SYNCHRONIZATION USING THE COMMUNICATION PROTOCOLS

All communication protocols have in-built time synchronization mechanisms. If an external time synchronization mechanism such as SNTP or PTP is not used to synchronize the devices, the time synchronization mechanism within the relevant protocol is used. The real time is usually defined in the master station and communicated to the relevant IEDs via the rear port using the chosen protocol. It is also possible to define the time locally.

9.8.3 COMPATIBILITY MODE/FLEXMAP FILE

The MM300 Enhanced supports compatibility mode of the MM300 and MM2 Modbus memory map for retrofit applications. The emulation supports mainly typical actual values for common data items and commands indicated under this chapter.

When Compatibility is enabled, the MM300 Enhanced relay will respond to Modbus packets from a PLC as configured by the mapping file. An additional setting for file name will be available.

The relay will stop communication with EnerVista Flex when using RS485 and Eth1/Eth2/Eth3. The user will only be able to communicate using EnerVista Flex through the Graphical Control Panel USB port or through the lateral RS485 port, where the Graphical Control Panel is usually connected. To connect through this lateral RS485 port, an MM300/MM2 1Ft. RS232-RJ45, PN: 0804-0180 cable must be used. Only serial connection is allowed to this port.

The FlexMap feature can be enabled using the **COMPATIBILITY** setting in **Setpoints > Configure > Comms > Modbus**.

Please see Comms for further information.

9.8.3.1 COMPATIBILITY MODE OF MM300

The following table shows actual values for Modbus addresses of old MM300 supported by the MM300 Enhanced when the FlexMap feature is enabled.

Actual values

ACTUAL VALUES			
Description	Address	Size in Words	
LastTripTime	30187	2	eFormat_F19
LastTripDate	30189	2	eFormat_F18
Week_Read_Only	30223	1	eFormat_FC171
Date_Read_Only	30224	2	eFormat_F18
Time_Read_Only	30226	2	eFormat_F19
DaylightSavingsActive	30228	1	eFormat_FC126
Total_Number_of_Trips	30230	1	eFormat_F1
Incomplete_Sequence_Trips	30231	1	eFormat_F1
Overload_Trips	30232	1	eFormat_F1
Mechanical_Jam_Trips	30233	1	eFormat_F1
Undercurrent_Trips	30234	1	eFormat_F1
Current_Unbalance_Trips	30235	1	eFormat_F1
Ground_Fault_Trips	30236	1	eFormat_F1
Motor_Acceleration_Trips	30237	1	eFormat_F1
Undervoltage_Trips	30238	1	eFormat_F1

ACTUAL VALUES			
Description	Address	Size in Words	
Overvoltage_Trips	30239	1	eFormat_F1
Number_of_Motor_Starts	30257	1	eFormat_F1
Number_of_UV_Restarts	30258	1	eFormat_F1
Motor_Running_Hours	30259	2	eFormat_F9
UVR_Timer	30261	1	eFormat_F1
Transfer_Timer	30267	1	eFormat_F1
Motor_Stopped_Hours	30269	1	eFormat_F1
SHBLockoutTime	30271	1	eFormat_F1
PreContactorTimer	30275	1	eFormat_F1
ContactInput64_33	30283	2	eFormat_FC168
ContactInput32_01	30285	2	eFormat_FC167
VirtualInput32_01	30288	2	eFormat_FC167
VirtualOutput32_01	30290	2	eFormat_FC167
ContactOutput32_01	30298	2	eFormat_FC167
MotorStatus	30305	1	eFormat_FC129
ThermalCap	30307	1	eFormat_F1
TimeToTrip	30308	2	eFormat_F20
DriveStatus	30310	1	eFormat_FC143
Command_Status	30312	1	eFormat_FC128
TimeToReset	30313	1	eFormat_F1
Ia	30328	2	eFormat_F10
Ib	30330	2	eFormat_F10
Ic	30332	2	eFormat_F10
Iavg	30334	2	eFormat_F10
Motor_Load	30336	1	eFormat_F1
I_Unb	30337	1	eFormat_F1
Igrd	30338	2	eFormat_F10
Va1_Angle	30340	1	eFormat_F1
Vb1_Angle	30341	1	eFormat_F1
Vc1_Angle	30342	1	eFormat_F1
Vab	30358	1	eFormat_F1
Vbc	30359	1	eFormat_F1
Vca	30360	1	eFormat_F1
AvLineVoltage	30361	1	eFormat_F1
Van	30362	1	eFormat_F1
Vbn	30363	1	eFormat_F1
Vcn	30364	1	eFormat_F1
SystemFreq	30366	1	eFormat_F3
VAux	30376	1	eFormat_F1
V_Unb	30377	1	eFormat_F1
PowerFactor	30384	1	eFormat_F21
RealPower	30385	2	eFormat_F13

ACTUAL VALUES			
Description	Address	Size in Words	
Reactive_Power	30389	2	eFormat_F13
Apparent_Power	30391	1	eFormat_F2
MWh_Consumption	30392	2	eFormat_F17
Mvarh_Consumption	30394	2	eFormat_F17
Apparent_Power_32	30398	2	eFormat_F10
Internal_Temp	30426	1	eFormat_F4
Hottest_Stator_RTD	30427	1	eFormat_F1
Hottest_Stator_RTD_Temp	30428	1	eFormat_F4
RTD_1_Temp	30429	1	eFormat_F4
RTD_2_Temp	30430	1	eFormat_F4
RTD_3_Temp	30431	1	eFormat_F4
RTD_4_Temp	30432	1	eFormat_F4
RTD_5_Temp	30433	1	eFormat_F4
RTD_6_Temp	30434	1	eFormat_F4
Thermistor30435	30435	1	eFormat_F1
Average_Motor_Load_Learned	30484	1	eFormat_F3
RTD_1_MAX_Temp	30485	1	eFormat_F4
RTD_2_MAX_Temperature	30486	1	eFormat_F4
RTD_3_MAX_Temperature	30487	1	eFormat_F4
RTD_4_MAX_Temperature	30488	1	eFormat_F4
RTD_5_MAX_Temperature	30489	1	eFormat_F4
RTD_6_MAX_Temperature	30490	1	eFormat_F4
LEDStatus	30505	2	eFormat_FC144
Event_Recorder_Last_Reset_2_words	30659	2	eFormat_F18
Total_Number_of_Events_Since_Last_Clear	30661	1	eFormat_F1
AlarmStatus2	30956	2	eFormat_FC180
AlarmStatus1	30958	2	eFormat_FC179
TripStatus2	30964	2	eFormat_FC184
TripStatus1	30966	2	eFormat_FC183
MsgStatus2	30972	2	eFormat_FC188
MsgStatus1	30974	2	eFormat_FC187
CtrlStatus2	30980	2	eFormat_FC192
CtrlStatus1	30982	2	eFormat_FC191

Command

Note:

MM300 Enhanced commands follow the same structure as the MM300.

9.8.3.2 COMPATIBILITY MODE OF MM2

Actual values

The following table shows actual values for Modbus addresses of old MM2 supported by the MM300 Enhanced when the FlexMap feature is enabled.

Description	Format	New modbus address	Hex modbus address
Gen Alarm Active Status Flags 1	F104	30021	14
Gen Alarm Active Status Flags 2	F105	30022	15
Interlock Alarm Active Status Flags	F106	30023	16
Interlock Start Block Status Flags	F106	30027	1A
Trip Active Status Flags 1	F107	30028	1B
Trip Active Status Flags 2	F108	30029	1C
Command Mode	F6	30035	22
Drive Status	F7	30036	23
Motor Mode	F8	30037	24
Phase Current Scale Factor	F1	30049	30
Phase A Current	F1	30050	31
Phase B Current	F1	30051	32
Phase C Current	F1	30052	33
Ground Current	F1	30053	34
Motor Load	F1	30054	35
Thermal Capacity	F1	30055	36
Current Unbalance	F1	30056	37
Switch Input Status	F100	30017	10
Operation Status Flags	F103	30020	13
Cause of Stop	F5	30034	21
Acceleration Time	F1	30057	38
Last Starting Current	F1	30058	39
O/L Time to Trip	F1	30059	3A
Cause of Trip	F9	30081	50
Time to Reset	F1	30082	51
Pre Trip Phase A Current	F1	30083	52
Pre Trip Phase B Current	F1	30084	53
Pre Trip Phase C Current	F1	30085	54
Pre Trip Ground Current	F1	30086	55
Cause of Last Trip	F9	30087	56
Power (scaled)	F21	30062	3D
Energy Used - high order	F2	30063	3E
Energy Used - low order	F2	30064	3F
Voltage	F1	30065	40
Analog Input	F1	30073	48
Running Time	F1	30089	58
Stopped Time	F1	30090	59

Description	Format	New modbus address	Hex modbus address
Number of Starts - high order	F2	30097	60
Number of Starts - low order	F2	30098	61
Total Trips	F1	30099	62
Overload Trips	F1	30100	63
Thermistor Trips	F1	30101	64
Ground Fault Trips	F1	30102	65
Single Phase Trips	F1	30103	66
Acceleration Time Trips	F1	30104	67
Undercurrent Trips	F1	30105	68
Underpower Trips	F1	30106	69
Stalled Rotor Trips	F1	30107	6A
Control Command Trips	F1	30108	6B
Interlock Counter	F1	30109	6C

Command

The following commands can be performed when using MM2 FlexMap with ***Bypass PW for Remote Control*** setting enable in MM300 Enhanced

COMMANDS		
Operation Code		Description
MM2	MM300E	
1	1	Reset
2	2	Lockout reset
3	3	Stop
4	4	Start A
5	5	Start B
8	102	Clear Maintenance Timers
9	99	Clear Maintenance Counters
10	97	Clear Energy Data

CHAPTER 10

CYBERSECURITY

10.1 CHAPTER OVERVIEW

This chapter contains the following sections:

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The need for cyber-security	369
Cyber-security implementation	370

10.2 OVERVIEW

In the past, substation networks were traditionally isolated and the protocols and data formats used to transfer information between devices were often proprietary. For these reasons, the substation environment was very secure against cyber-attacks. The terms used for this inherent type of security are:

- Security by isolation (if the substation network is not connected to the outside world, it cannot be accessed from the outside world).
- Security by obscurity (if the formats and protocols are proprietary, it is very difficult to interpret them).

The increasing sophistication of protection schemes, coupled with the advancement of technology and the desire for vendor interoperability, has resulted in standardization of networks and data interchange within substations. Today, devices within substations use standardized protocols for communication. Furthermore, substations can be interconnected with open networks, such as the Internet or corporate-wide networks, which use standardized protocols for communication. This introduces a major security risk making the grid vulnerable to cyber-attacks, which could in turn lead to major electrical outages. Clearly, there is now a need to secure communication and equipment within substation environments. This chapter describes the security measures that have been put in place for our range of Intelligent Electronic Devices (IEDs).

Note:

Cyber-security compatible devices do not enforce NERC compliance, they merely facilitate it. It is the responsibility of the user to ensure that compliance is adhered to as and when necessary.

10.3 THE NEED FOR CYBER-SECURITY

Cyber-security provides protection against unauthorized disclosure, transfer, modification, or destruction of information or information systems, whether accidental or intentional. To achieve this, there are several security requirements:

- Confidentiality (preventing unauthorized access to information)
- Integrity (preventing unauthorized modification)Availability / Authentication (preventing the denial of service and assuring authorized access to information)Non-repudiation (preventing the denial of an action that took place)Traceability / Detection (monitoring and logging of activity to detect intrusion and analyze incidents)

The threats to cyber-security may be unintentional (e.g. natural disasters, human error), or intentional (e.g. cyber-attacks by hackers).

Good cyber-security can be achieved with a range of measures, such as closing down vulnerability loopholes, implementing adequate security processes and procedures and providing technology to help achieve this.

Examples of vulnerabilities are:

- Indiscretions by personnel (users keep passwords on their computer)
- Bad practice (users do not change default passwords, or everyone uses the same password to access all substation equipment)
- Bypassing of controls (users turn off security measures)
- Inadequate technology (substation is not firewalled)

Examples of availability issues are:

- Equipment overload, resulting in reduced or no performance
- Expiry of a certificate preventing access to equipment

To help tackle these issues, standards organizations have produced various standards. Compliance with these standards significantly reduces the threats associated with lack of cyber-security.

10.4 CYBER-SECURITY IMPLEMENTATION

The General Electric IEDs have always been and will continue to be equipped with state-of-the-art security measures. Due to the ever-evolving communication technology and new threats to security, this requirement is not static. Hardware and software security measures are continuously being developed and implemented to mitigate the associated threats and risks.

This section describes the current implementation of cyber-security. The bulk of the implementation consists of RBAC (Role Based Access Control) Cyber-security mode, Centralized Authentication, Remote Logging and System Hardening. The features are compliant with NERC-CIPv6 and IEEE 1686. This is valid for the release of platform software to which this manual pertains.

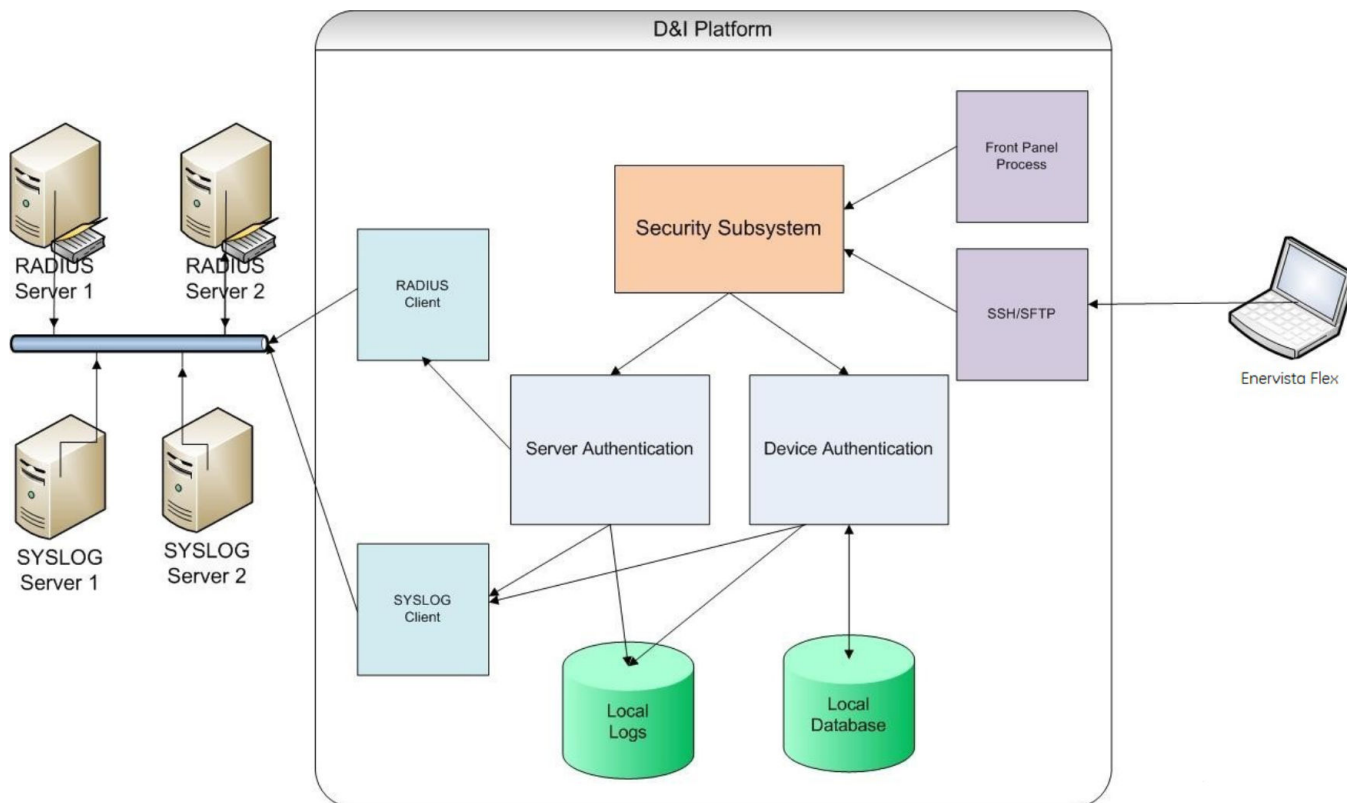


Figure 124: Cyber-security implementation

Two levels of Cyber-security are available as ordering options for the MM300 Enhanced:

- Basic Cyber-security
- Advanced Cyber-security

Basic Cyber-security includes the following security features:

- Device / Local Authentication
- Four-level access: Fixed local users and roles (Administrator, Engineer, Operator, Viewer)
- ByPass Access
- Password complexity
- Secure encrypted communication (Modbus/SSH, SFTP)
- Disabling of unused physical and logical ports
- Flag for failed authentication
- User lockout for a configurable period
- Inactivity time out

Advanced security includes additional security features as follows:

- Remote/Server Authentication (supports RADIUS)
- Local authentication with unique configurable usernames
- Syslog
- Increased product hardening

10.4.1 RBAC FUNCTIONALITY

Role based access control, RBAC, is the core of session management. Every login attempt will connect to the RBAC service and it will allow or deny the login of the user.

In Basic Security, default connection is done as Viewer, without password requirement.

In case of Advanced Security, a username and password will be required. If the login is successful, the access level will correspond to the role defined to this user.

The user cannot change their own role. So, if more rights needed, a different user with the corresponding role should be logged in.

The maximum number of concurrent sessions is only one for all roles, except for the Viewer role, which has a five session limit.

There is an inactivity timeout which can be configured using the **ACCESS TIMEOUT** setting. This timeout means that open sessions are automatically closed if they remain inactive until the timer elapses. This inactivity timer defines the period that IED waits in idleness before a logged in user will be automatically logged out. This timeout is different for HMI interface and other interfaces (Serial, Ethernet, etc).

There is a lockout period which can be configured using the **ACCESS LOCKOUT TIME** setting. For each account, when a maximum number of failed login attempts is reached, it is locked during the specified period. It doesn't matter the interface the login comes from. The account will be unlocked at the first successful login passed the lockout period.

If the **AUTHENTICATION METHOD** setting is changed, the logged in user will be forced to logout.

10.4.2 BASIC CYBER-SECURITY IMPLEMENTATION

10.4.2.1 SECURE ENCRYPTED COMMUNICATION

10.4.2.1.1 MODBUS/SSH

Secure Shell (SSH) protocol provides a secure channel over an unsecured network by using a clientserver architecture. The SSH server resides in the IED. It securely encrypts the Modbus commands and data between EnerVista Flex and itself using port forwarding.

SSH architecture is described in RFC4251 and is comprised of three components:

- Transport Layer protocol (SSH-TRANS) – RFC 4253
- User Authentication Protocol (SSH-USERAUTH) – RFC 4252
- Connection Protocol (SSH-CONNECT) – RFC 4254

The port forwarding feature is only available on TCP/IP frames. UDP is not supported. The SSH server on the IED runs on port 22.

It supports the following Encryption Ciphers: RSA 2048, AES-128-CBC or AES-128-GCM and HMAC-SHA-256.

The SSH server has a timeout for authentication and disconnects if the authentication has not been accepted within the timeout period.

10.4.2.1.2 SFTP

SFTP (SSH File Transfer Protocol) is the file transfer protocol used with SSHv2. It provides secure file access, file transfer and file management.

The SFTP commands will be limited to a given period of time to avoid DOS attacks and also implement role-based access to the file.

10.4.2.2 DEVICE/LOCAL AUTHENTICATION

In Device Authentication mode, the IED provides local RBAC Server security. The IED supports unique device usernames, and stores device passwords securely. For password encryption, PBKDF2 with SHA256 and a unique 64bits salt per user is used.

All device users can change their own passwords, no matter what access level they have, but only an Administrator can change other users' passwords.

Viewer access level has no password associated and is the default connection to the device. The default password for Administrator, Engineer and Operator access levels is 0.

10.4.2.3 FOUR-LEVEL ACCESS

Basic IED Security supports 4 fixed roles: Administrator, Engineer, Operator and Viewer. The fixed local usernames match with these roles.

All the roles are password protected except the Viewer. A Viewer connection is directly logged in without entering a password using front panel or any communication port.

The different features of each role or access level are shown in the table below:

Security access roles

		Administrator	Engineer	Operator	Viewer
Settings	Security settings	RW	R	R	R
	Change own PW (Basic security)	Yes	Yes	Yes	X
	Change own PW (Advanced security)	Yes	Yes	Yes	Yes
	Create new and modify users, assign roles (advanced security OC)	RW	X	X	X
	Non-Security settings	RW	RW	R	R
	FlexLogic	RW	RW	R	R
	IEC 61850 settings	RW	RW	R	R
	Factory Settings	X	X	X	X
Commands	Date change	RW	RW	X	X
	BKR related	RW	RW	RW	X
	Clear records	RW	X	X	X
	Restore Defaults	RW	X	X	X
	RESET	W	W	W	X
File	Config File read	R	R	R	R
	Config File write	W	W	X	X
Upload FW		W	X	X	X
Actual Values	Status	R	R	R	R
	Metering	R	R	R	R

		Administrator	Engineer	Operator	Viewer
Reports	Events	R	R	R	R
	Waveforms	R	R	R	R
	Security Audit log	R	R	X	X

10.4.2.4 BYPASS ACCESS

The **BYPASS ACCESS** feature allows the user to bypass security authentication. Once this setting is anything other than *Disabled*, the user gets Administrator access rights on configured interface. For example, if user configures it as *Local* then no user authentication is needed for accessing over USB or HMI. It is also possible to bypass authentication for *HMI only*, where the user can view and modify all settings, view actual values or execute commands. The bypass security feature provides an easier access, with no authentication and encryption, therefore the use of this feature should be restricted only to the commissioning phase or when it is considered safe. Only the Administrator can enable this feature.

10.4.2.5 ENHANCED PASSWORD SECURITY

When the **PSWD COMPLEXITY** setpoint is set to *Enabled*, it allows user to configure password strings which adhere to complexity rules defined below. When the setting is configured as *Disabled*, the user can change the password to any string with a maximum length of 20 characters.

When **PSWD COMPLEXITY** is *Enabled*, each password needs to adhere to following rules:

- They cannot contain the user's account name or parts of the user's full name that exceed two consecutive characters.
- They must be a minimum of 8 and a maximum of 20 ASCII characters.
- They must contain characters from all four of the below categories:

English uppercase characters (A through Z)
English lowercase characters (a through z)
Numeric (0 through 9)
Special non-alphanumeric (e.g. @,!,#,{, etc.)

The MM300 Enhanced supports encryption for passwords. The encryption algorithm used is PBKDF2 with SHA256 and a unique 64bits salt per user, where this salt is generated randomly.

10.4.2.6 DISABLING PHYSICAL AND LOGICAL PORTS

To secure your system it is advised to harden the product by disabling the unused protocols and physical ports. This is the simplest method to lessen security risk. The MM300 Enhanced offers possibility to enable or disable protocols or ports based on the usage.

The following physical ports can be turned off:

- Front USB serial port
- Rear RS485 port
- Ethernet port

The following communications protocols can be turned off:

- IEC 61850 (MMS and GOOSE)
- Modbus RTU
- Modbus TCP
- DNP3oE

- DNP3 Serial
- IEC 60870-5-103
- TFTP

Time synchronization protocols can be selectively enabled or disabled based on the configuration.

- IRIG-B
- SNTP

Services	Port Type	Port Numbers
Modbus TCP	TCP	502
DNP3oE	TCP	20000
	UDP	20000
IEC 61850 (MMS)	TCP	102
TFTP	UDP	69
SFTP (SSH)	TCP	22

Note:

For more detailed information on data protocols and service availability, please refer to the Communications interfaces.

10.4.2.7 NON-ENCRYPTED/CLEAR TEXT MODBUS

Due to customers' requests to use 'plain' or 'non-encrypted' Modbus communication with SCADA applications for certain scenarios, there is the option of using the Modbus TCP setting.

Path: *Device > Communications > Modbus*

Modbus TCP

Range: Disabled, Enabled, Read-Only

Default: Disabled

A user with an Administrator role can configure this setting. When *Disabled*, port 502 will be closed. When *Enabled*, the user can read or write over plain Modbus using port 502, on successful authentication. With the setting configured to anything other than *Disabled*, the IED will allow communication with a 3rd party SCADA application in plain text Modbus over port 502. The MM300 Enhanced will register a security event to indicate the user making the configuration change.

Note:

EnerVista Flex software will always communicate with the IED over SSH using port 22. The *Read-Only* option is only available for Basic Cybersecurity order codes. Advanced Cybersecurity only has *Disabled* and *Enabled* options for this setting.

10.4.2.8 SECURITY EVENTS

The 'Security_Events.CSV' file stores security events information. A minimum of 1024 events are stored in a circular buffer in non-volatile memory. Once the file reaches its max limit, oldest event will get over-written by the newest security event. The security information stored in the events file for each event is:

- Event Number
- Date/Time (UTC)
- Username

- IP Address
- Role
- Activity value

This file will be stored on the IED and will be accessible from EnerVista Flex software for users with the Administrator role. For Basic cyber-security, this is the only file to give security audit information to the user. This file is useful for an Advanced cyber-security user if Syslog is not configured or non-functional due to some issue.

10.4.3 ADVANCED CYBER-SECURITY IMPLEMENTATION

In Advanced cyber-security device authentication, all users; Viewer, Administrator, Engineer and Operator, need to enter a username and password to gain access privileges.

The default advanced cyber-security password is ChangeMe1#.

In addition to all the Basic security features, the Advanced security option provides the properties listed below.

10.4.3.1 SERVER/REMOTE AUTHENTICATION

In Server Authentication mode, the MM300 Enhanced authenticates the user using the RADIUS server. The RADIUS client resides in the device and connects to the RADIUS server. The user can use any of the following RADIUS servers as their central authentication server:

- FreeRADIUS server
- Microsoft NPS server
- RSA Authentication Manager

RADIUS users and passwords are created in the server (in the Active Directory). Each RADIUS user should have a password (that meets the password policy of the Active Directory) and specific role assigned to in the Active Directory.

MM300 Enhanced supports two servers in the configuration for redundancy. The IED will try each RADIUS server in sequence until one responds.

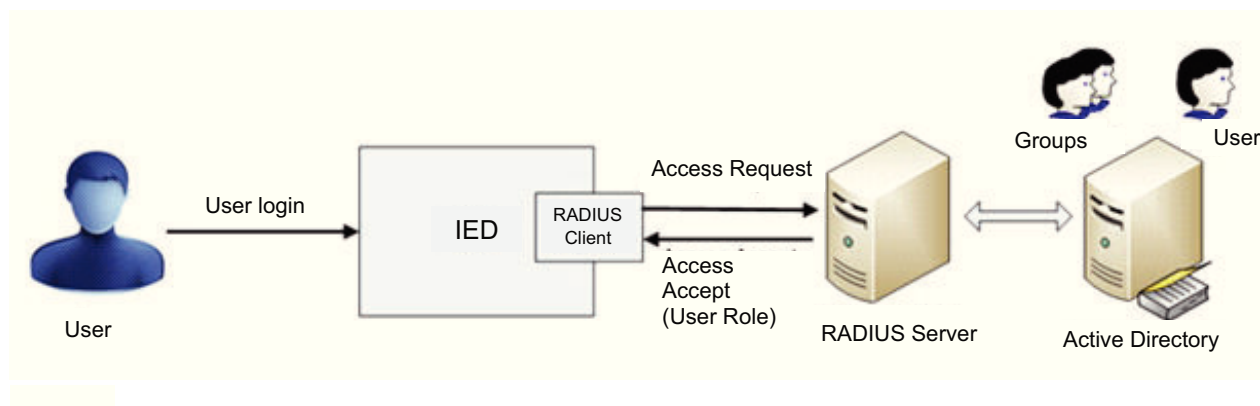


Figure 125: RADIUS server/client communication

First, the IED will try server 1 up to the configured number of retries, leaving request timeout between each request. If it does not receive a valid answer from server 1, it switches to server 2 and retries for up to the configured number again. If it reaches the maximum number of retries on the second server, it abandons Server Authentication and falls back to Device Authentication (Only if Authentication Method Server and Device is selected). A *RADIUS Server Unavailable* security event is also logged under this condition.

IED will authenticate and authorize RADIUS users using the following authentication stack:

- Primary Radius if enabled (stop on invalid credential failure, continue all other failures) Secondary Radius if enabled (stop on invalid credential failure, continue all other failures)

The RADIUS implementation supports the following authentication protocols

- PEAPv0 with inner authentication method MS-CHAPv2 (To support Microsoft NPS server)EAP-TTLS with inner authentication method PAP (To support RSA AM)EAP with inner authentication method GTC (To support RSA AM)PAP (unsecured, to support any RADIUS server)

The RADIUS implementation will query the Role ID vendor attribute and establish the logged-in user's security context with that role.

10.4.3.2 UNIQUE CONFIGURABLE USERNAMES

A user with the Administrator role can create up to 20 user accounts with the following attributes:

- Username (up to 20 ASCII characters)
- Password (in compliance with **PASSWORD COMPLEXITY**)
- User Role (Administrator, Engineer, Operator or Viewer)

Administrators can configure accounts and modify passwords for all types of accounts. All other roles can only modify their own account passwords.

Having more than one Administrator account is recommended.

10.4.3.3 SYSLOG

The IED supports security event reporting through the Syslog protocol. This in turn supports Security Information Event Management (SIEM) systems in providing centralized cyber-security monitoring over UDP protocol.

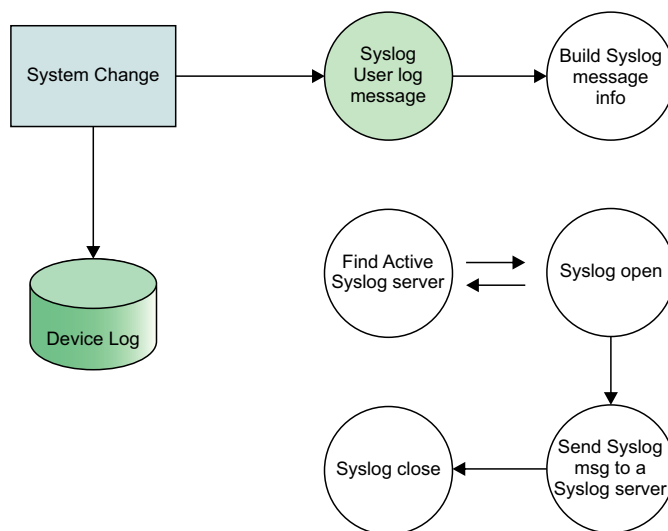


Figure 126: Syslog implementation

Two Syslog servers are supported in the configuration for redundancy. The IED will try each in sequence until one responds.

The IED logs the following items to the remote Syslog server:

- User log events (whether successful or not)
- Error log events
- Kernel error log events

Events logged to the Syslog server

Event	Level	Type of Event	Description	MSGID
SYSLOG_EVENT_LOGIN_SUCCESSFUL	Notice (5)	USER_LOG_EVENTS	'Login successful'. An event to indicate when a certain role logged in. Origin: Username and IP.	0
SYSLOG_EVENT_LOGIN_SUCCESSFUL_PASSWORD_EXPIRED	Notice (5)	USER_LOG_EVENTS	'Login successful - Password expired'. An event to indicate when a certain role logged in with an expired password. Origin: Username and IP address.	1
SYSLOG_EVENT_LOGIN_FAILED_BAD_CREDENTIALS	Notice (5)	USER_LOG_EVENTS	'Login failed - Bad credentials'. A failed authentication with origin information (username and IP address), a time stamp in UTC time when it occurred.	2
SYSLOG_EVENT_LOGIN_FAILED_USER_LOCKED	Error (3)	USER_LOG_EVENTS	'Access blocked due to login failed attempts'. The user lockout has occurred because of too many failed authentication attempts. Origin: username and IP address.	3
SYSLOG_EVENT_MANUAL_LOGOUT	Notice (5)	USER_LOG_EVENTS	'Manual logout'. An event to indicate when a certain role logged out. Origin: Username and IP address.	4
SYSLOG_EVENT_TIMED_LOGOUT	Notice (5)	USER_LOG_EVENTS	'Timed logout'. An event to indicate when a certain role logged out by idle timeout. Origin: Username and IP address.	5
SYSLOG_EVENT_LOGIN_FAILED_MAX_CONNECTIONS	Notice (5)	USER_LOG_EVENTS	'Login failed - Max number of connections reached'. A failed authentication with origin information (username and IP address) when max connections is reached.	6
SYSLOG_EVENT_SETTING_CHANGE	Notice (5)	USER_LOG_EVENTS	'Setting change'. An event to indicate setting change(s). Origin: Username and IP address.	7
SYSLOG_EVENT_PRIMARY_RADIUS_UNREACHABLE	Critical (2)	ERROR_LOG_EVENTS	'RADIUS primary server unreachable'. RADIUS server is unreachable. Origin: RADIUS server IP address and port number.	8
SYSLOG_EVENT_SECONDARY_RADIUS_UNREACHABLE	Critical (2)	ERROR_LOG_EVENTS	'RADIUS secondary server unreachable'. RADIUS server is unreachable. Origin: RADIUS server IP address and port number.	9
SYSLOG_EVENT_CLEAR_EVENT_RECORDS	Notice (5)	USER_LOG_EVENTS	'Clear events command'. Clear event records command was issued. Origin: Username and IP address.	10

Event	Level	Type of Event	Description	MSGID
SYSLOG_EVENT_CLEAR_TRANSIENT_RECORDS	Notice (5)	USER_LOG_EVENTS	'Clear transient records command'. Clear transient records command was issued. Origin: Username and IP address.	11
SYSLOG_EVENT_BYPASS_ACCESS_ENABLED	Warning (4)	ERROR_LOG_EVENTS	'Bypass Access activated'. Bypass access has been activated.	12
SYSLOG_EVENT_BYPASS_ACCESS_DISABLED	Warning (4)	ERROR_LOG_EVENTS	'Bypass Access deactivated'. Bypass access has been deactivated.	13
SYSLOG_EVENT_MODBUSTCP_DISABLED	Warning (4)	ERROR_LOG_EVENTS	'ModbusTCP Disabled'. Port 502 has been opened for Read/Write.	16
SYSLOG_EVENT_MODBUSTCP_ENABLED	Warning (4)	ERROR_LOG_EVENTS	'ModbusTCP Enabled'. Port 502 closed	17
SYSLOG_EVENT_MODBUSTCP_READONLY	Warning (4)	ERROR_LOG_EVENTS	'ModbusTCP ReadOnly'. Port 502 has been opened for Read Only operations.	18

10.4.3.4 INCREASED PRODUCT HARDENING

With the Advanced cyber-security option, the IED supports the ability to turn off the added features in encrypted communication. SSH and SFTP protocols on port 22 can be disabled.

10.4.3.5 ADDITIONAL FEATURES

10.4.3.5.1 LOST PASSWORD

MM300 Enhanced IEDs allow users with the Administrator role to modify all user account passwords. Users with other roles can only update their own passwords.

Having more than one user with the Administrator role is recommended. This will help in case the Administrator password is lost. Other users with Administrator accounts who have gone through local or remote authentication can modify the password for the Administrator whose password is lost.

If the remote authentication server is not configured or is unreachable, and only a single Administrator is configured on IED for local authentication, then the only way to reset the Administrator password is to execute a command from the HMI. This action will default passwords for all accounts.

In order to access the IED from the HMI as another role, go to **Setpoints > Product Setup > Install** and there will be the option to enter a Service command. From here the user can enter the command to reset passwords for all accounts.

Please contact GE customer support to get the code to perform this action.

10.4.3.5.2 LOADING FACTORY CONFIGURATION

Logged in as an Administrator the user can go to the Security page and select *Yes* for **RESTORE DEFAULTS**.

CHAPTER 11

MAINTENANCE

11.1 CHAPTER OVERVIEW

This chapter contains the following sections:

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Unscheduled maintenance (system interruption)	384
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11.2 MAINTENANCE

The MM300 Enhanced requires minimal maintenance. As a microprocessor-based relay, its characteristics do not change over time. The expected service life of an MM300 Enhanced is 20 years when the environment and electrical conditions are within stated

specifications.

While the MM300 Enhanced performs continual self-tests, it is recommended that maintenance be scheduled with other system maintenance. This maintenance can involve in-service, out-of-service, or unscheduled maintenance.

11.3 IN-SERVICE MAINTENANCE

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

11.4 OUT-OF-SERVICE MAINTENANCE

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

Note:

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

11.5 UNSCHEDULED MAINTENANCE (SYSTEM INTERRUPTION)

View the event recorder and oscillography for correct operation of inputs, outputs, and elements.

11.6 MOTOR HEALTH REPORT

This reporting provides critical information on the historical operating characteristics of the motor during motor starting and stopping operations during a programmable time period. The report can be generated as a PDF file the EnerVista Flex software.

The health report includes seven categories:

1. **Device Overview** gives general information on the motor, including requested period, user name, device name, order code, firmware version, motor and system settings, and motor total running time.
2. **Status Overview** summarizes the historical learned data and gives an evaluation of the status of the motor, including the oldest and latest values of acceleration time, starting current, start thermal capacity used, and average motor load, average power and power factor, and average running time. The data is extracted from the category of Motor Starting Learned Information below.
3. **Trip Summary** gives a summary of the events that have tripped the motor.
4. **Motor Operating History** analyzes the operands in the Event Records to count the amount of events in terms of Motor Starting/Running, Starting and Stop Commands, Trip Commands, Lockouts, and Alarm Conditions.
5. **Motor Starting Learned Information** collects the learned data from the element of Motor Learned Data, including acceleration time, starting current, start thermal capacity used, average motor load, average power and power factor, and average running time.. Every time a successful start occurs, a Learned Data Record is created. The relay stores the previous 250 Learned Data Records.
6. **Motor Start Records** displays the start data recorded in that element, including three-phase RMS currents, the average of three-phase RMS currents, ground current, the average of three-phase RMS voltages, real and reactive power, power factor, thermal capacity used, frequency and motor status. When a motor start status is detected, a start data record is triggered, where 1-second pre-trigger data and 30-second post-trigger data are recorded. A total of 6 records are stored in the relay. Record # 1 is the baseline record and it is written to only by the first start that occurs after clearing the motor start records. The rest records are a rolling buffer of the last 5 motor starts.
7. **Motor Stopping/Tripping** gives details on the events that are specifically related to the stopping and the tripping of the motor.

The analysis in Trip Summary, Motor Operating History and Motor Stopping/Tripping is based on the classification of operands stored in the Event Records. The classification rules are listed in the table below.

Note:

To ensure the listed operands are able to be classified, the Events function in the associated elements needs to be enabled.

Note:

If the **FUNCTION** setting of an element is set to *Alarm*, the generated operands would be classified as the alarm condition. For example, the **FUNCTION** setting of Phase TOC is set to *Alarm*, the operand of Ph TOC 1 OP would only result in the increment of Alarm Conditions in Motor Operating History, instead of Current in Trip Summary, Trip Commands in Motor Operating History and Overcurrent in Motor Stopping/Tripping.

Element	Operand	Trip Summary				Motor Operating History						Motor Stopping/Tripping												
		Overload/Thermal	Current	Volt/Frequency/Power	Miscellaneous	Start A Command	Start B Command	Starting / Running	Stop Commands	Trip Commands	Lockouts	Alarm Conditions	Overload Trip	Mechanical Jam	Under Power	Current Unbalance	RTD/Thermistor Protection	Ground Fault	Under/Over Voltage	Any Stop	Acceleration Time	Over Current	Under Current	Phase Reversal
Protection	Ph IOC 1 OP		X							X												X		
	Ph IOC 2 OP		X							X												X		
	Ph TOC 1 OP		X							X												X		
	Ph TOC 2 OP		X							X												X		
	Ground Fault Trip		X							X												X		
	Ground Fault Alarm		X									X										X		
	Undervoltage Alarm											X												
	Undervoltage Trip			X						X									X					
	Aux U/V Alarm											X												
	Aux U/V Trip			X						X									X					
	Overvoltage Alarm											X												
	Overvoltage Trip			X						X									X					
	Thermal Level Alarm											X												
	Thermal O/L Trip	X								X			X											
	Thermal O/L Lockout										X													
	Acceleration Trip				X					X											X			
	Acceleration Alarm											X												
	Mech Jam Trip		X							X				X										
	Mech Jam Alarm											X		X										
	Underpower Trip									X														
	Underpower Alarm			X								X			X									
	Unbalance Alarm											X												
	Unbalance Trip		X							X						X								
	Ground Fault Alarm											X												
	Ground Fault Trip		X							X								X						
	Load Increase Alarm											X												
	Undercurrent Alarm											X												
	Undercurrent Trip		X							X													X	
	RTD # Alarm											X												
	RTD # Trip	X								X							X							

Element	Operand	Trip Summary				Motor Operating History						Motor Stopping/Tripping												
		Overload/Thermal	Current	Volt/Frequency/Power	Miscellaneous	Start A Command	Start B Command	Starting / Running	Stop Commands	Trip Commands	Lockouts	Alarm Conditions	Overload Trip	Mechanical Jam	Under Power	Current Unbalance	RTD/Thermistor Protection	Ground Fault	Under/Over Voltage	Any Stop	Acceleration Time	Over Current	Under Current	Phase Reversal
Protection	Thermistor Alarm											X												
	Thermistor Trip	X								X							X							
	Thermal Inhibit										X													
	Starts/Hour Inhibit										X													
	Time Between Inhibit										X													
	Restart Inhibit										X													
	Phase Reversal Alarm			X								X												
	Phase Reversal Trip			X						X														X
	Phase Rev Inhibit										X													
	Fuse Fail1 Alarm											X												
	Fuse Fail1 Trip			X						X														
	Open Ctrl Cct Trip				X																			
	Open Ctrl Cct Alarm											X												
	Welded Contcr Trip				X																			
	Welded Contcr Alarm											X												
Control	Any Start A					X																		
	Any Start B						X																	
	Forced Start A					X																		
	Forced Start B						X																	
	Started							X																
	Any Stop Except UVR								X											X				
	URV Stop								X											X				
	Thermal Inhibit										X													
	Starts/Hour Inhibit										X													
	Time Between Inhibit										X													
	Restart Inhibit										X													
	Starting							X																
	Running							X																

Figure 127: Event classification rules

CHAPTER 12

SPECIFICATIONS

12.1 CHAPTER OVERVIEW

This chapter contains the following sections:

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12.2 SPECIFICATIONS

Note:
Specifications are subject to change without notice.

12.3 PROTECTION

Acceleration Protection	
Time delay	0.5 to 250.0 s in steps of 0.1 s
Timing accuracy	± 100 ms or $\pm 0.5\%$ of total time
Elements	trip and alarm
Auxiliary undervoltage	
Auxiliary voltage	phasor magnitude
Pickup level	50 to 300 V in steps of 1 V
Time delay	1 to 60 s in steps of 1 s
Pickup accuracy	as per voltage inputs
Timing accuracy	< 100 ms or $\pm 0.5\%$ of total time
Elements	trip and alarm
Current unbalance	
Unbalance	I_2/I_1 if $I_{avg} > FLA$
	$I_2/I_1 \times I_{avg}/FLA$ if $I_{avg} < FLA$
Range	0 to 100% in steps of 1%
Pickup level	4 to 40% in steps of 1%
Time delay	1 to 60 s in steps of 1 s
Pickup accuracy	$\pm 2\%$
Timing accuracy	± 0.5 s or $\pm 0.5\%$ of total time
Elements	trip and alarm
Fuse fail	
Voltage	RMS
Timing	< 100 ms
Elements	trip and alarm
Ground fault Protection	
Ground current	RMS
Pickup level	10 to 100% FLA primary in steps of 1% FLA, when Ground CT Type = 1A, 5A
	0.5 to 15.0 A in steps of 0.1 A with CBCT, when Ground CT Type = 2000:1
Trip time delay on start	0 to 10 s in steps of 0.1 s
Trip time delay on run	0 to 5 s in steps of 0.1 s
Alarm time delay on start/run	0 to 60 s in steps of 1 s
Pickup accuracy	as per ground current input
Timing accuracy	± 100 ms
Elements	trip and alarm
Load increase Alarm	
Pickup level	50 to 150% of FLA in steps of 1%
Timing accuracy	± 500 ms
Elements	alarm
Mechanical jam	
Current	fundamental phasor magnitude

Pickup level	1.01 to $4.50 \times \text{FLA}$ in steps of 0.01 of any one phase, blocked on start
Time delay	0.1 to 30 s in steps of 0.1 s
Pickup accuracy	as per phase current inputs
Timing accuracy	± 0.1 s
Elements	trip and alarm
Phase Instantaneous Overcurrent Protection	
Operating parameter	Ia, Ib, Ic (Fundamental)
Pickup level	0.20 to $8.00 \times \text{CT}$ in steps of $0.01 \times \text{CT}$
Dropout level	97 to 98% of pickup
Level accuracy	for 0.2 to $2.0 \times \text{CT}$: $\pm 0.5\%$ of reading
	for $> 2.0 \times \text{CT}$: $\pm 1.5\%$ of reading
Time delay	0.1 to 60.0 s in steps of 0.1 s
Reset time	0.1 to 60.0 s in steps of 0.1 s
Timing accuracy	± 100 ms or $\pm 0.5\%$ of total time
Phase Time Overcurrent Protection	
Operating parameter	Ia, Ib, Ic (RMS or Fundamental)
Pickup level	0.20 to $8.00 \times \text{CT}$ in steps of $0.01 \times \text{CT}$
Dropout level	97 to 98% of pickup
Level accuracy	for 0.2 to $2.0 \times \text{CT}$: $\pm 0.5\%$ of reading
	for $> 2.0 \times \text{CT}$: $\pm 1.5\%$ of reading
Curve shape	DT, IEC Standard/Very Inverse/Extremely Inverse, UK Long Time Inverse, Rectifier, FR Short Time Inverse, Standard Inverse (1.3s), RI, IEEE Moderately/Very Inverse/Extremely Inverse, US Inverse, US Short Time Inverse, ANSI Extremely/Very Inverse/Normally/Moderately Inverse, IAC Extremely/Very Inverse/Normally/Short Inverse, I2t, I4t, FlexCurves™ A, B, C and D
Curve multiplier	
TMS	0.025 to 1.200 in steps of 0.005
Time dial	0.01 to 10.00 in steps of 0.01
K (RI)	0.10 to 10.00 in steps of 0.01
Time delay	0.1 to 60.0 s in steps of 0.1 s
Reset char	DT, inverse
Reset time	0.0 to 60.0 s in steps of 0.1 s
Timing accuracy	± 100 ms or $\pm 0.5\%$ of total time (based on measured value)
Phase Overvoltage	
Voltage	fundamental phasor magnitude
Pickup level	101 to 120% of MNV in steps of 1%
Time delay	1 to 60 s in steps of 1 s
Pickup accuracy	as per voltage inputs
Timing accuracy	± 100 ms or $\pm 0.5\%$ of total time
Elements	trip and alarm
Phase Undervoltage	
Voltage	fundamental phasor magnitude
Pickup level	60 to 99% MNV in steps of 1

Time delay	0.1 to 60.0 s in steps of 0.1 s
Timing accuracy	<100 ms or $\pm 0.5\%$ of total time
Elements	trip and alarm
Phase Reversal	
Phase reversal condition	$V_2/V_1 = 100\%$ when phase to phase voltages are greater than 50% of V_T
Configuration	forward or reverse phase rotation
Pickup/Dropout time delay	0.00 to 180.00 s in steps of 0.01 s
Timer accuracy	± 500 ms
Elements	trip and alarm
Power Factor	
Lead/Lag pickup level	0.05 to 0.99 in steps of 0.01, lead and lag
Lead/Lag time delay	0.0 to 60.0 s in steps of 0.1 s
Level accuracy	$\pm 2\%$
Timer accuracy	± 100 ms or $\pm 0.5\%$ of total time
RTD Protection	
Pickup	1 to 250°C in steps of 1
Pickup hysteresis	2°C
Time delay	3 s
Elements	trip and alarm
Thermal Model	
Overload curves	standard overload curve with curve multiplier
	IEC trip class 5, 10, 20, 30 and 40
Biasing	phase unbalance
	hot/cold biasing
	stator RTD biasing
	exponential running and stopped cooling rates
Pickup accuracy	as per phase current inputs
Timer accuracy	± 200 ms or $\pm 2\%$ of total time (based on measured value)
	± 200 ms or $\pm 3\%$ of total time (with I2/I1 biasing)
Elements	trip and alarm
Thermistor	
Sensor types	positive temperature coefficient (PTC): $R_{HOT} = 100$ to 30 k Ω
	negative temperature coefficient (NTC): $R_{HOT} = 100$ to 30 k Ω
Delay	1 s
Timer accuracy	$\pm 6\%$ or 100 Ω , whichever is greater
Elements	trip and alarm
Undercurrent	
Current	RMS
Pickup level	1 to 100% of FLA primary in steps of 1%
Time delay	1 to 60 s in steps of 1 s
Pickup accuracy	as per phase current inputs
Timer accuracy	± 0.5 s or $\pm 0.5\%$ of total time
Elements	trip and alarm

Underpower	
Pickup level	1 to 100% of MNR in steps of 1
Time delay	1 to 60 s in steps of 1 s
Pickup accuracy	as per power monitoring specification
Timer accuracy	± 0.5 s or $\pm 0.5\%$ of total time
Elements	trip and alarm
Voltage Unbalance	
Operating parameter	$V2/V1$
Pickup level	4 to 40% in steps of 1%
Dropout level	97% of pickup
Level accuracy	$\pm 2\%$ of reading
Pickup time delay	0.0 to 60.0 s in steps of 0.1 s
Timer accuracy	± 100 ms or $\pm 0.5\%$ of total time

12.4 CONTROL

Thermal Start Inhibit	
TC used margin	0 to 11% in steps of 1%, Max. = Off
Starts Per Hour Inhibit	
Maximum number of starts	1 to 6 starts in steps of 1, Max. = Off
Time Between Starts Inhibit	
Time between starts	0 to 3601 s in steps of 1, Max. = Off
Restart Inhibit	
Restart inhibit delay	0 to 50001 s in steps of 1, Max. = Off
Starter Types	
8 pre-defined starter types	Full-voltage non-reversing, Full-voltage reversing, Two-speed, Wye-delta open transition, Inverter, Soft start, Autotransformer open transition, Autotransformer closed transition
Process interlocks	
	Ten process interlock functions configurable for trip, stop, or alarm
Auto/Manual Start and Stop Control	
Auto start/stop control through	Communications: controls received over a serial data link - Modbus, Profibus and/or Modbus TCP
	Hard-wired: via contact inputs from a PLC or DCS
Manual Start/Stop Control	Field Control: via contact inputs from pushbuttons or switches
	MCC (MM300 Motor control center): via control panel of the MM300 Enhanced
Undervoltage Restart	
Voltage	fundamental phasor magnitude
Dropout/Pickup level	60 to 100% NCV in steps of 1%
Short dip time	100 to 510 ms or Max = Off in steps of 10 ms
Medium dip time	0.1 to 10.0 s in steps of 0.1 s
Medium dip delay	0.2 to 90 s in steps of 0.2 s
Long dip time	0.5 to 60.5 min or Max = Off in steps of 0.5 min
Long dip delay	1.0 to 1200.0 s in steps of 1.0 s
Short dip time accuracy	0.2 s or $\pm 5\%$ of total time, whichever is greater
Medium and long dip time accuracy	± 1 s or $\pm 5\%$ of total time, whichever is greater
UVR Backup Protection	
Time accuracy	0.1 s or $\pm 5\%$ of total time, whichever is greater

12.5 DIAGNOSTICS & RECORDINGS

COUNTERS	
Trip counters	Total Number of Trips, Overload Trips, Mechanical Jam Trips, Undercurrent Trips, Current Unbalance Trips, Ground Fault Trips, Motor Acceleration Trips, Undervoltage Trips, Overvoltage Trips, Voltage Phase Reversal Trips, Underpower Trips
Length of counters	0 to 65535 trips in steps of 1
LEARNED DATA	
Number of records	250
Content	Learned Acceleration Time, Learned Starting Current, Learned Starting Capacity, Learned Average Load, Records Since Clear, Last Clear Date/Time, , Last Acceleration Time, Last Starting Current, Last Start TCU, Last Start Date/Time, Learned Average kW, Learned Average kvar, Learned Average PF, Average Run Time (Days), Average Run Time (Hr/Min), RTD 1(X) Max Temperature, RRTD 1(X) Max Temperature
Data storage	LDR File, CSV Format
Learned acceleration time accuracy	3%
Learned starting current accuracy	1%
Learned average motor load accuracy	1%
Learned average power accuracy	1%
EVENT DATA	
Number of records	1024 (matches the existing Event Recorder)
Data storage	non-volatile memory
Time-tag accuracy	1 μ s
Settings	64 configurable FlexAnalog parameters event selector
Actuals	selected event number timestamp of selected event cause of selected event 64 configurable FlexAnalog parameters
Commands	clear event record
LAST TRIP DATA	
Number of records	1
Data storage	non-volatile memory
Time-tag accuracy	1 μ s
Actuals	event number of last trip timestamp of last trip cause of last trip 64 configurable FlexAnalog parameters
Commands	clear last trip data
WAVEFORM	
Default AC channels	4 currents + 4 voltages configurable channels: 16 analog and 64 digital channels
Sampling rate	32 /c, 16 /c, 8 /c
Trigger source	any element pickup, drop-out or operate, digital input or output change of state, FlexLogic operand
Trigger position	0 to 100%

COUNTERS	
Storage capability	non-volatile memory
DATALOG	
Data logger channels	16
Data logger rate	1 cycle, 1 second, 30 seconds, 1 minute, 15 minutes, 30 minutes, 1 hour, 6 Hours, 8 hours, 12 hours, 24 hours
Inputs	any analog parameter from the list of available analog parameters
Data collection mode	continuous, triggered
Trigger source	any digital flag from the list of digital flags
Trigger position	0 to 100% in steps of 1%
Channel 1(16) mode	sample, min, max, mean
MOTOR START RECORDS	
Length	6 records, each containing a total of 30 seconds of motor starting data
Trigger	motor starting status
Trigger position	1 s pre-trigger duration
Sample rate	1 sample/100 ms

12.6 USER INTERFACE

Graphical Control Panel	
Size	width 153 mm, height 102 mm, depth 35 mm
LCD	3.5-inch color, 320 by 240 pixels
LED indicators	10 LEDs
Pushbuttons	Start A, Start B, Stop, plus 11 LCD screen display control keys
Ports	USB 2.0 port for laptop computer connection
Cable - GCP to Base Unit	Shielded RJ45; maximum length 6' (1.83 m)
BASIC Control Panel	
Size	width 75mm, height 75mm, depth 31mm
LCD	3.5-inch color, 320 by 240 pixels
LED indicators	12 LEDs
Pushbuttons	Start A, Start B, Stop, Reset, Auto, Manual
Cable - BCP to Base Unit	Shielded RJ45; maximum length 6' (1.83 m)

12.7 USER-PROGRAMMABLE ELEMENTS

FLEXLOGIC	
Lines of code	1024
Supported operations	NOT, XOR, OR (2 to 16 inputs), AND (2 to 16 inputs), NOR (2 to 16 inputs), NAND (2 to 16 inputs), latch (reset-dominant), timers
Inputs	any logical variable, contact, or virtual input
Number of timers	32
Pickup/Dropout delay	0 to 14,400,000 ms in steps of 1 ms
NON-VOLATILE LATCHES	
Type	set-dominant or reset-dominant
Number	16 individually programmed
Output	stored in non-volatile memory
Execution sequence	as per input to protection, control and FlexLogic™
FLEXCURVES	
Number	FlexCurve A, B, C and D
Reset points	40 (0 to 1 of pickup) for FlexCurves A, B, C and D
Operate points	80 (1 to 20 of pickup) for FlexCurves A, B, C and D
Time delay	0 to 200,000,000 ms in steps of 1 ms for FlexCurves A, B, C and D
Saturation level	20 times the pickup level

12.8 METERING AND MONITORING

Frequency Metering	
Range	40.00 to 70.00 Hz in steps of 0.01 Hz
Accuracy	±0.05 Hz
Power Metering	
Real power range	–2000.0 to 2000.0 kW in steps of 0.1 kW
Apparent power range	0.0 to 2500.0 kVA in steps of 0.1 kVA
Accuracy	±1% of full scale when power is calculated from IO_B module phase voltages
Power Factor Metering	
Range	–0.99 to +0.99 in steps of 0.01
Accuracy	±0.05
WATT-HOURS (POSITIVE AND NEGATIVE)	
Range	0 to 999999.999 MWh
Parameters	3-phase only
Update rate	50 ms
Accuracy	±2.0% of reading
VAR-HOURS (POSITIVE AND NEGATIVE)	
Range	0 to 999999.999 Mvarh
Parameters	3-phase only
Update rate	50 ms
Accuracy	±2.0% of reading

12.9 INPUTS

AUXILIARY Voltage Input (Undervoltage Restart and Auxiliary Undervoltage Input source)	
External VT primary	110 to 690 V AC in steps of 1
Input range	60 to 300 V AC
Nominal frequency	50 or 60 Hz
Accuracy	5% of reading
Phase Voltage Inputs	
Input range	60 to 690 V
Nominal frequency	50 or 60 Hz
Rated nominal voltage	60 to 300 V AC
Accuracy	±2% of reading or ±1 V, whichever is greater
Angle accuracy	1.0°
Phase Current Inputs and Residual Ground Current Input	
Range	0.2 to 40 A secondary (8 x CT), direct connection up to 5A FLA
Input type	combined 1 A/5 A
Frequency	50 to 60 Hz
Accuracy	external CT: ±2% of reading or ±1% of 10xCT secondary, whichever is greater
	direct: ±2% of reading or ±0.1 A, whichever is greater
Withstand (at 5A nominal)	0.2 s at 100x
	1.0 s at 50x
	2.0 s at 40x
	continuous at 3x rated current
Burden	< 4 mVA at 1 A
	< 0.1 VA at 5 A
Angle accuracy	2°
Resolution	0.1 A
Ground Current Input (50:0.025)	
CT primary	0.1 to 15.0 A
Frequency	50 or 60 Hz
Accuracy (CBCT)	±0.1 A (0.1 to 3.99) A
	±0.2 A (4.0 to 15) A
Burden	< 86 mVA at 25 A
RTD Inputs	
Sensor type	Three-wire RTD (100 Ω platinum)
Sensing current	5 mA
Accuracy	±3°C
Thermistor Inputs	
Sensor type	positive temperature coefficient (PTC): $R_{HOT} = 100$ to 30000 Ω negative temperature coefficient (NTC): $R_{HOT} = 100$ to 30000 Ω
Accuracy	±6% of reading or ±100 Ω, whichever is greater

12.10 CONTACT INPUTS

DIGITAL INPUTS (IO_C MODULE)	
Fixed pickup	65 V AC
Recognition time	6 cycles
Current draw at rated voltage	14 mA @ 120 V AC for 500 μ s every cycle 20 mA @ 220 V AC for 500 μ s every cycle
Input impedance	4.99 k Ω
Type	opto-isolated inputs
External switch	wet contact
Maximum input voltage	300 V AC
DIGITAL INPUTS (IO_M MODULE)	
Fixed pickup	20 V DC
Recognition time	2 cycles
Current draw at rated voltage	20 mA @ 24 V DC or dry contact (pulsed) 40 mA @ 48 V DC (pulsed)
Input impedance	1.23 k Ω
Type	wet or dry
Maximum input voltage	60 V DC

12.11 OUTPUTS

Output Relays	
Configuration	electromechanical form-A (IO_C) and form-C (IO_D)
Contact material	silver-alloy
Operate time	10 ms
Minimum contact load	10 mA at 5 V DC
Maximum switching rate	300 operations per minute (no load), 30 operations per minute (load)
Mechanical life	10,000,000 operations
Continuous current	10 A
Make and carry for 0.2s	30 A per ANSI C37.90
Output Relay Break Capacity (Form-A Relay)	
AC resistive, 120 V AC	10 A
AC resistive, 240 V AC	10 A
AC inductive, PF = 0.4 pilot duty	2 A
DC resistive, 30 V DC	10 A
Output Relay Break Capacity (Form-C Relay)	
AC resistive, 120 V AC	10 A normally-open, 5 A normally-closed
AC resistive, 240 V AC	10 A normally-open, 8 A normally-closed
AC inductive, PF = 0.4 pilot duty	2.5 A
DC resistive, 30 V DC	10 A

12.12 POWER SUPPLY

Power Supply (High PSU)	
Nominal	120 to 240 V AC 125 to 250 V DC
Range	60 to 300 V AC (50 and 60 Hz) 84 to 250 V DC
Ride-Through	35 ms
Power Supply (Low PSU)	
Nominal	24 to 48 V DC
Range	20 to 60 V DC
Ride-Through	35 ms
All Ranges	
Voltage withstand	2 × highest nominal voltage for 10 ms
Power consumption	16 W typical, 25 W maximum

12.13 COMMUNICATIONS

Ethernet (Copper)	
Modes	10/100 MB (auto-detect)
Connector	RJ-45
SNTP clock synchronization error	<200 ms (typical)
Protocol	Modbus TCP
Profibus (Copper)	
Modes	DPV0 slave, up to 1.5 Mbps DPV1 slave, up to 1.5 Mbps
Connector	5-pin terminal
RS485 port	
Port	opto-isolated
Baud rates	up to 115 kbps
Protocol	Modbus RTU, half-duplex
Maximum distance	1200 m
Isolation	2 kV
USB port (Graphic Control Panel Only)	
Standard specification	Compliant with both USB 2.0 and USB 1.1
Data transfer rate	USB device emulating serial communications port at 115 kbps

12.14 TESTING AND CERTIFICATION

TESTING AND CERTIFICATION		
Test	Reference Standard	Test Level
Dielectric Voltage Withstand:	EN60255-27	2.3KV (1 minute)
Impulse Voltage Withstand:	EN60255-27	5KV
Damped Oscillatory:	IEC61000-4-18	2.5KV CM, 1KV DM
Electrostatic Discharge:	IEC61000-4-2	Level 4
RF Immunity:	IEC61000-4-3	Level 3
Fast Transient Disturbance:	IEC61000-4-4	Class A
Surge Immunity:	IEC61000-4-5	Level 3
Conducted RF Immunity:	IEC61000-4-6	Level 3
Radiated & Conducted Emissions:	CISPR11/CISPR32	Class A
Sinusoidal Vibration:	IEC60255-21-1	Class 1
Shock & Bump:	IEC60255-21-2	Class 1
Seismic:	IEC60255-21-3	Class 2
Power Frequency (Binary Inputs):	IEC60255-26 (Clause 6.5)	Zone B
Power Magnetic Immunity:	IEC61000-4-8	Level 5
Pulse Magnetic Immunity:	IEC61000-4-9	Level 4
Magnetic Damped Oscillatory:	IEC61000-4-10	Level 4
Voltage Dip & Interruption:	IEC61000-4-11	0, 40, 70% dips, 250/300 cycle interrupts
Voltage Dips & Interruptions (DC):	IEC61000-4-29	Per IEC60255-26
Voltage Ripple:	IEC61000-4-17	15% ripple
Ingress Protection:	IEC60529	IP20 (base unit), IP54 (Control Panel)
Environmental (Cold):	IEC60068-2-1	-25°C 16 hrs
Environmental (Dry heat):	IEC60068-2-2	70°C 16hrs
Relative Humidity Cyclic:	IEC60068-2-30	6-day variant 2
APPROVALS		
	Applicable Council Directive	According to
CE compliance:	Low voltage directive	EN60255-27
	EMC Directive	EN60255-26
North America:	cULus	UL1053 [e83849 NKCR]
		UL508 [e83849 NKCR]
		C22.2-14 [e83849 NKCR7]
ISO:	Manufactured under a registered quality program	ISO9001
Item		Description
Country of origin		Spain or Canada; see label on the unit
Date of manufacture		See label on the MM300 Enhanced unit
Declaration of Conformity and/or Certificate of Conformity		Available on request

12.15 PHYSICAL

Dimensions	
Size	Base: 120 mm (W) × 90 mm (H) × 113 mm (D) [+ terminals 10mm]
	Expansion: 62 mm (W) × 90 mm (H) × 113 mm (D)
	GCP: 153 mm (W) × 102 mm (H) × 35 mm (D)
	BCP: 75 mm (W) × 75 mm (H) × 31 mm (D)
Weight (Base)	0.75 kg

12.16 ENVIRONMENTAL

Ambient temperatures:		
Storage/shipping:	- 40 °C to 85 °C	
Operating:	-25 °C to 60 °C *	
* 1" around Base Unit		
Humidity:	Operating up to 95% (non condensing) @ 55 °C (As per IEC60068-2-30 Variant 2, 6days)	
Altitude:	2000m (max)	
Overvoltage Category:	II	
Ingress Protection:	IP20 (Base Unit) IP54 (Control Panel)	
Environmental rating:	60 °C surrounding air	
Pollution Degree:	II	
	Type 1 (panel mount versions only)	
Noise:	0 dB	

CHAPTER 13

APPENDIX A

13.1 MM2 & MM300E COMPARISON

MM2, MM300 and MM300E Comparison

Press the button below to see the comparison between the Modbus addresses in MM2, MM300 and MM300E

MM300E_Compatibility_MM300_MM2

Press the button below to see the comparison between the Profibus in MM300 and MM300E

Profibus_MM300_MM300E_Comparative

13.2 CHANGE NOTES

Manual revision history

Revision History

MANUAL P/N	RELEASE DATE
1601-0806-A1	May 2022
1601-0806-A2	June 2024
1601-0806-240-1	March 2026

For information on the updates included in this release of the MM300 Enhanced Motor Management System Instruction Manual, please refer to the latest release notes for the MM300 Enhanced 2.40 version online.



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