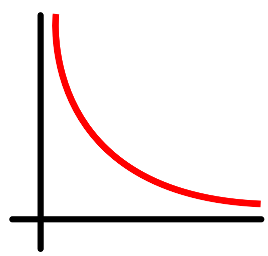
# F-PRO 298

## Feeder Protection Relay



## User Manual

**Version 1.7 Rev 0**

# Preface

Information in this document is subject to change without notice.



This manual is part of a complete set of product documentation that includes detailed drawings and operation. Users should evaluate the information in the context of the complete set of product documentation and their particular applications. ERLPhase assumes no liability for any incidental, indirect or consequential damages arising from the use of this documentation.

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# Using This Guide

This User Manual describes the installation and operation of the F-PRO 298 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 |
|---|---|
| *Start>Settings>Control Panel* | 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. |

# Table of Contents

# Acronyms

ASG- Active Setting Group

CT- Current Transformer

DCE- Data Communication Equipment

GPS- Global Positioning System

GUI- Graphical User Interface

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

LED- Light-emitting Diode

LCD- Liquid Crystal Display

LHS- Left Hand Side

RHS- Right Hand Side

RTU- Remote Terminal Unit

SCADA- Supervisory Control And Data Acquisition

SG- Setting Group

TCP- Transmission Control Protocol

TDR - Transient Disturbance Recording

UI - User Interface

VI - Virtual Input

# Version Compatibility

For version compatibility check D05105F-PRO Firmware Release Description which is available on the ERLPhase website: www.erlphase.com.

This manual was created using the following software and firmware versions:

- Relay Control Panel v3.3
- F-PRO Offliner v3.1

This manual is compatible with higher versions of firmware or software unless a higher version of this manual states otherwise.

# 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 operating systems must be installed and functional prior to installing the applications:

- Microsoft Windows 7
- Microsoft Windows 10

## 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 Configurator Tool
- RecordGraph
- RecordBase View
- USB Driver
- F-PRO 298 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 298 is a microprocessor-based relay providing protection, monitoring, logging and recording functions suitable for transmission, sub-transmission and distribution applications.

The ERLPhase software has two working modes - online and offline. Relay Control Panel is the online tool, which enables the user to:

- Change, review & retrieve relay settings
- View event, fault and metering information
- Store records
- Trigger and retrieve recordings

F-PRO Offliner is the offline tool which enables the user to create and review relay settings.

RecordGraph enables users to analyze fault waveforms.

In addition to the protection functions F-PRO 298 provides fault recording (32 samples / cycle) for analysis of the power system after a disturbance has occurred. The triggers for fault recording are established by programming the output matrix. The Output Matrix allows any internal relay function, external input or GOOSE messaging input to initiate record.

The primary protection provided is Voltage, Current and Frequency based. 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, F-PRO 298 provides other functions such as:

- Fault Locator
- Breaker failure Protection (50BF)
- Multi-shot Auto Recloser (79)
- CT Fail Supervision (60CTS)
- VT Fail Supervision (60VTS)
- 20 ProLogic statements
- 30 Virtual Inputs
- 8 Setting Groups

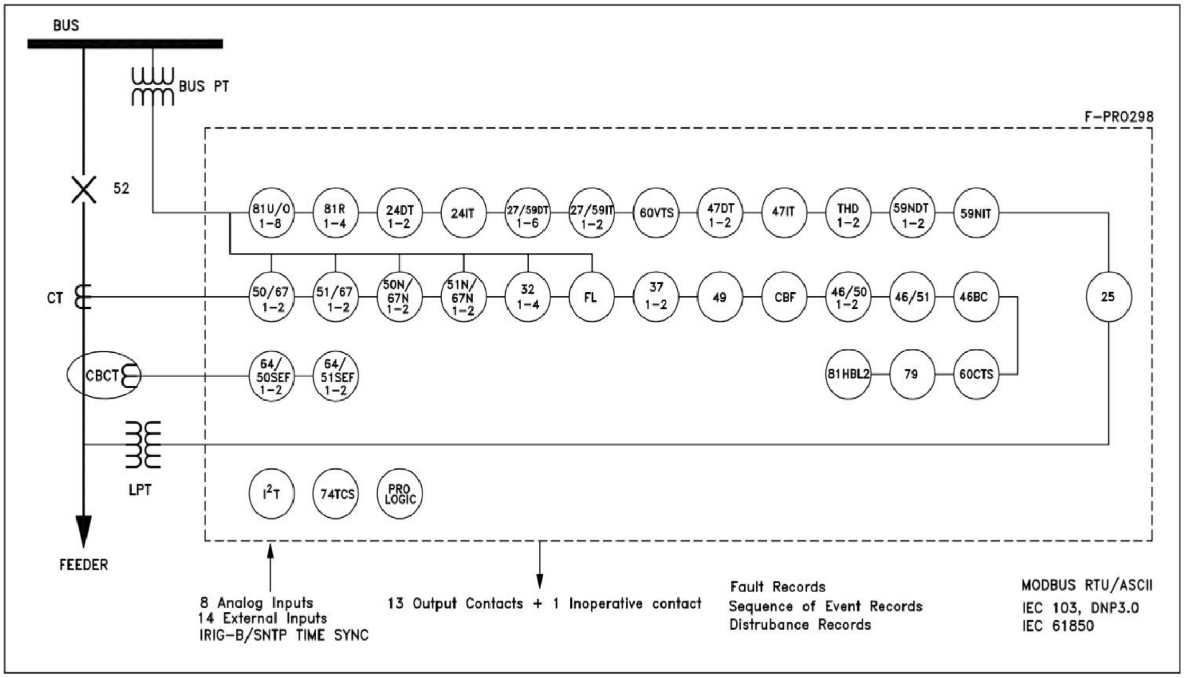



Figure 1.1: F-PRO 298 Relay Function Line Diagram

# 1.2 Front View

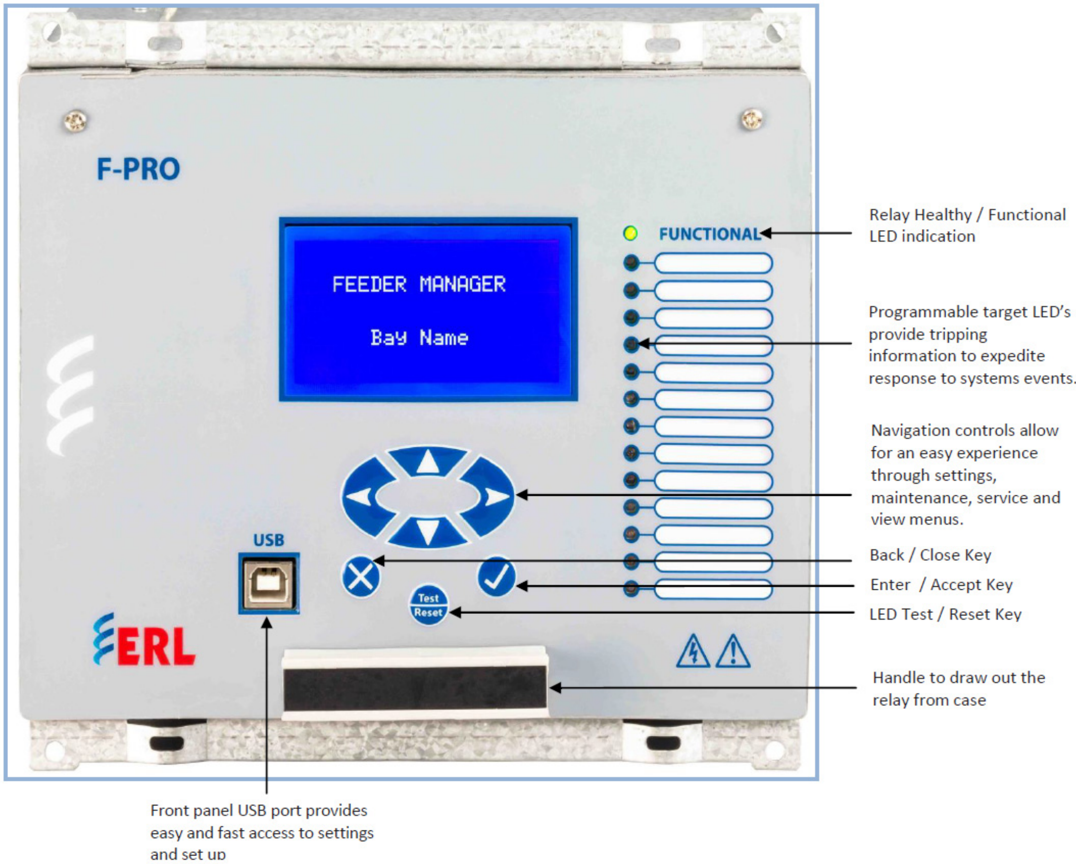



Figure 1.2: F-PRO 298 Relay Front View

# 1.3 Rear View

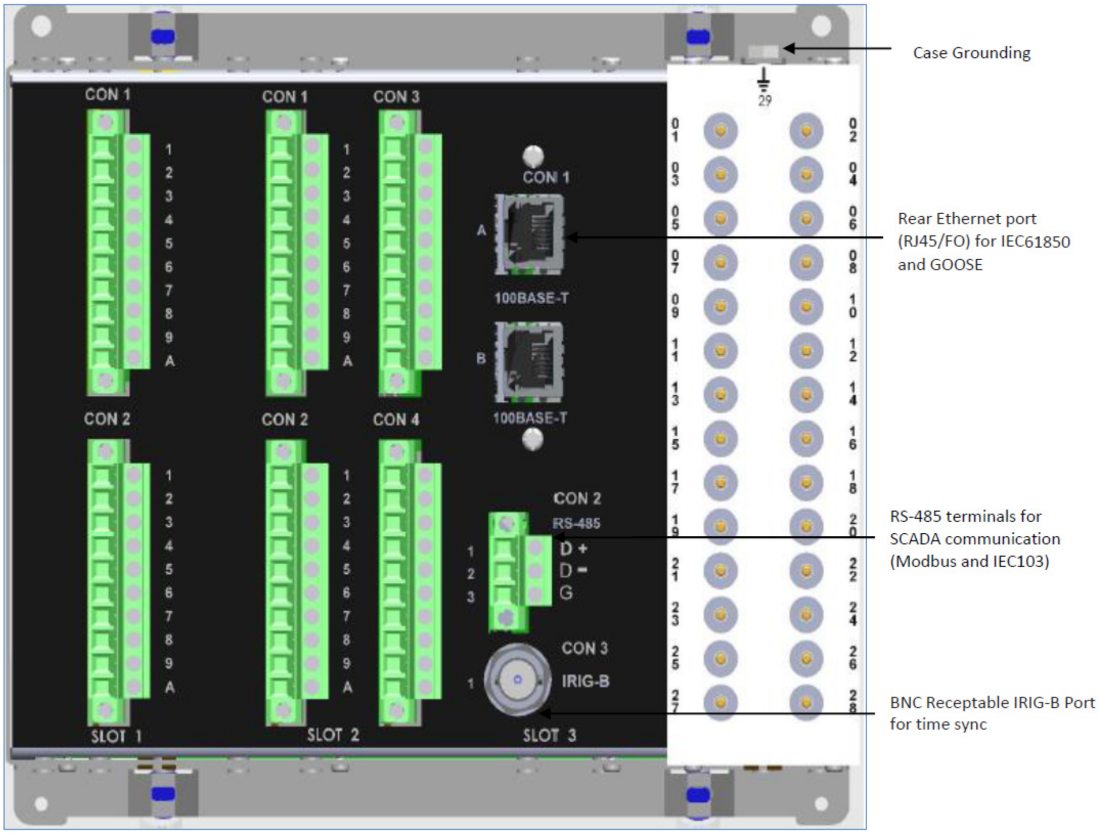



Figure 1.3: F-PRO 298 Relay Rear View

## AC Current and Voltage Inputs

The F-PRO 298 relay is provided with terminal blocks for 4 AC Voltages and 4 AC Currents. 1A and 5A terminals are provided with isolated neutral and CT Secondary is site selectable.

The complete schematics are available in "Mechanical Drawings" on page Appendix H-1 and "AC Schematic Drawings" on page Appendix I-1.

## External Inputs

The F-PRO 298 relay has 14 External Inputs.

External dc voltage of either 24, 48, 110 or 220 Vdc nominal are possible depending on the range requested. Selection of specific voltage is factory selectable.

## Output Relay Contacts

The F-PRO 298 Relay has 14 Output Contacts. Each contact is programmable and has breaker tripping capability. All output contacts are isolated from each other. All the contacts are provided with settable dropout timers (0-1 sec) which applies for the Self Reset (see "The relay configuration changes during a relay-initiated setting change, but the protection function operations are not disrupted. Since the relay setting file does not change, the interface processor uses the new setting group supplementary 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.” on page 5-67).

## Relay Functional Alarm Output

If the relay becomes inoperative, then the Relay Functional Alarm output contact opens and all tripping functions are blocked. Output Contact 14 may be enabled or disabled as Relay Functional Alarm Contact in the Output Matrix. During the relay inoperative period, all tripping functions are blocked.

# 1.4 Model Options/Ordering

- The relay is available as an E8 size and flush mount type along with standard IRIG-B /SNTP time sync. For details see “Mechanical Drawings” on page Appendix H-1
- The relay is available with optional Ethernet ports for PRP (RJ45/FO).
- The external inputs are 24, 48, 110, 220 Vdc rated. The Auxiliary supply is 20-60 Vdc or 80-300 Vdc rated.
- All of the above options must be specified at the time of ordering.

Refer to www.erlphase.com for the ordering template.

# 2 Installation and Safety Instructions

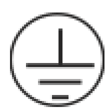
## 2.1 Introduction

This section deals with the installation of the F-PRO 298 when first delivered. The section covers the physical mounting, AC and DC wiring and the Communication wiring.

The following symbols are used in this manual and on the unit. They should be understood before working on the unit:

Caution: refer to equipment documentation

Caution: risk of electric shock



Protective Earth (or Ground) Terminal

Autoranging power supply

Both direct and alternating current

> The equipment ratings, operating instructions and installation instructions shall be checked before commissioning or maintenance. It is the responsibility of the user to ensure that the equipment is installed, operated and used for its intended function in the manner specified in this manual. If this is not the case then any safety protection provided by the equipment may be impaired.

# 2.2 Physical Mounting

The relay is 177mm high, 225mm deep and 207mm wide. A complete mechanical drawing is shown, for details see “Mechanical Drawings” in Appendix H

To install the relay the following is needed:

- E8 cutout (159mm(H) x 201.5mm(W))
- M4 screws and nuts

## Case Grounding

**WARNING**!

Ground the relay to station ground using the Case Grounding terminal at the back of the relay, for details see “F-PRO 298 Relay Rear View” on page 1-4

# 2.3 Power Supply

A wide range power supply is standard. The relay power supply is provided with nominal operating ranges of:

- 24-48 Vdc (-15%/+20%)
- 110-250 Vdc / 100-240 Vac (±20% for Vdc, -10%/+5% for Vac)

To protect against a possible short circuit in the supply use an inline fuse or circuit breaker with a 5A 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 and takes about 100 seconds to complete the boot up process (indicated by glowing green Relay Functional LED).

## 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.<br><br>CT circuits shall be short-circuited before working on the current input wires. |

# 2.5 Communication Wiring

## EIA-485

The relay's serial port (32) is an EIA RS-485 Data Communications Equipment (DCE) device. This allows them to be connected directly to other relays in parallel and communicated to a PC serial port with a standard straight-through male-to-female serial cable with RS485 to RS232 converter. RS 485 cable can work for a maximum of 1.2km with a single IED. Shielded cable is recommended, for pin-out see "Communication Port Details" on page 3-15.

## Ethernet Port

100BASE Ethernet Port (31A) with RJ-45/FO receptacle on rear side of the relay can be used with CAT5 or CAT5e straight or ST type FO for SCADA Communications. The maximum distance that RJ45 cable can support is 100meters (328 feet).

## USB

COM 1 on the front panel is a standard USB-B connector. This port is the Maintenance port of the relay. 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

IRIG-B on the rear panel (331) accepts both modulated and un-modulated 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. SNTP Time sync through RJ-45/FO can also be achieved.

> 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
- Inter-Range Instrumentation Group time codes (IRIG-B) time input
- Communicating with the relay using a network link, a direct serial link and a modem link (internal, external)
- 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 298 relay supports the use of modulated or unmodulated IRIG-B time signals (external), primary/secondary SNTP network based time synchronization (external) and manually configurable system time based on a free running internal oscillator. The internal free running oscillator is always present on the F-PRO 298 and in the absence of any external time source, will become the default mode of time synchronization.

## IRIG–B

An externally applied IRIG-B time source will have the highest order of precedence, and will typically offer the highest available time accuracy, when derived from an external GPS satellite source. The F-PRO 298 will also process derived IRIG-B style signals generated from alternate time sources, using time quality information to differentiate. The LED output selection on the front panel is available for ongoing presence of a valid IRIG-B time source indication and is evident in data records.

The relay is equipped to handle modulated or un-modulated GPS satellite time IRIG-B signals. The IRIG-B time signal is connected to the BNC connection on the back of the relay. Setting is required to differentiate between modulated or un-modulated signal. This has to be manually changed by the user as per the input provided.

When the relay is drawn out from its case, jumpers are accessible behind the IRIG-B connect. If the J5 and J6 jumpers are positioned to short pins 1 and 2, then the IRIG-B port is configured to accept a modulated signal. If the J5 and J6 jumpers are positioned to short pins 2 and 3, then the IRIG-B port is configured to accept an un-modulated signal. By default the jumper selection is positioned to modulated signal.

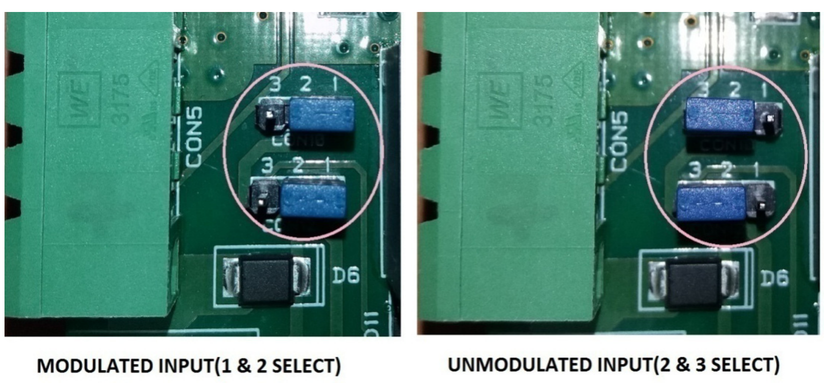



Figure 3.4: IRIG-B Port Selection for modulated and un-modulated input

If the IRIG-B signal contains year information, enable the IEEE 1344 extension on the *Utilities* > *Time* screen in Relay Control Panel. If the IRIG-B signal does not contain the year extension, this setting should be disabled.

## SNTP SYNC

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 F-PRO 298 system time to an accuracy of +/- 5 milliseconds in ideal network conditions. The LED output selection on the front panel is available for ongoing presence of a SNTP time source indication and is evident in data records.

The RCP time screen provides means to enable SNTP time source, set the poll interval, set the timeout interval and set the server IP addresses.

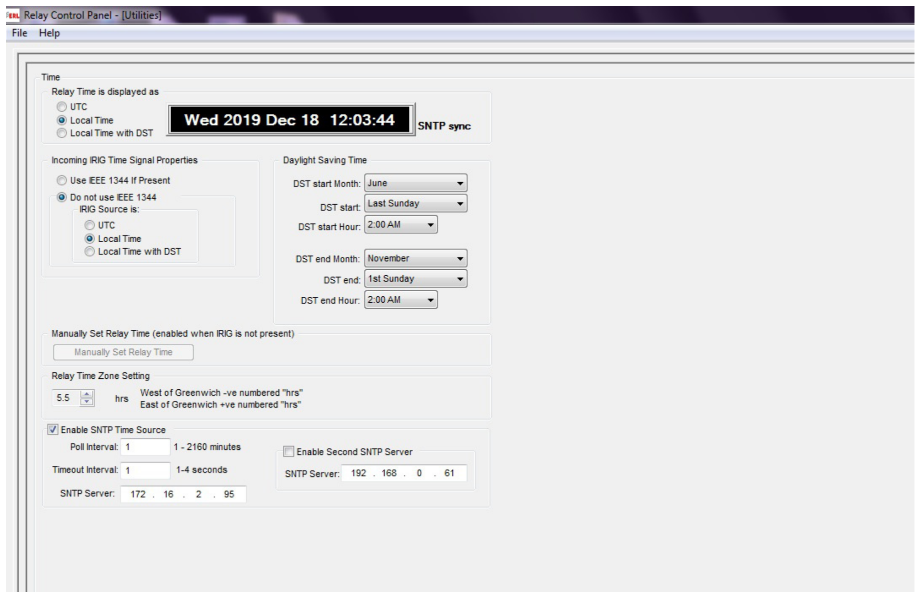



Figure 3.5: SNTP sync settings in RCP

If either a valid IRIG-B or SNTP source is present, then the relay will use the RTC run from the internal clock as the time source. The RTC is the lowest priority time source.

The IED comes equipped with an internal free-running oscillator used to generate a 1 PPS time signal in the absence of any alternate available time source. Use of this oscillator 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 +/-50 ppm.

# 3.4 Communicating with the Relay Intelligent Electronic Device (IED)

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

- Front USB 2.0 interface (user interface and maintenance)
- 2 Rear Ethernet network link -user interface and SCADA (Ordering Option)
- Rear panel serial link (RS485 serial link to SCADA only)

The relay has a front panel USB port and Rear Ethernet Ports (Copper / FO Port 31A & Port 31B) for user interface and SCADA, 1 rear RS485 Port (Port 32) to provide direct access to SCADA services.

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

# 3.5 USB Link

The PC must be appropriately configured for USB communication.

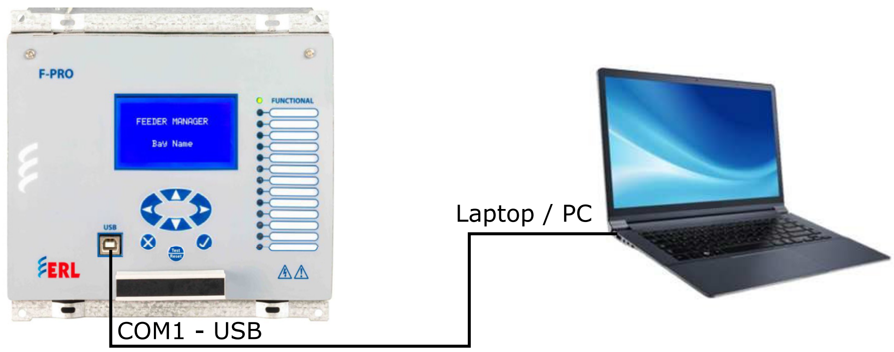



Figure 3.1: USB Link

## USB Driver Installation

To create a USB link between the relay and the computer, connect the PC to the front USB port of the F-PRO. The Gadget Driver needs to be installed in computer as follows. The Gadget Driver can be downloaded from ERLPhase website (https://www.erlphase.com/downloads/software).

Then go the Device Manager to check the port detect.

*Start > Control Panel> Device Manager > Other devices*

In this path a small icon with the name of Gadget Serial v2.4 will be found (If user removed USB cable, this icon will be removed from that path).

Next to that Right click on the Gadget Serial v2.4 icon and select “update Driver software”.

“Update Driver Software - Gadget Serial v2.4” Window will appear. In that select “Browse my computer for driver software”.

Now Browse the Gadget driver folder the path where it was saved.

Example;

*D:\Gadget_driver\win7 (for Windows 7)*

And click the next button. Now the Driver Installation will be started, after the Installation done click close.

Now check ports in Device Manager

*Start > Control Panel > Device Manager > Ports (COM & LPT)*

Find the “F-PRO2000 Series Relay” port, note COM port number which is installed Ex: COM 6.

Open Relay Control Panel.

Click the Add new Button. The Add New Relay Window will open. Select the “Add New Modem/Serial Link” Button.

A Window will appear. Select the “Add” Button.

“Add Hardware Wizard” Window will open. Click Next twice and click the “Have Disk” button.

Browse the Null_mdm file from the path: C:\Program Files (x86)\ERLPhase\Relay Control Panel

Then click ok and Next.

Select the COM Port at which the relay was connected. Click Next and Finish.

Now come to the “Add New Relay” Window and select the COM # in the Serial Link to which the Relay is connected. The Baud Rate is Default as “115200”.

Click the “Get Information From Relay” Button to Collect the Information from Relay. After the information is retrieved, enter relay name and click save button

# 3.6 Network Link

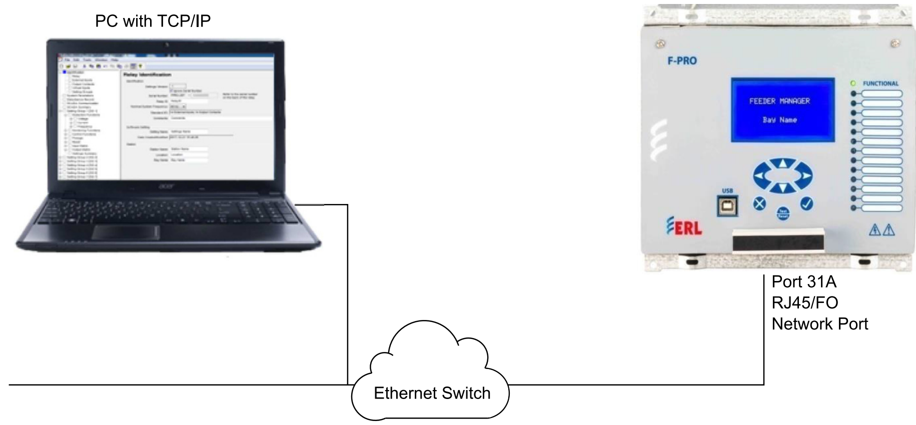



Figure 3.2: Network Link

Access both the relay’s user interface and 61850 SCADA services simultaneously with the Ethernet TCP/IP LAN link through the network port Port 31A. The rear Port is 100BASE-T copper interface with an RJ45 connector or FO with ST connector interface.

DNP3 SCADA services can also be accessed over the LAN, for details see Table 3.4: Communication Port Details.

Connect to the Ethernet LAN using a Cat 5 or above cable with an RJ-45 connector on both ends in straight fashion.

If an FO connector is used on the IED, then an Ethernet switch with an ST and RJ45 connector to communicate with the device.

By default, the Port 31 is assigned with an IP address of 192.168.100.80. If this address is not suitable, it may be modified using Relay’s interface accessed through the Terminal Utility (“Using Terminal to Access the Relay’s Maintenance Menu” on page 3-10) or Front LCD display in Change/Service mode. If IP address is changed, then the relay will restart automatically.

# 3.7 Accessing the Relay's SCADA Service

The relay supports IEC 60870-5-103 slave, DNP3(Level 2), IEC 61850 and Modbus slave SCADA protocols as a standard feature on all F-PRO series relays. The 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 and ASCII modes and is available through a direct RS485 serial link.

The relay rear serial Port CON 32 is dedicated for use with Modbus slave, IEC 60870-5-103 slave 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.

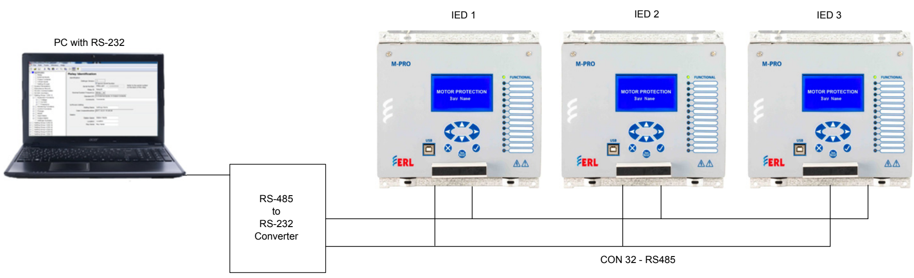



Figure 3.3: RS485 Connection diagram

The DNP3 and IEC 61850 protocols 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 3-8.

Complete details on the Modbus and IEC 60870-5-103 protocol services can be found in the Appendices, for details see "Modbus RTU Communication Protocol" on page Appendix E-1 and "IEC 103 Device Profile" on page Appendix G-1.

## Protocol Selection

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

## Communication Parameters

The serial port's communication parameters are set in the F-PRO Offliner SCADA communication 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, IEC 60870-5-103 and DNP3 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.

# 3.8 Using Terminal 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 for access to all of the Maintenance functions.

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.<br>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 HyperTerminal follow these instructions:

In Windows 7 or Windows 10,open HyperTerminal PE;

If “Default Telnet Program?” windows pops 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: “FPRO298”.

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.

Login as **maintenance** in lower case.

```
F-PRO 2000 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 150 access only

Please enter a command:
```

Figure 3.4: Maintenance Menu

## Maintenance Menu Commands

| |
|---|
| The Maintenance menu is available via a Serial USB connection only, it is not supported via a network connection. |

**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.<br><br>**NOTE:** If Command 4 is performed, the unit must be re-calibrated before being put back into service. See “Calibration” on page 8-2 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 | Enters network utilities sub-menu. |

| Table 3.2: Maintenance Menu Commands | |
|---|---|
| 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 |

## 3.9 Firmware Update

Contact ERLPhase Power Technologies Ltd., for instructions on Firmware update.

# 3.10 Communication Port Details

**Table 3.4: Communication Port Details**

| Location | Port | Function |
|---|---|---|
| Front Panel | USB | USB-B receptacle, high speed USB 2.0 interface<br>Used for user interface access<br>Default fixed baud rate 115200 8 N 1 (8 Data Bits, No Parity, 1 Stop Bit) |
| Rear Panel | 31A | RJ-45 receptacle or ST type optical receptacle (factory configured). 100Base-T or 100Base-FX (1300nm, multimode) Ethernet interface.<br>Used for user interface access or IEC61850 or DNP3 SCADA access through Ethernet LAN.<br>SNTP time sync is also available. |
| Rear Panel | 31B | Additional port for PRP communication as an ordering option (RJ45/ FO) |
| Rear Panel | 32 | RS-485.<br>Used for SCADA communication (MODBUS or IEC103 or DNP3).<br>Default setting: 9600 7 N 1 (7 Data Bits, No Parity, 1 Stop Bit) |
| Rear Panel | 331 | BNC receptacle, IRIG-B interface. Modulated or un-modulated, 65 ohm impedance |

**Table 3.5: RS485 Connections to Pins on the Relay Port**

| Signal Name | Direction PC $\leftrightarrow$ Relay | Pin # on the Relay Port |
|---|---|---|
| D+ | $\leftrightarrow$ | 1 |
| D- | $\leftrightarrow$ | 2 |
| G | | 3 |

Note:

If multiple IEDs are connected in daisy chain method, the end unit should be connected with an external 120Ω load resistance.

# 4 Using the IED (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:

- After 5 seconds “ERL logo with Booting…” displayed in the LCD
- At 70th second “ERL logo with Loading Firmware…” displayed in the LCD
- At 80th second all the LEDs blink once and from now onwards the DSP is actively protecting the system.
- At 100th second the Functional Green LED comes ON and it indicates that the relay is capable of recording and communicating with the user.
- Unit Restarted event displayed in the LCD.

# 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.

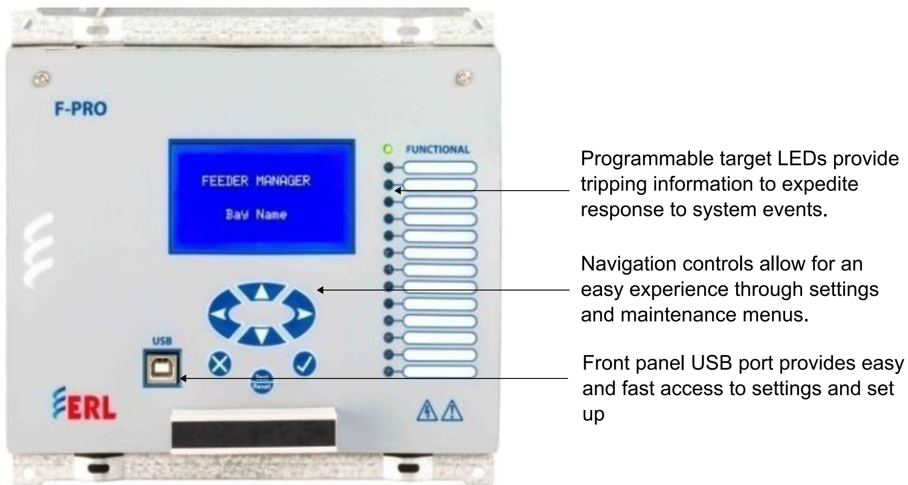



Figure 4.1: Front Panel Display

## LED Indicators

**Table 4.6: Description of LED Indicators**

| | |
|---|---|
| Relay Functional (LED 1) | Indicates the relay is functional. When the Relay Functional green LED goes on, the rear Relay Inoperative contact opens and the protective functions become functional. |
| LED 2-14 | Programmable for any Functions, ProLogics, Virtual Inputs, External Inputs and Time Sync. |

Target LED assignments are configurable by the user through the Offliner settings (output matrix configuration).

## Push Buttons

**Table 4.7: Identification of Push Buttons**

| | |
|---|---|
| Up, Down, Right, Left, Enter, Cancel, Test/Reset | Used to navigate the front panel screens. |

## Display

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

First, press the Enter button (check mark) on the front panel. The following screen will appear.

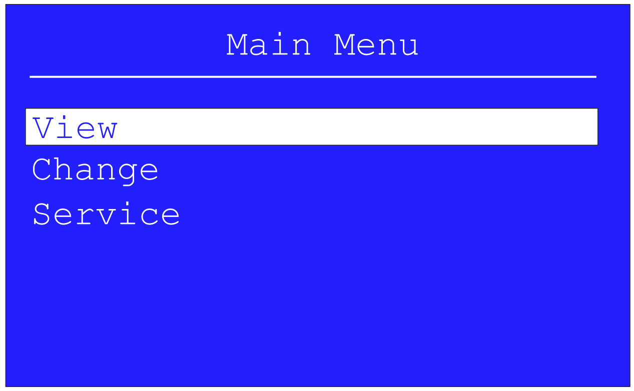



Figure 4.2: View / Change / Service: Choice Menu

Choose View, Change or Service access level and press Enter.

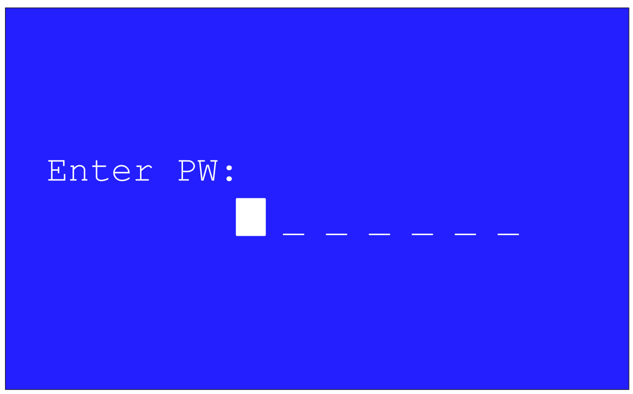



Figure 4.3: Enter Password (only required for Change and Service)

Enter the password for the given access level (see defaults below). Use the Up and Down arrows to scroll through characters. Once the correct character is selected, press the Right arrow button to select the character and move to the next character. Once the password has been entered, repeatedly press the Right arrow button until the field is filled. If correct password is entered, user will be granted access to the front panel menus.

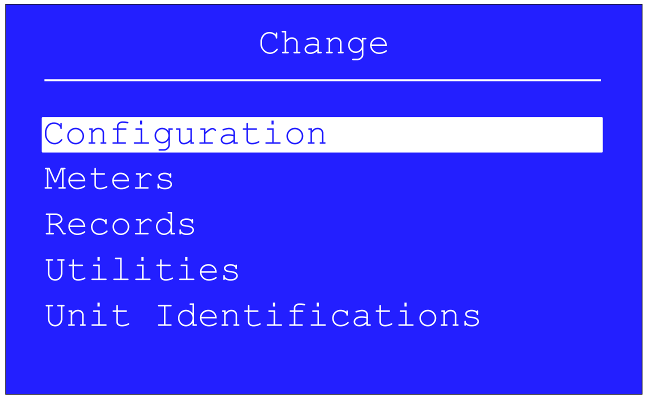



Figure 4.4: Main Menu

Note: The default passwords are (remove quotation marks)

View Access - no password required

Change Access “change”

Service Access “service”

Passwords may contain = . + - 0-9 a-z and A-Z

**Table 4.8: Navigation of the LCD Screen**

| Menu Item | | | | | | | Access Level Required [1] |
|---|---|---|---|---|---|---|---|
| Main Screen | | | | | | | |
| | View / Change / Service: Choice Menu | | | | | | |
| | Enter Password | | | | | | (C,S) |
| | Main Menu | | | | | | |
| | | Configuration | | | | | |
| | | | System Parameters | | | | |
| | | | | System Frequency | | | (C,S) |
| | | | | VT Configuration | | | (C,S) |
| | | | | CT Configuration | | | (C,S) |
| | | | | General | | | (C,S) |
| | | | | Display Backlight Timeout | | | (C,S) |
| | | | Setting Group | | | | |
| | | | Functions | | | | |
| | | | | Active SG | | | |
| | | | | | Fault Locator | | (C,S) |
| | | | | | Phase U/O Voltage | | |
| | | | | | | Fn. 27/59DT-1 | (C,S) |
| | | | | | | Fn. 27/59DT-2 | (C,S) |
| | | | | | | Fn. 27/59DT-3 | (C,S) |
| | | | | | | Fn. 27/59DT-4 | (C,S) |
| | | | | | | Fn. 27/59DT-5 | (C,S) |
| | | | | | | Fn. 27/59DT-6 | (C,S) |
| | | | | | | Fn. 27/59IT-1 | (C,S) |
| | | | | | | Fn. 27/59IT-2 | (C,S) |
| | | | | | Overflux | | |
| | | | | | | Fn. 24DT-1 | (C,S) |
| | | | | | | Fn. 24DT-1 | (C,S) |
| | | | | | | Fn. 24IT | (C,S) |
| | | | | | Neg. Seq. OV | | |
| | | | | | | Fn. 47DT-1 | (C,S) |
| | | | | | | Fn. 47DT-2 | (C,S) |
| | | | | | | Fn. 47IT-1 | (C,S) |

**Table 4.8: Navigation of the LCD Screen**

| Menu Item | | | Access Level Required [1] |
|---|---|---|---|
| | Der. Neut. OV | | |
| | | Fn. 59NDT-1 | (C,S) |
| | | Fn. 59NDT-2 | (C,S) |
| | | Fn. 59NIT-1 | (C,S) |
| | Phase UC | | |
| | | Fn. 37-1 | (C,S) |
| | | Fn. 37-2 | (C,S) |
| | Direction | | |
| | | Fn. 67 | (C,S) |
| | | Fn. 67N | (C,S) |
| | Phase OC | | |
| | | Fn. 50/67-1 | (C,S) |
| | | Fn. 50/67-2 | (C,S) |
| | | Fn. 51/67-1 | (C,S) |
| | | Fn. 51/67-2 | (C,S) |
| | Neutral OC | | |
| | | Fn. 50N/67N-1 | (C,S) |
| | | Fn. 50N/67N-2 | (C,S) |
| | | Fn. 51N/67N-1 | (C,S) |
| | | Fn. 51N/67N-2 | (C,S) |
| | Neg. Seq. OC | | |
| | | Fn. 46/50-1 | (C,S) |
| | | Fn. 46/51 | (C,S) |
| | SEF | | |
| | | Fn. 67SEF | (C,S) |
| | | Fn. 64/50SEF/67-1 | (C,S) |
| | | Fn. 64/50SEF/67-2 | (C,S) |
| | | Fn. 64/51SEF/67-1 | (C,S) |
| | | Fn. 64/50SEF/67-2 | (C,S) |
| | Thermal OL | | |
| | | Fn. 49 | (C,S) |
| | CB Failure | | |

**Table 4.8: Navigation of the LCD Screen**

| Menu Item | | | Access Level Required [1] |
|---|---|---|---|
| | | Fn. 50BF | (C,S) |
| | | Fn. DI-CBF | (C,S) |
| | Broken Conductor | | |
| | | Fn. 46BC | (C,S) |
| | Inrush Detection | | |
| | | Fn. 81HBL2 | (C,S) |
| | Frequency | | |
| | | Fn. 81O/U-1 | (C,S) |
| | | Fn. 81O/U-2 | (C,S) |
| | | Fn. 81O/U-3 | (C,S) |
| | | Fn. 81O/U-4 | (C,S) |
| | | Fn. 81O/U-5 | (C,S) |
| | | Fn. 81O/U-6 | (C,S) |
| | | Fn. 81O/U-7 | (C,S) |
| | | Fn. 81O/U-8 | (C,S) |
| | | Fn. 81R-1 | (C,S) |
| | | Fn. 81R-2 | (C,S) |
| | | Fn. 81R-3 | (C,S) |
| | | Fn. 81R-4 | (C,S) |
| | Directional Power | | |
| | | Fn. 32-1 | (C,S) |
| | | Fn. 32-2 | (C,S) |
| | | Fn. 32-3 | (C,S) |
| | | Fn. 32-4 | (C,S) |
| | Supervision | | |
| | | Fn. 60VTS | (C,S) |
| | | Fn. 60CTS | (C,S) |
| | Trip Circuit Supervision | | |
| | | Fn. 74TCS_1 | (C,S) |
| | | Fn. 74TCS_2 | (C,S) |
| | CB Monitoring | | |
| | | I^2t-CB | (C,S) |

**Table 4.8: Navigation of the LCD Screen**

| Menu Item | Access Level Required [1] |
|---|---|
| THD Voltage | |
| Fn. THD-1 | (C,S) |
| Fn. THD-2 | (C,S) |
| Count Alarm | |
| UV Alarm | (C,S) |
| OV Alarm | (C,S) |
| UF Alarm | (C,S) |
| OF Alarm | (C,S) |
| EI Alarm | (C,S) |
| AR Count | (C,S) |
| Sync Check | |
| Fn. 25/27/59 | (C,S) |
| Auto Reclose | |
| Fn. 79 | (C,S) |
| Disturbance Record Settings | (C,S) |
| Meters | |
| Meter Display Option | |
| Analog | |
| Digital | |
| EI Status | |
| DO Status | |
| 61850 Comm Alm Status | |
| MMS Commands | |
| Records | |
| View Events | |
| View Faults | |
| Utilities | |
| Time | |
| Date & Time | (C,S) |
| Display Time as | (C,S) |
| DST | (C,S) |
| UTC Offset | (C,S) |

**Table 4.8: Navigation of the LCD Screen**

| Menu Item | | | | Access Level Required [1] |
|---|---|---|---|---|
| | | SNTP | | (C,S) |
| | | Incoming IRIG Prop. | | (C,S) |
| | Communication | | | |
| | | USB(Serial) | | (C,S) |
| | | RS485(CON 2) | | (C,S) |
| | | Ethernet(CON 3) | | (C,S) |
| | Erase Records | | | (C,S) |
| | Maintenanace | | | |
| | | I2T | | (C,S) |
| | | 79 Cumm. Counter | | (C,S) |
| | Calibration | | | |
| | | Voltage & Current Channels | | (C,S) |
| | Password Settings | | | |
| | | Change PW | | (S) |
| | | PW Access Timer | | (S) |
| | | PW Enable/DIsable | | (S) |
| | Firmware Update | | | (S) |
| | Test Mode | | | |
| | | Test Mode Selection - Enable | | (S) |
| | | | Digital Output Control | (S) |
| | | | LED Control | (S) |
| | Contrast Control | | | (S) |
| | Virtual Input Control | | | (S) |
| | Control | | | |
| | | Control Configuration | | See for details see Configuration of Mode and Security on page 9-4 |
| Unit Identifications | | | | |

1. 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.

# 4.3 Relay Control Panel

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.

## Metering

The RCP displays the following metering parameters

- Voltage and current magnitudes and angles
- I^2t
- EI Status
- All protection function statuses
- All monitoring function statuses
- OC Statuses
- Virtual Input Statuses
- ProLogic Statuses
- Directional Element Statuses
- MMS Command Statuses

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

## Configure USB Link for Relay Control Panel

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

1. Execute.

   *Relay Control Panel.exe*
2. Execute.

   *F-PRO 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.

      Hit *Get Information From Relay.*

      Then RCP will communicate with the F-PRO 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 re-name the relay changing the “Relay Name” in the “Relay Definition” category, before saving.

After 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 4.9: Relay Control Panel Structure**

| | | | Access Level | |
|---|---|---|---|---|
| | | **View** | **Change** | **Service** |
| Relay Control Panel | | | | |
| | Records | | Trigger Fault | Trigger Fault |
| | | | Trigger Event | Trigger Event |
| | Faults | | Clear Faults | Clear Faults |
| | Events | | Erase | Erase |
| | Metering | | | |
| | Analog | | | |
| | I^2t | | | |
| | Status | | | |
| | Voltage | | | |
| | Current | | | |
| | Frequency | | | |
| | Power | | | |
| | Monitoring | | | |
| | Outputs | | | |
| | Virtual | | | |
| | Prologic | | | |
| | Direction | | | |
| | MMS Cmds | | | |

**Table 4.9: Relay Control Panel Structure**

| | | | | |
|---|---|---|---|---|
| Utilities | | | | |
| | Unit Identification | | | |
| | Settings Group | | Save | Save |
| | Time | | | |
| | Analog Input Calibration | N/A | N/A | |
| | Virtual Inputs | N/A | Latch/Pulse | Latch/Pulse |
| | Outputs | | | |
| | Maintenance | N/A | N/A | Close/Open |
| | Passwords | N/A | N/A | |
| | Control | | Save | Save |
| Configuration | | | | |
| | Present Settings | (Get From Relay) | | |
| | Saved Settings | | (Load to Relay) | (Load to Relay) |

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

# 5 Protection, Recording and Logging Functions

This section describes the equations and algorithms that are define the F-PRO 298 relay protection functions.

The available functions are Fault Locator, 27/59DT (1 to 6), 27/59IT (1 to 2), 24DT (1 to 2), 24IT, 47DT (1 to 2), 47IT, 59NDT (1 to 2), 59NIT, 37(1 to 2), 67, 50/67 (1 to 2), 51/67 (1 to 2), 67N, 50N/67N (1 to 2), 51N/67N (1 to 2), 46/50, 46/51, 67SEF, 64/50SEF (1 to 2), 64/51SEF (1 to 2), 49, 50BF_Int, 50BF_Ext, 50BF_DICBF, 46BC, 81HBL2, 81U/O (1 to 8), 81R (1 to 4), 32(1 to 4), 60VTS, 60CTS, 74TCS (1 to 2), I^2t-CB, THD(1 to 2), 79, 25/27/59 and ProLogic. These functions are explained below with setting ranges and logic diagrams.

The protection functions have user-settable pick-up and drop-off delays. The Alarm and Trip outputs are initiated when the function's input value exceeds the set pick-up value. When Alarms or Trips occur, programmable front LEDs turn on and output contacts close. The mapping of protection functions to LEDs and output contacts is performed in the Output Matrix. The output contacts and LEDs are user configurable for Self Reset or Hand Reset.

A complete list of the settings and their range values can be found in “IED Settings and Ranges” in Appendix B.

# 5.1 Fault Locator

The relay uses the Takagi algorithm to provide fault location based on single end measurement. This method is an on-line method i.e. when any of the following protection operates then the relay starts calculating the fault location value from one cycle data of 3 phase voltages and currents from the protection tripping and provides the fault locator's information compared with the line impedance data provided in the settings. This information is available in relay event log, fault log data and also on Modbus, DNP, 61850 and 103 protocols through COMM ports.

The fault locator is initiated only by any of the following protection function.

- 50/67 Trip
- 51/67 Trip
- 50N/67N Trip
- 51N/67N Trip
- 64/50SEF Trip
- 64/51SEF Trip

Fault locator can be enabled/disabled through setting, however there is no separate initiation setting for fault locator function.

At least 1V of positive sequence voltage is needed to provide the fault location information. If there is no voltage in all the three phases during any of the above protection operations then the relay will display the fault location value as ‘++++++++km’.

**Table 5.10: Fault Locator**

| Setting Description | Setting Range |
|---|---|
| Fault Locator | Enabled/Disabled |
| Line | |
| Line to Line Voltage | √3* Phase VT Sec Volt*Phase VT Ratio |
| Line Length | 0.50 to2000.00 Km (or) miles |
| Sequence Impedence | |
| Postive Sequence Impedence(Z1) | 0.05 to 330.00 ohm for (1A)<br>0.01 to 66.00 ohm for (5A) |
| Positive Sequence Angle(Z1) | 5.0 to 89.0 deg |
| Zero SequenceImpedence(Z0) | 0.05 to 1500.00 ohm for (1A)<br>0.01 to 300.00 ohm for (5A) |
| Zero Sequence Angle(Z0) | 5.0 to 89.0 deg |

# 5.2 Voltage Protection Functions

## 27/59DT - Phase Definite Time Under/ Overvoltage

The Phase Definite Time Under/Overvoltage function has six stages. Each individual stage consists of both time delayed and instantaneous protection.

- Undervoltage (UV) - Whenever the injected voltage is equal to or less than the precise pick-up value, this function operates after a set time delay. The drop-out value of this function mainly depends on the % hysteresis.
- Over Voltage (OV) - Whenever the injected voltage value is equal to or greater than the precise pick-up value, this function operates after a set time delay. The drop-out value of this function mainly depends on the % hysteresis.

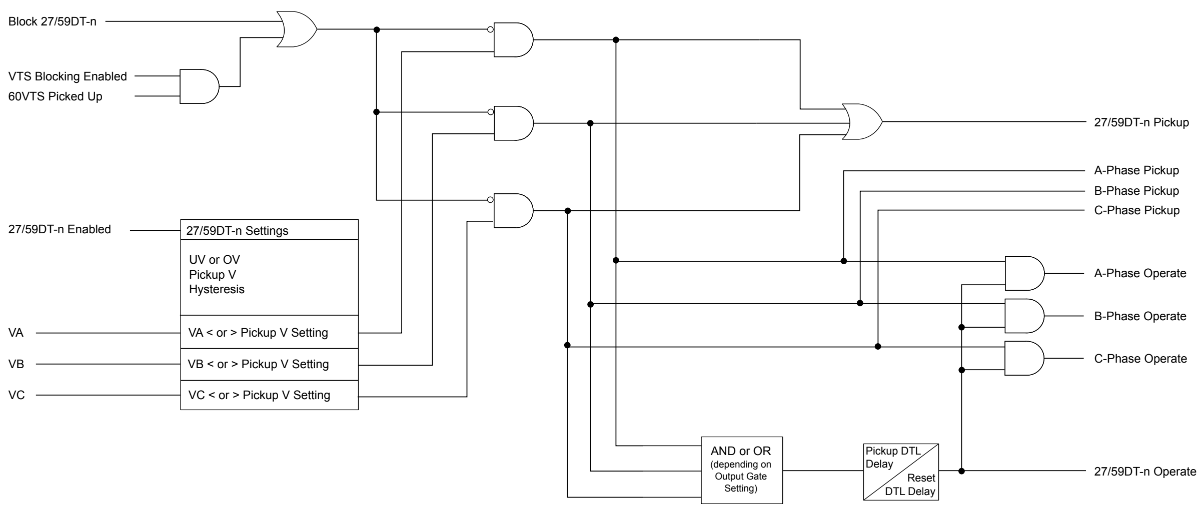



Figure 5.5: 27/59DT Function Logic

| **Table 5.11: 27/59DT - Phase Definite Time Under/Overvoltage Settings** | |
|---|---|
| **Setting Description** | **Setting Range** |
| 27/59DT-*n* | Enable/Disable |
| Function Selection | UV or OV |
| Measurement Input | Fundamental (non-configurable) |
| Input Type | Ph-N or Ph-Ph |
| Output Gate | AND or OR |
| Pickup V | 3.0V to 250.0V |
| Hysteresis | 1% to 80% |
| Pickup DTL Delay | 0.00s to 999.99s |
| Reset DTL Delay | 0.00s to 999.99s |
| VTS Blocking | Enable/Disable |

## 27/59IT - Phase Inverse Time Under/ Overvoltage

The Phase Inverse Time Under/Overvoltage function has two stages. Each individual stage consists of both time delayed and instantaneous protection.

The time delay options include DTL, IEC Standard, IEC Extreme, IEC Long Time inverse curve and user defined curve.

- Undervoltage (UV) - Whenever the injected voltage is equal to or less than the precise pick-up value, this function operates after a set time delay. The drop-out value of this function mainly depends on the % hysteresis.
- Over Voltage (OV) - Whenever the injected voltage value is equal to or greater than the precise pick-up value, this function operates after a set time delay. The drop-out value of this function mainly depends on the % hysteresis.

For 27IT(UV), the pickup time is determined by the following equation:

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

For 59IT(OV), the pickup time is determined by the following equation:

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

Where:

T - pickup time

V - Phase voltage

$V_{pickup}$ - User-settable voltage pickup setting

TMS, B, A, ρ - curve parameters (predetermined by IEC curve type, or user-settable for user defined curves)

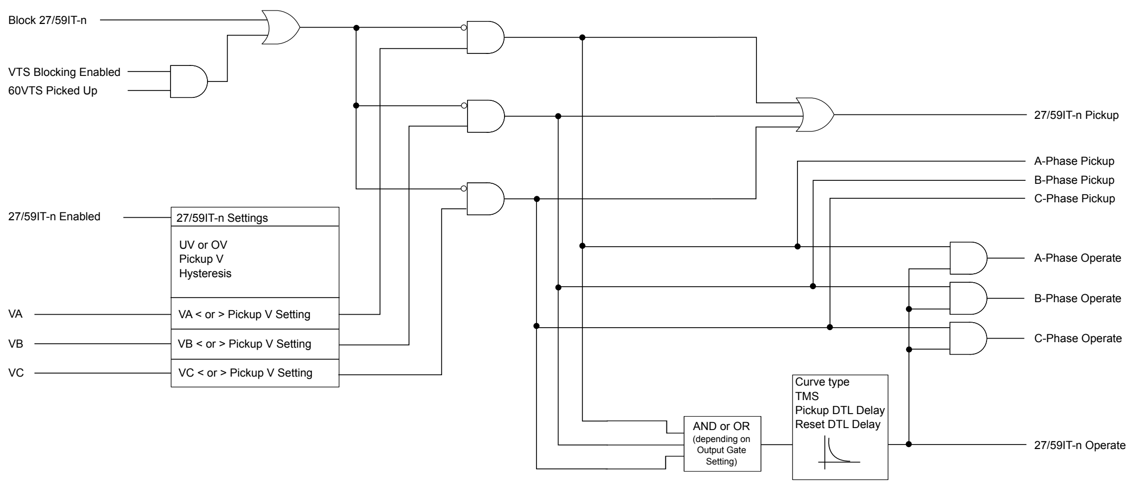



Figure 5.6: 27/59IT Function Logic

| **Table 5.12: 27/59IT - Phase Inverse Time Under/Overvoltage Settings** | |
|---|---|
| **Setting Description** | **Setting Range** |
| 27/59IT-*n* | Enable or Disable |
| Function Selected | UV or OV |
| Measurement Input | Fundamental (non-configurable) |
| Input Type | Ph-N or Ph-Ph |
| Output Gate | AND or OR |
| Pickup V | 3.0V to 250.0V |
| Hysteresis | 1% to 80% |
| Curve Type | DTL, IEC Standard Inverse, IEC Extreme Inverse, IEC Long Time Inverse, User Defined |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00s to 999.99s |
| Reset DTL Delay | 0.00s to 999.99s |
| 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 is used to detect the overflux condition in electrical equipment, which can damage equipment such as transformers and generators. These are caused due to the increase in voltage and decrease in frequency.

The magnetic flux density is directly proportional to voltage and inversely to its frequency, defined by the following equation:

$\Phi = V/F$

Whenever the injected (fundamental) value reaches the same or above the precise pick up (V/F) value, this function operates after a configurable pickup timer. The drop out value of this function varies with the % hysteresis. There are two stages provided, 24DT-1 and 24DT-2.

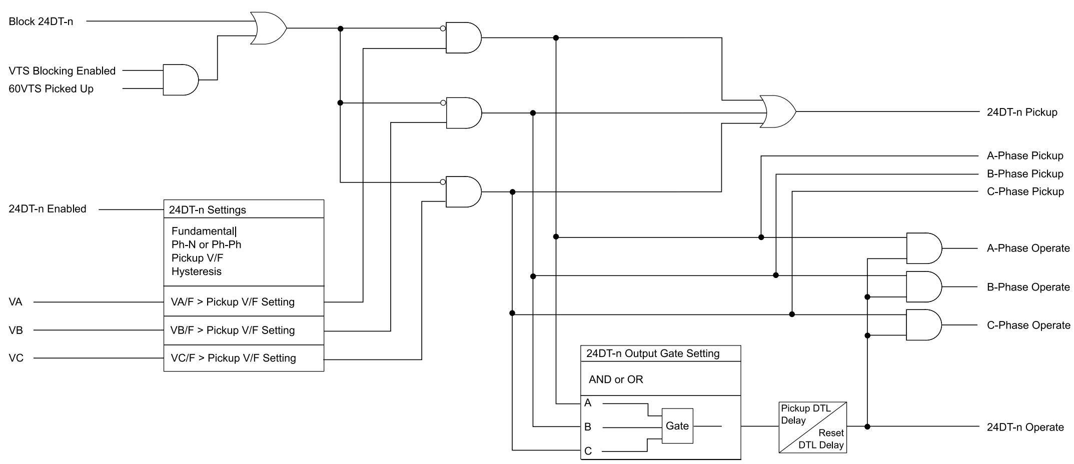



Figure 5.7: 24DT Function Logic

| Table 5.13: 24DT - Definite Time Overflux | |
|---|---|
| **Setting Description** | **Setting Range** |
| 24DT-*n* | Enable/Disable |
| Measurement Input | Fundamental (fixed) |
| Input Type | Ph-N or Ph-Ph |
| Output Gate | AND or OR |
| Pickup V/F | 1.00 to 2.00 pu |
| Hysteresis | 1 to 80% |
| Pickup DTL Delay | 0.05 to 999.99 s |
| Reset DTL Delay | 0.00 to 999.99 s |
| VTS Blocking | Disable or Enable |

## 24IT - Inverse Time Overflux

The over flux protection is used to detect the overflux condition in electrical equipment, which can damage equipment such as transformers and generators. These are caused due to the increase in voltage and decrease in frequency.

The magnetic flux density is directly proportional to voltage and inversely to its frequency, defined by the following equation:

$\Phi = V/F$

Whenever the injected (fundamental) value reaches the same or above the precise pick up (V/F) value, this function operates after a configurable inverse time pickup timer. The drop out value of this function varies with the % hysteresis. There is one stage of the 24IT provided (24IT-1).

The configurable inverse time characteristics are defined by the following equations.

For the IEC Extremely Inverse 1 Curve:

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

For the IEEE Extremely Inverse 1-3 Curves:

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

Where M and K are defined by:

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

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

For the Inverse Curve:

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

Where N is defined as:

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

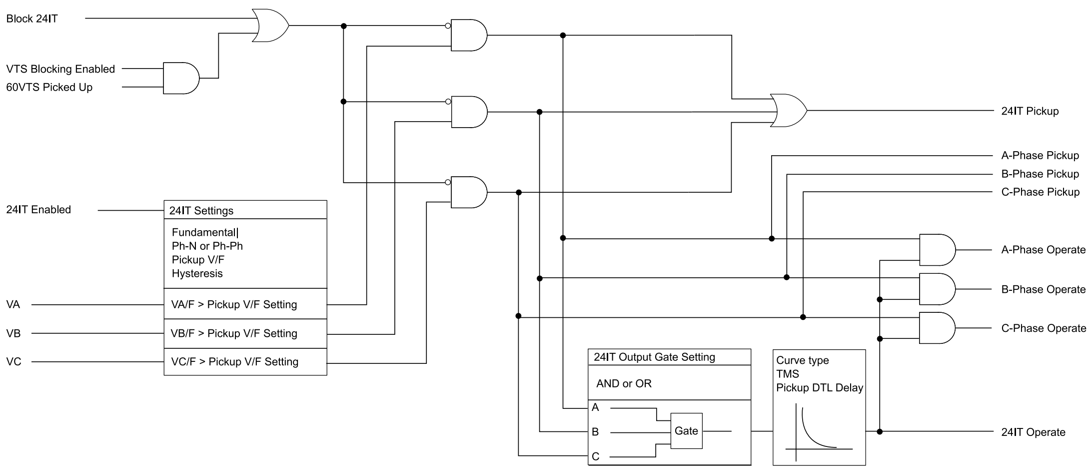



Figure 5.8: 24IT - Inverse Time Overflux Logic

| **Table 5.14: 24IT - Inverse Time Overflux** | |
|---|---|
| **Setting Description** | **Setting Range** |
| 24IT-1 | Enable/Disable |
| Measurement Input | Fundamental (fixed) |
| Input Type | Ph-N or Ph-Ph |
| Output Gate | AND or OR |
| Pickup V/F | 1.00 to 1.50 pu |
| Hysteresis | 1 to 80% |
| Curve Type | DTL, Inverse Curve, IEC Extremely Inverse 1, IEEE Extremely Inverse 1, IEEE Extremely Inverse 2, IEEE Extremely Inverse 3, User defined |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.05 to 999.99 s |
| Reset Delay | DTL or ANSI Decay |
| Reset DTL Delay | 0.0 to 99.9 s |
| A | Automatically configured based on curve |
| B | Automatically configured based on curve |
| C | Automatically configured based on curve |
| Inverse K | 0.01 to 99.90 |
| User defined set point - X1<br>User defined set point - Y1 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |
| User defined set point - X2<br>User defined set point - Y2 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |

| Table 5.14: 24IT - Inverse Time Overflux | |
|---|---|
| User defined set point - X3<br>User defined set point - Y3 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |
| User defined set point - X4<br>User defined set point - Y4 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |
| User defined set point - X5<br>User defined set point - Y5 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |
| User defined set point - X6<br>User defined set point - Y6 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |
| User defined set point - X7<br>User defined set point - Y7 | 1.00 to 3.00 pu<br>0.00 to 9999.99 s |
| VTS Blocking | Disable or Enable |

## 47DT - Negative Sequence Definite Time Overvoltage

The Negative Sequence Definite Time Overvoltage function provides protection for rotating equipment from the damaging effects of excessive negative sequence voltage resulting from phase failure, phase unbalance and reversed phase sequence.

When the relay detects negative phase sequence voltage greater than the set pickup value, the 47DT function operates. The drop-out value of this function varies with the % hysteresis.

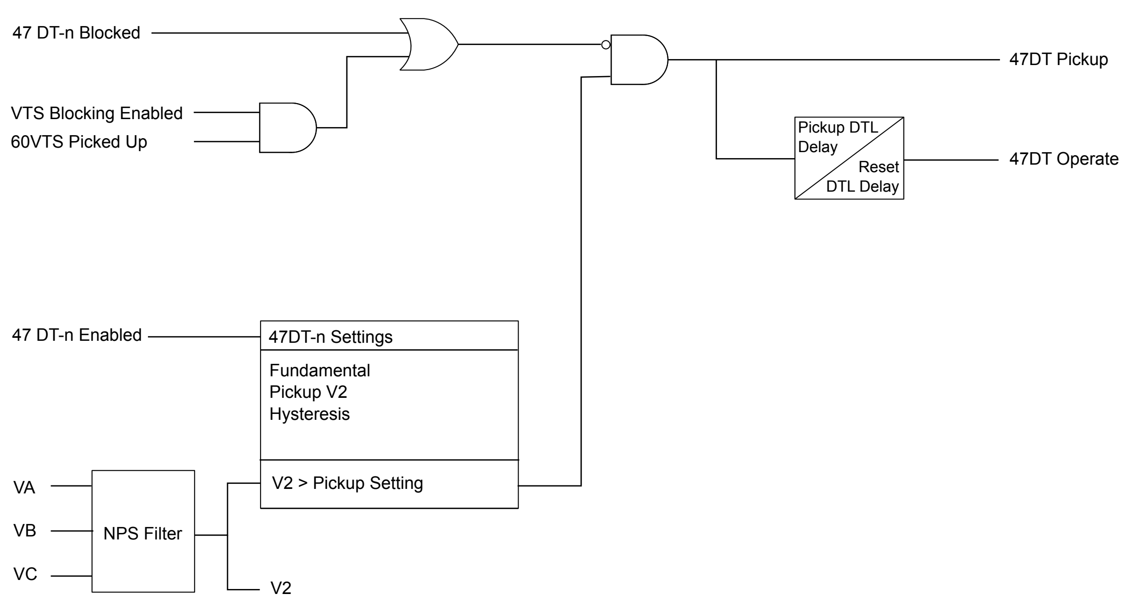



Figure 5.9: 47DT Function Logic

**Table 5.15: 47DT - Negative Sequence Definite Time Overvoltage Settings**

| Setting Description | Setting Range |
|---|---|
| 47DT-*n* | Enable/Disable |
| Pickup V2 | 1.0V to 150.0V |
| Hysteresis | 1% to 80% |
| Pickup DTL Delay | 0.02s to 999.99s |
| Reset DTL Delay | 0.00s to 999.99s |
| VTS Blocking | Enable/Disable |

## 47IT - Negative Sequence Inverse Time Overvoltage

The Negative Sequence Inverse Time Overvoltage function provides protection for rotating equipment from the damaging effects of excessive negative sequence voltage resulting from phase failure, phase unbalance and reversed phase sequence.

When the relay detects negative phase sequence voltage greater than the set pickup value, the 47IT function operates after an inverse time delay determined by the time curve settings and the equation shown below. The drop-out value of this function varies with the % hysteresis. The pickup time curve options consist of DTL, IEC inverse curves and User defined curves.

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

Where:

T - pickup time

$V_2$ - Negative phase sequence voltage

$V_{2\ pickup}$ - User-settable pickup setting

TMS, B, A, ρ - curve parameters (predetermined by IEC curve type, or user-settable for user defined curves)

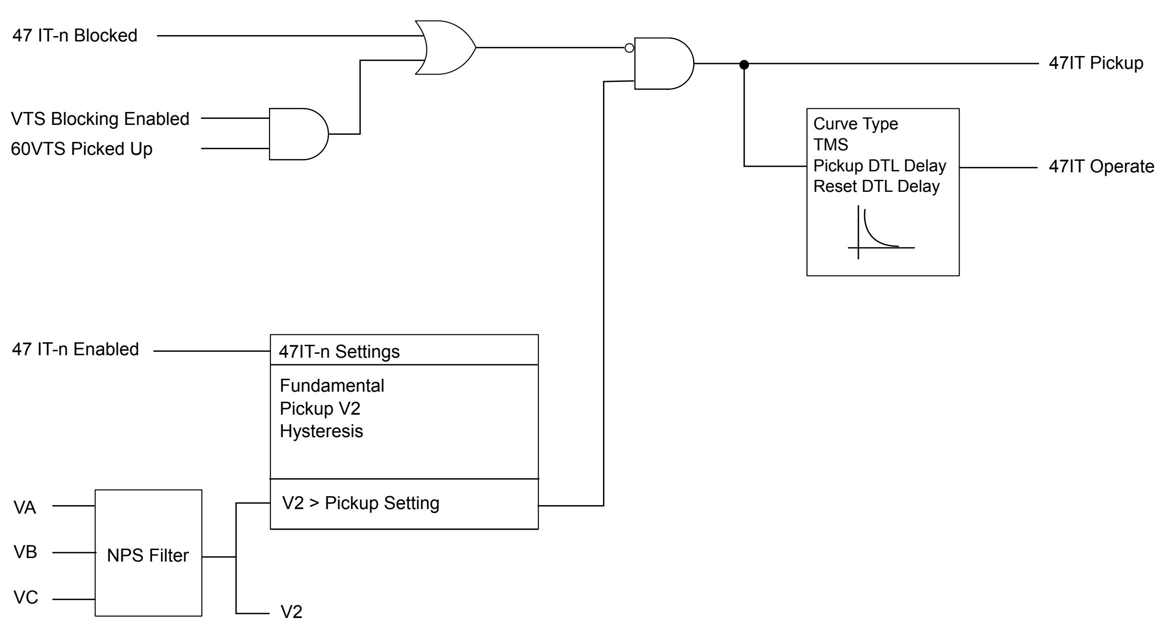



Figure 5.10: 47IT Function Logic

| Table 5.16: 47IT - Negative Sequence Inverse Time Overvoltage Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 47IT | Enabled/Disabled |
| Measurement Input | Fundamental (non-configurable) |
| Pickup V2 | 1.0V to 150.0V |
| Hysteresis | 1% to 80% |
| Curve Type | DTL, IEC Standard Inverse, IEC Extreme Inverse, IEC Long Time Inverse, User Defined |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00s to 999.99s |
| Reset DTL Delay | 0.02s to 999.99s |
| A | 0.1 to 50.0 |
| B | 0.0 to 10.0 |
| p | 0.1 to 10.0 |
| VTS Blocking | Enable/Disable |

## 59NDT - Derived Residual Definite Time Overvoltage

This function provides protection against ground faults irrespective of the system grounding connection used. The protection will operate from an internally calculated value from the 3 phase to neutral voltage.

This 59NDT function works based on the injected voltage (unbalanced). This unbalanced voltage flows through the ground via neutral. Whenever the neutral voltage (Vn) is equal to or exceeds the pickup value then the function operates after a definite time delay. The dropout voltage mainly depends on the % hysteresis.

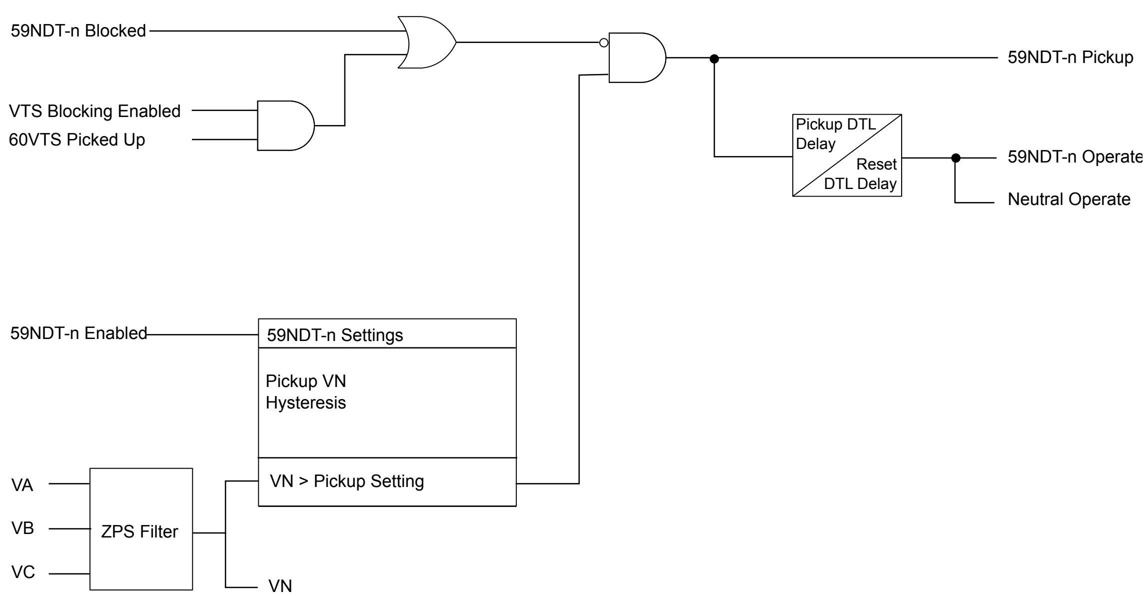



Figure 5.11: 59NDT Function Logic

| Table 5.17: 59NDT - Derived Residual Definite Time Overvoltage Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 59NDT-*n* | Enabled/Disabled |
| Measurement Input | Fundamental (non-configurable) |
| Pickup VN | 1.0V to 250.0V |
| Hysteresis | 1% to 80% |
| Pickup DTL Delay | 0.00s to 999.99s |
| Reset DTL Delay | 0.00s to 999.99s |
| VTS Blocking | Enable/Disable |

## 59NIT - Derived Residual Inverse Time Overvoltage

This function provides protection against ground faults irrespective of the system grounding connection used. Depending on the VT configuration, the protection will operate from an internally calculated value from the 3 phase to neutral voltage.

This 59NDT function works based on the injected voltage (unbalanced). This unbalanced voltage flows through the ground via neutral. Whenever the neutral voltage (Vn) is equal to or exceeds the pickup value then the function operates after an inverse time delay determined by the time curve settings and the equation shown below. The pickup time curve options consist of DTL, IEC inverse curves and User defined curves.

The dropout voltage mainly depends on the % hysteresis.

$$T(V_N) = TMS\left[B + \frac{A}{\left(\frac{V_N}{V_{N\,Pickup}}\right)^{\rho} - 1}\right]$$

Where:

T - pickup time

$V_N$ - Negative phase sequence voltage

$V_{N\ pickup}$ - User-settable pickup setting

TMS, B, A, ρ - curve parameters (predetermined by IEC curve type, or user-settable for user defined curves)

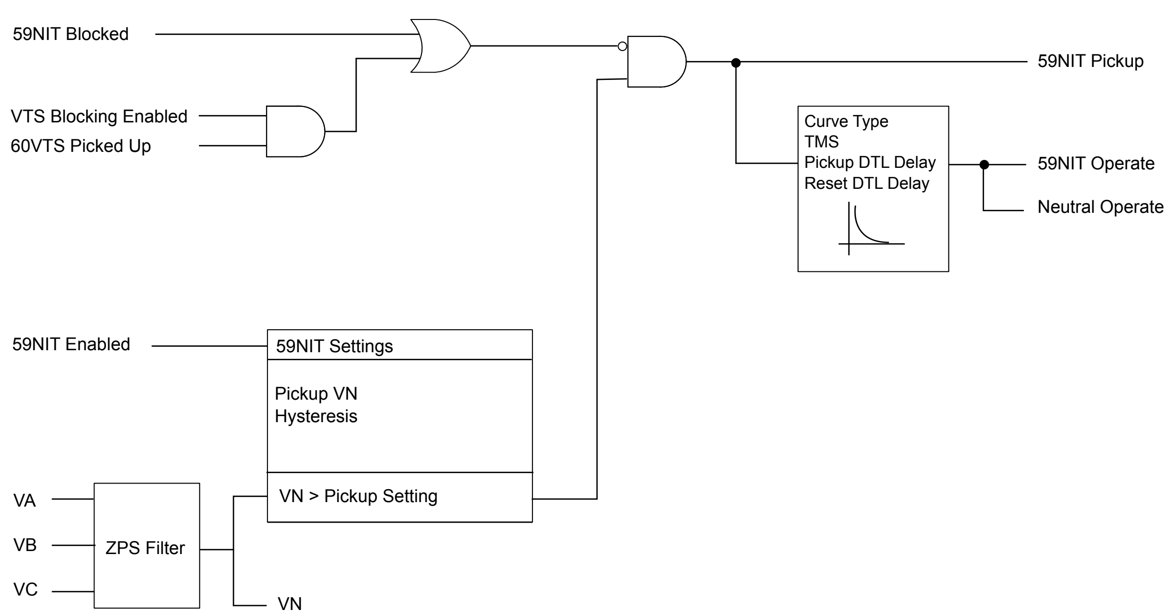



Figure 5.12: 59NIT Function Logic

**Table 5.18: 59NIT - Derived Residual Inverse Time Overvoltage Settings**

| Setting Description | Setting Range |
|---|---|
| Pickup VN | 1.0V to 250.0V |
| Hysteresis | 1% to 80% |
| Curve Type | DTL, IEC Standard Inverse, IEC Extreme Inverse, IEC Long Time Inverse, User Defined |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00s to 999.99s |
| Reset DTL Delay | 0.00s to 999.99s |
| A | 0.1 to 50.0 |
| B | 0.0 to 10.0 |
| p | 0.1 to 10.0 |
| VTS Blocking | Enable/Disable |

# 5.3 Current Protection Functions

## 37 - Instantaneous Phase Undercurrent

The 37 Instantaneous 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 (Ia, Ib, Ic) 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.

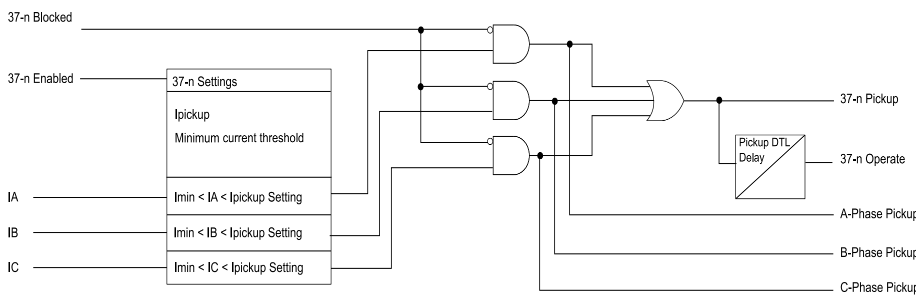



Figure 5.13: 37 - Loss of Load Protection Logic

**Table 5.19: 37 - Instantaneous Phase Undercurrent Protection Settings**

| Setting Description | Setting Range |
|---|---|
| 37-*n* | Enable/Disable |
| Pickup | 0.05A to 3.20A (1A)<br>0.25A to 16.00A (5A) |
| Pickup Delay | 0.00s to 999.99s |

## 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 5-21 and “51/67 IDMTL Phase Overcurrent” on page 5-23 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.

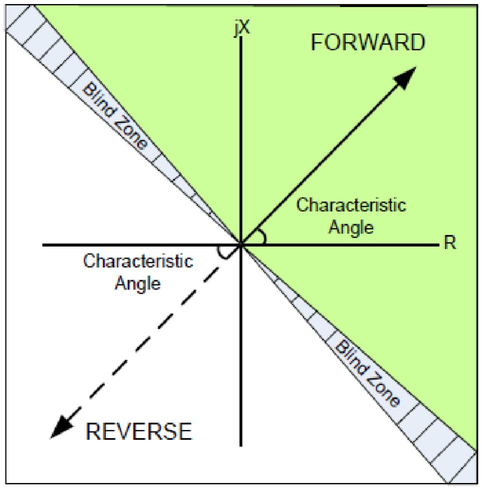



Figure 5.14: Characteristic Angle

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.

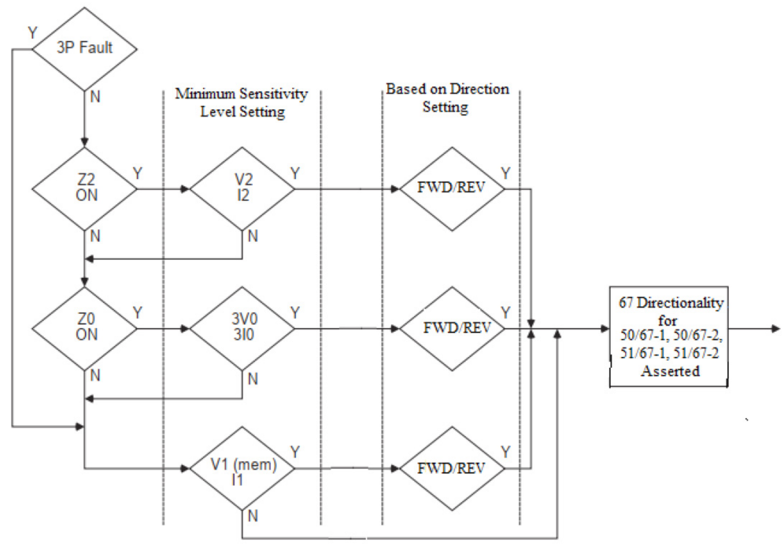



Figure 5.15: Sequence Logic

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 5.20: 67 Direction Function for Phase Overcurrent Settings**

| Setting Description | Setting Range |
|---|---|
| 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)<br>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)<br>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)<br>0.2 to 2.0A (5A) |
| 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 |

## 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 input 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.

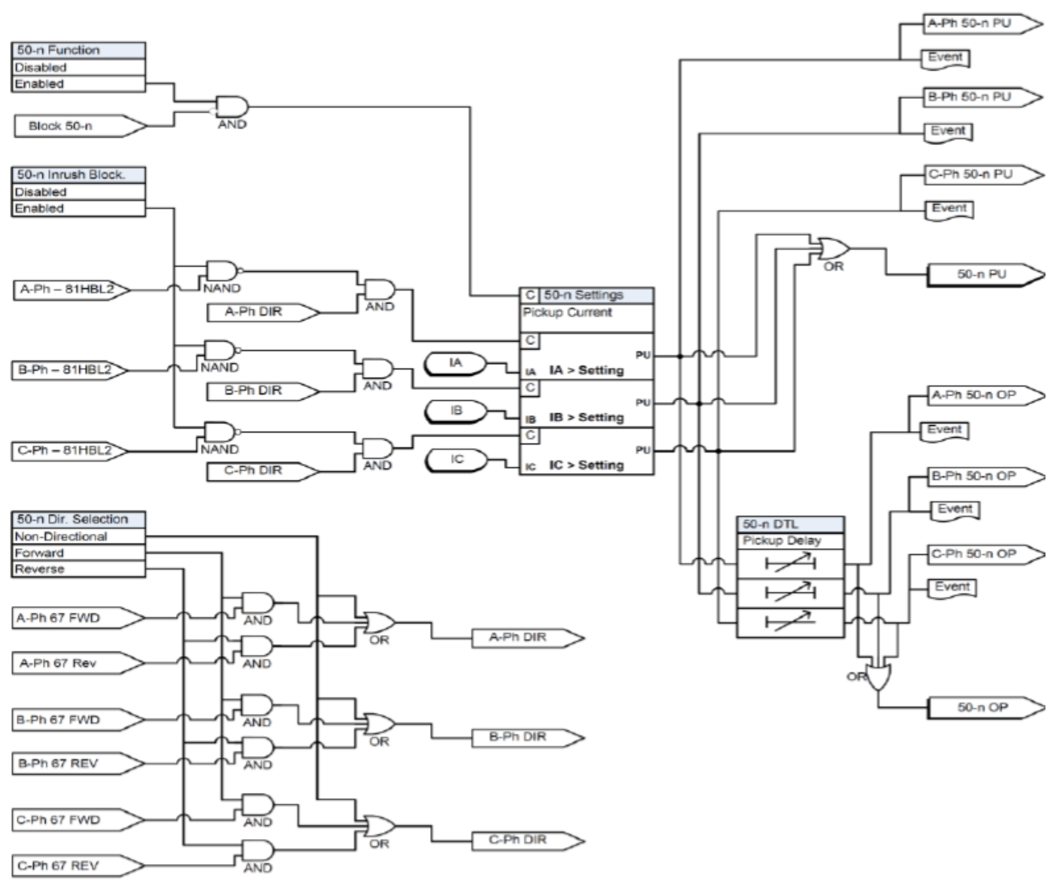



Figure 5.16: 50/67 Function Logic

**Table 5.21: 50/67 Instantaneous Phase Overcurrent Settings**

| Setting Description | Setting Range |
|---|---|
| 50-67-*n* | Enabled/Disabled |
| Direction Selection | Non-Dir, FWD, REV |
| Pickup I | 0.05 to 25.00 A (1A)<br>0.25 to 125.00A (5A) |
| Pickup Delay | 0.00 to 999.99 s (Non-Dir)<br>0.01 to 999.99 s (FWD or REV) |
| Inrush Blocking | Enabled/Disabled |

## 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 Zsource (the impedance between the relay and the power source) is small compared to that of the protected section ZL, there is an appreciable difference between the current for a fault at the far end of the section (Esource / (Zsource+Zline), and the current for a fault at the near end (Esource/Zsource). 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 51/67-1and 51/67-2 are listed in below.

Pickup:

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

Reset:

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

Each element (51/67-1, 51/67-2) can be independently inhibited via external input status which can be configured from input 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.

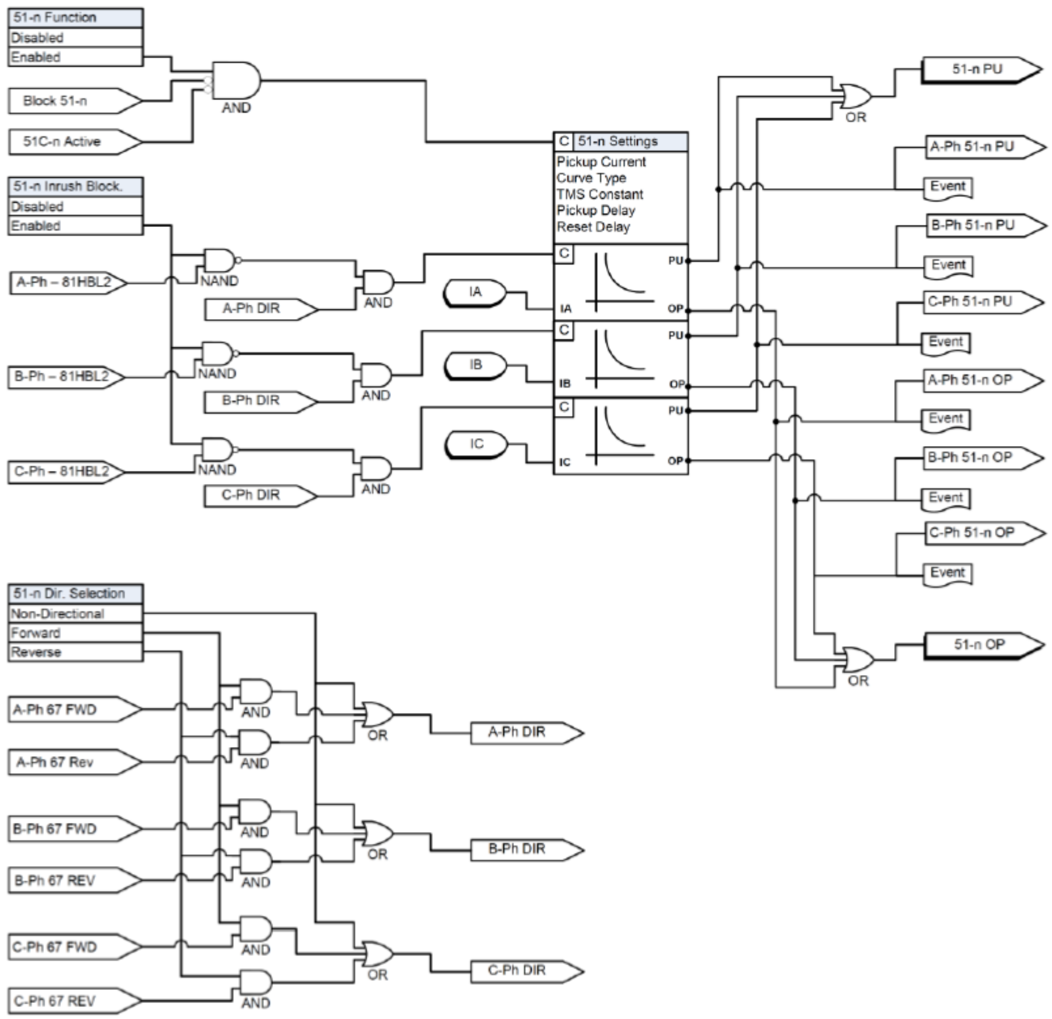



Figure 5.17: 51/67 Function Logic

| **Table 5.22: 51/67 IDMTL Phase Overcurrent Settings** | |
|---|---|
| **Setting Description** | **Setting Range** |
| 51/67-*n* | Enabled/Disabled |
| Direction Selection | Non-Dir, FWD, REV |
| Pickup I | For IDMTL curve type selection:<br>0.05 to 10.00A (1A)<br>0.25 to 50.00A (5A)<br><br>For DTL curve type selection:<br>0.05 to 25.00A (1A)<br>0.25 to 125.00A (5A) |

**Table 5.22: 51/67 IDMTL Phase 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 Defined |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00 to 999.99 s (Non-Dir)<br>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 |
| Inrush Blocking | Enable/Disable |

## 67N Directional Function for 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 3V0 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 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 (V2), Negative Sequence Current (I2), Residual Voltage 3V0, Neutral Current (3I0) 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 5-28 and “51N/67N IDMTL Derived Neutral Overcurrent” on page 5-30 for more details.

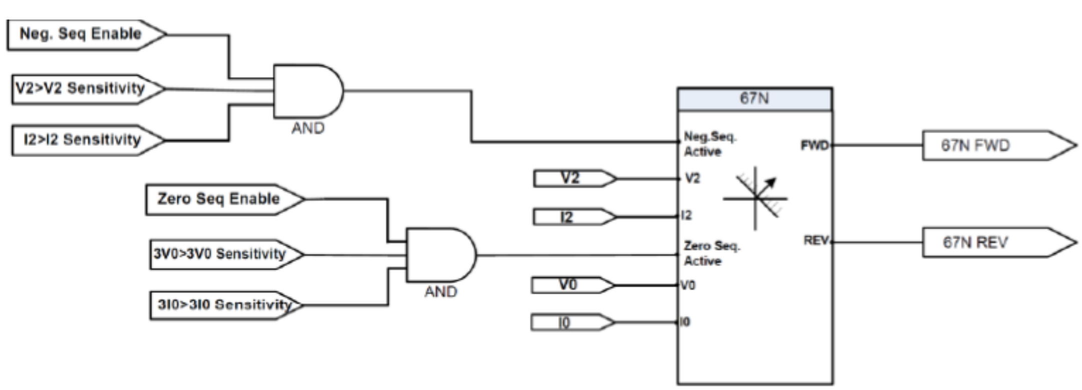



Figure 5.18: 67N Directional Function Logic

| Table 5.23: 67N Directional Function for Derived Neutral Overcurrent Settings | |
|---|---|
| **Setting Description** | **Setting Range** |

| Table 5.23: 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)<br>0.1 to 1.0A (5A) |
| VTS Blocking | Disable, Enable, Non-Dir |

## 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 has two stages 50N/67N-1 and 50N/67N-2 both can be set independently based on the requirement of the user.

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 input 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.

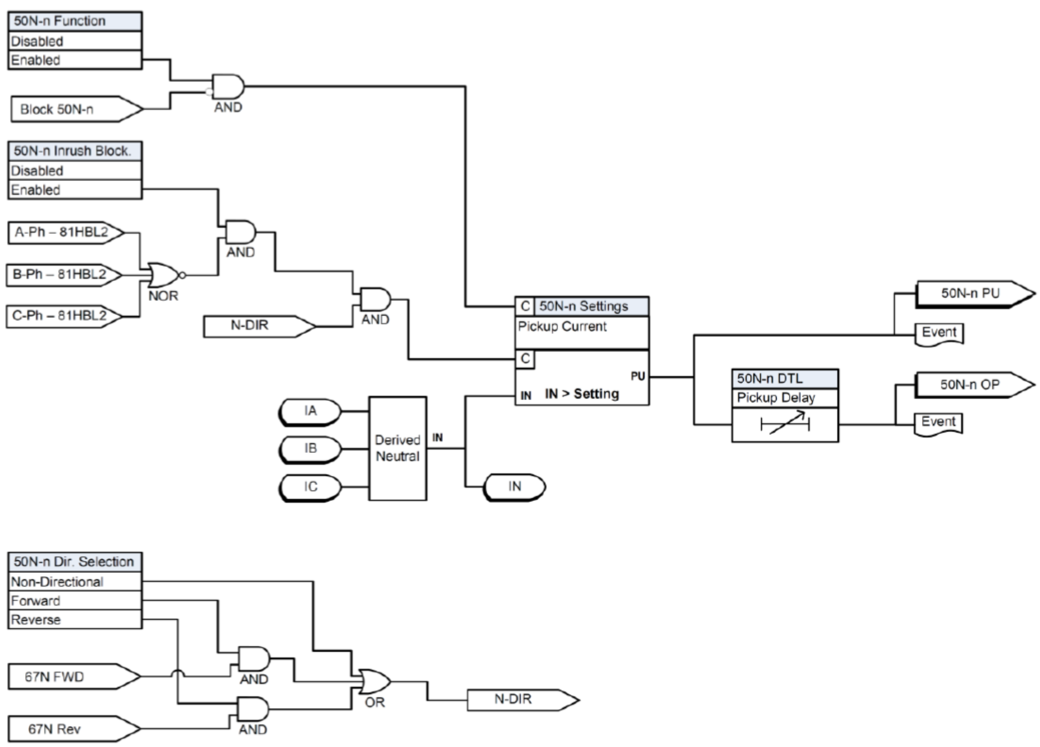



Figure 5.19: 50N/67 Function Logic

**Table 5.24: 50N/67 Directional Instantaneous Neutral Overcurrent Settings**

| Setting Description | Setting Range |
|---|---|
| 50N/67N-*n* | Enabled/Disabled |
| Direction Selection | Non-Dir, FWD, REV |
| Pickup IN | 0.05 to 25.00 A (1A)<br>0.25 to 125.00 A (5A) |
| Pickup Delay | 0.00 to 999.99 s (Non-Dir)<br>0.01 to 999.99 s (FWD or REV) |
| Inrush Blocking | Enabled/Disabled |

## 51N/67N IDMTL Derived Neutral Overcurrent

Neutral overcurrent provides protection for line-to-ground faults. All the curve definitions are the same as the phase overcurrent except that this function uses 3I0 rather than phase current. The equation is:

Pickup:

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

Reset:

$$T(I) = \left( \frac{TR}{1 - \left(\frac{I_N}{I_{NPickup}}\right)^2} \right) TMS$$

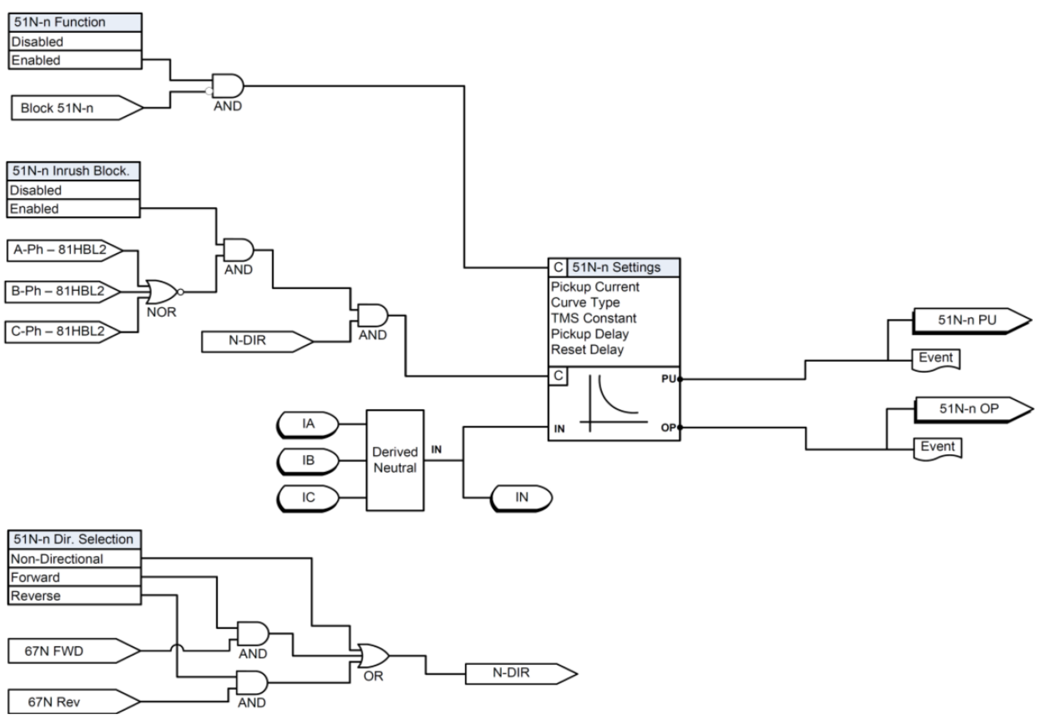



Figure 5.20: 51N/67N Function Logic

**Table 5.25: 51N/67N Derived IDMTL Neutral Overcurrent Settings**

| Setting Description | Setting Range |
|---|---|
| 51/67-*n* | Enabled/Disabled |
| Direction Selection | Non-Dir, FWD, REV |
| Pickup I | For IDMTL curve type selection:<br>0.05 to 10.00A (1A)<br>0.25 to 50.00A (5A)<br><br>For DTL curve type selection:<br>0.05 to 25.00A (1A)<br>0.25 to 125.00A (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 |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00 to 999.99 s (Non-Dir)<br>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 |
| Inrush Blocking | Enable/Disable |

## 46/50 Instantaneous 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.

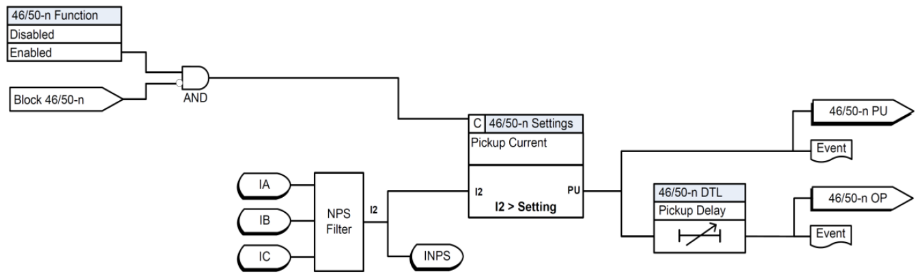



Figure 5.21: 46/50 Instantaneous Negative Sequence Overcurrent

**Table 5.26: 46/50 Instantaneous Negative Sequence Overcurrent Settings**

| Setting Description | Setting Range |
|---|---|
| 46/50 Function | Enabled/Disabled |
| Pickup I2 | 0.05 to 25.00 A (1A)<br>0.25 to 125.00A (5A) |
| Pickup Delay | 0.00 to 999.99 s |

## 46/51 IDMTL Instantaneous 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 ($I_2$) rather than phase current. The equations are as given below:

Pickup:

$$T(I) = \left( B + \frac{A}{\left(\left(\frac{I_2}{I_{2Pickup}}\right)^p - 1\right)} \right) TMS$$

Reset:

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

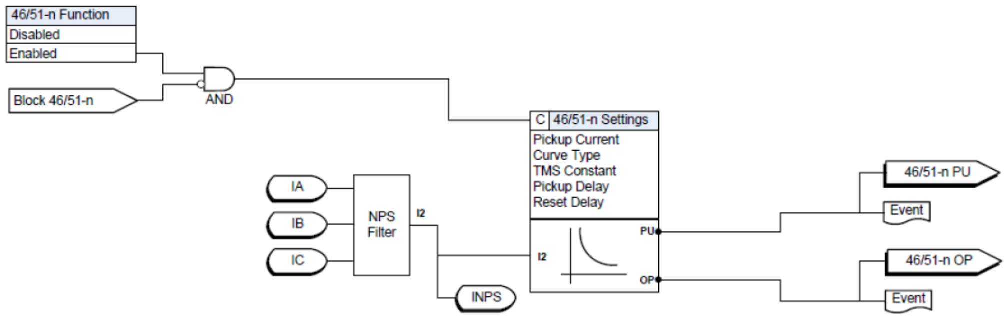



Figure 5.22: 46/51 Instantaneous Negative Sequence Overcurrent

| **Table 5.27: 46/51 IDMTL Negative Sequence Overcurrent Settings** | |
|---|---|
| **Setting Description** | **Setting Range** |
| 46-51 Function | Enabled/Disabled |
| Pickup I2 | 0.05 to 0.95 A (1A)<br>0.25 to 4.75 A (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 |
| 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 |
| 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 |

## 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 ($V_2$) 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). See “64/50 Instantaneous Sensitive Earth Fault” on page 5-36 and “64/51 Inverse Time Sensitive Earth Fault” on page 5-38 for more details

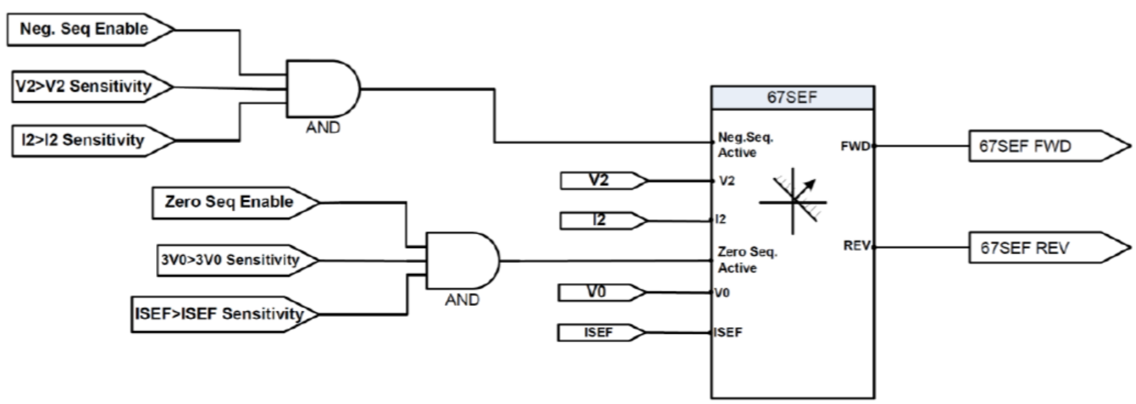



Figure 5.23: 67SEF Function Logic

**Table 5.28: 67SEF Direction Function for SEF Settings**

| Setting Description | Setting Range |
|---|---|
| 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)<br>0.1 to 1.0A (5A) |
| VTS Blocking | Enable, Disable, Non-Dir |

## 64/50 Instantaneous Sensitive Earth Fault

The 64/50 function provides instantaneous overcurrent 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 one 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

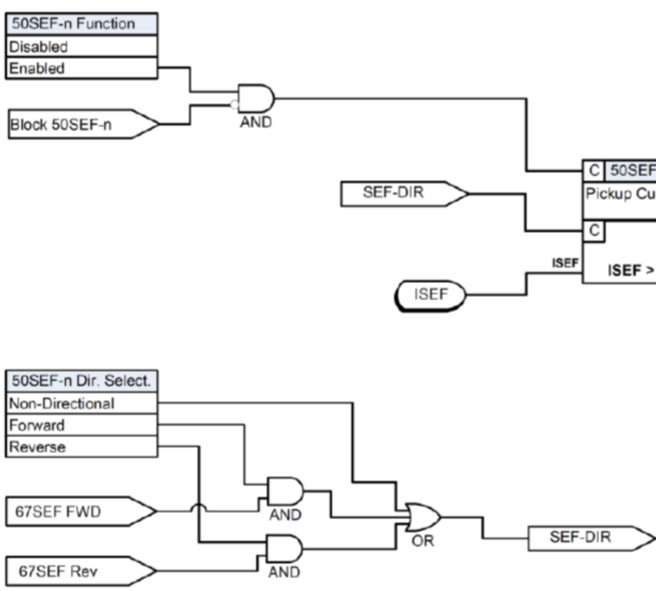



Figure 5.24: 64/50 Instantaneous SEF Function Logic

| Table 5.29: 64/50 Instantaneous SEF Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 64/50SEF-*n* | Enabled/Disabled |
| Direction Selection | Non-Dir, FWD, REV |
| Measurement Input | Fundamental (non-configurable) |
| Pickup Isef | 0.005 to 3.000 A (1A)<br>0.025 to 15.000 A (5A) |
| Pickup Delay | 0.00 to 999.99 s (Non-Dir)<br>0.01 to 999.99 s (FWD or REV) |

| Table 5.29: 64/50 Instantaneous SEF Settings | |
|---|---|
| Current Compensation | 0.000 to 0.500 A (1A)<br>0.000 to 2.500 A (5A) |

## 64/51 Inverse Time Sensitive Earth Fault

The 64/51 function provides time delayed overcurrent 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 one 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:

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

Reset:

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

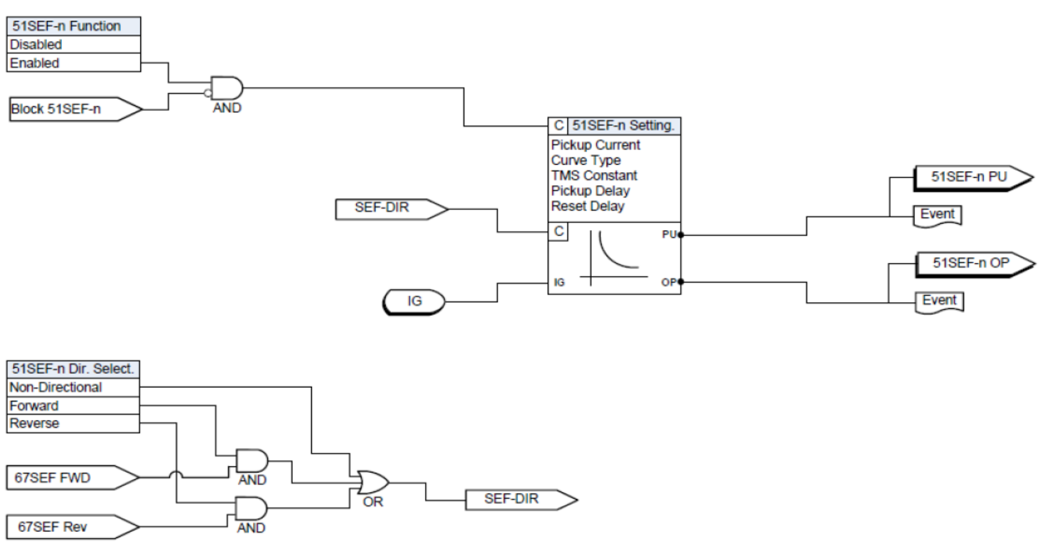



Figure 5.25: 64/51 Inverse Time SEF Function Logic

| Table 5.30: 64/51 Inverse Time SEF Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 64/51SEF-*n* | Enabled/Disabled |
| Direction Selection | Non-Dir, FWD or REV |
| Measurement Input | Fundamental (fixed) |
| Pickup Isef | 0.005 to 3.000 (1A)<br>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 Defined |
| 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 |
| Current Compensation | 0.000 to 0.500A (1A)<br>0.000 to 2.500A (5A) |

## 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

Ip = Steady state relay current prior to overload

IB = Basic current

I = Effective relay current

Basic current IB is full load current of the protected feeder. Constant k is a multiplying factor resulting in the 49 Thermal OL setting of the relay Iθ which is equal to k.IB. 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

IRMS = 3 phase RMS current

I2 = 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 Ip <0.02IB prior to thermal OL condition, then it is treated as cold condition, hence it adopts cold curve. If Ip 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:

$$\theta = \frac{I^2}{I_\theta^2} \cdot (1 - e^{-t/\tau}) \cdot 100\%$$

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

$$\theta = \theta_F \cdot e^{-t/\tau} \quad \text{[or]} \quad t = \tau \cdot Ln \frac{\theta}{\theta_F}$$

Where

θ = Thermal state in percentage at time t

$\theta_F$ = Final thermal state before disconnection of feeder

I = Effective relay current.

$I_\theta$ = Thermal overload setting

t = Thermal time constant in minutes.

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

$\Theta = I_2/I_{\theta 2} * 100\%$

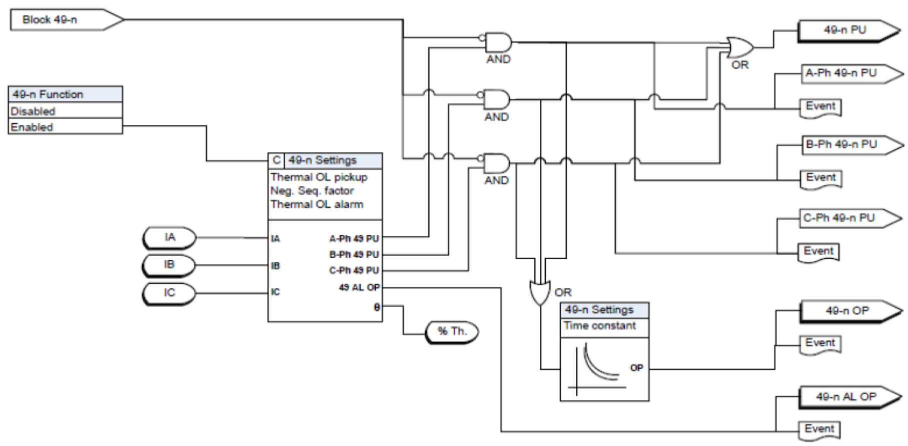



Figure 5.26: 49 Thermal Overload Function Logic

**Table 5.31: 49 Thermal Overload Settings**

| Setting Description | Setting Range |
|---|---|
| Themal Overload Pickup | 0.20 to 2.00A (1A)<br>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% |

## 50 CBF Circuit Breaker Failure

There are two sets of breaker failure protection functions. When breaker failure is initiated by an external 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. After these timers are timed out, and if the current still exists indicating a 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. The breaker failure protection logic diagram is shown below. Phase current supervision is fixed at 4% of I nominal.

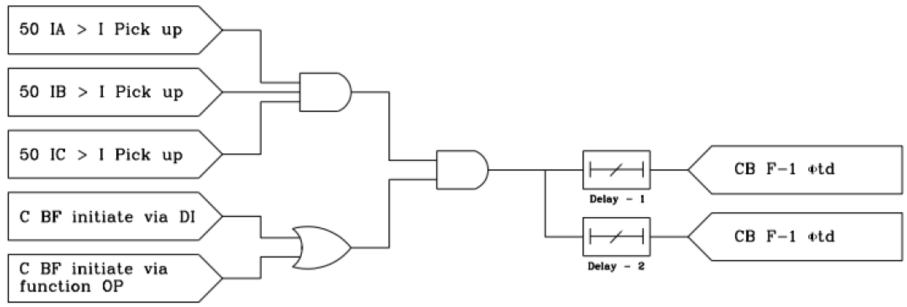



Figure 5.27: 50 CBF Function Logic

| **Table 5.32: 50 CBF Function Logic** | |
|---|---|
| **Setting Description** | **Setting Range** |
| Internal | Enable/Disable |
| External | Enable/Disable |
| Pickup I | 0.05 to 2.00A (1A)<br>0.25 to 10.00A (5A) |
| Pickup Delay 1 | 0.005 to 999.999s |
| Pickup Delay 2 | 0.005 to 999.999s |
| DI Circuit Breaker Failure | Enable/Disable |
| Pickup Delay 1 | 0.005 to 999.999s |
| Pickup Delay 2 | 0.005 to 999.999s |

## 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, misoperation 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 (I2/I1). 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.

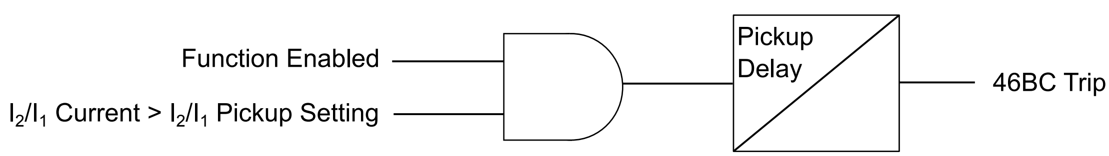



Figure 5.28: 46BC Protection Function Logic

### Settings

**Table 5.33: 46BC - Broken Conductor Protection Settings**

| Setting Description | Setting Range |
|---|---|
| 46BC | Enabled/Disabled |
| Pickup $I_2/I_1$ | 20.0% to 100.0% |
| Pickup Delay | 0.02s to 999.99s |

## 81HBL2 - Inrush Block

The protection relay may detect large magnetizing inrush current during transformer 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 misoperation.

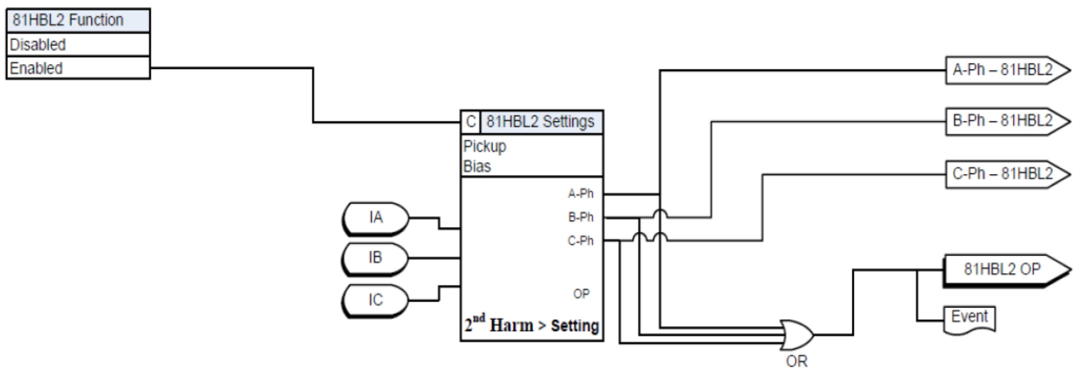



Figure 5.29: 81HBL2 Inrush Block Logic

| Table 5.34: 81HBL2 - Inrush Protection Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 81HBL2 Function | Enabled/Disabled |
| Cross Blocking | Enabled/Disabled |
| Pickup $I_{2nd}$ | 5% to 50% |

# 5.4 Frequency Protection Functions

## 81U/O Under/ Over frequency

**Over frequency:** Over frequency arise due to excess of power generation and it can easily be corrected by reduction in the power Outputs with the help of the governor or manual control.

**Under frequency:** Under frequency occurs due to the excess of load. During an overload, generation capability of the generator increases and reduction in frequency occurs. The power system survives only if we drop the load so that the generator output becomes equal or greater than the connected load. If the load increases the generation, then frequency will drop and load need to shed down to create the balance between the generator and the connected load. The rate at which frequency drops depend on the time, amount of overload and also on the load and generate or variations as the frequency changes. Frequency decay occurs within the seconds so we cannot correct it manually. Therefore automatic load shedding facility needs to be applied.

**Operation**:

The over frequency protection function operates, when the injected value of frequency is same or greater than the pickup value.

The under frequency function operates, when the injected value of frequency is equal or lesser than the pickup value.

The dropout of 81U/O Under/Over frequency function depends on the hysteresis setting.The user can set the hysteresis frequency (Hz) as per the requirement.

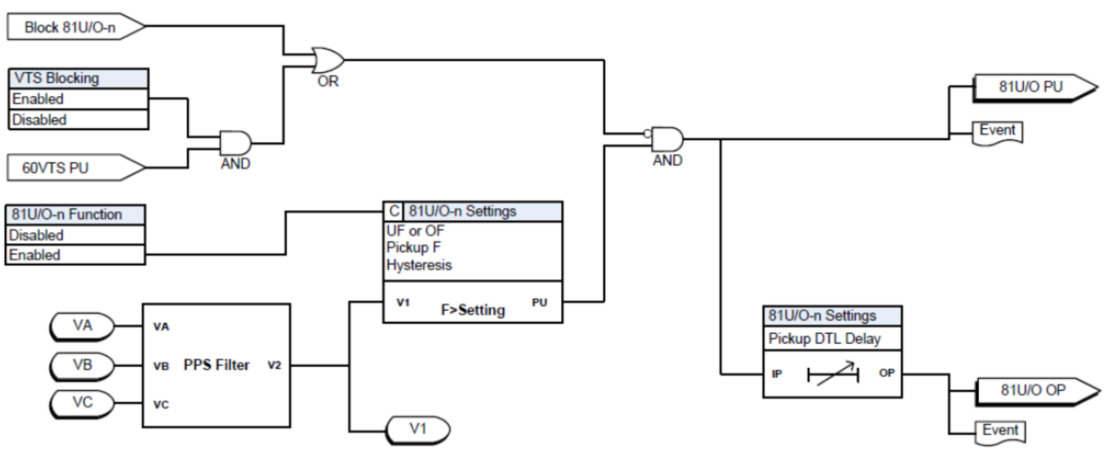



Figure 5.30: 81 U/O Function Logic

| Table 5.35: 81U/O - Under/Over Frequency | |
|---|---|
| **Setting Description** | **Setting Range** |
| 81/U/O-n | Enabled/Disabled |

| Table 5.35: 81U/O - Under/Over Frequency | |
|---|---|
| Function Selection | UF or OF |
| Pickup F | 40.00 to 49.99 for 50Hz UF<br>50.01 to 60.00 for 50Hz OF<br><br>50.00 to 59.99 for 60Hz UF<br>60.01 to 70.00 for 60Hz OF |
| Hysteresis | 0.05 to 2.00Hz |
| Pickup Delay | 0.05 to 999.99s |
| VTS Blocking | Enabled/Disabled |

## 81R Rate of change of frequency

**Rate of change of frequency (ROCOF or df/dt)**:- It is used for fast load shedding, to speed up operation time in over- and under-frequency situations and to detect loss of grid. For example a centralized dedicated load shedding relay can be omitted and replaced with distributed load shedding, if all outgoing feeders are equipped with protection devices.

A special application for ROCOF is to detect loss of grid (loss of mains, islanding). The more the remaining load differs from the load before the loss of grid, the better the ROCOF function detects the situation.

**Operation**:

Whenever the rate of change of frequency reaches same or above (If set Pickup is Positive values) the pickup value, then this function gets operated.

Whenever the rate of change of frequency reaches same or below (If set Pickup is Negative values) the pickup value, then this function gets operated.

The dropout frequency mainly depends on the % hysteresis.

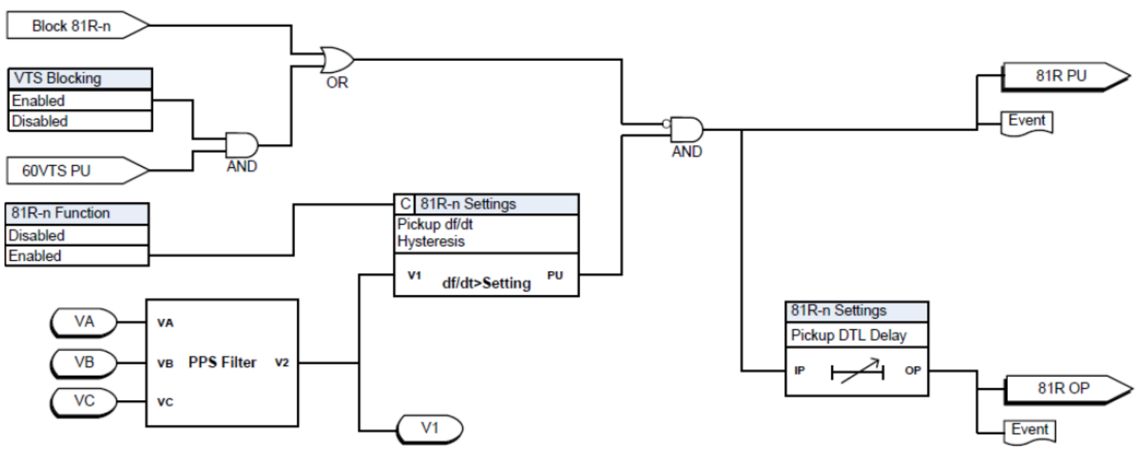



Figure 5.31: 81R Rate of Change of Frequency Function Logic

| Table 5.36: 81R Rate of Change of Frequency Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 81R-*n* | Enabled/Disabled |
| Pickup df/dt | -10.0 to -0.1Hz/s or 0.1 to 10.0Hz/s |
| Hysteresis | 1 to 80% |
| Pickup Delay | 0.20 to 999.99s |
| VTS Blocking | Disable or Enable |

# 5.5 Power Protection Functions

## 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).

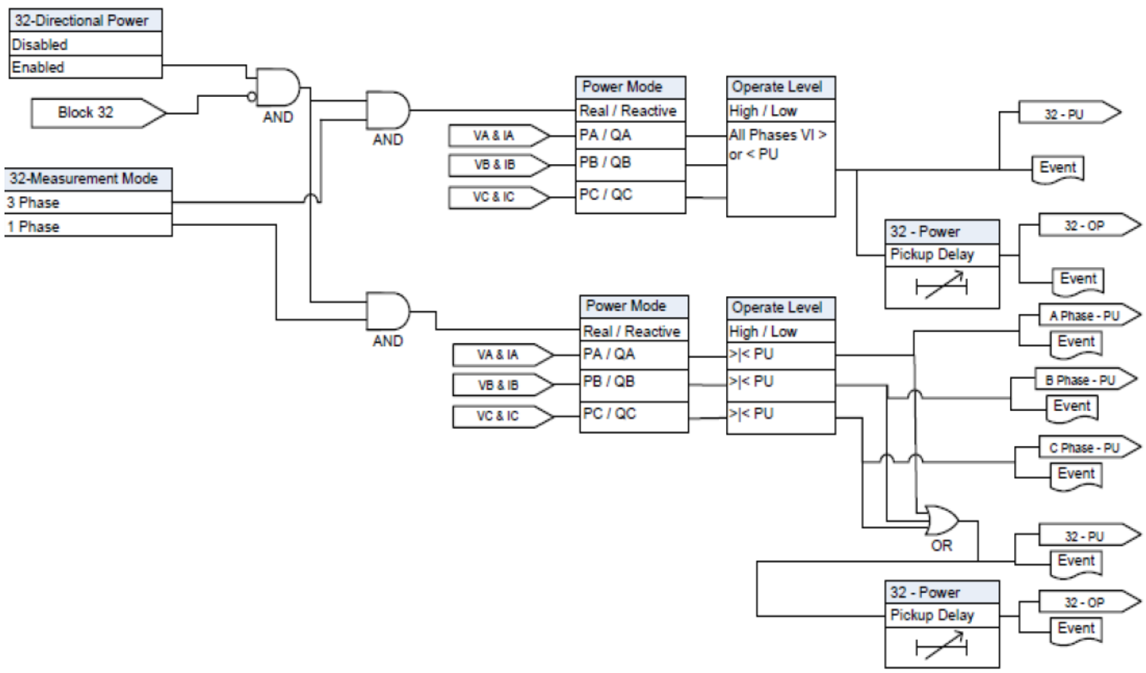



Figure 5.32: 32 Directional Power Protection Function Logic

| **Table 5.37: 32 Directional Power Settings** | |
|---|---|
| **Setting Description** | **Setting Range** |
| 32-*n* | Enabled/Disabled |
| Power Mode | Real or Reactive |
| Measurement Mode | 1 Phase or 3 Phase |
| Operate Level | High or Low |

| Table 5.37: 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 |

# 5.6 Monitoring Functions

## 60VTS - VT Supervision

The Voltage Supervision function is used to detect loss of one, two or all three phases of voltage input to the relay. The voltage failure may happen due to internal faults in the voltage transformer or due to human errors such as faults in terminal wiring to relay.

On detection of VT failure, the function may blocks the other voltage protection functions. The function detects VT failure on the basis that during single or two phase VT failure, there will be presence of negative sequence voltage but the negative sequence current which usually accompanies it during normal unbalance will not be present. But, during three phases VT fails, there will not be even negative sequence voltage. At that time, the function works according to the logic settings that have been loaded. The 60VTS function operates after a settable time-delay.

The 27/59 DT/IT, 47 DT/IT and 59N DT/IT functions may be cross-blocked when the 60VTS is high. However, this blocking feature may be enabled or disabled on the settings for each of these functions.

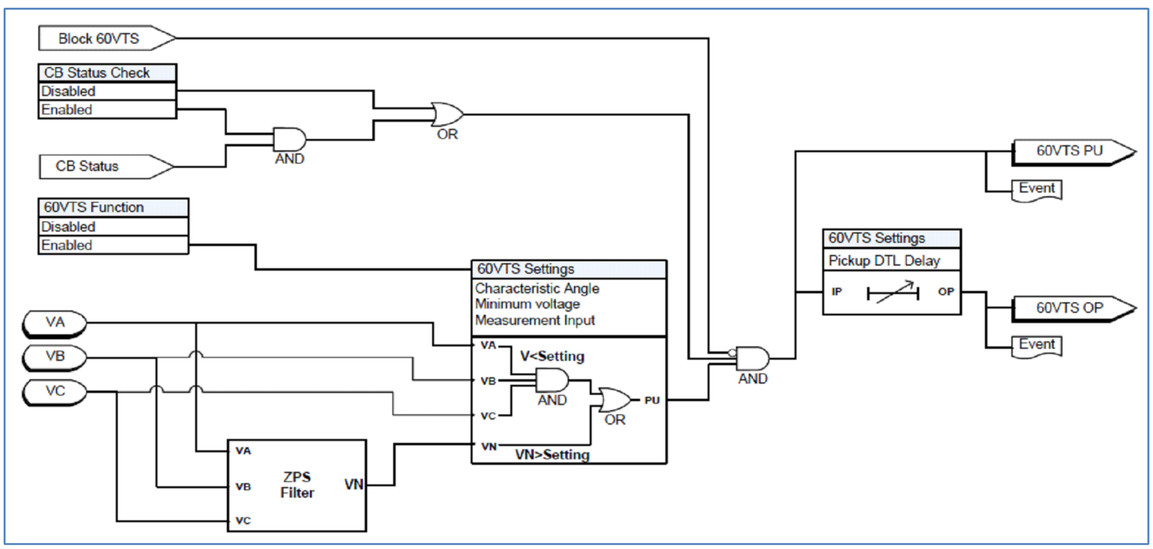



Figure 5.33: 60VTS Function Logic

| Table 5.38: 60VTS - VT Supervision Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| V phase to neutral less than 0.75 per unit (fixed) | |
| I1 Blocking | 0.1 to 10.0 A (1A)<br>0.5 to 50.0 A (5A) |

| Table 5.38: 60VTS - VT Supervision Settings | |
|---|---|
| 3I0 Blocking | 0.1 to 10.0 A (1)<br>0.5 to 50.0 A (5A) |
| Negative Sequence Monitoring | Enabled/Disabled |
| Vnps | 7.0V to 110.0V |
| Inps | 0.05A to 1.00A (1A)<br>0.25A to 5.00A (5A) |

## 60CTS - CT Supervision

Current Supervision function is used to detect failure of the current inputs to the relay. When a current input to the relay fails, there will be presence of negative sequence current and the absence of negative sequence voltage. The function operates when the negative sequence current is greater than the set value and the negative sequence voltage is less than the set value. The logic diagram for the function is shown below.

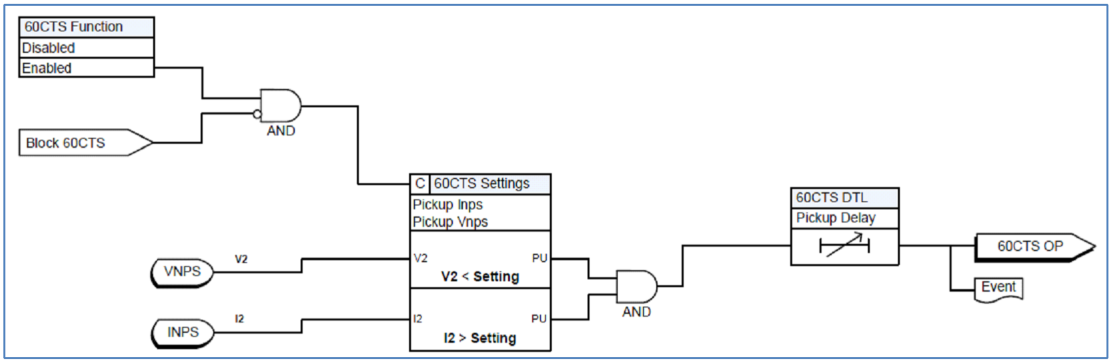



Figure 5.34: 60CTS Function Logic

### Settings

| Table 5.39: 60CTS - CT Supervision Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| Vnps Pickup | 7.0V to 110.0V |
| Inps Pickup | 0.05A to 1.00A (1A)<br>0.25A to 5.00A (5A) |
| Pickup Delay | 0.03s to 999.99s |

## 74TCS - Trip Circuit Supervision

Trip Circuit Supervision generates a trip circuit failure/unhealthy alarm, either if the trip circuit auxiliary supply is disconnected or the breakage of trip circuit connection.

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.

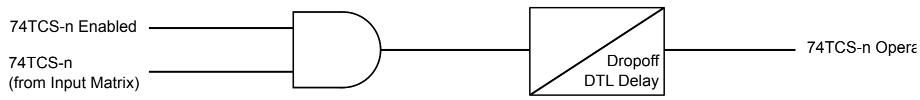



Figure 5.35: 74TCS Function Logic

### Settings

| Table 5.40: 74TCS - Trip Circuit Supervision Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| TCS-1 | Enabled/disabled |
| Name | Configurable text string. Max 12 characters. |
| Dropoff Delay | 0.00s to 9.99s |
| TCS-2 | Enabled/disabled |
| Name | Configurable text string. Max 12 characters. |
| Dropoff Delay | 0.00s to 9.99s |

### TCS Schemes

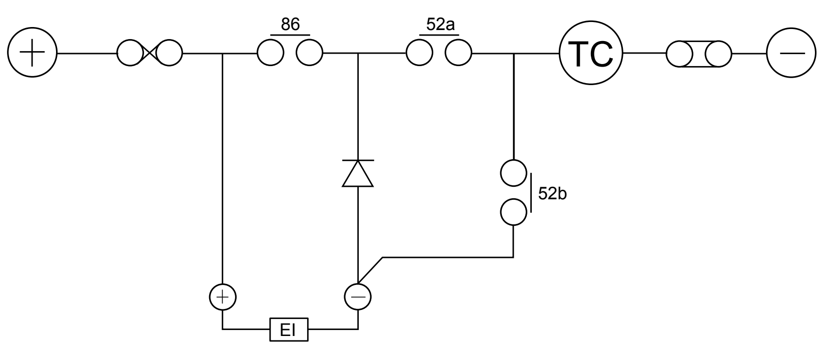



Figure 5.36: TCS Scheme 1

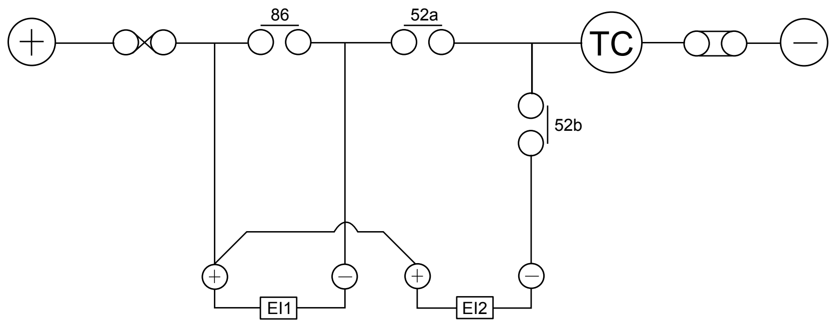



Figure 5.37: TCS Scheme 2

### 74TCS Using ProLogic

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

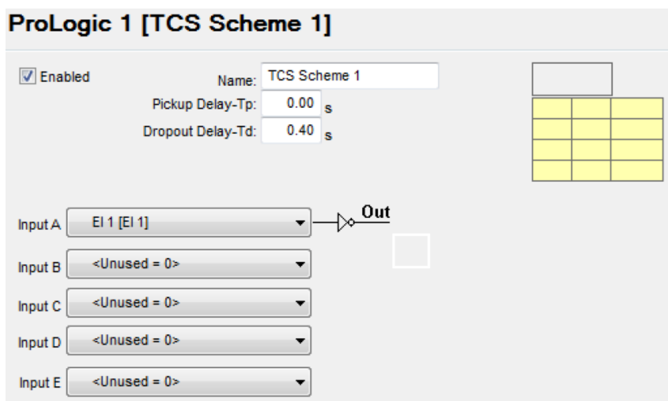



Figure 5.38: ProLogic TCS Scheme 1

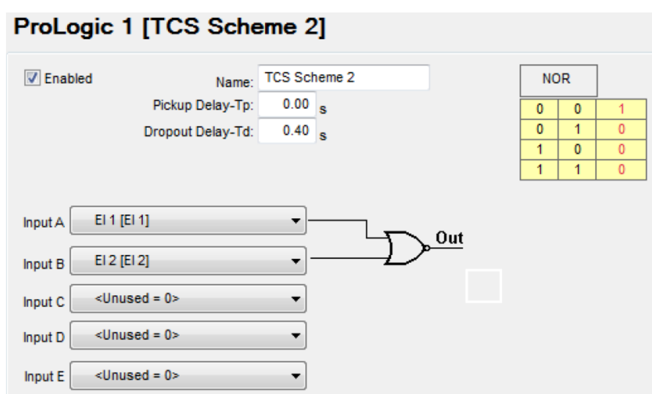



Figure 5.39: ProLogic TCS Scheme 2

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

## $I^2t$ - CB Condition

The $I^2t$ function is used for monitoring the wear and tear of the breaker due to fault interruptions. The $I^2t$ 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 $I^2t$ 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 $I^2t$ 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 $I^2t$ function and value of last operation. The terminal UI also includes the time of last reset/preset.

The following figure shows the $I^2t$ function's logic diagram. The accumulation is started 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-energized. The breaker open/close is determined by the tripping of the following functions:

- 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.

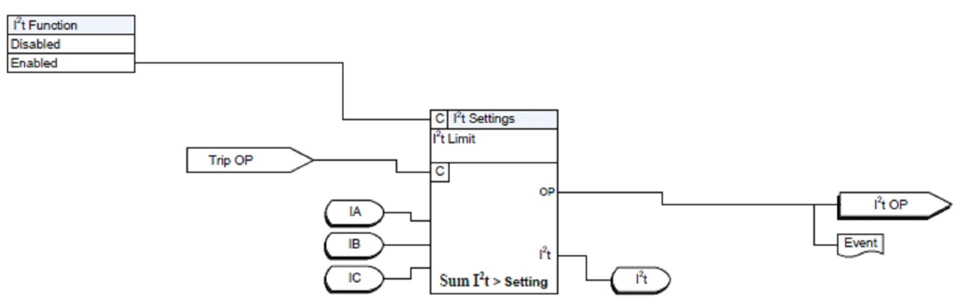



Figure 5.40: $I^2T$ Logic

### Settings

| Table 5.41: $I^2t$ - CB Condition Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| $I^2t$ CB Condition | Enabled/Disabled |
| $I^2t$ Limit | 0.1 to 99999.9 $kA^2s$ |

## 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.

$$THD - V_{percent} = \frac{100 \times \sqrt{V_2^2 + V_3^2 + V_4^2 + \ldots + V_n^2}}{V_1}$$

Where,

$V_1$ - Nominal voltage at fundamental frequency

$V_2$ - Harmonic voltage of 2nd order

...

$V_n$ - 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 5.42: THD - Total Harmonic Distortion Settings**

| Setting Description | Setting Range |
|---|---|
| THD-1 | Enable/disable |
| 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 |

## Count Alarms

The Count Alarms provide alarm indications for a number of recurring conditions including Undervoltage, Overvoltage, Underfrequency, Overfrequency, External Input and Autorecloser.

### UV Alarm

The UV alarm will provide an alarm if the pickup value is exceeded more times than the count setting, over the count accumulation period.

| Table 5.43: UV Count Alarm Settings | |
|---|---|
| UV Count Alarm | Enabled/disabled |
| Pickup V | 1.0 to 220.0 V |
| UV Count | 1 to 1000 |
| Count Accumulation Period | 1 to 31 days |

### OV Alarm

The OF alarm will provide an alarm if the pickup value is exceeded more times than the count setting, over the count accumulation period.

| Table 5.44: OV Count Alarm Settings | |
|---|---|
| OV Count Alarm | Enabled/disabled |
| Pickup V | 1.0 to 220.0 V |
| OV Count | 1 to 1000 |
| Count Accumulation Period | 1 to 31 days |

### UF Alarm

The UF alarm will provide an alarm if the pickup value is exceeded more times than the count setting, over the count accumulation period.

| Table 5.45: UF Count Alarm Settings | |
|---|---|
| UF Count Alarm | Enabled/disabled |
| Pickup F | 50.0 to 60.0Hz (60Hz)<br>40.0 to 50.0Hz (50Hz) |
| UF Count | 1 to 1000 |
| Count Accumulation Period | 1 to 31 days |

### OF Alarm

The OF alarm will provide an alarm if the pickup value is exceeded more times than the count setting, over the count accumulation period.

**Table 5.46: OF Count Alarm Settings**

| | |
|---|---|
| OF Count Alarm | Enabled/disabled |
| Pickup F | 60.0 to 70.0Hz (60Hz)<br>50.0 to 60.0Hz (50Hz) |
| OF Count | 1 to 1000 |
| Count Accumulation Period | 1 to 31 days |

### EI Alarm

The EI alarm will provide an alarm if the external inputs pickup times than the count setting, over the count accumulation period.

**Table 5.47: EI Count Alarm Settings**

| | |
|---|---|
| EI Count Alarm | Enabled/disabled |
| EI Count | 1 to 1000 |
| Count Accumulation Period | 1 to 31 days |

### AR Counter

The AR counter will provide an alarm if the total number of reclosures exceeds the count setting. This counter does not have a time period, it simply operates based on total accumulated reclosures.

**Table 5.48: AR Count Alarm Settings**

| | |
|---|---|
| AR Count Alarm | Enabled/disabled |
| Reclosure Cumulative count | 0 to 999 |

# 5.7 Control Functions

## 79 Reclose

F-PRO includes a four shot recloser. After four reclose attempts, the recloser is locked out. The lockout is cleared once the feeder returns to normal by manual operation, meaning that the feeder has been on with a load greater than the low set setting for a certain amount of time. The 79 function initiate and block functions are defined in the output matrix.

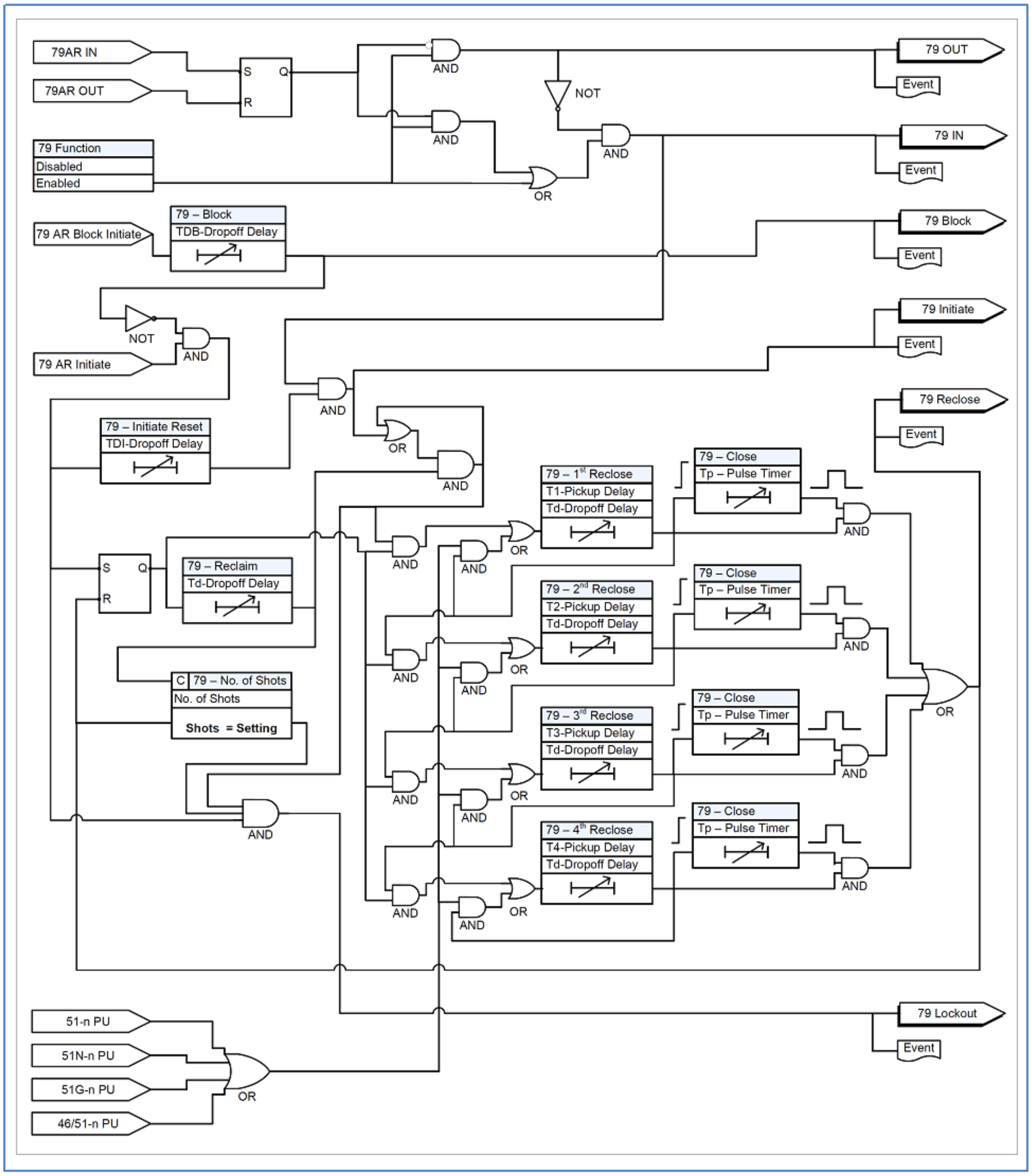



Figure 5.41: 79 Reclose Function Logic

**Table 5.49: 79 Settings**

| Setting Description | Setting Range |
|---|---|
| 79 Function | Enable/Disable |
| Number of Shots | 1 to 4 |
| First Reclose (T1) | 0.10 to 999.99 seconds |
| Second Reclose (T2) | 1.00 to 999.99 seconds |
| Third Reclose (T3) | 1.00 to 999.99 seconds |
| Fourth Reclose (T4) | 1.00 to 999.99 seconds |
| Close Time (Tp) | 0.01 to 1.00 seconds |
| Reclaim Time (Td) | 0.00 to 999.99 seconds |
| Initiate Reset (TDI) | 0.00 to 999.99 seconds |
| Block Reset (TDB) | 0.00 to 999.99 seconds |

## 25/27/59 Check Synchronization

The relay can bring in voltages from both Line and Bus PTs. The Sync Check function, If enabled, looks at the voltage magnitude, frequency and steady state angle of Line and Bus PT voltages. If the angle difference between Bus and Line PT's is within the specified value (1 to 50-degree), frequency difference is within the defined setting range and voltage magnitudes of both the PT's are between minimum and maximum voltage setting value, then the sync check function enables a definite time delay pickup(0.00 to 10.00 seconds) after which time, a sync-check output is generated.

The main voltage can be taken from either Bus or Line PT, depends on the system availability. The relay should only accepts 3-phase-to-neutral voltage.

The sync (Vsync) voltage can be taken from either Bus or Line PT and it accepts any phase-to-neutral voltage and the Synch Voltage Input setting shall be made accordingly in System Parameters menu.

The Dead Main Live Sync (DMLS), Live Main Dead Sync (LMDS) and Dead Main Dead Sync (DMDS) logic functions use fixed values of bus selected phase voltages & 'A' Synch voltage to determine the Sync Check condition. The voltage is fixed at 20 V secondary, voltages below 20 V are declared a dead state and voltages above 20 V are declared a live state. The above said functions have fixed delay of 25msec.

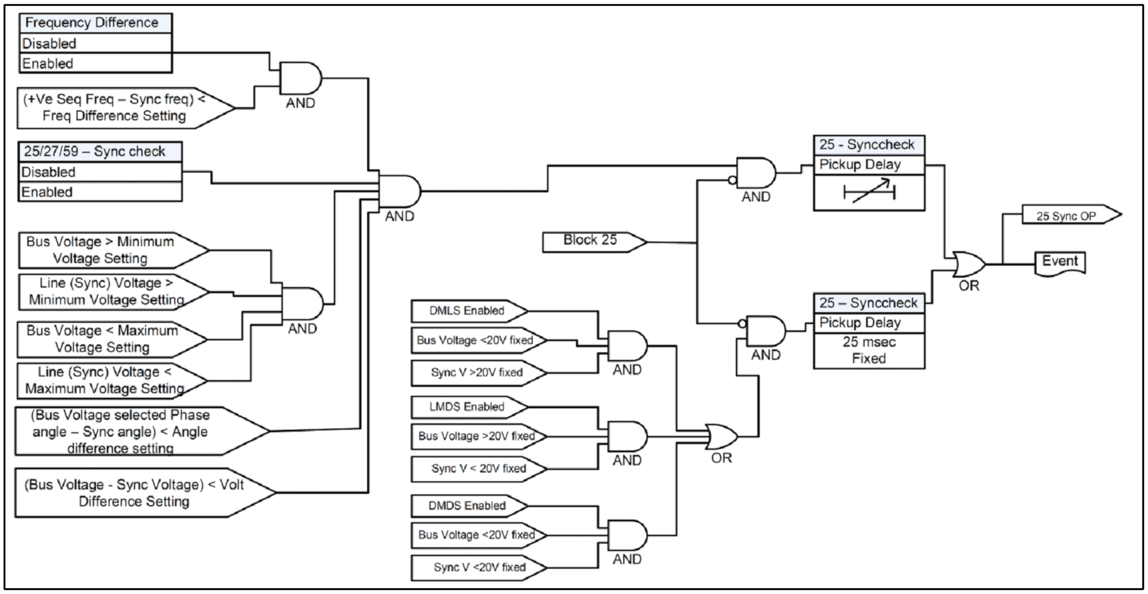



Figure 5.42: 25/27/59 Check Sync Function Logic

| Table 5.50: 25/27/59 Settings | |
|---|---|
| **Setting Description** | **Setting Range** |
| 25/27/59 Function | Enabled/Disabled |
| Maximum Voltage | 60.0 to 138.0 V |
| Minimum Voltage | 40.0 to 69.9 V |
| Voltage Difference | 1.0 to 20.0 V |
| Angle Difference | 1.0 to 50.0 deg |
| Pickup Delay | 0.00 to 10.00 s |
| Frequency Difference | Enabled/Disabled |
| Frequency Difference | 0.010 to 2.000 Hz |
| Main/Sync | |
| Enable Dead Main Live Sync (DMLS) | Enabled/Disabled |
| Enable Live Main Dead Sync (LMDS) | Enabled/Disabled |
| Enable Dead Main Dead Sync (DMDS) | Enabled/Disabled |

# 5.8 ProLogic

The relay includes 20 ProLogic functions. A ProLogic is a user customizable logic statement which can be created using any of the protection functions, External Inputs, Virtual Inputs or other ProLogics. These inputs are placed into Boolean-like statements. A graphical function logic interface is provided for creating the ProLogic logic. Each ProLogic handles up to 5 inputs to generate one ProLogic statement. The results from these statements are mapped to Output Contacts using the Output Matrix.

The ProLogic control statements are used to create Boolean-like logic. The possible gates are AND, NAND, OR, NOR, XOR, XNOR, and SR-LATCH. The control can be time delay pickup and or time delay dropout, and can drive the front panel target LED. Twenty-four ProLogic control statements outputs are available and can be used in the output matrix to customize the relay to specific needs. Inputs to ProLogic are all the elements plus previous ProLogic statements for logic nesting usage.

The example, for details see Figure 5.43: ProLogic on page 5-63, shows A to E inputs are status points of devices that are user-selectable. Each ProLogic output can be given a specific name, pickup and reset time delay.

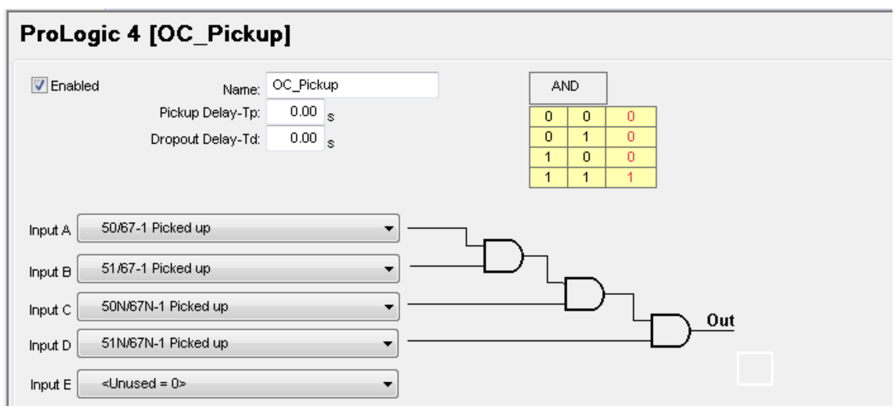



Figure 5.43: ProLogic

| Table 5.51: ProLogic Setting Functions | |
|---|---|
| Name | Give the ProLogic a meaningful name |
| Pickup Delay | Delay time from pickup to operate.<br>0.00 to 999.00 s |
| Dropout Delay | Delay time from dropout to ProLogic status of low.<br>0.00 to 999.00 s |
| A, B, C, D, E | Relay elements as input statements |
| Operators | Boolean-type logic gates |

## Pole Discrepancy Protection

Pole Discrepancy Protection ensures that all the three poles of Circuit Breaker are tripped / closed within a predefined time period. If there is a mismatch of Breaker opening / closing time, then Pole Discrepancy Protection will operate and will trip all the three poles of the Breaker. Suppose due a fault, a trip command is issued to the Breaker but due to some problem only two poles of Breaker could open simultaneously, and the third pole of Breaker is not opened. In this case Pole Discrepancy Protection will operate after the set time delay and will trip all the three pole of the Breaker.

This functionality shall be achieved by using F-PRO 298 relay ProLogic feature. Basically, Pole Discrepancy function is achieved through a Timer and breaker statuses connected to F-PRO 298 relay via External/Virtual inputs.

PD function shall be achieved in two methods depends on the CB contacts availability. If both NO and NC contacts of CB are available, then follow below Logic -1. If only NO contacts of CB are available, then follow Logic-2.

**Logic-1:**

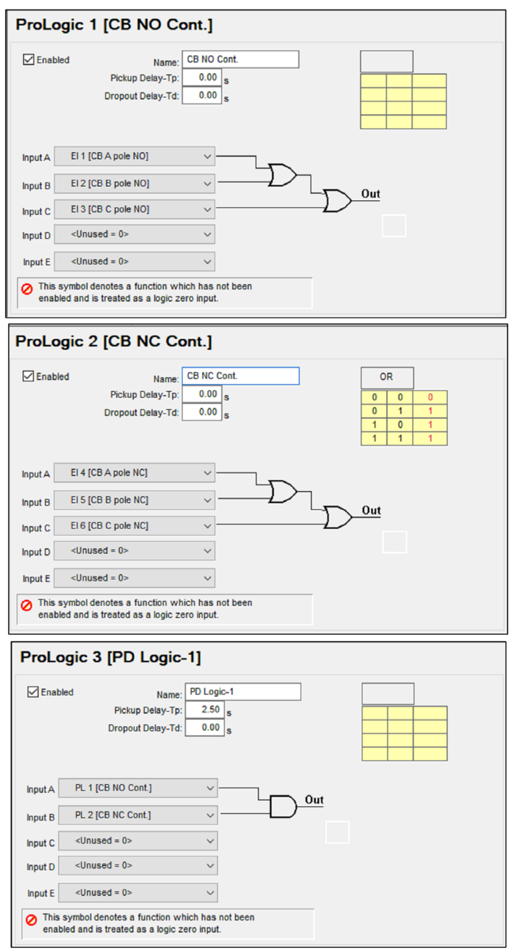



Figure 5.44: Logic 1

**Logic 2:**

All the three pole of CB Normally Closed (NC) and Normally Opened (NO) contacts shall be connected as either External or Virtual inputs to F-PRO 298 relay. The below ProLogic shall be configured in the setting file to achieve the Pole Discrepancy Protection.

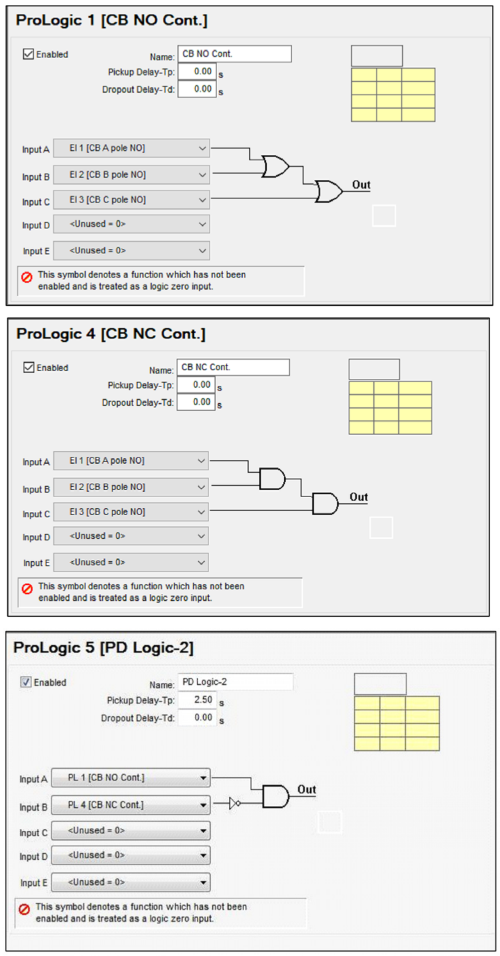
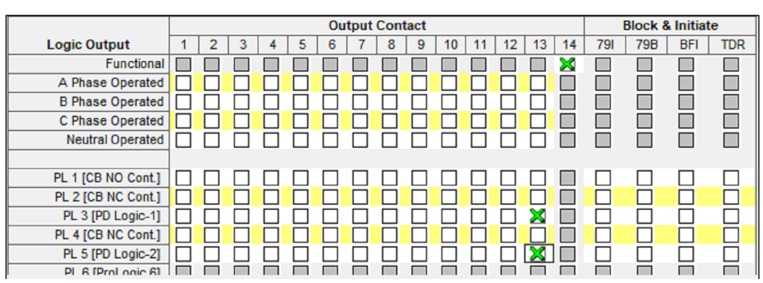



Figure 5.45: Logic 2

In the output matrix, ProLogic 3 or ProLogic 5 (depends on the Logic) shall be assigned to output contact(s) to trip the CB on PD protection operation.



# 5.9 Group Change Control Statement

The F-PRO298 relay has eight setting groups (SG1 to SG8). The user can change all relay setting parameters except the physical connections such as input, in each setting group. Setting group changes can also be performed by using any one of the 14 available Digital Inputs per setting group or through Relay Control Panel or through relay display interface. The Group change inputs are similar to the LED and output. The processing for activating the setting group is half a second. During the transition of one setting group to another setting group, the previous setting group will still be operational. The active setting group (ASG) is viewed using the Relay Control Panel, the front panel or from a record stored by the relay (the active setting group is stored within the record).

## Active 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.

## Default Setting

The user can at any time change the active setting group. When user initiate 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 Click *Save*.

## Group Change Through RCP

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 > Configuration > Setting Group> Active*

## Group Change Through LCD

In this screen, hit Enter and choose the desired setting group number using Up and Down keys, and then click Enter.

## Setting Group Change During Setting Load

The user can change the active setting group while loading settings from Offliner using Relay Control Panel. Relay Control Panel prompts the user for a setting group to active while loading the setting. The same setting group may be used or the user may switch to a different setting group.

## Manual Settings Change

Relay settings can be changed via the LCD manually. The relay logs an acceptance of the change request and puts the new setting file in service. When the new setting file is queued the relay loads the new setting configuration for protection functions. The relay loads the new name definitions for the supplementary settings (includes channel names, ProLogic names, Group Logic statement names, front panel target LED activation rules and record initiation rules) to the interface processor. When the setting load is completed, an event is logged to show the completion of the request. There is a delay (approximately five seconds) between the load request and the completion of the request where the new supplementary settings may be temporarily applied to the previous setting file.

> The Protection processor does not have any interruption in service.

## Automatic Settings Change

The relay configuration changes during a relay-initiated setting change, but the protection function operations are not disrupted. Since the relay setting file does not change, the interface processor uses the new setting group supplementary 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.

# 5.10 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.

## Fault Recording

The relay provides DFR-quality fault recording, capturing input signal waveforms and external input states at a rate of 32 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:

- 8 analog channels: 3 Phase current, 1 SEF current, 3 Phase voltage and 1 Vsync
- Voltages and current at 32 samples/cycle
- External digital inputs at 1msec resolution
- Relay Output internal logic signals at 8 samples/cycle
- Summation channel at 32 samples/cycle
- 30 Virtual Inputs at 8 samples/cycle
- 20 ProLogic signals at 8 samples/cycle
- Active setting group

## Record Initiation

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

The assignment of fault record initiation to the various relay functions is done through the relay's Output Matrix settings.

Recording can also be initiated manually through the Relay Control Panel interface in the Records tab and the command is Trigger Event.

## Record Duration and Extension

The length of each record is information by the Record Length setting. Fault record lengths can be set between 1 and 10 seconds. Pre-trigger times can be fixed from 0.1 to 0.5 seconds for fault records and are included as part of the normal record length.

F-PRO 298 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 stretched to include the full post-trigger time of subsequent triggers, up to a maximum length 10 seconds for fault 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 lengths settings can be set from either the HMI or the Offliner Settings software and accessible in Menu below.

*Configuration>Disturbance record setting >Record Length*

## Record Storage

The F-PRO compresses records on the fly, achieving a typical lossless compression rate of 4:1. As a result, the F-PRO 298 can store up to 200 seconds of fault recordings in non-volatile storage. If the storage is full, new records automatically overwrite the oldest, ensuring that the recording function is always available.

## Record Retrieval and Deletion

A list of stored records is available through the Relay Control Panel in the Records tab. From Relay Control Panel user can retrieve the record and delete or leave on the relay, graph the record, export the record to COMTRADE/ PTI & CSV formats. Records are named by combining the Unit ID setting with the date and time of the initiating record trigger.

To delete a record from storage, right-click on the record and select Delete, or alternatively, select the record and press the <Del> key. User can also do group deleting and group transferring. To select multiple records:

1.Select a record

2.Hold the <Shift> key.

3.Continue selecting records until all desired records are selected.

4.Press the <Del> key. A message asks "Are user sure user want to delete multiple records from the relay?" shown above. Select Delete and the files are deleted.

When a record is retrieved from the relay using Relay Control Panel program, it is automatically transferred to user PC as well. The record is placed in user Relay Control Panel program's Recordings folder.

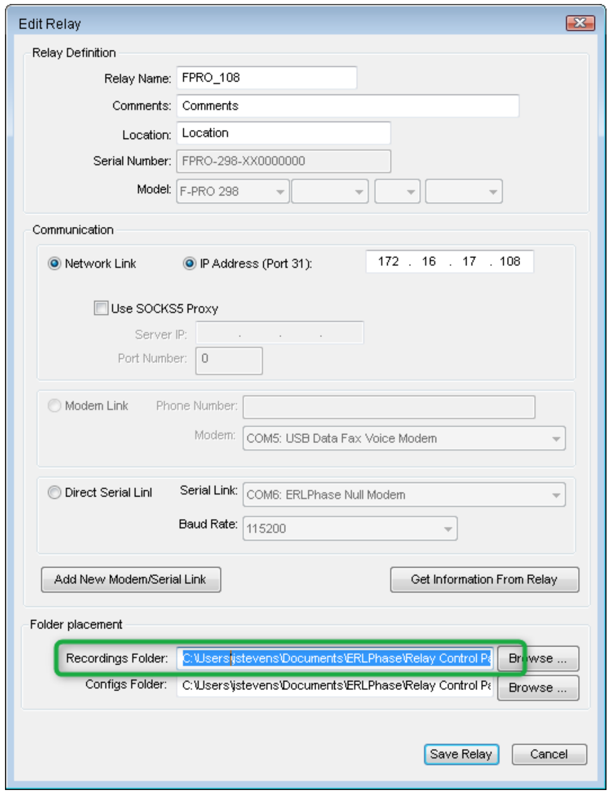



Figure 5.46: Recordings folder

## Event Recording

The event recording provides permanent storage for the event log. The user can create an event record automatically or manually.

# 5.11 Event Log

The F-PRO 298 maintains a log of events in a 1000 entry circular log. Each entry contains the time Logged events include trips, alarms, external input information plus internal events such as setting changes. Fault information and classification information is included in event messages where appropriate. For example, the event log entry for a function trip might be:

2019 DEC 25, 15:34:19.832: 51-1 ABC Operated.

The event log can be viewed in three ways:

•Relay Front HMI

•Relay Control Panel interface is in the Events tab

•SCADA protocols included in the F-PRO allow the SCADA server/client access to Trip and Alarm event data.

Events that occur during a transient fault recording are also embedded in the transient record and can be viewed in Relay Control Panel, RecordBase View and RecordGraph. Although the event log is circular, user may ensure events are not lost by checking the manual trigger option on the records menu in Relay Control Panel. When this option is selected, as the event log is required by user, it will save the records to an event file .fpe. The event log will then be ready to capture up to 1000 new events.

> 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 see “Event Messages” in Appendix D.

# 5.12 Fault Log

The F-PRO stores a log of faults in a 20 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 5.52: Fault Log**

| Fault Type | Fault Quantities |
|---|---|
| 27DT Under Voltage | VA / VB / VC Phasors |
| 27IT Inverse time Under Voltage | VA / VB / VC Phasors |
| 59DT Over Voltage | VA / VB / VC Phasors |
| 59IT Inverse Time Over Voltage | VA / VB / VC Phasors |
| 24DT Overflux | VA / VB / VC Phasors, %V/F |
| 24IT Inverse Time Overflux | VA / VB / VC Phasors, %V/F |
| 47DT Negative Sequence Overvoltage | VA / VB / VC Phasors, V2 |
| 47IT Negative Sequence Inverse Time Overvoltage | VA / VB / VC Phasors, V2 |
| 59NDT Residual Overvoltage | VN Phasor |
| 59NIT Residual Inverse Time Overvoltage | VN Phasor |
| 37 Undercurrent | IA/ IB / IC Phasors |
| 50/67 Overcurrent<br>51/67 Inverse Time Overcurrent | IA/ IB / IC Phasors |
| 50N/67N Neutral Overcurrent<br>51N/67N Inverse Time Neutral Overcurrent | IN Phasor |
| 46/50 Negative Sequence Overcurrent<br>46/51 Inverse time Negative Sequence Overcurrent | IA / IB / IC / I2 Phasors |
| 64/50SEF<br>64/51SEF Inverse Time SEF | ISEF Phasor |
| 49 Thermal Overload | IA / IB / IC / IN Phasors |
| 50BF Breaker Failure | IA / IB / IC / IN Phasors |
| 46BC Broken Conductor | IA / IB / IC / IN Phasors, %I2/I1 |
| 81U Under Frequency | VA / VB / VC Phasors, Frequency |
| 81O Over Frequency | VA / VB / VC Phasors, Frequency |
| 81R ROCOF | VA / VB / VC Phasors, dF/dt |
| 32 Power | VA / VB / VC / VN Phasors, IA / IB / IC / IN Phasors, A, B, C – Real & Reactive |

The fault log can be viewed in three ways:

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

# 6 Data Communications

## 6.1 Introduction

This chapter 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, IEC 60870-5-103 and DNP3 protocols. The SCADA configuration and its settings are described. The parameters for SCADA communications are defined using F-PRO Offliner software. Finally, details on how to monitor SCADA communications are given for maintenance and troubleshooting of the relay.

# 6.2 SCADA Protocols

## 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 serial Port 122, an RS-232 DCE DB9F port located on the back of the relay. An external RS-232 to RS-485 converter can be used to connect the relay to an RS-485 network. For details on connecting to serial Port, see “Communicating with the Relay Intelligent Electronic Device (IED)” on page 3-5 and “Communication Port Details” on page 3-15.

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 RTU Communication Protocol” in Appendix E.

## IEC 103 Protocol

The relay supports IEC 60870-5-103 SCADA connection. IEC 103 is available via a RS485 serial link.

Serial IEC 103 communications can be utilized exclusively via serial CON 32 (RS485 port) is located on the rear 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 Intelligent Electronic Device (IED)” on page 3-5 and “Communication Port Details” on page 3-15.

Complete details regarding the IEC 103 protocol emulation and data point lists can be found in “IEC 103 Device Profile” in Appendix G.

## 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 serial Port 122. Port 122 is an RS-232 DCE DB9F port located on the back of the relay. An external RS-232 to RS-485 converter can be used to connect the relay to an RS-485 network. For details on connecting to serial Port, see “Communicating with the Relay Intelligent Electronic Device (IED)” on page 3-5 and “Communication Port Details” on page 3-15.

Network DNP communications can be utilized via physical LAN Port 119 or Port 120. Port 119 is available as a RJ-45 port on the front of the relay and as an RJ-45 or ST fiber optic port on the rear. Port 120 located on the rear of the relay is available as an RJ-45 or ST fiber optic port. DNP communications can be used with multiple masters when it is utilized with TCP. For details on connecting to the Ethernet LAN, see “Network Link” on page 3-8.

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” in Appendix F

## Offliner SCADA Configuration

Open the Offliner application and highlight the SCADA Communication selection. The screen appears as follows.

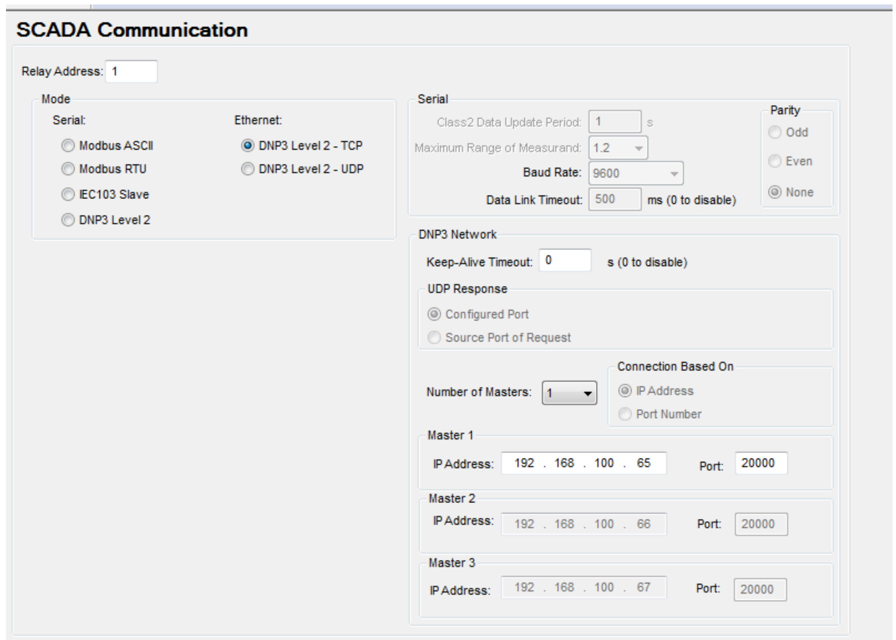



Figure 6.47: SCADA Communications

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. As noted before, there is no field to configure the number of data and stop bits. These values are fixed as follows:

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

## IEC 61850

For more details on the IEC 61850 standard, and it’s implementation on the F-PRO 298, see “IEC 61850 Implementation Overview” on page 9-1 and “IEC 61850 Conformance Statements and Data Mapping Specification” in Appendix L’ on page Appendix L-1.

# 7 Settings and Analysis Software

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 2000 Offliner Setting Software, RecordGraph and ERL 61850 IED Configurator. The F-PRO 2000 Offliner software will be described at length, while the RecordGraph and ERL 61850 IED Configurator tools will be briefly introduced.

F-PRO 2000 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 (see "Relay Control Panel" on page 4-10) via a communication link (see "Communicating with the Relay Intelligent Electronic Device (IED)" on page 3-5).

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.

RecordBase View is a Windows-based software tool for displaying and managing records from ERLPhase recorders and relays.

The RecordBase Central Station software provides automated collection, storage and network-wide access to fault and disturbance data produced by supported ERLPhase recorders and relays. It is available for purchase.

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 2000 Offliner Setting Software

## Introduction

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 Chapter 5.

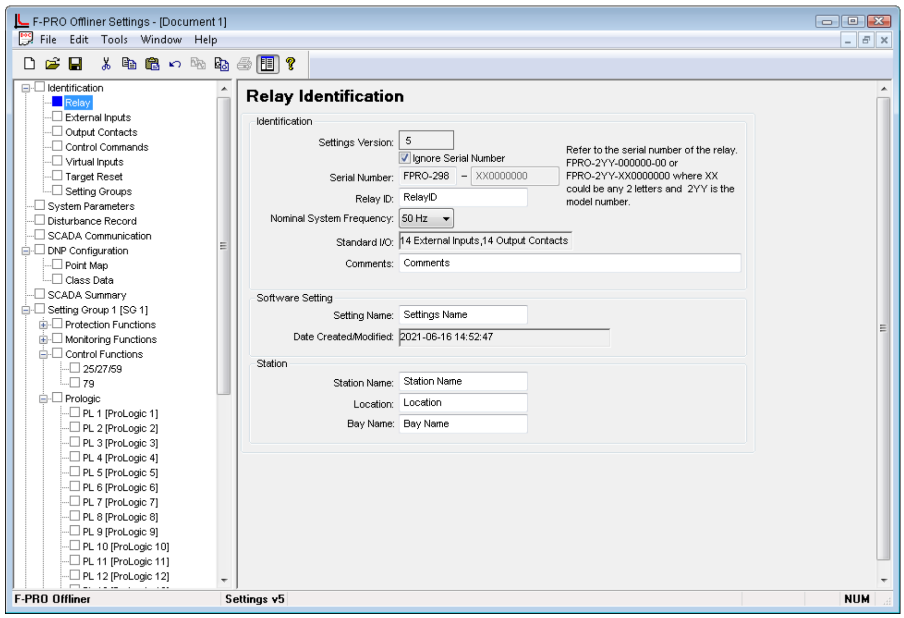



Figure 7.1: F-PRO 298 Offliner Software

## Menu and Toolbar

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

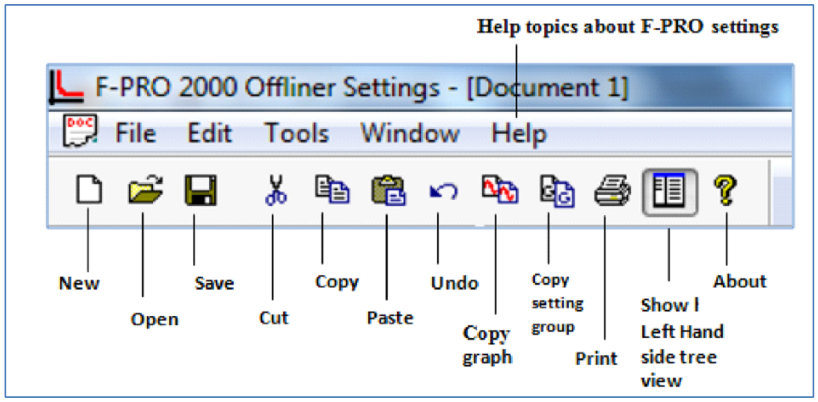



Figure 7.2: Top Tool Bar

| Table 7.1: Windows Menu | | |
|---|---|---|
| **Windows Menu** | **Sub Menu** | **Comment** |
| **Document Menu (Icon)** | Restore | Restores active window to previous size |
| | Move | Allows user to move active window |
| | Size | Allows user to resize active window |
| | Minimize | Makes the active window as small as possible |
| | Maximize | Makes the active window as large as possible |
| | Close | Closes the active Offliner setting document |
| | Next | Switches to the next open Offliner setting file, if more than setting file is being edited |

| Table 7.1: Windows Menu | | |
|---|---|---|
| **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 |
| | 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 |
| **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 |

| Table 7.1: Windows Menu | | |
|---|---|---|
| Cut | Cut the 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 |
| 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.

## Handling Backward Compatibility

Offliner Settings displays the version number in the second pane on the bottom status bar. The settings version is a whole number (v1, v2, v3, v4, etc.).

The Offliner Settings is backward compatible; open and edit older settings files and convert older settings files to a newer version. Offliner settings handles forward conversion only — it converts an older setting file to a newer setting file.

### Converting a Settings File

1. Open the setting file to convert.
2. In the *File* menu, select *Convert to Newer...* and then select the *version x* (where x is the newer version). A dialog box pops up prompting Offliner for a new file name. Use either the same file name or enter a new file name. The conversion process inserts default values for any newly added devices in the new setting file. When the conversion is complete, Offliner Settings displays the new file.
3. When the new file has been opened, it must be re-saved in order for the conversion to complete successfully.

> After converting to a new File Version, the newly converted file must be opened and re-saved in order for the conversion to complete properly.

## Sending a New Setting File to the Relay

1. 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 using the terminal mode ID menu item. Type this serial number into the F-PRO 298 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.

2. Check the serial number and the settings version of the relay. The Device Serial Number and Required Settings Version on the Identification screen indicate the serial number and the settings version of the relay.

## 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.

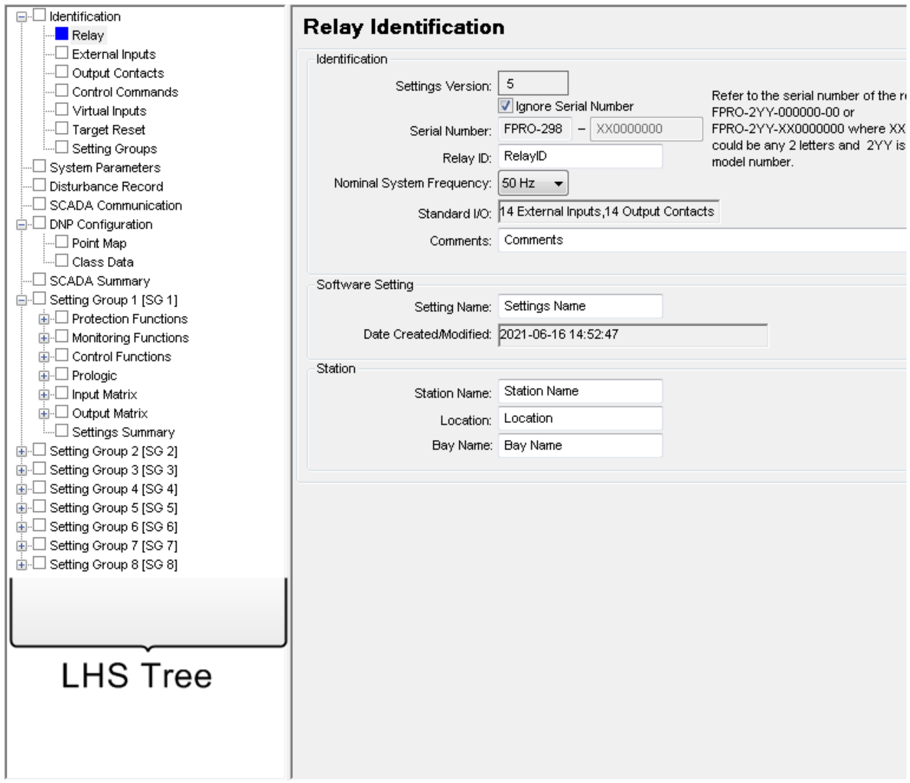



Figure 7.3: Relay Identification

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.

> 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.
>
> The user can choose to ignore the serial number enforcement in the identification screen. The relay only checks for proper relay type and setting version if the ignore serial number has been chosen.

## Identification

The first screen presents all the menu items in the left menu tree. Access the menu items by clicking the tabs at the top of the screen or the item on the left menu tree.

**Table 7.3: 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 |
| Standard I/O | Indicates standard I/O values, fixed. |
| Comments | User-defined up to 78 characters. |
| **Setting Software** | |
| 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. |

Important Note

Nominal System Frequency can be set to either 50 Hz or 60 Hz. Ensure setting selection matches that of target the relay.

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, requires relay firmware version 1.0 or greater.

## External Inputs

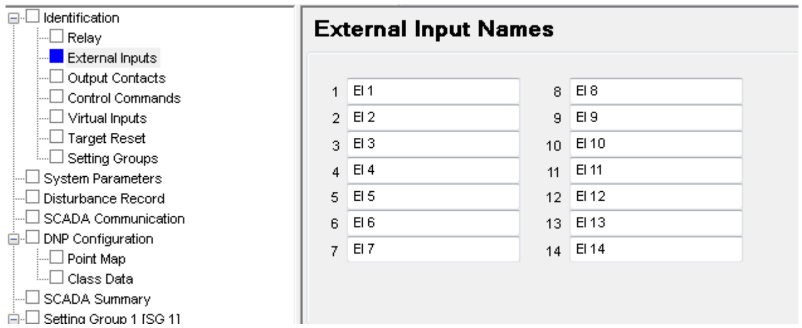



Figure 7.4: External Inputs

External Input Names screen allows the user to define meaningful names for 14 external digital inputs.

| Table 7.4: External Input Names | |
|---|---|
| 1 to 14 | User-defined |

## Output Contacts

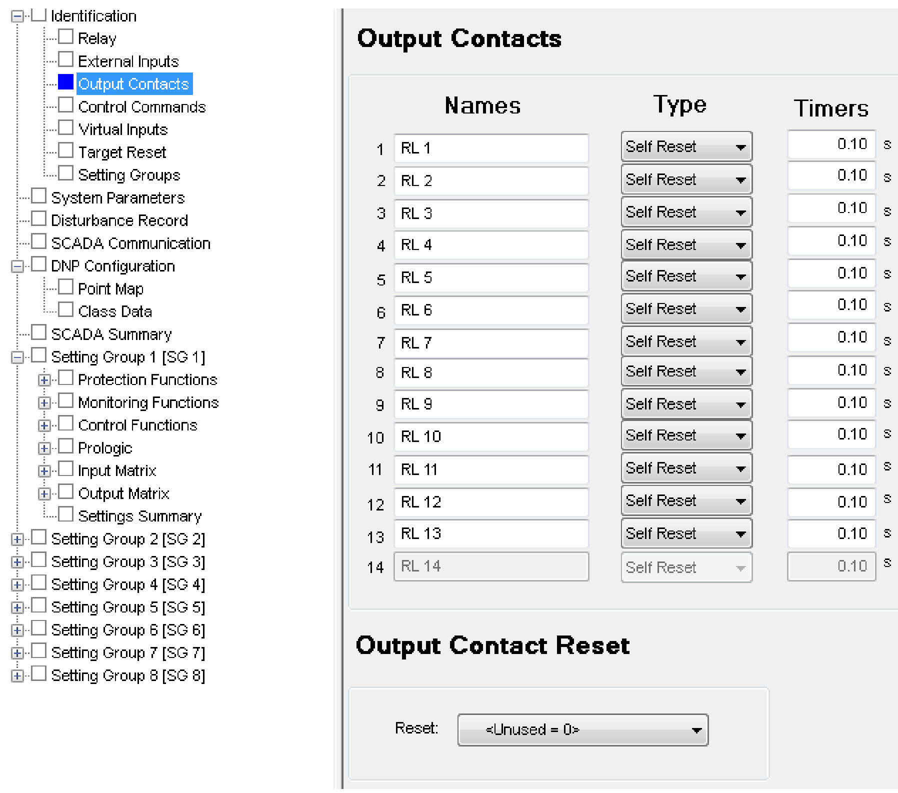



Figure 7.5: Output Contacts

The Output Contacts are also identified during the setting procedure using meaningful names. The dropout delay time settings are made here.

| Table 7.5: Output Contact Names | |
|---|---|
| Outputs 1 to 14 | User-defined |
| Type (per output) | Self Reset or Hand Reset |
| Dropout Timer (per output) | 0.00 to 1.00 s |
| Output Contact Reset | Any EI, PL, VI or SPC |

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 Hand Reset 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, Relay Control Panel's *Utilites>Outputs* Output Contact clear function or by the Output Contact Reset setting.

### Control Commands

Each control command can be configured with a user-defined name. There are 4 Double-Point Control and 12 Single-Point Control commands provided. See "Control Commands" on page 9-4 for more details.

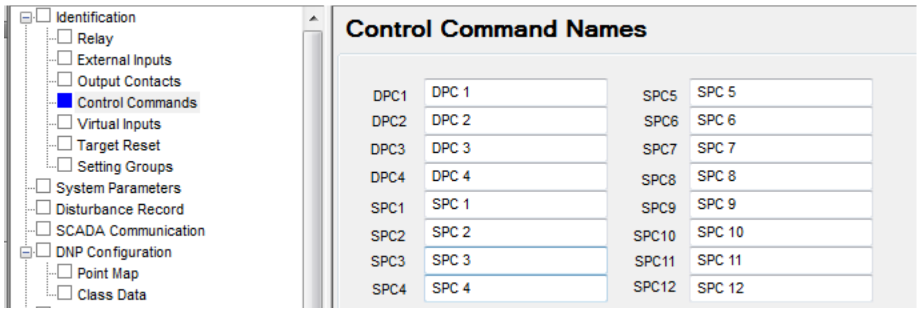



Figure 7.6: Control Command name configuration

| Table 7.6: Control Commands | |
|---|---|
| DPC1-4 | User-defined |
| SPC1-12 | User-defined |

### Virtual Inputs

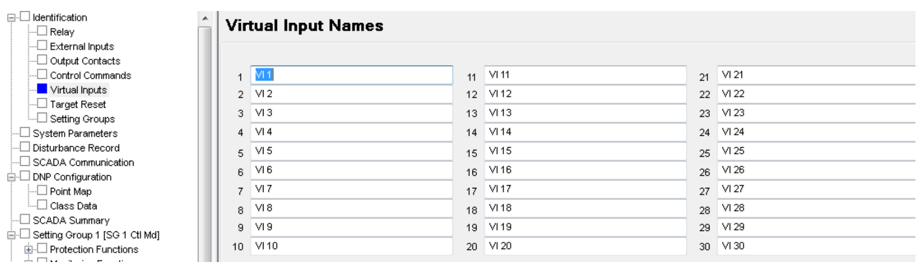



Figure 7.7: Virtual Inputs

| 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 and the TUI. 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.

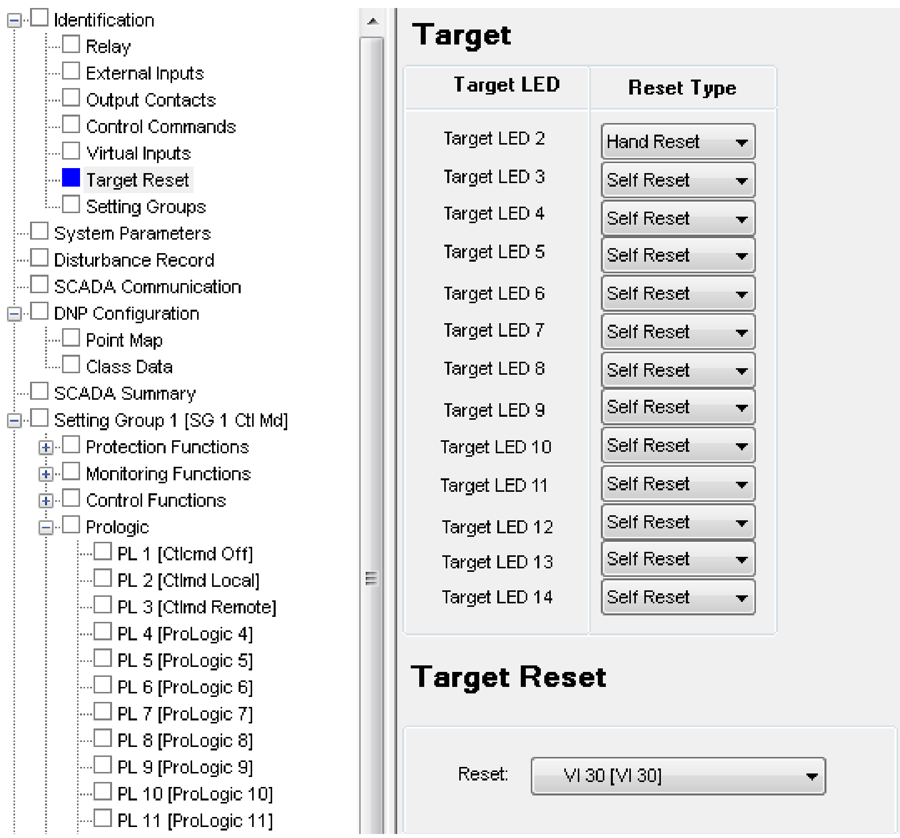



Figure 7.8: Target Reset

| Table 7.8: Target Reset Settings | |
|---|---|
| Target Reset Type (LED 1 to 14) | Self Reset, Hand Reset |
| Target Reset | |
| Reset | Any EI, VI or PL |

### Setting Groups

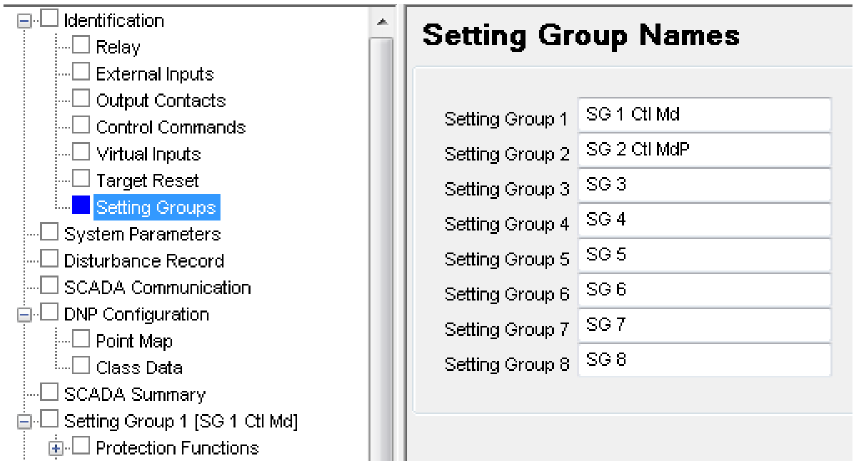



Figure 7.9: Setting Groups

| Table 7.9: Setting Groups | |
|---|---|
| Setting Groups 1 to 8 | User-defined |

## System Parameters

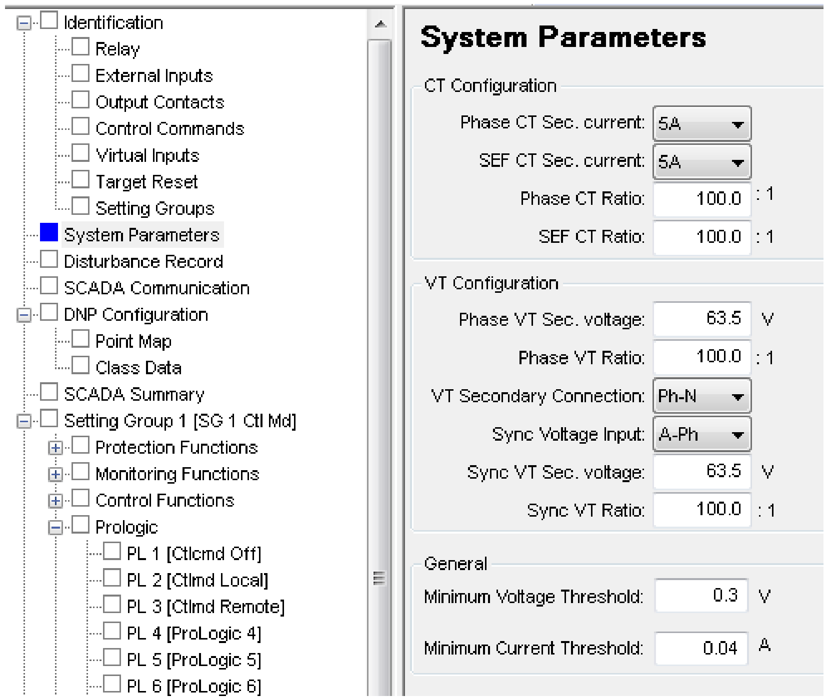



Figure 7.10: System Parameters

| Table 7.10: System Parameters | |
|---|---|
| **System Parameters** | |
| **CT Configuration** | |
| Phase CT Sec. current | 5A or 1A |
| SEF CT Sec. current | 5A or 1A |
| Phase CT Ratio | 1.0 to 30000.0 |
| SEF CT Ratio | 1.0 to 30000.0 |
| **VT Configuration** | |
| Phase VT Sec. Voltage | 40.0 to 160.0 V |
| Phase VT Ratio | 1.0 to 10000.0 |
| VT Secondary Connection | Ph-N or Ph-Ph |
| Sync Voltage Input | A-Ph, B-Ph or C-Ph |
| Sync VT Sec. Voltage | 40.0 to 160.0 V |
| Sync VT Ratio | 1.0 to 10000.0 |
| **General** | |
| Minimum Voltage Threshold | 0.0 to 2.9 V |
| Minimum Current Threshold | 0.00 to 1.00 A |

.

## SCADA Communication

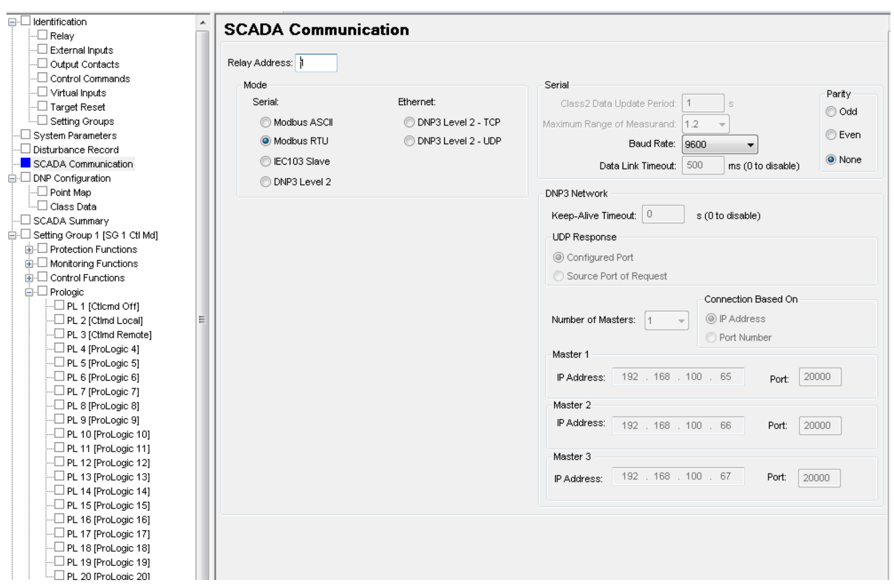



Figure 7.11: SCADA Communication

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

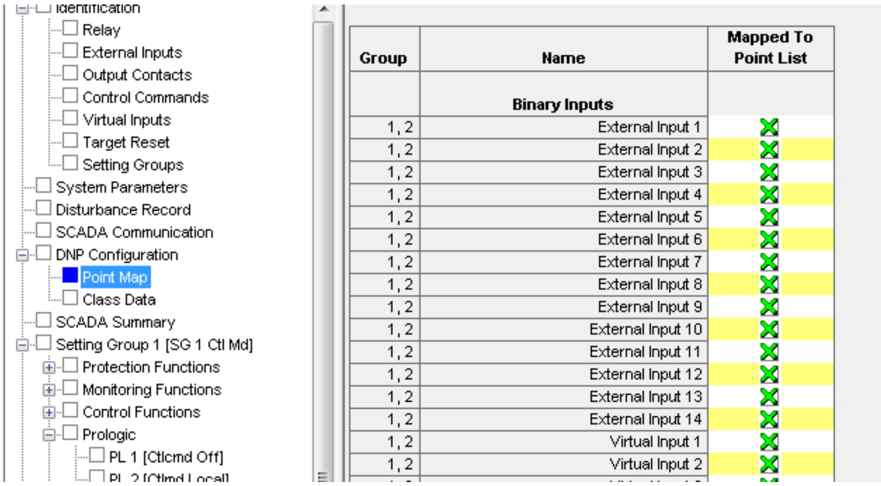



Figure 7.12: Point Map

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.

## DNP Configuration - Class Data

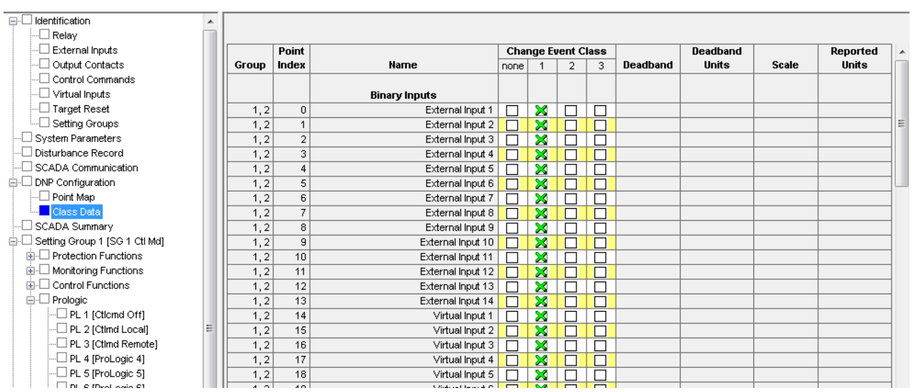



Figure 7.13: Class Data

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.

## Disturbance Record

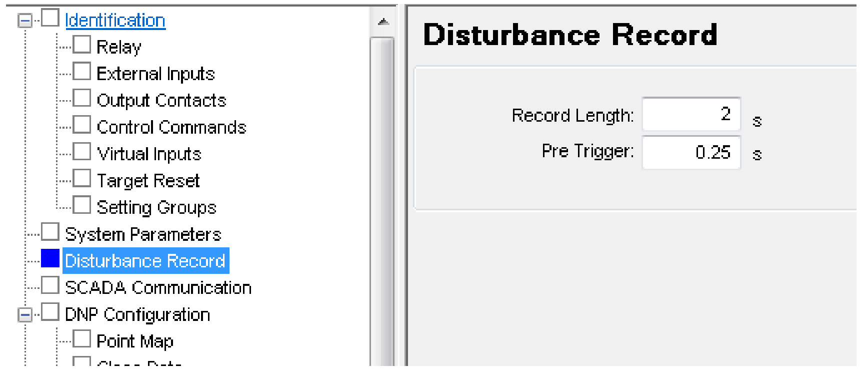



Figure 7.14: Record Length

| Table 7.11: Record Length | |
|---|---|
| **Fault** | |
| Fault Record Length | 1 to 10 seconds |
| Prefault Time | 0.10 to 0.50 seconds |

## SCADA Settings Summary

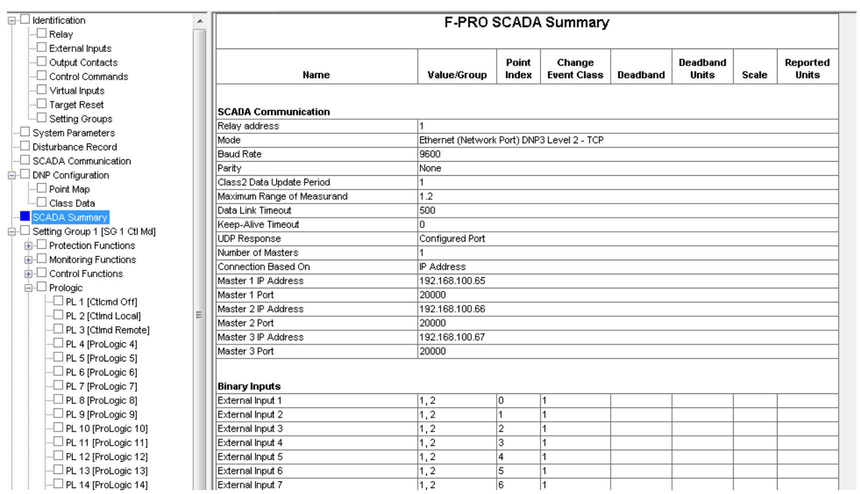



Figure 7.15: SCADA Settings Summary

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.

## Setting Groups

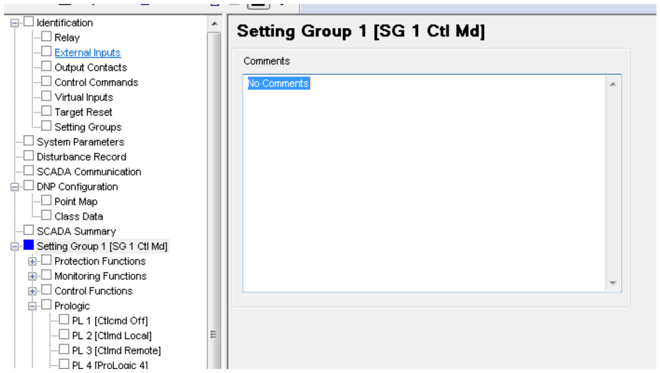



Figure 7.16: Setting Groups Comments

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.

### Protection, Monitoring and Control Functions

The Protection, Monitoring and Control Function sections provide all of the settings for the individual protection functions. The functions are sub-categorized by type (Voltage, Current, Frequency, Power etc.) to provide easy navigation.

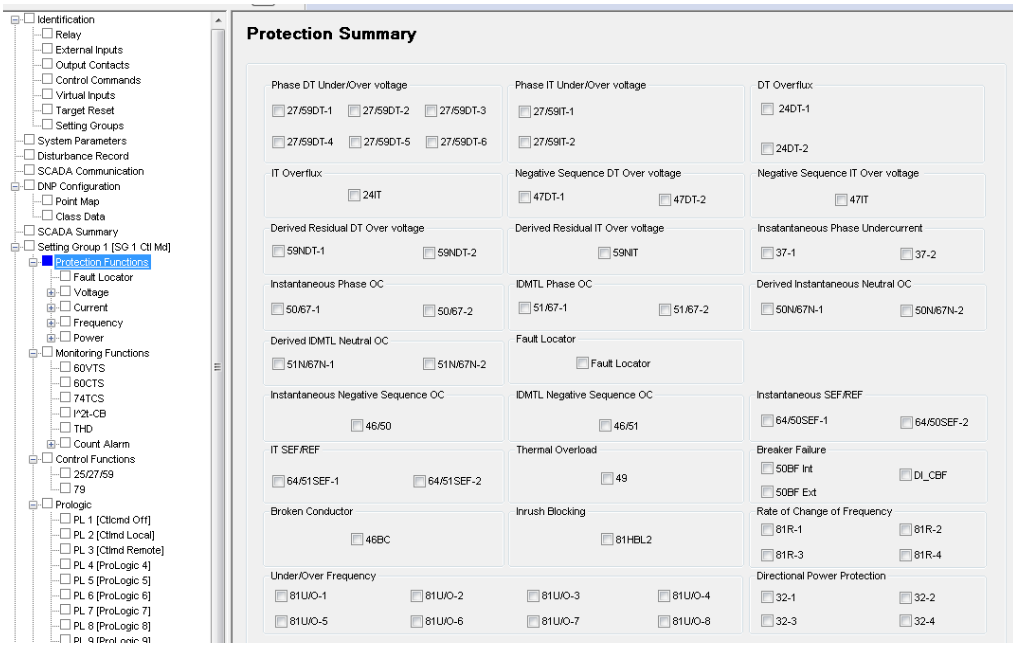



Figure 7.17: Protection Functions

For a detailed descriptions of each function see “Protection, Recording and Logging Functions” on page 5-1.

### ProLogic

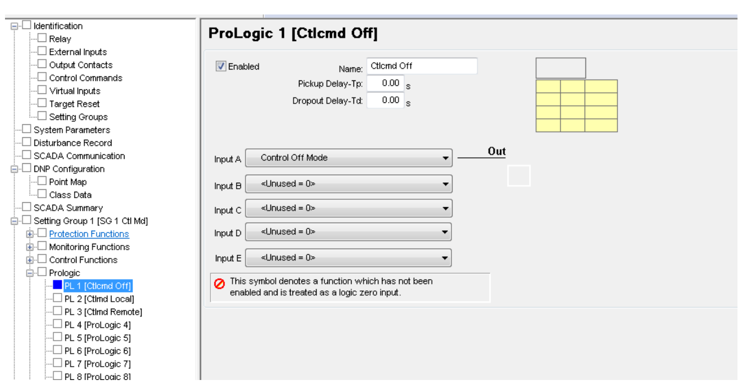



Figure 7.18: ProLogic

Apply ProLogic to multiple inputs to create an output based on qualified inputs. ProLogic enables up to 20 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.

## Input Matrix

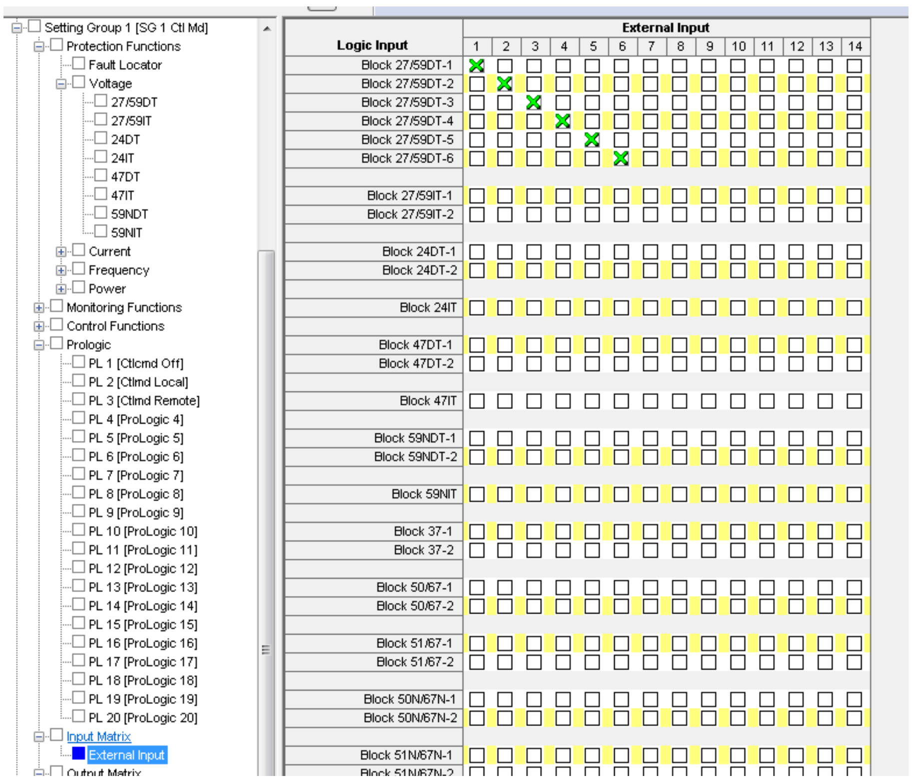



Figure 7.19: Input Matrix

The Input Matrix is used to assign External Inputs to block individual functions from operating.

## Output Matrix

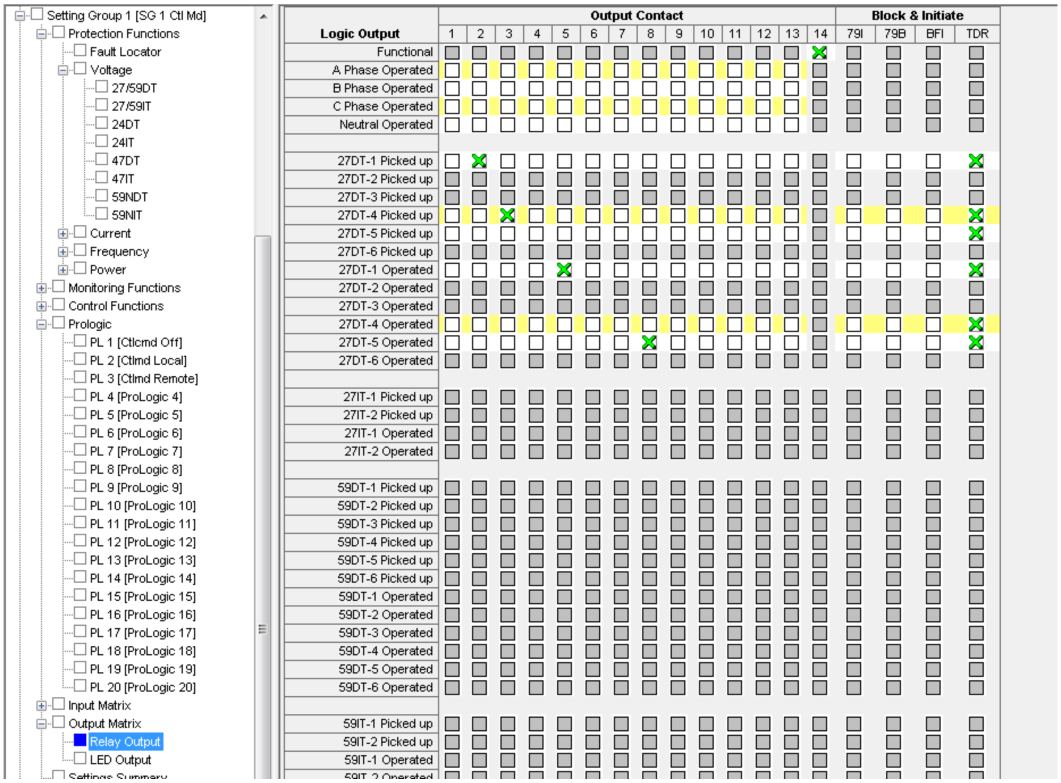


Figure 7.20: Relay Output Matrix

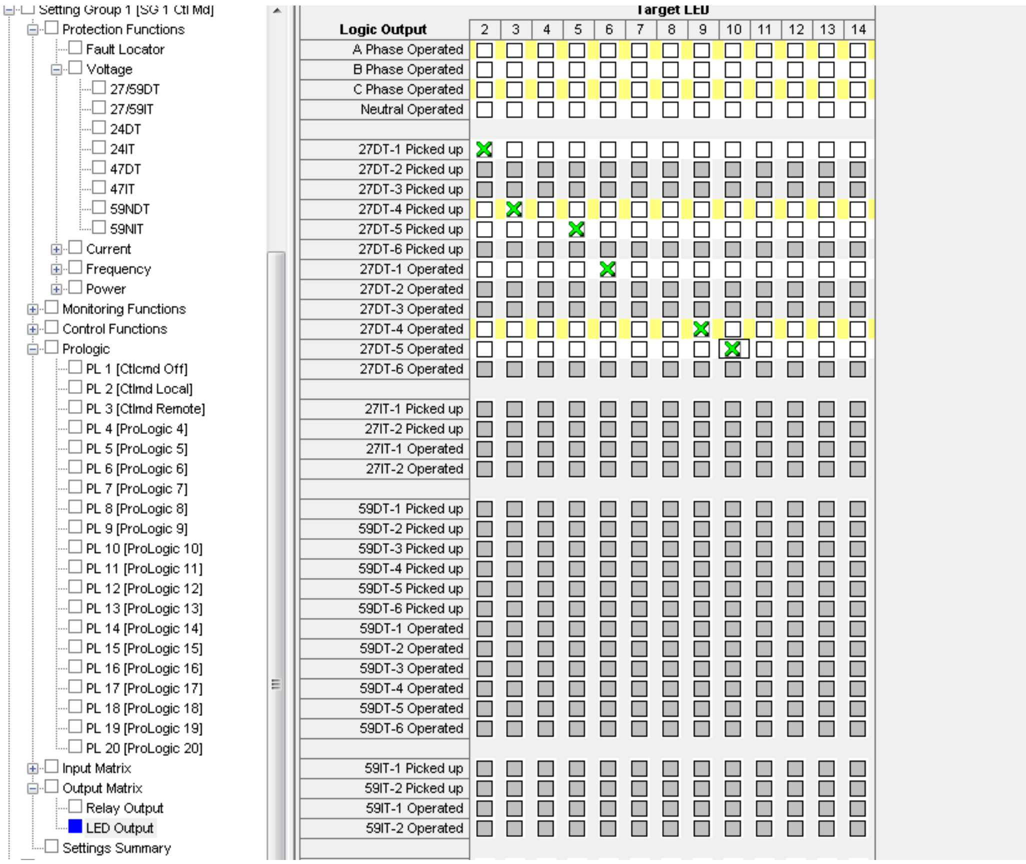


Figure 7.21: LED Output Matrix

The Relay Output and LED Output matrices determines which function initiates which output relay and LED. 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 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 2 pages.

## Settings Summary

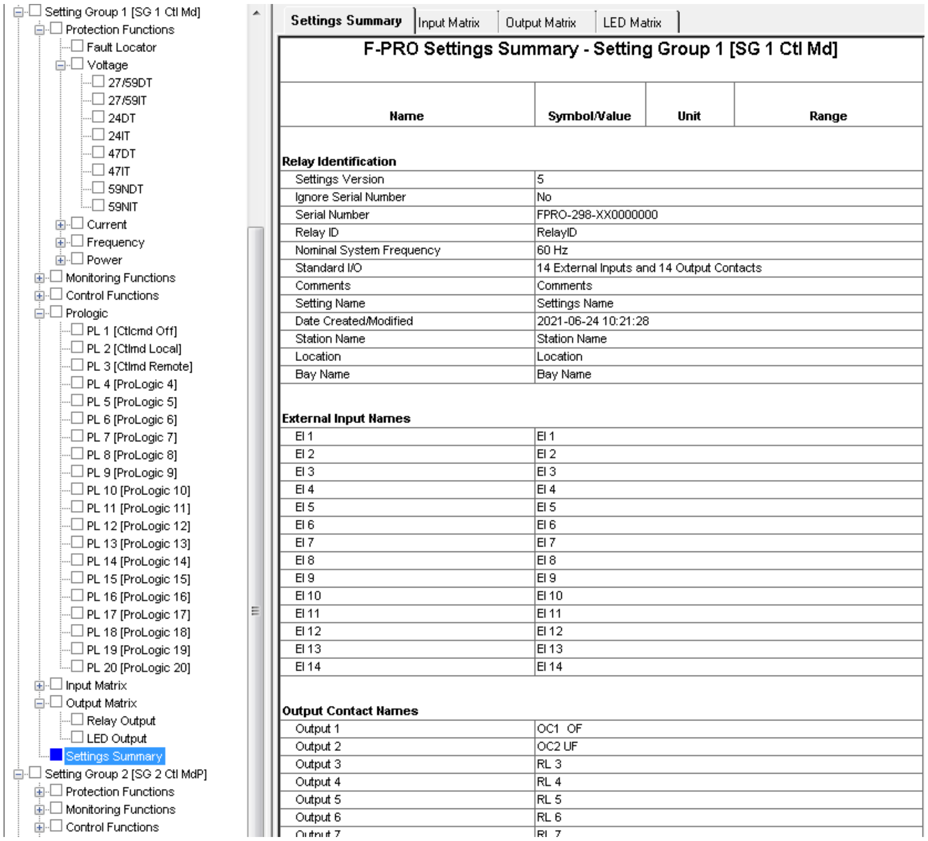



Figure 7.22: Settings Summary

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

# 7.2 RecordGraph Software

## Introduction

RecordGraph is a tool that is used to display and analyze records from ERL 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
- Symmetrical Component view
- Harmonic view
- Sub-Harmonic view

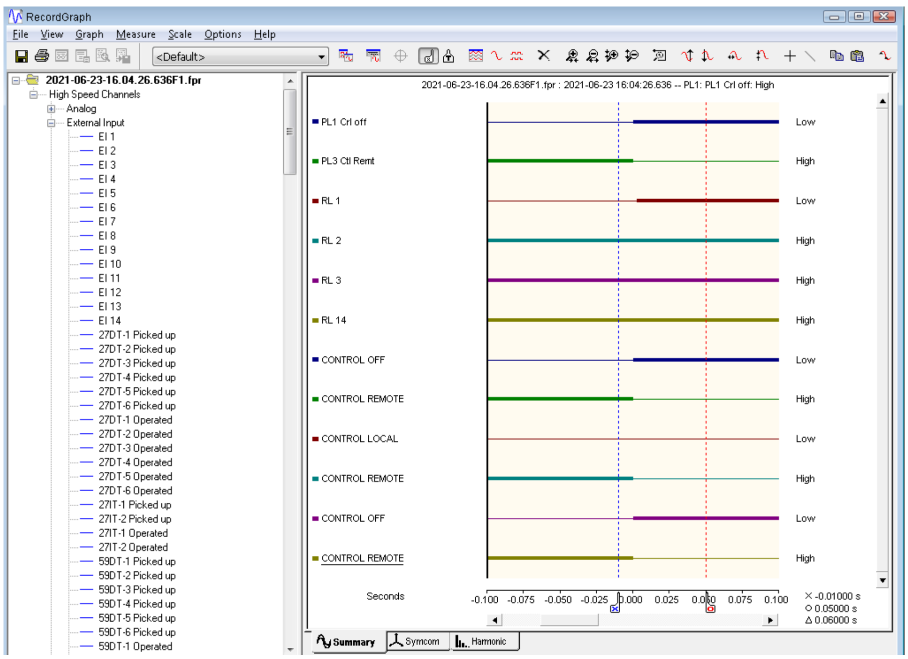



Figure 7.23: RecordGraph

## 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 RecordBase View Software

## Introduction

RecordBase View is a Windows-based software tool for displaying and managing records from ERL relays and recorders. RecordBase View features include:

- Record displays and analysis
- Storage and management of records in database
- Record summaries including event lists and user annotation
- COMTRADE, PTI and Excel export
- Windows Explorer integration
- Compatibility with RecordBase Server database

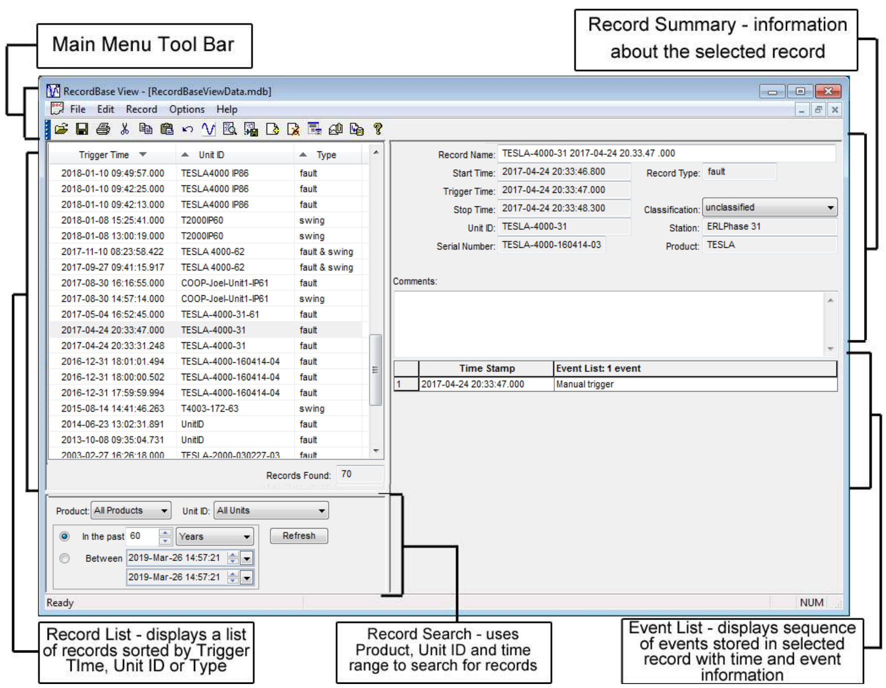



Figure 7.24: RecordBase View

> For further instructions on how to use the software, refer to the RecordBase View User Manual.

# 7.4 RecordBase Central Station Software

The RecordBase Central Station software provides automated collection, storage and network-wide access to fault and disturbance data produced by supported ERL recorders and relays. RecordBase ensures the recording data is automatically brought to a secure central location and is made available to staff throughout your company for display and analysis.

The RecordBase Central Station software is available for purchase. For more information, visit the ERLPhase website: www.erlphase.com

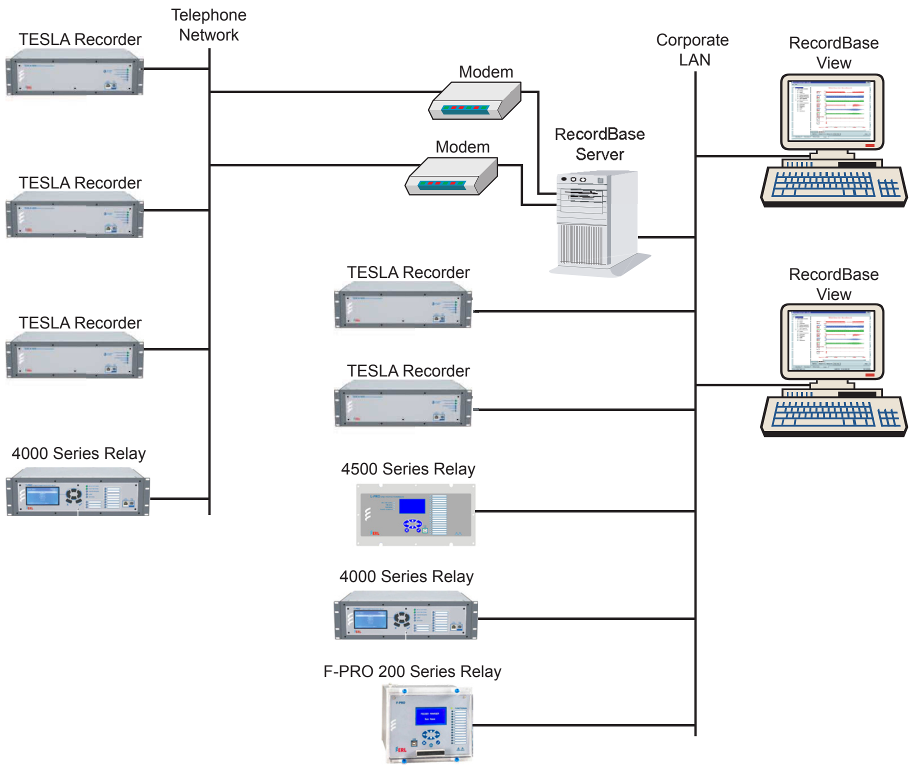



Figure 7.25: RecordBase System Overview

| |
|---|
| For further instructions on how to use the software, refer to the RecordBase Central Station User Manual. |

# 8 Acceptance/Protection Function Test Guide

## 8.1 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 in-service settings. Once in-service settings are applied, ERL 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 298 Acceptance Test Procedure.

First, the acceptance testing describes the test equipment requirements, calibration methods, 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.

## 8.2 Acceptance Testing

ERL 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 "IED Settings and Ranges" in Appendix B.

### Test Equipment Requirements

- 3 ac voltage sources (variable frequency capability)
- 3 ac current sources
- 1 ohmmeter
- 1 - 300 Vdc test supply

> Set nominal CT secondary current to either 5 A or 1 A, and nominal system frequency to either 60 Hz or 50 Hz. This example uses 5 A/ 60 Hz.

## Calibration

The relay is calibrated before it leaves the factory; but if component changes are made within the relay, the user may need to do a re-calibration.

| |
|---|
| Before beginning a new calibration, establish the accuracy of the equipment being used. |

To perform a calibration, the user must be logged into the relay using Relay Control Panel at the change/Service access level to the front USB/Ethernet Port.

1. Proceed to the *Utilities>Analog Input Calibration.tab* The Analog Input Calibration screen lists all of the F-PRO analog input channels.
2. Select the channel to calibrate with your mouse (you may select and calibrate multiple channels at once as long as they are the same qualities).
3. Enter the exact Magnitude of the *Applied Signal* you are applying your test source.
4. Execute the *Calibrate Offset and Gain* button.

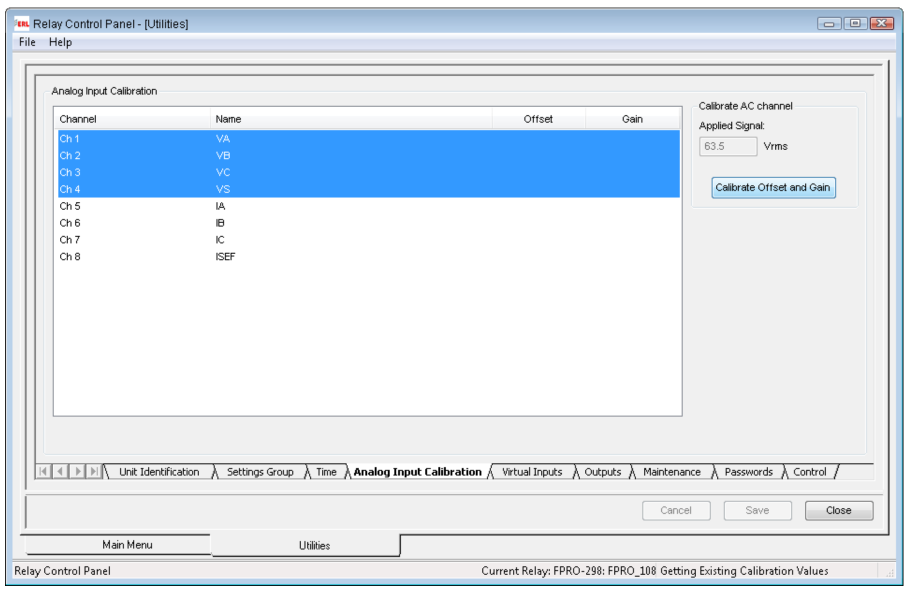



Figure 8.1: Enter actual applied signal level

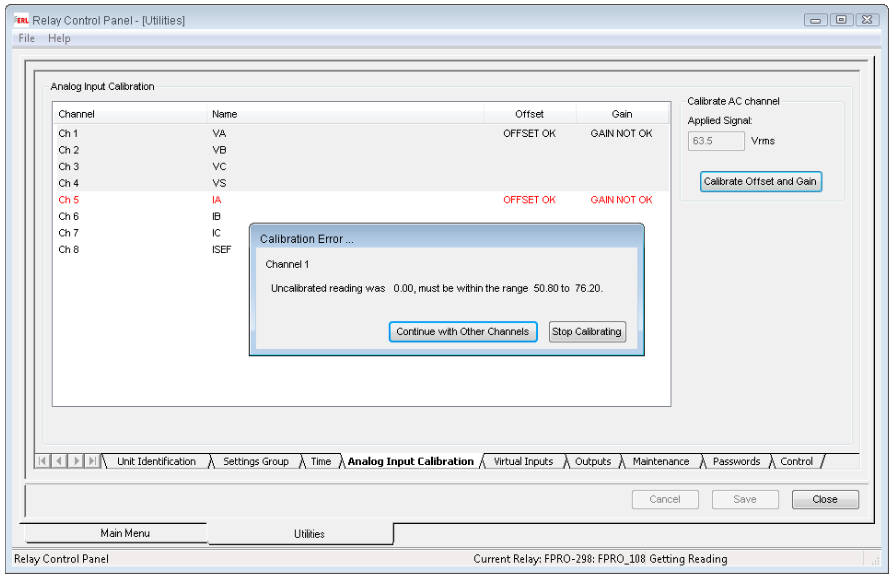



Figure 8.2: Calibration error - out of range

If the applied test signal is not reasonable, an error will be displayed and the calibration will not be applied. For example, the figure above, the displayed calibration error message indicates that we tried to calibrate a 63.5 V level with no voltage applied, which is not reasonable.

## Testing the External Inputs

To test the external inputs connect the relay using Relay Control Panel, *Metering>External Inputs.* This screen displays the status of the Input and Output Contacts. If the relay is 110V dc variant place a voltage of 110 V dc nominal, (135 V dc 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

Access the F-PRO service level in Relay Control Panel. Open the *Utilities>Outputs* tab screen. To toggle outputs you first need to enter *Test Mode* by selecting the *Relay in Test Mode* check box. When you check the box, a message will appear prompting you to confirm that you really want to enter this mode. Once you enter Test Mode, the functional green LED on the front of the F-PRO will blink and it will remain blinking until you exit Test Mode. The protection functions cannot access the output contacts in Test Mode; they are controllable only by the user via Relay Control Panel. To toggle a particular output, select it from the drop down list and then click on the *Closed* button. You can verify the contact is closed with an ohmmeter. The contact will remain closed until you either click the *Open* button or exit Test Mode.

# 9 IEC 61850 Implementation Overview

## 9.1 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 9.2)
- The Engineering Process (see Section 9.3)
- Edition 2.0 Implementation (see Section )

### 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

# 9.2 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 for 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).

# 9.3 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.

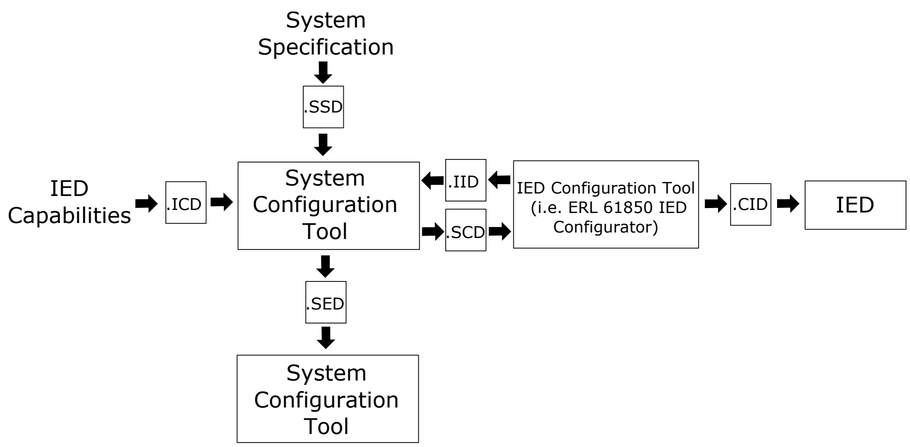



Figure 9.3: The Engineering Process

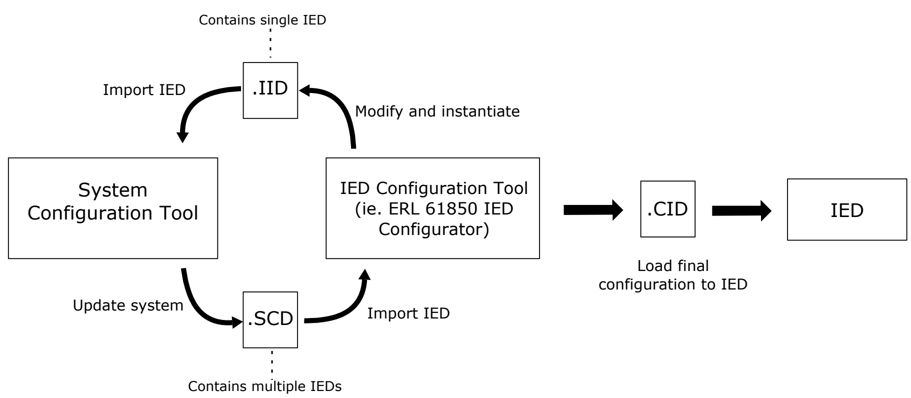



Figure 9.4: Iterations between IED Configuration Tool and System Configuration tool

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.

# 9.4 Control Commands

The F-PRO 298 provides both Single Point (SPC) and Double Point (DPC) Control Commands for control via a 61850 MMS Client. There are 12 Single Point Control Commands provided (six are latching, six are pulsing) and 4 Double Point Control Commands (pulsing). Each Control Command has a user configurable channel name.

The F-PRO 298 implementation provides support for Local and Remote modes. It also supports a Security option which limits configuration of the Local and Remote modes to Change and Service users.

These Control Commands are available as ProLogic inputs (DPC and SPC) as well as for mapping directly from the Output Matrix and LED Matrix (SPC only).

## Configuration of Control Command Names

Each of the 16 Control Command has a user configurable channel name. This Configuration is available in F-PRO Offliner (see “Control Commands” on page 7-12). The configured name will be reflected on the metering, events and recording.

## Configuration of Mode and Security

The Control Commands may be operated in three modes: Off, Local and Remote. These three modes are configurable via the *Utilities* > *Control* window in RCP, as shown below, or via the front panel user interface.

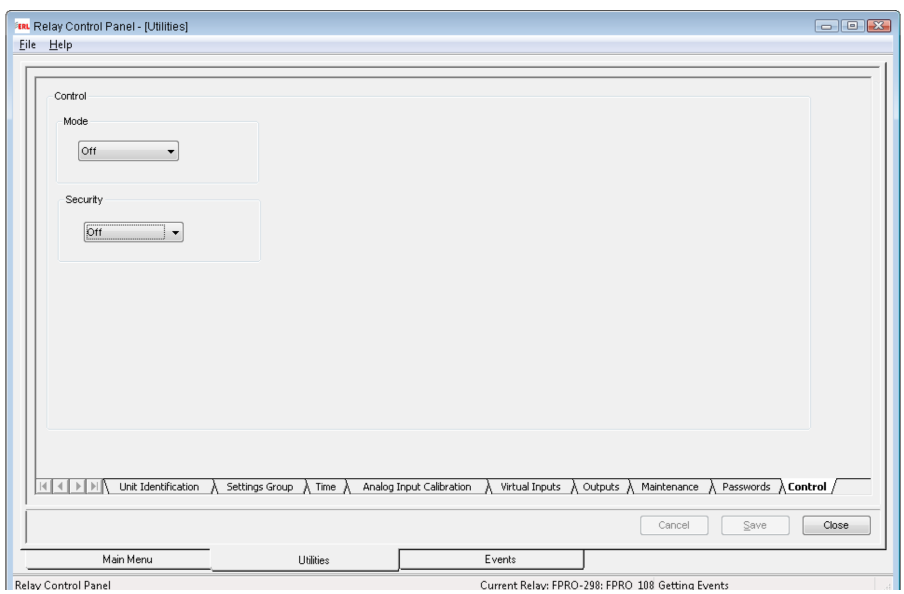



Figure 9.5: Control Window

When the Mode setting is changed, this mode change is reflected in the Event log and the current Mode status is available as a ProLogic input. This ProLogic may be used to create Local or Remote control schemes:

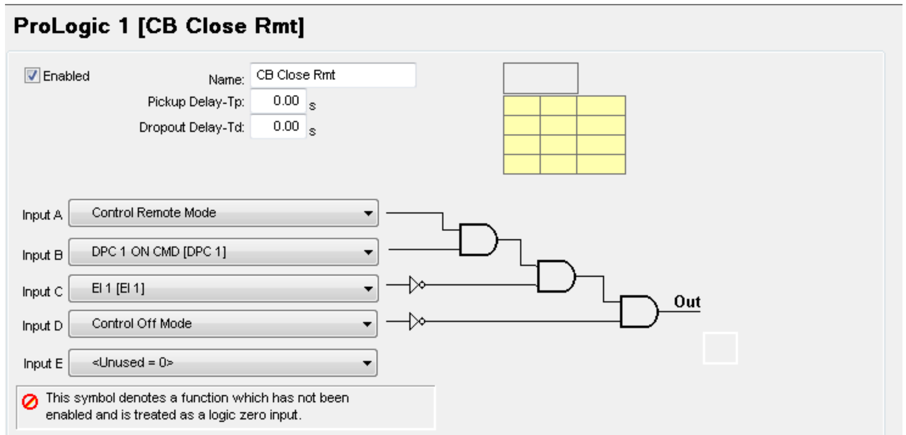



Figure 9.6: ProLogic Remote Control example

The Control Mode is also available for mapping to a status LED and is also shown in Events and Records. It is not available as a metering point.

The Security setting allows for limiting configuration of the Mode setting based on security access level. The Security setting may only be modified by the Service access level.

When the Security is set to Off, then all three access levels (View, Change and Service) may modify the Mode setting. When the Security is set to On, only the Change and Service access levels may modify the Mode setting.

## 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.

DPC 1-4 Controls are also set as Pulsing commands. This means when the Control Command is executed, the logic downstream from the DPC (PL, Events etc.) will transition to the On state for a period of 1 second and then will transition back to Off. However, in the current implementation, the Metering point and IEC 61850 Data attribute associated with this DPC will remain On until the 61850 client sets the DPC to Off via a control command execution.

| |
|---|
| In the current implementation, for the Pulse command points (SPC 1-6, DPC 1-4), 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.

# 9.5 IEC 61850 Edition 2.0 Implementation

The F-PRO 298, starting with firmware version 1.5, 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 298 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 subscribe 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 298 has the ability to subscribe to simulated GOOSE, but does not publish any simulated messages.

Figure 9.7 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 9.7). 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 9.7). The simulation mode works on a per-GOOSE subscription basis.

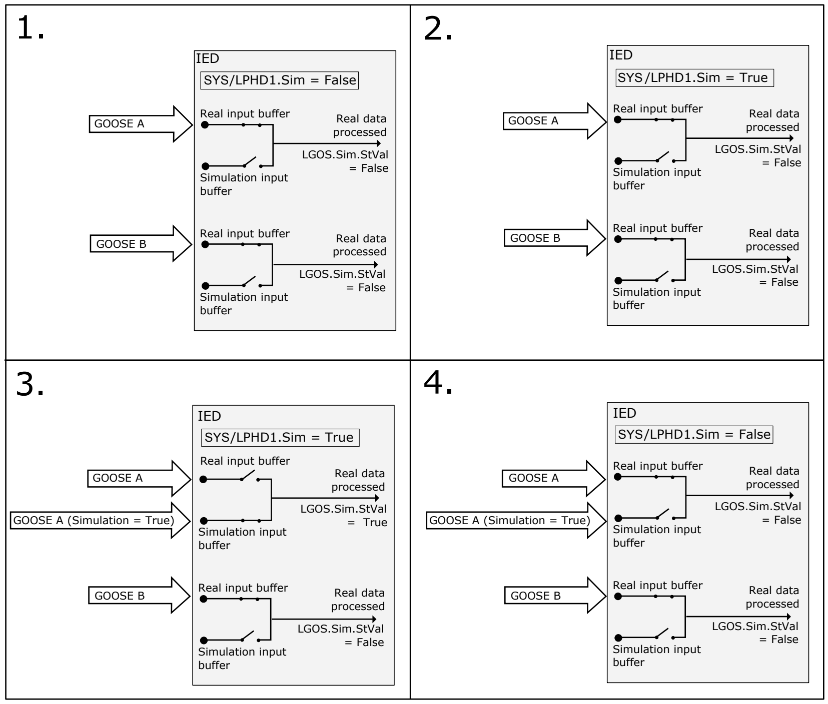



Figure 9.7: Simulated GOOSE processing

For example, imagine an F-PRO 298 is subscribing to GOOSE A and GOOSE B simultaneously (see diagram 1 in Figure 9.7) 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 9-10 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 included the following Modes:

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

The F-PRO 298 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 298.

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 9.12: Mode Implementation on the F-PRO 298**
**(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 |
| **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 nodes, 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 9.13: LGOS LN**

| Data Object | Description |
|---|---|
| NdsCom | Subscription needs commissioning |
| St | Status of the subscription (True = active, False = not active).<br>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 9-7) |
| LastStNum | Last state number received |
| ConfRevNum | Expected configuration revision number |
| GoCBRef | Reference to the subscribed GOOSE control block |

### Subscription Supervision in the Event Log

The LGOS logical nodes are used to indicate GOOSE Communication Alarms in the Event Log. When the LGOS.St attribute transitions states, an event is logged into the TESLA event log with the indexed logical node name. This indexed logical node may be used to troubleshoot communication issues.

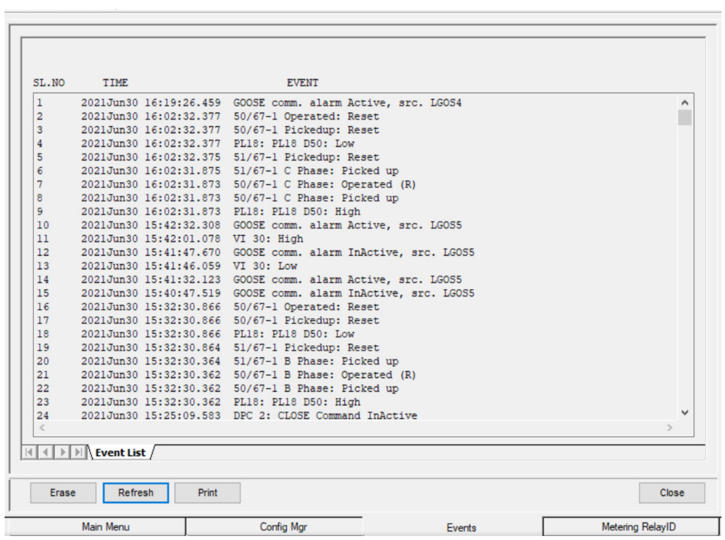



Figure 9.8: Event Log Subscription Supervision

## 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 298 with the IED name “MyL-PRO”, the LDName for the Protection LD would be:

LDName = IED name/LDevice inst = **MyLPRO/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.

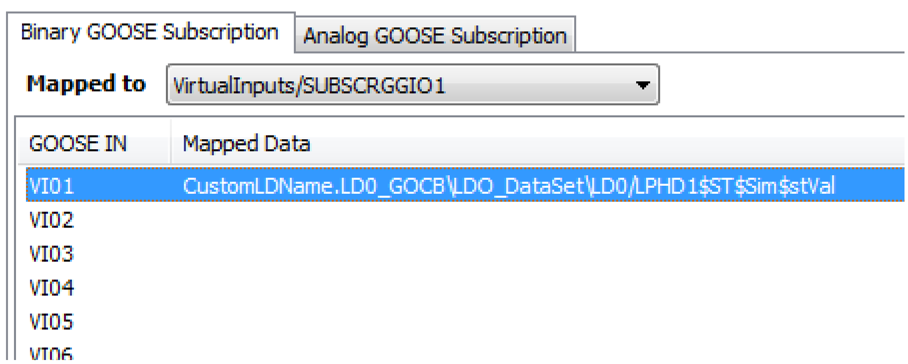



Figure 9.9: Mapping from IED which uses ldName attribute

> **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 9-13 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 *IED name/LDevice inst* (see “Subscription to ldName” on page 9-11). The total *IED name* + *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 298 implementation is the LLN0.Beh data object was changed from CDC Type INS to ENS. The F-PRO 298 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. *ldName* 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 298 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 298 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.

# Appendix A IED Specifications

| F-PRO 298 Specifications | | |
|---|---|---|
| **Item** | **Quantity/Specs** | **Note** |
| **General** | | |
| Overvoltage Category | Overvoltage Category III | |
| Pollution Degree | Pollution Degree 2 | |
| Insulation Class | Class I | |
| Ingress Protection | IP 5X (Front)<br>IP 1X (Rear) | |
| Nominal Frequency | 50 or 60 Hz | |
| Operate Time | Less than 35ms | Including output relay operation |
| Power Supply | Nominal Voltage:<br>High Range Supply Option:<br>110 - 250 Vdc, 100 - 240 Vac<br>Low Range Supply Option:<br>24 - 48 Vdc<br><br>Voltage Tolerance:<br>High Range Supply Option:<br>±20% for Vdc, -10%/+5% for Vac<br>Low Range Supply Option:<br>-15%/+20%<br><br>Power Consumption:<br><8VA (AC)<br><8W (DC) | |
| Memory | Settings and records are stored in non-volatile memory | Records are stored in a circular buffer |
| Sampling Rate - Analog and Digital Inputs | 32 samples/cycle for recording<br>8 samples /cycle for protection | Records up to the 8th Harmonic |
| A/D Resolution | 16 bits, 65536 counts full scale | |
| Operating Temperature | -25°C to 55°C continuous | LCD contrast impaired for temperatures below -20°C and above 60° C |
| **Protection Functions** | | |
| 27/59DT (1 to 6), 27/59IT (1 to 2), 24DT (1 to 2), 24IT, 47DT (1 to 2), 47IT, 59NDT (1 to 2), 59NIT, 37(1 to 2) 50/67 (1 to 2), 51/67 (1 to 2), 50N/67N (1 to 2), 51N/67N (1 to 2), 46/50, 46/51, 64/50SEF (1 to 2), 64/51SEF (1 to 2), 49, 50BF_Int, 50BF_Ext, 50BF_DICBF, 46BC, 81HBL2, 81U/O (1 to 8), 81R (1 to 4), 32(1 to 4), 60VTS, 60CTS, 74TCS(1 to 2), I^2t-CB, THD(1 to 2), 25/27/59, 79 and ProLogic | 4 current inputs<br>4 voltage inputs | |

## F-PRO 298 Specifications

| Item | Quantity/Specs | Note |
|---|---|---|
| ProLogic | 20 statements per setting group | 5 inputs per ProLogic$^{TM}$ statement |
| Setting Groups | 8 Setting Groups | |
| **Recording** | | |
| Transient (Fault) | 32 s/c oscillography of all analog and external input channels | User-configurable 1 to 10 seconds Record length and 0.1 to 0.5 seconds pre-fault length |
| Events | 1000 events circular log with 1ms resolution | A compressed event record can be created 1000 events with manual trigger. |
| Record Capacity | 20 records of a combination of transient and event records | |
| **Inputs & Outputs** | | |
| Analog Voltage Inputs<br>1 set of 3-phase voltage inputs, 1 voltage input for Vsync | Nominal Voltage - across input channel:<br>Vn = 63.5 Vrms (Ph-n) or 110 Vrms (Ph-Ph)<br><br>Full Scale/Continuous:<br>175 Vrms (Ph-n) or 247 Vrms (Ph-Ph)<br><br>Burden:<br><0.15VA @ Vn | |
| Analog Current Inputs<br>1 set of 3-phase current inputs, 1 single phase current input for SEF (4 current channels) | Phase CTs<br>Nominal Current:<br>In = 1 Arms or 5 Arms<br><br>Full Scale/Continuous:<br>4x In = 4 Arms or 20 Arms<br><br>Maximum full-scale rating:<br>100x In for 1 second symmetrical<br><br>Burden:<br><0.1 VA @ 1 Arms, <0.5VA @ 5 Arms | |
| | SEF CT<br>Nominal Current:<br>In = 1 Arms or 5 Arms<br><br>Full Scale/Continuous:<br>2x In = 2 Arms or 10 Arms<br><br>Maximum full-scale rating:<br>4x In for 1 second symmetrical<br><br>Burden:<br><1 VA @ 1 Arms, <2VA @ 5 Arms | |

## F-PRO 298 Specifications

| Item | Quantity/Specs | Note |
|---|---|---|
| External Inputs | 14 isolated inputs<br><br>Isolation:<br>2kV optical isolation<br><br>Burden:<br><0.2W @ 110V DC<br><br>Turn-on Voltage:<br>24Vdc nominal = 19 Vdc<br>48 Vdc nominal = 38 Vdc<br>110 Vdc nominal = 88 Vdc<br>220 Vdc nominal = 175 Vdc | Optional 24, 48, 110 or 220 Vdc nominal, externally wetted.<br><br>All inputs can be on continuously.<br><br>Specified voltages are over full ambient temperature range. |
| Output Relays (contacts) | 14 programmable outputs (13NO and 1NC)<br><br>Make:<br>30 A as per IEEE C37.90<br><br>Carry (all outputs active):<br>8 A<br><br>Break:<br>0.9 A at 125 Vdc resistive<br>0.35 A at 250 Vdc resistive | Externally wetted |
| Virtual Inputs | 30 Virtual Inputs | |
| **Interface & Communication** | | |
| Front Display | 128 x 64 pixels graphics LCD | |
| Front Panel Indicators | 14 LEDs: 13 programmable, 1 fixed | Fixed: Relay Functional |
| Front User Interface | USB port | Full Speed USB 2.0, 480 Mbps |
| Rear User Interface | Port 31A: 100Mbps-T,RJ45/100Mbps-Fx, ST<br>Port 31B: 100Mbps-T,RJ45/100Mbps-Fx, ST (PRP)<br>Port 32: RS-485 (2400bps to 57600bps) | 100 Mbps Copper/FO Ethernet port<br><br>Serial RS485 Port |
| SCADA Interface | IEC61850 (Ethernet) or DNP3 (RS-485 or Ethernet) or Modbus (RS-485) or IEC 60870-5-103 (RS-485) | Rear port |
| Time Sync | Port 331: IRIG-B, 1 BNC connector/unit, SNTP | Modulated or unmodulated, jumper selection |
| Self Checking/Relay Inoperative | RL14: 1CO contact configurable | Closed when relay inoperative |
| **Physical** | | |
| Weight | 6kg | |
| Dimensions | E8 case: 177mm Height x 207mm Width x 225mm Depth | |
| Mounting | Horizontal Rack Mount<br>E8 case: 159mm Height x 201.5mm Width | |
| **Time Synchronization** | | |

## F-PRO 298 Specifications

| Item | Quantity/Specs | Note |
|---|---|---|
| External Time Source | Synchronized using IRIG-B input (modulated or unmodulated)<br><br>1PPM<br><br>SNTP | In the absence of an external time source, the relay maintains time with a maximum 20ppm at a constant temperature of 25C. The relay can detect loss of re-establishment of external time source and automatically switch between internal and external time. |
| **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 4.0 x nominal current (In) | |
| Voltage | ± 1.0% of inputs of nominal voltage (Vn) | |
| Timers | ±2.5% of set value plus 1.00 to 1.50 cycles of inherent delay | |
| Inverse Overcurrent Timers | ±2.5% or ±1 cycle of selected curve | |
| Definite Overcurrent Timers | ±2.5% or ±1 cycle non-directional | |
| | ±2.5% or ±1.5 cycle directional | |

## Type Tests

| Test | Description | | Test Level |
|---|---|---|---|
| | Type Test | Test Points | |
| **Electromagnetic Compatibility** | | | |
| IEC 60255-26:2013 Cl.No.7.2.3 | Electrostatic discharge | Enclosure air | +/- 8 kV |
| | | Enclosure contact | +/- 6 kV |
| IEC 60255-26:2013 Cl.No.7.2.4 | Radiated Interference (Electromagnetic field immunity) | Enclosure ports | 10 V/m: 80-1000 MHz & 1.4 GHz - 2.7 GHz |
| IEC 60255-26:2013 Cl.No.7.2.5 | Electrical Fast Transient | AC/DC power ports | +/- 4 kV |
| | | AC voltage & current ports | |
| | | External I/P & O/P ports | |
| IEC 60255-26:2013 Cl.No.7.2.6 | Slow Damped Oscillatory / High Frequency Disturbance / 1 MHz Burst Disturbance | AC/DC power ports | +/- 2.5kV (CM)<br>+/- 1kV (DM) |
| | | AC voltage & current ports | |
| | | External I/P & O/P ports | |
| IEC 60255-27:2013 Cl.No.10.6.4.4 | Insulation Resistance Test | AC/DC power ports | >100MΩ @ 500 V/min |
| | | AC voltage & current ports | |
| | | External I/P & O/P ports | |
| IEC 60255-21-1, class 1<br>Frequency: (10-150)Hz | Vibration Response & Endurance Test | | Displacement:0.035mm(peak)<br>Acceleration: 0.5 g & 1 g<br>Sweep rate: 1octave/min<br>No. of Axis:3(X,Y & Z)<br>No. of Sweep Cycles:1/axis & 20/axis |
| IEC 60255-21-2, class 1 | Shock Response & Endurance Test | | Acceleration: 5 g & 15 g<br>Pulse Width:11ms<br>Pulse Sweep:1/2 sine wave<br>No. of Shocks:3/direction<br>No. of Directions:2/axis<br>No. of Axis:3(X,Y & Z)<br>Total No. of Shocks:18 + 18 |
| IEC 60255-21-3, class 1<br>Frequency: (5-35)Hz | Seismic Test | | For X-axis:<br>Displacement:3.5mm(peak)<br>Acceleration: 1.0 g<br>Sweep rate: 1octave/min<br><br>For Y-axis:<br>Displacement:1.5mm(peak)<br>Acceleration: 0.5 gn<br>Sweep rate:1 octave/min |

## Type Tests

| Test | Description | | Test Level |
|---|---|---|---|
| | Type Test | Test Points | |
| IEC 60255-21-2, class 1 | Bump Test | | Acceleration: 10 g<br>Pulse Width: 16ms<br>Pulse Shape: 1/2 sine wave<br>No. of Bumps: 1000/direction<br>No. of Directions: 2/axis<br>No. of Axis: 3 (X, Y & Z)<br>Total No. of Bumps: 6000 |
| **Safety** | | | |
| IEC 60255-27:2013 Cl.No.10.6.4.2 | Impulse Voltage | AC/DC power ports<br>AC voltage & current ports<br>External I/P & O/P ports | +/- 5 kV |
| IEC 60255-27:2013 Cl.No.10.6.4.3 | AC Dielectric Voltage | AC/DC power ports | 2 kV/min |
| | | AC voltage & current ports | |
| | | External I/P & O/P ports | |
| **Environmental Tests** | | | |
| IEC 60068-2-1 | Cold test - operational | Enclosure | -25°C for 16hr |
| IEC 60068-2-1 | Cold test - storage | Enclosure | -40°C for 16hr |
| IEC 60068-2-2 | Dry heat test - operational | Enclosure | +55°C for 16hr |
| IEC 60068-2-2 | Dry heat test - storage | Enclosure | +70°C for 16hr |
| IEC 60068-2-14 | Change of temperature | Enclosure | 25°C and +55°C for 5 cycles |
| IEC 60068-2-30 | Cyclic temperature | Enclosure | +55°C for 5 cycles |
| IEC 60068-2-78 | Damp heat - steady state | Enclosure | +40°C for 240 hrs |

# A.1 IDMTL Element Operating Time Curves

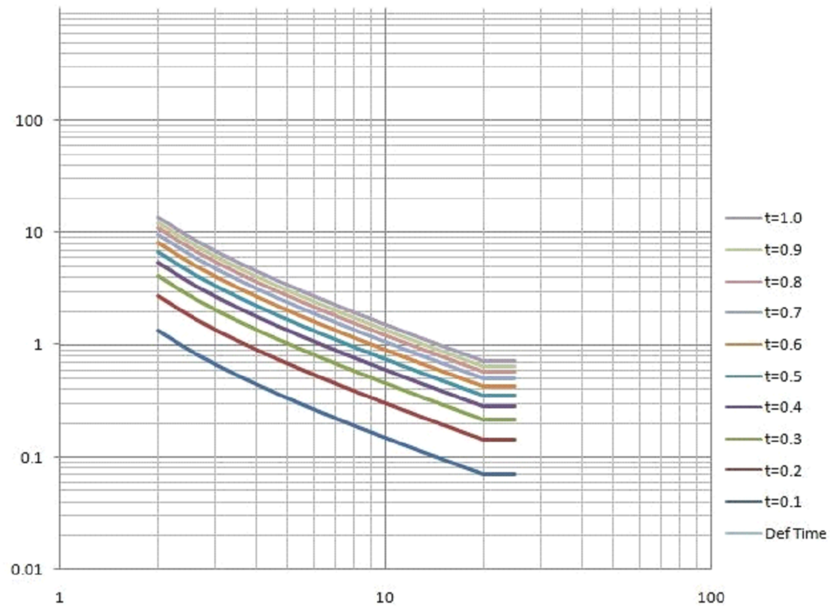



Figure A.10: IEC Very Inverse

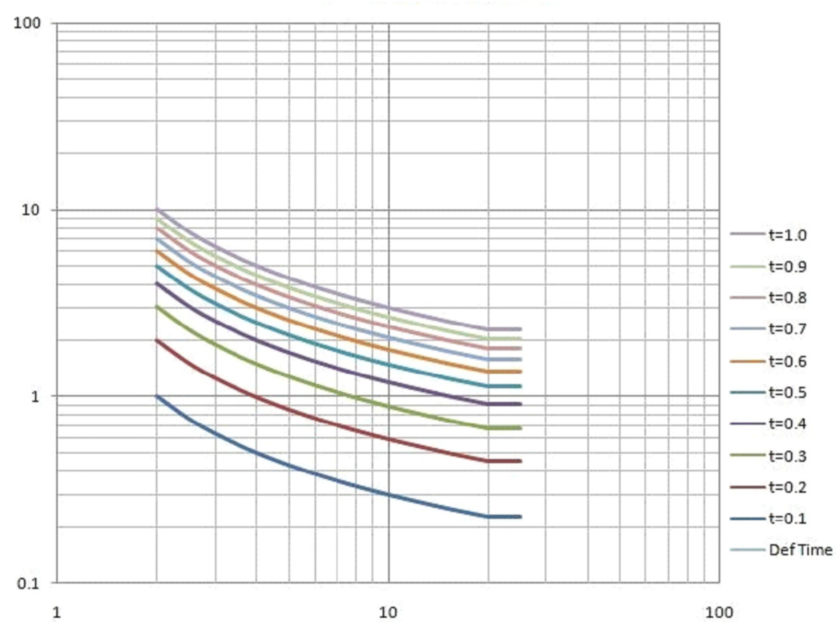



Figure A.11: IEC Standard Inverse 3

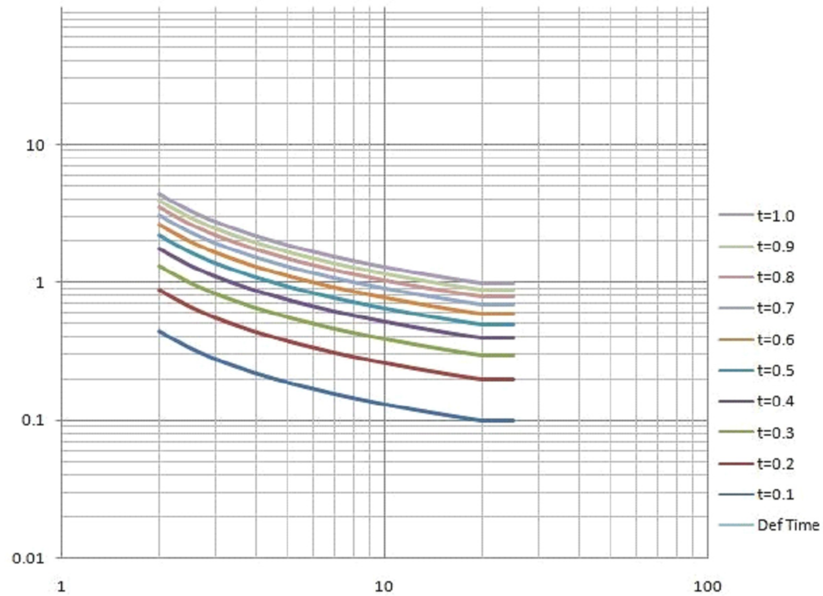



Figure A.12: IEC Standard Inverse 1

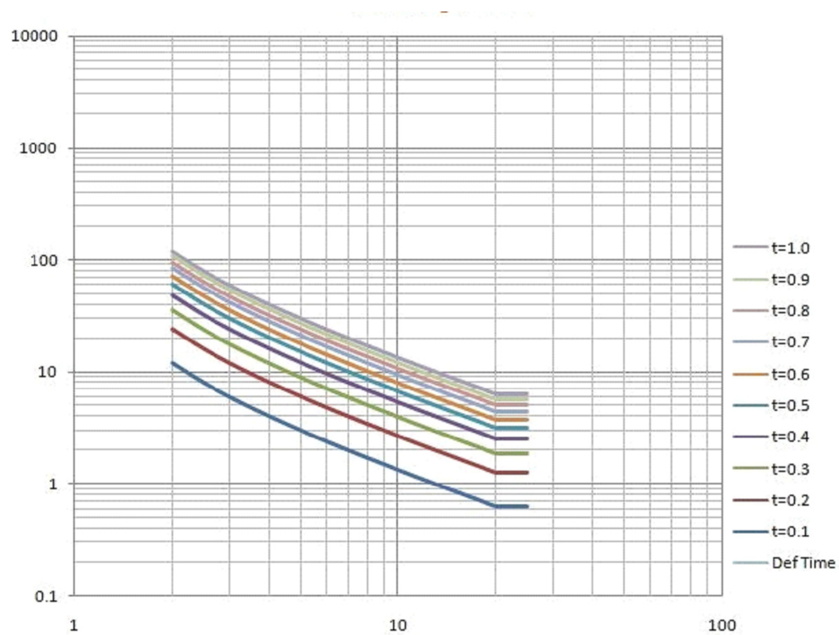



Figure A.13: IEC Long Inverse

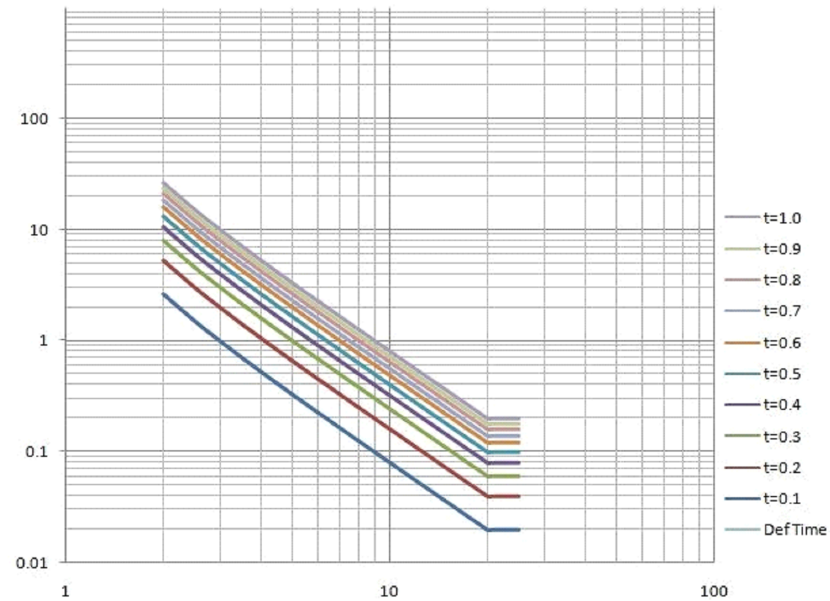



Figure A.14: IEC Extremely Inverse

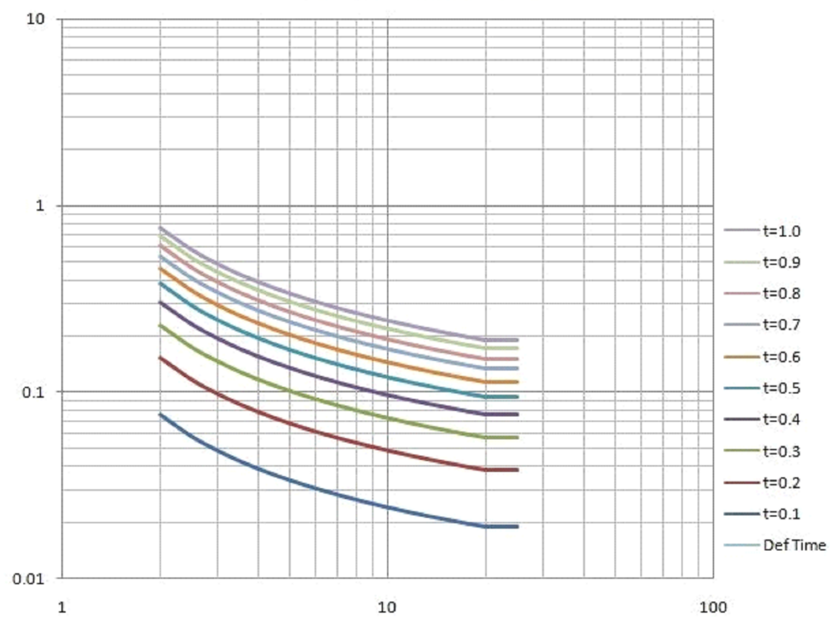



Figure A.15: IEEE Moderately Inverse

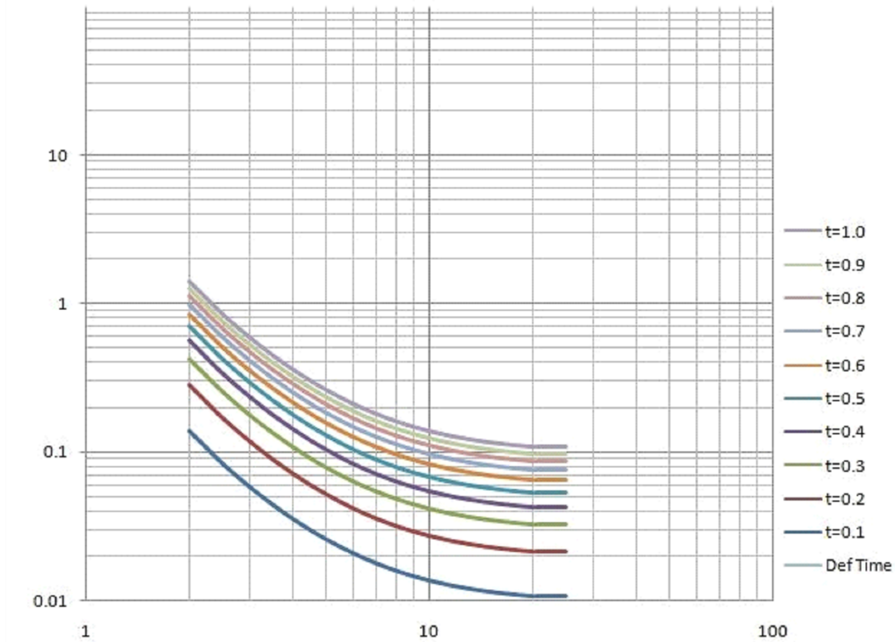



Figure A.16: IEEE Very Inverse

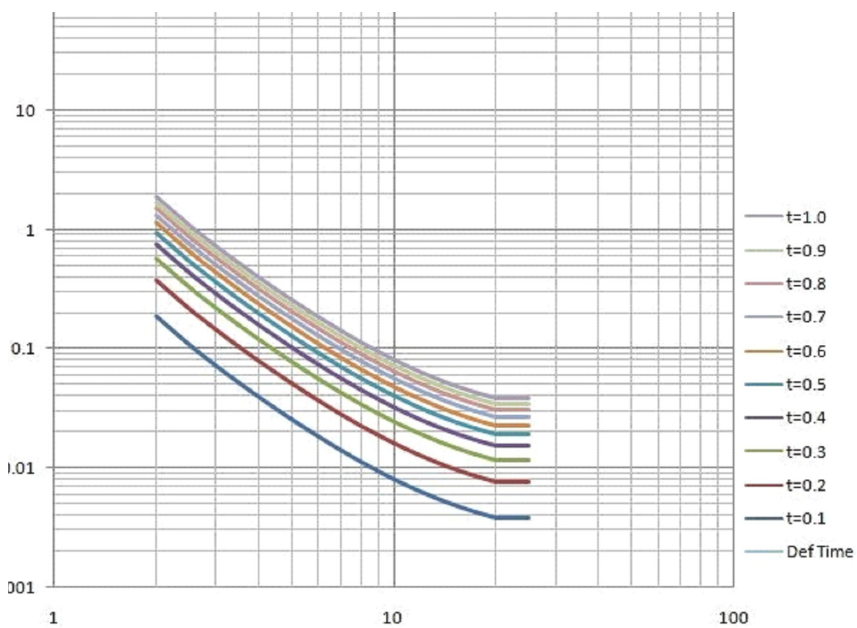



Figure A.17: IEEE Extremely Inverse

# 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 Settings Summary for Settings Group 1.

| **F-PRO Settings Summary - Setting Group 1 [SG 1]** | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **Relay Identification** | | | |
| Settings Version | 5 | | |
| Ignore Serial Number | Yes | | |
| Serial Number | FPRO-298-XX0000000 | | |
| Relay ID | RelayID | | |
| Nominal System Frequency | 50 Hz | | |
| Standard I/O | 14 External Inputs and<br>14 Output Contacts | | |
| Comments | Comments | | |
| Setting Name | Settings Name | | |
| Date Created/Modified | 2020-01-02 11:25:34 | | |
| Station Name | Station Name | | |
| Location | Location | | |
| Bay Name | Bay Name | | |
| External Input Names | | | |
| EI 1 | EI 1 | | |
| EI 2 | EI 2 | | |
| EI 3 | EI 3 | | |
| EI 4 | EI 4 | | |
| EI 5 | EI 5 | | |
| EI 6 | EI 6 | | |
| EI 7 | EI 7 | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| EI 8 | EI 8 | | |
| EI 9 | EI 9 | | |
| EI 10 | EI 10 | | |
| EI 11 | EI 11 | | |
| EI 12 | EI 12 | | |
| EI 13 | EI 13 | | |
| EI 14 | EI 14 | | |
| **Output Contact Names** | | | |
| Output 1 | RL 1 | | |
| Output 2 | RL 2 | | |
| Output 3 | RL 3 | | |
| Output 4 | RL 4 | | |
| Output 5 | RL 5 | | |
| Output 6 | RL 6 | | |
| Output 7 | RL 7 | | |
| Output 8 | RL 8 | | |
| Output 9 | RL 9 | | |
| Output 10 | RL 10 | | |
| Output 11 | RL 11 | | |
| Output 12 | RL 12 | | |
| Output 13 | RL 13 | | |
| Output 14 | RL 14 | | |
| **Output Contact Dropout Timers** | | | |
| Output1 ( RL 1 ) | 0.10 | s | 0.00 to 1.00 |
| Output2 ( RL 2 ) | 0.10 | s | 0.00 to 1.00 |
| Output3 ( RL 3 ) | 0.10 | s | 0.00 to 1.00 |
| Output4 ( RL 4 ) | 0.10 | s | 0.00 to 1.00 |
| Output5 ( RL 5 ) | 0.10 | s | 0.00 to 1.00 |
| Output6 ( RL 6 ) | 0.10 | s | 0.00 to 1.00 |
| Output7 ( RL 7 ) | 0.10 | s | 0.00 to 1.00 |
| Output8 ( RL 8 ) | 0.10 | s | 0.00 to 1.00 |
| Output9 ( RL 9 ) | 0.10 | s | 0.00 to 1.00 |
| Output10 ( RL 10 ) | 0.10 | s | 0.00 to 1.00 |
| Output11 ( RL 11 ) | 0.10 | s | 0.00 to 1.00 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Output12 ( RL 12 ) | 0.10 | s | 0.00 to 1.00 |
| Output13 ( RL 13 ) | 0.10 | s | 0.00 to 1.00 |
| Output14 ( RL 14 ) | 0.10 | s | 0.00 to 1.00 |
| **Output Contact Reset Types** | | | |
| Output 1 | Self Reset | | Self Reset or Hand Reset |
| Output 2 | Self Reset | | Self Reset or Hand Reset |
| Output 3 | Self Reset | | Self Reset or Hand Reset |
| Output 4 | Self Reset | | Self Reset or Hand Reset |
| Output 5 | Self Reset | | Self Reset or Hand Reset |
| Output 6 | Self Reset | | Self Reset or Hand Reset |
| Output 7 | Self Reset | | Self Reset or Hand Reset |
| Output 8 | Self Reset | | Self Reset or Hand Reset |
| Output 9 | Self Reset | | Self Reset or Hand Reset |
| Output 10 | Self Reset | | Self Reset or Hand Reset |
| Output 11 | Self Reset | | Self Reset or Hand Reset |
| Output 12 | Self Reset | | Self Reset or Hand Reset |
| Output 13 | Self Reset | | Self Reset or Hand Reset |
| Output 14 | Self Reset | | Self Reset or Hand Reset |
| **Output Contact Reset** | | | |
| Reset | <Unused =0> | | |
| **Control Command Names** | | | |
| DPC 1 | DPC 1 | | |
| DPC 2 | DPC 2 | | |
| DPC 3 | DPC 3 | | |
| DPC 4 | DPC 4 | | |
| SPC 1 | SPC 1 | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 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 | VI 1 | | |
| VI 2 | VI 2 | | |
| VI 3 | VI 3 | | |
| VI 4 | VI 4 | | |
| VI 5 | VI 5 | | |
| VI 6 | VI 6 | | |
| VI 7 | VI 7 | | |
| VI 8 | VI 8 | | |
| VI 9 | VI 9 | | |
| VI 10 | VI 10 | | |
| VI 11 | VI 11 | | |
| VI 12 | VI 12 | | |
| VI 13 | VI 13 | | |
| VI 14 | VI 14 | | |
| VI 15 | VI 15 | | |
| VI 16 | VI 16 | | |
| VI 17 | VI 17 | | |
| VI 18 | VI 18 | | |
| VI 19 | VI 19 | | |
| VI 20 | VI 20 | | |
| VI 21 | VI 21 | | |
| VI 22 | VI 22 | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| VI 23 | VI 23 | | |
| VI 24 | VI 24 | | |
| VI 25 | VI 25 | | |
| VI 26 | VI 26 | | |
| VI 27 | VI 27 | | |
| VI 28 | VI 28 | | |
| VI 29 | VI 29 | | |
| VI 30 | VI 30 | | |
| **Target** | | | |
| Target LED 2 | Self Reset | | Self Reset or Hand Reset |
| Target LED 3 | Self Reset | | Self Reset or Hand Reset |
| Target LED 4 | Self Reset | | Self Reset or Hand Reset |
| Target LED 5 | Self Reset | | Self Reset or Hand Reset |
| Target LED 6 | Self Reset | | Self Reset or Hand Reset |
| Target LED 7 | Self Reset | | Self Reset or Hand Reset |
| Target LED 8 | Self Reset | | Self Reset or Hand Reset |
| Target LED 9 | Self Reset | | Self Reset or Hand Reset |
| Target LED 10 | Self Reset | | Self Reset or Hand Reset |
| Target LED 11 | Self Reset | | Self Reset or Hand Reset |
| Target LED 12 | Self Reset | | Self Reset or Hand Reset |
| Target LED 13 | Self Reset | | Self Reset or Hand Reset |
| Target LED 14 | Self Reset | | Self Reset or Hand Reset |
| **Target Reset** | | | |
| Reset | <Unused =0> | | |
| **Setting Group Names** | | | |
| Setting Group 1 | SG 1 | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Setting Group 2 | SG 2 | | |
| Setting Group 3 | SG 3 | | |
| Setting Group 4 | SG 4 | | |
| Setting Group 5 | SG 5 | | |
| Setting Group 6 | SG 6 | | |
| Setting Group 7 | SG 7 | | |
| Setting Group 8 | SG 8 | | |
| **System Parameters** | | | |
| CT Configuration | | | |
| Phase CT Sec | 1A | | |
| SEF CT Sec. Current | 1A | | |
| Phase CT Ratio | 100.0 | | 1.0 to 30000.0 |
| SEF CT Ratio | 100.0 | | 1.0 to 30000.0 |
| VT Configuration | | | |
| Phase VT Sec. voltage | 63.5 | V | 40.0 to 160.0 |
| Phase VT Ratio | 100 | | 1.0 to 10000.0 |
| Phase CT Sec. Conn | Ph-N | | |
| Sync Voltage Input | A-Ph | | |
| Sync CT Sec. voltage | 63.5 | V | 40.0 to 160.0 |
| Sync VT Ratio | 100.0 | | 1.0 to 10000.0 |
| General | | | |
| Minimum Voltage Threshold | 0.3 | V | 0.0 to 2.9 |
| Minimum Current Threshold | 0.04 | A | 0.00 to 0.20 |
| **Disturbance Record** | | | |
| Record Length | 1 | s | 1 to 10 |
| Pre Trigger | 0.25 | s | 0.10 to 0.50 |
| Setting Group 1 [SG 1] | | | |
| Setting Group Comments: No Comments | | | |
| Protection Summary | | | |
| Fault Locator | Disabled | | |
| 27/59DT-1 | Disabled | | |
| 27/59DT-2 | Disabled | | |
| 27/59DT-3 | Disabled | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 27/59DT-4 | Disabled | | |
| 27/59DT-5 | Disabled | | |
| 27/59DT-6 | Disabled | | |
| 27/59IT-1 | Disabled | | |
| 27/59IT-2 | Disabled | | |
| 24DT-1 | Disabled | | |
| 24DT-2 | Disabled | | |
| 24IT | Disabled | | |
| 47DT-1 | Disabled | | |
| 47DT-2 | Disabled | | |
| 47IT | Disabled | | |
| 59NDT-1 | Disabled | | |
| 59NDT-2 | Disabled | | |
| 59NIT | Disabled | | |
| 37-1 | Disabled | | |
| 37-2 | Disabled | | |
| 50/67-1 | Disabled | | |
| 50/67-2 | Disabled | | |
| 51/67-1 | Disabled | | |
| 51/67-2 | Disabled | | |
| 50N/67N-1 | Disabled | | |
| 50N/67N-2 | Disabled | | |
| 51N/67N-1 | Disabled | | |
| 51N/67N-2 | Disabled | | |
| 46/50 | Disabled | | |
| 46/51 | Disabled | | |
| 64/50SEF-1 | Disabled | | |
| 64/50SEF-2 | Disabled | | |
| 64/51SEF-1 | Disabled | | |
| 64/51SEF-2 | Disabled | | |
| 49 | Disabled | | |
| 50BF_INT | Disabled | | |
| 50BF_EXT | Disabled | | |
| DI_CBF | Disabled | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 46BC | Disabled | | |
| 81HBL2 | Disabled | | |
| 51LR | Disabled | | |
| 81U/O-1 | Disabled | | |
| 81U/O-2 | Disabled | | |
| 81U/O-3 | Disabled | | |
| 81U/O-4 | Disabled | | |
| 81U/O-5 | Disabled | | |
| 81U/O-6 | Disabled | | |
| 81U/O-7 | Disabled | | |
| 81U/O-8 | Disabled | | |
| 81R-1 | Disabled | | |
| 81R-2 | Disabled | | |
| 81R-3 | Disabled | | |
| 81R-4 | Disabled | | |
| 32-1 | Disabled | | |
| 32-2 | Disabled | | |
| 32-3 | Disabled | | |
| 32-4 | Disabled | | |
| **Fault Locator** | | | |
| Fault Locator | Disabled | | |
| **Line Parameters** | | | |
| Line to Line Voltage | 11.00 | kV(Pri-mary) | |
| Line Length | 100.00 | km | 0.50 to 2000.00 |
| Positive Sequence Impedance | 10.00 | Ohm | 0.05 to 330.00 |
| Positive Sequence Angle | 80.0 | deg | 5.0 to 89.0 |
| Zero Sequence Impedance | 30.00 | Ohm | 0.05 to 1500.00 |
| Zero Sequence Angle | 80.0 | deg | 5.0 to 89.0 |
| **27/59DT - Phase Definite Time Under/Over Voltage** | | | |
| 27/59DT-1 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 51.0 | V | 3.0 to 250.0 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| 27/59DT-2 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 51.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| 27/59DT-3 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 51.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| 27/59DT-4 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 51.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| 27/59DT-5 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 51.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| 27/59DT-6 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 51.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| **27/59IT - Phase Inverse Time Under/Over Voltage** | | | |
| 27/59IT-1 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 55.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Curve Type | IEC Standard Inverse | | |
| TMS | 1.00 | - | 0.01 to 10.00 |
| Pick 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 |
| VTS Blocking | Disable | | |
| 27/59IT-2 | Disabled | | |
| Function Selection | UV | | |
| Output Gate | AND | | |
| Pickup V | 55.0 | V | 3.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Curve Type | IEC Standard Inverse | | |
| TMS | 1.00 | - | 0.01 to 10.00 |
| Pick 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 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| B | 0.0 | - | 0.0 to 10.0 |
| p | 1.0 | - | 0.1 to 10.0 |
| VTS Blocking | Disable | | |
| **47DT - Negative Sequence Definite Time Over Voltage** | | | |
| 47DT-1 | Disabled | | |
| Pickup V2 | 30.0 | V | 1.0 to 150.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.02 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| 47DT-2 | Disabled | | |
| Pickup V2 | 30.0 | V | 1.0 to 150.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.02 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| **47IT - Negative Sequence Inverse Time Over Voltage** | | | |
| 47IT | Disabled | | |
| 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 |
| Pick 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 |
| B | 0.0 | - | 0.0 to 10.0 |
| p | 1.0 | - | 0.1 to 10.0 |
| VTS Blocking | Disable | | |
| **59NDT - Derived Residual Definite Time Over Voltage** | | | |
| 59NDT-1 | Disabled | | |
| Pickup VN | 10.0 | V | 1.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| VTS Blocking | Disable | | |
| 59NDT-2 | Disabled | | |
| Pickup VN | 10.0 | V | 1.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pick DTL Delay | 0.20 | s | 0.00 to 999.99 |
| Reset DTL Delay | 0.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| **59NIT - Derived Residual Inverse Time Over Voltage** | | | |
| 59NIT | Disabled | | |
| Pickup VN | 7.0 | V | 1.0 to 250.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Curve Type | IEC Standard Inverse | | |
| TMS | 1.00 | - | 0.01 to 10.00 |
| Pick 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 |
| VTS Blocking | Disable | | |
| **37 - Instantaneous Phase Undercurrent** | | | |
| 37-1 | Disabled | | |
| Pickup I<< | 0.10 | A | 0.05 to 3.20 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| 37-2 | Disabled | | |
| Pickup I<< | 0.10 | A | 0.05 to 3.20 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| **67-Directional element for Phase Overcurrent** | | | |
| 2 out of 3 Logic | Disabled | | |
| VTS Blocking | Disabled | | |
| Polarization Method | Quadrature | | |
| Line Positive Sequence Angle | 80.0 | deg | 5.0 to 89.0 |
| Line Zero Sequence Angle | 80.0 | deg | 5.0 to 89.0 |
| **67-Sequence Method** | | | |

| **F-PRO Settings Summary - Setting Group 1 [SG 1]** | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Negative Sequence Directional Element | Disabled | | |
| V2 Sensitivity Level | 0.50 | V | 0.50 to 5.00 |
| I2 Sensitivity Level | 0.04 | A | 0.02 to 0.20 |
| Zero Sequence Directional Element | Disabled | | |
| 3V0 Sensitivity Level | 1.00 | V | 1.00 to 10.00 |
| 3I0 Sensitivity Level | 0.04 | A | 0.04 to 0.40 |
| Positive Sequence Directional Element | Disabled | | |
| V1 Sensitivity Level | 1.00 | V | 1.00 to 10.00 |
| I1 Sensitivity Level | 0.04 | A | 0.04 to 0.40 |
| **67 - Quadrature Method** | | | |
| Characteristic Angle | 45 | Deg | -95 to 95 |
| Minimum Voltage | 1.00 | V | 1.00 to 40.00 |
| **50/67 - Instantaneous Phase Overcurrent** | | | |
| 50/67-1 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Pickup I>> | 10.00 | A | 0.05 to 25.00 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| Inrush Block | Disabled | | |
| 50/67-2 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Pickup I>> | 10.00 | A | 0.05 to 25.00 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| Inrush Block | Disabled | | |
| **51/67 - IDMTL Phase Overcurrent** | | | |
| 51/67-1 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Pickup I> | 1.20 | A | 0.05 to 10.00 |
| 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 | 0.0 | s | 0.0 to 999.9 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| Inrush Block | Disabled | | |
| 51/67-2 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Pickup I> | 1.20 | A | 0.05 to 10.00 |
| 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 | 0.0 | s | 0.0 to 999.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| Inrush Block | Disabled | | |
| **67N-Directional element for Neutral Overcurrent** | | | |
| Characteristic Angle | -45 | Deg | -95 to 95 |
| Polarization Method | Neg Sequence | | |
| V2/3V0 Sensitivity Level | 0.50 | V | 0.50 to 5.00 |
| I2/3I0 Sensitivity Level | 0.04 | A | 0.02 to 0.20 |
| VTS Blocking | Disabled | | |
| **50/67N - Derived Instantaneous Neutral Overcurrent** | | | |
| 50N/67N-1 | Disabled | | |
| Pickup IN>> | 1.00 | A | 0.05 to 25.00 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| Inrush Block | Disabled | | |
| Inhibit Trip | Disabled | | |
| Inhibit Setting | 4.00 | | 4.00 to 10.00 |
| 50N/67N-2 | Disabled | | |
| Pickup IN>> | 1.00 | A | 0.05 to 25.00 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Inrush Block | Disabled | | |
| Inhibit Trip | Disabled | | |
| Inhibit Setting | 4.00 | | 4.00 to 10.00 |
| **51/67N - Derived IDMTL Neutral Overcurrent** | | | |
| 51N/67N-1 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Pickup IN> | 0.20 | A | 0.05 to 10.00 |
| 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 | 0.0 | s | 0.0 to 999.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| Inrush Block | Disabled | | |
| Inhibit Trip | Disabled | | |
| Inhibit Setting | 4.00 | | 4.00 to 10.00 |
| 51N/67N-2 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Pickup IN> | 0.20 | A | 0.05 to 10.00 |
| 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 | 0.0 | s | 0.0 to 999.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| Inrush Block | Disabled | | |
| Inhibit Trip | Disabled | | |
| Inhibit Setting | 4.00 | | 4.00 to 10.00 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **46/50 - Instantaneous Negative Sequence Overcurrent** | | | |
| 46/50 | Disabled | | |
| Pickup I2>> | 0.25 | A | 0.05 to 25.00 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| **46/51 - IDMTL Negative Sequence Overcurrent** | | | |
| 46/51 | Disabled | | |
| Pickup I2> | 0.25 | A | 0.05 to 10.00 |
| 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 Delay | DTL | | |
| Reset DTL Delay | 0.0 | s | 0.0 to 999.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| **67SEF - Directional element for SEF** | | | |
| Characteristic Angle | -15 | Deg | -95 to 95 |
| Polarization Method | Neg Sequence | | |
| V2/3V0 Sensitivity Level | 0.50 | V | 0.50 to 5.00 |
| ISEF Sensitivity Level | 0.04 | A | 0.02 to 0.20 |
| VTS Blocking | Disabled | | |
| **64/50SEF - Instantaneous SEF/REF** | | | |
| 64/50SEF-1 | Disabled | | |
| Measurement Input | Fundamental | | |
| Pickup ISEF>> | 0.200 | A | 0.005 to 3.000 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| Current Compensation | 0.000 | A | 0.000 to 0.500 |
| 64/50SEF-1 | Disabled | | |
| Measurement Input | Fundamental | | |
| Pickup ISEF>> | 0.200 | A | 0.005 to 3.000 |
| Pickup Delay | 0.00 | s | 0.00 to 999.99 |
| Current Compensation | 0.000 | A | 0.000 to 0.500 |
| **64/51SEF - Inverse Time Sensitive / Restricted Earth Fault** | | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 64/51SEF-1 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Measurement Input | Fundamental | | |
| Pickup ISEF> | 0.200 | A | 0.005 to 3.000 |
| 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 | 0.0 | s | 0.0 to 999.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Current Compensation | 0.000 | A | 0.000 to 0.500 |
| 64/51SEF-2 | Disabled | | |
| Direction Selection | Non-Directional | | |
| Measurement Input | Fundamental | | |
| Pickup ISEF> | 0.200 | A | 0.005 to 3.000 |
| 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 | 0.0 | s | 0.0 to 999.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Current Compensation | 0.000 | A | 0.000 to 0.500 |
| **49 - Thermal Overload** | | | |
| 49 | Disabled | | |
| Thermal Overload | 1.05 | A | 0.20 to 2.00 |
| Time Constant | 10.00 | min | 0.50 to 100.00 |
| Neg. Seq. Weighing Factor | 0.00 | - | 0.00 to 10.00 |
| Thermal OL Alarm | Disabled | | |
| Alarm % Th | 80 | % | 50 to 100 |
| **Circuit Breaker Failure** | | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 50BF-Int | Disabled | | |
| 50BF-Ext | Disabled | | |
| Pickup I>> | 0.20 | A | 0.05 to 2.00 |
| Pickup Delay 1 | 0.20 | s | 0.00 to 999.99 |
| Pickup Delay 2 | 0.40 | s | 0.00 to 999.99 |
| DI_CBF | Disabled | | |
| Pickup Delay 1 | 0.20 | s | 0.00 to 999.99 |
| Pickup Delay 2 | 0.40 | s | 0.00 to 999.99 |
| **46BC - Broken Conductor** | | | |
| 46BC | Disabled | | |
| Pickup I2/I1> | 30.00 | % | 20.00 to 100.00 |
| Pickup Delay | 10.00 | s | 0.02 to 999.99 |
| **81HBL2 - Inrush** | | | |
| 81HBL2 | Disabled | | |
| Cross Blocking | Enabled | | |
| Pickup I2nd> | 15 | % | 5 to 50 |
| **81U/O - Under/Over Frequency** | | | |
| 81U/O-1 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | Hz | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| 81U/O-2 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| 81U/O-3 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| VTS Blocking | Disable | | |
| 81U/O-4 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| 81U/O-5 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| 81U/O-6 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| 81U/O-7 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| 81U/O-8 | Disabled | | |
| Function Selection | UF | | |
| Pickup F | 49.0 | Hz | 40.0 to 50.0 |
| Hysteresis | 0.05 | HZ | 0.05 to 2 |
| Pickup Delay | 2.00 | s | 0.05 to 999.99 |
| VTS Blocking | Disable | | |
| **81R - Rate of Change of Frequency** | | | |
| 81R-1 | Disabled | | |
| Pickup df/dt | -0.5 | Hz/s | -10.0 to 10.0 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Hysteresis | 1 | % | 1 to 80 |
| Pickup Delay | 1.00 | s | 0.20 to 999.99 |
| VTS Blocking | Disable | | |
| 81R-2 | Disabled | | |
| Pickup df/dt | -0.5 | Hz/s | -10.0 to 10.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pickup Delay | 1.00 | s | 0.20 to 999.99 |
| VTS Blocking | Disable | | |
| 81R-3 | Disabled | | |
| Pickup df/dt | -0.5 | Hz/s | -10.0 to 10.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pickup Delay | 1.00 | s | 0.20 to 999.99 |
| VTS Blocking | Disable | | |
| 81R-4 | Disabled | | |
| Pickup df/dt | -0.5 | Hz/s | -10.0 to 10.0 |
| Hysteresis | 1 | % | 1 to 80 |
| Pickup Delay | 1.00 | s | 0.20 to 999.99 |
| VTS Blocking | Disable | | |
| **32 - Directional Power Protection** | | | |
| 32-1 | Disabled | | |
| 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 | | |
| 32-2 | Disabled | | |
| 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 | Disabled | | |

| F-PRO Settings Summary - Setting Group 1 [SG 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 | Disabled | | |
| 32-4 | Disabled | | |
| 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 | | |
| **Monitoring Summary** | | | |
| 60VTS | Disabled | | |
| 60CTS | Disabled | | |
| 74TCS-1 | Disabled | | |
| 74TCS-2 | Disabled | | |
| I^2t-CB | Disabled | | |
| THD-1 | Disabled | | |
| THD-2 | Disabled | | |
| UV | Disabled | | |
| OV | Disabled | | |
| UF | Disabled | | |
| OF | Disabled | | |
| EI | Disabled | | |
| AR Counter | Disabled | | |
| **60VTS - VT Supervision** | | | |
| 60VTS | Disabled | | |
| I1 Blocking | 1.5 | A | 0.1 to 10.0 |
| 3I0 Blocking | 0.2 | A | 0.1 to 10.0 |
| Negative Sequence Monitoring | Disabled | | |
| Vnps | 10.0 | V | 7.0 to 110.0 |
| Inps | 0.10 | A | 0.05 to 1.00 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **60CTS - CT Supervision** | | | |
| 60CTS | Disabled | | |
| Vnps Pickup | 20.00 | V | 7.00 to 110.00 |
| Inps Pickup | 0.10 | A | 0.05 to 1.00 |
| Pickup Delay | 10.00 | s | 0.03 to 999.99 |
| **74TCS - Trip Circuit Supervision** | | | |
| 74TCS-1[TCS 1] | Disabled | | |
| Dropoff  Delay | 0.40 | s | 0.00 to 9.99 |
| 74TCS-2[TCS 2] | Disabled | | |
| Dropoff  Delay | 0.40 | s | 0.00 to 9.99 |
| **I^2t-CB Condition** | | | |
| I^2t-CB | Disabled | | |
| I^2t Limit | 0.1 | kA^2s | 0.1 to 99999.9 |
| **THD - Total Harmonic Distortion** | | | |
| THD-1 | Disabled | | |
| Pickup THD-V | 3 | % | 1 to 100 |
| Pickup Delay | 5.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| THD-2 | Disabled | | |
| Pickup THD-V | 3 | % | 1 to 100 |
| Pickup Delay | 5.00 | s | 0.00 to 999.99 |
| VTS Blocking | Disable | | |
| **UV - Undervoltage Count Alarm** | | | |
| UV | Disabled | | |
| Pickup V | 40.0 | V | 1.0 to 220.0 |
| UV Count | 100 | | 1 to 1000 |
| Count Accumulation Period | 1 | days | 1 to 31 |
| **OV - Overvoltage Count Alarm** | | | |
| OV | Disabled | | |
| Pickup V | 70.0 | V | 1.0 to 220.0 |
| UV Count | 100 | | 1 to 1000 |
| Count Accumulation Period | 1 | days | 1 to 31 |
| **UF - Underfrequency Count Alarm** | | | |
| UF | Disabled | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Pickup F | 49.90 | Hz | 50.00 to 60.00 |
| UF Count | 100 | | 1 to 1000 |
| Count Accumulation Period | 1 | days | 1 to 31 |
| **OF - Overfrequency Count Alarm** | | | |
| OF | Disabled | | |
| Pickup F | 50.10 | Hz | 50.00 to 60.00 |
| OF Count | 100 | | 1 to 1000 |
| Count Accumulation Period | 1 | days | 1 to 31 |
| **EI - External Input Count Alarm** | | | |
| EI | Disabled | | |
| Pickup Delay | 0.10 | s | 0.00 to 99.99 |
| EI Count | 100 | | 1 to 1000 |
| Count Accumulation Period | 1 | days | 1 to 31 |
| **Reclosure Count Alarm** | | | |
| AR | Disabled | | |
| Reclosure Cumm Count | 100 | | 0 to 999 |
| **Control Summary** | | | |
| 25/27/59 | Disabled | | |
| Dead Main Live Sync (DMLS) | Disabled | | |
| Live Main Dead Sync (LMDS) | Disabled | | |
| Dead Main Dead Sync (DMDS) | Disabled | | |
| 79 | Disabled | | |
| **25/27/59 - Check Synchronization** | | | |
| 25/27/59 | Disabled | | |
| Maximum Voltage | 70.0 | V | 60.0 to 138.0 |
| Minimum Voltage | 40.0 | V | 40.0 to 69.9 |
| Voltage Difference | 5.0 | V | 1.0 to 20.0 |
| Angle Difference | 20.0 | deg | 1.0 to 50.0 |
| Pickup Delay | 0.10 | s | 0.00 to 10.00 |
| Frequency Difference | Disabled | | |
| Frequency Difference | 0.010 | Hz | 0.010 to 2.000 |
| Dead Main Live Sync (DMLS) | Disabled | | |
| Live Main Dead Sync (LMDS) | Disabled | | |
| Dead Main Dead Sync (DMDS) | Disabled | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **79 - Recloser** | | | |
| 79 | Disabled | | |
| Number Of Shots | 1 | | 1 to 4 |
| First Reclose - T1 | 1.00 | s | 0.10 to 999.99 |
| Second Reclose - T2 | 5.00 | s | 1.00 to 999.99 |
| Third Reclose - T3 | 10.00 | s | 1.00 to 999.99 |
| Fourth Reclose - T4 | 20.00 | s | 1.00 to 999.99 |
| Close Time - Tp | 0.20 | s | 0.01 to 1.00 |
| Reclaim Time - Td | 25.00 | s | 0.00 to 999.99 |
| Initiate Reset - TDI | 1.00 | s | 0.00 to 999.99 |
| Block Reset - TDB | 0.50 | s | 0.00 to 999.99 |
| **PL 1 [ProLogic 1]** | | | |
| ProLogic 1 | Disabled | | |
| 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 2 [ProLogic 2]** | | | |
| ProLogic 2 | Disabled | | |
| 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 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Input C | <Unused = 0> | | |
| Operator 4 | | | |
| Input D | <Unused = 0> | | |
| Operator 5 | | | |
| Input E | <Unused = 0> | | |
| **PL 3 [ProLogic 3]** | | | |
| ProLogic 3 | Disabled | | |
| 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 | Disabled | | |
| 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 5 [ProLogic 5]** | | | |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| ProLogic 5 | Disabled | | |
| 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 | Disabled | | |
| 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 7 [ProLogic 7]** | | | |
| ProLogic 7 | Disabled | | |
| 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 [SG 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 8 [ProLogic 8]** | | | |
| ProLogic 8 | Disabled | | |
| 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 | Disabled | | |
| 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 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Input E | <Unused = 0> | | |
| **PL 10 [ProLogic 10]** | | | |
| ProLogic 10 | Disabled | | |
| 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 | Disabled | | |
| 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 | Disabled | | |
| 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 [SG 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 | Disabled | | |
| 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 | Disabled | | |
| 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 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Input D | <Unused = 0> | | |
| Operator 5 | | | |
| Input E | <Unused = 0> | | |
| **PL 15 [ProLogic 15]** | | | |
| ProLogic 15 | Disabled | | |
| 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 | Disabled | | |
| 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 | Disabled | | |
| Pickup Delay-Tp | 0.00 | s | 0.00 to 999.00 |

| F-PRO Settings Summary - Setting Group 1 [SG 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 18 [ProLogic 18]** | | | |
| ProLogic 18 | Disabled | | |
| 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 | Disabled | | |
| 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 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Input C | <Unused = 0> | | |
| Operator 4 | | | |
| Input D | <Unused = 0> | | |
| Operator 5 | | | |
| Input E | <Unused = 0> | | |
| **PL 20 [ProLogic 20]** | | | |
| ProLogic 20 | Disabled | | |
| 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> | | |
| **Relay Reset** | | | |
| Reset Type [RL 1] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 2] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 3] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 4] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 5] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 6] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 7] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |

| F-PRO Settings Summary - Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Reset Type [RL 8] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 9] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 10] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 11] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 12] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 13] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |
| Reset Type [RL 14] | Self Reset | | |
| Dropout Timer | 0.10 | s | 0.00 to 1.00 |

# Appendix C Hardware Description

The relay is designed and manufactured with high quality features and recording components for a complete feeder protection package. The following information describes the main hardware components of the relay

## Fascia Board (FB):

The FB contains LED's and It also has 7 keys (The keypad is used to navigate the menus on the display to control relay operation by a local user).

## Mother Board (MB):

The mother board contains graphical LCD, USB interface and the interface connectors to interface to all the boards.

## CPU Board (CPUB):

The CPUB has System on Module and it contains high speed dual core processor which performs the entire relay operation. The CPUB is interfaced to Mother Board, which manages the protection features of the relay. The dual core processor manages the user interface and system control features of the relay and RTC backup battery.

The CPUB 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 records are stored in non-volatile memory.
- Runs on 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(input selection through jumper).
- High speed inbuilt link is provided between the DSP and ARM processor subsystems.
- Sophisticated fault detection.

## Analog Input Board (AIB):

AIB has 8 channel analog inputs (5 current transformer inputs and 3 voltage transformer inputs). It provides the analog to digital conversion of ac analog current & voltage inputs. The sampling rate is fixed at 32 samples/cycle. Each channel is simultaneously sampled using 16-bit analog to digital converters. The digitized data is sent to the CPUB for processing of protection algorithms.

## Power Supply Board (PSB):

SMPS 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 two power supply operating ranges are 20 – 60Vdc and 80 -300 Vdc, 100-240 Vac, +/-10%, 50/60 Hz. This wide operating range provides easier installation by eliminating power supply ordering options. It also 4 digital input channels (Inputs are optically isolated, externally wetted and ordering option with the voltage level of 24 / 48 / 110 / 220 Vdc selection), 3 normally open contact outputs, 1 form A contact output for relaying, alarms & control. This board is interfaced to the mother board.

## Digital Input Board (DIB):

This board contains 10 digital input channels (Inputs are optically isolated, externally wetted and ordering option with the voltage level of 24 / 48 / 110 / 220 Vdc selection). This board is interfaced to the mother board.

## Digital Output Board (DOB):

This board contains 10 normally open contact outputs for relaying, alarms & control, This board is interfaced to the mother board.

# 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.

| Event | Notes |
|---|---|
| 27DT-1 Picked up | The possible phase information will be:<br>• A<br>• B<br>• C<br>• AB<br>• BC<br>• CA<br>• ABC |
| 27DT-2 Picked up | |
| 27DT-3 Picked up | |
| 27DT-4 Picked up | |
| 27DT-5 Picked up | |
| 27DT-6 Picked up | |
| 27DT-1 Operated | |
| 27DT-2 Operated | |
| 27DT-3 Operated | |
| 27DT-4 Operated | |
| 27DT-5 Operated | |
| 27DT-6 Operated | |
| 27IT-1 Picked up | |
| 27IT-2 Picked up | |
| 27IT-1 Operated | |
| 27IT-2 Operated | |
| 59DT-1: Picked up | |
| 59DT-2 Picked up | |
| 59DT-3 Picked up | |
| 59DT-4 Picked up | |
| 59DT-5 Picked up | |
| 59DT-6 Picked up | |
| 59DT-1 Operated | |
| 59DT-2 Operated | |
| 59DT-3 Operated | |
| 59DT-4 Operated | |

<table>
<tr><th>Event</th><th>Notes</th></tr>
<tr><td>59DT-5 Operated</td><td rowspan="12">The possible phase information will be:<br>• A<br>• B<br>• C<br>• AB<br>• BC<br>• CA<br>• ABC</td></tr>
<tr><td>59DT-6 Operated</td></tr>
<tr><td>59IT-1 Picked up</td></tr>
<tr><td>59IT-2 Picked up</td></tr>
<tr><td>59IT-1 Operated</td></tr>
<tr><td>59IT-2 Operated</td></tr>
<tr><td>24DT-1 Picked up</td></tr>
<tr><td>24DT-2 Picked up</td></tr>
<tr><td>24DT-1 Operated</td></tr>
<tr><td>24DT-2 Operated</td></tr>
<tr><td>24IT Picked up</td></tr>
<tr><td>24IT Operated</td></tr>
<tr><td>47DT-1 Picked up</td><td></td></tr>
<tr><td>47DT-2 Picked up</td><td></td></tr>
<tr><td>47DT-1 Operated</td><td></td></tr>
<tr><td>47DT-2 Operated</td><td></td></tr>
<tr><td>47IT Picked up</td><td></td></tr>
<tr><td>47IT Operated</td><td></td></tr>
<tr><td>59NDT-1 Picked up</td><td></td></tr>
<tr><td>59NDT-2 Picked up</td><td></td></tr>
<tr><td>59NDT-1 Operated</td><td></td></tr>
<tr><td>59NDT-2 Operated</td><td></td></tr>
<tr><td>59NIT Picked up</td><td></td></tr>
<tr><td>59NIT Operated</td><td></td></tr>
</table>

| Event | Notes |
|---|---|
| 37-1 Picked up | The possible phase information will be:<br>• A<br>• B<br>• C<br>• AB<br>• BC<br>• CA<br>• ABC |
| 37-1 Operated | |
| 37-2 Picked up | |
| 37-2 Operated | |
| 50/67-1 Picked up | |
| 50/67-2 Picked up | |
| 50/67-1 Operated | |
| 50/67-2 Operated | |
| 51/67-1 Picked up | |
| 51/67-2 Picked up | |
| 51/67-1 Operated | |
| 51/67-2 Operated | |
| 49 Picked up | |
| 49 Operated | |
| 50BF-D1 Operated | |
| 50BF-D2 Operated | |
| CBF-D1 Operated | |
| CBF-D2 Operated | |
| 50N/67N-1 Picked up | |
| 50N/67N-2 Picked up | |
| 50N/67N-1 Operated | |
| 50N/67N-2 Operated | |
| 51N/67N-1 Picked up | |
| 51N/67N-2 Picked up | |
| 51N/67N-1 Operated | |
| 51N/67N-2 Operated | |
| 46/50 Picked up | |
| 46/50 Operated | |
| 46/51 Picked up | |
| 46/51 Operated | |
| 64/50SEF-1 Picked up | |
| 64/50SEF-2 Picked up | |
| 64/50SEF-1 Operated | |

| Event | Notes |
|---|---|
| 64/50SEF-2 Operated | |
| 64/51SEF-1 Picked up | |
| 64/51SEF-2 Picked up | |
| 64/51SEF-1 Operated | |
| 64/51SEF-2 Operated | |
| 49AL Operated | |
| 46BC Operated | |
| 81HBL2 Operated | |
| 81U-1 Picked up | |
| 81U-2 Picked up | |
| 81U-3 Picked up | |
| 81U-4 Picked up | |
| 81U-5 Picked up | |
| 81U-6 Picked up | |
| 81U-7 Picked up | |
| 81U-8 Picked up | |
| 81O-1 Picked up | |
| 81O-2 Picked up | |
| 81O-3 Picked up | |
| 81O-4 Picked up | |
| 81O-5 Picked up | |
| 81O-6 Picked up | |
| 81O-7 Picked up | |
| 81O-8 Picked up | |
| 81R-1 Picked up | |
| 81R-2 Picked up | |
| 81R-3 Picked up | |
| 81R-4 Picked up | |
| 81R-1 Operated | |
| 81R-2 Operated | |
| 81R-3 Operated | |
| 81R-4 Operated | |
| 32-1 Picked up | |

| Event | Notes |
|---|---|
| 32-1 Operated | |
| 32-2 Picked up | |
| 32-2 Operated | |
| 32-3 Picked up | |
| 32-3 Operated | |
| 32-4 Picked up | |
| 32-4 Operated | |
| 60VTS Operated | |
| 60CTS Operated | |
| 74TCS-1 Operated | |
| 74TCS-2 Operated | |
| I2t Limit Operated | |
| THD-1 Operated | |
| THD-2 Operated | |
| U/V Count Operated | |
| O/V Count Operated | |
| U/F Count Operated | |
| O/F Count Operated | |
| EI Count Operated | |
| 25 Vsync Operated | |
| 79 IN Operated | |
| 79 OUT Operated | |
| 79 Reclose Operated | Includes Shot Count |
| 79 AR Initiate Operated | |
| 79 Block Operated | |
| 79 Lockout Operated | |
| Control Mode Off Activated | |
| Control Mode Local Activated | |
| Control Mode Remote Activated | |
| Control Mode Security OFF Activated | |
| Control Mode Security ON Activated | |
| SPC n: Command Active | |
| SPC n: Command Inactive | |

| Event | Notes |
|---|---|
| DPC n: OPEN Command Active | |
| DPC n: OPEN Command Inactive | |
| DPC n: CLOSE Command Active | |
| DPC n: CLOSE Command Inactive | |

# Appendix E Modbus RTU Communication Protocol

The SCADA port supports IEC 103 and Modicon Modbus protocols. All metering values available through the terminal user interface are also available via the Modbus protocol. Additionally, the Modbus protocol support the reading of the unit time and time of the readings and provides access to trip and alarm events, include fault location information.

A “Hold Readings” function is available to freeze all metering readings into a snapshot (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 | Reserved |
| 27DT-1 Picked up | 513 | 0: OFF | 1: ON |
| 27DT-2 Picked up | 514 | 0: OFF | 1: ON |
| 27DT-3 Picked up | 515 | 0: OFF | 1: ON |
| 27DT-4 Picked up | 516 | 0: OFF | 1: ON |
| 27DT-5 Picked up | 517 | 0: OFF | 1: ON |
| 27DT-6 Picked up | 518 | 0: OFF | 1: ON |
| 27DT-1 Operated | 519 | 0: OFF | 1: ON |
| 27DT-2 Operated | 520 | 0: OFF | 1: ON |
| 27DT-3 Operated | 521 | 0: OFF | 1: ON |
| 27DT-4 Operated | 522 | 0: OFF | 1: ON |
| 27DT-5 Operated | 523 | 0: OFF | 1: ON |
| 27DT-6 Operated | 524 | 0: OFF | 1: ON |
| 27IT-1 Picked up | 525 | 0: OFF | 1: ON |
| 27IT-2 Picked up | 526 | 0: OFF | 1: ON |
| 27IT-1 Operated | 527 | 0: OFF | 1: ON |
| 27IT-2 Operated | 528 | 0: OFF | 1: ON |
| 59DT-1 Picked up | 529 | 0: OFF | 1: ON |
| 59DT-2 Picked up | 530 | 0: OFF | 1: ON |
| 59DT-3 Picked up | 531 | 0: OFF | 1: ON |
| 59DT-4 Picked up | 532 | 0: OFF | 1: ON |
| 59DT-5 Picked up | 533 | 0: OFF | 1: ON |
| 59DT-6 Picked up | 534 | 0: OFF | 1: ON |
| 59DT-1 Operated | 535 | 0: OFF | 1: ON |
| 59DT-2 Operated | 536 | 0: OFF | 1: ON |
| 59DT-3 Operated | 537 | 0: OFF | 1: ON |
| 59DT-4 Operated | 538 | 0: OFF | 1: ON |
| 59DT-5 Operated | 539 | 0: OFF | 1: ON |
| 59DT-6 Operated | 540 | 0: OFF | 1: ON |
| 59IT-1 Picked up | 541 | 0: OFF | 1: ON |
| 59IT-2 Picked up | 542 | 0: OFF | 1: ON |
| 59IT-1 Operated | 543 | 0: OFF | 1: ON |
| 59IT-2 Operated | 544 | 0: OFF | 1: ON |
| 24DT-1 Picked up | 545 | 0: OFF | 1: ON |
| 24DT-2 Picked up | 546 | 0: OFF | 1: ON |
| 24DT-1 Operated | 547 | 0: OFF | 1: ON |

| Read Coil Status (Function Code 01) | | | |
|---|---|---|---|
| Channel | Address | Value | |
| 24DT-2 Operated | 548 | 0: OFF | 1: ON |
| 24IT-1 Picked up | 549 | 0: OFF | 1: ON |
| 24IT-1 Operated | 550 | 0: OFF | 1: ON |
| 47DT-1 Picked up | 551 | 0: OFF | 1: ON |
| 47DT-2 Picked up | 552 | 0: OFF | 1: ON |
| 47DT-1 Operated | 553 | 0: OFF | 1: ON |
| 47DT-2 Operated | 554 | 0: OFF | 1: ON |
| 47IT-1 Picked up | 555 | 0: OFF | 1: ON |
| 47IT-1 Operated | 556 | 0: OFF | 1: ON |
| 59NDT-1 Picked up | 557 | 0: OFF | 1: ON |
| 59NDT-2 Picked up | 558 | 0: OFF | 1: ON |
| 59NDT-1 Operated | 559 | 0: OFF | 1: ON |
| 59NDT-2 Operated | 560 | 0: OFF | 1: ON |
| 59NIT-1 Picked up | 561 | 0: OFF | 1: ON |
| 59NIT-1 Operated | 562 | 0: OFF | 1: ON |
| 37-1 Picked up | 563 | 0: OFF | 1: ON |
| 37-2 Picked up | 564 | 0: OFF | 1: ON |
| 37-1 Operated | 565 | 0: OFF | 1: ON |
| 37-2 Operated | 566 | 0: OFF | 1: ON |
| 50-1 Picked up | 567 | 0: OFF | 1: ON |
| 50-2 Picked up | 568 | 0: OFF | 1: ON |
| 50-1 Operated | 569 | 0: OFF | 1: ON |
| 50-2 Operated | 570 | 0: OFF | 1: ON |
| 51-1 Picked up | 571 | 0: OFF | 1: ON |
| 51-2 Picked up | 572 | 0: OFF | 1: ON |
| 51-1 Operated | 573 | 0: OFF | 1: ON |
| 51-2 Operated | 574 | 0: OFF | 1: ON |
| 50N-1 Picked up | 575 | 0: OFF | 1: ON |
| 50N-2 Picked up | 576 | 0: OFF | 1: ON |
| 50N-1 Operated | 577 | 0: OFF | 1: ON |
| 50N-2 Operated | 578 | 0: OFF | 1: ON |
| 51N-1 Picked up | 579 | 0: OFF | 1: ON |
| 51N-2 Picked up | 580 | 0: OFF | 1: ON |
| 51N-1 Operated | 581 | 0: OFF | 1: ON |
| 51N-2 Operated | 582 | 0: OFF | 1: ON |
| 46/50 Picked up | 583 | 0: OFF | 1: ON |
| 46/50 Operated | 584 | 0: OFF | 1: ON |
| 46/51 Picked up | 585 | 0: OFF | 1: ON |
| 46/51 Operated | 586 | 0: OFF | 1: ON |
| 64/50SEF-1 Picked up | 587 | 0: OFF | 1: ON |
| 64/50SEF-2 Picked up | 588 | 0: OFF | 1: ON |
| 64/50SEF-1 Operated | 589 | 0: OFF | 1: ON |
| 64/50SEF-2 Operated | 590 | 0: OFF | 1: ON |
| 64/51SEF-1 Picked up | 591 | 0: OFF | 1: ON |
| 64/51SEF-2 Picked up | 592 | 0: OFF | 1: ON |
| 64/51SEF-1 Operated | 593 | 0: OFF | 1: ON |
| 64/51SEF-2 Operated | 594 | 0: OFF | 1: ON |
| 49 Picked up | 595 | 0: OFF | 1: ON |
| 49 Operated | 596 | 0: OFF | 1: ON |
| 49AL Operated | 597 | 0: OFF | 1: ON |
| 50BF-D1 Operated | 598 | 0: OFF | 1: ON |

| Read Coil Status (Function Code 01) | | | |
|---|---|---|---|
| Channel | Address | Value | |
| 50BF-D2 Operated | 599 | 0: OFF | 1: ON |
| DI_CBF-D1 Operated | 600 | 0: OFF | 1: ON |
| DI_CBF-D2 Operated | 601 | 0: OFF | 1: ON |
| 46BC Operated | 602 | 0: OFF | 1: ON |
| 81HBL2 Operated | 603 | 0: OFF | 1: ON |
| 81U-1 Picked up | 604 | 0: OFF | 1: ON |
| 81U-2 Picked up | 605 | 0: OFF | 1: ON |
| 81U-3 Picked up | 606 | 0: OFF | 1: ON |
| 81U-4 Picked up | 607 | 0: OFF | 1: ON |
| 81U-5 Picked up | 608 | 0: OFF | 1: ON |
| 81U-6 Picked up | 609 | 0: OFF | 1: ON |
| 81U-7 Picked up | 610 | 0: OFF | 1: ON |
| 81U-8 Picked up | 611 | 0: OFF | 1: ON |
| 81U-1 Operated | 612 | 0: OFF | 1: ON |
| 81U-2 Operated | 613 | 0: OFF | 1: ON |
| 81U-3 Operated | 614 | 0: OFF | 1: ON |
| 81U-4 Operated | 615 | 0: OFF | 1: ON |
| 81U-5 Operated | 616 | 0: OFF | 1: ON |
| 81U-6 Operated | 617 | 0: OFF | 1: ON |
| 81U-7 Operated | 618 | 0: OFF | 1: ON |
| 81U-8 Operated | 619 | 0: OFF | 1: ON |
| 81O-1 Picked up | 620 | 0: OFF | 1: ON |
| 81O-2 Picked up | 621 | 0: OFF | 1: ON |
| 81O-3 Picked up | 622 | 0: OFF | 1: ON |
| 81O-4 Picked up | 623 | 0: OFF | 1: ON |
| 81O-5 Picked up | 624 | 0: OFF | 1: ON |
| 81O-6 Picked up | 625 | 0: OFF | 1: ON |
| 81O-7 Picked up | 626 | 0: OFF | 1: ON |
| 81O-8 Picked up | 627 | 0: OFF | 1: ON |
| 81O-1 Operated | 628 | 0: OFF | 1: ON |
| 81O-2 Operated | 629 | 0: OFF | 1: ON |
| 81O-3 Operated | 630 | 0: OFF | 1: ON |
| 81O-4 Operated | 631 | 0: OFF | 1: ON |
| 81O-5 Operated | 632 | 0: OFF | 1: ON |
| 81O-6 Operated | 633 | 0: OFF | 1: ON |
| 81O-7 Operated | 634 | 0: OFF | 1: ON |
| 81O-8 Operated | 635 | 0: OFF | 1: ON |
| 81R-1 Picked up | 636 | 0: OFF | 1: ON |
| 81R-2 Picked up | 637 | 0: OFF | 1: ON |
| 81R-3 Picked up | 638 | 0: OFF | 1: ON |
| 81R-4 Picked up | 639 | 0: OFF | 1: ON |
| 81R-1 Operated | 640 | 0: OFF | 1: ON |
| 81R-2 Operated | 641 | 0: OFF | 1: ON |
| 81R-3 Operated | 642 | 0: OFF | 1: ON |
| 81R-4 Operated | 643 | 0: OFF | 1: ON |
| 32-1 Picked up | 644 | 0: OFF | 1: ON |
| 32-2 Picked up | 645 | 0: OFF | 1: ON |
| 32-3 Picked up | 646 | 0: OFF | 1: ON |
| 32-4 Picked up | 647 | 0: OFF | 1: ON |
| 32-1 Operated | 648 | 0: OFF | 1: ON |
| 32-2 Operated | 649 | 0: OFF | 1: ON |
| 32-3 Operated | 650 | 0: OFF | 1: ON |

| Read Coil Status (Function Code 01) | | | |
|---|---|---|---|
| Channel | Address | Value | |
| 32-4 Operated | 651 | 0: OFF | 1: ON |
| 60VTS Operated | 652 | 0: OFF | 1: ON |
| 60CTS Operated | 653 | 0: OFF | 1: ON |
| 74TCS-1 Operated | 654 | 0: OFF | 1: ON |
| 74TCS-2 Operated | 655 | 0: OFF | 1: ON |
| I2t Limit Operated | 656 | 0: OFF | 1: ON |
| THD-1 Operated | 657 | 0: OFF | 1: ON |
| THD-2 Operated | 658 | 0: OFF | 1: ON |
| UV Count Operated | 659 | 0: OFF | 1: ON |
| OV Count Operated | 660 | 0: OFF | 1: ON |
| UF Count Operated | 661 | 0: OFF | 1: ON |
| OF Count Operated | 662 | 0: OFF | 1: ON |
| EI Count Operated | 663 | 0: OFF | 1: ON |
| 79AR_Cumm_Count_Operated | 664 | 0: OFF | 1: ON |
| 25/27/29 Operated | 665 | 0: OFF | 1: ON |
| 79 IN | 666 | 0: OFF | 1: ON |
| 79 OUT | 667 | 0: OFF | 1: ON |
| 79 RECLOSE | 668 | 0: OFF | 1: ON |
| 79 AR Initiate | 669 | 0: OFF | 1: ON |
| 79 Block | 670 | 0: OFF | 1: ON |
| 79 LockOut | 671 | 0: OFF | 1: ON |
| ProLogic1 | 672 | 0: OFF | 1: ON |
| ProLogic2 | 673 | 0: OFF | 1: ON |
| ProLogic3 | 674 | 0: OFF | 1: ON |
| ProLogic4 | 675 | 0: OFF | 1: ON |
| ProLogic5 | 676 | 0: OFF | 1: ON |
| ProLogic6 | 677 | 0: OFF | 1: ON |
| ProLogic7 | 678 | 0: OFF | 1: ON |
| ProLogic8 | 679 | 0: OFF | 1: ON |
| ProLogic9 | 680 | 0: OFF | 1: ON |
| ProLogic10 | 681 | 0: OFF | 1: ON |
| ProLogic11 | 682 | 0: OFF | 1: ON |
| ProLogic12 | 683 | 0: OFF | 1: ON |
| ProLogic13 | 684 | 0: OFF | 1: ON |
| ProLogic14 | 685 | 0: OFF | 1: ON |
| ProLogic15 | 686 | 0: OFF | 1: ON |
| ProLogic16 | 687 | 0: OFF | 1: ON |
| ProLogic17 | 688 | 0: OFF | 1: ON |
| ProLogic18 | 689 | 0: OFF | 1: ON |
| 81R-1 Operated | 640 | 0: OFF | 1: ON |
| 81R-2 Operated | 641 | 0: OFF | 1: ON |
| 81R-3 Operated | 642 | 0: OFF | 1: ON |
| 81R-4 Operated | 643 | 0: OFF | 1: ON |
| 32-1 Picked up | 644 | 0: OFF | 1: ON |
| 32-2 Picked up | 645 | 0: OFF | 1: ON |
| 32-3 Picked up | 646 | 0: OFF | 1: ON |
| 32-4 Picked up | 647 | 0: OFF | 1: ON |
| 32-1 Operated | 648 | 0: OFF | 1: ON |
| 32-2 Operated | 649 | 0: OFF | 1: ON |
| 32-3 Operated | 650 | 0: OFF | 1: ON |
| 32-4 Operated | 651 | 0: OFF | 1: ON |
| 60VTS Operated | 652 | 0: OFF | 1: ON |
| 60CTS Operated | 653 | 0: OFF | 1: ON |
| 74TCS-1 Operated | 654 | 0: OFF | 1: ON |

| Read Coil Status (Function Code 01) | | | |
|---|---|---|---|
| Channel | Address | Value | |
| 74TCS-2 Operated | 655 | 0: OFF | 1: ON |
| I2t Limit Operated | 656 | 0: OFF | 1: ON |
| THD-1 Operated | 657 | 0: OFF | 1: ON |
| THD-2 Operated | 658 | 0: OFF | 1: ON |
| UV Count Operated | 659 | 0: OFF | 1: ON |
| OV Count Operated | 660 | 0: OFF | 1: ON |
| UF Count Operated | 661 | 0: OFF | 1: ON |
| OF Count Operated | 662 | 0: OFF | 1: ON |
| EI Count Operated | 663 | 0: OFF | 1: ON |
| 79AR_Cumm_Count_Operated | 664 | 0: OFF | 1: ON |
| 25/27/29 Operated | 665 | 0: OFF | 1: ON |
| 79 IN | 666 | 0: OFF | 1: ON |
| 79 OUT | 667 | 0: OFF | 1: ON |
| 79 RECLOSE | 668 | 0: OFF | 1: ON |
| 79 AR Initiate | 669 | 0: OFF | 1: ON |
| 79 Block | 670 | 0: OFF | 1: ON |
| 79 LockOut | 671 | 0: OFF | 1: ON |
| ProLogic1 | 672 | 0: OFF | 1: ON |
| ProLogic2 | 673 | 0: OFF | 1: ON |
| ProLogic3 | 674 | 0: OFF | 1: ON |
| ProLogic4 | 675 | 0: OFF | 1: ON |
| ProLogic5 | 676 | 0: OFF | 1: ON |
| ProLogic6 | 677 | 0: OFF | 1: ON |
| ProLogic7 | 678 | 0: OFF | 1: ON |
| ProLogic8 | 679 | 0: OFF | 1: ON |
| ProLogic9 | 680 | 0: OFF | 1: ON |
| ProLogic10 | 681 | 0: OFF | 1: ON |
| ProLogic11 | 682 | 0: OFF | 1: ON |
| ProLogic12 | 683 | 0: OFF | 1: ON |
| ProLogic13 | 684 | 0: OFF | 1: ON |
| ProLogic14 | 685 | 0: OFF | 1: ON |
| ProLogic15 | 686 | 0: OFF | 1: ON |
| ProLogic16 | 687 | 0: OFF | 1: ON |
| ProLogic17 | 688 | 0: OFF | 1: ON |
| ProLogic18 | 689 | 0: OFF | 1: ON |
| ProLogic19 | 690 | 0: OFF | 1: ON |
| ProLogic20 | 691 | 0: OFF | 1: ON |
| Relay O/P1 | 692 | 0: OFF | 1: ON |
| Relay O/P2 | 693 | 0: OFF | 1: ON |
| Relay O/P3 | 694 | 0: OFF | 1: ON |
| Relay O/P4 | 695 | 0: OFF | 1: ON |
| Relay O/P5 | 696 | 0: OFF | 1: ON |
| Relay O/P6 | 697 | 0: OFF | 1: ON |
| Relay O/P7 | 698 | 0: OFF | 1: ON |
| Relay O/P8 | 699 | 0: OFF | 1: ON |
| Relay O/P9 | 700 | 0: OFF | 1: ON |
| Relay O/P10 | 701 | 0: OFF | 1: ON |
| Relay O/P11 | 702 | 0: OFF | 1: ON |
| Relay O/P12 | 703 | 0: OFF | 1: ON |
| Relay O/P13 | 704 | 0: OFF | 1: ON |
| Relay O/P14 | 705 | 0: OFF | 1: ON |
| Relay O/P1 | 692 | 0: OFF | 1: ON |
| Relay O/P2 | 693 | 0: OFF | 1: ON |
| Relay O/P3 | 694 | 0: OFF | 1: ON |

| Read Coil Status (Function Code 01) | | | |
|---|---|---|---|
| Channel | Address | Value | |
| Relay O/P4 | 695 | 0: OFF | 1: ON |
| Relay O/P5 | 696 | 0: OFF | 1: ON |
| Relay O/P6 | 697 | 0: OFF | 1: ON |
| Relay O/P7 | 698 | 0: OFF | 1: ON |
| Relay O/P8 | 699 | 0: OFF | 1: ON |
| Relay O/P9 | 700 | 0: OFF | 1: ON |
| Relay O/P10 | 701 | 0: OFF | 1: ON |
| Relay O/P11 | 702 | 0: OFF | 1: ON |
| Relay O/P12 | 703 | 0: OFF | 1: ON |
| Relay O/P13 | 704 | 0: OFF | 1: ON |
| Relay O/P14 | 705 | 0: OFF | 1: ON |

In the below table, Scale value should be divided with the metering data obtained from Modbus.

| Read Holding Registers (Function Code 03) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Units** | **Scale** |
| VA Magnitude | 40257 | KV | 100 |
| VA Angle | 40258 | Degrees | 1 |
| VB Magnitude | 40259 | KV | 100 |
| VB Angle | 40260 | Degrees | 1 |
| VC Magnitude | 40261 | KV | 100 |
| VC Angle | 40262 | Degrees | 1 |
| VN Magnitude | 40263 | KV | 100 |
| VN Angle | 40264 | Degrees | 1 |
| VAB Magnitude | 40265 | KV | 100 |
| VAB Angle | 40266 | Degrees | 1 |
| VBC Magnitude | 40267 | KV | 100 |
| VBC Angle | 40268 | Degrees | 1 |
| VCA Magnitude | 40269 | KV | 100 |
| VCA Angle | 40270 | Degrees | 1 |
| VSYNC Magnitude | 40271 | KV | 100 |
| VSYNC Angle | 40272 | Degrees | 1 |
| V1 Magnitude | 40273 | KV | 100 |
| V2 Magnitude | 40274 | KV | 100 |
| V0 Magnitude | 40275 | KV | 100 |
| %V/F | 40276 | % | 100 |
| %THD | 40277 | % | 100 |
| IA Magnitude | 40278 | A | 100 |
| IA Angle | 40279 | Degrees | 1 |
| IB Magnitude | 40280 | A | 100 |
| IB Angle | 40281 | Degrees | 1 |
| IC Magnitude | 40282 | A | 100 |
| IC Angle | 40283 | Degrees | 1 |
| IN Magnitude | 40284 | A | 100 |
| IN Angle | 40285 | Degrees | 1 |
| ISEF Magnitude | 40286 | A | 100 |
| ISEF Angle | 40287 | Degrees | 1 |
| I1 Magnitude | 40288 | A | 100 |
| I2 Magnitude | 40289 | A | 100 |
| I0 Magnitude | 40290 | A | 100 |
| %(I2/I1) | 40291 | % | 100 |
| Real Power | 40292 | MW | 100 |
| Reactive Power | 40293 | MVAR | 100 |
| APH Real Power | 40294 | MW | 100 |
| BPH Real Power | 40295 | MW | 100 |
| CPH Real Power | 40296 | MW | 100 |
| APH Reactive Power | 40297 | MVAR | 100 |
| BPH Reactive Power | 40298 | MVAR | 100 |
| CPH Reactive Power | 40299 | MVAR | 100 |
| Frequency | 40300 | HZ | 10 |
| Power Factor | 40301 | - | 100 |
| Thermal state (%) | 40302 | % | 100 |
| $I^2t$ Accumulated | 40303 | $kA^2s$ | 1 |
| $I^2t$ for last operation | 40304 | $kA^2s$ | 1 |
| Bus Voltage | 40305 | KV | 100 |

| Read Holding Registers (Function Code 03) | | | |
|---|---|---|---|
| Channel | Address | Units | Scale |
| Line Voltage | 40306 | KV | 100 |
| Bus Angle | 40307 | Degrees | 1 |
| Line Angle | 40308 | Degrees | 1 |
| Bus Frequency | 40309 | HZ | 10 |
| Line Frequency | 40310 | HZ | 10 |
| 79 AR COUNT | 40311 | - | 1 |
| 79 AR Cumm Count | 40312 | - | 1 |

| **Read Discrete Inputs (Function Code 02)** | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | |
| Status I/P 1- Present state | 10001 | 0: OFF | 1: ON |
| Status I/P 2- Present state | 10002 | 0: OFF | 1: ON |
| Status I/P 3- Present state | 10003 | 0: OFF | 1: ON |
| Status I/P 4- Present state | 10004 | 0: OFF | 1: ON |
| Status I/P 5- Present state | 10005 | 0: OFF | 1: ON |
| Status I/P 6- Present state | 10006 | 0: OFF | 1: ON |
| Status I/P 7- Present state | 10007 | 0: OFF | 1: ON |
| Status I/P 8- Present state | 10008 | 0: OFF | 1: ON |
| Status I/P 9- Present state | 10009 | 0: OFF | 1: ON |
| Status I/P 10- Present state | 10010 | 0: OFF | 1: ON |
| Status I/P 11- Present state | 10011 | 0: OFF | 1: ON |
| Status I/P 12- Present state | 10012 | 0: OFF | 1: ON |
| Status I/P 13- Present state | 10013 | 0: OFF | 1: ON |
| Status I/P 14- Present state | 10014 | 0: OFF | 1: ON |
| Status I/P 1- Change of state | 10257 | 0: OFF | 1: ON |
| Status I/P 2- Change of state | 10258 | 0: OFF | 1: ON |
| Status I/P 3- Change of state | 10259 | 0: OFF | 1: ON |
| Status I/P 4- Change of state | 10260 | 0: OFF | 1: ON |
| Status I/P 5- Change of state | 10261 | 0: OFF | 1: ON |
| Status I/P 6- Change of state | 10262 | 0: OFF | 1: ON |
| Status I/P 7- Change of state | 10263 | 0: OFF | 1: ON |
| Status I/P 8- Change of state | 10264 | 0: OFF | 1: ON |
| Status I/P 9- Change of state | 10265 | 0: OFF | 1: ON |
| Status I/P 10- Change of state | 10266 | 0: OFF | 1: ON |
| Status I/P 11- Change of state | 10267 | 0: OFF | 1: ON |
| Status I/P 12- Change of state | 10268 | 0: OFF | 1: ON |
| Status I/P 13- Change of state | 10269 | 0: OFF | 1: ON |
| Status I/P 14- Change of state | 10270 | 0: OFF | 1: ON |
| Virtual Input1 | 10513 | 0: OFF | 1: ON |
| Virtual Input2 | 10514 | 0: OFF | 1: ON |
| Virtual Input3 | 10515 | 0: OFF | 1: ON |
| Virtual Input4 | 10516 | 0: OFF | 1: ON |
| Virtual Input5 | 10517 | 0: OFF | 1: ON |
| Virtual Input6 | 10518 | 0: OFF | 1: ON |
| Virtual Input7 | 10519 | 0: OFF | 1: ON |
| Virtual Input8 | 10520 | 0: OFF | 1: ON |
| Virtual Input9 | 10521 | 0: OFF | 1: ON |
| Virtual Input10 | 10522 | 0: OFF | 1: ON |
| Virtual Input11 | 10523 | 0: OFF | 1: ON |
| Virtual Input12 | 10524 | 0: OFF | 1: ON |
| Virtual Input13 | 10525 | 0: OFF | 1: ON |

| Read Discrete Inputs (Function Code 02) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | |
| Virtual Input14 | 10526 | 0: OFF | 1: ON |
| Virtual Input15 | 10527 | 0: OFF | 1: ON |
| Virtual Input16 | 10528 | 0: OFF | 1: ON |
| Virtual Input17 | 10529 | 0: OFF | 1: ON |
| Virtual Input18 | 10530 | 0: OFF | 1: ON |
| Virtual Input19 | 10531 | 0: OFF | 1: ON |
| Virtual Input20 | 10532 | 0: OFF | 1: ON |
| Virtual Input21 | 10533 | 0: OFF | 1: ON |
| Virtual Input22 | 10534 | 0: OFF | 1: ON |
| Virtual Input23 | 10535 | 0: OFF | 1: ON |
| Virtual Input24 | 10536 | 0: OFF | 1: ON |
| Virtual Input25 | 10537 | 0: OFF | 1: ON |
| Virtual Input26 | 10538 | 0: OFF | 1: ON |
| Virtual Input27 | 10539 | 0: OFF | 1: ON |
| Virtual Input28 | 10540 | 0: OFF | 1: ON |
| Virtual Input29 | 10541 | 0: OFF | 1: ON |
| Virtual Input30 | 10542 | 0: OFF | 1: ON |

| Read Holding Registers (Function Code 03) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Units** | **Scale** |
| F-PRO Clock Time (UTC) – Note: Read all in same query to ensure consistent time reading data | | | |
| Milliseconds now | 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 | 1 |
| Year since 1900 | 40006 | 90 – 137 | 1 |
| Synchronized to IRIG-B | 40007 | 0: No & 1: Yes | 1 |
| Synchronized to SNTP | 40008 | 0: No & 1: Yes | 1 |
| Time of Acquisition (UTC) – Note: Read all in same query to ensure consistent time reading data | | | |
| Milliseconds now | 40009 | 0 – 999 | 1 |
| Seconds now | 40010 | 0 – 59 | 1 |
| Minutes now | 40011 | 0 – 59 | 1 |
| Hours now | 40012 | 0 – 23 | 1 |
| Day of year now | 40013 | 1 – 365 | 1 |
| Year since 1900 | 40014 | 90 – 137 | 1 |
| Synchronized to IRIG-B | 40015 | 0: No & 1: Yes | 1 |
| Synchronized to SNTP | 40016 | 0: No & 1: Yes | 1 |
| Local time offset | 40017 | 2's compliment half hours, North America is negative | 1 |

| **Read Input Register (Function Code 04)** |
|---|
| No input registers supported. Response front IED indicates “ILLEGAL FUNCTION.” |

| **Write 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** | |
| Hold Readings | Read/Write | 01 | 0000: Readings update |

| **Write Single Register (Function Code 06)** | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | |
| Event Message Control (See ‘given below for details of use) | | | |
| Refresh event list | 40513 | No data required | |
| Acknowledge the current event and get the next event | 40514 | No data required | N/A |
| Get the next event (without acknowledge) | 40515 | No data required | N/A |

| **Diagnostic Subfunctions (Function Code 08)** | |
|---|---|
| Return Query Data (Subfunction00) | This provides an echo of the submitted |
| Restart Communication Option (Subfunction01) | This restarts the Modbus communications |

| | |
|---|---|
| Force Listen Only Mode (Subfunction04) | No response is returned. IED enters “Listen Only” mode. This mode can only be excited by the “Restart Communication Option” command. |

| **Write Multiple Registers (Function Code 16)** | | | |
|---|---|---|---|
| **Channel** | **Address** | **Units** | **Scale** |
| F-PRO Clock Time (UTC) – Note: Must write to all the registers in same query | | | |
| Milliseconds now | 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 | 1 |
| Year since 1900 | 40006 | 90 – 137 | 1 |
| | | | |
| A fixed response is returned by the IED, including system model, version and issue numbers. | | | |
| **Channel** | **Type** | **Bytes** | |
| Model Number | Read Only | 0 and 1 | |
| Version Number | Read Only | 2 and 3 | |
| Issue Number | Read Only | 4 and 5 | |

- The F-PRO IED model number is 298.
- Version and issue will each be positive integers, say X and Y.
- The F-PRO is defined as “Model, Version X Issue B”

| **Accessing F-PRO Event Information** | |
|---|---|
| *All F-PRO event messages displayed in the Event log are available via Modbus. This includes fault location information. The following controls are available.*<br>***Note: Fault Information is applicable only for FPRO 298 Variant.*** | |
| ***Refresh event list*** | (Function code 6, address 40512): Fetches the latest events from the F-PRO’s event log and makes them available for Modbus access. The most recent event becomes the current event available for reading. |

| Accessing F-PRO Event Information | |
|---|---|
| ***Acknowledge current event and Get next event*** | (Function code 6, address 40513): Clears the 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 40514): Places the next event in the read registers without acknowledging the current event. The current event will appear in the list when ***Refresh event list*** is used |
| ***Size of current event message*** | (Function code 3, address 40515): Indicates the number of 16 bit registers used to contain the current event. Event data is stored with two characters per register. A reading of zero indicates that there are no unacknowledged events available in the current set. (Note: 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, address 40516 to 40568): Contains the current event message. Two ASCII characters are packed into each 16bit register. All unused registers in the set are set to 0. |
| ***Fault Information - Type*** | (Function Code 3, address 40570): If the current event is a fault location event, this register contains the type of fault.<br>The following type bitmap:<br>0x0001 – Phase A<br>0x0002 – Phase B<br>0x0004 – Phase C<br>0x0008 – Ground<br>Any number of the flags may be set for a given fault. If the relay could not determine the fault type, then the register will not have any flags set and will read 0x0000. |
| ***Fault Information – Fault Distance*** | (Function Code 3, address 40571): If the current event is a fault location event, this register contains the distance to the fault. It is scaled up by a factor of 10. The units are the same as the units set in the relay configuration. |
| ***Fault Information – Time of Fault*** | (Function Code 3, addresses 40572 to 40575): If the current event is a fault location event, these registers contain the time of the fault in seconds since 1970. Each of these 16-bit registers contains an 8-bit portion of a 32-bit time value. Register 40572 contains the upper most 8 bits, and register 40575 contains the lowest 8 bits. |

## Sample Event Record

| **Register** | **Value** | | **Meaning** |
|---|---|---|---|
| | ***Low Byte*** | ***High Byte*** | |
| 40515 | 0x00 | 0x1E | Event text size = 30 (0x1E hex) |
| 40516 | 0x46 | 0x4C | ‘FL’ – Fault Location Event |
| 40517 | 0x32 | 0x30 | '2' , '0' |
| 40518 | 0x31 | 0x39 | '1' , '9' |
| 40519 | 0x4E | 0x6F | 'N' , 'o' |
| 40520 | 0x76 | 0x32 | 'v' , '2' |
| 40521 | 0x35 | 0x20 | '5' , '<SP>' |
| 40522 | 0x30 | 0x39 | '0' , '9' |
| 40523 | 0x3A | 0x33 | ':' , '3' |
| 40524 | 0x38 | 0x3A | '8' , ':' |
| 40525 | 0x32 | 0x39 | '2' , '9' |
| 40526 | 0x2E | 0x31 | '.' , '1' |
| 40527 | 0x36 | 0x30 | '6' , '0' |
| 40528 | 0x3A | 0x35 | ':' , '5' |
| 40529 | 0x30 | 0x2F | '0' , '/' |
| 40530 | 0x36 | 0x37 | '6' , '7' |
| 40531 | 0x2D | 0x31 | '-' , '1' |
| 40532 | 0x20 | 0x41 | '<SP>' , 'A' |
| 40533 | 0x20 | 0x50 | '<SP>' , 'P' |
| 40534 | 0x68 | 0x61 | 'h' , 'a' |
| 40535 | 0x73 | 0x65 | 's' , 'e' |
| 40536 | 0x3A | 0x20 | ':' , '<SP>' |
| 40537 | 0x30 | 0x2E | '0' , '.' |
| 40538 | 0x37 | 0x31 | '7' , '1' |
| 40539 | 0x6B | 0x6D | 'k' , 'm' |
| 40540 | 0x20 | 0x4F | '<SP>' , 'O' |
| 40541 | 0x70 | 0x65 | 'p' , 'e' |
| 40542 | 0x72 | 0x61 | 'r' , 'a' |
| 40543 | 0x74 | 0x65 | 't' , 'e' |
| 40544 | 0x64 | 0x00 | 'd' |
| **Fault Information** | | | |
| **Register** | **Value** | | **Meaning** |
| 40570 | 0x00 | 0x01 | Bitmap = 0x0001 - A Fault |
| 40571 | 0x00 | 0x07 | 0x0007 = 7 in decimal 0.7 km Fault Distance |
| 40572 | 0x00 | 0x5D | Upper 8 bits of timestamp * |
| 40573 | 0x00 | 0xDB | Next 8 bits of timestamp * |
| 40574 | 0x00 | 0xA5 | Next 8 bits of timestamp * |
| 40575 | 0x00 | 0x57 | Lowest 8 bits of timestamp * |
| | | | * Seconds since 1970 = 5DDBA557 Converted to readable timestamp: November 25, 2019 09:38:29 |

# 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<br>● Outstation | ○ Master<br>● Outstation | |
| 1.1.2 Vendor Name: | | ERLPhase Power Technologies | |
| 1.1.3 Device Name: | | F-PRO 298 | |
| 1.1.4 Device manufacturer's hardware version string: | | v1.0 | |
| 1.1.5 Device manufacturer's software version string: | | v1.4 | |
| 1.1.6 Device Profile Document Version Number: | | v1.02, Nov 26, 2019 | |
| 1.1.7 DNP Levels Supported for: | Outstations Only<br>Requests and Responses<br>☐ None<br>☐ Level 1<br>☒ Level 2<br>☐ Level 3 | | |
| 1.1.8 Supported Function Blocks: | ☐ Self-Address Reservation<br>☐ Object 0 - attribute objects<br>☐ Data Sets<br>☐ File Transfer<br>☐ Virtual Terminal<br>☐ 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)<br>• 32-bit and 16-bit Analog Inputs with and without flag (variations 1, 2, 3 and 4)<br>• 32-bit and 16-bit Analog Input events with time (variations 3 and 4)<br>• Fault Location information as analog readings<br>• 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<br>☐ XML - Loaded via other transport mechanism<br>☐ Terminal - ASCII Terminal Command Line<br>☒ Software - Vendor software named F-PRO 2000 Offliner<br>☐ Proprietary file loaded via DNP3 file transfer<br>☐ Proprietary file loaded via other transport mechanism<br>☐ Direct - Keypad on device front panel<br>☐ Factory - Specified when device is ordered<br>☐ Protocol - Set via DNP3 (e.g. assign class)<br>☐ Other - explain _________________ | | |
| 1.1.11 DNP3 XML files available On-Line: | RdWrFilenameDescription of Contents<br><br>☐ dnpDP.xml Complete Device Profile<br>☐ dnpDPcap.xml Device Profile Capabilities<br>☐ dnpDPcfg.xml Device Profile config. values<br>☐ ☐ _____*.xml ___________________<br><br>*The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns.<br>*The Device Profile Capabilities contains only the capabilities and configurable methods columns.<br>*The Device Profile Config. Values contains only the Current Value column. | Not supported | |
| 1.1.12 External DNP3 XML files available Off-line: | Rd WrFilenameDescription of Contents<br>☐ ☐ dnpDP.xml Complete Device Profile<br>☐ ☐ dnpDPcap.xml Device Profile Capabilities<br>☐ ☐ dnpDPcfg.xml Device Profile config. values<br>☐ ☐ _______*.xml ___________________<br><br>*The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns.<br>*The Device Profile Capabilities contains only the capabilities and configurable methods columns.<br>*The Device Profile Config. Values contains only the Current Value column. | Not supported | |
| 1.1.13 Connections Supported: | ☒ Serial (complete section 1.2)<br>☒ IP Networking (complete section 1.3)<br>☐ Other, explain ______________________ | | |

| 1.2 Serial Connections | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|
| 1.2.1 Port Name | Port 32 | | |
| 1.2.2 Serial Connection Parameters: | ☐ Asynchronous - 8 Data Bits, 1 Start Bit, 1 Stop Bit, No Parity<br>☒ Other, explain - Asynchronous with selectable parity | Not configured for DNP | F-PRO 2000 Offliner |
| 1.2.3 Baud Rate: | ☐ Fixed at _______<br>☐ Configurable, range _______ to _______<br>☒ Configurable, selectable from 300, 1200, 2400, 9600, 19200, 38400 and 57600<br>☐ Configurable, other, describe_______________ | Not configured for DNP | F-PRO 2000 Offliner |
| 1.2.4 Hardware Flow Control (Handshaking):<br>Describe hardware signaling requirements of the interface.<br>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.<br>Where a signal is asserted prior to transmitting, that signal will be maintained active until after the end of transmission.<br>Where a signal is asserted to enable reception, any data sent to the device when the signal is not active could be discarded. | ☐ None<br>**RS-232 / V.24 / V.28 Options:**<br>Before Tx, Asserts: ☐ RTS ☐ DTR<br>Before Rx, Asserts: ☐ RTS ☐ DTR<br>Always Asserts: ☐ RTS ☐ DTR<br>Before Tx, Requires: Asserted / Deasserted<br>☐ / ☐ CTS<br>☐ / ☐ DCD<br>☐ / ☐ DSR<br>☐ / ☐ RI<br>☐ / ☐ Rx Inactive<br>Before Rx, Requires: Asserted / Deasserted<br>☐ / ☐ CTS<br>☐ / ☐ DCD<br>☐ / ☐ DSR<br>☐ / ☐ RI<br>Always Ignores:<br>☐ CTS<br>☐ DCD<br>☐ DSR<br>☐ RI<br>☐ Other, explain ____________<br>**RS-422 / V.11 Options:**<br>☐ Requires Indication before Rx<br>☐ Asserts Control before Tx<br>☐ Other, explain ____________<br>**RS-485 Options:**<br>☐ Requires Rx inactive before Tx<br>☐ Other, explain ____________ | Not Supported | |
| 1.2.5 Interval to Request Link Status: | ☒ Not Supported<br>☐ Fixed at_________ seconds<br>☐ Configurable, range _____ to ______ seconds<br>☐ Configurable, selectable from __,__,__ seconds<br>☐ Configurable, other, describe______________ | | |
| 1.2.6 Supports DNP3 Collision Avoidance: | ☒ No<br>☐ Yes, explain ______________________ | | |

| 1.2 Serial Connections | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|
| 1.2.7 Receiver Inter-character Timeout: | ☒ Not checked<br>☐ No gap permitted<br>☐ Fixed at _____ bit times<br>☐ Fixed at _____ ms<br>☐ Configurable, range ____ to ____ bit times<br>☐ Configurable, range ____ to ____ ms<br>☐ Configurable, Selectable from __,__,__bit times<br>☐ Configurable, Selectable from ___, ___, ___ ms<br>☐ Configurable, other, describe______________<br>☐ Variable, explain ____ | | |
| 1.2.8 Inter-character gaps in transmission: | ☒ None (always transmits with no inter-character gap)<br>☐ Maximum _____ bit times<br>☐ Maximum _____ ms | | |

| 1.3 IP Networking | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|
| 1.3.1 Port Name | CON 1 Network | | |
| 1.3.2 Type of End Point: | ☐ TCP Initiating (Master Only)<br>☒ TCP Listening (Outstation Only)<br>☐ TCP Dual (required for Masters)<br>☒ UDP Datagram (required) | Not configured for DNP | F-PRO 2000 Offliner |
| 1.3.3 IP Address of this Device: | | 192.168.100.80 | F-PRO 2000 Offliner |
| 1.3.4 Subnet Mask: | | 255.255.255.0 | F-PRO 2000 Offliner |
| 1.3.5 Gateway IP Address: | | 192.168.100.65 | F-PRO 2000 Offliner |
| 1.3.6 Accepts TCP Connections or UDP Datagrams from: | ☒ Allows all (show as *.*.*.* in 1.3.7)<br>☒ Limits based on an IP address<br>☒ Limits based on list of IP addresses<br>☐ Limits based on a wildcard IP address<br>☐ Limits based on list of wildcard IP addresses<br>☐ Other validation, explain_________________ | Limits based on an IP address | F-PRO 2000 Offliner |
| 1.3.7 IP Address(es) from which TCP Connections or UDP Datagrams are accepted: | | 192.168.1.1 | F-PRO 2000 Offliner |
| 1.3.8 TCP Listen Port Number: | ☐ Not Applicable (Master w/o dual end point)<br>☐ Fixed at 20,000<br>☒ Configurable, range 1025 to 32737<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | 20,000 | F-PRO 2000 Offliner |
| 1.3.9 TCP Listen Port Number of remote device: | ☒ Not Applicable (Outstation w/o dual end point)<br>☐ Fixed at 20,000<br>☐ Configurable, range _______ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | NA | F-PRO 2000 Offliner |
| 1.3.10 TCP Keep-alive timer: | ☐ Fixed at ___________ms<br>☒ Configurable, range 5 to 3,600 s<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe______________ | Disabled | F-PRO 2000 Offliner |
| 1.3.11 Local UDP port: | ☐ Fixed at 20,000<br>☒ Configurable, range 1025 to 32737<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________<br>☐ Let system choose (Master only) | 20,000 | F-PRO 2000 Offliner |
| 1.3.12 Destination UDP port for initial unsolicited null responses (UDP only Outstations): | ☒ None<br>☐ Fixed at 20,000<br>☐ Configurable, range _______ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | NA | |

| **1.3 IP Networking** | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| 1.3.13 Destination UDP port for responses: | ☐ None<br>☐ Fixed at 20,000<br>☒ Configurable, range 1025 to 32737<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________<br>☐ Use source port number | 20,000 | F-PRO 2000 Offliner |
| 1.3.14 Multiple master connections (Outstations Only): | ☒ Supports multiple masters (Outstations only)<br>If supported, the following methods may be used:<br>☒ Method 1 (based on IP address) - required<br>☒ Method 2 (based on IP port number) - recommended<br>☒ Method 3 (browsing for static data) - optional | Method 1 (based on IP address) | F-PRO 2000 Offliner |
| 1.3.15 Time synchronization support: | ☐ DNP3 LAN procedure (function code 24)<br>☐ DNP3 Write Time (not recommended over LAN)<br>☐ Other, explain ______________________<br>☒ Not Supported | | |

| 1.4 Link Layer | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|
| 1.4.1 Data Link Address: | ☐ Fixed at______<br>☒ Configurable, range 1 to 65519<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | 1 | F-PRO 2000 Offliner |
| 1.4.2 DNP3 Source Address Validation: | ☒ Never<br>☐ Always, one address allowed (shown in 1.4.3)<br>☐ Always, any one of multiple addresses allowed<br>☐ (each selectable as shown in 1.4.3)<br>☐ Sometimes, explain________________ | | |
| 1.4.3 DNP3 Source Address(es) expected when Validation is Enabled: | ☐ Configurable to any 16 bit DNP Data Link Address value<br>☐ Configurable, range _______ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | NA | |
| 1.4.4 Self Address Support using address 0xFFFC: | ☐ Yes (only allowed if configurable)<br>☒ No | NA | |
| 1.4.5 Sends Confirmed User Data Frames: | ☐ Always<br>☐ Sometimes, explain ____________________<br>☐ Never<br>☒ Configurable, either always or never | | F-PRO 2000 Offliner (to disable, set Data Link Time-out to 0) |
| 1.4.6 Data Link Layer Confirmation Timeout: | ☐ None<br>☐ Fixed at __ ms<br>☒ Configurable, range 0 to 2,000 ms<br>☐ Configurable, selectable from____________ms<br>☐ Configurable, other, describe______________<br>☐ Variable, explain _______________________ | 500 | F-PRO 2000 Offliner |
| 1.4.7 Maximum Data Link Retries: | ☐ Never Retries<br>☒ Fixed at 3<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | 3 | |
| 1.4.8 Maximum number of octets Transmitted in a Data Link Frame: | ☒ Fixed at 292<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | 292 | |
| 1.4.9 Maximum number of octets that can be Received in a Data Link Frame: | ☒ Fixed at 292<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ 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<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | 2048 | |
| 1.5.2 | Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer: | ☐ Fixed at ___________<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | NA | |
| 1.5.3 | Maximum number of octets that can be Received in an Application Layer Fragment: | ☒ Fixed at 2048<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________ | 2048 | |
| 1.5.4 | Timeout waiting for Complete Application Layer Fragment: | ☐ None<br>☒ Fixed at 2,000 ms<br>☐ Configurable, range _______ to _______ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe______________<br>☐ 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<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________<br>☐ Variable, explain _______________________ | 16 | |
| 1.5.6 | Maximum number of objects allowed in a single control request for Analog Outputs (group 41): | ☐ Fixed at _<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________<br>☐ 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 __<br>☐ Configurable, range ________ to _______<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe______________<br>☐ 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<br>☐ Yes<br>☒ 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<br>☒ Fixed at 5,000 ms<br>☐ Configurable, range _______ to _______ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe______________<br>☐ Variable, explain _______________________ | 5,000 ms | |
| 1.6.2 How often is time synchronization required from the master? | ☒ Never needs time<br>☐ Within ______ seconds after IIN1.4 is set<br>☐ Periodically every _______ seconds | | |
| 1.6.3 Device Trouble Bit IIN1.6: | ☐ Never used<br>☒ Reason for setting: Unable to access requested data or execute CROB, assuming a valid request has been received | | |
| 1.6.4 File Handle Timeout: | ☒ Not applicable, files not supported<br>☐ Fixed at______ ms<br>☐ Configurable, range _______ to _______ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe______________<br>☐ Variable, explain _______________________ | | |
| 1.6.5 Event Buffer Overflow Behaviour: | ☐ Discard the oldest event<br>☒ Discard the newest event<br>☐ Other, explain _________________________ | | |
| 1.6.6 Event Buffer Organization: | • Single buffer for the Object Groups 2 and 32, size 200.<br>• Separate buffer for the Object Group 111, size 100.<br>• Separate buffer for the Fault Locator events, size 100. | | |
| 1.6.7 Sends Multi-Fragment Responses: | ☒ Yes<br>☐ No | | |
| 1.6.8 DNP Command Settings preserved through a device reset: | ☐ Assign Class<br>☐ Analog Deadbands<br>☐ Data Set Prototypes<br>☐ 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<br>☐ 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<br>☐ Asserted at startup until first Time Synchronization request received<br>☐ Periodically, range ____to____ seconds<br>☐ Periodically, selectable from ____,____,___ seconds<br>☐ Range ____to____ seconds after last time sync<br>☐ Selectable from___,___,___seconds after last time sync<br>☐ When time error may have drifted by range ____to____ ms<br>☐ 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): | | 300 ms - TCP mode (for the case all supported points mapped to the DNP point lists) | F-PRO 2000 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): | | • 0.5208 ms for 60Hz systems<br>• 0.6250 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): | | • 0.5208 ms for 60Hz systems<br>• 0.6250 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**<br>Static (Steady-State) Group Number: 1<br>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<br>☐ Variation 2 - Single-bit with flag<br>☐ Based on point Index (add column to table below) | | |
| 2.1.2 Event Variation reported when variation 0 requested: | ☐ Variation 1 - without time<br>☒ Variation 2 - with absolute time<br>☐ Variation 3 - with relative time<br>☐ Based on point Index (add column to table below) | | |
| 2.1.3 Event reporting mode: | ☐ Only most recent<br>☒ All events | | |
| 2.1.4 Binary Inputs included in Class 0 response: | ☒ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | | F-PRO 2000 Offliner |
| 2.1.5 Definition of Binary Input Point List: | ☐ Fixed, list shown in table below<br>☒ Configurable<br>☐ Other, explain______________________ | Complete list is shown in the table below; points excluded from the default configuration are marked with '*' | F-PRO 2000 Offliner |

| | |
|---|---|
| **Notes** | 1. Binary Inputs are scanned with 1 ms resolution.<br><br>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 2000 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 | External Input 1 | 1 | Inactive | Active | |
| 1 | External Input 2 | 1 | Inactive | Active | |
| 2 | External Input 3 | 1 | Inactive | Active | |
| 3 | External Input 4 | 1 | Inactive | Active | |
| 4 | External Input 5 | 1 | Inactive | Active | |
| 5 | External Input 6 | 1 | Inactive | Active | |
| 6 | External Input 7 | 1 | Inactive | Active | |
| 7 | External Input 8 | 1 | Inactive | Active | |
| 8 | External Input 9 | 1 | Inactive | Active | |
| 9 | External Input 10 | 1 | Inactive | Active | |
| 10 | External Input 11 | 1 | Inactive | Active | |
| 11 | External Input 12 | 1 | Inactive | Active | |
| 12 | External Input 13 | 1 | Inactive | Active | |
| 13 | External Input 14 | 1 | Inactive | Active | |
| 14 | Virtual Input 1 | 1 | Inactive | Active | |
| 15 | Virtual Input 2 | 1 | Inactive | Active | |
| 16 | Virtual Input 3 | 1 | Inactive | Active | |
| 17 | Virtual Input 4 | 1 | Inactive | Active | |
| 18 | Virtual Input 5 | 1 | Inactive | Active | |
| 19 | Virtual Input 6 | 1 | Inactive | Active | |
| 20 | Virtual Input 7 | 1 | Inactive | Active | |
| 21 | Virtual Input 8 | 1 | Inactive | Active | |
| 22 | Virtual Input 9 | 1 | Inactive | Active | |
| 23 | Virtual Input 10 | 1 | Inactive | Active | |
| 24 | Virtual Input 11 | 1 | Inactive | Active | |
| 25 | Virtual Input 12 | 1 | Inactive | Active | |
| 26 | Virtual Input 13 | 1 | Inactive | Active | |
| 27 | Virtual Input 14 | 1 | Inactive | Active | |
| 28 | Virtual Input 15 | 1 | Inactive | Active | |
| 29 | Virtual Input 16 | 1 | Inactive | Active | |
| 30 | Virtual Input 17 | 1 | Inactive | Active | |
| 31 | Virtual Input 18 | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| 32 | Virtual Input 19 | 1 | Inactive | Active | |
| 33 | Virtual Input 20 | 1 | Inactive | Active | |
| 34 | Virtual Input 21 | 1 | Inactive | Active | |
| 35 | Virtual Input 22 | 1 | Inactive | Active | |
| 36 | Virtual Input 23 | 1 | Inactive | Active | |
| 37 | Virtual Input 24 | 1 | Inactive | Active | |
| 38 | Virtual Input 25 | 1 | Inactive | Active | |
| 39 | Virtual Input 26 | 1 | Inactive | Active | |
| 40 | Virtual Input 27 | 1 | Inactive | Active | |
| 41 | Virtual Input 28 | 1 | Inactive | Active | |
| 42 | Virtual Input 29 | 1 | Inactive | Active | |
| 43 | Virtual Input 30 | 1 | Inactive | Active | |
| 44 | ProLogic 1 | 1 | Inactive | Active | |
| 45 | ProLogic 2 | 1 | Inactive | Active | |
| 46 | ProLogic 3 | 1 | Inactive | Active | |
| 47 | ProLogic 4 | 1 | Inactive | Active | |
| 48 | ProLogic 5 | 1 | Inactive | Active | |
| 49 | ProLogic 6 | 1 | Inactive | Active | |
| 50 | ProLogic 7 | 1 | Inactive | Active | |
| 51 | ProLogic 8 | 1 | Inactive | Active | |
| 52 | ProLogic 9 | 1 | Inactive | Active | |
| 53 | ProLogic 10 | 1 | Inactive | Active | |
| 54 | ProLogic 11 | 1 | Inactive | Active | |
| 55 | ProLogic 12 | 1 | Inactive | Active | |
| 56 | ProLogic 13 | 1 | Inactive | Active | |
| 57 | ProLogic 14 | 1 | Inactive | Active | |
| 58 | ProLogic 15 | 1 | Inactive | Active | |
| 59 | ProLogic 16 | 1 | Inactive | Active | |
| 60 | ProLogic 17 | 1 | Inactive | Active | |
| 61 | ProLogic 18 | 1 | Inactive | Active | |
| 62 | ProLogic 19 | 1 | Inactive | Active | |
| 63 | ProLogic 20 | 1 | Inactive | Active | |
| 64 | 27DT-1 Operated | 1 | Inactive | Active | |
| 65 | Fault Information Available | 1 | Inactive | Active | |
| 66 | 27DT-1 Operated A | 1 | Inactive | Active | |
| 67 | 27DT-1 Operated B | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| 68 | 27DT-1 Operated C | 1 | Inactive | Active | |
| 69 | 27DT-2 Operated | 1 | Inactive | Active | |
| 70 | 27DT-2 Operated A | 1 | Inactive | Active | |
| 71 | 27DT-2 Operated B | 1 | Inactive | Active | |
| 72 | 27DT-2 Operated C | 1 | Inactive | Active | |
| 73 | 27DT-3 Operated | 1 | Inactive | Active | |
| 74 | 27DT-3 Operated A | 1 | Inactive | Active | |
| 75 | 27DT-3 Operated B | 1 | Inactive | Active | |
| 76 | 27DT-3 Operated C | 1 | Inactive | Active | |
| 77 | 27DT-4 Operated | 1 | Inactive | Active | |
| 78 | 27DT-4 Operated A | 1 | Inactive | Active | |
| 79 | 27DT-4 Operated B | 1 | Inactive | Active | |
| 80 | 27DT-4 Operated C | 1 | Inactive | Active | |
| 81 | 27DT-5 Operated | 1 | Inactive | Active | |
| 82 | 27DT-5 Operated A | 1 | Inactive | Active | |
| 83 | 27DT-5 Operated B | 1 | Inactive | Active | |
| 84 | 27DT-5 Operated C | 1 | Inactive | Active | |
| 85 | 27DT-6 Operated | 1 | Inactive | Active | |
| 86 | 27DT-6 Operated A | 1 | Inactive | Active | |
| 87 | 27DT-6 Operated B | 1 | Inactive | Active | |
| 88 | 27DT-6 Operated C | 1 | Inactive | Active | |
| 89 | 27IT-1 Operated | 1 | Inactive | Active | |
| 90 | 27IT-1 Operated A | 1 | Inactive | Active | |
| 91 | 27IT-1 Operated B | 1 | Inactive | Active | |
| 92 | 27IT-1 Operated C | 1 | Inactive | Active | |
| 93 | 27IT-2 Operated | 1 | Inactive | Active | |
| 94 | 27IT-2 Operated A | 1 | Inactive | Active | |
| 95 | 27IT-2 Operated B | 1 | Inactive | Active | |
| 96 | 27IT-2 Operated C | 1 | Inactive | Active | |
| 97 | 59DT-1 Operated | 1 | Inactive | Active | |
| 98 | 59DT-1 Operated A | 1 | Inactive | Active | |
| 99 | 59DT-1 Operated B | 1 | Inactive | Active | |
| 100 | 59DT-1 Operated C | 1 | Inactive | Active | |
| 101 | 59DT-2 Operated | 1 | Inactive | Active | |
| 102 | 59DT-2 Operated A | 1 | Inactive | Active | |
| 103 | 59DT-2 Operated B | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| 104 | 59DT-2 Operated C | 1 | Inactive | Active | |
| 105 | 59DT-3 Operated | 1 | Inactive | Active | |
| 106 | 59DT-3 Operated A | 1 | Inactive | Active | |
| 107 | 59DT-3 Operated B | 1 | Inactive | Active | |
| 108 | 59DT-3 Operated C | 1 | Inactive | Active | |
| 109 | 59DT-4 Operated | 1 | Inactive | Active | |
| 110 | 59DT-4 Operated A | 1 | Inactive | Active | |
| 111 | 59DT-4 Operated B | 1 | Inactive | Active | |
| 112 | 59DT-4 Operated C | 1 | Inactive | Active | |
| 113 | 59DT-5 Operated | 1 | Inactive | Active | |
| 114 | 59DT-5 Operated A | 1 | Inactive | Active | |
| 115 | 59DT-5 Operated B | 1 | Inactive | Active | |
| 116 | 59DT-5 Operated C | 1 | Inactive | Active | |
| 117 | 59DT-6 Operated | 1 | Inactive | Active | |
| 118 | 59DT-6 Operated A | 1 | Inactive | Active | |
| 119 | 59DT-6 Operated B | 1 | Inactive | Active | |
| 120 | 59DT-6 Operated C | 1 | Inactive | Active | |
| 121 | 59IT-1 Operated | 1 | Inactive | Active | |
| 122 | 59IT-1 Operated A | 1 | Inactive | Active | |
| 123 | 59IT-1 Operated B | 1 | Inactive | Active | |
| 124 | 59IT-1 Operated C | 1 | Inactive | Active | |
| 125 | 59IT-2 Operated | 1 | Inactive | Active | |
| 126 | 59IT-2 Operated A | 1 | Inactive | Active | |
| 127 | 59IT-2 Operated B | 1 | Inactive | Active | |
| 128 | 59IT-2 Operated C | 1 | Inactive | Active | |
| 129 | 24DT-1 Operated | 1 | Inactive | Active | |
| 130 | 24DT-2 Operated | 1 | Inactive | Active | |
| 131 | 24IT Operated | 1 | Inactive | Active | |
| 132 | 47DT-1 Operated | 1 | Inactive | Active | |
| 133 | 47DT-2 Operated | 1 | Inactive | Active | |
| 134 | 47IT Operated | 1 | Inactive | Active | |
| 135 | 59NDT-1 Operated | 1 | Inactive | Active | |
| 136 | 59NDT-2 Operated | 1 | Inactive | Active | |
| 137 | 59NIT Operated | 1 | Inactive | Active | |
| 138 | 37-1 Operated | 1 | Inactive | Active | |
| 139 | 37-1 Operated A | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| 140 | 37-1 Operated B | 1 | Inactive | Active | |
| 141 | 37-1 Operated C | 1 | Inactive | Active | |
| 142 | 37-2 Operated | 1 | Inactive | Active | |
| 143 | 37-2 Operated A | 1 | Inactive | Active | |
| 144 | 37-2 Operated B | 1 | Inactive | Active | |
| 145 | 37-2 Operated C | 1 | Inactive | Active | |
| 146 | 50/67-1 Operated | 1 | Inactive | Active | |
| 147 | 50/67-1 Operated A | 1 | Inactive | Active | |
| 148 | 50/67-1 Operated B | 1 | Inactive | Active | |
| 149 | 50/67-1 Operated C | 1 | Inactive | Active | |
| 150 | 50/67-2 Operated | 1 | Inactive | Active | |
| 151 | 50/67-2 Operated A | 1 | Inactive | Active | |
| 152 | 50/67-2 Operated B | 1 | Inactive | Active | |
| 153 | 50/67-2 Operated C | 1 | Inactive | Active | |
| 154 | 51/67-1 Operated | 1 | Inactive | Active | |
| 155 | 51/67-1 Operated A | 1 | Inactive | Active | |
| 156 | 51/67-1 Operated B | 1 | Inactive | Active | |
| 157 | 51/67-1 Operated C | 1 | Inactive | Active | |
| 158 | 51/67-2 Operated | 1 | Inactive | Active | |
| 159 | 51/67-2 Operated A | 1 | Inactive | Active | |
| 160 | 51/67-2 Operated B | 1 | Inactive | Active | |
| 161 | 51/67-2 Operated C | 1 | Inactive | Active | |
| 162 | 50N/67N-1 Operated | 1 | Inactive | Active | |
| 163 | 50N/67N-2 Operated | 1 | Inactive | Active | |
| 164 | 51N/67N-1 Operated | 1 | Inactive | Active | |
| 165 | 51N/67N-2 Operated | 1 | Inactive | Active | |
| 166 | 46/50 Operated | 1 | Inactive | Active | |
| 167 | 46/51 Operated | 1 | Inactive | Active | |
| 168 | 64/50SEF-1 Operated | 1 | Inactive | Active | |
| 169 | 64/50SEF-2 Operated | 1 | Inactive | Active | |
| 170 | 64/51SEF-1 Operated | 1 | Inactive | Active | |
| 171 | 64/51SEF-2 Operated | 1 | Inactive | Active | |
| 172 | 49 Operated | 1 | Inactive | Active | |
| 173 | 49 Alarm Operated | 1 | Inactive | Active | |
| 174 | 50BF-D1 Operated | 1 | Inactive | Active | |
| 175 | 50BF-D2 Operated | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| 176 | DICBF-D1 Operated | 1 | Inactive | Active | |
| 177 | DICBF-D2 Operated | 1 | Inactive | Active | |
| 178 | 46BC Operated | 1 | Inactive | Active | |
| 179 | 81HBL2 Operated | 1 | Inactive | Active | |
| 180 | 81U-1 Operated | 1 | Inactive | Active | |
| 181 | 81U-2 Operated | 1 | Inactive | Active | |
| 182 | 81U-3 Operated | 1 | Inactive | Active | |
| 183 | 81U-4 Operated | 1 | Inactive | Active | |
| 184 | 81U-5 Operated | 1 | Inactive | Active | |
| 185 | 81U-6 Operated | 1 | Inactive | Active | |
| 186 | 81U-7 Operated | 1 | Inactive | Active | |
| 187 | 81U-8 Operated | 1 | Inactive | Active | |
| 188 | 81O-1 Operated | 1 | Inactive | Active | |
| 189 | 81O-2 Operated | 1 | Inactive | Active | |
| 190 | 81O-3 Operated | 1 | Inactive | Active | |
| 191 | 81O-4 Operated | 1 | Inactive | Active | |
| 192 | 81O-5 Operated | 1 | Inactive | Active | |
| 193 | 81O-6 Operated | 1 | Inactive | Active | |
| 194 | 81O-7 Operated | 1 | Inactive | Active | |
| 195 | 81O-8 Operated | 1 | Inactive | Active | |
| 196 | 81R-1 Operated | 1 | Inactive | Active | |
| 197 | 81R-2 Operated | 1 | Inactive | Active | |
| 198 | 81R-3 Operated | 1 | Inactive | Active | |
| 199 | 81R-4 Operated | 1 | Inactive | Active | |
| 200 | 32-1 Operated | 1 | Inactive | Active | |
| 201 | 32-1 Operated A | 1 | Inactive | Active | |
| 202 | 32-1 Operated B | 1 | Inactive | Active | |
| 203 | 32-1 Operated C | 1 | Inactive | Active | |
| 204 | 32-2 Operated | 1 | Inactive | Active | |
| 205 | 32-2 Operated A | 1 | Inactive | Active | |
| 206 | 32-2 Operated B | 1 | Inactive | Active | |
| 207 | 32-2 Operated C | 1 | Inactive | Active | |
| 208 | 32-3 Operated | 1 | Inactive | Active | |
| 209 | 32-3 Operated A | 1 | Inactive | Active | |
| 210 | 32-3 Operated B | 1 | Inactive | Active | |
| 211 | 32-3 Operated C | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| 212 | 32-4 Operated | 1 | Inactive | Active | |
| 213 | 32-4 Operated A | 1 | Inactive | Active | |
| 214 | 32-4 Operated B | 1 | Inactive | Active | |
| 215 | 32-4 Operated C | 1 | Inactive | Active | |
| 216 | 60VTS Operated | 1 | Inactive | Active | |
| 217 | 60CTS Operated | 1 | Inactive | Active | |
| 218 | 74TCS-1 Operated | 1 | Inactive | Active | |
| 219 | 74TCS-2 Operated | 1 | Inactive | Active | |
| 220 | I2T Limit Operated | 1 | Inactive | Active | |
| 221 | THD-1 Operated | 1 | Inactive | Active | |
| 222 | THD-2 Operated | 1 | Inactive | Active | |
| 223 | UV Counter Operated | 1 | Inactive | Active | |
| 224 | OV Counter Operated | 1 | Inactive | Active | |
| 225 | UF Counter Operated | 1 | Inactive | Active | |
| 226 | OF Counter Operated | 1 | Inactive | Active | |
| 227 | EI Counter Operated | 1 | Inactive | Active | |
| 228 | 79AR_Cumm_Count_ | | | | |
| 229 | 25/27/59 Operated | 1 | Inactive | Active | |
| 230 | 79 Initiate | 1 | Inactive | Active | |
| 231 | 79 Reclose | 1 | Inactive | Active | |
| 232 | 79 Lockout | 1 | Inactive | Active | |
| 233 | 79 Block | 1 | Inactive | Active | |
| 234 | Output Contact 1 | 1 | Open | Closed | |
| 235 | Output Contact 2 | 1 | Open | Closed | |
| 236 | Output Contact 3 | 1 | Open | Closed | |
| 237 | Output Contact 4 | 1 | Open | Closed | |
| 238 | Output Contact 5 | 1 | Open | Closed | |
| 239 | Output Contact 6 | 1 | Open | Closed | |
| 240 | Output Contact 7 | 1 | Open | Closed | |
| 241 | Output Contact 8 | 1 | Open | Closed | |
| 242 | Output Contact 9 | 1 | Open | Closed | |
| 243 | Output Contact 10 | 1 | Open | Closed | |
| 244 | Output Contact 11 | 1 | Open | Closed | |
| 245 | Output Contact 12 | 1 | Open | Closed | |
| 246 | Output Contact 13 | 1 | Open | Closed | |
| 247 | Output Contact 14 | 1 | Open | Closed | |

| **2.2 Binary Output Status And Control Relay Output Block**<br>Binary Output Status Group Number: 10<br>Binary Output Event Group Number: 11<br>CROB Group Number: 12<br>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)<br>☐ 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)<br>☐ Based on point Index (add column to table below) | | |
| 2.2.3 Binary Output Status included in Class 0 response: | ☒ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | | |
| 2.2.4 Reports Output Command Event Objects: | ☒ Never<br>☐ Only upon a successful Control<br>☐ Upon all control attempts | Not supported | |
| 2.2.5 Event Variation reported when variation 0 requested: | ☐ Variation 1 - without time<br>☐ Variation 2 - with absolute time<br>☐ Based on point Index (add column to table below) | Not supported | F-PRO 2000 Offliner (See Note 2 below) |
| 2.2.6 Command Event Variation reported when variation 0 requested: | ☐ Variation 1 - without time<br>☐ Variation 2 - with absolute time<br>☐ Based on point Index (add column to table below) | Not supported | F-PRO 2000 Offliner (See Note 2 below) |
| 2.2.7 Event reporting mode: | ☐ Only most recent<br>☐ All events | Not supported | F-PRO 2000 Offliner (See Note 2 below) |
| 2.2.8 Command Event reporting mode: | ☐ Only most recent<br>☐ All events | Not supported | |
| 2.2.9 Maximum Time between Select and Operate: | ☐ Not Applicable<br>☒ Fixed at 10 seconds<br>☐ Configurable, range ______ to ______ seconds<br>☐ Configurable, selectable from___,___,___seconds<br>☐ Configurable, other, describe______________<br>☐ Variable, explain _______________________<br>☐ 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<br>☒ Configurable<br>☐ Other, explain_____________________ | Complete list is shown in the table below; points excluded from the default configuration are marked with '*' | F-PRO 2000 Offliner |

| | |
|---|---|
| **NOTES** | 1. Binary Outputs are scanned with 500 ms resolution.<br><br>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 2000 Offliner/DNP Configuration/Point Map screen for complete point lists and configuration options.<br><br>3. Virtual Inputs (default Binary Output points 94-123) can be used to control relay output contacts. See F-PRO 2000 Offliner/Setting Group X/Output Matrix screen for configuration options.<br><br>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 2000 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 Ack | Pulse On / NUL | Pulse Off | Latch On / NUL | Latch Off / NUL | Trip | Close | Count > 1 | Cancel Currently Running Operation | | | Change | Command | |
| 0 | Output contact 1 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 1 | Output contact 2 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 2 | Output contact 3 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 3 | Output contact 4 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 4 | Output contact 5 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 5 | Output contact 6 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 6 | Output contact 7 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 7 | Output contact 8 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 8 | Output contact 9 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 9 | Output contact 10 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 10 | Output contact 11 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 11 | Output contact 12 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 12 | Output contact 13 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 13 | Output contact 14 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 14 | Get Next Fault Events | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inavtive | Active | None | None | Pulse duration fixed at 1 s |
| 15 | Virtual Input 1 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 16 | Virtual Input 2 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 17 | Virtual Input 3 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 18 | Virtual Input 4 | 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 Ack | Pulse On / NUL | Pulse Off | Latch On / NUL | Latch Off / NUL | Trip | Close | Count > 1 | Cancel Currently Running Operation | | | Change | Command | |
| 19 | Virtual Input 5 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 20 | Virtual Input 6 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 21 | Virtual Input 7 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 22 | Virtual Input 8 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 23 | Virtual Input 9 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 24 | Virtual Input 10 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 25 | Virtual Input 11 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 26 | Virtual Input 12 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 27 | Virtual Input 13 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 28 | Virtual Input 14 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 29 | Virtual Input 15 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 30 | Virtual Input 16 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 31 | Virtual Input 17 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 32 | Virtual Input 18 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 33 | Virtual Input 19 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 34 | Virtual Input 20 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 35 | Virtual Input 21 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 36 | Virtual Input 22 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 37 | Virtual Input 23 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 38 | Virtual Input 24 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 39 | Virtual Input 25 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 40 | Virtual Input 26 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 41 | Virtual Input 27 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 42 | Virtual Input 28 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 43 | Virtual Input 29 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 44 | Virtual Input 30 | Y | Y | Y | Y | - | Y | - | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |

| **2.3 Analog Input Points**<br>Static (Steady-State) Group Number: 30<br>Event Group Number: 32 | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| 2.3.1 Static Variation reported when variation 0 requested: | ☐ Variation 1 - 32-bit with flag<br>☐ Variation 2 - 16-bit with flag<br>☒ Variation 3 - 32-bit without flag<br>☒ Variation 4 - 16-bit without flag<br>☐ Variation 5 - single-precision floating point with flag<br>☐ Variation 6 - double-precision floating point with flag<br>☐ Based on point Index (add column to table below) | | |
| 2.3.2 Event Variation reported when variation 0 requested: | ☒ Variation 1 - 32-bit without time<br>☒ Variation 2 - 16-bit without time<br>☐ Variation 3 - 32-bit with time<br>☐ Variation 4 - 16-bit with time<br>☐ Variation 5 - single-precision floating point w/o time<br>☐ Variation 6 - double-precision floating point w/o time<br>☐ Variation 7 - single-precision floating point with time<br>☐ Variation 8 - double-precision floating point with time<br>☐ Based on point Index (add column to table below) | | |
| 2.3.3 Event reporting mode: | ☐ Only most recent<br>☒ All events | | |
| 2.3.4 Analog Inputs Included in Class 0 response: | ☒ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | | |
| 2.3.5 How Deadbands are set: | ☐ A. Global Fixed<br>☐ B. Configurable through DNP<br>☒ C. Configurable via other means<br>☐ D. Other, explain ________________________<br>☐ Based on point Index - column specifies which of the options applies, B, C, or D | | F-PRO 2000 Offliner |
| 2.3.6 Analog Deadband Algorithm:<br>simple - just compares the difference from the previous reported value | ☒ Simple<br>☐ Integrating<br>☐ Other, explain __________________________ | | |
| 2.3.7 Definition of Analog Input Point List: | ☐ Fixed, list shown in table below<br>☒ Configurable<br>☐ Other, explain_____________________ | Complete list is shown in the table below; points excluded from the default configuration are marked with '*' | F-PRO 2000 Offliner |

| | |
|---|---|
| **NOTES** | 1. Analog Inputs are scanned with 500 ms resolution.<br><br>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 installed in the F-PRO.<br><br>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 2000 Offliner software (see SCADA Setting Summary).<br><br>4. When a fault location event is available, Binary Input Fault Information Available (default point index 39) 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 44, 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.<br><br>Not all fault location events are reported trough 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.<br><br>The following bitmap id used for the fault information Type points:<br><br>0x0001 Phase A<br>0x0002 Phase B<br>0x0004 Phase C<br>0x0008 Ground |

| Point Index | Name | Default Class Assigned to Events (1, 2, 3 or none) | Transmitted Value[a] | | Scaling[b] | | Units | Resolution[c] (default/ maximal) | Description |
|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum[d] | Multiplier (default/ (range)) | Offset | | | |
| 0 | Va Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 1 | Va Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 - 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 2 | Vb Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 3 | Vb Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 4 | Vc Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 5 | Vc Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 6 | VN Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 7 | VN Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 8 | Vab Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 9 | Vab Angle | 2 | -18,000 | 18,000 | 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] | | Units | Resolution[c] (default/ maximal) | Description |
|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum[d] | Multiplier (default/ (range)) | Offset | | | |
| 10 | Vbc Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 11 | Vbc Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 12 | Vca Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 13 | Vca Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 14 | Vsync Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 15 | Vsync Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 16 | V1 Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 17 | V2 Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 18 | V0 Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.1 / 0.00001 | |
| 19 | V/F | 2 | 0 | Configurable | 0.01 / (0.0001- 1.0) | 0.0 | pu | | |
| 20 | %THD Voltage | 2 | 0 | 10,000 | 0.1 / (0.01- 1.0) | 0.0 | % | | |
| 21 | Ia Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 22 | Ia Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 23 | Ib Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 24 | Ib Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 25 | Ic Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 26 | Ic Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 27 | In Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 28 | In Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 29 | Isef Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 30 | Isef Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | Degrees | 0.1 / 0.01 | |
| 31 | I1 Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 32 | I2 Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 33 | I0 Magnitude | 2 | 0 | Configurable | 0.01 / (0.000001 – 10.0) | 0.0 | A | 1.0 / 0.01 | |
| 34 | %I2/I1 | 2 | 0 | Configurable | 0.1 / (0.01 – 1.0) | 0.0 | % | 0.1 / 0.01 | |
| 35 | P | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | MW | 0.1 / 0.00001 | |
| 36 | Q | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | Mvar | 0.1 / 0.00001 | |
| 37 | Pa | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | MW | 0.1 / 0.00001 | |
| 38 | Pb | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | MW | 0.1 / 0.00001 | |
| 39 | Pc | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | MW | 0.1 / 0.00001 | |
| 40 | Qa | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | Mvar | 0.1 / 0.00001 | |
| 41 | Qb | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | Mvar | 0.1 / 0.00001 | |
| 42 | Qc | 2 | 0 | Configurable | 0.001 / (0.000001 – 1.0) | 0.0 | Mvar | 0.1 / 0.00001 | |
| 43 | Frequency | 2 | 0 | Max F x 100 | 0.01 / (0.01 – 1.0) | 0.0 | Hz | 0.01 / 0.01 | |
| 44 | Power Factor | 2 | 0 | 1,000 | 0.01 / (0.001 – 0.1) | 0.0 | N/A | 0.01 / 0.001 | |
| 45 | Thermal State | 2 | 0 | 10,000 | 0.1 / (0.01 – 1.0) | 0.0 | % | 0.1 / 0.01 | |
| 46 | I2t Accumulated | 2 | 0 | Configurable | 1.0 / (0.1 – 10.0) | 0.0 | kA^2s | 1.0 / 0.1 | |
| 47 | I2t for Last Operation | 2 | 0 | Configurable | 1.0 / (0.1 – 10.0) | 0.0 | kA^2s | 1.0 / 0.1 | |
| 48 | Bus Voltage | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.01 / 0.000001 | |
| 49 | Line Voltage | 2 | 0 | Configurable | 0.01 / (0.000001- 1.0) | 0.0 | kV | 0.01 / 0.000001 | |
| 50 | Bus Phase Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | |
| 51 | Line Phase Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | |
| 52 | Bus Frequency | 2 | 0 | Max F x 100 | 0.01 / (0.01 – 1.0) | 0.0 | Hz | 0.01 / 0.01 | |
| 53 | Line Frequency | 2 | 0 | Max F x 100 | 0.01 / (0.01 – 1.0) | 0.0 | Hz | 0.01 / 0.01 | |
| 54 | 79AR_Count | 2 | 0 | Configurable | 1/1 | 0.0 | N/A | 1/1 | |
| 55 | 79AR_Cum-m_Count | 2 | 0 | Configurable | 1/1 | 0.0 | N/A | 1/1 | |

| Point Index | Name | Default Class Assigned to Events (1, 2, 3 or none) | Transmitted Value[a] | | Scaling[b] | | Units | Resolution[c] (default/ maximal) | Description |
|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum[d] | Multiplier (default/ (range)) | Offset | | | |
| 56 | Fault Information – DNP Time (High 16 bits) | 2 | 0 | 65535 | 1.0/1.0 | 0.0 | N/A | 1.0/1.0 | |
| 57 | Fault Information – DNP Time (Middle 16 bits) | 2 | 0 | 65535 | 1.0/1.0 | 0.0 | N/A | 1.0/1.0 | |
| 58 | Fault Information – DNP Time (Low 16 bits) | 2 | 0 | 65535 | 1.0/1.0 | 0.0 | N/A | 1.0/1.0 | |
| 59 | Fault Information - Fault Distance | 2 | 0 | Configurable | 0.1/0.1 | 0.0 | Configur-able (km or miles) | 0.1/0.1 | |
| 60 | Fault Information - Type | 2 | 0 | 15 | 1.0/1.0 | 0.0 | N/A | 1/1 | |

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.

d. 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).

| **2.4 Octet String Points**<br>Static (Steady-State) Group Number: 110<br>Event Group Number: 111 | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| 2.4.1 Event reporting mode *: | ☐ Only most recent<br>☐ All events | Not supported | |
| 2.4.2 Octet Strings Included in Class 0 response: | ☐ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | Not supported | |
| 2.4.3 Definition of Octet String Point List: | ☐ Fixed, list shown in table below<br>☐ Configurable (current list may be shown in table below)<br>☒ Other, explain Used for Event Log access as described below | | |

* 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 fault distance event returned through either of the octet string objects:

Event Message:

| FL2019Nov26 12:35:30.267: 50/67-1 A Phase: 4.16 km Operated |
|---|

| **DNP Octet string object components:** | | | | | |
|---|---|---|---|---|---|
| 0x46 | 0x4c | 0x32 | 0x30 | 0x31 | 0x39 |
| 0x4e | 0x6f | 0x76 | 0x32 | 0x36 | 0x20 |
| 0x31 | 0x32 | 0x3a | 0x33 | 0x35 | 0x3a |
| 0x33 | 0x30 | 0x2e | 0x32 | 0x36 | 0x37 |
| 0x20 | 0x3a | 0x20 | 0x35 | 0x30 | 0x2f |
| 0x36 | 0x37 | 0x2d | 0x31 | 0x20 | 0x41 |
| 0x20 | 0x50 | 0x68 | 0x61 | 0x73 | 0x65 |
| 0x3a | 0x20 | 0x34 | 0x2E | 0x31 | 0x36 |
| 0x20 | 0x6b | 0x6d | 0x20 | 0x4f | 0x70 |
| 0x65 | 0x72 | 0x61 | 0x74 | 0x65 | 0x64 |

## 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.

| NOTE | 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 ~~strikethrough~~ (note these Object Groups will still be parsed). |
|---|---|

| 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) |
| 1 | 0 | Binary Input - Any Variation | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 1 | 1 | Binary Input - Packed format | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 1 | 2 | Binary Input - With flags | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 2 | 0 | Binary Input Event - Any Variation | 1 (read) | 06 (no range, or all)<br>07, 08 (limited qty) | 129 (response) | 17, 28 (index) |
| 2 | 1 | Binary Input Event - Without time | 1 (read) | 06 (no range, or all)<br>07, 08 (limited qty) | 129 (response)<br>~~130 (unsol. resp)~~ | 17, 28 (index) |
| 2 | 2 | Binary Input Event - With absolute time | 1 (read) | 06 (no range, or all)<br>07, 08 (limited qty) | 129 (response)<br>~~130 (unsol. resp)~~ | 17, 28 (index) |
| 2 | 3 | Binary Input Event - With relative time | 1 (read) | 06 (no range, or all)<br>07, 08 (limited qty) | 129 (response)<br>~~130 (unsol. resp)~~ | 17, 28 (index) |
| 10 | 0 | Binary Output - Any Variation | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 10 | 2 | Binary Output - Output Status with flag | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 12 | 1 | Binary Command - Control relay output block (CROB) | 3 (select)<br>4 (operate)<br>5 (direct op)<br>6 (dir. op, no ack) | 17, 28 (index) | 129 (response) | Echo of request |

| DNP Object Group & Variation | | | Request<br>Outstation parses | | Response<br>Outstation can issue | |
|---|---|---|---|---|---|---|
| Group Num | Var Num | Description | Function Codes (dec) | Qualifier Codes (hex) | Function Codes (dec) | Qualifier Codes (hex) |
| 20 | 0 | ~~Counter - Any Variation~~ | 1 (read)<br>7 (freeze)<br>8 ( freeze noack)<br>9 (freeze clear)<br>10 (frz. cl. noack) | 06 (no range, or all) | 129 (response) | |
| 20 | 1 | ~~Counter - 32-bit with flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 20 | 2 | ~~Counter - 16-bit with flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 20 | 5 | ~~Counter - 32-bit without flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 20 | 6 | ~~Counter - 16-bit without flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 21 | 0 | ~~Frozen Counter - Any Variation~~ | 1 (read) | 06 (no range, or all) | | |
| 21 | 1 | ~~Frozen Counter - 32-bit with flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 21 | 2 | ~~Frozen Counter - 16-bit with flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 21 | 9 | ~~Frozen Counter - 32-bit without flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 21 | 10 | ~~Frozen Counter - 16-bit without flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 22 | 0 | ~~Counter Event - Any Variation~~ | 1 (read) | 06 (no range, or all)<br>07, 08 (limited qty) | | |
| 22 | 1 | ~~Counter Event - 32-bit with flag~~ | | | 129 (response)<br>~~130 (unsol. resp)~~ | ~~17, 28 (index)~~ |
| 22 | 2 | ~~Counter Event - 16-bit with flag~~ | | | 129 (response)<br>~~130 (unsol. resp)~~ | ~~17, 28 (index)~~ |
| 30 | 0 | Analog Input - Any Variation | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 30 | 1 | Analog Input - 32-bit with flag | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 30 | 2 | Analog Input - 16-bit with flag | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 30 | 3 | Analog Input - 32-bit without flag | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 30 | 4 | Analog Input - 16-bit without flag | 1 (read) | 06 (no range, or all)<br>00, 01 (start-stop)<br>07, 08 (limited qty)<br>17, 28 (index) | 129 (response) | 00, 01 (start-stop) |
| 32 | 0 | Analog Input Event - Any Variation | 1 (read) | 06 (no range, or all)<br>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)<br>07, 08 (limited qty) | 129 (response)<br>~~130 (unsol. resp)~~ | 17, 28 (index) |
| 32 | 2 | Analog Input Event - 16-bit without time | 1 (read) | 06 (no range, or all)<br>07, 08 (limited qty) | 129 (response)<br>~~130 (unsol. resp)~~ | 17, 28 (index) |
| 32 | 3 | Analog Input Event - 32-bit with time | 1 (read) | 06 (no range, or all)<br>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)<br>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) | |

| DNP Object Group & Variation | | | Request<br>Outstation parses | | Response<br>Outstation can issue | |
|---|---|---|---|---|---|---|
| **Group Num** | **Var Num** | **Description** | **Function Codes (dec)** | **Qualifier Codes (hex)** | **Function Codes (dec)** | **Qualifier Codes (hex)** |
| 40 | 2 | ~~Analog Output Status - 16-bit with flag~~ | | | 129 (response) | ~~00, 01 (start-stop)~~ |
| 41 | 2 | ~~Analog Output - 16-bit~~ | 3 (select)<br>4 (operate)<br>5 (direct op)<br>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) | |
| 51 | 1 | ~~Time and Date CTO - Absolute time, synchronized~~ | | | ~~129 (response)~~<br>~~130 (unsol. resp)~~ | ~~07 (limited qty) (qty = 1)~~ |
| 51 | 2 | Time and Date CTO - Absolute time, unsynchronized | | | 129 (response)<br>~~130 (unsol. resp)~~ | 07 (limited qty) (qty = 1) |
| 52 | 1 | Time Delay - Coarse | | | 129 (response) | 07 (limited qty) (qty = 1) |
| 52 | 2 | ~~Time delay - Fine~~ | | | ~~129 (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) |
| 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 IEC 103 Device Profile

## G.1 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.

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### IEC60870 Function Type & COT Descriptions

| Function Type | Description |
|---|---|
| 160 | IEC Overcurrent Protection |
| 163 | ERL Feeder Protection |
| 164 | ERL Overcurrent Protection |
| 165 | ERL Voltage Protection |
| 166 | ERL Frequency Protection |
| 167 | ERL Synchronizing Function |
| 168 | ERL High Impedance Differential Protection |
| 169 | ERL Motor Protection |
| 170 | ERL Capacitor Protection |
| 176 | IEC Transformer Protection |
| 178 | ERL Transformer Protection |
| 254 | IEC Generic |
| 255 | IEC Global |

| Cause of Transmission (COT) | Description |
|---|---|
| 1 | Spontaneous Events |
| 2 | Cyclic |
| 3 | Reset Frame Count Bit (FCB) |
| 4 | Reset Communication Unit (CU) |
| 5 | Start Restart |

| | |
|---|---|
| 8 | Time Synchronization |
| 9 | General Interrogation |
| 10 | Termination of General Interrogation |
| 11 | Local Operation |
| 12 | Remote Operation |
| 20 | Positive Command Acknowledge |
| 21 | Negative Command Acknowledge |

This section contains the event & command codes defined

KEY: **FUN** Function Type

**INF** Information Number

**GI** Event supports General Interrogation x = supported

**TYP** ASDU Type

**COT** Cause of Transmission

**DIR** Direction of event Raised Only (RO), Raised / Cleared (RC) or Double Point Travelling, Cleared, Raised or Unknown (DP)

**x** Supported

**-** Not supported

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 165 | 2 | Reset FCB | - | 5 | 3 | RO |
| 165 | 3 | Reset CU | - | 5 | 4 | RO |
| 165 | 4 | Start/Restart | - | 5 | 5 | RO |
| 165 | 5 | Power ON | - | 5 | 6 | RO |
| | | | | | | |
| 165 | 19 | Arc In Progress | x | 1 | 1,9 | RC |
| | | | | | | |
| 165 | 19 | LEDs reset | - | 1 | 1, 11, 12, 20, 21 | RO |
| | | | | | | |
| 165 | 22 | Settings changed | x | 1 | 1, 9, 11, 12 | RC |
| 165 | 23 | Setting G1 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 165 | 24 | Setting G2 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 165 | 25 | Setting G3 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 165 | 26 | Setting G4 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| | | | | | | |
| 165 | 27 | Status Input1 | x | 1 | 1, 9 | RC |
| 165 | 28 | Status Input2 | x | 1 | 1, 9 | RC |
| 165 | 29 | Status Input3 | x | 1 | 1, 9 | RC |
| 165 | 30 | Status Input4 | x | 1 | 1, 9 | RC |
| | | | | | | |
| 165 | 36 | Trip Circuit Supervision(TCS-1) | x | 1 | 1,9 | RC |
| | | | | | | |
| 164 | 64 | A-Starter | x | 2 | 1,9 | RC |
| 164 | 65 | B-Starter | X | 2 | 1,9 | RC |
| 164 | 66 | C-Starter | X | 2 | 1,9 | RC |
| 164 | 67 | E-Starter | X | 2 | 1,9 | RC |
| 164 | 68 | General trip | - | 2 | 1 | RO |
| 164 | 69 | A-general trip | - | 2 | 1 | RO |
| 164 | 70 | B-genenral –trip | - | 2 | 1 | RO |
| 164 | 71 | C-general trip | - | 2 | 1 | RO |
| | | | | | | |
| 164 | 74 | Fault Forward | - | 2 | 1 | RO |
| 164 | 75 | Fault Reverse | - | 2 | 1 | RO |
| 163 148 | | | | | | |
| 164 | 84 | General starter | x | 2 | 1,9 | RC |
| 164 | 85 | Circuit Breaker Fail(50BF) | - | 2 | 1 | RO |
| | | | | | | |
| 164 | 90 | P/F Genaral LS Trip(51) | - | 2 | 1 | RO |
| 164 | 91 | P/F Genaral HS Trip(50) | - | 2 | 1 | RO |
| 164 | 92 | E/F Genaral LS Trip(51N) | - | 2 | 1 | RO |
| 164 | 93 | E/F Genaral HS Trip(50N) | - | 2 | 1 | RO |
| | | | | | | |
| 164 | 128 | CB on by Auto-reclose | x | 1 | 1,9 | RC |
| | | | | | | |
| 164 | 130 | Reclose Blocked | x | 1 | 1,9 | RC |
| | | | | | | |
| 164 | 147 | Measurand I ( VSync) | x | 3 | 2 | - |
| 164 | 148 | Measurand II (IL1,2,3, VL1,2,3, P, Q, f) | x | 9 | 2 | - |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| | | | | | | |
| 163 | 209 | 37-1 Picked up | - | 2 | 1 | RC |
| 163 | 210 | 37-2 Picked up | - | 2 | 1 | RC |
| 163 | 211 | 37-1 operated | - | 2 | 1 | RO |
| 163 | 212 | 37-2 operated | - | 2 | 1 | RO |
| 164 | 160 | 50-1 Picked up | - | 2 | 1 | RC |
| 164 | 161 | 50-2 Picked up | - | 2 | 1 | RC |
| 164 | 162 | 50-1 operated | - | 2 | 1 | RO |
| 164 | 163 | 50-2 operated | - | 2 | 1 | RO |
| 164 | 164 | 51-1 Picked up | - | 2 | 1 | RC |
| 164 | 165 | 51-2 Picked up | - | 2 | 1 | RO |
| 164 | 166 | 51-1 operated | - | 2 | 1 | RC |
| 164 | 167 | 51-2 operated | - | 2 | 1 | RO |
| 164 | 168 | 50N-1 Picked up | - | 2 | 1 | RC |
| 164 | 169 | 50N-2 Picked up | - | 2 | 1 | RC |
| 164 | 170 | 50N-1 operated | - | 2 | 1 | RO |
| 164 | 171 | 50N-2 operated | - | 2 | 1 | RO |
| 164 | 172 | 51N-1 Picked up | - | 2 | 1 | RC |
| 164 | 173 | 51N-2 Picked up | - | 2 | 1 | RO |
| 164 | 174 | 51N-1 operated | - | 2 | 1 | RC |
| 164 | 175 | 51N-2 operated | - | 2 | 1 | RO |
| 164 | 176 | 46/50 Picked up | - | 2 | 1 | RC |
| 164 | 177 | 46/50 operated | - | 2 | 1 | RO |
| 164 | 178 | 46/51 Picked up | - | 2 | 1 | RC |
| 164 | 179 | 46/51 operated | - | 2 | 1 | RO |
| 164 | 180 | 49 Picked up | - | 2 | 1 | RC |
| 164 | 181 | 49 operated | - | 2 | 1 | RO |
| 164 | 182 | 49AL operated | - | 2 | 1 | RO |
| 164 | 183 | 50BF-D1 operated | - | 2 | 1 | RO |
| 164 | 184 | 50BF-D2 operated | - | 2 | 1 | RO |
| 164 | 185 | DI-CBF-D1 Operated | - | 2 | 1 | RO |
| 164 | 186 | DI-CBF-D2 Operated | - | 2 | 1 | RO |
| 164 | 187 | 46BC Operated | - | 1 | 1 | RO |
| 164 | 188 | I2t Limit Operated | - | 1 | 1 | RO |
| 164 | 189 | 81HBL2 Operated | - | 1 | 1 | RO |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 164 | 190 | 60CTS Operated | - | 1 | 1 | RO |
| 164 | 191 | 60VTS Operated | - | 1 | 1 | RO |
| 164 | 192 | Trip Circuit Supervision(TCS-2) | X | 1 | 1,9 | RC |
| 164 | 193 | 64/50SEF-1 Picked up | - | 2 | 1 | RC |
| 164 | 194 | 64/50SEF-2 Picked up | - | 2 | 1 | RC |
| 164 | 195 | 64/50SEF-1 Operated | - | 2 | 1 | RO |
| 164 | 196 | 64/50SEF-2 Operated | - | 2 | 1 | RO |
| 164 | 197 | 64/50SEF-1 Picked up | - | 2 | 1 | RC |
| 164 | 198 | 64/51SEF-2 Picked up | - | 2 | 1 | RC |
| 164 | 199 | 64/51SEF-1 operated | - | 2 | 1 | RO |
| 164 | 200 | 64/51SEF-2 operated | - | 2 | 1 | RO |
| 164 | 201 | 79AR Cumm Count Operated | - | 1 | 1 | RO |
| | | | | | | |
| 164 | 160 | Output1 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 161 | Output2 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 162 | Output3 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 163 | Output4 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 164 | Output5 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 165 | Output6 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 166 | Output7 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 167 | Output8 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 168 | Output9 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 169 | Output10 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 170 | Output11 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 171 | Output12 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 172 | Output13 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 16 | 173 | Output14 | x | 1 | 1, 9, 12, 20, 21 | RC |
| | | | | | | |
| 164 | 174 | Setting G5 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 164 | 175 | Setting G6 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 164 | 176 | Setting G7 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 164 | 177 | Setting G8 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| | | | | | | |
| 163 | 178 | Status Input5 | x | 1 | 1, 9 | RC |
| 163 | 179 | Status Input6 | x | 1 | 1, 9 | RC |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 163 | 180 | Status Input7 | x | 1 | 1, 9 | RC |
| 163 | 181 | Status Input8 | x | 1 | 1, 9 | RC |
| 163 | 182 | Status Input9 | x | 1 | 1, 9 | RC |
| 163 | 183 | Status Input10 | x | 1 | 1, 9 | RC |
| 163 | 184 | Status Input11 | x | 1 | 1, 9 | RC |
| 163 | 185 | Status Input12 | x | 1 | 1, 9 | RC |
| 163 | 186 | Status Input13 | x | 1 | 1, 9 | RC |
| 163 | 187 | Status Input14 | x | 1 | 1, 9 | RC |
| 163 | 188 | Disturbance record stored | x | 1 | 1, 12, 20, 21 | RO |
| 163 | 189 | VA Fault Voltage | x | 4 | 1,9 | - |
| 163 | 190 | VB Fault Voltage | x | 4 | 1,9 | - |
| 163 | 191 | VC Fault Voltage | x | 4 | 1,9 | - |
| 163 | 192 | VAB Fault Voltage | x | 4 | 1,9 | - |
| 163 | 193 | VBC Fault Voltage | x | 4 | 1,9 | - |
| 163 | 194 | VCA Fault Voltage | x | 4 | 1,9 | - |
| 163 | 195 | IA Fault current | x | 4 | 1,9 | - |
| 163 | 196 | IB Fault current | x | 4 | 1,9 | - |
| 163 | 197 | IC Fault current | x | 4 | 1,9 | - |
| 163 | 198 | ISEF Fault current | x | 4 | 1,9 | - |
| 163 | 199 | In Fault current | x | 4 | 1,9 | - |
| 163 | 200 | Vn Fault Voltage | x | 4 | 1,9 | - |
| 163 | 201 | V2 Fault Voltage | x | 4 | 1,9 | - |
| 163 | 202 | %VF Fault voltage | x | 4 | 1,9 | - |
| 163 | 203 | Frequency | x | 4 | 1,9 | - |
| 163 | 204 | dF/dT | x | 4 | 1,9 | - |
| 163 | 205 | Fault location | x | 4 | 1,9 | - |
| 163 | 206 | Fault mag | x | 4 | 1,9 | - |
| | | | | | | |
| 165 | 160 | 27DT-1 Picked up | - | 2 | 1 | RC |
| 165 | 161 | 27DT-2 Picked up | - | 2 | 1 | RC |
| 165 | 162 | 27DT-3 Picked up | - | 2 | 1 | RC |
| 165 | 163 | 27DT-4 Picked up | - | 2 | 1 | RC |
| 165 | 164 | 27DT-5 Picked up | - | 2 | 1 | RC |
| 165 | 165 | 27DT-6 Picked up | - | 2 | 1 | RC |
| 165 | 166 | 27DT-1 Operated | - | 2 | 1 | RO |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 165 | 167 | 27DT-2 Operated | - | 2 | 1 | RO |
| 165 | 168 | 27DT-3 Operated | - | 2 | 1 | RO |
| 165 | 169 | 27DT-4 Operated | - | 2 | 1 | RO |
| 165 | 170 | 27DT-5 Operated | - | 2 | 1 | RO |
| 165 | 171 | 27DT-6 Operated | - | 2 | 1 | RO |
| 165 | 172 | 27IT-1 Picked up | - | 2 | 1 | RC |
| 165 | 173 | 27IT-2 Picked up | - | 2 | 1 | RC |
| 165 | 174 | 27IT-1 Operated | - | 2 | 1 | RO |
| 165 | 175 | 27IT-2 Operated | - | 2 | 1 | RO |
| 165 | 176 | 59DT-1 Picked up | - | 2 | 1 | RC |
| 165 | 177 | 59DT-2 Picked up | - | 2 | 1 | RC |
| 165 | 178 | 59DT-3 Picked up | - | 2 | 1 | RC |
| 165 | 179 | 59DT-4 Picked up | - | 2 | 1 | RC |
| 165 | 180 | 59DT-5 Picked up | - | 2 | 1 | RC |
| 165 | 181 | 59DT-6 Picked up | - | 2 | 1 | RC |
| 165 | 182 | 59DT-1 Operated | - | 2 | 1 | RO |
| 165 | 183 | 59DT-2 Operated | - | 2 | 1 | RO |
| 165 | 184 | 59DT-3 Operated | - | 2 | 1 | RO |
| 165 | 185 | 59DT-4 Operated | - | 2 | 1 | RO |
| 165 | 186 | 59DT-5 Operated | - | 2 | 1 | RO |
| 165 | 187 | 59DT-6 Operated | - | 2 | 1 | RO |
| 165 | 188 | 59IT-1 Picked up | - | 2 | 1 | RC |
| 165 | 189 | 59IT-2 Picked up | - | 2 | 1 | RC |
| 165 | 190 | 59IT-1 Operated | - | 2 | 1 | RO |
| 165 | 191 | 59IT-2 Operated | - | 2 | 1 | RO |
| 165 | 192 | 24DT-1 Picked up | - | 2 | 1 | RC |
| 165 | 193 | 24DT-2 Picked up | - | 2 | 1 | RC |
| 165 | 194 | 24DT-1 Operated | - | 2 | 1 | RO |
| 165 | 195 | 24DT-2 Operated | - | 2 | 1 | RO |
| 165 | 196 | 24IT Picked up | - | 2 | 1 | RC |
| 165 | 197 | 24IT Operated | - | 2 | 1 | RO |
| 165 | 198 | 47DT-1 Picked up | - | 2 | 1 | RC |
| 165 | 199 | 47DT-2 Picked up | - | 2 | 1 | RC |
| 165 | 200 | 47DT-1 Operated | - | 2 | 1 | RO |
| 165 | 201 | 47DT-2 Operated | - | 2 | 1 | RO |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 165 | 202 | 47IT Picked up | - | 2 | 1 | RC |
| 165 | 203 | 47IT Operated | - | 2 | 1 | RO |
| 165 | 204 | 59NDT-1 Picked up | - | 2 | 1 | RC |
| 165 | 205 | 59NDT-2 Picked up | - | 2 | 1 | RC |
| 165 | 206 | 59NDT-1 Operated | - | 2 | 1 | RO |
| 165 | 207 | 59NDT-2 Operated | - | 2 | 1 | RO |
| 165 | 208 | 59NIT Picked up | - | 2 | 1 | RC |
| 165 | 209 | 59NIT Operated | - | 2 | 1 | RO |
| 165 | 210 | THD-1 Operated | - | 1 | 1 | RO |
| 165 | 211 | THD-2 Operated | - | 1 | 1 | RO |
| 165 | 212 | UV Count Operated | - | 1 | 1 | RO |
| 165 | 213 | OV Count Operated | - | 1 | 1 | RO |
| | | | | | | |
| 163 | 206 | EI Count Operated | - | 1 | 1 | RO |
| | | | | | | |
| 166 | 160 | 81U-1 Picked up | - | 2 | 1 | RC |
| 166 | 161 | 81U-2 Picked up | - | 2 | 1 | RC |
| 166 | 162 | 81U-3 Picked up | - | 2 | 1 | RC |
| 166 | 163 | 81U-4 Picked up | - | 2 | 1 | RC |
| 166 | 164 | 81U-5 Picked up | - | 2 | 1 | RC |
| 166 | 165 | 81U-6 Picked up | - | 2 | 1 | RC |
| 166 | 166 | 81U-7 Picked up | - | 2 | 1 | RC |
| 166 | 167 | 81U-8 Picked up | - | 2 | 1 | RC |
| 166 | 168 | 81U-1 Operated | - | 2 | 1 | RO |
| 166 | 169 | 81U-2 Operated | - | 2 | 1 | RO |
| 166 | 170 | 81U-3 Operated | - | 2 | 1 | RO |
| 166 | 171 | 81U-4 Operated | - | 2 | 1 | RO |
| 166 | 172 | 81U-5 Operated | - | 2 | 1 | RO |
| 166 | 173 | 81U-6 Operated | - | 2 | 1 | RO |
| 166 | 174 | 81U-7 Operated | - | 2 | 1 | RO |
| 166 | 175 | 81U-8 Operated | - | 2 | 1 | RO |
| 166 | 176 | 81O-1 Picked up | - | 2 | 1 | RC |
| 166 | 177 | 81O-2 Picked up | - | 2 | 1 | RC |
| 166 | 178 | 81O-3 Picked up | - | 2 | 1 | RC |
| 166 | 179 | 81O-4 Picked up | - | 2 | 1 | RC |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 166 | 180 | 81O-5 Picked up | - | 2 | 1 | RC |
| 166 | 181 | 81O-6 Picked up | - | 2 | 1 | RC |
| 166 | 182 | 81O-7 Picked up | - | 2 | 1 | RC |
| 166 | 183 | 81O-8 Picked up | - | 2 | 1 | RC |
| 166 | 184 | 81O-1 Operated | - | 2 | 1 | RO |
| 166 | 185 | 81O-2 Operated | - | 2 | 1 | RO |
| 166 | 186 | 81O-3 Operated | - | 2 | 1 | RO |
| 166 | 187 | 81O-4 Operated | - | 2 | 1 | RO |
| 166 | 188 | 81O-5 Operated | - | 2 | 1 | RO |
| 166 | 189 | 81O-6 Operated | - | 2 | 1 | RO |
| 166 | 190 | 81O-7 Operated | - | 2 | 1 | RO |
| 166 | 191 | 81O-8 Operated | - | 2 | 1 | RO |
| 166 | 192 | 81R-1 Picked up | - | 2 | 1 | RC |
| 166 | 193 | 81R-2 Picked up | - | 2 | 1 | RC |
| 166 | 195 | 81R-4 Picked up | - | 2 | 1 | RC |
| 166 | 195 | 81R-4 Picked up | - | 2 | 1 | RC |
| 166 | 196 | 81R-1 Operated | - | 2 | 1 | RO |
| 166 | 197 | 81R-2 Operated | - | 2 | 1 | RO |
| 166 | 198 | 81R-3 Operated | - | 2 | 1 | RO |
| 166 | 199 | 81R-4 Operated | - | 2 | 1 | RO |
| 166 | 200 | UF Count Operated | - | 1 | 1 | RO |
| 166 | 201 | OF Count Operated | - | 1 | 1 | RO |
| 163 | 213 | 32-1 Picked up | - | 2 | 1 | RC |
| 163 | 214 | 32-2 Picked up | - | 2 | 1 | RC |
| 163 | 215 | 32-3 Picked up | - | 2 | 1 | RC |
| 163 | 216 | 32-4 Picked up | - | 2 | 1 | RC |
| 163 | 217 | 32-1 operated | - | 2 | 1 | RO |
| 163 | 218 | 32-2 operated | - | 2 | 1 | RO |
| 163 | 219 | 32-3 operated | - | 2 | 1 | RO |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 163 | 220 | 32-4 operated | - | 2 | 1 | RO |
| | | | | | | |
| 167 | 160 | 25/27/59 Operated | - | 1 | 1 | RO |
| | | | | | | |
| 164 | 206 | IRIG_B Synchronization | x | 1 | 1,9 | RC |
| 164 | 207 | SNTP Synchronization | x | 1 | 1,9 | RC |
| | | | | | | |
| 255 | 0 | Time Synchronization | - | 6 | 8 | - |

# Appendix H Mechanical Drawings

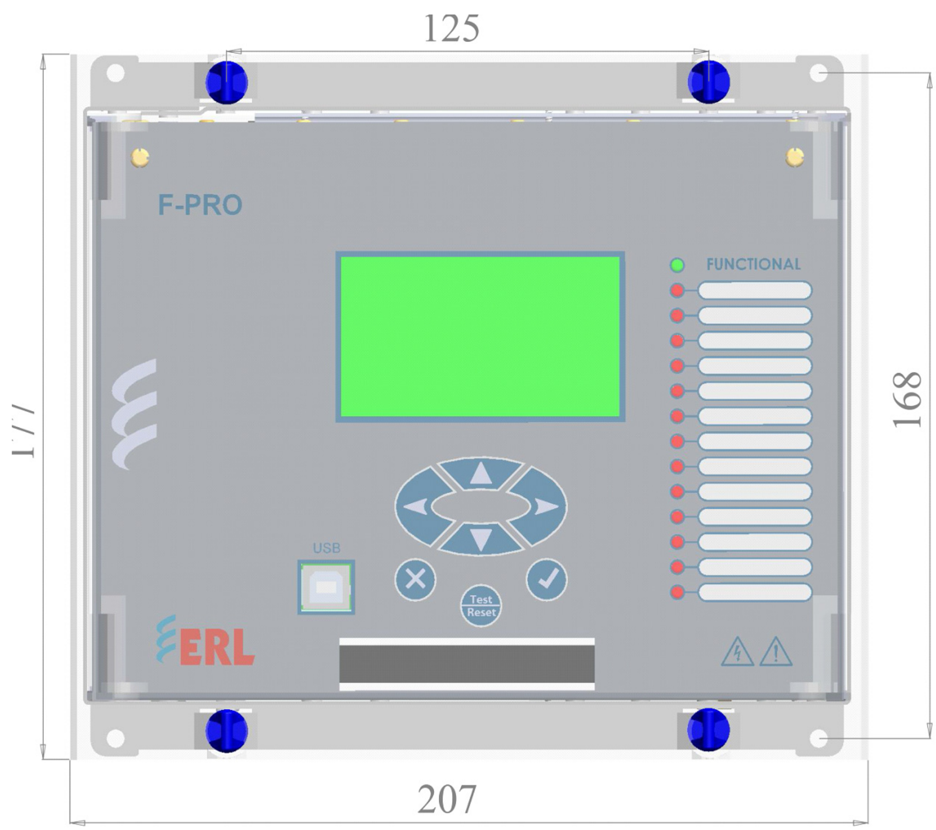


Figure H.1: Front View Drawing

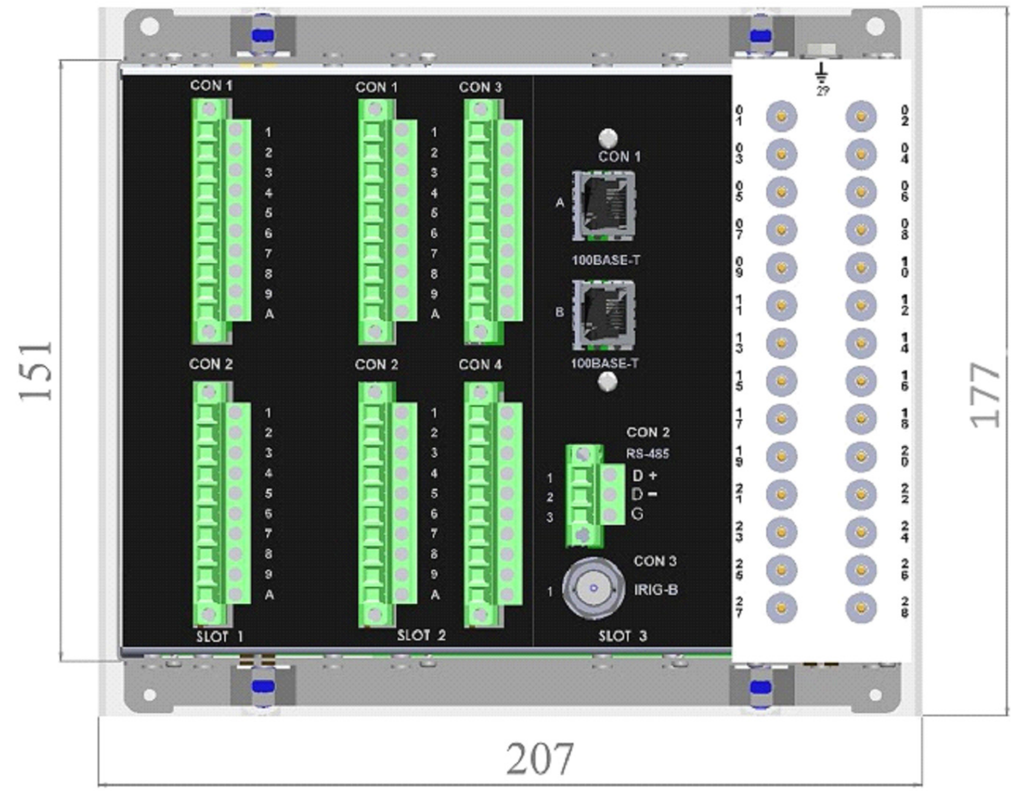


Figure G.1:  Rear Panel Drawing

# Appendix I AC Schematic Drawings

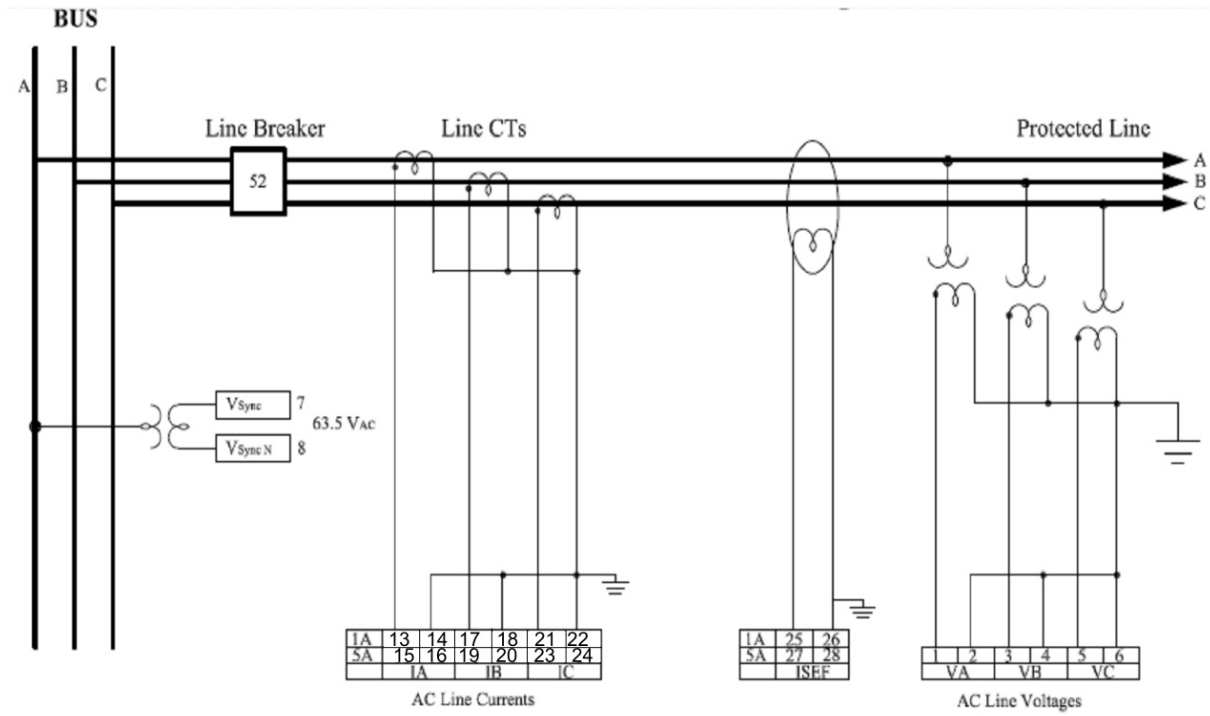


Figure I.1: F-PRO 298 AC Schematic

# Appendix J DC Schematic Drawings

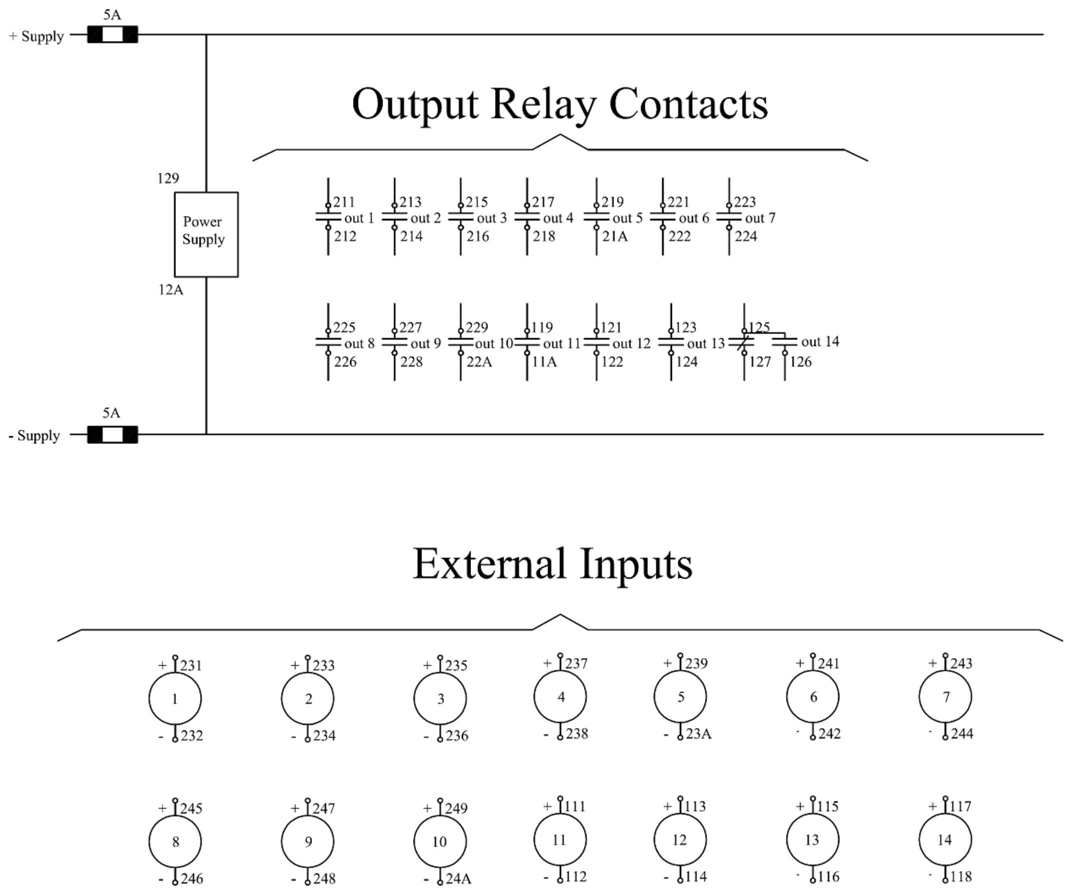


Figure J.1: F-PRO 298 DC Schematic

# Appendix K Connection Diagram

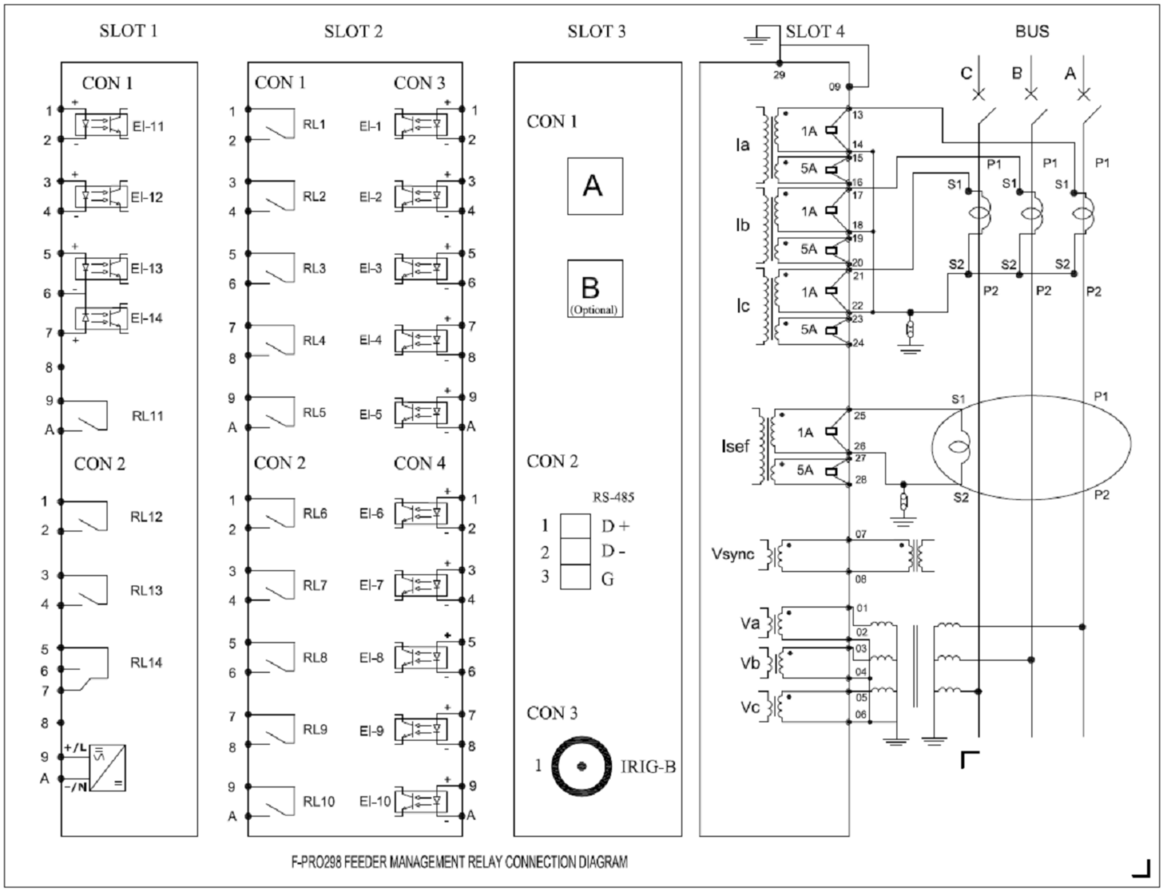


Figure K.1: F-PRO 298 Connection Diagram

# 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 298

Document Version[1]: D05032R01.10

Date: 2021-12-27

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 298, with firmware v1.7:

-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 | |
| M8-5 | data-reference | | YES | |
| M8-6 | BufTm | | YES | |
| M8-7 | IntgPd | | YES | |
| M8-8 | GI | | YES | |
| M8-9 | conf-revision | | YES | |

| Table L.2: ACSI models conformance statement | | | | |
|---|---|---|---|---|
| | | **Client/ Subscriber** | **Server/ Publisher** | **Value/ Comments** |
| | **Logging** | | NO | |
| M9 | **Log control** | | NO | |
| M9-1 | IntgPd | | NO | |
| M10 | **Log** | | NO | |
| M11 | **Control** | | YES | |
| 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=Yes; Client must be Y if B12=Y<br>c2 Server must be Y if M7-Y or M8=Y or M9=Y or M19=Y or M20=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 | |
| YES = service is supported<br>NO 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 | |
| S16 | 1,2 | GetDataSetDirectory | TP | | YES | |

| **Table L.3: ACSI service Conformance statement** | | | | | | |
|---|---|---|---|---|---|---|
| | **Ed.** | **Services** | **AA: TP/MC** | **Client (C)** | **Server (S)** | **Comments** |
| **Substitution: if M5=Y** | | | | | | |
| 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** | | | | | | |
|---|---|---|---|---|---|---|
| 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 | |

| Table L.3: ACSI service Conformance statement | | | | | | |
|---|---|---|---|---|---|---|
| | **Ed.** | **Services** | **AA: TP/MC** | **Client (C)** | **Server (S)** | **Comments** |
| 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 | GetGOOSEElementNum-ber | 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 | |

**Table L.3: ACSI service Conformance statement**

| | Ed. | Services | AA: TP/MC | Client (C) | Server (S) | Comments |
|---|---|---|---|---|---|---|
| **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)<br><br>T0 (ms)(<=10ms), 7 <= T3 < 10 (c1)<br><br>T1 (µs)(<=1ms), 10<= T3 < 13<br><br>T2 (µs)(<=100µs), 13 <= T3 < 15<br><br>T3 (µs)(<=25µs), 15 <= T3 < 18<br><br>T4 (µs)(<=4µs), 18 <= T3 < 20<br><br>T5 (µs)(<=1µs), 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 298

Document Version[1]: D05033R01.10
Date: 2021-12-27

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 298, with firmware v1.7.

This MICS document specifies the modelling extensions compared to IEC 61850 Edition 2. For the exact details on the standardized model please compare the ICD substation configuration file: "ERLFPRO2000_298.icd", version 4 revision 8.

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) |
| **PSDE** (Sensitive directional earthfault) |
| **PTTR** (Thermal overload) |
| **PHAR** (Harmonic restraint) |
| **PTUC** (Undercurrent) |
| **PDUP** (Directional underpower) |
| **PDOP** (Directional overpower) |
| **R: Logical nodes for protection related functions** |
| **RSYN** (Synchronism-check) |
| **RBRF** (Breaker failure) |
| **RREC** (Autoreclosing) |

| |
|---|
| **RDRE** (Disturbance record function) |
| **G: Logical Nodes for generic references** |
| **GGIO** (Generic process I/O) |
| **M: Logical Nodes for metering and measurement** |
| **MSQI** (Sequence and Imbalance) |
| **MMXU** (Measurement) |
| **C: Logical Nodes for Supervisory Control** |
| **CALH** (Alarm Handling) |

## Logical Node Extensions

The following table use:

M: Data is mandatory in the IEC-61850-7-4 Ed.2.

O: Data is optional in the IEC-61850-7-4 Ed.2 and is used in the device.

E: Data is an extension to the IEC-61850-7-4 Ed.2.

### New Logical Nodes

New logical nodes have the descriptions in the Name plate.

### RTCS - Trip Circuit Supervision

| RTCS class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| D74TCSRTCS | Trip Circuit Supervision, indexed D74TCSRTCS 1 - D74TCSRTCS2. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Status Information** | | | | |
| Op | ACT | General indication (Operated) | E | |

## RCBC - Circuit Breaker Condition

| RCBC class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| I2TRCBC | I2t-CB Condition, indexed I2TRCBC1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| I2TAcc | MV | I2T Accumulated Value | E | |
| I2TLstOp | MV | I2T Last Operated Value | E | |
| **Status Information** | | | | |
| Op | ACT | I2T Operated | E | |

## RTHD - Total Harmonic Distortion

| | | | | RTHD class |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| THDRTHD | Total Harmonic Distortion, indexed THDRTHD 1 - THDRTHD 2. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Status Information** | | | | |
| Op | ACT | General indication (Operated) | E | |

## RUVC - Under Voltage Counter

| | | | | RUVC class |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| UVCRUVC | Under Voltage Counter, indexed UVCRUVC1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| Acc | MV | Under Voltage Counter value | E | |
| **Status Information** | | | | |
| Op | ACT | General indication (Counter Operated) | E | |

## ROVC- Over Voltage Counter

| ROVC class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| OVCROVC | Over Voltage Counter, indexed OVCROVC1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| Acc | MV | Over Voltage Counter value | E | |
| **Status Information** | | | | |
| Op | ACT | General indication (Counter Operated) | E | |

## RUFC - Under Frequency Counter

| RUFC class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| UFCRUFC | Under Frequency Counter, indexed UFCRUFC1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| Acc | MV | Under frequency counter value | E | |
| **Status Information** | | | | |
| Op | ACT | General indication (Counter Operated) | E | |

## ROFC - Over Frequency Counter

| ROFC class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| OFCROFC | Over Frequency Counter, indexed OFCROFC1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| Acc | MV | Over frequency counter value | E | |
| **Status Information** | | | | |
| Op | ACT | General indication (Counter Operated) | E | |

## REIC - External Input Counter

| REIC class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| EIREIC | External Input Counter, indexed EIREIC1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| Acc | MV | External Input counter value | E | |
| **Status Information** | | | | |
| Op | ACT | General indication (Counter Operated) | E | |

## MTHR - Auto Reclosure Counter

| MTHR class | | | | |
|---|---|---|---|---|
| **Name** | **Description** | | | |
| MMMTHR | Auto Reclose Counter, indexed MMMTHR1. | | | |
| **Data object name** | **Common data class** | **Explanation** | **M/O/E** | **Remarks** |
| **Data Objects** | | | | |
| **Common Logical Node Information** | | | | |
| Beh | ENS | Behaviour | M | |
| **Measured Values** | | | | |
| Tmp01 | MV | Auto Reclose Count | E | |
| Tmp02 | MV | Auto Reclose Cumulative Count Value | E | |

# 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 298 with firmware v1.7.

Document Version[1]: D05034R01.10
Date: 2021-12-27

## 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 consulted for details of changes.

**Table L.5: Mandatory Edition 2 Tissues**

| Tissue | Description | Implemented Y/na |
|---|---|---|
| **Part 6** | | |
| 658 | Tracking related features<br>*EntryID and CST missing, these are checked by schema* | na |
| 663 | FCDA element cannot be a “functionally constrained logical node”<br>*doName now mandatory in FCDA element,*<br>*SCT: refuse to make empty doName? ICT: Refuse SCD* | Y |
| 668 | Autotransformer modeling<br>*Autotransformer model in substation section has changed* | na |
| 687 | SGCB ResvTms<br>*SettingControl has added attribute resvTms*<br>*see also TISSUE 845* | na |
| 719 | ConfDataSet - maxAttributes definition is confusing<br>*maxAttributes now means max count of FCDA in dataset* | Y |
| 721 | Log element name<br>*LN0/Log now has optional attribute “name”* | na |
| 768 | bType VisString65 is missing<br>*VisString65 added as SCL BasicType* | na |
| 779 | object references<br>*“@” as first character in object references now allowed* | na |
| 788 | SICS S56 from optional to mandatory<br>*SICS S56=”Interpret IED capabilities and prohibit unsupported usage”* | na |

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.

**Table L.5: Mandatory Edition 2 Tissues**

| Tissue | Description | Implemented Y/na |
|---|---|---|
| 789 | ConfLdName as services applies to both server and client<br>*Many changes made to Services section* | na |
| 804 | valKind and IED versus System configuration<br>*valImport missing/false DAI means ICT shall ignore value in SCD and SCT shall not change from ICD/IID value. Instance section inherits from DA/BDA element.* | na |
| 806 | Max length of log name inconsistent between -6 and -7-2<br>*LogControl.logName and Log.name restricted to 32 chars* | na |
| 807 | Need a way to indicate if “Owner” present in RCB<br>*Services/ReportSettings@owner added* | Y |
| 823 | ValKind for structured data attributes<br>*valKind is prohibited on structured attributes* | Y |
| 824 | Short addresses on structured data attributes<br>*sAddr is now allowed for structured attributes* | na |
| 825 | Floating point value<br>*Server shall support <Val> with exponential notation* | na |
| 845 | SGCB ResvTms<br>*Services/SettingGroups/SGEdit added attribute resvTms Services/SettingGroups/ConfSG added attribute resvTms See also TISSUE 687* | na |
| 853 | SBO and ProtNs<br>*DA[@name=SBO] element shall have ProtNS element* | na |
| 855 | Recursive SubFunction<br>*Substation section extension must be tolerated* | na |
| 856 | VoltageLevel frequency and phases<br>*Substation section extension must be tolerated* | na |
| 857 | Function/SubFunction for ConductingEquipment<br>*Substation section extension must be tolerated* | na |
| 886 | Missing 8-1 P-types<br>*“tP_IP_UDP_PORT” and “tP_IP_TCP_PORT” added* | na |
| 901 | tServices as AP or as IED element<br>*Rules for contents of AP/Server/Services are now defined* | Y |
| 936 | SupSubscription parameter usage is difficult<br>*SupSubscription “max” replaced by “maxGo” and “maxSv”* | Y |
| 1147 | tServices - FileHandling not consistent with -7-2<br>*Services/FileHandling now means only support for GetFile and GetFileAttributeValues and NOT SetFile/DeleteFile* | Y |
| 1185 | Valkind value Conf for EX FC data<br>*valKind=Conf is allowed for dataNs* | na |
| 1284 | SCSM mapping may require a communication section in an ICD file<br>*Server IEDs supporting client/server associations to 61850-8-1 shall include a <Communication> section* | Y |

**Table L.5: Mandatory Edition 2 Tissues**

| Tissue | Description | Implemented Y/na |
|---|---|---|
| 1328 | Limitation on the size of data type templates identifiers<br>*Identifer now limited to 255 characters* | Y |
| 1395 | Client LN attributes<br>*ReportControl/RptEnabled/ClientLN@ldInst shall be “LD0” for pure clients (without any Logical Devices)* | na |
| 1402 | ExtRef during engineering<br>*an ExtRef.intAddr attribute value unequal to empty string (pre-scribed 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*<br><<applicable for SCL tool test>> | na |
| 1415 | SICS-S110 IID import mandatory for Edition2<br>*only the import of data model modifications and CF value changes is mandatory for system tool*<br><<applicable for SCL tool test>> | na |
| 1419 | Support of ldName on other IEDs<br>*SICS I212 is now mandatory* | Y |
| 1444 | Need to support fixed and SCT controlled Datasets<br>*Services/xxxSetttings@datSet=fix now means “data set pointed by Control Block cannot be altered from ICD/IID* value <<appli-cable for SCL tool test>> | na |
| 1445 | ConfReportControl and a fixed ReportSettings<br>*Control block capabilities must be consistent*<br>*<<applicable for SCL tool test>>* | na |
| 1450 | originalSclXxx computation rules<br>*Ed2 ICD/IID files specifying SCL@version=2007 SHALL include originalSCLVersion=2007 and originalSCLRevision as attributes of the <IED>element* | Y |
| 1485 | Need to supercede Tissue 1398 to clarify SCT behavior<br>*Same as TISSUE 1450 <<applicable for SCL tool test>>* | na |
| **Part 7-1** | | |
| 828 | Data model namespace revision IEC 61850-7-4:2007[A]<br>*Both 2007 and 2007A are allowed for namespace name* | Y |
| 948 | Enumeration (string) values format<br>*Enums are limited to 127 characters from Basic-Latin and Latin-1 character sets* | Y |
| 1151 | simulated GOOSE disappears after 1st appearance when LPHD.Sim = TRUE<br>*New LGOS state machine defined, but TISSUE is not IntOp2, therefore TISSUE is optional if LGOS is used* | Y |
| 1396 | The use and configuration flow of LGOS and LSVS is unclear<br>*If Services/SupSubscription@maxGo > 1 then at least 1 LGOS must exist. Same for maxSv/LSVS.*<br>*If maxGo > count(LGOS) then SCT can create additional LGOS. Same for maxSv/LSVS* | Y |

| Table L.5: Mandatory Edition 2 Tissues | | |
|---|---|---|
| **Tissue** | **Description** | **Implemented Y/na** |
| 1447 | Restriction on ENUMtypes in SCL<br>*If a ENUM DA limits write or configuration to a subset, then that subset must be declared* | na |
| 1457 | Multiple DOI nodes with the same name<br>*LN can have no more than one DOI with same name* | Y |
| 1468 | Re-use DO from other LN<br>*allow standard or private dataNs* | na |
| 1491 | CmdBlk blocks itself?<br>*The data CmdBlk shall have no effect on the controllable data Mod or CmdBlk* | na |
| 1495 | GetVariableAccessAttributes error code<br>*Return MMS error access/object-non-existent if the object does not exist* | Y |
| **Part 7-2** | | |
| 728 | BRCB: could PurgeBuf be set when RptEna=TRUE?<br>*PurgeBuf while RptEna=true is prohibited* | Y |
| 778 | AddCause values – add value not-supported<br>*Align 7-2 with 8-1 (nothing new to 8-1)* | na |
| 780 | What are unsupported trigger option at a control block?<br><br>*All control blocks must support all trigger options* | Y |
| 783 | TimOper Resp- ; add Authorization check<br>*Clarifies Time-Operated Controls* | na |
| 786 | AddCause values 26 and 27 are switched<br>*Annex B.2 has wrong AddCause values* | na |
| 820 | Mandatory ACSI services (use for PICS template)<br>*Model entries M18 (Application Association), M19 (GCB), M20 (SVCB) are new. Services S17 (Substitution) and S61 (Get-ServerDirectory) are new. Services S1, S3, S4, S5, S6, S8, S16, S18, S23, S36, S37, S41, S42 are changed.* | Y |
| 858 | typo in enumeration ServiceType<br>*Tracking serviceType now has GetLogicalNodeDirectory* | na |
| 861 | dchg of ConfRev attribute<br>*Clarifies (tracking) BTS.confRev is AFTER BRCB change* | na |
| 1050 | GTS Phycomaddr definition in SCL<br>*(Tracking) GTS needs a special structure for SCL* | na |
| 1071 | Length of DO name<br>*Private DO name length shall be <=12 including instance* | Y |
| 1127 | Missing owner attribute in BTS and UTS<br>*NSD files for 61850-7-3 show owner in (tracking) BTS/UTS* | na |
| 1202 | GI not optional<br>*GI support is mandatory for both URCB and BRCB* | Y |
| 1232 | EntryID needs clarification<br>*Segments of a report shall have same identifiers* | Y |

**Table L.5: Mandatory Edition 2 Tissues**

| Tissue | Description | Implemented Y/na |
|---|---|---|
| 1242 | NTS definition<br>*NTS.resv have been added* | na |
| 1307 | Segmented report with Buffer overflow<br>*Segments of a report shall have identical buf-overflow value* | Y |
| 1428 | MTS and NTS should use svOptFlds<br>*MTS.optFlds and NTS.optFlds now have bType=SvOptFlds* | na |
| 1630 | Attributes in CDC=LTS do not match 8-1 definition<br>*Order of attributes in LTS changed to:*<br>*logEna, logRef, datSet, oldEntrTm, newEntrTm, oldEnt, newEnt, trgOps, intgPd* | na |
| **Part 7-3** | | |
| 697 | persistent command / PulseConfig<br>*PulseConfig adds enum “persistent-feedback”*<br>*DPC.cmdQual==”persistent” is conditionally allowed* | na |
| 698 | Wrong case is BAC.dB attribute<br>*attribute renamed from “dB” to “db”* | na |
| 711 | blkEna freeze data update while setting its quality to operater-Blocked<br>*Mode=Blocked shall not cause q.operatorBlocked* | na |
| 722 | Units for 'h' and 'min' not in UnitKind enumeration.<br>*New unit enums 84=hours, 85=minutes* | na |
| 919 | Presence Condition for sVC<br>*svC may be valKind=Conf in ICD file* | na |
| 925 | Presence of i or f attribute - Problem with writing<br>*New constructed attribute class "AnalogueValueCtl"* | na |
| 926 | Presence Conditions within RangeConfig<br>*All or none of hhLim+hLim+lLim+llLim shall be present* | Y |
| 954 | Data attributes with FC=CF should have trgOp=dchg<br>*Some INS and HST and CSG attributes missing dchg* | Y |
| 1078 | CMV.t update if rangeAng changed<br>*Add rangeAng to“reasons-to-update-timestamp-of-CMV”* | na |
| 1565 | db = 0 behaviour<br>*db=0 not longer suppresses reporting* | na |
| 1578 | dataAttribute NameSpace content<br>*Attributes with FC=EX must be initialized in ICD/IID file* | Y |
| **Part 7-4** | | |
| 671 | mistake in definition of Mod & Beh<br>*Beh=on, q=test should be “Processed as valid”* | Y |
| 674 | CDC of ZRRC.LocSta is wrong<br>*ZRRC LocSta should be CDC=SPC* | na |
| 676 | Same data object name used with different CDC<br>*LCCH.Fer renamed to FerCh, LCCH.RedFer to RedFerCh* | 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<br>*Rename SOPM.MotStr to MotStrNum* | na |
| 679 | Remove CycTrMod Enum<br>*Enum is no longer used, use TrMod instead* | na |
| 680 | SI unit for MHYD.Cndct<br>*Change unit from S/cm$^2$ to S/m* | na |
| 681 | Enum PIDAlg<br>*Typographical error, invalid XML syntax* | na |
| 682 | ANCR.ParColMod<br>*ParColMod enum values text have changed* | na |
| 683 | Enum QVVR.IntrDetMth<br>*IntrDetMth enum values text have changed* | na |
| 685 | Enum ParTraMod<br>*ParTraMod enum values text have changed* | na |
| 686 | New annex H - enums types in XML<br>*Many changes have been made to enumeration names* | Y |
| 694 | Data object CmdBlk<br>*CmdBlk semantics have changed* | na |
| 696 | LSVS.St (Status of subscription)<br>*LSVS.St is now mandatory* | Y |
| 712 | interpretation of quality operatorBlocked<br>*Mode and Behavior semantics have changed* | na |
| 713 | DO Naming of time constants in FFIL<br>*Many DO names in FFIL have changed* | na |
| 714 | Enums for ShOpCap and SwOpCap<br>*Type for YPSH.ShOpCap and XSWI.SwOpCap have changed* | na |
| 715 | RBDR.ChNum1<br>*RBDR.ChNum1 changes from optional to conditional* | na |
| 716 | TAXD text for condition<br>*TAXD.SmRte condition for inclusion has changed* | na |
| 724 | ANCR.Auto<br>*ANCR.Auto changes from mandatory to optional* | na |
| 725 | Loc in LN A-group<br>*Loc changes to optional, LocKey/LocSta conditions change* | na |
| 734 | LLN0.OpTmh vs. LPHD.OpTmh<br>*LLN0.OpTmh deleted, LPHD.OpTmH added as conditional* | na |
| 736 | PFSign<br>*MMXU.PFSign enum is extended with 3=Excitation* | na |
| 742 | GAPC.Str, GAPC.Op and GAPC.StrVal<br>*Objects have instance indicator removed (ex, Str1 to Str)* | na |

**Table L.5: Mandatory Edition 2 Tissues**

| Tissue | Description | Implemented Y/na |
|---|---|---|
| 743 | CCGR.PmpCtl and CCGR.FanCtl<br>*Object have instance indicator added (ex:PmpCtl to PmpCtl1)* | na |
| 744 | LN STMP, EEHealth and EEName<br>*Removed STMP.EEHealth and STMP.EEName* | na |
| 772 | LPHD.PwrUp/PwrDn should be transient<br>*These objects are now transient* | na |
| 773 | Loc, LocKey and LocSta YPSH and YLTC<br>*Add Loc, LocKey and LocSta in YLTC and YPSH (optional)* | na |
| 774 | ITCI.LocKey<br>*Add ITCI.LocKey as optional* | na |
| 776 | LPHD.OutOv/InOv and LCCH.OutOv/InOv<br>*Clarified: stays true until buffer space again available* | na |
| 800 | Misspelling in CSYN<br>*CSYN.VInvTmms renamed to CSYN.VIntvTmms* | na |
| 802 | CCGR and Harmonized control authority<br>*Add Loc, LocKSta to every controllable LN (e.g. FSPT)* | na |
| 808 | Presence condition of ZMoT.DExt and new DOs<br>*Change ZMOT.DExt to optional; add TotThmSt and MotSt* | na |
| 831 | Setting of ConfRevNum in LGOS<br>*Add RxConfRevNum to LGOS and LSVS* | Y |
| 838 | Testing in Beh=Blocked<br>*Change sematic of Beh=Blocked to allow controls to be acknowledged even when LN is blocked.* | na |
| 844 | MFLK.PhPiMax, MFLK.PhPiLoFil, MFLK.PhPiRoot DEL->WYE<br>*Change these NFLK objects from cdc=DEL to cdc=WYE* | na |
| 877 | QVUB -settings should be optional<br>*Change QVUB.UnbDetMth and QVUB.StrVal to optional* | na |
| 908 | ARIS.StrSeq – transient<br>*Change ARIS.StrSeq to transient* | na |
| 909 | Remove ANCR.ColOpR and ColOpL<br>*Replace ANCR.ColOpR and ANCR.ColOpL with ANCR.Col-Chg. Add YEFN.ColChg* | na |
| 912 | Clarification of PwrRtg/VARtg<br>*Change many DOs in YPTR, and ZGEN, see name space 2007A2.nsd for final result* | na |
| 920 | Resetable Counter is NOT resetable<br>*Change GGIO.CntRs to CntVal; Same for FCNT* | na |
| 932 | Rename AVCO.SptVol to AVCO.VolSpt | na |
| 933 | Presence of LCCH.RedFerCh and RedRxCnt<br>*Change the presence condition of LCCH.RedChLiv* | na |
| 939 | Change CDC for ANCR.FixCol<br>*Change ANCR.FixCol from APC to ASG* | na |

| Table L.5: Mandatory Edition 2 Tissues | | |
|---|---|---|
| **Tissue** | **Description** | **Implemented Y/na** |
| 991 | LGOS: GoCBRef (as well as LSVS.SvCBRanre ef) should be mandatory<br>*LGOS.GoCBRef and LSVS.SvCBRef are now both mandatory* | Y |
| 1007 | PTRC as fault indicator - Update of description required<br>*PTRC.Tr and Op and Str conditional (at least 1 of group)* | na |
| 1044 | TapChg in AVCO<br>*AVCO.TapChg is now optional* | na |
| 1077 | Rename DOnames within LTIM<br>*LTIM.TmChgDayTm, changed to TmChgDay;*<br>*LTIM.TmChgStdTm changed to TmChgStd* | na |
| 1256 | New DO for LTIM to set time “manually”<br>*Add LTIM.TmSet* | na |
| 1331 | Mod, Beh and Health with q=TEST, client can't receive their states<br>*Mod while in Blocked will always be processed* | Y |
| 1426 | Add two DO for leap seconds in LTIM<br>*LTIM.Leap added,* | na |
| 1456 | Annex A and Mod/Beh/Health<br>*Mod.stVal writes always igore test bits in controls* | Y |
| 1568 | ISAF.AlmReset ->transient<br>*Change ISAF.AmlReset to transient* | na |

Note: TISSUE 675, 735, 772, 775, 776, 878 are not relevant for conformance testing

| Part 8-1 | | |
|---|---|---|
| 770 | GoID type mitmatch 18.1.1 and 18.1.2.5.2<br>*GoID string length is now 129* | Y |
| 784 | Tracking of control (CTS)<br>*Tracking CTS has been added* | na |
| 817 | Fixed-length GOOSE float encoding<br>*GOOSE float is encoded Tag-0x87, length=5, first octet=8* | na |
| 827 | Mandatory ACSI services (Part of 7-2 TISSUE resolution)<br>*Change Table 111 (ServicesSupported): Add initiate, abort, and release. Change conditions for defineNamedVariables.* | Y |
| 834 | File dir name length 64<br>*Filename length changed from 32 to 64* | Y |
| 951 | Encoding of Owner attribute<br>*xRCB.owner is encoded as 4 octets(IPv4) or 16 octets(IPv6)* | na |
| 1040 | More associate error codes<br>*3 additional associate error codes added* | Y |

| | | |
|---|---|---|
| 1178 | Select Response+ is non-null value<br>*Response to SBO read should be <CO_CtrlObjectRef>* | na |
| 1324 | The response- for DeleteNamedVariableList is not defined<br>*numDeleted=0; error=service/object-constraint-conflict* | na |
| 1345 | Fixed-length GOOSE ASN.1 length encoding<br>*GOOSE publisher shall always encode minimum size legth field* | na |
| 1441 | Optonal fields in buffered reports<br>*Writing BRCB.optFld shall not cause a purgeBuf operation* | Y |
| 1442 | Journal variableTag for ReasonCode<br>*Example in the standard is incorrect* | na |
| 1453 | Purge buffer on write to BRCB<br>*PurgeBuf only occurs if different value is written* | 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<br>*CreateDataSet/DefineNamedVariableList specifying a non-existing LD/LN shall fail with access/object-non-existent* | na |
| 1626 | PICS for Information Report is incorrect MMS ServicesSupported "informationReport" should be optional for servers because they never receive InformationReport requests.<br>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 298

Document Version[1]: D05035R01.10
Date: 2021-12-27

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 298 with firmware version v1.7.

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. |

## 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 | 5 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:<br>Called value:<br><br><br><br><br><br><br>Calling values: | Transport selector Y<br>Session selector Y<br>Presentation selector Y<br>AP Title N<br>AE Qualifier N<br>other<br><br>Transport selector Y<br>Session selector Y<br>Presentation selector Y<br>AP Title N<br>AE Qualifier N<br>other |
| As6 | 1,2 | If association parameters are necessary for association, describe the correct Called values: e.g.<br><br><br>Calling parameters: e.g. | Transport selector 0001<br>Session selector 0001<br>Presentation selector 00000001<br>other<br><br>Transport selector 0001<br>Session selector 0001<br>Presentation selector 00000001<br>other |
| As7 | 1,2 | What is the maximum and minimum MMS PDU size | Max MMS PDU size 32,000<br><br>Min MMS PDU size 1300 |
| As8 | 1,2 | What is the maximum start up time after a power supply interrupt | 180 seconds |
| As9 | 1,2 | Does this device function only as test equipment?<br>(test equipment need not have a non-volatile configuration; but it cannot be part of the substation automation system) | N |

## 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:<br>Y Good,<br>N Invalid,<br>N Reserved,<br>N Questionable<br>Detail Quality<br>N Overflow<br>N OutofRange<br>N BadReference<br>N Oscillatory<br>N Failure<br>N OldData<br>N Inconsistent<br>N Inaccurate<br>Miscellaneous:<br>Y Source<br>Y Test<br>N<br>OperatorBlocked |
| Sr2 | 1,2 | Which status value (ST) quality bits are supported (can be set by server) | Validity:<br>Y Good,<br>N Invalid,<br>N Reserved,<br>N Questionable<br>Detail Quality<br>N BadReference<br>N Oscillatory<br>N Failure<br>N OldData<br>N Inconsistent<br>N Inaccurate<br>Miscellaneous:<br>Y Source<br>Y Test<br>N Operator-<br>Blocked |
| Sr3 | - | What is the maximum number of data object references in one GetDataValues request | Deprecated |
| Sr4 | - | What is the maximum number of data object references in one SetDataValues request | Deprecated |
| Sr5 | 1 | Which Mode values are supported [a] | On Y<br>[On-Blocked] N<br>Test Y<br>Test/Blocked Y<br>Off N |

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) | 128 |
| Ds2 | 1 | How many persistent data sets can be created by one or more clients<br>(this number includes predefined datasets) | CreateDataSet not supported. |
| Ds3 | 1 | How many non-persistent data sets can be created by one or more clients | CreateDataSet not supported. |

## PIXIT for SUBSTITUTION MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Sb1 | 1 | Are substituted values stored in volatile memory | Not Supported |

## PIXIT for SETTING GROUP CONTROL MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Sg1 | 1 | What is the number of supported setting groups for each logical device | Not Supported |
| Sg2 | 1,2 | What is the effect of when and how the non-volatile storage is updated<br>(compare IEC 61850-8-1 §16.2.4) | Not Supported |
| Sg3 | 1 | Can multiple clients edit the same setting group | Not Supported |
| Sg4 | 1 | What happens if the association is lost while editing a setting group | Not Supported |
| Sg5 | 1 | Is EditSG value 0 allowed | Not Supported |
| Sg6 | 2 | When ResvTms is not present how long is an edit setting group locked | Not Supported |

## PIXIT for REPORTING MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Rp1 | 1 | The supported trigger conditions are (compare PICS) | integrity Y<br>data change Y<br>quality change Y<br>data update Y<br>general interrogation Y<br><br>*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. |
| Rp2 | 1 | The supported optional fields are | sequence-number Y<br>report-time-stamp Y<br>reason-for-inclusion Y<br>data-set-name Y<br>data-reference Y<br>buffer-overflow Y<br>entryID Y<br>conf-rev Y<br>segmentation Y |
| Rp3 | 1,2 | Can the server send segmented reports<br>(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 §14.2.2.9) | Send report immediately |
| Rp5 | 1 | Multi client URCB approach (compare IEC 61850-7-2:2003 §14.2.1) | Each URCB is visible to all clients |
| Rp6 | - | What is the format of EntryID | Deprecated |
| Rp7 | 1,2 | What is the buffer size for each BRCB or how many reports can be buffered | Buffer size 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:<br>- structured data objects<br>- data attributes | <br>Y<br>Y |
| Rp10 | 1,2 | What is the scan cycle for binary events. Is this fixed, configurable? | 3 ms<br>Fixed |
| Rp11 | 1 | Does the device support to pre-assign a RCB to a specific client in the SCL | N |

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| 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?<br>What fields are used to do the identi-fication? | 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)<br><br>When BRCB.ResvTms is not exposed, what is the internal reservation time (must be >= 0) | N/A<br><br><br><br>0 seconds |
| Rp15 | 2 | Is data model db=0 supported | N |

## 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 spec-ify the Journaling of the same MMS NamedVari-able 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 logging<br><br>(note Ed2 and up requires support for all TrgOps) | Not Supported |

## PIXIT for GOOSE PUBLISH MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Gp1 | 1,2 | Can the test (Ed1) / simulation (Ed2) flag in the published GOOSE be set | N |
| Gp2 | 1 | What is the behaviour when the GOOSE publish configuration is incorrect | NdsCom=T<br>DUT keeps GoEna=F |
| Gp3 | 1,2 | Published FCD supported common data classes are | SPS, ENS, ACD, LPL, DPL, ACT, INS, ORG, SPC<br>Arrays are not supported |
| Gp4 | 1,2 | What is the maximum value of TAL (maxTime)<br>Is it fixed or configurable | Configurable by ICT<br>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<br>See PICS - SetGoCBValues |
| Gp7 | 1,2 | What is the initial GOOSE sqNum after restart | sqNum = 0 |
| Gp8 | 1 | May the GOOSE data set contain:<br>- structured data objects (FCD)<br>- timestamp data attributes | <br>Y<br>Y |
| Gp9 | 1,2 | Does Server or ICT refuse GOOSE payload dataset length greater than SCSM supports? | Y – ICT refuses |

## 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 allData values are accepted? If yes, describe the conditions.<br>Notes:<br>• the VLAN tag may be removed by an Ethernet switch and shall not be checked<br>• the simulation flag shall always be checked (Ed2) | Y destination MAC address<br>Y APPID<br>Y gocbRef<br>Y timeAllowedtoLive<br>N datSet<br>N goID<br>N T<br>Y stNum<br>NsqNum<br>Y simulation / test<br>N confRev<br>Y ndsCom<br>Y numDatSetEntries<br>Y out-of-order dataset members |
| Gs2 | 1,2 | When is a subscribed GOOSE marked as lost<br>(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<br>(Incorrect stNum increment) received within the TAL are discarded, message will be processed after TAL expires and<br>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<br>Y, without the VLAN tag |
| Gs7 | 1 | May the GOOSE data set contain:<br>- structured data objects (FCD)<br>- timestamp data attributes | <br>Y<br>Y |
| Gs8 | 1,2 | Subscribed FCD supported common data classes are | SPS, ACD, ACT, SPC<br>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 |
| Gs11 | 1 | Is Fixed-length encoded GOOSE supported | Y |
| Gs12 | 2 | Is IEC 62351-6 security supported | N |

## PIXIT for GOOSE PERFORMANCE

| ID | Ed | Description | Value / Clarification | |
|---|---|---|---|---|
| Gf1 | 1,2 | Performance class | P2 = 10ms<br>P3 = 20ms | |
| Gf2 | 1,2 | GOOSE ping-pong processing method | Scan cycle based | |
| Gf3 | 1,2 | Application logic scan cycle (ms) | Max. | 4ms (GOOSE PUB)<br>100us (GOOSE SUBS) |
| | | | Min. | 100us (GOOSE PUB)<br>100us (GOOSE PUB) |
| 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 | |

## PIXIT for CONTROL MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Ct1 | 1 | What control models are supported (compare ICD file enums for Ed2) | Dons: Y<br>SBOns: N<br>DOes: N<br>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) |
| Ct5 | 1 | Will the DUT activate the control output when the test attribute is set in the SelectWithValue and/or Operate request (when N test procedure Ctl2 is applicable) | N |
| Ct6 | - | What are the conditions for the time (T) attribute in the SelectWithValue and/or Operate request | Deprecated |
| Ct7 | - | Is pulse configuration supported (compare pulseConfig) | Deprecated |
| Ct8 | 1 | What is the behaviour of the DUT when the check conditions are set<br><br>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<br>N Not-supported<br>N Blocked-by-switching-hierar-chy<br>N Select-failed<br>N Invalid-position<br>N Position-reached<br>N Step-limit<br>N Blocked-by-Mode<br>N Blocked-by-process<br>N Blocked-by-interlocking<br>N Blocked-by-synchrocheck<br>N Command-already-in-execu-tion<br>N Blocked-by-health<br>N 1-of-n-control<br>N Abortion-by-cancel<br>N Time-limit-over<br>N Abortion-by-trip<br>N Object-not-selected<br><br>Edition 1 specific values:<br>N Parameter-change-in-execu-tion ( Ed1 semantics)<br>Edition 2 specific values:<br>N Object-already-selected<br>N No-access-authority<br>N Ended-with-overshoot<br>N Abortion-due-to-deviation<br>N Abortion-by-communication-loss<br>N Blocked-by-command<br>N None<br>N Locked-by-other-client<br>N Parameter-change-in-execu-tion (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 |
| Ct13 | 1,2 | Which origin categories are supported / accepted | Y bay-control<br>Y station-control<br>Y remote-control<br>Y automatic-bay<br>Y automatic-station<br>Y automatic-remote<br>Y maintenance<br>Y process |
| Ct14 | 1,2 | What happens if the orCat value is not supported or invalid | DOns:<br>Operate response- |

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Ct15 | 1,2 | Does the IED accept a SelectWithValue / Operate with the same control value as the current status value<br><br>Is this behaviour configurable | DOns: N<br>Configurable: N |
| Ct16 | 1 | Does the IED accept a select/operate on the same control object from 2 different cli-ents at the same time | DOns: N |
| Ct17 | 1 | Does the IED accept a Select/SelectWith-Value from the same client when the con-trol object is already selected (Tissue #334) | Not Suported |
| 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 oper-ation | 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-exe-cution” | Not Supported |
| Ct23 | 1,2 | How many SBOns/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 possi-ble to have DPC (Controllable Double Point) go to the intermediate state? (00) | N/A |
| Ct26 | 1,2 | Name an enhanced security point (if any) with a finite operate timeout<br><br>specify the timeout (in milliseconds) | Ld/Ln.DataObject, xxx or<br>No DOes points have timeout<br><br>DOes: No<br>SBOes: No |
| Ct27 | 2 | Does the IED support control objects with external signals? | DOns: N<br>SBOns: N<br>DOes: N<br>SBOes: N |
| Ct28 | | Deprecated, kept as placeholder | |

## 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<br>Y ClockFailure<br>Y ClockNotSynchronized |
| Tm2 | 1,2 | Describe the behaviour when all time server(s) cease to respond<br><br>What is the time server lost detection time | IRIG – next second<br><br>SNTP – Configurable<br>“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 5 seconds<br>For the same SNTP time master time adjustment: it takes<br>“Poll Interval” + 5*” 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,<br>SNTP is detected<br>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 |
| Tm8 | 1,2 | Which attributes of the SNTP response packet are validated | N Leap indicator not equal to 3<br>Y Mode is equal to SERVER<br>Y OriginateTimestamp is equal to value sent by the SNTP client as Transmit Timestamp<br>Y RX/TX timestamp fields are checked for reasonableness<br>Y SNTP version 3 and/or 4<br>N other (describe) |
| Tm9 | 1,2 | Do the COMTRADE files have local time or UTC time and is this configur-able | COMTRADE files are not supported on the IED. Native Records may be converted to COMTRADE via software tools.<br>It is configurable to display either Local or UTC time. |

## PIXIT for FILE TRANSFER MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Ft1 | 1 | What is the structure of files and directories<br><br>Where are the COMTRADE files stored<br><br>Are COMTRADE files zipped and what files are included in each zip file | Flat file system with pseudo folders (Ed2)<br><br>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<br>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.<br>(Ed2: always complete path) |
| Ft7 | 1 | Is the wild card supported in the MMS fileDirectory request | Yes, wild card = * |
| Ft8 | 1,2 | Is it allowed that 2 clients get a file at the same time | Y same file<br>Y different files |
| Ft9 | 1,2 | Which files can be deleted | No restriction for deleting files |

## PIXIT for SERVICE TRACKING MODEL

| ID | Ed | Description | Value / Clarification |
|---|---|---|---|
| Tr1 | 2 | Which ACSI services are tracked by LTRK.GenTrk | Not Supported |

# L.5 Data Mapping Specifications

## F-PRO Logical Device

The F-PRO 298 has the following IEC 61850 logical devices (LD) defined in its ICD file:

- FPROProtection
- FPROMeasurements
- FPRORecords
- FPROSystem
- FPROSubscription
- FPROFaultData
- FPROControl

## F-PRO Logical Node Summary

Table L.6: F-PRO 298 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 298 Logical Nodes**

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| **PROTECTION FUNCTIONS** | | | | | |
| FPROProtection | DT27PTUV1 | Time Under Voltage | Dev 27_1 | DTL Under Voltage_1 | PTUV |
| FPROProtection | DT27PTUV2 | Time Under Voltage | Dev 27_2 | DTL Under Voltage_2 | PTUV |
| FPROProtection | DT27PTUV3 | Time Under Voltage | Dev 27_3 | DTL Under Voltage_3 | PTUV |
| FPROProtection | DT27PTUV4 | Time Under Voltage | Dev 27_4 | DTL Under Voltage_4 | PTUV |
| FPROProtection | DT27PTUV5 | Time Under Voltage | Dev 27_5 | DTL Under Voltage_5 | PTUV |
| FPROProtection | DT27PTUV6 | Time Under Voltage | Dev 27_6 | DTL Under Voltage_6 | PTUV |
| FPROProtection | IT27PTUV1 | Time Under Voltage | Dev 27_IT | IDMTL Under Voltage_1 | PTUV |
| FPROProtection | IT27PTUV2 | Time Under Voltage | Dev 27_IT | IDMTL Under Voltage_2 | PTUV |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| FPROProtection | DT59PTOV1 | Time Over Voltage | Dev 59_1 | DTL Over Voltage_1 | PTOV |
| FPROProtection | DT59PTOV2 | Time Over Voltage | Dev 59_2 | DTL Over Voltage_2 | PTOV |
| FPROProtection | DT59PTOV3 | Time Over Voltage | Dev 59_3 | DTL Over Voltage_3 | PTOV |
| FPROProtection | DT59PTOV4 | Time Over Voltage | Dev 59_4 | DTL Over Voltage_4 | PTOV |
| FPROProtection | DT59PTOV5 | Time Over Voltage | Dev 59_5 | DTL Over Voltage_5 | PTOV |
| FPROProtection | DT59PTOV6 | Time Over Voltage | Dev 59_6 | DTL Over Voltage_6 | PTOV |
| FPROProtection | IT59PTOV1 | Time Over Voltage | Dev 59_1 | IDMTL Over Voltage_1 | PTOV |
| FPROProtection | IT59PTOV2 | Time Over Voltage | Dev 59_2 | IDMTL Over Voltage_2 | PTOV |
| FPROProtection | DT24PVPH1 | Time Over Flux | Dev 24_1 | DTL Over Flux_1 | PVPH |
| FPROProtection | DT24PVPH2 | Time Over Flux | Dev 24_2 | DTL Over Flux_2 | PVPH |
| FPROProtection | IT24PVPH3 | Time Over Flux | Dev 24_3 | IDMTL Over Flux_3 | PVPH |
| FPROProtection | DT47PTOV1 | Time Over Voltage | Dev 47_1 | DTL Negative Sequence Over Voltage_1 | PTOV |
| FPROProtection | DT47PTOV2 | Time Over Voltage | Dev 47_2 | DTL Negative Sequence Over Voltage_2 | PTOV |
| FPROProtection | IT47PTOV1 | Time Over Voltage | Dev 47_3 | IDMTL Negative Sequence Over Voltage_1 | PTOV |
| FPROProtection | DT59NPTOV1 | Time Over Voltage | Dev 59N_1 | DTL Derived Ground Over Voltage_1 | PTOV |
| FPROProtection | DT59NPTOV2 | Time Over Voltage | Dev 59N_2 | DTL Derived Ground Over Voltage_1 | PTOV |
| FPROProtection | IT59NPTOV1 | Time Over Voltage | Dev 59N_1 | IDMTL Derived Ground Over Voltage_31 | PTOV |
| FPROProtection | D37PTUC1 | Undercurrent (directional) | Dev 37_1 | Inst. Phase Undercurrent_1 | PIUC |
| FPROProtection | D37PTUC2 | Undercurrent (directional) | Dev 37_2 | Inst. Phase Undercurrent_2 | PIUC |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| FPROProtection | D50PIOC1 | Instantaneous Overcurrent (directional) | Dev 50/ 67_1 | Inst. Phase Overcurrent_1 | PIOC |
| FPROProtection | D50PIOC2 | Instantaneous Overcurrent (directional) | Dev 50/ 67_2 | Inst. Phase Overcurrent_2 | PIOC |
| FPROProtection | D51PTOC1 | Time Overcurrent (directional) | Dev 51/ 67_1 | IDMTL Phase Overcurrent | PTOC |
| FPROProtection | D51PTOC2 | Time Overcurrent (directional) | Dev 51/ 67_2 | IDMTL Phase Overcurrent | PTOC |
| FPROProtection | D50NPIOC1 | Instantaneous Overcurrent (directional) | Dev 50/ 67N_1 | Inst. Phase Overcurrent_1 (Derived) | PIOC |
| FPROProtection | D50NPIOC2 | Instantaneous Overcurrent (directional) | Dev 50N/ 67_2 | Inst. Phase Overcurrent_2 (Derived) | PIOC |
| FPROProtection | D51NPTOC1 | Time Overcurrent (directional) | Dev 51/ 67N_1 | IDMTL Neutral Overcurrent (Derived) | PTOC |
| FPROProtection | D51NPTOC2 | Time Overcurrent (directional) | Dev 51/ 67N_2 | IDMTL Neutral Overcurrent (Derived) | PTOC |
| FPROProtection | D50GPIOC1 | Instantaneous Overcurrent (directional) | Dev 50G_1 | Inst. Phase Overcurrent_1 (Measured) | PIOC |
| FPROProtection | D50GPIOC2 | Instantaneous Overcurrent (directional) | Dev 50G_2 | Inst. Phase Overcurrent_2(Measured) | PIOC |
| FPROProtection | D51GPTOC1 | Time Overcurrent (directional) | Dev 51G_1 | IDMTL Neutral Overcurrent (Measured) | PTOC |
| FPROProtection | D4650PIOC1 | Instantaneous Overcurrent | Dev 46_50 | Inst. Negative Sequence Overcurrent | PIOC |
| FPROProtection | D4651PTOC1 | Time Overcurrent | Dev 46_51 | IDMTL Negative Sequence Overcurrent | PTOC |
| FPROProtection | D50RPIOC1 | Instantaneous Overcurrent | Dev 50R_1 | Inst. REF/SEF Overcurrent_1 | PIOC |
| FPROProtection | D50RPIOC2 | Instantaneous Overcurrent | Dev 50R_2 | Inst. REF/SEF Overcurrent_2 | PIOC |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| FPROProtection | D51RPTOC1 | Time Overcurrent (directional) | Dev 51R_1 | IDMTL REF/SEF Overcurrent_1 | PTOC |
| FPROProtection | D51RPTOC2 | Time Overcurrent (directional) | Dev 51R_2 | IDMTL REF/SEF Overcurrent_2 | PTOC |
| FPROProtection | D49PTTR1 | Thermal Overload | Dev 49 | Thermal Overload | PTTR |
| FPROProtection | D81H2PHAR1 | Harmonic Restraint | Dev 81HBL2 | 2nd Harmonic Inrush Block | PHAR |
| FPROProtection | D81UPTUF1 | Under Frequency | Dev 81UF_1 | Under Frequency_1 | PTUF |
| FPROProtection | D81UPTUF2 | Under Frequency | Dev 81UF_2 | Under Frequency_2 | PTUF |
| FPROProtection | D81UPTUF3 | Under Frequency | Dev 81UF_3 | Under Frequency_3 | PTUF |
| FPROProtection | D81UPTUF4 | Under Frequency | Dev 81UF_4 | Under Frequency_4 | PTUF |
| FPROProtection | D81UPTUF5 | Under Frequency | Dev 81UF_5 | Under Frequency_5 | PTUF |
| FPROProtection | D81UPTUF6 | Under Frequency | Dev 81UF_6 | Under Frequency_6 | PTUF |
| FPROProtection | D81UPTUF7 | Under Frequency | Dev 81UF_7 | Under Frequency_7 | PTUF |
| FPROProtection | D81UPTUF8 | Under Frequency | Dev 81UF_8 | Under Frequency_8 | PTUF |
| FPROProtection | D81OPTOF1 | Over Frequency | Dev 81OF_1 | Over Frequency_1 | PTOF |
| FPROProtection | D81OPTOF2 | Over Frequency | Dev 81OF_2 | Over Frequency_2 | PTOF |
| FPROProtection | D81OPTOF3 | Over Frequency | Dev 81OF_3 | Over Frequency_3 | PTOF |
| FPROProtection | D81OPTOF4 | Over Frequency | Dev 81OF_4 | Over Frequency_4 | PTOF |
| FPROProtection | D81OPTOF5 | Over Frequency | Dev 81OF_5 | Over Frequency_5 | PTOF |
| FPROProtection | D81OPTOF6 | Over Frequency | Dev 81OF_6 | Over Frequency_6 | PTOF |
| FPROProtection | D81OPTOF7 | Over Frequency | Dev 81OF_7 | Over Frequency_7 | PTOF |
| FPROProtection | D81OPTOF8 | Over Frequency | Dev 81OF_8 | Over Frequency_8 | PTOF |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| FPROProtection | D81RPFRC1 | Rate of Change of Frequency | Dev 81ROCOF_1 | Rate of Change of Frequency_1 | PFRC |
| FPROProtection | D81RPFRC2 | Rate of Change of Frequency | Dev 81ROCOF_2 | Rate of Change of Frequency_1 | PFRC |
| FPROProtection | D81RPFRC3 | Rate of Change of Frequency | Dev 81ROCOF_3 | Rate of Change of Frequency_1 | PFRC |
| FPROProtection | D81RPFRC4 | Rate of Change of Frequency | Dev 81ROCOF_4 | Rate of Change of Frequency_1 | PFRC |
| FPROProtection | D32PDUP1 | Directional Underpower | Dev 32PDUP_1 | Directional Underpower_1 | PDOP |
| FPROProtection | D32PDUP2 | Directional Underpower | Dev 32PDUP_2 | Directional Underpower _2 | PDOP |
| FPROProtection | D32PDUP3 | Directional Underpower | Dev 32PDUP_3 | Directional Underpower _3 | PDOP |
| FPROProtection | D32PDUP4 | Directional Underpower | Dev 32PDUP_4 | Directional Underpower _4 | PDOP |
| FPROProtection | D32PDOP1 | Directional Overpower | Dev 32PDOP_1 | Directional Overpower_1 | PDOP |
| FPROProtection | D32PDOP2 | Directional Overpower | Dev 32PDOP_2 | Directional Overpower_2 | PDOP |
| FPROProtection | D32PDOP3 | Directional Overpower | Dev 32PDOP_3 | Directional Overpower_3 | PDOP |
| FPROProtection | D32PDOP4 | Directional Overpower | Dev 32PDOP_4 | Directional Overpower_4 | PDOP |
| **PROTECTION RELATED FUNCTIONS** | | | | | |
| FPROProtection | D46BCPTOC3 | Time Overcurrent (directional) | Dev 46BC | Broken Conductor Detection | PTOC |
| FPROProtection | D60PTSPTOV7 | Time Over Voltage | Dev PTS | VT Supervision | PTOV |
| FPROProtection | D60CTSPTOC4 | Time Overcurrent (directional) | Dev CTS | CT Supervision | PTOC |
| FPROProtection | D50BFRBRF1 | Breaker Failure | Dev 50BF | Breaker Failure | RBRF |
| FPROProtection | DDICBFRBRF2 | Breaker Failure | Dev CBF | Breaker Failure | RBRF |
| FPROProtection | D74TCSRTCS1 | **New LN**: **R**-LN Group; **T**-Trip; **C**-Circuit; **S**-Supervision | Dev 74TCS1 | Trip Circuit Supervision | RTCS |
| FPROProtection | D74TCSRTCS2 | **New LN**: **R**-LN Group; **T**-Trip; **C**-Circuit; **S**-Supervision | Dev 74TCS2 | Trip Circuit Supervision | RTCS |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| FPROProtection | I2TRCBC1 | **New LN**: **R**-LN Group; **C**-Circuit; **B**-Breaker; **C**-Condition | Dev I2T | CB Monitoring | RCBC |
| FPROProtection | THDRTHD1 | **New LN**: **R**-LN Group; **T**-Total; **H**-Harmonic; **D**-Distortion | Dev THD_1 | Total Harmonic Distortion_1 | RTHD |
| FPROProtection | THDRTHD2 | **New LN**: **R**-LN Group; **T**-Total; **H**-Harmonic; **D**-Distortion | Dev THD_2 | Total Harmonic Distortion_2 | RTHD |
| FPROProtection | UVCRUVC1 | **New LN**: **R**-LN Group; **U**-Under; **V**- Voltage; **C**-Counter | Dev UVC_1 | Under Voltage Counter | RUVC |
| FPROProtection | OVCROVC1 | **New LN**: **R**-LN Group; **U**-Under; **V**- Voltage; **C**-Counter | Dev OVC_1 | Over Voltage Counter | ROVC |
| FPROProtection | UFCRUFC1 | **New LN**: **R**-LN Group; **U**-Under; **V**- Voltage; **C**-Counter | Dev UFC_1 | Under Frequency Counter | RUFC |
| FPROProtection | OFCROFC1 | **New LN**: **R**-LN Group; **U**-Under; **V**- Voltage; **C**-Counter | Dev OFC_1 | Over Frequency Counter | ROFC |
| FPROProtection | EICREIC1 | **New LN**: **R**-LN Group; **U**-Under; **V**- Voltage; **C**-Counter | Dev EIC_1 | External Input Counter | REIC |
| FPROProtection | D79RREC1 | Auto Reclosing | Dev 79 | Auto Reclose | RREC |
| FPROProtection | D79GGIO1 | Auto Reclosing | Dev 79 | Auto Reclose | GGIO |
| **PROTECTION CONTROL** | | | | | |
| FPROProtection | TRCALH1 | Alarm Handling | NA | Status of Starter/ Trip Elements | CALH |
| **MEASUREMENTS** | | | | | |
| FPROMeasurements | ANAMMXU1 | Measurements | NA | Analog Channel Input Measurement (3 Phase Current(s) & Voltage(s)) | MMXU |
| FPROMeasurements | ANAMMXU2 | Measurements | NA | Analog Channel Input Measurement | MMXU |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| FPROMeasurements | SEQMSQI1 | Sequence & Imbalance | NA | Sequence Components of Voltage & Current (V1, V2, V0, I1, I2, I0) | MSQI |
| FPROMeasurements | MMMTHR1 | Measurements | NA | 79count and 79Cumm_count_alarm | MTHR1 |
| **RECORDS** | | | | | |
| FPRORecords | DRRDRE1 | Disturbance Record | NA | Disturbance Record | RDRE |
| **GENERIC FUNCTIONS** | | | | | |
| FPROSystem | HEALTHGGIO8 | Generic Process I/O | Relay Health | Relay Health Status | GGIO |
| FPROSystem | IRIGGGIO6 | Generic Process I/O | IRIG-B | IRIG-B Status | GGIO |
| FPROSystem | SNTPGGIO7 | Generic Process I/O | SNTP Monitoring | SNTP Status | GGIO |
| FPROSystem | ComAlmGGIO9 | Generic Process I/O | IEC61850 Comm. Alarm | IEC61850 Comm. Alarm Status | GGIO |
| FPROSystem | LEDGGIO4 | Generic Process I/O | HMI LED Monitoring | LED Status (1-14) | GGIO |
| FPROSystem | EIGGIO1 | Generic Process I/O | External Inputs | Status of External Inputs (1-14) | GGIO |
| FPROSystem | OCGGIO2 | Generic Process I/O | Output Contacts | Status of Output Contacts (1-14) | GGIO |
| FPROSystem | PLGGIO3 | Generic Process I/O | Prologic's | Status of Prologic's (1-20) | GGIO |
| FPROSystem | VIGGIO5 | Generic Process I/O | Virtual Input Status | Virtual Inputs Status (1-30) | GGIO |
| **SUBSCRIPTION** | | | | | |
| FPROSubscription | SUBSCRGGIO1 | Generic Process I/O | GOOSE Subscription | Virtual Inputs Status (1-30) | GGIO |
| **FAULT** | | | | | |
| FPROFaultData | FLTMMXU1 | Fault Measurement Data | NA | Fault Current & Voltage Details | MMXU |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Refere nce |
|---|---|---|---|---|---|
| FPROFaultData | FLTMSQI1 | Fault Sequence & Imbalance Data | NA | Negative Sequence Current D& Voltage Details | MSQI |
| FPROFaultData | FLTMTHR1 | Fault Location & Impedance Data | NA | Fault Location, Fault Angle and Magnitude | MTHR |
| **CONTROL** | | | | | |
| FPROControl | SPCSOPULG GIO1 | Generic Process I/O | Single Point Pulse Type Control Input | Single Point Control Input & Status Output (1-6) | GGIO |
| FPROControl | SPCSOLATG GIO2 | Generic Process I/O | Single Point Latch Type Control Input | Single Point Control Input & Status Output (7-12) | GGIO |
| FPROControl | DPCSOPULG GIO3 | Generic Process I/O | Double Point Pulse Type Control Input | Double Point Control Input & Status Output (1-4) | GGIO |
| FPROControl | CtlModGGIO4 | Generic Process I/O | Control Mode Status | Control Input Status (1-3) | GGIO |

## Logical Node Specifications

The following sections provide detailed spec information on the F-PRO 298xAy logical device and logical nodes as defined in the Table N.19 “F-PRO Logical Nodes”.

Common Logical Node information is not shown here. Only the data that are provided from the F-PRO application to the IEC 61850 sub-system are listed here.

## Protection Logical Device

### DT27PTUV1

This section defines the logical node data for DT27PTUV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV1.ST.Str.general | Start (27DT-1 Picked up) | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.PhsA | Start (27DT-1 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.PhsB | Start (27DT-1 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.PhsC | Start (27DT-1 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.general | Operate (27DT-1 Operated) | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.PhsA | Operate(27DT-1Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.PhsB | Operate(27DT-1 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.PhsC | Operate(27DT-1 Operated) Phase C | | STATUS_HANDLER |

### DT27PTUV1

This section defines the logical node data for DT27PTUV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV1.ST.Str.general | Start (27DT-1 Picked up) | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.PhsA | Start (27DT-1 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.PhsB | Start (27DT-1 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV1.ST.Str.PhsC | Start (27DT-1 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.general | Operate (27DT-1 Operated) | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.PhsA | Operate(27DT-1Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.PhsB | Operate(27DT-1 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV1.ST.Op.PhsC | Operate(27DT-1 Operated) Phase C | | STATUS_HANDLER |

### DT27PTUV2

This section defines the logical node data for DT27PTUV2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV2.ST.Str.general | Start (27DT-2 Picked up) | | STATUS_HANDLER |
| DT27PTUV2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV2.ST.Str.PhsA | Start (27DT-2 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV2.ST.Str.PhsB | Start (27DT-2 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV2.ST.Str.PhsC | Start (27DT-2 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV2.ST.Op.general | Operate (27DT-2 Operated) | | STATUS_HANDLER |
| DT27PTUV2.ST.Op.PhsA | Operate(27DT-2 Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV2.ST.Op.PhsB | Operate(27DT-2 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV2.ST.Op.PhsC | Operate(27DT-2 Operated) Phase C | | STATUS_HANDLER |

### DT27PTUV3

This section defines the logical node data for DT27PTUV3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV3.ST.Str.general | Start (27DT-3 Picked up) | | STATUS_HANDLER |
| DT27PTUV3.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV3.ST.Str.PhsA | Start (27DT-3 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV3.ST.Str.PhsB | Start (27DT-3 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV3.ST.Str.PhsC | Start (27DT-3 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV3.ST.Op.general | Operate (27DT-3 Operated) | | STATUS_HANDLER |
| DT27PTUV3.ST.Op.PhsA | Operate(27DT-3 Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV3.ST.Op.PhsB | Operate(27DT-3 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV3.ST.Op.PhsC | Operate(27DT-2 Operated) Phase C | | STATUS_HANDLER |

### DT27PTUV4

This section defines the logical node data for DT27PTUV4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV4.ST.Str. general | Start (27DT-4 Picked up) | | STATUS_HANDLER |
| DT27PTUV4.ST.Str. dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV4.ST.Str. PhsA | Start (27DT-4 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV4.ST.Str. PhsB | Start (27DT-4 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV4.ST.Str. PhsC | Start (27DT-4 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV4.ST.Op. general | Operate (27DT-4 Operated) | | STATUS_HANDLER |
| DT27PTUV4.ST.Op. PhsA | Operate(27DT-4 Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV4.ST.Op. PhsB | Operate(27DT-4 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV4.ST.Op. PhsC | Operate(27DT-4 Operated) Phase C | | STATUS_HANDLER |

### DT27PTUV5

This section defines the logical node data for DT27PTUV5 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV5.ST.Str. general | Start (27DT-5 Picked up) | | STATUS_HANDLER |
| DT27PTUV5.ST.Str. dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV5.ST.Str. PhsA | Start (27DT-5 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV5.ST.Str. PhsB | Start (27DT-5 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV5.ST.Str. PhsC | Start (27DT-5 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV5.ST.Op. general | Operate (27DT-5 Operated) | | STATUS_HANDLER |
| DT27PTUV5.ST.Op. PhsA | Operate(27DT-5 Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV5.ST.Op. PhsB | Operate(27DT-5 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV5.ST.Op. PhsC | Operate(27DT-5 Operated) Phase C | | STATUS_HANDLER |

### DT27PTUV6

This section defines the logical node data for DT27PTUV6 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT27PTUV6.ST.Str.general | Start (27DT-6 Picked up) | | STATUS_HANDLER |
| DT27PTUV6.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT27PTUV6.ST.Str.PhsA | Start (27DT-6 Picked up) Phase A | | STATUS_HANDLER |
| DT27PTUV6.ST.Str.PhsB | Start (27DT-6 Picked up) Phase B | | STATUS_HANDLER |
| DT27PTUV6.ST.Str.PhsC | Start (27DT-6 Picked up) Phase C | | STATUS_HANDLER |
| DT27PTUV6.ST.Op.general | Operate (27DT-6 Operated) | | STATUS_HANDLER |
| DT27PTUV6.ST.Op.PhsA | Operate(27DT-6 Operated) Phase A | | STATUS_HANDLER |
| DT27PTUV6.ST.Op.PhsB | Operate(27DT-6 Operated) Phase B | | STATUS_HANDLER |
| DT27PTUV6.ST.Op.PhsC | Operate(27DT-6 Operated) Phase C | | STATUS_HANDLER |

### IT27PTUV1

This section defines the logical node data for IT27PTUV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT27PTUV1.ST.Str.general | Start (27IT-1 Picked up) | | STATUS_HANDLER |
| IT27PTUV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT27PTUV1.ST.Str.PhsA | Start (27IT-1 Picked up) Phase A | | STATUS_HANDLER |
| IT27PTUV1.ST.Str.PhsB | Start (27IT-1 Picked up) Phase B | | STATUS_HANDLER |
| IT27PTUV1.ST.Str.PhsC | Start (27IT-1 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| IT27PTUV1.ST.Op.general | Operate (27IT-1 Operated) | | STATUS_HANDLER |
| IT27PTUV1.ST.Op.PhsA | Operate(27IT-1 Operated) Phase A | | STATUS_HANDLER |
| IT27PTUV1.ST.Op.PhsB | Operate(27IT-1 Operated) Phase B | | STATUS_HANDLER |
| IT27PTUV1.ST.Op.PhsC | Operate(27IT-1 Operated) Phase C | | STATUS_HANDLER |

### IT27PTUV2

This section defines the logical node data for IT27PTUV2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT27PTUV2.ST.Str.general | Start (27IT-2 Picked up) | | STATUS_HANDLER |
| IT27PTUV2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT27PTUV2.ST.Str.PhsA | Start (27IT-2 Picked up) Phase A | | STATUS_HANDLER |
| IT27PTUV2.ST.Str.PhsB | Start (27IT-2 Picked up) Phase B | | STATUS_HANDLER |
| IT27PTUV2.ST.Str.PhsC | Start (27IT-2 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| IT27PTUV2.ST.Op.general | Operate (27IT-2 Operated) | | STATUS_HANDLER |
| IT27PTUV2.ST.Op.PhsA | Operate(27IT-2 Operated) Phase A | | STATUS_HANDLER |
| IT27PTUV2.ST.Op.PhsB | Operate(27IT-2 Operated) Phase B | | STATUS_HANDLER |
| IT27PTUV2.ST.Op.PhsC | Operate(27IT-2 Operated) Phase C | | STATUS_HANDLER |

### DT59PTOV1

This section defines the logical node data for DT59PTOV1 of the FPROProtection logical device

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59PTOV1.ST.Str.general | Start (59DT-1 Picked up) | | STATUS_HANDLER |
| DT59PTOV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PTOV1.ST.Str.PhsA | Start (59DT-1 Picked up) Phase A | | STATUS_HANDLER |
| DT59PTOV1.ST.Str.PhsB | Start (59DT-1 Picked up) Phase B | | STATUS_HANDLER |
| DT59PTOV1.ST.Str.PhsC | Start (59DT-1 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT59PTOV1.ST.Op.general | Operate (59DT-1 Operated) | | STATUS_HANDLER |
| DT59PTOV1.ST.Op.PhsA | Operate(59DT-1 Operated) Phase A | | STATUS_HANDLER |
| DT59PTOV1.ST.Op.PhsB | Operate(59DT-1 Operated) Phase B | | STATUS_HANDLER |
| DT59PTOV1.ST.Op.PhsC | Operate(59DT-1 Operated) Phase C | | STATUS_HANDLER |

### DT59PTOV2

This section defines the logical node data for DT59PTOV2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59PTOV2.ST.Str.general | Start (59DT-2 Picked up) | | STATUS_HANDLER |
| DT59PTOV2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PTOV2.ST.Str.PhsA | Start (59DT-2 Picked up) Phase A | | STATUS_HANDLER |
| DT59PTOV2.ST.Str.PhsB | Start (59DT-2 Picked up) Phase B | | STATUS_HANDLER |
| DT59PTOV2.ST.Str.PhsC | Start (59DT-2 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT59PTOV2.ST.Op.general | Operate (59DT-2 Operated) | | STATUS_HANDLER |
| DT59PTOV2.ST.Op.PhsA | Operate(59DT-2 Operated) Phase A | | STATUS_HANDLER |
| DT59PTOV2.ST.Op.PhsB | Operate(59DT-2 Operated) Phase B | | STATUS_HANDLER |
| DT59PTOV2.ST.Op.PhsC | Operate(59DT-2 Operated) Phase C | | STATUS_HANDLER |

### DT59PTOV3

This section defines the logical node data for DT59PTOV3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59PTOV3.ST.Str.general | Start (59DT-3 Picked up) | | STATUS_HANDLER |
| DT59PTOV3.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PTOV3.ST.Str.PhsA | Start (59DT-3 Picked up) Phase A | | STATUS_HANDLER |
| DT59PTOV3.ST.Str.PhsB | Start (59DT-3 Picked up) Phase B | | STATUS_HANDLER |
| DT59PTOV3.ST.Str.PhsC | Start (59DT-3 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT59PTOV3.ST.Op.general | Operate (59DT-3 Operated) | | STATUS_HANDLER |
| DT59PTOV3.ST.Op.PhsA | Operate(59DT-3 Operated) Phase A | | STATUS_HANDLER |
| DT59PTOV3.ST.Op.PhsB | Operate(59DT-3 Operated) Phase B | | STATUS_HANDLER |
| DT59PTOV3.ST.Op.PhsC | Operate(59DT-3 Operated) Phase C | | STATUS_HANDLER |

### DT59PTOV4

This section defines the logical node data for DT59PTOV4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59PTOV4.ST.Str.general | Start (59DT-4 Picked up) | | STATUS_HANDLER |
| DT59PTOV4.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PTOV4.ST.Str.PhsA | Start (59DT-4 Picked up) Phase A | | STATUS_HANDLER |
| DT59PTOV4.ST.Str.PhsB | Start (59DT-4 Picked up) Phase B | | STATUS_HANDLER |
| DT59PTOV4.ST.Str.PhsC | Start (59DT-4 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT59PTOV4.ST.Op.general | Operate (59DT-4 Operated) | | STATUS_HANDLER |
| DT59PTOV4.ST.Op.PhsA | Operate(59DT-4 Operated) Phase A | | STATUS_HANDLER |
| DT59PTOV4.ST.Op.PhsB | Operate(59DT-4 Operated) Phase B | | STATUS_HANDLER |
| DT59PTOV4.ST.Op.PhsC | Operate(59DT-4 Operated) Phase C | | STATUS_HANDLER |

### DT59PTOV5

This section defines the logical node data for DT59PTOV5 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59PTOV5.ST.Str.general | Start (59DT-5 Picked up) | | STATUS_HANDLER |
| DT59PTOV5.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PTOV5.ST.Str.PhsA | Start (59DT-5 Picked up) Phase A | | STATUS_HANDLER |
| DT59PTOV5.ST.Str.PhsB | Start (59DT-5 Picked up) Phase B | | STATUS_HANDLER |
| DT59PTOV5.ST.Str.PhsC | Start (59DT-5 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT59PTOV5.ST.Op.general | Operate (59DT-5 Operated) | | STATUS_HANDLER |
| DT59PTOV5.ST.Op.PhsA | Operate(59DT-5 Operated) Phase A | | STATUS_HANDLER |
| DT59PTOV5.ST.Op.PhsB | Operate(59DT-5 Operated) Phase B | | STATUS_HANDLER |
| DT59PTOV5.ST.Op.PhsC | Operate(59DT-5 Operated) Phase C | | STATUS_HANDLER |

### DT59PTOV6

This section defines the logical node data for DT59PTOV6 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59PTOV6.ST.Str.general | Start (59DT-6 Picked up) | | STATUS_HANDLER |
| DT59PTOV6.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PTOV6.ST.Str.PhsA | Start (59DT-6 Picked up) Phase A | | STATUS_HANDLER |
| DT59PTOV6.ST.Str.PhsB | Start (59DT-6 Picked up) Phase B | | STATUS_HANDLER |
| DT59PTOV6.ST.Str.PhsC | Start (59DT-6 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT59PTOV6.ST.Op.general | Operate (59DT-6 Operated) | | STATUS_HANDLER |
| DT59PTOV6.ST.Op.PhsA | Operate(59DT-6 Operated) Phase A | | STATUS_HANDLER |
| DT59PTOV6.ST.Op.PhsB | Operate(59DT-6 Operated) Phase B | | STATUS_HANDLER |
| DT59PTOV6.ST.Op.PhsC | Operate(59DT-6 Operated) Phase C | | STATUS_HANDLER |

### IT59PTOV1

This section defines the logical node data for IT59PTOV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT59PTOV1.ST.Str.general | Start (59IT-1 Picked up) | | STATUS_HANDLER |
| IT59PTOV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT59PTOV1.ST.Str.PhsA | Start (59IT-1 Picked up) Phase A | | STATUS_HANDLER |
| IT59PTOV1.ST.Str.PhsB | Start (59IT-1 Picked up) Phase B | | STATUS_HANDLER |
| IT59PTOV1.ST.Str.PhsC | Start (59IT-1 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| IT59PTOV1.ST.Op.general | Operate (59IT-1 Operated) | | STATUS_HANDLER |
| IT59PTOV1.ST.Op.PhsA | Operate(59IT-1 Operated) Phase A | | STATUS_HANDLER |
| IT59PTOV1.ST.Op.PhsB | Operate(59IT-1 Operated) Phase B | | STATUS_HANDLER |
| IT59PTO17.ST.Op.PhsC | Operate(59IT-1 Operated) Phase C | | STATUS_HANDLER |

### IT59PTOV2

This section defines the logical node data for IT59PTOV2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT59PTOV2.ST.Str.general | Start (59IT-2 Picked up) | | STATUS_HANDLER |
| IT59PTOV2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT59PTOV2.ST.Str.PhsA | Start (59IT-2 Picked up) Phase A | | STATUS_HANDLER |
| IT59PTOV2.ST.Str.PhsB | Start (59IT-2 Picked up) Phase B | | STATUS_HANDLER |
| IT59PTOV2.ST.Str.PhsC | Start (59IT-2 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| IT59PTOV2.ST.Op.general | Operate (59IT-2 Operated) | | STATUS_HANDLER |
| IT59PTOV2.ST.Op.PhsA | Operate(59IT-2 Operated) Phase A | | STATUS_HANDLER |
| IT59PTOV2.ST.Op.PhsB | Operate(59IT-2 Operated) Phase B | | STATUS_HANDLER |
| IT59PTOV2.ST.Op.PhsC | Operate(59IT-2 Operated) Phase C | | STATUS_HANDLER |

### DT24PVPH1

This section defines the logical node data for DT24PVPH1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT24PVPH1.ST.Str.general | Start (24DT-1 Picked up) | | STATUS_HANDLER |
| DT24PVPH1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT24PVPH1.ST.Str.PhsA | Start (24DT-1 Picked up) Phase A | | STATUS_HANDLER |
| DT24PVPH1.ST.Str.PhsB | Start (24DT-1 Picked up) Phase B | | STATUS_HANDLER |
| DT24PVPH1.ST.Str.PhsC | Start (24DT-1 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT24PVPH1.ST.Op.general | Operate (24DT-1 Operated) | | STATUS_HANDLER |
| DT24PVPH1.ST.Op.PhsA | Operate(24DT-1 Operated) Phase A | | STATUS_HANDLER |
| DT24PVPH1.ST.Op.PhsB | Operate(24DT-1 Operated) Phase B | | STATUS_HANDLER |
| DT24PVPH1.ST.Op.PhsC | Operate(24DT-1 Operated) Phase C | | STATUS_HANDLER |

### DT24PVPH2

This section defines the logical node data for DT24PVPH2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT24PVPH2.ST.Str.general | Start (24DT-2 Picked up) | | STATUS_HANDLER |
| DT24PVPH2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT24PVPH2.ST.Str.PhsA | Start (24DT-2 Picked up) Phase A | | STATUS_HANDLER |
| DT24PVPH2.ST.Str.PhsB | Start (24DT-2 Picked up) Phase B | | STATUS_HANDLER |
| DT24PVPH2.ST.Str.PhsC | Start (24DT-2 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| DT24PVPH2.ST.Op.general | Operate (24DT-2 Operated) | | STATUS_HANDLER |
| DT24PVPH2.ST.Op.PhsA | Operate(24DT-2 Operated) Phase A | | STATUS_HANDLER |
| DT24PVPH2.ST.Op.PhsB | Operate(24DT-2 Operated) Phase B | | STATUS_HANDLER |
| DT24PVPH2.ST.Op.PhsC | Operate(24DT-2 Operated) Phase C | | STATUS_HANDLER |

### IT24PVPH1

This section defines the logical node data for IT24PVPH1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT24PVPH1.ST.Str.general | Start (24IT-1 Picked up) | | STATUS_HANDLER |
| IT24PVPH1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT24PVPH1.ST.Str.PhsA | Start (24IT-1 Picked up) Phase A | | STATUS_HANDLER |
| IT24PVPH1.ST.Str.PhsB | Start (24IT-1 Picked up) Phase B | | STATUS_HANDLER |
| IT24PVPH1.ST.Str.PhsC | Start (24IT-1 Picked up) Phase C | | STATUS_HANDLER |
| IT24PVPH1.ST.Op.general | Operate (24IT-1 Operated) | | STATUS_HANDLER |
| IT24PVPH1.ST.Op.PhsA | Operate(24IT-1 Operated) Phase A | | STATUS_HANDLER |
| IT24PVPH1.ST.Op.PhsB | Operate(24IT-1 Operated) Phase B | | STATUS_HANDLER |
| IT24PVPH1.ST.Op.PhsC | Operate(24IT-1 Operated) Phase C | | STATUS_HANDLER |

### DT47PTOV1

This section defines the logical node data for DT47PTOV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT47PTOV1.ST.Str.general | Start (47DT-1 Picked up) | | STATUS_HANDLER |
| DT47PTOV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT47PTOV1.ST.Op.general | Operate (47DT-1 Operated) | | STATUS_HANDLER |

### DT47PTOV2

This section defines the logical node data for DT47PTOV2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT47PTOV2.ST.Str.general | Start (47DT-2 Picked up) | | STATUS_HANDLER |
| DT47PTOV2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT47PTOV2.ST.Op.general | Operate (47DT-2 Operated) | | STATUS_HANDLER |

### IT47PTOV1

This section defines the logical node data for DT47PTOV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT47PTOV1.ST.Str.general | Start (47IT-1 Picked up) | | STATUS_HANDLER |
| IT47PTOV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT47PTOV1.ST.Op.general | Operate (47IT-1 Operated) | | STATUS_HANDLER |

### DT59NPTOV1

This section defines the logical node data for DT59NPTOV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59NPTOV1.ST.Str.general | Start (59NDT-1 Picked up) | | STATUS_HANDLER |
| DT59NPTOV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59PNTOV1.ST.Op.general | Operate (59NDT-1 Operated) | | STATUS_HANDLER |

### DT59NPTOV2

This section defines the logical node data for DT59NPTOV2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DT59NPTOV2.ST.Str.general | Start (59NDT-2 Picked up) | | STATUS_HANDLER |
| DT59NPTOV2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| DT59NPTOV2.ST.Op.general | Operate (59NDT-2 Operated) | | STATUS_HANDLER |

### IT59NPTOV1

This section defines the logical node data for IT59NPTOV1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IT59NPTOV1.ST.Str.general | Start (59NIT-1 Picked up) | | STATUS_HANDLER |
| IT59NPTOV1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| IT59NPTOV1.ST.Op.general | Operate (59NIT-1 Operated) | | STATUS_HANDLER |

### D37PTUC1

This section defines the logical node data for D37PTUC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D37PTUC1.ST.Str.general | Start (37-1 Picked up) | | STATUS_HANDLER |
| D37PTUC1.ST.Str.phsA | Start (37-1 Picked up) Phase A | | STATUS_HANDLER |
| D37PTUC1.ST.Str.phsB | Start (37-1 Picked up) Phase B | | STATUS_HANDLER |
| D37PTUC1.ST.Str.phsC | Start (37-1 Picked up) Phase C | | STATUS_HANDLER |
| D37PTUC1.ST.Op.general | Operate (37-1 Operated) | | STATUS_HANDLER |
| D37PTUC1.ST.Op.phsA | Operate (37-1 Operated) Phase A | | STATUS_HANDLER |
| D37PTUC1.ST.Op.phsB | Operate (37-1 Operated) Phase B | | STATUS_HANDLER |
| D37PTUC1.ST.Op.phsC | Operate (37-1 Operated) Phase C | | STATUS_HANDLER |

### D37PTUC2

This section defines the logical node data for D37PTUC2 of the FPROProtection logicaldevice.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D37PTUC2.ST.Str.general | Start (37-2 Picked up) | | STATUS_HANDLER |
| D37PTUC2.ST.Str.phsA | Start (37-2 Picked up) Phase A | | STATUS_HANDLER |
| D37PTUC2.ST.Str.phsB | Start (37-2 Picked up) Phase B | | STATUS_HANDLER |
| D37PTUC2.ST.Str.phsC | Start (37-2 Picked up) Phase C | | STATUS_HANDLER |
| D37PTUC2.ST.Op.general | Operate (37-2 Operated) | | STATUS_HANDLER |
| D37PTUC2.ST.Op.phsA | Operate (37-2 Operated) Phase A | | STATUS_HANDLER |
| D37PTUC2.ST.Op.phsB | Operate (37-2 Operated) Phase B | | STATUS_HANDLER |
| D37PTUC2.ST.Op.phsC | Operate (37-2 Operated) Phase C | | STATUS_HANDLER |

### D50PIOC1

This section defines the logical node data for D50PIOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50PIOC1.ST.Str.general | Start (50-1 Picked up) | | STATUS_HANDLER |
| D50PIOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D50PIOC1.ST.Str.phsA | Start (50-1 Picked up) Phase A | | STATUS_HANDLER |
| D50PIOC1.ST.Str.dirPhsA | Direction Phase A | | STATUS_HANDLER |
| D50PIOC1.ST.Str.phsB | Start (50-1 Picked up) Phase B | | STATUS_HANDLER |
| D50PIOC1.ST.Str.dirPhsB | Direction Phase B | | STATUS_HANDLER |
| D50PIOC1.ST.Str.phsC | Start (50-1 Picked up) Phase C | | STATUS_HANDLER |
| D50PIOC1.ST.Str.dirPhsC | Direction Phase C | | STATUS_HANDLER |
| D50PIOC1.ST.Op.general | Operate (50-1 Operated) | | STATUS_HANDLER |
| D50PIOC1.ST.Op.phsA | Operate (50-1 Operated) Phase A | | STATUS_HANDLER |
| D50PIOC1.ST.Op.phsB | Operate (50-1 Operated) Phase B | | STATUS_HANDLER |
| D50PIOC1.ST.Op.phsC | Operate (50-1 Operated) Phase C | | STATUS_HANDLER |

### D50PIOC2

This section defines the logical node data for D50PIOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50PIOC2.ST.Str.general | Start (50-2 Picked up) | | STATUS_HANDLER |
| D50PIOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D50PIOC2.ST.Str.phsA | Start (50-2 Picked up) Phase A | | STATUS_HANDLER |
| D50PIOC2.ST.Str.dirPhsA | Direction Phase A | | STATUS_HANDLER |
| D50PIOC2.ST.Str.phsB | Start (50-2 Picked up) Phase B | | STATUS_HANDLER |
| D50PIOC2.ST.Str.dirPhsB | Direction Phase B | | STATUS_HANDLER |
| D50PIOC2.ST.Str.phsC | Start (50-2 Picked up) Phase C | | STATUS_HANDLER |
| D50PIOC2.ST.Str.dirPhsC | Direction Phase C | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| D50PIOC2.ST.Op.general | Operate (50-2 Operated) | | STATUS_HANDLER |
| D50PIOC2.ST.Op.phsA | Operate (50-2 Operated) Phase A | | STATUS_HANDLER |
| D50PIOC2.ST.Op.phsB | Operate (50-2 Operated) Phase B | | STATUS_HANDLER |
| D50PIOC2.ST.Op.phsC | Operate (50-2 Operated) Phase C | | STATUS_HANDLER |

## D51PTOC1

This section defines the logical node data for D51PTOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51PTOC1.ST.Str.general | Start (51-1 Picked up) | | STATUS_HANDLER |
| D51PTOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D51PTOC1.ST.Str.phsA | Start (51-1 Picked up) Phase A | | STATUS_HANDLER |
| D51PIOC1.ST.Str.dirPhsA | Direction Phase A | | STATUS_HANDLER |
| D51PTOC1.ST.Str.phsB | Start (51-1 Picked up) Phase B | | STATUS_HANDLER |
| D51PIOC1.ST.Str.dirPhsB | Direction Phase B | | STATUS_HANDLER |
| D51PTOC1.ST.Str.phsC | Start (51-1 Picked up) Phase C | | STATUS_HANDLER |
| D51PIOC1.ST.Str.dirPhsC | Direction Phase C | | STATUS_HANDLER |
| D51PTOC1.ST.Op.general | Operate (51-1 Operated) | | STATUS_HANDLER |
| D51PTOC1.ST.Op.phsA | Operate (51-1 Operated) Phase A | | STATUS_HANDLER |
| D51PTOC1.ST.Op.phsB | Operate (51-1 Operated) Phase B | | STATUS_HANDLER |
| D51PTOC1.ST.Op.phsC | Operate (51-1 Operated) Phase C | | STATUS_HANDLER |

## D51PTOC2

This section defines the logical node data for D51PTOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51PTOC2.ST.Str.general | Start (51-2 Picked up) | | STATUS_HANDLER |
| D51PTOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| D51PTOC2.ST.Str.phsA | Start (51-2 Picked up) Phase A | | STATUS_HANDLER |
| D51PTOC2.ST.Str.dirPhsA | Direction Phase A | | STATUS_HANDLER |
| D51PTOC2.ST.Str.phsB | Start (51-2 Picked up) Phase B | | STATUS_HANDLER |
| D51PTOC2.ST.Str.dirPhsB | Direction Phase B | | STATUS_HANDLER |
| D51PTOC2.ST.Str.phsC | Start (51-2 Picked up) Phase C | | STATUS_HANDLER |
| D51PTOC2.ST.Str.dirPhsC | Direction Phase C | | STATUS_HANDLER |
| D51PTOC2.ST.Op.general | Operate (51-2 Operated) | | STATUS_HANDLER |
| D51PTOC2.ST.Op.phsA | Operate (51-2 Operated) Phase A | | STATUS_HANDLER |
| D51PTOC2.ST.Op.phsB | Operate (51-2 Operated) Phase B | | STATUS_HANDLER |
| D51PTOC2.ST.Op.phsC | Operate (51-2 Operated) Phase C | | STATUS_HANDLER |

## D50NPIOC1

This section defines the logical node data for D50NPIOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50NPIOC1.ST.Str.general | Start (50N-1 Picked up) | | STATUS_HANDLER |
| D50NPIOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D50NPIOC1.ST.Op.general | Operate (50N-1 Operated) | | STATUS_HANDLER |

## D50NPIOC2

This section defines the logical node data for D50NPIOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50NPIOC2.ST.Str.general | Start (50N-2 Picked up) | | STATUS_HANDLER |
| D50NPIOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D50NPIOC2.ST.Op.general | Operate (50N-2 Operated) | | STATUS_HANDLER |

### D51NPTOC1

This section defines the logical node data for D51NPTOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51NPTOC1.ST.Str.general | Start (51N-1 Picked up) | | STATUS_HANDLER |
| D51NPTOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D51NPTOC1.ST.Op.general | Operate (51N-1 Operated) | | STATUS_HANDLER |

### D51NPTOC2

This section defines the logical node data for D51NPTOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51NPTOC2.ST.Str.general | Start (51N-2 Picked up) | | STATUS_HANDLER |
| D51NPTOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D51NPTOC2.ST.Op.general | Operate (51N-2 Operated) | | STATUS_HANDLER |

### D50GPIOC1

This section defines the logical node data for D50GPIOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50GPIOC1.ST.Str.general | Start (50G-1 Picked up) | | STATUS_HANDLER |
| D50GPIOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D50GPIOC1.ST.Op.general | Operate (50G-1 Operated) | | STATUS_HANDLER |

### D50GPIOC2

This section defines the logical node data for D50GPIOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50GPIOC2.ST.Str.general | Start (50G-2 Picked up) | | STATUS_HANDLER |
| D50GPIOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D50GPIOC2.ST.Op.general | Operate (50G-2 Operated) | | STATUS_HANDLER |

### D51GPTOC1

This section defines the logical node data for D51GPTOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| **D51GPTOC1.ST.Str.general** | **Start (51G-1 Picked up)** | | **STATUS_HANDLER** |
| **D51GPTOC1.ST.Str.dirGeneral** | **Direction General** | | **STATUS_HANDLER** |
| **D51GPTOC1.ST.Op.general** | **Operate (51G-1 Operated)** | | **STATUS_HANDLER** |

### D51GPTOC2

This section defines the logical node data for D51GPTOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51GPTOC2.ST.Str.general | Start (51G-2 Picked up) | | STATUS_HANDLER |
| D51GPTOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D51GPTOC2.ST.Op.general | Operate (51G-2 Operated) | | STATUS_HANDLER |

### D4650PIOC1

This section defines the logical node data for D4650PIOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D4650PIOC1.ST.Str.general | Start (46-50 Picked up) | | STATUS_HANDLER |
| D4650PIOC1.ST.Op.general | Operate (46-50 Operated) | | STATUS_HANDLER |

### D4651PTOC1

This section defines the logical node data for D4651PTOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D4651PTOC1.ST.Str.general | Start (46-51 Picked up) | | STATUS_HANDLER |
| D4651PTOC1.ST.Op.general | Operate (46-51 Operated) | | STATUS_HANDLER |

### D50RPIOC1

This section defines the logical node data for D50RPIOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50RPIOC1.ST.Str.general | Start (50R Picked up) | | STATUS_HANDLER |
| D50RPIOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D50RPIOC1.ST.Op.general | Operate (50R Operated) | | STATUS_HANDLER |

### D50RPIOC2

This section defines the logical node data for D50RPIOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50RPIOC2.ST.Str.general | Start (51R Picked up) | | STATUS_HANDLER |
| D50RPIOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D50RPIOC2.ST.Op.general | Operate (51R Operated) | | STATUS_HANDLER |

### D51RPTOC1

This section defines the logical node data for D51RPTOC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51RPTOC1.ST.Str.general | Start (51R Picked up) | | STATUS_HANDLER |
| D51RPTOC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D51RPTOC1.ST.Op.general | Operate (51R Operated) | | STATUS_HANDLER |

### D51RPTOC2

This section defines the logical node data for D51RPTOC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D51RPTOC2.ST.Str.general | Start (51R Picked up) | | STATUS_HANDLER |
| D51RPTOC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D51RPTOC2.ST.Op.general | Operate (51R Operated) | | STATUS_HANDLER |

### D49PTTR1

This section defines the logical node data for D49PTTR1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D49PTTR1.MX.Tmp.mag.f | 49 Temperature ( % Thermal OL) | | METER |
| | | | |
| D49PTTR1.ST.Str.general | Start (49 Picked up) | | STATUS_HANDLER |
| D49PTTR1.ST.Str.phsA | Start (49 Picked up) Phase A | | STATUS_HANDLER |
| D49PTTR1.ST.Str.phsB | Start (49 Picked up) Phase B | | STATUS_HANDLER |
| D49PTTR1.ST.Str.phsC | Start (49 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| D49PTTR1.ST.AlmThm.general | Alarm (49 AL Operated) | | STATUS_HANDLER |
| | | | |
| D49PTTR1.ST.Op.general | Operate (49 Operated) | | STATUS_HANDLER |
| D49PTTR1.ST.Op.phsA | Operate (49 Operated) Phase A | | STATUS_HANDLER |
| D49PTTR1.ST.Op.phsB | Operate (49 Operated) Phase B | | STATUS_HANDLER |
| D49PTTR1.ST.Op.phsC | Operate (49 Operated) Phase C | | STATUS_HANDLER |

### D81H2PHAR1

This section defines the logical node data for D81H2PHAR1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81H2PHAR1.ST.Str.general | Operate (81HBL2 Operated) | | STATUS_HANDLER |

### D81UPTUF1

This section defines the logical node data for D81UPTUF1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF1.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| D81UPTUF1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D81UPTUF1.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF2

This section defines the logical node data for D81UPTUF2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF2.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| D81UPTUF2.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF3

This section defines the logical node data for D81UPTUF3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF3.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF3.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81UPTUF3.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF4

This section defines the logical node data for D81UPTUF4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF4.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF4.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81UPTUF4.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF5

This section defines the logical node data for D81UPTUF5 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF5.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF5.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81UPTUF5.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF6

This section defines the logical node data for D81UPTUF6 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF6.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF6.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81UPTUF6.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF7

This section defines the logical node data for D81UPTUF7 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF7.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF7.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81UPTUF7.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81UPTUF8

This section defines the logical node data for D81UPTUF8 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81UPTUF8.ST.Str.general | Start (81UF-1 Picked up) | | STATUS_HANDLER |
| D81UPTUF8.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81UPTUF8.ST.Op.general | Operate (81UF-1 Operated) | | STATUS_HANDLER |

### D81OPTOF1

This section defines the logical node data for D81OPTOF1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF1.ST.Str.general | Start (81OF-1 Picked up) | | STATUS_HANDLER |
| D81OPTOF1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF1.ST.Op.general | Operate (81OF-1 Operated) | | STATUS_HANDLER |

### D81OPTOF2

This section defines the logical node data for D81OPTOF2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF2.ST.Str.general | Start (81OF-2 Picked up) | | STATUS_HANDLER |
| D81OPTOF2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF2.ST.Op.general | Operate (81OF-2 Operated) | | STATUS_HANDLER |

### D81OPTOF3

This section defines the logical node data for D81OPTOF3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF3.ST.Str.general | Start (81OF-3 Picked up) | | STATUS_HANDLER |
| D81OPTOF3.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF3.ST.Op.general | Operate (81OF-3 Operated) | | STATUS_HANDLER |

### D81OPTOF4

This section defines the logical node data for D81OPTOF4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF4.ST.Str.general | Start (81OF-4 Picked up) | | STATUS_HANDLER |
| D81OPTOF4.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF4.ST.Op.general | Operate (81OF-4 Operated) | | STATUS_HANDLER |

### D81OPTOF5

This section defines the logical node data for D81OPTOF5 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF5.ST.Str.general | Start (81OF-5 Picked up) | | STATUS_HANDLER |
| D81OPTOF5.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF5.ST.Op.general | Operate (81OF-5 Operated) | | STATUS_HANDLER |

### D81OPTOF6

This section defines the logical node data for D81OPTOF6 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF6.ST.Str.general | Start (81OF-6 Picked up) | | STATUS_HANDLER |
| D81OPTOF6.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF6.ST.Op.general | Operate (81OF-6 Operated) | | STATUS_HANDLER |

### D81OPTOF7

This section defines the logical node data for D81OPTOF7 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF7.ST.Str.general | Start (81OF-7 Picked up) | | STATUS_HANDLER |
| D81OPTOF7.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF7.ST.Op.general | Operate (81OF-7 Operated) | | STATUS_HANDLER |

### D81OPTOF8

This section defines the logical node data for D81OPTOF8 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81OPTOF8.ST.Str.general | Start (81OF-8 Picked up) | | STATUS_HANDLER |
| D81OPTOF8.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81OPTOF8.ST.Op.general | Operate (81OF-8 Operated) | | STATUS_HANDLER |

### D81RPFRC1

This section defines the logical node data for D81RPFRC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81RPFRC1.ST.Str.general | Start (81ROCOF-1 Picked up) | | STATUS_HANDLER |
| D81RPFRC1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81RPFRC1.ST.Op.general | Operate (81 ROCOF-1 Operated) | | STATUS_HANDLER |

### D81RPFRC2

This section defines the logical node data for D81RPFRC2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81RPFRC2.ST.Str.general | Start (81ROCOF-2 Picked up) | | STATUS_HANDLER |
| D81RPFRC2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81RPFRC2.ST.Op.general | Operate (81 ROCOF-2 Operated) | | STATUS_HANDLER |

### D81RPFRC3

This section defines the logical node data for D81RPFRC3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81RPFRC3.ST.Str.general | Start (81ROCOF-3 Picked up) | | STATUS_HANDLER |
| D81RPFRC3.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81RPFRC3.ST.Op.general | Operate (81ROCOF-3 Operated) | | STATUS_HANDLER |

### D81RPFRC4

This section defines the logical node data for D81RPFRC4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D81RPFRC4.ST.Str.general | Start (81ROCOF-4 Picked up) | | STATUS_HANDLER |
| D81RPFRC4.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| | | | |
| D81RPFRC4.ST.Op.general | Operate (81ROCOF-4 Operated) | | STATUS_HANDLER |

### D32PDUP1

This section defines the logical node data for D32PDUP1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDUP1.ST.Str.general | Start (32-1 Picked up) | | STATUS_HANDLER |
| D32PDUP1.ST.Str.phsA | Start (32-1 Picked up) Phase A | | STATUS_HANDLER |
| D32PDUP1.ST.Str.phsB | Start (32-1 Picked up) Phase B | | STATUS_HANDLER |
| D32PDUP1.ST.Str.phsC | Start (32-1 Picked up) Phase C | | STATUS_HANDLER |
| D32PDUP1.ST.Op.general | Operate (32-1 Operated) | | STATUS_HANDLER |
| D32PDUP1.ST.Op.phsA | Operate (32-1 Operated) Phase A | | STATUS_HANDLER |
| D32PDUP1.ST.Op.phsB | Operate (32-1 Operated) Phase B | | STATUS_HANDLER |
| D32PDUP1.ST.Op.phsC | Operate (32-1 Operated) Phase C | | STATUS_HANDLER |

### D32PDUP2

This section defines the logical node data for D32PDUP2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDUP2.ST.Str.general | Start (32-2 Picked up) | | STATUS_HANDLER |
| D32PDUP2.ST.Str.phsA | Start (32-2 Picked up) Phase A | | STATUS_HANDLER |
| D32PDUP2.ST.Str.phsB | Start (32-2 Picked up) Phase B | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| D32PDUP2.ST.Str.phsC | Start (32-2 Picked up) Phase C | | STATUS_HANDLER |
| D32PDUP2.ST.Op.general | Operate (32-2 Operated) | | STATUS_HANDLER |
| D32PDUP2.ST.Op.phsA | Operate (32-2 Operated) Phase A | | STATUS_HANDLER |
| D32PDUP2.ST.Op.phsB | Operate (32-2 Operated) Phase B | | STATUS_HANDLER |
| D32PDUP2.ST.Op.phsC | Operate (32-2 Operated) Phase C | | STATUS_HANDLER |

## D32PDUP3

This section defines the logical node data for D32PDUP3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDUP3.ST.Str.general | Start (32-3 Picked up) | | STATUS_HANDLER |
| D32PDUP3.ST.Str.phsA | Start (32-3 Picked up) Phase A | | STATUS_HANDLER |
| D32PDUP3.ST.Str.phsB | Start (32-3 Picked up) Phase B | | STATUS_HANDLER |
| D32PDUP3.ST.Str.phsC | Start (32-3 Picked up) Phase C | | STATUS_HANDLER |
| D32PDUP3.ST.Op.general | Operate (32-3 Operated) | | STATUS_HANDLER |
| D32PDUP3.ST.Op.phsA | Operate (32-3 Operated) Phase A | | STATUS_HANDLER |
| D32PDUP3.ST.Op.phsB | Operate (32-3 Operated) Phase B | | STATUS_HANDLER |
| D32PDUP3.ST.Op.phsC | Operate (32-3 Operated) Phase C | | STATUS_HANDLER |

## D32PDUP4

This section defines the logical node data for D32PDUP4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDUP4.ST.Str.general | Start (32-4 Picked up) | | STATUS_HANDLER |
| D32PDUP4.ST.Str.phsA | Start (32-4 Picked up) Phase A | | STATUS_HANDLER |
| D32PDUP4.ST.Str.phsB | Start (32-4 Picked up) Phase B | | STATUS_HANDLER |
| D32PDUP4.ST.Str.phsC | Start (32-4 Picked up) Phase C | | STATUS_HANDLER |
| D32PDUP4.ST.Op.general | Operate (32-4 Operated) | | STATUS_HANDLER |
| D32PDUP4.ST.Op.phsA | Operate (32-4 Operated) Phase A | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| D32PDUP4.ST.Op.phsB | Operate (32-4 Operated) Phase B | | STATUS_HANDLER |
| D32PDUP4.ST.Op.phsC | Operate (32-4 Operated) Phase C | | STATUS_HANDLER |

### D32PDOP1

This section defines the logical node data for D32PDOP1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDOP1.ST.Str.general | Start (32-1 Picked up) | | STATUS_HANDLER |
| D32PDOP1.ST.Str.phsA | Start (32-1 Picked up) Phase A | | STATUS_HANDLER |
| D32PDOP1.ST.Str.phsB | Start (32-1 Picked up) Phase B | | STATUS_HANDLER |
| D32PDOP1.ST.Str.phsC | Start (32-1 Picked up) Phase C | | STATUS_HANDLER |
| D32PDOP1.ST.Op.general | Operate (32-1 Operated) | | STATUS_HANDLER |
| D32PDOP1.ST.Op.phsA | Operate (32-1 Operated) Phase A | | STATUS_HANDLER |
| D32PDOP1.ST.Op.phsB | Operate (32-1 Operated) Phase B | | STATUS_HANDLER |
| D32PDOP1.ST.Op.phsC | Operate (32-1 Operated) Phase C | | STATUS_HANDLER |

### D32PDOP2

This section defines the logical node data for D32PDOP2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDOP2.ST.Str.general | Start (32-2 Picked up) | | STATUS_HANDLER |
| D32PDOP2.ST.Str.phsA | Start (32-2 Picked up) Phase A | | STATUS_HANDLER |
| D32PDOP2.ST.Str.phsB | Start (32-2 Picked up) Phase B | | STATUS_HANDLER |
| D32PDOP2.ST.Str.phsC | Start (32-2 Picked up) Phase C | | STATUS_HANDLER |
| D32PDOP2.ST.Op.general | Operate (32-2 Operated) | | STATUS_HANDLER |
| D32PDOP2.ST.Op.phsA | Operate (32-2 Operated) Phase A | | STATUS_HANDLER |
| D32PDOP2.ST.Op.phsB | Operate (32-2 Operated) Phase B | | STATUS_HANDLER |
| D32PDOP2.ST.Op.phsC | Operate (32-2 Operated) Phase C | | STATUS_HANDLER |

### D32PDOP3

This section defines the logical node data for D32PDOP3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDOP3.ST.Str.general | Start (32-3 Picked up) | | STATUS_HANDLER |
| D32PDOP3.ST.Str.phsA | Start (32-3 Picked up) Phase A | | STATUS_ HANDLER |
| D32PDOP3.ST.Str.phsB | Start (32-3 Picked up) Phase B | | STATUS_HANDLER |
| D32PDOP3.ST.Str.phsC | Start (32-3 Picked up) Phase C | | STATUS_HANDLER |
| D32PDOP3.ST.Op.general | Operate (32-3 Operated) | | STATUS_HANDLER |
| D32PDOP3.ST.Op.phsA | Operate (32-3 Operated) Phase A | | STATUS_HANDLER |
| D32PDOP3.ST.Op.phsB | Operate (32-3 Operated) Phase B | | STATUS_HANDLER |
| D32PDOP3.ST.Op.phsC | Operate (32-3 Operated) Phase C | | STATUS_HANDLER |

### D32PDOP4

This section defines the logical node data for D32PDOP4 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D32PDOP4.ST.Str.general | Start (32-4 Picked up) | | STATUS_HANDLER |
| D32PDOP4.ST.Str.phsA | Start (32-4 Picked up) Phase A | | STATUS_HANDLER |
| D32PDOP4.ST.Str.phsB | Start (32-4 Picked up) Phase B | | STATUS_HANDLER |
| D32PDOP4.ST.Str.phsC | Start (32-4 Picked up) Phase C | | STATUS_HANDLER |
| D32PDOP4.ST.Op.general | Operate (32-4 Operated) | | STATUS_HANDLER |
| D32PDOP4.ST.Op.phsA | Operate (32-4 Operated) Phase A | | STATUS_HANDLER |
| D32PDOP4.ST.Op.phsB | Operate (32-4 Operated) Phase B | | STATUS_HANDLER |
| D32PDOP4.ST.Op.phsC | Operate (32-4 Operated) Phase C | | STATUS_HANDLER |

## D50BFRBRF1

This section defines the logical node data for D50BFRBRF1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D50BFRBRF1.ST.OpIn.general | Operate (50BF D1 Operated) | | STATUS_HANDLER |
| D50BFRBRF1.ST.OpIn.phsA | Operate (50BF D1 Phase A Operated) | | STATUS_HANDLER |
| D50BFRBRF1.ST.OpIn.phsB | Operate (50BF D1 Phase B Operated) | | STATUS_HANDLER |
| D50BFRBRF1.ST.OpIn.phsC | Operate (50BF D1 Phase C Operated) | | STATUS_HANDLER |
| | | | |
| D50BFRBRF1.ST.OpEx.general | Operate (50BF D2 Operated) | | STATUS_HANDLER |
| D50BFRBRF1.ST.OpEx.phsA | Operate (50BF D2 Phase A Operated) | | STATUS_HANDLER |
| D50BFRBRF1.ST.OpEx.phsB | Operate (50BF D2 Phase B Operated) | | STATUS_HANDLER |
| D50BFRBRF1.ST.OpEx.phsC | Operate (50BF D2 Phase C Operated) | | STATUS_HANDLER |

## DICBFRBRF2

This section defines the logical node data for DDICBFRBRF2of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DDICBFRBRF2.ST.OpIn.general | Operate (CBF D1 Operated) | | STATUS_HANDLER |
| DDICBFRBRF2.ST.OpEx.general | Operate (CBF D2 Operated) | | STATUS_HANDLER |

### D46BCPTOC3

This section defines the logical node data for D46BCPTOC3 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D46BCPTOC3.ST.Op.general | Operate (46BC Operated) | | STATUS_HANDLER |

### D60PTSPTOV7

This section defines the logical node data for D60PTSPTOV7 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D60PTSPTOV7.ST.Op.general | Operate (60PTS Operated) | | STATUS_HANDLER |

### D60CTSPTOC4

This section defines the logical node data for D60CTSPTOC4 of the FPRO-Protection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D60CTSPTOC4.ST.Op.general | Operate (60CTS Operated) | | STATUS_HANDLER |

### 74TCSRTCS1

This section defines the logical node data for 74TCSRTCS1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| 74TCSRTCS1.ST.Op.general | Operate (74TCSRTCS-1 Operated) | | STATUS_HANDLER |

### 74TCSRTCS2

This section defines the logical node data for 74TCSRTCS2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| 74TCSRTCS2.ST.Op.general | Operate (74TCSRTCS-2 Operated) | | STATUS_HANDLER |

### I2TRCBC1

This section defines the logical node data for I2TRCBC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| I2TRCBC1.MX.I2TAcc.mag.f | I2T Accumulated | | METER |
| I2TRCBC1.MX.I2TLstOp.mag.f | I2T Value – (Last Operation) | | METER |
| I2TRCBC1.ST.Op.general | Operate (I2T Operated) | | STATUS_HANDLER |

### THDRTHD1

This section defines the logical node data for THDRTHD1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| THDRTHD1.ST.Str.general | Start (THD-1 Picked up) | | STATUS_HANDLER |
| THDRTHD1.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| THDRTHD1.ST.Str.PhsA | Start (THD-1 Picked up) Phase A | | STATUS_HANDLER |
| THDRTHD1.ST.Str.PhsB | Start (THD-1 Picked up) Phase B | | STATUS_HANDLER |
| THDRTHD1.ST.Str.PhsC | Start (THD-1 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| THDRTHD1.ST.Op.general | Operate (THD-1 Operated) | | STATUS_HANDLER |
| THDRTHD1.ST.Op.PhsA | Operate(THD-1 Operated) Phase A | | STATUS_HANDLER |
| THDRTHD1.ST.Op.PhsB | Operate(THD-1 Operated) Phase B | | STATUS_HANDLER |
| THDRTHD1.ST.Op.PhsC | Operate(THD-1 Operated) Phase C | | STATUS_HANDLER |

### THDRTHD2

This section defines the logical node data for THDRTHD2 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| THDRTHD2.ST.Str.general | Start (THD-2 Picked up) | | STATUS_HANDLER |
| THDRTHD2.ST.Str.dirGeneral | Direction General | | STATUS_HANDLER |
| THDRTHD2.ST.Str.PhsA | Start (THD-2 Picked up) Phase A | | STATUS_HANDLER |
| THDRTHD2.ST.Str.PhsB | Start (THD-2 Picked up) Phase B | | STATUS_HANDLER |
| THDRTHD2.ST.Str.PhsC | Start (THD-2 Picked up) Phase C | | STATUS_HANDLER |
| | | | |
| THDRTHD2.ST.Op.general | Operate (THD-2 Operated) | | STATUS_HANDLER |
| THDRTHD2.ST.Op.PhsA | Operate(THD-2 Operated) Phase A | | STATUS_HANDLER |
| THDRTHD2.ST.Op.PhsB | Operate(THD-2 Operated) Phase B | | STATUS_HANDLER |
| THDRTHD1.ST.Op.PhsC | Operate(THD-2 Operated) Phase C | | STATUS_HANDLER |

### UVCRUVC1

This section defines the logical node data for UVCRUVC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| UVCRUVC1.ST.Op.general | Operate (Under Voltage Counter exceeded) | | STATUS_HANDLER |
| UVCRUVC1.MX.UVCAcc.mag.f | | | |

### OVCROVC1

This section defines the logical node data for OVCROVC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| OVCROVC1.ST.Op.general | Operate (Under Voltage Counter exceeded) | | STATUS_HANDLER |
| OVCROVC1.MX.OVCAcc.mag.f | | | |

### UFCRUFC1

This section defines the logical node data for UFCRUFC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| UFCRUFC1.ST.Op.general | Operate (Under Frequency Counter exceeded) | | STATUS_HANDLER |
| UFCRUFC1.MX.UFCAcc.mag.f | | | |

### OFCROFC1

This section defines the logical node data for OFCROFC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| OFCROFC1.ST.Op.general | Operate (Over Frequency Counter exceeded) | | STATUS_HANDLER |
| OFCROFC1.MX.OFCAcc.mag.f | | | |

### EICREIC1

This section defines the logical node data for EICREIC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| EICREIC1.ST.Op.general | Operate (External Input Counter exceeded) | | STATUS_HANDLER |
| EICREIC1.MX.OFCAcc.mag.f | | | |

### D79RREC1

This section defines the logical node data for D79RREC1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D79RREC1.ST.OpCls.general | AR Operation (79 Operated) | | STATUS_HANDLER |
| D79RREC1.ST.AutoRecSt.stVal | AR Multiple Operation | | STATUS_HANDLER |

### D79GGIO1

This section defines the logical node data for D79GGIO1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| D79GGIO1.ST.CntRs1.actVal | 79 Cumulative Count Operated | | STATUS_HANDLER |
| D79GGIO1.ST.Ind1.stVal | 79 Block Status | | STATUS_HANDLER |
| D79GGIO1.ST.Ind2.stVal | ExternalSwitchStatus (79 IN function output) | | STATUS_HANDLER |

## Logical Nodes for Control (LN Group C...)

### TRCALH1

This section defines the logical node data for TRCALH1 of the FPROProtection logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| TRCALH1.ST.GrAlm.stVal | Function(s) Starter Picked up | | EVENT_HANDLER |
| TRCALH1.ST.GrWrn.stVal | Function(s) Trip Operated | | EVENT_HANDLER |

## Logical Nodes for Measurements & DR (LN Group M.., R…)

### ANAMMXU1

This section defines the logical node data for ANAMMXU1 of the FPROMeasurements logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| ANAMMXU1.MX.PhV.phsA.cVal.mag.f | VA – Magnitude | | METER |
| ANAMMXU1.MX.PhV.phsA.cVal.ang.f | VA – Angle | | METER |
| ANAMMXU1.MX.PhV.phsB.cVal.mag.f | VB – Magnitude | | METER |
| ANAMMXU1.MX.PhV.phsB.cVal.ang.f | VB – Angle | | METER |
| ANAMMXU1.MX.PhV.phsC.cVal.mag.f | VC – Magnitude | | METER |
| ANAMMXU1.MX.PhV.phsC.cVal.ng.f | VC – Angle | | METER |
| ANAMMXU1.MX.PhV.Neut.cVal.mag.f | VN – Magnitude | | METER |
| ANAMMXU1.MX.PhV.Neut.cVal.ang.f | VN – Angle | | METER |
| ANAMMXU1.MX.PhV.phsAB.cVal.mag.f | VAB – Magnitude | | METER |
| ANAMMXU1.MX.PhV.phsAB.cVal.ang.f | VAB – Angle | | METER |
| ANAMMXU1.MX.PhV.phsBC.cVal.mag.f | VBC – Magnitude | | METER |
| ANAMMXU1.MX.PhV.phsBC.cVal.ang.f | VBC – Angle | | METER |
| ANAMMXU1.MX.PhV.phsCA.cVal.mag.f | VCA – Magnitude | | METER |
| ANAMMXU1.MX.PhV.phsCA.cVal.ng.f | VCA – Angle | | METER |
| ANAMMXU1 | V/F (%) | | METER |
| ANAMMXU1 | THD (%) | | METER |
| | | | |
| ANAMMXU1.MX.A.phsA.cVal.mag.f | IA – Magnitude | | METER |
| ANAMMXU1.MX.A.phsA.cVal.ang.f | IA – Angle | | METER |
| ANAMMXU1.MX.A.phsB.cVal.mag.f | IB – Magnitude | | METER |
| ANAMMXU1.MX.A.phsB.cVal.ang.f | IB – Angle | | METER |
| ANAMMXU1.MX.A.phsC.cVal.mag.f | IC – Magnitude | | METER |
| ANAMMXU1.MX.A.phsC.cVal.ang.f | IC – Angle | | METER |
| ANAMMXU1.MX.A.neut.cVal.mag.f | IN – Magnitude | | METER |

| | | | |
|---|---|---|---|
| ANAMMXU1.MX.A.neut.cVal.ang.f | IN – Angle | | METER |
| | | | |
| ANAMMXU1.MX.TotW.cVal.mag.f | Real Power | | METER |
| ANAMMXU1.MX.TotVAr.cVal.mag.f | Reactive Power | | METER |
| ANAMMXU1.MX.Hz.cVal.mag.f | Frequency | | METER |
| ANAMMXU1.MX.TotPF.cVal.mag.f | Power Factor | | METER |

### ANAMMXU2

This section defines the logical node data for ANAMMXU2 of the FPROMeasurements logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| ANAMMXU2.MX.A.res.cVal.mag.f | ISEF – Magnitude | | METER |
| ANAMMXU2.MX.A.res.cVal.ang.f | ISEF – Angle | | METER |

### SEQMSQI1

This section defines the logical node data for SEQMSQI1 of the FPROMeasurements logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| SEQMSQI1.MX.SeqV.c1.cVal.mag.f | V1 – Pos. Seq. Magnitude | | METER |
| SEQMSQI1.MX.SeqV.c2.cVal.mag.f | V2 – Neg. Seq. Magnitude | | METER |
| SEQMSQI1.MX.SeqV.c3.cVal.mag.f | V0 – Zero Seq. Magnitude | | METER |
| | | | |
| SEQMSQI1.MX.SeqA.c1.cVal.mag.f | I1 – Pos. Seq. Magnitude | | METER |
| SEQMSQI1.MX.SeqA.c2.cVal.mag.f | I2 – Neg. Seq. Magnitude | | METER |
| SEQMSQI1.MX.SeqA.c3.cVal.mag.f | I0 – Zero Seq. Magnitude | | METER |
| SEQMSQI1.MX.SeqA | I2/I1 (%) | | METER |

### MMMTHR1

This section defines the logical node data for MMMTHR1 of the FPROMeasurements logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| MMMTHR1$MX$Tmp01$mag$i | 79 Count | | METER |
| MMMTHR1$MX$Tmp02$mag$i | 79Cumm Count | | METER |

### DRRDRE1

This section defines the logical node data for DRRDRE1 of the FPROMeasurements logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DRRDRE1.ST.RcdMade.stVal | Record made | | RECORD |
| DRRDRE1.ST.FltNum.stVal | Fault Record number | | RECORD |
| DRRDRE1.ST.RcdStr.stVal | Record Start | | RECORD |
| DRRDRE1.ST.MemUsed.stVal | Memory used | | RECORD |

### HEALTHGGIO8

This section defines the logical node data for HEALTHGGIO8 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| HEALTHGGIO8.ST.Ind1.stVal | Relay Healthy Status Info. | | STATUS_HANDLER |

### IRIGGGIO6

This section defines the logical node data for IRIGGGIO6 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| IRIGGGIO6.ST.Ind1.stVal | IRIG-B Status Info. | | STATUS_HANDLER |

### SNTPGGIO7

This section defines the logical node data for SNTPGGIO7 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| SNTPGGIO7.ST.Ind1.stVal | SNTP Status Info. | | STATUS_HANDLER |

### ComAlmGGIO9

This section defines the logical node data for ComAlmGGIO9 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| ComAlmGGIO9.ST.Ind1.stVal | IEC61850 Comm. Alarm Status Info. | | STATUS_HANDLER |

### LEDGGIO4

This section defines the logical node data for LEDGGIO4 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| LEDGGIO4.ST.Ind1.stVal | LED Status- 1 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind2.stVal | LED Status- 2 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind3.stVal | LED Status- 3 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind4.stVal | LED Status- 4 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind5.stVal | LED Status- 5 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind6.stVal | LED Status- 6 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind7.stVal | LED Status- 7 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind8.stVal | LED Status- 8 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind9.stVal | LED Status- 9 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind10.stVal | LED Status- 10 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind11.stVal | LED Status- 11 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind12.stVal | LED Status- 12 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind13.stVal | LED Status- 13 | | STATUS_HANDLER |
| LEDGGIO4.ST.Ind14.stVal | LED Status- 14 | | STATUS_HANDLER |

### EIGGIO1

This section defines the logical node data for EIGGIO1 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| EIGGIO1.ST.Ind1.stVal | External Input - 1 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind2.stVal | External Input - 2 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind3.stVal | External Input - 3 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind4.stVal | External Input - 4 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind5.stVal | External Input – 5 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind6.stVal | External Input – 6 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind7.stVal | External Input – 7 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind8.stVal | External Input – 8 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind9.stVal | External Input – 9 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind10.stVal | External Input – 10 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind11.stVal | External Input – 11 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind12.stVal | External Input – 12 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind13.stVal | External Input – 13 | | STATUS_HANDLER |
| EIGGIO1.ST.Ind14.stVal | External Input - 14 | | STATUS_HANDLER |

### OCGGIO2

This section defines the logical node data for OCGGIO2 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| OCGGIO2.ST.Ind1.stVal | Output Contact - 1 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind2.stVal | Output Contact - 2 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind3.stVal | Output Contact - 3 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind4.stVal | Output Contact - 4 | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| OCGGIO2.ST.Ind5.stVal | Output Contact - 5 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind6.stVal | Output Contact - 6 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind7.stVal | Output Contact - 7 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind8.stVal | Output Contact - 8 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind9.stVal | Output Contact – 9 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind10.stVal | Output Contact – 10 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind11.stVal | Output Contact – 11 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind12.stVal | Output Contact – 12 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind13.stVal | Output Contact – 13 | | STATUS_HANDLER |
| OCGGIO2.ST.Ind14.stVal | Output Contact - 14 | | STATUS_HANDLER |

### PLGGIO3

This section defines the logical node data for PLGGIO3 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| PLGGIO3.ST.Ind1.stVal | Prologic - 1 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind2.stVal | Prologic – 2 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind3.stVal | Prologic – 3 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind4.stVal | Prologic – 4 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind5.stVal | Prologic – 5 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind6.stVal | Prologic – 6 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind7.stVal | Prologic – 7 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind8.stVal | Prologic – 8 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind9.stVal | Prologic – 9 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind10.stVal | Prologic – 10 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind11.stVal | Prologic – 11 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind12.stVal | Prologic – 12 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind13.stVal | Prologic – 13 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind14.stVal | Prologic – 14 | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| PLGGIO3.ST.Ind15.stVal | Prologic – 15 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind16.stVal | Prologic – 16 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind17.stVal | Prologic – 17 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind18.stVal | Prologic – 18 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind19.stVal | Prologic – 19 | | STATUS_HANDLER |
| PLGGIO3.ST.Ind20.stVal | Prologic – 20 | | STATUS_HANDLER |

## VIGGIO5

This section defines the logical node data for VIGGIO5 of the FPROSystem logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| VIGGIO5.ST.Ind1.stVal | Virtual Input – 1 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind2.stVal | Virtual Input – 2 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind3.stVal | Virtual Input – 3 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind4.stVal | Virtual Input – 4 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind5.stVal | Virtual Input – 5 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind6.stVal | Virtual Input – 6 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind7.stVal | Virtual Input – 7 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind8.stVal | Virtual Input – 8 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind9.stVal | Virtual Input – 9 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind10.stVal | Virtual Input – 10 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind11.stVal | Virtual Input – 11 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind12.stVal | Virtual Input – 12 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind13.stVal | Virtual Input – 13 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind14.stVal | Virtual Input – 14 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind15.stVal | Virtual Input – 15 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind16.stVal | Virtual Input – 16 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind17.stVal | Virtual Input – 17 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind18.stVal | Virtual Input – 18 | | STATUS_HANDLER |

| | | | |
|---|---|---|---|
| VIGGIO5.ST.Ind19.stVal | Virtual Input – 19 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind20.stVal | Virtual Input – 20 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind21.stVal | Virtual Input – 21 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind22.stVal | Virtual Input – 22 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind23.stVal | Virtual Input – 23 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind24.stVal | Virtual Input – 24 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind25.stVal | Virtual Input – 25 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind26.stVal | Virtual Input – 26 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind27.stVal | Virtual Input – 27 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind28.stVal | Virtual Input – 28 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind29.stVal | Virtual Input – 29 | | STATUS_HANDLER |
| VIGGIO5.ST.Ind30.stVal | Virtual Input – 30 | | STATUS_HANDLER |

### SUBSCRGGIO1

This section defines the logical node data SUBSCRGGIO1 of the FPROVirtualElements logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| SUBSCRGGIO1.ST.Ind1.stVal | Virtual Input – 1 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind2.stVal | Virtual Input – 2 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind3.stVal | Virtual Input – 3 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind4.stVal | Virtual Input – 4 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind5.stVal | Virtual Input – 5 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind6.stVal | Virtual Input – 6 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind7.stVal | Virtual Input – 7 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind8.stVal | Virtual Input – 8 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind9.stVal | Virtual Input – 9 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind10.stVal | Virtual Input – 10 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind11.stVal | Virtual Input – 11 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind12.stVal | Virtual Input – 12 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind13.stVal | Virtual Input – 13 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind14.stVal | Virtual Input – 14 | | SERVER_GOOSE |

| | | | |
|---|---|---|---|
| SUBSCRGGIO1.ST.Ind15.stVal | Virtual Input – 15 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind16.stVal | Virtual Input – 16 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind17.stVal | Virtual Input – 17 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind18.stVal | Virtual Input – 18 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind19.stVal | Virtual Input – 19 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind20.stVal | Virtual Input – 20 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind21.stVal | Virtual Input – 21 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind22.stVal | Virtual Input – 22 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind23.stVal | Virtual Input – 23 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind24.stVal | Virtual Input – 24 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind25.stVal | Virtual Input – 25 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind26.stVal | Virtual Input – 26 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind27.stVal | Virtual Input – 27 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind28.stVal | Virtual Input – 28 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind29.stVal | Virtual Input – 29 | | SERVER_GOOSE |
| SUBSCRGGIO1.ST.Ind30.stVal | Virtual Input – 30 | | SERVER_GOOSE |

## Logical Nodes for Fault Data (LN Group G…)

This section defines the logical nodes for FPROFaultData logical device.

| Logical Node Data Objects | Functions Defined |
|---|---|
| FLTMMXU1.MX.PhV | Fault Voltages (VA, VB, VC, VN) |
| FLTMMXU1.MX.PhV | Fault Voltages (VAB, VBC, VCA) |
| FLTMMXU1.MX.A | Fault Currents (IA, IB, IC, IG, IN) |
| FLTMMXU1.MX.Hz | Frequency |
| FLTMMXU1.MX.TotW | Total Real Power |
| FLTMMXU1.MX.TotVAr | Total Reactive Power |
| FLTMMXU1.MX.W | Phase-Wise Real Power |
| FLTMMXU1.MX.VAr | Phase-Wise Reactive Power |
| FLTMSQI1.MX.SeqV | Fault Voltage(V2) |
| FLTMSQI1.MX.SeqA | Fault Currents (I2, I2/I1) |
| FLTMTHR1.MX.Tmp* | Fault Location & Impedance |

### FLTMMXU1

This section defines the logical node data for FLTMMXU1 of the FPROFault-Data logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| FLTMMXU1.MX.PhV.phsA.cVal.mag.f | VA – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.PhV.phsA.cVal.ang.f | VA – Angle | | FAULT_LOG |
| FLTMMXU1.MX.PhV.phsB.cVal.mag.f | VB – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.PhV.phsB.cVal.ang.f | VB – Angle | | FAULT_LOG |
| FLTMMXU1.MX.PhV.phsC.cVal.mag.f | VC – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.PhV.phsC.cVal.ang.f | VC – Angle | | FAULT_LOG |
| FLTMMXU1.MX.PhV.neut.cVal.mag.f | VN – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.PhV.neut.cVal.ang.f | VN – Angle | | FAULT_LOG |
| FLTMMXU1.MX.PPV.phsAB.cVal.mag.f | VAB – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.PPV.phsAB.cVal.ang.f | VAB – Angle | | FAULT_LOG |
| FLTMMXU1.MX.PPV.phsBC.cVal.mag.f | VBC – Magnitude | | FAULT_LOG |

| | | | |
|---|---|---|---|
| FLTMMXU1.MX.PPV.phsBC.cVal.ang.f | VBC – Angle | | FAULT_LOG |
| FLTMMXU1.MX.PPV.phsCA.cVal.mag.f | VCA – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.PPV.phsCA.cVal.ang.f | VCA – Angle | | FAULT_LOG |
| FLTMMXU1.MX.A.phsA.cVal.mag.f | IA - Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.A.phsA.cVal.ang.f | IA - Angle | | FAULT_LOG |
| FLTMMXU1.MX.A.phsB.cVal.mag.f | IB - Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.A.phsB.cVal.ang.f | IB - Angle | | FAULT_LOG |
| FLTMMXU1.MX.A.phsC.cVal.mag.f | IC - Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.A.phsC.cVal.ang.f | IC - Angle | | FAULT_LOG |
| FLTMMXU1.MX.A.neut.cVal.mag.f | IN – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.A.neut.cVal.ang.f | IN – Angle | | FAULT_LOG |
| FLTMMXU1.MX.A.res.cVal.mag.f | IG – Magnitude | | FAULT_LOG |
| FLTMMXU1.MX.A.res.cVal.ang.f | IG – Angle | | FAULT_LOG |
| FLTMMXU1.MX.Hz.mag.f | Frequency | | FAULT_LOG |
| FLTMMXU1.MX.TotW.mag.f | Total Real Power | | FAULT_LOG |
| FLTMMXU1.MX.TotVAr.mag.f | Total Reactive Power | | FAULT_LOG |
| FLTMMXU1.MX.W.phsA.cVal.mag.f | A Phase Real Power | | FAULT_LOG |
| FLTMMXU1.MX.W.phsB.cVal.mag.f | B Phase Real Power | | FAULT_LOG |
| FLTMMXU1.MX.W.phsC.cVal.mag.f | C Phase Real Power | | FAULT_LOG |
| FLTMMXU1.MX.VAr.phsA.cVal.mag.f | A Phase Reactive Power | | FAULT_LOG |
| FLTMMXU1.MX.VAr.phsB.cVal.mag.f | B Phase Reactive Power | | FAULT_LOG |
| FLTMMXU1.MX.VAr.phsC.cVal.mag.f | C Phase Reactive Power | | FAULT_LOG |

## FLTMSQI1

This section defines the logical node data for FLTMSQI1 of the FPROFault-Data logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| FLTMSQI1.MX.SeqA.c1.cVal.mag.f | 46BC I2/I1 Magnitude | | FAULT_LOG |
| FLTMSQI1.MX.SeqA.c2.cVal.mag.f | Neg. Seq. Magnitude (46/50, 46/51) | | FAULT_LOG |

| | | | |
|---|---|---|---|
| FLTMSQI1.MX.SeqA.c2.cVal.ang.f | Neg. Seq. Angle (46/50, 46/51) | | FAULT_LOG |
| FLTMSQI1.MX.SeqV.c2.cVal.mag.f | Neg. Seq. Magnitude (47DT, 47IT) | | FAULT_LOG |

### FLTMTHR1

This section defines the logical node data for FLTMTHR1 of the FPROFault-Data logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| FLTMTHR1.MX.Tmp01.mag.f | Fault location | | FAULT_LOG |
| FLTMTHR1.MX.Tmp02.mag.f | Fault - Magnitude | | FAULT_LOG |
| FLTMTHR1.MX.Tmp03.mag.f | Fault - Angle | | FAULT_LOG |

### SPCSOPULGGIO1

This section defines the logical node data for SPCSOPULGGIO1 of the FPRO-Control logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| SPCSOPULGGIO1.CO.SPCSO1.Oper.ctlVal | Single Point Pulse Type Control Input – 1 | | RELAY_CONTROL |
| SPCSOPULGGIO1.ST.SPCSO1.stVal | Single Point Status output – 1 | | |
| SPCSOPULGGIO1.CO.SPCSO2.Oper.ctlVal | Single Point Pulse Type Control Input – 2 | | RELAY_CONTROL |
| SPCSOPULGGIO1.ST.SPCSO2.stVal | Single Point Status output – 2 | | |
| SPCSOPULGGIO1.CO.SPCSO3.Oper.ctlVal | Single Point Pulse Type Control Input - 3 | | RELAY_CONTROL |
| SPCSOPULGGIO1.ST.SPCSO3.stVal | Single Point Status output – 3 | | |
| SPCSOPULGGIO1.CO.SPCSO4.Oper.ctlVal | Single Point Pulse Type Control Input - 4 | | RELAY_CONTROL |
| SPCSOPULGGIO1.ST.SPCSO4.stVal | Single Point Status output – 4 | | |
| SPCSOPULGGIO1.CO.SPCSO5.Oper.ctlVal | Single Point Pulse Type Control Input - 5 | | RELAY_CONTROL |
| SPCSOPULGGIO1.ST.SPCSO5.stVal | Single Point Status output – 5 | | |
| SPCSOPULGGIO1.CO.SPCSO6.Oper.ctlVal | Single Point Pulse Type Control Input - 6 | | RELAY_CONTROL |
| SPCSOPULGGIO1.ST.SPCSO6.stVal | Single Point Status output – 6 | | |

## Logical Nodes for Control Object's

### SPCSOLATGGIO2

This section defines the logical node data for SPCSOLATGGIO2 of the FPROControl logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| SPCSOLATGGIO2.CO. SPCSO7.Oper.ctlVal | Single Point Latch Type Control Input – 7 | | RELAY_CONTROL |
| SPCSOLATGGIO2.ST. SPCSO7.stVal | Single Point Status output – 7 | | |
| SPCSOLATGGIO2.CO. SPCSO8.Oper.ctlVal | Single Point Latch Type Control Input – 8 | | RELAY_CONTROL |
| SPCSOLATGGIO2.ST. SPCSO8.stVal | Single Point Status output – 8 | | |
| SPCSOLATGGIO2.CO. SPCSO9.Oper.ctlVal | Single Point Latch Type Control Input - 9 | | RELAY_CONTROL |
| SPCSOLATGGIO2.ST. SPCSO9.stVal | Single Point Status output – 9 | | |
| SPCSOLATGGIO2.CO. SPCSO10.Oper.ctlVal | Single Point Latch Type Control Input - 10 | | RELAY_CONTROL |
| SPCSOLATGGIO2.ST. SPCSO10.stVal | Single Point Status output – 10 | | |
| SPCSOLATGGIO2.CO. SPCSO11.Oper.ctlVal | Single Point Latch Type Control Input - 11 | | RELAY_CONTROL |
| SPCSOLATGGIO2.ST. SPCSO11.stVal | Single Point Status output – 11 | | |
| SPCSOLATGGIO2.CO. SPCSO12.Oper.ctlVal | Single Point Latch Type Control Input - 12 | | RELAY_CONTROL |
| SPCSOLATGGIO2.ST. SPCSO12.stVal | Single Point Status output – 12 | | |

### DPCSOPULGGIO3

This section defines the logical node data for DPCSOPULGGIO3 of the FPROControl logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| DPCSOPULGGIO3.CO. DPCSO1.Oper.ctlVal | Double Point Pulse Type Control Input – 1 | | RELAY_CONTROL |
| DPCSOPULGGIO3.ST. DPCSO1.stVal | Double Point Status output – 1 | | |
| DPCSOPULGGIO3.CO. DPCSO2.Oper.ctlVal | Double Point Pulse Type Control Input – 2 | | RELAY_CONTROL |
| DPCSOPULGGIO3.ST. DPCSO2.stVal | Double Point Status output – 2 | | |
| DPCSOPULGGIO3.CO. DPCSO3.Oper.ctlVal | Double Point Pulse Type Control Input - 3 | | RELAY_CONTROL |

| | | | |
|---|---|---|---|
| DPCSOPULGGIO3.ST.DPCSO3.stVal | Double Point Status output – 3 | | |
| DPCSOPULGGIO3.CO.DPCSO4.Oper.ctlVal | Double Point Pulse Type Control Input - 4 | | RELAY_CONTROL |
| DPCSOPULGGIO3.ST.DPCSO4.stVal | Double Point Status output – 4 | | |

### CtlModGGIO4

This section defines the logical node data for CtlModGGIO4 of the FPROControl logical device.

| Data Name | Description | IEC61850 Index | Source |
|---|---|---|---|
| CtlModGGIO4.ST.Ind1.stVal | Control Mode Status - OFF | | STATUS_HANDLER |
| CtlModGGIO4.ST.Ind2.stVal | Control Mode Status – LOCAL | | STATUS_HANDLER |
| CtlModGGIO4.ST.Ind3.stVal | Control Mode Status – REMOTE | | STATUS_HANDLER |