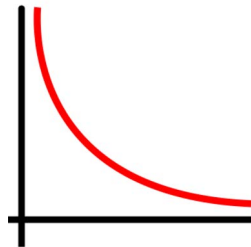




F-PRO 4500

Feeder Protection Relay



User Manual

Version 1.2 Revision 0

Preface

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Using This Guide

This User Manual describes the installation and operation of the F-PRO 4500 Feeder protection relay. It is intended to support the first-time user and clarify the details of the equipment.

The manual uses a number of conventions to denote special information:

Example	Describes
<i>Start>Settings>Control Panel</i>	Choose the Control Panel submenu in the Settings submenu on the Start menu.
Right-click	Click the right mouse button.
Recordings	Menu items and tabs are shown in italics.
Service	User input or keystrokes are shown in bold.
Text boxes similar to this one	Relate important notes and information.
..	Indicates more screens.
	Indicates further drop-down menu, click to display list.
	Indicates a warning.

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Acronyms

ASG - Active Setting Group

CID - file extension (.CID) for Configured IED Description

CS - Control Switch

CT - Current Transformer

DCE - Data Communication Equipment

DIB - Digital Input Board

DIGIO - Digital Input/Output Board

DMDA - Dead Main Dead Aux

DMLA - Dead Main Live Aux

DSP - Digital signal processor

DTE - Data Terminal Equipment

GPS – Global Positioning System

HMI – Human Machine Interface

ICD - file extension (.ICD) for IED Capability Description

IEC - International Electro Technical Commission

IED - Intelligent Electronic Device

IP - Internet Protocol (IP) address

IRIG-B - Inter-range instrumentation group time codes

LCD – Liquid Crystal Display

LED - Light-emitting Diode

LHS - Left Hand Side

LMDA - Live Main Dead Aux

PLC - Programmable Logic Controller

RHS - Right Hand Side

RTOS - Real Time Operating System

RTU - Remote Terminal Unit

SCADA – Supervisory Control And Data Acquisition

SG – Setting Group

TCP – Transmission Control Protocol

TDR – Transient Disturbance Recording

TUI – Terminal User Interface

UI – User Interface

VI – Virtual Input

Version Compatibility

For version compatibility, refer to the following document on the ERLPhase website, www.erlphase.com:

- D05839- F-PRO 4500 Firmware User Release Description

PC System Requirements and Software Installation

Hardware

The minimum hardware requirements are:

- 1 GHz processor
- 2 GB RAM
- 20 GB available hard disk space
- USB port
- Serial communication port

Operating System

One of the following 64 - bit operating systems must be installed and functional prior to installing the applications:

- Microsoft Windows 10
- Microsoft Windows 11

Software Installation

All required software for user interface, settings and record analysis is available directly from the ERLPhase website. The following relevant software and documentation is available:

- F-PRO Offliner
- Relay Control Panel
- ERL 61850 IED Configurator Tool
- Record Graph
- USB Driver
- F-PRO 4500 User Manual

Anti-virus/Anti-spyware Software

If an anti-virus/anti-spyware software on your local system identifies any of the ERLPhase applications as a “potential threat”, it will be necessary to configure your anti-virus/anti-software to classify it as “safe” for its proper operation. Please consult the appropriate anti-virus/anti-spyware software documentation to determine the relevant procedure.

1 Overview

1. 1 Introduction

The F-PRO 4500 provides easy-to-use, state-of-the-art comprehensive protection for Transmission, Sub – transmission and Distribution applications. It provides Protection, control, automation, metering, monitoring, dynamic swing recording & event logging with advanced communications in a flexible cost-effective package.

The primary protection are Current (Both Directional & Non -Directional), Voltage, Power & Frequency based protection. A library for these functions provides commonly used IEEE and IEC inverse curves. Since the curves are equation driven, the user can choose to enter equation parameters directly to create other overcurrent curve shapes as needed.

To provide a complete package of protection and control the relay supplies other functions such as:

- Fault locator
- Breaker failure (50BF) and breaker monitoring
- 4-shot reclose with dead line/dead bus control and sync check
- Single pole and three pole trip and reclose
- 24 statements of Pro Logic address for special protection needs.
- VT Supervision function
- CT Supervision function
- Over / Under Voltage functions
- 8 Setting Groups (SG) with setting group logic
- Broken Conductor protection
- Over / Under / Rate of change of frequency devices

Relay Control Panel (RCP) is the Windows graphical user interface software tool provided with all 4000 series and higher (new generation) ERL relays to communicate, retrieve and manage records, event logs, fault logs, manage setting files (identification, protection, SCADA etc.), display real time metering values, view, analyze, and export records in COMTRADE format.

In addition to the protection functions the relay provides fault recording (128 samples/cycle) to analyze faults and to review the operation of the overall protection scheme & it also provides low speed swing recording which can be used to analyze system stability. The triggers for fault re-

cording are established by programming the output matrix and allowing any internal relay function, external input or GOOSE messaging input to initiate recording.

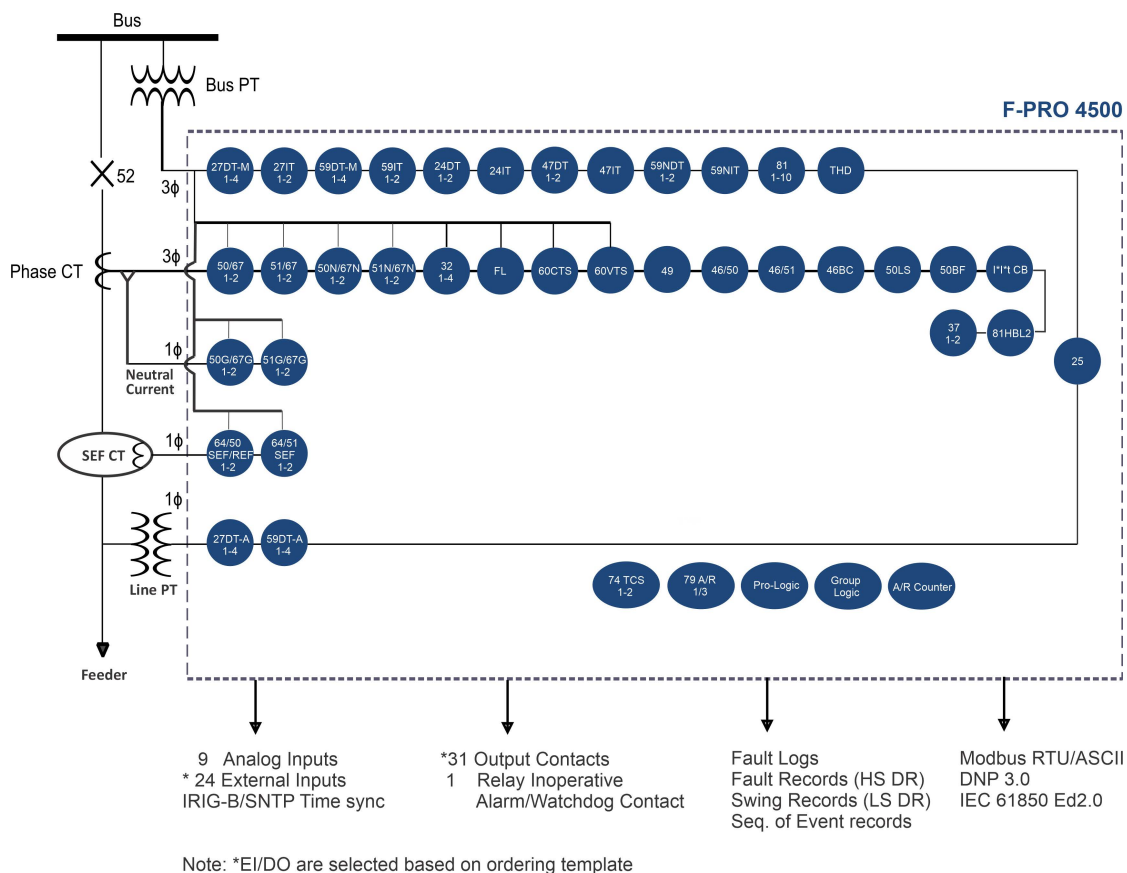
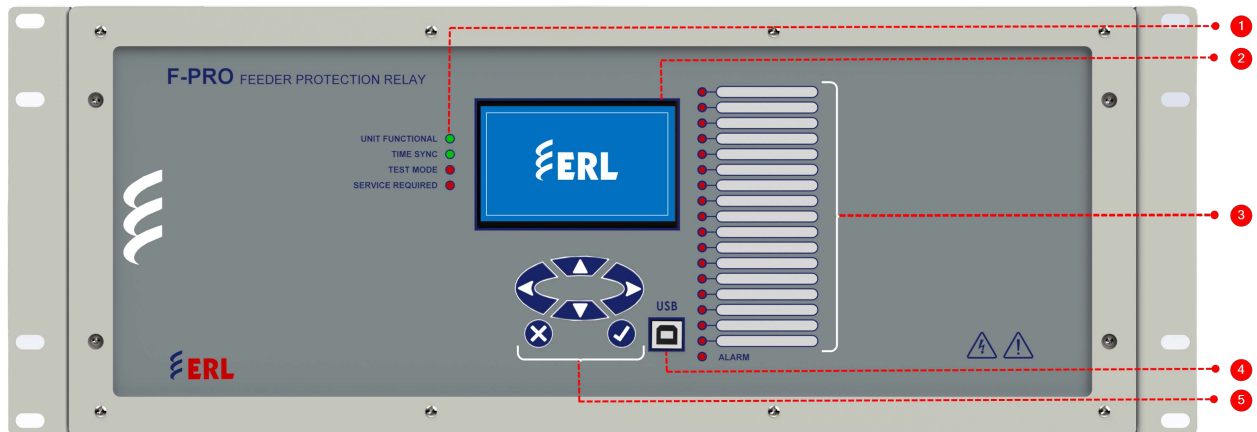


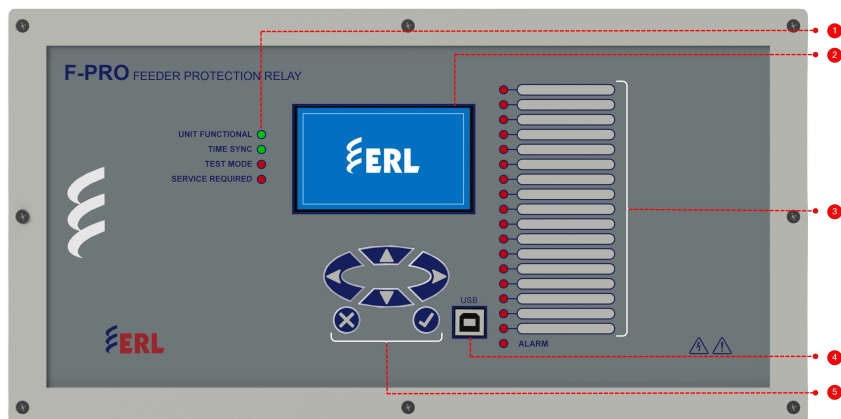
Figure 1.1: F-PRO 4500 Relay Function Line Diagram

1.2 Front View

Standard 19"



Standard E12

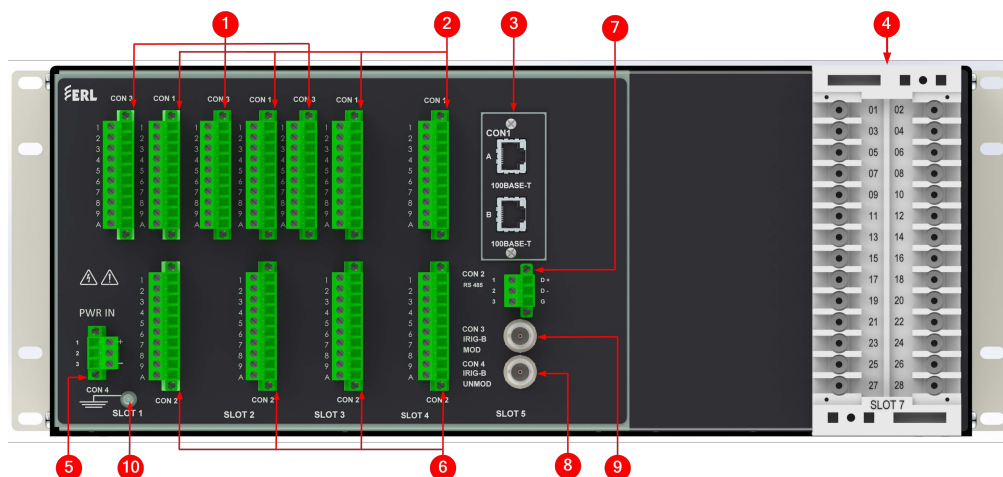


1. LEDs for displaying the status of the IED
2. Front Panel LCD display for events, targets, settings etc.
3. 18 Programmable Target LEDs
4. USB Port for maintenance and user interface
5. Push buttons used for navigation of LCD menus

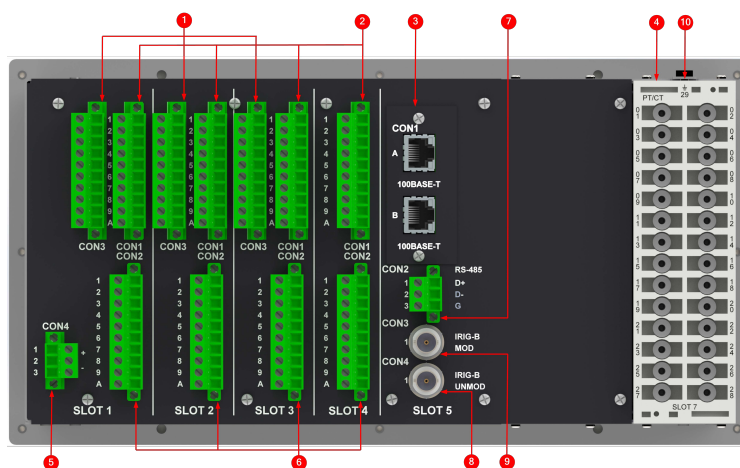
Figure 1.2: F-PRO 4500 Relay Front View

1.3 Rear View

Standard 19"



Standard E12



- 1.SLOT 1 to 3 / CON 3: Programmable External Inputs
- 2.SLOT 1 to 4 / CON 1: Programmable Outputs
- 3.SLOT 5 / CON 1 (A & B): 100BASE-T or 100BASE-FX
- 4.SLOT 6 / 01-04: AC Voltage Inputs
SLOT 6 / 09-28: AC Current Inputs
- 5.SLOT 7 / 01-04: AC Voltage Inputs
SLOT 7 / 09-28: AC Current Inputs
- 6.SLOT 1 / CON 4: Power Supply
- 7.SLOT 1 to 4 / CON 2 (1-6): Programmable External Inputs
SLOT 1 to 4 / CON 2 (8-A): Programmable Outputs
- 8.SLOT 5 / CON 2: RS485
- 9.SLOT 5 / CON 4: External Clock, IRIG-B Un-Modulated Input
- 10.SLOT 5 / CON 3: External Clock, IRIG-B Modulated Input
- 11.SLOT 1/ 40E : Earth Terminal (19" Case)
SLOT 7 / 29: Earth terminal (E12 Case)

Figure 1.3: F-PRO 4500 Relay Rear View

AC Current and Voltage Inputs

The relay is provided with screw type terminal blocks for the analog inputs. There is one order-configurable analog input configuration available.

5 current inputs, 4 voltage inputs. Includes one three-phase current input, one single-phase neutral current input, one single-phase sensitive earth current input, one three-phase voltage input and one single-phase voltage input.

The relay supports 1A and 5A CT secondary input levels.

Each of the current input circuits has polarity (•) marks.

A complete schematic of current and voltage circuits is shown in “AC Schematic Drawings” in Appendix I.

External Inputs and Relay Output Contacts

The relay contains an order-configurable number of external inputs and output contacts. The ordering options for external inputs and output contacts are:

- 8 External Inputs, 8 Output Contacts (Option A)
- 16 External Inputs, 16 Output Contacts (Option B)
- 16 External Inputs, 24 Output Contacts (Option C)
- 24 External Inputs, 32 Output Contacts (Option D)

External dc voltage of either 24, 48, 110/125 V or 220/250 V nominal are available. Selection of specific voltage is factory selectable.

To guarantee security from spurious voltage pulses, the F-PRO has an external input pickup filter setting. This setting is made in Relay Control Panel under *Utilities > External Inputs*. The setting is an integer number representing the number of samples in a packet of 16 that must be recognized by the DSP as high before an External Input status is changed from low to high. See specifications for External Input Pickup Filter in “External Input Pickup Filter” in Appendix A.

Relay Functional Alarm Output

If the relay becomes inoperative, then the Relay Inoperative Alarm output contact (Output Contact 1 - NC) closes and all tripping functions are blocked.

1. 4 Model Options/Ordering

The following options must be specified at the time of ordering:

1. Enclosure type: The relay is available as a flush mount or rack mount, for details see “Mechanical Drawings” in Appendix G.
2. The system base frequency of 50 Hz or 60 Hz.
3. Power supply rating of 20 to 60Vdc or 80 to 300 Vdc/80 to 250 Vac.
4. Number of External Inputs and Relay Output Contacts. See “External Inputs and Relay Output Contacts” on page 1-5 for options
5. External Input rating of 24, 48, 110/125 or 220/250 Vdc.
6. Number of rear Ethernet ports. If PRP is needed, two ports shall be selected. The two rear Ethernet ports can be ordered as both optical ports (100BASE-FX Optical ST) or both copper ports (100BASE-T RJ-45).

2 Installation

This section deals with the installation of the F-PRO relay when first delivered. The section covers the physical mounting, AC and DC wiring and the Communication wiring.

2. 1 Physical Mounting

Standard 19"

The relay is 176 mm (6.93 in.) Height x 486 mm (19.13 in.) Width x 277 mm (10.91 in.) Depth. A complete mechanical drawing is shown, for details see “Mechanical Drawings” in Appendix G

To install the relay the following is needed:

- Standard 19-inch rack space (4U height)
- M6 screws and nuts

Standard E12

The relay is 177 mm (6.97 in.) Height x 340 mm (13.38 in.) Width x 283 mm (11.14 in.) Depth. A complete mechanical drawing is shown, for details see “Mechanical Drawings” in Appendix G

To install the relay the following is needed:

- Cut-out (159mm/6.25Inch(H)x320mm/12.59Inch(W))
- M4 screws and nuts

2. 2 Case Grounding

WARNING!

The ground terminal (also known as the protective earth) on the rear of the unit and the modules must be connected. Refer to the diagram of the rear of the unit, F-PRO 4500 Relay Rear View on page 1-4 for the location of the ground terminal. The protective earth connection shall be checked before carrying out any other actions and shall not be removed when the unit is energized.

The terminal used must be made of a material that is galvanically compatible with the zinc plated washers, nut and stud provided with the unit. Tinned terminals are acceptable. The recommended minimum protective earth conductor wire size is 3.3 mm² unless otherwise required by local or country wiring regulations. Copper wire is recommended and must be low-inductance and as short as possible.

2. 3 Power Supply

A wide range power supply is standard. The nominal voltage is 24 - 48 Vdc or 110 – 250 Vdc +/- 20% or 100 – 240 Vac +5%/-20%, 50/60 Hz. To protect against a possible short circuit in the supply use an inline fuse or circuit breaker with a 5 A rating. Ensure that the chassis is grounded for proper operation and safety.

There are no power switches on the relay. When the power supply is connected, the relay starts its initialization process. See “Using the Relay (Getting Started)” on page 4-4 for the startup process details.

WARNING!

Ground the relay to station ground using the case-grounding terminal at the back of the relay. For further details see Figure 1.3: "F-PRO 4500 Relay Rear View on page 1-4.

2. 4 AC and DC Wiring

For details see “AC Schematic Drawings” in Appendix I and “DC Schematic Drawings” in Appendix J.

Ensure the power supply input and the AC and DC wires are de-energized before working on the wiring. Failure to do so could result in electric shock.

CT circuits shall be short-circuited before working on the current input wires.

2. 5 Communication Wiring

EIA-RS485

The relay's serial port (Port 52) is a EIA RS485 Data Communications Equipment (DCE) device with a 3 pin connector. This allows them to be connected directly to other relays in parallel and communication to a PC serial port with a standard straight-through male-to-female serial cable with RS485 to RS232 serial converter.

RS485 communication can work for maximum 1.2Kms with single IED. Shielded cable is recommended for pin-out, see See "Communication Port Details" on page 3-13

RJ-45

The rear two Ethernet Ports 51A and 51B may also be configured as 100BASE-T Ethernet Ports.

Optical ST

51A and 51B in the rear panel may be configured with ST style optical connectors if desired. These are 1300 nm 100BASE-FX optical Ethernet ports. The transmit and receive connections are indicated on the rear panel. Use standard multi-mode cables with ST connectors for this interface.

USB

There is a standard USB-B connector on the front panel. This is a USB 2.0 Full Speed interface and can be connected to a PC with a standard USB peripheral cable (A style to B style).

IRIG-B Wiring

The relay accepts both modulated and unmodulated IRIG-B standard time signals with or without the IEEE 1344 extensions. The IRIG-B connector on the back of the relay is BNC type (Port 531 & 541). Shielded cable is recommended.

Shielded wire shall be used for all connections that run outside of the panel in which the F-PRO is installed. The shield must be grounded only at one end at the point where the cable enters the panel. The IRIG input is the ONLY exception which uses unbalanced co-axial cable.

3 Setup and Communications

3.1 Introduction

This chapter discusses setting up and communicating with the relay including the following:

- Power supply
- Time Sources
- Communicating with the relay using a network link and a direct serial link
- Using Relay Control Panel to access the relay's user interface
- Using HyperTerminal to access the relay's maintenance menu
- Setting the Baud rate
- Accessing the relay's Supervisory Control and Data Acquisition (SCADA) services

3. 2 Power Supply

See “Power Supply” on page 2-3 and “Case Grounding” on page 2-2 for details regarding the power supply.

3. 3 Time Sources

The F-PRO 4500 relay supports the use of modulated or un-modulated IRIG- B time signals (external), primary/secondary SNTP network based time synchronization (external), a proprietary System Sync signal, and manually configurable system time based on a free-running, internal oscillator. The internal free-running oscillator is always present on the IED and, in the absence of any external time source, will become the default mode of time synchronization.

An externally applied IRIG-B time source will have the highest order of precedence, and will typically offer the highest available time accuracy, exceeding 1 μ s after calibration, when derived from an external GPS satellite source.

The F-PRO 4500 supports synchronization with the proprietary ERLPhase System Sync time source, available via the ERLPhase I/O Expansion IED. The I/O Expansion IED may be used as time source (called System Sync). System Sync is an IRIG-type generated signal which is available for use via the BNC input on the rear of the relay. For more information on the ERLPhase I/O Expansion IED, visit www.erlphase.com for more information.

An SNTP time source has a lower order of precedence from a valid IRIG-B source. SNTP operation (primary and secondary) requires network access and the selection and configuration of suitable SNTP network sources. The SNTP time may be configured for re-synchronization cycles ranging from 15 minutes to 36 hours, adjusting the IED system time to an accuracy of +/- 5 milliseconds in ideal network conditions.

The IED is equipped with an internal free-running oscillator used to generate a 1 PPS time signal (real-time clock or RTC) in the absence of any alternate available time source. Use of the RTC as the primary IED time source requires manual time configuration, with the general accuracy subject to user input parameters, and is recommended primarily for stand-alone, unsynchronized applications. The internal oscillator carries a lifetime accuracy (including temperature effects and aging) of +/-20 ppm.

The order of precedence for time sources is as follows:

1. IRIG-B or System Sync
2. SNTP
3. Internal clock (RTC)

For example, if a valid IRIG-B and SNTP source are both connected to the IED, IRIG-B will automatically be used. The ongoing presence of a valid IRIG-B or SNTP time source is indicated by an LED on the front panel of the IED and is evident in data records.

The Output Matrix also provides an option to assign Output Contacts to the Time Sync Alarm. When a valid external time source is not present then the Time Sync Alarm will go High and the associated Output Contacts will close.

3. 4 Communicating with the Relay

Connect to the relay to access its user interface and supervisory control and data acquisition (SCADA) services by:

- Front panel USB 2.0 interface (user interface and maintenance)
- Rear panel Ethernet network link (user interface and SCADA)
- Rear panel serial link (SCADA only)

The relay has a front panel USB port (Port 010), two rear panel Ethernet network ports (Port 51A and 51B, redundant ports) and one rear serial RS-485 port (Port 52) to provide access to SCADA services.

The relay's user interface is accessed through the Relay Control Panel.

3. 5 USB Link

The PC must be appropriately configured for USB communication.

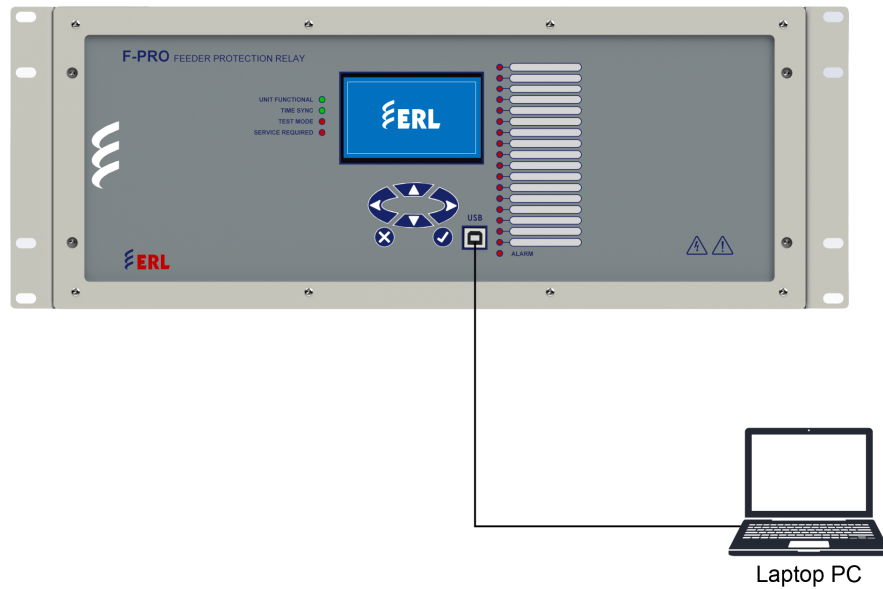


Figure 3.1: USB Link

USB Driver Installation

To create a USB link between the relay and the computer, simply connect the PC to the front USB port of the F-PRO. The USB driver is automatically installed from the Windows operating system.

To verify that the USB connection was successfully recognized, and to verify which port the USB Serial Port is using, do the following:

Go to

Windows Explorer > Right click on Computer > Manage > Device Manager > Ports

Look for the port number associated to this device.

“USB Serial Port”

Look for a COM#, where “#” can be 1, 2, 3, etc. Leave the default settings for this port.

The baud rate for the relay USB Port is fixed at 115200. The baud rate can be viewed on the front LCD display of the relay by navigating to:

Main Menu > System & Utilities > Communication

3. 6 Network Link

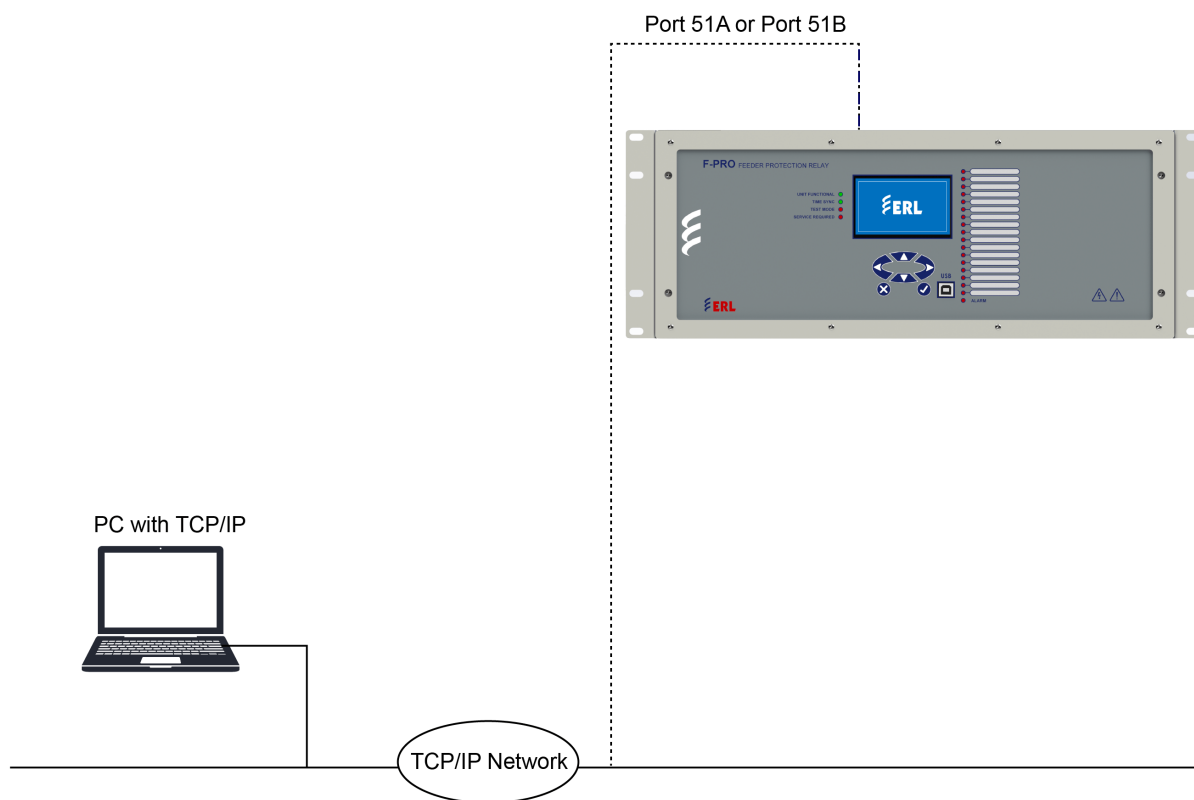


Figure 3.2: Network Link

Access both the relay's user interface and DNP3/IEC61850 SCADA services simultaneously with the Ethernet TCP/IP LAN link through the rear network port. The F-PRO 4500 has two physical network ports for redundancy support that share a common IP and MAC address. Each physical port is either a 100BASE-T copper interface with an RJ-45 connector or 100BASE-FX optical interface with an ST style connector. Both ports are factory configurable as a copper or optical interface.

DNP3 SCADA services can also be accessed over the LAN, for details see "Communication Port Details" on page 3-13 .

Connect to the Ethernet LAN using a Cat 5 cable with an RJ-45 connector or 100BASE-FX 1300 nm, multi-mode optical fiber with an ST style connector.

By default, the network port is assigned with an IP address of 192.168.100.80. If this address is not suitable, it may be modified using the relay's Maintenance Menu. For details see "Use HyperTerminal to Access the Relay's Maintenance Menu" on page 3-7 .

3.7 Use HyperTerminal to Access the Relay's Maintenance Menu

This section describes how to configure a standard Windows VT-100 terminal program on the PC for use with the relay.

The computer must be connected to the relay via the front USB Port 010 for access to all the Maintenance functions. A network connection can be used for limited access to the Maintenance Menu.

The relay is accessed using a standard VT-100 terminal style program on the computer, eliminating the need for specialized software. Any terminal program that fully supports VT-100 emulation and provides z-modem file transfer services can be used. HyperTerminal PE, is used here as an example.

Configure the terminal program as described in Table 3.1: Terminal Program Setup and link it to the appropriate serial port, modem or TCP/IP socket on the computer.

Table 3.1: Terminal Program Setup	
Baud rate	Default fixed baud rate 115,200 N81 (no parity, 8 data bits, 1 stop bit).
Data bits	8
Parity	None
Stop bits	1
Flow control	Hardware or Software. Hardware flow control is recommended. The relay automatically supports both on all its serial ports.
Function, arrow and control keys	Terminal keys
Emulation	VT100
Font	Use a font that supports line drawing (e.g. Terminal or MS Line Draw). If the menu appears outlined in odd characters, the font selected is not supporting line drawing characters.

To configure Hyper Terminal, follow these instructions: In Windows 11 or Windows 10, open HyperTerminal PE; If “Default Telnet Program?” windows pop up,

Check “Don’t ask me this question again”

Hit *No*.

First time use of HyperTerminal will ask for “Location Information”.

Fill with appropriate information, e.g.:

“What country/region are you in now”

Choose “Canada”

“What area code (or city code) are you are in now?”

Enter “306”

“If you need to specify a carrier code, what is it?”

Enter “”, i.e. leave blank

“If you dial a number to access an outside line, what is it?”

Enter “”.

“The phone system at this location uses:”

Choose “Tone dialing”.

Hit *OK*.

First time use of HyperTerminal will show “Phone and Modem Options”.

Hit *Cancel*.

HyperTerminal will show initially “Connection Description”.

Enter a name for the relay, e.g: “FPRO4500”.

Hit *OK*.

In the window “Connect To”

“Connect using”

Choose “COM#”, where “#” was obtained previously in Section 2.5 USB Link, after installing the USB driver.

Let’s assume in this case it is COM3.

In the window “COM3 Properties” choose:

“115200”

“8”

“None”

“1”

“Hardware”

Hit *Apply* then hit *OK*

At this time the connection should already be established.

Hit Enter in the terminal window.

Maintenance Menu Commands

Login as **maintenance** in lower case.

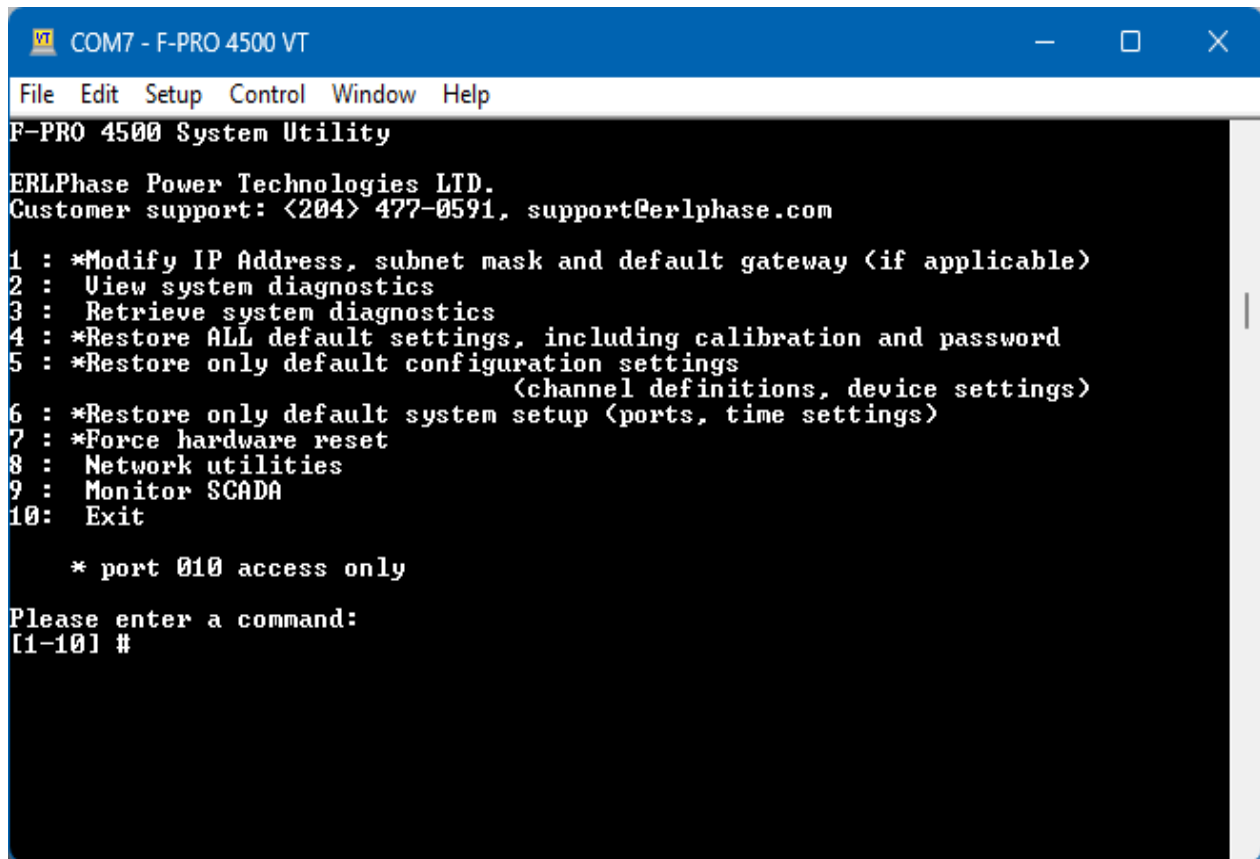


Figure 3.3: Maintenance menu

Commands 1, 4, 5, 6 and 7 are Port 010 access only.

Table 3.2: Maintenance Menu Commands

Modify IP address	Modifies the LAN IP addresses, network mask, default gateway and IEC61850 network port assignment.
View system diagnostic	Displays the internal status log.
Retrieve system diagnostics	Automatically packages up the internal status log plus setting and setup information and downloads it in compressed form to the computer. This file can then be sent to our customer support to help diagnose a problem.
Restore settings (commands 4, 5 and 6)	Use these commands to force the system back to default values, if a problem is suspected due to the unit's settings, calibration and/or setup parameters. NOTE: If Command 4 is performed, the unit must be re-calibrated before being put back into service. Please contact ERLPhase Technical Support for calibration instructions.
Force hardware reset	Manually initiates a hardware reset. Note that the communication link is immediately lost and cannot be reestablished until the unit completes its start-up.
Network utilities	If this command is prompted it Enters into the network utilities Submenu listed in the table 3.3
Monitor SCADA	Shows real time display of SCADA data.

Table 3.3: Network Utilities Menu Commands

View protocol statistics	View IP, TCP and UDP statistics
View active socket states	View current states of active sockets
View routing tables	View routing tables
Ping	Check network connection to given point
Exit network utilities	Exit network utilities menu and return to Maintenance Menu Commands

3. 8 Firmware Update

The relay has an update login that can be accessed by a connection through a VT100 terminal emulator (such as HyperTerminal). This login is available only from the front USB port.

1. Use the terminal program to connect to Port 010.
2. Select *Enter*, the terminal responds with a login prompt.
3. Login as **update** in lower case.

The firmware update is used to update the relay's software with maintenance or enhancement releases. Please see the F-PRO Firmware Update Procedure documentation that comes with the firmware update for instructions on how to update the firmware on the relay.

3. 9 Accessing the Relay's SCADA Services

The relay supports IEC61850/ DNP3 (Level 2) and Modbus SCADA protocols as a standard feature on all ERLPhase relays. DNP3 is available through a direct serial link or the Ethernet LAN on top of either TCP or UDP protocols. The Modbus implementation supports both Remote Terminal Unit (RTU) binary or ASCII modes and is available through a serial link.

The relay's serial port (Port 52) is dedicated for use with Modbus or DNP3 serial protocols. The serial port uses standard RS-485 signaling. An external RS-485 ↔ RS-232 converter can be used to connect to an RS-232 network.

For details on connecting to the serial port see “Communicating with the Relay” on page 3-4 and “Communication Port Details” on page 3-13 .

The DNP3 protocol can also be run across the Ethernet LAN. Both DNP over TCP and DNP over UDP are supported. For details on connecting to the Ethernet LAN see “Network Link” on page 3-6 .

Complete details on the Modbus and DNP3 protocol services can be found in the Appendices, for details see “Modbus Communication Protocol” in Appendix E and “DNP3 Device Profile” in Appendix F.

Protocol Selection

To select the desired SCADA protocol, go to F-PRO 4500 Offliner SCADA communications section. Select the protocol and set the corresponding parameters.

Communication Parameters

The serial port's communication parameters are set in the F-PRO 4500 Offliner SCADA communications section. Both the baud rate and the parity bit can be configured. The number of data bits and stop bits are determined automatically by the selected SCADA protocol. Modbus ASCII uses 7 data bits. Modbus RTU and DNP Serial use 8 data bits. All protocols use 1 stop bit except in the case where either Modbus protocol is used with no parity; this uses 2 stop bits, as defined in the Modbus standard.

Diagnostics

Protocol monitor utilities are available to assist in resolving SCADA communication difficulties such as incompatible baud rate or addressing. The utilities can be accessed through the Maintenance Menu Commands, see "Maintenance menu" on page 3-9.

3. 10 Communication Port Details

Table 3.4: Communication Port Details

Location	Port ^a	Function
Front Panel	010	USB-B receptacle, high speed USB 2.0 interface Used for user interface access Default fixed baud rate 115,200 N81 (no parity, 8 data bits, 1 stop bit).
Rear Panel	51A	RJ-45 receptacle or ST type optical receptacle (factory configured). 100BASE-T or 100BASE-FX (1300nm, multi-mode) Ethernet interface. Same MAC and IP address as Port 51B (for redundancy support). Used for user interface access or IEC61850/DNP SCADA access through Ethernet LAN.
	51B	RJ-45 receptacle or ST type optical receptacle (factory configured). 100BASE-T or 100BASE-FX (1300 nm, multi-mode) Ethernet interface. Same MAC and IP address as Port 51A (for redundancy support). Used for user interface access or IEC61850/DNP SCADA access through Ethernet LAN.
Rear Panel	52	RS-485 terminal block connector. Used only for SCADA communication. Default Setting: 19,200 baud O71 (odd parity, 7 data bits, 1 stop)
Rear Panel	531	BNC receptacle, IRIG-B Interface. Modulated.
Rear Panel	541	BNC receptacle, IRIG-B Interface. Un-modulated.

- a. See “Connection Diagram” in Appendix H for the connection diagram and the terminal numbering description.

4 Using the Relay (Getting Started)

This section provides information on the start-up sequence and ways to interface with the relay. Descriptions of the Front Panel Display, Terminal Mode and Metering Data are provided.

4.1 Start-up Sequence

When the power supply is connected, the following initialization initializing sequence takes place:

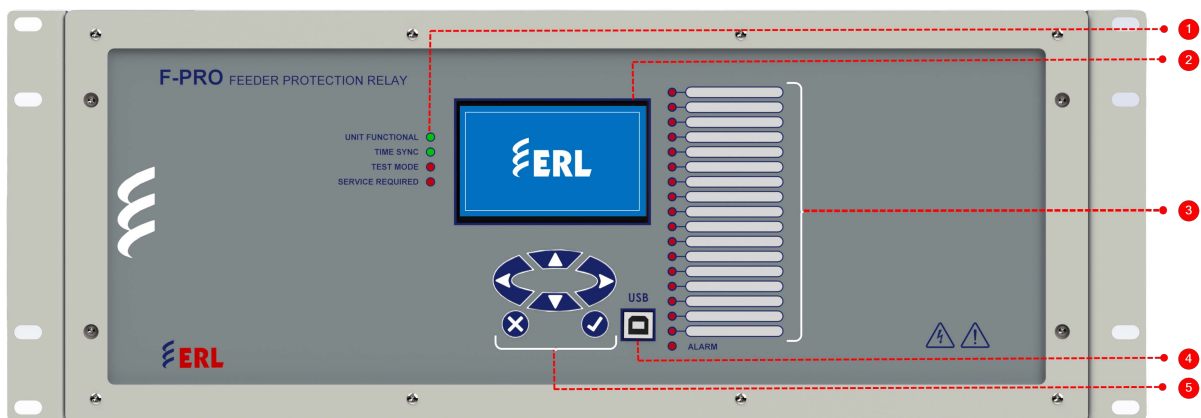
Table 4.1: Initialization Sequence	
TEST MODE — red LED on	when power applied
RELAY FUNCTIONAL — green LED on	within 7 seconds after power applied
TEST MODE — red LED off then on	within 20 seconds
Front Display — on	on within 20 seconds after power applied
TEST MODE — red LED off	within 30 seconds after power applied

When the Relay Functional LED comes on, it indicates that the DSP is actively protecting the system.

When the test mode LED goes off, the relay is capable of recording and communicating with the user.

4. 2 Front Panel Display

The front panel display of the IED allows the user to interact with the unit to obtain immediate system information. User interface is provided through a graphical LCD screen, LEDs and a push button keypad. The level of interaction and system access is controlled through a series of access level; VIEW, CHANGE and SERVICE, with each requiring a unique password allowing differing levels of accessibility. Additionally, the IED front panel provides a USB Type B port, used in general unit communications and controlled service access.



1. LEDs for displaying the status of the IED
2. Front Panel LCD display for events, targets, settings etc.
3. 18 Programmable Target LEDs
4. USB Port for maintenance and user interface
5. Push buttons used for navigation of LCD menus

Figure 4.1: Front Panel Display

LED Lights

Table 4.2: Description of LED Indicators

Unit Functional	Indicates when the relay is functional. When the Relay Functional green LED goes on, the rear Relay Inoperative contact changes to an open and the protective functions become functional.
Time Sync	Indicates the presence of a valid IRIG-B or SNTP time signal.
Service Required	Indicates the relay needs service. This LED can be the same state as the Relay Functional LED or can be of the opposite state depending on the nature of the problem. The following items bring up this LED: • DSP failure - protection difficulties within the relay. • Communication failure within the relay. • Internal relay problems.
Test Mode	Occurs when the relay output contacts are intentionally blocked. Possible reasons are: • Relay initialization on startup • User interface processor has reset and is being tested. The user cannot communicate with the relay through the ports until the front display becomes active and the TEST MODE LED goes out. Normally, the red Target LED remains off after this start-up unless the relay had unviewed target messages.
Target LED	
LED 1-17	User Configurable via Output Matrix
Alarm LED 18	Occurs when an enabled relay function picks up. The red Alarm LED should be off if there are no inputs to the relay. If the Alarm LED is on, check the event log messages which are available through the menu system.

For more information on configuring the Target LEDs, for details see Target LED on page 5-84 and for details see Phase Indication Tripping on page 5-87

Target LED assignments shown in the table above are the default values. The Target LEDs are configurable by the user through the Offliner settings (output matrix).

Push Buttons

Table 4.3: Identification of Push Buttons

Up, Down, Right, Left, Enter, Escape	Used to navigate the front panel screens.
--------------------------------------	---

Display

The LCD screen of the F-PRO 4500 relay provides information to the user in the form of data, messages and visual feedback for user interaction. It also allows for the user to modify protection function settings directly. A series of access controlled menu options are available through the front panel LCD and Push Button keypad provided on the unit, allowing unit less access to many of the same features available through the supporting ERLPhase relay software tools. In all cases, a password is required to obtain more than the basic IED information.

The LCD screen displays the following metering parameters.

- Phase-wise voltage magnitude & angle
- Phase-to-phase voltage magnitude & angle
- Phase-wise current magnitude & angle
- 3-phase real power
- 3-phase reactive power
- Frequency
- 3-phase apparent power
- Power factor
- All sequence voltages
- All sequence currents
- Single-phase real power
- Single-phase reactive power
- Single-phase Apparent power
- Single-phase power factor
- Thermal Percentage
- I^2t Accumulated, Last operated
- % of THD voltage
- 79AR Count, Cumulative Counts
- V/F
- %I2/I1

The metering display in LCD screen has a resolution of three decimals for both measured and calculated analog values.

The basic menu structure for navigation of the LCD Screen is given below:

Table 4.4: Navigation of the LCD Screen			
Menu			Rights Required*
Main Menu			
	Relay Info.		
	Metering		
	Analog		
	Analog Inputs		
	Derived Quantities		
	External Inputs		
	Output contacts		
	Logic		
	Voltage		
	Current		
	Frequency		
	Power		
	Monitoring Functions		
	Control Functions		
	Pro Logic		
	Group Logic		
	Virtual Inputs		
	MMS Commands		
	Direction		
	Events		
	Faults		

Table 4.4: Navigation of the LCD Screen

Menu			Rights Required*
	Utilities		
	View / Change / Service: Choice login		
	Enter Password		(C,S)
	Setup		
	Timeouts		
		Login timeout	(C, S)
		Screen timeout	(C, S)
	Time Settings		
		Current Date & Time	
		Set Time Display as	(C, S)
		Set Manual Time	(C, S)
		Set DST Time	(C, S)
		Set Time Zone	(C, S)
		IRIG-B & SNTP	
		IRIG-B	(C, S)
		SNTp	(C, S)
	External Inputs		(C, S)
	Maintenance		
	Output Contacts Ctrl		(S)
	Virtual Inputs Ctrl		(C, S)
	Setting Groups Ctrl		(C, S)
	Erase		(C, S)
	Erase Records		(C, S)
	Erase Event Logs		(C, S)
	Erase Fault Logs		(C, S)
	79 Cumulative Count		(C, S)
	I ² t Accumulated		(C, S)

Table 4.4: Navigation of the LCD Screen

Menu		Rights Required*
	Communication	
	IP Address and Mask	(S)
	IEC61850 Port	(S)
	Front USB Baud rate	
	Records	
	View Record List	
	Record List	
	Trigger Fault	(C,S)
	Trigger Event	(C,S)
	Trigger Swing	(C,S)
	Calibration	(S)
	Settings	
	View / Change / Service: Choice login	
	Enter Password	
	System Parameters	
	General	(C,S)
	Line	(C,S)
	CT Turns Ratio	
	Main Phase CT	(C,S)
	Main Neutral CT	(C,S)
	SEF CT	(C,S)
	PT Turns Ratio	
	Main PT	(C,S)
	Auxiliary PT	(C,S)
	Threshold Limits	(C,S)
	Record Length	(C,S)
	Setting Group N	

Table 4.4: Navigation of the LCD Screen

Menu		Rights Required*
	Line Parameters	(C,S)
	Scheme Selector	(C,S)
	Breaker Status	(C,S)
	Protection Functions	
	27 - Undervoltage	
	Main	(C,S)
	Auxiliary	(C,S)
	59 - Overvoltage	
	Main	(C,S)
	Aux	(C,S)
	24 – Over Flux	
	24 DT - 1	(C,S)
	24 DT - 2	(C,S)
	24IT	(C,S)
	47 – Neg seq O/V	
	47 DT - 1	(C,S)
	47 DT - 2	(C,S)
	47IT	(C,S)
	59N – Zero Seq. Overvoltage	
	59N DT – 1	(C,S)
	59N DT – 2	(C,S)
	59N IT	(C,S)
	37 – Under Current	
	37 - 1	(C,S)
	37 - 2	(C,S)
	50/51/67 – Phase OC	
	50 - 1	(C,S)

Table 4.4: Navigation of the LCD Screen

Menu		Rights Required*
	50 - 2	(C,S)
	51 - 1	(C,S)
	51 - 2	(C,S)
	67	(C,S)
	Phase Setting Multiplier	(C,S)
	50G/51G/67 – Neut. OC	(C,S)
	50G - 1	(C,S)
	50G - 2	(C,S)
	51G - 1	(C,S)
	51G - 2	(C,S)
	67G	(C,S)
	Phase Setting Multiplier	(C,S)
	50N/51N/67 – Neut. OC	(C,S)
	50N - 1	(C,S)
	50N - 2	(C,S)
	51N - 1	(C,S)
	51N - 2	(C,S)
	67N	(C,S)
	Phase Setting Multiplier	(C,S)
	46-50/46-51	(C,S)
	46-50	(C,S)
	46-51	(C,S)
	Phase Setting Multiplier	(C,S)
	64-50/64-51/67SEF/REF	(C,S)
	64 – 50SEF/REF - 1	(C,S)

Table 4.4: Navigation of the LCD Screen		
Menu		Rights Required*
	64 – 50SEF/REF - 2	(C,S)
	64 – 51SEF - 1	(C,S)
	64 – 51SEF - 2	(C,S)
	67SEF	(C,S)
	Phase Setting Multiplier	(C,S)
	49 – Thermal Overload	
	50BF - Breaker Failure	
	50BF	(C,S)
	External Initiate.50BF	(C,S)
	46BC	(C,S)
	50LS – Low Set Overcurrent	(C,S)
	81HLB2 - Inrush	(C,S)
	81 – Over/Under Freq.	(C,S)
	81 - 1	(C,S)
	81 - 2	(C,S)
	81 - 3	(C,S)
	81 - 4	(C,S)
	81 - 5	(C,S)
	81 - 6	(C,S)
	81 - 7	(C,S)
	81 - 8	(C,S)
	81 - 9	(C,S)
	81 - 10	(C,S)
	32 Over/Under Power	(C,S)
	32 - 1	(C,S)
	32 - 2	(C,S)

Table 4.4: Navigation of the LCD Screen

Menu		Rights Required*
	32 - 3	(C,S)
	32 - 4	(C,S)
	60 – LOP Alarm	(C,S)
	60 – CT Supervision	(C,S)
	74 - TCS	
	TCS - 1	(C,S)
	TCS - 2	(C,S)
	I ² T	(C,S)
	THD	
	AR Counter	(C,S)
	25/27/59 Sync Check	(C,S)
	79 - Auto Recloser	
	Prot. Scheme Timer	(C,S)
	79-3Ph Recloser	(C,S)
	79-1Ph Recloser	(C,S)
	Login/Logout	(C,S)
	Clear Target	
	Clear Output	(C,S)
	Test LEDs	

* All front panel menus may be viewed with View rights. Items marked as C or S require Change or Service rights in order to make and save changes.

To login into the LCD menu structure, follow these steps:



Figure 4.2: Main Screen

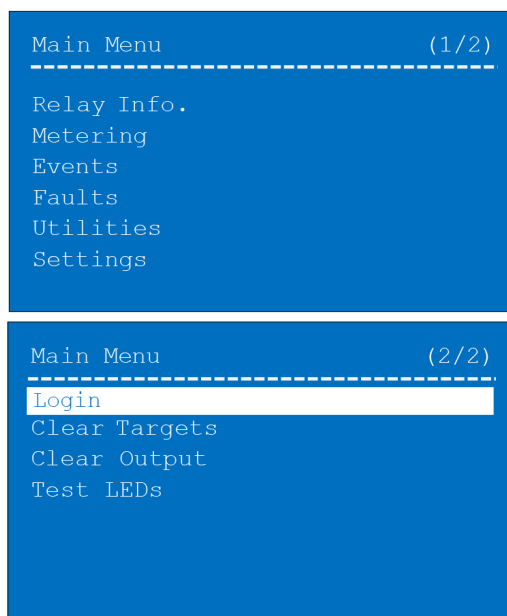


Figure 4.3: Main Menu

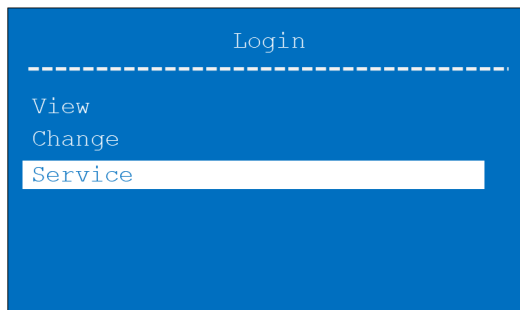


Figure 4.4: Login Window (View / Change / Service)

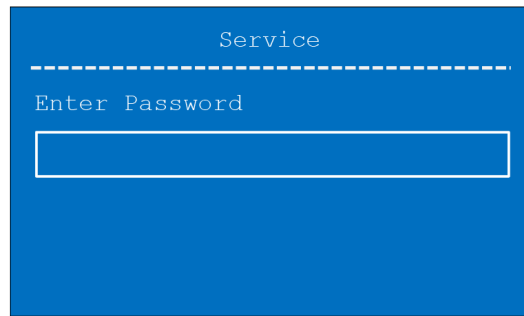


Figure 4.5: Enter Password

In the Main Screen, Select Login and hit Enter. Alternatively, selecting Utilities or Settings will also prompt the Login screen.

In the Login screen, choose desired access level, hit Enter.

In the Enter Password screen, enter the password by clicking the up or down arrows to select characters and the side arrows to move the cursor forward or backward and press Enter button to complete the password entry.

Note: The default passwords are (remove quotation marks)

View Access - no password required

Change Access “change”

Service Access “service”

Password can contain ~ ! @ #

\$ % ^ & * () _ + = { } [] : ; " ' , < > ? / \ () 0-9 a-z and A-Z

Target LED Reset Type

The front panel of the F-PRO 4500 displays the fault/event and phase information via the target LEDs and target event messages on the LCD.

Each Target LED is configurable in the Setting File as either “Self Reset” or “Latched” as shown in below.

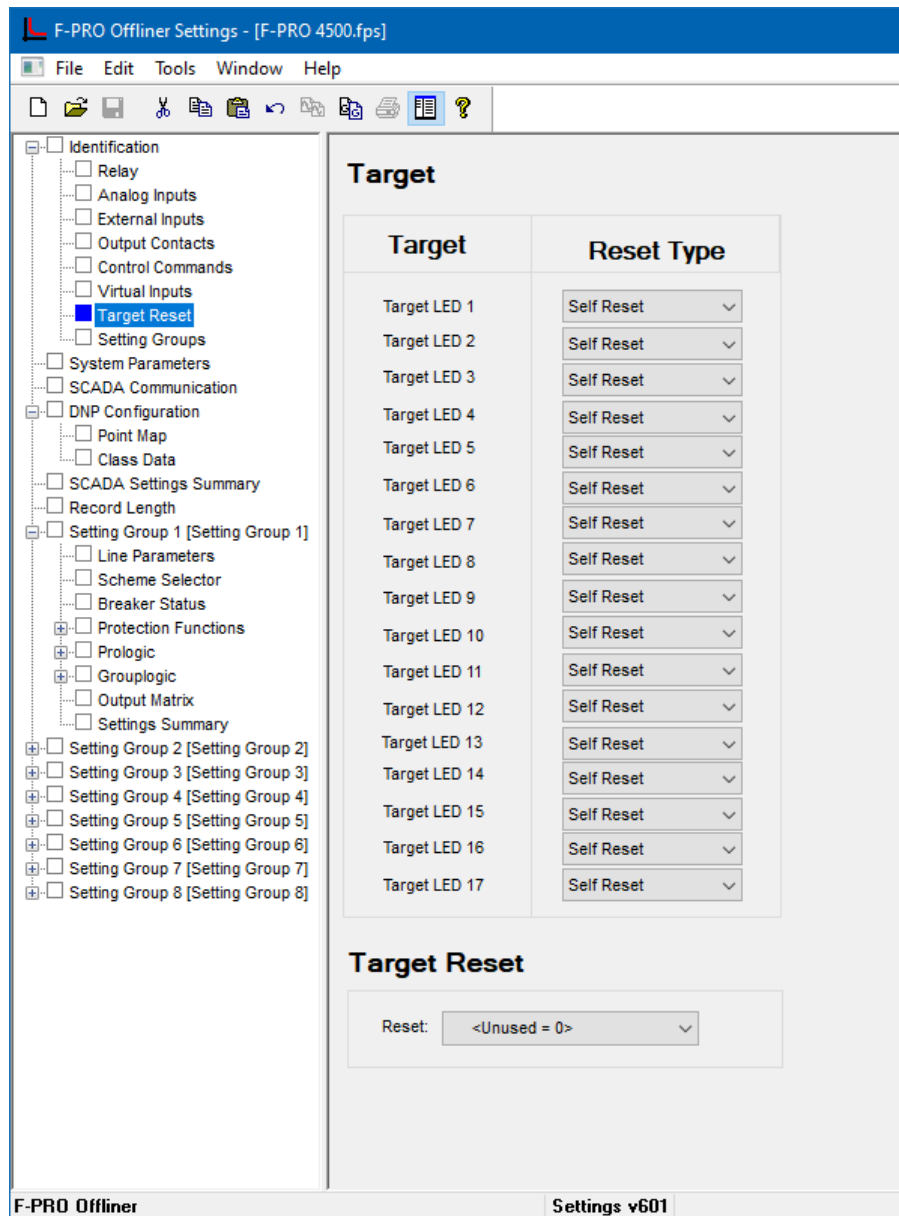


Figure 4.6: Target Reset Type

In Self Reset mode, the LED will only remain on while the associated function is high. When the associated function goes low, the LED will turn Off automatically.

In Latched Mode, the LED will turn on when the associated function goes high, and will remain on until the user manually resets the target.

Target Test and Reset

There are multiple ways to reset latched LEDs and target messages and to test the LEDs, as shown below.

Front Panel LCD

To reset the targets from the front panel LCD, select the *Clear Targets* item from the *Main Menu*. Selecting this item will clear all latched LED indicators, and will clear the event target from the LCD. The *Clear Target* function does not delete any fault or event information; this information is still available in the fault and event logs.

To test the target LED functionality, select the *Test LEDs* item from the *Main Menu*. The *Test LEDs* feature illuminates all of the front panel LED indicators momentarily to verify their functionality. This function does not clear the target LEDs or events.

Relay Control Panel

Relay Control Panel offers a *Target Test* and *Target Clear* feature.

The *Target Test* feature works in the same manner as the front panel LCD target reset feature. To access this feature in RCP, login as Change or Service and navigate to *Utilities > Control Targets*.

The *Target Clear* feature works in the same manner as the front panel LCD target reset feature. To access this feature in RCP, login as Change or Service and navigate to *Utilities > Control Targets*.

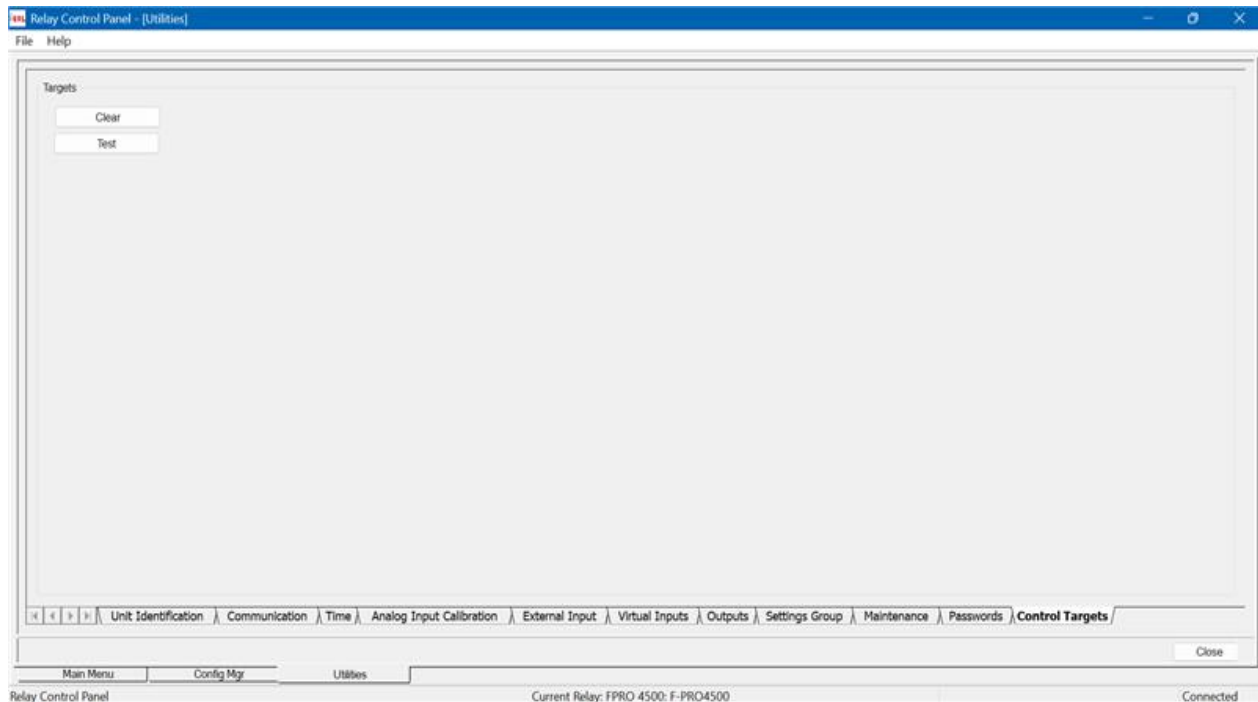
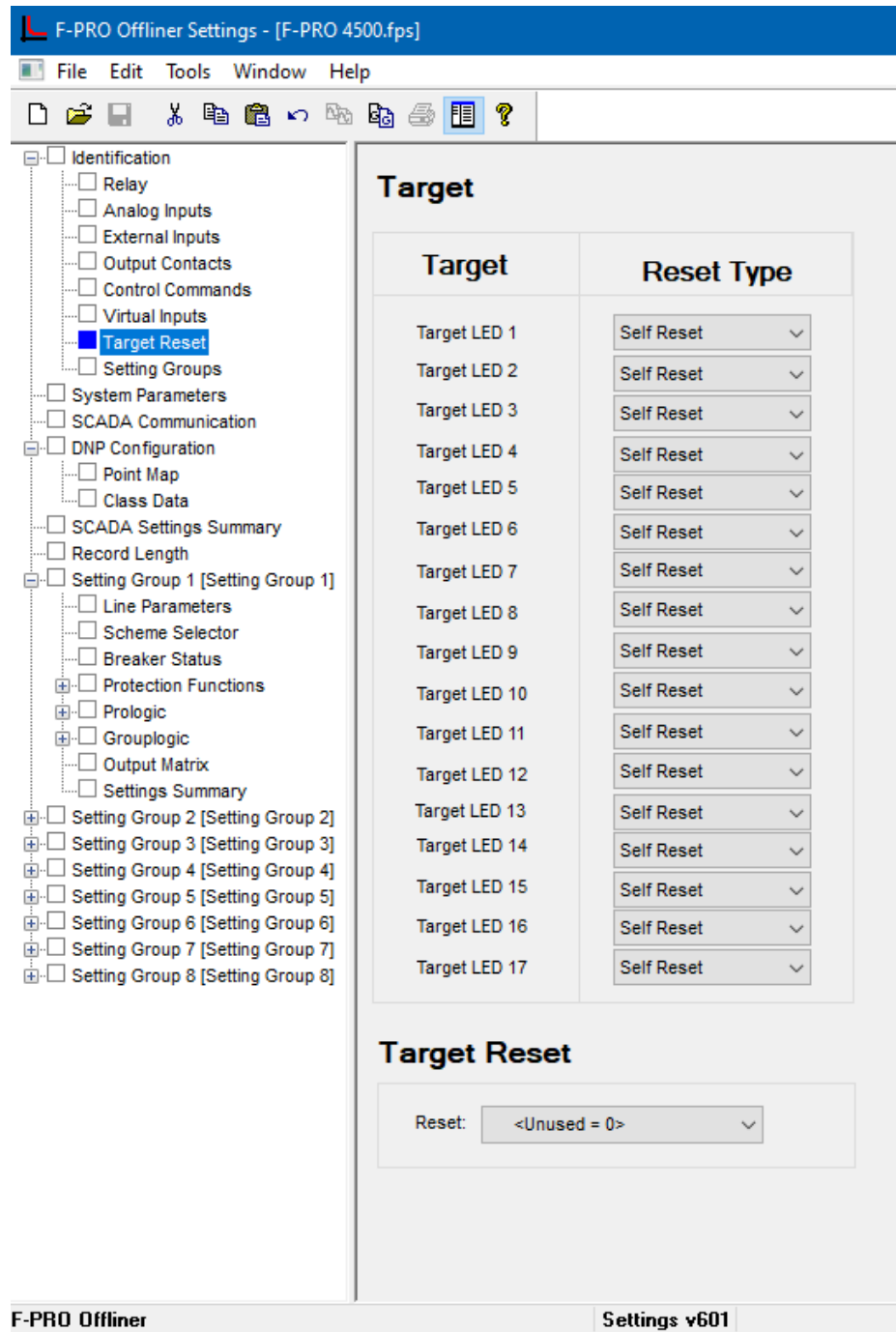


Figure 4.7: Relay Control Panel Control Targets screen

External Reset

F-PRO Offliner provides an option to configure the external resetting of targets. This setting uses one of the External Inputs, ProLogics, SPC Control Command or Virtual Inputs to remotely reset the front panel targets. When this external target reset input goes high, the latched front panel targets are immediately cleared. One *Target Reset* setting is available which applies globally to all of the LEDs. To configure this setting, go to the *Identification > Target Reset* screen in F-PRO Offliner. see Table 7.8: Target Reset Settings on page 7-17 for more details.

Figure 4.8: F-PRO Offliner *Target Reset* setting

SCADA

The front panel targets may be reset using either the DNP3 or IEC61850 protocols.

To reset the front panel targets via DNP3, a combination of the F-PRO Offliner external target reset setting and DNP3 control operations are used. To use this feature, assign any Virtual Input as the External Target reset input in F-PRO Offliner. Then use the DNP3 Control Operations for the assigned Virtual Input. For more information on DNP3 Control Operations, “Binary Output Status And Control Relay Output Block” in Appendix F

The front panel targets may also be reset via the IEC61850 protocol via SPC Control Commands. Assign any SPC to the Target Reset setting (see “External Reset” above). Then using a 61850 Client the targets may be reset by operating the associated SPC Control Command. “Control Commands” on page 8-5 for more details.

Output Contact Reset

The front panel provides an option to manually reset latched Output Contacts (“Output Contacts” on page 7-12 for more details). To reset the latched Output Contacts, select the *Clear Outputs* item from the *Main Menu*. Change or Service login credentials are required to reset the Output Contacts.

LCD Contrast Adjustment

The LCD contrast of the front panel display is adjustable using the push buttons. To adjust the screen contrast, hold the escape (X) button for five seconds. While continuing to hold the escape (X) button, press the up or down buttons to increase or decrease the contrast.

4. 3 Terminal Mode

The terminal mode is used to access the relay for maintenance functions “Use HyperTerminal to Access the Relay’s Maintenance Menu” on page 3-7 and “Firmware Update” on page 3-11.

4. 4 Relay Control Panel (RCP)

RCP is used for all user interface. A short description of the RCP configuration to connect to a relay is given here. Please refer to the Relay Control Panel User Manual for details.

Configure USB Link

Follow this sequence to configure RCP for USB link to the relay.

1. Execute.

Relay Control Panel.exe

2. Execute.

F-PRO 4500 Offliner.exe

3. Install Null Modem Driver.

Please refer to the Relay Control Panel User Manual for details.

4. Run Relay Control Panel.

Go to:

Start > All Programs > ERLPhase > Relay Control Panel > Relay Control Panel

First time RCP is run.

Hit *.Add New*

“Add New Relay”

Choose Communication > Direct Serial Link.

Select correct serial link and baud rate.

Hit *Get Information From Relay*.

Then RCP will communicate with the F-PRO 4500 and retrieve information to fill required fields.

When this is done, hit *Save Relay*.

If the window “Relay already exists...” pops up, you may need to rename the relay changing the “Relay Name” in the “Relay Definition” category, before saving.

After the first time, in “Select Relay”, choose relay and hit *Connect*.

In “Relay Password Prompt”

Choose desired access level, enter appropriate password

Note: Default passwords are listed below (remove the quotation marks)

View Access “view”

Change Access “change”

Service Access “service”

Relay Control Panel Structure

The basic structure of the Relay Control Panel information, including basic actions available, is given below:

Table 4.5: Relay Control Panel Structure

		View	Change	Service
Relay Control Panel				
	Records		Trigger Fault	Trigger Fault
			Trigger Swing	Trigger Swing
			Trigger Event	Trigger Event
	Faults		Erase	Erase
	Events		Erase	Erase
	Metering			
	Analog			
	Derived			
	Voltage			
	Current			
	Frequency			
	Power			
	Monitoring			
	Control			
	Pro Logic			
	Outputs			
	Group Logic			
	Virtual			
	MMS Cmds			
	Direction			

Table 4.5: Relay Control Panel Structure				
	Utilities			
	Unit Identification			
	Communication			
	Time	N/A	Save	Save
	Analog Input Calibration	N/A	N/A	Calibrate offset and gain
	External Input	N/A	Save	Save
	Virtual Inputs	N/A	Latch/Pulse	Latch/Pulse
	Outputs	N/A	N/A	Activate/Deactivate
	Settings Group	N/A	Save	Save
	Maintenance			
	Passwords	N/A	N/A	Save
	Control Targets	N/A	Test/Clear	Test/Clear
	Configuration			
	Present Settings	(Get From Relay)	(Get From Relay)	(Get From Relay)
	Saved Settings	N/A	(Load to Relay)	(Load to Relay)

Notice that some options are not available (N/A) depending on the access level.

RCP Metering

The RCP displays the following metering parameters

- Phase-wise voltage magnitude & angle
- Phase wise current magnitude & angle
- 3-phase real power
- 3-phase reactive power
- Frequency
- 3-phase apparent power
- Power factor
- All sequence voltages
- All sequence currents
- Thermal Percentage
- I^2t Accumulated, Last operated
- % of THD voltage
- 79AR Count, Cumulative Counts
- V/F
- %I2/I1
- All protection function statuses
- All Virtual Input, External Input, ProLogic, Group Logic, MMS commands and Output Contact Statuses

The metering display in RCP has a resolution of three decimals for both measured and calculated analog values.

5 Protection Functions and Specifications

5. 1 Protection and Monitoring Functions

Introduction

This section describes the equations and algorithms of the relay protection functions. All functions with time delay provide an alarm output when their pickup level is exceeded. The available functions are Mentioned Below:

- 50/67 (1 to 2), 51/67 (1 to 2) - Phase Overcurrent
- 50N/67N (1 to 2), 51N/67N (1 to 2) - Derived Neutral Overcurrent
- 50G/67G (1 to 2), 51G/67G (1 to 2) - Measured Neutral Overcurrent
- 67, 67N, 67G, 67SEF - Directionality
- 64/50 SEF/REF (1 to 2), 64/51SEF (1 to 2) - Sensitive/Restricted Earth Fault
- 46/50, 46/51- Negative Sequence Overcurrent
- 49 - Thermal Overload
- 37(1 to 2) - Under Current
- 27DT-Main (1 to 4), 27DT-Aux (1 to 4), 27IT-Main(1 to 2) - Under voltage
- 59DT-Main (1 to 4), 59DT-Aux (1 to 4), 59IT-Main (1 to 2) - Overvoltage
- 47DT (1 to 2), 47IT - Negative Sequence Overvoltage
- 59NDT (1 to 2), 59NIT- Zero Sequence Overvoltage
- 24DT (1 to 2), 24IT - Overflux
- 50LS - Low Set Current
- 81U/O/ROC (1 to 10) - Frequency
- 32(1 to 4) - Directional Power
- 81HBL2 - Inrush
- THD(1 to 2) - Total harmonic Distortion
- 25/27/59 - Sync Check
- 79 - Auto Recloser
- 50BF - Breaker Failure
- 46BC - Broken Conductor
- 60LOP - Voltage Supervision (Referred to as 60VTS also)

- 60CTS - Current Supervision
- 74TCS (1 to 2) - Trip Circuit Supervision
- I^2t -CB - Breaker Monitoring
- Fault Locator

These functions are explained below with setting ranges and logic diagrams & complete list of the settings and their range values can be found in “IED Settings and Ranges” in Appendix B

50/67 Phase Overcurrent

The Phase Overcurrent function (50/67) provides instantaneous or definite time lag protection to the protected equipment. The current and time settings for the operation of the function are user defined. This function has two elements, 50/67-1 and 50/67-2, both of which can be configured independently as required. Each function has independent directional settings (Non-directional, forward or reverse). Each phase is compared with the set value after current filtering. If the measured current is greater than the set pick-up value, the relay will operate after the set time delay.

The function has an additional “Inrush Blocking” feature. This blocks the operation of the function when the second harmonic current is present over the fundamental. This allows the relay to be used in transformer applications.

Each element (50/67-1, 50/67-2) can be independently inhibited via an external input status which can be configured from the Output matrix. This is useful in comprehensive blocking schemes.

The Metering menu provides the current and voltage values and their phase angles. The correctness of the polarity of the directional overcurrent element should be verified on the metering screens.

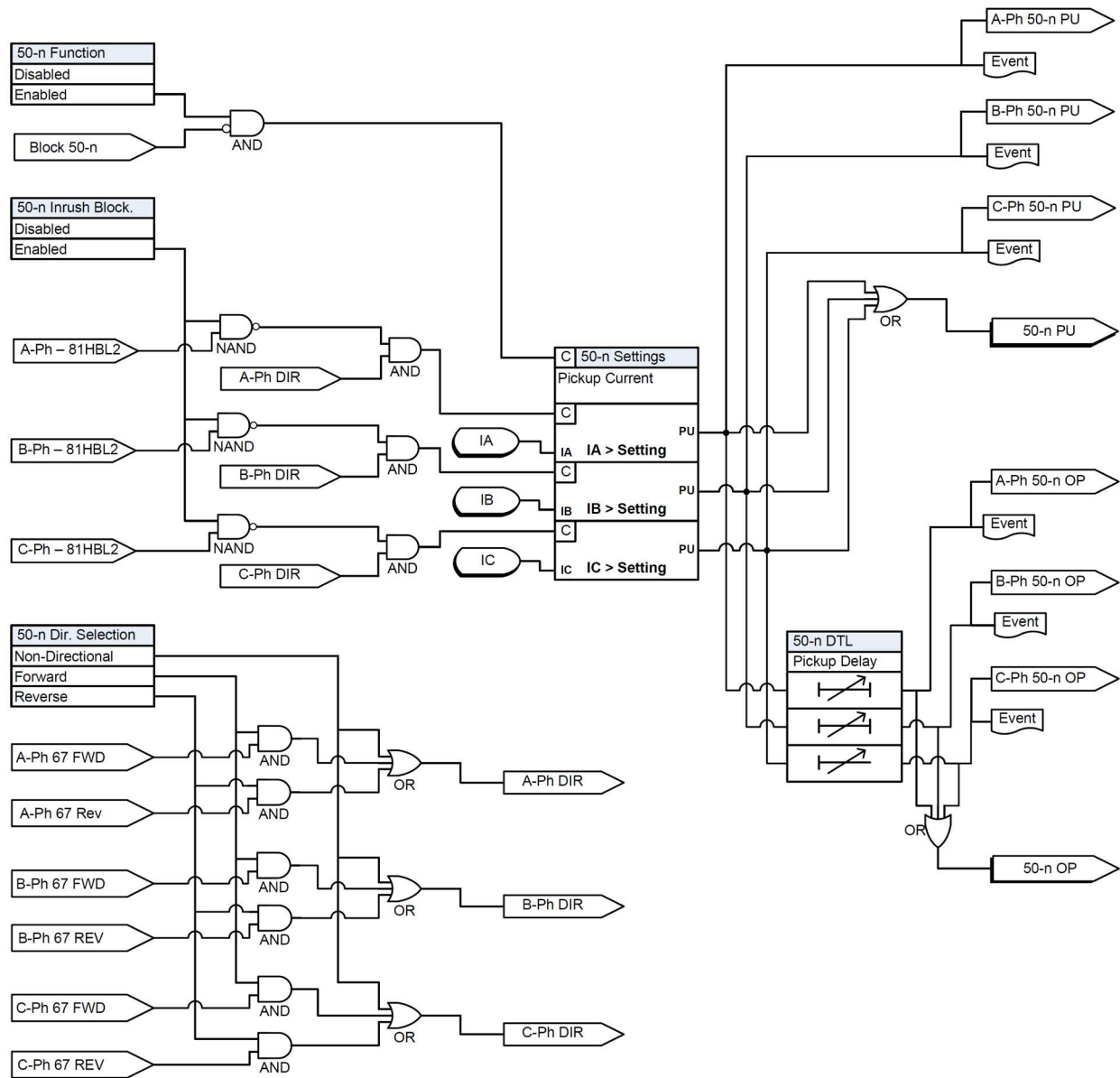


Figure 5.1: 50/67 Function logic diagram

Table 5.1: 50/67 Phase Overcurrent Settings

50-67-1,2	Enable/Disable
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.1 to 30.00 A (1A) 0.50 to 150.00A (5A)
Pickup Delay	0.00 to 99.99 s (Non-Dir) 0.01 to 99.99 s (FWD or REV)
Phase Setting Multiplier for Single Phase Open Pole Condition	
50 Pickup Current Multiplier	0.10 to 2.00
50 Pickup Time Multiplier	0.10 to 2.00
Inrush Blocking	Enable/Disable

51/67 IDMTL Phase Overcurrent

Relay co-ordination can be achieved by means of adjusting Time Multiplier Settings (TMS), current setting or a combination of both time and current. Based on the fault, the relay can be used with current grading. If fault current is approximately constant then time grading can be used. For grid connected stations combination of both is used. When Z_{source} (the impedance between the relay and the power source) is small compared to that of the protected section Z_L , there is an appreciable difference between the current for a fault at the far end of the section ($E_{source} / (Z_{source} + Z_{line})$), and the current for a fault at the near end (E_{source} / Z_{source}). When operating time is inversely proportional to the current, the relay operates faster for a fault nearer the power source, and the operating time is more for a fault at far end. Grading by time is used in rare cases since it can often lead to excessive fault clearance time at substations where the fault level is high. For these reasons the most commonly applied characteristic in coordinating Overcurrent relays is the IDMTL type.

Each function has independent setting for direction selection – Non Direction / Forward / Reverse. Function 51/67 provides five IEC inverse time curve types, three IEEE inverse time curve types of Overcurrent protection and one user-defined curve as well as definite time delayed protection also i.e. DTL. The equation and the parameters of Function 51/67-1 and 51/67-2 are listed in below.

Pickup:

$$T(I) = TMS \left[B + \frac{A}{\left(\frac{I}{I_{Pickup}} \right)^p - 1} \right]$$

Reset:

$$T(I) = TMS \left[\frac{TR}{1 - \left[\frac{I}{I_{Pickup}} \right]^2} \right]$$

Each element (51/67-1, 51/67-2) can be independently inhibited via external input status which can be configured from Output matrix. This will help in achieving comprehensive blocking schemes.

User can define the reset delay for the relay; It can be set as DTL or by ANSI delay. Setting of the timer to a value other than zero, delays the resetting of the protection element timers for this period. This may be useful in special applications especially in cable feeders. By providing the setting, fault clearance gets reduced for intermittent faults.

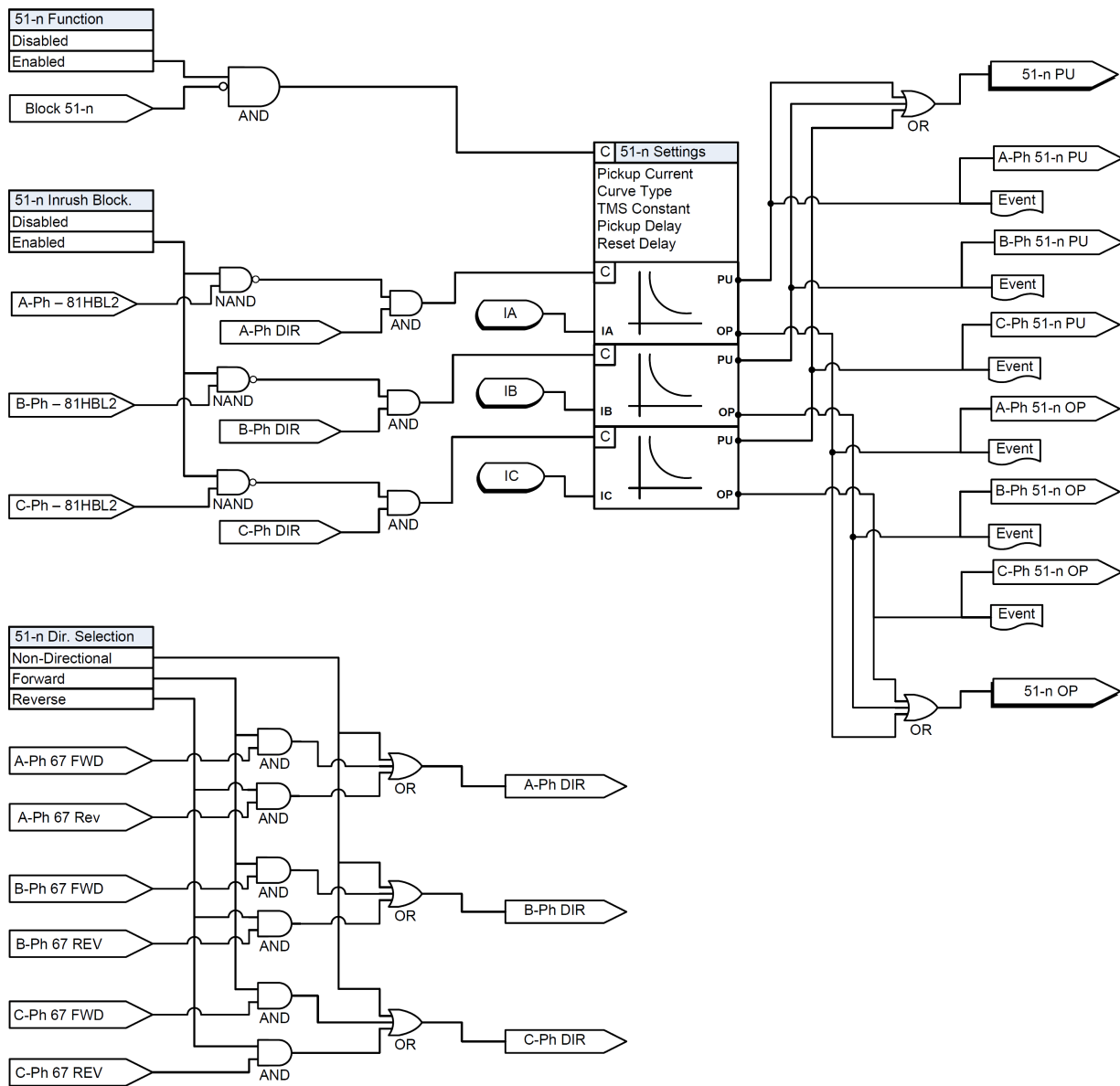


Figure 5.2: 51/67 Function logic diagram

Table 5.2: 51/67 IDMTL Phase Overcurrent Settings

51/67-1,2	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 5.00A (1A) 0.25 to 25.00A (5A)
Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User Defined Refer "Table 5.3:"
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 s (Non-Dir) 0.01 to 999.99 s (FWD or REV)
Reset Delay	DTL or ANSI Decay
Reset DTL Delay	0.0 to 99.9s
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Phase Setting Multiplier for Single Phase Open Pole Condition	
51 Pickup Current Multiplier	0.10 to 2.00
51 Pickup Time Multiplier	0.10 to 2.00
Inrush Blocking	Enable/Disable

Table 5.3: IEC and IEEE Curves

S NO	Curve Type	A	B	P	TR
1	IEC Standard Inverse -3	0.14 (Fixed)	0.00 (Fixed)	0.02 (Fixed)	13.5
2	IEC Standard Inverse -1	0.0613(Fixed)	0.00 (Fixed)	0.02 (Fixed)	6
3	IEC Very Inverse	13.5 (Fixed)	0.00 (Fixed)	1.00 (Fixed)	47.3
4	IEC Extremely Inverse	80.00 (Fixed)	0.00 (Fixed)	2.00 (Fixed)	80
5	IEC Long Time Inverse	120.00 (Fixed)	0.00 (Fixed)	1.00 (Fixed)	120
6	IEEE Moderately Inverse	0.0104 (Fixed)	0.0228 (Fixed)	0.02 (Fixed)	0.97
7	IEEE Very Inverse	3.880 (Fixed)	0.0963 (Fixed)	2.00 (Fixed)	4.32
8	IEEE Extremely Inverse	5.67 (Fixed)	0.0352 (Fixed)	2.00 (Fixed)	5.82
9	User-defined	0.0010 to 1000.0000	0.0000 to 10.0000	0.01 to 10.00	[0.1, 100]

67 Directional Function for Phase Overcurrent

Power systems may have various circuit combinations such as parallel feeders, transformers, ring main circuits and circuits with sources on either end. In these cases faults can occur in any circuit and fault current can flow in either direction. It is necessary to restrict breaker tripping to a particular direction to avoid mis-operation of a healthy system.

The directional overcurrent has four stages (two 50/67, two 51/67). see "50/67 Phase Overcurrent" on page 5-2 and see "51/67 IDMTL Phase Overcurrent" on page 5-5 for more details.

In the event of a VT fuse fail, the relay does not have a polarizing quantity to determine direction. In this case, the element may be set to operate as non-directional or it may set to block. VTS Blocking is applicable for Quadrature Method (Cross polarization technique for directional analysis) and Sequence Method (Symmetrical Components for directional analysis).

For the relay to determine direction (forward or reverse), the reference polarization signal and the direction boundary must be defined. The relays uses two types of polarization methods based on the user selection

1. Quadrature Method (Cross polarization technique)
2. Sequence Method (Symmetrical Components)

Quadrature Method

Generally, voltages are used as the reference since the angles remain constant in all cases in the Quadrature method. Voltage polarization for the phase-fault elements is achieved by using the quadrature voltage.

Each phase current is compared to the voltage between the other two phases (IA compared to VBC, IB compared to VCA, IC compared to VAB).

There are following settings used to govern the directional element based on Quadrature method:

- Characteristic angle
- Minimum Voltage
- Two Out-Of- Three Logic

When a fault occurs in the system, in general, current lags the voltage by an angle corresponding to the system X/R ratio. Therefore it is required to set the characteristic angle according to the equipment which the overcurrent relay is protecting. The forward and reverse regions are determined based on the characteristic angle. The total 360° region is divided into two exact halves, one half is forward and another half is reverse. A Blind Zone is introduced as the 5° region on either side.

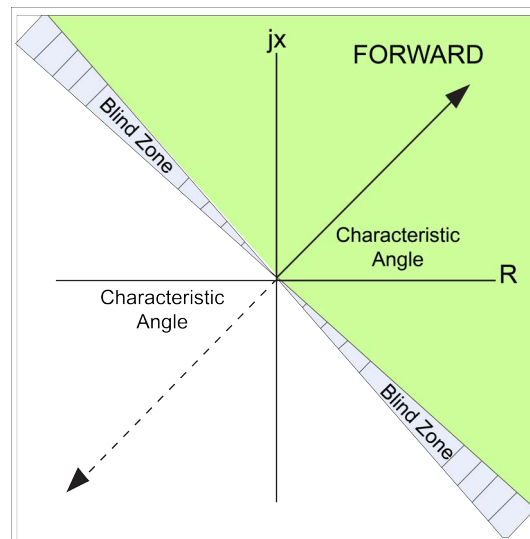


Figure 5.3: Characteristic Angle

In the F-PRO, the directional overcurrent element has a settable minimum voltage pick-up level. This is the minimum polarization voltage to enable directional element operation.

The Two-Out-Of-Three Logic provides additional security to the directional function. In some power system applications fault current may flow in different directions in the different phases. When the Two-Out-Of-Three Logic setting is enabled, the directional element will operate only for the majority direction. For example, if phase A and C detect forward current flow and phase B detects reverse current flow, phase A and C will operate forward, while phase B will be blocked.

Sequence Method

Sequence method directional element considers negative-sequence impedance, zero-sequence impedance, or positive sequence impedance, depending on relay settings and system conditions at the time of the fault. The element declares a forward fault when the impedance determined by the directional element is within 90deg of the line impedance.

This directional element actually consists of 3 separate internal elements: a negative-sequence element, a zero-sequence element, and a positive-sequence element. All the three elements use directly measured currents and voltages. The sensitivity for the negative and zero sequence elements may be set by the user, to correctly account for load conditions and system configuration. Both of these elements may be disabled as well. The positive-sequence element is always active.

For 3-phase faults, the directional element will only use the positive-sequence element. For all other faults, the directional element will consider, in order, the negative-sequence calculation, the zero-sequence calculation, and the positive sequence calculation. The directional element will only move from one calculation to the next calculation if insufficient sequence voltages and currents exist to make a valid calculation.

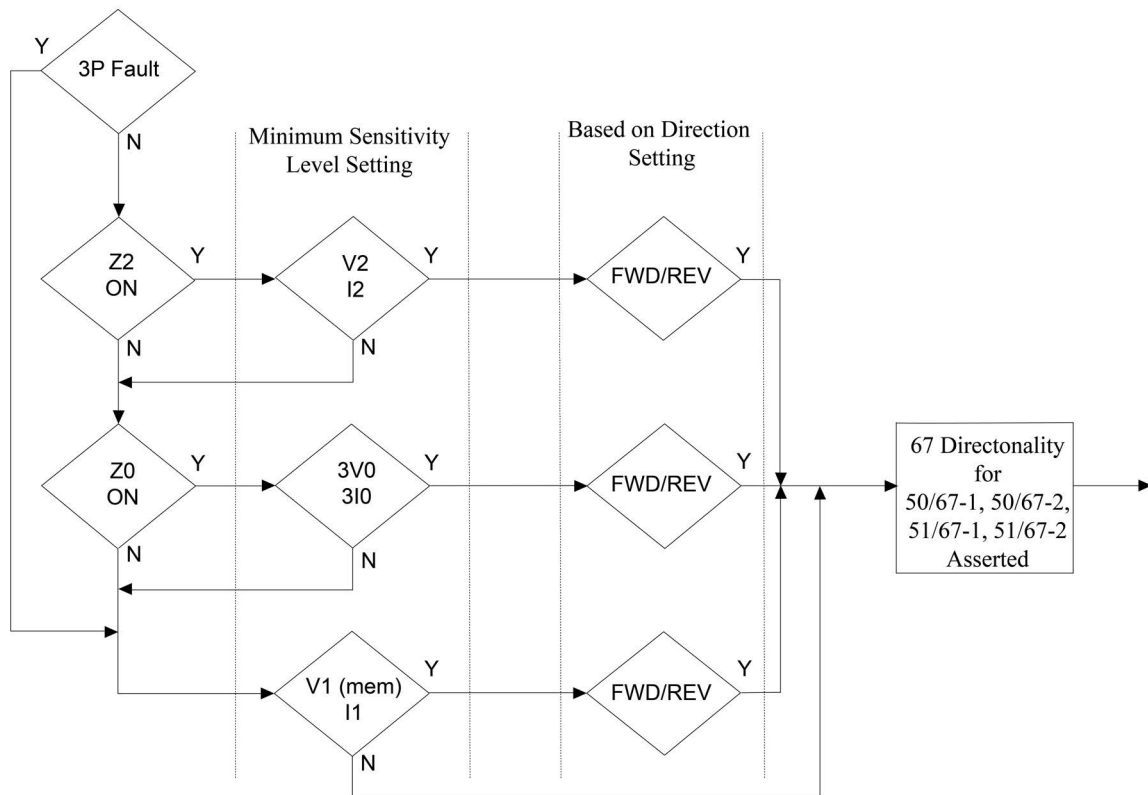


Figure 5.4: Sequence logic diagram

The negative-sequence calculation determines the angle between the measured negative-sequence impedance, and the positive-sequence line impedance angle (Z1) entered in settings. To perform this calculation, the default minimum amount of negative-sequence voltage required is 0.5 V secondary, and the default minimum amount of negative-sequence current required is 0.04 x In secondary.

The zero-sequence calculation determines the angle between the measured zero-sequence impedance and the zero-sequence line impedance angle (Z0) entered in settings. To perform this calculation, the default minimum amount of zero-sequence voltage (3V0) required is 1.0 V secondary, and the default minimum amount of zero-sequence current (3I0) required is 0.04 x In secondary.

The positive-sequence calculation determines the angle between the measured positive-sequence impedance and the positive-sequence line impedance angle (Z1) entered in settings. To perform the positive-sequence impedance calculation, the directly measured positive-sequence current must exceed 0.04 x In secondary and the positive-sequence voltage must exceed 1 V secondary.

The default setting of the directional element in the relay should be correct for most applications. There are some applications where it may be advisable to change the sensitivity thresholds for the negative-sequence or zero-sequence calculations or Positive-sequence calculations as per system conditions (V2 Sensitivity level, I2 Sensitivity level, V0 Sensitivity level, I0 Sensitivity level, V1 Sensitivity level, I1 Sensitivity level) or it may be desirable to disable Negative-sequence directional element or Zero-sequence directional element or both of these elements.

The settings for the negative-sequence voltage sensitivity level (V2) and negative-sequence current sensitivity level (I2) should be normally higher than the maximum negative sequence quantities generated by unbalanced load. These settings should also be low enough to maintain sensitivity for the minimum unbalanced fault, in terms of negative sequence quantities.

The zero-sequence directional element can be used in many applications. However, where strong mutual coupling between parallel lines exist, the zero-sequence calculation must be disabled to prevent an incorrect directional determination. The sensitivity settings should be low enough to permit operation during the lowest expected ground fault in terms of zero-sequence quantities expected during a fault and high enough to allow for normal load imbalance.

Table 5.4: 67 Direction Function for Phase Overcurrent Settings	
2 out of 3 Logic	Enable/Disable
VTs Blocking	Disable, Enable, Non-Dir
Polarization Method	Sequence or Quadrature
Sequence Method	
Negative Sequence Direction Element	Enabled/Disabled
V2 Sensitivity Level	0.5 to 5.0 V
I2 Sensitivity Level	0.02 to 0.20 A (1A) 0.10 to 1.00 A (5A)
Zero Sequence Direction Element	Enabled/Disabled
3V0 Sensitivity Level	1.0 to 10.0 V
3I0 Sensitivity Level	0.04 to 0.40 A (1A) 0.2 to 2.0A (5A)
V1 Sensitivity Level	1.0 to 10.0 V
I1 Sensitivity Level	0.04 to 0.40 A (1A) 0.2 to 2.0A (5A)

Table 5.4: 67 Direction Function for Phase Overcurrent Settings

Characteristic/Positive Sequence Angle (Z1)	5.0 to 89.0 deg
Zero Sequence Angle (Z0)	5.0 to 89.0 deg
Quadrature Method	
Characteristic Angle	-95 to 95 deg
Minimum Voltage	1.0 to 40.0 V

50N/67N Derived Neutral Overcurrent

Neutral Overcurrent provides protection for line-to-ground faults. Derived neutral Overcurrent (50N/67N) provides instantaneous and definite time lag protection to the equipment. Relay internally sums all three phase currents and calculates 3I₀ current flowing in the neutral. The function operates on the derived neutral current. User can define the current and time setting for the function operation. This function operates in two stages: 50N/67N-1 and 50N/67N-2, each of which can be set independently based on the user's requirements. Additionally, each stage allows independent directional feature (As defined by 67N) selection with options for Non-Directional, Forward, or Reverse

Derived neutral current is compared with the set value of current after filtering. If calculated current is greater than the pickup current, the function will operate after the set time delay. The function has an additional feature of "Inrush Blocking". This is provided to block the function from operation when second harmonic current is present over the fundamental.

Each element (50N/67N-1, 50N/67N-2) can be independently inhibited via external input status which can be configured from output matrix. This will help in achieving comprehensive blocking schemes.

Metering menu provides the current and voltage values and their phase angles. The correctness of the polarity of the directional overcurrent elements can be verified in metering.

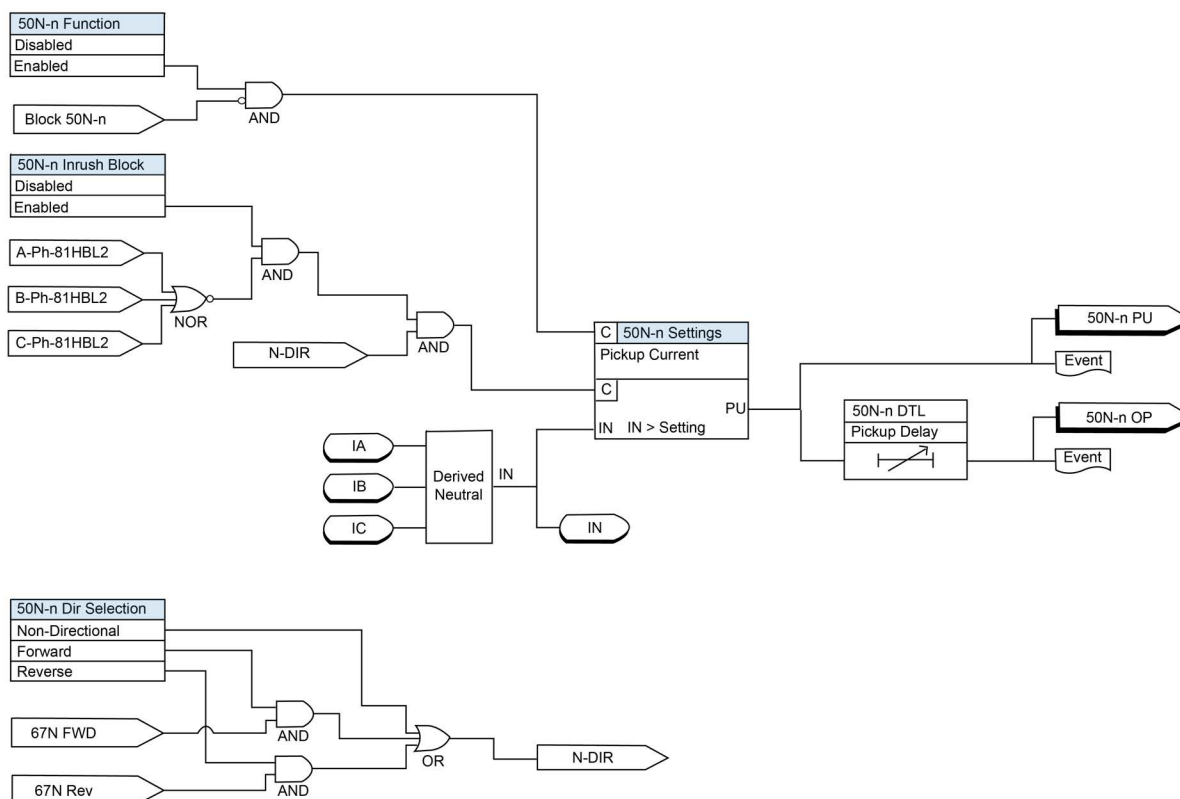


Figure 5.5: 50N/67N Function logic diagram

Table 5.5: 50N/67 Derived Neutral Overcurrent Settings	
50N/67N-1,2	Enable/Disable
Direction Selection	Non-Dir, FWD, REV
Pickup IN	0.05 to 10.00 A (1A) 0.25 to 50.00 A (5A)
Pickup Delay	0.00 to 99.9 s (Non-Dir) 0.01 to 99.9 s (FWD or REV)
Phase Setting Multiplier for Single Phase Open Pole Condition	
50N Pickup Current Multiplier	0.10 to 2.00
50N Pickup Time Multiplier	0.10 to 2.00
Inrush Blocking	Enabled/Disabled

51N/67N IDMTL Derived Neutral Overcurrent

The definition of this Function are the same as that of the 51/67 IDMTL. Except that this function provides protection for line to ground faults and it uses 3I0 (where Relay internally sums all three phase currents and calculates 3I0 current flowing in the neutral) Detection for operation rather than phase Current. This function operates in two stages: 51N/67N-1 and 51N/67N-2, each of which can be set independently based on the user's requirements. Additionally, each stage allows independent directional feature (As defined by 67N) selection, with options for Non-Directional, Forward, or Reverse Apart from this the function has an additional feature of "Inrush Blocking" which is provided to block the function from operation when second harmonic current is present over the fundamental

Each element (51N/67N-1, 51N/67N-2) can be independently inhibited via external input status which can be configured from Output matrix. This will help in achieving comprehensive blocking schemes.

The inverse time delay is determined by the following equations

Pickup:

$$T(3I0) = TMS \left[B + \frac{A}{\left(\frac{3I0}{I_{Pickup}} \right)^p - 1} \right]$$

Reset:

$$T(3I0) = TMS \left[\frac{TR}{1 - \left[\frac{3I0}{I_{Pickup}} \right]^2} \right]$$

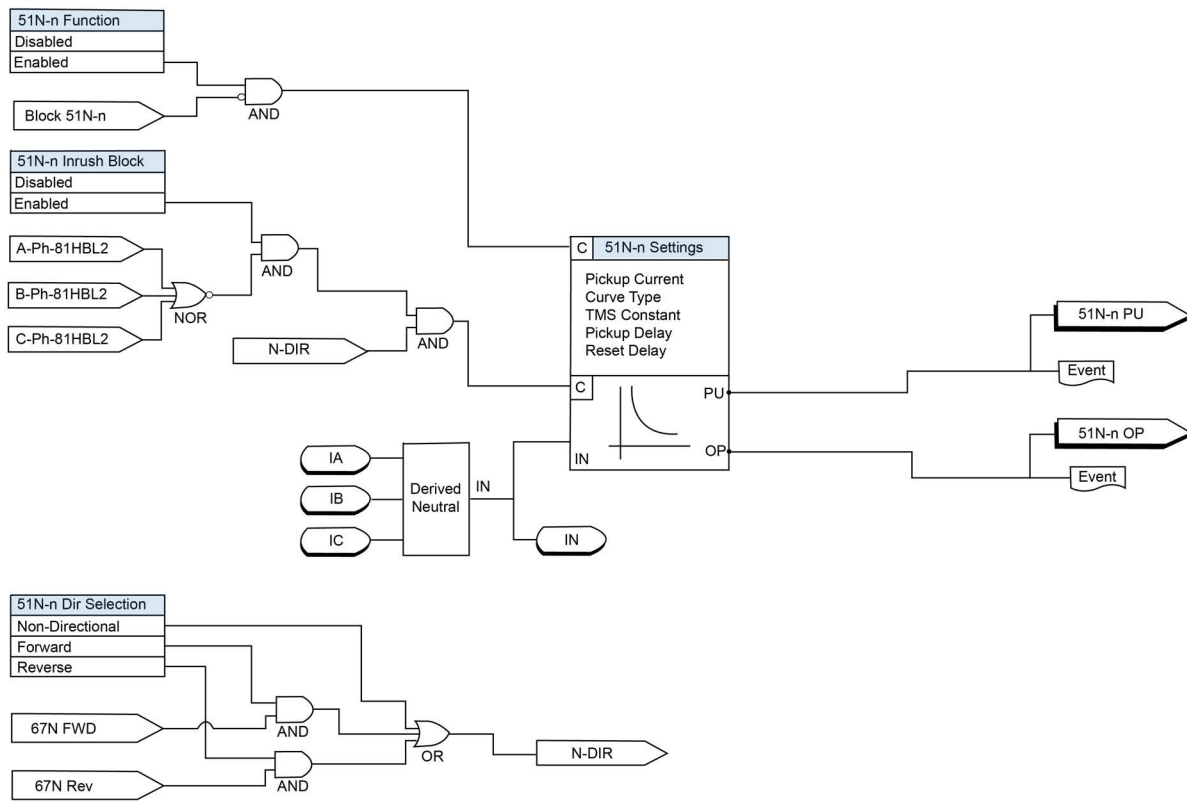


Figure 5.6: 51N/67N Function logic diagram

Setting Description	Setting Range
51N/67N - 1,2	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 10.00A (1A) 0.25 to 50.00A (5A)
Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User Define Refer "Table 5.3:"

Table 5.6: 51N/67N IDMTL Derived Neutral Overcurrent Settings

TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 s (Non-Dir) 0.01 to 999.99 s (FWD or REV)
Reset Delay	DTL or ANSI Decay
Reset DTL Delay	0.0 to 99.9s
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Phase Setting Multiplier for Single Phase Open Pole Condition	
51 Pickup Current Multiplier	0.10 to 2.00
51 Pickup Time Multiplier	0.10 to 2.00
Inrush Blocking	Enable/Disable

67N Directional Function for Derived Neutral Overcurrent

In a solidly earthed system the neutral points of the power transformers are connected directly to earth to reduce overvoltage and facilitate fault detection. The disadvantage of solid earthing is that fault currents can be very high and must be disconnected quickly. Since the impedance of the source is normally very low, fault current varies greatly in magnitude depending on the location of the fault. Selective isolation of a faulty section is therefore possible via time/ current graded earth fault over current protection. Fault current is detected by measuring the system residual current.

In an interconnected system, where fault current can flow in either direction, directional earth fault relays are applied. The earth fault causes a residual voltage/ negative sequence voltage to be generated, and this can be used for directional polarization.

The F-PRO 67N Directional Function provides two user selectable polarization methods:

1. Zero sequence voltage polarization / residual voltage polarization (ZPS)
2. Negative sequence voltage polarization (NPS)

For the Zero Sequence polarization method, the residual voltage and current generated during earth fault conditions is used for polarization. The relay internally derives $3V_0$ voltage & $3I_0$ Current for directionality.

For the Negative Sequence polarization method, the negative sequence voltage and current is used for polarization. In some applications zero sequence polarization cannot be applied. In such cases negative sequence polarization can be used. This will help in using the relay in parallel lines with mutual impedance. The relay derives negative sequence voltage and negative sequence current for directionality.

The Minimum sensitivity level for negative sequence Voltage (V_2), Negative Sequence Current (I_2), Residual Voltage $3V_0$, Neutral Current ($3I_0$) are user settable level used to determine the pick-up level for the directional earth fault elements. The sensitivity settings should be low enough to permit operation during the lowest expected ground fault in terms of zero-sequence and Negative Sequence quantities expected during a fault and high enough to allow for normal load imbalance.

When a fault occurs in the system, in general, current lags the voltage by an angle corresponding to the system X/R ratio. Therefore it is required to set the characteristic angle according to the equipment which the overcurrent relay is protecting. The forward and reverse regions are determined based on the characteristic angle. The total 360° region is divided into two exact halves, one half is forward and one half is reverse. As the relay directional element operation is based on the impedance plane, the relay will operate for Forward directional faults when the characteristic angle is set in positive value similar like impedance/distance relay. Similarly for negative characteristic angle setting, the relay will operate for reverse directional faults.

In the event of a VT fuse fail, the relay does not have a polarizing quantity to determine direction. In this case, the element may be set to operate as non-directional or it may set to block.

The F-PRO directional overcurrent has four stages (two 50N/67 and two 51N/ 67). see "50N/67N Derived Neutral Overcurrent" on page 5-13 and see "51N/67N IDMTL Derived Neutral Overcurrent" on page 5-15 for more details.

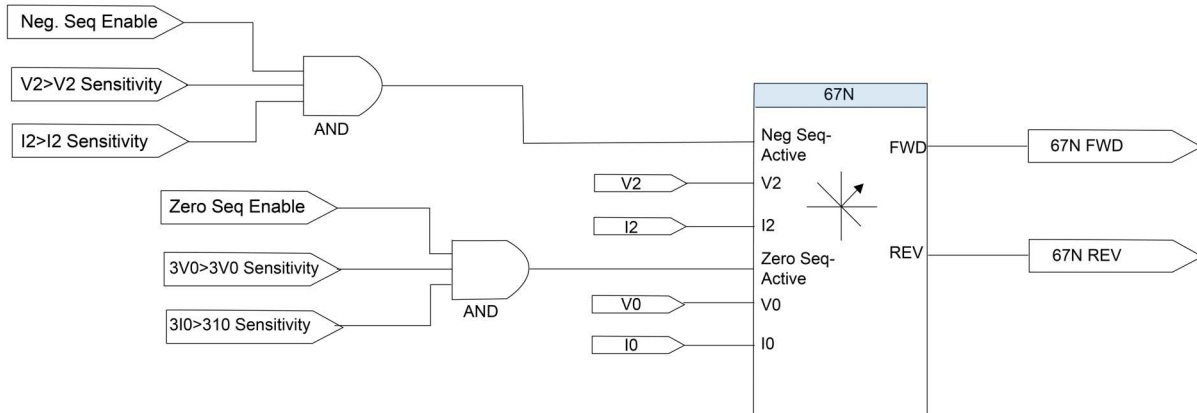


Figure 5.7: 67N Directional Function logic diagram

Table 5.7: 67N Directional Function for Derived Neutral Overcurrent Settings

Characteristic Angle	-95 to 95 deg
Polarization Method	Negative or Zero Sequence
V2 or 3V0 Sensitivity Level	0.5 to 5.0V
I2 or 3I0 Sensitivity Level	0.02 to 0.20 A (1A) 0.1 to 1.0A (5A)
VTs Blocking	Disable, Enable, Non-Dir

50G/51G/67 Neutral Measured Overcurrent

All the definition of this Function are the same as that of the neutral calculated overcurrent function Except this function uses Measured neutral overcurrent instead of calculated 3I0 Current. This function operates in Four stages 50G/67G-1 and 50G/67G-2 for a Definite time lag protection 51G/67G-1 & 51G/67G-2 for grading protection where each of this can be set independently based on the user's requirements. Additionally, each stage allows independent directional feature (As defined by 67G) selection, with options for Non-Directional, Forward, or Reverse Apart from this the function has an additional feature of “Inrush Blocking which is provided to block the function from operation when second harmonic current is present over the fundamental

Each element (50G/67G-1,50G/67G-2,51G/67G-1, 51G/67G-2) can be independently inhibited via external input status which can be configured from Output matrix. This will help in achieving comprehensive blocking schemes

The inverse time delay is determined by the following equations

For $I_g > \text{pickup}$ (9)

$$T(IG) = TMS \left[B + \frac{A}{\left(\frac{IG}{\text{Pickup}} \right)^p - 1} \right]$$

For $I_g < \text{pickup}$ (10)

$$T(IG) = TMS \left[\frac{TR}{1 - \left[\frac{IG}{\text{Pickup}} \right]^2} \right]$$

Table 5.8: 50G/67G Measured Neutral Overcurrent Settings

50G/67G-1,2	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 10.00A (1A) 0.25 to 50.00A (5A)
Pickup Delay	0.00 to 99.9 s (Non-Dir) 0.01 to 99.9 s (FWD or REV)
Phase Setting Multiplier for Single Phase Open Pole Condition	
50N Pickup Current Multiplier	0.10 to 2.00
50N Pickup Time Multiplier	0.10 to 2.00
Inrush Blocking	Enabled/Disabled

Table 5.9: 51G/67G IDMTL Measured Neutral Overcurrent Settings

Setting Description	Setting Range
51G/67G - 1,2	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 10.00A (1A) 0.25 to 50.00A (5A)

Table 5.9: 51G/67G IDMTL Measured Neutral Overcurrent Settings

Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User Define Refer "Table 5.3:"
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 s (Non-Dir) 0.01 to 999.99 s (FWD or REV)
Reset Delay	DTL or ANSI Decay
Reset DTL Delay	0.0 to 99.9s
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Phase Setting Multiplier for Single Phase Open Pole Condition	
51 Pickup Current Multiplier	0.10 to 2.00
51 Pickup Time Multiplier	0.10 to 2.00
Inrush Blocking	Enable/Disable

67G Directional Function for Measured Neutral Overcurrent

In a solidly earthed system the neutral points of the power transformers are connected directly to earth to reduce overvoltage and facilitate fault detection. The disadvantage of solid earthing is that fault currents can be very high and must be disconnected quickly. Since the impedance of the source is normally very low, fault current varies greatly in magnitude depending on the location of the fault. Selective isolation of a faulty section is therefore possible via time/current graded earth fault over current protection. Fault current is detected by measuring the system residual current.

In an interconnected system, where fault current can flow in either direction, directional earth fault relays are applied. The earth fault causes a residual voltage/ negative sequence voltage to be generated, and this can be used for directional polarization.

The F-PRO 67G Directional Function provides two user selectable polarization methods:

3. Zero sequence voltage polarization / residual voltage polarization (ZPS)
4. Negative sequence voltage polarization (NPS)

For the Zero Sequence polarization method, the residual voltage and current generated during earth fault conditions is used for polarization. The relay internally derives $3V_0$ voltage & I_g Current for directionality.

For the Negative Sequence polarization method, the negative sequence voltage and current is used for polarization. In some applications zero sequence polarization cannot be adaptive. In such cases negative sequence polarization can be used. This will help in using the relay in parallel lines with mutual impedance. The relay derives negative sequence voltage and negative sequence current for directionality.

The Minimum sensitivity level for negative sequence Voltage (V_2), Negative Sequence Current (I_2), Residual Voltage $3V_0$, Neutral Current (I_g) are user settable level used to determine the pick-up level for the directional earth fault elements. The sensitivity settings should be low enough to permit operation during the lowest expected ground fault in terms of zero-sequence and Negative Sequence quantities expected during a fault and high enough to allow for normal load imbalance.

When a fault occurs in the system, in general, current lags the voltage by an angle corresponding to the system X/R ratio. Therefore, it is required to set the characteristic angle according to the equipment which the overcurrent relay is protecting. The forward and reverse regions are determined based on the characteristic angle. The total 360° region is divided into two exact halves, one half is forward and one half is reverse. As the relay directional element operation is based on the impedance plane, the relay will operate for Forward directional faults when the characteristic angle is set in positive value similar like impedance/distance relay. Similarly for negative characteristic angle setting, the relay will operate for reverse directional faults.

In the event of a VT fuse fail, the relay does not have a polarizing quantity to determine direction. In this case, the element may be set to operate as non-directional or it may set to block.

The F-PRO directional Measure neutral overcurrent has four stages (two 50G/67 and two 51G/ 67). “50G/51G/67 Neutral Measured Overcurrent” on page 5-19 for more details.

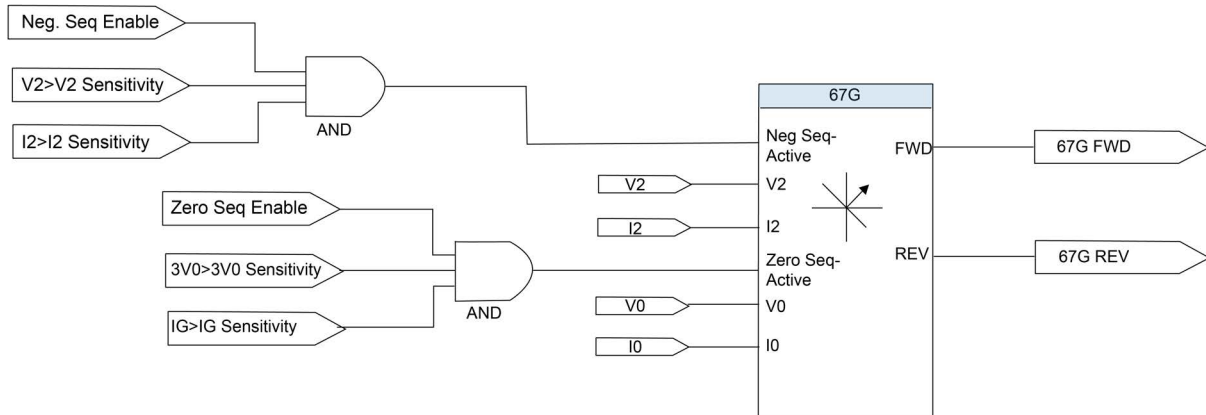


Figure 5.8: 67G Directional Function Logic diagram

Table 5.10: 67G Directional Function for Measured Neutral Overcurrent Settings

Characteristic Angle	-95 to 95 deg
Polarization Method	Negative or Zero Sequence
V2 or 3V0 Sensitivity Level	0.5 to 5.0V
I2 or IG Sensitivity Level	0.02 to 0.20 A (1A) 0.1 to 1.0A (5A)
VTs Blocking	Disable, Enable, Non-Dir

64/50 Sensitive/ Restricted Earth Fault

The 64/50 function provides instantaneous or Definite time Lag over-current protection for sensitive earth fault conditions. It has two modes of operation, non-direction and directional (FWD and REV).

For the Non directional mode of operation, the relay will operate irrespective of the current angle. When the injected current on the SEF CT input is equal to or greater than the pickup value, the function will operate after the time delay. The voltage level is not considered in this mode of operation.

For the forward or reverse modes of operation (directional) the function gets considers the polarization characteristic angle and the injected voltage and current is same or above the pickup value configured

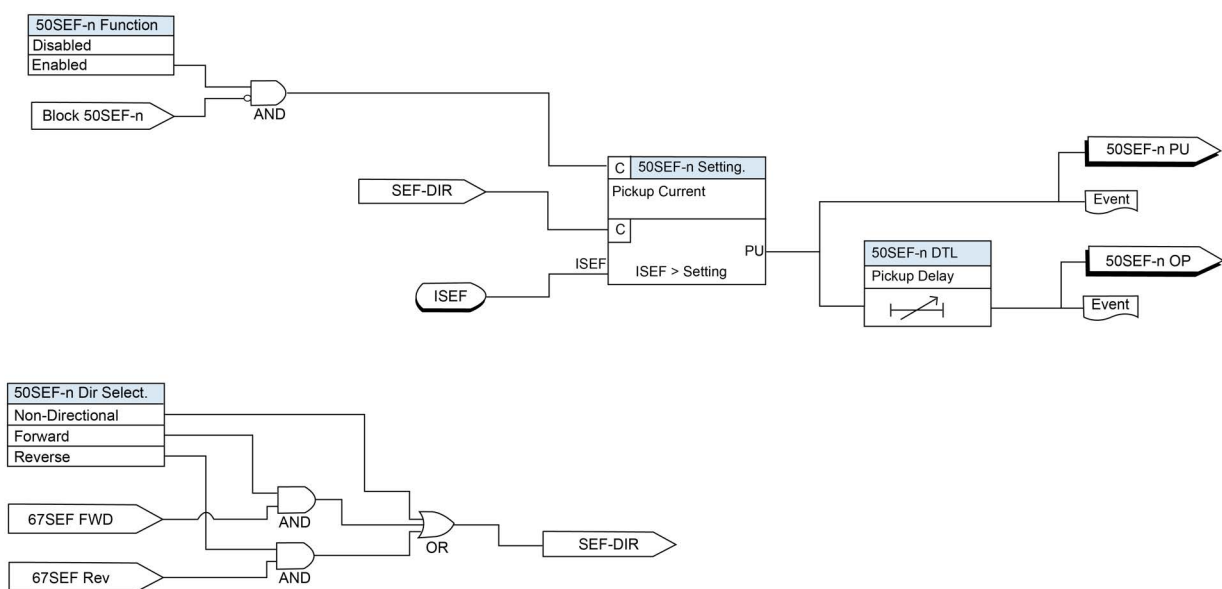


Figure 5.9: 64/50 SEF/REF function logic diagram

Table 5.11: 64/50 SEF/REF Settings	
64/50 SEF/REF-1,2	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup Isef	0.005 to 3.000 A (1A) 0.025 to 15.000 A (5A)
Pickup Delay	0.00 to 999.99 s (Non-Dir) 0.01 to 999.99 s (FWD or REV)
Phase Setting Multiplier for Single Phase Open Pole Condition	
64/50 SEF/REF Pickup Current Multiplier	0.10 to 2.00
64/50 SEF/REF Pickup Time Multiplier	0.10 to 2.00

64/51 Inverse Time Sensitive Earth Fault

The 64/51 function provides Curve based overcurrent protection for sensitive earth fault conditions. It has two modes of operation, non-directional and directional (FWD and REV).

For the Non directional mode of operation, the relay will operate irrespective of the current angle. When the injected current on the SEF CT input is equal to or greater than the pickup value, the function will operate after the inverse time delay. The voltage level is not considered in this mode of operation.

For the forward or reverse modes of operation (directional) the function gets considers the polarization characteristic angle and the injected voltage and current is same or above the pickup value configured

The inverse time delay is determined by the following equations:

Pickup:

$$T(I) = TMS \left[B + \frac{A}{\left(\frac{ISEF}{I_{SEFPickup}} \right)^p - 1} \right]$$

Reset:

$$T(I) = TMS \left[\frac{TR}{1 - \left[\frac{ISEF}{I_{SEFPickup}} \right]^2} \right]$$

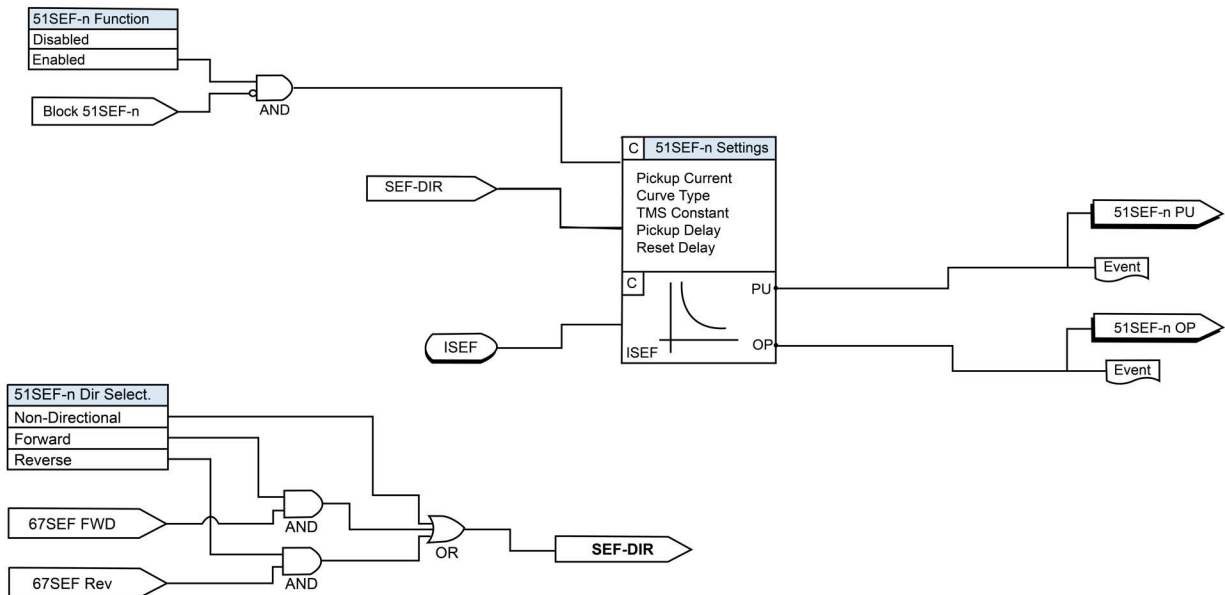


Figure 5.10: 64/51 Inverse Time SEF Function Logic

Table 5.12: 64/51 Inverse Time SEF Settings

Setting Description	Setting Range
64/51SEF-1,2	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup Isef	0.005 to 3.000 (1A) 0.025 to 15.000A (5A)
Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User Define Refer " Table 5.3: "
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99s
Reset Delay	DTL or ANSI Decay
Reset DTL Delay	0.0 to 99.9s
A	0.0010 to 1000.0000
B	0.0000 to 10.0000
p	0.01 to 100.00
TR	0.10 to 150.00
Phase Setting Multiplier for Single Phase Open Pole Condition	
64/51 SEF/REF Pickup Current Multiplier	0.10 to 2.00
64/51 SEF/REF Pickup Time Multiplier	0.10 to 2.00

67SEF Directional Function for Sensitive Earth Fault

The sensitive earth fault protection works by measuring the residual current across the three phases in a system. This is done using a Core balanced current transformer (CBCT). In the event of a fault, the residual current over the three phases will not be equal to zero as the current from the faulted phase flows through the earth. The sensitive earth fault protection is usually used in alternators and transformers with high resistance grounding. High resistance grounding restricts the earth fault current to lower than load current. High resistance grounding enables electrical systems to continue running when one of the phases is faulted. This prevents interruptions to the power supply. This kind of earthing system provides time to identify and isolate the fault.

Once an earth fault occurs in the high resistance grounding system, an alarm needs to be generated and the fault needs to be traced. For this a reliable protection which detects earth faults even when the fault current is very low is necessary. Undetected earth faults in this system are dangerous as a second earth fault in another phase may result in a short-circuit. Conventional earth fault relays may not be accurate in detecting an earth fault at such low current values.

The sensitive earth fault protection, as the name suggests, is a highly sensitive relay. It can sense currents as low as 0.2% of the CT secondary current.

The sensitive earth fault relay may be configured to either generate an alarm or a trip signal.

The F-PRO 67SEF Directional Function provides two user selectable polarization methods:

1. Zero sequence voltage polarization / residual voltage polarization (ZPS)
2. Negative sequence voltage polarization (NPS)

For the Zero Sequence polarization method, the residual voltage and current generated during earth fault conditions in power system are used for polarization. The relay internally derives 3V0 voltage & ISEF Current for directionality.

In some applications zero sequence polarization cannot be adaptive. In such cases negative sequence polarization can be used. This will help in using the relay in parallel lines with mutual impedance. Relay derives (V2) negative sequence voltage & I2 negative sequence current for directionality.

The Minimum sensitivity level for negative sequence Voltage (V2), I2, ISEF Current, Residual Voltage 3V0 are user settable level used to determine the pick-up level for the directional earth fault elements. The sensitivity settings should be low enough to permit operation during the lowest expected ground fault in terms of zero-sequence and Negative

Sequence quantities expected during a fault and high enough to allow for normal load imbalance.

When a fault occurs in the system, in general, current lags the voltage by an angle corresponding to the system X/R ratio. Therefore it is required to set the characteristic angle according to the equipment which the overcurrent relay is protecting. The forward and reverse regions are determined based on the characteristic angle. The total 360° region is divided into two exact halves, one half is forward and one half is reverse. As the relay directional element operation is based on the impedance plane, the relay will operate for Forward directional faults when the characteristic angle is set in positive value similar like impedance/distance relay. Similarly for negative characteristic angle setting, the relay will operate for reverse directional faults.

In the event of a VT fuse fail, the relay does not have a polarizing quantity to determine direction. In this case, the element may be set to operate as non-directional or it may set to block.

The 67SEF directional overcurrent has four stages (two 64/50 and two 64/51). for details see 64/50 Sensitive/Restricted Earth Fault on page 5-24 and for details see 64/51 Inverse Time Sensitive Earth Fault on page 5-25 for more details.

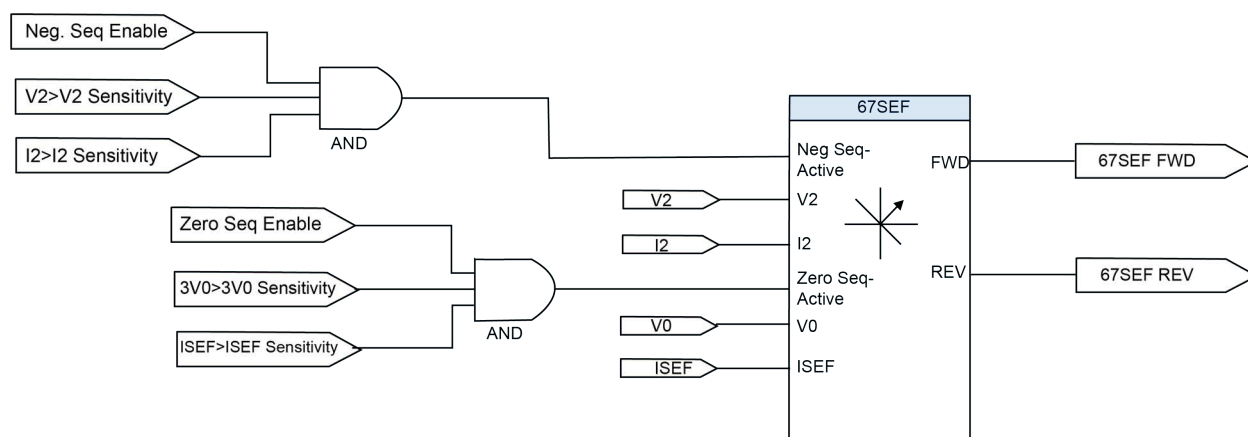


Figure 5.11: 67SEF Directional function logic Diagram

Table 5.13: 67 SEF/REF Directional Function Settings

Characteristic Angle	-95 to 95 degrees
Polarization Method	Negative or Zero Sequence
V2 or 3V0 Sensitivity	0.5 to 5.0 V
I2 or ISEF Sensitivity Level	0.02 to 0.2 A (1A) 0.1 to 1.0A (5A)
VTS Blocking	Enable, Disable, Non-Dir

46/50 Negative Sequence Overcurrent

Negative Sequence Overcurrent provides protection for any unbalanced faults. The 46-50 function is similar to that of 50N except that it uses the calculated negative sequence current as the input to the function.

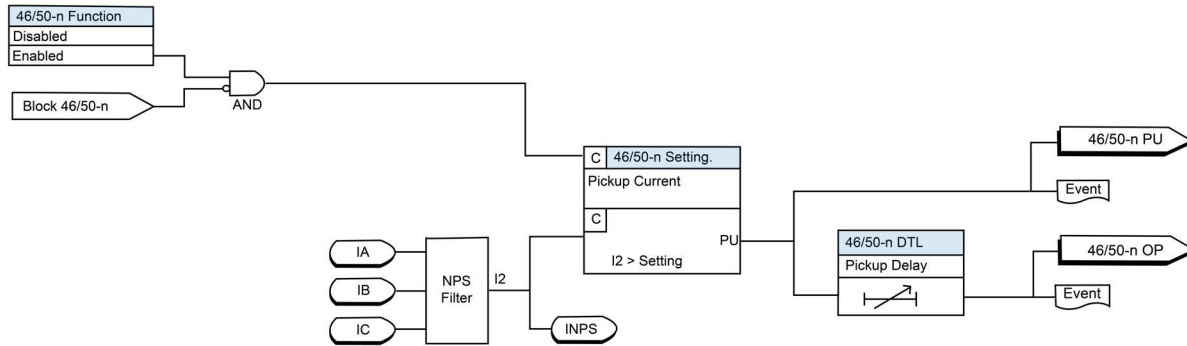


Figure 5.12: 46/50 functional logic diagram

Table 5.14: 46/50 Negative Sequence Overcurrent Settings

46/50 Function	Enabled/Disabled
Pickup I2	0.10 to 10.00 A (1A) 0.5 to 50.00A (5A)
Pickup Delay	0.00 to 99.99 s
Phase Setting Multiplier for Single Phase Open Pole Condition	
46/50 Pickup Current Multiplier	0.10 to 2.00
46/50 Pickup Time Multiplier	0.10 to 2.00

46/51 IDMTL Negative Sequence Overcurrent

All the curve definitions are the same as the Phase Overcurrent except standard inverse is merged to one curve. The only difference is that this function uses the negative sequence current (I2) rather than phase current. The equations are as given below:

Pickup:

$$T(I2) = TMS \left[B + \frac{A}{\left(\frac{I2}{I_{Pickup}} \right)^p - 1} \right]$$

Reset:

$$T(I_2) = TMS \left[\frac{TR}{1 - \left[\frac{I_2}{I_{Pickup}} \right]^2} \right]$$

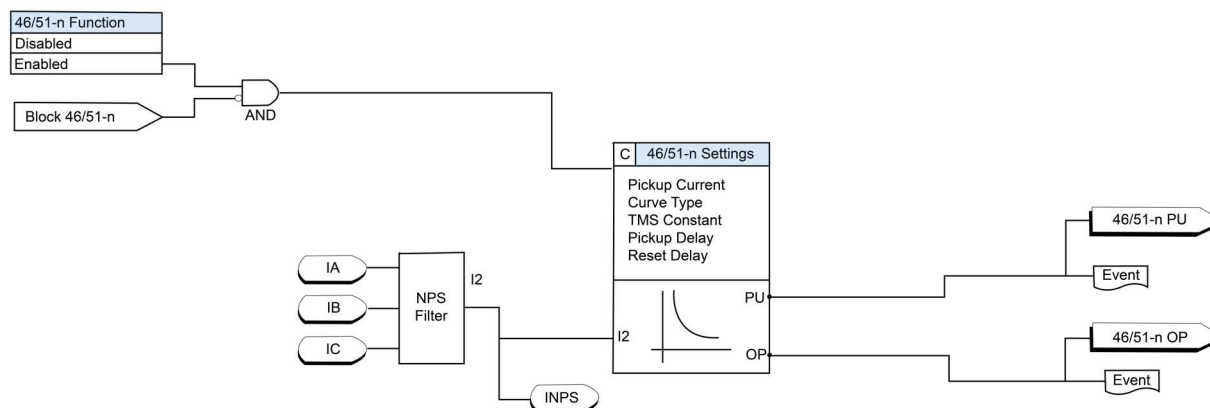


Figure 5.13: 46/51 functional logic diagram

Table 5.15: 46/51 IDMTL Negative Sequence Overcurrent Settings

46-51 Function	Enabled/Disabled
Pickup I2	0.10 to 10.00 A (1A) 0.50 to 50.00 A (5A)
Curve Type	DTL, IEC Standard Inverse, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User Define Refer "Table 5.3:"
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99s
Reset Delay	DTL or ANSI Decay
Reset DTL Delay	0.0 to 99.9s
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics

Table 5.15: 46/51 IDMTL Negative Sequence Overcurrent Settings

B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Phase Setting Multiplier for Single Phase Open Pole Condition	
46/51 Pickup Current Multiplier	0.10 to 2.00
46/51 Pickup Time Multiplier	0.10 to 2.00

49 Thermal Overload

The insulating material surrounding the windings ages rapidly if the temperature exceeds the design limit value. Thus, a thermal protection function is required to supplement the existing winding temperature device. The thermal overload protection estimates winding temperature and thus prevents it from thermal damaging. The thermal overload protection operates based on an approximate replica of the temperature rise in the protected object caused by overload. The thermal overload in the IED is provided with one trip stage as well as one alarm stage. It is possible to set the alarm stage at a certain percentage of the setting value applied at the trip stage. The calculation is performed separately for three phase, based on fundamental component and negative sequence components.

The function takes single input energizing quantity for measurement. The input used for the measurement is phase current. Thermal overload is measured based on the input current applied to it. There are dedicated functions for each phase. Operate time of the thermal overload characteristics can be calculated from the following formula given below:

$$t = \tau \cdot \ln \frac{I^2 - I_p^2}{I^2 - I_\theta^2}$$

Where,

t = Operating time in minutes

τ = Thermal time constant in minutes

ln = Natural log

I_p = Steady state relay current prior to overload

I_B = Basic current

I = Effective relay current

Basic current I_B is full load current of the protected feeder. Constant k is a multiplying factor resulting in the 49 Thermal OL setting of the relay I_θ which is equal to $k \cdot I_B$. Thermal time constant τ for the relay can be set using 49 Time constant setting. The effective relay current I is calculated as below:

$$I = \sqrt{I_{RMS}^2 + KI_2^2}$$

Where:

I = Effective relay current

I_{RMS} = 3 phase RMS current

I_2 = Negative sequence current

K = Negative sequence weighing factor

Negative sequence weighing factor- K for the relay can be set using 49 Neg. Seq. weighing factor setting.

Thermal operating time of thermal OL function is based on prior load current to the relay. If $I_p < 0.02I_B$ prior to thermal OL condition, then it is treated as cold condition, hence it adopts cold curve. If I_p is greater than zero prior to thermal OL condition, then it is treated as hot condition, hence it adopts hot curve.

Thermal state (θ) for the heating curve is calculated as below:

$$\theta = \frac{I^2}{I_\theta^2} \cdot \left(1 - e^{-\frac{t}{\tau}}\right) \cdot 100_{percent}$$

Thermal state (θ) for the cooling [or] reset curve is calculated as below:

$$\theta = \theta_F \cdot e^{-\frac{t}{\tau}} \text{ (or) } t = \tau \cdot \ln \frac{\theta}{\theta_F}$$

Where

θ = Thermal state in percentage at time t

θ_F = Final thermal state before disconnection of feeder

I = Effective relay current.

I_0 = Thermal overload setting

t = Thermal time constant in minutes.

The final thermal state θ_F for any steady state value of input current can be predicted using the following formula.

$$\theta = I_2/I_{02} * 100\%$$

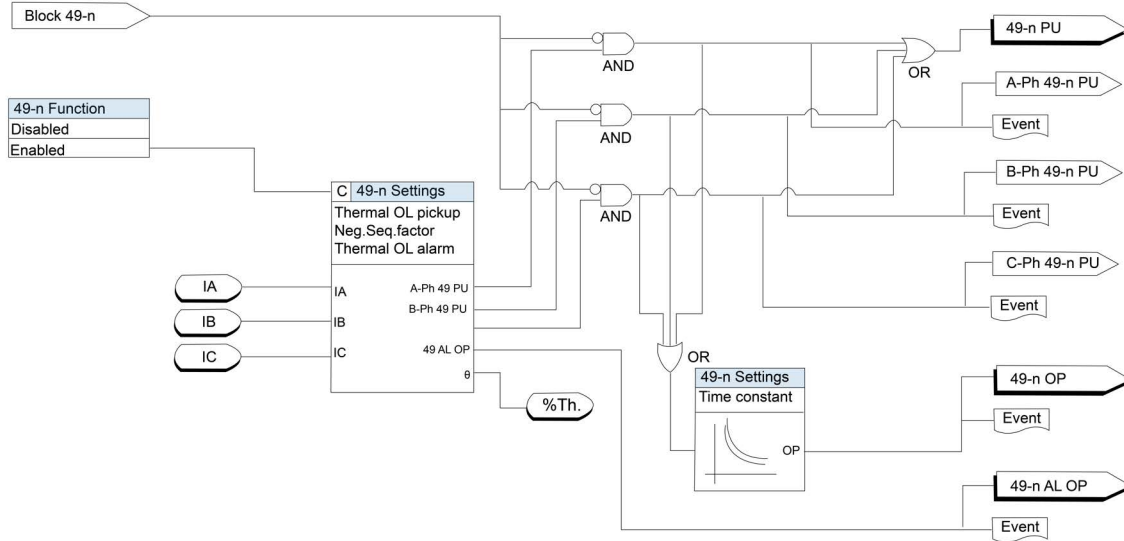


Figure 5.14: 49 function logic diagram

Table 5.16: 49 Thermal Overload Settings

Thermal Overload Pickup	0.20 to 2.00A (1A) 1.00 to 10.00A (5A)
Time Constant	0.5 to 100.0 min
Neg. Seq. Weighting Factor (k)	0.0 to 10.0
Enable Thermal OL Alarm	Enable or disable
Alarm % Th	50 to 100%

37 Phase Undercurrent

The 37 Instantaneous or Definite time Phase Undercurrent protection function is an undercurrent element that is used to protect against the no-load condition.

If this function is enabled, when individual phase current or three phase currents (I_a , I_b , I_c) exceeds the minimum current threshold value and are less than the 37 pickup setting, this function will operate after the specified pickup time delay.

To prevent spurious tripping, the function requires current greater than the minimum current threshold (configured on the System Parameters screen in Offliner). If the current is less than the pickup value, and greater than the minimum current threshold, the function will operate after the configured pickup delay.

Two 37 function elements, 37-1 and 37-2 are provided with independent pickup and delay settings.

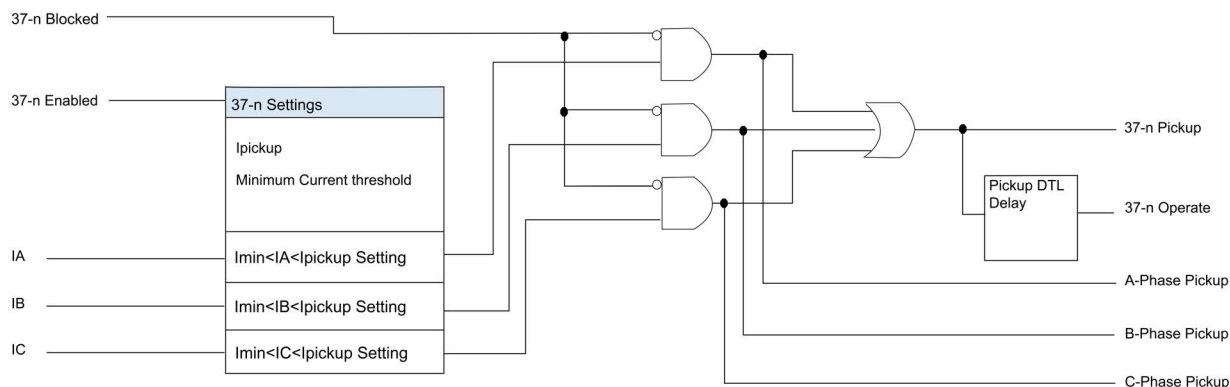


Figure 5.15: 37 function Protection Logic

Table 5.17: 37 Phase Undercurrent Settings

37-1,2	Enable/Disable
Pickup	0.05A to 3.20A (1A) 0.25A to 16.00A (5A)
Pickup Delay	0.00s to 999.99s

27DT Main/ Auxiliary Undervoltage

The relay provides a definite time-delay Undervoltage protection for both the bus and line potential transformers (PTs), categorizing it into two functions: Main (Line) Protection and Auxiliary (Bus) Protection, with added VT Supervision (VTS) blocking (Applicable for only Main under voltage functions).

The Main under voltage function monitors all three phase-to-neutral RMS (Fundamental) voltages to determine an undervoltage condition. If the measured voltage fell short the set pick-up value, an under voltage condition is detected. This function can be configured using either AND logic (where Undervoltage detection depends on all three-phase voltages) or OR logic (where detection depends on any one of the phase voltages). A hysteresis percentage is applied to the settings to define the drop-out value, which determines when the relay functional deactivates after the pick-up condition is cleared.

The Auxiliary Undervoltage function operates similarly to the Main under voltage function but is based on a single phase-to-neutral Aux voltage input.

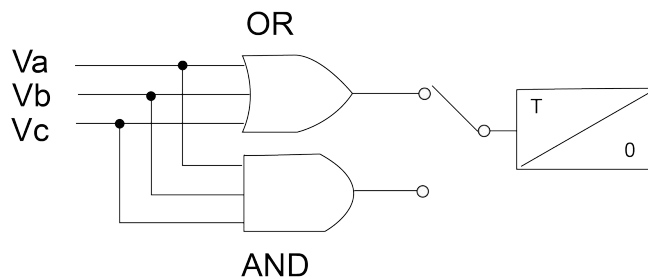


Figure 5.16: 27DT function logic diagram

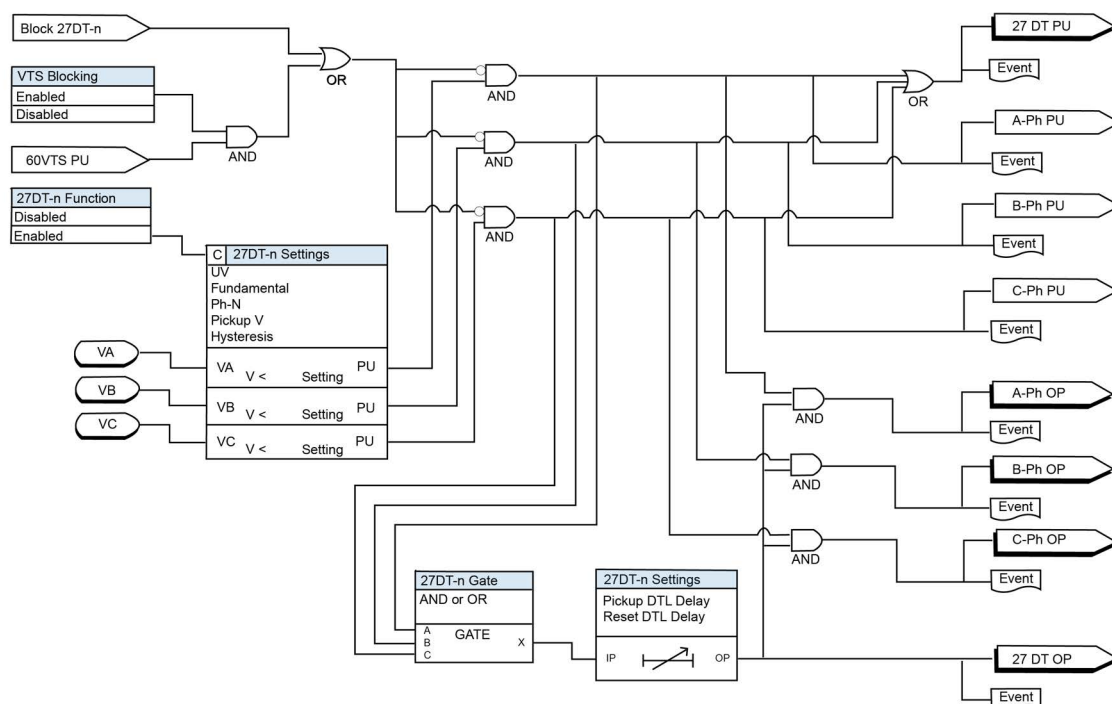


Figure 5.17: 27DT function logic diagram

Table 5.18: 27DT Main Undervoltage Settings

Main-1,2,3,4	Enable/Disable
Gate Switch	AND or OR
Hysteresis	1 % to 80 %
Pickup	0.00 to 10.00 seconds
Reset DTL Delay	0.00 to 999.99 seconds
VTS Blocking	Enable/Disable

Table 5.19: 27DT Aux Undervoltage Settings

Aux-1,2,3,4	Enable/Disable
Hysteresis	1 % to 80 %
Pickup	1.0 to 120.0 V secondary
Pickup Delay	0.00 to 10.00 seconds
Reset DTL Delay	0.00 to 999.99 seconds

27IT Phase Inverse Time Overvoltage

The relay provides curve-based time under voltage protection with integrated VT supervision blocking. This function can be configured using either AND logic (where overvoltage detection depends on all three-phase voltages) or OR logic (where detection depends on any one of the phase voltages). A hysteresis percentage is applied to the settings to determine the drop-out voltage, which governs when the relay deactivates after the pick-up condition has been cleared.

- **Inverse Time Characteristic:** The relay's trip time is inversely proportional to the under voltage level. A lower under voltage results in a longer trip time, while a higher under voltage level leads to a faster response.
- **Pick-Up Setting:** This defines the voltage threshold at which the under voltage protection activates. It can be adjusted to meet specific system requirements.
- **Time-Voltage Characteristic:** Various curve options are available, including DTL, IEC Standard Inverse, IEC Extremely Inverse, and IEC Long-Time Inverse, to tailor the relay's response to different under voltage levels. Additionally, a user-defined curve allows for customized time-voltage characteristics.
- **TMS Setting:** The Time Multiplier Setting (TMS) adjusts the relay's operating time according to the selected Time Voltage Characteristic curve. This feature is essential for ensuring proper coordination between the relay and other protective devices in the system.

The formula used to calculate the trip time for the inverse curves is provided below

$$T(V) = TMS \left[B + \frac{A}{1 - \left[\frac{V}{V_{pickup}} \right]^p} \right]$$

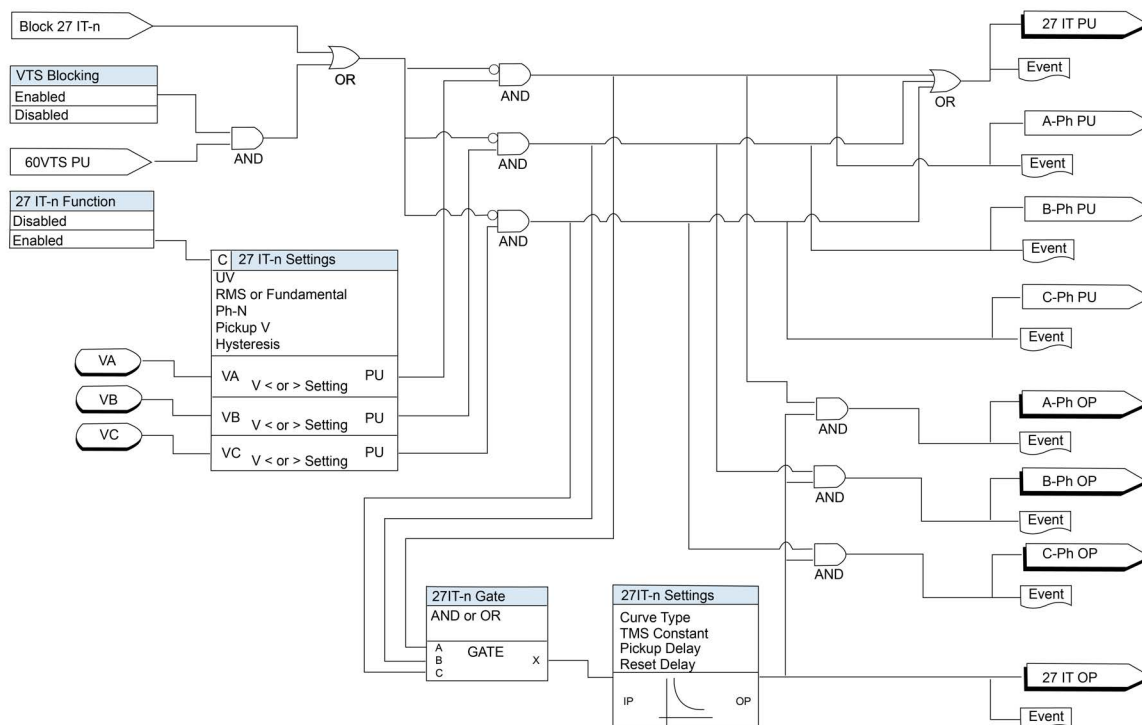


Figure 5.18: 27IT function logic diagram

Table 5.20: 27IT Phase Inverse Time Under voltage Settings

Main 1,2	Enable/Disable
Gate Switch	AND/OR
Hysteresis	1 % to 80 %
Curve Type	DTL, User Defined For IEC Curves details see "Table 5.24"
Pickup	1.0 to 150.0 V secondary
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 seconds
Reset DTL Delay	0.00 to 999.99 seconds
A	0.1 to 50.0
B	0.0 to 10.0

Table 5.20: 27IT Phase Inverse Time Under voltage Settings

P	0.1 to 10.0
VTS Blocking	Enable/Disable

59 DT Main/ Auxiliary Overvoltage

The relay provides a definite time-delay overvoltage protection for both the bus and line potential transformers (PTs), categorizing it into two functions: Main (Line) Protection and Auxiliary (Bus) Protection, with added VT Supervision (VTS) blocking (Applicable for only Main over voltage functions).

The Main overvoltage function monitors all three phase-to-neutral RMS (Fundamental) voltages to determine an overvoltage condition. If the measured voltage exceeds the set pick-up value, an overvoltage condition is detected. This function can be configured using either AND logic (where overvoltage detection depends on all three-phase voltages) or OR logic (where detection depends on any one of the phase voltages). A hysteresis percentage is applied to the settings to define the drop-out value, which determines when the relay functional deactivates after the pick-up condition is cleared.

The Auxiliary overvoltage function operates similarly to the Main overvoltage function but is based on a single phase-to-neutral Aux voltage input.

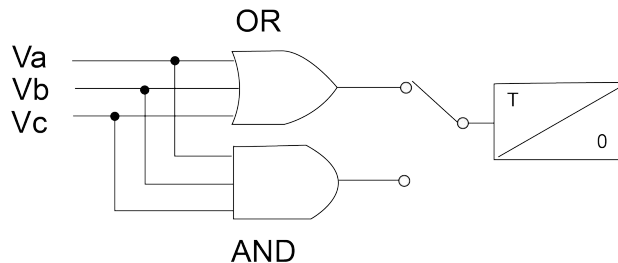


Figure 5.19: 59 Function Gate Switch Setting

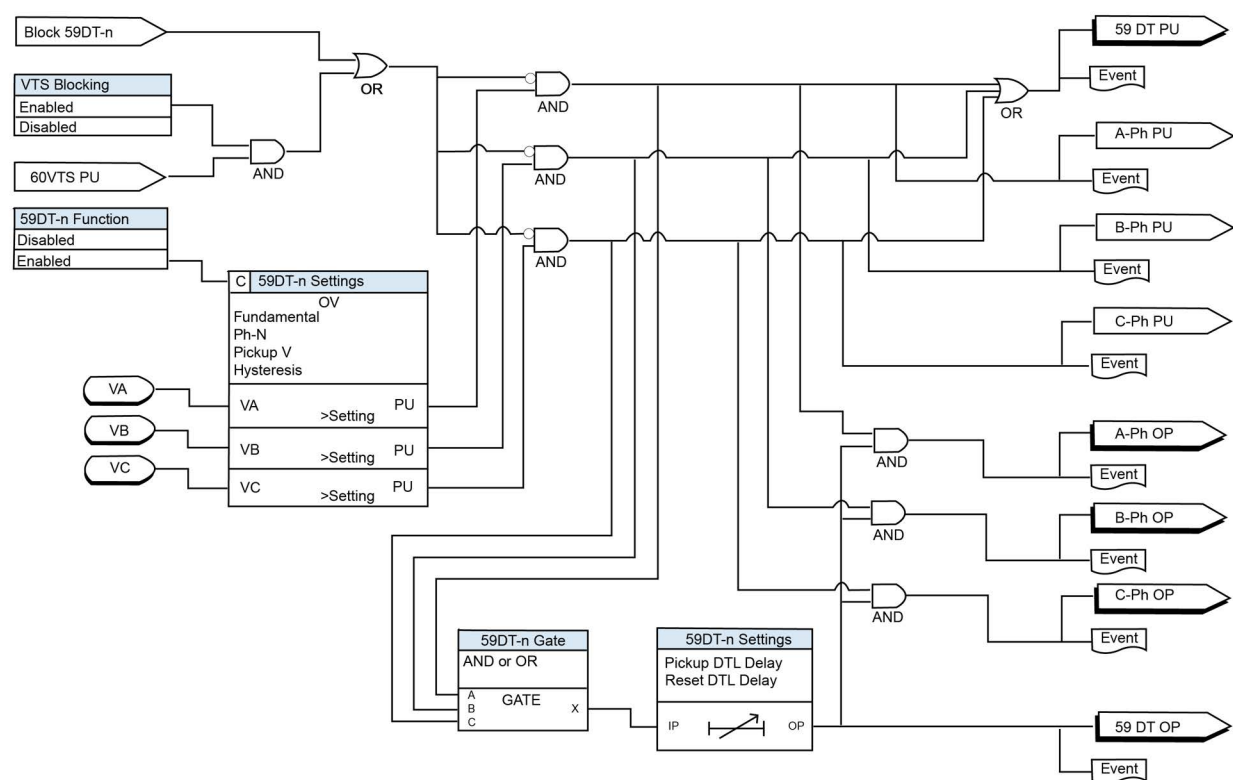


Figure 5.20: 59 DT main function logic diagram

Table 5.21: 59 DT Main Overvoltage Settings

Main-1,2,3,4	Enable/Disable
Gate Switch	AND or OR
Hysteresis	1 % to 80 %
Pickup	1.0 to 138.0 V secondary
Pickup Delay	0.00 to 10.00 second
Reset DTL Delay	0.00 to 999.99 seconds
VTS Blocking	Enable/Disable

Table 5.22: 59 DT Aux Overvoltage Settings

Aux-1,2,3,4	Enable/Disable
Hysteresis	1 % to 80 %
Pickup	1.0 to 138.0 V secondary

Table 5.22: 59 DT Aux Overvoltage Settings

Pickup Delay	0.00 to 10.00 seconds
Reset DTL Delay	0.00 to 999.99 seconds

59IT Phase Inverse Time Overvoltage

The relay provides curve-based time overvoltage protection with added VT supervision blocking. This function can be configured using either AND logic (where overvoltage detection depends on all three-phase voltages) or OR logic (where detection depends on any one of the phase voltages). A hysteresis percentage is applied to the settings to define the drop-out value, which determines when the relay function deactivates after the pick-up condition is cleared.

- **Inverse Time Characteristic:** The relay's trip time is inversely proportional to the over voltage level. Lower over voltage results in a longer trip time, while higher over voltage leads to a faster response.
- **Pick-Up Setting:** This defines the voltage threshold at which the overvoltage protection activates, and it can be adjusted based on system requirements.
- **Time-Voltage Characteristic:** Different curve options are available, such as DTL, IEC Standard Inverse, IEC Extremely Inverse, IEC Long time Inverse to tailor the relay's response to varying levels of over voltage and a user defined curve is given which allows the user to customize the time-voltage characteristic of the relay
- **TMS Setting:** It is used to adjust the operating time of the relay based on a selected time-voltage characteristic curve. This is also crucial for coordinating the relay with other protective devices in the system.

The formula used to calculate the trip time for the inverse curves is provided below

$$T(V) = TMS \left[B + \frac{A}{\left(\frac{V}{V_{Pickup}} \right)^p - 1} \right]$$

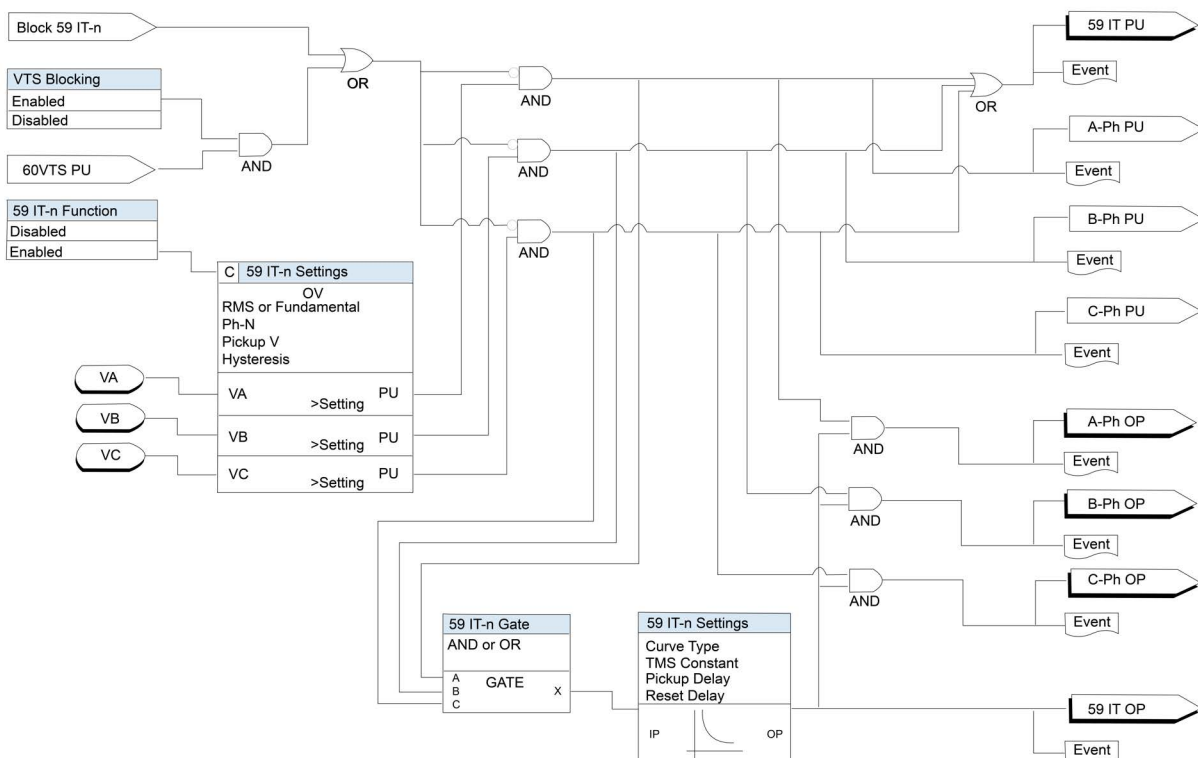


Figure 5.21: 59 IT function logic diagram

Table 5.23: 59IT Phase Inverse Time Overvoltage Settings

Main 1,2	Enable/Disable
Gate Switch	AND/OR
Hysteresis	1 % to 80 %
Curve Type	DTL, User Defined For IEC Curves details see " Table 5.24 "
Pickup	1.0 to 150.0 V secondary
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 seconds
Reset DTL Delay	0.00 to 999.99 seconds
A	0.1 to 50.0
B	0.0 to 10.0
P	0.1 to 10.0
VTS Blocking	Enable/Disable

Table 5.24: IEC Curves

S NO	Curve Type	A	B	P
1	IEC Standard Inverse	1 (Fixed)	0.0 (Fixed)	1 (Fixed)
2	IEC Long time Inverse	5.0 (Fixed)	2.0 (Fixed)	2.0 (Fixed)
3	IEC Extremely Inverse	40.0 (Fixed)	1.0 (Fixed)	2.0 (Fixed)

59N DT/IT Zero Sequence Overvoltage

The relay provides zero sequence overvoltage protection from the line-side potential transformer (PT), operating based on the residual voltage quantity ($3V_0$). When the $3V_0$ voltage reaches or exceeds the pickup value, the protection element is activated.

The relay offers two definite time stages and one inverse time stage, along with VT supervision blocking. A hysteresis percentage is applied to the settings to define the drop-out voltage, ensuring the relay deactivates after the pickup condition is cleared.

Inverse Time Protection

The 59N inverse time protection device supports three IEC inverse time curve types, along with a definite time limit (DTL) and user-defined curve for zero sequence over voltage protection. The formula used to calculate the trip time for the inverse curves is provided below:

The formula used to calculate the trip time for the inverse curves is provided below

$$T(3V_0) = TMS \left[B + \frac{A}{\left(\frac{3V_0}{3V_{0pickup}} \right)^p - 1} \right]$$

Table 5.25: 59N DT Zero sequence overvoltage setting ranges

59NDT 1, 2	Enable/Disable
$3V_0$ Pickup	5.00 to 150.00 volts
Hysteresis	1 % to 80 %
Pickup DTL Delay	0.00 to 99.99 Seconds
Reset DTL Delay	0.00 to 999.99 Seconds
VTB Blocking	Enable/Disable

Table 5.26: 59N IT Zero sequence overvoltage setting ranges

Main 1	Enable/Disable
Hysteresis	1 % to 80 %
Curve Type	DTL, User Defined For IEC Curves details see "Table 5.24:"
Pickup	5.0 to 150.0 V secondary
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 seconds
Reset DTL Delay	0.00 to 999.99 seconds
A	0.0010 to 1000.0000
B	0.0000 to 10.0000
P	0.01 to 10.0
VTs Blocking	Enable/Disable

47DT Negative Sequence Definite Time Overvoltage

The Negative Phase Sequence (NPS) Overvoltage function protects rotating equipment (such as motors and generators) from the damaging effects of excessive negative sequence voltage. These conditions often arise due to phase failure, phase unbalance, or reversed phase sequence, leading to overheating and mechanical stress.

The negative phase sequence voltage (V2) is calculated using the following formula:

$$v2 = \frac{1}{3}[va + vb + \alpha^2vc]$$

Where:

- V_a, V_b, V_c = Phase voltages
- α = Constant representing a 120-degree phase shift ($\alpha = e^{j2\pi/3}$)
- $V2$ = Negative phase sequence voltage

Operation

The relay operates when the sensed negative phase sequence voltage exceeds the set pickup value. If the negative sequence voltage rises above this threshold, the relay will trip to protect the equipment. The function includes hysteresis, which defines the drop-out value and ensures stable

operation, preventing nuisance tripping when the voltage returns below the threshold.

The function also includes VT supervision blocking.

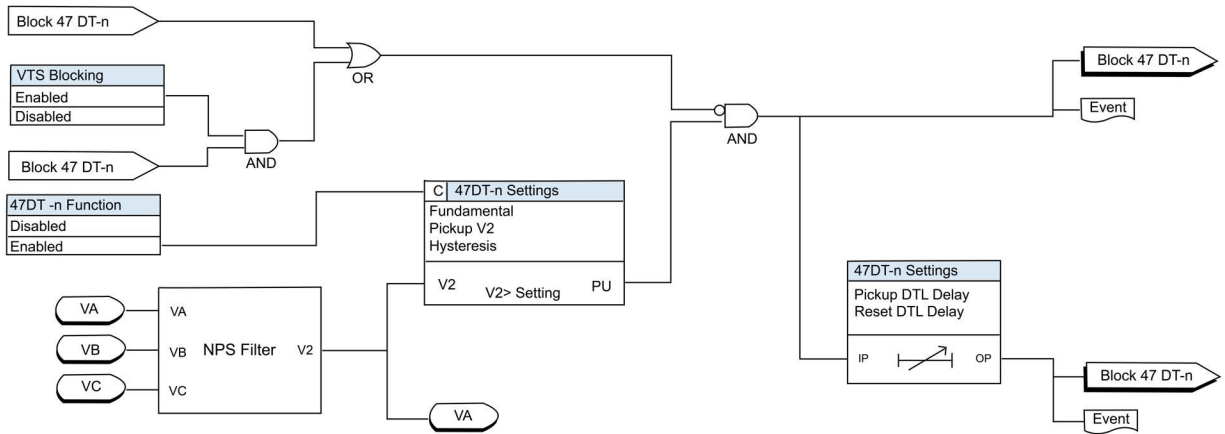


Figure 5.22: 47DT function logic diagram

Table 5.27: 47DT Negative sequence Definite Time Over voltage Settings

47DT-1,2	Enable/Disable
Hysteresis	1 % to 80 %
Pickup V2	1.0 to 150 V secondary
Pickup DTL Delay	0.02 to 999.99 seconds
Reset DTL Delay	0.00 to 999.99 second
VTS Blocking	Enable / Disable

47IT Negative Sequence Inverse Time Overvoltage

The Inverse Negative Phase Sequence (NPS) Relay protects rotating equipment such as motors and generators from the damaging effects of excessive negative sequence voltage, which can result from phase failure, phase unbalance, or reversed phase sequence.

The negative phase sequence voltage (V2) is calculated using the following formula:

$$v_2 = \frac{1}{3}[v_a + \alpha v_b + \alpha^2 v_c]$$

Where:

- V_a, V_b, V_c = Phase voltages
- α = Constant representing a 120-degree phase shift ($\alpha = e^{(j2\pi/3)}$)
- V_2 = Negative phase sequence voltage

Operation

The relay operates when the negative phase sequence voltage exceeds the set pickup value, using curve-based settings to determine the operating time. The trip time is determined by an inverse time characteristic, where higher negative sequence voltages result in faster relay operation. The available curve options include:

- Definite Time Limit (DTL)
- IEC Standard Inverse Curve
- IEC Extreme Inverse
- IEC Long Time Inverse
- User-Defined Curves

The drop-out value is controlled by a percentage of hysteresis, ensuring stable deactivation of the relay once the voltage returns to normal levels. This function is also provided with VTS blocking.

The formulae used to calculate the operating time for the Negative phase sequence overvoltage protection curves are given below.

$$T(V_2) = TMS \left[B + \frac{A}{\left(\frac{V}{V_{2Pickup}} \right)^p - 1} \right]$$

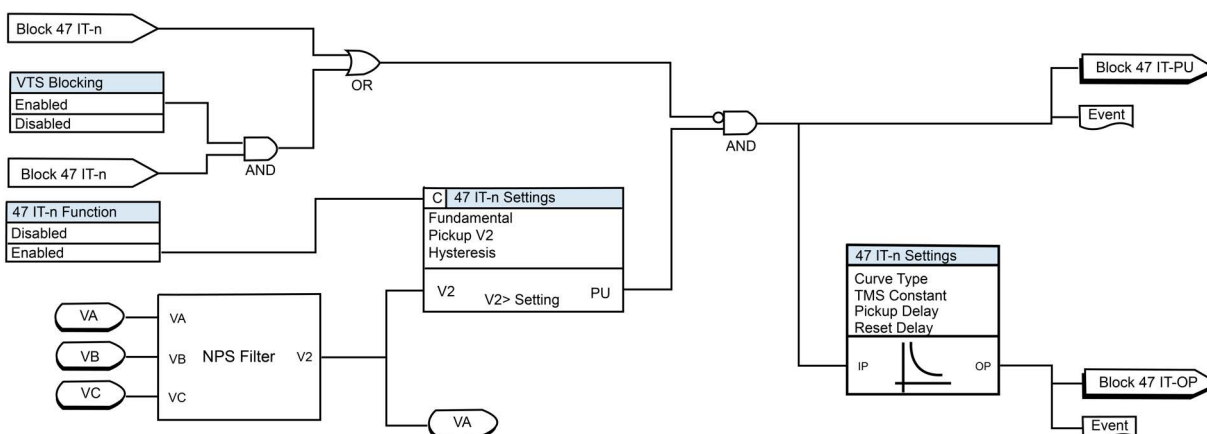


Figure 5.23: 47IT function logic diagram

Table 5.28: 47IT Negative Sequence Inverse Time Overvoltage Settings

47IT	Enable/Disable
Hysteresis	1 % to 80 %
Curve Type	DTL, User Defined For IEC Curves details see "Table 5.24"
Pickup v2	1.0 to 150.0 V secondary
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99 seconds
Reset DTL Delay	0.00 to 999.99 seconds
A	0.1 to 50.0
B	0.0 to 10.0
P	0.1 to 10.0
VTs Blocking	Enable/Disable

24DT Definite Time OverFlux

The over flux protection function detects impermissible over flux conditions in electrical equipment, such as transformers and generators, which could pose serious risks. Over flux conditions typically arise due to an increase in voltage or a decrease in frequency. Additionally, the protection function includes VT supervision (VTS) blocking.

Magnetic flux density (Φ) is directly proportional to voltage (V) and inversely proportional to frequency (F), expressed as:

$$\Phi = V/F$$

Operation

The protection function activates when the injected (fundamental) value of the voltage-to-frequency ratio (V/F) reaches or exceeds the precise pickup value. The drop-out value, at which the function deactivates, depends on the applied hysteresis percentage, which ensures proper operation after the pickup condition has been cleared.

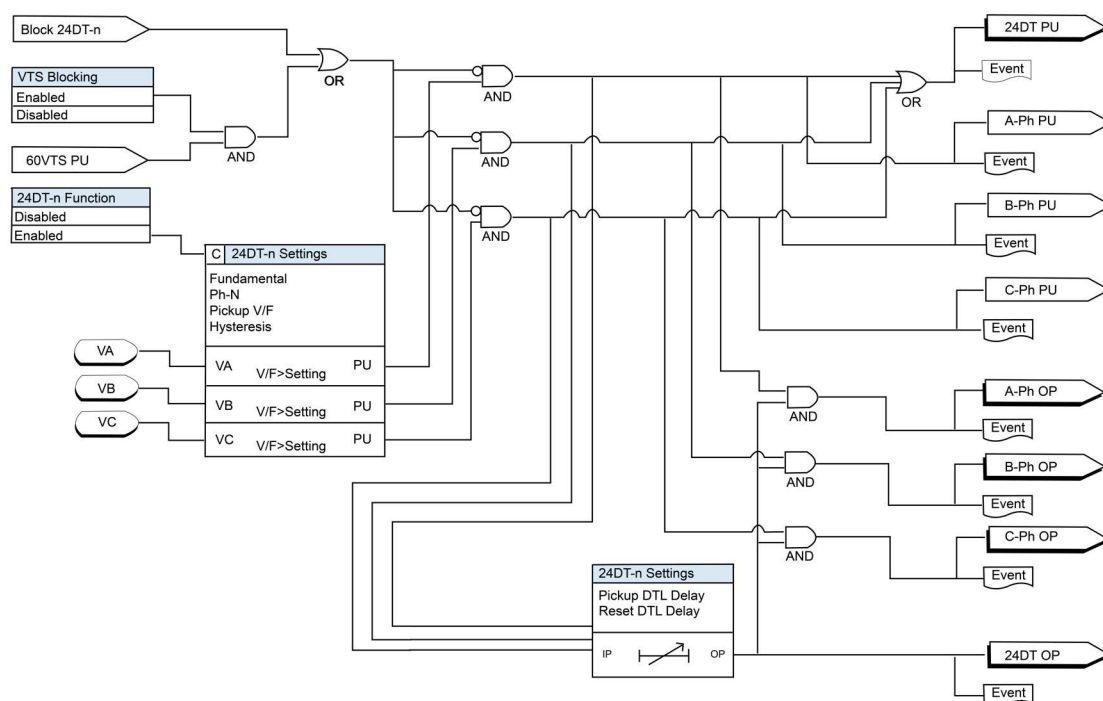


Figure 5.24: 24DT function logic diagram

Table 5.29: 24DT Over flux Settings

24DT-1,2	Enable/Disable
Hysteresis	1 % to 80 %
Pickup V/F	1.0 to 2.0 PU
Pickup DTL Delay	0.05 to 999.99 seconds
Reset DTL Delay	0.00 to 999.99 seconds
VTS Blocking	Enable/Disable

24IT Inverse Time OverFlux

The inverse time over flux protection function is designed to detect excessive magnetic flux (over flux) in electrical equipment such as transformers and generators, which can cause overheating and potential damage. Over flux conditions occur due to a rise in voltage or a drop in frequency. Additionally, the protection function includes VT supervision (VTS) blocking.

Magnetic flux density (Φ) is directly proportional to voltage (V) and inversely proportional to frequency (F), expressed as:

$$\Phi = V/F$$

Operation

The inverse time characteristic ensures that the trip time decreases as the over flux condition (V/F) increases. The higher the over flux ratio, the faster the relay will operate. This characteristic allows the relay to respond appropriately to varying degrees of over flux conditions.

- **Pick-Up Value:** The protection activates when the V/F ratio reaches or exceeds the set pickup value.
- **Inverse Time Characteristic:** The trip time decreases as the V/F ratio increases, providing a faster response for more severe over flux conditions. Several curve options are available to tailor the relay's response to different over flux levels, including:
 - DTL (Definite Time Limit)
 - Inverse Curve
 - IEC Extremely Inverse-1
 - IEEE Extremely Inverse-1
 - IEEE Extremely Inverse-2
 - IEEE Extremely Inverse-3
 - Additionally, a user-defined curve is available for customized time-over flux characteristics.
- **VT Supervision Blocking:** VT supervision prevents unnecessary operations by blocking the protection function in the event of a VT fault, ensuring the relay only trips in genuine over flux conditions.
- **Drop-Out Value:** The function deactivates based on a hysteresis percentage, ensuring stable operation and preventing nuisance tripping once the over flux condition has cleared.

The formula used to calculate the operating time for the inverse time over flux protection curves are given below.

For IEC EI 1

$$T = \left[\frac{A}{(M^2 - 1)^2} \right] TMS$$

For IEEE EI 1,2,3

$$T = e^{-(M \times 100 - K)/C}$$

For Inverse Curve

$$T = \frac{InverseK}{(N - Pickup)^2}$$

$$K = A + ((TMS \times 10) - 1)2.5$$

$$N = \left[\frac{(V/F)}{V_n/F_n} \right]$$

$$M = \left[\frac{(V/F)}{(V_n/F_n)^B} \right]$$

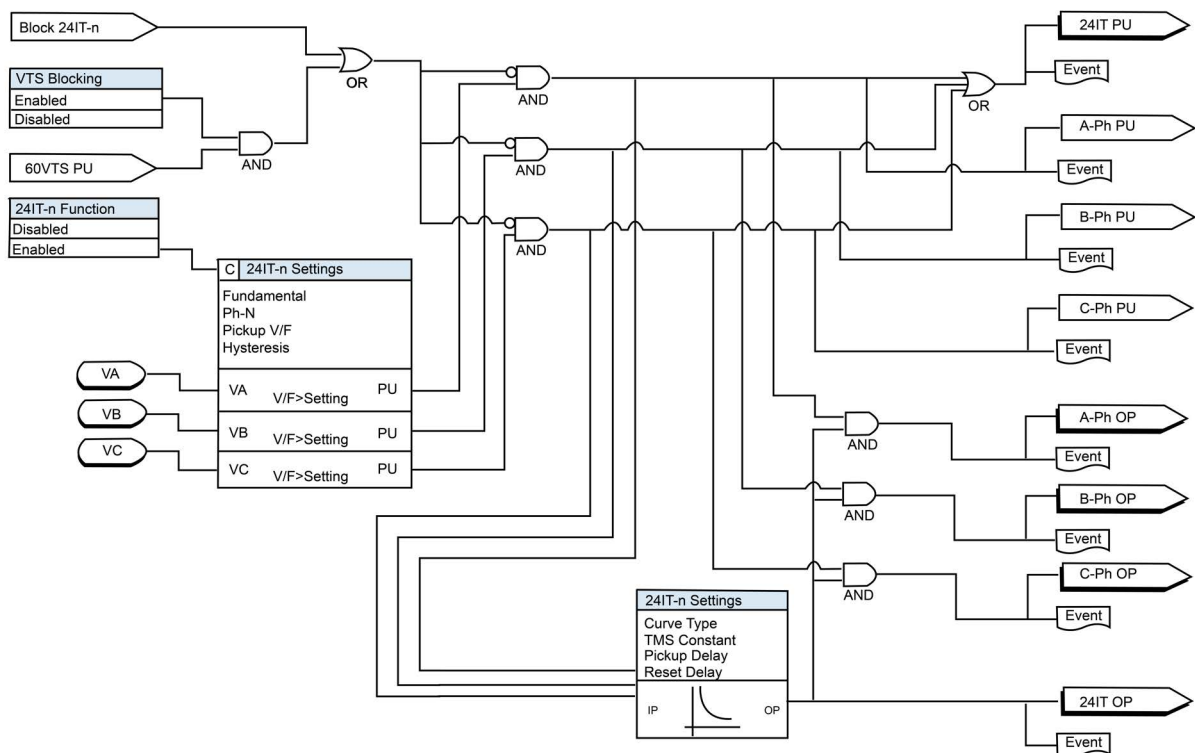


Figure 5.25: 24IT function logic diagram

Table 5.30: IEC & IEEE Curves

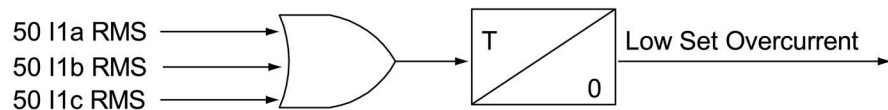
S NO	Characteristics	A	B	P
1	Inverse Curve	0.0	1.0	0.0
2	IEC Extremely Inverse-1	9.50	1.0	0.0
3	IEEE Extremely Inverse-1	115.0	1.0	4.8858
4	IEEE Extremely Inverse-2	113.50	1.0	3.0400
5	IEEE Extremely Inverse-3	108.75	1.0	2.4490

Table 5.31: 24IT Over flux Settings

24IT	Enable/Disable
Hysteresis	1 % to 80 %
Pickup V/F	1.0 to 1.5 PU
Curve Type	DTL, User Defined For other Curve details see "Table 5.30"
TMS	0.01 to 10.00
Pickup DTL Delay	0.05 to 999.99 seconds
Reset DTL Delay	0.00 to 99.9 seconds
Inverse K	0.01 to 99.90 seconds
User define set points X1 to X7	1.00 to 3.00 PU
User define set points X1 to X7	0.00 to 9999.99 seconds
VTB Blocking	Enable/Disable

50LS Overcurrent

Individual Overcurrent devices are provided for the main CT's. These individual Overcurrent devices can be used with ProLogic to create logic or used directly from the Output Matrix. This feature helps in detecting faults based on the load current. It can be set to be active only when the load current exceeds a certain minimum level, ensuring that the relay is sensitive to fault conditions only when necessary (i.e., when the system is under load). These can be used with ProLogic to create logic or used directly from the Output Matrix.

**Figure 5.26: 50LS function logic diagram****Table 5.32: 50LS Low Set Overcurrent Settings**

50LS 1,2	Enable/Disable
Pickup	0.10 to 50.0 A secondary (5A) 0.02 to 10.0 A secondary (1A)

Table 5.32: 50LS Low Set Overcurrent Settings

Pickup Delay	0.00 to 10.00 Seconds
Pickup V/F	1.0 to 1.5 PU

81 Frequency

The relay has 10 frequency devices available. Each frequency element can be set to operate either at a fixed level of under-frequency, a fixed level of over-frequency, or at a rate of change level (df/dt). The df/dt function can be set to operate for a positive rate of change or a negative rate of change. Each frequency element has a definite time delay setting to create a time delayed output. A fixed level of positive sequence voltage of 0.25 pu provides an undervoltage inhibit on each element.

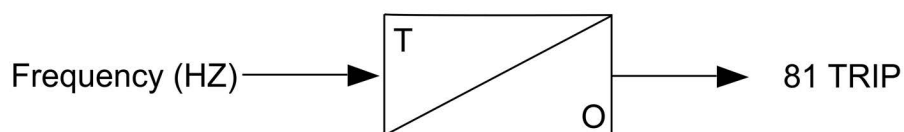


Figure 5.27: 81 Logic diagram for Fixed Level

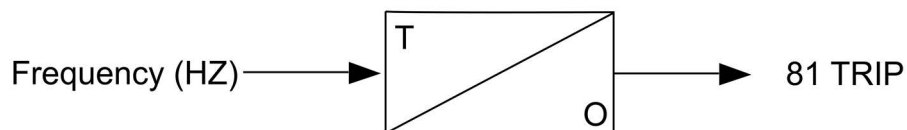


Figure 5.28: 81 Logic diagram for Rate of Change

Table 5.33: IEC & IEEE Curves

81 –1 to 10	Enabled	Disabled / Fixed level / Rate of Change
	Pickup	50.000 to 59.995 or 60.005 to 70.000 (fixed level) -10.0 to -0.1 or 0.1 to 10.0 (rate of change)
	Hysteresis	0.05 to 2.0Hz (fixed level) 1% to 80% (rate of change)
	Pickup Delay	0.05 to 99.99 seconds (fixed level) 0.20 to 99.99 seconds (rate of change)
	VTS Blocking	Enabled / Disabled

32 Directional Power

Directional Power protection is used to detect the abnormal power flow in a power system and isolate it from the healthy system. Directional power protection measures either the active or the reactive power (based on the setting) flowing through the power system in which the current transformers are placed and operates if the power is greater/lesser than a set value based on the setting selection and flowing in a required direction.

The power pickup settings in FPRO relay is in Per Unit value. Directional protection is useful for all networks in which the direction of flow of power is likely to change, notably in the instance of a short circuit between phases or of an earthing fault (single phase fault).

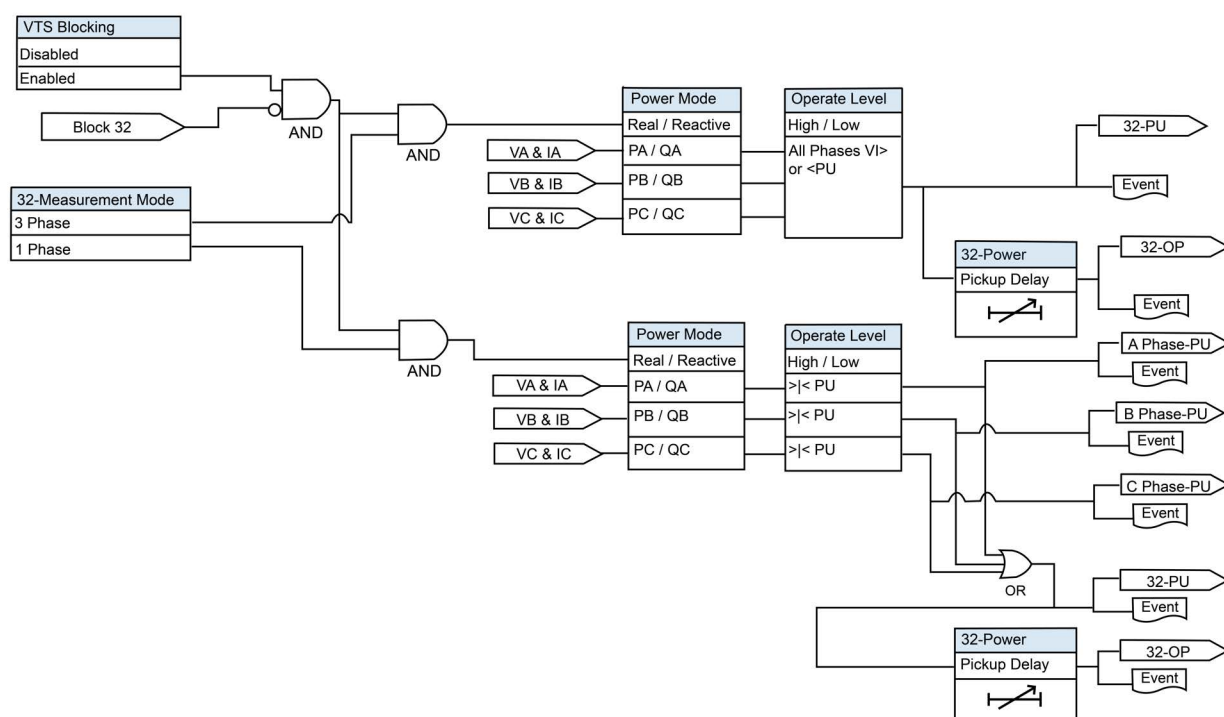


Figure 5.29: 32 Directional Power Protection Function Logic

Table 5.34: 32 Directional Power Settings	
32-1,2,3,4	Enable/Disable
Power Mode	Real or Reactive
Measurement Mode	1 Phase or 3 Phase

Table 5.34: 32 Directional Power Settings

Power Pick-up	-3.000 to -0.030 pu or 0.030 to 3.000 pu
Pickup Delay	0.00 to 999.99s
Polarity Reversal	Enabled or disabled

81HBL2 - Inrush Block

The protection relay may detect large magnetizing inrush current during trans- former energizing. In addition to considerably unbalanced fundamental current, inrush current comprised of large second harmonic current which doesn't appear in short circuit current. Therefore, the inrush current may affect the protection functions which operate based on the fundamental component of the measured current. Accordingly, inrush restraint logic is provided to prevent overcurrent protection from mis operation.

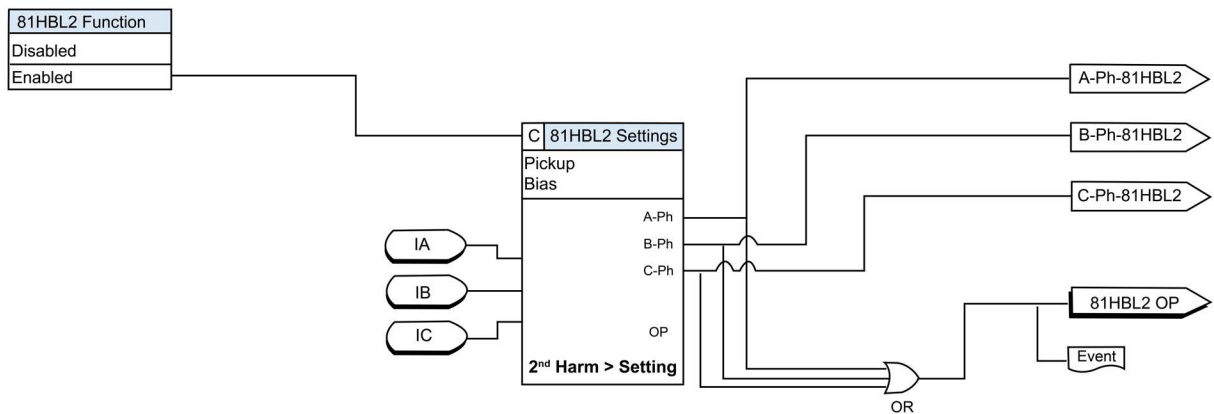


Figure 5.30: 81HBL2 Inrush function logic diagram

Table 5.35: 81HBL2 - Inrush Protection Settings

81HBL2 Function	Enable/Disable
Cross Blocking	Enabled/Disabled
Pickup I_{2nd}	5% to 50%

THD - Total Harmonic Distortion

The Total Harmonic Distortion monitoring function is used to trigger an alarm based on the total harmonic distortion present in the voltage input.

Total harmonic distortion of the voltage, or THD-V, is the summation of all harmonic components of the voltage waveform compared against the fundamental component of the voltage waveform.

$$THD - V_{Percent} = \frac{100 \sqrt{V_2^2 + V_3^2 + V_4^2 + \dots + V_n^2}}{V_1}$$

Where,

V1 - Nominal voltage at fundamental frequency

V2 - Harmonic voltage of 2nd order

...

Vn - Harmonic voltage of nth order

The function includes two stages, both of which are based on the voltage input, which have independent pickup values and time delays. Both stages include a VTS blocking enable/disable setting. If enabled, when the VTS condition occurs, the THD-V function output will be blocked.

Table 5.36: THD - Total Harmonic Distortion Settings

Setting Description	Setting Range
THD-1	Enabled/Disabled
Pickup THD-V	1% to 100%
Pickup Delay	0.00s to 999.99s
VTS Blocking	Enable/Disable
THD-2	Enable/disable
Pickup THD-V	1% to 100%
Pickup Delay	0.00s to 999.99s
VTS Blocking	Enable/Disable

25/27/59 Sync Check

When the Sync Check function is enabled, it compares the voltage magnitude, steady-state phase angle and frequency between the Main Voltage input (3ph) and Aux Voltage input(1-ph).

Voltage Inputs:

1. Main Voltage Input: The relay can take the main voltage from either the Bus or the Line PT, depending on system availability. The relay accepts three phase-to-neutral voltage only for this input.

2. Aux Voltage Input: The Aux voltage (used as Sync voltage input) can be taken from either the Bus or Line PT. It accepts any Single phase-

to-neutral voltage. The Aux Voltage Input can be either A-N/B-N/C-N and that can be configured accordingly in the System Parameters menu.

The sync check logic follows these steps:

1. **Voltage Magnitude:** The positive sequence Magnitude of the Main voltage is compared with the Aux voltage magnitude. Both must be within the defined minimum and maximum voltage settings and the difference should be within the defined setting range (1 to 20V)
2. **Angle Comparison:** The angle difference between Main Voltage and Aux voltage should be within the defined setting range (1° to 50°)
3. **Frequency Comparison:** The frequency difference between Main Voltage and Aux voltage should be within the defined setting range (0.010 to 2.000Hz).

If all these conditions are met, a definite time delay (set between 0.00 and 10.00 seconds) is initiated. After this time, the sync-check output is generated.

Note: Frequency Difference check will be considered only if the Frequency difference check box is enabled.

The Dead Main Live Sync (DMLS), Live Main Dead Sync (LMDS), and Dead Main Dead Sync (DMDS) logic functions use fixed values of the Main phase voltage and Auxiliary voltage (Sync voltage) to determine the sync check condition. The voltage threshold is set at 20 V secondary:

- Voltages below 20 V secondary are considered a dead state.
- Voltages above 20 V secondary are considered a live state.

These functions are associated with a fixed time delay of 25 milliseconds

Table 5.37: 25/27/59 Sync Check Settings	
25 Sync Check	Enabled/Disabled
Maximum Voltage	60.0 to 138.0 V secondary
Minimum Voltage	40.0 to 69.9 V secondary
Voltage Difference	1.0 to 20.0 V secondary
Angle Difference	1.0 to 50.0 degrees
Pickup Delay	0.00 to 10.00 seconds
Enable Frequency Difference	Enable/Disable

Table 5.37: 25/27/59 Sync Check Settings

Frequency Difference	0.010 to 2.000 Hz
Main/Aux	
Enable Dead Main Live Aux. (DMLA)	Enable/Disable
Enable Live Main Dead Aux. (LMDA)	Enable/Disable
Enable Dead Main Dead Aux. (DMDA)	Enable/Disable

79 Recloser

The relay provides single-phase tripping and reclosing and 3-phase tripping and reclosing on the 4500 hardware platform.

The schemes available are user-programmable and consist of the following user setting options:

- 3-Phase Trip and Reclose Scheme
- 1-Phase Trip and Reclose Scheme
- 1-Phase/3-Phase Trip and Reclose Scheme

Please note that the user can select only one scheme at a time, although the user can change the scheme selected by using the setting groups within the setting software.

Table 5.38: 79 Recloser Settings

Protection Scheme Timers	
1 Ph max open Pickup Delay (TM) (Pole Discrepancy Time)	0.100 to 5.000 seconds
1Ph/3ph for 3ph Dropout Delay (TD4) (Reclaim Time for 3Ph AR)	0.100 to 999.000 seconds
1Ph/3ph for 1ph Pickup Delay (TL5)	0.100 to 5.000 seconds
1Ph/3ph for 1ph Dropout Delay (TD5) (Reclaim Time for 1Ph AR)	0.100 to 999.000 seconds
Fault Timer	Enable/Disable
Fault Timer Pickup	0.05 to 10.00 seconds
79-3Ph Recloser	
79-3Ph Recloser Enable	Enable/Disable

Table 5.38: 79 Recloser Settings	
Number of Shots	1 to 4
First Dead Time/Reclose (T1)	0.1 to 999.9 seconds
Second Dead Time/Reclose (T2)	1.0 to 999.9 seconds
Third Dead Time/Reclose (T3)	1.0 to 999.9 seconds
Fourth Dead Time/Reclose (T4)	1.0 to 999.9 seconds
Closing Pulse Time (Tp)	0.1 to 1.0 seconds
(Lead) Lockout Time (TD)	0.1 to 999.9 seconds
Reclose Initiate Reset (TDI)	0.0 to 999.9 seconds
Block Reset (TDB)	0.0 to 999.9 seconds
Breaker Out of Service (TC)	0.0 to 999.9 seconds
Sync Control	Enabled/Disable
79-1Ph Recloser	
79-1Ph Recloser Enable	Enabled/Disabled (determined by Protect Scheme setting on Scheme Selector screen)
Main Breaker Pole Dead/Live Detection	Phase Current/CB Status
CB AR External Initiation Pole A	EI 1-24, PL 1-24, VI 1-30
CB AR External Initiation Pole B	EI 1-24, PL 1-24, VI 1-30
CB AR External Initiation Pole C	EI 1-24, PL 1-24, VI 1-30
Number of Shots	1
Dead Time/Reclose (T1)	0.1 to 999.9 seconds
Closing Pulse Time (Tp)	0.1 to 1.0 seconds
(Lead) Lockout Reset (TD)	0.1 to 999.9 seconds
Reclose Initiate Reset (TDI)	0.0 to 999.9 seconds
Block Reset (TDB)	0.0 to 999.9 seconds
Breaker Out of Service (TC)	0.0 to 999.9 seconds

3-Phase Trip and Reclose Scheme

This scheme allows the relay to 3 phase trip always (even if the fault is single phase in nature) and reclose the 3 phases after a period of time. Up to 4 shots of reclosing is possible, depending upon the user recloser settings. The reclosing can be done with or without synch check supervision. The output matrix is used to determine the inputs and the outputs to the 3-phase 79 recloser. The line breaker is deemed to be open based on the Breaker Status input.

3-Phase Reclose Timers

The lead breaker open interval times are settable for each reclosing shot (T1 to T4) for the 3-phase recloser.

External Reclose Blocking

The 79 also supports blocking from external devices via the output matrix and the internal 79 Lockout indication. The user can control the 79 remotely or locally with external or virtual inputs.

Sync Control

The flexibility provided with device 79 allows the user to control circuit breaker with complete Dead Main Live Auxiliary, Live Main Dead Auxiliary, Dead Main Dead Auxiliary or Live Main Live Auxiliary supervision (slip frequency).

1-Phase Trip and Reclose Scheme Setting

This setting allows the relay to trip only the faulted phase if the fault is single phase in nature, then initiate a reclose of that phase after a line dead time. The reason for this is that many faults are transient in nature, such as those caused by lightning. Tripping only the faulted phase, and then reclosing it some time later, should in many cases allow the line to return into service.

In operation, the Single-Phase Trip Setting blocks 79-3 from any attempts to reclose on a 3 Phase basis. If a single phase fault occurs on the line, the faulted phase is identified and only that phase is opened. After a period of time as defined by the pickup time of timer T1 in the single phase recloser 79-1, that phase will be reclosed. If the fault starts as a single phase fault and then evolves into a multiphase fault, or commutates to a different phase while the first phase is open, the line will initiate a 3 phase trip and reclosing will be inhibited. If the first single phase fault is detected, then reclosed upon, and if the fault persists, the line will initiate a 3-phase trip and lockout. Timer TD5 dropout time determines how soon a subsequent single line to ground fault can occur after the first one in order for the line to attempt another single phase trip and reclosure. If a single phase fault is detected and that phase opens but fails to reclose before timer TM times out, the line will initiate a 3-phase trip and lockout. It is important therefore that timer TM be set longer in du-

ration than the single phase recloser time. Only one single phase reclose is attempted. If upon reclosure the fault persists, before timer TD5 has had a chance to dropout, the line will initiate a 3-phase trip and lockout. To get the line out of a locked out state, the line must be manually reclosed and stay in service for longer than the single phase lockout timer TD reset.

There are two methods of recloser initiation for the 1-phase recloser, internal and external initiation. Internal initiation is performed via protection functions assigned to the 94 1-ph in the output matrix. External initiation is performed by EIs, VIs or PLs assigned to the “CB AR External Initiation Pole A/B/C” setting in the 79 1-Ph settings. The internal and external initiation methods work in parallel.

For the internal initiation, the protection functions that can initiate a single phase trip and reclose are defined by the user in the output matrix setting screen. The user has full control to dictate which protection functions should initiate the recloser logic. The single phase initiation is performed by assigning a protection function to the 94 1-Ph. For more information on the 94 tripping function, see "94 Tripping" on page 5-86. Time delayed trips for instance may be considered backup functions where recloser initiation is undesired. In this case these types of operations can be set to block any attempted reclosures in any of the chosen reclosure schemes. These protection functions can also be set to initiate transient fault or dynamic swing recordings and breaker failure initiations on the output matrix as well.

The external initiation method is controlled by the “CB AR External Initiation Pole A/B/C” setting in the 79 1-Ph settings. Any EI, PL or VI can be assigned to each Pole. When these external signals go High, they act as the initiator for the 79 1-Ph. Once the reclose sequence has been initiated, any subsequent initiations are ignored during the sequence.

The Pole Dead/Live detection for the 79 1-phase scheme can be set to either CB Status or Phase Current detection methods. In the CB Status Method, the pole dead/live detection is performed by monitoring the circuit breaker status input configured on the Breaker Status screen (see "Breaker Status" on page 7-26). The Phase Current detection method monitors the phase currents to determine the dead/live condition for the circuit breaker. If measured current flow is less than 4% nominal current (0.2 A for 5 A relay) the breaker is considered to be open (see "79 Recloser Logic" on page 5-57).

During the single pole open condition while in the single pole tripping mode, unbalanced line load current will create negative and zero sequence line quantities. In order to override these unbalances, provisions have been made in the relay logic to allow the user to apply modified protective relay settings via phase setting multiplier. These settings can be determined through load flow and fault study cases for the protected

line. Once the line phase recloses, the protective settings that have been modified will return to their original settings. In this way, protection security can be maintained while the line goes through a single-phase trip and reclose operation.

If the Protection Scheme is set to 1 Phase, the 79 1-Ph Recloser function is automatically always enabled.

1-Phase/3-Phase Trip and Reclose Scheme

With this scheme setting, the relay will trip and reclose a single phase for an initial Single Phase fault and will trip and reclose for a Three Phase or multi-phase fault. Only one attempt to reclose will occur if the fault is permanent in nature before lockout will occur.

If sufficient time takes place between the first fault and subsequent new line faults, as determined by the TD4 and TD5 dropout times, the protection will try to keep the line in service by tripping and reclosing the line as required.

It should be noted that the relay has two types of reclosers, a single phase type 79-1 and a 3-phase type 79-3 recloser.

The single phase recloser has only one shot, determined by timer T1. This time delay applies for both the Single Phase Scheme and for the Single Phase/Three Phase Scheme settings.

The 3-phase recloser has a common setting for the first reclose of the Three Phase or the Single Phase/Three Phase Trip and Reclose Schemes.

Summary of Trip and Reclose Schemes

3-Phase Trip and Reclose Scheme Setting

Provides 3-phase tripping for any type of line fault with up to four (4) shots of reclosure possible.

1-Phase Trip and Reclose Scheme Setting

This scheme allows one shot of trip and reclose if the fault is single phase in nature. Multiple Phase line faults will cause a 3-phase trip and lockout. Single phase faults occurring at a frequency less than TD5 reset time will result in 3 phase trip and lockout after first attempted reclose.

1-Phase/Multi-Phase Trip Scheme Setting

An initial line fault will cause the line to either 3-phase trip or single-phase trip. If subsequent line faults occur before timers TD4 or TD5 reset it will result in a 3-phase trip and lockout.

For any schemes selected, if a line goes into the lockout state, only a successful manual line reclose or a relay power supply reboot will reset the lockout logic.

50BF Breaker Failure

The Breaker Failure (BF) protection function detects breaker failures. When breaker failure is detected by a trip or other internal logic (user-settable through the output matrix) and the breaker current still exists, two timers (T1 and T2, user-settable) are started. When the timers are timed out and the current still exists (which indicates breaker failure), the output of this function is set high. Use the two outputs of this function to trip another trip coil or the next level of breakers, such as bus breakers.

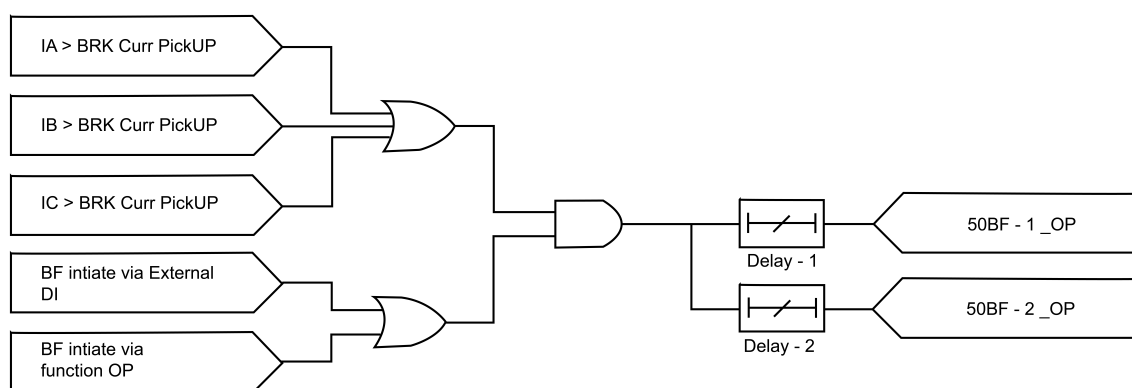


Figure 5.31: 50BF function logic diagram

Table 5.39: 50BF Breaker Failure Settings

50BF	Enable/Disable
Pickup Delay 1	0.01 to 99.99 Seconds
Pickup Delay 2	0.01 to 99.99 Seconds
Breaker Current Pickup	0.10 to 50.0 A secondary (5A) 0.02 to 10.0 A secondary (1A)
External Single Phase 50BF Initiate	
A Phase	Disabled, EI 1 to EI 24, PL1 to PL24, VI1 to VI 30
B Phase	Disabled, EI 1 to EI 24, PL1 to PL24, VI1 to VI 30
C Phase	Disabled, EI 1 to EI 24, PL1 to PL24, VI1 to VI 30

The F-PRO breaker failure protection can be initiated by any protection function located within the F-PRO relay by initiating the BFI column in the Output Matrix screen. When the breaker failure function is initiated this way several modes of operation may occur.

- If the 3 Pole tripping option for the relay is selected, initiation of the BFI column in the Output matrix will result in 3 pole breaker failure initiation. Output of the breaker failure function will then be a three pole output. The 3 pole BF initiation will occur regardless of the type of fault detected, single phase or multi-phase fault.
- If the 1 Pole (single pole) tripping option for the relay is selected, initiation of the BFI column in the Output matrix will result in a 1 pole breaker failure initiation if a single phase trip by a protection function operates. If a multi phase fault occurs, a multi-phase protection function will be initiated and the BF initiation will be a 3 pole breaker failure. For this case all three poles of the breaker will be checked to see if they open correctly. Breaker failure operation will result in 3 pole backup breaker tripping just like the single pole BF initiation.
- If the 1/3 Pole Scheme tripping option for the relay is selected, the breaker failure initiation will be a combination of (1) and (2) above, with single or three pole BF initiation as required by the fault detection.

The breaker failure function can also be initiated by an input to one of the external inputs from an outside protective relay or by a ProLogic input. This input can be a phase segregated input that can come from a single pole trip from an external relay.

The breaker failure logic uses a current detector that is user settable in the 50BF Setting screen to determine whether a pole is open or closed in the range of 0.1- 50 A secondary. There are two (2) breaker failure functions available per line breaker with adjustable pickup definite time delays from 0.01 to 99.9 seconds.

In any case, the output of the Breaker Failure function must be set to close output contacts to perform its function. This is done by mapping the BF output to the appropriate output contact in the Output Matrix screen.

46BC - Broken Conductor

The Broken Conductor (46BC) function can detect unbalanced series or open- circuit faults (referred to as *series faults* from here on). Series faults can arise from broken conductors or jumpers, mis-operation of single-phase switchgear and the operation of series fuses. Series faults do not cause an increase in phase currents in the system and thus are not easily detectable by standard overcurrent relays. However, series faults

produce an unbalance and a detectable level of negative sequence current.

A negative sequence overcurrent relay (46-50/46-51) could possibly be used to detect series fault conditions. However, on a lightly loaded line, the negative sequence current resulting from a series fault may be very close to, or less than, the full load steady state unbalance in the system. A negative sequence element therefore would not operate at low load levels. For this reason, the 46BC function is used to detect series faults.

The function incorporates an element which measures the ratio of negative sequence to positive phase sequence current (I_2/I_1). This ratio is affected less severely than the measurement of negative sequence current alone, since the ratio remains approximately constant with variations in load current. This ratio allows for a more sensitive setting to be achieved.

An adequate time delay should be used to coordinate with other protective devices and to ensure that the device does not trip during the operation of single-phase switchgear or during re-close sequences.

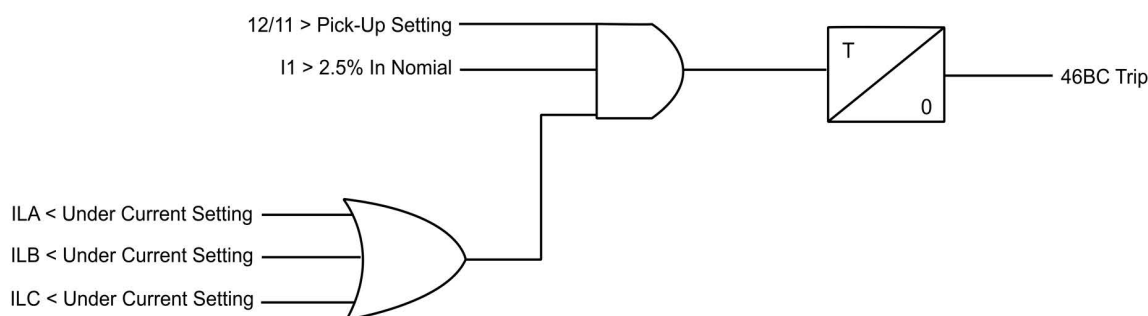


Figure 5.32: 46BC function logic diagram

Table 5.40: 46BC Settings	
46BC Function	Enable/Disable
I2/I1 Pickup	10% to 100% (selectable in 5% increments)
Undercurrent	0.04 to 0.50 A (1A) 0.20 to 2.50 A (5A)
Pickup Delay	0.01 to 999.0 s

60LOP Loss of Potential

The loss of potential (LOP) function uses rate of change values for the positive sequence voltage and current signal along with voltage and current supervision to detect loss of potential conditions.

The function looks for a negative rate of change on the positive sequence voltage while determining if the positive sequence current is changing. A loss of potential in itself should result in only a loss of voltage or a negative rate of change of voltage. A fault results in a high rate of change of current as well. In some rare cases there is a negative rate of change of fault current, therefore we use an absolute rate of change of current. When the loss of potential condition is detected, it is latched until all the 3-phase voltages are above 75% or a positive rate of change of voltage is detected. So the circuit detects a loss of potential that results in a voltage of less than 75%. Select positive and zero sequence current blocking functions above the maximum load current, this ensures that LOP does not pick up on fault.

A dropout timer has been added on the dI/dt signal (in front of gate 169) to ensure that the dI/dt signal will not reset earlier than the dV/dt signal. This change improves the security of the algorithm in some particular fault situations.

If desired, negative sequence monitoring can be enabled to provide enhanced performance against PT fuse failure conditions occur during line energization.

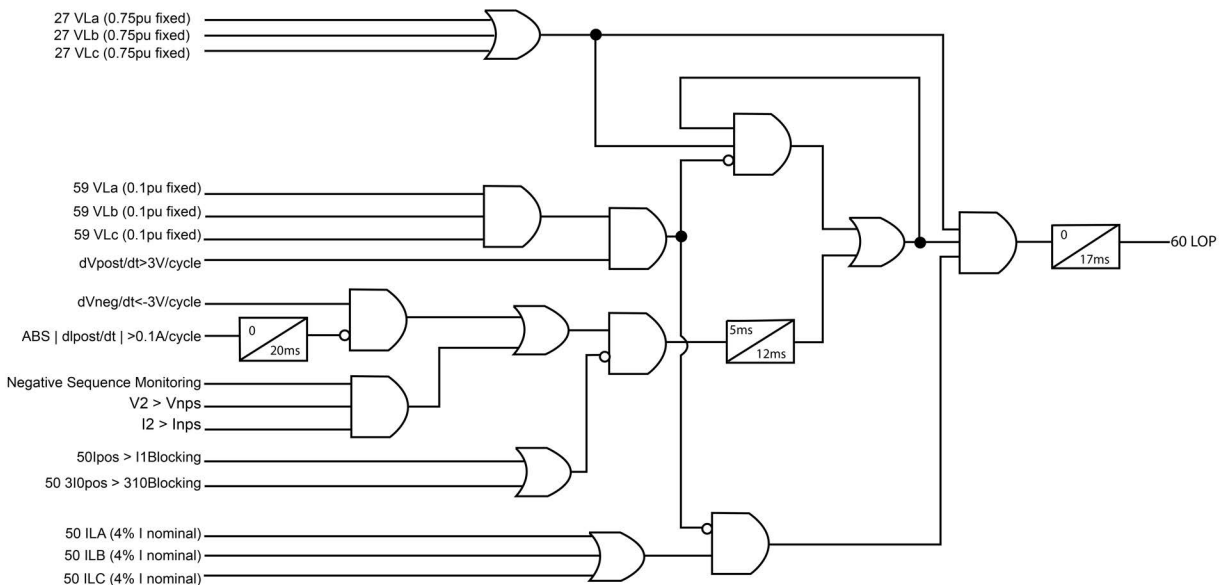


Figure 5.33: 60LOP function logic diagram

Table 5.41: 60LOP Loss of Potential Settings

60 VT supervision	Enable/Disable
I1 Blocking	0.5 to 50.0 A secondary (5 A) 0.1 to 10.0 A secondary (1 A)
3I ₀ Blocking	0.5 to 50.0 A secondary (5 A) 0.1 to 10.0 A secondary (1 A)
Negative Sequence Monitoring	Enable/Disable
Vnps	7.0 to 110 V
Inps	0.25 to 5.0 A secondary (5 A) 0.05 to 1.0 A secondary (1 A)

If this function is enabled and an AC Loss of Potential takes place, an output contact can be closed.

Loss of potential causes an alarm and respective Protection element will be blocked. Positive and zero sequence current settings provided will block this function for faults. If voltage goes below 75% nominal (49.8 V) and the currents obtained do not exceed the settings, the loss of potential will be initiated.

Note that the positive and zero sequence current blocking level should be set above the maximum line current.

60 CT Supervision

The Current Supervision function is used to detect the failure of current inputs to the relay. When a current input fails, a negative sequence current is typically present, while the negative sequence voltage remains absent.

The function operates when the following conditions are met:

- Negative Sequence Current exceeds the set threshold.
- Negative Sequence Voltage is less than the configured

This ensures that the relay can accurately detect current input failures and trigger the appropriate response.

The logic diagram illustrating the operation of the Current Supervision function is provided below.

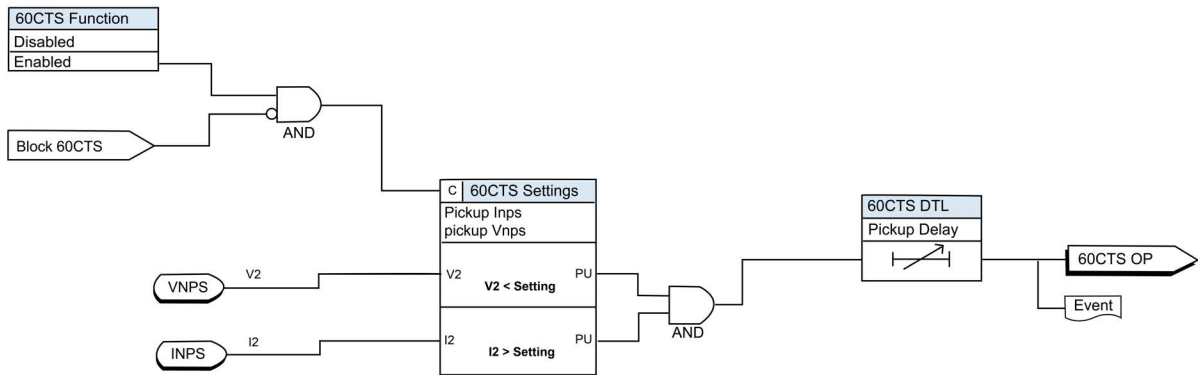


Figure 5.34: 60 CT Supervision function logic diagram

Table 5.42: 60 CT Supervision Settings

Main	Enable/Disable
Inps Pickup	0.25 to 5.00 A secondary (5A) 0.05 to 1.00 A secondary (1A)
Vnps Pickup	7.00 to 110.00 V secondary
Pickup Delay	0.03 to 99.99 seconds

74TCS - Trip Circuit Supervision

The Current Supervision function is used to detect the failure of current inputs to the relay. When a current input fails, a negative sequence current is typically present, while the negative sequence voltage remains absent.

74TCS function detects trip circuit failure when 74TCS asserts and followed by the drop-off timer unit operation. The drop-off timer delay can be set using 74TCS DTL setting value. On expiry of the drop-off delay, the final operate output of the function is issued. The 74TCS is externally initiated via an External Input, configured on the Input Matrix. If the 74TCS initiation is not configured in the Input Matrix, the function cannot operate.



Figure 5.35: 74TCS Trip Circuit Supervision logic diagram

74TCS Using Prologic

If the Trip Coil Supervision function is required for more than two coils, it can be achieved using Prologic's. The above-mentioned schemes can be achieved using the Prologic feature, as shown in the figures below.

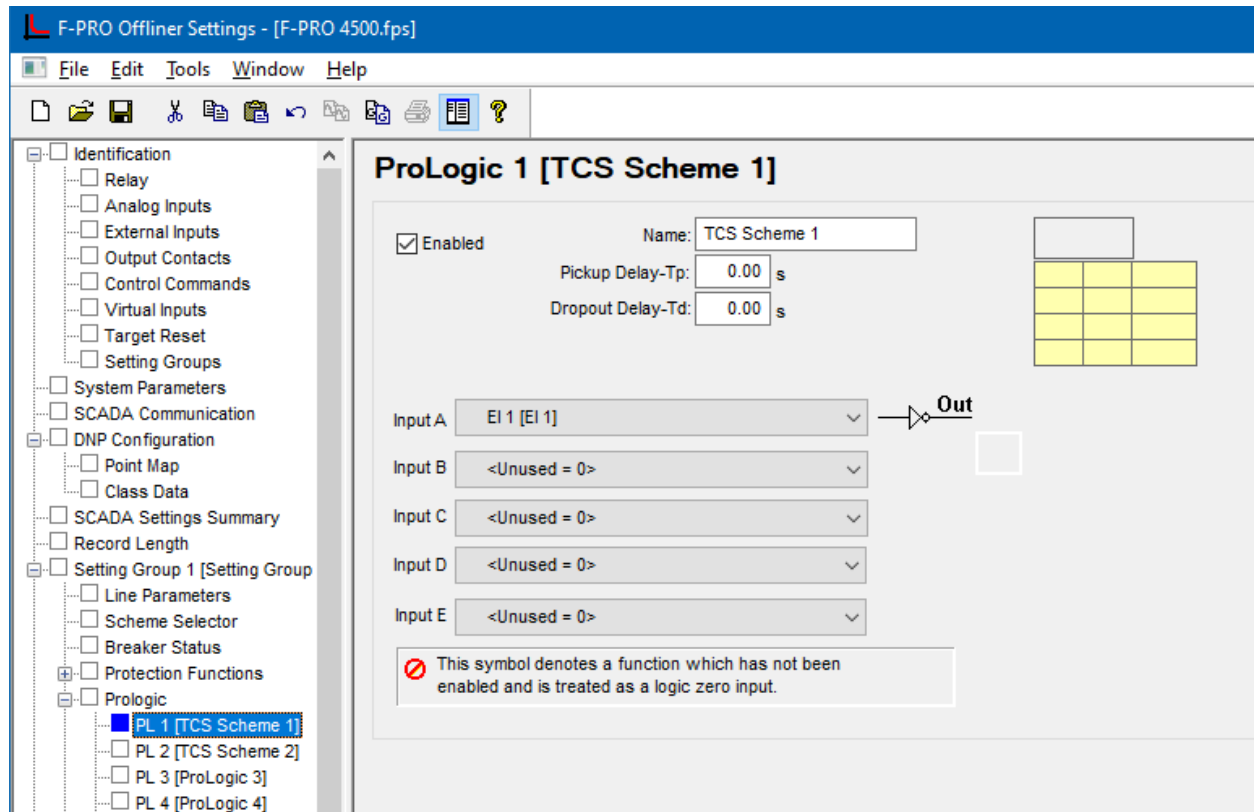


Figure 5.38: ProLogic TCS Scheme 1

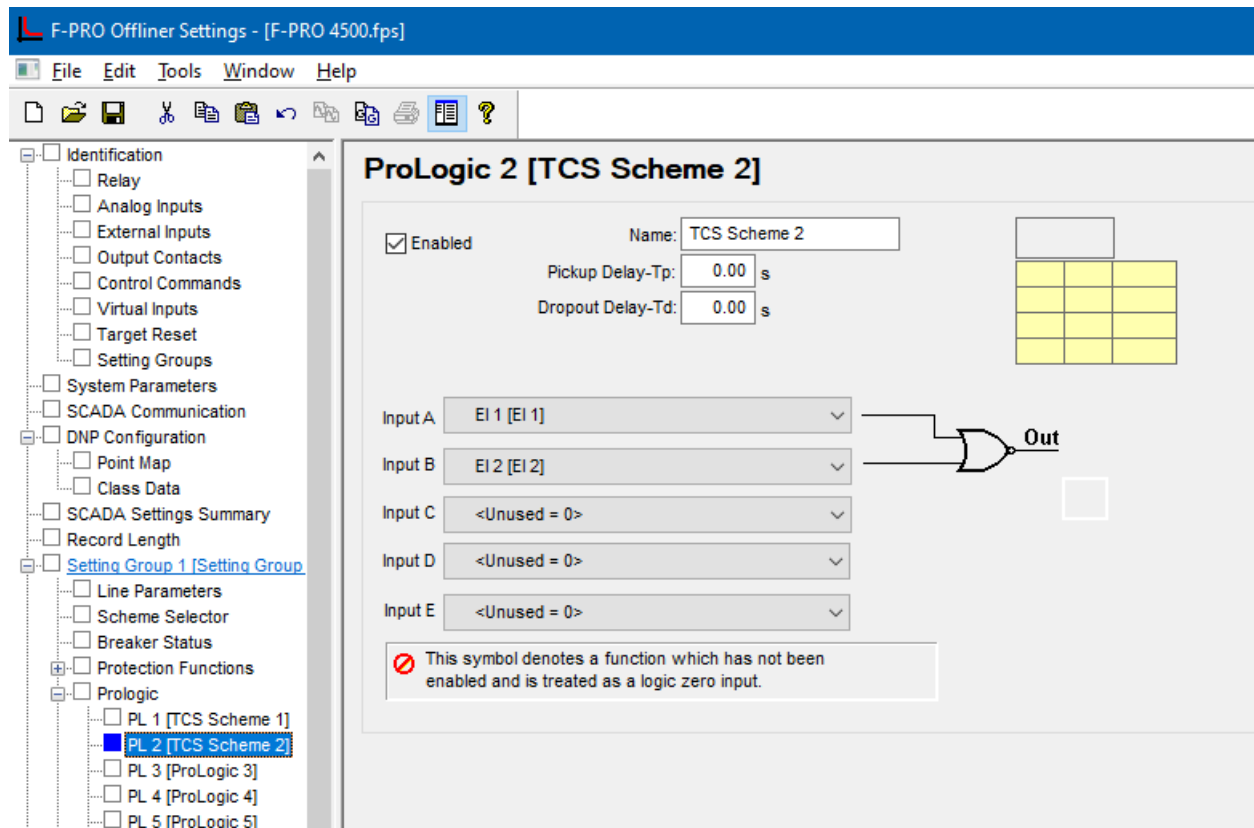


Figure 5.39: ProLogic TCS Scheme 2

The Output Contact and LED can be assigned for ProLogic 1 to generate an alarm during Trip Circuit unhealthy condition.

I²t - CB Condition

The I²t function is used for monitoring the wear and tear of the breaker due to fault interruptions. The I²t value is accumulated for every operation and stored in the non-volatile memory. The write time interval is 0.5 seconds. A fixed maximum write time of 20 seconds prevents the I²t function from constantly writing to non-volatile memory. Therefore, if the start signal is held on for longer than 20 seconds the accumulator stops accumulating and stops writing to the flash memory. The output of the I²t function is only available in the Event Log, the Output Matrix or in the ProLogic input list.

The terminal UI and SCADA interfaces show the accumulated value of each breaker I²t function and value of last operation. The terminal UI also includes the time of last reset/preset.

The following figure shows the I²t function's logic diagram. The accumulation starts when the trip coil of the breaker is energized (breaker starts to open) and is stopped when the trip coil of the breaker is de-en-

energized. The breaker open/close is determined by the tripping of the following functions:

- 37 Trip
- 50 Trip, 51 Trip
- 50N Trip, 51N Trip
- 46/50 Trip, 46/51 Trip
- 49 Trip, 49 Alarm
- 50BF Trip

The current that is used for accumulation is the maximum current among phase A, B and C. An event message is generated when the accumulated I^2t value is above the limit.

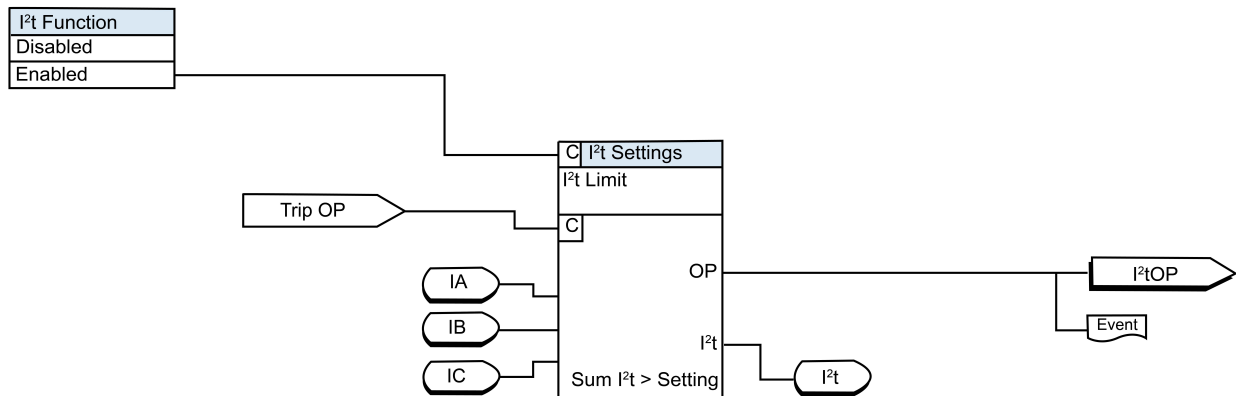


Figure 5.40: I^2T function logic diagram

Table 5.44: I^2t - CB Condition Settings

Setting Description	Setting Range
I^2t CB Condition	Enabled/Disabled
I^2t Limit	0.00s to 9.99s

Fault Locator

Whenever a fault occurs and the line trips, the fault locator calculates the fault type and the distance to the fault. This information is available from the front display of the relay or through Port 010, 51A or the SCA-DA port or through Relay Control Panel software. Fault locator information can also be captured optionally in event records. Fault locator can be enabled/disabled through settings (system parameters).

The fault locator is initiated by the following logic:

- 50/67 Trip

- 51/67 Trip
- 50N/67N Trip
- 51N/67N Trip
- 50G/67G Trip
- 51G/67G Trip

The relay fault locator uses the Takagi method of fault location. The impedance calculated for a fault initiated by any of the above functions will be calculated and compared with the line impedance to calculate distance to fault.

Adaptive Additional Delay for 50 O/C Elements

The relay provides an adaptive additional time delay (maximum 16 ms) response to the 50 O/C elements to prevent operation during RFI testing with minimal pickup set points and operation near pickup.

This adaptive delay is applied to: 50LS-1, 50LS-2, 50LS-3, 50LS-4, 50, 50N, 50G, 46/50.

If the Pickup Delay setting (T_p) < 20ms AND Pickup Level setting <

$I_{nominal}$ (nominal current), an extra 8 ms delay is added. After this 8 ms timer expires, if $I < \text{threshold}$, the second 8 ms extra delay will be added in addition to the original T_p . If $I > \text{threshold}$ after the first 8 ms timer expires, only T_p is used for the delay. (Note: T_p is the setting which is less than 20 ms, could be 0 ms).

The threshold is equal to $2 * \text{PickupLevel}$ if pickup is between

$40\% * I_{nominal}$ and $I_{nominal}$ (i.e. between 2 A and 5 A for 5 ACT). The threshold is equal to $40\% * I_{nominal}$ if $2 * \text{PickupLevel} < 40\% * I_{nominal}$. The threshold is equal to $I_{nominal}$ if $2 * \text{PickupLevel} > I_{nominal}$.

Pro Logic

Pro Logic Control Statements

Using Pro Logic, the relay can pick any of the protection functions, external inputs or virtual inputs and place them into Boolean-like statements. Pro Logic handles up to 5 functions to generate one Pro Logic statement; 24 statements are possible. The results from these statements are mapped to output contacts using the output matrix.

The Pro Logic control statements are used to create Boolean-like logic. The relay can use any of the protection functions or external inputs combined with logic gates to create a Pro Logic control statement. The possible gates are AND, NAND, OR, NOR, XOR, NXOR, and LATCH. The control can be time delay pickup and or time delay dropout, and can drive the front panel target LED. 24 Pro Logic control statements outputs are available and can be used in the output matrix to customize the relay to specific needs. Inputs to Pro Logic are all the elements plus previous Pro Logic statements for logic nesting usage.

The example, for details see 5.41 "Pro Logic" on page 5-73, shows A to E inputs are status points of devices that are user-selectable. Each Pro Logic output can be given a specific name, pickup and reset time delay.

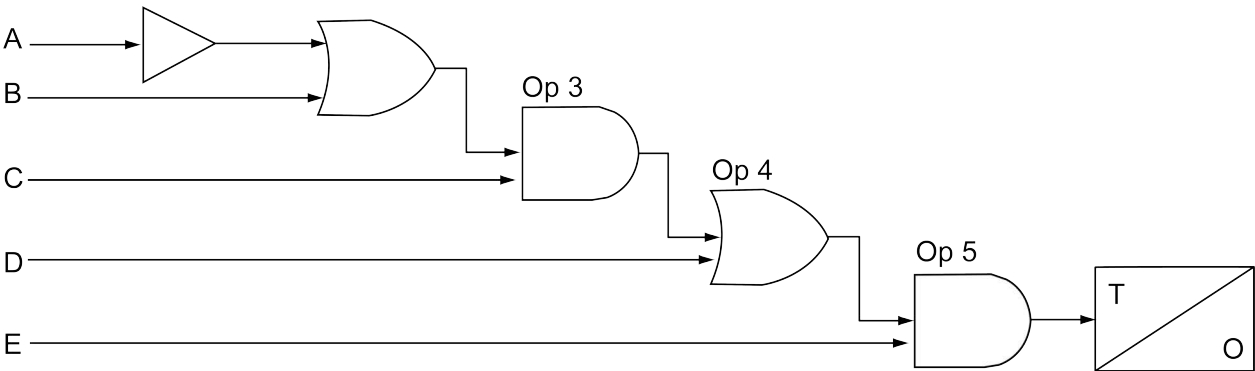


Figure 5.41: Pro Logic

Table 5.45: Pro Logic Setting Functions	
Name	Give the Pro Logic a meaningful name
Pickup Delay	Delay time from pickup to operate
Dropout Delay	Delay time from dropout to a Pro Logic status of low
A, B, C, D, E	Relay elements as input statements
Operators	Boolean-type logic gates

Group Logic

Group Logic Control Statements

The relay has 8 Setting Groups (SG). The user can change all relay setting parameters except the physical connections such as input or output parameters in each setting group. Setting group changes are performed by using any one of the 16 available Group Logic statements per setting group. The Group Logic statements are similar to the ProLogic statements with the following exceptions – the sole function is to activate one of the 8 setting groups and the processing is in a slower half second cycle. Group Logic inputs statements are driven from ProLogic or any external input or virtual input or from previous Group Logic statements. Each Group Logic statement includes 5 inputs (with Boolean statements), one latch state and one pickup delay timer. The Active Setting Group (ASG) is viewed from the Terminal Mode, the front panel or from a record stored by the relay, the ASG is stored with the record).

Group Logic Processing

The 16 Group Logic statements reside in a slower processing thread within the relay protection algorithms. The processing cycle happens once every half second (0.5 second). When using ProLogic statements remember that a latch or dropout timer should be used if the initiating condition does not last at least 0.5 seconds. In the example following, we will create a definite pulse length using ProLogic.

Default Setting Group

The relay uses Setting Group 1 as the factory default setting group and retains the current active setting group in memory. This allows the relay to use the last active setting group prior to interruption of relay power as the default setting group following power up.

Change Active Group

The user can at any time change the active setting group. When initiating a setting group change, this change takes precedence over an automatic setting group change.

The setting group can be changed using the Relay Control Panel, with either Change or Service access level, using the following path:

Relay Control Panel > Utilities > Settings Group

In this tab, choose desired setting group number and hit *Save*.

The setting group can also be changed using the relay display interface, after login in with the Change or Service access level, using the following path:

Main Menu > Utilities > Maintenance > Settings Group Control

In this screen, highlight the group number, and then hit *Edit*. Choose the desired setting group number, and then hit *Enter* with the cursor in the return character (bottom right).

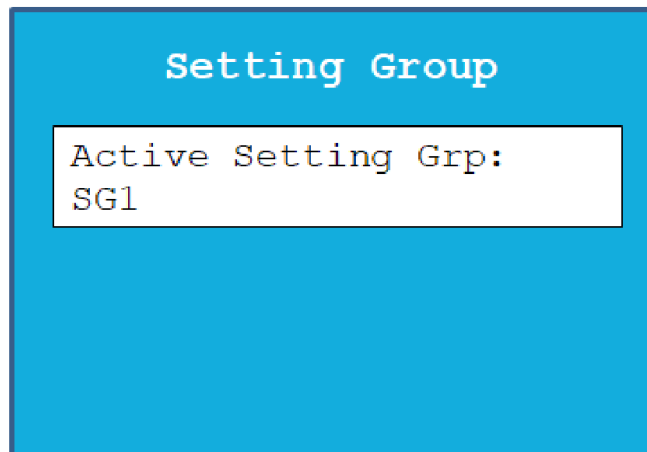


Figure 5.42: Setting Group Control

The protection processor does not have any interruption in service.

Automatic Settings Change

Relay configuration changes during a relay-initiated setting; change does not disrupt the relay protection functions. Since the relay setting file does not change, the interface processor uses the new setting group ancillary setting information at the same time as the protection processor switches to the new setting group. An event is logged to show when the new setting group is in service.

5. 2 Recording Functions

Introduction

The relay has high speed fault recording and logging functions to allow the user to analyze faults and to review the operation of the overall protection scheme. Slow speed swing recording can be used to analyze system stability. If the relay has reached its recording capacity, new records overwrite the oldest records.

Fault Recording

The relay provides DFR-quality fault recording, capturing input signal waveforms and external input states at a rate of 128 samples per cycle. Each record also contains the timing of the internal logic produced by the relay (e.g. Device 51 trip). Obtain this information by uploading the records from the relay via the Relay Control Panel file transfer process and view them with RecordBase View software.

The quantities recorded are:

- 9 analog channels (4 voltages and 5 currents) @ 128 samples/cycle which captures up to the 33rd harmonic
- External inputs @ 1 ms resolution
- Protection element output signals @ 8 samples/cycle
- ProLogic signals @ 8 samples/cycle
- Active setting group

The recorded protection element output signals include Phase segregated Start and Trip signals of the Over Current, Earth Fault, Overvoltage, Undervoltage and CB Fail Protection.

Parameters that are user-selectable with respect to recording transients:

- Record length (0.2 to 10.0 seconds => 12 to 600 cycles @ 60 Hz Base) with automatic extension to capture successive triggers
- Recorder triggering by any internal logic or external input signal (e.g. 52 A)
- Pre trigger time configurable between 0.10 to 2.00 seconds

Swing Recording

The relay records dynamic system responses allowing the user to analyze system stability and to provide a larger context for fault analysis. Swing records contain positive sequence phasor measurements and system frequency calculated at a rate of 1 phasor per cycle. Swing records can extend to 2 minutes in duration.

The quantities recorded are:

- Positive sequence voltage (magnitude)
- Positive sequence current (magnitude)
- System Frequency

The event recording provides permanent storage for the event log. The user can create an event record automatically or manually. When the event auto save is enabled, an event record is created approximately every 230 events.

Event Recording

The user can initiate an event recording manually through the Relay Control Panel.

Recording can be initiated automatically by the relay when a fault or abnormal condition is detected. Set the relay to initiate a fault record on activation of any of its trip or alarm functions or on assertion of any external digital inputs.

Record Initiation

The assignment of fault record initiation to the various relay functions is done through the relay's Output Matrix settings (see "Recording Trigger" on page 5-83).

A recording can also be initiated manually through the Relay Control Panel. The commands Trigger Fault, Trigger Swing and Trigger Event are available under the following path:

Relay Control Panel > Records

Also the relay display provides the option to initiate Fault Recording, under the following path:

Main Menu > Records > Fault Recording

A swing record can take a couple of minutes to produce due to the long post-trigger time.

Record Duration and Extension

The length of each record is determined by the Record Length setting. Fault (transient) record lengths can be set between 0.2 and 10.0 seconds; Swing record lengths can be set between 60 and 120 seconds. Pre-trigger times are configurable between 0.10 to 2.00 seconds for Fault records and fixed at 30 seconds for Swing records and are included as part of the normal record length.

The relay automatically extends a record as required to capture consecutive triggers that are close together. If a trigger occurs while a recording is in progress, the record is extended to include the full post-trigger time of subsequent triggers, up to a maximum length —12.0 seconds for Fault records; 180 seconds for Swing records. If a trigger occurs before the end of a record caused by a previous trigger, but too late to allow sufficient post-trigger time in a maximum extended record, a new overlapping record is created.

The normal record length settings are accessible under the Record Length heading of the relay settings, and can be set with the Offliner Settings software.

Record Storage

The relay compresses records on the fly, achieving a typical lossless compression rate of 4:1. As a result, the relay can store up to 150 Fault records, or up to 150 Swing records, or a combination of 150 Fault, Swing and optionally Event records. If the storage is full, new records automatically overwrite the

oldest, ensuring that the recording function is always available.

The record length and the number of events stored within the records may reduce how many records can be stored on the relay. The record storage capacity may be reduced to 80 fault records if the record duration is set to 10 seconds.

Record Retrieval and Deletion

"Record Retrieval can be done via the RCP tool where it provides a display of list of Record's available in the relay and which can be retrieved from the relay to the RCP Record's page and also store them in a predefined local folder (as Defined during IED communication setup) in PC

Record deletion can be handled in two ways:

- Manual Deletion: Performed through Delete Option in the RCP tool Record's page
- Automatic Deletion (FIFO): When the IED's internal memory reaches its maximum storage capacity, it follows a First-In, First-Out (FIFO) mechanism, where the oldest records are automatically deleted to make space for new ones."

5. 3 Event Log

The relay maintains a log of events in a 250 entry circular log. Each entry contains the time of the event plus an event description.

Logged events include trips, alarms, external input assertions plus internal events such as setting changes. Phase information is included in event messages where appropriate. For example, the event log entry for a device trip might be:

2010 Nov 21, 15:34:19.832: 51 on ABC Trip

The event log can be viewed in 2 ways:

Table 5.46: Event Log

Front Panel	The front panel display shows events in abbreviated form (Trip and Alarm events only).
Relay Control Panel	The full event log is available through the Main Menu->Events of the Relay Control Panel
SCADA	The protocols included in the relay allow all the SCADA master access to the event data from the relay (Trip and Alarm events only).

This display is a snapshot of the event list which must be manually refreshed to display new events that occur while the display is up.

There is a list of Event Messages, for details “Event Messages” in Appendix D.

Event Log Filter

The relay event log contains a 100ms pickup filter to ensure that duplicate events are not stored for the same protection function. When a protection function operates, only the first operation will be logged in the event log. If the protection function re-occurs within 100ms, it will be ignored by the event log.

5.4 Fault Log

The F-PRO stores a log of faults in a 100 entry circular log. Each entry contains the time of the fault, fault type, faulted phase, fault quantities as per the below table. Fault log will be triggered only for trip condition and it won't log for an alarm condition.

Table 5.47: Fault Log	
Fault Type	Fault Quantities
27 Main Under Voltage 59 Main Over Voltage	- Main VA/VB/VC Phasors
59 Aux Over voltage 27 Aux Under voltage	- Aux VA/VB/VC
24 Over Flux	- Main VA/VB/VC Phasors - V/F magnitude
47 NPS Over Voltage	- Main VA/VB/VC Phasors. - V2 negative Sequence Voltage Phasor
59N Zero Sequence Over Voltage	- Main VA/VB/VC Phasors - V0 Zero Sequence Voltage phasor
50-67/51-67 Phase Over Current	- Line IA/IB/IC Phasors - Fault Location - Fault Impedance & angle
50N-67/51N-67 Derived Neutral Overcurrent	- Fault Location - Fault Impedance & angle -Line Current 3I0 Zero Sequence Phasor
50G-67/51G-67 Measured Neutral Overcurrent	- Fault Location - Fault Impedance & angle - Line Current IG Phasor
46-50/46-51 NPS Overcurrent	- Line Current 3I2 Negative Sequence Phasor
49 Thermal Overload	- Line IA/IB/IC Phasors - Line Current I2 Negative Sequence Phasor
64-50/64-51 SEF/REF	- Line IA/IB/IC Phasors - Line Current ISEF Phasor

Table 5.47: Fault Log	
32 Directional Power	- Main VA/VB/VC Phasors - Line IA/IB/IC Phasors - P & Q - A/BC Quantities
81 Frequency	Main VA/VB/VC Phasors Frequency
37 Phase undercurrent / 50 BF / 50LS	- Line IA/IB/IC Phasors
60CTS	Main VA/VB/VC Phasors - Line IA/IB/IC Phasors - Line Current I2 Negative Sequence Phasor - V2 negative Sequence Voltage Phasor
60LOP	Main VA/VB/VC Phasors - Line IA/IB/IC Phasors - V2 negative Sequence Voltage Phasor - Line Current 3I0 Zero Sequence Phasor - Line Current I1 Positive Sequence Phasor
46BC	Main VA/VB/VC Phasors "Line" IA/IB/IC Phasors "Line" Current (I1/I2) Magnitude

The fault log can be viewed in three ways:

- Relay Front HMI
- Relay Control Panel interface is in the Faults tab
- 61850 SCADA protocol included in the F-PRO allow the SCADA client access to Trip event data.

5. 5 Output Matrix

The Output Matrix is a powerful, easy-to-use, single-screen tool that allows for the assignment of protection and control functions (referred to as “devices” in this section) to output contacts, recording triggers and target LEDs. The Output Matrix also provides the initiation settings for the Single Pole Tripping, Breaker Failure and the 79 Recloser functions.

The Output Matrix contains seven setting sections which will be described in detail:

- see "Device Output Contacts Logic" on page 5-82
- see "Recording Trigger Logic" on page 5-83
- see "Target LED Logic" on page 5-84
- see "Blocking & Initiation Logic" on page 5-84
- see "Pole Tripping Logic" on page 5-85
- see "94 Tripping Logic" on page 5-86
- see "Phase Indication Tripping Logic" on page 5-87

NOTE:

- 1 79B column is used to block 1Ph or 3Ph Auto Reclose. 79I column is used to initiate 3Ph Auto Reclose.
- 2 94-1Ph column is used to initiate 1Ph Auto Reclose. 94-1Ph (Single Pole Trip) selection is valid only for the following functions to initiate single pole tripping. Rest of the functions will lead for three pole trip even if the selection is 1Ph.
- 51 Trip, 50 Trip, 51N Trip, 50N Trip, 51G Trip, 50G Trip, 50LS Trip.

	Output Contact																																Block & Initiate			94	Recording		Target LED	External Blocking																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	79B	79I	BFI	1Ph	3Ph	Fault			Swing																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Figure 5.43: Output Matrix

Device Output Contacts

The Device Output Contact section of the Output Matrix allows for easy assignment of output contacts to devices. The same output contact may be assigned to multiple devices.

The assigned output contact will operate when the associated device transitions to a High state. Each Output Contact can be configured as Self Reset, Latched or Pulse reset type. For more details see "Output Contacts Logic" on page 7-12.

[illegible]

Figure 5.44: Device Output Contact assignment

Recording Trigger

The Recording Trigger section of the Output Matrix allows for devices to be assigned to initiate Fault and/or Swing recordings. When the assigned device transitions to a High state, the recording is immediately initiated. see "Recording Functions Logic" on page 5-76 for more details on the recording functions.

[illegible]

Figure 5.45: Recording Trigger assignment

Target LED

The Target LED section of the Output Matrix allows for the front-panel Target LEDs to be assigned to devices via the use of a drop-down box for each device. The LEDs may be set to operate with or without “Target Latching” enabled (see “Target LED Reset Type Logic” on page 4-14).

Note: The “Target LED” function enables both the front panel LEDs and the event pop-up message on the front panel LCD screen. If no LED is assigned to the protection device, then there will be no target event pop-up messages displayed on the LCD screen for that device.

	Output Contact																																Block & Initiate			94		Recording		Target LED			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	79B	79I	8FI	1Ph	3Ph	Fault	Swing				
Poles																																											
Pole A Trip																																											
Pole B Trip																																											
Pole C Trip																																											
Phase																																											
Phase A																																											<None>
Phase B																																											<None>
Phase C																																											<None>
Ground																																											<None>
Device																																											
27DT-1 Main Alarm																																											Alarm LED
27DT-2 Main Alarm																																											Alarm LED
27DT-3 Main Alarm																																											<None>
27DT-4 Main Alarm																																											<None>
27DT-1 Main Trip																																											Target LED 1
27DT-2 Main Trip																																											Target LED 2
27DT-3 Main Trip																																											<None>
27DT-4 Main Trip																																											<None>
27DT-1 Aux Alarm																																											Alarm LED
27DT-2 Aux Alarm																																											Alarm LED
27DT-3 Aux Alarm																																											<None>
27DT-4 Aux Alarm																																											<None>
27DT-1 Aux Trip																																											Target LED 3
27DT-2 Aux Trip																																											Target LED 4
27DT-3 Aux Trip																																											<None>
27DT-4 Aux Trip																																											<None>
27IT-1 Main Alarm																																											<None>
27IT-2 Main Alarm																																											

Figure 5.46: Target LED assignment

Blocking & Initiation

The Blocking & Initiation section of the Output Matrix is used to assign devices to block and initiate the Recloser and Breaker Failure functions.

The 79I (initiate) and 79B (block) columns are used to assign devices to either initiate a 3-Phase 79 Recloser sequence or to block the 1/3 Phase 79 Recloser from operating. Monitor the Logic 4 metering screen to directly view the status of the 79 initiate and 79 block.

The BFI column is used to assign protection functions to initiate the 50BF function.

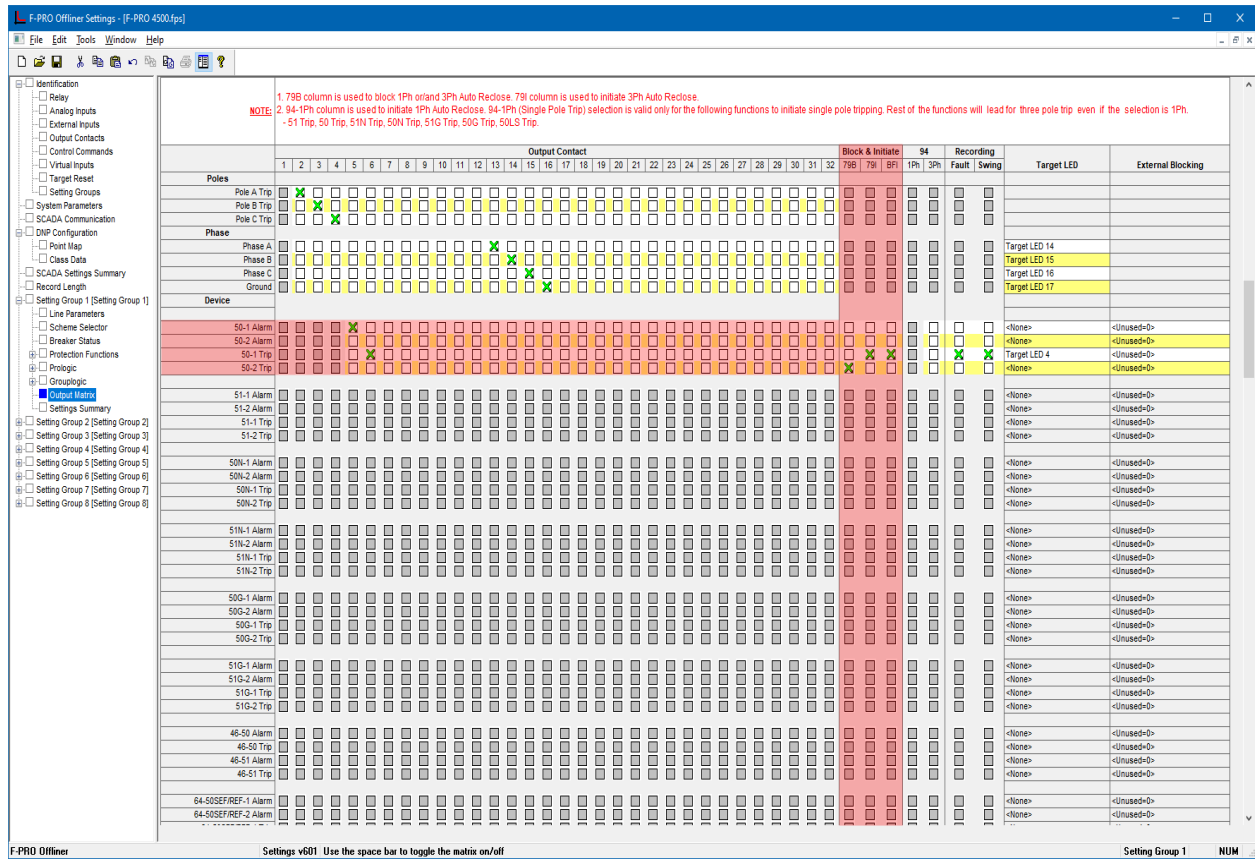


Figure 5.47: Blocking and Initiation assignment

Pole Tripping

The “Poles” setting in the Output Matrix is used in conjunction with the 79 Recloser and 94 Tripping functions for single or three-phase Pole tripping. The Pole tripping operation directly follows the operation of the 94 tripping function. When a 94 1-Ph trip occurs, the corresponding Pole output contact operates. When a 94 3-Ph trip occurs, all three Pole output contacts operate. see "94 Tripping Logic" on page 5-86 for a list of functions that support Single Pole Tripping (SPT).

If pole tripping is enabled for a particular output contact, that output contact may not be assigned to any other function. For example, you may not assign both Pole A Trip and 50 Trip to output contact 2, as shown in Figure 5.48: Pole Tripping assignment.

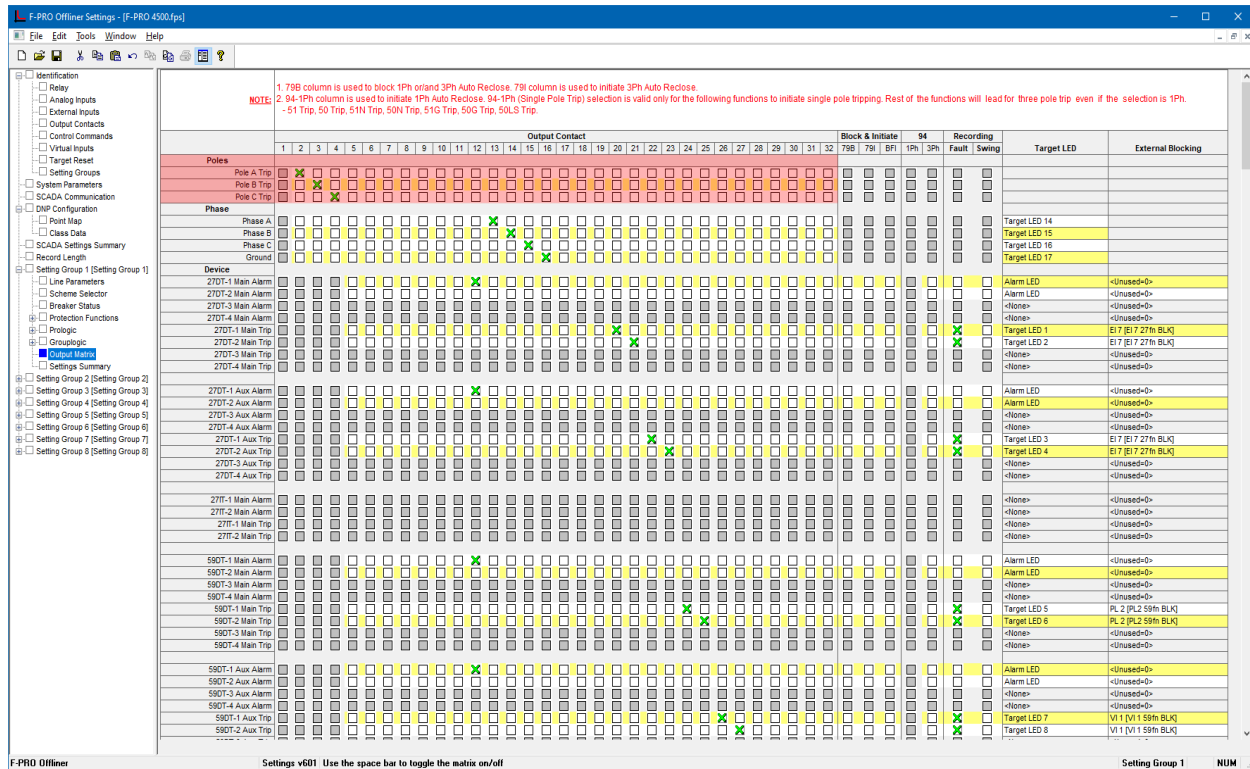


Figure 5.48: Pole Tripping assignment

94 Tripping

The Output Matrix provides the ability to assign devices to trip a 94 Tripping function which is used to initiate single pole tripping and as the internal initiation for the 79 1-Ph Recloser. Any device may be assigned to the 94 1-Ph or the 94 3-Ph outputs, however, only the devices listed in the table below are capable of initiating a 94 1-Ph trip. All other devices (those not listed in the table) will cause a 3-Ph trip. The 94 Tripping function follows the logic shown in Figure 5.49: 94 Tripping Logic, and acts as an internal initiator for the 79-1Ph Recloser.

The 94 tripping outputs are not directly displayed in the event log, metering or targets, but they can be monitored by assigning the 94 phase-wise outputs to ProLogic functions. The Pole A/B/C trips are available in shown event log.

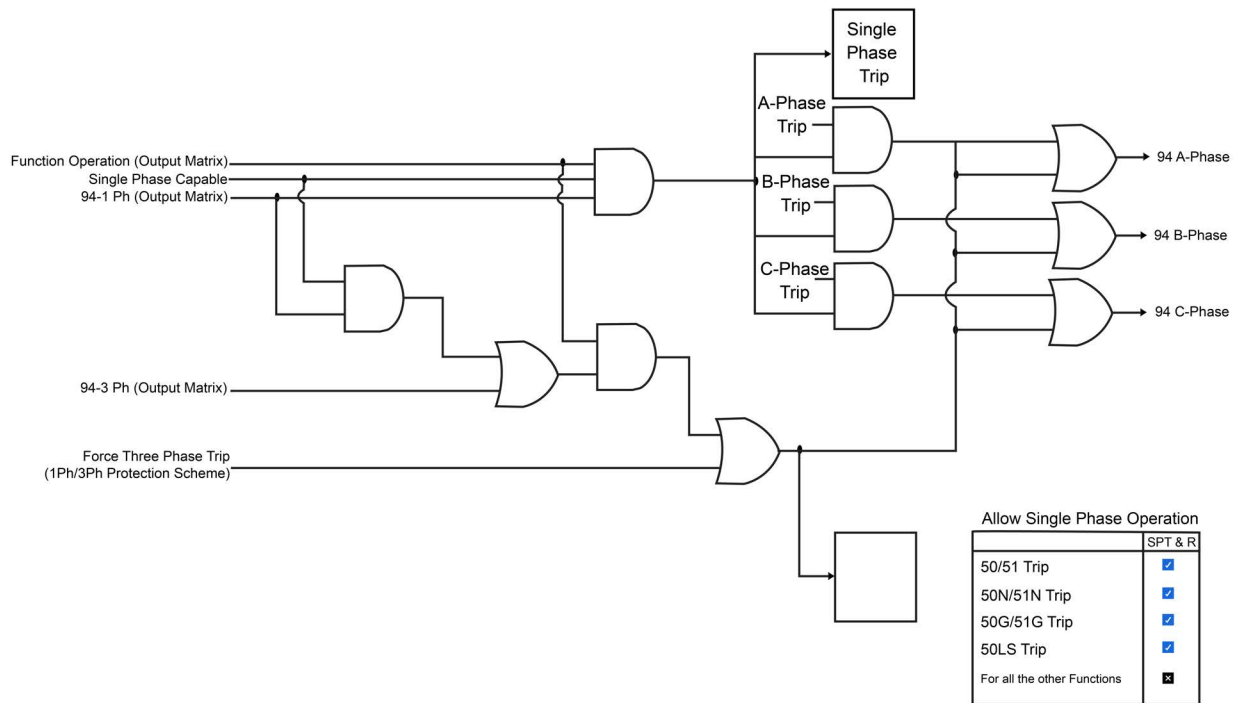


Figure 5.49: 94 Tripping Logic

Phase Indication Tripping

The Phase Indication Tripping function is used to provide phase indication for protection function operation via the output contacts and target LEDs. The user may assign any output contact or LED to Phase A, Phase B, Phase C or Ground. When a trip occurs for a supported protection function (see "Supported Phase Indication Tripping Functions Logic" on page 5-87), the assigned Phase output contact and LED will operate.

Table 5.48: Supported Phase Indication Tripping Functions

Protection Function	Phase Indications Available
50 Trip, 51 Trip	A, B, C
50N Trip, 51N Trip	A, B, C, G
50BF Main-1 Trip, 50BF Main-2 Trip,	A, B, C

For any supported protection device, the user may assign both normal device output contacts and phase indication output contacts. If the relay is configured as shown in Figure 5.50: Phase Indication Tripping assignment, when a 50 AB Trip occurs:

- Phase A Output Contact 13 and Phase B Output Contact 14 will operate
- Phase A Target LED 14 and Phase B Target LED 15 will turn on

[illegible]

Figure 5.50: Phase Indication Tripping assignment

External Blocking

The External Blocking column of the Output Matrix provides the ability to block the respective protection function operation completely (no event log, LED indication, SCADA reporting etc.). Any External Input, ProLogic or Virtual Input can be used to block protection functions.

[illegible]

Figure 5.51: : External Blocking

6 Data Communications

Section 6 deals with data communications with the relay. First, the SCADA protocol is discussed, and it is then followed by the IEC 61850 communication standard.

The SCADA protocol deals with the Modbus and DNP (Distributed Network Protocol) protocols. The SCADA configuration and its settings are described. The parameters for SCADA communications are defined using F-PRO 4500 Offliner software. Finally, details on how to monitor SCADA communications for maintenance and troubleshooting of the relay are given.

6. 1 SCADA Protocol

Modbus Protocol

The relay supports either a Modbus RTU or Modbus ASCII SCADA connection. Modbus is available exclusively via a direct serial link. Serial Modbus communications can be utilized exclusively via the serial port (Port 52), an RS-485 terminal block port located on the back of the relay. An external RS-485 to RS-232 converter can be used to connect the relay to an RS-232 network. For details on connecting to serial Port, see "Communicating with the Relay" on page 3-4 see "Accessing the Relay's SCADA Services" on page 3-12 and see "Communication Port Details" on page 3-13.

The data points available for Modbus SCADA interface are fixed and are not selectable by the user. Complete details regarding the Modbus protocol emulation and data point lists can be found in "Modbus Communication Protocol" .

DNP Protocol

The relay supports a DNP3 (Level 2) SCADA connection. DNP3 is available via a direct serial link or an Ethernet LAN connection using either TCP or UDP.

Serial DNP communications can be utilized exclusively via the serial port (Port 52), an RS-485 terminal block port located on the back of the relay. An external RS-485 to RS-232 converter can be used to connect the relay to an RS-232 network. For details on connecting to serial port, see "Communicating with the Relay" on page 3-4, see "Accessing the Relay's SCADA Services" on page 3-12 and see "Communication Port Details" on page 3-13.

The data points available for DNP SCADA interface are user configurable. Complete details regarding the DNP3 protocol emulation and data point lists can be found in “DNP3 Device Profile”

SCADA Configuration and Settings

The parameters for SCADA communications may be defined using F-PRO 4500 Offliner.

If DNP3 LAN/WAN communications were chosen, the relay’s network parameters need to be defined. This is done via the Maintenance interface. Note that this effort may already have been completed as part of the steps taken to establish a network maintenance connection to the relay.

1. Establish a TUI session with the relay and login as **maintenance**. The following screen appears.

```

COM7 - F-PRO 4500 VT
File Edit Setup Control Window Help
F-PRO 4500 System Utility
ERLPhase Power Technologies LTD.
Customer support: <204> 477-0591, support@erlphase.com

1 : *Modify IP Address, subnet mask and default gateway <if applicable>
2 : View system diagnostics
3 : Retrieve system diagnostics
4 : *Restore ALL default settings, including calibration and password
5 : *Restore only default configuration settings
   (channel definitions, device settings)
6 : *Restore only default system setup (ports, time settings)
7 : *Force hardware reset
8 : Network utilities
9 : Monitor SCADA
10: Exit

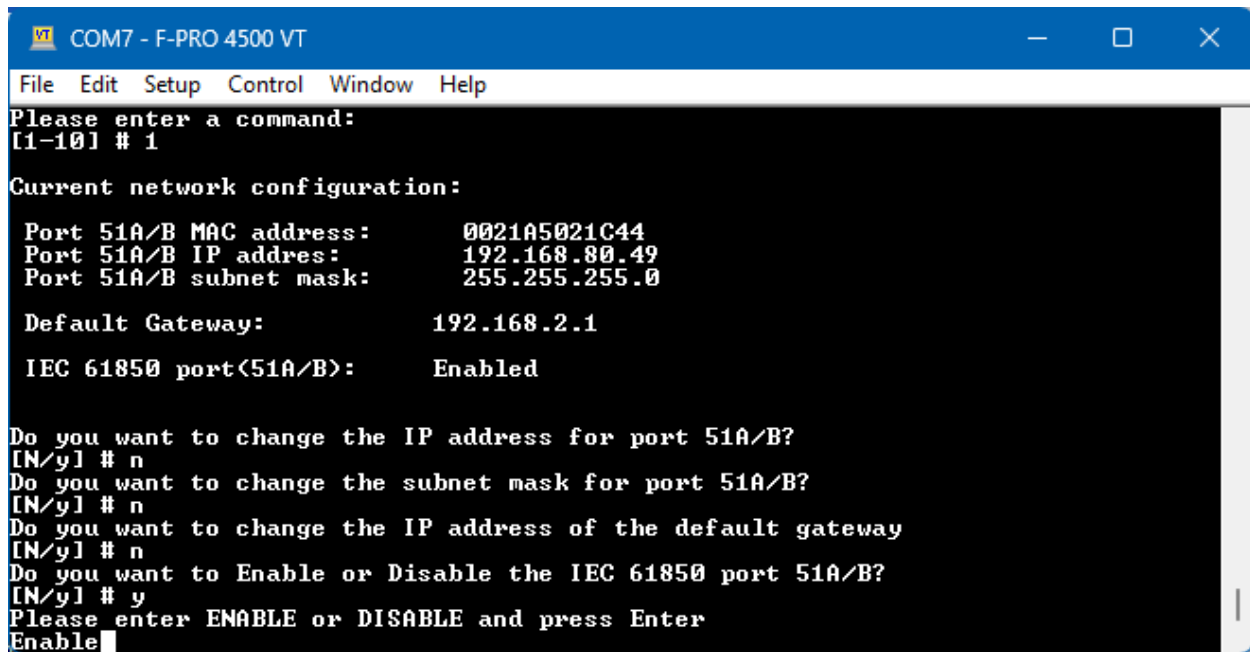
* port 010 access only

Please enter a command:
[1-10] #

```

Figure 6.1: F-PRO 4500 System Utility

2. Select the first option by entering the number 1 followed by Enter. The following screen appears.



```
COM7 - F-PRO 4500 VT
File Edit Setup Control Window Help
Please enter a command:
[1-10] # 1

Current network configuration:

Port 51A/B MAC address:      0021A5021C44
Port 51A/B IP address:       192.168.80.49
Port 51A/B subnet mask:     255.255.255.0

Default Gateway:             192.168.2.1
IEC 61850 port(51A/B):      Enabled

Do you want to change the IP address for port 51A/B?
[N/y] # n
Do you want to change the subnet mask for port 51A/B?
[N/y] # n
Do you want to change the IP address of the default gateway
[N/y] # n
Do you want to Enable or Disable the IEC 61850 port 51A/B?
[N/y] # y
Please enter ENABLE or DISABLE and press Enter
Enable
```

Figure 6.2: Change the network parameters as needed for the particular application

Offliner SCADA Configuration

Details on using the Offliner software are available in “F-PRO Offliner Setting Software” on page 7-2. Details on downloading a completed settings file to the relay are available in “Sending a Setting File to the Relay” on page 7-6.

Open the Offliner application according to the instructions found in the indicated section and highlight the SCADA Communication selection. The screen appears as follows.

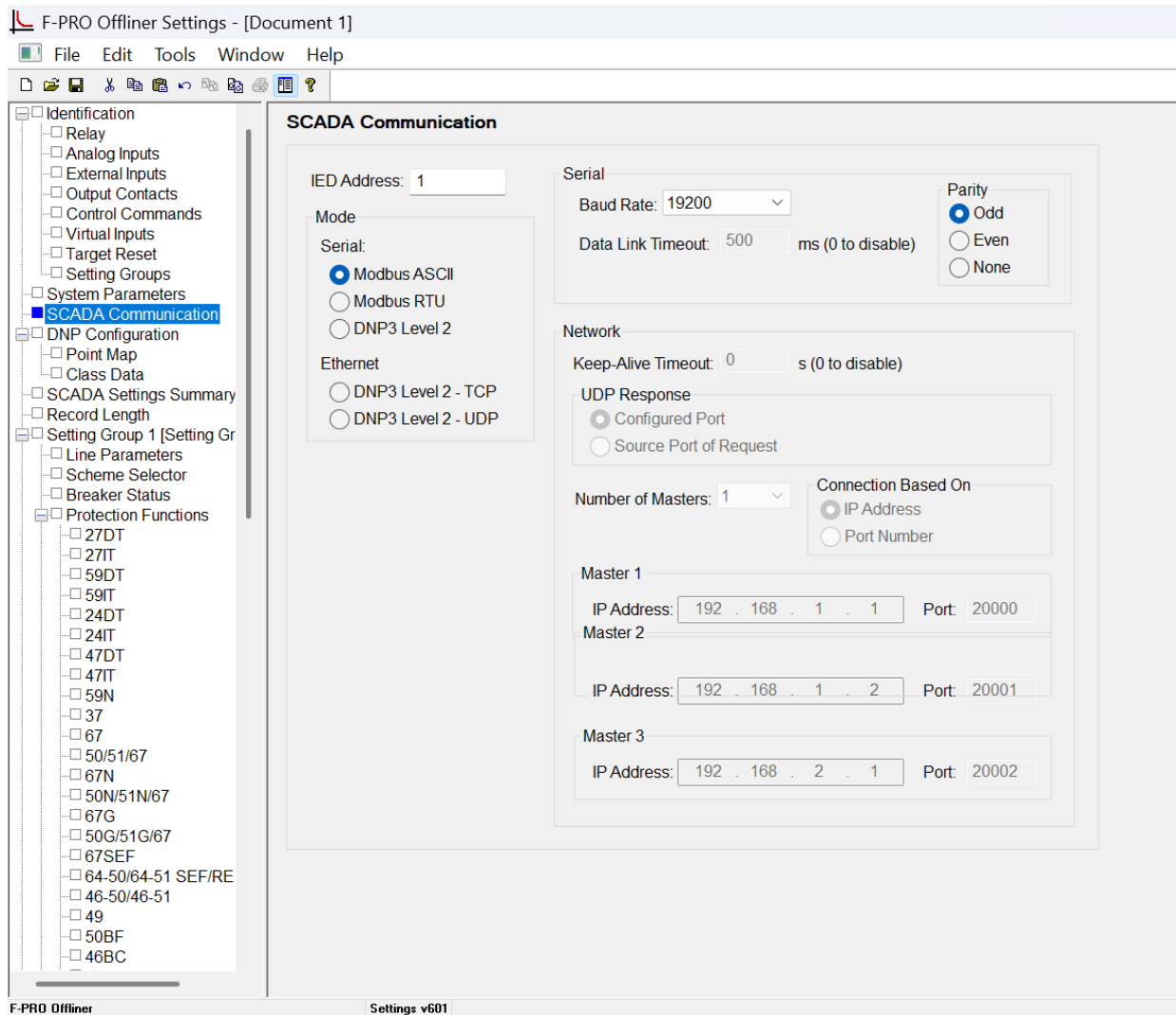


Figure 6.3: SCADA Communications

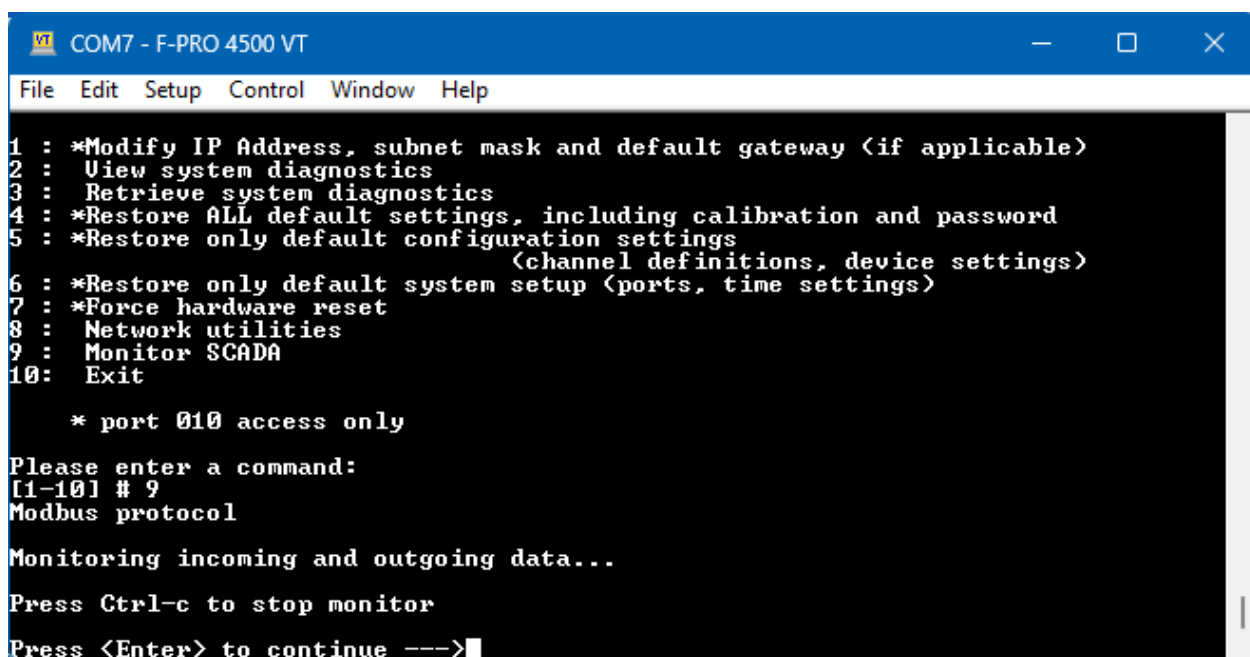
The configuration of SCADA communication parameters via the Offliner application is very intuitive. Several settings options are progressively visible and available depending on other selections. No Configuration available in the offliner tool as the values for the number of data and stop bits are fixed as given below

- Modbus Serial – 7 data bits, 1 stop bit
- DNP Serial – 8 data bits, 1 stop bit

Monitoring SCADA Communications

The ability to monitor SCADA communications directly can be a valuable commissioning and troubleshooting tool. It assists in resolving SCADA communication difficulties such as incompatible baud rate or addressing. The utility is accessed through the Maintenance user interface.

1. Establish a TUI session with the relay and login as maintenance.
2. Select option 9 by entering the number 9 followed by *Enter*. The following screen appears.



```

COM7 - F-PRO 4500 VT
File Edit Setup Control Window Help
1 : *Modify IP Address, subnet mask and default gateway <if applicable>
2 : View system diagnostics
3 : Retrieve system diagnostics
4 : *Restore ALL default settings, including calibration and password
5 : *Restore only default configuration settings
   (channel definitions, device settings)
6 : *Restore only default system setup <ports, time settings>
7 : *Force hardware reset
8 : Network utilities
9 : Monitor SCADA
10: Exit

    * port 010 access only

Please enter a command:
[1-10] # 9
Modbus protocol

Monitoring incoming and outgoing data...

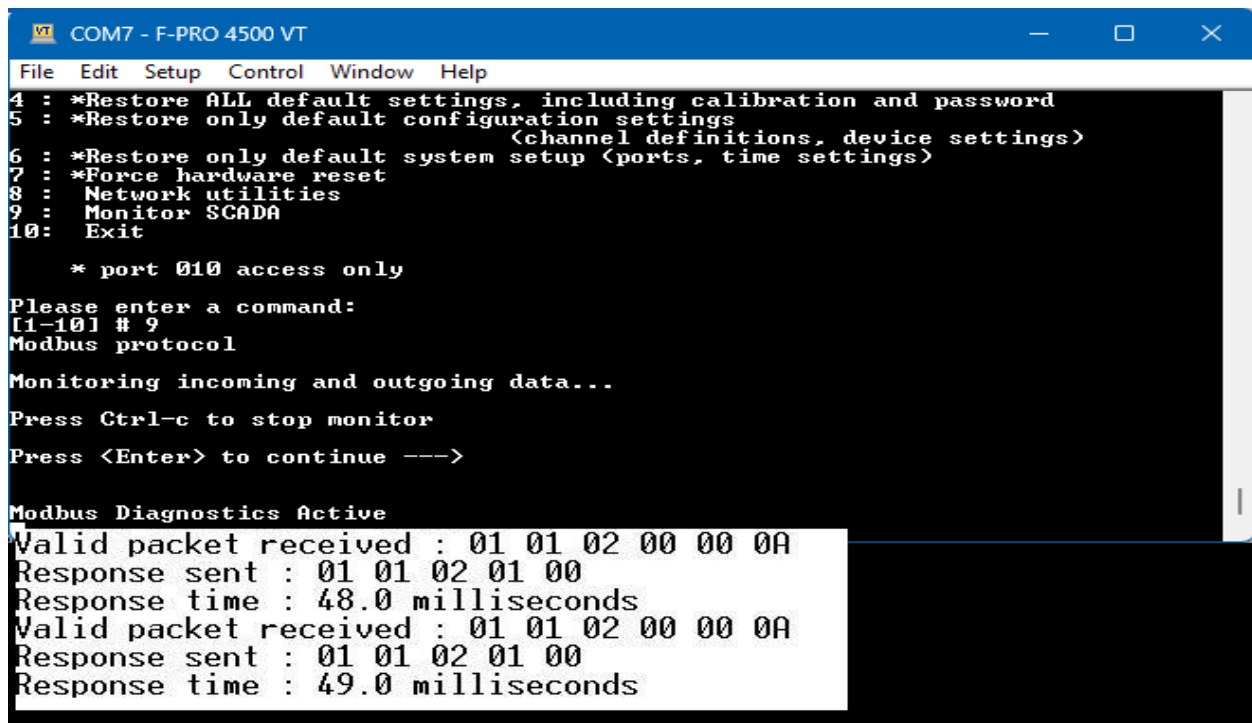
Press Ctrl-c to stop monitor

Press <Enter> to continue --->

```

Figure 6.4: Select option 9 – Monitor SCADA

3. Pressing the *Enter* key results in all SCADA communications characters to be displayed as hexadecimal characters.



```
COM7 - F-PRO 4500 VT
File Edit Setup Control Window Help
4 : *Restore ALL default settings, including calibration and password
5 : *Restore only default configuration settings
   (channel definitions, device settings)
6 : *Restore only default system setup (ports, time settings)
7 : *Force hardware reset
8 : Network utilities
9 : Monitor SCADA
10: Exit

   * port 010 access only

Please enter a command:
[1-10] # 9
Modbus protocol

Monitoring incoming and outgoing data...

Press Ctrl-c to stop monitor
Press <Enter> to continue --->

Modbus Diagnostics Active
Valid packet received : 01 01 02 00 00 0A
Response sent : 01 01 02 01 00
Response time : 48.0 milliseconds
Valid packet received : 01 01 02 00 00 0A
Response sent : 01 01 02 01 00
Response time : 49.0 milliseconds
```

Figure 6.5: SCADA monitoring with Modbus Protocol

4. Press *Ctrl-C* to end the monitor session.

6.2 IEC 61850 Communication

The F-PRO 4500 is an IEC 61850 enabled device. For details on the IEC 61850 implementation on the F-PRO 4500, refer to “IEC 61850 Implementation Overview” on page 8-1. Also, refer to Appendix L for the relevant conformance statements and data mapping specification.

Enabling IEC61850 Communication

The IEC61850 port must be enabled in order to use the IEC61850 communication protocol on the IED. The IEC61850 port is enabled or disabled using the relay’s Maintenance menu. see "Use HyperTerminal to Access the Relay’s Maintenance Menu" on page 3-7 for more details on the use of the Maintenance Menu.

To enable the IEC61850 port:

1. Establish a TUI session with the relay and login as **maintenance**. The following screen appears.

```

COM7 - F-PRO 4500 VT
File Edit Setup Control Window Help

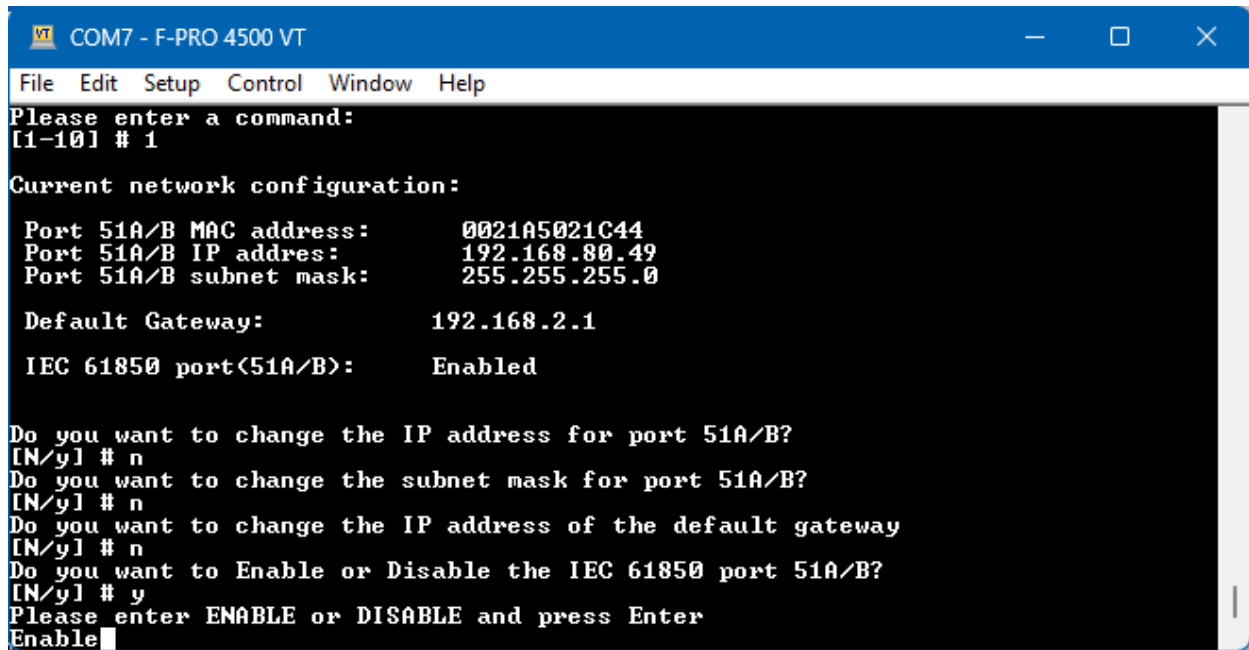
F-PRO 4500 System Utility
ERLPhase Power Technologies LTD.
Customer support: <204> 477-0591, support@erlphase.com

1 : *Modify IP Address, subnet mask and default gateway (if applicable)
2 :   View system diagnostics
3 :   Retrieve system diagnostics
4 : *Restore ALL default settings, including calibration and password
5 : *Restore only default configuration settings
   (channel definitions, device settings)
6 : *Restore only default system setup (ports, time settings)
7 : *Force hardware reset
8 :   Network utilities
9 :   Monitor SCADA
10:   Exit

* port 010 access only
  
```

Figure 6.6: Maintenance Interface

2. Select the first option by entering the number 1 followed by <Enter>. The following screen appears. Follow the prompts to enable the IEC61850 port as shown in Figure 6.69:

A screenshot of a terminal window titled "COM7 - F-PRO 4500 VT". The window has a menu bar with "File", "Edit", "Setup", "Control", "Window", and "Help". The terminal text shows a prompt "Please enter a command:" followed by "[1-10] # 1". Below this, it displays "Current network configuration:" with the following details: "Port 51A/B MAC address: 0021A5021C44", "Port 51A/B IP address: 192.168.80.49", "Port 51A/B subnet mask: 255.255.255.0", "Default Gateway: 192.168.2.1", and "IEC 61850 port(51A/B): Enabled". Then, it asks "Do you want to change the IP address for port 51A/B?" with "[N/y] # n", "Do you want to change the subnet mask for port 51A/B?" with "[N/y] # n", "Do you want to change the IP address of the default gateway" with "[N/y] # n", and "Do you want to Enable or Disable the IEC 61850 port 51A/B?" with "[N/y] # y". Finally, it says "Please enter ENABLE or DISABLE and press Enter" and shows "Enable" with a cursor at the end.

```
COM7 - F-PRO 4500 VT
File Edit Setup Control Window Help
Please enter a command:
[1-10] # 1

Current network configuration:

Port 51A/B MAC address:      0021A5021C44
Port 51A/B IP address:       192.168.80.49
Port 51A/B subnet mask:      255.255.255.0

Default Gateway:             192.168.2.1
IEC 61850 port(51A/B):      Enabled

Do you want to change the IP address for port 51A/B?
[N/y] # n
Do you want to change the subnet mask for port 51A/B?
[N/y] # n
Do you want to change the IP address of the default gateway
[N/y] # n
Do you want to Enable or Disable the IEC 61850 port 51A/B?
[N/y] # y
Please enter ENABLE or DISABLE and press Enter
Enable
```

Figure 6.7: Change the network parameters as needed for the particular application

Note that unit's IP address can be used on the IEC61850 client side for unique unit identification instead of a physical device "PD Name". The publisher configuration is defined in the ICD file and available for reading to any IEC61850 client. IEC61850 configuration is configured using the ERL 61850 Configurator Tool software. Subscriber functionality is fixed and supported for the Virtual Inputs only.

7 Settings and Analysis Software

Introduction

This section describes the supporting software used to set the relay parameters and to analyze records. There are three main software tools used for these purposes: F-PRO Offliner Setting Software, RecordGraph and ERL 61850 IED Configurator. The F-PRO Offliner software will be described at length, while the RecordGraph and ERL 61850 IED Configurator tools will be briefly introduced.

F-PRO Offliner is used to configure all of the protection and system parameter variables on the IED. Setting files are created locally on a personal computer with the Offliner software and then are sent to the IED through Relay Control Panel (4. 4" Relay Control Panel (RCP) on page 4) via a communication link (3. 4" Communicating with the Relay on page 3).

RecordGraph is a powerful record analysis tool used to analyze both high-speed Fault Recordings and low-speed Swing Recordings. RecordGraph provides many useful tools including fault impedance plotting and harmonic analysis.

The ERL 61850 IED Configurator is used to configure ERLPhase IEC 61850 based devices for substation automation. This tool helps the user to map data from remote GOOSE into ERLPhase IED data, to perform GOOSE mapping from ERLPhase IEDs to other devices and to map the required RCB (Report Control Block) datasets for SCADA.

7. 1 F-PRO Offliner Setting Software

Introduction

F-PRO Offliner is used to configure all of the protection and system parameter variables on the IED. The following section provides a full breakdown of the user interface and all of the features available within the software.

More detailed information about relay settings and protection functions are provided in Chapter5.

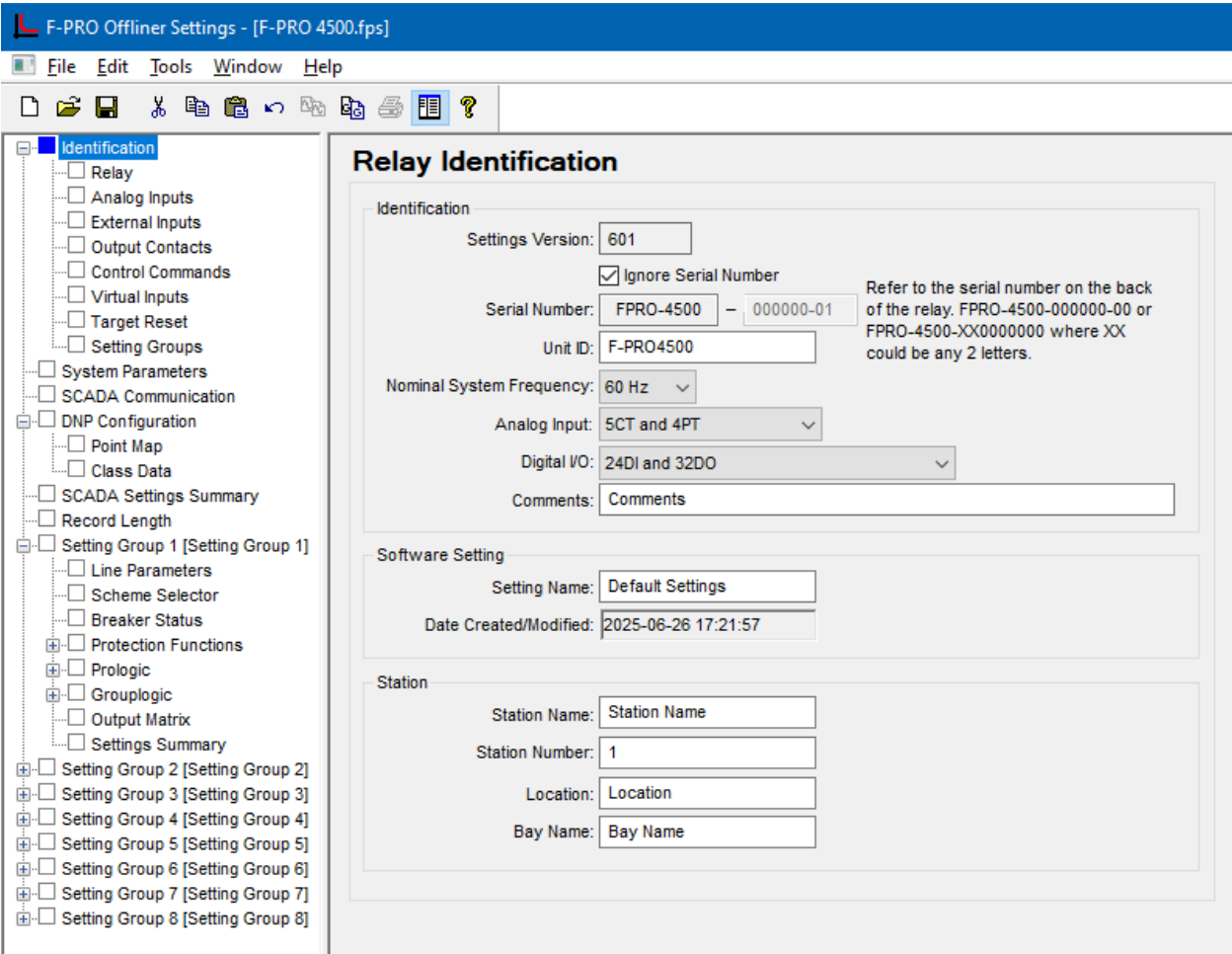


Figure 7.1: F-PRO Offliner Software

Toolbar and Menu Structure

The Offliner software includes the following menu and system tool bar.

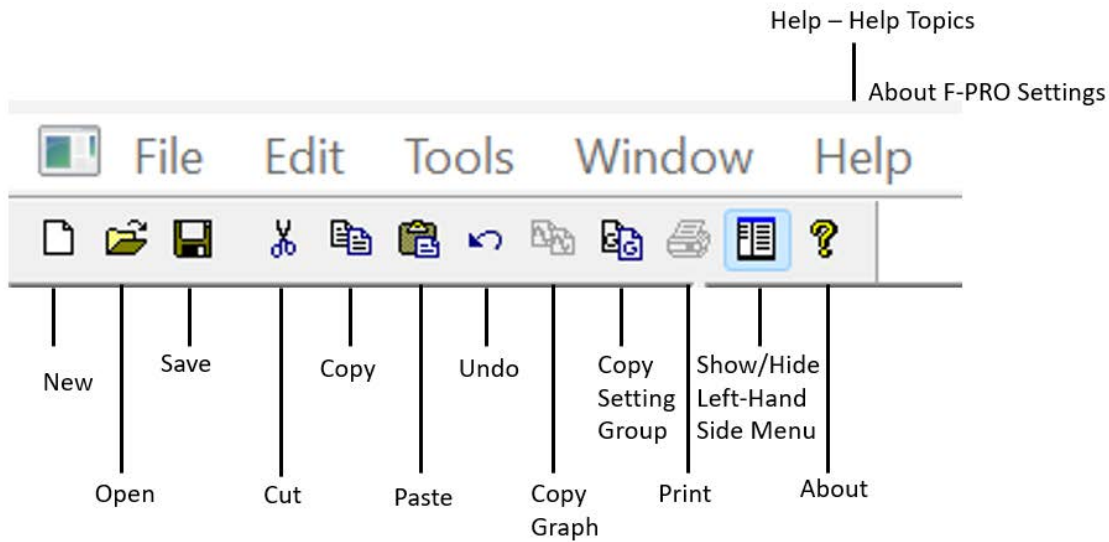


Figure 7.2: Top Tool Bar

Table 7.1: Windows Menu

Windows Menu	Sub Menu	Comment
File Menu	New	Opens up a default setting file of the most recent setting version
	Open	Open an existing setting file
	Close	Closes the active Offliner setting document
	Save	Saves the active setting file
	Save As	Saves the active setting file with a new name or location
	Convert to Newer	Convert an older setting version to a newer version.
	Print	Prints graphs or setting summary depending on active screen
	Print Preview	Provides a print preview of the setting summary
	Print Setup	Changes printers or print options

Table 7.1: Windows Menu

	1-8	The eight most recently accessed setting files
	Exit	Quits the program
Edit Menu	Undo	Undo last action
	Cut	Cut the selection
	Copy	Copy the selection
	Paste	Insert clipboard contents
	Copy Graph	Copy the graph for the active screen to the clipboard
	Copy Setting Group	Copy values from one Setting Group to another
Tools	Options	Setting summary print selection
Window	Cascade	Cascades all open windows
	Tile	Tiles all open windows
	Hide/Show Tree	If this option is checked then the LHS Tree view will be hidden
	1-9, More Windows	Allows access to all open Offliner setting files. The active document will have a check beside it
Help	User Manual	Displays the user manual
	About Offliner	Displays the Offliner version
Toolbar		
New	Create a new document.	Create a new document of the most recent setting version
Open	Open an existing document	Open an existing document
Save	Save the active document	Save the active document.
Cut	Cut selection	Cut selection
Copy	Copy the selection	Copy the selection
Paste	Insert clipboard contents	Insert clipboard contents
Undo	Copy graph to clipboard	Undo last action
Copy Graph		Copy the graph for the active screen to the clipboard

Table 7.1: Windows Menu

Copy Setting Group	Copy values from one Setting Group to another.	Brings up the Copy Inputs dialog box
Show/Hide LHS Tree		If this option is checked then the LHS Tree view will be hidden
Print	Print active document	Prints Graphs or the setting summary, depending on which seen is selected
About	Display program information	Displays the Offliner version

Offliner Keyboard Shortcuts

The following table lists the keyboard shortcuts that Offliner provides.

Table 7.2: Keyboard Shortcuts

Ctrl+N	Opens up a default setting file of the most recent setting version
Ctrl+O	Open an existing setting file
Ctrl+S	Saves the active setting file
Ctrl+Z	Undo
Ctrl+X	Cut
Ctrl+C	Copy
Ctrl+V	Paste
Ctrl+F4	Closes the active Offliner setting document
Ctrl+F6	Switches to the next open Offliner setting file, if more than one setting file is being edited
F6	Toggles between the LHS Tree view and HRS screen
F10, Alt	Enables menu keyboard short-cuts
F1	Displays the user manual

Graphing Protection Functions

Grid On/Grid Off

The graph can be viewed with the grid on or off by clicking the Grid On or Grid Off button. A right-click on the trace of the curve gives the user the x and y coordinates.

Refresh

This button will manually refresh the graph if it has been zoomed.

Print Graph

To print a particular graph, click the *Print Graph* button.

Zoom on Graphs

Graphs can be zoomed to bring portions of the traces into clearer display. Left- click on any graph and drag to form a small box around the graph area. When the user releases the mouse, the trace assumes a new zoom position determined by the area of the zoom coordinates.

To undo the zoom on the graph, click the Refresh button.

Displaying Co-ordinates

At any time the user may right-click on the graph to display the co-ordinates of the point the user selected.

Sending a Setting File to the Relay

Loading setting files to the IED is performed on the Configurations screen in Relay Control Panel. To send a setting file to the relay, select a setting file from the Saved Settings list and then press the figure does not highlight load to relay box in Figure 7.3). Make sure the settings version and the serial number of the relay in the setting file match. The relay will reject the setting file if either the serial number or the settings version do not match.

A “serial number discrepancy” message may appear. This is to ensure that the user is aware of the exact relay in which settings are to be loaded. If this happens, check the relay serial number on the Utilities > Unit Identification. Type this serial number into the F-PRO Serial No. box in the Identification tab display area of Offliner Settings. Alternately the user may check the Ignore Serial Number check box to bypass serial number supervision.

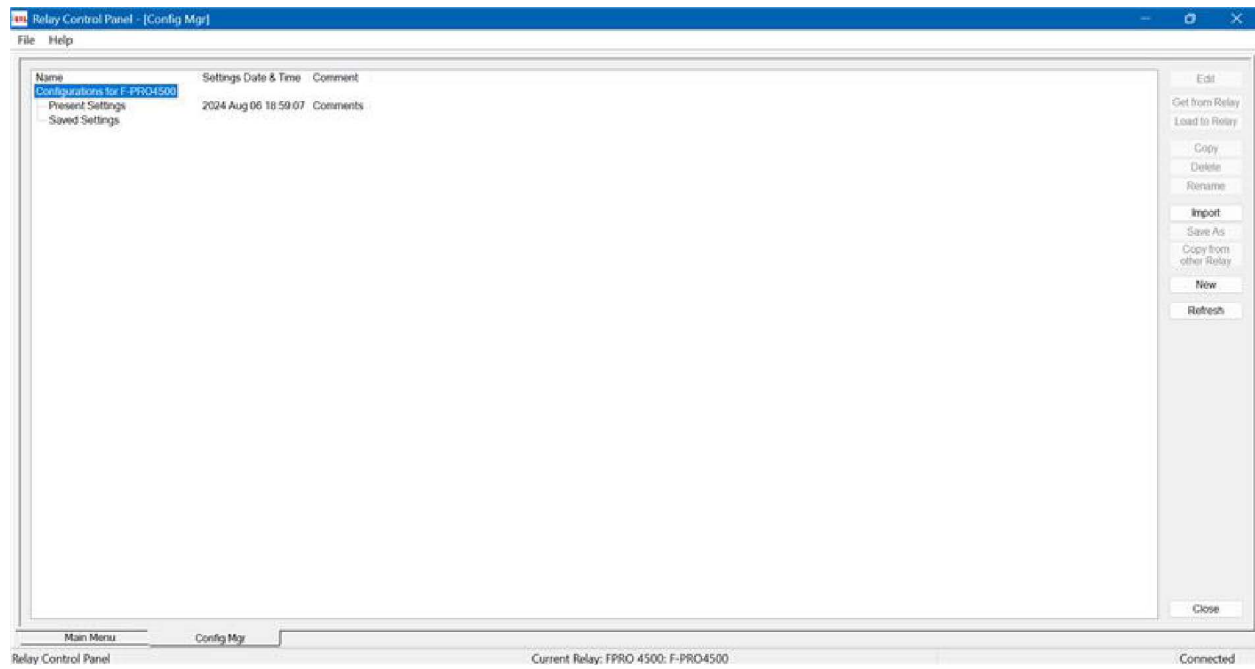


Figure 7.3: RCP Configuration screen

Tree View - Introduction

The following sections describe the tree view, which provide access to the various setting screens. This section will not describe individual settings, but will provide a general description of where to find the individual settings. For a detailed description of the individual settings see Chapter 5.

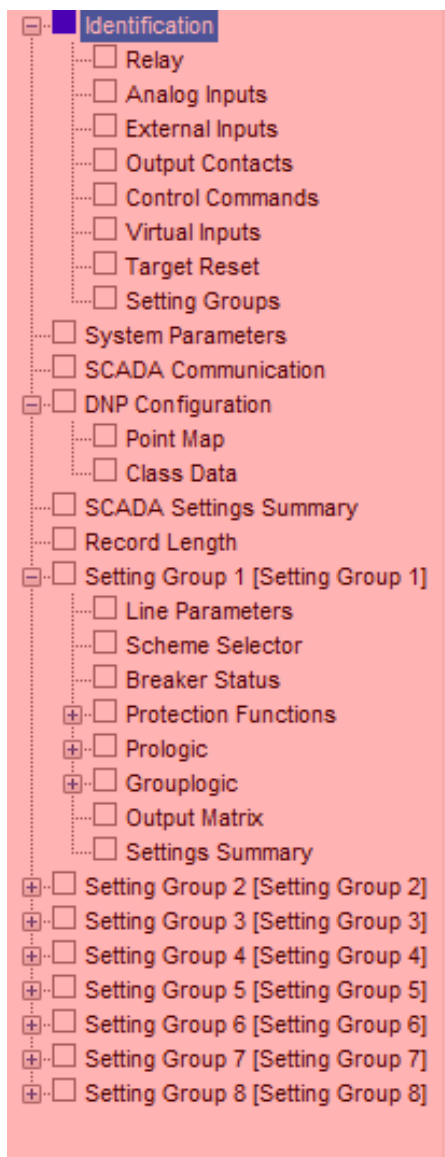


Figure 7.4: LHS Tree View Menu

In the LHS Menu Tree there are a series of menu headings that may have sub menus associated with them. Clicking on an item in the left-hand side tree view will display its corresponding menu in the RHS view. Similarly, the user can use the arrow keys to scroll through the menu tree.

Identification

The Identification screen provides information related to the specific IED's hardware, software and installation location. The items on the identification screen are described in Table 7.3 below.

Table 7.3: Relay Identification	
Identification	
Settings Version	Indicates the settings version number, fixed.
Ignore Serial Number	Bypass serial number check, if enabled.
Serial Number	Available at back of each relay.
Unit ID	User-defined up to 20 characters.
Nominal System Frequency	60 Hz or 50 Hz
Analog Input	5CT, 4PT
Digital I/O	24 Digital Inputs and 32 Digital Outputs, 16 Digital Inputs and 24 Digital Outputs, 16 Digital Inputs and 16 Digital Outputs, 8 Digital Inputs and 8 Digital Outputs
Comments	User-defined up to 78 characters.
Software Setting	
Setting Name	User-defined up to 20 characters.
Date Created/Modified	Indicates the last time settings were entered.
Station	
Station Name	User-defined up to 20 characters.
Station Number	User-defined up to 20 characters.
Location	User-defined up to 20 characters.
Line	User-defined up to 20 characters.

The serial number of the relay must match the one in the setting file, or the setting will be rejected by the relay. This feature ensures that the correct setting file is applied to the right relay.

Choose to ignore the serial number enforcement in the identification screen by checking the Ignore Serial Number check box. The relay only checks for proper relay type and setting version if the ignore serial number has been chosen.

Analog Inputs

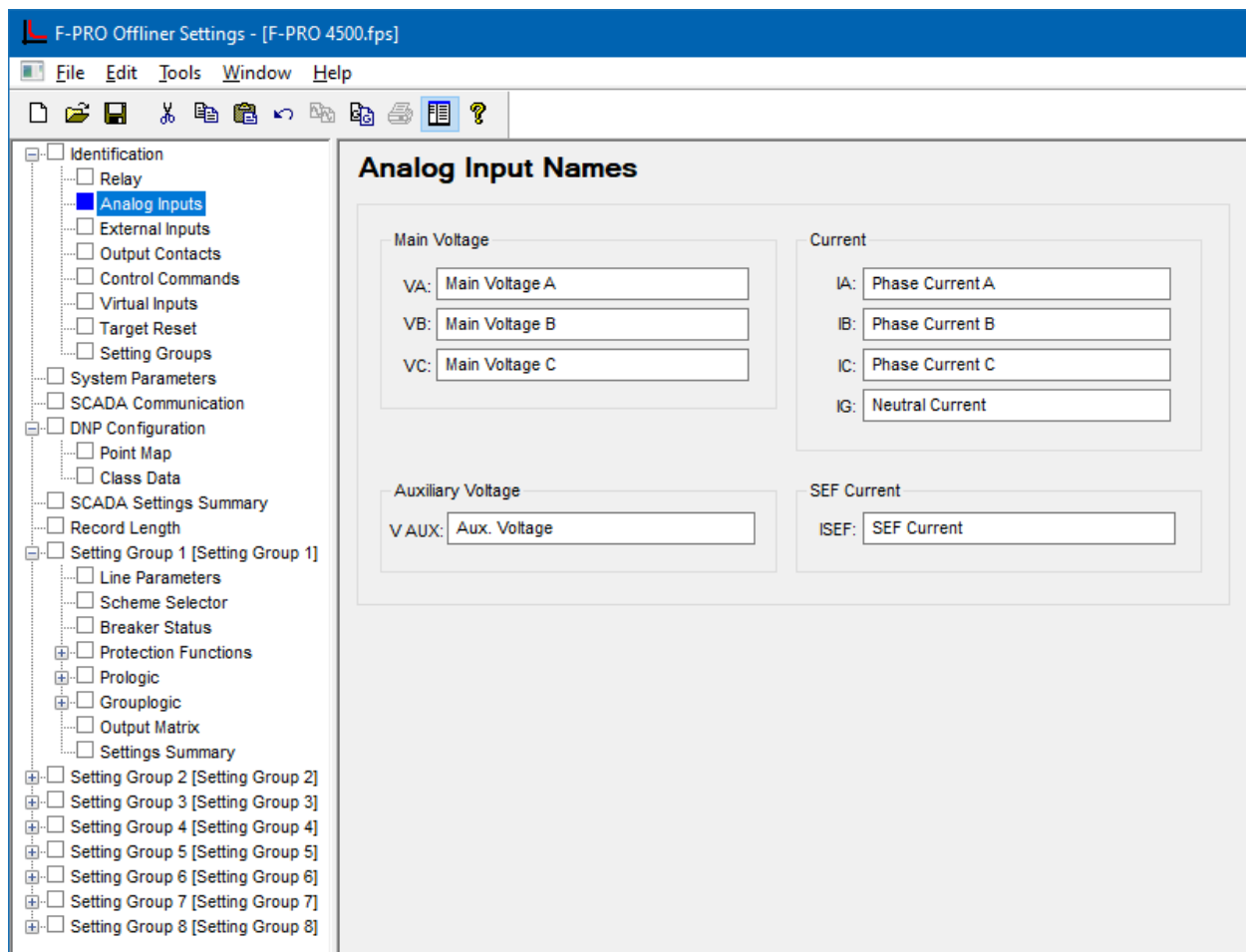


Figure 7.5: Analog Inputs

Analog Input Names screen identifies all the ac voltage and current inputs to the relay. These names appear in any fault disturbance records the relay produces.

Table 7.4: Analog Inputs	
Input	Channels
Main Voltage	VA, VB, VC
Current	IA, IB, IC, IG
Auxiliary voltage	V. AUX
SEF Current	ISEF

External Inputs

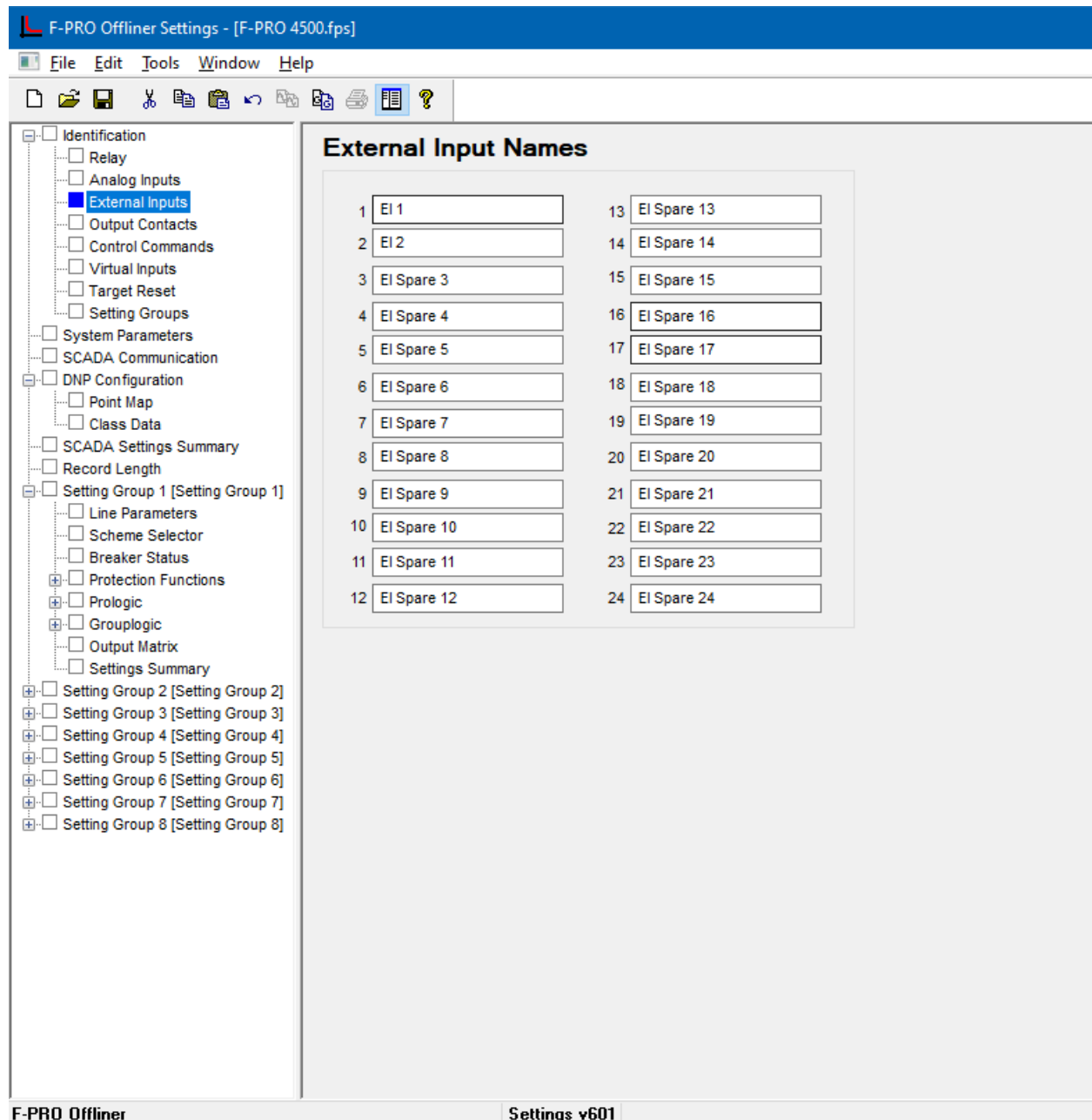


Figure 7.6: External Inputs

External Input Names screen allows the user to define meaningful names for up to 24 external digital inputs (varies depending on the hardware configuration).

Table 7.5: External Input Names

1 to 24 (may vary depending on hardware configuration)	User-defined
--	--------------

Output Contacts

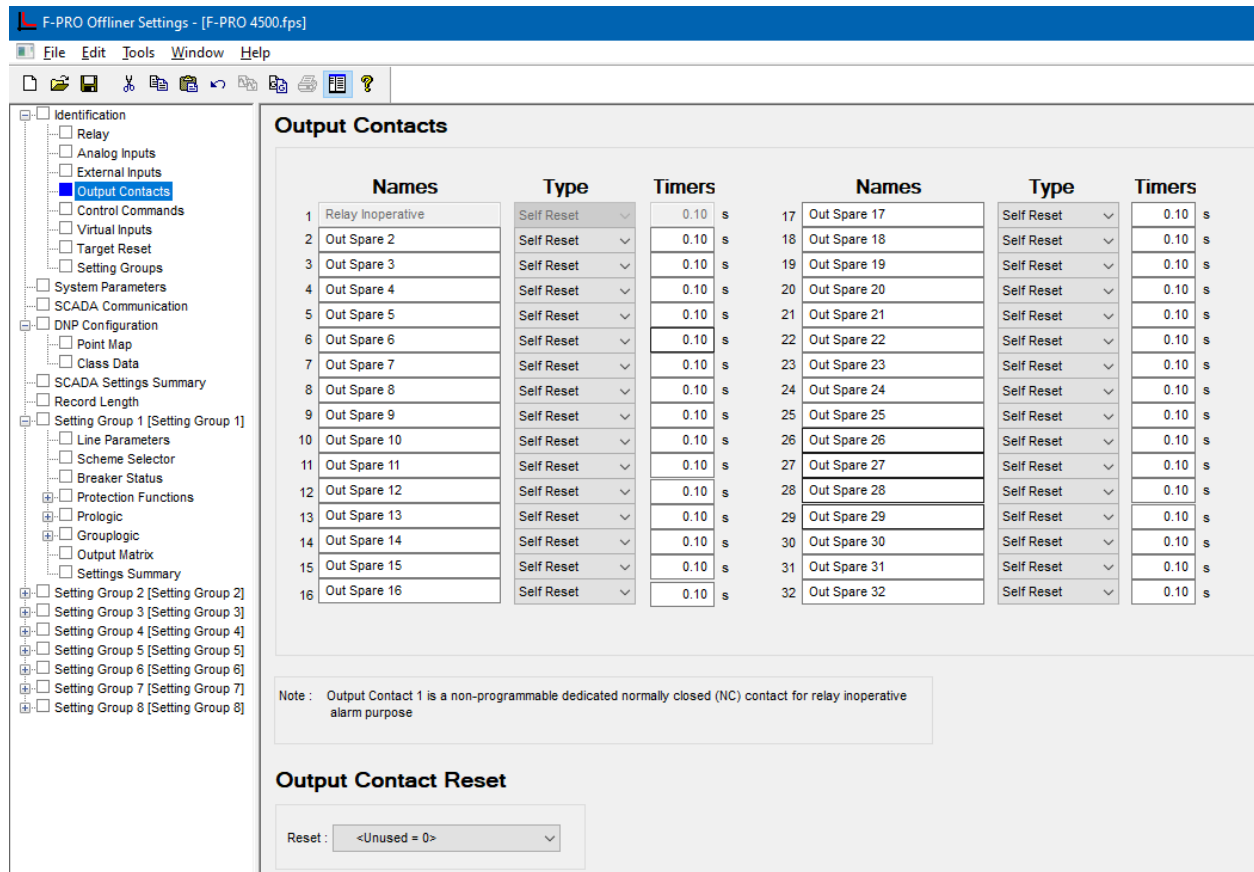


Figure 7.7: Output Contacts

The Output Contacts screen allows for configuration of each Output Contact's name and reset type. It also allows for configuration of a global Output Contact Reset input which is used to externally reset all latched Output Contacts.

Each Output Contact may be given a unique user-configurable Name.

If the Output Contact is set to the Self Reset type, it will close for the duration that the associated function is High, plus the duration of the configured Timer.

If the Output Contact is set to the Pulsed type, it will close when the associated function goes High and will remain closed only for the duration of the configured Timer, regardless of how long the associated function is High.

If the Output Contact is set to the Latched type it will close when the associated function goes High and will remain closed until the user manually resets it. A latched Output Contact can be reset either by the Front Panel (see "Output Contact Reset" on page 4-18), Relay Control Panel's

Utilites>Outputs Output Contact clear function or by the Output Contact Reset setting shown in Output Contacts

Output Contact Reset Types example shows a timing diagram of the different Output Contact Reset types.

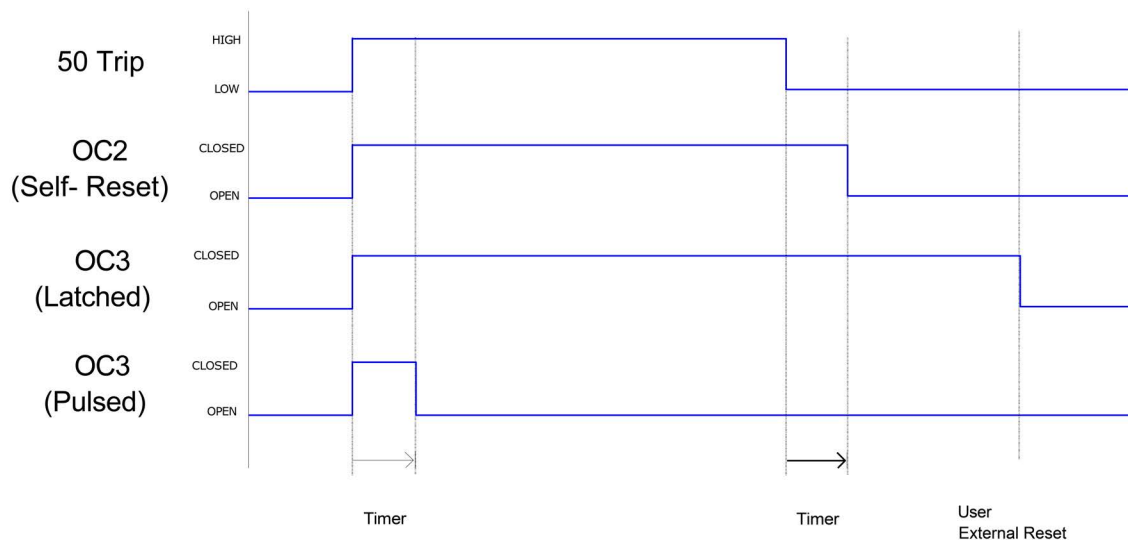


Figure 7.8: Output Contact Reset Types example

Table 7.6: Output Contacts	
Outputs 1 to 32 (may vary depending on hardware configuration)	User-defined name
Type	Self-Reset, Latched, Pulsed
Dropout Timer (only used for Self-Reset and Pulsed Type)	0.00 to 20.00 s
Output Contact Reset	
Reset	Select any EI, VI, SPC 1-6 or PL to be used for resetting Latched Output Contacts.

Control Commands

Each control command can be configured with a user-defined name. There are 12 Single-Point Control commands provided. see "Control Commands" on page 8-5 for more details.

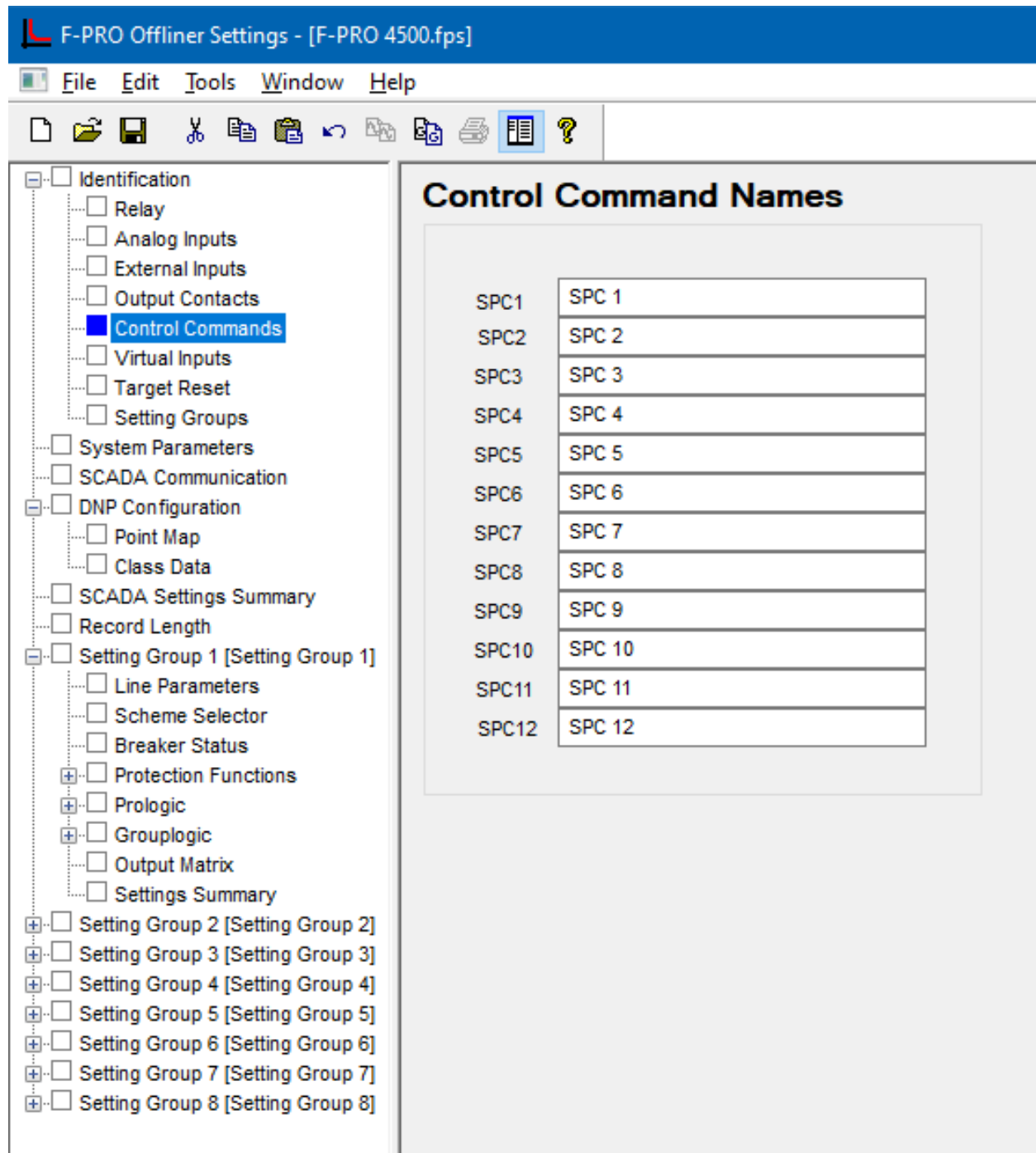


Figure 7.9: Control Command name configuration

Virtual Inputs

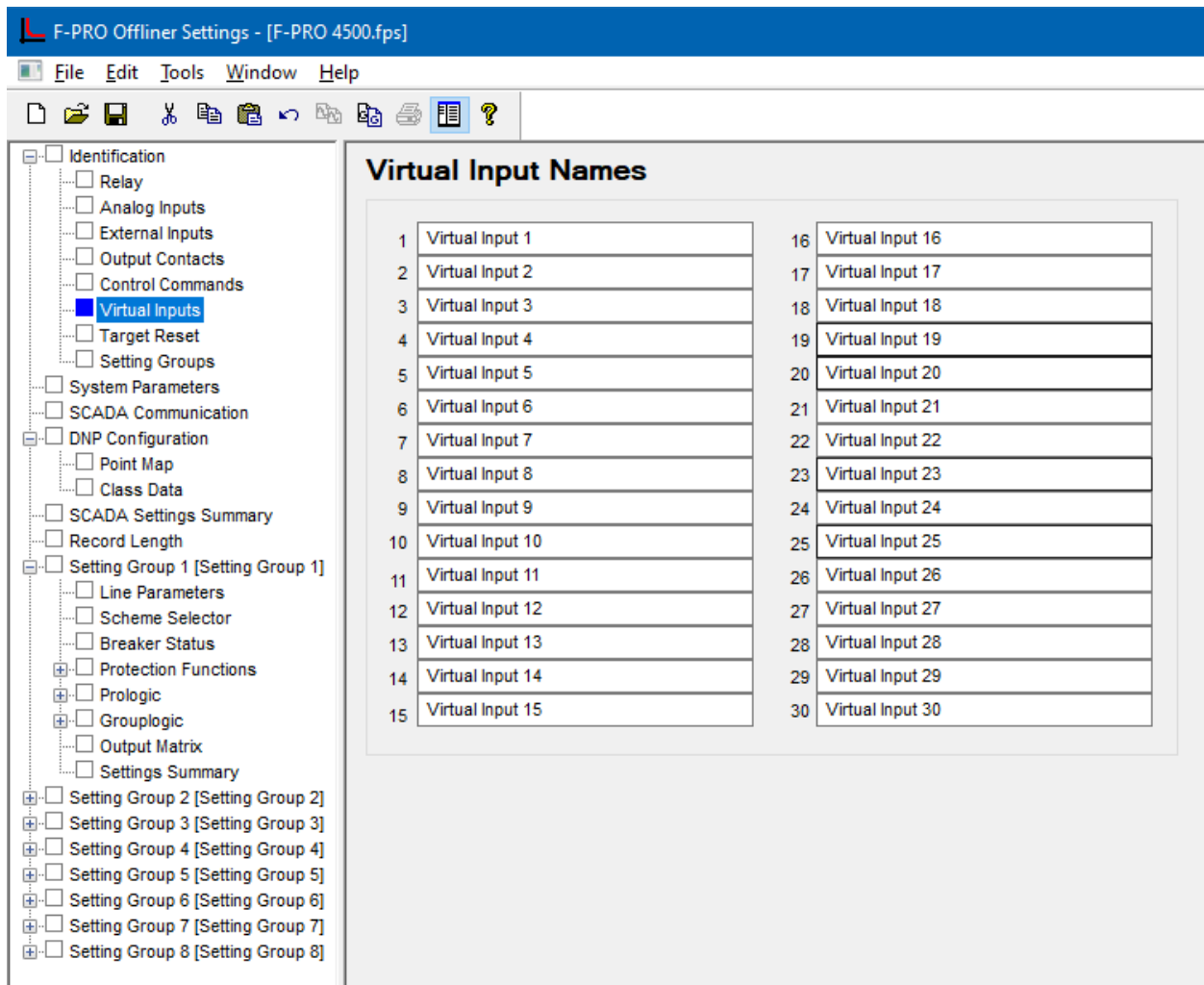


Figure 7.10: Virtual inputs

Table 7.7: Virtual Inputs

Virtual Inputs 1 to 30	User-defined
------------------------	--------------

The relay can control its internal functions and connected devices both locally and remotely. Thirty general purpose logic points are accessible via DNP3, IEC 61850 and RCP. The 30 virtual inputs are individually controlled and include a set, reset and pulse function. The latch state is retained during setting changes and relay power down conditions. The 30 virtual inputs conform to DNP3 standards. Use the DNP3 functions such as SBO (select before operate), Direct Operate, or Direct Operate with no acknowledge to control virtual inputs.

Use virtual inputs to:

- control circuit breakers
- enable or disable reclosing
- enable or disable under-frequency load shedding
- change setting groups
- provide interlocking between local/remote supervisory control

Target Reset

The Target Reset screen is used for configuration of each LED Reset Type and an external Target Reset input. For more details see "Target LED Reset Type" on page 4-14.

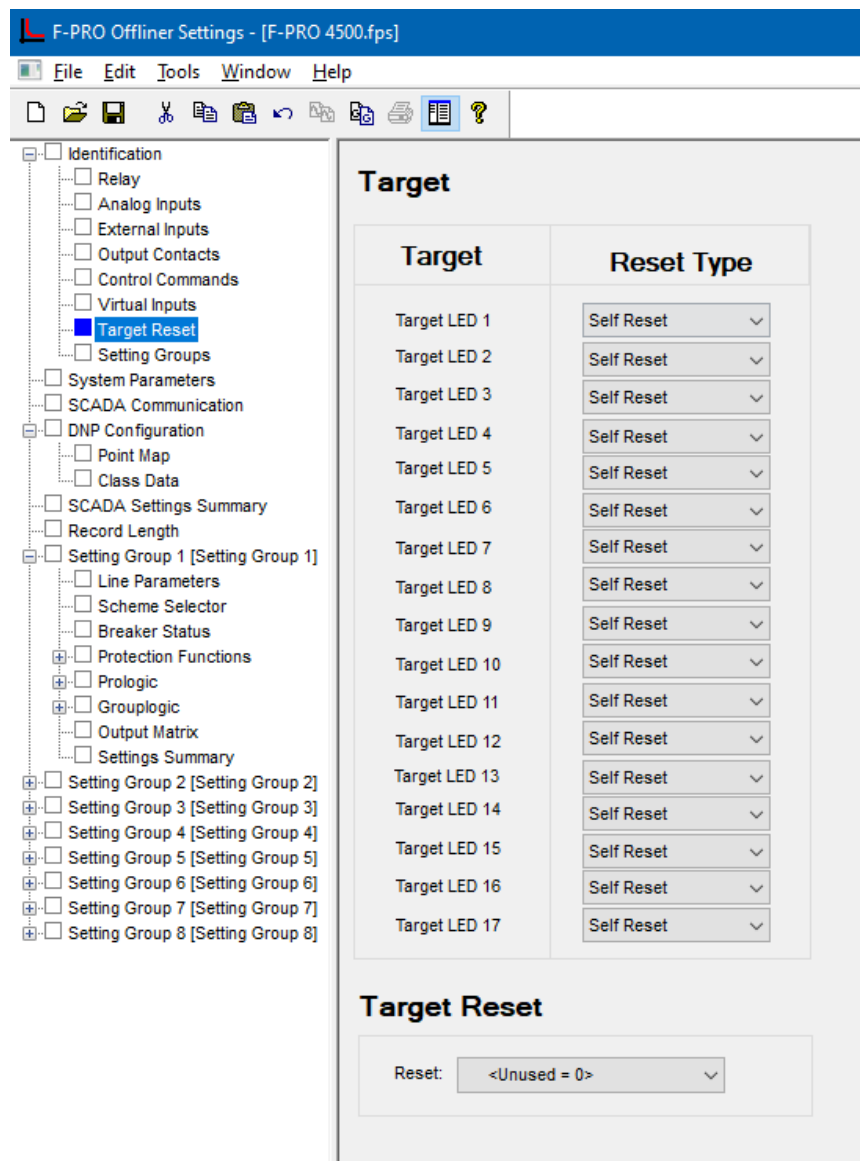


Figure 7.11: Target Reset

Table 7.8: Target Reset Settings

Target Reset Type (LED 1 to 17)	Self Reset, Latched
Target Reset	
Reset	Any EI, VI, SPC 1-6 or PL

Setting Groups

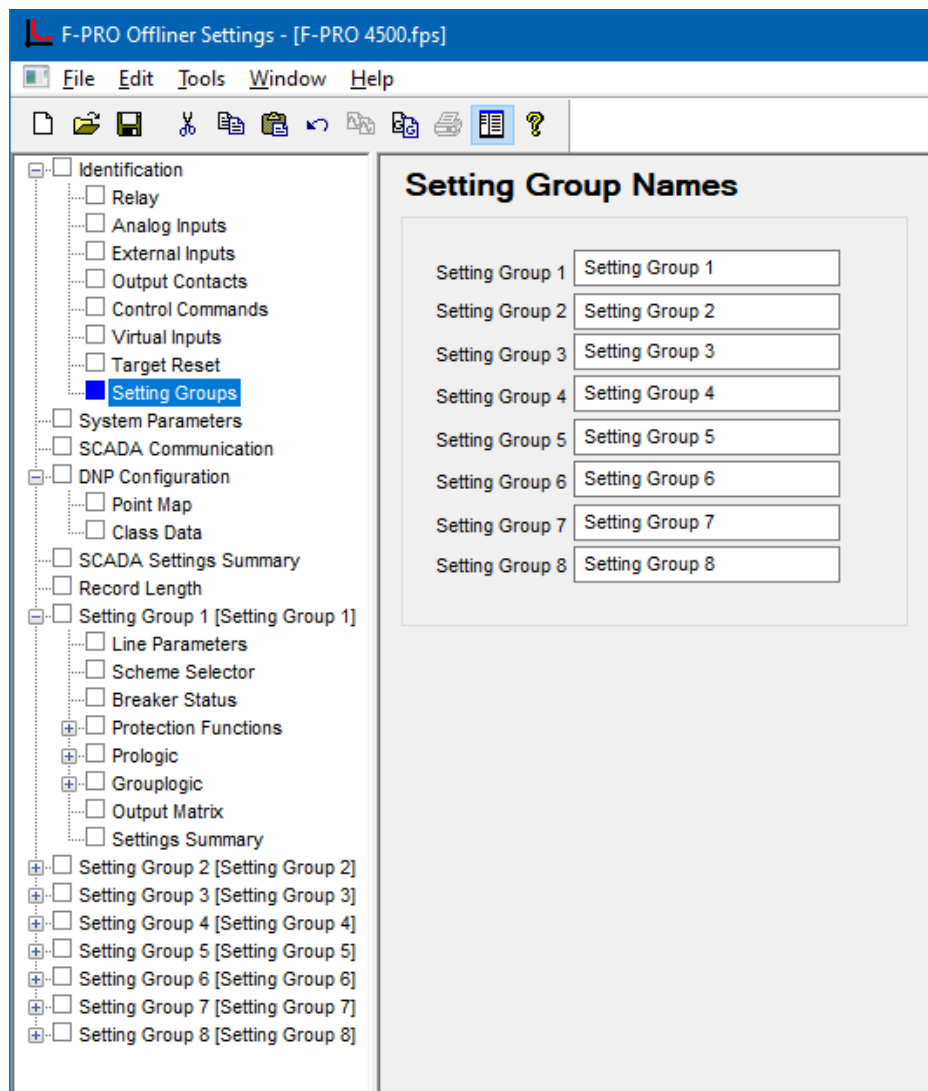


Figure 7.12: Setting Groups

Table 7.9: Setting Groups

Setting Groups 1 to 8	User-defined
-----------------------	--------------

System Parameters

F-PRO Offliner Settings - [F-PRO 4500.fps]

File Edit Tools Window Help

Identification

- Relay
- Analog Inputs
- External Inputs
- Output Contacts
- Control Commands
- Virtual Inputs
- Target Reset
- Setting Groups
- System Parameters**
- SCADA Communication
- DNP Configuration
 - Point Map
 - Class Data
- SCADA Settings Summary
- Record Length
- Setting Group 1 [Setting Group 1]
 - Line Parameters
 - Scheme Selector
 - Breaker Status
 - Protection Functions
 - Prologic
 - Grouplogic
 - Output Matrix
 - Settings Summary
- Setting Group 2 [Setting Group 2]
- Setting Group 3 [Setting Group 3]
- Setting Group 4 [Setting Group 4]
- Setting Group 5 [Setting Group 5]
- Setting Group 6 [Setting Group 6]
- Setting Group 7 [Setting Group 7]
- Setting Group 8 [Setting Group 8]

System Parameters

Phase Rotation: ABC ☒ Fault Location Display

Aux. Voltage Input: A Phase

Line

Line to Line Voltage: 230.00 kV Primary

Distance Unit: km

CT Turns Ratio

	CT Primary (A)	CT Secondary	CT Turns Ratio (:1)
Main Phase CT:	1200	5A v	240
Main Neutral CT:	1200	5A v	240
SEF CT:	1200	5A v	240

PT Turns Ratio

	PT Primary (kV, Ph-Ph)	PT Secondary (V, Ph-Ph)	PT Turns Ratio (:1)
Main PT:	230.00	115.00	2000.00
Auxiliary PT:	230.00	115.00	2000.00

Threshold Limits

Minimum Voltage Threshold: 0.3 V

Minimum Current Threshold: 0.20 A

Figure 7.13: System Parameters

Table 7.10: System Parameters**System Parameters**

Phase Rotation	ABC or ACB
Fault Location Display	Enable/Disable
Aux Voltage Input	A-Phase, B-Phase or C-Phase

Line

Line to Line Voltage	1.00 to 2000.00 kV (Primary)
Distance Units	km or miles

Table 7.10: System Parameters

CT Turns Ratio	
Main Phase CT Primary	1.00 to 30000.00
Main Neutral CT Primary	1.00 to 30000.00
310 Input #1 CT Primary	1.00 to 30000.00
CT Secondary	1A/5A
CT Turns Ratio	Calculated quantity. CT Turns Ratio = CT Primary/CT Secondary
PT Turns Ratio	
PT Primary	Same setting as Line to Line Voltage setting
Main PT Secondary	100.00 to 150.00 (V, Ph-Ph)
Auxiliary PT Secondary	100.00 to 150.00 (V, Ph-Ph)
PT Turns Ratio	Calculated quantity. PT Turns Ratio = PT Primary/PT Secondary
Minimum Voltage Threshold	0.0 to 2.9 (V)
Minimum Current Threshold	0.00 to 0.20 (1A) 0.00 to 1.0 (5A)

CT Turns Ratio and PT Turns Ratio

The CT and PT ratios are specified for the monitoring of analog inputs. All CT and PT ratios are specified with a ratio relative to one. F-PRO Offliner provides means to select the CT Primary and CT Secondary values, and from these values the CT Ratio is determined. Likewise, the PT Primary and PT secondary are both configurable and the PT Ratio is determined from these two settings.

SCADA Communication

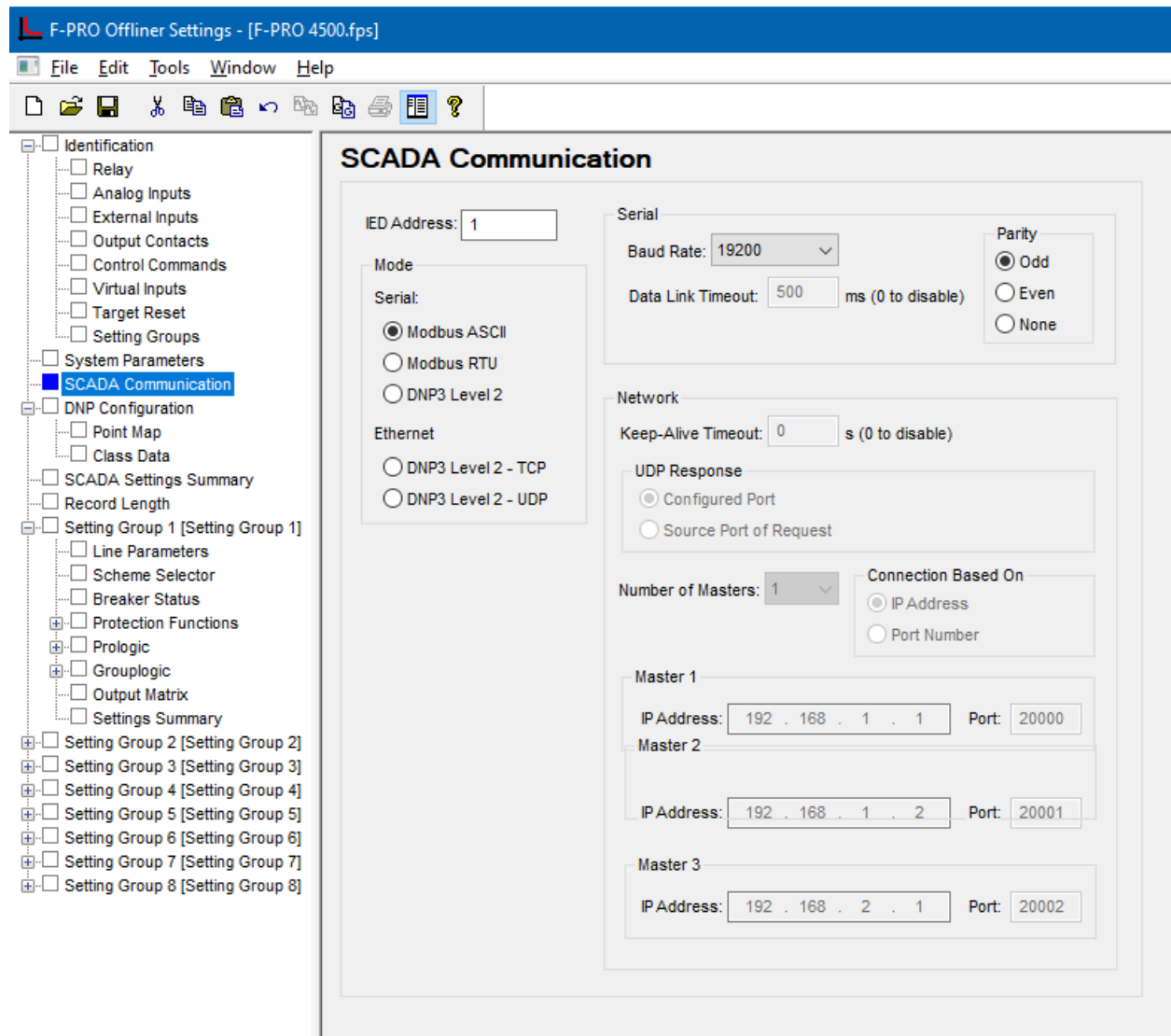


Figure 7.14: SCADA Communications

The relay has configurable SCADA communication parameters for both Serial and Ethernet (TCP and UDP). For DNP3 Level 2 (TCP) up to 3 independent Masters are supported.

DNP Configuration

Point Map

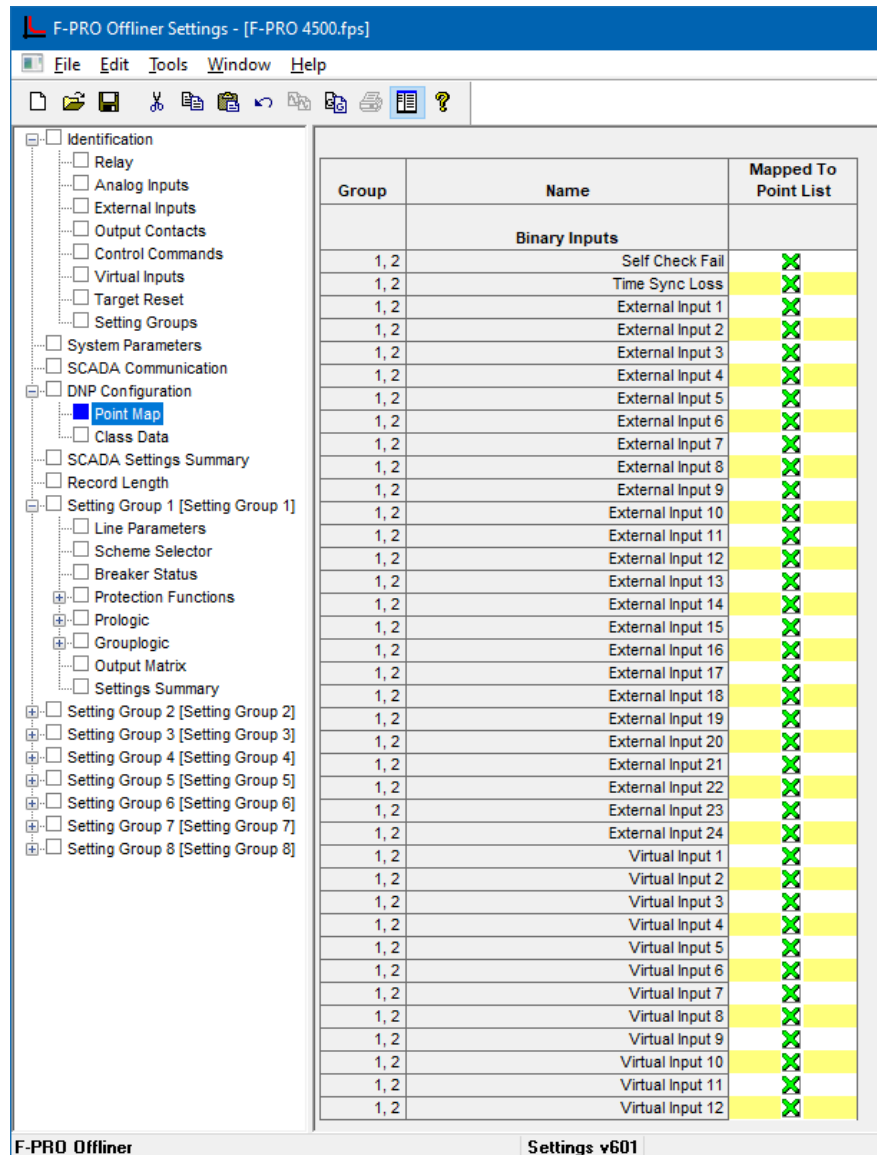


Figure 7.15: Point Map

The relay has configurable DNP point mapping. On the Point Map screen, any of the configurable points may be added or removed from the Point List by clicking (or using the cursor keys and space bar on the keyboard) on the associated check box. A green 'X' denotes that the item will be mapped to the Point List.

The list contains separate sections for Binary Inputs, Binary Outputs, and Analog Inputs. The list is scrollable by using the scroll control on the right hand side.

Class Data

F-PRO Offliner Settings - [F-PRO 4500.fps]

File Edit Tools Window Help

Identification

- Relay
- Analog Inputs
- External Inputs
- Output Contacts
- Control Commands
- Virtual Inputs
- Target Reset
- Setting Groups
- System Parameters
- SCADA Communication
- DNP Configuration
 - Point Map
 - Class Data**
 - SCADA Settings Summary
 - Record Length
- Setting Group 1 [Setting Group 1]
 - Line Parameters
 - Scheme Selector
 - Breaker Status
 - Protection Functions
 - Prologic
 - Grouplogic
 - Output Matrix
 - Settings Summary
- Setting Group 2 [Setting Group 2]
- Setting Group 3 [Setting Group 3]
- Setting Group 4 [Setting Group 4]
- Setting Group 5 [Setting Group 5]
- Setting Group 6 [Setting Group 6]
- Setting Group 7 [Setting Group 7]
- Setting Group 8 [Setting Group 8]

Group	Point Index	Name	Change Event Class				Deadband	Deadband Units	Scale	Reported Units
			none	1	2	3				
30, 32	0	V1a Magnitude			X		2	% of nominal	0.1	kV
30, 32	1	V1a Angle			X		0.5	degrees	0.1	degrees
30, 32	2	V1b Magnitude			X		2	% of nominal	0.1	kV
30, 32	3	V1b Angle			X		0.5	degrees	0.1	degree
30, 32	4	V1c Magnitude			X		2	% of nominal	0.1	kV
30, 32	5	V1c Angle			X		0.5	degrees	0.1	degrees
30, 32	6	I1a Magnitude			X		2	% of nominal	1	A
30, 32	7	I1a Angle			X		0.5	degrees	0.1	degrees
30, 32	8	I1b Magnitude			X		2	% of nominal	1	A
30, 32	9	I1b Angle			X		0.5	degrees	0.1	degrees
30, 32	10	I1c Magnitude			X		2	% of nominal	1	A
30, 32	11	I1c Angle			X		0.5	degrees	0.1	degrees
30, 32	12	I1g Magnitude			X		2	% of nominal	1	A
30, 32	13	I1g Angle			X		0.5	degrees	0.1	degrees
30, 32	14	Isef Magnitude			X		2	% of nominal	1	A
30, 32	15	Isef Angle			X		0.5	degrees	0.1	degrees
30, 32	16	VAux Magnitude			X		2	% of nominal	0.1	kV
30, 32	17	VAux Angle			X		0.5	degrees	0.1	degrees
30, 32	18	Frequency			X		0.05	Hz	0.01	Hz
30, 32	19	Voltage (V1)			X		2	% of nominal	0.1	kV
30, 32	20	Voltage (V2)			X		2	% of nominal	0.1	kV
30, 32	21	Voltage (V0)			X		2	% of nominal	0.1	kV
30, 32	22	Current (I1)			X		2	% of nominal	1	A
30, 32	23	Current (I2)			X		2	% of nominal	1	A
30, 32	24	Current (I0)			X		2	% of nominal	1	A
30, 32	25	P			X		4	% of nominal	0.1	MW
30, 32	26	Q			X		4	% of nominal	0.1	MVA _r
30, 32	27	S			X		4	% of nominal	0.1	MVA
30, 32	28	Power Factor			X		5	%	0.01	N/A
30, 32	29	Fault Information – DNP Time (High 16 bits)			X		32767	N/A	1	N/A
30, 32	30	Fault Information – DNP Time (Middle 16 bits)			X		32767	N/A	1	N/A
30, 32	31	Fault Information – DNP Time (Low 16 bits)			X		32767	N/A	1	N/A
30, 32	32	Fault Information – Fault Distance			X		32767	N/A	1	km
30, 32	33	Fault Information – Type			X		32767	N/A	1	N/A
30, 32	34	Active Setting Group Number			X		0.5	N/A	1	N/A
30, 32	35	Self check Fail			X		0.5	N/A	1	N/A
30, 32	36	Pa			X		4	% of nominal	0.1	MW
30, 32	37	Pb			X		4	% of nominal	0.1	MW

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Figure 7.16: Class Data

Class data for each DNP point can be assigned on the Class Data screen. Only Points which were mapped in the Point Map screen will appear here. Sections for Binary Inputs and Analog Inputs appear here; Binary Outputs cannot be assigned a Class. The list is scrollable by using the scroll control on the right hand side.

In addition to assigning a Change Event Class to each mapped point, most Analog Inputs can also be assigned a Deadband and Scaling factor.

SCADA Settings Summary

F-PRO Offliner Settings - [F-PRO 4500.fps]

File Edit Tools Window Help

Identification

- ☐ Relay
- ☐ Analog Inputs
- ☐ External Inputs
- ☐ Output Contacts
- ☐ Control Commands
- ☐ Virtual Inputs
- ☐ Target Reset
- ☐ Setting Groups
- ☐ System Parameters
- ☐ SCADA Communication
- ☐ DNP Configuration
 - ☐ Point Map
 - ☐ Class Data
- SCADA Settings Summary**
- ☐ Record Length
- ☐ Setting Group 1 [Setting Group 1]
 - ☐ Line Parameters
 - ☐ Scheme Selector
 - ☐ Breaker Status
 - ☐ Protection Functions
 - ☐ Prologic
 - ☐ Grouplogic
 - ☐ Output Matrix
 - ☐ Settings Summary
- ☐ Setting Group 2 [Setting Group 2]
- ☐ Setting Group 3 [Setting Group 3]
- ☐ Setting Group 4 [Setting Group 4]
- ☐ Setting Group 5 [Setting Group 5]
- ☐ Setting Group 6 [Setting Group 6]
- ☐ Setting Group 7 [Setting Group 7]
- ☐ Setting Group 8 [Setting Group 8]

F-PRO SCADA Summary

Name	Value/Group	Point Index	Change Event Class	Deadband	Deadband Units	Scale	Reported Units
SCADA Communication							
IED address	1						
Mode	Ethernet (Network Port) DNP3 Level 2 - TCP						
Baud Rate	19200						
Parity	Odd						
Data Link Timeout	500						
Keep-Alive Timeout	0						
UDP Response	Configured Port						
Number of Masters	1						
Connection Based On	IP Address						
Master 1 IP Address	192.168.1.1						
Master 1 Port	20000						
Master 2 IP Address	192.168.1.2						
Master 2 Port	20001						
Master 3 IP Address	192.168.2.1						
Master 3 Port	20002						
Binary Inputs							
Self Check Fail	1, 2	0	1				
Time Sync Loss	1, 2	1	1				
External Input 1	1, 2	2	1				
External Input 2	1, 2	3	1				
External Input 3	1, 2	4	1				
External Input 4	1, 2	5	1				
External Input 5	1, 2	6	1				
External Input 6	1, 2	7	1				
External Input 7	1, 2	8	1				
External Input 8	1, 2	9	1				
External Input 9	1, 2	10	1				
External Input 10	1, 2	11	1				
External Input 11	1, 2	12	1				
External Input 12	1, 2	13	1				
External Input 13	1, 2	14	1				
External Input 14	1, 2	15	1				
External Input 15	1, 2	16	1				
External Input 16	1, 2	17	1				
External Input 17	1, 2	18	1				

F-PRO Offliner Settings v601

Figure 7.17: SCADA Settings Summary

This screen provides a summary of the current SCADA settings as set in the working setting file. This includes SCADA Communication parameters and (if the SCADA mode is set to DNP) Binary Input, Binary Output, and Analog Input information including Deadband and Scaling factors.

This SCADA Summary screen is scrollable and can be printed.

Record Length

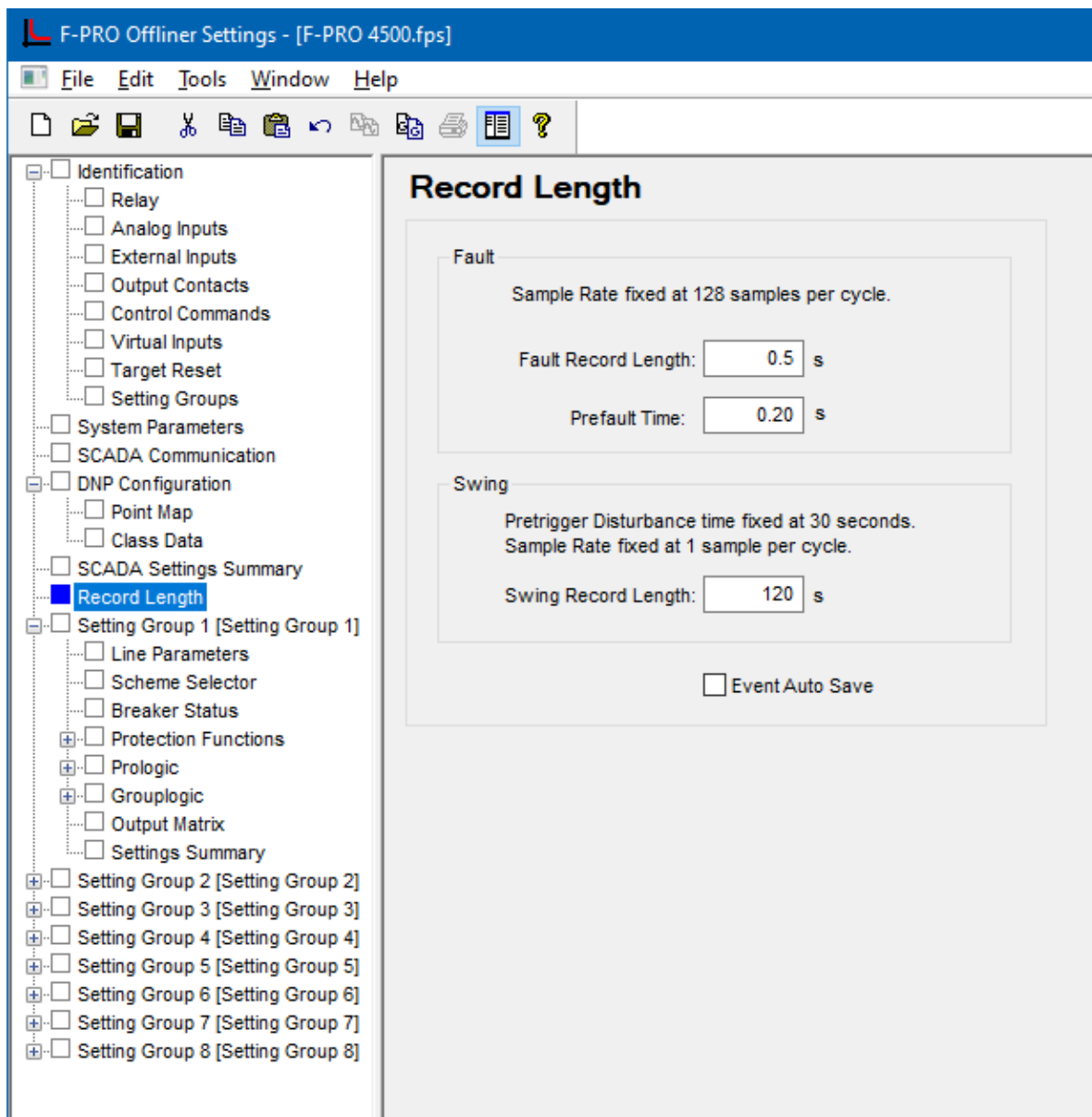


Figure 7.18: Record Length

Table 7.11: Record Length

Table 7.11: Record Length	
Fault	
Fault Record Length	0.2 to 10.0 seconds
Prefault Time	0.10 to 2.00 seconds
Swing	
Swing Record Length	60 to 120 seconds
Event Auto Save	Enable/Disable

The relay has recording and logging functions to analyze faults and dynamic swing, and to review the operation of the overall protection scheme.

This screen displays the record length for each of the two types of recordings provided: fault and swing. Pre-trigger times are configurable between 0.10 to 2.00 seconds for fault records and fixed at 30 seconds for swing records and are included as part of the record length.

Setting Groups

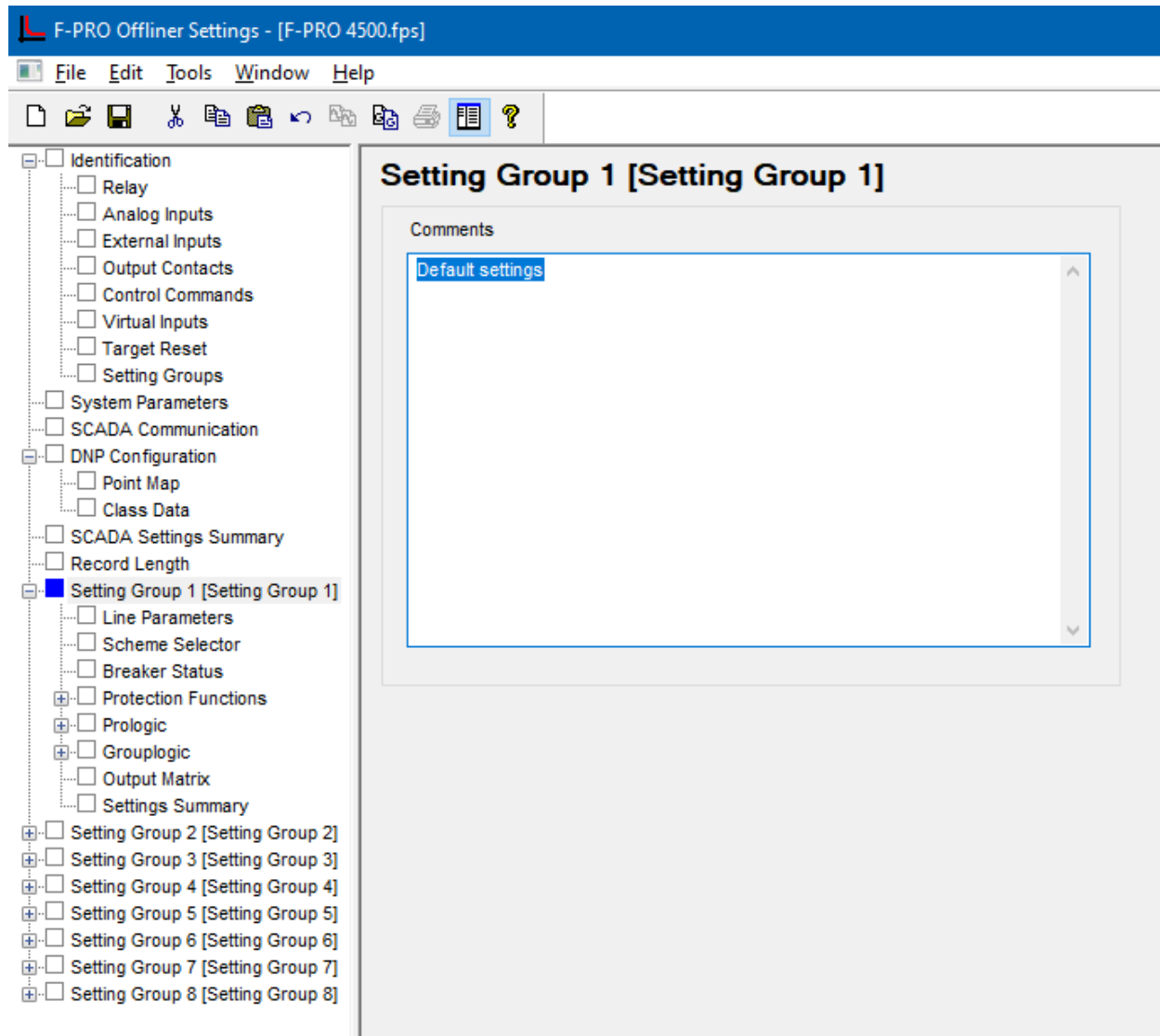


Figure 7.19: Setting Groups Comments

The relay has 8 setting groups (SG). The user can change all relay setting parameters except the physical connections such as input or output parameters in each setting group. Use any one of the 16 available Group

Logic Statements per setting group to perform Setting Group changes. The Group Logic statements are similar to the ProLogic statements with the following exceptions, the sole function is to activate one of the 8 setting groups and the processing is in a slower half second cycle. Group Logic inputs statements can be driven from ProLogic or any external input or virtual input or from previous Group Logic statements. Each Group Logic statement includes 5 inputs (with Boolean statements), one latch state and one pickup delay timer. View the active setting group (ASG) from the Terminal Mode, from the front panel or from a record stored by the relay (the active setting group is stored with the record).

Breaker Status

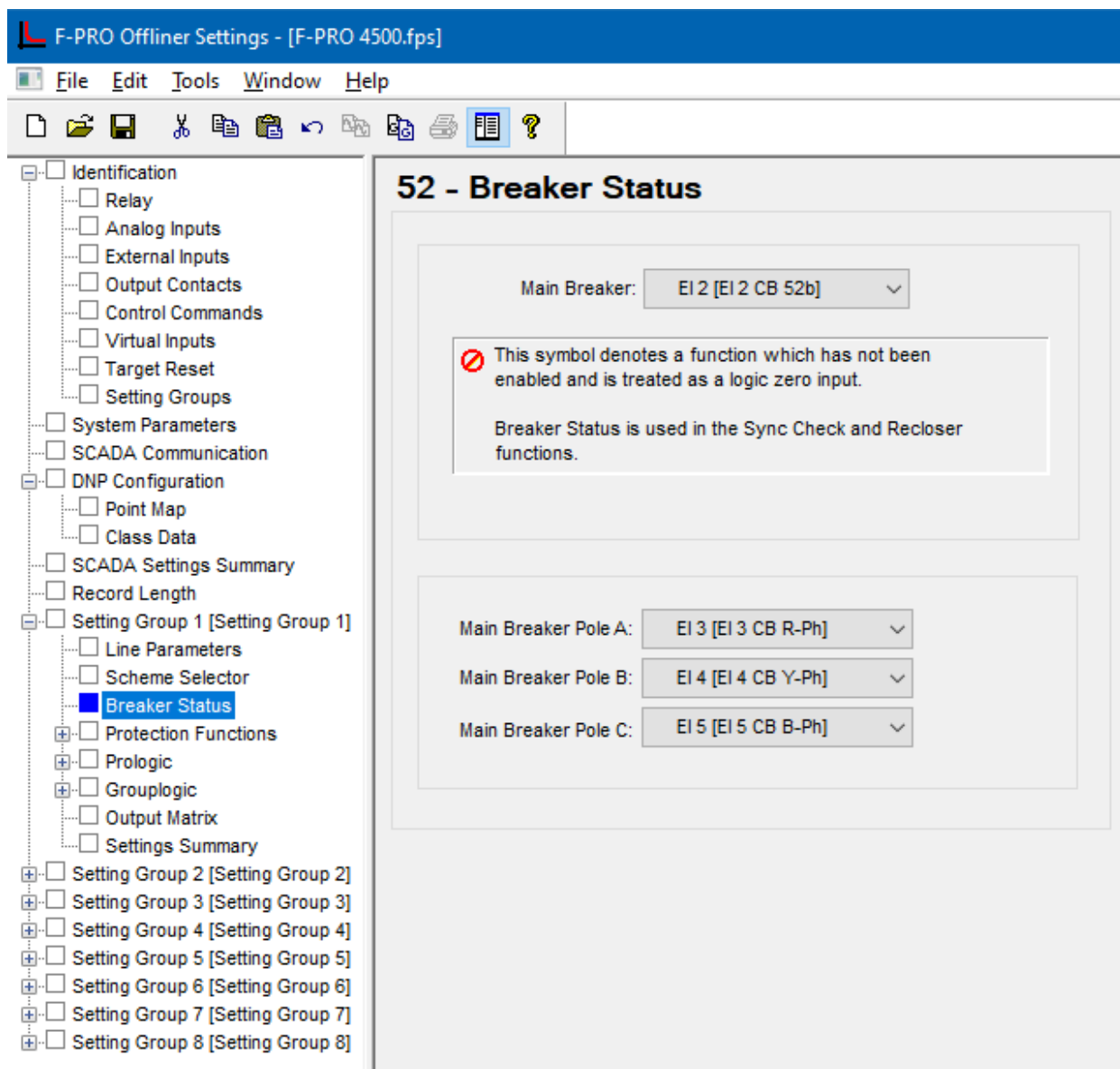


Figure 7.20: Breaker Status

This screen provides configuration options for the breaker status inputs. Any EI, PL or VI can be assigned to each breaker status input.

Table 7.12: Breaker Status

Main Breaker	EI1-24, PL1-24, VI 1-30
Main Breaker Pole A	EI1-24, PL1-24, VI 1-30
Main Breaker Pole B	EI1-24, PL1-24, VI 1-30
Main Breaker Pole C	EI1-24, PL1-24, VI 1-30

Protection Functions

Protection Summary

27DT - Undervoltage

☐ 27DT-1 Main ☐ 27DT-1 Aux

☐ 27DT-2 Main ☐ 27DT-2 Aux

☐ 27DT-3 Main ☐ 27DT-3 Aux

☐ 27DT-4 Main ☐ 27DT-4 Aux

59DT - Overvoltage

☐ 59DT-1 Main ☐ 59DT-1 Aux

☐ 59DT-2 Main ☐ 59DT-2 Aux

☐ 59DT-3 Main ☐ 59DT-3 Aux

☐ 59DT-4 Main ☐ 59DT-4 Aux

24DT Overflux

☐ 24DT-1

☐ 24DT-2

47DT - Negative Sequence Overvoltage

☐ 47DT-1

☐ 47DT-2

59N-Zero Sequence OverVoltage

☐ 59NIT

☐ 59NDT - 1

☐ 59NDT - 2

27IT - Phase Overvoltage

☐ 27IT-1 Main ☐ 27IT-2 Main

59IT - Phase Overvoltage

☐ 59IT-1 Main ☐ 59IT-2 Main

37 - Phase Undercurrent

☐ 37-1 ☐ 37-2

50/51 - Phase Overcurrent

☐ 50-1 ☐ 50-2

☐ 51-1 ☐ 51-2

50N/51N - Deriv.Neutral Overcurrent

☐ 50N-1 ☐ 50N-2

☐ 51N-1 ☐ 51N-2

50G/51G - Meas.Neutral Overcurrent

☐ 50G-1 ☐ 50G-2

☐ 51G-1 ☐ 51G-2

64-50/64-51 - Sensitive /Restricted Earth Fault

☐ 64-50 SEF/REF-1 ☐ 64-50 SEF/REF-2

☐ 64/51SEF-1 ☐ 64/51SEF-2

46-50/46-51 - Neg. Seq. Overcurrent

☐ 46-50 ☐ 46-51

49 - Thermal Overload

☐ 49

50BF - Breaker Failure

☐ 50BF

46 - Broken Conductor

☐ 46-BC

50LS - Low Set Overcurrent

☐ 50LS

81HBL2 - Inrush

☐ 81HBL2

74TCS - Trip Circuit Supervision

☐ TCS-1 ☐ TCS-2

Reclosure Count Alarm

☐ AR Counter

81 - Over/Under/ROC - Frequency

81-1 Disabled 81-2 Disabled

81-3 Disabled 81-4 Disabled

81-5 Disabled 81-6 Disabled

81-7 Disabled 81-8 Disabled

81-9 Disabled 81-10 Disabled

32 - Directional Power

☐ 32-1 ☐ 32-2

☐ 32-3 ☐ 32-4

I²t-CB Condition

☐ I²t-CB

25/27/59 - Sync Check

☐ Sync Check

☐ Dead Main Live Aux

☐ Live Main Dead Aux

☐ Dead Main Dead Aux

79 Recloser

☐ 79-3Ph Recloser

☐ 79-1Ph Recloser

THD - Total Harmonic Distortion

☐ THD-1 ☐ THD-2

60VT Supervision

☐ 60VT Supervision

60CT Supervision

☐ 60CT Supervision

Figure 7.21: Protection Functions

The Protection Summary screen gives a summary of which protection functions are enabled, and allows the user to easily enable and disable functions. There is one configuration screen available for each protection function in the tree view. For a detailed descriptions of each of these

protection function see" Protection Functions and Specifications" on page 5-1.

ProLogic

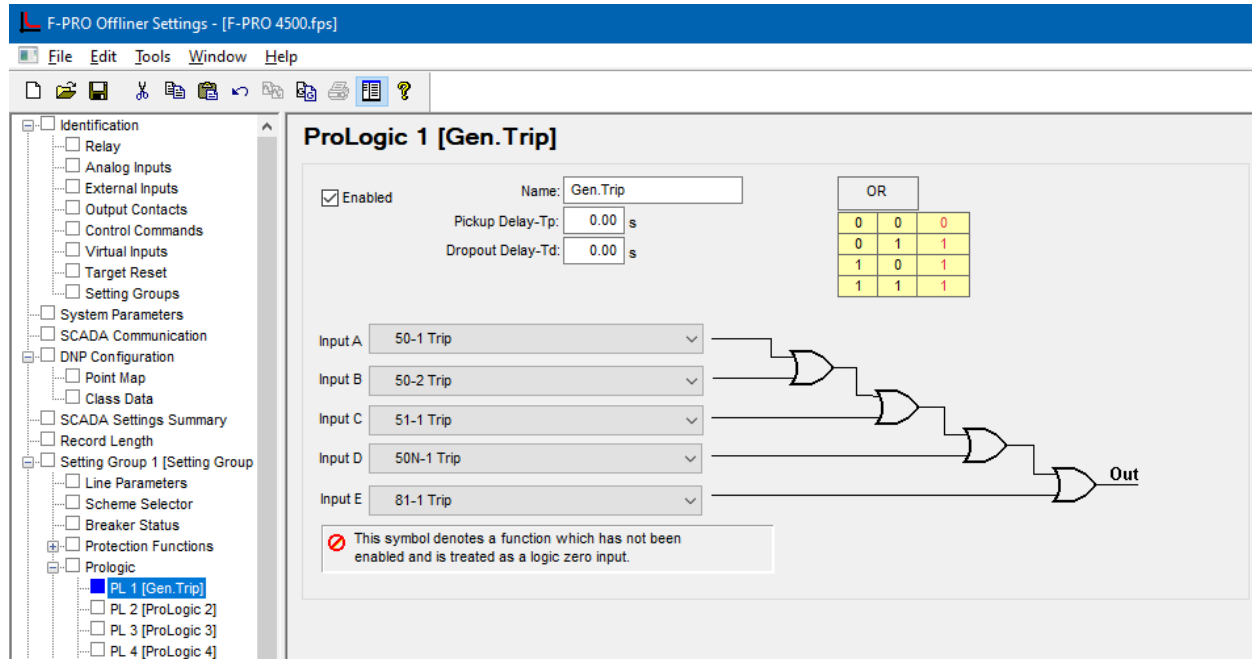


Figure 7.22: ProLogic

Apply ProLogic to multiple inputs to create an output based on qualified inputs. ProLogic enables up to 24 ProLogic control statements and programs those logics to output contacts. The user can name the function being created and set a pickup and dropout delay. Start with input A by selecting any of the relay functions using the list for up to 5 possible inputs. Put these inputs into AND, NAND, OR, NOR, XOR, NXOR and LATCH logics by clicking on the gate. Invert the input by clicking on the input line.

The output of ProLogic 1 can be nested into ProLogic 2 and so forth. If described, the user can illuminate the front target LED on operation of this function by enabling this feature. The operation of the ProLogic statements are recorded in the events logs.

GroupLogic

The 16 Group Logic statements reside in a slower processing thread within the relay protection algorithms. The processing cycle happens once every half second (0.5 s). When using ProLogic statements the user must keep in mind that a latch or dropout timer should be used if the initiating condition does not last at least 0.5 seconds.

Output Matrix

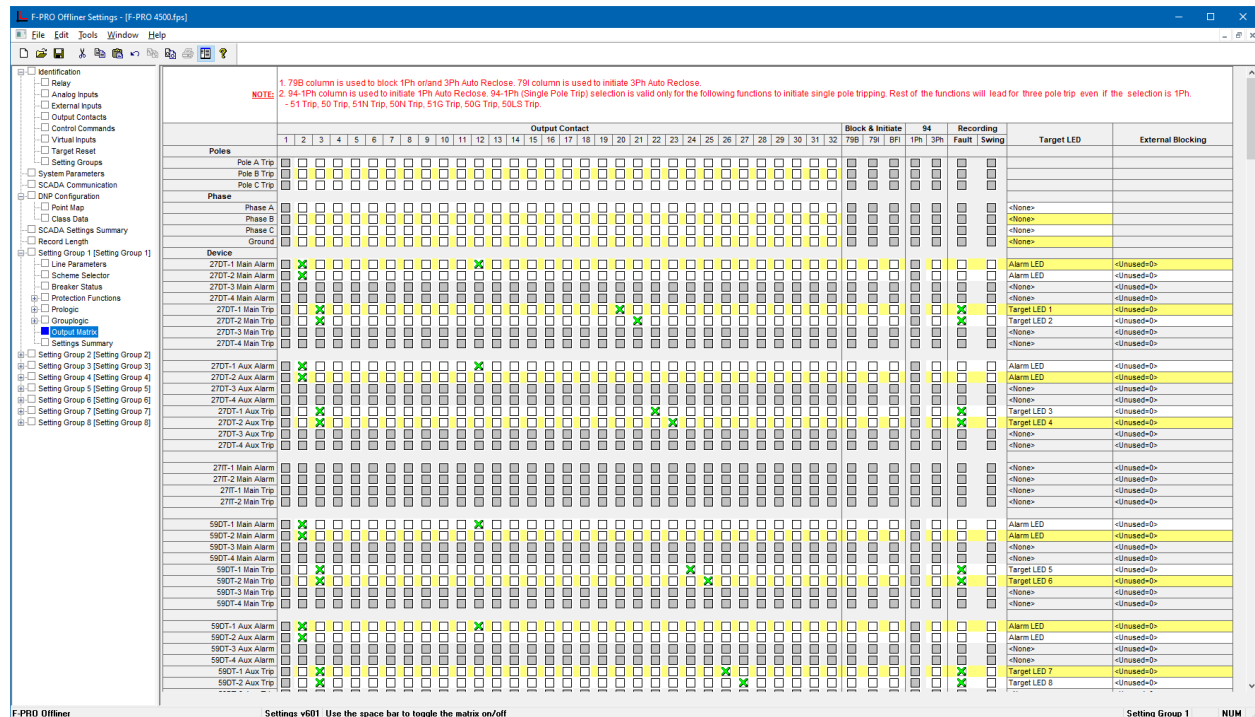


Figure 7.23: Output Matrix

The output contact matrix determines which function initiates which output relay. All output relays have an individual user-selectable stretch time, except those outputs identified as communication initiation outputs. They can have their time delay characteristics changed. Functions also initiate recording as required.

For a more detailed description of the functions available on the output matrix, see "Output Matrix" on page 5-82.

For a particular function to operate correctly, it must be enabled and must also have its logic output assigned to at least one output contact if it is involved in a tripping function.

Print the entire output matrix by selecting Print under the File menu. This printout is produced on two pages.

Settings Summary

F-PRO Offliner Settings - [F-PRO 4500.fps]

File Edit Tools Window Help

Identification

- Relay
- Analog Inputs
- External Inputs
- Output Contacts
- Control Commands
- Virtual Inputs
- Target Reset
- Setting Groups
- System Parameters
- SCADA Communication
- DNP Configuration
 - Point Map
 - Class Data
- SCADA Settings Summary
- Record Length
- Setting Group 1 [Setting Group 1]
 - Line Parameters
 - Scheme Selector
 - Breaker Status
 - Protection Functions
 - Prologic
 - Grouplogic
 - Output Matrix
 - Settings Summary**
- Setting Group 2 [Setting Group 2]
- Setting Group 3 [Setting Group 3]
- Setting Group 4 [Setting Group 4]
- Setting Group 5 [Setting Group 5]
- Setting Group 6 [Setting Group 6]
- Setting Group 7 [Setting Group 7]
- Setting Group 8 [Setting Group 8]

Settings Summary | Output Matrix | SCADA Summary

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Relay Identification			
Settings Version	601		
Ignore Serial Number	Yes		
Serial Number	FPRO-4500-000000-01		
Relay ID	F-PRO4500		
Nominal System Frequency	60 Hz		
Analog Input	5CT and 4PT		
Digital I/O	24DI and 32DO		
Comments	Comments		
Setting Name	Default Settings		
Date Created/Modified	2025-06-26 17:21:57		
Station Name	Station Name		
Station Number	1		
Location	Location		
Bay Name	Bay Name		
Analog Input Names			
VA	Main Voltage A		
VB	Main Voltage B		
VC	Main Voltage C		
V AUX	Aux. Voltage		
IA	Phase Current A		
IB	Phase Current B		
IC	Phase Current C		
IG	Neutral Current		
ISEF	SEF Current		
External Input Names			
EI 1	EI 1 CB 52a		
EI 2	EI 2 CB 52b		
EI 3	EI 3 CB R-Ph		
EI 4	EI 4 CB Y-Ph		
EI 5	EI 5 CB B-Ph		
EI 6	EI 6 CB 52c		

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Figure 7.24: Settings Summary

Select *Settings Summary* to view and print the relay settings in text form, for details See “IED Settings and Ranges” Appendix B.

7.2 RecordGraph Software

Introduction

RecordGraph is a tool that is used to display and analyze records from ERLPhase relays and recorders. Use it to graphically view the data recorded during faults and swings. RecordGraph provides many powerful analysis tools including:

- Timeline view
- Overlay view
- Phasor view
- Absolute Time view
- Harmonic view
- Sub-Harmonic view

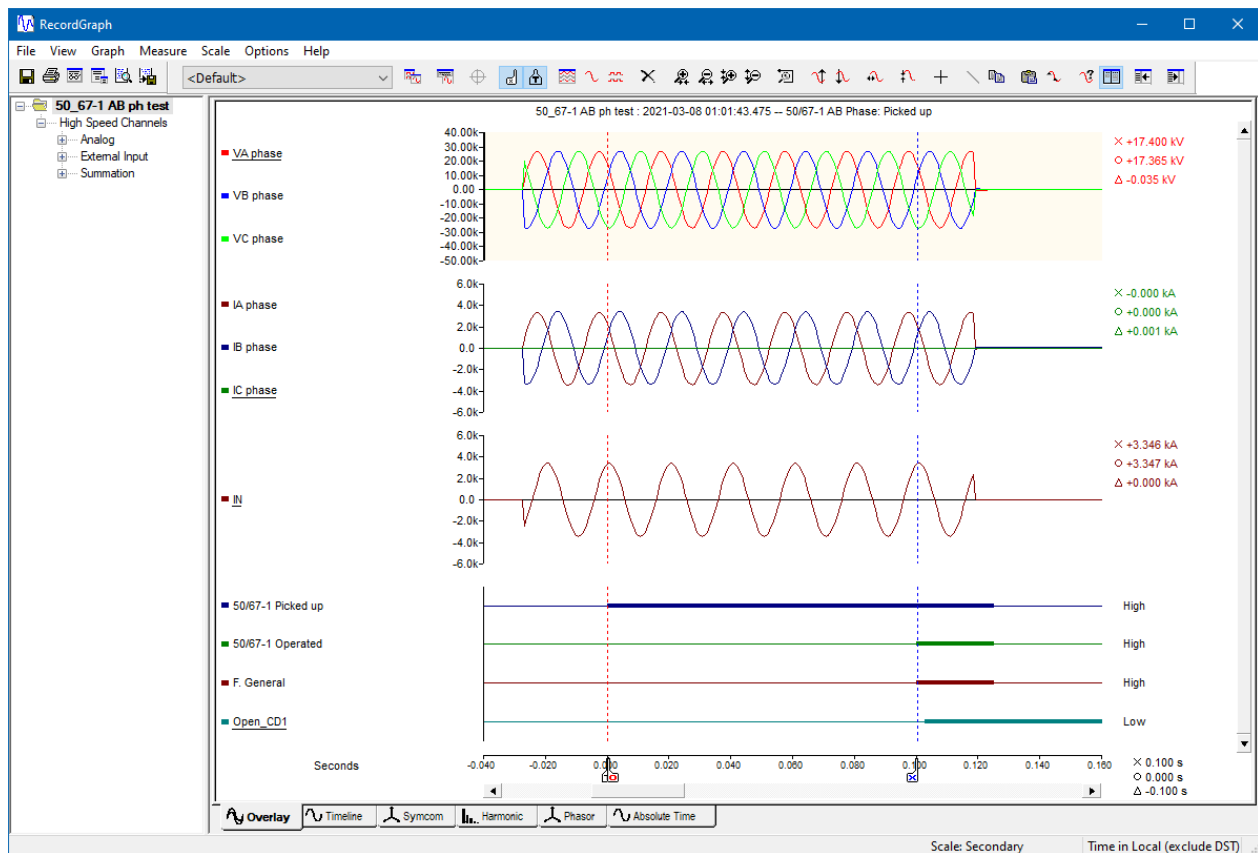


Figure 7.25: RecordGraph

Launching RecordGraph from Relay Control Panel

- 1 Go to the *Records* screen in Relay Control Panel.
- 2 Select one or more remote records on the relay. Press the *Get from Relay* Button to retrieve the records from the relay and to store them locally. Select one or more local records and press the *Graph* button to launch the record(s) in RecordGraph.

OR

Double-click on a remote record to directly graph it in RecordGraph

For further instructions on how to use the software, refer to the RecordGraph Manual.

7.3 ERL 61850 IED Configurator

Introduction

The ERL 61850 IED Configurator is used to configure ERLPhase IEC 61850 based devices for substation automation. This tool helps the user to map data from remote GOOSE into ERLPhase IED data, to perform GOOSE mapping from ERLPhase IEDs to other devices and to configure the required RCBs (Report Control Block) for SCADA.

The ERL 61850 IED Configurator provides configuration options for GOOSE Control Blocks, Sample Value Control Blocks, Report Control Blocks and Datasets. It also provides GOOSE Mapping and Sample Value Mapping configuration.

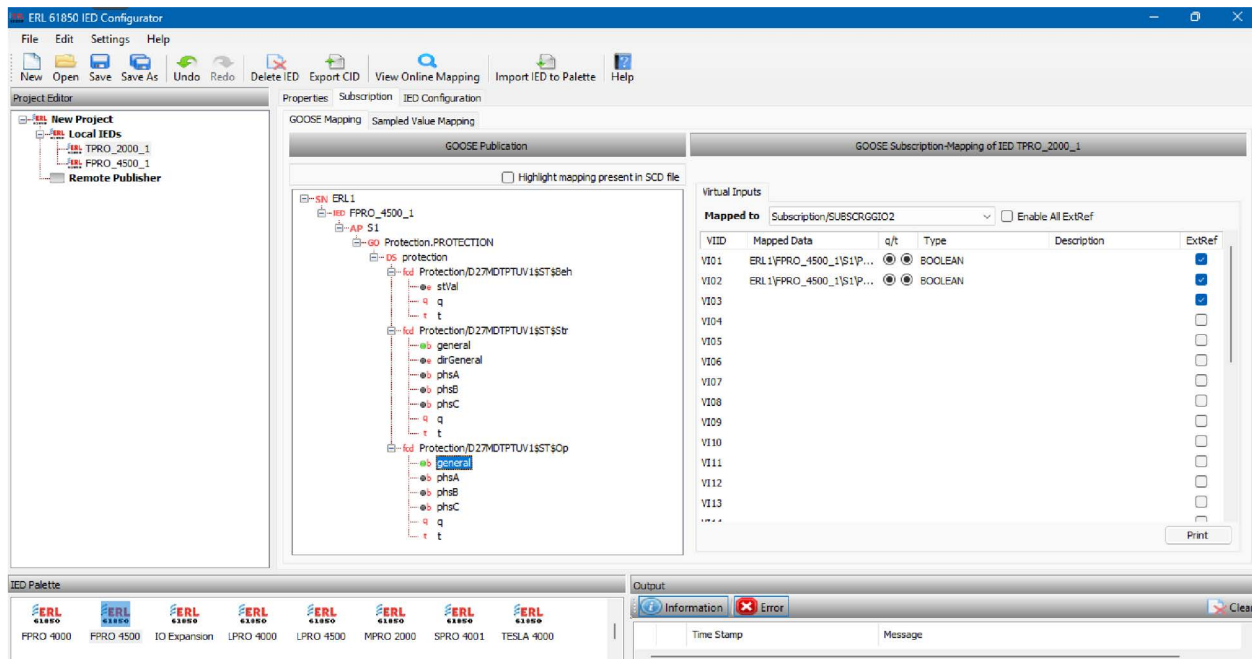


Figure 7.26: ERL 61850 IED Configurator

For further details refer to Chapter 8 and to the ERL 61850 IED Configurator Manual.

8 IEC 61850 Implementation Overview

8.1 Introduction

The IEC 61850 standard defines a suite of protocols that permit substation equipment from different manufacturers to communicate with each other. ERL is dedicated to developing IEC 61850-based devices that can be used as part of an open and versatile communications network for power system automation.

The IEC 61850 defines an Ethernet-based protocol used in power systems for data communication. Power systems implement a number of devices for protection, measurement, detection, alarms, and monitoring. System implementation is often slowed down by the fact that the devices produced by different manufacturers are incompatible, since they do not support the same communication protocols. The problems associated with this incompatibility are quite serious, and result in increased costs for protocol integration and system maintenance.

The IEC 61850 is a broad ranging standard which encompasses the entire scope of power system automation, from the highest level of substation design to the lowest level of the communication protocol implementation on IEDs.

The IEC 61850 Standard also defines a standard Engineering Process which is an iterative process which allows for the implementation and management of power system automation.

Some key concepts which are discussed further in the following sections are:

- Substation Configuration Language (see Section 8.2)
- The Engineering Process (see Section 8.3)
- Edition 2.0 Implementation (see Section 8.5)

Parts of the Standard

The IEC 61850 Standard is comprised of many parts. The parts of the standard which are most relevant to the implementation in this device are:

- IEC 61850-6 Edition 2.0: Configuration description language for communication in electrical substations related to IEDs
- IEC 61850-7-2 Edition 2.0: Basic information and communication structure – Abstract communication service interface (ACSI)

-
- IEC 61850-7-3 Edition 2.0: Basic communication structure – Common data classes
 - IEC 61850 -7-4 Edition 2.0: Basic communication structure – Compatible logical node classes and data object classes

8.2 The Substation Configuration Language (SCL)

The Substation Configuration Language (SCL) is an XML based language which provides the basis for interoperable data exchange between IEDs from different vendors and between configuration tools. The SCL file structure is comprised of five main parts:

- Header - defines file information history
- Communication - defines access points and network configurations
- Substation - defines the substation equipment and provides coordinates locating equipment on a Single Line Diagram
- IED - provides the definition of the IED(s) including the Services, Logical Devices, Logical Nodes, DataSets, Report Control Blocks, GOOSE Control Blocks and Sampled Value Control Blocks
- DataType Templates - contains the templates which define common data used within the data model

There are multiple types of SCL files which are used for different applications within the Engineering Process. Each type of SCL file is constructed using the sections defined above, but not all SCL file types contain all five sections (for example, the CID file type does not include a Substation section).

The SCL File types are:

- SSD - System Specification Description.
Data exchange from a system specification tool to the system configuration tool.
- SED - System Exchange Description.
Data exchange between system configuration tools of different projects.
- SCD - System Configuration Description.
Data exchange from the system configuration tool to IED configuration tools.
- ICD - IED Configuration Description.
Data exchange from the IED configuration tool to the system configuration tool. Defines the IEDs capabilities and Data Model.

- IID - Instantiated IED Description.
Data exchange from the IED configuration tool to the system configuration tool which contains add-on and/or modified values.
- CID - Configured IED Description.
Data exchange from the IED configuration tool to the IED.

ERL 61850 IED Configurator supports all of the SCL File types which are directly related to IED configuration (SCD, ICD, IID and CID).

8.3 The Engineering Process

The IEC 61850 standard defines an Engineering Process which is used to manage and implement substation automation. The basic Engineering Process is shown in the diagrams below. For further details, refer to IEC 61850-6 Edition 2.0.

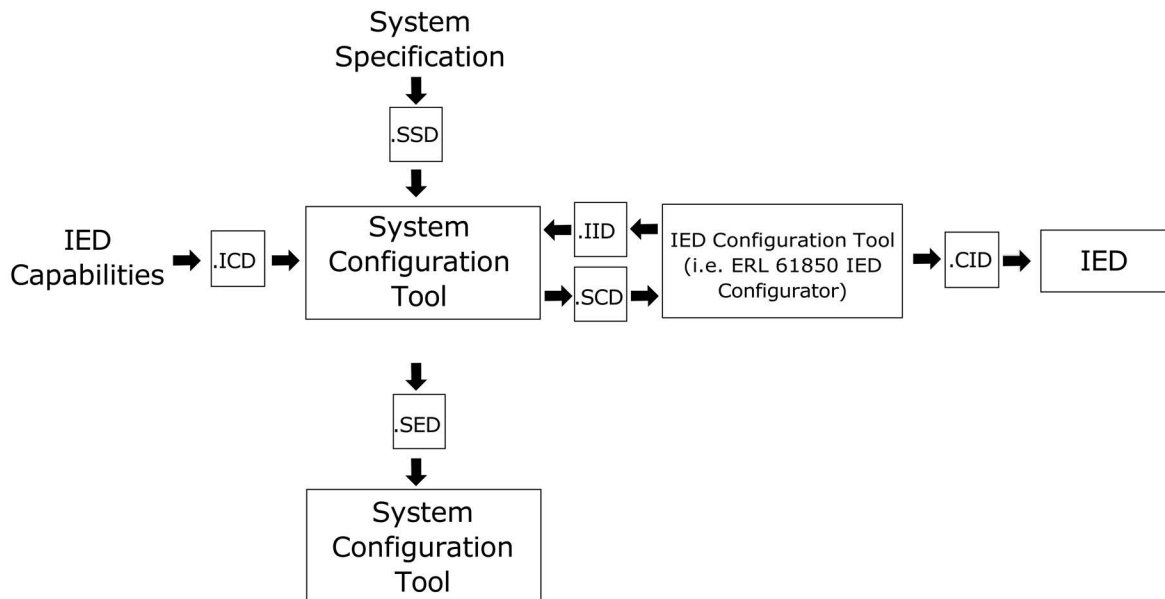


Figure 8.1: The Engineering Process

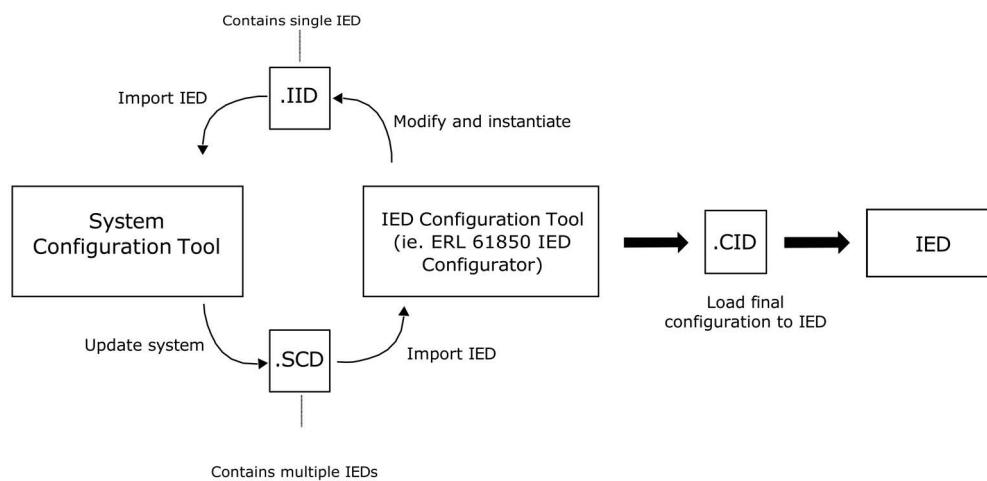


Figure 8.2: Iterations between IED Configuration Tool and System Configuration tool

ERL 61850 IED Configurator supports import and export of CID, ICD, IID and SCD, thus making it compatible with the Engineering Process. Refer to the ERL 61850 IED Configurator user manual for more details.

Note: Importing SCD files which contain mapping to ERL Devices which use IEC 61850 Edition 1.0 is not fully supported and is not recommended. ERL devices which support IEC 61850 Edition 2.0 fully support the SCD import feature and thus are compatible with System Configuration Tools as part of the Engineering Process.

8.4 Control Commands

The F-PRO 4500 provides Single Point (SPC) Control Commands for control via a 61850 MMS Client. There are 12 Single Point Control Commands provided (six are latching, six are pulsing). Each Control Command has a user configurable channel name.

These Control Commands are available as ProLogic inputs as well as for mapping directly from the Output Matrix.

Configuration of Control Command Names

Each of the 12 Control Command has a user configurable channel name. This Configuration is available in F-PRO Offliner (see "Control Commands" on page 7-14). The configured name will be reflected on the metering, events and recording.

Latching and Pulsing

There are two methods of activation for the Control Commands, Pulse and Latch.

SPC 1-6 Controls are set as Pulsing commands. This means when the Control Command is executed, all of the logic downstream from the SPC (PL, OC, LED, Event etc.) will transition to the "True" state for a period of 1 second and then will transition back to "False". However, in the current implementation, the Metering point and IEC 61850 Data attribute associated with this SPC will remain True until the 61850 client sets the SPC to False via a control command execution.

In the current implementation, for the Pulse command points (SPC 1-6), the associated Metering channel and IEC 61850 Data Attribute will remain latched in the True state after a command execution. The state must manually be reset using a command execution to return the state to False.

SPC 7-12 Controls are set as Latching commands. This means when the Control Command is executed, the SPC point will remain in it's new state until a new Control Command is executed.

8.5 IEC 61850 Edition 2.0 Implementation

The F-PRO 4500, starting with firmware version 1.0, uses the second edition of the 61850 Standard. Edition 2.0 of the standard provides many new functionalities. The major changes which have been implemented in the F-PRO 4500 from Edition 2.0 of the standard are described below.

Test Features

IEC 61850 Edition 2.0 introduced two new test features: Simulation and Mode Control. Simulation is an IED level test feature which allows the IED to sub- scribe to simulated GOOSE messages from test-set devices. The Mode Control is an LD level test feature (for testing LDs independently) which allows the LD to process or ignore incoming “test” data. These two features are described in detail below.

Simulation

Edition 2.0 introduced a new Simulation function. Simulation allows for 61850 publisher devices to publish “simulated” GOOSE messages, and for 61850 subscriber devices to subscribe to these “simulated” GOOSE. The devices which publish simulated GOOSE are typically test-set devices used for testing and commissioning. A simulated GOOSE means a GOOSE message with the “Simulation/Test” flag set to True. The F-PRO 4500 has the ability to subscribe to simulated GOOSE, but does not publish any simulated messages.

Figure 8.3: shows the basic flow of how Simulation subscription works for GOOSE subscription.

Setting the IED into Simulation mode allows for the IED to subscribe to both real and simulated GOOSE messages simultaneously. The simulation mode is controlled by the SYS/LPHD1.Sim attribute. If the LPHD1.Sim attribute is set to True via a control command, then the IED may begin to subscribe to Simulated GOOSE messages.

When the IED is in Simulation mode (LPHD1.Sim = True), then the IED will continue to subscribe to real GOOSE (see diagram 2 in Figure 8.3:). However, once a simulated GOOS has been received, the IED will ignore the real GOOSE message if a duplicate real and simulated GOOSE exist simultaneously (see diagram 3 in Figure 8.3:). The simulation mode works on a per GOOSE subscription basis.

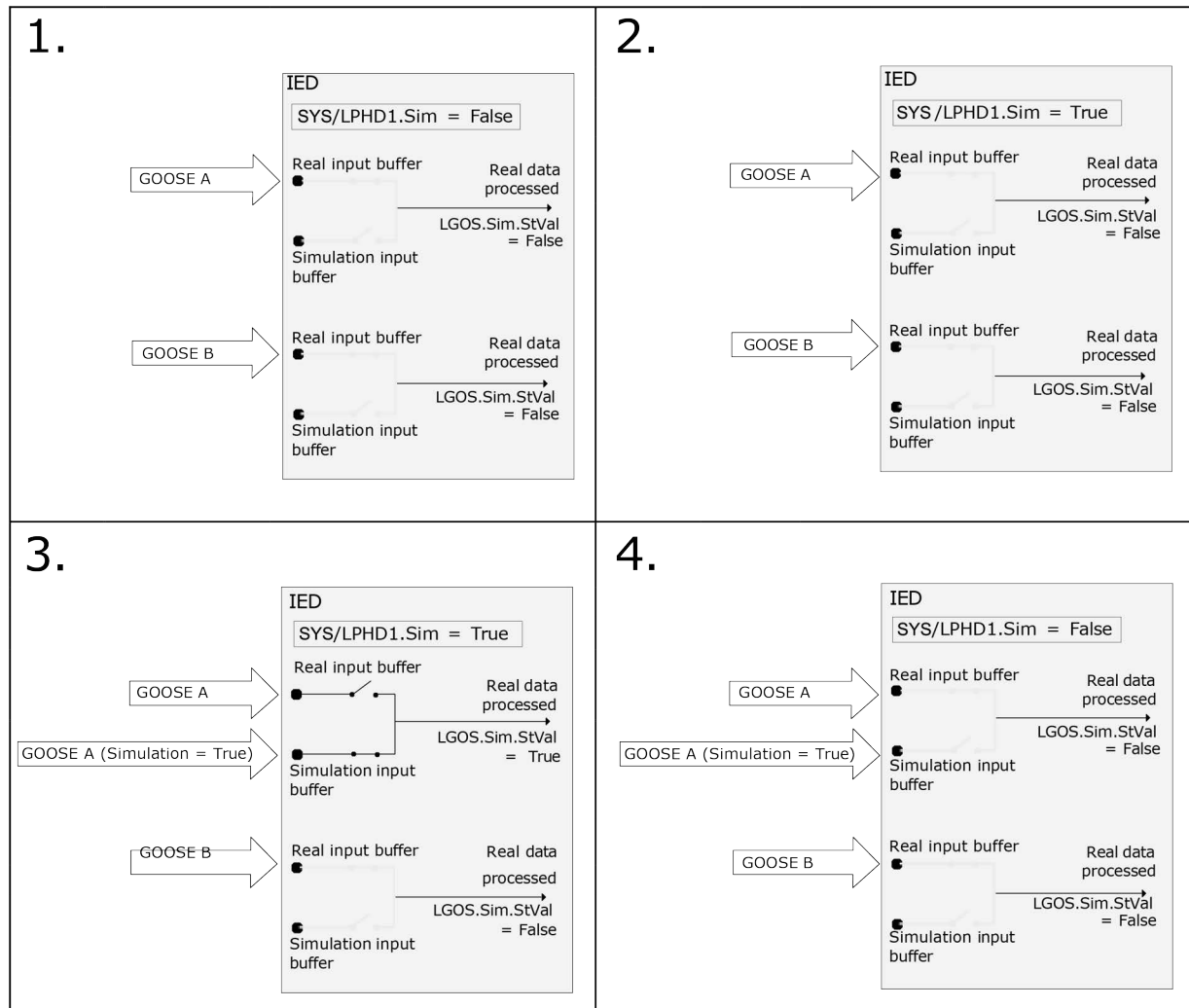


Figure 8.3: : Simulated GOOSE processing

For example, imagine an F-PRO 4500 is subscribing to GOOSE A and GOOSE B simultaneously (see diagram 1 in Figure 8.3:) and then the IED is then set into simulation mode (see diagram 2). The IED will continue to subscribe to the real GOOSE messages as no simulated messages have been received yet. Next, a test-set publisher begins to publish GOOSE A (Simulation = True) and while the real GOOSE A and GOOSE B are still being published on the network (see diagram 3). The IED will successfully subscribe to GOOSE A (Simulation = True) and GOOSE B, but GOOSE A will be ignored. If the test-set stops publishing GOOSE A (Simulation = True) the IED will not return to subscribing to the real GOOSE A until the simulation mode is manually turned off (see diagram 4).

In order to monitor the simulation state of the device, monitor the `LGOS.Sim.StVal` attribute for each GOOSE subscription see "Subscription

Supervision via LGOS" on page 8-9 for more details). LGOS.Sim.StVal = True is an indication that only simulated GOOSE will be accepted for this particular GOOSE subscription. Once the LPHD1.Sim is set back to FALSE, all LGOS.Sim.StVal attributes will change back to FALSE.

Mode Control

The use of the Mod data object was expanded in Edition 2.0 (appended by TISSUE #671) to include the following Modes:

- On
- Blocked
- Test
- Test/Blocked
- Off

The F-PRO 4500 implementation currently supports the use of modes On, Test and Test/Blocked. Control the mode via a control command to change the value of the LLN0.Mod data object. The LLN0.Mod may only be controlled for subscription Logical Devices on the F-PRO 4500.

The LLN0.Mod value determines how incoming data is processed and how data quality output is published. It also determines how control commands are processed. For example, a subscription LD will only process incoming data with q.test = True if the LLN0.Mod is also set to Test or Test/Blocked.

The status of the LLN0.Mod object is reflected in the Beh object for all LNs within the LD. If any LD LLN0.Mod is set to Test or Test/Blocked, the front panel "Test Mode" LED will be turned on.

For further details regarding the behavior different modes, refer to IEC 61850- 7-4 Annex A (appended by TISSUE #671).

Table 8.1: Mode Implementation on the F-PRO 4500
(based on Table A.2 in IEC 61850-7-4 (Edition 2) Appended by TISSUE #671)

	Mode		
	On	Test	Test/Blocked
Output to process via a non 61850 link	Yes	Yes	No
Output of FC, ST, MX (issued independently from Beh)	Value is relevant. q is relevant.	Value is relevant. q.test=true	Value is relevant. q.test=true
Response to Normal Command from Client	Positive Acknowledgement	Negative Acknowledgement	Negative Acknowledgement

Table 8.1: Mode Implementation on the F-PRO 4500
(based on Table A.2 in IEC 61850-7-4 (Edition 2) Appended by TISSUE #671)

Response to TEST Command from Client	Negative Acknowledgement	Positive Acknowledgement	Positive Acknowledgement
Incoming Data with Validity = Good and Test = False and operatorBlocked = false	Process as Valid	Process as Valid	Process as Valid
Incoming Data with Validity = Good and Test = True and operatorBlocked = false	Process as Invalid	Process as Valid	Process as Valid

Subscription Supervision via LGOS

A new logical node, LGOS has been added in Edition 2.0 to provide the ability to supervise GOOSE subscription statuses. The LGOS LN is used to monitor GOOSE subscriptions.

One LGOS LN is created for each GOOSE Control Block which the IED subscribes to. The data objects of the LGOS LN are described in the table below:

Table 8.2: LGOS LN

Data Object	Description
NdsCom	Subscription needs commissioning
St	Status of the subscription (True = active, False = not active). If LGOS.St = False, this means that this GOOSE has not been received for 2x Time Allowed to Live.
SimSt	Status showing if simulated messages are received and accepted (see "Simulation" on page 8-5)
LastStNum	Last state number received
ConfRevNum	Expected configuration revision number
GoCRef	Reference to the subscribed GOOSE control block

Subscription Supervision in the Event Log

Along with the LGOS.St attribute, the Event Log also displays when there is a GOOSE Subscription loss. When the LGOS.St attribute transitions states, there is an event logged into the Event Log. This Event Log entry contains a MAC address which can be used to identify the GOOSE which caused the communication alarm. This MAC address corresponds to the Multicast MAC of the published GOOSE.

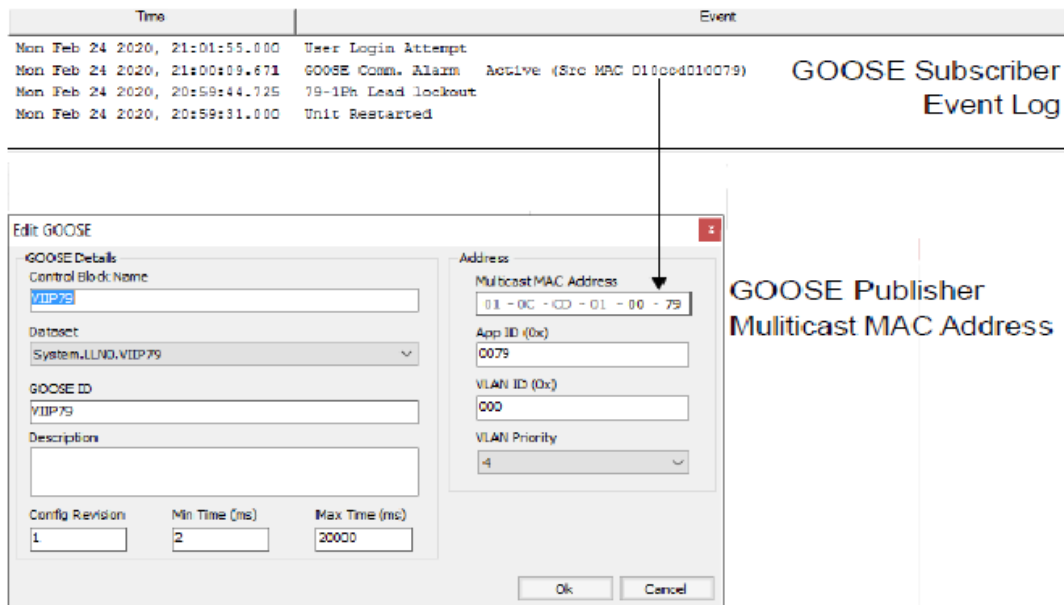


Figure 8.4: Event Log Subscription Supervision

Subscription to *ldName*

There are two Logical Device naming methods (LDName), used for object references, described in IEC 61850-6 Edition 2.0. These methods are:

- Product-related naming
- Function-related naming

In product-related naming, the LDName is comprised of the *IED name* and the *LDevice inst* attribute. ERL IEDs only use product-related naming for Logical Device naming. For example, for an F-PRO 4500 with the IED name “MyF- PRO”, the LDName for the Protection LD would be:

LDName = IED name/LDevice inst = **MyFPRO/Protection**

In function-related naming, the LDName is derived from the *LDevice ldName* attribute. For IEDs to support the use of *ldName*, they must support the free setting of the Logical Device names. ERL IEDs do not support free setting of the Logical Device names, and so do not use the *ldName* attribute. However, Edition 2.0 ERL IEDs do support subscribing to data from other vendor's IEDs which use the function-related naming via the *ldName* attribute.

Data from an IED which uses the *ldName* attribute may be mapped to the ERL Edition 2.0 IED for subscription. The *ldName* attribute shows

in the `ldName` column on the GOOSE Subscription screen in ERL 61850 IED Configurator.

GOOSE IN	Mapped Data
VI01	CustomLDName.LD0_GOCB\LD0_DataSet\LD0/LPHD1\$ST\$Sim\$stVal
VI02	
VI03	
VI04	
VI05	
VI06	

Figure 8.5: Mapping from IED which uses `ldName` attribute

Note: Edition 1.0 does not support the `ldName` attribute, so Edition 1.0 IEDs cannot subscribe to Edition 2.0 IEDs which use the `ldName` attribute. See “Mapping Edition 2.0 Data to an Edition 1.0 IED” on page 8-11 for other a summary of Edition 2.0 to 1.0 mapping incompatibilities.

Subscription to Fixed-Length GOOSE

In IEC 61850 Edition 2.0, fixed-length encoded GOOSE messages were introduced. This is an optimized version of GOOSE encoding which uses a fixed length offset for each field of the GOOSE packet. If a GOOSE Control Block has the `fixedOffs` attribute set to `True`, this indicates that the GOOSE message uses fixed-length encoding.

ERL IEDs do not support publishing the fixed-length encoded GOOSE messages (`fixedOffs` attribute is always set to `False`). However, ERL IEDs can subscribe to GOOSE messages from other vendors which use fixed-length encoded GOOSE messages.

The fixed-length GOOSE subscription is backwards compatible, meaning that even ERL devices which use Edition 1.0 of the standard can subscribe to fixed-length GOOSE messages.

IED Name Length

Edition 2.0 of the IEC 61850 standard allows for longer IED names. The maximum *IED name* length allowed according to the standard is 64 characters. However, this is limited by the total maximum allowed

length for LDName references which is also limited 64 characters. The LDName is defined as *IEDname/LDevice inst* (see "Subscription to ldName" on page 8-10). The total *IEDname* + *LDevice inst* character count may not exceed 64 characters. This is handled automatically in ERL 61850 IED Configurator. The software ensures that *IED name* length does cause the maximum length for the LDName to be exceeded. For example, if the longest *LDevice inst* name is 10 characters long, then *IED name* length is limited to 54 characters, so that *IED name* + *LDevice inst* does not exceed 64 characters.

Common Data Classes

In Edition 2.0 of the IEC 61850 Standard some new Common Data Classes (CDC) were added and others were updated. The only CDC change in Edition 2.0 which affects the F-PRO 4500 implementation is the LLN0.Beh data object was changed from CDC Type INS to ENS. The F-PRO 4500 uses the ENS CDC type for LLN0.Beh as required by Edition 2.0.

Edition 1.0 Compatibility

In general, Edition 1.0 and Edition 2.0 devices are compatible with each other for GOOSE mapping. However, there are some backward compatibility issues which the user should be aware of before attempting mapping between Edition 1.0 and Edition 2.0 devices.

Mapping Edition 1.0 Data to an Edition 2.0 IED

There are no compatibility issues when mapping data from an Edition 1.0 ERL IED to an Edition 2.0 ERL IED. The Edition 2.0 of the IEC 61850 Standard is designed to handle this forward-compatibility case.

Mapping Edition 2.0 Data to an Edition 1.0 IED

Edition 2.0 of the IEC 61850 introduced some backward-compatibility limitations when mapping to an Edition 1.0 IED. The user should be aware of these limitations before configuring mapping Edition 2.0 data to an Edition 1.0 IED.

In order to map data from an Edition 2.0 IED to an Edition 1 IED, the following restrictions must be followed:

- The IED Name on the Edition 2.0 IED (publisher) must be limited such that *IED Name* + *Longest LD Inst* does not exceed 32 characters. This restriction is not enforced by ERL IEC 61850 Configurator, it is the responsibility of the user to ensure name length on the Edition 2.0 IED is not too long.
- The Edition 2.0 publisher cannot use function-related naming (i.e. *ld-Name* attribute). Edition 1.0 does not support the *ldName* attribute.

If the Edition 2.0 publisher uses the *ldName* attribute, then its data may not be mapped to an Edition 1.0 ERL IED. ERL 61850 IED Configurator prevents this mapping when attempted by the user. The F-PRO 4500 does not support publishing the *ldName* attribute, so this condition only applies when mapping with third party vendors who support the *ldName* attribute.

- In Edition 2.0 of the standard, new CDCs were introduced which may cause backward-compatibility issues. These new CDCs do not apply to the implementation in the F-PRO 4500 and therefore this should not cause any issues when mapping between ERL Edition 1.0 and 2.0 devices. However, the user should be aware when mapping from other vendor's IEDs that there may be issues if using data from CDCs which are newly introduced in Edition 2.0.

9 Acceptance Test Guide

9.1 Introduction

The acceptance test section is a guide for testing any and all protection elements in the relay. These tests should be performed upon first delivery of the relay, prior to applying inservice settings. Once inservice settings are applied, ERLPhase recommends that the user test enabled functions to ensure the designed application is fulfilled.

This section deals with the Acceptance Testing and the F-PRO Acceptance Test Procedure.

First, the acceptance testing describes the test equipment requirements, testing the external inputs and testing the output relay contacts.

Next, a step-by-step test procedure for testing all the relay devices is outlined.

9.2 Acceptance Testing

ERLPhase relays are fully tested before leaving the factory. A visual inspection of the relay and its packaging is recommended on receipt to ensure the relay was not damaged during shipping.

The electronics in the relay contain static sensitive devices and are not user-serviceable. If the front of the relay is opened for any reason exposing the electronics, take extreme care to ensure that the user and the relay are solidly grounded.

Generally an analog metering check, as well as testing the I/O (External Inputs and Output Contacts) is sufficient to ensure the functionality of the relay. Further tests can be performed on delivery and acceptance of the purchaser's option according to the published relay specifications in See "IED Settings and Ranges" Appendix B.

Calibration

The F-PRO is calibrated before it leaves the factory and should only be recalibrated as per ERLPhase recommendation. Please contact ERLPhase Technical Support for instructions.

Testing the External Inputs

To test the external inputs connect the relay using Relay Control Panel, *Metering>External*. This screen displays the status of the Input and Output Contacts.

Placing a voltage of 125 Vdc_{nominal}, (150 V_{maximum}), to each of the external inputs in turn causes the input to change from Low to High status. These inputs are polarity sensitive and this screen has a 0.5 second update rate.

Testing the Output Relay Contacts

Test the output relays to verify their integrity using the *Utilities>Toggle Outputs*. The output contacts are toggled from open to closed by pressing the *Closed* button. Verify the output contact status using an ohmmeter. When exiting this sub-menu, each contact status reverts to the open position.

Appendix A IED Specifications

A. 1 F-PRO Model 4500 Specifications

F-PRO Model 4500 Specifications		
Item	Quantity/Specs	Note
General:		
Nominal Frequency	50 or 60 Hz	
Operate Time	< 25 msec typical	Including output relay operation
Power Supply	Range: 20 - 60 Vdc / 20 – 60 Vac, 80 - 300 Vdc / 80 – 250 Vac	Power Consumption: 20 – 30 W/VA
Memory	Settings and records are stored in non-volatile memory	Records are stored in FIFO method
Protection Functions:		
27, 59, 24, 47, 59N, 50BF, 50LS, 50/51/67, 50N/51N/67N, 50G/51G/67G, 50SEF/51SEF/67SEF, 46-50/46- 51/67, 60VTS, 60CTS, 79, 81U/81O/81R, 32, 49, 37, 74TCS, THD, I ² t, 25/27/59 (Check Sync	1x 3-phase voltage input for protection 1x 1-phase voltage input for protection and check synchronizing 1 x 3-phase current inputs for protection 1X 1-phase current for Measured Ground protection 1X 1-phase current for SEF/ REF protection	
ProLogic™	24 statements per setting group	5 inputs per ProLogic™ statement
Group Logic	16 statements per setting group	5 inputs per group logic statement
Recording		
Transient (Fault)	128 s/c oscillography of all analog and external input channels	User-configurable 0.2 to 10.0 seconds Record length and 0.1 to 2.0 seconds pre-trigger record length
Swing	1 s/c oscillography	User-configurable 60 – 120 seconds record length with 30 seconds pretrigger
Sequence of Events Recorder	250 events circular log with 1ms resolution	When “event auto save” is enabled, a compressed event record is created approximately every 230 events.
Record Capacity	A maximum of 150 total records (Fault, Swing and Event) are possible with 4 second record length. Fault Records with 10 second duration are the largest records.	

F-PRO Model 4500 Specifications

	Quantity/Specs	Note
Input & Output:		
Analog Voltage Inputs 1 set of 3-phase voltage input 1 set of 1-phase voltage input	Nominal Voltage Continuous Rating Over Voltage Maximum Over-Scale Thermal Rating Burden	Vn = 69 Vrms 2 x Vn = 138 Vrms 3 x Vn = 207 Vrms for 10 seconds < 0.15VA @ 69 Vrms
Analog Current Inputs (1 set of 3-phase current inputs 2 x 1 sets of 1-phase current inputs)	Nominal Current Continuous Rating Maximum Full-Scale Rating Thermal Rating Burden	In = 1 and 5 Arms (Site Selectable) 4 x In(for Phase and neutral CT), 2 x In (for SEF CT) 40 x In(for Phase and neutral CT), 4 x In (for SEF CT) 100 X In rms for 1 second (for Phase and neutral CT) 10 X In rms for 1 second (for SEF CT) <0.25 VA @ 5 Arms, <0.10 VA @ 1 Arms (for Phase and neutral CT), <1VA @ 1Arms, <2VA @ 5Arms (for SEF CT)
External Inputs (digital)	8/16/24 isolated inputs selection Via ordering option Burden Isolation	24/48/110/220 Vdc nominal (Ordering Option) Externally wetted Burden resistance: > 200 k ohms 2 kV optical isolation
Output Relays (contacts)	31 programmable outputs and 1 relay inoperative contact (N.C.)	Externally wetted Make: 30 A as per IEEE C37.90 Carry: 8 A Break: 0.9 A at 125 Vdc resistive 0.35 A at 250 Vdc resistive
Virtual Inputs	30 Virtual Inputs	
Interface & Communication		
Front Display	128 x 64 pixels graphics LCD	
Front Panel Indicators	22 LEDs: 18 programmable, 4 fixed	Target (18), Unit Functional, Time Sync, Test Mode, Service Required
Front User Interface	USB port	Full Speed USB 2.0

F-PRO Model 4500 Specifications

Rear User Interface	LAN Port 1: 100BASE – Copper or Optical 1300 nm LAN Port 2: 100BASE – Copper or Optical 1300 nm One serial RS-485 ports	Copper: RJ-45, 100BASE-T Optical: 100BASE-FX, Multimode ST style connector 300 – 57600 Baud Rate
SCADA Interface	IEC 61850 Edition 2, DNP3 (RS-485 or Ethernet) or Modbus (RS-485)	Rear port
Time Sync	IRIG-B, BNC connector B003, B004, B123 and B124 Time Codes SNTP	Modulated or unmodulated. Through Ethernet Ports
Self Checking/Relay Inoperative	1 contact	Closed when relay inoperative
Physical (19")		
Weight	9.5 Kg (approximate)	
Dimensions	176 mm (6.93 in.) Height x 486 mm (19.13 in.) Width x 277 mm (10.91 in.) Depth	
Mounting	Rack mount	
Physical (E12)		
Weight	11 kg (approximate)	
Dimensions	177 mm (6.97 in.) Height x 340 mm (13.38 in.) Width x 283 mm (11.14 in.) Depth.	
Mounting	Flush mount	
Time Synchronization		
External Time Source	Synchronized using IRIG-B input (modulated or unmodulated) and SNTP	In the absence of an external source of time, the relay maintains time with an internal RTC. The relay can detect loss of re-establishment of external time source and automatically switch between internal and external time.
Synchronization Accuracy	Sampling clocks synchronized with the time source (internal or external).	
Overall F-PRO Accuracies		
Current	±2.5% of inputs from 0.1 to 1.0 x nominal current (In)	
	± 1.0% of inputs from 1.0 to 40.0 x nominal current (In)	
Voltage	± 1.0% of inputs from 0.01 to 2.0 x nominal voltage (Vn)	
Directional Phase Angle	±2.5% or > 2.0 of set value from 0.01 to 360.0	
Frequency Elements	±0.001 Hz (for 81U/O)	
	±0.05 Hz (for 81R)	
Inverse Overcurrent Timers	±2.5% or 1 cycle of the selected curve	

Type Tests			
Test	Description		Test Level
	Type Test	Test Points	
Electromagnetic Compatibility			
IEC 60255-26:2013 Cl.No. 7.1.2 Cl.No. 7.1.3	RF emissions	Enclosure ports	30 - 1000 MHz, 1000MHz - 6000 MHz
	Conducted emissions	Power supply ports	Class A: 0.15 - 30 MHz
IEC 60255-26:2013 Cl.No. 7.2.3	ESD	Enclosure contact	+/- 6 kV
		Enclosure air	+/- 8 kV
IEC60255-26:2013 Cl.No. 7.2.4	Radiated RFI	Enclosure ports	10 V/m modulated: 80 - 1000 MHz & 1.4 - 2.7 GHz
IEC 60255-26:2013 Cl.No. 7.2.5	Burst (fast transient)	Signal ports	+/- 4 kV @ 5 kHz
		Power Supply Ports	+/- 4 kV @ 5 kHz
		Earth ground ports	+/- 4 kV@ 5 kHz
		Communication ports	+/- 2 kV @ 5 kHz
IEC 60255-26:2013 Cl.No. 7.2.8	Induced (conducted) RFI	Signal ports	10 Vrms: 0.150 - 80 MHz
		Power supply ports	10 Vrms: 0.150 - 80 MHz
IEC 60255-26:2013 Cl.No. 7.2.10	Power frequency magnetic field	Enclosure	30A/m for each axis for 60s 300A/m for each axis for 3s
IEC 60255-26:2013 Cl.No. 7.2.10	Power frequency	Binary input ports: Class A	Differential = 150 Vrms
			Common = 300 Vrms
IEC 60255-26:2013 Cl.No. 7.2.11	Voltage dips & interrupts	ac power port	100% for 2.5 cycles, 60% for 10 cycles, 30% for 25 cycles
			100% for 250 cycles
		dc power port	100% for 250 cycles
IEC 60255-26:2013 Cl.No. 7.2.6	Slow Damped oscillatory wave immunity test	Communication ports	1.0 kV Common
		Signal ports	2.5 kV Common, 1 kV Diff
		Power supply ports	2.5 kV Common, 1 kV Diff
Safety			
IEC 60255-27:2013, Cl. No. 10.6.4.2	HV Impulse	Signal ports	±5 kV
		I/O ports	±5 kV
		Power supply ports	±5 kV
		Earth (Case ground)	±5 kV

Type Tests			
Test	Description		Test Level
	Type Test	Test Points	
IEC 60255-27:2013, Cl. No. 10.6.4.3	Dielectric / HiPot	Power supply ports	2 kV
		Signal ports	2 kV
		I/O ports	2 kV
		Earth (case ground)	2 kV
		Output contact terminals	1 kV
IEC 60255-27:2013, Cl. No. 10.6.4.4	Insulation Resistance	Power supply ports	500 Vdc
		Signal ports	500 Vdc
		I/O ports	500 Vdc
		Earth (case ground)	500 Vdc
Environmental Tests			
IEC 60068-2-30	Humidity	Enclosure	
IEC 60068-2-78 IEC 60255-1 Cl. No. 10.6.5.3	Damp heat steady state	Enclosure	10 days
IEC 60068-2-30 IEC 60255-1 Cl. No. 6.12.3.7	Cyclic temperature with humidity	Enclosure	6 days of cycles from 25°C to 55°C at 90 to 100% Relative Humidity
IEC 60068-2-2 IEC 60255-1 Cl. No. 6.12.3.3	Dry Heat Storage Test	Enclosure	70°C for 16 hours
IEC 60068-2-2 IEC 60255-1 Cl. No. 6.12.3.1	Dry Heat Operational Test	Enclosure	55°C for 16 hours
IEC 60068-2-1 IEC 60255-1 Cl. No. 6.12.3.4	Cold Storage Test	Enclosure	-40°C for 16 hours
IEC 60068-2-1 IEC 60255-1 Cl. No. 6.12.3.2	Cold Operational Test	Enclosure	-25°C for 16 hours
IEC 60068-2-14 IEC 60255-1 Cl. No. 6.12.3.5	Change of Temperature	Enclosure	5 cycles of change of temperature from -25°C to 55°C.

Type Tests			
Test	Description		Test Level
	Type Test	Test Points	
Mechanical			
IEC 60255-21-2 IEC/EN 60068-2-27	Shock and Bump	Enclosure	Shock Response: 5g, 11ms pulse width, 1/2 sine wave, 3 shocks/direction, 2 directions/axis, 36 shocks total
			Shock Withstand: 15g, 11ms pulse width, 1/2 sine wave, 3 shocks/direction, 2 directions/axis, 18 shocks total
			Bump: 10g, 16ms pulse width, 1/2 sine wave, 1000 bumps/direction, 2 directions/ axis, 6000 bumps total
IEC/EN 60255-21-1 IEC/EN 60068-26	Vibration	Enclosure	Vibration Response Class 1: 0.5 g, 10 Hz to 150 Hz, 1.0 octave/ min, 1 sweep/axis
			Vibration Endurance Class 1: 1.0 g, 10 Hz to 150 Hz, 1.0 octave/ min, 20 sweep/axis
IEC 60255-21-3	Seismic	Enclosure	Class 1: 5-35 Hz, 1 sweep cycle/axis

A. 2 Frequency Element Operating Time Curves

Figure A.4 Time delay Error at 0.2 seconds, Figure A.5 Time Delay Error at 1 second and Figure A.6 Time Delay Error at 10 seconds show operating times for the relay frequency rate of change elements at different time delay settings and rate of change settings.

The diagrams show operating times at each test point including output contact operate time. Operating times are the same for both 50 Hz and 60 Hz.

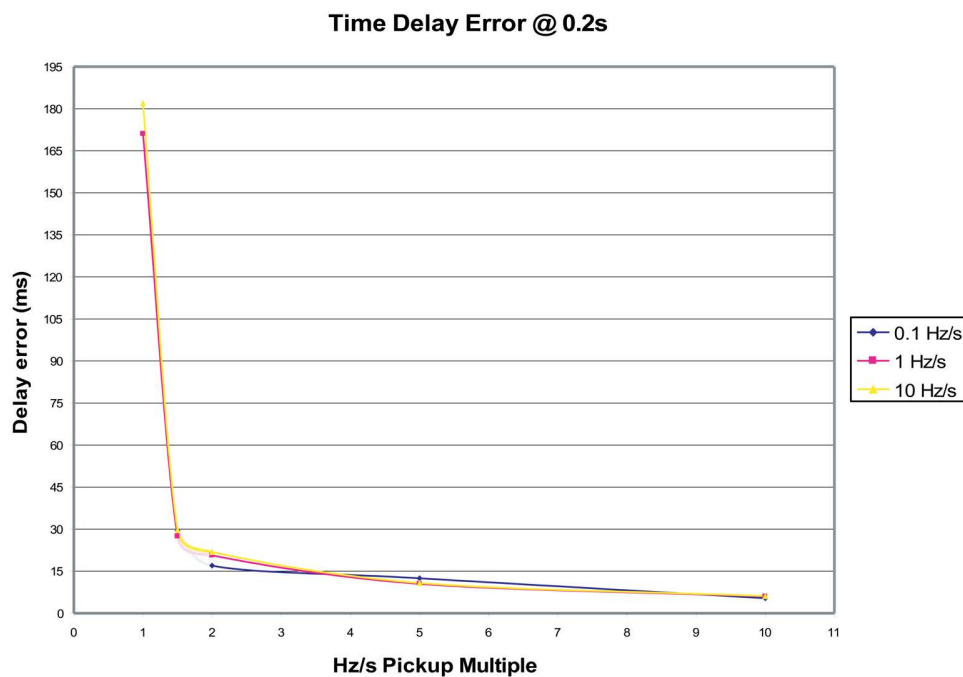


Figure A.4 Time delay Error at 0.2 seconds

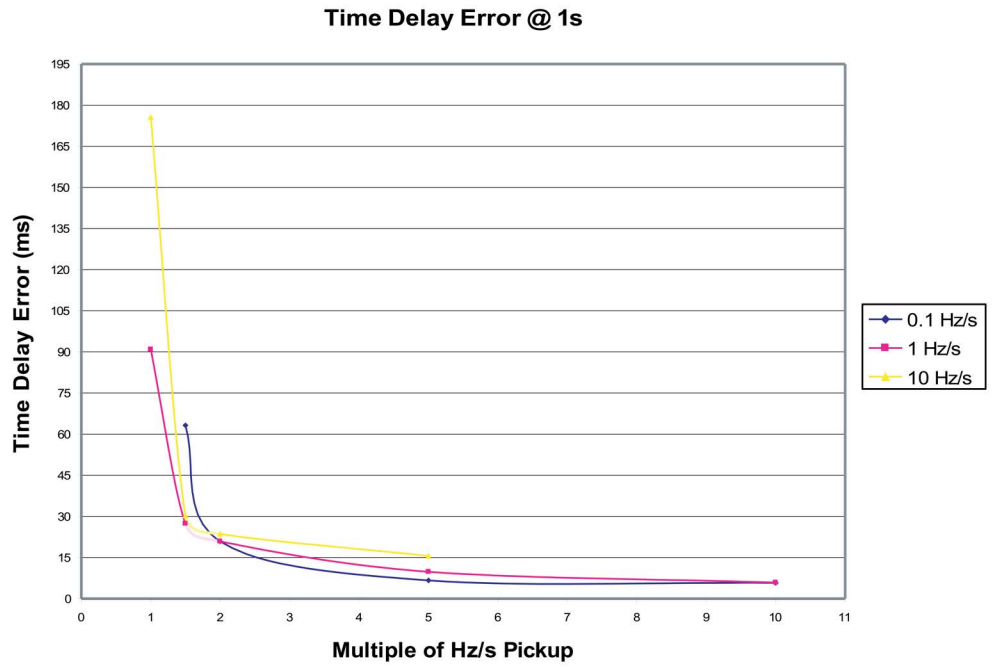


Figure A.5 Time Delay Error at 1 second

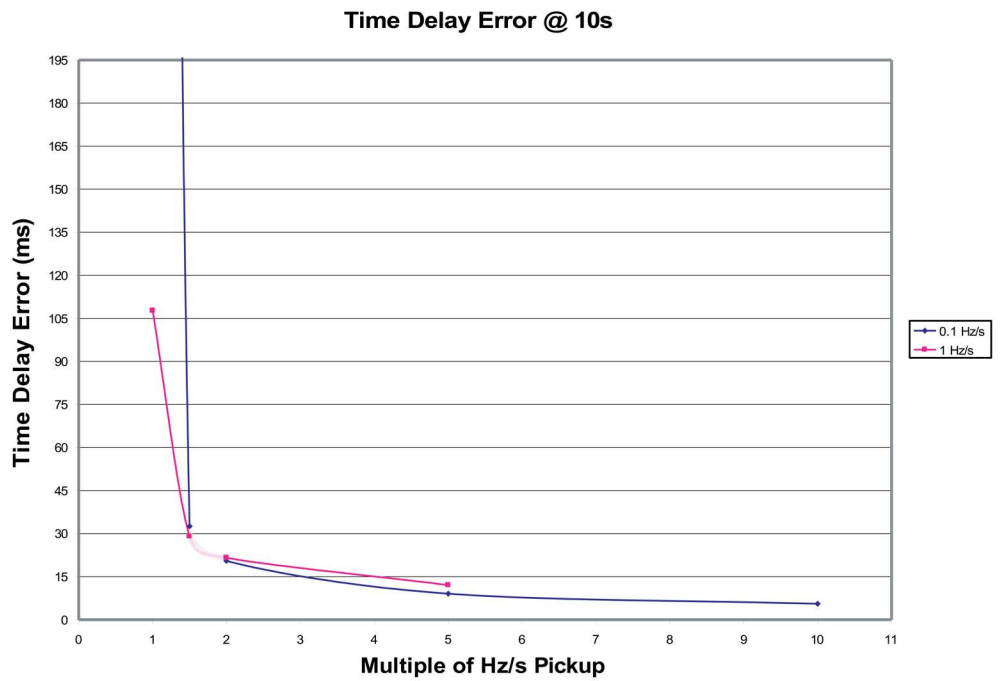


Figure A.6 Time Delay Error at 10 seconds

A.3 External Input Pickup Filter

To guarantee security from spurious voltage pulses an external input pickup filter setting has been introduced. This setting is made in Relay Control Panel under, *Utilities>Setup>External Inputs*. The setting is an integer number representing the number of samples in a packet of 16 that must be recognized by the DSP as high before an External Input status is changed from low to high.

This will affect the pulse width required for the External Inputs to be detected. Below is a table describing the pulse widths for possible and definite defection for each setting.

Pickup Filter Count	Input Pulse Width required for EI to be possibly detected	Input Pulse Width required for EI to be definitely detected
4	0.521 ms	0.911 ms
5	0.651 ms	1.1172 ms
6	0.781 ms	1.432 ms
7	0.911 ms	1.693 ms
8	1.042 ms	1.953 ms
9	1.172 ms	2.214 ms
10	1.302 ms	2.474 ms
11	1.432 ms	2.734 ms
12	1.563 ms	2.995 ms
13	1.693 ms	3.255 ms
14	1.823 ms	3.516 ms
15	1.953 ms	3.776 ms
16	2.083 ms	4.036 ms

For a setting of 6, it will take between 0.781 and 1.432 ms for an External Input to be declared as high. The default setting is 4.

Appendix B IED Settings and Ranges

B. 1 Settings and Ranges

The Offliner software provides a means for the user to view and print a compact summary of the settings defined in each Setting Group, for a given device. The user can view the summary by selecting the Settings Summary option (last item) under each Setting Group listed in the Offliner application.

The summary includes general data from the Relay Identification screen, as well as all the user-defined names of inputs (e.g. current, voltage, virtual) and control outputs, and Group Logic definitions. It also includes all the user-defined settings along with their respective units and permissible value range.

The following pages illustrate the Default Settings Summary for Settings Group 1.

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Relay Identification			
Settings Version	601		
Ignore Serial Number	Yes		
Serial Number	FPRO-4500-000000-01		
Relay ID	F-PRO4500		
Nominal System Frequency	60 Hz		
Analog Input	5CT and 4PT		
Digital I/O	24DI and 32DO		
Comments	Comments		
Setting Name	Default Settings		
Date Created-Modified	2024-04-16 09:47:14:00		
Station Name	Station Name		
Station Number	1		
Location	Location		
Bay Name	Bay Name		
Analog Input Names			
VA	Main Voltage A		
VB	Main Voltage B		
VC	Main Voltage C		
V AUX	Auxiliary Voltage		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
IA	Phase Current A		
IB	Phase Current B		
IC	Phase Current C		
IG	Neutral Current		
ISEF	SEF Current		
External Input Names			
EI 1	EI Spare 1		
EI 2	EI Spare 2		
EI 3	EI Spare 3		
EI 4	EI Spare 4		
EI 5	EI Spare 5		
EI 6	EI Spare 6		
EI 7	EI Spare 7		
EI 8	EI Spare 8		
EI 9	EI Spare 9		
EI 10	EI Spare 10		
EI 11	EI Spare 11		
EI 12	EI Spare 12		
EI 13	EI Spare 13		
EI 14	EI Spare 14		
EI 15	EI Spare 15		
EI 16	EI Spare 16		
EI 17	EI Spare 17		
EI 18	EI Spare 18		
EI 19	EI Spare 19		
EI 20	EI Spare 20		
EI 21	EI Spare 21		
EI 22	EI Spare 22		
EI 23	EI Spare 23		
EI 24	EI Spare 24		
Output Contact Names			
Output 1	Relay Inoperative		
Output 2	Out Spare 2		
Output 3	Out Spare 3		
Output 4	Out Spare 4		
Output 5	Out Spare 5		
Output 6	Out Spare 6		
Output 7	Out Spare 7		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Output 8	Out Spare 8		
Output 9	Out Spare 9		
Output 10	Out Spare 10		
Output 11	Out Spare 11		
Output 12	Out Spare 12		
Output 13	Out Spare 13		
Output 14	Out Spare 14		
Output 15	Out Spare 15		
Output 16	Out Spare 16		
Output 17	Out Spare 17		
Output 18	Out Spare 18		
Output 19	Out Spare 19		
Output 20	Out Spare 20		
Output 21	Out Spare 21		
Output 22	Out Spare 22		
Output 23	Out Spare 23		
Output 24	Out Spare 24		
Output 25	Out Spare 25		
Output 26	Out Spare 26		
Output 27	Out Spare 27		
Output 28	Out Spare 28		
Output 29	Out Spare 29		
Output 30	Out Spare 30		
Output 31	Out Spare 31		
Output 32	Out Spare 32		
Output Contact Dropout Timers			
Output1 (Relay Inoperative)	0.10	s	0.00 to 20.00
Output2 (Out Spare 2)	0.10	s	0.00 to 20.00
Output3 (Out Spare 3)	0.10	s	0.00 to 20.00
Output4 (Out Spare 4)	0.10	s	0.00 to 20.00
Output5 (Out Spare 5)	0.10	s	0.00 to 20.00
Output6 (Out Spare 6)	0.10	s	0.00 to 20.00
Output7 (Out Spare 7)	0.10	s	0.00 to 20.00
Output8 (Out Spare 8)	0.10	s	0.00 to 20.00
Output9 (Out Spare 9)	0.10	s	0.00 to 20.00
Output10 (Out Spare 10)	0.10	s	0.00 to 20.00
Output11 (Out Spare 11)	0.10	s	0.00 to 20.00
Output12 (Out Spare 12)	0.10	s	0.00 to 20.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Output13 (Out Spare 13)	0.10	s	0.00 to 20.00
Output14 (Out Spare 14)	0.10	s	0.00 to 20.00
Output15 (Out Spare 15)	0.10	s	0.00 to 20.00
Output16 (Out Spare 16)	0.10	s	0.00 to 20.00
Output17 (Out Spare 17)	0.10	s	0.00 to 20.00
Output18 (Out Spare 18)	0.10	s	0.00 to 20.00
Output19 (Out Spare 19)	0.10	s	0.00 to 20.00
Output20 (Out Spare 20)	0.10	s	0.00 to 20.00
Output21 (Out Spare 21)	0.10	s	0.00 to 20.00
Output22 (Out Spare 22)	0.10	s	0.00 to 20.00
Output23 (Out Spare 23)	0.10	s	0.00 to 20.00
Output24 (Out Spare 24)	0.10	s	0.00 to 20.00
Output25 (Out Spare 25)	0.10	s	0.00 to 20.00
Output26 (Out Spare 26)	0.10	s	0.00 to 20.00
Output27 (Out Spare 27)	0.10	s	0.00 to 20.00
Output28 (Out Spare 28)	0.10	s	0.00 to 20.00
Output29 (Out Spare 29)	0.10	s	0.00 to 20.00
Output30 (Out Spare 30)	0.10	s	0.00 to 20.00
Output31 (Out Spare 31)	0.10	s	0.00 to 20.00
Output32 (Out Spare 32)	0.10	s	0.00 to 20.00
Output Contact Reset Type			
Output 1	Self Reset		
Output 2	Self Reset		
Output 3	Self Reset		
Output 4	Self Reset		
Output 5	Self Reset		
Output 6	Self Reset		
Output 7	Self Reset		
Output 8	Self Reset		
Output 9	Self Reset		
Output 10	Self Reset		
Output 11	Self Reset		
Output 12	Self Reset		
Output 13	Self Reset		
Output 14	Self Reset		
Output 15	Self Reset		
Output 16	Self Reset		
Output 17	Self Reset		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Output 18	Self Reset		
Output 19	Self Reset		
Output 20	Self Reset		
Output 21	Self Reset		
Output 22	Self Reset		
Output 23	Self Reset		
Output 24	Self Reset		
Output 25	Self Reset		
Output 26	Self Reset		
Output 27	Self Reset		
Output 28	Self Reset		
Output 29	Self Reset		
Output 30	Self Reset		
Output 31	Self Reset		
Output 32	Self Reset		
Output Contact Reset			
Reset	<Unused = 0>		
Control Command Names			
SPC 1	SPC 1		
SPC 2	SPC 2		
SPC 3	SPC 3		
SPC 4	SPC 4		
SPC 5	SPC 5		
SPC 6	SPC 6		
SPC 7	SPC 7		
SPC 8	SPC 8		
SPC 9	SPC 9		
SPC 10	SPC 10		
SPC 11	SPC 11		
SPC 12	SPC 12		
Virtual Input Names			
VI 1	Virtual Input 1		
VI 2	Virtual Input 2		
VI 3	Virtual Input 3		
VI 4	Virtual Input 4		
VI 5	Virtual Input 5		
VI 6	Virtual Input 6		
VI 7	Virtual Input 7		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
VI 8	Virtual Input 8		
VI 9	Virtual Input 9		
VI 10	Virtual Input 10		
VI 11	Virtual Input 11		
VI 12	Virtual Input 12		
VI 13	Virtual Input 13		
VI 14	Virtual Input 14		
VI 15	Virtual Input 15		
VI 16	Virtual Input 16		
VI 17	Virtual Input 17		
VI 18	Virtual Input 18		
VI 19	Virtual Input 19		
VI 20	Virtual Input 20		
VI 21	Virtual Input 21		
VI 22	Virtual Input 22		
VI 23	Virtual Input 23		
VI 24	Virtual Input 24		
VI 25	Virtual Input 25		
VI 26	Virtual Input 26		
VI 27	Virtual Input 27		
VI 28	Virtual Input 28		
VI 29	Virtual Input 29		
VI 30	Virtual Input 30		
Target Reset			
Reset	<Unused=0>		
Target			
Target LED 1	Self Reset		
Target LED 2	Self Reset		
Target LED 3	Self Reset		
Target LED 4	Self Reset		
Target LED 5	Self Reset		
Target LED 6	Self Reset		
Target LED 7	Self Reset		
Target LED 8	Self Reset		
Target LED 9	Self Reset		
Target LED 10	Self Reset		
Target LED 11	Self Reset		
Target LED 12	Self Reset		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Target LED 13	Self Reset		
Target LED 14	Self Reset		
Target LED 15	Self Reset		
Target LED 16	Self Reset		
Target LED 17	Self Reset		
Setting Group Names			
Setting Group 1	Setting Group 1		
Setting Group 2	Setting Group 2		
Setting Group 3	Setting Group 3		
Setting Group 4	Setting Group 4		
Setting Group 5	Setting Group 5		
Setting Group 6	Setting Group 6		
Setting Group 7	Setting Group 7		
Setting Group 8	Setting Group 8		
System Parameters			
Phase Rotation	ABC		
Aux Voltage Input	A-Phase		
Fault Location Display	Enabled		
Main Phase CT Primary	1200.00	A	1.00 to 30000.00
Main Phase CT Secondary	5A		
Main Phase CT Turns Ratio	240.00	:1	1.00 to 30000.00
Main Neutral CT Primary	1200.00	A	1.00 to 30000.00
Main Neutral CT Secondary	5A		
Main Neutral CT Turns Ratio	240.00	:1	1.00 to 30000.00
SEF CT Primary	1200.00	A	1.00 to 30000.00
SEF CT Secondary	5A		
SEF CT Turns Ratio	240.00	:1	1.00 to 30000.00
Main PT Primary	230.00	kV (Ph-Ph)	1.00 to 2000.00
Main PT Secondary	115.00	V (Ph-Ph)	100.00 to 150.00
Main PT Turns Ratio	2000.00	:1	1.00 to 20000.00
Auxiliary PT Primary	230.00	kV (Ph-Ph)	1.00 to 2000.00
Auxiliary PT Secondary	115.00	V (Ph-Ph)	100.00 to 150.00
Auxiliary PT Turns Ratio	2000.00	:1	1.00 to 20000.00
Minimum Voltage Threshold	0.30	V	0.00 to 2.90
Minimum Current Threshold	0.20	A	0.00 to 1.00
Record Length			
Fault Record Length	0.5	s	0.2 to 10.0
Prefault Time	0.20	s	0.10 to 0.40

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Swing Rcd. Length	120	s	60 to 120
Event Auto Save	Disabled		
Setting Group 1 [Setting Group 1]			
Setting Group Comments: Default settings			
Line Parameters			
Line Voltage	230.00	kV Primary	1.00 to 2000.00
Line Length	100.00	km	0.50 to 2000.00
Positive Sequence Impedance (Z1)	10.00	ohm	0.01 to 66.00
Positive Sequence Angle (Z1)	80.0	deg	5.0 to 89.0
Zero Sequence Impedance (Z0)	30.00	ohm	0.01 to 300.00
Zero Sequence Angle (Z0)	80.0	deg	5.0 to 89.0
Scheme Selector			
Protection Scheme	3 Phase		
52 - Breaker Status			
Main Breaker	EI 3 [EI Spare 3]		
Main Breaker Pole A	<Unused = 0>		
Main Breaker Pole B	<Unused = 0>		
Main Breaker Pole C	<Unused = 0>		
Protection Summary			
25 Sync Check	Enabled		
Dead Main Live Aux (DMLA)	Enabled		
Live Main Dead Aux (LMDA)	Enabled		
Dead Main Dead Aux (DMDA)	Enabled		
79-3Ph	Enabled		
79-1Ph	Enabled		
59DT - 1 - Main	Enabled		
59DT - 2 - Main	Enabled		
59DT - 3 - Main	Enabled		
59DT - 4 - Main	Enabled		
59DT - 1 - Aux	Enabled		
59DT - 2 - Aux	Enabled		
59DT - 3 - Aux	Enabled		
59DT - 4 - Aux	Enabled		
59NIT	Enabled		
59NDT - 1	Enabled		
59NDT - 2	Enabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
27DT - 1 - Main	Enabled		
27DT - 2 - Main	Enabled		
27DT - 3 - Main	Enabled		
27DT - 4 - Main	Enabled		
27DT - 1 - Aux	Enabled		
27DT - 2 - Aux	Enabled		
27DT - 3 - Aux	Enabled		
27DT - 4 - Aux	Enabled		
47DT - 1	Enabled		
47DT - 2	Enabled		
24DT - 1	Enabled		
24DT - 2	Enabled		
27IT - 1 Main	Enabled		
27IT - 2 Main	Enabled		
59IT - 1 Main	Enabled		
59IT - 2 Main	Enabled		
60 VTS	Enabled		
60 CTS Main	Enabled		
THD - 1	Enabled		
THD - 2	Enabled		
AR	Enabled		
I ² t-CB	Enabled		
81 - 1	Disabled		
81 - 2	Disabled		
81 - 3	Disabled		
81 - 4	Disabled		
81 - 5	Disabled		
81 - 6	Disabled		
81 - 7	Disabled		
81 - 8	Disabled		
81 - 9	Disabled		
81 - 10	Disabled		
50LS	Enabled		
32 - 1	Enabled		
32 - 2	Enabled		
32 - 3	Enabled		
32 - 4	Disabled		
49	Enabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
37 - 1	Enabled		
37 - 2	Enabled		
47IT	Enabled		
24IT	Enabled		
50BF Main	Enabled		
50 - 1	Enabled		
50 - 2	Enabled		
51 - 1	Enabled		
51 - 2	Enabled		
50N - 1	Enabled		
50N - 2	Enabled		
51N - 1	Enabled		
51N - 2	Enabled		
50G - 1	Enabled		
50G - 2	Enabled		
51G - 1	Enabled		
51G - 2	Enabled		
64/50SEF-1	Enabled		
64/50SEF-2	Enabled		
64/51SEF-1	Enabled		
64/51SEF-2	Enabled		
46 - 50	Enabled		
46 - 51	Enabled		
74TCS - 1	Enabled		
74TCS - 2	Enabled		
46 - BC	Enabled		
81HBL2	Enabled		
27DT - Undervoltage			
27DT – 1 – Main	Enabled		
Gate Switch	AND		
Pickup	25.0	V	1.0 to 120.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTS Blocking	Disable		
27DT – 2 – Main	Enabled		
Gate Switch	AND		
Pickup	25.0	V	1.0 to 120.0

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTS Blocking	Disable		
27DT – 3 – Main	Enabled		
Gate Switch	AND		
Pickup	25.0	V	1.0 to 120.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTS Blocking	Disable		
27DT – 4 – Main	Enabled		
Gate Switch	AND		
Pickup	24.0	V	1.0 to 120.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTS Blocking	Disable		
27DT – 1 – Aux	Enabled		
Pickup	25.00	V	1.0 to 120.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
27DT – 2 - Aux	Enabled		
Pickup	1.50	s	0.00 to 99.99
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
27DT – 3 – Aux	Enabled		
Pickup	25.0	V	1.0 to 120.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
27DT – 4 – Main	Enabled		
Pickup	25.0	V	1.0 to 120.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
27IT – Phase Reverse Time Overvoltage			
27IT – 1 Main	Enabled		
Pickup V	55.00	V	1.0 to 150.0
Hysteresis	1	%	1 to 80
Curve Type	IEC Standard Inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
A	1.0	-	0.1 to 50.0
B	0.0	-	0.0 to 10.0
p	1.0	-	0.1 to 10.0
VTB Blocking	Disabled		
27IT – 2 Main	Enabled		
Pickup V	55.0	V	1.0 to 150.0
Hysteresis	1	%	1 to 80
Curve Type	IEC Standard Inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
A	1.0	-	0.1 to 50.0
B	0.0	-	0.0 to 10.0
p	1.0	-	0.1 to 10.0
VTB Blocking	Disabled		
59DT - Overvoltage			
59DT – 1 - Main	Enabled		
Gate Switch	OR		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
59DT – 2- Main	Enabled		
Gate Switch	OR		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
59DT – 3 - Main	Enabled		
Gate Switch	OR		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
59DT – 4 - Main	Enabled		
Gate Switch	OR		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
59DT – 1 – Aux	Enabled		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
59DT – 2 – Aux	Enabled		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 89
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
59DT – 3 – Aux	Enabled		
Pickup	70.0	V1	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
59DT – 4 – Main	Enabled		
Pickup	70.0	V	1.0 to 138.0
Hysteresis	1	%	1 to 80
Pickup Delay	5.00	s	0.00 to 10.00
Reset DTL Delay	0.00	s	0.00 to 999.99
59IT – Phase Inverse Time Overvoltage			
59IT – Main	Enabled		
Pickup V	55.0	V	1.0 to 150.0
Hysteresis	1	%	1 to 80

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Curve Type	IEC Standard Inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
A	1.0	-	0.1 to 50.0
B	0.0	-	0.0 to 10.0
p	1.0	-	0.1 to 10.0
VTB Blocking	Disabled		
59IT – 2 Main	Enabled		
Pickup V	55.0	V	1.0 to 150.0
Hysteresis	1	%	1 to 80
Curve Type	IEC Standard Inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
A	1.0	-	0.1 to 50.0
B	0.0	-	0.0 to 10.0
p	1.0	-	0.1 to 10.0
VTB Blocking	Disabled		
24DT – Definite Time Overflux			
24DT - 1	Enabled		
Pickup V/F	1.10	pu	1.00 to 2.00
Hysteresis	1	%	1 to 80
Pickup DTL Delay	0.20	s	0.05 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
24IT – Inverse Time Overflux			
24IT	Enabled		
Pickup V/F	1.10	pu	1.00 to 1.50
Hysteresis	1	%	1 to 80
Curve Type	ANSI Extremely Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.05 to 999.99
Reset DTL Delay	0.0	s	0.0 to 99.9
A	108.75		
B	1.00		
C	2.4490		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Inverse of K	0.1000		
X1	1.10	s	1.00 to 3.00
X2	1.15	s	1.00 to 3.00
X3	1.20	s	1.00 to 3.00
X4	1.25	s	1.00 to 3.00
X5	1.30	s	1.00 to 3.00
X6	1.35	s	1.00 to 3.00
X7	1.40	s	1.00 to 3.00
Y1	70.0	s	0.00 to 9999.99
Y2	60.00	s	0.00 to 9999.99
Y3	50.00	s	0.00 to 9999.99
Y4	40.00	s	0.00 to 9999.99
Y5	30.00	s	0.00 to 9999.99
Y6	20.00	s	0.00 to 9999.99
Y7	10.00	s	0.00 to 9999.99
VTB Blocking	Disabled		
47DT – Negative Sequence Definite Time OverVoltage			
47DT – 1	Enabled		
Pickup V2	30.0	V	1.0 to 150.0
Hysteresis	1	%	1 to 80
Pickup DTL Delay	0.20	s	0.02 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
47DT – 2	Enabled		
Pickup V2	30.0	V	1.0 to 150.0
Hysteresis	1	%	1 to 80
Pickup DTL Delay	0.20	s	0.02 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
47IT – Negative Sequence Inverse Time OverVoltage			
47IT	Enabled		
Pickup V2	25.0	V	1.0 to 150.0
Hysteresis	1	%	1 to 80
Curve Type	IEC Standard Inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.02 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
A	1.0	-	0.1 to 50.0

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
B	0.0	-	0.0 to 10.0
p	1.0	-	0.1 to 10.0
VTB Blocking	Disabled		
59N – Zero Sequence OverVoltage			
59NIT	Enabled		
3V0 Pickup	10.00	V	5.00 to 150.00
Hysteresis	1	%	1 to 80
Curve Type	IEC Standard Inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
A	1.0		
B	0.0		
p	1.0		
VTB Blocking	Disable		
59IT – 1	Enabled		
3V0 Pickup	10.00	V	5.00 to 150.00
Hysteresis	1	%	1 to 80
Pickup DTL Delay	2.00	s	0.00 to 99.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
59DT – 2	Enabled		
3V0 Pickup	10.00	V	5.00 to 150.00
Hysteresis	1	%	1 to 80
Pickup DTL Delay	2.00	s	0.00 to 99.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTB Blocking	Disabled		
37 – Instantaneous Phase Undercurrent			
37 – 1	Enabled		
Pickup I<<	0.50	A	0.25 to 16.00
Pickup Delay	0.00	s	0.00 to 999.99
37 – 2	Enabled		
Pickup I<<	0.50	A	0.25 to 16.00
Pickup Delay	0.00	s	0.00 to 999.99
67 – Directional Function for Phase Overcurrent			
2 out 3 Logic	Disabled		
VTB Blocking	Disabled		
Polarization Method	Quadrature		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Characteristic/Positive Sequence Angle	80.0	deg	5.0 to 89.0
Zero Sequence Angle	80.0	deg	5.0 to 89.0
67 – Sequence Method			
Negative Sequence Directional Element	Disabled		
V2 Sensitivity Level	0.5	V	0.5 to 5.0
I2 Sensitivity Level	0.20	A	0.10 to 1.00
Zero Sequence Directional Element	Disabled		
3V0 Sensitivity Level	1.0	V	1.0 to 10.0
3I0 Sensitivity Level	0.20	A	0.20 to 2.00
Positive Sequence Directional Element			
V1 Sensitivity Level	1.0	V	1.0 to 10.0
I1 Sensitivity Level	0.20	A	0.20 to 2.00
67 – Quadrature Method			
Characteristic Angle	45	deg	-95 to 95
Minimum Voltage	1.0	V	1.0 to 40.0
50/51/67 – Phase Overcurrent			
50 – 1	Enabled		
Directional Control	non-directional		
Pickup	50.00	A	0.50 to 150.00
Pickup Delay	1.00	s	0.00 to 99.99
Inrush Blocking	Disabled		
51 – 1	Enabled		
Directional Control	non-directional		
Pickup	7.50	A	0.25 to 25.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
Inrush Blocking	Disabled		
50 – 2	Enabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Directional Control	non-directional		
Pickup	50.00	A	0.50 to 150.00
Pickup Delay	1.00	s	0.00 to 99.99
Inrush Blocking	Disabled		
51 – 2	Enabled		
Directional Control	non-directional		
Pickup	7.50	A	0.25 to 25.00
Curve Type	IEC Standard Inverse - 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.00	-	-
TR	13.50	-	0.10 to 150.00
Inrush Blocking	Disabled		
50 Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
50 Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
51 Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
51 Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
67N – Directional Element for Derived Neutral Overcurrent			
Characteristic Angle	-45	deg	-95 to 95
Polarization Method	Neg Sequence		
V2/3V0 Sensitivity Level	0.5	V	0.5 to 5.0
I2/3I0 Sensitivity Level	0.20	A	0.10 to 1.00
VTs Blocking	Disabled		
50N/51N/67 – Neutral Overcurrent (Calculated)			
50N – 1	Enabled		
Directional Control	non-directional		
Pickup	5.00	A	0.25 to 50.00
Pickup Delay	1.00	s	0.00 to 99.99
Inrush Blocking	Disabled		
51N – 1	Enabled		
Directional Control	non-directional		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Pickup	1.00	A	0.25 to 50.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
Inrush Blocking	Disabled		
50N – 2	Enabled		
Directional Control	non-directional		
Pickup	5.00	A	0.25 to 50.00
Pickup Delay	1.00	s	0.00 to 99.99
Inrush Blocking	Disabled		
51N – 2	Enabled		
Directional Control	non-directional		
Pickup	1.00	A	0.25 to 50.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
Inrush Blocking	Disabled		
50N Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
50N Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
51N Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
51N Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
67G – Directional Function for Measured Neutral Overcurrent			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Characteristic Angle	-15	deg	-
Polarization Method	Neg Sequence		
V2/3V0 Sensitivity Level	0.5	V	-
I2/3I0 Sensitivity Level	0.20	A	-
VTB Blocking	Disabled		
50G/51G/67 - Neutral Overcurrent (Measured)			
50G – 1	Enabled		
Directional Control	non-directional		
Pickup	5.00	A	0.25 to 50.00
Pickup Delay	1.00	s	0.00 to 99.99
Inrush Blocking	Disabled		
51G – 1	Enabled		
Directional Control	non-directional		
Pickup	1.00	A	0.25 to 50.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
Inrush Blocking	Disabled		
50G – 2	Enabled		
Directional Control	non-directional		
Pickup	5.00	A	0.25 to 50.00
Pickup Delay	1.00	s	0.00 to 99.99
Inrush Blocking	Disabled		
51G – 2	Enabled		
Directional Control	non-directional		
Pickup	1.00	A	0.25 to 50.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
Inrush Blocking	Disabled	=	=
50G Pickup Current Multiplier	1.00	time setting	0.10 to 2.00
50G Pickup Time Multiplier	1.00	time setting	0.10 to 2.00
51G Pickup Current Multiplier	1.00	time setting	0.10 to 2.00
51G Pickup Time Multiplier	1.00	time setting	0.10 to 2.00
67SEF – Directional Function for SEF			
Characteristic Angle	-15	deg	-95 to 95
Polarization Method	Neg Sequence		
V2/3V0 Sensitivity Level	0.5	V	0.5 to 5.0
I2/ISEF Sensitivity Level	0.20	A	0.10 to 1.00
VTS Blocking	Disabled		
64/50/51 – Sensitive/Restricted Earth Fault			
64-50 SEF/REF-1	Enabled		
Directional Control	non-directional		
Pickup	1.00	A	0.03 to 15.00
Pickup Delay	0.00	s	0.00 to 999.99
64/51SEF – 1	Enabled		
Directional Control	non-directional		
Pickup	1.00	A	0.03 to 15.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
64-50 SEF/REF – 2	Enabled		
Directional Control	non-directional		
Pickup	1.00	A	0.03 to 15.00
Pickup Delay	0.00	s	0.00 to 999.99
64-50 SEF/REF – 2	Enabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Directional Control	non-directional		
Pickup	1.00	A	0.03 to 15.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
64-50 SEF/REF Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
64-50 SEF/REF Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
64/51SEF Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
64/51SEF Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
46-50/46-51 – Negative Sequence Overcurrent			
46/50	Enabled		
Pickup	2.50	A	0.50 to 50.00
Pickup Delay	1.00	s	0.00 to 99.99
46/51	Enabled		
Pickup	1.00	A	0.50 to 50.00
Curve Type	IEC Standard Inverse – 3		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	ANSI Decay		
Reset DTL Delay	0.00	s	0.00 to 99.90
A	0.1	-	-
B	0.0	-	-
p	0.0	-	-
TR	13.50	-	0.10 to 150.00
46-50 Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
46-50 Pickup Time Multiplier	1.00	times setting	0.10 to 2.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
46-51 Pickup Current Multiplier	1.00	times setting	0.10 to 2.00
46-51 Pickup Time Multiplier	1.00	times setting	0.10 to 2.00
49 – Thermal Overload			
49	Enabled		
Thermal Overload Pickup	5.25	A	1.00 to 10.00
Time Constant	10.0	min	0.5 to 100.0
Neg. Seq. Weighing Factor	0.0		
Thermal OL Alarm	Enabled		
Alarm % Th	80	%	50 to 100
50BF – Breaker Failure			
50BF Main	Enabled		
Pickup Delay 1	0.20	s	0.01 to 99.99
Pickup Delay 2	0.20	s	0.01 to 99.99
Breaker Current Pickup	1.00	A	0.10 to 50.00
External Single Phase – Main A Phase	<disabled>		
External Single Phase – Main B Phase	<disabled>		
External Single Phase – Main C Phase	<disabled>		
External Single Phase – Main 3 Phase	<disabled>		
46 – Broken Conductor			
46	Enabled		
I2/I1 Pickup	20.0	%	10.0 to 100.0
Under Current	0.20	A	0.20 to 2.50
Pickup Delay	5.00	s	0.01 to 999.00
50LS – Low Set Overcurrent			
50LS	Enabled		
Pickup	50.00	A	0.10 to 50.00
Pickup Delay	1.00	s	0.00 to 10.00
Inrush Block	Disabled		
81HBL2 – Inrush			
81HBL2	Enabled		
Cross Blocking	Enabled		
Pickup I2nd>	15	%	5 to 50
32 – Directional Power Protection			
32 – 1	Enabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Power Mode	Real		
Measurement Mode	3 Phase		
Operate Level	High		
Power Pickup	1.000	pu	-3.000 to 3.000
Pickup Delay	0.00	s	0.00 to 999.99
Polarity			
32 – 2	Enabled		
Power Mode	Real		
Measurement Mode	3 Phase		
Operate Level	High		
Power Pickup	1.000	pu	-3.000 to 3.000
Pickup Delay	0.00	s	0.00 to 999.99
Polarity	Disabled		
32 – 3	Enabled		
Power Mode	Real		
Measurement Mode	3 Phase		
Operate Level	High		
Power Pickup	1.000	pu	-3.000 to 3.000
Polarity	Disabled		
60VTS – VT Supervision			
60VTS	Enabled		
I1 Blocking	7.5	A	0.5 to 50.0
3I0 Blocking	1.0	A	0.5 to 50.0
Negative Sequence Monitoring	Disabled		
Vnps	10.0	V	7.0 to 110.0
Inps	0.50	A	0.25 to 5.00
60CTS – CT Supervision			
60CTS	Enabled		
Vnps Pickup	7.00	V	7.00 to 110.00
Inps Pickup	1.00	A	0.25 to 5.00
Pickup Delay	2.00	s	0.03 to 99.99
74TCS – Trip Circuit Supervision			
74TCS – 1	Enabled		
Name	TCS 1		
Dropoff Delay	0.40	s	0.00 to 9.99
TCS Input	<Unused = 0>		
74TCS – 2	Enabled		

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Name	TCS 2		
Dropoff Delay	0.40	s	0.00 to 9.99
TCS Input	<Unused = 0>		
I²t-CB Condition			
I ² t-CB	Enabled		
I ² t Limit	99999.9	kA ² s	0.1 to 99999.9
THD – Total Harmonic Distortion			
THD – 1	Enabled		
Pickup THD – V	3	%	1 to 100
Pickup Delay	5.00	s	0.00 to 999.99
VTB Blocking	Disabled		
THD – 2	Enabled		
Pickup THD – V	3	%	1 to 100
Pickup Delay	5.00	s	0.00 to 999.99
VTB Blocking	Disabled		
Reclosure Count Alarm			
AR	Enabled		
Reclosure Comm Count	100	-	1 to 999
Sync Check			
25 Sync Check	Enabled		
Maximum Voltage	70.00	V	60.00 to 138.00
Minimum Voltage	40.00	V	40.00 to 69.90
Voltage Difference	5.00	V	1.00 to 20.00
Angle Difference	20.00	deg	1.00 to 50.00
Pickup Delay	0.10	s	0.00 to 10.00
Frequency Difference	Disabled		
Frequency Difference	0.01	Hz	0.01 to 2.00
Main/Aux			
Dead Main Live Aux	Enabled		
Live Main Dead Aux	Enabled		
Dead Main Dead Aux	Enabled		
Protection Scheme			
1Ph Max Open Pickup Delay (TM)	2.500	s	0.100 to 5.000
1Ph/3Ph for 3Ph Dropout Delay (TDR4)	25.000	s	0.100 to 999.000
1Ph/3Ph for 1Ph Pickup Delay (TL5)	0.100	s	0.100 to 5.000
1Ph/3Ph for 1Ph Dropout Delay (TD5)	25.000	s	0.100 to 999.000

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Fault Timer	Disabled		
Fault Timer Pickup	0.20	s	0.05 to 10.00
79 – 3Ph Recloser			
79 – 3Ph	Enabled		
Number of Shots	1		
First Reclose (T1)	1.0	s	0.1 to 999.9
Second Reclose (T2)	5.0	s	1.0 to 999.9
Third Reclose (T3)	10.0	s	1.0 to 999.9
Fourth Reclose (T4)	20.0	s	1.0 to 999.9
Close Time (Tp)	0.2	s	0.1 to 1.0
Lockout Reset (TD)	25.0	s	0.1 to 999.9
Initiate Reset (TDI)	0.1	s	0.0 to 999.9
Sync Control	Disabled		
Block Reset (TDB)	0.1	s	0.0 to 999.9
Breaker Out of Service (TC)	50.0	s	0.0 to 999.9
79 – 1Ph - Recloser			
79 – 1Ph	Enabled		
Main Breaker Pole Dead/Live Detection	Phase Current		
CB AR External Initiation Pole A	<Unused = 0>		
CB AR External Initiation Pole B	<Unused = 0>		
CB AR External Initiation Pole C	<Unused = 0>		
Number of Shots	1		
Reclose (T1)	1.0	s	0.1 to 999.9
Close Time (Tp)	0.2	s	0.1 to 1.0
Lockout Reset (TD)	25.0	s	0.1 to 999.9
Initiate Reset (TDI)	0.1	s	0.0 to 999.9
Recloser Mode	1		
Block Reset (TDB)	0.1	s	0.0 to 999.9
Breaker Out of Service (TC)	50.0	s	0.0 to 999.9
PL 1 [Prologic 1]			
ProLogic 1	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 2 [ProLogic 2]			
ProLogic 2	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 3 [ProLogic 3]			
ProLogic 3	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 4 [ProLogic 4]			
ProLogic 4	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 5 [ProLogic 5]			
ProLogic 5	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 6 [ProLogic 6]			
ProLogic 6	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input E	<Unused = 0>		
PL 7 [ProLogic 7]			
ProLogic 7	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 8 [ProLogic 8]			
ProLogic 8	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 9 [ProLogic 9]			
ProLogic 9	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 10 [ProLogic 10]			
ProLogic 10	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 11 [ProLogic 11]			
ProLogic 11	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 12 [ProLogic 12]			
ProLogic 12	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 13 [ProLogic 13]			
ProLogic 13	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 14 [ProLogic 14]			
ProLogic 14	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 15 [ProLogic 15]			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
ProLogic 15	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 16 [ProLogic 16]			
ProLogic 16	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 17 [ProLogic 17]			
ProLogic 17	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 18 [ProLogic 18]			
ProLogic 18	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 19 [ProLogic 19]			
ProLogic 19	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 20 [ProLogic 20]			
ProLogic 20	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 21[ProLogic 21]			
ProLogic 21	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 22 [ProLogic 22]			
ProLogic 22	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 23 [ProLogic 23]			
ProLogic 23	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]

Name	Symbol/Value	Unit	Range
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 24 [ProLogic 24]			
ProLogic 24	Enabled		
Pickup Delay - Tp	0.00	s	0.00 to 999.00
Dropout Delay - Td	0.00	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 1 [Group Logic 1]			
Group Logic 1	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input E	<Unused = 0>		
Group Logic 2 [Group Logic 2]			
Group Logic 2	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 3 [Group Logic 3]			
Group Logic 3	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 4 [Group Logic 4]			
Group Logic 4	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 5 [Group Logic 5]			
Group Logic 5	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 6 [Group Logic 6]			
Group Logic 6	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 7 [Group Logic 7]			
Group Logic 7	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 8 [Group Logic 8]			
Group Logic 8	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 9 [Group Logic 9]			
Group Logic 9	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 10 [Group Logic 10]			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Group Logic 10	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 11 [Group Logic 11]			
Group Logic 11	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 12 [Group Logic 12]			
Group Logic 12	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 13 [Group Logic 13]			
Group Logic 13	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 14 [Group Logic 14]			
Group Logic 14	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 15 [Group Logic 15]			
Group Logic 15	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			

F-PRO Settings Summary - Setting Group 1 [Setting Group 1]			
Name	Symbol/Value	Unit	Range
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
Group Logic 16 [Group Logic 16]			
Group Logic 16	Enabled		
Setting Group to Activate	none		
Pickup Delay	0	s	0 to 999
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		

Appendix C Hardware Description

The relay is a complete Feeder protection relay package designed and manufactured with high quality features and recording components. The following information describes the main hardware components of the relay:

Central Processing Unit

The CPU has System On Module and it contains high speed dual core processor which performs the entire relay operation. The CPU is interfaced to Analog Input Board, Digital Input & Output Board, Digital Output Board, Front Fascia Board and Mezzanine Board, powered by SMPS Board, which manages the protection features of the relay. The dual core processor manages the user interface and system control features of the relay.

The CPU provides the following functionality:

- DSP processor subsystem manages the protection features of the relay with the floating point arithmetic to provide fast capture and manipulation of data.
- ARM processor subsystem performs the post processing activity like disturbance recording, logging fault & event, communication protocol support, LCD HMI and PC interface activity.
- NOR and NAND Flash memory supports field software upgrades.
- Settings and recordings stored in non-volatile memory.
- Runs a Real Time Operating System (RTOS).
- Provides Ethernet ports, RS-485 port and USB interface.
- Time synchronism co-processor with modulated and un-modulated IRIG-B.
- High speed inbuilt link is provided between the DSP and ARM processor-subsystems.
- Sophisticated fault detection and “watchdog” recovery hardware.
- Provides the relay with one RS-485 port (Port 52) and IRIG-B time synchronization input (Mod. Port 531 & Un-Mod. Port 541, male BNC).

Digital Input Board (DIB)

This board provides optional digital input channels (availability of 8DI, 16DI, 24DI based on the ordering code). Inputs are optically isolated, externally wetted and field configurable with the voltage level of 48 / 110 / 220 Vdc selection through on-board jumpers. This board is interfaced to the CPU board.

Digital Output Board (DOB)

The board provides 32DO normally open contact outputs for relaying, alarms and control. This board is interfaced to the CPU Board.

AC Analog Input Boards (AIB)

The relay has 1 AIB. The AIBs have 4 voltage transformer inputs and 5 current transformer inputs. These boards provide 5 current and 4 voltage ac analog measurement inputs, interfaced to the CPU. The AIBs provide the analog to digital conversion of the ac analog current inputs and the ac analog voltage inputs. The sampling rate is fixed at 128 samples/cycle. Each channel is simultaneously sampled using 16-bit analog to digital converters. The digitized data is sent to the CPU for processing of protection algorithm.

Front Fascia Board (FFB)

This board provides 128x64 monochrome graphics front panel display, the front panel USB, the front panel status LEDs and the keypad. The keypad is used to navigate the menus on the display to control relay operation by a local user. This board is interfaced to the CPU board.

Mezzanine Board (MB)

It contains FPGA and Ethernet Phy's. It is an add-on card to CPU Board. It provides the relay with two Ethernet ports (Port 51A and 51B, RJ-45 or 100BASE-FX MM 1300nm ST, depending upon order specification).

SMPS Board (SMPSB)

It provides the power supply for the entire unit. The switching frequency is 132 kHz and it reduces the transformer size with no noticeable impact on EMI, accurate programmable current limit, fully integrated soft-start for minimum start-up stress. The nominal operating range is 24 - 48 Vdc or 110 – 250 Vdc+/- 20% or 100 – 240 Vac +5%/-20%, 50/60 Hz.

Appendix D Event Messages

The following is a list of event messages that are created in the relay for events including trips, alarms, external input assertions, and internal events such as setting changes. This list is referred to from multiple places in this manual.

F-PRO Event Messages	
Event Log Message	Notes
50/51 50N/51N 50G/51G:Alarm/Trip	The possible phase information is: • A • B • C • AB • BC • CA • ABC
49/50BF: Alarm/Trip	The possible phase information is: • A • B • C • AB • BC • CA • ABC
32 / 37: Alarm/Trip	The possible phase information is: • A • B • C • AB • BC • CA • ABC
50LS: Alarm/Trip	The possible phase information is: • A • B • C • AB • BC • CA • ABC
81: Alarm/Trip	The possible Information is: ROC / OF / UF
27/59-Main : Alarm/Trip	The possible phase information is: • A • B • C • AB • BC • CA • ABC

F-PRO Event Messages	
24:Alarm/Trip	The possible phase information is: • A • B • C • AB • BC • CA
ProLogic Name: PLn	ProLogic outputs names are user assigned
Extern Input Name: EIn: High	External Input names are user assigned
Extern Input Name: EIn: Low	External Input names are user assigned
Virtual Input Name: VIn: High	Virtual Input names are user assigned
Virtual Input Name: VIn: Low	Virtual Input names are user assigned
Output Contact Name: OCn: High	Output Contact names are user assigned
Output Contact Name: OCn: Low	Output Contacts names are user assigned
46BC : Trip	The possible phase information is: • A • B • C • AB • BC • CA • ABC
Self Check: DC Ch.n: Alarm	Continuous dc level on Ch. n, where n = 1 to 18.
Self Check: DC Alarm Reset	Continuous dc level, condition has reset
Self Check: DC Ch.n: O/P Block	Continuous dc level on Ch. n, where n = 1 to 18. Relay is blocked.
GOOSE Comm. Alarm: Active	Indicates a loss of GOOSE Subscription with a reference to the Multicast MAC Address of the Published GOOSE.(see "Subscription Supervision in the Event Log" on page 8-9)
New Settings loaded, Active group n	Where n = 1-8
New Setting Loaded	
Manual Settings Load request, activate SGn	Manual or user-initiated settings change.
Manual Settings Load request completed	Completion of user-initiated settings change.
Changed Active Group from x to y Logic n	This happens when relay changes setting group. Automatic group logic initiated setting group change
User changed Active Group from x to y	This happens when the relay changes setting group. User initiated setting group change

Self Check Fail due to DC Offset Detector

The DSP has an algorithm that detects continuous dc levels on the analog inputs and initiates alarms and relay output contact blocking when the measured dc level exceeds the Alarm or Block level. The Alarm level is intended to provide an early indication of a problem. The Block level blocks the relay from false-tripping by preventing any output contact from closing. The Relay Functional LED turns off, but the protection functions will operate normally, with the exception that the output contacts will not be allowed to close. The Relay Inoperative contact will close for a Block condition. The following table describes all the Alarm/Block indication function.

	Condition	
	Alarm	Block
Relay Functional LED off		X

Action	Condition	
Service Required LED on	X	X
Self Check Fail Signal high	X	X
Relay Inoperative Contact closed		X
Output Contacts held open		X
Event Log Message	X	X
Status available through SCADA	X	X

The Self Check Fail signal, which is available in the Output Matrix, TUI metering and SCADA, can be used to signal an alarm. Note that if this signal is mapped to an output contact, the contact which it is mapped to will only be closed for an alarm condition. If the relay is in the Block condition, the Relay Inoperative contact must be used to signal an alarm.

The status of the Self Check Fail is available through the SCADA services provided by the relay. The digital signal Self Check Fail will indicate that DSP has detected a continuous dc level and the analog metering value Self Check Fail Parameter is used to indicate which condition, Alarm or Block. The failure types and which analog values they are associated with are described in the table below. Both signals are available in DNP and Modbus.

Point Value	Condition
0	Normal
1	Alarm
2	Block
3	Alarm has evolved to block

The Alarm condition is allowed to reset if the continuous dc level drops below the pickup level. The Block condition has no reset level. If power is cycled to the relay it will go into its normal state until the continuous dc level is detected again.

Appendix E Modbus Communication Protocol

All metering values available through the terminal user interface are also available via the Modbus protocol. Additionally, the Modbus protocol supports the reading of unit time and time of the readings and provides access to trip and alarm events, including fault location information. All metering readings can be frozen into a snapshot via the ~Hold Readings~ function (see Force Single Coil function, address 0).

Read Coil Status (Function Code 01)			
Channel	Address	Value	
Hold Readings	1	0: Readings not held	1: Readings held
Reserved	257	Reserved	
Output Contacts 1	513	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 2	514	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 3	515	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 4	516	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 5	517	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 6	518	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 7	519	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 8	520	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 9	521	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 10	522	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 11	523	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 12	524	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 13	525	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 14	526	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 15	527	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 16	528	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 17	529	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 18	530	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 19	531	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 20	532	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 21	533	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 22	534	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 23	535	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 24	536	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 25	537	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 26	538	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 27	539	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 28	540	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 29	541	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 30	542	0: Contact Open (inactive)	1: Contact Closed (active)

Read Coil Status (Function Code 01)			
Output Contacts 31	543	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contacts 32	544	0: Contact Open (inactive)	1: Contact Closed (active)
27DT-1 Main Alarm	769	0: Off (inactive)	1: On (active)
27DT-2 Main Alarm	770	0: Off (inactive)	1: On (active)
27DT-3 Main Alarm	771	0: Off (inactive)	1: On (active)
27DT-4 Main Alarm	772	0: Off (inactive)	1: On (active)
27DT-1 Main Trip	773	0: Off (inactive)	1: On (active)
27DT-2 Main Trip	774	0: Off (inactive)	1: On (active)
27DT-3 Main Trip	775	0: Off (inactive)	1: On (active)
27DT-4 Main Trip	776	0: Off (inactive)	1: On (active)
27DT-1 Aux Alarm	777	0: Off (inactive)	1: On (active)
27DT-2 Aux Alarm	778	0: Off (inactive)	1: On (active)
27DT-3 Aux Alarm	779	0: Off (inactive)	1: On (active)
27DT-4 Aux Alarm	780	0: Off (inactive)	1: On (active)
27DT-1 Aux Trip	781	0: Off (inactive)	1: On (active)
27DT-2 Aux Trip	782	0: Off (inactive)	1: On (active)
27DT-3 Aux Trip	783	0: Off (inactive)	1: On (active)
27DT-4 Aux Trip	784	0: Off (inactive)	1: On (active)
27IT-1 Alarm	785	0: Off (inactive)	1: On (active)
27IT-2 Alarm	786	0: Off (inactive)	1: On (active)
27IT-1 Trip	787	0: Off (inactive)	1: On (active)
27IT-2 Trip	788	0: Off (inactive)	1: On (active)
59DT-1 Main Alarm	789	0: Off (inactive)	1: On (active)
59DT-2 Main Alarm	790	0: Off (inactive)	1: On (active)
59DT-3 Main Alarm	791	0: Off (inactive)	1: On (active)
59DT-4 Main Alarm	792	0: Off (inactive)	1: On (active)
59DT-1 Main Trip	793	0: Off (inactive)	1: On (active)
59DT-2 Main Trip	794	0: Off (inactive)	1: On (active)
59DT-3 Main Trip	795	0: Off (inactive)	1: On (active)
59DT-4 Main Trip	796	0: Off (inactive)	1: On (active)
59DT-1 Aux Alarm	797	0: Off (inactive)	1: On (active)
59DT-2 Aux Alarm	798	0: Off (inactive)	1: On (active)
59DT-3 Aux Alarm	799	0: Off (inactive)	1: On (active)
59DT-4 Aux Alarm	800	0: Off (inactive)	1: On (active)
59DT-1 Aux Trip	801	0: Off (inactive)	1: On (active)
59DT-2 Aux Trip	802	0: Off (inactive)	1: On (active)
59DT-3 Aux Trip	803	0: Off (inactive)	1: On (active)
59DT-4 Aux Trip	804	0: Off (inactive)	1: On (active)
59IT-1 Alarm	805	0: Off (inactive)	1: On (active)
59IT-2 Alarm	806	0: Off (inactive)	1: On (active)
59IT-1 Trip	807	0: Off (inactive)	1: On (active)
59IT-2 Trip	808	0: Off (inactive)	1: On (active)
24DT-1 Alarm	809	0: Off (inactive)	1: On (active)
24DT-2 Alarm	810	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
24DT-1 Trip	811	0: Off (inactive)	1: On (active)
24DT-2 Trip	812	0: Off (inactive)	1: On (active)
24IT Alarm	813	0: Off (inactive)	1: On (active)
24IT Trip	814	0: Off (inactive)	1: On (active)
47DT-1 Alarm	815	0: Off (inactive)	1: On (active)
47DT-2 Alarm	816	0: Off (inactive)	1: On (active)
47DT-1 Trip	817	0: Off (inactive)	1: On (active)
47DT-2 Trip	818	0: Off (inactive)	1: On (active)
47IT Alarm	819	0: Off (inactive)	1: On (active)
47IT Trip	820	0: Off (inactive)	1: On (active)
59N DT-1 Alarm	821	0: Off (inactive)	1: On (active)
59N DT-2 Alarm	822	0: Off (inactive)	1: On (active)
59N DT-1 Trip	823	0: Off (inactive)	1: On (active)
59N DT-2 Trip	824	0: Off (inactive)	1: On (active)
59N IT Alarm	825	0: Off (inactive)	1: On (active)
59N IT Trip	826	0: Off (inactive)	1: On (active)
37-1 Alarm	827	0: Off (inactive)	1: On (active)
37-1 Alarm	828	0: Off (inactive)	1: On (active)
37-1 Trip	829	0: Off (inactive)	1: On (active)
37-1 Trip	830	0: Off (inactive)	1: On (active)
50-1 Alarm	831	0: Off (inactive)	1: On (active)
50-1 Alarm	832	0: Off (inactive)	1: On (active)
50-1 Trip	833	0: Off (inactive)	1: On (active)
50-2 Trip	834	0: Off (inactive)	1: On (active)
51-1 Alarm	835	0: Off (inactive)	1: On (active)
51-2 Alarm	836	0: Off (inactive)	1: On (active)
51-1 Trip	837	0: Off (inactive)	1: On (active)
51-2 Trip	838	0: Off (inactive)	1: On (active)
50N-1 Alarm	839	0: Off (inactive)	1: On (active)
50N-2 Alarm	840	0: Off (inactive)	1: On (active)
50N-1 Trip	841	0: Off (inactive)	1: On (active)
50N-2 Trip	842	0: Off (inactive)	1: On (active)
51N-1 Alarm	843	0: Off (inactive)	1: On (active)
51N-2 Alarm	844	0: Off (inactive)	1: On (active)
51N-1 Trip	845	0: Off (inactive)	1: On (active)
51N-2 Trip	846	0: Off (inactive)	1: On (active)
50G-1 Alarm	847	0: Off (inactive)	1: On (active)
50G-2 Alarm	848	0: Off (inactive)	1: On (active)
50G-1 Trip	849	0: Off (inactive)	1: On (active)
50G-2 Trip	850	0: Off (inactive)	1: On (active)
51G-1 Alarm	851	0: Off (inactive)	1: On (active)
51G-2 Alarm	852	0: Off (inactive)	1: On (active)
51G-1 Trip	853	0: Off (inactive)	1: On (active)
51G-2 Trip	854	0: Off (inactive)	1: On (active)
46-50 Alarm	855	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
46-50 Trip	856	0: Off (inactive)	1: On (active)
46-51 Alarm	857	0: Off (inactive)	1: On (active)
46-51 Trip	858	0: Off (inactive)	1: On (active)
64/50SEF-1 Alarm	859	0: Off (inactive)	1: On (active)
64/50SEF-2 Alarm	860	0: Off (inactive)	1: On (active)
64/50SEF-1 Trip	861	0: Off (inactive)	1: On (active)
64/50SEF-2 Trip	862	0: Off (inactive)	1: On (active)
64/51SEF-1 Alarm	863	0: Off (inactive)	1: On (active)
64/51SEF-2 Alarm	864	0: Off (inactive)	1: On (active)
64/51SEF-1 Trip	865	0: Off (inactive)	1: On (active)
64/51SEF-2 Trip	866	0: Off (inactive)	1: On (active)
49 Alarm	867	0: Off (inactive)	1: On (active)
49 Trip	868	0: Off (inactive)	1: On (active)
49Thermal Overload Alarm	869	0: Off (inactive)	1: On (active)
50BF-1 Trip	870	0: Off (inactive)	1: On (active)
50BF-2 Trip	871	0: Off (inactive)	1: On (active)
50BF Initiate	872	0: Off (inactive)	1: On (active)
46BC Trip	873	0: Off (inactive)	1: On (active)
50LS Alarm	874	0: Off (inactive)	1: On (active)
50LS Trip	875	0: Off (inactive)	1: On (active)
81HBL2 Alarm	876	0: Off (inactive)	1: On (active)
81-1 Alarm	877	0: Off (inactive)	1: On (active)
81-2 Alarm	878	0: Off (inactive)	1: On (active)
81-3 Alarm	879	0: Off (inactive)	1: On (active)
81-4 Alarm	880	0: Off (inactive)	1: On (active)
81-5 Alarm	881	0: Off (inactive)	1: On (active)
81-6 Alarm	882	0: Off (inactive)	1: On (active)
81-7 Alarm	883	0: Off (inactive)	1: On (active)
81-8 Alarm	884	0: Off (inactive)	1: On (active)
81-9 Alarm	885	0: Off (inactive)	1: On (active)
81-10 Alarm	886	0: Off (inactive)	1: On (active)
81-1 Trip	887	0: Off (inactive)	1: On (active)
81-2 Trip	888	0: Off (inactive)	1: On (active)
81-3 Trip	889	0: Off (inactive)	1: On (active)
81-4 Trip	890	0: Off (inactive)	1: On (active)
81-5 Trip	891	0: Off (inactive)	1: On (active)
81-6 Trip	892	0: Off (inactive)	1: On (active)
81-7 Trip	893	0: Off (inactive)	1: On (active)
81-8 Trip	894	0: Off (inactive)	1: On (active)
81-9 Trip	895	0: Off (inactive)	1: On (active)
81-10 Trip	896	0: Off (inactive)	1: On (active)
32-1 Alarm	897	0: Off (inactive)	1: On (active)
32-2 Alarm	898	0: Off (inactive)	1: On (active)
32-3 Alarm	899	0: Off (inactive)	1: On (active)
32-4 Alarm	900	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
32-1 Trip	901	0: Off (inactive)	1: On (active)
32-2 Trip	902	0: Off (inactive)	1: On (active)
32-3 Trip	903	0: Off (inactive)	1: On (active)
32-4 Trip	904	0: Off (inactive)	1: On (active)
60 LOP Alarm	905	0: Off (inactive)	1: On (active)
60 CTS Alarm	906	0: Off (inactive)	1: On (active)
74TCS-1 Alarm	907	0: Off (inactive)	1: On (active)
74TCS-2 Alarm	908	0: Off (inactive)	1: On (active)
I ^Δ 2t Limit Alarm	909	0: Off (inactive)	1: On (active)
THD-1 Alarm	910	0: Off (inactive)	1: On (active)
THD-2 Alarm	911	0: Off (inactive)	1: On (active)
79 AR Counter Alarm	912	0: Off (inactive)	1: On (active)
25/27/59 Sync Check	913	0: Off (inactive)	1: On (active)
79-3Ph Reclose	914	0: Off (inactive)	1: On (active)
79-3Ph Lead Lockout	915	0: Off (inactive)	1: On (active)
79-1Ph A Reclose	916	0: Off (inactive)	1: On (active)
79-1Ph B Reclose	917	0: Off (inactive)	1: On (active)
79-1Ph C Reclose	918	0: Off (inactive)	1: On (active)
79-1Ph Lead Lockout	919	0: Off (inactive)	1: On (active)
Successful Reclose	920	0: Off (inactive)	1: On (active)
79 Fault Lockout	921	0: Off (inactive)	1: On (active)
1Ph Open Timeout	922	0: Off (inactive)	1: On (active)
1Ph Fault Lockout	923	0: Off (inactive)	1: On (active)
3Ph Fault Lockout	924	0: Off (inactive)	1: On (active)
1/3Ph Fault Lockout	925	0: Off (inactive)	1: On (active)
79-3Ph Initiate	926	0: Off (inactive)	1: On (active)
79-3Ph Block	927	0: Off (inactive)	1: On (active)
79-1Ph Initiate	928	0: Off (inactive)	1: On (active)
79-1Ph Block	929	0: Off (inactive)	1: On (active)
Self-Check Fail	930	0: Off (inactive)	1: On (active)
Time Sync Loss	931	0: Off (inactive)	1: On (active)
IEC61850 Communication Alarm	932	0: Off (inactive)	1: On (active)
Prologic 1	933	0: Off (inactive)	1: On (active)
Prologic 2	934	0: Off (inactive)	1: On (active)
Prologic 3	935	0: Off (inactive)	1: On (active)
Prologic 4	936	0: Off (inactive)	1: On (active)
Prologic 5	937	0: Off (inactive)	1: On (active)
Prologic 6	938	0: Off (inactive)	1: On (active)
Prologic 7	939	0: Off (inactive)	1: On (active)
Prologic 8	940	0: Off (inactive)	1: On (active)
Prologic 9	941	0: Off (inactive)	1: On (active)
Prologic 10	942	0: Off (inactive)	1: On (active)
Prologic 11	943	0: Off (inactive)	1: On (active)
Prologic 12	944	0: Off (inactive)	1: On (active)
Prologic 13	945	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
Prologic 14	946	0: Off (inactive)	1: On (active)
Prologic 15	947	0: Off (inactive)	1: On (active)
Prologic 16	948	0: Off (inactive)	1: On (active)
Prologic 17	949	0: Off (inactive)	1: On (active)
Prologic 18	950	0: Off (inactive)	1: On (active)
Prologic 19	951	0: Off (inactive)	1: On (active)
Prologic 20	952	0: Off (inactive)	1: On (active)
Prologic 21	953	0: Off (inactive)	1: On (active)
Prologic 22	954	0: Off (inactive)	1: On (active)
Prologic 23	955	0: Off (inactive)	1: On (active)
Prologic 24	956	0: Off (inactive)	1: On (active)
Group Logic 1	957	0: Off (inactive)	1: On (active)
Group Logic 2	958	0: Off (inactive)	1: On (active)
Group Logic 3	959	0: Off (inactive)	1: On (active)
Group Logic 4	960	0: Off (inactive)	1: On (active)
Group Logic 5	961	0: Off (inactive)	1: On (active)
Group Logic 6	962	0: Off (inactive)	1: On (active)
Group Logic 7	963	0: Off (inactive)	1: On (active)
Group Logic 8	964	0: Off (inactive)	1: On (active)
Group Logic 9	965	0: Off (inactive)	1: On (active)
Group Logic 10	966	0: Off (inactive)	1: On (active)
Group Logic 11	967	0: Off (inactive)	1: On (active)
Group Logic 12	968	0: Off (inactive)	1: On (active)
Group Logic 13	969	0: Off (inactive)	1: On (active)
Group Logic 14	970	0: Off (inactive)	1: On (active)
Group Logic 15	971	0: Off (inactive)	1: On (active)
Group Logic 16	972	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
Channel	Address	Value	
External Input 1	10001	0: Off (inactive)	1: On (active)
External Input 2	10002	0: Off (inactive)	1: On (active)
External Input 3	10003	0: Off (inactive)	1: On (active)
External Input 4	10004	0: Off (inactive)	1: On (active)
External Input 5	10005	0: Off (inactive)	1: On (active)
External Input 6	10006	0: Off (inactive)	1: On (active)
External Input 7	10007	0: Off (inactive)	1: On (active)
External Input 8	10008	0: Off (inactive)	1: On (active)
External Input 9	10009	0: Off (inactive)	1: On (active)
External Input 10	10010	0: Off (inactive)	1: On (active)
External Input 11	10011	0: Off (inactive)	1: On (active)
External Input 12	10012	0: Off (inactive)	1: On (active)
External Input 13	10013	0: Off (inactive)	1: On (active)
External Input 14	10014	0: Off (inactive)	1: On (active)
External Input 15	10015	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
External Input 16	10016	0: Off (inactive)	1: On (active)
External Input 17	10017	0: Off (inactive)	1: On (active)
External Input 18	10018	0: Off (inactive)	1: On (active)
External Input 19	10019	0: Off (inactive)	1: On (active)
External Input 20	10020	0: Off (inactive)	1: On (active)
External Input 21	10021	0: Off (inactive)	1: On (active)
External Input 22	10022	0: Off (inactive)	1: On (active)
External Input 23	10023	0: Off (inactive)	1: On (active)
External Input 24	10024	0: Off (inactive)	1: On (active)
External Input 1 Change of state latch	10257	0: Off (inactive)	1: On (active)
External Input 2 Change of state latch	10258	0: Off (inactive)	1: On (active)
External Input 3 Change of state latch	10259	0: Off (inactive)	1: On (active)
External Input 4 Change of state latch	10260	0: Off (inactive)	1: On (active)
External Input 5 Change of state latch	10261	0: Off (inactive)	1: On (active)
External Input 6 Change of state latch	10262	0: Off (inactive)	1: On (active)
External Input 7 Change of state latch	10263	0: Off (inactive)	1: On (active)
External Input 8 Change of state latch	10264	0: Off (inactive)	1: On (active)
External Input 9 Change of state latch	10265	0: Off (inactive)	1: On (active)
External Input 10 Change of state latch	10266	0: Off (inactive)	1: On (active)
External Input 11 Change of state latch	10267	0: Off (inactive)	1: On (active)
External Input 12 Change of state latch	10268	0: Off (inactive)	1: On (active)
External Input 13 Change of state latch	10269	0: Off (inactive)	1: On (active)
External Input 14 Change of state latch	10270	0: Off (inactive)	1: On (active)
External Input 15 Change of state latch	10271	0: Off (inactive)	1: On (active)
External Input 16 Change of state latch	10272	0: Off (inactive)	1: On (active)
External Input 17 Change of state latch	10273	0: Off (inactive)	1: On (active)
External Input 18 Change of state latch	10274	0: Off (inactive)	1: On (active)
External Input 19 Change of state latch	10275	0: Off (inactive)	1: On (active)
External Input 20 Change of state latch	10276	0: Off (inactive)	1: On (active)
External Input 21 Change of state latch	10277	0: Off (inactive)	1: On (active)
External Input 22 Change of state latch	10278	0: Off (inactive)	1: On (active)
External Input 23 Change of state latch	10279	0: Off (inactive)	1: On (active)
External Input 24 Change of state latch	10280	0: Off (inactive)	1: On (active)
Virtual Input 1	10513	0: Off (inactive)	1: On (active)
Virtual Input 2	10514	0: Off (inactive)	1: On (active)
Virtual Input 3	10515	0: Off (inactive)	1: On (active)
Virtual Input 4	10516	0: Off (inactive)	1: On (active)
Virtual Input 5	10517	0: Off (inactive)	1: On (active)
Virtual Input 6	10518	0: Off (inactive)	1: On (active)
Virtual Input 7	10519	0: Off (inactive)	1: On (active)
Virtual Input 8	10520	0: Off (inactive)	1: On (active)
Virtual Input 9	10521	0: Off (inactive)	1: On (active)
Virtual Input 10	10522	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
Virtual Input 11	10523	0: Off (inactive)	1: On (active)
Virtual Input 12	10524	0: Off (inactive)	1: On (active)
Virtual Input 13	10525	0: Off (inactive)	1: On (active)
Virtual Input 14	10526	0: Off (inactive)	1: On (active)
Virtual Input 15	10527	0: Off (inactive)	1: On (active)
Virtual Input 16	10528	0: Off (inactive)	1: On (active)
Virtual Input 17	10529	0: Off (inactive)	1: On (active)
Virtual Input 18	10530	0: Off (inactive)	1: On (active)
Virtual Input 19	10531	0: Off (inactive)	1: On (active)
Virtual Input 20	10532	0: Off (inactive)	1: On (active)
Virtual Input 21	10533	0: Off (inactive)	1: On (active)
Virtual Input 22	10534	0: Off (inactive)	1: On (active)
Virtual Input 23	10535	0: Off (inactive)	1: On (active)
Virtual Input 24	10536	0: Off (inactive)	1: On (active)
Virtual Input 25	10537	0: Off (inactive)	1: On (active)
Virtual Input 26	10538	0: Off (inactive)	1: On (active)
Virtual Input 27	10539	0: Off (inactive)	1: On (active)
Virtual Input 28	10540	0: Off (inactive)	1: On (active)
Virtual Input 29	10541	0: Off (inactive)	1: On (active)
Virtual Input 30	10542	0: Off (inactive)	1: On (active)

Read Holding Registers (Function Code 03)			
Channel	Address	Units	Scale
F-PRO Clock Time (UTC). Read all in same query to ensure consistent time reading data			
Milliseconds Now * Millisecond information not supported.	40001	0-999	1
Seconds Now	40002	0-59	1
Minutes Now	40003	0-59	1
Hours Now	40004	0-23	1
Day of Year Now	40005	1-365 (up to 366 if leap year)	1
Years since 1900	40006	90-137	1
Sync'd to IRIG-B	40007	0: No 1: Yes	1
Time of Acquisition (UTC). Read all in same query to ensure consistent time reading data			
Milliseconds Now * Millisecond information not supported.	40008	0-999	1
Seconds Now	40009	0-59	1
Minutes Now	40010	0-59	1
Hours Now	40011	0-23	1

Read Holding Registers (Function Code 03)

Day of Year Now	40012	1-365 (up to 366 if leap year)	1
Years since 1900	40013	90-137	1
Sync'd to IRIG-B	40014	0: No 1: Yes	1
Offset of UTC to IED time.	40015	2's complement half hours, North America is negative	1

Read Holding Registers (Function Code 03)

Channel	Address	Units	Scale
V1A Magnitude	40257	kV	10*0.001
V1A Angle	40258	Degrees	10
V1B Magnitude	40259	kV	10*0.001
V1B Angle	40260	Degrees	10
V1C Magnitude	40261	kV	10*0.001
V1C Angle	40262	Degrees	10
I1A Magnitude	40263	A	1
I1A Angle	40264	Degrees	10
I1B Magnitude	40265	A	1
I1B Angle	40266	Degrees	10
I1C Magnitude	40267	A	1
I1C Angle	40268	Degrees	10
I1G Magnitude	40269	A	1
I1G Angle	40270	Degrees	10
ISEF Magnitude	40271	A	1
ISEF Angle	40272	Degrees	10
VAUX Magnitude	40273	kV	10*0.001
VAUX Angle	40274	Degrees	10
V1 Pos. Seq. Frequency	40275	Hz	100
P	40276	MW	0.00000001
Q	40277	Mvar	0.00000001
V1 Pos. Seq.	40278	kV	10*0.001
IL Pos. Seq.	40279	A	1
Active Setting Group	40280	NA	1
Self Check Fail Parameter (see Note 1)	40281	NA	1
S	40282	MVA	0.00000001
PF	40283	NA	100
V1 Neg. Seq	40284	kV	10*0.001
V1 Zero Seq.	40285	kV	10*0.001
IL Neg. Seq.	40286	A	1
IL Zero Seq.	40287	A	1
PA	40288	MW	0.00000001
PB	40289	MW	0.00000001
PC	40290	MW	0.00000001

Read Holding Registers (Function Code 03)			
QA	40291	Mvar	0.0000001
QB	40292	Mvar	0.0000001
QC	40293	Mvar	0.0000001
SA	40294	MVA	0.0000001
SB	40295	MVA	0.0000001
SC	40296	MVA	0.0000001
PFA	40297	NA	100
PFB	40298	NA	100
PFC	40299	NA	100
V1AB Magnitude	40300	kV	10*0.001
V1AB Angle	40301	degrees	10
V1BC Magnitude	40301	kV	10*0.001
V1BC Angle	40301	degrees	10
V1CA Magnitude	40301	kV	10*0.001
V1CA Angle	40301	degrees	10
V/F	40301	%	100
% THD - Voltage	40301	%	100
% I2/I1	40301	%	100
Thermal state	40301	%	100
I2T Accumulated	40301	kA2s	1
I2T Last Operation	40301	kA2s	1
79 AR Count	40301	-	1
79 AR Cumulative Counter	40313	-	1

Read Input Register (Function Code 04)
No input registers supported. Response from IED indicates "ILLEGAL FUNCTION."

Force Single Coil (Function Code 05)			
Only the “hold readings” coil can be forced. When active, this coil locks all coil, input and holding register readings simultaneously at their present values. When inactive, coil, input and holding register values will read their most recently available state.			
Channel	Type	Address	Value
Hold Readings	Read/Write	01	0000: Readings update normally (inactive) FF00: Hold readings (active)

Preset Single Register (Function Code 06)			
Channel	Address	Value	Scaled Up By
Event Message Control (See below for details of use)			
Refresh event list	40769	No data required	N/A
Acknowledge the current event and get the next event	40770	No data required	N/A
Get the next event (without acknowledge)	40771	No data required	N/A

Diagnostic Subfunctions (Function Code 08)	
Return Query Data (Subfunction 00)	This provides an echo of the submitted message.
Restart Comm. Option (Subfunction 01)	This restarts the Modbus communications process.
Force Listen Only Mode (Subfunction 04)	No response is returned. IED enters “Listen Only” mode. This mode can only be exited by the “Restart Comm. Option” command.

Report Slave ID (Function Code 17/0x11)			
A fixed response is returned by the IED, including system model, version and issue numbers.			
Channel	Type	Bytes	Value
Model Number	Read Only	0 and 1	0x1194 = 4500 decimal
Version Number	Read Only	2 and 3	Version number
Issue Number	Read Only	4 and 5	Issue number

- The F-PRO IED model number is 4500.
- Version and issue will each be positive integers, say X and Y.
- The F-PRO is defined as “Model 4500, Version X Issue Y”

Accessing F-PRO Event Information)	
All F-PRO detector event messages displayed in the Event Log are available via Modbus. The following controls are available.	
Refresh Event List	(Function Code 6, address 40769): Fetches the latest events from the relay's event log and makes them available for Modbus access. The most recent event becomes the current event available for reading.
Acknowledge Current Event and Get Next Event	(Function Code 6, address 40770): Clears the current event from the read registers and places the next event into them. An acknowledged event is no longer available for reading.
Get Next Event	(Function Code 6, address 40771): Places the next event in the read registers without acknowledging the current event. The current event will reappear in the list when Refresh Event List is used.
Size of Current Event Message	(Function Code 3, address 40772): Indicates the number of 16 bit registers used to contain the current event. Event data is stored with 2 characters per register. A reading of zero indicates that there are no unacknowledged events available in the current set. (NB. The Refresh Event List function can be used to check for new events that have occurred since the last Refresh Event List.)
Read Event Message	(Function Code 3, addresses 40774 – 40832): Contains the current message. Two. ASCII characters are packed into each 16 bit register. All unused registers in the set are set to 0.

Appendix F DNP3 Device Profile

Device Properties

This document shows the device capabilities and the current value of each parameter for the default unit configuration as defined in the default configuration file.

1.1 Device Identification	Capabilities	Current Value	If configurable, list methods
1.1.1 Device Function:	☐ Master ☒ Outstation	☐ Master ☒ Outstation	
1.1.2 Vendor Name:		ERLPhase Power Technologies	
1.1.3 Device Name:		F-PRO 4500	
1.1.4 Device manufacturer's hardware version string:		NA	
1.1.5 Device manufacturer's software version string:		NA	
1.1.6 Device Profile Document Version Number:		V0.03, Mar 25, 2024	
1.1.7 DNP Levels Supported for:	Outstations Only Request and Responses ☐None ☐Level 1 ☒Level 2 ☐Level 3		
1.1.8 Supported Function Blocks:	☐ Self-Address Reservation ☐ Object 0 - attribute objects ☐ Data Sets ☐ File Transfer ☐ Virtual Terminal ☐ Mapping to IEC 61850 Object Models defined in a DNP3 XML file		
1.1.9 Notable Additions:	• Start-stop (qualifier codes 0x00 and 0x01), limited quantity (qualifier codes 0x07 and 0x08) and indices (qualifier codes 0x17 and 0x28) for Binary Inputs, Binary Outputs and Analog Inputs (object groups 1, 10 and 30) • 32-bit and 16-bit Analog Inputs with and without flag (variations 1, 2, 3 and 4) • Analog Input events with time (variations 3 and 4) • Fault Location information as analog readings • Event Log messages as Object groups 110 and 111		

1.1 Device Identification	Capabilities	Current Value	If configurable, list methods
1.1.10 Methods to set Configurable Parameters:	☐ XML - Loaded via DNP3 File Transfer ☐ XML - Loaded via other transport mechanism ☐ Terminal - ASCII Terminal Command Line ☒ Software - Vendor software named <u>F-PRO Offliner</u> ☐ Proprietary file loaded via DNP3 file transfer ☐ Proprietary file loaded via other transport mechanism ☐ Direct - Keypad on device front panel ☐ Factory - Specified when device is ordered ☐ Protocol - Set via DNP3 (e.g. assign class) ☐ Other - explain _____		
1.1.11 DNP3 XML files available On-Line:	RdWrFilename Description of Contents ☐ dnpDP.xml Complete Device Profile ☐ dnpDPcap.xml Device Profile Capabilities ☐ dnpDPcfg.xml Device Profile config. values ☐ ☐ ____*.xml _____ *The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns. *The Device Profile Capabilities contains only the capabilities and configurable methods columns. *The Device Profile Config. Values contains only the Current Value column.	Not supported	
1.1.12 External DNP3 XML files available Off-line:	RdWrFilename Description of Contents ☐ ☐ dnpDP.xml Complete Device Profile ☐ ☐ dnpDPcap.xml Device Profile Capabilities ☐ ☐ dnpDPcfg.xml Device Profile config. values ☐ ☐ ____*.xml _____ *The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns. *The Device Profile Capabilities contains only the capabilities and configurable methods columns. *The Device Profile Config. Values contains only the Current Value column.	Not supported	
1.1.13 Connections Supported:	☒ Serial (complete section 1.2) ☒ IP Networking (complete section 1.3) ☐ Other, explain _____		

1.2 Serial Connections	Capabilities	Current Value	If configurable, list methods
1.2.1 Port Name	Port 530		
1.2.2 Serial Connection Parameters:	☐ Asynchronous - 8 Data Bits, 1 Start Bit, 1 Stop Bit, No Parity ☒ Other, explain - <u>Asynchronous with selectable parity</u>	Not configured for DNP	F-PRO Offliner
1.2.3 Baud Rate:	☐ Fixed at _____ ☐ Configurable, range _____ to _____ ☒ Configurable, selectable from 300, 1200, 2400, 9600, 19200, 38400 and 57600 ☐ Configurable, other, describe _____	Not configured for DNP	F-PRO Offliner
1.2.4 <i>Hardware Flow Control (Handshaking):</i> <i>Describe hardware signaling requirements of the interface.</i> <i>Where a transmitter or receiver is inhibited until a given control signal is asserted, it is considered to require that signal prior to sending or receiving characters.</i> <i>Where a signal is asserted prior to transmitting, that signal will be maintained active until after the end of transmission.</i> <i>Where a signal is asserted to enable reception, any data sent to the device when the signal is not active could be discarded.</i>	☐ None RS-232 / V.24 / V.28 Options: Before Tx, Asserts: ☐ RTS ☐ DTR Before Rx, Asserts: ☐ RTS ☐ DTR ☒ RTS ☒ DTR Before Tx, Requires: Asserted Deasserted ☐ ☐ CTS ☐ ☐ DCD ☐ ☐ DSR ☐ ☐ RI ☐ ☐ Rx Inactive Before Rx, Requires: Asserted Deasserted ☐ ☐ CTS ☐ ☐ DCD ☐ ☐ DSR ☐ ☐ RI Always Ignores: ☒ CTS ☒ DCD ☒ DSR ☒ RI ☐ Other, explain _____ RS-422 / V.11 Options: ☐ Requires Indication before Rx ☐ Asserts Control before Tx ☐ Other, explain _____ RS-485 Options: ☐ Requires Rx inactive before Tx ☐ Other, explain _____		
1.2.5 Interval to Request Link Status:	☒ Not Supported ☐ Fixed at _____ seconds ☐ Configurable, range _____ to _____ seconds ☐ Configurable, selectable from __, __, __ seconds ☐ Configurable, other, describe _____		
1.2.6 Supports DNP3 Collision Avoidance:	☒ No ☐ Yes, explain _____		

1.2 Serial Connections	Capabilities	Current Value	If configurable, list methods
1.2.7 Receiver Inter-character Timeout:	☒ Not checked ☐ No gap permitted ☐ Fixed at _____ bit times ☐ Fixed at _____ ms ☐ Configurable, range _____ to _____ bit times ☐ Configurable, range _____ to _____ ms ☐ Configurable, Selectable from __, __, __ bit times ☐ Configurable, Selectable from __, __, __ ms ☐ Configurable, other, describe _____ ☐ Variable, explain _____		
1.2.8 Inter-character gaps in transmission:	☒ None (always transmits with no inter-character gap) ☐ Maximum _____ bit times ☐ Maximum _____ ms		

1.3 IP Networking	Capabilities	Current Value	If configurable, list methods
1.3.1 Port Name	Port 510		
1.3.2 Type of End Point:	☐ TCP Initiating (Master Only) ☒ TCP Listening (Outstation Only) ☐ TCP Dual (required for Masters) ☒ UDP Datagram (required)	Not configured for DNP	F-PRO Offliner
1.3.3 IP Address of this Device:		192.168.100.101	F-PRO Maintenance utilities
1.3.4 Subnet Mask:		Not set	F-PRO Maintenance utilities
1.3.5 Gateway IP Address:		Not set	F-PRO Maintenance utilities
1.3.6 Accepts TCP Connections or UDP Datagrams from:	☒ Allows all (show as *.*.* in 1.3.7) ☒ Limits based on an IP address ☒ Limits based on list of IP addresses ☐ Limits based on a wildcard IP address ☐ Limits based on list of wildcard IP addresses ☐ Other validation, explain _____	Limits based on an IP address	F-PRO Offliner
1.3.7 IP Address(es) from which TCP Connections or UDP Datagrams are accepted:		192.168.1.1	F-PRO Offliner
1.3.8 TCP Listen Port Number:	☐ Not Applicable (Master w/o dual end point) ☐ Fixed at 20,000 ☒ Configurable, range <u>1025 to 32737</u> ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	20,000	F-PRO Offliner
1.3.9 TCP Listen Port Number of remote device:	☒ Not Applicable (Outstation w/o dual end point) ☐ Fixed at 20,000 ☐ Configurable, range ____ to ____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	NA	F-PRO Offliner
1.3.10 TCP Keep-alive timer:	☐ Fixed at ____ms ☒ Configurable, range <u>5 to 3,600</u> s ☐ Configurable, selectable from ____, ____, ____ms ☐ Configurable, other, describe _____	Disabled	F-PRO Offliner
1.3.11 Local UDP port:	☐ Fixed at 20,000 ☒ Configurable, range <u>1025 to 32737</u> ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____ ☐ Let system choose (Master only)	20,000	F-PRO Offliner
1.3.12 Destination UDP port for initial unsolicited null responses (UDP only Outstations):	☒ None ☐ Fixed at 20,000 ☐ Configurable, range ____ to ____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	NA	

1.3 IP Networking	Capabilities	Current Value	If configurable, list methods
1.3.13 Destination UDP port for DNP3 Requests (Master Only):	☐ None ☐ Fixed at 20,000 ☒ Configurable, range <u>1025 to 32737</u> ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe ____ ☐ Use source port number	20,000	F-PRO Offliner
1.3.14 Multiple master connections (Outstations Only):	☒ Supports multiple masters (Outstations only) If supported, the following methods may be used: ☒ Method 1 (based on IP address) - required ☒ Method 2 (based on IP port number) - recommended ☒ Method 3 (browsing for static data) - optional	Method 1 (based on IP address)	F-PRO Offliner
1.3.15 Time synchronization support:	☐ DNP3 LAN procedure (function code 24) ☐ DNP3 Write Time (not recommended over LAN) ☐ Other, explain ____ ☒ Not Supported		

1.4 Link Layer	Capabilities	Current Value	If configurable, list methods
1.4.1 Data Link Address:	☐ Fixed at _____ ☒ Configurable, range 1 to 65519 ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	1	F-PRO Offliner
1.4.2 DNP3 Source Address Validation:	☒ Never ☐ Always, one address allowed (shown in 1.4.3) ☐ Always, any one of multiple addresses allowed (each selectable as shown in 1.4.3) ☐ Sometimes, explain _____		
1.4.3 DNP3 Source Address(es) expected when Validation is Enabled:	☐ Configurable to any 16 bit DNP Data Link Address value ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	NA	
1.4.4 Self Address Support using address 0xFFFC:	☐ Yes (only allowed if configurable) ☒ No	NA	
1.4.5 Sends Confirmed User Data Frames:	☐ Always ☐ Sometimes, explain _____ ☐ Never ☒ Configurable, either always or never		F-PRO Offliner (to disable, set Data Link Time-out to 0)
1.4.6 Data Link Layer Confirmation Timeout:	☐ None ☐ Fixed at __ ms ☒ Configurable, range 0 to 2,000 ms ☐ Configurable, selectable from _____ms ☐ Configurable, other, describe _____ ☐ Variable, explain _____	500	
1.4.7 Maximum Data Link Retries:	☐ Never Retries ☒ Fixed at 3 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	3	
1.4.8 Maximum number of octets Transmitted in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	292	
1.4.9 Maximum number of octets that can be Received in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	292	

1.5 Application Layer	Capabilities	Current Value	If configurable, list methods
1.5.1 Maximum number of octets Transmitted in an Application Layer Fragment other than File Transfer:	☒ Fixed at 2048 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	2048	
1.5.2 Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer:	☐ Fixed at _____ ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	NA	
1.5.3 Maximum number of octets that can be Received in an Application Layer Fragment:	☒ Fixed at 2048 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____	2048	
1.5.4 Timeout waiting for Complete Application Layer Fragment:	☐ None ☒ Fixed at 2,000 ms ☐ Configurable, range _____ to _____ ms ☐ Configurable, selectable from ____, ____, ____ ms ☐ Configurable, other, describe _____ ☐ Variable, explain _____	2,000 ms	
1.5.5 Maximum number of objects allowed in a single control request for CROB (group 12):	☒ Fixed at 16 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____ ☐ Variable, explain _____	16	
1.5.6 Maximum number of objects allowed in a single control request for Analog Outputs (group 41):	☐ Fixed at _ ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____ ☐ Variable, explain _____	Analog Outputs not supported	
1.5.7 Maximum number of objects allowed in a single control request for Data Sets (groups 85,86,87):	☐ Fixed at _ ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____, ____, ____ ☐ Configurable, other, describe _____ ☐ Variable, explain _____	Data Sets not supported	
1.5.8 Supports mixing object groups (AOBs, CROBs and Data Sets) in the same control request:	☐ Not applicable - controls are not supported ☐ Yes ☒ No	Analog Outputs not supported	

1.6 Fill Out The Following Items For Outstations Only	Capabilities	Current Value	If configurable, list methods
1.6.1 Timeout waiting for Application Confirm of solicited response message:	☐ None ☒ Fixed at <u>5,000</u> ms ☐ Configurable, range _____ to _____ ms ☐ Configurable, selectable from ____, ____, ____ ms ☐ Configurable, other, describe _____ ☐ Variable, explain _____	5,000 ms	
1.6.2 How often is time synchronization required from the master?	☒ Never needs time ☐ Within _____ seconds after IIN1.4 is set ☐ Periodically every _____ seconds		
1.6.3 Device Trouble Bit IIN1.6:	☐ Never used ☒ Reason for setting: <u>Unable to access requested data or execute CROB, assuming a valid request has been received</u>		
1.6.4 File Handle Timeout:	☒ Not applicable, files not supported ☐ Fixed at _____ ms ☐ Configurable, range _____ to _____ ms ☐ Configurable, selectable from ____, ____, ____ ms ☐ Configurable, other, describe _____ ☐ Variable, explain _____		
1.6.5 Event Buffer Overflow Behaviour:	☐ Discard the oldest event ☒ Discard the newest event ☐ Other, explain _____		
1.6.6 Event Buffer Organization:	• Single buffer for the Object Groups 2 and 32, size 200. • Separate buffer for the Object Group 111, size 100. • Separate buffer for the Fault Locator events, size 100		
1.6.7 Sends Multi-Fragment Responses:	☒ Yes ☐ No		
1.6.8 DNP Command Settings preserved through a device reset:	☐ Assign Class ☐ Analog Deadbands ☐ Data Set Prototypes ☐ Data Set Descriptors	Not supported	

1.7 Outstation Unsolicited Response Support	Capabilities	Current Value	If configurable, list methods
1.7.1 Supports Unsolicited Reporting:	☒ Not Supported ☐ Configurable, selectable from On and Off	NA	

1.8 Outstation Performance	Capabilities	Current Value	If configurable, list methods
1.8.1 Maximum Time Base Drift (milliseconds per minute):		NA, not synchronized by DNP	
1.8.2 When does outstation set IIN1.4?	☒ Never ☐ Asserted at startup until first Time Synchronization request received ☐ Periodically, range ____ to ____ seconds ☐ Periodically, selectable from ____, ____, ____ seconds ☐ Range ____ to ____ seconds after last time sync ☐ Selectable from ____, ____, ____ seconds after last time sync ☐ When time error may have drifted by range ____ to ____ ms ☐ When time error may have drifted by selectable from ____, ____, ____	NA	
1.8.3 Maximum Internal Time Reference Error when set via DNP (ms):		NA	
1.8.4 Maximum Delay Measurement error (ms):		NA	
1.8.5 Maximum Response time (ms):		100 ms (for the case all supported points mapped to the DNP point lists)	F-PRO Offliner
1.8.6 Maximum time from start-up to IIN 1.4 assertion (ms):		NA	
1.8.7 Maximum Event Time-tag error for local Binary and Double-bit I/O (ms):		• 0.1302 ms for 60Hz systems • 0.1563 ms for 50 Hz systems	
1.8.8 Maximum Event Time-tag error for local I/O other than Binary and Double-bit data types (ms):		• 0.1302 ms for 60Hz systems • 0.1563 ms for 50 Hz systems	

Capabilities and Current Settings for Device Database

The following tables identify the capabilities and current settings for each DNP3 data type. Each data type also provides a table defining the data points available in the device, default point lists configuration and a description of how this information can be obtained in case of customized point configuration.

2.1 Single-Bit Binary Inputs Static (Steady-State) Group Number: 1 Event Group Number: 2		Capabilities	Current Value	If configurable, list methods
2.1.1	Static Variation reported when variation 0 requested:	☒ Variation 1 - Single-bit Packed format ☐ Variation 2 - Single-bit with flag ☐ Based on point Index (add column to table below)		
2.1.2	Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☒ Variation 2 - with absolute time ☐ Variation 3 - with relative time ☐ Based on point Index (add column to table below)		
2.1.3	Event reporting mode:	☐ Only most recent ☒ All events		
2.1.4	Binary Inputs included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		F-PRO Offliner
2.1.5	Definition of Binary Input Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain _____	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO Offliner

Notes

1. Binary Inputs are scanned with 1 ms resolution.
2. Binary Input data points are user selectable; the data points available in the device for any given Binary Input point selection can be obtained through the F-PRO Offliner software (see SCADA Setting Summary).

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Name for State when value is 0	Name for State when value is 1	Description
0	Self Check Fail	1	Inactive	Active	
1	Time Sync Loss	1	Inactive	Active	
2	External Input 1	1	Inactive	Active	
3	External Input 2	1	Inactive	Active	
4	External Input 3	1	Inactive	Active	
5	External Input 4	1	Inactive	Active	
6	External Input 5	1	Inactive	Active	
7	External Input 6	1	Inactive	Active	
8	External Input 7	1	Inactive	Active	
9	External Input 8	1	Inactive	Active	
10	External Input 9	1	Inactive	Active	
11	External Input 10	1	Inactive	Active	
12	External Input 11	1	Inactive	Active	
13	External Input 12	1	Inactive	Active	
14	External Input 13	1	Inactive	Active	
15	External Input 14	1	Inactive	Active	
16	External Input 15	1	Inactive	Active	
17	External Input 16	1	Inactive	Active	
18	External Input 17	1	Inactive	Active	
19	External Input 18	1	Inactive	Active	
20	External Input 19	1	Inactive	Active	
21	External Input 20	1	Inactive	Active	
22	External Input 21	1	Inactive	Active	
23	External Input 22	1	Inactive	Active	
24	External Input 23	1	Inactive	Active	
25	External Input 24	1	Inactive	Active	

26	Virtual Input 1	1	Inactive	Active	
27	Virtual Input 2	1	Inactive	Active	
28	Virtual Input 3	1	Inactive	Active	
29	Virtual Input 4	1	Inactive	Active	
30	Virtual Input 5	1	Inactive	Active	
31	Virtual Input 6	1	Inactive	Active	
32	Virtual Input 7	1	Inactive	Active	
33	Virtual Input 8	1	Inactive	Active	
34	Virtual Input 9	1	Inactive	Active	
35	Virtual Input 10	1	Inactive	Active	
36	Virtual Input 11	1	Inactive	Active	
37	Virtual Input 12	1	Inactive	Active	
38	Virtual Input 13	1	Inactive	Active	
39	Virtual Input 14	1	Inactive	Active	
40	Virtual Input 15	1	Inactive	Active	
41	Virtual Input 16	1	Inactive	Active	
42	Virtual Input 17	1	Inactive	Active	
43	Virtual Input 18	1	Inactive	Active	
44	Virtual Input 19	1	Inactive	Active	
45	Virtual Input 20	1	Inactive	Active	
46	Virtual Input 21	1	Inactive	Active	
47	Virtual Input 22	1	Inactive	Active	
48	Virtual Input 23	1	Inactive	Active	
49	Virtual Input 24	1	Inactive	Active	
50	Virtual Input 25	1	Inactive	Active	
51	Virtual Input 26	1	Inactive	Active	
52	Virtual Input 27	1	Inactive	Active	
53	Virtual Input 28	1	Inactive	Active	
54	Virtual Input 29	1	Inactive	Active	
55	Virtual Input 30	1	Inactive	Active	

56	ProLogic 1	1	Inactive	Active	
57	ProLogic 2	1	Inactive	Active	
58	ProLogic 3	1	Inactive	Active	
59	ProLogic 4	1	Inactive	Active	
60	ProLogic 5	1	Inactive	Active	
61	ProLogic 6	1	Inactive	Active	
62	ProLogic 7	1	Inactive	Active	
63	ProLogic 8	1	Inactive	Active	
64	ProLogic 9	1	Inactive	Active	
65	ProLogic 10	1	Inactive	Active	
66	ProLogic 11	1	Inactive	Active	
67	ProLogic 12	1	Inactive	Active	
68	ProLogic 13	1	Inactive	Active	
69	ProLogic 14	1	Inactive	Active	
70	ProLogic 15	1	Inactive	Active	
71	ProLogic 16	1	Inactive	Active	
72	ProLogic 17	1	Inactive	Active	
73	ProLogic 18	1	Inactive	Active	
74	ProLogic 19	1	Inactive	Active	
75	ProLogic 20	1	Inactive	Active	
76	ProLogic 21	1	Inactive	Active	
77	ProLogic 22	1	Inactive	Active	
78	ProLogic 23	1	Inactive	Active	
79	ProLogic 24	1	Inactive	Active	
80	Fault Information Available	1	Inactive	Active	
81	27DT-1 Main Alarm	1	Inactive	Active	
82	27DT-2 Main Alarm	1	Inactive	Active	
83	27DT-3 Main Alarm	1	Inactive	Active	
84	27DT-4 Main Alarm	1	Inactive	Active	
85	27DT-1 Main Trip	1	Inactive	Active	

86	27DT-2 Main Trip	1	Inactive	Active	
87	27DT-3 Main Trip	1	Inactive	Active	
88	27DT-4 Main Trip	1	Inactive	Active	
89	27DT-1 Aux Alarm	1	Inactive	Active	
90	27DT-2 Aux Alarm	1	Inactive	Active	
91	27DT-3 Aux Alarm	1	Inactive	Active	
92	27DT-4 Aux Alarm	1	Inactive	Active	
93	27DT-1 Aux Trip	1	Inactive	Active	
94	27DT-2 Aux Trip	1	Inactive	Active	
95	27DT-3 Aux Trip	1	Inactive	Active	
96	27DT-4 Aux Trip	1	Inactive	Active	
97	27IT-1 Main Alarm	1	Inactive	Active	
98	27IT-2 Main Alarm	1	Inactive	Active	
99	27IT-1 Main Trip	1	Inactive	Active	
100	27IT-2 Main Trip	1	Inactive	Active	
101	59DT-1 Main Alarm	1	Inactive	Active	
102	59DT-2 Main Alarm	1	Inactive	Active	
103	59DT-3 Main Alarm	1	Inactive	Active	
104	59DT-4 Main Alarm	1	Inactive	Active	
105	59DT-1 Main Trip	1	Inactive	Active	
106	59DT-2 Main Trip	1	Inactive	Active	
107	59DT-3 Main Trip	1	Inactive	Active	
108	59DT-4 Main Trip	1	Inactive	Active	
109	59DT-1 Aux Alarm	1	Inactive	Active	
110	59DT-2 Aux Alarm	1	Inactive	Active	
111	59DT-3 Aux Alarm	1	Inactive	Active	
112	59DT-4 Aux Alarm	1	Inactive	Active	
113	59DT-1 Aux Trip	1	Inactive	Active	
114	59DT-2 Aux Trip	1	Inactive	Active	
115	59DT-3 Aux Trip	1	Inactive	Active	

116	59DT-4 Aux Trip	1	Inactive	Active	
117	59IT-1 Main Alarm	1	Inactive	Active	
118	59IT-2 Main Alarm	1	Inactive	Active	
119	59IT-1 Main Trip	1	Inactive	Active	
120	59IT-2 Main Trip	1	Inactive	Active	
121	24DT-1 Alarm	1	Inactive	Active	
122	24DT-2 Alarm	1	Inactive	Active	
123	24DT-1 Trip	1	Inactive	Active	
124	24DT-2 Trip	1	Inactive	Active	
125	24IT Alarm	1	Inactive	Active	
126	24IT Trip	1	Inactive	Active	
127	47DT-1 Alarm	1	Inactive	Active	
128	47DT-2 Alarm	1	Inactive	Active	
129	47DT-1 Trip	1	Inactive	Active	
130	47DT-2 Trip	1	Inactive	Active	
131	47IT Alarm	1	Inactive	Active	
132	47IT Trip	1	Inactive	Active	
133	59NDT-1 Alarm	1	Inactive	Active	
134	59NDT-2 Alarm	1	Inactive	Active	
135	59NDT-1 Trip	1	Inactive	Active	
136	59NDT-2 Trip	1	Inactive	Active	
137	59NIT Alarm	1	Inactive	Active	
138	59NIT Trip	1	Inactive	Active	
139	37-1 Alarm	1	Inactive	Active	
140	37-2 Alarm	1	Inactive	Active	
141	37-1 Trip	1	Inactive	Active	
142	37-2 Trip	1	Inactive	Active	
143	50-1 Alarm	1	Inactive	Active	
144	50-2 Alarm	1	Inactive	Active	
145	50-1 Trip	1	Inactive	Active	

146	50-2 Trip	1	Inactive	Active	
147	51-1 Alarm	1	Inactive	Active	
148	51-2 Alarm	1	Inactive	Active	
149	51-1 Trip	1	Inactive	Active	
150	51-2 Trip	1	Inactive	Active	
151	50N-1 Alarm	1	Inactive	Active	
152	50N-2 Alarm	1	Inactive	Active	
153	50N-1 Trip	1	Inactive	Active	
154	50N-2 Trip	1	Inactive	Active	
155	51N-1 Alarm	1	Inactive	Active	
156	51N-2 Alarm	1	Inactive	Active	
157	51N-1 Trip	1	Inactive	Active	
158	51N-2 Trip	1	Inactive	Active	
159	50G-1 Alarm	1	Inactive	Active	
160	50G-2 Alarm	1	Inactive	Active	
161	50G-1 Trip	1	Inactive	Active	
162	50G-2 Trip	1	Inactive	Active	
163	51G-1 Alarm	1	Inactive	Active	
164	51G-2 Alarm	1	Inactive	Active	
165	51G-1 Trip	1	Inactive	Active	
166	51G-2 Trip	1	Inactive	Active	
167	46-50 Alarm	1	Inactive	Active	
168	46-50 Trip	1	Inactive	Active	
169	46-51 Alarm	1	Inactive	Active	
170	46-51 Trip	1	Inactive	Active	
171	64/50SEF-1 Alarm	1	Inactive	Active	
172	64/50SEF-2 Alarm	1	Inactive	Active	
173	64/50SEF-1 Trip	1	Inactive	Active	
174	64/50SEF-2 Trip	1	Inactive	Active	
175	64/51SEF-1 Alarm	1	Inactive	Active	

176	64/51SEF-2 Alarm	1	Inactive	Active	
177	64/51SEF-1 Trip	1	Inactive	Active	
18	64/51SEF-2 Trip	1	Inactive	Active	
179	49 Alarm	1	Inactive	Active	
180	49 Trip	1	Inactive	Active	
181	49 Thermal Overload Alarm	1	Inactive	Active	
182	50BF-1 Trip	1	Inactive	Active	
183	50BF-2 Trip	1	Inactive	Active	
184	50BF Initiate	1	Inactive	Active	
185	46BC Trip	1	Inactive	Active	
186	50LS Alarm	1	Inactive	Active	
187	50LS Trip	1	Inactive	Active	
188	81HBL2 Alarm	1	Inactive	Active	
189	81-1 Alarm	1	Inactive	Active	
190	81-2 Alarm	1	Inactive	Active	
191	81-3 Alarm	1	Inactive	Active	
192	81-4 Alarm	1	Inactive	Active	
193	81-5 Alarm	1	Inactive	Active	
194	81-6 Alarm	1	Inactive	Active	
195	81-7 Alarm	1	Inactive	Active	
196	81-8 Alarm	1	Inactive	Active	
197	81-9 Alarm	1	Inactive	Active	
198	81-10 Alarm	1	Inactive	Active	
199	81-1 Trip	1	Inactive	Active	
200	81-2 Trip	1	Inactive	Active	
201	81-3 Trip	1	Inactive	Active	
202	81-4 Trip	1	Inactive	Active	
203	81-5 Trip	1	Inactive	Active	
204	81-6 Trip	1	Inactive	Active	
205	81-7 Trip	1	Inactive	Active	

206	81-8 Trip	1	Inactive	Active	
207	81-9 Trip	1	Inactive	Active	
208	81-10 Trip	1	Inactive	Active	
209	32-1 Alarm	1	Inactive	Active	
210	32-2 Alarm	1	Inactive	Active	
211	32-3 Alarm	1	Inactive	Active	
212	32-4 Alarm	1	Inactive	Active	
213	32-1 Trip	1	Inactive	Active	
214	32-2 Trip	1	Inactive	Active	
215	32-3 Trip	1	Inactive	Active	
216	32-4 Trip	1	Inactive	Active	
217	60 LOP Alarm	1	Inactive	Active	
218	60 CTS Alarm	1	Inactive	Active	
219	74TCS-1 Alarm	1	Inactive	Active	
220	74TCS-2 Alarm	1	Inactive	Active	
221	I ² t Limit Alarm	1	Inactive	Active	
222	THD-1 Alarm	1	Inactive	Active	
223	THD-2 Alarm	1	Inactive	Active	
224	79 AR Cumulative Counter Alarm	1	Inactive	Active	
225	25/27/59 Sync Check	1	Inactive	Active	
226	79 – 3 Phase Initiated	1	Inactive	Active	
227	79 – 3 Phase Blocked	1	Inactive	Active	
228	79 – 3 Phase Reclose	1	Inactive	Active	
229	79 – 3 Phase Lead Lockout	1	Inactive	Active	
230	79 – 1 Phase A Reclose	1	Inactive	Active	
231	79 – 1 Phase B Reclose	1	Inactive	Active	
232	79 – 1 Phase C Reclose	1	Inactive	Active	
233	79 – 1 Phase Lead Lockout	1	Inactive	Active	
234	79 – 1 Phase Initiated	1	Inactive	Active	

235	79 – 1 Phase Blocked	1	Inactive	Active	
236	1 Phase Open Timeout	1	Inactive	Active	
237	1 Phase Fault Lockout	1	Inactive	Active	
238	3 Phase Fault Lockout	1	Inactive	Active	
239	1/3 Phase Fault Lockout	1	Inactive	Active	
240	79 Fault lockout	1	Inactive	Active	
241	Successful Reclose	1	Inactive	Active	
242	27DT-1 Main Trip A	1	Inactive	Active	
243	27DT-1 Main Trip B	1	Inactive	Active	
244	27DT-1 Main Trip C	1	Inactive	Active	
245	27DT-2 Main Trip A	1	Inactive	Active	
246	27DT-2 Main Trip B	1	Inactive	Active	
247	27DT-2 Main Trip C	1	Inactive	Active	
248	27DT-3 Main Trip A	1	Inactive	Active	
249	27DT-3 Main Trip B	1	Inactive	Active	
250	27DT-3 Main Trip C	1	Inactive	Active	
251	27DT-4 Main Trip A	1	Inactive	Active	
252	27DT-4 Main Trip B	1	Inactive	Active	
253	27DT-4 Main Trip C	1	Inactive	Active	
254	27IT-1 Main Trip A	1	Inactive	Active	
255	27IT-1 Main Trip B	1	Inactive	Active	
256	27IT-1 Main Trip C	1	Inactive	Active	
257	27IT-2 Main Trip A	1	Inactive	Active	
258	27IT-2 Main Trip B	1	Inactive	Active	
259	27IT-2 Main Trip C	1	Inactive	Active	
260	59DT-1 Main Trip A	1	Inactive	Active	
261	59DT-1 Main Trip B	1	Inactive	Active	
262	59DT-1 Main Trip C	1	Inactive	Active	
263	59DT-2 Main Trip A	1	Inactive	Active	
264	59DT-2 Main Trip B	1	Inactive	Active	

265	59DT-2 Main Trip C	1	Inactive	Active	
266	59DT-3 Main Trip A	1	Inactive	Active	
267	59DT-3 Main Trip B	1	Inactive	Active	
268	59DT-3 Main Trip C	1	Inactive	Active	
269	59DT-4 Main Trip A	1	Inactive	Active	
270	59DT-4 Main Trip B	1	Inactive	Active	
271	59DT-4 Main Trip C	1	Inactive	Active	
272	59IT-1 Main Trip A	1	Inactive	Active	
273	59IT-1 Main Trip B	1	Inactive	Active	
274	59IT-1 Main Trip C	1	Inactive	Active	
275	59IT-2 Main Trip A	1	Inactive	Active	
276	59IT-2 Main Trip B	1	Inactive	Active	
277	59IT-2 Main Trip C	1	Inactive	Active	
278	24DT-1 Trip A	1	Inactive	Active	
279	24DT-1 Trip B	1	Inactive	Active	
280	24DT-1 Trip C	1	Inactive	Active	
281	24DT-2 Trip A	1	Inactive	Active	
282	24DT-2 Trip B	1	Inactive	Active	
283	24DT-2 Trip C	1	Inactive	Active	
284	24IT Trip A	1	Inactive	Active	
285	24IT Trip B	1	Inactive	Active	
286	24IT Trip C	1	Inactive	Active	
287	37-1 Trip A	1	Inactive	Active	
288	37-1 Trip B	1	Inactive	Active	
289	37-1 Trip C	1	Inactive	Active	
290	37-2 Trip A	1	Inactive	Active	
291	37-2 Trip B	1	Inactive	Active	
292	37-2 Trip C	1	Inactive	Active	
293	50-1 Trip A	1	Inactive	Active	
294	50-1 Trip B	1	Inactive	Active	

295	50-1 Trip C	1	Inactive	Active	
296	50-2 Trip A	1	Inactive	Active	
297	50-2 Trip B	1	Inactive	Active	
298	50-2 Trip C	1	Inactive	Active	
299	51-1 Trip A	1	Inactive	Active	
300	51-1 Trip B	1	Inactive	Active	
301	51-1 Trip C	1	Inactive	Active	
302	51-2 Trip A	1	Inactive	Active	
303	51-2 Trip B	1	Inactive	Active	
304	51-2 Trip C	1	Inactive	Active	
305	50N-1 Trip A	1	Inactive	Active	
306	50N-1 Trip B	1	Inactive	Active	
307	50N-1 Trip C	1	Inactive	Active	
308	50N-2 Trip A	1	Inactive	Active	
309	50N-2 Trip B	1	Inactive	Active	
310	50N-2 Trip C	1	Inactive	Active	
311	51N-1 Trip A	1	Inactive	Active	
312	51N-1 Trip B	1	Inactive	Active	
313	51N-1 Trip C	1	Inactive	Active	
314	51N-2 Trip A	1	Inactive	Active	
315	51N-2 Trip B	1	Inactive	Active	
316	51N-2 Trip C	1	Inactive	Active	
317	49 Trip A	1	Inactive	Active	
318	49 Trip B	1	Inactive	Active	
319	49 Trip C	1	Inactive	Active	
320	50BF-1 Trip A	1	Inactive	Active	
321	50BF-1 Trip B	1	Inactive	Active	
322	50BF-1 Trip C	1	Inactive	Active	
323	50BF-2 Trip A	1	Inactive	Active	
324	50BF-2 Trip B	1	Inactive	Active	

325	50BF-2 Trip C	1	Inactive	Active	
326	50LS Trip A	1	Inactive	Active	
327	50LS Trip B	1	Inactive	Active	
328	50LS Trip C	1	Inactive	Active	
329	81-1 OF Trip	1	Inactive	Active	
330	81-1 UF Trip	1	Inactive	Active	
331	81-1 ROC Trip	1	Inactive	Active	
332	81-2 OF Trip	1	Inactive	Active	
333	81-2 UF Trip	1	Inactive	Active	
334	81-2 ROC Trip	1	Inactive	Active	
335	81-3 OF Trip	1	Inactive	Active	
336	81-3 UF Trip	1	Inactive	Active	
337	81-3 ROC Trip	1	Inactive	Active	
338	81-4 OF Trip	1	Inactive	Active	
339	81-4 UF Trip	1	Inactive	Active	
340	81-4 ROC Trip	1	Inactive	Active	
341	81-5 OF Trip	1	Inactive	Active	
342	81-5 UF Trip	1	Inactive	Active	
343	81-5 ROC Trip	1	Inactive	Active	
344	81-6 OF Trip	1	Inactive	Active	
345	81-6 UF Trip	1	Inactive	Active	
346	81-6 ROC Trip	1	Inactive	Active	
347	81-7 OF Trip	1	Inactive	Active	
348	81-7 UF Trip	1	Inactive	Active	
349	81-7 ROC Trip	1	Inactive	Active	
350	81-8 OF Trip	1	Inactive	Active	
351	81-8 UF Trip	1	Inactive	Active	
352	81-8 ROC Trip	1	Inactive	Active	
353	81-9 OF Trip	1	Inactive	Active	
354	81-9 UF Trip	1	Inactive	Active	

355	81-9 ROC Trip	1	Inactive	Active	
356	81-10 OF Trip	1	Inactive	Active	
357	81-10 UF Trip	1	Inactive	Active	
358	81-10 ROC Trip	1	Inactive	Active	
359	32-1 Trip A	1	Inactive	Active	
360	32-1 Trip B	1	Inactive	Active	
361	32-1 Trip C	1	Inactive	Active	
362	32-2 Trip A	1	Inactive	Active	
363	32-2 Trip B	1	Inactive	Active	
364	32-2 Trip C	1	Inactive	Active	
365	32-3 Trip A	1	Inactive	Active	
366	32-3 Trip B	1	Inactive	Active	
367	32-3 Trip C	1	Inactive	Active	
368	32-4 Trip A	1	Inactive	Active	
369	32-4 Trip B	1	Inactive	Active	
370	32-4 Trip C	1	Inactive	Active	
371	Output Contact 2	1	Open	Closed	
372	Output Contact 3	1	Open	Closed	
373	Output Contact 4	1	Open	Closed	
374	Output Contact 5	1	Open	Closed	
375	Output Contact 6	1	Open	Closed	
376	Output Contact 7	1	Open	Closed	
377	Output Contact 8	1	Open	Closed	
378	Output Contact 9	1	Open	Closed	
379	Output Contact 10	1	Open	Closed	
380	Output Contact 11	1	Open	Closed	
381	Output Contact 12	1	Open	Closed	
382	Output Contact 13	1	Open	Closed	
383	Output Contact 14	1	Open	Closed	
384	Output Contact 15	1	Open	Closed	

385	Output Contact 16	1	Open	Closed	
386	Output Contact 17	1	Open	Closed	
387	Output Contact 18	1	Open	Closed	
388	Output Contact 19	1	Open	Closed	
389	Output Contact 20	1	Open	Closed	
390	Output Contact 21	1	Open	Closed	
391	Output Contact 22	1	Open	Closed	
392	Output Contact 23	1	Open	Closed	
393	Output Contact 24	1	Open	Closed	
394	Output Contact 25	1	Open	Closed	
395	Output Contact 26	1	Open	Closed	
396	Output Contact 27	1	Open	Closed	
397	Output Contact 28	1	Open	Closed	
398	Output Contact 29	1	Open	Closed	
399	Output Contact 30	1	Open	Closed	
400	Output Contact 31	1	Open	Closed	
401	Output Contact 32	1	Open	Closed	

2.2 Binary Output Status And Control Relay Output Block Binary Output Status Group Number: 10 Binary Output Event Group Number: 11 CROB Group Number: 12 Binary Output Command Event Object Num: 13	Capabilities	Current Value	If configurable, list methods
2.2.1 Minimum pulse time allowed with Trip, Close, and Pulse On commands:	☒ Fixed at 0.000 ms (hardware may limit this further) ☐ Based on point Index (add column to table below)		
2.2.2 Maximum pulse time allowed with Trip, Close, and Pulse On commands:	☒ Fixed at 0.000 ms (hardware may limit this further) ☐ Based on point Index (add column to table below)		
2.2.3 Binary Output Status included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.2.4 Reports Output Command Event Objects:	☒ Never ☐ Only upon a successful Control ☐ Upon all control attempts	Not supported	
2.2.5 Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☐ Variation 2 - with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO Offliner (See Note 2 below)
2.2.6 Command Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☐ Variation 2 - with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO Offliner (See Note 2 below)
2.2.7 Event reporting mode:	☐ Only most recent ☐ All events	Not supported	F-PRO Offliner (See Note 2 below)
2.2.8 Command Event reporting mode:	☐ Only most recent ☐ All events	Not supported	
2.2.9 Maximum Time between Select and Operate:	☐ Not Applicable ☒ Fixed at 10 seconds ☐ Configurable, range _____ to _____ seconds ☐ Configurable, selectable from ___, ___, ___ seconds ☐ Configurable, other, describe _____ ☐ Variable, explain _____ ☐ Based on point Index (add column to table below)	10 s	
2.2.10 Definition of Binary Output Status/Control relay output block (CROB) Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain _____	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO Offliner

NOTES

1. Binary Outputs are scanned with 500 ms resolution.
2. Events are not supported for Binary Outputs (group 10), but most of Binary Output points can be mapped to Binary Inputs (group 2) with full Event and Class Data support. See F-PRO Offliner/DNP Configuration/Point Map screen for complete point lists and configuration options.
3. Virtual Inputs (default Binary Output points 0-29) can be used to control relay output contacts. See F-PRO Offliner/Setting Group X/Output Matrix screen for configuration options.
4. Binary Output data points are user selectable; the data points available in the device for any given Binary Output point selection can be obtained through the F-PRO Offliner software (see SCADA Setting Summary).

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate – No	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
0	Virtual Input 1	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
1	Virtual Input 2	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
2	Virtual Input 3	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
3	Virtual Input 4	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
4	Virtual Input 5	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
5	Virtual Input 6	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
6	Virtual Input 7	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
7	Virtual Input 8	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate – No	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
8	Virtual Input 9	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
9	Virtual Input 10	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
10	Virtual Input 11	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
11	Virtual Input 12	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
12	Virtual Input 13	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
13	Virtual Input 14	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
14	Virtual Input 15	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
15	Virtual Input 16	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
16	Virtual Input 17	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
17	Virtual Input 18	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
18	Virtual Input 19	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
19	Virtual Input 20	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
20	Virtual Input 21	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
21	Virtual Input 22	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
22	Virtual Input 23	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s
23	Virtual Input 24	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inac-tive	Active	None	None	Pulse duration fixed at 1 s

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate – No	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
24	Virtual Input 25	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
25	Virtual Input 26	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
26	Virtual Input 27	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
27	Virtual Input 28	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
28	Virtual Input 29	Y	Y	Y	Y	-	Y	Y	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
29	Virtual Input 30	Y	Y	Y	Y	-	Y	-	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
30	Get Next Fault Event	Y	Y	Y	Y	-	Y	-	-	-	-	-	Inactive	Active	None	None	Pulse duration fixed at 1 s
31	Output Contact 2	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
32	Output Contact 3	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
33	Output Contact 4	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
34	Output Contact 5	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
35	Output Contact 6	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
36	Output Contact 7	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
37	Output Contact 8	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
38	Output Contact 9	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
39	Output Contact 10	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
40	Output Contact 11	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
41	Output Contact 12	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
42	Output Contact 13	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
43	Output Contact 14	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate – No	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
44	Output Contact 15	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
45	Output Contact 16	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
46	Output Contact 17	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
47	Output Contact 18	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
48	Output Contact 19	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
49	Output Contact 20	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
50	Output Contact 21	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
51	Output Contact 22	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
52	Output Contact 23	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
53	Output Contact 24	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
54	Output Contact 25	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
55	Output Contact 26	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
56	Output Contact 27	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
57	Output Contact 28	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
58	Output Contact 29	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
59	Output Contact 30	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
60	Output Contact 31	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
61	Output Contact 32	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	

NOTES

1. Analog Inputs are scanned with 500 ms resolution.
2. Nominal values in calculations for the following table are based on 69V secondary voltage * PT ratio for voltage channels, and either 1 A or 5A secondary current * CT ratio for current channels dependent upon the format of CT configured on the F-PRO.
3. Analog Input data points are user selectable; the data points available in the device for any given Analog Input point selection can be obtained through the F- PRO Offliner software (see SCADA Setting Summary).
4. When a fault location event is available, Binary Input "Fault Information Available" (default point index 80) is asserted while there are still fault location events in the buffer (size 100). When a Pulse or Latch is received for the Binary Output Get Next Fault Event (default point index 30, previous state is not important), fault event information is put into the Analog Inputs. If there is no fault location event available when the Binary Output is pulsed, the fault type is set to zero

Not all fault location events are reported through DNP. In a burst of fault locations from a fault, only the first processed event is available through DNP, all other events within the following 100 ms interval are ignored. Outside 100 ms from the processed fault location event, the system accepts another fault location event and performs the same filtering. In addition, only fault location events generated by trip elements are available.

The following bitmap id used for the fault information Type points:

0x0001 Phase A

0x0002 Phase B

0x0004 Phase C

0x0008 Ground

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value ^a		Scaling ^b		Scale Units	Resolution ^c (default/ maximal)	Description
			Minimum	Maximum	Multiplier (default / (range))	Offset			
0	V1a Magnitude	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	
1	V1a Angle	2	-18000	18000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
2	V1b Magnitude	2	0	Configurable	0.01 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	
3	V1b Angle	2	-18000	18000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
4	V1c Magnitude	2	0	Configurable	0.01 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	
5	V1c Angle	2	-18000	18000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
6	I1a Magnitude	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	
7	I1a Angle	2	-18000	180000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value ^a		Scaling ^b		Scale Units	Resolution ^c (default/ maximal)	Description
			Minimum	Maximum	Multiplier (default / (range))	Offset			
8	I1b Magnitude	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	
9	I1b Angle	2	-18000	180000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
10	I1c Magnitude	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	
11	I1c Angle	2	-18000	180000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
12	I1g Magnitude	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	
13	I1g Angle	2	-18000	180000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
14	Isef Magnitude	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	
15	Isef Angle	2	-18,000	18,000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
16	VAux Magnitude	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	
17	VAux Angle	2	-18,000	18,000	0.1 / (0.01 – 1.0)	0.0	degrees	0.1 / 0.01	
18	Frequency	2	0	Configurable	0.01 / (0.001 – 1.0)	0.0	Hz	0.01 / 0.001	Positive sequence frequency
19	Voltage (V ₁)	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	Positive sequence main voltage
20	Voltage (V ₂)	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	Negative sequence main voltage
21	Voltage (V ₀)	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	Zero sequence main voltage
22	Current (I ₁)	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	Positive sequence line current, dependant on the Ring Bus Configuration.
23	Current (I ₂)	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	A	1.0 / 0.01	Negative sequence line current, dependant on the Ring Bus Configuration.

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value ^a		Scaling ^b		Scale Units	Resolution ^c (default/ maximal)	Description
			Minimum	Maximum	Multiplier (default / (range))	Offset			
24	Current (I ₀)	2	0	Configurable	1.0 / (0.01 – 1000)	0.0	degrees	1.0 / 0.01	Zero sequence line current, dependant on

a. The minimum and maximum transmitted values are the lowest and highest values that the outstation will report in DNP analog input objects. These values are integers if the outstation transmits only integers. If the outstation is capable of transmitting both integers and floating-point, then integer and floating-point values are required for the minimums and maximums.

For example, a pressure sensor is able to measure 0 to 500 kPa. The outstation provides a linear conversion of the sensor's output signal to integers in the range of 0 to 25000 or floating-point values of 0 to 500,000. The sensor and outstation are used in an application where the maximum possible pressure is 380 kPa. For this input, the minimum transmitted value would be stated as 0 / 0.0 and the maximum transmitted value would be stated as 19000 / 380,000.

b. The scaling information for each point specifies how data transmitted in integer variations (16 bit and 32 bit) is converted to engineering units when received by the Master (i.e. scaled according to the equation: scaled value = multiplier * raw + offset). Scaling is not applied to Floating point variations since they are already transmitted in engineering units.

c. Resolution is the smallest change that may be detected in the value due to quantization errors and is given in the units shown in the previous column. This parameter does not represent the accuracy of the measurement.

5 Maximal values are calculated as (2 * Configured Nominal / Multiplier) for voltage channels and as (40 * Configured Nominal / Multiplier) for current channels (see Note 2 above for the nominal definitions).

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value ¹		Scaling ²		Scale Units	Resolution ³ (default/ maximal)	Description
			Minimum	Maximum	Multiplier (default / (range))	Offset			
									the Ring Bus Configuration.
25	P	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MW	0.1 / 0.00001	
26	Q	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVA	0.1 / 0.00001	
27	S	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVA	0.1 / 0.00001	
28	Power Factor		-1000	1000	0.01 / (0.001- 0.1)	0.0	NA	0.01 / 0.001	

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value ¹		Scaling ²		Scale Units	Resolution ³ (default/ maximal)	Description
			Minimum	Maximum	Multiplier (default / (range))	Offset			
29	Fault Information – DNP Time (High 16 bits)	none	0	65,535	1.0	0.0	NA	1.0	See note #4 on how to access Fault Information.
30	Fault Information – DNP Time (Middle 16 bits)	none	0	65,535	1.0	0.0	NA	1.0	
31	Fault Information – DNP Time (Low 16 bits)	none	0	65,535	1.0	0.0	NA	1.0	
32	Fault Information – Fault Distance	none	0	Configurable	0.1	0.0	Configurable (km or miles)	0.1	
33	Fault Information – Type	none	0	15	1.0	0.0	NA	1.0	
34	Active Setting Group Number	2	1	8	1.0	0.0	NA	1.0	
35	Self check Fail	2	0	65,535	1.0	0.0	NA	1.0	
36 *	Pa	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MW	0.1 / 0.00001	
37 *	Pb	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MW	0.1 / 0.00001	
38 *	Pc	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MW	0.1 / 0.00001	
39 *	Qa	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVAr	0.1 / 0.00001	
40 *	Qb	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVAr	0.1 / 0.00001	
41 *	Qc	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVAr	0.1 / 0.00001	
42 *	Sa	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVA	0.1 / 0.00001	

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value ¹		Scaling ²		Scale Units	Resolution ³ (default/ maximal)	Description
			Minimum	Maximum	Multiplier (default / (range))	Offset			
43 *	Sb	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVA	0.1 / 0.00001	
44 *	Sc	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	MVA	0.1 / 0.00001	
45 *	Power Factor a	2	-1000	1000	0.01 / (0.001- 0.1)	0.0	NA	0.01 / 0.001	
46 *	Power Factor b	2	-1000	1000	0.01 / (0.001- 0.1)	0.0	NA	0.01 / 0.001	
47 *	Power Factor c	2	-1000	1000	0.01 / (0.001- 0.1)	0.0	NA	0.01 / 0.001	
48	V1ab Magnitude	2	0	Configurable	0.1 / (0.00001-1.0)	0.0	kV	0.1 / 0.00001	
49	V1ab Angle	2	- 18,000	18,000	0.1 / (0.01 – 1.0)	0	degrees	0.1 / 0.01	
50	V1bc Magnitude	2	0	Configurable	0.1 / (0.00001-1.0)	0	kV	0.1 / 0.00001	
51	V1bc Angle	2	- 18,000	18,000	0.1 / (0.01 – 1.0)	0	degrees	0.1 / 0.01	
52	V1ca Magnitude	2	0	Configurable	0.1 / (0.00001-1.0)	0	kV	0.1 / 0.00001	
53	V1ca Angle	2	- 18,000	18,000	0.1 / (0.01 – 1.0)	0	degrees	0.1 / 0.01	
54	V/F	2	0	Configurable	0.01 / (0.0001-1.0)	0	pu	0.01 / 0.0001	
55	%THD Voltage	2	0	10,000	0.1 / (0.01-1.0)	0	%	0.1 / 0.01	
56	%I2/I1	2	0	10,000	0.1 / (0.01-1.0)	0	%	0.1 / 0.01	
57	Thermal State	2	0	10,000	0.1 / (0.01 – 1.0)	0	%	0.1 / 0.01	
58	I2t Accumulated	2	0	Configurable	1.0 / (0.1 – 10.0)	0	kA^2s	1.0 / 0.1	
59	I2t Last Operation	2	0	Configurable	1.0 / (0.1 – 10.0)	0	kA^2s	1.0 / 0.1	
60	79 AR Count	2	0	Configurable	1/1	0	N/A	1/1	
61	79 AR Cumulative count	2	0	Configurable	1/1	0	N/A	1/1	

2.4 Octet String Points Static (Steady-State) Group Number: 110 Event Group Number: 111	Capabilities	Current Value	If configurable, list methods
2.4.1 Event reporting mode *:	☐ Only most recent ☒ All events		
2.4.2 Octet Strings Included in Class 0 response:	☐ Always ☒ Configurable ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.4.3 Definition of Octet String Point List:	☐ Fixed, list shown in table below ☐ Configurable (current list may be shown in table below) ☒ Other, explain <u>Used for Event Log access as described below</u>		

* Object 110 and 111 are Octet String Object used to provide access to the Event Log text of the relay. Object 110 always contains the most recent event in the relay. Object 111 is the corresponding change event object.

As stated in the DNP specifications, the variation of the response object represents the length of the string. The string represents the ASCII values of the event text. The first two characters in the string can be used to quickly identify fault location events. Fault locator events begin with the characters "FL" (0x46, 0x4C hex). The following example shows a 50 Fn event returned through either of the octet string objects:

Event Message:

FL2016Sep21 20:16:16.966: 50-1 AB 1.0km: Trip

DNP Octet string object components:					
0x46	0x4C	0x32	0x30	0x31	0x36
0x53	0x65	0x70	0x32	0x31	0x20
0x32	0x30	0x3A	0x31	0x36	0x3A
0x31	0x36	0x2E	0x39	0x36	0x36
0x20	0x32	0x31	0x50	0x31	0x20
0x41	0x42	0x20	0x31	0x2E	0x30
0x6B	0x6D	0x3A	0x20	0x54	0x72
0x69	0x70				

Implementation Table

The following implementation table identifies which object groups and variations, function codes and qualifiers the device supports in both requests and responses. The Request columns identify all requests that may be sent by a Master, or all requests that must be parsed by an Outstation. The Response columns identify all responses that must be parsed by a Master, or all responses that may be sent by an Outstation.

NOTES

The implementation table must list all functionality required by the device whether Master or Outstation as defined within the DNP3 IED Conformance Test Procedures. Any functionality beyond the highest subset level supported is indicated by highlighted rows. Any Object Groups not provided by an outstation or not processed by a Master are indicated by strike through (note these Object Groups will still be parsed).

DNP OBJECT GROUP & VARIATION			REQUEST		RESPONSE	
Group Num	Var Num	Description	Outstation parses		Outstation can issue	
			Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
1	0	Binary Input – Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
1	1	Binary Input – Packed format	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
1	2	Binary Input – With flags	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
2	0	Binary Input Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
2	1	Binary Input Event – Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol.resp)	17, 28 (index)
2	2	Binary Input Event – With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol.resp)	17, 28 (index)
2	3	Binary Input Event – With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 130 (unsol.resp)	17, 28 (index)
10	0	Binary Output – Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)

DNP OBJECT GROUP & VARIATION			REQUEST		RESPONSE	
Group Num	Var Num	Description	Outstation parses		Outstation can issue	
			Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
10	2	Binary Output – Output Status with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
12	1	Binary Command – Control relay output block (CROB)	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	Echo of request
20	0	Counter – Any Variation	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	
20	1	Counter – 32-bit with flag			129 (response)	
20	2	Counter – 16-bit with flag			129 (response)	
20	5	Counter – 32-bit without flag			129 (response)	
20	6	Counter – 16-bit without flag			129 (response)	
21	0	Frozen Counter – Any Variation	1 (read)	06 (no range, or all)		
21	1	Frozen Counter – 32-bit with flag			129 (response)	
21	2	Frozen Counter – 16-bit with flag			129 (response)	
21	9	Frozen Counter – 32-bit without flag			129 (response)	
21	10	Frozen Counter – 16-bit without flag			129 (response)	
22	0	Counter Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)		
22	1	Counter Event – 32-bit with flag			129 (response) 430 (unsol.resp)	17, 28 (index)
22	2	Counter Event – 16-bit with flag			129 (response) 430 (unsol.resp)	17, 28 (index)
30	0	Analog Input – Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	1	Analog Input – 32-bit with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	2	Analog Input – 16-bit with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)

DNP OBJECT GROUP & VARIATION			REQUEST		RESPONSE	
			Outstation parses		Outstation can issue	
Group Num	Var Num	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
30	3	Analog Input – 32-bit without flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	4	Analog Input – 16-bit without flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
32	0	Analog Input Event – Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	1	Analog Input Event – 32-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 430— (unsol.resp)	17, 28 (index)
32	2	Analog Input Event – 16-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) 430— (unsol.resp)	17, 28 (index)
32	3	Analog Input Event – 32-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	4	Analog Input Event – 16-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
40	0	Analog Output Status – Any Variation	1 (read)	06 (no range, or all)	129 (response)	
40	2	Analog Output Status – 16-bit with flag			129 (response)	00, 01 (start-stop)
41	2	Analog Output – 16-bit	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	Echo of request
50	1	Time and Date – Absolute time	2 (write)	07 (limited qty = 1)	129 (response) 429— (response)	
51	1	Time and Date CTO – Absolute time, synchronized			430— (unsol.resp)	07 (limited qty) (qty = 1)
51	2	Time and Date CTO - Absolute time, unsynchronized			430— (unsol.resp)	07 (limited qty) (qty = 1)
52	1	Time Delay – Coarse			129 (response)	07 (limited qty) (qty = 1)
52	1	Time delay – Fine			429— (response)	07 (limited qty) (qty = 1)
60	1	Class Objects – Class 0 data	1 (read)	06 (no range, or all)	129 (response)	00, 01 (start-stop)
60	2	Class Objects – Class 1 data	1 (read)	06 (no range, or all)	129 (response)	17, 28 (index)

DNP OBJECT GROUP & VARIATION			REQUEST Outstation parses		RESPONSE Outstation can issue	
Group Num	Var Num	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (dec)	Qualifier Codes (hex)
60	3	Class Objects – Class 2 data	1 (read)	06 (no range, or all)	129 (response)	17,28 (index)
60	4	Class Objects – Class 3 data	1 (read)	06 (no range, or all)	129 (response)	17,28 (index)
80	1	Internal Indications – Packet format	2 (write)	00 (start-stop) (index = 7)	129 (response)	
110	0	Octet string	1 (read)	06 (no range, or all)	129 (response)	07 , (limited qty)
111	0	Octet string event	1 (read)	06 (no range, or all)	129 (response)	07 , (limited qty)
No Object (function code only)			13 (cold restart)		129 (response)	
No Object (function code only)			14 (warm restart)		129 (response)	
No Object (function code only)			23 (delay meas.)		129 (response)	

Appendix G Mechanical Drawings

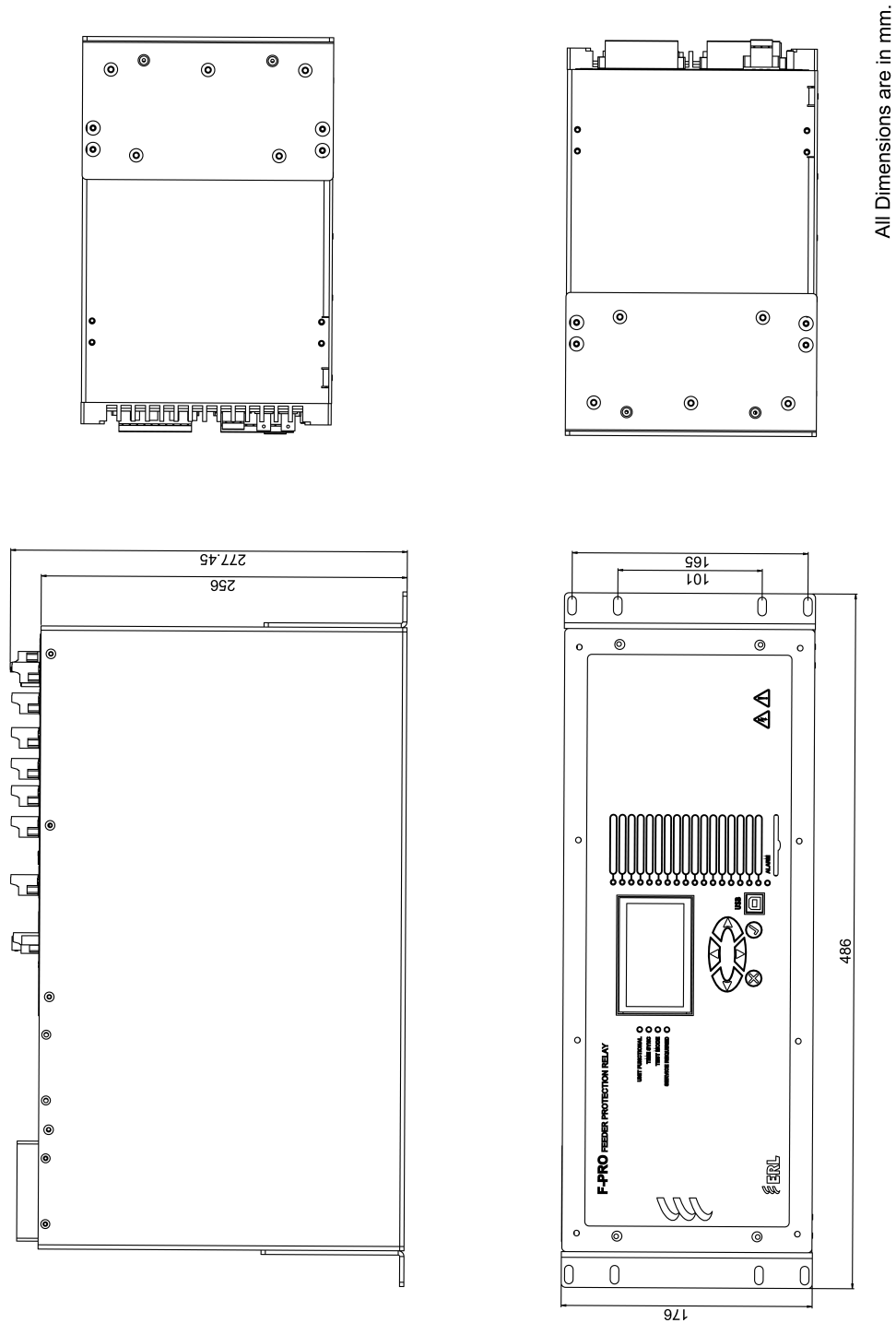


Figure G.1: Mechanical Drawing

All Dimensions are in mm [inch],

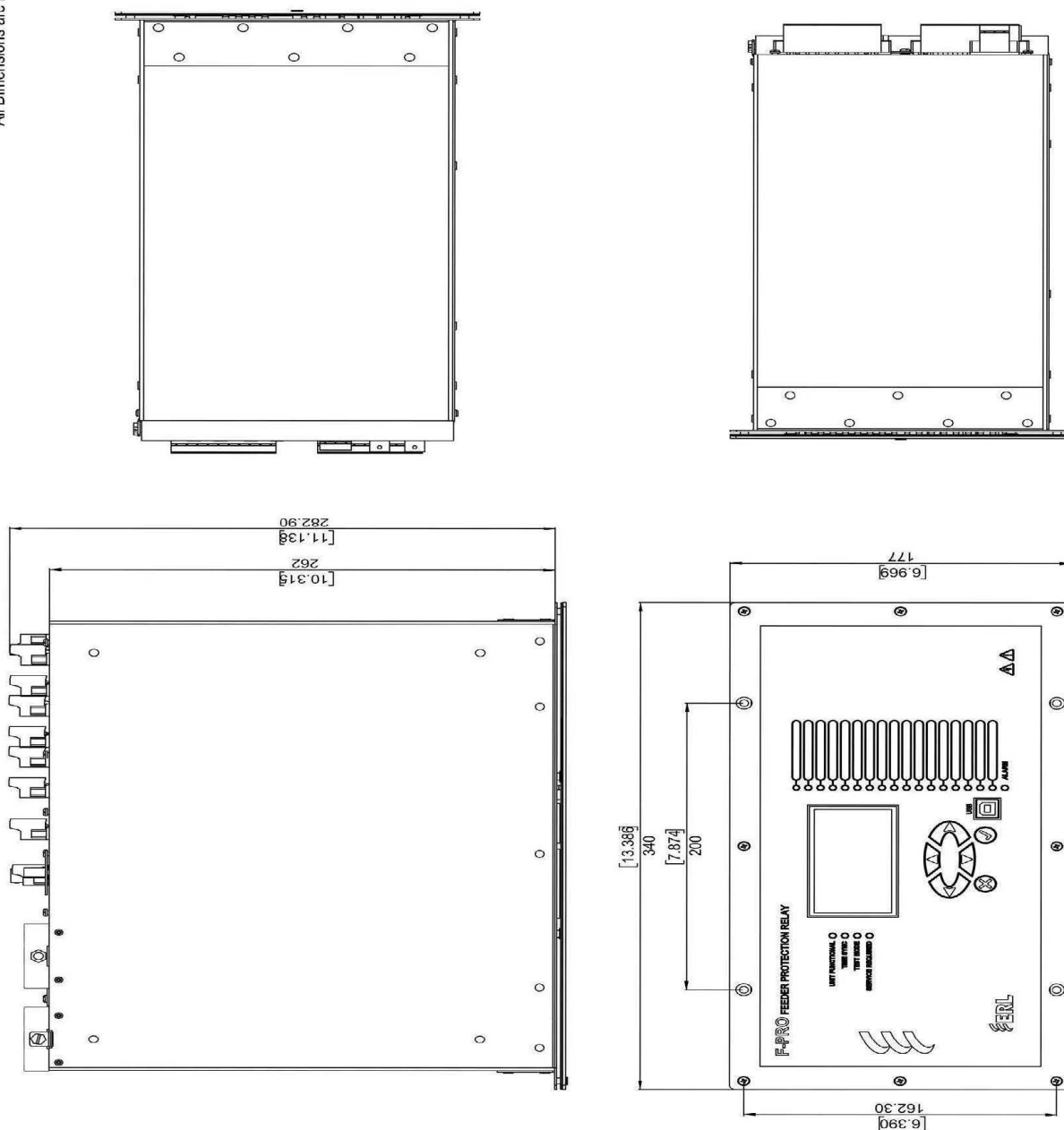


Figure G.2: Mechanical Drawing

Appendix H Connection Diagram

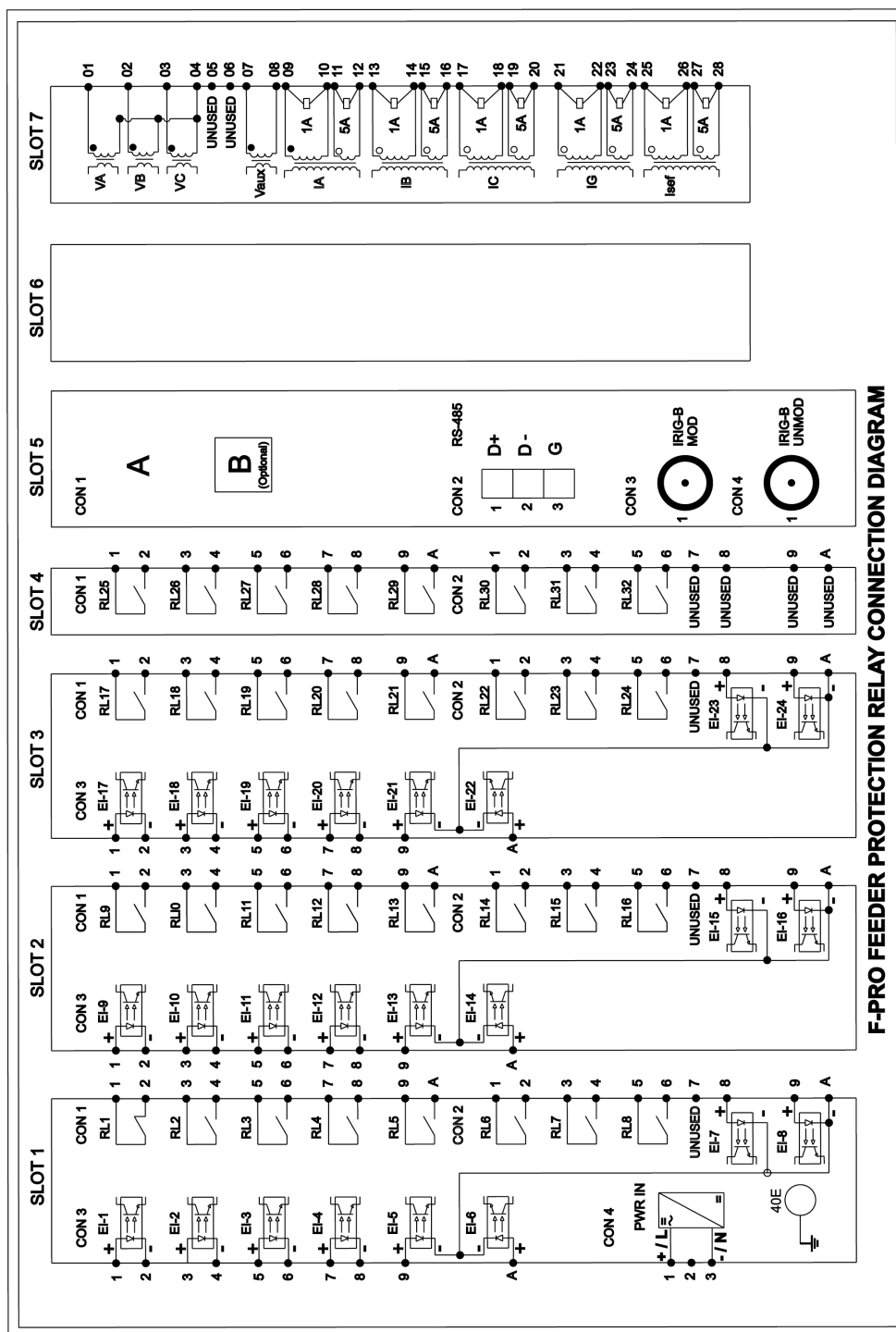
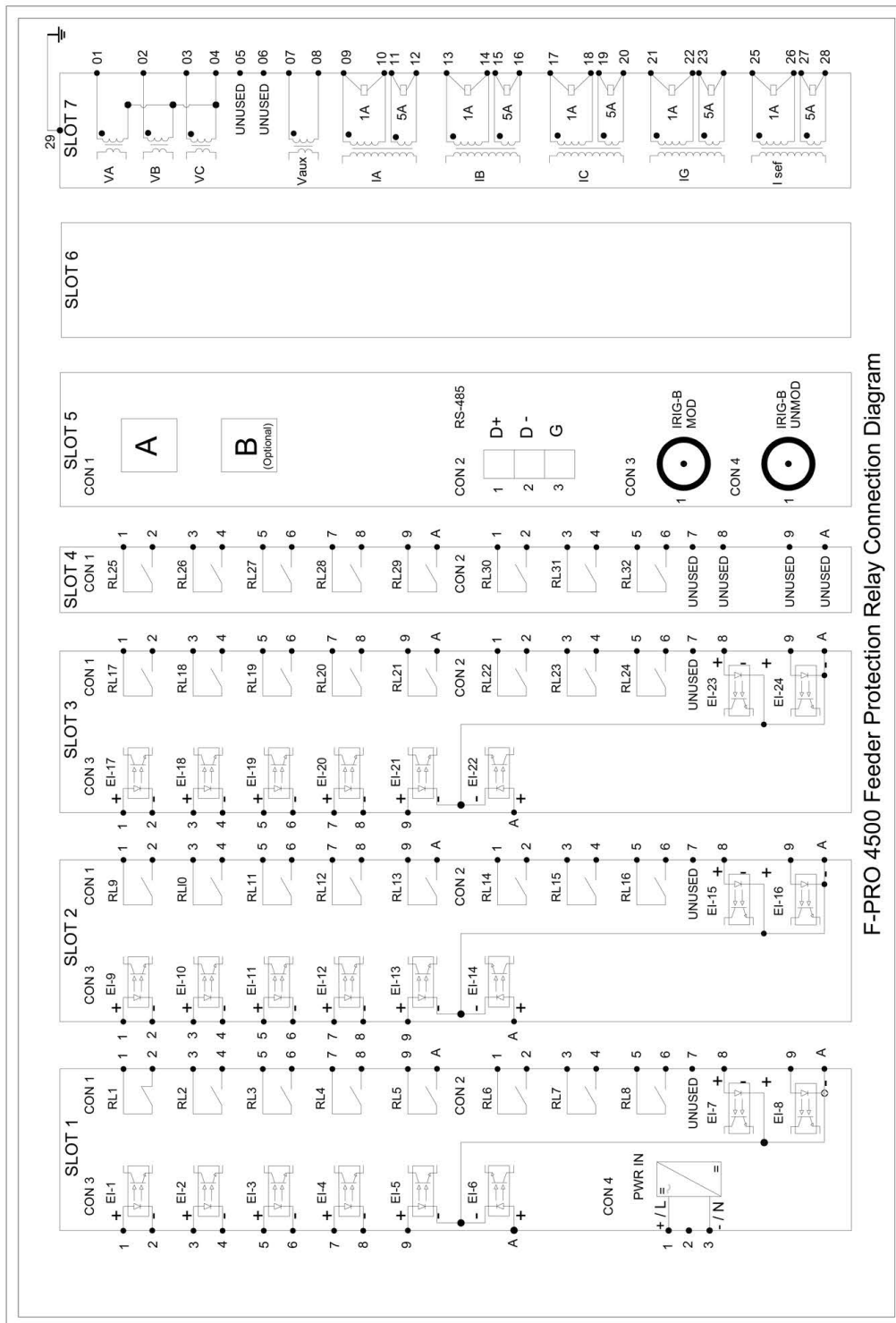


Figure H.1: F-PRO 4500 Connection Diagram for 5CT, 4PT with 24DI, 32DO hardware configuration (19")



F-PRO 4500 Feeder Protection Relay Connection Diagram

Figure H.2: F-PRO 4500 Connection Diagram for 5CT, 4PT with 24DI, 32DO hardware configuration (E12)

H. 1 Terminal Numbering and Hardware Configurations

The F-PRO 4500 uses a concatenation of Slot, Connector and Terminal for identifying terminals. For example, Slot 1, Connector 1, Terminal 1 is referred to as “111”. The terminal numbering is shown in Table H.1 and Table H.2. Table H.1 and Table H.2 also show the availability of the slots for each hardware configuration (an “X” denotes that this slot is included in the hardware configuration).

Table H.3: F-PRO Terminal Numbering and DIDO Hardware Configuration						
Slot Number	Terminal Type(s)	Terminal Numbering	Hardware Configuration Availability			
			8DI, 8DO	16DI, 16DO	16DI, 24DO	24DI, 32DO
0 (Front Panel)	USB Port	010	X	X	X	X
1	8 Digital Inputs and 8 Digital Outputs, Power Supply	111-11A 121-12A 131-13A 141-143 (Power Supply)	X	X	X	X
2	8 Digital Inputs and 8 Digital Outputs	211-21A 221-22A 231-23A		X	X	X
3	8 Digital Inputs and 8 Digital Outputs	311-31A 321-32A 331-33A				X
4	8 Digital Outputs	411-41A 421-42A			X	X
5	Communication Ports	51A, 51B (Ethernet) 52 (Serial) 531, 541 (IRIG)	X	X	X	X

Table H.4: Terminal Numbering and Analog Hardware Configuration			
Slot Number	Terminal Type(s)	Terminal Numbering	Hardware Configuration Availability
			5CT, 4PT
7	Analogs	701-729	X

Appendix I AC Schematic Drawings

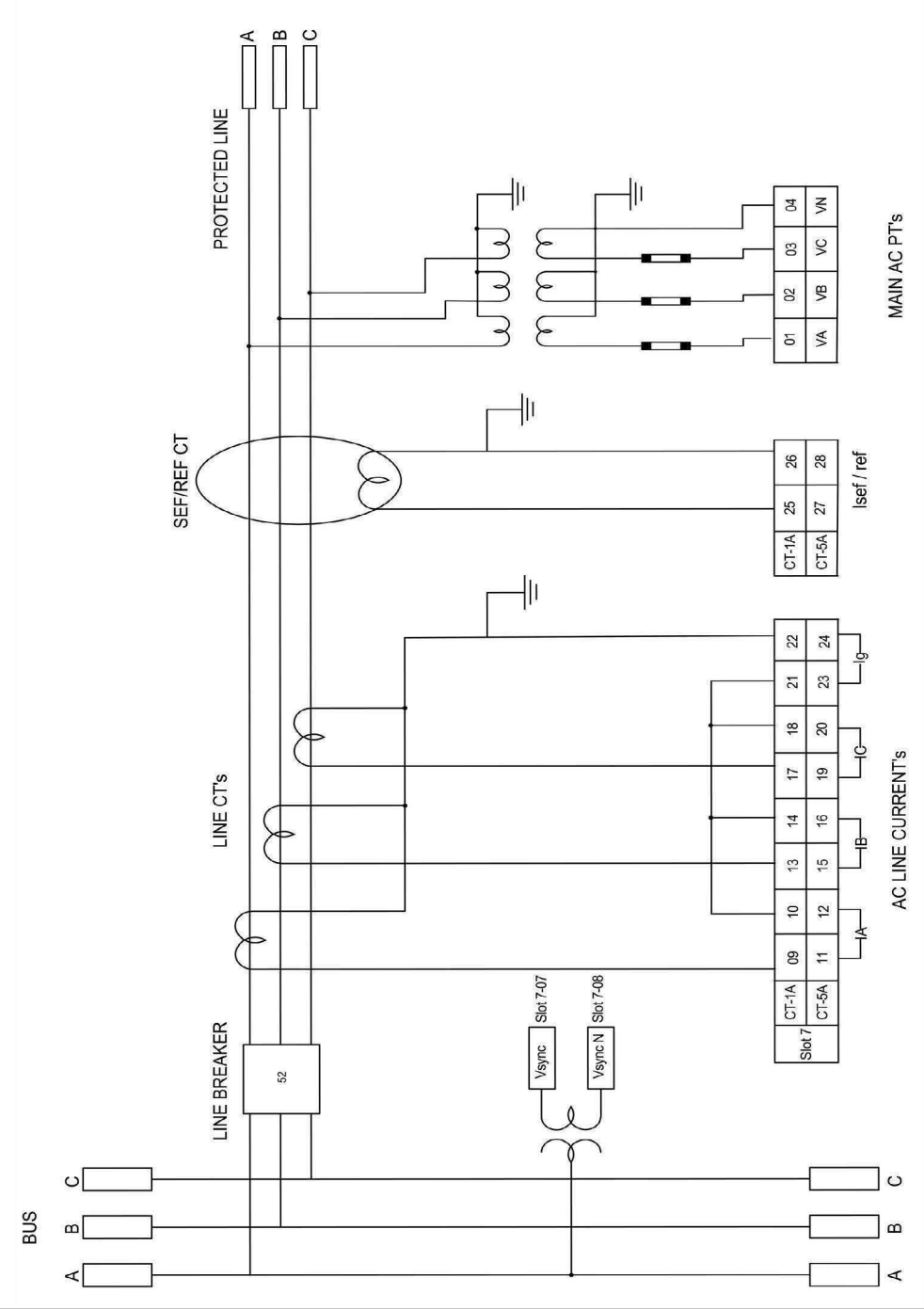


Figure I.1: F-PRO 4500 AC Schematic

Appendix J DC Schematic Drawings

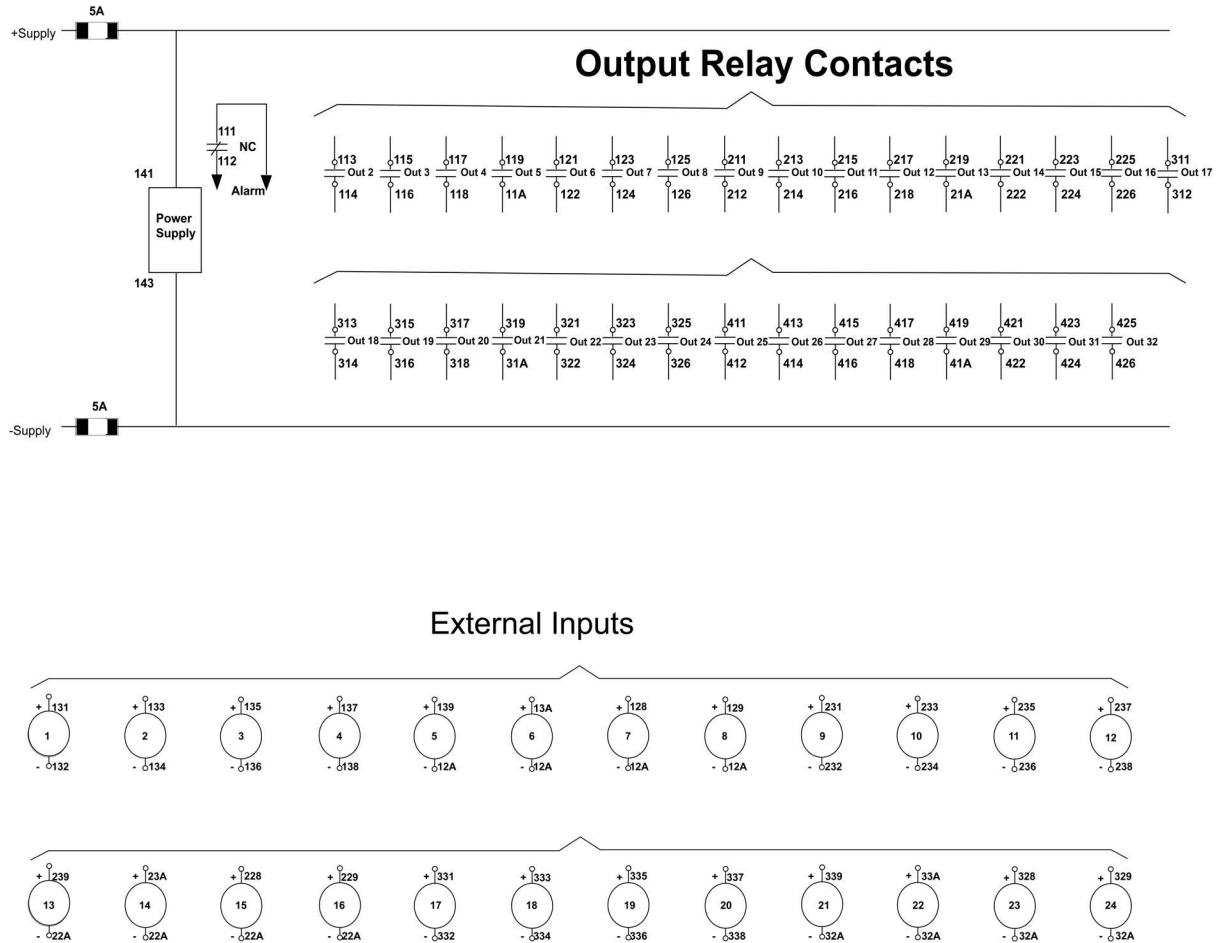
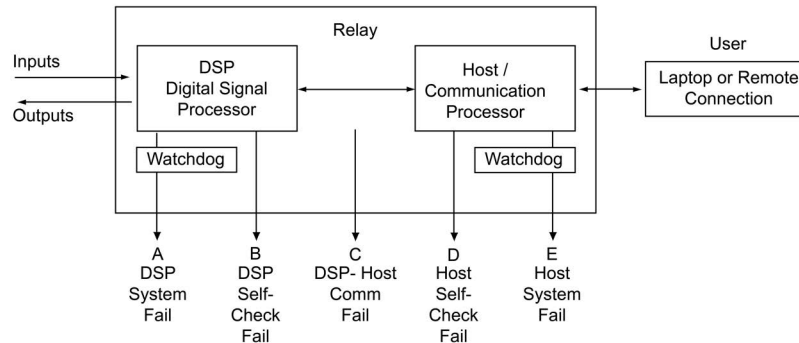


Figure J.1: F-PRO 4500 DC Schematic

Appendix K Failure Modes



K. 1 Actions

A - DSP System Failure

The Unit Functional LED changes from green to off. The RL1 contact on the rear panel closes to activate a remote alarm. All other contacts are forced inactive.

The watch-dog repeatedly attempts to restart the DSP for diagnostic purposes. The Unit Functional LED stays off, RL1 remains closed and the other contacts remain de-energized, even for a successful restart. Only a power-down/power-up cycle will reset the Unit Functional LED to green, open RL1, and re-energize the other contacts.

B - DSP Self-Check Fail

The Self Check Fail output can be assigned and used in ProLogic statements and the Output Matrix.

There are two possibilities for DSP Self Check Fail, either Alarm or Block. Both are related to the dc offset on a channel which should not occur with proper calibration. Alarm just drives the optional output contact but Block causes the Relay Functional LED to go out and the relay to be unable to drive any output contact (as in the first and last paragraphs of section A - DSP System Failure above).

C - DSP- Host Comm Failure

D - Host Self-Check Fail

The Service Required LED changes from off to red.

E - Host System Fail

The Test Mode LED changes from off to red until the Host has rebooted. The watchdog will continue to attempt to restart the Host several times. If the Host reboots but cannot return to normal operation, the Service Required LED changes from off to red.

Appendix L IEC 61850 Conformance Statements and Data Mapping Specification

L.1 Protocol Implementation Conformance Statement (PICS)

Protocol Implementation Conformance Statement
for the IEC 61850 interface in F-PRO 4500

Document Version¹: D05836R00.00

Date: 2024-08-05

Based upon UCAIUG PICS Template version 2.3

UCA International Users Group
Testing Sub Committee

1. The version shown in the user manual differs slightly in formatting to the official released version.

General

The following ACSI conformance statements are used to provide an overview and details about F-PRO 4500, with firmware v1.00:

- ACSI basic conformance statement
- ACSI models conformance statement
- ACSI service conformance statement

The statements specify the communication features mapped to IEC 61850-8-1 and IEC 61850-9-2.

ACSI basic conformance statement

The “Basic conformance statement” is defined in Table L.1, “Basic conformance statement”.

Table L.1: Basic conformance statement				
		Client/ Subscriber	Server/ Publisher	Value/ Comments
Client-Server roles				
B11	Server side (of TWO-PARTY-APPLICATION-ASSOCIATION)	-	YES	
B12	Client side of (TWO-PARTY-APPLICATION-ASSOCIATION)		-	
SCSMs supported				
B21	SCSM: IEC 61850-8-1 used		YES	
B22	SCSM: IEC 61850-9-1 used			Deprecated Ed2
B23	SCSM: IEC 61850-9-2 used			
B24	SCSM: other		NO	
Generic substation event model (GSE)				
B31	Publisher side	-	YES	
B32	Subscriber side	YES	-	
Transmission of sampled value model (SVC)				
B41	Publisher side	-		
B42	Subscriber side		-	
– = not applicable YES = supported NO or empty = not supported				

ACSI Models Conformance Statement

The ACSI models conformance statement is defined in Table L.2, “ACSI models conformance statement”.

Table L.2: ACSI models conformance statement				
		Client/ Subscriber	Server/ Publisher	Value/ Comments
If Server side (B11) and/or Client side (B12) supported				
M1	Logical device		YES	c1
M2	Logical node		YES	c1
M3	Data		YES	c1
M4	Data set		YES	c2
M5	Substitution		NO	
M6	Setting group control		NO	
	Reporting			
M7	Buffered report control		YES	
M7-1	sequence number		YES	
M7-2	report time stamp		YES	
M7-3	reason for inclusion		YES	
M7-4	data set name		YES	
M7-5	data reference		YES	
M7-6	buffer overflow		YES	
M7-7	entryID		YES	
M7-8	BufTm		YES	
M7-9	IntgPd		YES	
M7-10	GI		YES	
M7-11	conf revision		YES	
M8	Unbuffered report control		YES	
M8-1	sequence number		YES	
M8-2	report time stamp		YES	
M8-3	reason for inclusion		YES	
M8-4	data set name		YES	

Table L.2: ASCI models conformance statement				
		Client/ Subscriber	Server/ Publisher	Value/ Comments
M8-5	data reference		YES	
M8-6	BufTm		YES	
M8-7	IntgPd		YES	
M8-8	GI		YES	
M8-9	conf revision		YES	
	Logging		NO	
M9	Log control		NO	
M9-1	IntgPd		NO	
M10	Log		NO	
M11	Control		NO	
M17	File Transfer		YES	
M18	Application association		YES	c1
M19	GOOSE Control Block		YES	
M20	Sampled Value Control Block		NO	
c1 server must be Y if B11=Y; Client must be Y if B12=Y; c2 server must be Y if any M7, M8, M9 or M20 are Y				
If GSE (B31/32) is supported				
M12	GOOSE	YES	YES	
M13	GSSE			Deprecated Ed2
If SVC (B41/42) is supported				
M14	Multicast SVC		NO	
M15	Unicast SVC		NO	
For all IEDs				
M16	Time		YES	
Y = service is supported N or empty = service is not supported				

ACSI Service Conformance Statement

The ACSI service conformance statement is defined in ACSI service Conformance statement (depending on the statements in Table L.1, “Basic conformance statement” and Table L.2, “ACSI models conformance statement”).

Table L.3: ACSI service Conformance statement						
	Ed.	Services	AA: TP/MC	Client (C)	Server (S)	Comments
Server: if B11=Y or B12=Y						
S1	1,2	GetServerDirectory (LOGICAL DEVICE)	TP		YES	
Application association: if B11=Y or B12=Y						
S2	1,2	Associate			YES	
S3	1,2	Abort			YES	
S4	1,2	Release			YES	
Logical device: if M1=Y						
S5	1,2	GetLogicalDeviceDirectory	TP		YES	
Logical node: if M2=Y						
S6	1,2	GetLogicalNodeDirectory	TP		YES	
S7	1,2	GetAllDataValues	TP		YES	
Data: if M3=Y						
S8	1,2	GetDataValues	TP		YES	
S9	1,2	SetDataValues	TP		NO	
S10	1,2	GetDataDirectory	TP		YES	
S11	1,2	GetDataDefinition	TP		YES	
Data set: if M4=Y						
S12	1,2	GetDataSetValues	TP		YES	
S13	1,2	SetDataSetValues	TP		NO	Deprecated in Ed2
S14	1,2	CreateDataSet	TP		NO	
S15	1,2	DeleteDataSet	TP		NO	

Table L.3 ACSI service Conformance statement						
	Ed.	Services	AA: TP/ MC	Cle nt (C)	Server (S)	Comments
Substitution: if M5=Y						
S16	1,2	GetDataSetDirectory	TP		YES	
S17	1,2	SetDataValues	TP		NO	

Setting group control: if M6=Y						
S18	1,2	SelectActiveSG	TP		NO	
S19	1,2	SelectEditSG	TP		NO	
S20	1,2	SetEditSGValues	TP		NO	
S21	1,2	ConfirmEditSGValues	TP		NO	
S22	1,2	GetEditSGValues	TP		NO	
S23	1,2	GetSGCBValues	TP		NO	

Reporting: If M7=Y or M8=Y						
Buffered report control block (BRCB); If M7=Y						
S24	1,2	Report	TP		YES	
S24-1	1,2	data-change (dchg)			YES	
S24-2	1,2	quality-change (qchg)			YES	
S24-3	1,2	data-update (dupd)			YES	
S25	1,2	GetBRCBValues	TP		YES	
S26	1,2	SetBRCBValues	TP		YES	
Unbuffered report control block (URCB) If M8=Y						
S27	1,2	Report	TP		YES	
S27-1	1,2	data-change (dchg)			YES	
S27-2	1,2	quality-change (qchg)			YES	
S27-3	1,2	data-update (dupd)			YES	
S28	1,2	GetURCBValues	TP		YES	
S29	1,2	SetURCBValues	TP		YES	

Logging: If M9=Y or M10=Y						
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Log control block; If M9=Y						
S30	1,2	GetLCBValues	TP		NO	
S31	1,2	SetLCBValues	TP		NO	
Log; If M10=Y						
S32	1,2	QueryLogByTime	TP		NO	
S33	1,2	QueryLogAfter	TP		NO	
S34	1,2	GetLogStatusValues	TP		NO	

Generic substation event model (GSE): If M19=Y						
GOOSE						
S35	1,2	SendGOOSEMessage	MC		YES	
GOOSE-CONTROL-BLOCK						
S36	1,2	GetGoReference	TP		NO	
S37	1,2	GetGOOSEElementNumber	TP		NO	
S38	1,2	GetGoCBValues	TP		YES	
S39	1,2	SetGoCBValues	TP		NO	
GSSE						
S40	1	SendGSSEMessage	MC	-	-	Deprecated in Edition 2
GSSE-CONTROL-BLOCK						
S41	1	GetReference	TP	-	-	Deprecated in Edition 2
S42	1	GetGSSEElementNumber	TP	-	-	Deprecated in Edition 2
S43	1	GetGsCBValues	TP	-	-	Deprecated in Edition 2
S44	1	SetGsCBValues	TP	-	-	Deprecated in Edition 2

Transmission of sampled value model (SVC): If M20=Y						
Multicast SV						
S45	1,2	SendMSVMessage	MC		NO	
Multicast Sampled Value Control Block						
S46	1,2	GetMSVCBValues	TP		NO	
S47	1,2	SetMSVCBValues	TP		NO	

Unicast SV						
S48	1,2	SendUSVMessage	TP		NO	
Unicast Sampled Value Control Block						
S49	1,2	GetUSVCBValues	TP		NO	
S50	1,2	SetUSVCBValues	TP		NO	
Control: If M11=Y						
S51	1,2	Select			NO	
S52	1,2	SelectWithValue	TP		NO	
S53	1,2	Cancel	TP		NO	
S54	1,2	Operate	TP		YES	
S55	1,2	CommandTermination	TP		NO	
S56	1,2	TimeActivatedOperate	TP		NO	
File transfer: If M17=Y						
S57	1,2	GetFile	TP		YES	
S58	1,2	SetFile	TP		NO	
S59	1,2	DeleteFile	TP		YES	
S60	1,2	GetFileAttributeValues	TP		YES	
S61	1,2	GetServerDirectory (FILE-SYSTEM)	TP		YES	

Time					
T1	1,2	Time resolution of internal clock			10 (1ms) Nearest negative power of 2 ⁻ⁿ in seconds (number 0 .. 24)
T2	1,2	Time accuracy of internal clock			T3 TL (ms) (low accuracy), T3 < 7) (c1) T0 (ms) (<= 10 ms), 7 <= T3 < 10 (c1) T1 (μs) (<= 1 ms), 10 <= T3 < 13 T2 (μs) (<= 100 μS), 13 <= T3 < 15 T3 (μs) (<= 25 μS), 15 <= T3 < 18 T4 (μs) (<= 4 μS), 18 <= T3 < 20 T5 (μs) (<= 1 μS), 20 <= T3 < 25
T3	1,2	Supported TimeStamp resolution	-		16 (25 μs) Nearest value of 2 ⁻ⁿ in seconds(number 0 .. 24)
c1 TL may only be specified for Ed2. If Ed1 has accuracy which is better than 1 second but is not T1 then declare T0.					

L.2 Model Implementation Conformance Statement (MICS)

Model Implementation Conformance Statement (MICS)
for the IEC 61850 Edition 2 server interface in F-PRO 4500

Document Version¹: D05837R00.00

Date: 2024-08-05

Based upon
UCA International Users Group
Testing Sub Committee

MICS template for Server Test Procedures First edition and Edition 2 servers
Template version 1.2

1. The formatting of the official version of this document differs slightly from the version shown here in the user manual, but the content is the same.

Introduction

This model implementation conformance statement is applicable for F-PRO 4500, with firmware v1.00:

This MICS document specifies the modeling extensions compared to IEC 61850 Edition 2. For the exact details on the standardized model please compare the ICD substation configuration file: “ERLPhaseFPRO4500.icd”, version 1 revision 0.

Table L.4, “Logical Nodes List” contains the list of implemented logical nodes.

Logical Nodes List

The following table contains the list of logical nodes implemented in the device:

Table L.4: Logical Nodes List
L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
LGOS (GOOSE Subscription)
P: Logical Nodes for protection functions
PTOF (Overfrequency)
PTUF (Underfrequency)
PFRC (Rate of change of frequency)
PTOC (Time overcurrent)
PIOC (Instantaneous overcurrent)
PTUV (Undervoltage)
PTOV (Overvoltage)
PVPH (Volts per Hz)
PTUC (Undercurrent)
PSDE (Sensitive directional earth fault)
PTTR (Thermal overload)
PHAR (Harmonic restraint)
PDUP (Directional underpower)
R: Logical nodes for protection related functions

RSYN (Synchronism-check)
RBRF (Breaker failure)
RREC (Auto reclose)
RFLO (Fault locator)
RDRE (Disturbance record function)
RTCS (Trip circuit supervision)
RCBC (I^2 T-CB condition)
RTHD (Total Harmonic Distortion)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MSQI (Sequence and Imbalance)
MMXU (Measurement)
MHAN (THD)
MTHR (Volts/Hz)

L.3 TISSUES Implementation Conformance Statement (TICS)

Introduction

This document provides a template for the Tissues conformance statement. According to the UCA IUG QAP the Tissue conformance statement is required to perform a conformance test and is referenced on the certificate.

This document is applicable for F-PRO 4500 with firmware v1.00.

Document Version¹: D05836R00.00

Date: 2024-08-05

Mandatory Edition 2 Tissues

Below tables give an overview of the applicable mandatory Tissues. Items in *italic* are brief interpretations provided by the UCA International Users Group to aid in interpretation and is not normative. The original TISSUE should be consulted for details of changes.

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
Part 6		
658	Tracking related features <i>EntryID and CST missing, these are checked by schema</i>	na
663	FCDA element cannot be a "functionally constrained logical node" <i>doName now mandatory in FCDA element, SCT: refuse to make empty doName? ICT: Refuse SCD</i>	Y
668	Autotransformer modeling <i>Autotransformer model in substation section has changed</i>	na
687	SGCB ResvTms <i>SettingControl has added attribute resvTms see also TISSUE 845</i>	na
719	ConfDataSet - maxAttributes definition is confusing <i>maxAttributes now means max count of FCDA in dataset</i>	Y
721	Log element name <i>LN0/Log now has optional attribute "name"</i>	na
768	bType VisString65 is missing <i>VisString65 added as SCL BasicType</i>	na
779	object references <i>"@" as first character in object references now allowed</i>	na
788	SICS S56 from optional to mandatory <i>SICS S56="Interpret IED capabilities and prohibit unsupported usage"</i>	na

1. The version shown in the user manual differs slightly in formatting to the official released version.

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
789	ConfLdName as services applies to both server and client <i>Many changes made to Services section</i>	na
804	valKind and IED versus System configuration <i>valImport missing/false DAI means ICT shall ignore value in SCD and SCT shall not change from ICD/IID value.</i> <i>Instance section inherits from DA/BDA element.</i>	na
806	Max length of log name inconsistent between -6 and -7-2 <i>LogControl.logName and Log.name restricted to 32 chars</i>	na
807	Need a way to indicate if "Owner" present in RCB <i>Services/ReportSettings@owner added</i>	Y
823	ValKind for structured data attributes <i>valKind is prohibited on structured attributes</i>	Y
824	Short addresses on structured data attributes <i>sAddr is now allowed for structured attributes</i>	na
825	Floating point value <i>Server shall support <Val> with exponential notation</i>	na
845	SGCB ResvTms <i>Services/SettingGroups/SGEdit added attribute resvTms</i> <i>Services/SettingGroups/ConfSG added attribute resvTms</i> <i>See also TISSUE 687</i>	na
853	SBO and ProtNs <i>DA[@name=SBO] element shall have ProtNS element</i>	na
855	Recursive SubFunction <i>Substation section extension must be tolerated</i>	na
856	VoltageLevel frequency and phases <i>Substation section extension must be tolerated</i>	na
857	Function/SubFunction for ConductingEquipment <i>Substation section extension must be tolerated</i>	na
886	Missing 8-1 P-types <i>"tP_IP_UDP_PORT" and "tP_IP_TCP_PORT" added</i>	na
901	tServices as AP or as IED element <i>Rules for contents of AP/Server/Services are now defined</i>	Y
936	SupSubscription parameter usage is difficult <i>SupSubscription "max" replaced by "maxGo" and "maxSv"</i>	Y
1147	tServices - FileHandling not consistent with -7-2 <i>Services/FileHandling now means only support for GetFile and GetFileAttributeValues and NOT SetFile/DeleteFile</i>	Y
1185	Valkind value Conf for EX FC data <i>valKind=Conf is allowed for dataNs</i>	na
1284	SCSM mapping may require a communication section in an ICD file <i>Server IEDs supporting client/server associations to 61850-8-1 shall include a <Communication> section</i>	Y

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
1328	Limitation on the size of data type templates identifiers <i>Identifier now limited to 255 characters</i>	Y
1395	Client LN attributes <i>ReportControl/RptEnabled/ClientLN@IdInst shall be "LD0" for pure clients (without any Logical Devices)</i>	na
1402	ExtRef during engineering <i>an ExtRef.intAddr attribute value unequal to empty string (prescribed or filled by the IED tool) is the flag indicating that the ExtRef shall not be deleted by the system tool. The system tool can however remove the link to the source IED</i> <<applicable for SCL tool test>>	na
1415	SICS-S110 IID import mandatory for Edition2 <i>only the import of data model modifications and CF value changes is mandatory for system tool</i> <<applicable for SCL tool test>>	na
1419	Support of IdName on other IEDs <i>SICS I212 is now mandatory</i>	Y
1444	Need to support fixed and SCT controlled Datasets <i>Services/xxxSettings@datSet=fix now means "data set pointed by Control Block cannot be altered from ICD/IID value</i> <<applicable for SCL tool test>>	na
1445	ConfReportControl and a fixed ReportSettings <i>Control block capabilities must be consistent</i> <<applicable for SCL tool test>>	na
1450	originalSclXxx computation rules <i>Ed2 ICD/IID files specifying SCL@version=2007 SHALL include originalSCLVersion=2007 and originalSCLRevision as attributes of the <IED>element</i>	Y
1485	Need to supercede Tissue 1398 to clarify SCT behavior <i>Same as TISSUE 1450</i> <<applicable for SCL tool test>>	na
Part 7-1		
828	Data model namespace revision IEC 61850-7-4:2007[A] <i>Both 2007 and 2007A are allowed for namespace name</i>	Y
948	Enumeration (string) values format <i>Enums are limited to 127 characters from Basic-Latin and Latin-1 character sets</i>	Y
1151	simulated GOOSE disappears after 1st appearance when LPHD.Sim = TRUE <i>New LGOS state machine defined, but TISSUE is not IntOp2, therefore TISSUE is optional if LGOS is used</i>	Y
1396	The use and configuration flow of LGOS and LSVS is unclear <i>If Services/SupSubscription@maxGo > 1 then at least 1 LGOS must exist. Same for maxSv/LSVS.</i> <i>If maxGo > count(LGOS) then SCT can create additional LGOS. Same for maxSv/LSVS</i>	Y
1447	Restriction on ENUMtypes in SCL <i>If a ENUM DA limits write or configuration to a subset, then that subset must be declared</i>	na
1457	Multiple DOI nodes with the same name <i>LN can have no more than one DOI with same name</i>	Y

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
1468	Re-use DO from other LN <i>allow standard or private dataNs</i>	na
1491	CmdBlk blocks itself? <i>The data CmdBlk shall have no effect on the controllable data Mod or CmdBlk</i>	na
1495	GetVariableAccessAttributes error code <i>Return MMS error access/object-non-existent if the object does not exist</i>	Y
Part 7-2		
728	BRCB: could PurgeBuf be set when RptEna=TRUE? <i>PurgeBuf while RptEna=true is prohibited</i>	Y
778	AddCause values – add value not-supported <i>Align 7-2 with 8-1 (nothing new to 8-1)</i>	na
780	What are unsupported trigger option at a control block? <i>All control blocks must support all trigger options</i>	Y
783	TimOper Resp- ; add Authorization check <i>Clarifies Time-Operated Controls</i>	na
786	AddCause values 26 and 27 are switched <i>Annex B.2 has wrong AddCause values</i>	na
820	Mandatory ACSI services (use for PICS template) <i>Model entries M18 (Application Association), M19 (GCB), M20 (SVCB) are new. Services S17 (Substitution) and S61 (GetServerDirectory) are new. Services S1, S3, S4, S5, S6, S8, S16, S18, S23, S36, S37, S41, S42 are changed.</i>	Y
858	typo in enumeration ServiceType <i>Tracking serviceType now has GetLogicalNodeDirectory</i>	na
861	dchg of ConfRev attribute <i>Clarifies (tracking) BTS.confRev is AFTER BRCB change</i>	na
1050	GTS Phycomaddr definition in SCL <i>(Tracking) GTS needs a special structure for SCL</i>	na
1071	Length of DO name <i>Private DO name length shall be <=12 including instance</i>	Y
1127	Missing owner attribute in BTS and UTS <i>NSD files for 61850-7-3 show owner in (tracking) BTS/UTS</i>	na
1202	GI not optional <i>GI support is mandatory for both URCB and BRCB</i>	Y
1232	EntryID needs clarification <i>Segments of a report shall have same identifiers</i>	Y
1242	NTS definition <i>NTS.resv have been added</i>	na
1307	Segmented report with Buffer overflow <i>Segments of a report shall have identical buf-overflow value</i>	Y

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
1428	MTS and NTS should use svOptFlds <i>MTS.optFlds and NTS.optFlds now have bType=SvOptFlds</i>	na
1630	Attributes in CDC=LTS do not match 8-1 definition Order of attributes in LTS changed to: logEna, logRef, datSet, oldEntrTm, newEntrTm, oldEnt, <i>newEnt, trgOps, intgPd</i>	na
Part 7-3		
697	persistent command / PulseConfig <i>PulseConfig adds enum "persistent-feedback"</i> <i>DPC.cmdQual=="persistent" is conditionally allowed</i>	na
698	Wrong case is BAC.dB attribute <i>attribute renamed from "dB" to "db"</i>	na
711	blkEna freeze data update while setting its quality to operatorBlocked <i>Mode=Blocked shall not cause q.operatorBlocked</i>	na
722	Units for 'h' and 'min' not in UnitKind enumeration. <i>New unit enums 84=hours, 85=minutes</i>	na
919	Presence Condition for sVC <i>svC may be valKind=Conf in ICD file</i>	na
925	Presence of i or f attribute - Problem with writing <i>New constructed attribute class "AnalogueValueCtl"</i>	na
926	Presence Conditions within RangeConfig <i>All or none of hhLim+hLim+ILim+ILim shall be present</i>	Y
954	Data attributes with FC=CF should have trgOp=dchg <i>Some INS and HST and CSG attributes missing dchg</i>	Y
1078	CMV.t update if rangeAng changed <i>Add rangeAng to "reasons-to-update-timestamp-of-CMV"</i>	na
1565	db = 0 behaviour <i>db=0 not longer suppresses reporting</i>	na
1578	dataAttribute NameSpace content <i>Attributes with FC=EX must be initialized in ICD/IID file</i>	Y
Part 7-4		
671	mistake in definition of Mod & Beh <i>Beh=on, q=test should be "Processed as valid"</i>	Y
674	CDC of ZRRCLocSta is wrong <i>ZRRCLocSta should be CDC=SPC</i>	na
676	Same data object name used with different CDC <i>LCCH.Fer renamed to FerCh, LCCH.RedFer to RedFerCh</i>	na

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
677	MotStr is used with different CDC in PMMS and SOPM LN classes <i>Rename SOPM.MotStr to MotStrNum</i>	na
679	Remove CycTrMod Enum <i>Enum is no longer used, use TrMod instead</i>	na
680	SI unit for MHYD.Cndct <i>Change unit from S/cm² to S/m</i>	na
681	Enum PIDAlg <i>Typographical error, invalid XML syntax</i>	na
682	ANCR.ParColMod <i>ParColMod enum values text have changed</i>	na
683	Enum QVVR.IntrDetMth <i>IntrDetMth enum values text have changed</i>	na
685	Enum ParTraMod <i>ParTraMod enum values text have changed</i>	na
686	New annex H - enums types in XML <i>Many changes have been made to enumeration names</i>	Y
694	Data object CmdBlk CmdBlk semantics have changed	na
696	LSVS.St (Status of subscription) LSVS.St is now mandatory	Y
712	interpretation of quality operatorBlocked Mode and Behavior semantics have changed	na
713	DO Naming of time constants in FFIL Many DO names in FFIL have changed	na
714	Enums for ShOpCap and SwOpCap Type for YPSH.ShOpCap and XSWI.SwOpCap have changed	na
715	RBDR.ChNum1 RBDR.ChNum1 changes from optional to conditional	na
716	TAXD text for condition TAXD.SmRte condition for inclusion has changed	na
724	ANCR.Auto ANCR.Auto changes from mandatory to optional	na
725	Loc in LN A-group <i>Loc changes to optional, LocKey/LocSta conditions change</i>	na
734	LLN0.OpTmh vs. LPHD.OpTmh <i>LLN0.OpTmh deleted, LPHD.OpTmh added as conditional</i>	na
736	PFSign <i>MMXU.PFSign enum is extended with 3=Excitation</i>	na

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
742	GAPC.Str, GAPC.Op and GAPC.StrVal <i>Objects have instance indicator removed (ex, Str1 to Str)</i>	na
743	CCGR.PmpCtl and CCGR.FanCtl <i>Object have instance indicator added (ex:PmpCtl to PmpCtl1)</i>	na
744	LN STMP, EEHealth and EENAME <i>Removed STMP.EEHealth and STMP.EENAME</i>	na
772	LPHD.PwrUp/PwrDn should be transient <i>These objects are now transient</i>	na
773	Loc, LocKey and LocSta YPSH and YLTC <i>Add Loc, LocKey and LocSta in YLTC and YPSH (optional)</i>	na
774	ITCI.LocKey <i>Add ITCI.LocKey as optional</i>	na
776	LPHD.OutOv/InOv and LCCH.OutOv/InOv <i>Clarified: stays true until buffer space again available</i>	na
800	Misspelling in CSYN <i>CSYN.VInvTmms renamed to CSYN.VIntvTmms</i>	na
802	CCGR and Harmonized control authority <i>Add Loc, LockSta to every controllable LN (e.g. FSPT)</i>	na
808	Presence condition of ZMoT.DExt and new DOs <i>Change ZMOT.DExt to optional; add TotThmSt and MotSt</i>	na
831	Setting of ConfRevNum in LGOS <i>Add RxConfRevNum to LGOS and LSVS</i>	Y
838	Testing in Beh=Blocked <i>Change sematic of Beh=Blocked to allow controls to be acknowledged even when LN is blocked.</i>	na
844	MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE <i>Change these NFLK objects from cdc=DEL to cdc=WYE</i>	na
877	QVUB -settings should be optional <i>Change QVUB.UnbDetMth and QVUB.StrVal to optional</i>	na
908	ARIS.StrSeq – transient <i>Change ARIS.StrSeq to transient</i>	na
909	Remove ANCR.ColOpR and ColOpL <i>Replace ANCR.ColOpR and ANCR.ColOpL with ANCR.ColChg. Add YEFN.ColChg</i>	na
912	Clarification of PwrRtg/VARtg <i>Change many DOs in YPTR, and ZGEN, see name space 2007A2.nsd for final result</i>	na
920	Resetable Counter is NOT resetable <i>Change GGIO.CntRs to CntVal; Same for FCNT</i>	na
932	Rename AVCO.SptVol to AVCO.VolSpt	na
933	Presence of LCCH.RedFerCh and RedRxCnt <i>Change the presence condition of LCCH.RedChLiv</i>	na

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
939	Change CDC for ANCR.FixCol <i>Change ANCR.FixCol from APC to ASG</i>	na
991	LGOS: GoCBRef (as well as LSVS.SvCBRef) should be mandatory <i>LGOS.GoCBRef and LSVS.SvCBRef are now both mandatory</i>	Y
1007	PTRC as fault indicator - Update of description required <i>PTRC.Tr and Op and Str conditional (at least 1 of group)</i>	na
1044	TapChg in AVCO <i>AVCO.TapChg is now optional</i>	na
1077	Rename DOnames within LTIM <i>LTIM.TmChgDayTm, changed to TmChgDay; LTIM.TmChgStdTm changed to TmChgStd</i>	na
1256	New DO for LTIM to set time "manually" <i>Add LTIM.TmSet</i>	na
1331	Mod, Beh and Health with q=TEST, client can't receive their states <i>Mod while in Blocked will always be processed</i>	Y
1426	Add two DO for leap seconds in LTIM <i>LTIM.Leap added,</i>	na
1456	Annex A and Mod/Beh/Health <i>Mod.stVal writes always ignore test bits in controls</i>	Y
1568	ISAF.AlmReset ->transient <i>Change ISAF.AmIReset to transient</i>	na
Note: TISSUE 675, 735, 772, 775, 776, 878 are not relevant for conformance testing		
Part 8-1		
770	GOLD type mismatch 18.1.1 and 18.1.2.5.2 <i>GOLD string length is now 129</i>	Y
784	Tracking of control (CTS) <i>Tracking CTS has been added</i>	na
817	Fixed-length GOOSE float encoding <i>GOOSE float is encoded Tag-0x87, length=5, first octet=8</i>	na
827	Mandatory ACSI services (Part of 7-2 TISSUE resolution) <i>Change Table 111 (ServicesSupported): Add initiate, abort, and release. Change conditions for defineNamedVariables.</i>	Y
834	File dir name length 64 <i>Filename length changed from 32 to 64</i>	Y
951	Encoding of Owner attribute <i>xRCB.owner is encoded as 4 octets(IPv4) or 16 octets(IPv6)</i>	na
1040	More associate error codes <i>3 additional associate error codes added</i>	Y
1178	Select Response+ is non-null value <i>Response to SBO read should be <CO_CtrlObjectRef></i>	na

Table L.5: Mandatory Edition 2 Tissues		
Tissue	Description	Implemented Y/na
1324	The response- for DeleteNamedVariableList is not defined <i>numDeleted=0; error=service/object-constraint-conflict</i>	na
1345	Fixed-length GOOSE ASN.1 length encoding <i>GOOSE publisher shall always encode minimum size length field</i>	na
1441	Optional fields in buffered reports <i>Writing BRCB.optFld shall not cause a purgeBuf operation</i>	Y
1442	Journal variableTag for ReasonCode <i>Example in the standard is incorrect</i>	na
1453	Purge buffer on write to BRCB <i>PurgeBuf only occurs if different value is written</i>	Y
1454	Reports can be transmitted before write(RptEna=true) is confirmed	na
1495	GetVariableAccessAttributes error code Return MMS error access/object-non-existent if the object does not exist	Y
1500	the response for DeleteNamedVariableList with a non-existent LN is not specified <i>CreateDataSet/DefineNamedVariableList specifying a non-existing LD/LN shall fail with access/object-non-existent</i>	na
1626	PICS for Information Report is incorrect MMS ServicesSupported "informationReport" should be optional for servers because they never receive InformationReport requests. It is only required for clients which process reports or control command-termination	Y

L.4 Protocol Implementation eXtra Information for Testing (PIXIT)

Protocol Implementation eXtra Information for Testing (PIXIT) for the IEC 61850

Edition 2 server interface in

F-PRO 4500

Document Version¹: D05834R00.00

Date: 2024-08-05

Based Upon UCAIug Server PIXIT
Template version 20

1. The formatting of the official version of this document differs slightly from the version shown here in the user manual, but the content is the same.

PIXIT for Server

Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in F-PRO 4500 with firmware version v1.00.

Together with the PICS and the MICS the PIXIT forms the basis for a conformance test according to IEC 61850-10. The PIXIT entries contain information which is not available in the PICS, MICS, TICS documents or SCL file.

Each table specifies the PIXIT for applicable ACSI service model as structured in IEC 61850-10. The “Ed” column indicates if the entry is applicable for IEC 61850 Edition 1 and/or Edition 2. A hyphen (“-”) in the Ed column indicates the PIXIT entry is not applicable for any version.

PIXIT for DOCUMENTATION

ID	Ed	Description	Value / Clarification
Do1	2	How to expose required firmware versions not present in the datamodel	Firmware version and ICD file compatibility listed in the firmware release notes.
		<additional items>	

PIXIT for ASSOCIATION MODEL

ID	Ed	Description	Value / Clarification
As1	1	Maximum number of clients that can set-up an association simultaneously	4
As2	1,2	TCP_KEEPALIVE value. The recommended range is 1...20s	10 seconds
As3	1,2	Lost connection detection time	20 seconds
As4	-	Authentication is not supported yet	
As5	1,2	What association parameters are necessary for successful association: Called value: Calling values:	Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N other Transport selector Y Session selector Y Presentation selector Y AP Title N AE Qualifier N other
As6	1,2	If association parameters are necessary for association, describe the correct Called values: e.g. Calling parameters: e.g.	Transport selector 0001 Session selector 0001 Presentation selector 00000001 other Transport selector 0001 Session selector 0001 Presentation selector 00000001 other
As7	1,2	What is the maximum and minimum MMS PDU size	Max MMS PDU size 32,000 Min MMS PDU size 1300
As8	1,2	What is the maximum start up time after a power supply interrupt	75 seconds
As9	1,2	Does this device function only as test equipment? (test equipment need not have a non-volatile configuration; but it cannot be part of the sub station automation system)	N
		<additional items>	

PIXIT for SERVER MODEL

ID	Ed	Description	Value / Clarification
Sr1	1,2	Which analogue value (MX) quality bits are supported (can be set by server)	Validity: YGood, N Invalid, N Reserved, N Questionable Detail Quality N Overflow N OutofRange N BadReference N Oscillatory N Failure N OldData N Inconsistent N Inaccurate Miscellaneous: YSource Y Test N OperatorBlocked
Sr2	1,2	Which status value (ST) quality bits are supported (can be set by server)	Validity: YGood, N Invalid, N Reserved, N Questionable Detail Quality N Overflow N OutofRange N BadReference N Oscillatory N Failure N OldData N Inconsistent N Inaccurate Miscellaneous: YSource Y Test N OperatorBlocked
Sr3	-	What is the maximum number of data object references in one Get-DataValues request	Deprecated
Sr4	-	What is the maximum number of data object references in one Set-DataValues request	Deprecated

ID	Ed	Description	Value / Clarification
Sr5	1	Which Mode values are supported ^a	On Y [On-]Blocked N Test Y Test/Blocked Y Off N
		<additional items>	

- a. IEC 61850-6:2009 clause 9.5.6 states that if only a subrange of the enumeration value set is supported, this shall be indicated within an ICD file by an enumeration type, where the unsupported values are missing

PIXIT for DATA SET MODEL

ID	Ed	Description	Value / Clarification
Ds1	1	What is the maximum number of data elements in one data set (compare ICD setting)	60
Ds2	1	How many persistent data sets can be created by one or more clients (this number includes predefined data-sets)	CreateDataSet not supported.
Ds3	1	How many non-persistent data sets can be created by one or more clients	CreateDataSet not supported.
		<additional items>	

PIXIT for SUBSTITUTION MODEL

ID	Ed	Description	Value / Clarification
Sb1	1	Are substituted values stored in volatile memory	Not Supported
		<additional items>	

PIXIT for SETTING GROUP CONTROL MODEL

ID	Ed	Description	Value / Clarification
Sg1	1	What is the number of supported setting groups for each logical device	Not Supported
Sg2	1,2	What is the effect of when and how the non-volatile storage is updated (compare IEC 61850-8-1 §16.2.4)	Not Supported

ID	Ed	Description	Value / Clarification
Sg3	1	Can multiple clients edit the same setting group	Not Supported
Sg4	1	What happens if the association is lost while editing a setting group	Not Supported
Sg5	1	Is EditSG value 0 allowed	Not Supported
Sg6	2	When ResvTms is not present how long is an edit setting group locked	Not Supported
		<additional items>	

PIXIT for REPORTING MODEL

ID	Ed	Description	Value / Clarification																		
Rp1	1	The supported trigger conditions are (compare PICS)	<table><tr><td>integrity</td><td>Y</td></tr><tr><td>data change</td><td>Y</td></tr><tr><td>quality change</td><td>Y</td></tr><tr><td>data update</td><td>Y</td></tr><tr><td>general interrogation</td><td>Y</td></tr></table> *Trigger option Data Update (dupd) is supported by the IED. However data model doesn't contain any CDC DA with trigger dupd=true. Therefore, such an event will not be possible to generate.	integrity	Y	data change	Y	quality change	Y	data update	Y	general interrogation	Y								
integrity	Y																				
data change	Y																				
quality change	Y																				
data update	Y																				
general interrogation	Y																				
Rp2	1	The supported optional fields are	<table><tr><td>sequence-number</td><td>Y</td></tr><tr><td>report-time-stamp</td><td>Y</td></tr><tr><td>reason-for-inclusion</td><td>Y</td></tr><tr><td>data-set-name</td><td>Y</td></tr><tr><td>data-reference</td><td>Y</td></tr><tr><td>buffer-overflow</td><td>Y</td></tr><tr><td>entryID</td><td>Y</td></tr><tr><td>conf-rev</td><td>Y</td></tr><tr><td>segmentation</td><td>Y</td></tr></table>	sequence-number	Y	report-time-stamp	Y	reason-for-inclusion	Y	data-set-name	Y	data-reference	Y	buffer-overflow	Y	entryID	Y	conf-rev	Y	segmentation	Y
sequence-number	Y																				
report-time-stamp	Y																				
reason-for-inclusion	Y																				
data-set-name	Y																				
data-reference	Y																				
buffer-overflow	Y																				
entryID	Y																				
conf-rev	Y																				
segmentation	Y																				
Rp3	1,2	Can the server send segmented reports (when not supported the device shall refuse an association request with a smaller than minimum PDU size)	Y																		
Rp4	1,2	Mechanism on second internal data change notification of the same analogue data value within buffer period (Compare IEC 61850-7-2 §17.2.2.9)	Send report immediately																		

ID	Ed	Description	Value / Clarification
Rp5	1	Multi client URCB approach (compare IEC 61850-7-2:2003 §14.2.1)	Each URCB is visible to all clients
Rp6	-	What is the format of EntryID	Deprecated
Rp7	1,2	What is the buffer size for each BRCB or how many reports can be buffered	Buffer size is 50,000 bytes for each BRCB
Rp8	-	Pre-configured RCB attributes that are dynamic, compare SCL report settings	Deprecated
Rp9	1	May the reported data set contain: - structured data objects - data attributes	Y Y
Rp10	1,2	What is the scan cycle for binary events. Is this fixed, configurable?	3 ms Fixed
Rp11	1	Does the device support to pre-assign a RCB to a specific client in the SCL	N
Rp12	2	After restart of the server is the value of ConfRev restored from the original configuration or retained prior to restart	Restored from original configuration
Rp13	1,2	Does the server accept any client to configure / enable a BRCB with ResvTms=-1? What fields are used to do the identification?	N
Rp14	1,2	When BRCB.ResvTms is exposed, what is the default value for BRCB.ResvTms if client does not write (must be > 0) When BRCB.ResvTms is not exposed, what is the internal reservation time (must be >= 0)	N/A 0 seconds
Rp15	2	Is data model db=0 supported	Y
		<additional items>	

PIXIT for LOGGING MODEL

ID	Ed	Description	Value / Clarification
Lg1	1,2	What is the default value of LogEna (Compare IEC 61850-8-1 §17.3.3.2.1, the default value should be FALSE)	Not Supported
Lg2	-	What is the format of EntryID	Deprecated
Lg3	1,2	Are there multiple Log Control Blocks that specify the Journaling of the same MMS NamedVariable and TrgOps and the Event Condition (Compare IEC 61850-8-1 §17.3.3.3.2)	Not Supported
Lg4	-	Pre-configured LCB attributes that cannot be changed online	Deprecated, the informa- tion is already available in SCL
Lg5	1	Which TrgOps are supported for log- ging (note Ed2 and up requires support for all TrgOps)	Not Supported
		<additional items>	

PIXIT for GOOSE PUBLISH MODEL

ID	Ed	Description	Value / Clarification
Gp1	1,2	Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set	N
Gp2	1	What is the behaviour when the GOOSE publish configuration is incorrect	NdsCom=T DUT keeps GoEna=F
Gp3	1,2	Published FCD supported common data classes are	SPS, ENS, ACD, LPL, DPS, ACT, INS, ORG, SPC Arrays are not supported
Gp4	1,2	What is the maximum value of TAL (maxTime) Is it fixed or configurable	Configured by ICT MaxTime 120,000ms
Gp5	1,2	What is the fastest retransmission time	2 ms
Gp6	-	Can the GOOSE publish be turned on / off by using SetGoCBValues(GoEna)	Deprecated See PICS - SetGoCBValues
Gp7	1,2	What is the initial GOOSE sqNum after restart	sqNum = 0
Gp8	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	Y Y
Gp9	1,2	Does Server or ICT refuse GOOSE payload dataset length greater than SCSM supports?	Y – ICT refuses
		<additional items>	

PIXIT for GOOSE SUBSCRIBE MODEL

ID	Ed	Description	Value / Clarification
Gs1	1,2	What elements of a subscribed GOOSE message are checked to decide the message is valid and the all-Data values are accepted? If yes, describe the conditions. Notes: - the VLAN tag may be removed by an Ethernet switch and shall not be checked - the simulation flag shall always be checked (Ed2)	Y destination MAC address Y APPID Y gocbRef Y timeAllowedtoLive N dataSet N gold N T Y stNum N sqNum Y simulation / test N confRev Y ndsCom Y numDataSetEntries Y out-of-order dataset members
Gs2	1,2	When is a subscribed GOOSE marked as lost (TAL = time allowed to live value from the last received GOOSE message)	message does not arrive by 2x TAL
Gs3	1,2	What is the behaviour when one or more subscribed GOOSE messages is not received or syntactically incorrect (missing GOOSE)	Syntactically incorrect messages (incorrect stNum increment) received within the TAL are discarded, message will be processed after TAL expires and syntactically correct message is not received
Gs4	1,2	What is the behaviour when a subscribed GOOSE message is out-of-order	Older messages are discarded
Gs5	1,2	What is the behaviour when a subscribed GOOSE message is duplicated	First message will process and second message will discard.
Gs6	1	Does the device subscribe to GOOSE messages with/without the VLAN tag	Y, with the VLAN tag Y, without the VLAN tag
Gs7	1	May the GOOSE data set contain: - structured data objects (FCD) - timestamp data attributes	Y Y
Gs8	1,2	Subscribed FCD supported common data classes are	SPS, ACD, ACT, SPC Arrays are not supported
Gs9	1,2	Are subscribed GOOSE with test=T (Ed1) / simulation=T (Ed2) accepted in test/simulation mode	Y
Gs10	1,2	Max number of dataset members	Fixed at 60

ID	Ed	Description	Value / Clarification
Gs11	1	Is Fixed-length encoded GOOSE supported	Y
Gs12	2	Is IEC 62351-6 security supported	N
		<additional items>	

PIXIT for GOOSE PERFORMANCE

ID	Ed	Description	Value / Clarification	
Gf1	1,2	Performance class	P2 = 10 ms P3 = 20 ms	
Gf2	1,2	GOOSE ping-pong processing method	Scan cycle based	
Gf3	1,2	Application logic scan cycle (ms)	Max.	4ms (GOOSE PUB) 100us (GOOSE SUBS)
			Min.	100us (GOOSE PUB) 100us (GOOSE SUBS)
Gf4	1	Maximum number of data attributes in GOOSE dataset (value and quality has to be counted as separate attributes)	Such that dataset does not exceed GOOSE: 1000 Bytes	
		<additional items>		

PIXIT for CONTROL MODEL

ID	Ed	Description	Value / Clarification
Ct1	1	What control models are supported (compare ICD file enums for Ed2)	Dons: Y SBOs: N DOes: N SBOes: N
Ct2	1,2	Is the control model fixed, configurable and/or dynamic	Fixed
Ct3	-	Is TimeActivatedOperate supported (compare PICS or SCL)	Deprecated
Ct4	-	Is "operate-many" supported (compare sboClass)	Deprecated, see sboClass in datamodel (ICD)

ID	Ed	Description	Value / Clarification
Ct5	1	Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ct12 is applicable)	N
Ct6	-	What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request	Deprecated
Ct7	-	Is pulse configuration supported (compare pulseConfig)	Deprecated
Ct8	1	What is the behaviour of the DUT when the check conditions are set Is this behaviour fixed, configurable, online changeable	Check conditions are not checked.

ID	Ed	Description	Value / Clarification
Ct9	1,2	Which additional cause diagnosis are supported	N Unknown N Not-supported N Blocked-by-switching-hierarchy N Select-failed N Invalid-position N Position-reached N Step-limit N Blocked-by-Mode N Blocked-by-process N Blocked-by-interlocking N Blocked-by-synchro-check N Command-already-in-execution N Blocked-by-health N 1-of-n-control N Abortion-by-cancel N Time-limit-over N Abortion-by-trip N Object-not-selected Edition 1 specific values: N Parameter-change-in-execution (Ed1 semantics) Edition 2 specific values: N Object-already-selected N No-access-authority N Ended-with-overshoot N Abortion-due-to-deviation N Abortion-by-communication-loss N Blocked-by-command N None N Locked-by-other-client N Parameter-change-in-execution (Ed2 semantics)
Ct10	1,2	How to force a “test-not-ok” respond with SelectWithValue request	Not Supported
Ct11	1,2	How to force a “test-not-ok” respond with Select request	Not Supported
Ct12	1,2	How to force a “test-not-ok” respond with Operate request	Not supported

ID	Ed	Description	Value / Clarification
Ct13	1,2	Which origin categories are supported / accepted	Y bay-control Y station-control Y emote-control Y automatic-bay Y automatic-station Y automatic-remote Y maintenance Y process
Ct14	1,2	What happens if the orCat value is not supported or invalid	DOns: Operate response-
Ct15	1,2	Does the IED accept a SelectWith-Value / Operate with the same control value as the current status value Is this behaviour configurable	DOns: N Configurable N
Ct16	1	Does the IED accept a select/operate on the same control object from 2 different clients at the same time	DOns: N
Ct17	1	Does the IED accept a Select/SelectWithValue from the same client when the control object is already selected (Tissue #334)	Not Supported
Ct18	1	Deprecated	
Ct19	-	Can a control operation be blocked by Mod=Off or [On-]Blocked (Compare PIXIT-Sr5)	Deprecated
Ct20	1,2	Does the IED support local / remote operation	N
Ct21	1,2	Does the IED send an InformationReport with LastApplError as part of the Operate response- for control with normal security	DOns: N
Ct22	2	How to force a “parameter-change-in-execution”	Not Supported
Ct23	1,2	How many SBOs/SBOes control objects can be selected at the same time?	Not Supported
Ct24	1,2	Can a controllable object be forced to keep its old state e.g., Internal Controllable Objects may not be accessible to force this, whereas a switch like Circuit Breaker outside the DUT can?	N
Ct25	1,2	When CDC=DPC is supported, is it possible to have DPC (Controllable Double Point) go to the intermediate state? (00)	N/A

ID	Ed	Description	Value / Clarification
Ct26	1,2	Name an enhanced security point (if any) with a finite operate timeout specify the timeout (in milliseconds)	Ld/Ln.DataObject, xxx or No DOes points have timeout DOes: No SBOes: No
Ct27	2	Does the IED support control objects with external signals?	DOns: N SBOns: N DOes: N SBOes: N
Ct28		Deprecated, kept as placeholder	
		<additional items>	

PIXIT for TIME SYNCHRONIZATION MODEL

ID	Ed	Description	Value / Clarification
Tm1	1	What time quality bits are supported (may be set by the IED)	Y LeapSecondsKnown Y ClockFailure Y ClockNotSynchronized
Tm2	1,2	Describe the behaviour when all time server(s) cease to respond What is the time server lost detection time	IRIG – next second SNTP – Configurable “Poll Interval” + 5*“Timeout Interval”
Tm3	1,2	How long does it take to take over the new time from time server	From ‘no sync’ to ‘SNTP sync’: it takes approximately 1 second. For the same SNTP time master time adjustment: it takes “Poll Interval” + “Timeout Interval” to get the new time from the same time server
Tm4	1,2	When is the time quality bit “Clock-Failure” set	Bit is set, when no IRIG-B or SNTP is detected
Tm5	1	When is the time quality bit “Clock not Synchronized” set	Bit is set, when No IRIG-B, SNTP is detected Unlocked IRIG-B is detected
Tm6	-	Is the timestamp of a binary event adjusted to the configured scan cycle	Deprecated
Tm7	1	Does the device support time zone and daylight saving	Y

ID	Ed	Description	Value / Clarification
Tm8	1,2	Which attributes of the SNTP response packet are validated	N Leap indicator not equal to 3 Y Mode is equal to SERVER Y OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp Y RX/TX timestamp fields are checked for reasonableness Y SNTP version 3 and/or 4 N other (describe)
Tm9	1,2	Do the COMTRADE files have local time or UTC time and is this configurable	COMTRADE files are not supported on the IED. Native Records may be converted to COMTRADE via software tools. It is configurable to display either Local or UTC time.
		<additional items>	

PIXIT for FILE TRANSFER MODEL

ID	Ed	Description	Value / Clarification
Ft1	1	What is the structure of files and directories Where are the COMTRADE files stored Are COMTRADE files zipped and what files are included in each zip file	Flat file system with pseudo folders (Ed2) COMTRADE files are not stored on the IED
Ft2	1,2	Directory names are separated from the file name by	“/”
Ft3	1	The maximum file name size including path (recommended 64 chars)	64 chars
Ft4	1,2	Are directory/file name case sensitive	Y
Ft5	1,2	Maximum file size for SetFile	SetFile Not Supported
Ft6	1	Is the requested file path included in the MMS fileDirectory respond file name	Y But client is not allowed to use any path names that contain anything other than “/” In that case Server will return response with zero files. (Ed2: always complete path)
Ft7	1	Is the wild card supported in the MMS fileDirectory request	Yes, wild card = *

ID	Ed	Description	Value / Clarification
Ft8	1,2	Is it allowed that 2 clients get a file at the same time	Y same file Y different files
Ft9	1,2	Which files can be deleted	No restriction for deleting files
		<additional items>	

PIXIT for SERVICE TRACKING MODEL

ID	Ed	Description	Value / Clarification
Tr 1	2	Which ACSI services are tracked by LTRK.GenTrk	Not Supported

L.5 Data Mapping Specifications

F-PRO Logical Device

The F-PRO 4500 has the following IEC 61850 logical devices defined in its ICD file

- Measurements
- Fault Data
- Protection
- System
- Subscription
- Records
- SYS
- Control

F-PRO Logical Node Summary

Table L.6: F-PRO Logical Nodes on page 39 F-PRO Logical Nodes defines the list of logical nodes (LN) for the F-PRO logical devices.
Note: System logical nodes (group L) are not shown here

Table L.6: F-PRO Logical Nodes				
LD Name	LN Instance Name	LN Description	Protection Function	Comments
Measurements	MainMMXU1	Measurement		Main channel metering data: • Phase Voltages (P-P) • Phase Voltages (P-N) • Phase Currents • Frequency (Hz) • Total Active Power P (W) • Total reactive Power Q (VAr) • Total Apparent Power (VA) • Total PF • Phase Wise Active Power • Phase Wise reactive Power • Phase Wise apparent Power • Phase Wise Power Factor
Measurements	AuxMMXU2	Measurement		Auxiliary Phase voltage
Measurements	MainGMMXU3	Measurement		Main IG current
Measurements	SEFMMXU4	Measurements		Main ISEF current
Measurements	MainMSQI1	Measurements		Seq. Current & Voltage

Measurements	MVHzMMXU1	Measurements		Volts per Hz
Measurements	MTHDMHAN1	Measurements		% THD Voltage
Measurements	M79MTHR1	Measurements		A/R Count & Cumulative Counter
LD → Measurement				
FaultData	D27MDTMMXU1	Measurement	D27M-1	Main DT Undervoltage Stage-1
FaultData	D27MDTMMXU2	Measurement	D27M-2	Main DT Undervoltage Stage-2
FaultData	D27MDTMMXU3	Measurement	D27M-3	Main DT Undervoltage Stage-3
FaultData	D27MDTMMXU4	Measurement	D27M-4	Main DT Undervoltage Stage-4
FaultData	D27ADTMMXU1	Measurements	D27A-1	Aux DT Undervoltage Stage-1
FaultData	D27ADTMMXU2	Measurements	D27A-2	Aux DT Undervoltage Stage-2
FaultData	D27ADTMMXU3	Measurements	D27A-3	Aux DT Undervoltage Stage-3
FaultData	D27ADTMMXU4	Measurements	D27A-4	Aux DT Undervoltage Stage-4
FaultData	D59MDTMMXU1	Measurement	D59M-1	Main DT Overvoltage Stage-1
FaultData	D59MDTMMXU2	Measurement	D59M-2	Main DT Overvoltage Stage-2
FaultData	D59MDTMMXU3	Measurements	D59M-3	Main DT Overvoltage Stage-3
FaultData	D59MDTMMXU4	Measurements	D59M-4	Main DT Overvoltage Stage-4
FaultData	D59ADTMMXU1	Measurements	D59A-1	Aux DT Overvoltage Stage-1
FaultData	D59ADTMMXU2	Measurements	D59A-2	Aux DT Overvoltage Stage-2
FaultData	D59ADTMMXU3	Measurement	D59A-3	Aux DT Overvoltage Stage-3
FaultData	D59ADTMMXU4	Measurement	D59A-4	Aux DT Overvoltage Stage-4
FaultData	D27ITMMXU1	Measurements	D27IT-1	Main Inverse Undervoltage Stage-1
FaultData	D27ITMMXU2	Measurements	D27IT-2	Main Inverse Undervoltage Stage-2
FaultData	D59ITMMXU1	Measurements	D59IT-1	Main Inverse Overvoltage Stage-1
FaultData	D59ITMMXU2	Measurements	D59IT-2	Main Inverse Overvoltage Stage-2
FaultData	D24DTMMXU1	Measurement	D24-1	DT Overflux Stage-1
FaultData	D24DTMMXU2	Measurement	D24-2	DT Overflux Stage-2
FaultData	D24ITMMXU1	Measurements	D24IT-1	Inverse Overflux Stage-1
FaultData	D24MTHR1	Measurements	D24	Overflux metering
FaultData	D47DTMMXU1	Measurements	D47DT-1	DT Neg. Seq. Overvoltage Stage-1

FaultData	D47DTMSQI1	Measurements	D47DT-1	DT Neg. Seq. Overvoltage Stage-1 (Seq & Imbalance)
FaultData	D47DTMMXU2	Measurement	D47DT-2	DT Neg. Seq. Overvoltage Stage-2
FaultData	D47DTMSQI2	Measurement	D47DT-2	DT Neg. Seq. Overvoltage Stage-2 (Seq & Imbalance)
FaultData	D47ITMMXU1	Measurements	D47IT	Inverse Neg. Seq. Overvoltage
FaultData	D47ITMSQI1	Measurements	D47IT	Inverse Neg. Seq. Overvoltage (Seq & Imbalance)
FaultData	D59NDTMMXU1	Measurements	D59N-1	DT Zero. Seq. Overvoltage Stage-1
FaultData	D59NDTMSQI1	Measurements	D59N-1	DT Zero. Seq. Overvoltage Stage-1 (Seq & Imbalance)
FaultData	D59NDTMMXU2	Measurement	D59N-2	DT Zero. Seq. Overvoltage Stage-2
FaultData	D59NDTMSQI2	Measurement	D59N-2	DT Zero. Seq. Overvoltage Stage-2 (Seq & Imbalance)
FaultData	D59NITMMXU1	Measurements	D59N-1	Inverse Zero. Seq. Overvoltage
FaultData	D59NITMSQI1	Measurements	D59N-1	Inverse Zero. Seq. Overvoltage (Seq & Imbalance)
FaultData	D37MMXU1	Measurements	D37-1	DT Undercurrent Stage-1
FaultData	D37MMXU2	Measurements	D37-2	DT Undercurrent Stage-2
FaultData	D50RFLO1	Measurement	D5067-1	Instantaneous Overcurrent Stage-1 (Fault location Z, km)
FaultData	D50MMXU1	Measurement	D5067-1	Instantaneous Overcurrent Stage-1
FaultData	D50RFLO2	Measurements	D5067-2	Instantaneous Overcurrent Stage-2 (Fault location Z, km)
FaultData	D50MMXU2	Measurements	D5067-2	Instantaneous Overcurrent Stage-2
FaultData	D51RFLO1	Measurements	D5167-1	Time Phase Overcurrent Stage-1 (Fault location Z, km)
FaultData	D51MMXU1	Measurements	D5167-1	Time Phase Overcurrent Stage-1
FaultData	D51RFLO2	Measurement	D5167-2	Time Phase Overcurrent Stage-2 (Fault location Z, km)
FaultData	D51MMXU2	Measurement	D5167-2	Time Phase Overcurrent Stage-2
FaultData	D50NRFLO1	Measurements	D50N-1	Instantaneous Derived Neutral Overcurrent Stage-1 (Fault location Z, km)
FaultData	D50NMMXU1	Measurements	D50N-1	Instantaneous Derived Neutral Overcurrent Stage-1
FaultData	D50NRFLO2	Measurements	D50N-2	Instantaneous Derived Neutral Overcurrent Stage-2 (Fault location Z, km)
FaultData	D50NMMXU2	Measurements	D50N-2	Instantaneous Derived Neutral Overcurrent Stage-2
FaultData	D51NRFLO1	Measurement	D51N-1	Time Derived Neutral Overcurrent Stage-1 (Fault location Z, km)
FaultData	D51NMMXU1	Measurement	D51N-1	Time Derived Neutral Overcurrent Stage-1

FaultData	D51NRFLO2	Measurements	D51N-2	Time Derived Neutral Overcurrent Stage-2 (Fault location Z, km)
FaultData	D51NMMXU2	Measurements	D51N-2	Time Derived Neutral Overcurrent Stage-2
FaultData	D50GRFLO1	Measurements	D50G-1	Instantaneous Measured Neutral Overcurrent Stage-1 (Fault location Z, km)
FaultData	D50GMMXU1	Measurements	D50G-1	Instantaneous Measured Neutral Overcurrent Stage-1
FaultData	D50GRFLO2	Measurement	D50G-2	Instantaneous Measured Neutral Overcurrent Stage-2 (Fault location Z, km)
FaultData	D50GMMXU2	Measurement	D50G-2	Instantaneous Measured Neutral Overcurrent Stage-2
FaultData	D51GRFLO1	Measurements	D51G-1	Time Measured Neutral Overcurrent Stage-1 (Fault location Z, km)
FaultData	D51GMMXU1	Measurements	D51G-1	Time Measured Neutral Overcurrent Stage-1
FaultData	D51GRFLO2	Measurements	D51G-2	Time Measured Neutral Overcurrent Stage-2 (Fault location Z, km)
FaultData	D51GMMXU2	Measurements	D51G-2	Time Measured Neutral Overcurrent Stage-2
FaultData	D4650MSQI1	Measurement	D4650	Instantaneous Neg. Seq. Overcurrent (Seq & Imbalance)
FaultData	D4651MSQI1	Measurement	D4651	Time Neg. Seq. Overcurrent (Seq & Imbalance)
FaultData	D6450MMXU1	Measurements	D6450-1	Instantaneous Sensitive/Restricted Earthfault Stage-1
FaultData	D6450MMXU2	Measurements	D6450-2	Instantaneous Sensitive/Restricted Earthfault Stage-2
FaultData	D6451MMXU1	Measurements	D6451-1	Time Sensitive Earthfault Stage-1
FaultData	D6451MMXU2	Measurements	D6451-2	Time Sensitive Earthfault Stage-2
FaultData	D49MMXU1	Measurement	D49	Thermal Overload
FaultData	D49MSQI1	Measurement	D49	Thermal Overload (Seq & Imbalance)
FaultData	D50BFMMXU1	Measurements	D50BF-1	Breaker Failure Re-Trip
FaultData	D50BFMMXU2	Measurements	D50BF-2	Breaker Failure Back-Trip
FaultData	D50LSMMXU1	Measurements	D50LS	Instantaneous Low Set Overcurrent
FaultData	D46BCMMXU1	Measurements	D46BC	Broken Conductor
FaultData	D46BCMSQI1	Measurement	D46BC	Broken Conductor (Seq & Imbalance)
FaultData	D81MMXU1	Measurement	D81-1	Frequency Stage-1
FaultData	D81MMXU2	Measurements	D81-2	Frequency Stage-2
FaultData	D81MMXU3	Measurements	D81-3	Frequency Stage-3
FaultData	D81MMXU4	Measurements	D81-4	Frequency Stage-4

FaultData	D81MMXU5	Measurements	D81-5	Frequency Stage-5
FaultData	D81MMXU6	Measurement	D81-6	Frequency Stage-6
FaultData	D81MMXU7	Measurement	D81-7	Frequency Stage-7
FaultData	D81MMXU8	Measurements	D81-8	Frequency Stage-8
FaultData	D81MMXU9	Measurements	D81-9	Frequency Stage-9
FaultData	D81MMXU10	Measurements	D81-10	Frequency Stage-10
FaultData	D32MMXU1	Measurements	D32-1	Dir. Underpower Stage-1
FaultData	D32MMXU2		D32-2	Dir. Underpower Stage-2
FaultData	D32MMXU3	Measurement	D32-3	Dir. Underpower Stage-3
FaultData	D32MMXU4	Measurement	D32-4	Dir. Underpower Stage-4
FaultData	D60LOPMXU1	Measurements	D60LOP	PT Supervision
FaultData	D60LOPMSQ11	Measurements	D60LOP	PT Supervision (Seq & Imbalance)
FaultData	D60CTSMMXU1	Measurements	D60CTS	CT Supervision
FaultData	D60CTSMSQ11	Measurements	D60CTS	CT Supervision (Seq & Imbalance)
LD → Protection				
Protection	D27MDTPTUV1	Under Voltage	D27M-1	Main DT Undervoltage Stage-1
Protection	D27MDTPTUV2	Under Voltage	D27M-2	Main DT Undervoltage Stage-2
Protection	D27MDTPTUV3	Under Voltage	D27M-3	Main DT Undervoltage Stage-3
Protection	D27MDTPTUV4	Under Voltage	D27M-4	Main DT Undervoltage Stage-4
Protection	D27ADTPTUV1	Under Voltage	D27A-1	Aux DT Undervoltage Stage-1
Protection	D27ADTPTUV2	Under Voltage	D27A-2	Aux DT Undervoltage Stage-2
Protection	D27ADTPTUV3	Under Voltage	D27A-3	Aux DT Undervoltage Stage-3
Protection	D27ADTPTUV4	Under Voltage	D27A-4	Aux DT Undervoltage Stage-4
Protection	D59MDTPTOV1	Overvoltage	D59M-1	Main DT Overvoltage Stage-1
Protection	D59MDTPTOV2	Overvoltage	D59M-2	Main DT Overvoltage Stage-2
Protection	D59MDTPTOV3	Overvoltage	D59M-3	Main DT Overvoltage Stage-3
Protection	D59MDTPTOV4	Overvoltage	D59M-4	Main DT Overvoltage Stage-4
Protection	D59ADTPTOV1	Overvoltage	D59A-1	Aux DT Overvoltage Stage-1
Protection	D59ADTPTOV2	Overvoltage	D59A-2	Aux DT Overvoltage Stage-2

Protection	D59ADTPTOV3	Overvoltage	D59A-3	Aux DT Overvoltage Stage-3
Protection	D59ADTPTOV4	Overvoltage	D59A-4	Aux DT Overvoltage Stage-4
Protection	D27ITPTUV1	Under Voltage	D27IT-1	Main Inverse Undervoltage Stage-1
Protection	D27ITPTUV2	Under Voltage	D27IT-2	Main Inverse Undervoltage Stage-2
Protection	D59ITPTOV1	Overvoltage	D59IT-1	Main Inverse Overvoltage Stage-1
Protection	D59ITPTOV2	Overvoltage	D59IT-1	Main Inverse Overvoltage Stage-2
Protection	D24DTPVPH1	Overflux	D24-1	DT Overflux Stage-1
Protection	D24DTPVPH2	Overflux	D24-2	DT Overflux Stage-2
Protection	D24ITPVPH2	Overflux	D24-2	Inverse Overflux
Protection	D47DTPTOV1	Neg Seq Overvoltage	D47-1	DT Neg. Seq. Overvoltage Stage-1
Protection	D47DTPTOV2	Neg Seq Overvoltage	D47-2	DT Neg. Seq. Overvoltage Stage-2
Protection	D47ITPTOV1	Neg Seq Overvoltage	D47IT-1	Inverse Neg. Seq. Overvoltage
Protection	D59NDTPTOV1	Derived Overvoltage	D59NDT-1	DT Zero. Seq. Overvoltage Stage-1
Protection	D59NDTPTOV2	Derived Overvoltage	D59NDT-2	DT Zero. Seq. Overvoltage Stage-2
Protection	D59NITPTOV1	Derived Overvoltage	D59NIT-1	Inverse Zero. Seq. Overvoltage
Protection	D37PTUC1	Under Current	D37-1	DT Undercurrent Stage-1
Protection	D37PTUC2	Under Current	D37-2	DT Undercurrent Stage-2
Protection	D50PIOC1	Over Current	D50-1	Instantaneous Overcurrent Stage-1
Protection	D50PIOC2	Over Current	D50-2	Instantaneous Overcurrent Stage-2
Protection	D51PTOC1	Inverse Overcurrent	D51-1	Time Phase Overcurrent Stage-1
Protection	D51PTOC2	Inverse Overcurrent	D51-2	Time Phase Overcurrent Stage-2
Protection	D50NPIOC1	Derived Neutral Overcurrent	D50N-1	Instantaneous Derived Neutral Overcurrent Stage-1
Protection	D50NPIOC2	Derived Neutral Overcurrent	D50N-2	Instantaneous Derived Neutral Overcurrent Stage-2
Protection	D51NPTOC1	Derived Neutral Overcurrent	D51N-1	Time Derived Neutral Overcurrent Stage-1
Protection	D51NPTOC2	Derived Inverse Neutral Overcurrent	D51N-2	Time Derived Neutral Overcurrent Stage-2
Protection	D50GPIOC1	Measured Neutral overcurrent	D50G-1	Instantaneous Measured Neutral Overcurrent Stage-1

Protection	D50GPIOC2	Measured Neutral overcurrent	D50G-1	Instantaneous Measured Neutral Overcurrent Stage-2
Protection	D51GPTOC1	Measured Inverse Neutral overcurrent	D51G-1	Time Measured Neutral Overcurrent Stage-1
Protection	D51GPTOC2	Measured Inverse Neutral overcurrent	D51G-1	Time Measured Neutral Overcurrent Stage-2
Protection	D4650PIOC1	Negative Seq Overcurrent	D4650	Instantaneous Neg. Seq. Overcurrent
Protection	D4651PTOC1	Inverse Negative Seq Overcurrent	D4651	Time Neg. Seq. Overcurrent
Protection	D6450PSDE-1	Instant SEF/REF	D6450-1	Instantaneous Sensitive/ Restricted Earthfault Stage-1
Protection	D6450PSDE-2	Instant SEF/REF	D6450-2	Instantaneous Sensitive/ Restricted Earthfault Stage-2
Protection	D6451PSDE-1	Inverse SEF	D6451-1	Time Sensitive Earthfault Stage-1
Protection	D6451PSDE-2	Inverse SEF	D6451-2	Time Sensitive Earthfault Stage-2
Protection	D49PTTR1	Thermal Overload	D49	Thermal Overload
Protection	D50BFRBRF1	Breaker Failure	D50BF-1	Breaker Failure Re-trip
Protection	D50BFRBRF2	Breaker Failure	D50BF-2	Breaker Failure Back-trip
Protection	DBFIRBRF1	Breaker Failure	BFI	Breaker Failure Initiation through Breaker Inputs
Protection	D50LSPIOC1	Low Set OC	D50LS	Instantaneous Low Set Overcurrent
Protection	D81HBL2PHAR1	2 nd harmonic	D81HBL2	2nd Harmonic Restraint/Inrush
Protection	D46BCPTOC1	Broken Conductor	D46BC	Broken Conductor
Protection	D81PFRC1	Frequency	D81-1	Rate-of-Change-of-Frequency Stage-1
Protection	D81PFRC2	Frequency	D81-2	Rate-of-Change-of-Frequency Stage-2
Protection	D81PFRC3	Frequency	D81-3	Rate-of-Change-of-Frequency Stage-3
Protection	D81PFRC4	Frequency	D81-4	Rate-of-Change-of-Frequency Stage-4
Protection	D81PFRC5	Frequency	D81-5	Rate-of-Change-of-Frequency Stage-5
Protection	D81PFRC6	Frequency	D81-6	Rate-of-Change-of-Frequency Stage-6
Protection	D81PFRC7	Frequency	D81-7	Rate-of-Change-of-Frequency Stage-7
Protection	D81PFRC8	Frequency	D81-8	Rate-of-Change-of-Frequency Stage-8
Protection	D81PFRC9	Frequency	D81-9	Rate-of-Change-of-Frequency Stage-9
Protection	D81PFRC9	Frequency	D81-10	Rate-of-Change-of-Frequency Stage 10
Protection	D81PTOF1	Frequency	D81-1	Overfrequency Stage-1
Protection	D81PTOF2	Frequency	D81-2	Overfrequency Stage-2

Protection	D81PTOF3	Frequency	D81-3	Overfrequency Stage-3
Protection	D81PTOF4	Frequency	D81-4	Overfrequency Stage-4
Protection	D81PTOF5	Frequency	D81-5	Overfrequency Stage-5
Protection	D81PTOF6	Frequency	D81-6	Overfrequency Stage-6
Protection	D81PTOF7	Frequency	D81-7	Overfrequency Stage-7
Protection	D81PTOF8	Frequency	D81-8	Overfrequency Stage-8
Protection	D81PTOF9	Frequency	D81-9	Overfrequency Stage-9
Protection	D81PTOF10	Frequency	D81-10	Overfrequency Stage-10
Protection	D81PTUF1	Frequency	D81-1	Underfrequency Stage-1
Protection	D81PTUF2	Frequency	D81-2	Underfrequency Stage-2
Protection	D81PTUF3	Frequency	D81-3	Underfrequency Stage-3
Protection	D81PTUF4	Frequency	D81-4	Underfrequency Stage-4
Protection	D81PTUF5	Frequency	D81-5	Underfrequency Stage-5
Protection	D81PTUF6	Frequency	D81-6	Underfrequency Stage-6
Protection	D81PTUF7	Frequency	D81-7	Underfrequency Stage-7
Protection	D81PTUF8	Frequency	D81-8	Underfrequency Stage-8
Protection	D81PTUF9	Frequency	D81-9	Underfrequency Stage-9
Protection	D81PTUF10	Frequency	D81-10	Underfrequency Stage-10
Protection	D32PDUP1	Under Power	D32-1	Dir. Underpower Stage-1
Protection	D32PDUP2	Under Power	D32-2	Dir. Underpower Stage-2
Protection	D32PDUP3	Under Power	D32-3	Dir. Underpower Stage-3
Protection	D32PDUP4	Under Power	D32-4	Dir. Underpower Stage-4
Protection	D60CTSPTOC1	CT Supervision	D60CTS	CT Supervision
Protection	D60LOPPTOV1	PT Supervision	D60LOP	PT Supervision
Protection	D74TCSRTCS1	TCS	D74TCS1	Trip Circuit-1 Supervision
Protection	D74TCSRTCS2	TCS	D74TCS2	Trip Circuit-2 Supervision
Protection	I2TRCBC	CB Condition	DI2T	CB Condition
Protection	THDRTHD1	THD	DTHD	Total Harmonic Distortion Stage-1
Protection	THDRTHD2	THD	DTHD	Total Harmonic Distortion Stage-2

Protection	D25SYCRSYN	Check Sync	D252759	Synchro Check
Protection	D79RREC1	Auto Reclose	D79	Auto Reclose
Protection	D79GGIO1	Auto Reclose	D79	Auto Reclosure Cumulative Count Alarm
LD → System				
System	PLGGIO1	Generic process	GGIO	Prologic functions from 1 through 24
System	SGGGIO2	Generic process	GGIO	Active setting group
System	EIGGIO3	Generic process	GGIO	External Inputs from 1 through 24
System	OCGGIO4	Generic process	GGIO	Output Contacts from 1 through 32
System	LEDGGIO5	Generic process	GGIO	Front Panel LED state Target from 1 through 17; ALARM; SERVICE REQUIRED
System	VIGGIO6	Generic process	GGIO	Virtual Inputs from 1 through 30
System	TSAlmGGIO7	Generic process	GGIO	Time Synchronization Loss Alarm
System	SChAlmGGIO8	Generic process	GGIO	Self-Check Fail Alarm
System	ComAlmGGIO9	Generic process	GGIO	IEC61850 GOOSE Communication Alarm
LD → Subscription				
Subscription	SUBSCRGGIO1	Generic process	GGIO	External GOOSE Virtual Inputs from 1 through 30
LD → Records				
Records	RDRE1	Disturbance Recording	RDRE	Fault Recorder information
LD → SYS				
SYS	LGOS1-LGOS15	Subscription Supervision	LGOS	GOOSE Subscription Supervision
LD → Control				
Control	SPCSOPULGGIO1	Control Commands	GGIO	Pulse Type Control Commands
Control	SPCSOLATGGIO2	Control Commands	GGIO	Latched Type Control Commands

Logical Node Specifications

The following sections provide detailed spec information on the F-PRO logical device and logical nodes as defined in the Table L.6 “F-PRO Logical Nodes”.

Note: System logical nodes (group L) are not shown here.

Measurement Logical Device

MainMMXU1

This section defines logical node data for the logical node MainMMXU1.

Data Attributes	Description
MainMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	VA – Magnitude
MainMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	VA – Angle
MainMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	VB – Magnitude
MainMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	VB – Angle
MainMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	VC – Magnitude
MainMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	VC – Angle
MainMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	IA – Magnitude
MainMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	IA – Angle
MainMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	IB – Magnitude
MainMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	IB – Angle
MainMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	IC – Magnitude
MainMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	IC – Angle
MainMMXU1\$MX\$Hz\$mag\$f	Frequency
MainMMXU1\$MX\$TotW\$mag\$f	Total Active Power
MainMMXU1\$MX\$TotVAr\$mag\$f	Total reactive Power
MainMMXU1\$MX\$TotVA\$mag\$f	Total Apparent Power
MainMMXU1\$MX\$TotPF\$mag\$f	Total PF
MainMMXU1\$MX\$W\$phsA\$cVal\$mag\$f	A Ph Real Power
MainMMXU1\$MX\$W\$phsB\$cVal\$mag\$f	B Ph Real Power
MainMMXU1\$MX\$W\$phsC\$cVal\$mag\$f	C Ph Real Power

MainMMXU1\$MX\$VAr\$phsA\$cVal\$mag\$f	A Ph Reactive Power
MainMMXU1\$MX\$VAr\$phsB\$cVal\$mag\$f	B Ph Reactive Power
MainMMXU1\$MX\$VAr\$phsC\$cVal\$mag\$f	C Ph Reactive Power
MainMMXU1\$MX\$VA\$phsA\$cVal\$mag\$f	A Ph Apparent Power
MainMMXU1\$MX\$VA\$phsB\$cVal\$mag\$f	B Ph Apparent Power
MainMMXU1\$MX\$VA\$phsC\$cVal\$mag\$f	C Ph Apparent Power
MainMMXU1\$MX\$PF\$phsA\$cVal\$mag\$f	A Ph Power Factor
MainMMXU1\$MX\$PF\$phsB\$cVal\$mag\$f	B Ph Power Factor
MainMMXU1\$MX\$PF\$phsC\$cVal\$mag\$f	C Ph Power Factor
MainMMXU1\$MX\$PPV\$phsAB\$cVal\$mag\$f	VAB – Magnitude
MainMMXU1\$MX\$PPV\$phsAB\$cVal\$ang\$f	VAB – Angle
MainMMXU1\$MX\$PPV\$phsBC\$cVal\$mag\$f	VBC – Magnitude
MainMMXU1\$MX\$PPV\$phsBC\$cVal\$ang\$f	VBC – Angle
MainMMXU1\$MX\$PPV\$phsCA\$cVal\$mag\$f	VCA – Magnitude
MainMMXU1\$MX\$PPV\$phsCA\$cVal\$ang\$f	VCA – Angle

MainMSQI1

This section defines logical node data for the logical node MainMSQI1.

Data Attributes	Description
MainMSQI1\$MX\$SeqV\$c1\$cVal\$mag\$f	V1 Pos. Seq. Voltage
MainMSQI1\$MX\$SeqA\$c1\$cVal\$mag\$f	I1 Pos. Seq. Current
MainMSQI1\$MX\$SeqV\$c2\$cVal\$mag\$f	V2 Neg. Seq. Voltage
MainMSQI1\$MX\$SeqA\$c2\$cVal\$mag\$f	V0 Zero. Seq. Voltage
MainMSQI1\$MX\$SeqA\$c2\$cVal\$mag\$f	I2 Neg. Seq. Current
MainMSQI1\$MX\$SeqA\$c3\$cVal\$mag\$f	I0 Zero. Seq. Current
MainMSQI1\$MX\$ImbNgA\$mag\$f	I2/I1

AuxMMXU2

This section defines logical node data for the logical node AuxMMXU2.

Data Attributes	Description
AUXMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	V Aux - Magnitude
AUXMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	V Aux - Angle

MainGMMXU3

This section defines logical node data for the logical node MainGMMXU3.

Data Attributes	Description
MainGMMXU3\$MX\$A\$neut\$cVal\$mag\$f	IG - Magnitude
MainGMMXU3\$MX\$A\$neut\$cVal\$ang\$f	IG - Angle

SEFMMXU4

This section defines logical node data for the logical node SEFMMXU4.

Data Attributes	Description
SEFMMXU4\$MX\$A\$res\$cVal\$mag\$f	SEF - Magnitude
SEFMMXU4\$MX\$A\$res\$cVal\$ang\$f	SEF - Angle

MVHzMMXU1

This section defines logical node data for the logical node MVHzMMXU1.

Data Attributes	Description
MVHzMMXU1\$MX\$VHz\$mag\$f	Volts per Hz

MTHDMHAN1

This section defines logical node data for the logical node MTHDMHAN1.

Data Attributes	Description
MTHDMHAN1\$MX\$ThdAmp\$mag\$f	THD in %

M79MTHR1

This section defines logical node data for the logical node M79MTHR1.

Data Attributes	Description
M79MTHR1\$MX\$Tmp01\$mag\$f	A/R Count
M79MTHR1\$MX\$Tmp02\$mag\$f	A/R Cumulative Counter

FaultData Logical Device

D27MDTMMXU1

This section defines logical node data for the logical node D27MDTMMXU1.

Data Attributes	Description
D27MDTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-1 Main phase A voltage magnitude
D27MDTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-1 Main phase A voltage angle
D27MDTMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D27-1 Main phase B voltage magnitude
D27MDTMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D27-1 Main phase B voltage angle
D27MDTMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D27-1 Main phase C voltage magnitude
D27MDTMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D27-1 Main phase C voltage angle

D27MDTMMXU2

This section defines logical node data for the logical node D27MDTMMXU2.

Data Attributes	Description
D27MDTMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-2 Main phase A voltage magnitude
D27MDTMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-2 Main phase A voltage angle
D27MDTMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D27-2 Main phase B voltage magnitude
D27MDTMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D27-2 Main phase B voltage angle
D27MDTMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D27-2 Main phase C voltage magnitude
D27MDTMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D27-2 Main phase C voltage angle

D27MDTMMXU3

This section defines logical node data for the logical node D27MDTMMXU3.

Data Attributes	Description
D27MDTMMXU3\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-3 Main phase A voltage magnitude
D27MDTMMXU3\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-3 Main phase A voltage angle

D27MDTMMXU3\$MX\$PhV\$phsB\$cVal\$mag\$f	D27-3 Main phase B voltage magnitude
D27MDTMMXU3\$MX\$PhV\$phsB\$cVal\$ang\$f	D27-3 Main phase B voltage angle
D27MDTMMXU3\$MX\$PhV\$phsC\$cVal\$mag\$f	D27-3 Main phase C voltage magnitude
D27MDTMMXU3\$MX\$PhV\$phsC\$cVal\$ang\$f	D27-3 Main phase C voltage angle

D27MDTMMXU4

This section defines logical node data for the logical node D27MDTMMXU4.

Data Attributes	Description
D27MDTMMXU4\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-4 Main phase A voltage magnitude
D27MDTMMXU4\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-4 Main phase A voltage angle
D27MDTMMXU4\$MX\$PhV\$phsB\$cVal\$mag\$f	D27-4 Main phase B voltage magnitude
D27MDTMMXU4\$MX\$PhV\$phsB\$cVal\$ang\$f	D27-4 Main phase B voltage angle
D27MDTMMXU4\$MX\$PhV\$phsC\$cVal\$mag\$f	D27-4 Main phase C voltage magnitude
D27MDTMMXU4\$MX\$PhV\$phsC\$cVal\$ang\$f	D27-4 Main phase C voltage angle

D27ADTMMXU1

This section defines logical node data for the logical node D27ADTMMXU1.

Data Attributes	Description
D27ADTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-1 Aux voltage magnitude
D27ADTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-1 Aux voltage angle

D27ADTMMXU2

This section defines logical node data for the logical node D27ADTMMXU2.

Data Attributes	Description
D27ADTMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-2 Aux voltage magnitude
D27ADTMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-2 Aux voltage angle

D27ADTMMXU3

This section defines logical node data for the logical node D27ADTMMXU3.

Data Attributes	Description
D27ADTMMXU3\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-3 Aux voltage magnitude
D27ADTMMXU3\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-3 Aux voltage angle

D27ADTMMXU4

This section defines logical node data for the logical node D27ADTMMXU4.

Data Attributes	Description
D27ADTMMXU4\$MX\$PhV\$phsA\$cVal\$mag\$f	D27-4 Aux voltage magnitude
D27ADTMMXU4\$MX\$PhV\$phsA\$cVal\$ang\$f	D27-4 Aux voltage angle

D59MDTMMXU1

This section defines logical node data for the logical node D59MDTMMXU1.

Data Attributes	Description
D59MDTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-1 Main phase A voltage magnitude
D59MDTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-1 Main phase A voltage angle
D59MDTMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D59-1 Main phase B voltage magnitude
D59MDTMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D59-1 Main phase B voltage angle
D59MDTMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D59-1 Main phase C voltage magnitude
D59MDTMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D59-1 Main phase C voltage angle

D59MDTMMXU2

This section defines logical node data for the logical node D59MDTMMXU2.

Data Attributes	Description
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D59MDTMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-2 Main phase A voltage magnitude
D59MDTMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-2 Main phase A voltage angle
D59MDTMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D59-2 Main phase B voltage magnitude
D59MDTMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D59-2 Main phase B voltage angle
D59MDTMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D59-2 Main phase C voltage magnitude
D59MDTMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D59-2 Main phase C voltage angle

D59MDTMMXU3

This section defines logical node data for the logical node D59MDTMMXU3.

Data Attributes	Description
D59MDTMMXU3\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-3 Main phase A voltage magnitude
D59MDTMMXU3\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-3 Main phase A voltage angle
D59MDTMMXU3\$MX\$PhV\$phsB\$cVal\$mag\$f	D59-3 Main phase B voltage magnitude
D59MDTMMXU3\$MX\$PhV\$phsB\$cVal\$ang\$f	D59-3 Main phase B voltage angle
D59MDTMMXU3\$MX\$PhV\$phsC\$cVal\$mag\$f	D59-3 Main phase C voltage magnitude
D59MDTMMXU3\$MX\$PhV\$phsC\$cVal\$ang\$f	D59-3 Main phase C voltage angle

D59MDTMMXU4

This section defines logical node data for the logical node D59MDTMMXU4.

Data Attributes	Description
D59MDTMMXU4\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-4 Main phase A voltage magnitude
D59MDTMMXU4\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-4 Main phase A voltage angle
D59MDTMMXU4\$MX\$PhV\$phsB\$cVal\$mag\$f	D59-4 Main phase B voltage magnitude
D59MDTMMXU4\$MX\$PhV\$phsB\$cVal\$ang\$f	D59-4 Main phase B voltage angle
D59MDTMMXU4\$MX\$PhV\$phsC\$cVal\$mag\$f	D59-4 Main phase C voltage magnitude
D59MDTMMXU4\$MX\$PhV\$phsC\$cVal\$ang\$f	D59-4 Main phase C voltage angle

D59ADTMMXU1

This section defines logical node data for the logical node D59ADTMMXU1.

Data Attributes	Description
D59ADTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-1 Aux voltage magnitude
D59ADTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-1 Aux voltage angle

D59ADTMMXU2

This section defines logical node data for the logical node D59ADTMMXU2.

Data Attributes	Description
D59ADTMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-2 Aux voltage magnitude
D59ADTMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-2 Aux voltage angle

D59ADTMMXU3

This section defines logical node data for the logical node D59ADTMMXU3.

Data Attributes	Description
D59ADTMMXU3\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-3 Aux voltage magnitude
D59ADTMMXU3\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-3 Aux voltage angle

D59ADTMMXU4

This section defines logical node data for the logical node D59ADTMMXU4.

Data Attributes	Description
D59ADTMMXU4\$MX\$PhV\$phsA\$cVal\$mag\$f	D59-4 Aux voltage magnitude
D59ADTMMXU4\$MX\$PhV\$phsA\$cVal\$ang\$f	D59-4 Aux voltage angle

D27ITMMXU1

This section defines logical node data for the logical node D27ITMMXU1.

Data Attributes	Description
D27ITMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D27IT-1 Main phase A voltage magnitude
D27ITMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D27IT-1 Main phase A voltage angle
D27ITMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D27IT-1 Main phase B voltage magnitude
D27ITMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D27IT-1 Main phase B voltage angle
D27ITMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D27IT-1 Main phase C voltage magnitude
D27ITMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D27IT-1 Main phase C voltage angle

D27ITMMXU2

This section defines logical node data for the logical node D27ITMMXU2.

Data Attributes	Description
D27ITMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D27IT-2 Main phase A voltage magnitude
D27ITMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D27IT-2 Main phase A voltage angle
D27ITMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D27IT-2 Main phase B voltage magnitude
D27ITMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D27IT-2 Main phase B voltage angle
D27ITMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D27IT-2 Main phase C voltage magnitude
D27ITMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D27IT-2 Main phase C voltage angle

D59ITMMXU1

This section defines logical node data for the logical node D59ITMMXU1.

Data Attributes	Description
D59ITMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D59IT-1 Main phase A voltage magnitude
D59ITMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D59IT-1 Main phase A voltage angle
D59ITMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D59IT-1 Main phase B voltage magnitude

D59ITMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D59IT-1 Main phase B voltage angle
D59ITMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D59IT-1 Main phase C voltage magnitude
D59ITMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D59IT-1 Main phase C voltage angle

D59ITMMXU2

This section defines logical node data for the logical node D59ITMMXU2.

Data Attributes	Description
D59ITMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D59IT-2 Main phase A voltage magnitude
D59ITMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D59IT-2 Main phase A voltage angle
D59ITMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D59IT-2 Main phase B voltage magnitude
D59ITMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D59IT-2 Main phase B voltage angle
D59ITMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D59IT-2 Main phase C voltage magnitude
D59ITMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D59IT-2 Main phase C voltage angle

D24DTMMXU1 & D24MTHR1

This section defines logical node data for the logical nodes D24DTMMXU1 & D24MTHR1.

Data Attributes	Description
D24DTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D24-1 phase A overflux magnitude
D24DTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D24-1 phase A overflux angle
D24DTMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D24-1 phase B overflux magnitude
D24DTMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D24-1 phase B overflux angle
D24DTMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D24-1 phase C overflux magnitude
D24DTMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D24-1 phase C overflux angle
D24MTHR1\$MX\$Tmp01\$mag\$f	D24-1 V/F

D24ITMMXU1& D24MTHR1

This section defines logical node data for the logical nodes D24ITMMXU1& D24MTHR1.

Data Attributes	Description
D24ITMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D24IT phase A overflux magnitude
D24ITMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D24IT phase A overflux angle
D24ITMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D24IT phase B overflux magnitude
D24ITMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D24IT phase B overflux angle
D24ITMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D24IT phase C overflux magnitude
D24ITMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D24IT phase C overflux angle
D24MTHR1\$MX\$Tmp03\$mag\$f	D24IT V/F

D47DTMMXU1 & D47DTMSQI1

This section defines logical node data for the logical nodes D47DTMMXU1 & D47DTMSQI1.

Data Attributes	Description
D47DTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D47DT-1 phase A voltage magnitude
D47DTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D47DT-1 phase A voltage angle
D47DTMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D47DT-1 phase B voltage magnitude
D47DTMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D47DT-1 phase B voltage angle
D47DTMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D47DT-1 phase C voltage magnitude
D47DTMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D47DT-1 phase C voltage angle
D47DTMSQI1\$MX\$SeqV\$c2\$cVal\$mag\$f	D47DT-1 Neg seq voltage magnitude
D47DTMSQI1\$MX\$SeqV\$c2\$cVal\$ang\$f	D47DT-1 Neg seq voltage angle

D47DTMMXU2 & D47DTMSQI2

This section defines logical node data for the logical nodes D47DTMMXU2 & D47DTMSQI2.

Data Attributes	Description
D47DTMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D47DT-2 phase A voltage magnitude
D47DTMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D47DT-2 phase A voltage angle
D47DTMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D47DT-2 phase B voltage magnitude
D47DTMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D47DT-2 phase B voltage angle
D47DTMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D47DT-2 phase C voltage magnitude
D47DTMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D47DT-2 phase C voltage angle
D47DTMSQI2\$MX\$SeqV\$c2\$cVal\$mag\$f	D47DT-2 Neg seq voltage magnitude
D47DTMSQI2\$MX\$SeqV\$c2\$cVal\$ang\$f	D47DT-2 Neg seq voltage angle

D47ITMMXU1 & D47ITMSQI1

This section defines logical node data for the logical nodes D47ITMMXU1 & D47ITMSQI1.

Data Attributes	Description
D47ITMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D47IT phase A voltage magnitude
D47ITMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D47IT phase A voltage angle
D47ITMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D47IT phase B voltage magnitude
D47ITMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D47IT phase B voltage angle
D47ITMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D47IT phase C voltage magnitude
D47ITMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D47IT phase C voltage angle
D47ITMSQI1\$MX\$SeqV\$c2\$cVal\$mag\$f	D47IT Neg seq voltage magnitude
D47ITMSQI1\$MX\$SeqV\$c2\$cVal\$ang\$f	D47IT Neg seq voltage angle

D59NDTMMXU1 & D59NDTMSQI1

This section defines logical node data for the logical nodes D59NDTMMXU1 & D59NDTMSQI1.

Data Attributes	Description
D59NDTMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D59NDT-1 phase A voltage magnitude
D59NDTMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D59NDT-1 phase A voltage angle
D59NDTMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D59NDT-1 phase B voltage magnitude
D59NDTMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D59NDT-1 phase B voltage angle
D59NDTMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D59NDT-1 phase C voltage magnitude
D59NDTMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D59NDT-1 phase C voltage angle
D59NDTMSQI1\$MX\$SeqV\$c3\$cVal\$mag\$f	D59NDT-1 zero seq voltage magnitude
D59NDTMSQI1\$MX\$SeqV\$c3\$cVal\$ang\$f	D59NDT-1 zero seq voltage angle

D59NDTMMXU2 & D59NDTMSQI2

This section defines logical node data for the logical nodes D59NDTMMXU2 & D59NDTMSQI2.

Data Attributes	Description
D59NDTMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D59NDT-2 phase A voltage magnitude
D59NDTMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D59NDT-2 phase A voltage angle
D59NDTMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D59NDT-2 phase B voltage magnitude
D59NDTMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D59NDT-2 phase B voltage angle
D59NDTMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D59NDT-2 phase C voltage magnitude
D59NDTMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D59NDT-2 phase C voltage angle
D59NDTMSQI2\$MX\$SeqV\$c3\$cVal\$mag\$f	D59NDT-2 zero seq voltage magnitude
D59NDTMSQI2\$MX\$SeqV\$c3\$cVal\$ang\$f	D59NDT-2 zero seq voltage angle

D59NITMMXU1& D59NITMSQI1

This section defines logical node data for the logical nodes D59NITMMXU1 & D59NITMSQI1.

Data Attributes	Description
D59NITMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D59NIT phase A voltage magnitude
D59NITMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D59NIT phase A voltage angle
D59NITMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D59NIT phase B voltage magnitude
D59NITMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D59NIT phase B voltage angle
D59NITMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D59NIT phase C voltage magnitude
D59NITMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D59NIT phase C voltage angle
D59NITMSQI1\$MX\$SeqV\$c3\$cVal\$mag\$f	D59NIT zero seq voltage magnitude
D59NITMSQI1\$MX\$SeqV\$c3\$cVal\$ang\$f	D59NIT zero seq voltage angle

D37MMXU1

This section defines logical node data for the logical node D37MMXU1.

Data Attributes	Description
D37MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D37-1 phase A Undercurrent magnitude
D37MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D37-1 phase A Undercurrent angle
D37MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D37-1 phase B Undercurrent magnitude
D37MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D37-1 phase B Undercurrent angle
D37MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D37-1 phase C Undercurrent magnitude
D37MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D37-1 phase C Undercurrent angle

D37MMXU2

This section defines logical node data for the logical node D37MMXU2.

Data Attributes	Description
D37MMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D37-2 phase A Undercurrent magnitude
D37MMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D37-2 phase A Undercurrent angle

D37MMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D37-2 phase B Undercurrent magnitude
D37MMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D37-2 phase B Undercurrent angle
D37MMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D37-2 phase C Undercurrent magnitude
D37MMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D37-2 phase C Undercurrent angle

D50MMXU1 & D50RFLO1

This section defines logical node data for the logical nodes D50MMXU1 & D50RFLO1.

Data Attributes	Description
D50RFLO1\$MX\$FltDiskm\$mag\$f	D50-1 fault Location km
D50RFLO1\$MX\$FltZ\$cVal\$mag\$f	D50-1 fault Impedance magnitude
D50RFLO1\$MX\$FltZ\$cVal\$ang\$f	D50-1 fault Impedance angle
D50MMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D50-1 phase A voltage magnitude
D50MMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D50-1 phase A voltage angle
D50MMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D50-1 phase B voltage magnitude
D50MMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D50-1 phase B voltage angle
D50MMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D50-1 phase C voltage magnitude
D50MMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D50-1 phase C voltage angle
D50MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D50-1 phase A current magnitude
D50MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D50-1 phase A current angle
D50MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D50-1 phase B current magnitude
D50MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D50-1 phase B current angle
D50MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D50-1 phase C current magnitude
D50MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D50-1 phase C current angle

D50MMXU2 & D50RFLO2

This section defines logical node data for the logical nodes D50MMXU2 & D50RFLO2.

Data Attributes	Description
D50RFLO2\$MX\$FltDiskm\$mag\$f	D50-2 fault Location km
D50RFLO2\$MX\$FltZ\$cVal\$mag\$f	D50-2 fault Impedance magnitude
D50RFLO2\$MX\$FltZ\$cVal\$ang\$f	D50-2 fault Impedance angle
D50MMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D50-2 phase A voltage magnitude
D50MMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D50-2 phase A voltage angle
D50MMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D50-2 phase B voltage magnitude
D50MMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D50-2 phase B voltage angle
D50MMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D50-2 phase C voltage magnitude
D50MMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D50-2 phase C voltage angle
D50MMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D50-2 phase A current magnitude
D50MMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D50-2 phase A current angle
D50MMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D50-2 phase B current magnitude
D50MMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D50-2 phase B current angle
D50MMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D50-2 phase C current magnitude
D50MMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D50-2 phase C current angle

D51MMXU1 & D51RFLO1

This section defines logical node data for the logical nodes D51MMXU1 & D51RFLO1.

Data Attributes	Description
D51RFLO1\$MX\$FltDiskm\$mag\$f	D51-1 fault Location km
D51RFLO1\$MX\$FltZ\$cVal\$mag\$f	D51-1 fault Impedance magnitude
D51RFLO1\$MX\$FltZ\$cVal\$ang\$f	D51-1 fault Impedance angle
D51MMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D51-1 phase A voltage magnitude
D51MMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D51-1 phase A voltage angle

D51MMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D51-1 phase B voltage magnitude
D51MMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D51-1 phase B voltage angle
D51MMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D51-1 phase C voltage magnitude
D51MMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D51-1 phase C voltage angle
D51MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D51-1 phase A current magnitude
D51MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D51-1 phase A current angle
D51MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D51-1 phase B current magnitude
D51MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D51-1 phase B current angle
D51MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D51-1 phase C current magnitude
D51MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D51-1 phase C current angle

D51MMXU2 & D51RFLO2

This section defines logical node data for the logical nodes D51MMXU2 & D51RFLO2.

Data Attributes	Description
D51RFLO2\$MX\$FltDiskm\$mag\$f	D51-2 fault Location km
D51RFLO2\$MX\$FltZ\$cVal\$mag\$f	D51-2 fault Impedance magnitude
D51RFLO2\$MX\$FltZ\$cVal\$ang\$f	D51-2 fault Impedance angle
D51MMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D51-2 phase A voltage magnitude
D51MMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D51-2 phase A voltage angle
D51MMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D51-2 phase B voltage magnitude
D51MMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D51-2 phase B voltage angle
D51MMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D51-2 phase C voltage magnitude
D51MMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D51-2 phase C voltage angle
D51MMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D51-2 phase A current magnitude
D51MMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D51-2 phase A current angle
D51MMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D51-2 phase B current magnitude
D51MMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D51-2 phase B current angle
D51MMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D51-2 phase C current magnitude

D51MMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D51-2 phase C current angle
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D50NMMXU1, D50NRFLO1 & D50NMSQI1

This section defines logical node data for the logical nodes D50NMMXU1, D50NRFLO1 & D50NMSQI1.

Data Attributes	Description
D50NRFLO1\$MX\$FltDiskm\$mag\$f	D50N-1 fault Location
D50NRFLO1\$MX\$FltZ\$cVal\$mag\$f	D50N-1 fault Impedance
D50NRFLO1\$MX\$FltZ\$cVal\$ang\$f	D50N-1 fault Impedance angle
D50NMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D50N-1 phase A voltage magnitude
D50NMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D50N-1 phase A voltage angle
D50NMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D50N-1 phase B voltage magnitude
D50NMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D50N-1 phase B voltage angle
D50NMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D50N-1 phase C voltage magnitude
D50NMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D50N-1 phase C voltage angle
D50NMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D50N-1 phase A current magnitude
D50NMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D50N-1 phase A current angle
D50NMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D50N-1 phase B current magnitude
D50NMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D50N-1 phase B current angle
D50NMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D50N-1 phase C current magnitude
D50NMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D50N-1 phase C current angle
D50NMSQI1\$MX\$SeqA\$c3\$cVal\$mag\$f	D50N-1 zero seq current magnitude
D50NMSQI1\$MX\$SeqA\$c3\$cVal\$ang\$f	D50N-1 zero seq current angle

D50NRFLO2, D50NRFLO2 & D50NMSQI2

This section defines logical node data for the logical nodes D50NRFLO2, D50NRFLO2 & D50NMSQI2.

Data Attributes	Description
D50NRFLO2\$MX\$FltDiskm\$mag\$f	D50N-2 fault Location
D50NRFLO2\$MX\$FltZ\$cVal\$mag\$f	D50N-2 fault Impedance
D50NRFLO2\$MX\$FltZ\$cVal\$ang\$f	D50N-2 fault Impedance angle
D50NMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D50N-2 phase A voltage magnitude
D50NMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D50N-2 phase A voltage angle
D50NMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D50N-2 phase B voltage magnitude
D50NMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D50N-2 phase B voltage angle
D50NMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D50N-2 phase C voltage magnitude
D50NMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D50N-2 phase C voltage angle
D50NMMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D50N-2 phase A current magnitude
D50NMMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D50N-2 phase A current angle
D50NMMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D50N-2 phase B current magnitude
D50NMMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D50N-2 phase B current angle
D50NMMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D50N-2 phase C current magnitude
D50NMMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D50N-2 phase C current angle
D50NMSQI2\$MX\$SeqA\$c3\$cVal\$mag\$f	D50N-2 zero seq current magnitude
D50NMSQI2\$MX\$SeqA\$c3\$cVal\$ang\$f	D50N-2 zero seq current angle

D51NMMXU1, D51NRFLO1 & D51NMSQI1

This section defines logical node data for the logical nodes D51NMMXU1, D51NRFLO1 & D51NMSQI1.

Data Attributes	Description
D51NRFLO1\$MX\$FltDiskm\$mag\$f	D51N-1 fault Location
D51NRFLO1\$MX\$FltZ\$cVal\$mag\$f	D51N-1 fault Impedance
D51NRFLO1\$MX\$FltZ\$cVal\$ang\$f	D51N-1 fault Impedance angle

D51NMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D51N-1 phase A voltage magnitude
D51NMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D51N-1 phase A voltage angle
D51NMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D51N-1 phase B voltage magnitude
D51NMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D51N-1 phase B voltage angle
D51NMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D51N-1 phase C voltage magnitude
D51NMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D51N-1 phase C voltage angle
D51NMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D51N-1 phase A current magnitude
D51NMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D51N-1 phase A current angle
D51NMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D51N-1 phase B current magnitude
D51NMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D51N-1 phase B current angle
D51NMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D51N-1 phase C current magnitude
D51NMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D51N-1 phase C current angle
D51NMSQI1\$MX\$SeqA\$c3\$cVal\$mag\$f	D51N-1 zero seq current magnitude
D51NMSQI1\$MX\$SeqA\$c3\$cVal\$ang\$f	D51N-1 zero seq current angle

D51NMMXU2, D51NRFLO2 & D51NMSQI2

This section defines logical node data for the logical nodes D51NMMXU2, D51NRFLO2 & D51NMSQI2.

Data Attributes	Description
D51NRFLO2\$MX\$FltDiskm\$mag\$f	D51N-2 fault Location
D51NRFLO2\$MX\$FltZ\$cVal\$mag\$f	D51N-2 fault Impedance
D51NRFLO2\$MX\$FltZ\$cVal\$ang\$f	D51N-2 fault Impedance angle
D51NMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D51N-2 phase A voltage magnitude
D51NMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D51N-2 phase A voltage angle
D51NMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D51N-2 phase B voltage magnitude
D51NMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D51N-2 phase B voltage angle
D51NMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D51N-2 phase C voltage magnitude
D51NMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D51N-2 phase C voltage angle
D51NMMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D51N-2 phase A current magnitude

D51NMMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D51N-2 phase A current angle
D51NMMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D51N-2 phase B current magnitude
D51NMMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D51N-2 phase B current angle
D51NMMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D51N-2 phase C current magnitude
D51NMMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D51N-2 phase C current angle
D51NMSQI2\$MX\$SeqA\$c3\$cVal\$mag\$f	D51N-2 zero seq current magnitude
D51NMSQI2\$MX\$SeqA\$c3\$cVal\$ang\$f	D51N-2 zero seq current angle

D50GMMXU1 & D50GRFLO1

This section defines logical node data for the logical nodes D50GMMXU1 & D50GRFLO1.

Data Attributes	Description
D50GRFLO1\$MX\$FltDiskm\$mag\$f	D50G-1 fault Location
D50GRFLO1\$MX\$FltZ\$cVal\$mag\$f	D50G-1 fault Impedance
D50GRFLO1\$MX\$FltZ\$cVal\$ang\$f	D50G-1 fault Impedance angle
D50GMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D50G-1 phase A voltage magnitude
D50GMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D50G-1 phase A voltage angle
D50GMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D50G-1 phase B voltage magnitude
D50GMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D50G-1 phase B voltage angle
D50GMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D50G-1 phase C voltage magnitude
D50GMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D50G-1 phase C voltage angle
D50GMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D50G-1 phase A current magnitude
D50GMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D50G-1 phase A current angle
D50GMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D50G-1 phase B current magnitude
D50GMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D50G-1 phase B current angle
D50GMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D50G-1 phase C current magnitude
D50GMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D50G-1 phase C current angle
D50GMMXU1\$MX\$A\$neut\$cVal\$mag\$f	D50G-1 phase IG current magnitude
D50GMMXU1\$MX\$A\$neut\$cVal\$ang\$f	D50G-1 phase IG current angle

D50GMMXU2 & D50GRFLO2

This section defines logical node data for the logical nodes D50GMMXU2 & D50GRFLO2.

Data Attributes	Description
D50GRFLO2\$MX\$FltDiskm\$mag\$f	D50G-2 fault Location
D50GRFLO2\$MX\$FltZ\$cVal\$mag\$f	D50G-2 fault Impedance
D50GRFLO2\$MX\$FltZ\$cVal\$ang\$f	D50G-2 fault Impedance angle
D50GMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D50G-2 phase A voltage magnitude
D50GMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D50G-2 phase A voltage angle
D50GMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D50G-2 phase B voltage magnitude
D50GMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D50G-2 phase B voltage angle
D50GMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D50G-2 phase C voltage magnitude
D50GMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D50G-2 phase C voltage angle
D50GMMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D50G-2 phase A current magnitude
D50GMMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D50G-2 phase A current angle
D50GMMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D50G-2 phase B current magnitude
D50GMMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D50G-2 phase B current angle
D50GMMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D50G-2 phase C current magnitude
D50GMMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D50G-2 phase C current angle
D50GMMXU2\$MX\$A\$neut\$cVal\$mag\$f	D50G-2 phase IG current magnitude
D50GMMXU2\$MX\$A\$neut\$cVal\$ang\$f	D50G-2 phase IG current angle

D51GMMXU1 & D51GRFLO1

This section defines logical node data for the logical nodes D51GMMXU1 & D51GRFLO1.

Data Attributes	Description
D51GRFLO1\$MX\$FltDiskm\$mag\$f	D51G-1 fault Location
D51GRFLO1\$MX\$FltZ\$cVal\$mag\$f	D51G-1 fault Impedance
D51GRFLO1\$MX\$FltZ\$cVal\$ang\$f	D51G-1 fault Impedance angle

D51GMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D51G-1 phase A voltage magnitude
D51GMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D51G-1 phase A voltage angle
D51GMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D51G-1 phase B voltage magnitude
D51GMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D51G-1 phase B voltage angle
D51GMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D51G-1 phase C voltage magnitude
D51GMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D51G-1 phase C voltage angle
D51GMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D51G-1 phase A current magnitude
D51GMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D51G-1 phase A current angle
D51GMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D51G-1 phase B current magnitude
D51GMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D51G-1 phase B current angle
D51GMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D51G-1 phase C current magnitude
D51GMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D51G-1 phase C current angle
D51GMMXU1\$MX\$A\$neut\$cVal\$mag\$f	D51G-1 phase IG current magnitude
D51GMMXU1\$MX\$A\$neut\$cVal\$ang\$f	D51G-1 phase IG current angle

D51GMMXU2 & D51GRFLO2

This section defines logical node data for the logical nodes D51GMMXU2 & D51GRFLO2.

Data Attributes	Description
D51GRFLO2\$MX\$FltDiskm\$mag\$f	D51G-2 fault Location
D51GRFLO2\$MX\$FltZ\$cVal\$mag\$f	D51G-2 fault Impedance
D51GRFLO2\$MX\$FltZ\$cVal\$ang\$f	D51G-2 fault Impedance angle
D51GMMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D51G-2 phase A voltage magnitude
D51GMMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D51G-2 phase A voltage angle
D51GMMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D51G-2 phase B voltage magnitude
D51GMMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D51G-2 phase B voltage angle
D51GMMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D51G-2 phase C voltage magnitude
D51GMMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D51G-2 phase C voltage angle
D51GMMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D51G-2 phase A current magnitude

D51GMMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D51G-2 phase A current angle
D51GMMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D51G-2 phase B current magnitude
D51GMMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D51G-2 phase B current angle
D51GMMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D51G-2 phase C current magnitude
D51GMMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D51G-2 phase C current angle
D51GMMXU2\$MX\$A\$neut\$cVal\$mag\$f	D51G-2 phase IG current magnitude
D51GMMXU2\$MX\$A\$neut\$cVal\$ang\$f	D51G-2 phase IG current angle

D4650MSQI1

This section defines logical node data for the logical node D4650MSQI1.

Data Attributes	Description
D4650MSQI1\$MX\$SeqA\$c2\$cVal\$mag\$f	D4650-1 Neg. Seq voltage magnitude
D4650MSQI1\$MX\$SeqA\$c2\$cVal\$ang\$f	D4650-1 Neg. Seq voltage angle

D4651MSQI2

This section defines logical node data for the logical node D4651MSQI2.

Data Attributes	Description
D4651MSQI2\$MX\$SeqA\$c2\$cVal\$mag\$f	D4651-1 Neg. Seq voltage magnitude
D4651MSQI2\$MX\$SeqA\$c2\$cVal\$ang\$f	D4651-1 Neg. Seq voltage angle

D6450MMXU1

This section defines logical node data for the logical node D6450MMXU1.

Data Attributes	Description
D6450MMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D6450-1 phase A voltage magnitude
D6450MMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D6450-1 phase A voltage angle
D6450MMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D6450-1 phase B voltage magnitude

D6450MMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D6450-1 phase B voltage angle
D6450MMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D6450-1 phase C voltage magnitude
D6450MMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D6450-1 phase C voltage angle
D6450MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D6450-1 phase A current magnitude
D6450MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D6450-1 phase A current angle
D6450MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D6450-1 phase B current magnitude
D6450MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D6450-1 phase B current angle
D6450MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D6450-1 phase C current magnitude
D6450MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D6450-1 phase C current angle
D6450MMXU1\$MX\$A\$res\$cVal\$mag\$f	D6450-1 phase ISEF current magnitude
D6450MMXU1\$MX\$A\$res\$cVal\$ang\$f	D6450-1 phase ISEF current angle

D6450MMXU2

This section defines logical node data for the logical node D6450MMXU2.

Data Attributes	Description
D6450MMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D6450-2 phase A voltage magnitude
D6450MMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D6450-2 phase A voltage angle
D6450MMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D6450-2 phase B voltage magnitude
D6450MMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D6450-2 phase B voltage angle
D6450MMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D6450-2 phase C voltage magnitude
D6450MMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D6450-2 phase C voltage angle
D6450MMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D6450-2 phase A current magnitude
D6450MMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D6450-2 phase A current angle
D6450MMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D6450-2 phase B current magnitude
D6450MMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D6450-2 phase B current angle
D6450MMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D6450-2 phase C current magnitude
D6450MMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D6450-2 phase C current angle
D6450MMXU2\$MX\$A\$res\$cVal\$mag\$f	D6450-2 phase ISEF current magnitude

D6450MMXU2\$MX\$A\$res\$cVal\$ang\$f	D6450-2 phase ISEF current angle
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D6451MMXU1

This section defines logical node data for the logical node D6451MMXU1.

Data Attributes	Description
D6451MMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D6451-1 phase A voltage magnitude
D6451MMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D6451-1 phase A voltage angle
D6451MMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D6451-1 phase B voltage magnitude
D6451MMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D6451-1 phase B voltage angle
D6451MMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D6451-1 phase C voltage magnitude
D6451MMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D6451-1 phase C voltage angle
D6451MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D6451-1 phase A current magnitude
D6451MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D6451-1 phase A current angle
D6451MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D6451-1 phase B current magnitude
D6451MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D6451-1 phase B current angle
D6451MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D6451-1 phase C current magnitude
D6451MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D6451-1 phase C current angle
D6451MMXU1\$MX\$A\$res\$cVal\$mag\$f	D6451-1 phase ISEF current magnitude
D6451MMXU1\$MX\$A\$res\$cVal\$ang\$f	D6451-1 phase ISEF current angle

D6451MMXU2

This section defines logical node data for the logical node D6451MMXU2.

Data Attributes	Description
D6451MMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D6451-2 phase A voltage magnitude
D6451MMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D6451-2 phase A voltage angle
D6451MMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D6451-2 phase B voltage magnitude
D6451MMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D6451-2 phase B voltage angle

D6451MMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D6451-2 phase C voltage magnitude
D6451MMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D6451-2 phase C voltage angle
D6451MMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D6451-2 phase A current magnitude
D6451MMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D6451-2 phase A current angle
D6451MMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D6451-2 phase B current magnitude
D6451MMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D6451-2 phase B current angle
D6451MMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D6451-2 phase C current magnitude
D6451MMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D6451-2 phase C current angle
D6451MMXU2\$MX\$A\$res\$cVal\$mag\$f	D6451-2 phase ISEF current magnitude
D6451MMXU2\$MX\$A\$res\$cVal\$ang\$f	D6451-2 phase ISEF current angle

D49MMXU1 & D49MSQI1

This section defines logical node data for the logical nodes D49MMXU1 & D49MSQI1.

Data Attributes	Description
D49MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D49 phase A current magnitude
D49MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D49 phase A current angle
D49MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D49 phase B current magnitude
D49MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D49 phase B current angle
D49MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D49 phase C current magnitude
D49MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D49 phase C current angle
D49MSQI1\$MX\$SeqA\$c1\$cVal\$mag\$f	D49 Pos. Seq Current magnitude
D49MSQI1\$MX\$SeqA\$c1\$cVal\$ang\$f	D49 Pos. Seq Current angle
D50BFMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D50BF-1 phase A current magnitude
D50BFMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D50BF-1 phase A current angle
D50BFMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D50BF-1 phase B current magnitude
D50BFMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D50BF-1 phase B current angle
D50BFMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D50BF-1 phase C current magnitude
D50BFMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D50BF-1 phase C current angle

D50BFMMXU1

This section defines logical node data for the logical node D50BFMMXU2.

Data Attributes	Description
D50BFMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D50BF-1 phase A current magnitude
D50BFMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D50BF-1 phase A current angle
D50BFMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D50BF-1 phase B current magnitude
D50BFMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D50BF-1 phase B current angle
D50BFMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D50BF-1 phase C current magnitude
D50BFMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D50BF-1 phase C current angle

D50BFMMXU2

This section defines logical node data for the logical node D50BFMMXU2.

Data Attributes	Description
D50BFMMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D50BF-2 phase A current magnitude
D50BFMMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D50BF-2 phase A current angle
D50BFMMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D50BF-2 phase B current magnitude
D50BFMMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D50BF-2 phase B current angle
D50BFMMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D50BF-2 phase C current magnitude
D50BFMMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D50BF-2 phase C current angle

D50LSMMXU1

This section defines logical node data for the logical node D50LSMMXU1.

Data Attributes	Description
D50LSMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D50LS phase A current magnitude
D50LSMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D50LS phase A current angle

D50LSMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D50LS phase B current magnitude
D50LSMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D50LS phase B current angle
D50LSMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D50LS phase C current magnitude
D50LSMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D50LS phase C current angle

D46BCMMXU1 & D46BCMSQI1

This section defines logical node data for the logical node D46BCMMXU1 & D46BCMSQI1.

Data Attributes	Description
D46BCMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D46BC phase A voltage magnitude
D46BCMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D46BC phase A voltage angle
D46BCMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D46BC phase B voltage magnitude
D46BCMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D46BC phase B voltage angle
D46BCMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D46BC phase C voltage magnitude
D46BCMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D46BC phase C voltage angle
D46BCMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D46BC phase A current magnitude
D46BCMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D46BC phase A current angle
D46BCMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D46BC phase B current magnitude
D46BCMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D46BC phase B current angle
D46BCMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D46BC phase C current magnitude
D46BCMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D46BC phase C current angle
D46BCMSQI1\$MX\$SeqA\$c1\$cVal\$mag\$f	D46BC Seq Current

D81MMXU1

This section defines logical node data for the logical node D81MMXU1.

Data Attributes	Description
D81MMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-1 phase A voltage magnitude
D81MMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-1 phase A voltage angle
D81MMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-1 phase B voltage magnitude

D81MMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-1 phase B voltage angle
D81MMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-1 phase C voltage magnitude
D81MMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-1 phase C voltage angle
D81MMXU1\$MX\$Hz\$mag\$f	D81-1 Frequency
D81MMXU1\$MX\$HzRte\$mag\$f	D81-1 Frequency ROCOF

D81MMXU3

This section defines logical node data for the logical node D81MMXU3.

Data Attributes	Description
D81MMXU3\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-3 phase A voltage magnitude
D81MMXU3\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-3 phase A voltage angle
D81MMXU3\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-3 phase B voltage magnitude
D81MMXU3\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-3 phase B voltage angle
D81MMXU3\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-3 phase C voltage magnitude
D81MMXU3\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-3 phase C voltage angle
D81MMXU3\$MX\$Hz\$mag\$f	D81-3 Frequency
D81MMXU3\$MX\$HzRte\$mag\$f	D81-3 Frequency ROCOF

D81MMXU4

This section defines logical node data for the logical node D81MMXU4.

Data Attributes	Description
D81MMXU4\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-4 phase A voltage magnitude
D81MMXU4\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-4 phase A voltage angle
D81MMXU4\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-4 phase B voltage magnitude
D81MMXU4\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-4 phase B voltage angle
D81MMXU4\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-4 phase C voltage magnitude
D81MMXU4\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-4 phase C voltage angle
D81MMXU4\$MX\$Hz\$mag\$f	D81-4 Frequency

D81MMXU4\$MX\$HzRte\$mag\$f	D81-4 Frequency ROCOF
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D81MMXU5

This section defines logical node data for the logical node D81MMXU5.

Data Attributes	Description
D81MMXU5\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-5 phase A voltage magnitude
D81MMXU5\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-5 phase A voltage angle
D81MMXU5\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-5 phase B voltage magnitude
D81MMXU5\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-5 phase B voltage angle
D81MMXU5\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-5 phase C voltage magnitude
D81MMXU5\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-5 phase C voltage angle
D81MMXU5\$MX\$Hz\$mag\$f	D81-5 Frequency
D81MMXU5\$MX\$HzRte\$mag\$f	D81-5 Frequency ROCOF

D81MMXU6

This section defines logical node data for the logical node D81MMXU6.

Data Attributes	Description
D81MMXU6\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-6 phase A voltage magnitude
D81MMXU6\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-6 phase A voltage angle
D81MMXU6\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-6 phase B voltage magnitude
D81MMXU6\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-6 phase B voltage angle
D81MMXU6\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-6 phase C voltage magnitude
D81MMXU6\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-6 phase C voltage angle
D81MMXU6\$MX\$Hz\$mag\$f	D81-6 Frequency
D81MMXU6\$MX\$HzRte\$mag\$f	D81-6 Frequency ROCOF

D81MMXU7

This section defines logical node data for the logical node D81MMXU7.

Data Attributes	Description
D81MMXU7\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-7 phase A voltage magnitude
D81MMXU7\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-7 phase A voltage angle
D81MMXU7\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-7 phase B voltage magnitude
D81MMXU7\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-7 phase B voltage angle
D81MMXU7\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-7 phase C voltage magnitude
D81MMXU7\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-7 phase C voltage angle
D81MMXU7\$MX\$Hz\$mag\$f	D81-7 Frequency
D81MMXU7\$MX\$HzRte\$mag\$f	D81-7 Frequency ROCOF

D81MMXU8

This section defines logical node data for the logical node D81MMXU8.

Data Attributes	Description
D81MMXU8\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-8 phase A voltage magnitude
D81MMXU8\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-8 phase A voltage angle
D81MMXU8\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-8 phase B voltage magnitude
D81MMXU8\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-8 phase B voltage angle
D81MMXU8\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-8 phase C voltage magnitude
D81MMXU8\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-8 phase C voltage angle
D81MMXU8\$MX\$Hz\$mag\$f	D81-8 Frequency
D81MMXU8\$MX\$HzRte\$mag\$f	D81-8 Frequency ROCOF

D81MMXU9

This section defines logical node data for the logical node D81MMXU9.

Data Attributes	Description
D81MMXU9\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-9 phase A voltage magnitude
D81MMXU9\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-9 phase A voltage angle
D81MMXU9\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-9 phase B voltage magnitude
D81MMXU9\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-9 phase B voltage angle
D81MMXU9\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-9 phase C voltage magnitude
D81MMXU9\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-9 phase C voltage angle
D81MMXU9\$MX\$Hz\$mag\$f	D81-9 Frequency
D81MMXU9\$MX\$HzRte\$mag\$f	D81-9 Frequency ROCOF

D81MMXU10

This section defines logical node data for the logical node D81MMXU10.

Data Attributes	Description
D81MMXU10\$MX\$PhV\$phsA\$cVal\$mag\$f	D81-10 phase A voltage magnitude
D81MMXU10\$MX\$PhV\$phsA\$cVal\$ang\$f	D81-10 phase A voltage angle
D81MMXU10\$MX\$PhV\$phsB\$cVal\$mag\$f	D81-10 phase B voltage magnitude
D81MMXU10\$MX\$PhV\$phsB\$cVal\$ang\$f	D81-10 phase B voltage angle
D81MMXU10\$MX\$PhV\$phsC\$cVal\$mag\$f	D81-10 phase C voltage magnitude
D81MMXU10\$MX\$PhV\$phsC\$cVal\$ang\$f	D81-10 phase C voltage angle
D81MMXU10\$MX\$Hz\$mag\$f	D81-10 Frequency
D81MMXU10\$MX\$HzRte\$mag\$f	D81-10 Frequency ROCOF

D32MMXU1

This section defines logical node data for the logical node D32MMXU1.

Data Attributes	Description
D32MMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D32-1 phase A voltage magnitude
D32MMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D32-1 phase A voltage angle
D32MMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D32-1 phase B voltage magnitude
D32MMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D32-1 phase B voltage angle
D32MMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D32-1 phase C voltage magnitude
D32MMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D32-1 phase C voltage angle
D32MMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D32-1 phase A current magnitude
D32MMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D32-1 phase A current angle
D32MMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D32-1 phase B current magnitude
D32MMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D32-1 phase B current angle
D32MMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D32-1 phase C current magnitude
D32MMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D32-1 phase C current angle
D32MMXU1\$MX\$TotW\$mag\$f	D32-1 Total Real Power
D32MMXU1\$MX\$TotVAr\$mag\$f	D32-1 Total Reactive Power
D32MMXU1\$MX\$W\$phsA\$cVal\$mag\$f	D32-1 Phase-A Real Power
D32MMXU1\$MX\$W\$phsB\$cVal\$mag\$f	D32-1 Phase-B Real Power
D32MMXU1\$MX\$W\$phsC\$cVal\$mag\$f	D32-1 Phase-C Real Power
D32MMXU1\$MX\$VAr\$phsA\$cVal\$mag\$f	D32-1 Phase-A Reactive Power
D32MMXU1\$MX\$VAr\$phsB\$cVal\$mag\$f	D32-1 Phase-B Reactive Power
D32MMXU1\$MX\$VAr\$phsC\$cVal\$mag\$f	D32-1 Phase-C Reactive Power

D32MMXU2

This section defines logical node data for the logical node D32MMXU2.

Data Attributes	Description
D32MMXU2\$MX\$PhV\$phsA\$cVal\$mag\$f	D32-2 phase A voltage magnitude
D32MMXU2\$MX\$PhV\$phsA\$cVal\$ang\$f	D32-2 phase A voltage angle
D32MMXU2\$MX\$PhV\$phsB\$cVal\$mag\$f	D32-2 phase B voltage magnitude
D32MMXU2\$MX\$PhV\$phsB\$cVal\$ang\$f	D32-2 phase B voltage angle
D32MMXU2\$MX\$PhV\$phsC\$cVal\$mag\$f	D32-2 phase C voltage magnitude
D32MMXU2\$MX\$PhV\$phsC\$cVal\$ang\$f	D32-2 phase C voltage angle
D32MMXU2\$MX\$A\$phsA\$cVal\$mag\$f	D32-2 phase A current magnitude
D32MMXU2\$MX\$A\$phsA\$cVal\$ang\$f	D32-2 phase A current angle
D32MMXU2\$MX\$A\$phsB\$cVal\$mag\$f	D32-2 phase B current magnitude
D32MMXU2\$MX\$A\$phsB\$cVal\$ang\$f	D32-2 phase B current angle
D32MMXU2\$MX\$A\$phsC\$cVal\$mag\$f	D32-2 phase C current magnitude
D32MMXU2\$MX\$A\$phsC\$cVal\$ang\$f	D32-2 phase C current angle
D32MMXU2\$MX\$TotW\$mag\$f	D32-2 Total Real Power
D32MMXU2\$MX\$TotVAr\$mag\$f	D32-2 Total Reactive Power
D32MMXU2\$MX\$W\$phsA\$cVal\$mag\$f	D32-2 Phase-A Real Power
D32MMXU2\$MX\$W\$phsB\$cVal\$mag\$f	D32-2 Phase-B Real Power
D32MMXU2\$MX\$W\$phsC\$cVal\$mag\$f	D32-2 Phase-C Real Power
D32MMXU2\$MX\$VAr\$phsA\$cVal\$mag\$f	D32-2 Phase-A Reactive Power
D32MMXU2\$MX\$VAr\$phsB\$cVal\$mag\$f	D32-2 Phase-B Reactive Power
D32MMXU2\$MX\$VAr\$phsC\$cVal\$mag\$f	D32-2 Phase-C Reactive Power

D32MMXU3

This section defines logical node data for the logical node D32MMXU3.

Data Attributes	Description
D32MMXU3\$MX\$PhV\$phsA\$cVal\$mag\$f	D32-3 phase A voltage magnitude
D32MMXU3\$MX\$PhV\$phsA\$cVal\$ang\$f	D32-3 phase A voltage angle
D32MMXU3\$MX\$PhV\$phsB\$cVal\$mag\$f	D32-3 phase B voltage magnitude
D32MMXU3\$MX\$PhV\$phsB\$cVal\$ang\$f	D32-3 phase B voltage angle
D32MMXU3\$MX\$PhV\$phsC\$cVal\$mag\$f	D32-3 phase C voltage magnitude
D32MMXU3\$MX\$PhV\$phsC\$cVal\$ang\$f	D32-3 phase C voltage angle
D32MMXU3\$MX\$A\$phsA\$cVal\$mag\$f	D32-3 phase A current magnitude
D32MMXU3\$MX\$A\$phsA\$cVal\$ang\$f	D32-3 phase A current angle
D32MMXU3\$MX\$A\$phsB\$cVal\$mag\$f	D32-3 phase B current magnitude
D32MMXU3\$MX\$A\$phsB\$cVal\$ang\$f	D32-3 phase B current angle
D32MMXU3\$MX\$A\$phsC\$cVal\$mag\$f	D32-3 phase C current magnitude
D32MMXU3\$MX\$A\$phsC\$cVal\$ang\$f	D32-3 phase C current angle
D32MMXU3\$MX\$TotW\$mag\$f	D32-3 Total Real Power
D32MMXU3\$MX\$TotVAr\$mag\$f	D32-3 Total Reactive Power
D32MMXU3\$MX\$W\$phsA\$cVal\$mag\$f	D32-3 Phase-A Real Power
D32MMXU3\$MX\$W\$phsB\$cVal\$mag\$f	D32-3 Phase-B Real Power
D32MMXU3\$MX\$W\$phsC\$cVal\$mag\$f	D32-3 Phase-C Real Power
D32MMXU3\$MX\$VAr\$phsA\$cVal\$mag\$f	D32-3 Phase-A Reactive Power
D32MMXU3\$MX\$VAr\$phsB\$cVal\$mag\$f	D32-3 Phase-B Reactive Power
D32MMXU3\$MX\$VAr\$phsC\$cVal\$mag\$f	D32-3 Phase-C Reactive Power

D32MMXU4

This section defines logical node data for the logical node D32MMXU4.

Data Attributes	Description
D32MMXU4\$MX\$PhV\$phsA\$cVal\$mag\$f	D32-4 phase A voltage magnitude
D32MMXU4\$MX\$PhV\$phsA\$cVal\$ang\$f	D32-4 phase A voltage angle

D32MMXU4\$MX\$PhV\$phsB\$cVal\$mag\$f	D32-4 phase B voltage magnitude
D32MMXU4\$MX\$PhV\$phsB\$cVal\$ang\$f	D32-4 phase B voltage angle
D32MMXU4\$MX\$PhV\$phsC\$cVal\$mag\$f	D32-4 phase C voltage magnitude
D32MMXU4\$MX\$PhV\$phsC\$cVal\$ang\$f	D32-4 phase C voltage angle
D32MMXU4\$MX\$A\$phsA\$cVal\$mag\$f	D32-4 phase A current magnitude
D32MMXU4\$MX\$A\$phsA\$cVal\$ang\$f	D32-4 phase A current angle
D32MMXU4\$MX\$A\$phsB\$cVal\$mag\$f	D32-4 phase B current magnitude
D32MMXU4\$MX\$A\$phsB\$cVal\$ang\$f	D32-4 phase B current angle
D32MMXU4\$MX\$A\$phsC\$cVal\$mag\$f	D32-4 phase C current magnitude
D32MMXU4\$MX\$A\$phsC\$cVal\$ang\$f	D32-4 phase C current angle
D32MMXU4\$MX\$TotW\$mag\$f	D32-4 Total Real Power
D32MMXU4\$MX\$TotVar\$mag\$f	D32-4 Total Reactive Power
D32MMXU4\$MX\$W\$phsA\$cVal\$mag\$f	D32-4 Phase-A Real Power
D32MMXU4\$MX\$W\$phsB\$cVal\$mag\$f	D32-4 Phase-B Real Power
D32MMXU4\$MX\$W\$phsC\$cVal\$mag\$f	D32-4 Phase-C Real Power
D32MMXU4\$MX\$VAr\$phsA\$cVal\$mag\$f	D32-4 Phase-A Reactive Power
D32MMXU4\$MX\$VAr\$phsB\$cVal\$mag\$f	D32-4 Phase-B Reactive Power
D32MMXU4\$MX\$VAr\$phsC\$cVal\$mag\$f	D32-4 Phase-C Reactive Power

D60LOPMMXU1

This section defines logical node data for the logical node D60LOPMMXU1.

Data Attributes	Description
D60LOPMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D60LOP phase A voltage magnitude
D60LOPMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D60LOP phase A voltage angle
D60LOPMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D60LOP phase B voltage magnitude
D60LOPMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D60LOP phase B voltage angle
D60LOPMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D60LOP phase C voltage magnitude
D60LOPMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D60LOP phase C voltage angle

D60LOPMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D60LOP phase A current magnitude
D60LOPMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D60LOP phase A current angle
D60LOPMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D60LOP phase B current magnitude
D60LOPMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D60LOP phase B current angle
D60LOPMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D60LOP phase C current magnitude
D60LOPMMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D60LOP phase C current angle
D60LOPMSQI1\$MX\$SeqV\$c2\$cVal\$mag\$f	D60LOP Neq. Seq voltage magnitude
D60LOPMSQI1\$MX\$SeqV\$c2\$cVal\$ang\$f	D60LOP Neq. Seq voltage angle
D60LOPMSQI1\$MX\$SeqA\$c1\$cVal\$mag\$f	D60LOP Pos. Seq current magnitude
D60LOPMSQI1\$MX\$SeqA\$c1\$cVal\$ang\$f	D60LOP Pos. Seq current angle
D60LOPMSQI1\$MX\$SeqA\$c2\$cVal\$mag\$f	D60LOP Neg. Seq current angle
D60LOPMSQI1\$MX\$SeqA\$c3\$cVal\$mag\$f	D60LOP Zero. Seq current magnitude
D60LOPMSQI1\$MX\$SeqA\$c3\$cVal\$ang\$f	D60LOP Zero. Seq current angle

D60CTSMMXU1

This section defines logical node data for the logical node D60CTSMMXU1.

Data Attributes	Description
D60CTSMMXU1\$MX\$PhV\$phsA\$cVal\$mag\$f	D60LOP phase A voltage magnitude
D60CTSMMXU1\$MX\$PhV\$phsA\$cVal\$ang\$f	D60LOP phase A voltage angle
D60CTSMMXU1\$MX\$PhV\$phsB\$cVal\$mag\$f	D60LOP phase B voltage magnitude
D60CTSMMXU1\$MX\$PhV\$phsB\$cVal\$ang\$f	D60LOP phase B voltage angle
D60CTSMMXU1\$MX\$PhV\$phsC\$cVal\$mag\$f	D60LOP phase C voltage magnitude
D60CTSMMXU1\$MX\$PhV\$phsC\$cVal\$ang\$f	D60LOP phase C voltage angle
D60CTSMMXU1\$MX\$A\$phsA\$cVal\$mag\$f	D60LOP phase A current magnitude
D60CTSMMXU1\$MX\$A\$phsA\$cVal\$ang\$f	D60LOP phase A current angle
D60CTSMMXU1\$MX\$A\$phsB\$cVal\$mag\$f	D60LOP phase B current magnitude
D60CTSMMXU1\$MX\$A\$phsB\$cVal\$ang\$f	D60LOP phase B current angle
D60CTSMMXU1\$MX\$A\$phsC\$cVal\$mag\$f	D60LOP phase C current magnitude

D60CTSMXU1\$MX\$A\$phsC\$cVal\$ang\$f	D60LOP Neq. Seq voltage magnitude
D60CTSMSQI1\$MX\$SeqV\$c2\$cVal\$ang\$f	D60LOP Neq. Seq voltage angle
D60CTSMSQI1\$MX\$SeqA\$c2\$cVal\$mag\$f	D60LOP Neq. Seq current magnitude
D60CTSMSQI1\$MX\$SeqA\$c2\$cVal\$ang\$f	D60LOP Neq. Seq current angle

Protection Logical Device

D27MDTPTUV1

This section defines logical node data for the logical node D27MDTPTUV1.

Data Attributes	Description
D27MDTPTUV1\$ST\$Str\$general	27DT-1 Main DT Undervoltage Stage-1 Pickup
D27MDTPTUV1\$ST\$Str\$phsA	27DT-1 Main DT Undervoltage Stage-1 Phase A Pickup
D27MDTPTUV1\$ST\$Str\$phsB	27DT-1 Main DT Undervoltage Stage-1 Phase B Pickup
D27MDTPTUV1\$ST\$Str\$phsC	27DT-1 Main DT Undervoltage Stage-1 Phase C Pickup
D27MDTPTUV1\$ST\$Op\$general	27DT-1 Main DT Undervoltage Stage-1 Operated
D27MDTPTUV1\$ST\$Op\$phsA	27DT-1 Main DT Undervoltage Stage-1 Phase A Operated
D27MDTPTUV1\$ST\$Op\$phsB	27DT-1 Main DT Undervoltage Stage-1 Phase B Operated
D27MDTPTUV1\$ST\$Op\$phsC	27DT-1 Main DT Undervoltage Stage-1 Phase C Operated

D27MDTPTUV2

This section defines logical node data for the logical node D27MDTPTUV2.

Data Attributes	Description
D27MDTPTUV2\$ST\$Str\$general	27DT-2 Main DT Undervoltage Stage-2 Pickup
D27MDTPTUV2\$ST\$Str\$phsA	27DT-2 Main DT Undervoltage Stage-2 Phase A Pickup
D27MDTPTUV2\$ST\$Str\$phsB	27DT-2 Main DT Undervoltage Stage-2 Phase B Pickup
D27MDTPTUV2\$ST\$Str\$phsC	27DT-2 Main DT Undervoltage Stage-2 Phase C Pickup
D27MDTPTUV2\$ST\$Op\$general	27DT-2 Main DT Undervoltage Stage-2 Operated

D27MDTPTUV2\$ST\$Op\$phsA	27DT-2 Main DT Undervoltage Stage-2 Phase A Operated
D27MDTPTUV2\$ST\$Op\$phsB	27DT-2 Main DT Undervoltage Stage-2 Phase B Operated
D27MDTPTUV2\$ST\$Op\$phsC	27DT-2 Main DT Undervoltage Stage-2 Phase C Operated

D27MDTPTUV3

This section defines logical node data for the logical node D27MDTPTUV3.

Data Attributes	Description
D27MDTPTUV3\$ST\$Str\$general	27DT-3 Main DT Undervoltage Stage-3 Pickup
D27MDTPTUV3\$ST\$Str\$phsA	27DT-3 Main DT Undervoltage Stage-3 Phase A Pickup
D27MDTPTUV3\$ST\$Str\$phsB	27DT-3 Main DT Undervoltage Stage-3 Phase B Pickup
D27MDTPTUV3\$ST\$Str\$phsC	27DT-3 Main DT Undervoltage Stage-3 Phase C Pickup
D27MDTPTUV3\$ST\$Op\$general	27DT-3 Main DT Undervoltage Stage-3 Operated
D27MDTPTUV3\$ST\$Op\$phsA	27DT-3 Main DT Undervoltage Stage-3 Phase A Operated
D27MDTPTUV3\$ST\$Op\$phsB	27DT-3 Main DT Undervoltage Stage-3 Phase B Operated
D27MDTPTUV3\$ST\$Op\$phsC	27DT-3 Main DT Undervoltage Stage-3 Phase C Operated

D27MDTPTUV4

This section defines logical node data for the logical node D27MDTPTUV4.

Data Attributes	Description
D27MDTPTUV4\$ST\$Str\$general	27DT-4 Main DT Undervoltage Stage-4 Pickup
D27MDTPTUV4\$ST\$Str\$phsA	27DT-4 Main DT Undervoltage Stage-4 Phase A Pickup
D27MDTPTUV4\$ST\$Str\$phsB	27DT-4 Main DT Undervoltage Stage-4 Phase B Pickup
D27MDTPTUV4\$ST\$Str\$phsC	27DT-4 Main DT Undervoltage Stage-4 Phase C Pickup
D27MDTPTUV4\$ST\$Op\$genera	27DT-4 Main DT Undervoltage Stage-4 Operated
D27MDTPTUV4\$ST\$Op\$phsA	27DT-4 Main DT Undervoltage Stage-4 Phase A Operated
D27MDTPTUV4\$ST\$Op\$phsB	27DT-4 Main DT Undervoltage Stage-4 Phase B Operated
D27MDTPTUV4\$ST\$Op\$phsC	27DT-4 Main DT Undervoltage Stage-4 hase C Operated

D27ITPTUV1

This section defines logical node data for the logical node D27MDTPTUV4.

Data Attributes	Description
D27ITPTUV1\$ST\$Str\$general	27IT-1 Main Inverse Undervoltage Stage-1 Pickup
D27ITPTUV1\$ST\$Str\$phsA	27IT-1 Main Inverse Undervoltage Stage-1 Phase A Pickup
D27ITPTUV1\$ST\$Str\$phsB	27IT-1 Main Inverse Undervoltage Stage-1 Phase B Pickup
D27ITPTUV1\$ST\$Str\$phsC	27IT-1 Main Inverse Undervoltage Stage-1 Phase C Pickup
D27ITPTUV1\$ST\$Op\$general	27IT-1 Main Inverse Undervoltage Stage-1 Operated
D27ITPTUV1\$ST\$Op\$phsA	27IT-1 Main Inverse Undervoltage Stage-1 Phase A Operated
D27ITPTUV1\$ST\$Op\$phsB	27IT-1 Main Inverse Undervoltage Stage-1 Phase B Operated
D27ITPTUV1\$ST\$Op\$phsC	27IT-1 Main Inverse Undervoltage Stage-1 Phase C Operated

D27ITPTUV2

This section defines logical node data for the logical node D27ITPTUV2.

Data Attributes	Description
D27ITPTUV2\$ST\$Str\$general	27IT-2 Main Inverse Undervoltage Stage-2 Pickup
D27ITPTUV2\$ST\$Str\$phsA	27IT-2 Main Inverse Undervoltage Stage-2 Phase A Pickup
D27ITPTUV2\$ST\$Str\$phsB	27IT-2 Main Inverse Undervoltage Stage-2 Phase B Pickup
D27ITPTUV2\$ST\$Str\$phsC	27IT-2 Main Inverse Undervoltage Stage-2 Phase C Pickup
D27ITPTUV2\$ST\$Op\$general	27IT-2 Main Inverse Undervoltage Stage-2 Operated
D27ITPTUV2\$ST\$Op\$phsA	27IT-2 Main Inverse Undervoltage Stage-2 Phase A Operated
D27ITPTUV2\$ST\$Op\$phsB	27IT-2 Main Inverse Undervoltage Stage-2 Phase B Operated
D27ITPTUV2\$ST\$Op\$phsC	27IT-2 Main Inverse Undervoltage Stage-2 Phase C Operated

D27ADTPTUV1

This section defines logical node data for the logical node D27ADTPTUV1.

Data Attributes	Description
D27ADTPTUV1\$ST\$Str\$general	27DT-1 Aux DT Undervoltage Stage-1 Pickup
D27ADTPTUV1\$ST\$Op\$general	27DT-1 Aux DT Undervoltage Stage-1 Operated

D27ADTPTUV2

This section defines logical node data for the logical node D27ADTPTUV2.

Data Attributes	Description
D27ADTPTUV2\$ST\$Str\$general	27DT-2 Aux DT Undervoltage Stage-2 Pickup
D27ADTPTUV2\$ST\$Op\$general	27DT-2 Aux DT Undervoltage Stage-2 Operated

D27ADTPTUV3

This section defines logical node data for the logical node D27ADTPTUV2.

Data Attributes	Description
D27ADTPTUV3\$ST\$Str\$general	27DT-3 Aux DT Undervoltage Stage-3 Pickup
D27ADTPTUV3\$ST\$Op\$general	27DT-3 Aux DT Undervoltage Stage-3 Operated

D27ADTPTUV4

This section defines logical node data for the logical node D27ADTPTUV4.

Data Attributes	Description
D27ADTPTUV4\$ST\$Str\$general	27DT-4 Aux DT Undervoltage Stage-4 Pickup
D27ADTPTUV4\$ST\$Op\$general	27DT-4 Aux DT Undervoltage Stage-4 Operated

D59MDTPTOV1

This section defines logical node data for the logical node D59MDTPTOV1.

Data Attributes	Description
D59MDTPTOV1\$ST\$Str\$general	59DT-1 Main DT Overvoltage Stage-1 Pickup
D59MDTPTOV1\$ST\$Str\$phsA	59DT-1 Main DT Overvoltage Stage-1 Phase A Pickup
D59MDTPTOV1\$ST\$Str\$phsB	59DT-1 Main DT Overvoltage Stage-1 Phase B Pickup
D59MDTPTOV1\$ST\$Str\$phsC	59DT-1 Main DT Overvoltage Stage-1 Phase C Pickup
D59MDTPTOV1\$ST\$Op\$general	59DT-1 Main DT Overvoltage Stage-1 Operated
D59MDTPTOV1\$ST\$Op\$phsA	59DT-1 Main DT Overvoltage Stage-1 Phase A Operated
D59MDTPTOV1\$ST\$Op\$phsB	59DT-1 Main DT Overvoltage Stage-1 Phase B Operated
D59MDTPTOV1\$ST\$Op\$phsC	59DT-1 Main DT Overvoltage Stage-1 Phase C Operated

D59MDTPTOV2

This section defines logical node data for the logical node D59MDTPTOV2.

Data Attributes	Description
D59MDTPTOV2\$ST\$Str\$general	59DT-2 Main DT Overvoltage Stage-2 Pickup
D59MDTPTOV2\$ST\$Str\$phsA	59DT-2 Main DT Overvoltage Stage-2 Phase A Pickup
D59MDTPTOV2\$ST\$Str\$phsB	59DT-2 Main DT Overvoltage Stage-2 Phase B Pickup
D59MDTPTOV2\$ST\$Str\$phsC	59DT-2 Main DT Overvoltage Stage-2 Phase C Pickup
D59MDTPTOV2\$ST\$Op\$general	59DT-2 Main DT Overvoltage Stage-2 Operated
D59MDTPTOV2\$ST\$Op\$phsA	59DT-2 Main DT Overvoltage Stage-2 Phase A Operated
D59MDTPTOV2\$ST\$Op\$phsB	59DT-2 Main DT Overvoltage Stage-2 Phase B Operated
D59MDTPTOV2\$ST\$Op\$phsC	59DT-2 Main DT Overvoltage Stage-2 Phase C Operated

D59MDTPTOV3

This section defines logical node data for the logical node D59MDTPTOV3.

Data Attributes	Description
D59MDTPTOV3\$ST\$Str\$general	59DT-3 Main DT Overvoltage Stage-3 Pickup
D59MDTPTOV3\$ST\$Str\$phsA	59DT-3 Main DT Overvoltage Stage-3 Phase A Pickup
D59MDTPTOV3\$ST\$Str\$phsB	59DT-3 Main DT Overvoltage Stage-3 Phase B Pickup
D59MDTPTOV3\$ST\$Str\$phsC	59DT-3 Main DT Overvoltage Stage-3 Phase C Pickup
D59MDTPTOV3\$ST\$Op\$general	59DT-3 Main DT Overvoltage Stage-3 Operated
D59MDTPTOV3\$ST\$Op\$phsA	59DT-3 Main DT Overvoltage Stage-3 Phase A Operated
D59MDTPTOV3\$ST\$Op\$phsB	59DT-3 Main DT Overvoltage Stage-3 Phase B Operated
D59MDTPTOV3\$ST\$Op\$phsC	59DT-3 Main DT Overvoltage Stage-3 Phase C Operated

D59MDTPTOV4

This section defines logical node data for the logical node D59MDTPTOV4.

Data Attributes	Description
D59MDTPTOV4\$ST\$Str\$general	59DT-4 Main DT Overvoltage Stage-4 Pickup
D59MDTPTOV4\$ST\$Str\$phsA	59DT-4 Main DT Overvoltage Stage-4 Phase A Pickup
D59MDTPTOV4\$ST\$Str\$phsB	59DT-4 Main DT Overvoltage Stage-4 Phase B Pickup
D59MDTPTOV4\$ST\$Str\$phsC	59DT-4 Main DT Overvoltage Stage-4 Phase C Pickup
D59MDTPTOV4\$ST\$Op\$general	59DT-4 Main DT Overvoltage Stage-4 Operated
D59MDTPTOV4\$ST\$Op\$phsA	59DT-4 Main DT Overvoltage Stage-4 Phase A Operated
D59MDTPTOV4\$ST\$Op\$phsB	59DT-4 Main DT Overvoltage Stage-4 Phase B Operated
D59MDTPTOV4\$ST\$Op\$phsC	59DT-4 Main DT Overvoltage Stage-4 Phase C Operated

D59ITPTOV1

This section defines logical node data for the logical node D59ITPTOV1.

Data Attributes	Description
D59ITPTOV1\$ST\$Str\$general	59IT-1 Main Inverse Overvoltage Stage-1 Pickup
D59ITPTOV1\$ST\$Str\$phsA	59IT-1 Main Inverse Overvoltage Stage-1 Phase A Pickup
D59ITPTOV1\$ST\$Str\$phsB	59IT-1 Main Inverse Overvoltage Stage-1 Phase B Pickup
D59ITPTOV1\$ST\$Str\$phsC	59IT-1 Main Inverse Overvoltage Stage-1 Phase C Pickup
D59ITPTOV1\$ST\$Op\$general	59IT-1 Main Inverse Overvoltage Stage-1 Operated
D59ITPTOV1\$ST\$Op\$phsA	59IT-1 Main Inverse Overvoltage Stage-1 Phase A Operated
D59ITPTOV1\$ST\$Op\$phsB	59IT-1 Main Inverse Overvoltage Stage-1 Phase B Operated
D59ITPTOV1\$ST\$Op\$phsC	59IT-1 Main Inverse Overvoltage Stage 1 Phase C Operated

D59ITPTOV2

This section defines logical node data for the logical node D59ITPTOV2.

Data Attributes	Description
D59ITPTOV2\$ST\$Str\$general	59IT-2 Main Inverse Overvoltage Stage-2 Pickup
D59ITPTOV2\$ST\$Str\$phsA	59IT-2 Main Inverse Overvoltage Stage-2 Phase A Pickup
D59ITPTOV2\$ST\$Str\$phsB	59IT-2 Main Inverse Overvoltage Stage-2 Phase B Pickup
D59ITPTOV2\$ST\$Str\$phsC	59IT-2 Main Inverse Overvoltage Stage-2 Phase C Pickup
D59ITPTOV2\$ST\$Op\$general	59IT-2 Main Inverse Overvoltage Stage-2 Operated
D59ITPTOV2\$ST\$Op\$phsA	59IT-2 Main Inverse Overvoltage Stage-2 Phase A Operated
D59ITPTOV2\$ST\$Op\$phsB	59IT-2 Main Inverse Overvoltage Stage-2 Phase B Operated
D59ITPTOV2\$ST\$Op\$phsC	59IT-2 Main Inverse Overvoltage Stage 2 Phase C Operated

D59ADTPTOV1

This section defines logical node data for the logical node D59ADTPTOV1.

Data Attributes	Description
D59ADTPTOV1\$ST\$Str\$general	59DT-1 Aux DT Overvoltage Stage-1 Pickup
D59ADTPTOV1\$ST\$Op\$general	59DT-1 Aux DT Overvoltage Stage-1 Operated

D59ADTPTOV2

This section defines logical node data for the logical node D59ADTPTOV2.

Data Attributes	Description
D59ADTPTOV1\$ST\$Str\$general	59DT-2 Aux DT Overvoltage Stage-2 Pickup
D59ADTPTOV2\$ST\$Op\$general	59DT-2 Aux DT Overvoltage Stage-2 Operated

D59ADTPTOV3

This section defines logical node data for the logical node D59ADTPTOV3.

Data Attributes	Description
D59ADTPTOV3\$ST\$Str\$general	59DT-3 Aux DT Overvoltage Stage-3 Pickup
D59ADTPTOV3\$ST\$Op\$general	59DT-3 Aux DT Overvoltage Stage-3 Operated

D59ADTPTOV4

This section defines logical node data for the logical node D59ADTPTOV4.

Data Attributes	Description
D59ADTPTOV4\$ST\$Str\$general	59DT-4 Aux DT Overvoltage Stage-4 Pickup
D59ADTPTOV4\$ST\$Op\$general	59DT-4 Aux DT Overvoltage Stage-4 Operated

D24DTPVPH1

This section defines logical node data for the logical node D24DTPVPH1.

Data Attributes	Description
D24DTPVPH1\$ST\$Str\$general	24DT-1 DT Overflux Stage-1 Pickup
D24DTPVPH1\$ST\$Str\$phsA	24DT-1 DT Overflux Stage-1 Phase A Pickup
D24DTPVPH1\$ST\$Str\$phsB	24DT-1 DT Overflux Stage-1 Phase B Pickup
D24DTPVPH1\$ST\$Str\$phsC	24DT-1 DT Overflux Stage-1 Phase C Pickup
D24DTPVPH1\$ST\$Op\$general	24DT-1 DT Overflux Stage-1 Operated
D24DTPVPH1\$ST\$Op\$phsA	24DT-1 DT Overflux Stage-1 Phase A Operated
D24DTPVPH1\$ST\$Op\$phsB	24DT-1 DT Overflux Stage-1 Phase B Operated
D24DTPVPH1\$ST\$Op\$phsC	24DT-1 DT Overflux Stage-1 Phase C Operated

D59ITPTOV2

This section defines logical node data for the logical node D24DTPVPH2.

Data Attributes	Description
D24DTPVPH2\$ST\$Str\$general	24DT-2 DT Overflux Stage-2 Pickup
D24DTPVPH2\$ST\$Str\$phsA	24DT-2 DT Overflux Stage-2 Phase A Pickup
D24DTPVPH2\$ST\$Str\$phsB	24DT-2 DT Overflux Stage-2 Phase B Pickup
D24DTPVPH2\$ST\$Str\$phsC	24DT-2 DT Overflux Stage-2 Phase C Pickup
D24DTPVPH2\$ST\$Op\$general	24DT-2 DT Overflux Stage-2 Operated
D24DTPVPH2\$ST\$Op\$phsA	24DT-2 DT Overflux Stage-2 Phase A Operated
D24DTPVPH2\$ST\$Op\$phsB	24DT-2 DT Overflux Stage-2 Phase B Operated
D24DTPVPH2\$ST\$Op\$phsC	24DT-2 DT Overflux Stage-2 Phase C Operated

D24ITPVPH1

This section defines logical node data for the logical node D24ITPVPH1.

Data Attributes	Description
D24ITPVPH1\$ST\$Str\$general	24IT-1 Inverse Overflux Stage Pickup
D24ITPVPH1\$ST\$Str\$phsA	24IT-1 Inverse Overflux Stage Phase A Pickup
D24ITPVPH1\$ST\$Str\$phsB	24IT-1 Inverse Overflux Stage Phase B Pickup
D24ITPVPH1\$ST\$Str\$phsC	24IT-1 Inverse Overflux Stage Phase C Pickup
D24ITPVPH1\$ST\$Op\$general	24IT-1 Inverse Overflux Stage Operated
D24ITPVPH1\$ST\$Op\$phsA	24IT-1 Inverse Overflux Stage Phase A Operated
D24ITPVPH1\$ST\$Op\$phsB	24IT-1 Inverse Overflux Stage Phase B Operated
D24ITPVPH1\$ST\$Op\$phsC	24IT-1 Inverse Overflux Stage Phase C Operated

D47DTPTOV1

This section defines logical node data for the logical node D47DTPTOV1.

Data Attributes	Description
D47DTPTOV1\$ST\$Str\$general	47DT-1 DT Neg. Seq. Overvoltage Stage 1 Pickup
D47DTPTOV1\$ST\$Op\$general	47DT-1 DT Neg. Seq. Overvoltage Stage 1 Operated

D47DTPTOV2

This section defines logical node data for the logical node D47DTPTOV2.

Data Attributes	Description
D47DTPTOV2\$ST\$Str\$general	47DT-2 DT Neg. Seq. Overvoltage Stage 2 Pickup
D47DTPTOV2\$ST\$Op\$general	47DT-2 DT Neg. Seq. Overvoltage Stage 2 Operated

D47ITPTOV1

This section defines logical node data for the logical node D47ITPTOV1.

Data Attributes	Description
D47ITPTOV1\$ST\$Str\$general	47IT-1 Inverse Neg. Seq. Overvoltage Stage-1 Pickup
D47ITPTOV1\$ST\$Op\$general	47IT-1 Inverse Neg. Seq. Overvoltage Stage-1 Operated

D59NDTPTOV1

This section defines logical node data for the logical node D59NDTPTOV1.

Data Attributes	Description
D59NDTPTOV1\$ST\$Str\$general	59NDT-1 DT Zero. Seq. Overvoltage Stage-1 Pickup
D59NDTPTOV1\$ST\$Op\$genera	59NDT-1 DT Zero. Seq. Overvoltage Stage-1 Operated

D59NDTPTOV2

This section defines logical node data for the logical node D59NDTPTOV2.

Data Attributes	Description
D59NDTPTOV2\$ST\$Str\$general	59NDT-2 DT Zero. Seq. Overvoltage Stage-2 Pickup
D59NDTPTOV2\$ST\$Op\$general	59NDT-2 DT Zero. Seq. Overvoltage Stage-2 Operated

D59NITPTOV1

This section defines logical node data for the logical node D59NITPTOV1.

Data Attributes	Description
D59NITPTOV1\$ST\$Str\$general	59NIT-1 Inverse Zero. Seq. Overvoltage Stage-1 Pickup
D59NITPTOV1\$ST\$Op\$general	59NIT-1 Inverse Zero. Seq. Overvoltage Stage-1 Operated

D37PTUC1

This section defines logical node data for the logical node D37PTUC1.

Data Attributes	Description
D37PTUC1\$ST\$Str\$general	37-1 DT Undercurrent Stage-1 Pickup
D37PTUC1\$ST\$Str\$phsA	37-1 DT Undercurrent Stage-1 Phase A Pickup
D37PTUC1\$ST\$Str\$phsB	37-1 DT Undercurrent Stage-1 Phase B Pickup
D37PTUC1\$ST\$Str\$phsC	37-1 DT Undercurrent Stage-1 Phase C Pickup
D37PTUC1\$ST\$Op\$general	37-1 DT Undercurrent Stage-1 Operated
D37PTUC1\$ST\$Op\$phsA	37-1 DT Undercurrent Stage-1 Phase A Operated
D37PTUC1\$ST\$Op\$phsB	37-1 DT Undercurrent Stage-1 Phase B Operated
D37PTUC1\$ST\$Op\$phsC	37-1 DT Undercurrent Stage-1 Phase C Operated

D37PTUC2

This section defines logical node data for the logical node D37PTUC2.

Data Attributes	Description
D37PTUC2\$ST\$Str\$general	37-2 DT Undercurrent Stage-2 Pickup
D37PTUC2\$ST\$Str\$phsA	37-2 DT Undercurrent Stage-2 Phase A Pickup
D37PTUC2\$ST\$Str\$phsB	37-2 DT Undercurrent Stage-2 Phase B Pickup
D37PTUC2\$ST\$Str\$phsC	37-2 DT Undercurrent Stage-2 Phase C Pickup
D37PTUC2\$ST\$Op\$general	37-2 DT Undercurrent Stage-2 Operated
D37PTUC2\$ST\$Op\$phsA	37-2 DT Undercurrent Stage-2 Phase A Operated
D37PTUC2\$ST\$Op\$phsB	37-2 DT Undercurrent Stage-2 Phase B Operated
D37PTUC2\$ST\$Op\$phsC	37-2 DT Undercurrent Stage-2 Phase C Operated

D50PIOC1

This section defines logical node data for the logical node D50PIOC1.

Data Attributes	Description
D50PIOC1\$ST\$Str\$general	50-1 Instantaneous Overcurrent Stage-1 Pickup
D50PIOC1\$ST\$Str\$dirGeneral	50-1 Instantaneous Overcurrent Stage-1 Directional
D50PIOC1\$ST\$Str\$dirPhsA	50-1 Instantaneous Overcurrent Stage-1 Phase A Directional
D50PIOC1\$ST\$Str\$dirPhsB	50-1 Instantaneous Overcurrent Stage-1 Phase B Directional
D50PIOC1\$ST\$Str\$dirPhsC	50-1 Instantaneous Overcurrent Stage-1 Phase C Directional
D50PIOC1\$ST\$Str\$phsA	50-1 Instantaneous Overcurrent Stage-1 Phase A Pickup
D50PIOC1\$ST\$Str\$phsB	50-1 Instantaneous Overcurrent Stage-1 Phase B Pickup
D50PIOC1\$ST\$Str\$phsC	50-1 Instantaneous Overcurrent Stage-1 Phase C Pickup
D50PIOC1\$ST\$Op\$general	50-1 Instantaneous Overcurrent Stage-1 Operated
D50PIOC1\$ST\$Op\$phsA	50-1 Instantaneous Overcurrent Stage-1 Phase A Operated
D50PIOC1\$ST\$Op\$phsB	50-1 Instantaneous Overcurrent Stage-1 Phase B Operated
D50PIOC1\$ST\$Op\$phsC	50-1 Instantaneous Overcurrent Stage-1 Phase C Operated

D50PIOC2

This section defines logical node data for the logical node D50PIOC2.

Data Attributes	Description
D50PIOC2\$ST\$Str\$general	50-2 Instantaneous Overcurrent Stage-2 Pickup
D50PIOC2\$ST\$Str\$dirGeneral	50-2 Instantaneous Overcurrent Stage-2 Directional
D50PIOC2\$ST\$Str\$dirPhsA	50-2 Instantaneous Overcurrent Stage-2 Phase A Directional
D50PIOC2\$ST\$Str\$dirPhsB	50-2 Instantaneous Overcurrent Stage-2 Phase B Directional
D50PIOC2\$ST\$Str\$dirPhsC	50-2 Instantaneous Overcurrent Stage-2 Phase C Directional
D50PIOC2\$ST\$Str\$phsA	50-2 Instantaneous Overcurrent Stage-2 Phase A Pickup
D50PIOC2\$ST\$Str\$phsB	50-2 Instantaneous Overcurrent Stage-2 Phase B Pickup
D50PIOC2\$ST\$Str\$phsC	50-2 Instantaneous Overcurrent Stage-2 Phase C Pickup
D50PIOC2\$ST\$Op\$general	50-2 Instantaneous Overcurrent Stage-2 Operated
D50PIOC2\$ST\$Op\$phsA	50-2 Instantaneous Overcurrent Stage-2 Phase A Operated
D50PIOC2\$ST\$Op\$phsB	50-2 Instantaneous Overcurrent Stage-2 Phase B Operated
D50PIOC2\$ST\$Op\$phsC	50-2 Instantaneous Overcurrent Stage-2 Phase C Operated

D51PTOC1

This section defines logical node data for the logical node D51PTOC1.

Data Attributes	Description
D51PTOC1\$ST\$Str\$general	51-1 Time Phase Overcurrent Stage-1 Pickup
D51PTOC1\$ST\$Str\$dirGeneral	51-1 Time Phase Overcurrent Stage-1 Directional
D51PTOC1\$ST\$Str\$dirPhsA	51-1 Time Phase Overcurrent Stage-1 Phase A Directional
D51PTOC1\$ST\$Str\$dirPhsB	51-1 Time Phase Overcurrent Stage-1 Phase B Directional
D51PTOC1\$ST\$Str\$dirPhsC	51-1 Time Phase Overcurrent Stage-1 Phase C Directional
D51PTOC1\$ST\$Str\$phsA	51-1 Time Phase Overcurrent Stage-1 Phase A Pickup
D51PTOC1\$ST\$Str\$phsB	51-1 Time Phase Overcurrent Stage-1 Phase B Pickup
D51PTOC1\$ST\$Str\$phsC	51-1 Time Phase Overcurrent Stage-1 Phase C Pickup
D51PTOC1\$ST\$Op\$general	51-1 Time Phase Overcurrent Stage-1 Operated
D51PTOC1\$ST\$Op\$phsA	51-1 Time Phase Overcurrent Stage-1 Phase A Operated
D51PTOC1\$ST\$Op\$phsB	51-1 Time Phase Overcurrent Stage-1 Phase B Operated
D51PTOC1\$ST\$Op\$phsC	51-1 Time Phase Overcurrent Stage-1 Phase C Operated

D51PTOC2

This section defines logical node data for the logical node D51PTOC2.

Data Attributes	Description
D51PTOC2\$ST\$Str\$genera	51-2 Time Phase Overcurrent Stage-2 Pickup
D51PTOC2\$ST\$Str\$dirGeneral	51-2 Time Phase Overcurrent Stage-2 Directional
D51PTOC2\$ST\$Str\$dirPhsA	51-2 Time Phase Overcurrent Stage-2 Phase A Directional
D51PTOC2\$ST\$Str\$dirPhsB	51-2 Time Phase Overcurrent Stage-2 Phase B Directional
D51PTOC2\$ST\$Str\$dirPhsC	51-2 Time Phase Overcurrent Stage-2 Phase C Directional
D51PTOC2\$ST\$Str\$phsA	51-2 Time Phase Overcurrent Stage-2 Phase A Pickup
D51PTOC2\$ST\$Str\$phsB	51-2 Time Phase Overcurrent Stage-2 Phase B Pickup
D51PTOC2\$ST\$Str\$phsC	51-2 Time Phase Overcurrent Stage-2 Phase C Pickup
D51PTOC2\$ST\$Op\$general	51-2 Time Phase Overcurrent Stage-2 Operated
D51PTOC2\$ST\$Op\$phsA	51-2 Time Phase Overcurrent Stage-2 Phase A Operated
D51PTOC2\$ST\$Op\$phsB	51-2 Time Phase Overcurrent Stage-2 Phase B Operated
D51PTOC2\$ST\$Op\$phsC	51-2 Time Phase Overcurrent Stage-2 Phase C Operated

D50NPIOC1

This section defines logical node data for the logical node D50NPIOC1.

Data Attributes	Description
D50NPIOC1\$ST\$Str\$general	50N-1 Instantaneous Derived Neutral Overcurrent Stage-1 Pickup
D50NPIOC1\$ST\$Str\$dirGeneral	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Directional
D50NPIOC1\$ST\$Str\$phsA	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Phase A Pickup
D50NPIOC1\$ST\$Str\$phsB	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Phase B Pickup
D50NPIOC1\$ST\$Str\$phsC	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Phase C Pickup
D50NPIOC1\$ST\$Op\$general	50N-1 Instantaneous Derived Neutral Overcurrent Stage-1 Operated
D50NPIOC1\$ST\$Op\$phsA	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Phase A Operated
D50NPIOC1\$ST\$Op\$phsB	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Phase B Operated
D50NPIOC1\$ST\$Op\$phsC	50N -1 Instantaneous Derived Neutral Overcurrent Stage-1 Phase C Operated

D50NPIOC2

This section defines logical node data for the logical node D50NPIOC2.

Data Attributes	Description
D50NPIOC2\$ST\$Str\$general	50N-2 Instantaneous Derived Neutral Overcurrent Stage-2 Pickup
D50NPIOC2\$ST\$Str\$dirGeneral	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Directional
D50NPIOC2\$ST\$Str\$phsA	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Phase A Pickup

D50NPIOC2\$ST\$Str\$phsB	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Phase B Pickup
D50NPIOC2\$ST\$Str\$phsC	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Phase C Pickup
D50NPIOC2\$ST\$Op\$general	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Operated
D50NPIOC2\$ST\$Op\$phsA	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Phase A Operated
D50NPIOC2\$ST\$Op\$phsB	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Phase B Operated
D50NPIOC2\$ST\$Op\$phsC	50N -2 Instantaneous Derived Neutral Overcurrent Stage-2 Phase C Operated

D51NPTOC1

This section defines logical node data for the logical node D51NPTOC1.

Data Attributes	Description
D51NPTOC1\$ST\$Str\$general	51N-1 Time Derived Neutral Overcurrent Stage-1 Pickup
D51NPTOC1\$ST\$Str\$dirGeneral	51N-1 Time Derived Neutral Overcurrent Stage-1 Directional
D51NPTOC1\$ST\$Str\$phsA	51N-1 Time Derived Neutral Overcurrent Stage-1 Phase A Pickup
D51NPTOC1\$ST\$Str\$phsB	51N-1 Time Derived Neutral Overcurrent Stage-1 Phase B Pickup
D51NPTOC1\$ST\$Str\$phsC	51N-1 Time Derived Neutral Overcurrent Stage-1 Phase C Pickup
D51NPTOC1\$ST\$Op\$general	51N-1 Time Derived Neutral Overcurrent Stage-1 Operated
D51NPTOC1\$ST\$Op\$phsA	51N-1 Time Derived Neutral Overcurrent Stage-1 Phase A Operated
D51NPTOC1\$ST\$Op\$phsB	51N-1 Time Derived Neutral Overcurrent Stage-1 Phase B Operated
D51NPTOC1\$ST\$Op\$phsC	51N-1 Time Derived Neutral Overcurrent Stage-1 Phase C Operated

D51NPTOC2

This section defines logical node data for the logical node D51NPTOC2.

Data Attributes	Description
D51NPTOC2\$ST\$Str\$general	51N-2 Time Derived Neutral Overcurrent Stage-2 Pickup
D51NPTOC2\$ST\$Str\$dirGeneral	51N-2 Time Derived Neutral Overcurrent Stage-2 Directional
D51NPTOC2\$ST\$Str\$phsA	51N-2 Time Derived Neutral Overcurrent Stage-2 Phase A Pickup
D51NPTOC2\$ST\$Str\$phsB	51N-2 Time Derived Neutral Overcurrent Stage-2 Phase B Pickup
D51NPTOC2\$ST\$Str\$phsC	51N-2 Time Derived Neutral Overcurrent Stage-2 Phase C Pickup
D51NPTOC2\$ST\$Op\$general	51N-2 Time Derived Neutral Overcurrent Stage-2 Operated
D51NPTOC2\$ST\$Op\$phsA	51N-2 Time Derived Neutral Overcurrent Stage-2 Phase A Operated
D51NPTOC2\$ST\$Op\$phsB	51N-2 Time Derived Neutral Overcurrent Stage-2 Phase B Operated
D51NPTOC2\$ST\$Op\$phsC	51N-2 Time Derived Neutral Overcurrent Stage-2 Phase C Operated

D50GPIOC1

This section defines logical node data for the logical node D50GPIOC1.

Data Attributes	Description
D50GPIOC1\$ST\$Str\$general	50G -1 Instantaneous Measured Neutral Overcurrent Stage-1 Pickup
D50GPIOC1\$ST\$Str\$dirGeneral	50G -1 Instantaneous Measured Neutral Overcurrent Stage-1 Directional
D50GPIOC1\$ST\$Op\$general	50G -1 Instantaneous Measured Neutral Overcurrent Stage-1 Operated

D50GPIOC2

This section defines logical node data for the logical node D50GPIOC2.

Data Attributes	Description
D50GPIOC2\$ST\$Str\$general	50G -2 Instantaneous Measured Neutral Overcurrent Stage-2 Pickup
D50GPIOC2\$ST\$Str\$dirGeneral	50G -2 Instantaneous Measured Neutral Overcurrent Stage-2 Directional
D50GPIOC2\$ST\$Op\$general	50G -2 Instantaneous Measured Neutral Overcurrent Stage-2 Operated

D51GPTOC1

This section defines logical node data for the logical node D51GPTOC1.

Data Attributes	Description
D51GPTOC1\$ST\$Str\$general	51G -1 Time Measured Neutral Overcurrent Stage-1 Pickup
D51GPTOC1\$ST\$Str\$dirGeneral	51G -1 Time Measured Neutral Overcurrent Stage-1 Directional
D51GPTOC1\$ST\$Op\$general	51G -1 Time Measured Neutral Overcurrent Stage-1 Operated

D51GPTOC2

This section defines logical node data for the logical node D51GPTOC2.

Data Attributes	Description
D51GPTOC2\$ST\$Str\$general	51G -2 Time Measured Neutral Overcurrent Stage-2 Pickup
D51GPTOC2\$ST\$Str\$dirGeneral	51G -2 Time Measured Neutral Overcurrent Stage-2 Directional
D51GPTOC2\$ST\$Op\$general	51G -2 Time Measured Neutral Overcurrent Stage-2 Operated

D4650PIOC1

This section defines logical node data for the logical node D4650PIOC1.

Data Attributes	Description
D4650PIOC1\$ST\$Str\$general	4650-1 Instantaneous Neg. Seq. Overcurrent Pickup
D4650PIOC1\$ST\$Op\$general	4650-1 Instantaneous Neg. Seq. Overcurrent Operated

D4651PTOC1

This section defines logical node data for the logical node D51GPTOC1.

Data Attributes	Description
D4651PTOC1\$ST\$Str\$general	4651-1 Time Neg. Seq. Overcurrent Pickup
D4651PTOC1\$ST\$Op\$general	4651-1 Time Neg. Seq. Overcurrent Operated

D6450PSDE1

This section defines logical node data for the logical node D6450PSDE1.

Data Attributes	Description
D6450PSDE1\$ST\$Str\$general	6450 -1 Instantaneous Sensitive/Restricted Earthfault Stage-1 Pickup
D6450PSDE1\$ST\$Str\$dirGenerl	6450 -1 Instantaneous Sensitive/Restricted Earthfault Stage-1 Directional
D6450PSDE1\$ST\$Op\$general	6450 -1 Instantaneous Sensitive/Restricted Earthfault Stage-1 Operated

D6450PSDE2

This section defines logical node data for the logical node D6450PSDE2.

Data Attributes	Description
D6450PSDE2\$ST\$Str\$general	6450 -2 Instantaneous Sensitive/Restricted Earthfault Stage-2 Pickup
D6450PSDE2\$ST\$Str\$dirGeneral	6450 -2 Instantaneous Sensitive/Restricted Earthfault Stage-2 Directional
D6450PSDE2\$ST\$Op\$general	6450 -2 Instantaneous Sensitive/Restricted Earthfault Stage-2 Operated

D6451PSDE1

This section defines logical node data for the logical node D6451PSDE1.

Data Attributes	Description
D6451PSDE1\$ST\$Str\$general	6451 -1 Time Sensitive Earthfault Stage-1 Pickup
D6451PSDE1\$ST\$Str\$dirGeneral	6451 -1 Time Sensitive Earthfault Stage-1 Directional
D6451PSDE1\$ST\$Op\$general	6451 -1 Time Sensitive Earthfault Stage-1 Operated

D6451PSDE2

This section defines logical node data for the logical node D6451PSDE2.

Data Attributes	Description
D6451PSDE2\$ST\$Str\$general	6451 -2 Time Sensitive Earthfault Stage-2 Pickup
D6451PSDE2\$ST\$Str\$dirGeneral	6451 -2 Time Sensitive Earthfault Stage-2 Directional

D6451PSDE2\$ST\$Op\$general	6451 -2 Time Sensitive Earthfault Stage-2 Operated
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D49PTTR1

This section defines logical node data for the logical node D49PTTR1.

Data Attributes	Description
D49PTTR1\$MX\$Tmp\$mag\$f	49 Thermal Overload metering
D49PTTR1\$ST\$Str\$general	49 Thermal Overload Pickup
D49PTTR1\$ST\$Str\$phsA	49 Thermal Overload Phase A Pickup
D49PTTR1\$ST\$Str\$phsB	49 Thermal Overload Phase B Pickup
D49PTTR1\$ST\$Str\$phsC	49 Thermal Overload Phase C Pickup
D49PTTR1\$ST\$AlmThm\$stVal	49 Thermal Overload Alarm
D49PTTR1\$ST\$Op\$general	49 Thermal Overload Operated
D49PTTR1\$ST\$Op\$phsA	49 Thermal Overload Phase A Operated
D49PTTR1\$ST\$Op\$phsB	49 Thermal Overload Phase B Operated
D49PTTR1\$ST\$Op\$phsC	49 Thermal Overload Phase C Operated

D50BFRBRF1

This section defines logical node data for the logical node D50BFRBRF1.

Data Attributes	Description
D50BFRBRF1\$ST\$OpEx\$general	50BF-1 Breaker Failure Re-trip Operated
D50BFRBRF1\$ST\$OpEx\$phsA	50BF-1 Breaker Failure Re-trip Phase A Operated
D50BFRBRF1\$ST\$OpEx\$phsB	50BF-1 Breaker Failure Re-trip Phase B Operated
D50BFRBRF1\$ST\$OpEx\$phsC	50BF-1 Breaker Failure Re-trip Phase C Operated

D50BFRBRF2

This section defines logical node data for the logical node D50BFRBRF2.

Data Attributes	Description
D50BFRBRF2\$ST\$OpEx\$general	50BF-2 Breaker Failure Back-trip Operated
D50BFRBRF2\$ST\$OpEx\$phsA	50BF-2 Breaker Failure Back-trip Phase A Operated
D50BFRBRF2\$ST\$OpEx\$phsB	50BF-2 Breaker Failure Back-trip Phase B Operated
D50BFRBRF2\$ST\$OpEx\$phsC	50BF-2 Breaker Failure Back-trip Phase C Operated

D81HBL2PHAR1.

This section defines logical node data for the logical node D81HBL2PHAR1.

Data Attributes	Description
D81HBL2PHAR1\$ST\$Str\$genera	81HBL2 Second Harmonic Restraint/Inrush

D46BCPTOC1

This section defines logical node data for the logical node D46BCPTOC1.

Data Attributes	Description
D46BCPTOC1\$ST\$Str\$general	46BC-1 Broken Conductor Operated
D46BCPTOC1\$ST\$Op\$general	46BC-1 Broken Conductor Operated

D46BCPTOC1\$ST\$Op\$phsA	46BC-1 Broken Conductor Phase A Operated
D46BCPTOC1\$ST\$Op\$ phsB	46BC-1 Broken Conductor Phase B Operated
D46BCPTOC1\$ST\$Op\$ phsC	46BC-1 Broken Conductor Phase C Operated

D81PFRC1

This section defines logical node data for the logical node D81PFRC1.

Data Attributes	Description
D81PFRC1\$ST\$Str\$general	81-1 Rate-of-Change-of-Frequency Stage1 Pickup
D81PFRC1\$ST\$Op\$general	81-1 Rate-of-Change-of-Frequency Stage1 Operated

D81PFRC2

This section defines logical node data for the logical node D81PFRC2.

Data Attributes	Description
D81PFRC2\$ST\$Str\$general	81-2 Rate-of-Change-of-Frequency Stage2 Pickup
D81PFRC2\$ST\$Op\$general	81-2 Rate-of-Change-of-Frequency Stage2 Operated

D81PFRC3

This section defines logical node data for the logical node D81PFRC3.

Data Attributes	Description
D81PFRC3\$ST\$Str\$general	81-3 Rate-of-Change-of-Frequency Stage3 Pickup
D81PFRC3\$ST\$Op\$general	81-3 Rate-of-Change-of-Frequency Stage3 Operated

D81PFC4

This section defines logical node data for the logical node D81PFC4.

Data Attributes	Description
D81PFC4\$ST\$Str\$general	81-4 Rate-of-Change-of-Frequency Stage4 Pickup
D81PFC4\$ST\$Op\$general	81-4 Rate-of-Change-of-Frequency Stage4 Operated

D81PFC5

This section defines logical node data for the logical node D81PFC5.

Data Attributes	Description
D81PFC5\$ST\$Str\$general	81-4 Rate-of-Change-of-Frequency Stage4 Pickup
D81PFC5\$ST\$Op\$general	81-5 Rate-of-Change-of-Frequency Stage5 Operated

D81PFC6

This section defines logical node data for the logical node D81PFC6.

Data Attributes	Description
D81PFC6\$ST\$Str\$general	81-6 Rate-of-Change-of-Frequency Stage6 Pickup
D81PFC6\$ST\$Op\$general	81-6 Rate-of-Change-of-Frequency Stage6 Operated

D81PFC7

This section defines logical node data for the logical node D81PFC7.

Data Attributes	Description
D81PFC7\$ST\$Str\$general	81-7 Rate-of-Change-of-Frequency Stage7 Pickup
D81PFC7\$ST\$Op\$general	81-7 Rate-of-Change-of-Frequency Stage7 Operated

D81PFC8

This section defines logical node data for the logical node D81PFC8.

Data Attributes	Description
D81PFC8\$ST\$Str\$genera	81-8 Rate-of-Change-of-Frequency Stage8 Pickup
D81PFC8\$ST\$Op\$general	81-8 Rate-of-Change-of-Frequency Stage8 Operated

D81PFC9

This section defines logical node data for the logical node D81PFC9.

Data Attributes	Description
D81PFC9\$ST\$Str\$genera	81-9 Rate-of-Change-of-Frequency Stage9 Pickup
D81PFC9\$ST\$Op\$general	81-9 Rate-of-Change-of-Frequency Stage9 Operated

D81PFC10

This section defines logical node data for the logical node D81PFC10.

Data Attributes	Description
D81PFC10\$ST\$Str\$general	81-10 Rate-of-Change-of-Frequency Stage-10 Pickup
D81PFC9\$ST\$Op\$general	81-10 Rate-of-Change-of-Frequency Stage-10 Operated

D81PTOF1

This section defines logical node data for the logical node D81PTOF1.

Data Attributes	Description
D81PTOF1\$ST\$Str\$general	81-1 Overfrequency Stage-1 Pickup
D81PTOF1\$ST\$Op\$general	81-1 Overfrequency Stage-1 Operated

D81PFC2

This section defines logical node data for the logical node D81PTOF2.

Data Attributes	Description
D81PTOF2\$ST\$Str\$general	81-2 Overfrequency Stage-2 Pickup
D81PTOF2\$ST\$Op\$general	81-2 Overfrequency Stage-2 Operated

D81PTOF3

This section defines logical node data for the logical node D81PTOF3.

Data Attributes	Description
D81PTOF3\$ST\$Str\$general	81-3 Overfrequency Stage-3 Pickup
D81PTOF3\$ST\$Op\$general	81-3 Overfrequency Stage-3 Operated

D81PTOF4

This section defines logical node data for the logical node D81PTOF4.

Data Attributes	Description
D81PTOF5\$ST\$Str\$general	81-5 Overfrequency Stage-5 Pickup
D81PTOF5\$ST\$Op\$general	81-5 Overfrequency Stage-5 Operated

D81PTOF5

This section defines logical node data for the logical node D81PTOF5.

Data Attributes	Description
D81PTOF5\$ST\$Str\$general	81-5 Overfrequency Stage-5 Pickup
D81PTOF5\$ST\$Op\$general	81-5 Overfrequency Stage-5 Operated

D81PTOF6

This section defines logical node data for the logical node D81PTOF6.

Data Attributes	Description
D81PTOF6\$ST\$Str\$general	81-6 Overfrequency Stage-6 Pickup
D81PTOF6\$ST\$Op\$general	81-6 Overfrequency Stage-6 Operate

D81PTOF7

This section defines logical node data for the logical node D81PTOF6.

Data Attributes	Description
D81PTOF7\$ST\$Str\$general	81-7 Overfrequency Stage-7 Pickup
D81PTOF7\$ST\$Op\$general	81-7 Overfrequency Stage-7 Operated

D81PTOF8

This section defines logical node data for the logical node D81PTOF8

Data Attributes	Description
D81PTOF8\$ST\$Str\$general	81-8 Overfrequency Stage-8 Pickup
D81PTOF8\$ST\$Op\$general	81-8 Overfrequency Stage-8 Operated

D81PTOF9

This section defines logical node data for the logical node D81PTOF9.

Data Attributes	Description
D81PTOF9\$ST\$Str\$general	81-9 Overfrequency Stage-9 Pickup
D81PTOF9\$ST\$Op\$general	81-9 Overfrequency Stage-9 Operated

D81PTOF10

This section defines logical node data for the logical node D81PTOF10.

Data Attributes	Description
D81PTOF10\$ST\$Str\$general	81-10 Overfrequency Stage-10 Pickup
D81PTOF10\$ST\$Op\$general	81-10 Overfrequency Stage-10 Operated

D81PTUF1

This section defines logical node data for the logical node D81PTUF1.

Data Attributes	Description
D81PTUF1\$ST\$Str\$general	81-1 Underfrequency Stage-1 Pickup
D81PTUF1\$ST\$Op\$general	81-1 Underfrequency Stage-1 Operated

D81PTUF2

This section defines logical node data for the logical node D81PTUF2.

Data Attributes	Description
D81PTUF2\$ST\$Str\$general	81-2 Underfrequency Stage-2 Pickup
D81PTUF2\$ST\$Op\$general	81-2 Underfrequency Stage-2 Operated

D81PTUF3

This section defines logical node data for the logical node D81PTUF3.

Data Attributes	Description
D81PTUF3\$ST\$Str\$general	81-3 Underfrequency Stage-3 Pickup
D81PTUF3\$ST\$Op\$general	81-3 Underfrequency Stage-3 Operated

D81PTUF4

This section defines logical node data for the logical node D81PTUF4.

Data Attributes	Description
D81PTUF4\$ST\$Str\$general	81-4 Underfrequency Stage-4 Pickup
D81PTUF4\$ST\$Op\$general	81-4 Underfrequency Stage-4 Operated

D81PTUF5

This section defines logical node data for the logical node D81PTUF5.

Data Attributes	Description
D81PTUF5\$ST\$Str\$general	81-5 Underfrequency Stage-5 Pickup D81PTUF5\$ST\$Op\$general
D81PTUF5\$ST\$Op\$general	81-5 Underfrequency Stage-5 Operated

D81PTUF6

This section defines logical node data for the logical node D81PTUF6.

Data Attributes	Description
D81PTUF6\$ST\$Str\$general	81-6 Underfrequency Stage-6 Pickup
D81PTUF6\$ST\$Op\$general	81-6 Underfrequency Stage-6 Operated

D81PTUF7

This section defines logical node data for the logical node D81PTUF7.

Data Attributes	Description
D81PTUF7\$ST\$Str\$general	81-7 Underfrequency Stage-7 Pickup
D81PTUF7\$ST\$Op\$general	81-7 Underfrequency Stage-7 Operated

D81PTUF8

This section defines logical node data for the logical node D81PTUF8.

Data Attributes	Description
D81PTUF8\$ST\$Str\$general	81-8 Underfrequency Stage-8 Pickup
D81PTUF8\$ST\$Op\$general	81-8 Underfrequency Stage-8 Operated

D81PTUF9

This section defines logical node data for the logical node D81PTUF9.

Data Attributes	Description
D81PTUF9\$ST\$Str\$general	81-9 Underfrequency Stage-9 Pickup
D81PTUF9\$ST\$Op\$general	81-9 Underfrequency Stage-9 Operated

D81PTUF10

This section defines logical node data for the logical node D81PTUF10.

Data Attributes	Description
D81PTUF10\$ST\$Str\$general	81-10 Underfrequency Stage-10 Pickup
D81PTUF10\$ST\$Op\$general	81-10 Underfrequency Stage-10 Operated

D32PDUP1

This section defines logical node data for the logical node D32PDUP1.

Data Attributes	Description
D32PDUP1\$ST\$Str\$general	32-1 Dir. Underpower Stage-1 Pickup
D32PDUP1\$ST\$Str\$phsA	32-1 Dir. Underpower Stage-1 Phase A Pickup
D32PDUP1\$ST\$Str\$phsB	32-1 Dir. Underpower Stage-1 Phase B Pickup
D32PDUP1\$ST\$Str\$phsC	32-1 Dir. Underpower Stage-1 Phase C Pickup
D32PDUP1\$ST\$Op\$general	32-1 Dir. Underpower Stage-1 Operated
D32PDUP1\$ST\$Op\$phsA	32-1 Dir. Underpower Stage-1 Phase A Operated
D32PDUP1\$ST\$Op\$phsB	32-1 Dir. Underpower Stage-1 Phase B Operated
D32PDUP1\$ST\$Op\$phsC	32-1 Dir. Underpower Stage-1 Phase C Operated

D32PDUP2

This section defines logical node data for the logical node D32PDUP2.

Data Attributes	Description
D32PDUP2\$ST\$Str\$general	32-2 Dir. Underpower Stage-2 Pickup
D32PDUP2\$ST\$Str\$phsA	32-2 Dir. Underpower Stage-2 Phase A Pickup
D32PDUP2\$ST\$Str\$phsB	32-2 Dir. Underpower Stage-2 Phase B Pickup
D32PDUP2\$ST\$Str\$phsC	32-2 Dir. Underpower Stage-2 Phase C Pickup
D32PDUP2\$ST\$Op\$general	32-2 Dir. Underpower Stage-2 Operated

D32PDUP2\$ST\$Op\$phsA	32-2 Dir. Underpower Stage-2 Phase A Operated
D32PDUP2\$ST\$Op\$phsB	32-2 Dir. Underpower Stage-2 Phase B Operated
D32PDUP2\$ST\$Op\$phsC	32-2 Dir. Underpower Stage-2 Phase C Operated

D32PDUP3

This section defines logical node data for the logical node D32PDUP3.

Data Attributes	Description
D32PDUP3\$ST\$Str\$general	32-3 Dir. Underpower Stage-3 Pickup
D32PDUP3\$ST\$Str\$phsA	32-3 Dir. Underpower Stage-3 Phase A Pickup
D32PDUP3\$ST\$Str\$phsB	32-3 Dir. Underpower Stage-3 Phase B Pickup
D32PDUP3\$ST\$Str\$phsC	32-3 Dir. Underpower Stage-3 Phase C Pickup
D32PDUP3\$ST\$Op\$general	32-3 Dir. Underpower Stage-3 Operated
D32PDUP3\$ST\$Op\$phsA	32-3 Dir. Underpower Stage-3 Phase A Operated
D32PDUP3\$ST\$Op\$phsB	32-3 Dir. Underpower Stage-3 Phase B Operated
D32PDUP3\$ST\$Op\$phsC	32-3 Dir. Underpower Stage-3 Phase C Operated

D32PDUP4

This section defines logical node data for the logical node D32PDUP4.

Data Attributes	Description
D32PDUP4\$ST\$Str\$general	32-4 Dir. Underpower Stage-4 Pickup
D32PDUP4\$ST\$Str\$phsA	32-4 Dir. Underpower Stage-4 Phase A Pickup
D32PDUP4\$ST\$Str\$phsB	32-4 Dir. Underpower Stage-4 Phase B Pickup
D32PDUP4\$ST\$Str\$phsC	32-4 Dir. Underpower Stage-4 Phase C Pickup
D32PDUP4\$ST\$Op\$general	32-4 Dir. Underpower Stage-4 Operated
D32PDUP4\$ST\$Op\$phsA	32-4 Dir. Underpower Stage-4 Phase A Operated
D32PDUP4\$ST\$Op\$phsB	32-4 Dir. Underpower Stage-4 Phase B Operated

D32PDUP4\$ST\$Op\$phsC	32-4 Dir. Underpower Stage-4 Phase C Operated
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D60CTSPTOC1

This section defines logical node data for the logical node D60CTSPTOC1.

Data Attributes	Description
D60CTSPTOC1\$ST\$Str\$general	60CTS CT Supervision Operated
D60CTSPTOC1\$ST\$Op\$general	60CTS CT Supervision Operated

D60LOPPTOV1

This section defines logical node data for the logical node D60LOPPTOV1.

Data Attributes	Description
D60LOPPTOV1\$ST\$Str\$general	60PTS PT Supervision Operated
D60LOPPTOV1\$ST\$Op\$general	60PTS PT Supervision Operated

D74TCSRTCS

This section defines logical node data for the logical node D74TCSRTCS.

Data Attributes	Description
D74TCSRTCS1\$ST\$Op\$general	74TCS Trip Circuit-1 Supervision Operated
D74TCSRTCS2\$ST\$Op\$general	74TCS Trip Circuit-2 Supervision Operated

D74TCSRTCS

This section defines logical node data for the logical node D74TCSRTCS.

Data Attributes	Description
D74TCSRTCS1\$ST\$Op\$general	74TCS Trip Circuit-1 Supervision Operated
D74TCSRTCS2\$ST\$Op\$general	74TCS Trip Circuit-2 Supervision Operated

I2TRCBC1

This section defines logical node data for the logical node I2TRCBC1.

Data Attributes	Description
I2TRCBC1\$ST\$Op\$general	I2TCB CB Condition Operated
I2TRCBC1\$MX\$I2TAcc\$mag\$f	I2TCB CB Condition Accumulated metering value
I2TRCBC1\$MX\$I2TlStOp\$mag\$f	I2TCB CB Condition Last Operated metering value

THDRTHD

This section defines logical node data for the logical node THDRTHD.

Data Attributes	Description
THDRTHD1\$ST\$Op\$general	THD Total Harmonic Distortion Stage-1
THDRTHD2\$ST\$Op\$general	THD Total Harmonic Distortion Stage-2

D25SYCRSYN1

This section defines logical node data for the logical node D25SYCRSYN1.

Data Attributes	Description
D25SYCRSYN1\$ST\$Rel\$stVal	25/27/59 Synchro Check

D79RREC1 & D79GGIO1

This section defines logical node data for the logical nodes D79RREC1 & D79GGIO1.

Data Attributes	Description
D79RREC1\$ST\$OpCls\$general	79 Auto Reclose Operated
D79RREC1\$ST\$OpCls\$phsA	79 Auto Reclose Phase A Operated
D79RREC1\$ST\$OpCls\$phsB	79 Auto Reclose Phase B Operated
D79RREC1\$ST\$OpCls\$phsC	79 Auto Reclose Phase C Operated
D79RREC1\$ST\$AutoRecSt\$stVal	79 Auto Reclose Status change event
D79GGIO1\$ST\$Ind1\$stVal	79 Auto Reclose Cumulative Count Alarm Status

Record Logical Device

RDRE1

This section defines logical node data for the logical node RDRE1.

Data Attributes	Description
RDRE1\$ST\$MemUsed\$stVal	RDRE Used Record Memory
RDRE1\$ST\$RcdMade\$stVal	RDRE Record Made
RDRE1\$ST\$FltNum\$stVal	RDRE Record Fault Qty
RDRE1\$ST\$RcdStr\$stVal	RDRE Record Start

System Logical Device

EIGGIO3

This section defines logical node data for the logical node EIGGIO3.

Data Attributes	Description
EIGGIO3\$ST\$Ind1\$stVal	External Input - 01
EIGGIO3\$ST\$Ind2\$stVal	External Input - 02
EIGGIO3\$ST\$Ind3\$stVal	External Input - 03
EIGGIO3\$ST\$Ind4\$stVal	External Input - 04

EIGGIO3\$ST\$Ind5\$stVal	External Input – 05
EIGGIO3\$ST\$Ind6\$stVal	External Input – 06
EIGGIO3\$ST\$Ind7\$stVal	External Input – 07
EIGGIO3\$ST\$Ind8\$stVal	External Input – 08
EIGGIO3\$ST\$Ind9\$stVal	External Input – 09
EIGGIO3\$ST\$Ind10\$stVal	External Input – 10
EIGGIO3\$ST\$Ind11\$stVal	External Input – 11
EIGGIO3\$ST\$Ind12\$stVal	External Input – 12
EIGGIO3\$ST\$Ind13\$stVal	External Input – 13
EIGGIO3\$ST\$Ind14\$stVal	External Input – 14
EIGGIO3\$ST\$Ind15\$stVal	External Input – 15
EIGGIO3\$ST\$Ind16\$stVal	External Input – 16
EIGGIO3\$ST\$Ind17\$stVal	External Input – 17
EIGGIO3\$ST\$Ind18\$stVal	External Input – 18
EIGGIO3\$ST\$Ind19\$stVal	External Input – 19
EIGGIO3\$ST\$Ind20\$stVal	External Input – 20
EIGGIO3\$ST\$Ind21\$stVal	External Input – 21
EIGGIO3\$ST\$Ind22\$stVal	External Input – 22
EIGGIO3\$ST\$Ind23\$stVal	External Input – 23
EIGGIO3\$ST\$Ind24\$stVal	External Input – 24

LEDGGIO5

This section defines logical node data for the logical node LEDGGIO5.

Data Attributes	Description
LEDGGIO5\$ST\$Ind1\$stVal	LED - 01
LEDGGIO5\$ST\$Ind2\$stVal	LED - 02
LEDGGIO5\$ST\$Ind3\$stVal	LED - 03
LEDGGIO5\$ST\$Ind4\$stVal	LED - 04
LEDGGIO5\$ST\$Ind5\$stVal	LED - 05

LEDGGIO5\$ST\$Ind6\$stVal	LED - 06
LEDGGIO5\$ST\$Ind7\$stVal	LED - 07
LEDGGIO5\$ST\$Ind8\$stVal	LED - 08
LEDGGIO5\$ST\$Ind9\$stVal	LED - 09
LEDGGIO5\$ST\$Ind10\$stVal	LED - 10
LEDGGIO5\$ST\$Ind11\$stVal	LED - 11
LEDGGIO5\$ST\$Ind12\$stVal	LED - 12
LEDGGIO5\$ST\$Ind13\$stVal	LED - 13
LEDGGIO5\$ST\$Ind14\$stVal	LED - 14
LEDGGIO5\$ST\$Ind15\$stVal	LED - 15
LEDGGIO5\$ST\$Ind16\$stVal	LED - 16
LEDGGIO5\$ST\$Ind17\$stVal	LED - 17
LEDGGIO5\$ST\$Ind18\$stVal	LED – 18 (Alarm LED)
LEDGGIO5\$ST\$Ind19\$stVal	LED – 19 (Service Required mode LED)

OCGGIO4

This section defines logical node data for the logical node OCGGIO4.

Data Attributes	Description
OCGGIO4\$ST\$Ind1\$stVal	Output Contact – 01
OCGGIO4\$ST\$Ind2\$stVal	Output Contact – 02
OCGGIO4\$ST\$Ind3\$stVal	Output Contact – 03
OCGGIO4\$ST\$Ind4\$stVal	Output Contact – 04
OCGGIO4\$ST\$Ind5\$stVal	Output Contact – 05
OCGGIO4\$ST\$Ind6\$stVal	Output Contact – 06
OCGGIO4\$ST\$Ind7\$stVal	Output Contact – 07
OCGGIO4\$ST\$Ind8\$stVal	Output Contact – 08
OCGGIO4\$ST\$Ind9\$stVal	Output Contact – 09
OCGGIO4\$ST\$Ind10\$stVal	Output Contact – 10
OCGGIO4\$ST\$Ind11\$stVal	Output Contact – 11

OCGGIO4\$ST\$Ind12\$stVal	Output Contact – 12
OCGGIO4\$ST\$Ind13\$stVal	Output Contact – 13
OCGGIO4\$ST\$Ind14\$stVal	Output Contact – 14
OCGGIO4\$ST\$Ind15\$stVal	Output Contact – 15
OCGGIO4\$ST\$Ind16\$stVal	Output Contact – 16
OCGGIO4\$ST\$Ind17\$stVal	Output Contact – 17
OCGGIO4\$ST\$Ind18\$stVal	Output Contact – 18
OCGGIO4\$ST\$Ind19\$stVal	Output Contact – 19
OCGGIO4\$ST\$Ind20\$stVal	Output Contact – 20
OCGGIO4\$ST\$Ind21\$stVal	Output Contact – 21
OCGGIO4\$ST\$Ind22\$stVal	Output Contact – 22
OCGGIO4\$ST\$Ind23\$stVal	Output Contact – 23
OCGGIO4\$ST\$Ind24\$stVal	Output Contact – 24
OCGGIO4\$ST\$Ind25\$stVal	Output Contact – 25
OCGGIO4\$ST\$Ind26\$stVal	Output Contact – 26
OCGGIO4\$ST\$Ind27\$stVal	Output Contact – 27
OCGGIO4\$ST\$Ind28\$stVal	Output Contact – 28
OCGGIO4\$ST\$Ind29\$stVal	Output Contact – 29
OCGGIO4\$ST\$Ind30\$stVal	Output Contact – 30
OCGGIO4\$ST\$Ind31\$stVal	Output Contact – 31
OCGGIO4\$ST\$Ind32\$stVal	Output Contact – 32

PLGGIO1

This section defines logical node data for the logical node PLGGIO1.

Data Attributes	Description
PLGGIO1\$ST\$Ind1\$stVal	Prologic - 01
PLGGIO1\$ST\$Ind2\$stVal	Prologic - 02
PLGGIO1\$ST\$Ind3\$stVal	Prologic - 03

PLGGIO1\$ST\$Ind4\$stVal	Prologic - 04
PLGGIO1\$ST\$Ind5\$stVal	Prologic - 05
PLGGIO1\$ST\$Ind6\$stVal	Prologic - 06
PLGGIO1\$ST\$Ind7\$stVal	Prologic - 07
PLGGIO1\$ST\$Ind8\$stVal	Prologic - 08
PLGGIO1\$ST\$Ind9\$stVal	Prologic - 09
PLGGIO1\$ST\$Ind10\$stVal	Prologic - 10
PLGGIO1\$ST\$Ind11\$stVa	Prologic - 11
PLGGIO1\$ST\$Ind12\$stVal	Prologic - 12
PLGGIO1\$ST\$Ind13\$stVal	Prologic - 13
PLGGIO1\$ST\$Ind14\$stVal	Prologic - 14
PLGGIO1\$ST\$Ind15\$stVal	Prologic - 15
PLGGIO1\$ST\$Ind16\$stVal	Prologic - 16
PLGGIO1\$ST\$Ind17\$stVal	Prologic - 17
PLGGIO1\$ST\$Ind18\$stVal	Prologic - 18
PLGGIO1\$ST\$Ind19\$stVal	Prologic - 19
PLGGIO1\$ST\$Ind20\$stVal	Prologic - 20
PLGGIO1\$ST\$Ind21\$stVal	Prologic - 21
PLGGIO1\$ST\$Ind22\$stVal	Prologic - 22
PLGGIO1\$ST\$Ind23\$stVal	Prologic - 23
PLGGIO1\$ST\$Ind24\$stVal	Prologic - 24

SChAlmGGIO8

This section defines logical node data for the logical node SChAlmGGIO8.

Data Attributes	Description
SChAlmGGIO8\$ST\$Ind1\$stVal	Self Check Fail Alarm

ComAlmGGIO9

This section defines logical node data for the logical node ComAlmGGIO9.

Data Attributes	Description
ComAlmGGIO9\$ST\$Ind1\$stVal	GOOSE Communication fail alarm

SGGGIO2

This section defines logical node data for the logical node SGGGIO2.

Data Attributes	Description
SGGGIO2\$ST\$IntIn1\$stVal	Setting Group Change Status

TSAlmGGIO7

This section defines logical node data for the logical node TSAlmGGIO7.

Data Attributes	Description
TSAlmGGIO7\$ST\$Ind1\$stVal	Time Sync Loss Alarm Status

VIGGIO6

This section defines logical node data for the logical node VIGGIO6.

Data Attributes	Description
VIGGIO6\$ST\$Ind1\$stVal	Virtual Input - 01
VIGGIO6\$ST\$Ind2\$stVal	Virtual Input - 02
VIGGIO6\$ST\$Ind3\$stVal	Virtual Input - 03
VIGGIO6\$ST\$Ind4\$stVal	Virtual Input - 04
VIGGIO6\$ST\$Ind5\$stVal	Virtual Input - 05
VIGGIO6\$ST\$Ind6\$stVal	Virtual Input - 06
VIGGIO6\$ST\$Ind7\$stVal	Virtual Input - 07
VIGGIO6\$ST\$Ind8\$stVal	Virtual Input - 08
VIGGIO6\$ST\$Ind9\$stVal	Virtual Input - 09
VIGGIO6\$ST\$Ind10\$stVal	Virtual Input - 10
VIGGIO6\$ST\$Ind11\$stVa	Virtual Input - 11
VIGGIO6\$ST\$Ind12\$stVal	Virtual Input - 12
VIGGIO6\$ST\$Ind13\$stVal	Virtual Input - 13
VIGGIO6\$ST\$Ind14\$stVal	Virtual Input - 14
VIGGIO6\$ST\$Ind15\$stVal	Virtual Input - 15
VIGGIO6\$ST\$Ind16\$stVal	Virtual Input - 16
VIGGIO6\$ST\$Ind17\$stVal	Virtual Input - 17
VIGGIO6\$ST\$Ind18\$stVal	Virtual Input - 18
VIGGIO6\$ST\$Ind19\$stVal	Virtual Input - 19
VIGGIO6\$ST\$Ind20\$stVal	Virtual Input - 20
VIGGIO6\$ST\$Ind21\$stVal	Virtual Input - 21
VIGGIO6\$ST\$Ind22\$stVal	Virtual Input - 22
VIGGIO6\$ST\$Ind23\$stVal	Virtual Input - 23
VIGGIO6\$ST\$Ind24\$stVal	Virtual Input - 24
VIGGIO6\$ST\$Ind25\$stVa	Virtual Input - 25
VIGGIO6\$ST\$Ind26\$stVal	Virtual Input - 26

VIGGIO6\$ST\$Ind27\$stVal	Virtual Input - 27
VIGGIO6\$ST\$Ind28\$stVal	Virtual Input - 28
VIGGIO6\$ST\$Ind29\$stVal	Virtual Input - 29
VIGGIO6\$ST\$Ind30\$stVa	Virtual Input - 30

Subscription Logical Device:

SUBSCRGGIO

This section defines logical node data for the logical node SUBSCRGGIO.

Data Attributes	Description
SUBSCRGGIO1\$ST\$Ind1\$stVal	Subscribed Input - 01
SUBSCRGGIO1\$ST\$Ind2\$stVal	Subscribed Input - 02
SUBSCRGGIO1\$ST\$Ind3\$stVal	Subscribed Input - 03
SUBSCRGGIO1\$ST\$Ind4\$stVal	Subscribed Input - 04
SUBSCRGGIO1\$ST\$Ind5\$stVal	Subscribed Input - 05
SUBSCRGGIO1\$ST\$Ind6\$stVal	Subscribed Input - 06
SUBSCRGGIO1\$ST\$Ind7\$stVal	Subscribed Input - 07
SUBSCRGGIO1\$ST\$Ind8\$stVal	Subscribed Input - 08
SUBSCRGGIO1\$ST\$Ind9\$stVal	Subscribed Input - 09
SUBSCRGGIO1\$ST\$Ind10\$stVal	Subscribed Input - 10
SUBSCRGGIO1\$ST\$Ind11\$stVal	Subscribed Input - 11
SUBSCRGGIO1\$ST\$Ind12\$stVal	Subscribed Input - 12
SUBSCRGGIO1\$ST\$Ind13\$stVal	Subscribed Input - 13
SUBSCRGGIO1\$ST\$Ind14\$stVal	Subscribed Input - 14
SUBSCRGGIO1\$ST\$Ind15\$stVal	Subscribed Input - 15
SUBSCRGGIO1\$ST\$Ind16\$stVal	Subscribed Input - 16
SUBSCRGGIO1\$ST\$Ind17\$stVal	Subscribed Input - 17
SUBSCRGGIO1\$ST\$Ind18\$stVal	Subscribed Input - 18

SUBSCRGGIO1\$ST\$Ind19\$stVal	Subscribed Input - 19
SUBSCRGGIO1\$ST\$Ind20\$stVal	Subscribed Input - 20
SUBSCRGGIO1\$ST\$Ind21\$stVal	Subscribed Input - 21
SUBSCRGGIO1\$ST\$Ind22\$stVal	Subscribed Input - 22
SUBSCRGGIO1\$ST\$Ind23\$stVal	Subscribed Input - 23
SUBSCRGGIO1\$ST\$Ind24\$stVal	Subscribed Input - 24
SUBSCRGGIO1\$ST\$Ind25\$stVal	Subscribed Input- 25
SUBSCRGGIO1\$ST\$Ind26\$stVal	Subscribed Input- 26
SUBSCRGGIO1\$ST\$Ind27\$stVal	Subscribed Input - 27
SUBSCRGGIO1\$ST\$Ind28\$stVal	Subscribed Input - 28
SUBSCRGGIO1\$ST\$Ind29\$stVal	Subscribed Input - 29
SUBSCRGGIO1\$ST\$Ind30\$stVal	Subscribed Input - 30

Test/simulation

LPHD

This section defines logical node data for the logical node LPHD

Data Attributes	Description
LPHD1\$ST\$Sim\$stVal	Simulation mode
LLN0\$ST\$Beh\$stVal	Beh
SUBSCRGGIO1\$ST\$Beh\$stVal	Test mode

Single Point Control Commands

SPCSOPULGGIO1

This section defines logical node data for the logical node SPCSOPULGGIO1.

Data Attributes	Description
SPCSOPULGGIO1\$CO\$SPCS01\$Oper\$ctlVal	Single Point Control – Pulsed - 01
SPCSOPULGGIO1\$CO\$SPCS02\$Oper\$ctlVal	Single Point Control – Pulsed - 02

SPCSOPULGGIO1\$CO\$SPCS03\$Oper\$ctlVal	Single Point Control – Pulsed - 03
SPCSOPULGGIO1\$CO\$SPCS04\$Oper\$ctlVal	Single Point Control – Pulsed - 04
SPCSOPULGGIO1\$CO\$SPCS05\$Oper\$ctlVal	Single Point Control – Pulsed - 05
SPCSOPULGGIO1\$CO\$SPCS06\$Oper\$ctlVal	Single Point Control – Pulsed - 06
SPCSOPULGGIO1\$CO\$SPCS07\$Oper\$ctlVal	Single Point Control – Latched - 07
SPCSOPULGGIO1\$CO\$SPCS08\$Oper\$ctlVal	Single Point Control – Latched - 08
SPCSOPULGGIO1\$CO\$SPCS09\$Oper\$ctlVal	Single Point Control – Latched - 09
SPCSOPULGGIO1\$CO\$SPCS010\$Oper\$ctlVal	Single Point Control – Latched - 10
SPCSOPULGGIO1\$CO\$SPCS011\$Oper\$ctlVal	Single Point Control – Latched - 11
SPCSOPULGGIO1\$CO\$SPCS012\$Oper\$ctlVal	Single Point Control – Latched - 12

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