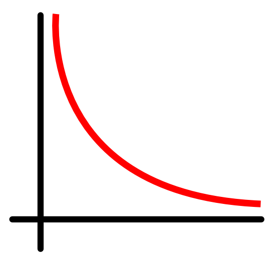
F-PRO 297

Feeder Protection Relay



User Manual

Version 1.2 Revision 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.

While all information presented is believed to be reliable and in accordance with accepted engineering practices, ERLPhase makes no warranties as to the completeness of the information.

All trademarks used in association with B-PRO, B-PRO Multi Busbar, Multi Busbar Protection, F-PRO, iTMU, L-PRO, ProLogic, S-PRO, T-PRO, M-PRO, TESLA, I/O Expansion Module, TESLA Control Panel, Relay Control Panel, RecordGraph and RecordBase are trademarks of ERLPhase Power Technologies Ltd.

Windows® is a registered trademark of the Microsoft Corporation.

HyperTerminal® is a registered trademark of Hilgraeve.

Modbus® is a registered trademark of Modicon.

Contact Information

ERLPhase Power Technologies Ltd.

Website: www.erlphase.com

Email: info@erlphase.com

Technical Support

Email: support@erlphase.com

Tel: 1-204-477-0591

Using This Guide

This User Manual describes the installation and operation of the F-PRO 297 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 D05321 - F-PRO 297 Firmware User 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 v3.0

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 297 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 297 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 297 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 297 provides other functions such as:

- 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

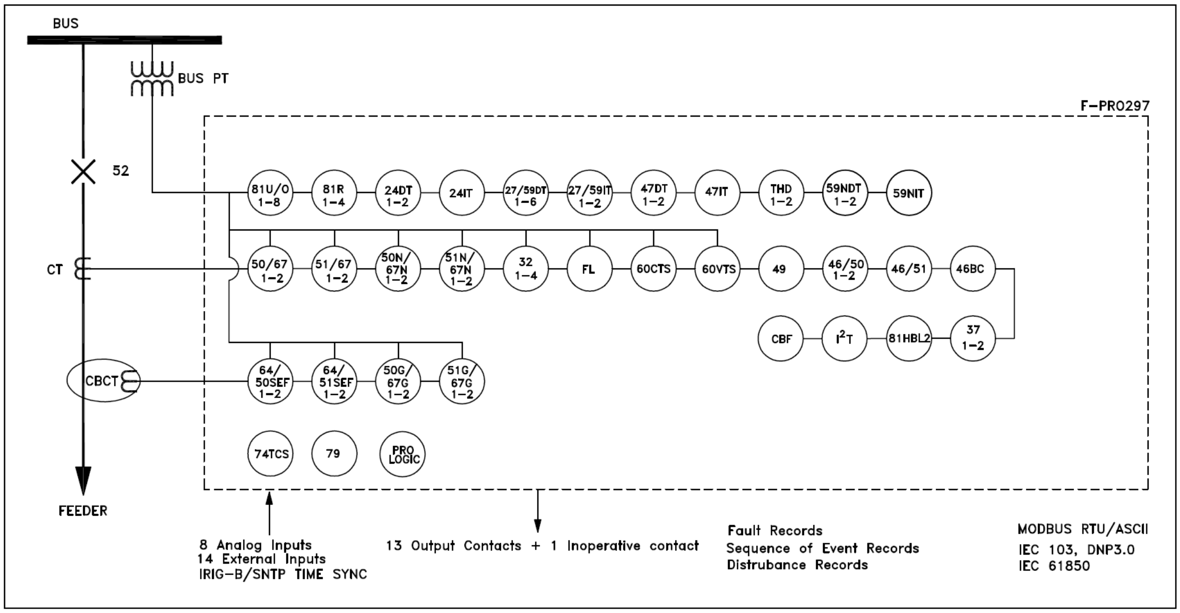


Figure 1.1: F-PRO 297 Relay Function Line Diagram

1.2 Front View

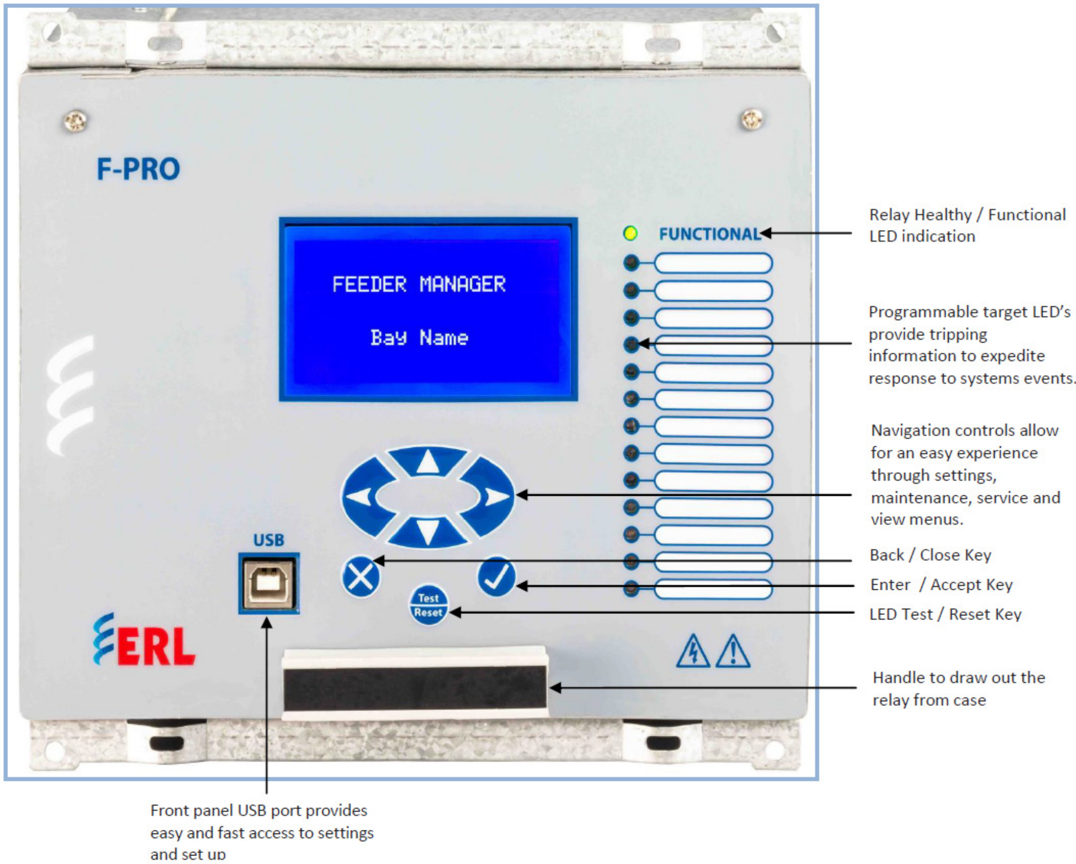


Figure 1.2: F-PRO 297 Relay Front View

1.3 Rear View

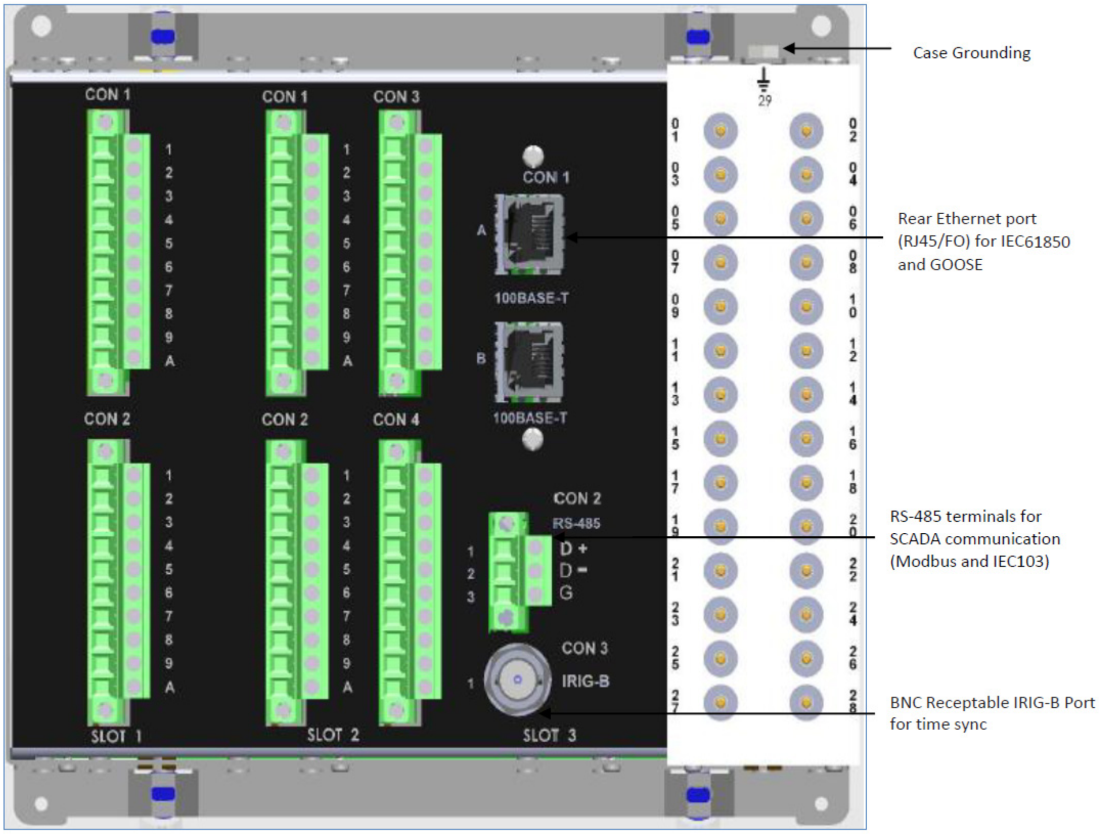


Figure 1.3: F-PRO 297 Relay Rear View

AC Current and Voltage Inputs

The F-PRO 297 relay is provided with terminal blocks for 3 AC Voltages and 5 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 297 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 297 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 “Output Contacts” on page 7-11).

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.

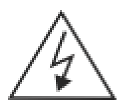
2 Installation and Safety Instructions

2.1 Introduction

This section deals with the installation of the F-PRO 297 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 297 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.
>
> 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 3-24.

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 2-4 and “Case Grounding” on page 2-3 for details regarding the power supply.

3.3 Time Sources

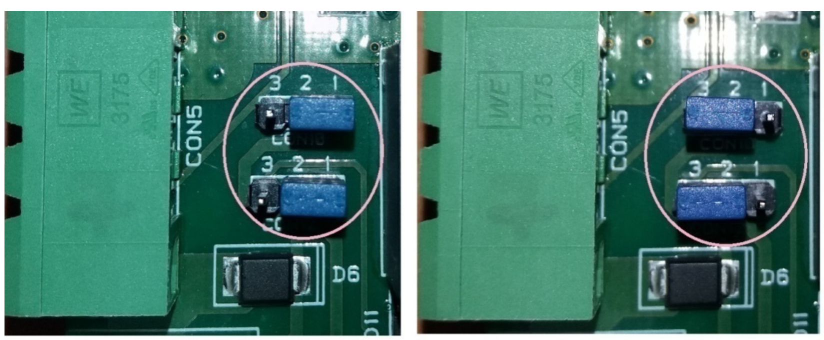
The F-PRO 297 relay supports the use of modulated or unmodulated IRIG-B time signals (external), primary/secondary SNTP network based time synchronization (external) and manually configurable system time based on a free running internal oscillator. The internal free running oscillator is always present on the F-PRO 297 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 297 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.



MODULATED INPUT(1 & 2 SELECT)   UNMODULATED INPUT(2 & 3 SELECT)

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 1 minute to 36 hours, adjusting the F-PRO 297 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.

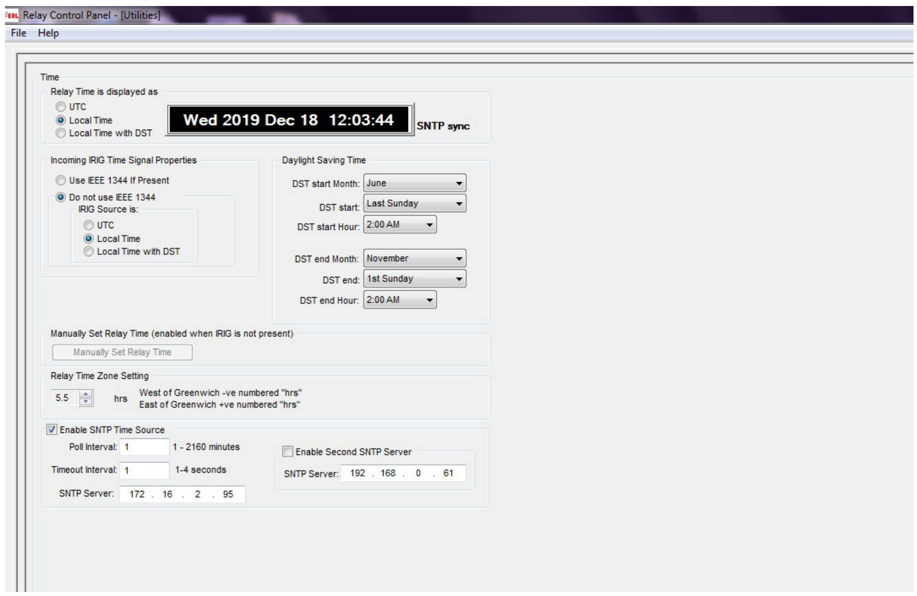


Figure 3.5: SNTP sync settings in RCP

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.

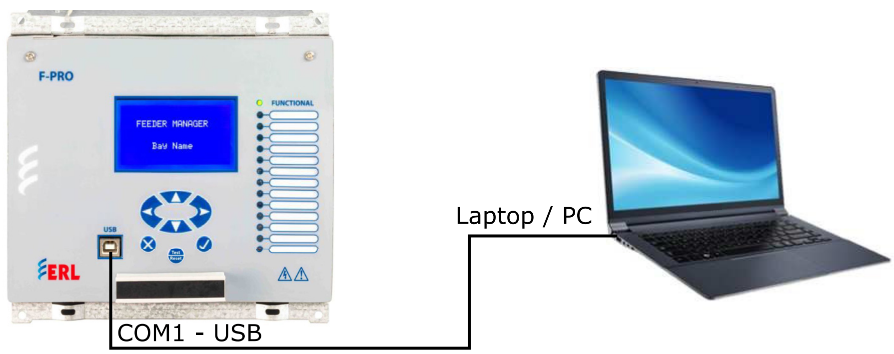


Figure 3.1: USB Link

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

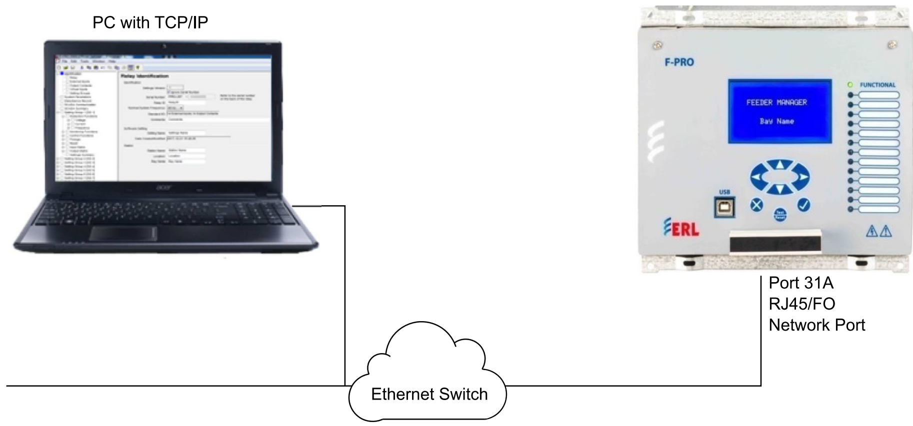


Figure 3.2: Network Link

Access both the relay’s user interface and 61850 SCADA services simultaneously with the Ethernet TCP/IP LAN link through the network port Port 31. 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.

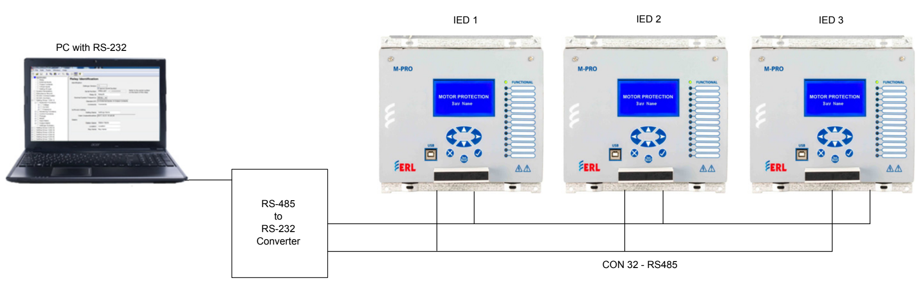


Figure 3.3: RS485 Connection diagram

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. 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: "FPRO297".

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.

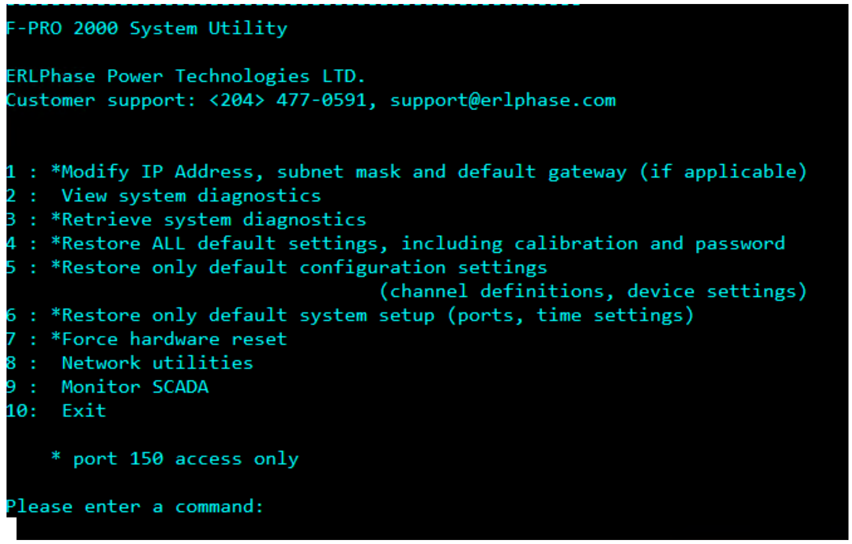


Figure 3.4: Maintenance Menu

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. **NOTE:** If Command 4 is performed, the unit must be recalibrated before being put back into service. See “Calibration” on page 9-2 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

IMPORTANT NOTES:

This process updates the F-PRO 297 relay's firmware. The Firmware Update cannot be reversed once it is completed.

The update procedure will take approximately 5 minutes.

If the update process is interrupted before it is completed, Relay should be restarted and the firmware update procedure needs to be performed again.

During firmware update process the analog (Voltage, Current) inputs and the Digital Inputs (External Inputs) should be isolated from the F-PRO 297 relay. Please ensure the disconnection of CTs, PTs and External Inputs from the relay before the firmware update.

Prerequisites

The following software needs to be installed on the computer to start the firmware update process.

- FTP Client Software (Such as WinSCP, CoreFTP,FileZilla)
- Terminal Emulator Software (such as Tera Term, HyperTerminal)
- USB serial driver for the F-PRO2000 Relays (Gadget_driver)

The following hardware is required:

- Ethernet Cable
- USB (standard, A-B cable)

Check and confirm the following Firmware Update Files are in the provided **Firmware update Files** Folder before starting the firmware update process.

Firmware update Files folder consists of 2 folders

- File System Update
- Firmware Update

Files found under the 'File System Update' folder:

- fpro2k_update.tar
- relay_fw_update_msg
- relay_restart_msg
- erl_update.sh

Files found under the 'Firmware Update' folder:

- update-fpro-297-v1.2.erl

> **Note**: If the provided folders are in the compressed file format (rar or zip file format). Extract the compressed file.

Firmware Update Process

The instructions for the firmware update process are given in this section. The update consists of two parts:

- File System Update
- Firmware Update

Both the File system Update and the Firmware Update must be performed for relays having firmware version F-PRO 297 v1.1 and earlier. The user should perform both the procedures described in “File System Update” on page 3-15 and “Firmware Update” on page 3-19.

Only the Firmware Update must be performed for relays having firmware version F-PRO 297 v1.2 and above. The user should perform the procedure described in “Firmware Update” on page 3-19.

File System Update

To update the file system, follow the steps given below.

1. Open the FTP client Software:
   - Connect the relay to the PC through the Ethernet cable.
   - Open the FTP Client software (Such as WinSCP, CoreFTP, FileZilla).
   - In this document WinSCP software is used.

2. Login to the relay using FTP client Software
   - Enter the following details as shown and click login:
     - File protocol: FTP
     - Encryption: No encryption
     - Host name: IP address of the relay
     - Port number: 21
     - User name: update
     - Password: proup

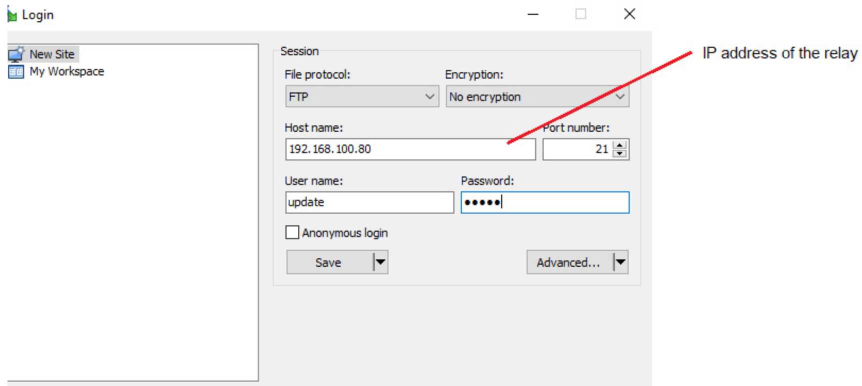


Figure 3.5: Login to the unit via FTP Client

3. Transfer the update files and set permissions

- The left pane in the WinSCP software shows the PC folders and the right pane shows the Relay folders.

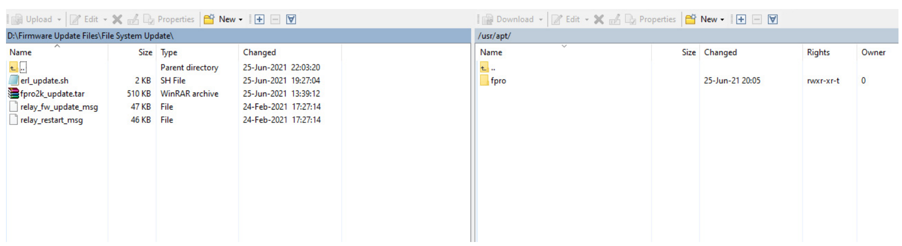


Figure 3.6: Navigate folder structure in FTP client

- Browse to the folder location on the PC where the 'File System Update' files are located and browse to **root/usr/apt** on the Relay.
- Drag and drop or copy the files from the local computer to the relay

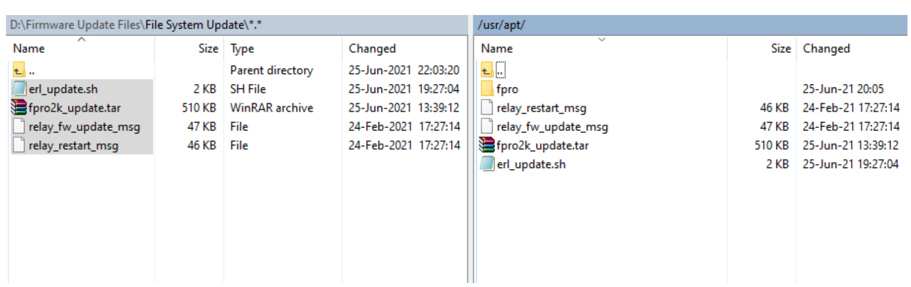


Figure 3.7: Transfer files to F-PRO

- Select all the files copied to the relay and right click>select properties

- Change the permissions to 0777 as shown below and click Ok.

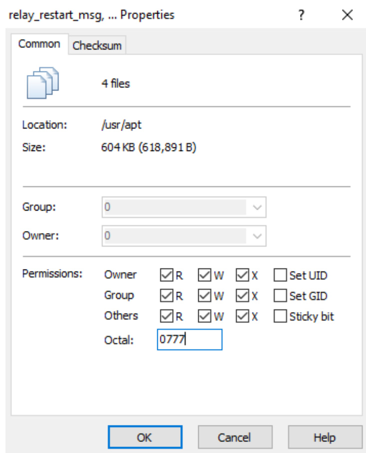


Figure 3.8: Modify permissions

- Confirm that the rights of the files on Relay are as shown below:

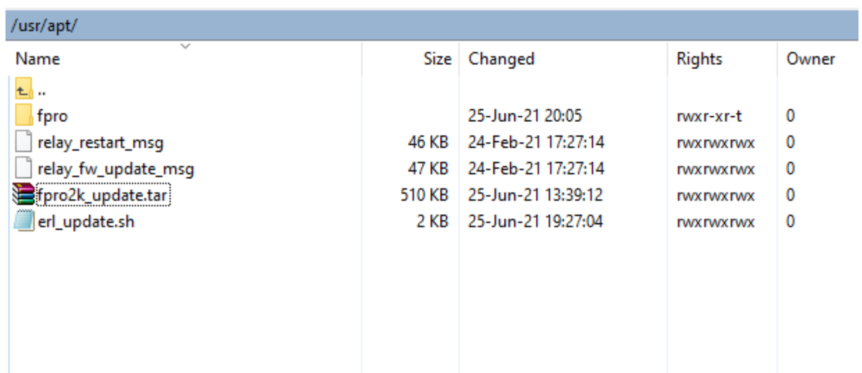


Figure 3.9: Confirm rights are correct

4. Select Firmware update option through the LCD/HMI
   - Login to the relay front panel HMI using the Service login
   - Navigate to Utilities>Firmware Update>Confirm Firmware Update>Yes
   - The F-PRO will prompt the user for password. Enter the password ‘proup’.

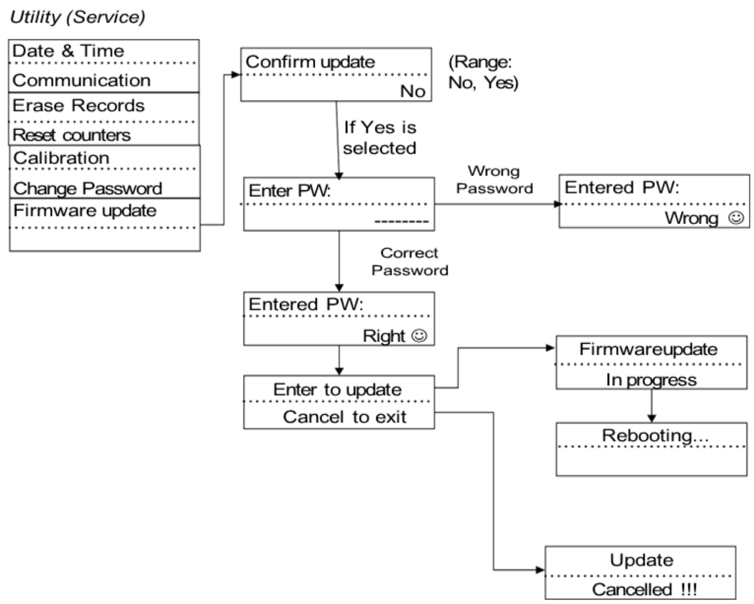


Figure 3.10: Update procedure on front panel HMI

The file system update will start and the relay will display ‘Firmware Update in progress’ message on the display.

Once the file system update process is completed successfully the relay will re-boot and the functional green LED will turn on.

After the File System Update, the user can proceed to the Firmware update pro-cess.

Firmware Update

The firmware update process consists of the following steps.

- Preparations before firmware update
- Establish connection with relay and terminal emulator
- Transfer the firmware files into the relay using terminal emulator
- Restore the settings and CID file if required

1. Preparations before the firmware update:
   - **The relay's present settings will be overwritten during the firmware update.** User should download a copy of setting file from the relay using RCP software if required.
   - **The relay's present CID file will be overwritten during the firmware update.** User should download a copy of the CID file from the relay using ERL IED 61850 Configurator Tool if required.
   - Events, Disturbance Records, Fault Records stored on the relay will be erased during the firmware update process. Download and backup these files if required.
   - Relay serial number, IP address, MAC address, and Login passwords will not be affected by the firmware update process.
   - Once the firmware is installed, the relay will accept only Setting files with the setting version compatible with the newly installed firmware. Refer to the Firmware User Release Description for the compatible setting version. The user should update the setting file version using the F-PRO Offliner software if required.
   - Once the firmware is installed, the relay will accept only CID files created with the ICD version compatible with the newly installed firmware. The ERL 61850 IED Configurator program can be used to create and upload a compatible F-PRO 297 CID file.

2. Establish Connection with the relay and terminal emulator
   - Connect front USB cable to the relay and communicate with the computer.
   - Note the Port number through the ‘Windows Device Manager’ (In this example: Com6 is allotted for F-PRO 297 relay)

- Open Terminal Emulator Software (TeraTerm is used in this document for demonstration)

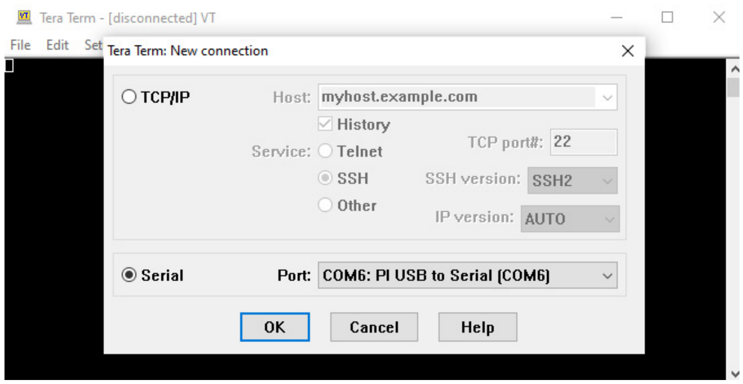


Figure 3.11: New connection in Terminal software

- Select the port number allotted for the F-PRO 297 relay and click 'OK'.
- The Relay is now connected with Tera Terminal
- Note that some terminal emulator tools, such as HyperTerminal, require setting communication properties to 115,200 baud, no parity, 8 bits, 1 stop bit, no flow control.

3. Transfer the firmware files into the relay
   - Press 'Enter' key from the keyboard, once the connection is established
   - **F-PRO2000-297 login:** will appear on the terminal window. Type **update** and press Enter.

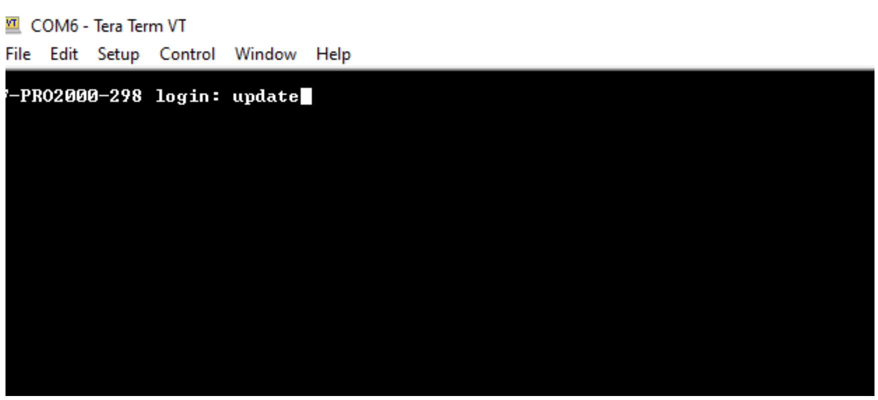


Figure 3.12: Login to Terminal utility

- The following screen will appear after pressing the Enter key

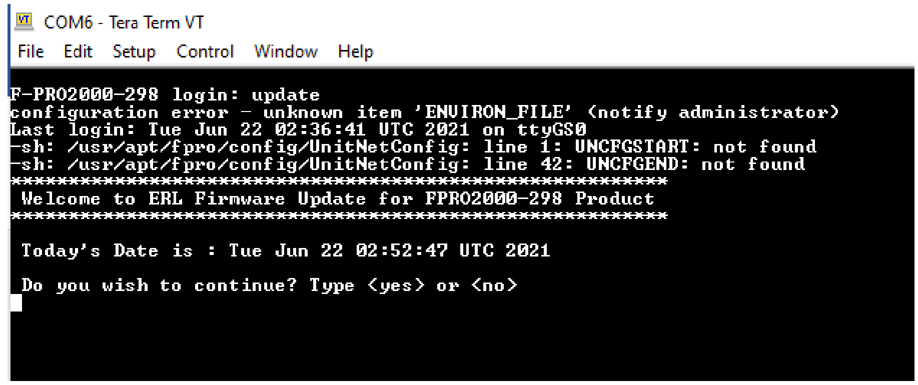


Figure 3.13: Update utility

- Type ‘yes’ in the terminal and hit Enter to continue the firmware update process.
- The terminal screen will prompt the following message ‘Upload the Firmware Update File you want to update’ as shown:

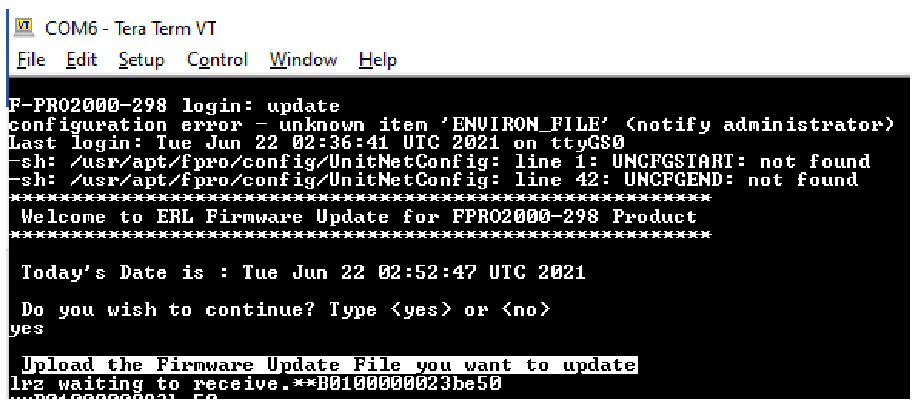


Figure 3.14: Upload prompt

- Select the following menus as shown below: File > Transfer > ZMODEM > Send

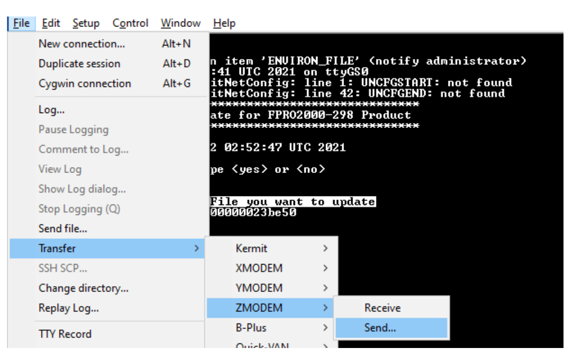


Figure 3.15: Select ZMODEM Send

- Browse the firmware file path and select the respective update-fpro-297-v1.2.erl and click Open

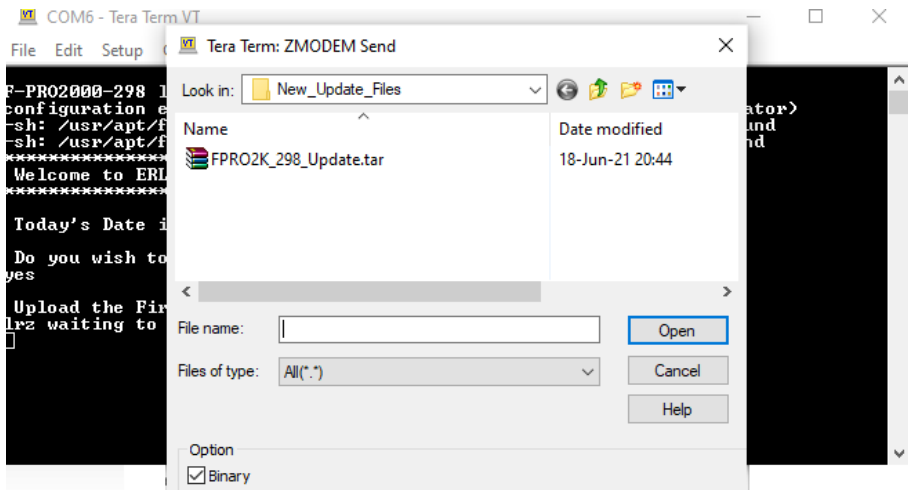


Figure 3.16: Open update file

- The Selected firmware update file will be transfered to the relay as shown below:

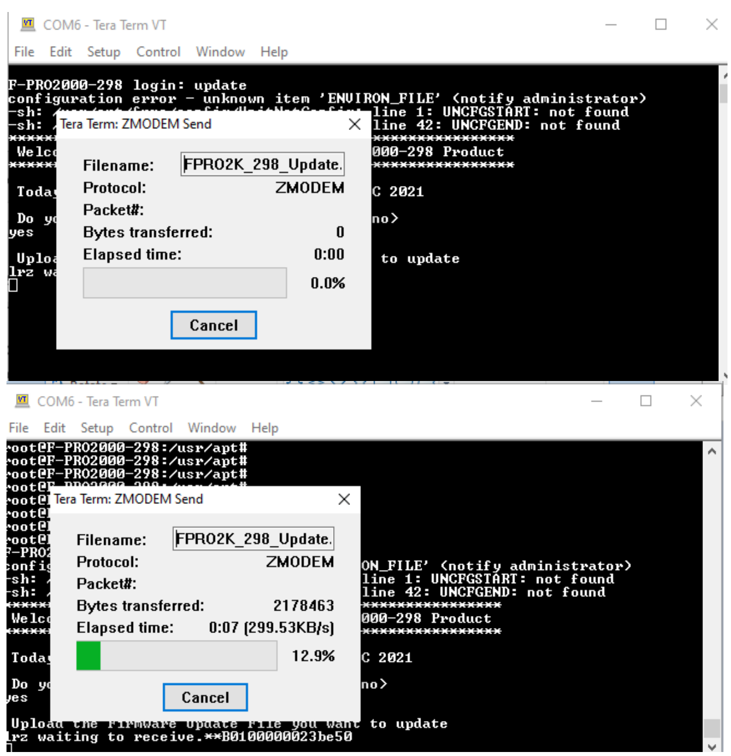


Figure 3.17: Upload in progress

- After the update file has been fully transferred it will be automatically extracted and executed. (**Note**: If the file transfer is interrupted before it reaches 100% the user should restart the relay and repeat step 3.)

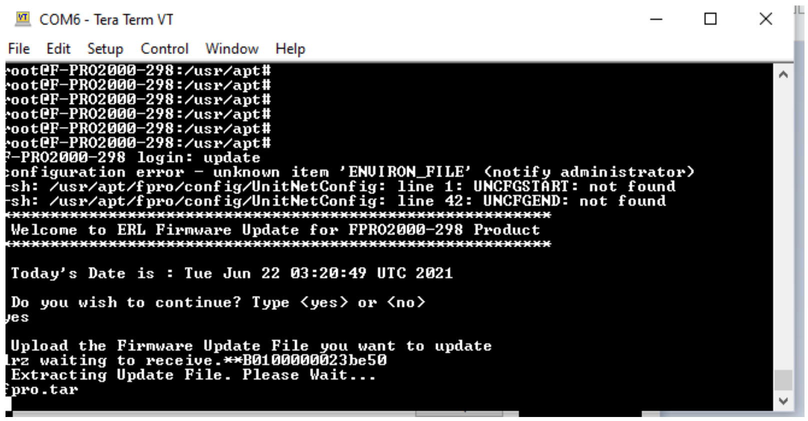


Figure 3.18: Update started

- The Relay will be restarted during the update process.
- The 'Booting' message will be displayed on Relay HMI. After the firmware update process has successfully completed, the Relay functional LED will turn on.
- Verify the updated firmware version in the relay through LCD/HMI or RCP (firmware version found in Unit identification menu in LCD/HMI, Utilities>Unit Identification in RCP).

4. Restore the Settings

- After the firmware update process is complete. Restore the setting file and CID file of the Relay.
- The Relay will accept only a setting file with the setting version specified in the Firmware User Release Description of the newly installed firmware. The user needs to update the setting file version using F-PRO Offliner software if required. Use RCP to load the Setting File to the Relay.
- The relay will accept only CID files created with the ICD file version specified in the Firmware User Release Description of the newly installed firmware. the specified CID files. The ERL 61850 IED Configurator program is used to create and load the F-PRO 297 CID file.

3.10 Communication Port Details

Table 3.4: Communication Port Details

Location	Port[a]	Function
Front Panel	USB	USB-B receptacle, high speed USB 2.0 interface Used for user interface access 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. Used for user interface access or IEC61850 or DNP3 SCADA access through Ethernet LAN. SNTP time sync is also available.
Rear Panel	31B	Additional port for PRP communication as an ordering option (RJ45/FO)
Rear Panel	321-323	RS-485. Used for SCADA communication (MODBUS or IEC103 or DNP3). Default setting: 9600 8 N 1 (8 Data Bits, No Parity, 1 Stop bit)
Rear Panel	331	BNC receptacle, IRIG-B interface. Modulated or un-modulated, 65 ohm impedance

a. Port numbering is a concatenation of the Slot number and Connector number. For example, Port 31A refers to Slot 3, Connector 1A.

Table 3.5: RS485 Connections to Pins on the Relay Port

Signal Name	Direction PC ↔ Relay	Pin # on the Relay Port
D+	↔	SLOT 3, CON2/1
D-	↔	SLOT 3, CON2/2
G		SLOT 3, CON2/3

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.

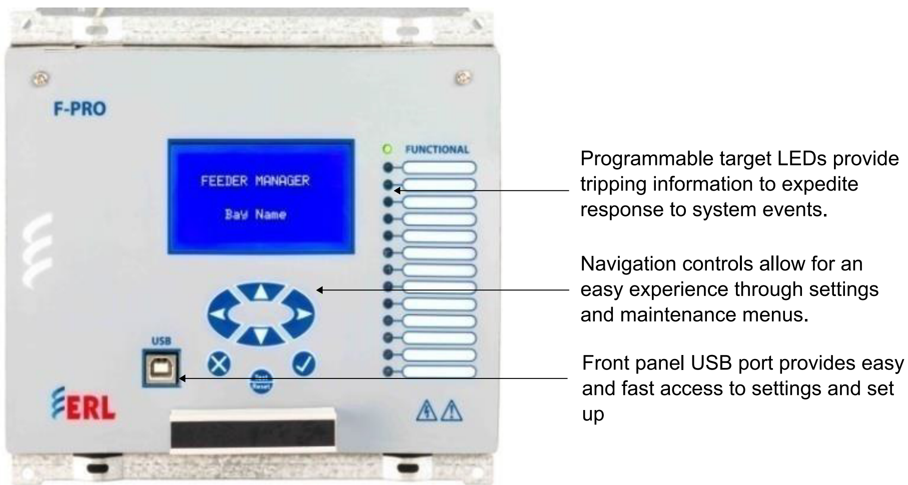


Figure 4.1: Front Panel Display

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.

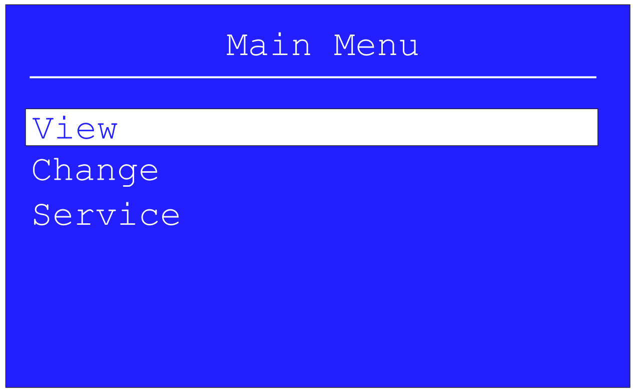


Figure 4.2: View / Change / Service: Choice Menu

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

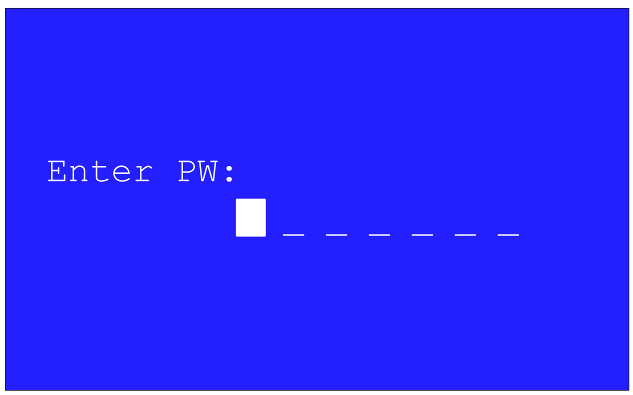


Figure 4.3: Enter Password (only required for Change and Service)

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.

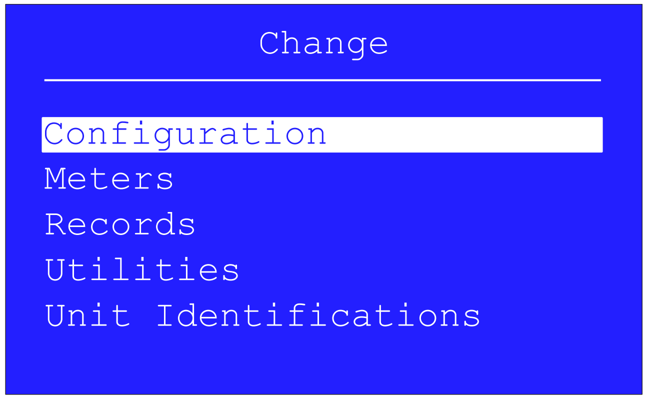


Figure 4.4: Main Menu

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			
					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)
					Der. Neut. OV		

Table 4.8: Navigation of the LCD Screen

Menu Item			Access Level Required [1]
		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/67G	(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)
	Measured Neutral OC		
		Fn. 50G/67G-1	(C,S)
		Fn. 50G/67G-2	(C,S)
		Fn. 51G/67G-1	(C,S)
		Fn. 51G/67G-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)

Table 4.8: Navigation of the LCD Screen

Menu Item			Access Level Required [1]
		Fn. 64/50SEF/67-2	(C,S)
	Thermal OL		
		Fn. 49	(C,S)
	CB Failure		
		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		

Table 4.8: Navigation of the LCD Screen

Menu Item					Access Level Required [1]
				Fn. 74TCS_1	(C,S)
				Fn. 74TCS_2	(C,S)
			CB Monitoring		
				I^2t-CB	(C,S)
			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)
			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)

Table 4.8: Navigation of the LCD Screen

Menu Item				Access Level Required [1]
		DST		(C,S)
		UTC Offset		(C,S)
		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			(C,S)
	Virtual Input Control			(C,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

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			
	Utilities				

Table 4.9: Relay Control Panel Structure

	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 297 relay protection functions.

The available functions are 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/67G, 50G/67G (1 to 2), 51G/67G (1 to 2), 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 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 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.

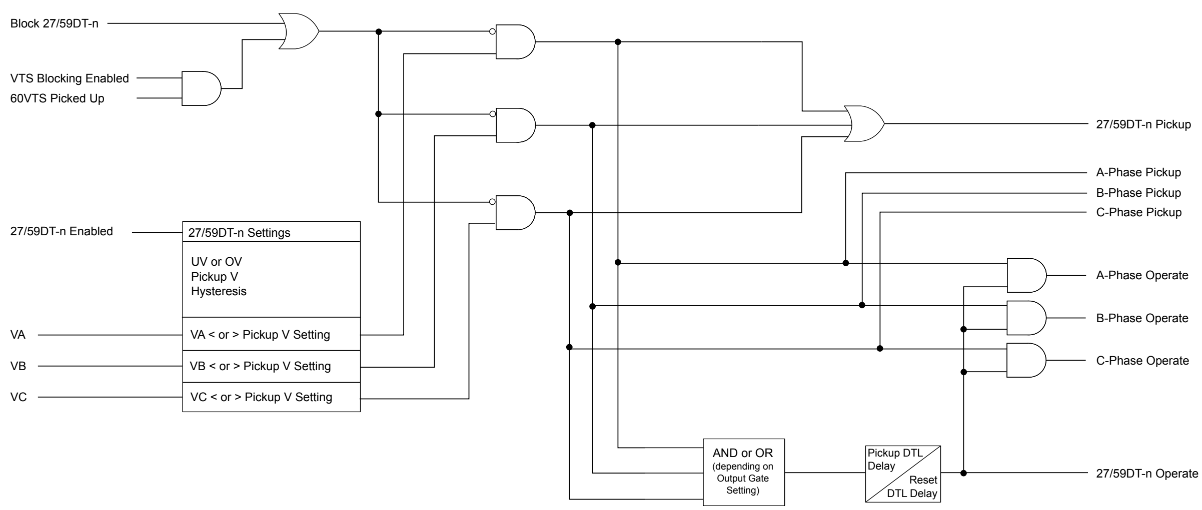


Figure 5.5: 27/59DT Function Logic

Table 5.10: 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, p - curve parameters (predetermined by IEC curve type, or user-settable for user defined curves)

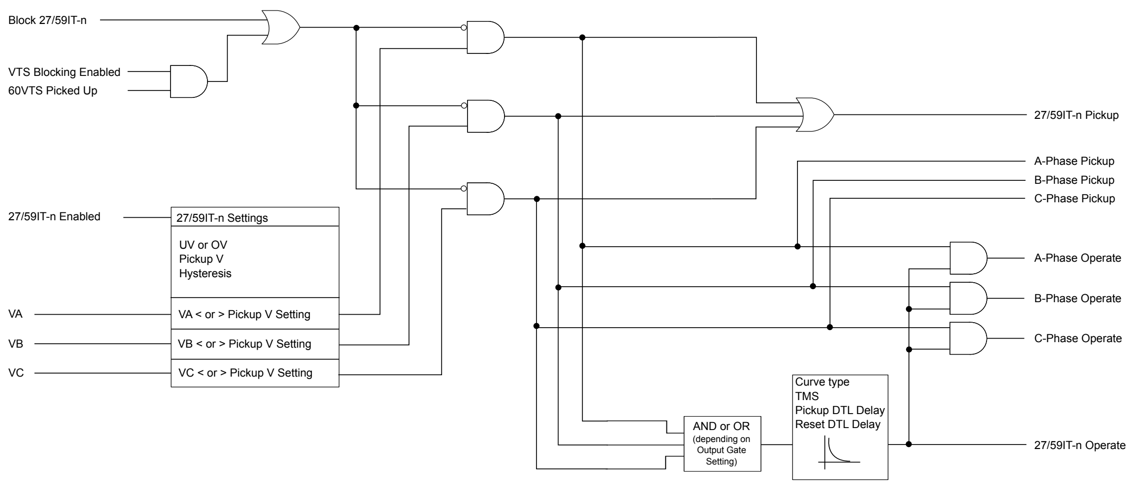


Figure 5.6: 27/59IT Function Logic

Table 5.11: 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.

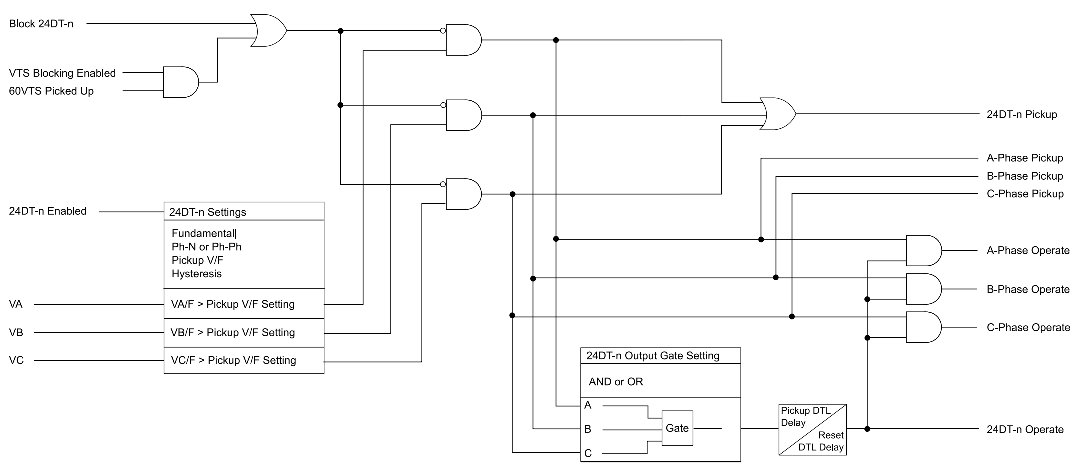


Figure 5.7: 24DT Function Logic

Table 5.12: 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:

Φ = 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.

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:

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

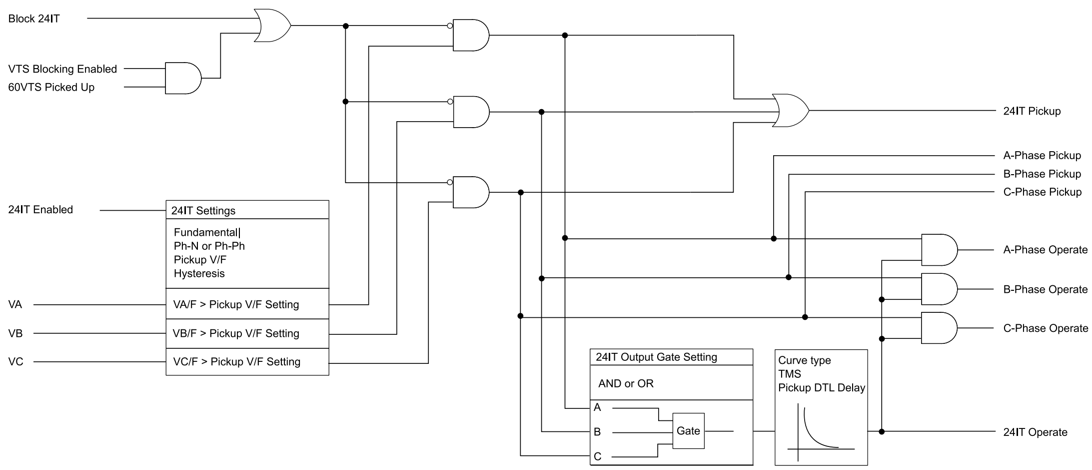


Figure 5.8: 24IT - Inverse Time Overflux Logic

Table 5.13: 24IT - Inverse Time Overflux

Setting Description	Setting Range
24IT	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 User defined set point - Y1	1.00 to 3.00 pu 0.00 to 9999.99 s
User defined set point - X2 User defined set point - Y2	1.00 to 3.00 pu 0.00 to 9999.99 s

Table 5.13: 24IT - Inverse Time Overflux	
User defined set point - X3 User defined set point - Y3	1.00 to 3.00 pu 0.00 to 9999.99 s
User defined set point - X4 User defined set point - Y4	1.00 to 3.00 pu 0.00 to 9999.99 s
User defined set point - X5 User defined set point - Y5	1.00 to 3.00 pu 0.00 to 9999.99 s
User defined set point - X6 User defined set point - Y6	1.00 to 3.00 pu 0.00 to 9999.99 s
User defined set point - X7 User defined set point - Y7	1.00 to 3.00 pu 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. There are two stages provided, 47DT-1 and 47DT-2.

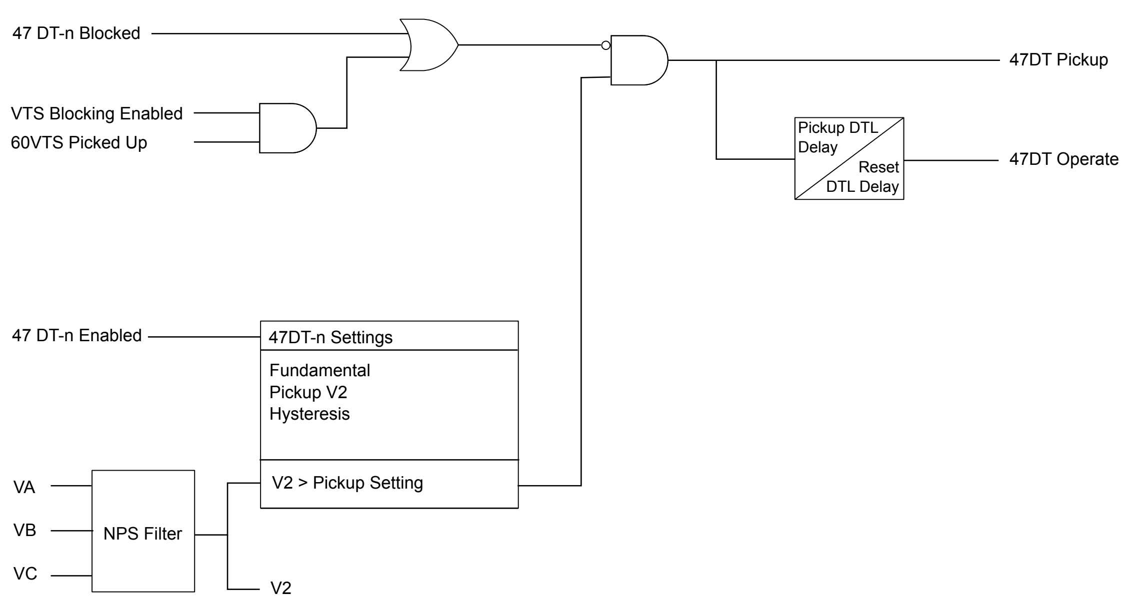


Figure 5.9: 47DT Function Logic

Table 5.14: 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)

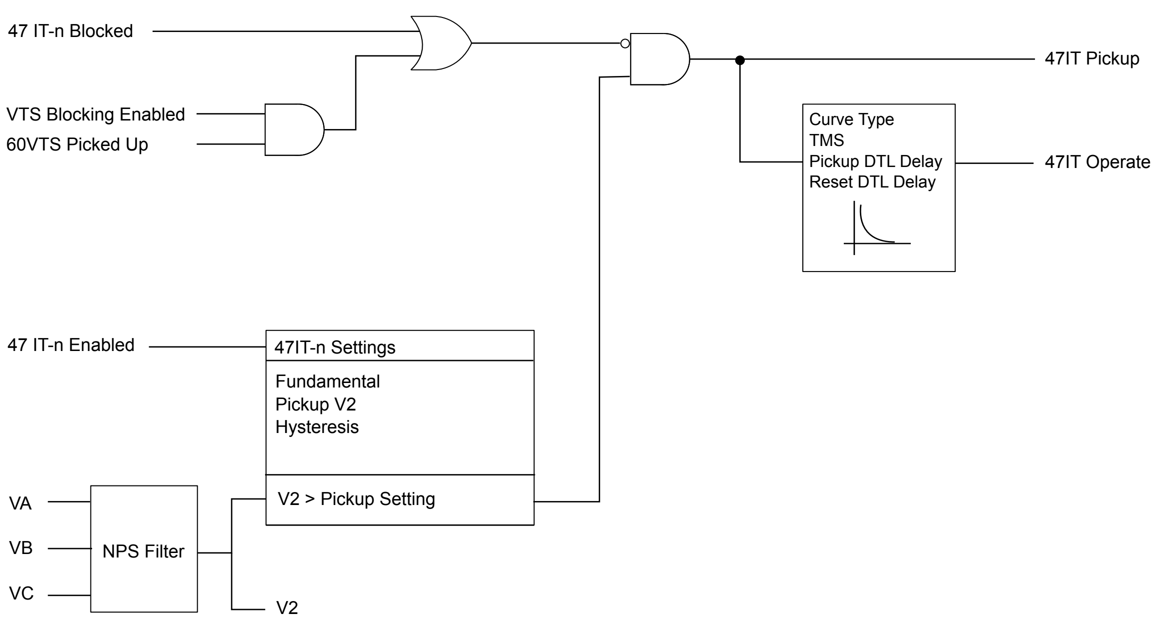


Figure 5.10: 47IT Function Logic

Table 5.15: 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.There are two stages provided, 59NDT-1 and 59NDT-2.

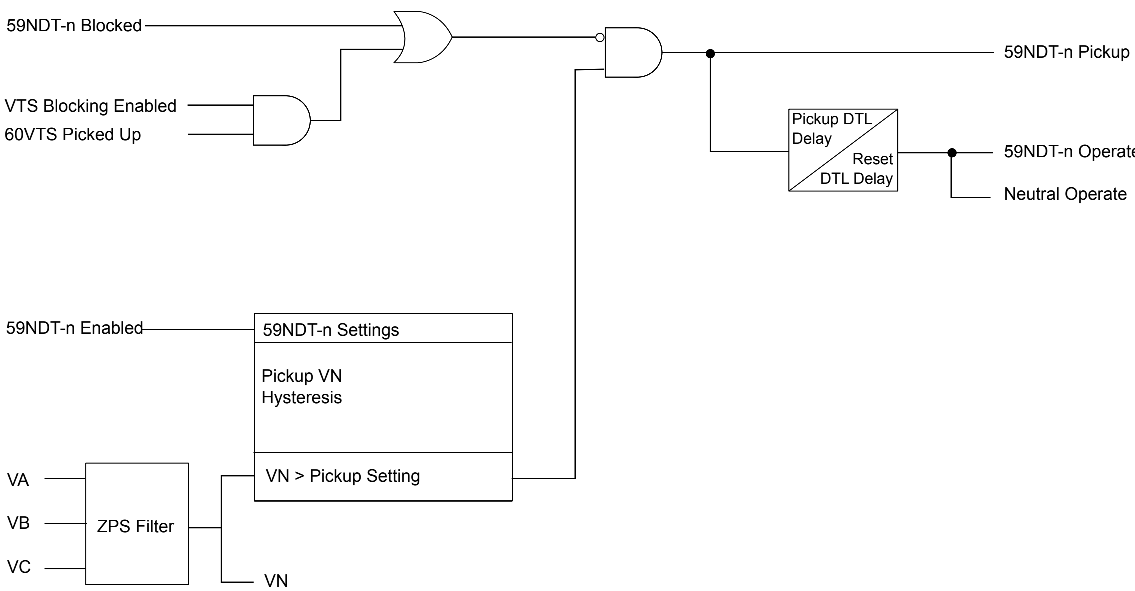


Figure 5.11: 59NDT Function Logic

Table 5.16: 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.

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

Where:

T - pickup time

V_N - Negative phase sequence voltage

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

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

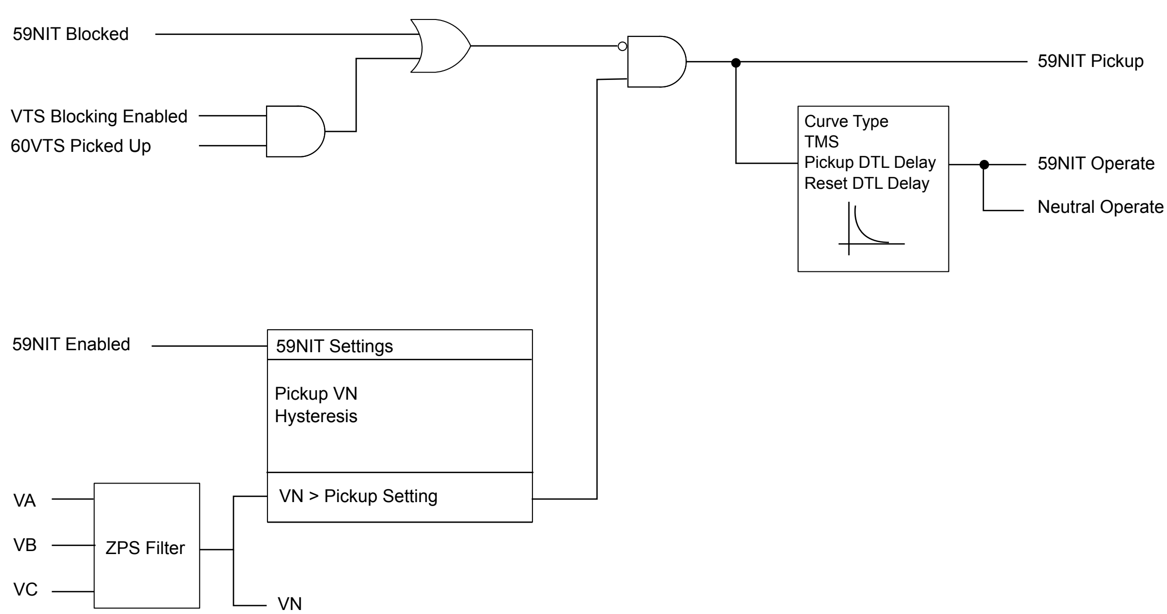


Figure 5.12: 59NIT Function Logic

Table 5.17: 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

5.2 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.

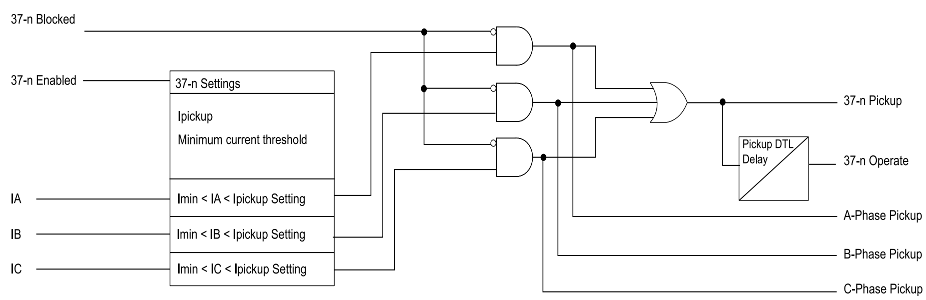


Figure 5.13: 37 - Loss of Load Protection Logic

Table 5.18: 37 - Instantaneous Phase Undercurrent Protection Settings

Setting Description	Setting Range
37-*n*	Enable/Disable
Pickup	0.05A to 3.20A (1A) 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.

For the relay to determine direction (forward or reverse), the reference polarization signal and the direction boundary must be defined. Generally, voltages are used as the reference since the angles remain constant in all cases. F-PRO relays use the cross polarization technique for directional sensing. 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 four settings used to govern the directional element:

- Characteristic angle
- Minimum Voltage
- Two –Out-Of- Three Logic
- VTS
- Blocking

Characteristic angle

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. A Blind Zone is introduced as the 5° region on either side.

Minimum Voltage

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. This helps to avoid mis-operation during normal operation.

Two-Out-Of-Three Logic

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.

VTS Blocking

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.

Directional Overcurrent Stages

The F-PRO directional overcurrent has four stages. The first two stages (50/67-1, 50/67-2) may be set to time delayed or instantaneous operations. The third and fourth stages (51/67-1, 51/67-2) may be set to have IDMTL, time delayed or instantaneous operations.

Table 5.19: 67 Direction Function for Phase Overcurrent Settings

Setting Description	Setting Range
Characteristic Angle	-95 to 95 deg
Minimum Voltage	1.0 to 40.0 V
2 out of 3 Logic	Enable/Disable
VTS Blocking	Disable, Enable, Non-Dir

50/67 Instantaneous Phase Overcurrent

The Instantaneous 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.

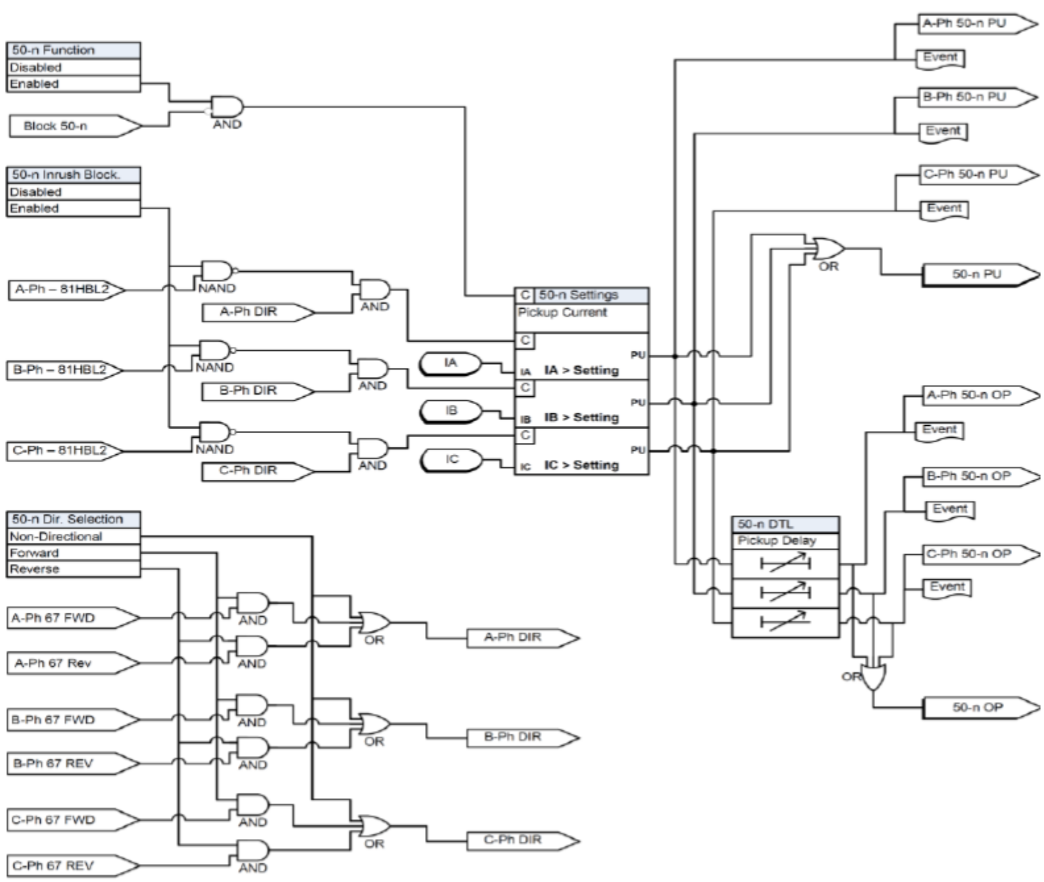


Figure 5.14: 50/67 Function Logic

Table 5.20: 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) 0.25 to 125.00A (5A)
Pickup Delay	0.00s to 999.99 s
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 decay. 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.

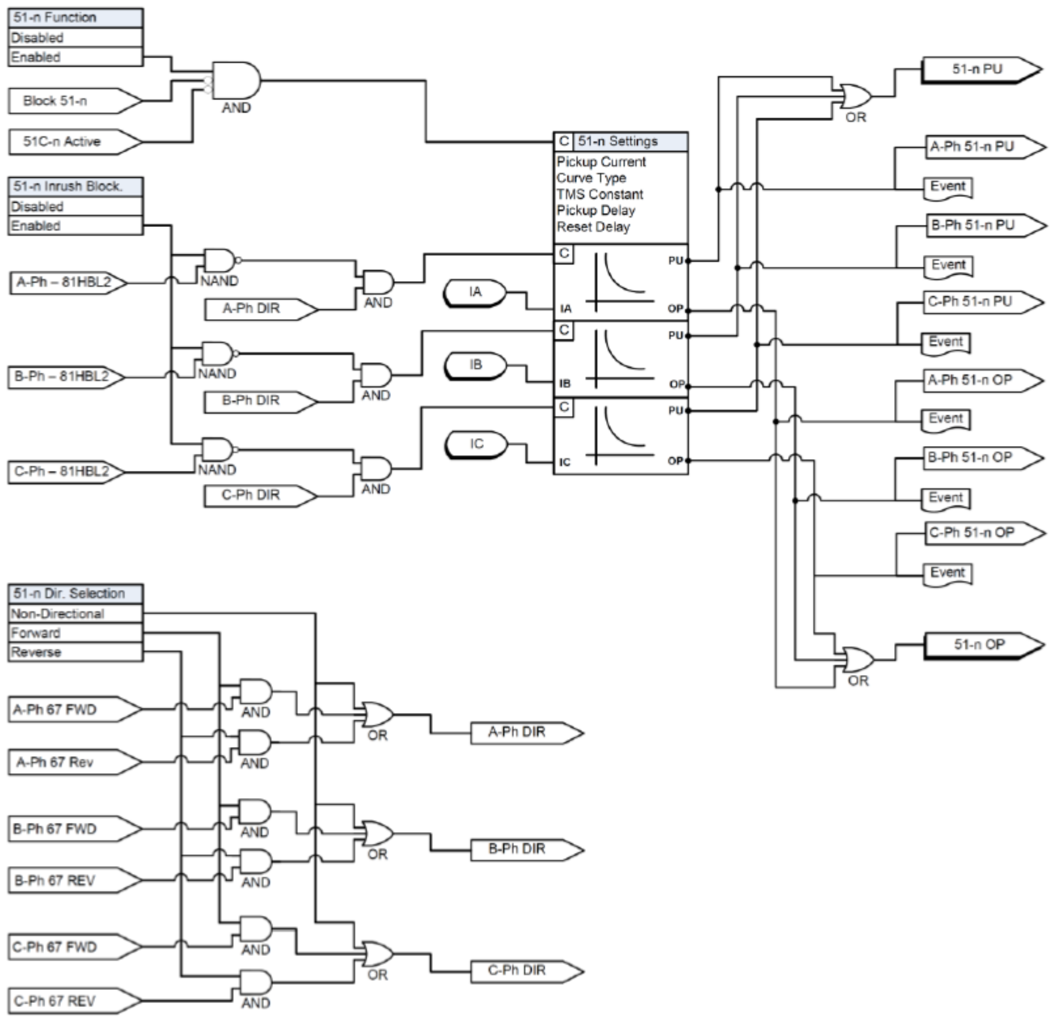


Figure 5.15: 51/67 Function Logic

Table 5.21: 51/67 IDMTL Phase Overcurrent Settings	
Setting Description	**Setting Range**
51/67-*n*	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 10.00A (1A) 0.25 to 50.00A (5A)
Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User Defined
TMS	0.01 to 10.00
Pickup DTL Delay	0.00 to 999.99s

Table 5.21: 51/67 IDMTL Phase Overcurrent Settings

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
Inrush Blocking	Enable/Disable

67N/67G Directional Function for Derived/ Measured Neutral Overcurrent

In a solidly earthed system the neutral points of the power transformers are connected directly to earth to reduce overvoltage and facilitate fault detection. The disadvantage of solid earthing is that fault currents can be very high and must be disconnected quickly. Since the impedance of the source is normally very low, fault current varies greatly in magnitude depending on the location of the fault. Selective isolation of a faulty section is therefore possible via time/ current graded earth fault overcurrent 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 fault causes a residual voltage to be generated, and this can be used for directional polarization. This can be selected in measurement input.

Measurement Input:

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

- Zero sequence voltage polarization / residual voltage polarization (ZPS)
- Negative sequence voltage polarization (NPS)

Zero Sequence Polarization:

Residual voltage is generated during earth fault conditions in power system. This voltage is commonly used to polarize directional earth fault elements. Relay internally derives 3V0 voltage for directionality.

Negative Sequence 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.

Minimum Voltage:

The Minimum Voltage is a user settable voltage level used to determine the pick-up level for the directional earth fault elements. It is possible that minimum percentage of residual voltage will be present under normal system conditions such as system imbalances, VT mismatch and tolerance and relay error.

Characteristic angle:

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. A Blind Zone is introduced as the 5° region on either side.

The F-PRO Derived Neutral directional overcurrent has four stages (two 50N/67 and two 51N/67). See “50N/67N Derived Neutral Overcurrent” on page 5-24 and “51N/67N Derived IDMTL Neutral Overcurrent” on page 5-26 for more details.

The F-PRO Measured Neutral directional overcurrent has four stages (two 50G/67 and two 51G/67). See “50G/67G Measured Neutral Overcurrent” on page 5-28 and “51G/67G IDMTL Measured Neutral Overcurrent” on page 5-29 for more details.

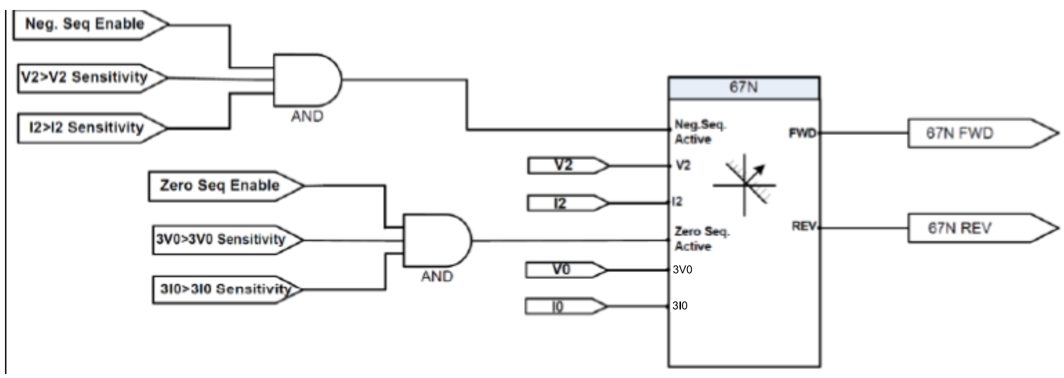


Figure 5.16: 67N/67G Directional Function Logic

Table 5.22: 67N/67G Directional Function for Derived Neutral Overcurrent Settings

Setting Description	Setting Range
Characteristic Angle	-95 to 95 deg
Measurement Input	Negative Phase Sequence, Zero Phase Sequence
Minimum voltage	0.3 to 40.0 V
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.

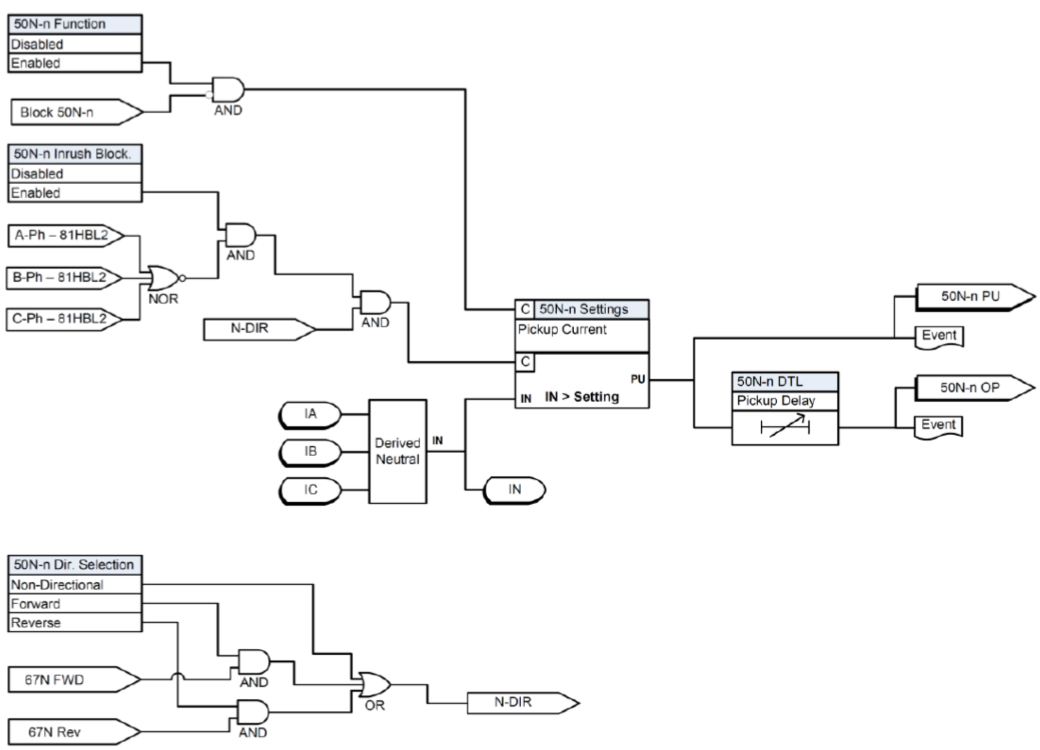


Figure 5.17: 50N/67 Function Logic

Table 5.23: 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) 0.25 to 125.00 A (5A)
Pickup Delay	0.00 to 999.99 s (Non-Dir) 0.01 to 999.99 s (FWD or REV)
Inrush Blocking	Enabled/Disabled

51N/67N Derived IDMTL 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:

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

The Curve Type selection allows user to use a number of curves available in this menu. All of these curve types are generated by the equation shown at the bottom of the screen. If user choose a user-selectable curve, it can be created using the parameters A, B and p.

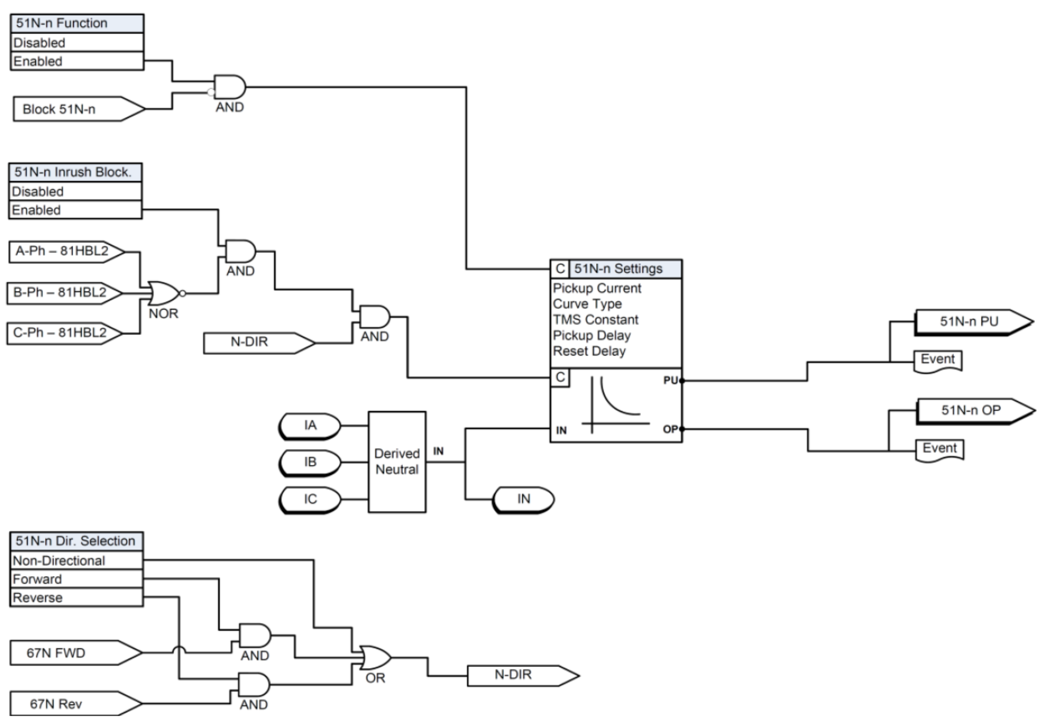


Figure 5.18: 51N/67N Function Logic

Table 5.24: 51N/67N Derived IDMTL Neutral Overcurrent Settings	
Setting Description	**Setting Range**
51/67-*n*	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 10.00 A (1A) 0.25A to 50.00A (5A)
Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User 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
Inrush Blocking	Enable/Disable

50G/67G Measured Neutral Overcurrent

Measured Neutral Overcurrent Protection is provided for detection & clearance of Ground faults. Though Phase Overcurrent can also detect Line to Ground faults, for high resistance Ground faults, Neutral Overcurrent protection will be more sensitive than Phase Overcurrent Protection. User can define 50G functions for instantaneous overcurrent protection.

Measured Neutral current is processed after filtering; if the current measured is greater than the set current the enabled function will go for the operation after the set delay or instantaneous (50G).

The function is provided with the additional feature of “Inrush Blocking”. This is provided to block the function from operation when second harmonic current is present along with the fundamental (When used in transformers application).

Each stage (50G-1 & 50G-2) can be independently inhibited via external input status which can be configured from input matrix, in case blocking of any stage is required depending on application needs.

Metering menu provided will be additional information for the user as it displays the value of current, voltage & the angle between them.

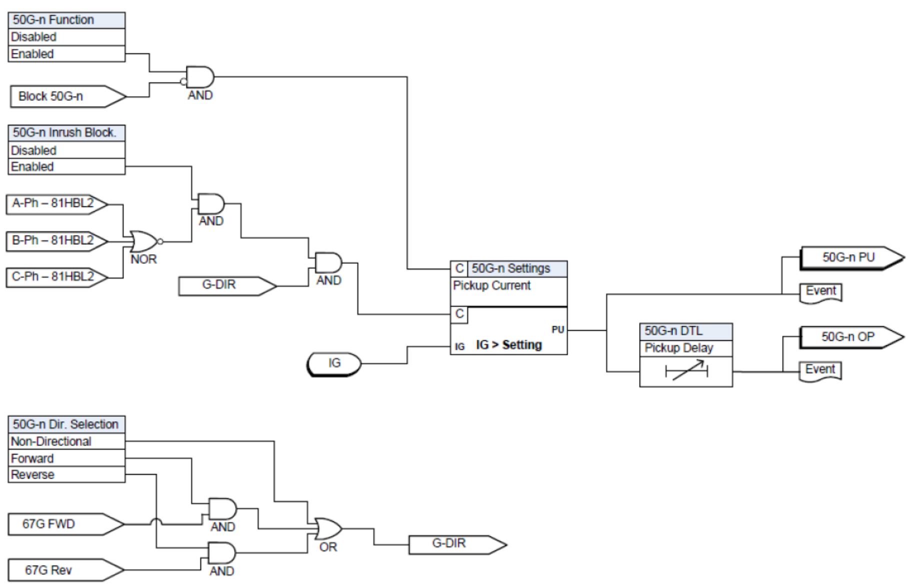


Figure 5.19: 50G/67G Function Logic

Table 5.25: 50G/67G Directional Instantaneous Neutral Overcurrent Settings

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

51G/67G IDMTL Measured Neutral Overcurrent

Measured 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 the measured IG rather than phase current. The equation is:

Pickup:

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

Reset:

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

The Curve Type selection allows user to use a number of curves available in this menu. All of these curve types are generated by the equation shown at the bottom of the screen. If user choose a user-selectable curve, it can be created using the parameters A, B and p.

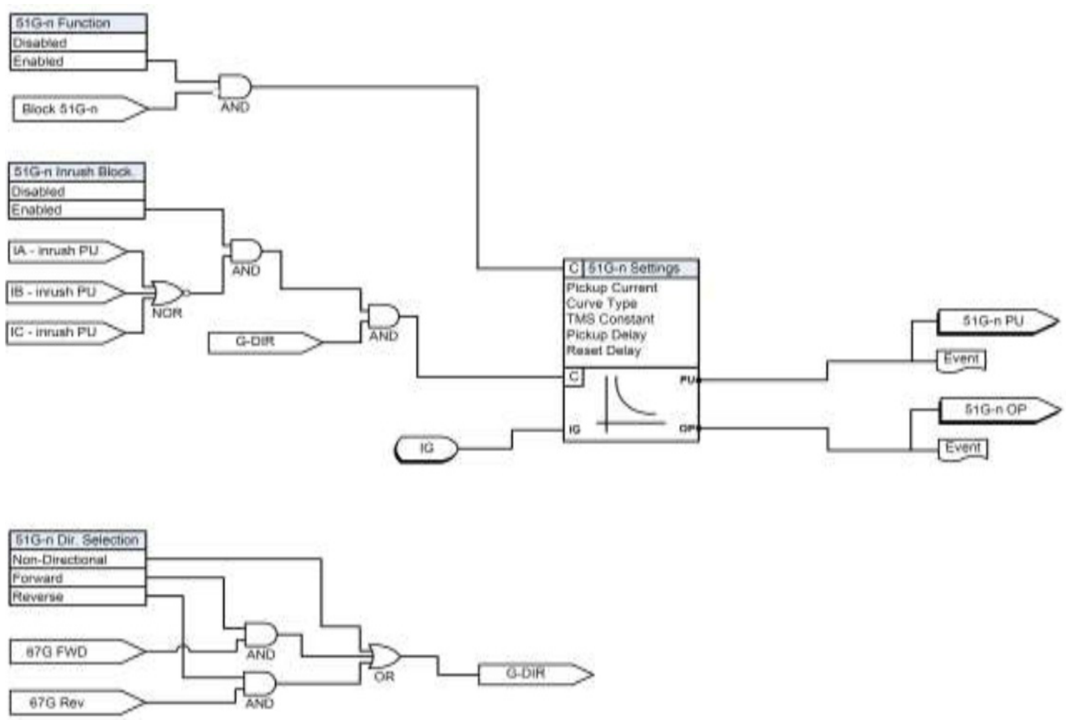


Figure 5.20: 51G/67G Function Logic

Table 5.26: 51G/67G Measured IDMTL Neutral Overcurrent Settings	
Setting Description	**Setting Range**
51/67-*n*	Enabled/Disabled
Direction Selection	Non-Dir, FWD, REV
Pickup I	0.05 to 10.00 A (1A) 0.25A to 50.00A (5A)
Curve Type	DTL, IEC Standard Inverse-1, IEC Standard Inverse-3, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User 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
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.

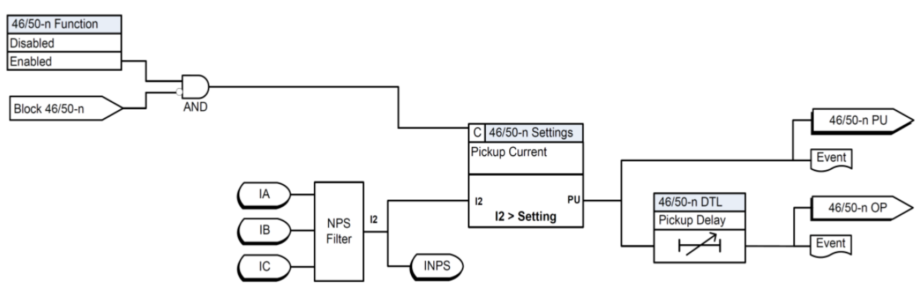


Figure 5.21: 46/50 Instantaneous Negative Sequence Overcurrent

Table 5.27: 46/50 Instantaneous Negative Sequence Overcurrent Settings	
Setting Description	**Setting Range**

Table 5.27: 46/50 Instantaneous Negative Sequence Overcurrent Settings	
46/50 Function	Enabled/Disabled
Pickup I2	0.05A to 0.95A (1A) 0.25A to 4.75A (5A)
Pickup Delay	0.00 to 999.99 s

46/51 IDMTL Negative Sequence Overcurrent

All the curve definitions are the same as the Phase Overcurrent except standard inverse is merged to one curve. The only difference is that this function uses the negative sequence current (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:

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

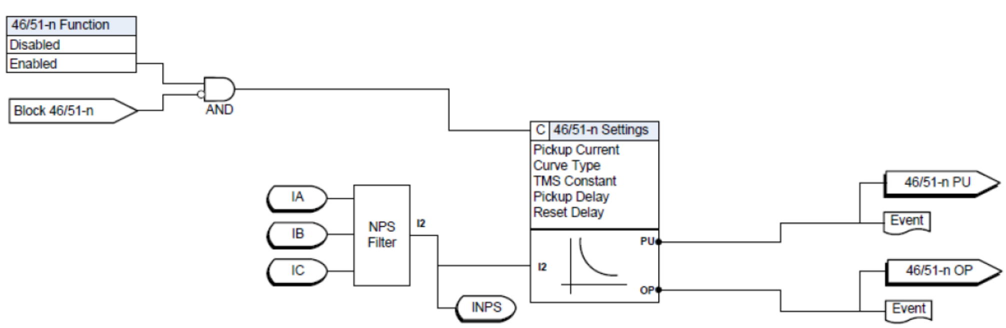


Figure 5.22: 46/51 Instantaneous Negative Sequence Overcurrent

Table 5.28: 46/51 IDMTL Negative Sequence Overcurrent Settings	
Setting Description	**Setting Range**
46-51 Function	Enabled/Disabled

Table 5.28: 46/51 IDMTL Negative Sequence Overcurrent Settings	
Pickup I2	0.05A to 0.95A (1A) 0.25A to 4.75A (5A)
Curve Type	DTL, IEC Standard Inverse, IEC Very Inverse, IEC Extremely Inverse, IEC Long Time Inverse, IEEE Moderately Inverse, IEEE Very Inverse, IEEE Extremely Inverse, User 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

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 less than 10A. 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.

Operation:

Non directional - For this function the relay will operates irrespective of the angle as the name suggests when the injected voltage and current is same or above the pickup value. In this function, pickup voltage value will not take in to account.

Directional (FWD & REV) – For this function the relay gets operated by considering the polarization characteristics angle (whether fwd or rev direction) and the injected voltage and current is same or above the pickup value.

Table 5.29: 67SEF Direction Function for SEF Settings

Setting Description	Setting Range
Characteristic Angle	-95 to 95 degrees
Minimum Voltage	0.3 to 40.0 V
Measurement Input	VN or V2
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.

There are two stages provided, 64/50SEF-1 and 64/50SEF-2.

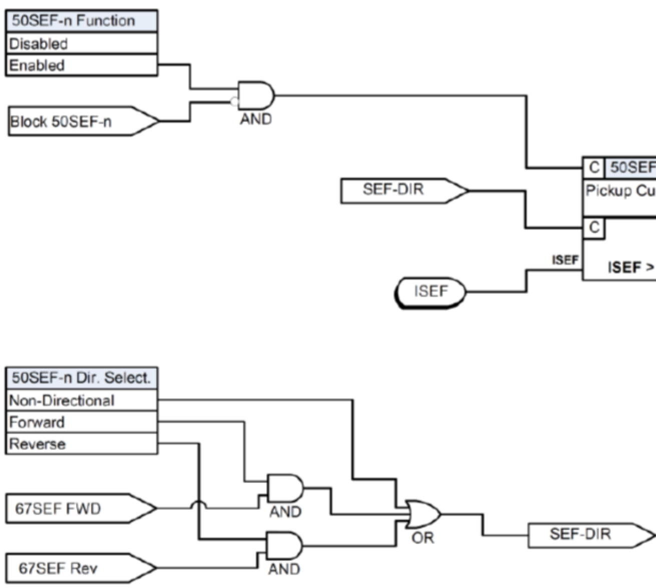


Figure 5.23: 64/50 Instantaneous SEF Function Logic

Table 5.30: 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) 0.025 to 15.000 A (5A)
Pickup Delay	0.00 to 999.99 s (Non-Dir) 0.01 to 999.99 s (FWD or REV)

Table 5.30: 64/50 Instantaneous SEF Settings	
Current Compensation	0.000 to 0.500 A (1A) 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:

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

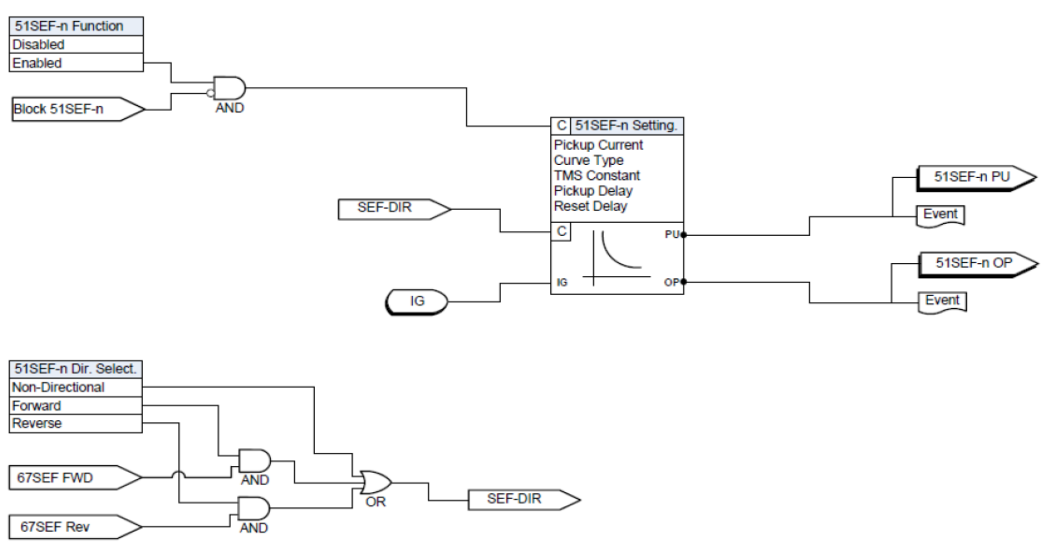


Figure 5.24: 64/51 Inverse Time SEF Function Logic

Table 5.31: 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) 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) 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:

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

Where

θ = Thermal state in percentage at time t

θ_F = Final thermal state before disconnection of feeder

I = Effective relay current.

I_θ = Thermal overload setting

t = Thermal time constant in minutes.

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

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

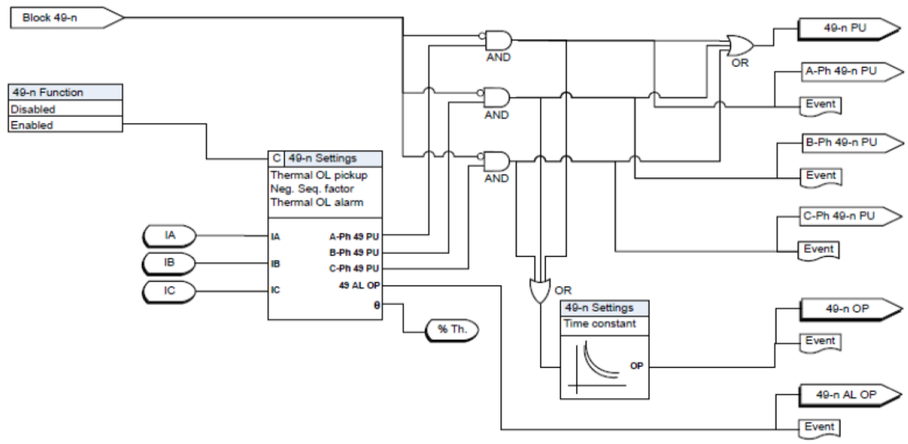


Figure 5.25: 49 Thermal Overload Function Logic

Table 5.32: 49 Thermal Overload Settings

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

50 CBF Circuit Breaker Failure and DI Circuit Breaker Failure

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 (pickup delay 1 and pickup delay 2 – 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.

DI Circuit Breaker Failure

DI CBF function operates based on two External inputs. They are DI CBF initiation and CB closed status (52-A). If the breaker is in closed status and the DI CBF initiation is given to the relay, the DI CBF function will get operated External inputs can be user selectable and can be configured using input matrix of the Offliner.

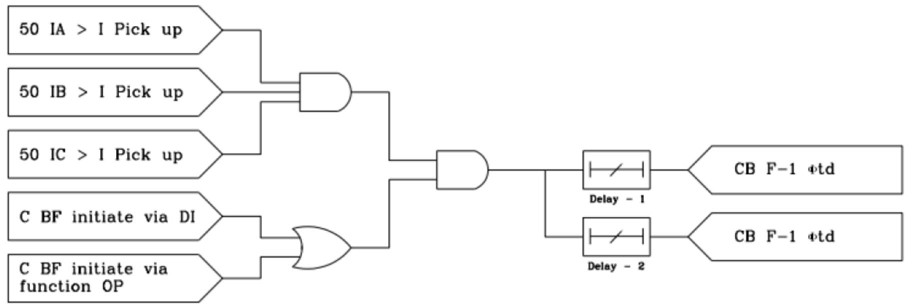


Figure 5.26: 50 CBF Function Logic

Table 5.33: 50 CBF Function Logic	
Setting Description	**Setting Range**
Internal	Enable/Disable
External	Enable/Disable
Pickup I	0.05 to 2.00A (1A) 0.25 to 10.00A (5A)
Pickup Delay 1	0.005 to 999.999s
Pickup Delay 2	0.005 to 999.999s

Table 5.34: DI CBF Function Logic	
Setting Description	**Setting Range**
DI CBF Function	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.

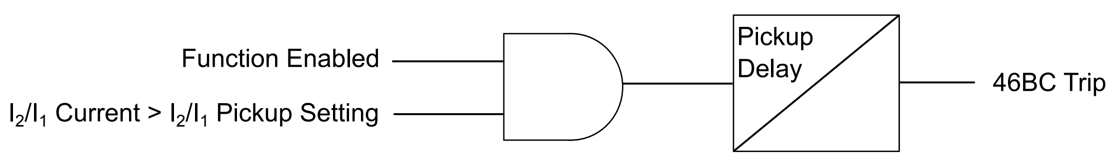


Figure 5.27: 46BC Protection Function Logic

Settings

Table 5.35: 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.

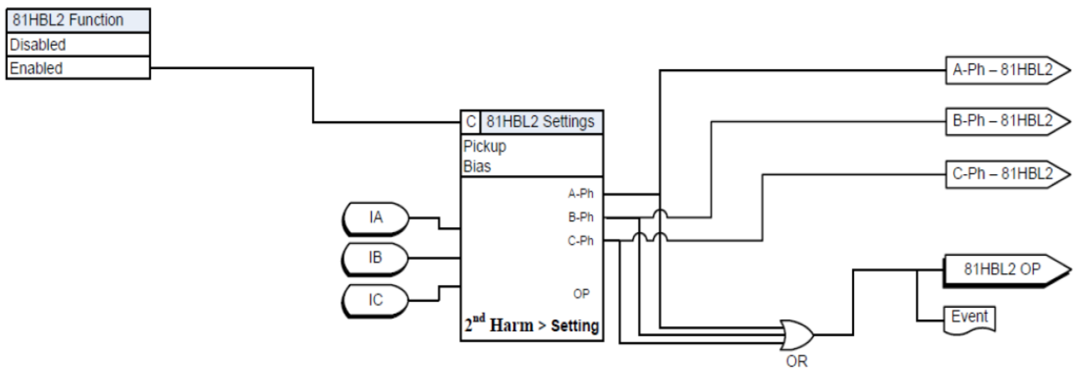


Figure 5.28: 81HBL2 Inrush Block Logic

Table 5.36: 81HBL2 - Inrush Protection Settings	
Setting Description	**Setting Range**
81HBL2 Function	Enabled/Disabled
Cross Blocking	Enabled/Disabled
Pickup I_{2nd}	5% to 50%

5.3 Frequency Protection Functions

81U/O Under/ Over frequency

Eight stages of 81U/O Under or Over frequency function available in F-PRO 297. These stages can be selected by user either as Under frequency or Over frequency function.

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 frequency mainly depends on the % hysteresis.

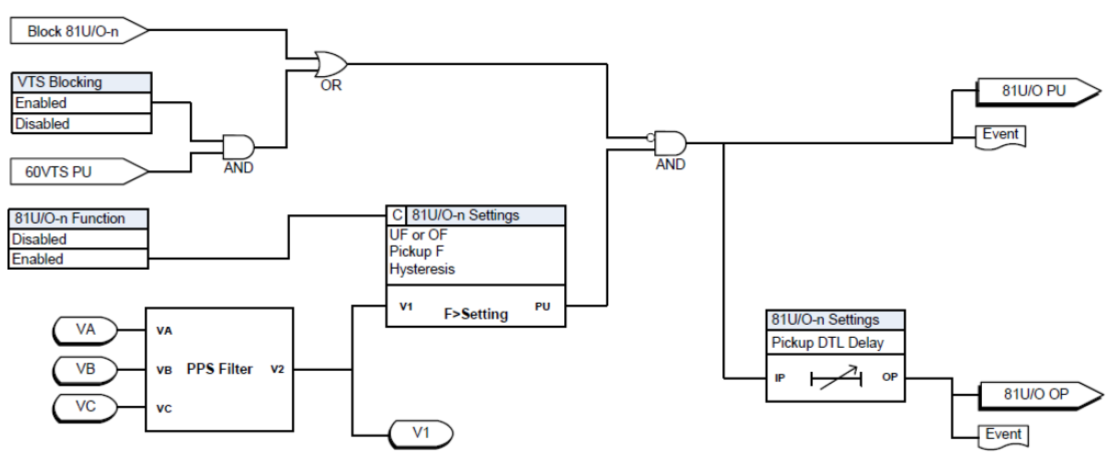


Figure 5.29: 81 U/O Function Logic

Table 5.37: 81U/O - Under/Over Frequency	
Setting Description	**Setting Range**
81/U/O-n	Enabled/Disabled
Function Selection	UF or OF
Pickup F	40.00 to 49.99 for 50Hz UF 50.01 to 60.00 for 50Hz OF 50.00 to 59.99 for 60Hz UF 60.01 to 70.00 for 60Hz OF
Hysteresis	1% to 80%
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 voltage mainly depends on the % hysteresis.

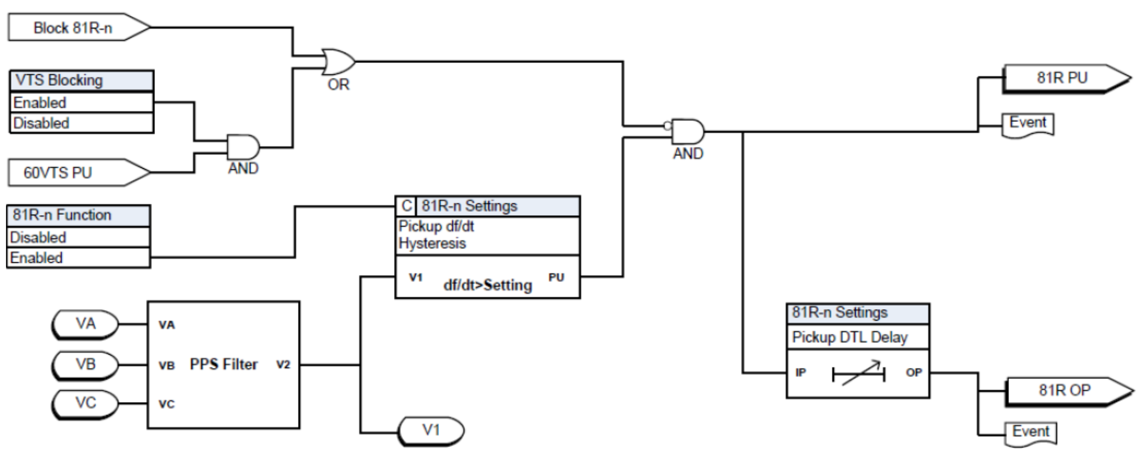


Figure 5.30: 81R Rate of Change of Frequency Function Logic

Table 5.38: 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

5.4 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).

There are 4 stages of 32 Directional Power available 32-1, 32-2, 32-3, 32-4.

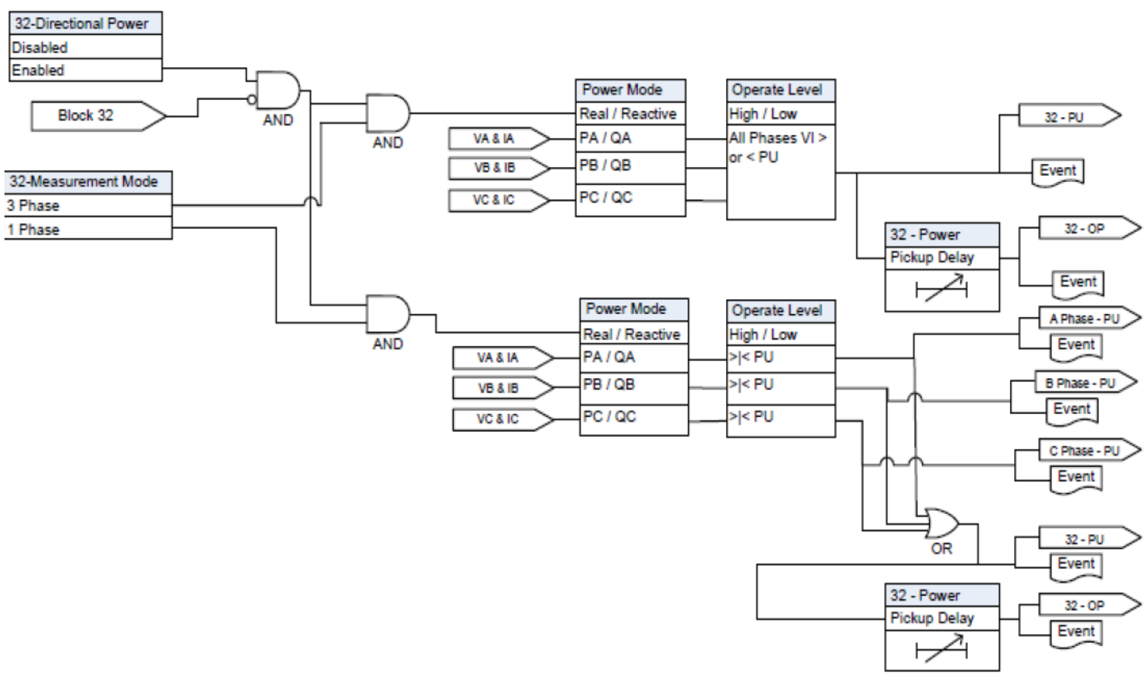


Figure 5.31: 32 Directional Power Protection Function Logic

Table 5.39: 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 5.39: 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

5.5 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.

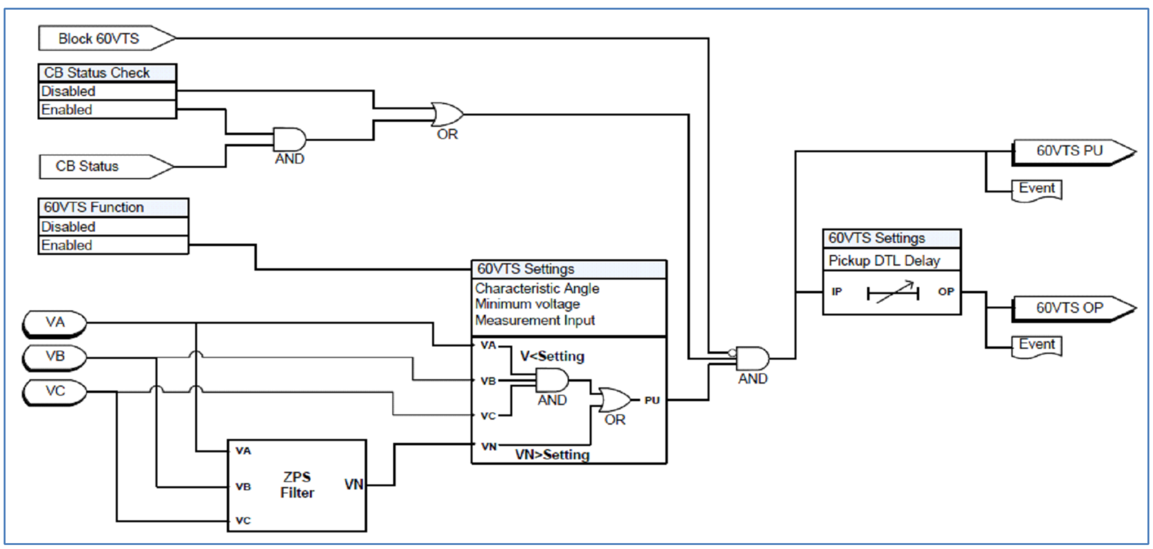


Figure 5.32: 60VTS Function Logic

Table 5.40: 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) 0.5 to 50.0 A (5A)

Table 5.40: 60VTS - VT Supervision Settings	
3I0 Blocking	0.1 to 10.0 A (1) 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) 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.

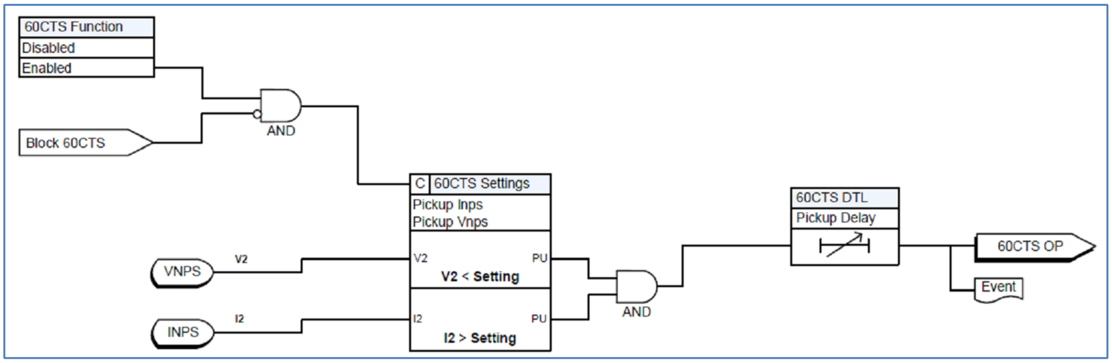


Figure 5.33: 60CTS Function Logic

Settings

Table 5.41: 60CTS - CT Supervision Settings	
Setting Description	**Setting Range**
Vnps Pickup	7.0V to 110.0V
Inps Pickup	0.05A to 1.00A (1A) 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.

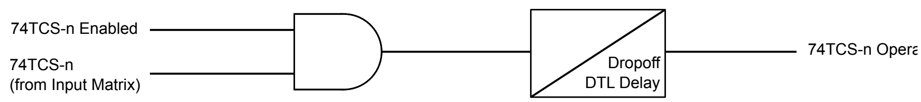


Figure 5.34: 74TCS Function Logic

Settings

Table 5.42: 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

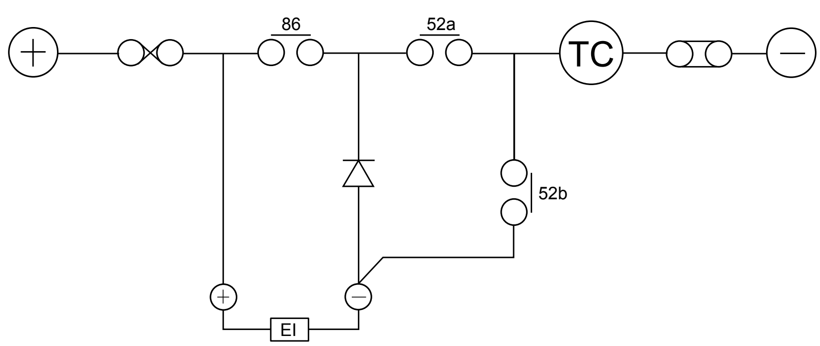


Figure 5.35: TCS Scheme 1

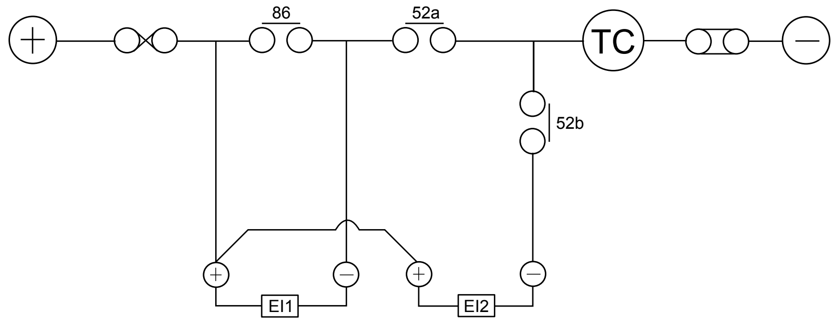


Figure 5.36: TCS Scheme 2

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.

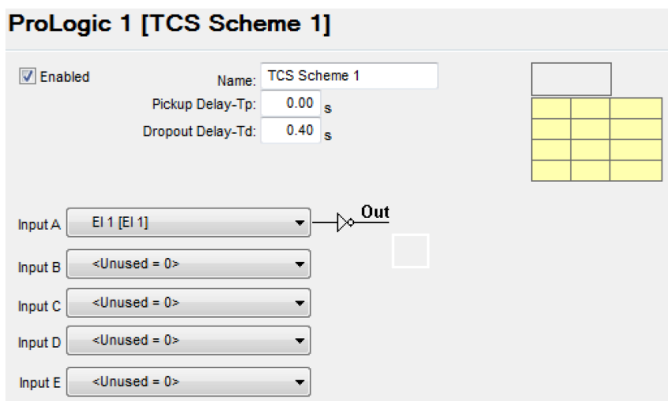


Figure 5.37: ProLogic TCS Scheme 1

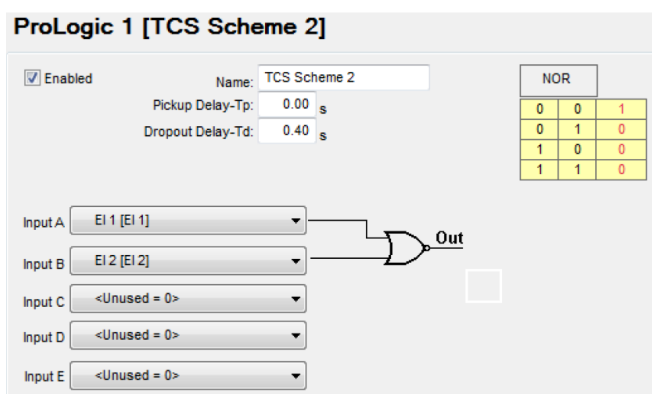


Figure 5.38: ProLogic TCS Scheme 2

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.

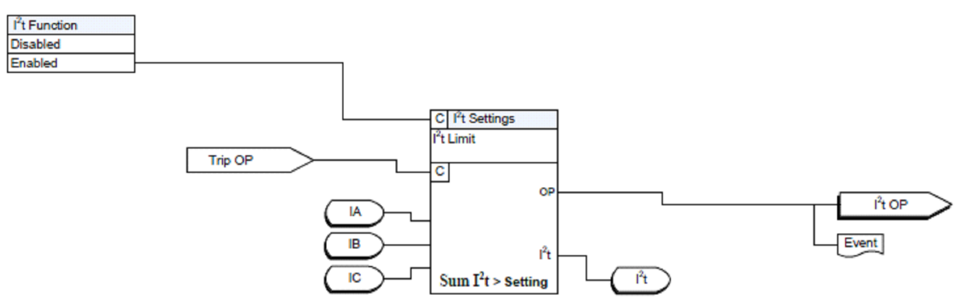


Figure 5.39: I^2T Logic

Settings

Table 5.43: 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 5.44: 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 5.45: 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 5.46: 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 5.47: UF Count Alarm Settings

UF Count Alarm	Enabled/disabled
Pickup F	50.0 to 60.0Hz (60Hz) 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 5.48: OF Count Alarm Settings

OF Count Alarm	Enabled/disabled
Pickup F	60.0 to 70.0Hz (60Hz) 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 5.49: 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 5.50: AR Count Alarm Settings

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

5.6 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.

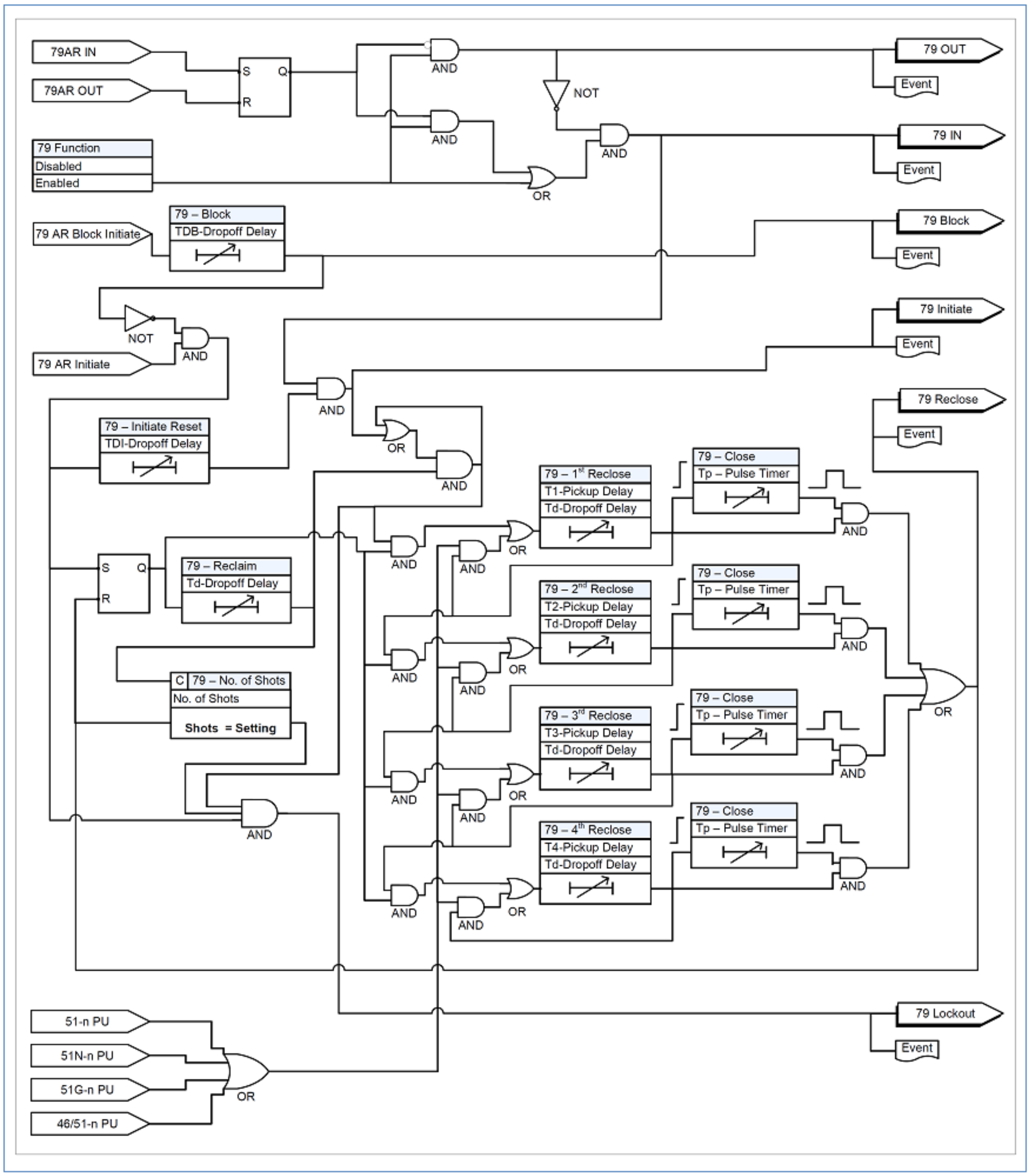


Figure 5.40: 79 Reclose Function Logic

Table 5.51: 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

5.7 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 5.41: ProLogic on page 5-60, 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.

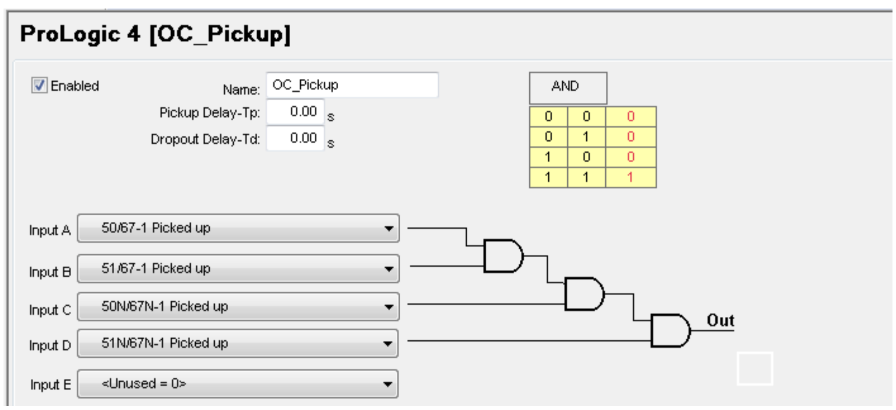


Figure 5.41: ProLogic

Table 5.52: ProLogic Setting Functions	
Name	Give the ProLogic a meaningful name
Pickup Delay	Delay time from pickup to operate. 0.00 to 999.00 s
Dropout Delay	Delay time from dropout to ProLogic status of low. 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 297 relay ProLogic feature. Basically, Pole Discrepancy function is achieved through a Timer and breaker statuses connected to F-PRO 297 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:

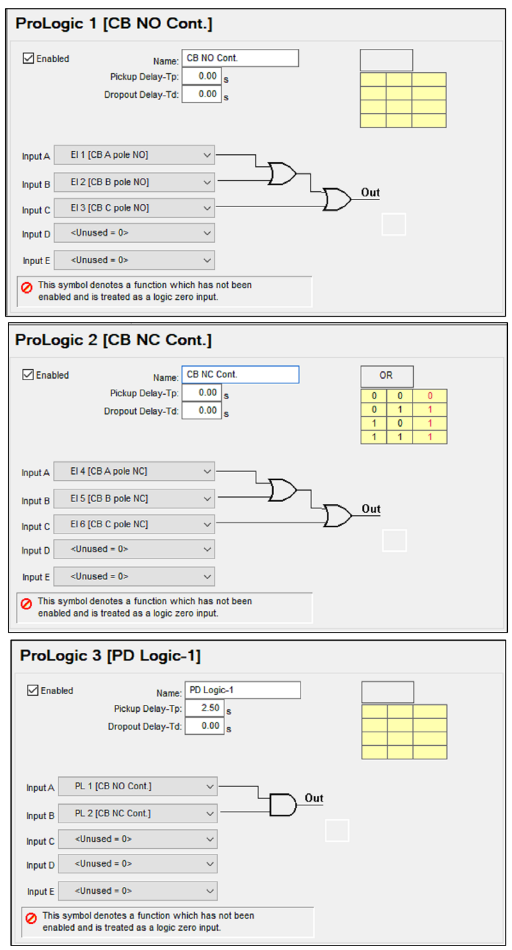


Figure 5.42: Logic 1

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 297 relay. The below ProLogic shall be configured in the setting file to achieve the Pole Discrepancy Protection.

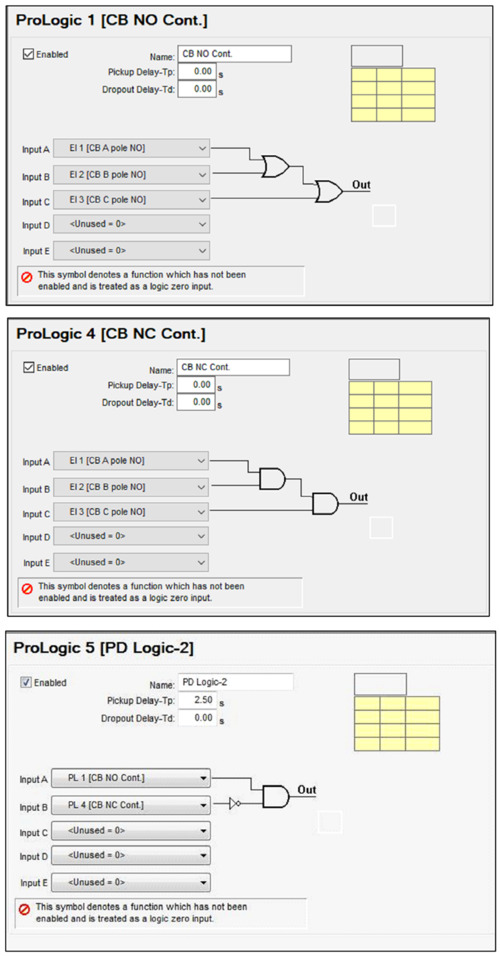
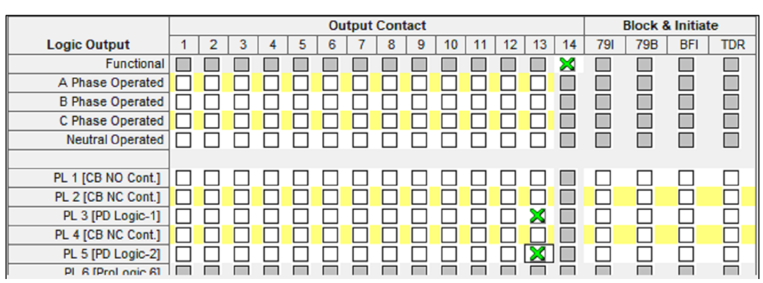


Figure 5.43: Logic 2

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.



5.8 Group Change Control Statement

The F-PRO297 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.

5.9 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 wave-forms 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 Fault/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 297 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 297 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.

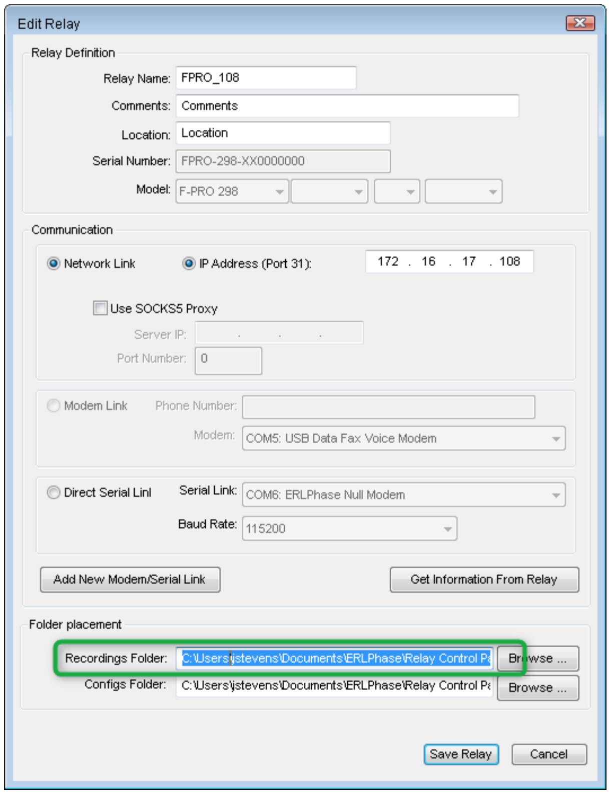


Figure 5.44: Recordings folder

Event Recording

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

5.10 Event Log

The F-PRO 297 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.

5.11 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 is triggered only for trip condition and it won't log for an alarm.

Table 5.53: 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 51/67 Inverse Time Overcurrent	IA/ IB / IC Phasors
50N/67N Neutral Overcurrent 51N/67N Inverse Time Neutral Overcurrent	IN Phasor
50G/67G Neutral Overcurrent 51G/67G Inverse Time Neutral Overcurrent	IG Phasor
46/50 Negative Sequence Overcurrent 46/51 Inverse time Negative Sequence Overcurrent	IA / IB / IC / I2 Phasors
64/50SEF 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 CON 32 (RS-485 port). 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 3-24.

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 3-24.

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 CON 32 (RS-485 port). 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 3-24.

Network DNP communications can be utilized via Ethernet CON 31 (31A or 31B). 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.

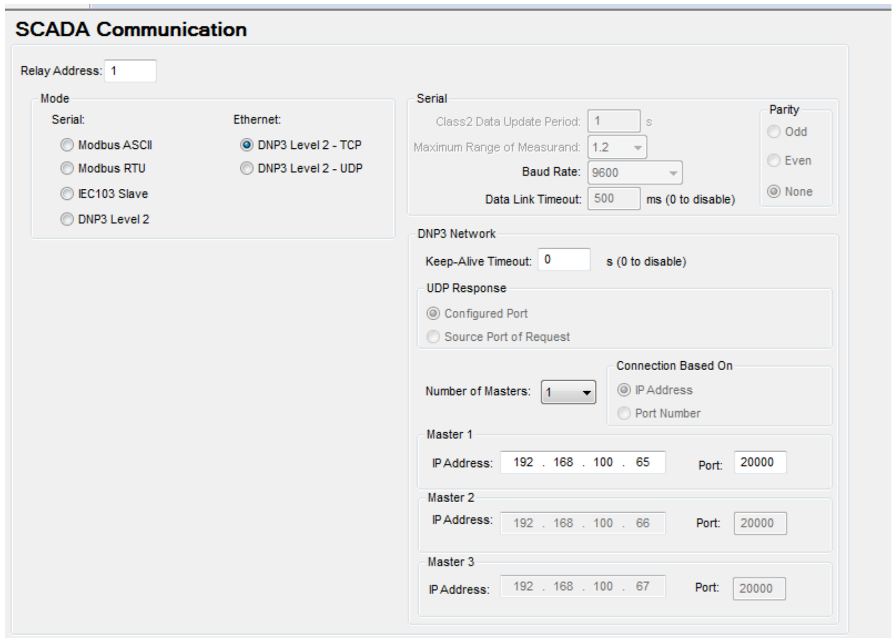


Figure 6.45: SCADA Communications

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

6.3 IEC 61850 Communication

The IEC 61850 Standard

The Smart Grid is transforming the electrical power industry by using digital technology to deliver electricity in a more intelligent, efficient and controlled way. Embedded control and communication devices are central to this transformation by adding intelligent automation to electrical networks.

The IEC 61850 standard defines a new protocol that permits substation equipment to communicate with each other. Like many other well-known manufacturers, ERL is dedicated for using IEC61850-based devices that can be used as part of an open and versatile communications network for substation automation.

The IEC 61850 defines an Ethernet-based protocol used in substations for data communication.Substations implement a number of controllers for protection, measurement, detection, alarms, and monitoring. System implementation is often slowed down by the fact that the controllers 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.

Implementation Details

The F-PRO conforms to IEC 61850-8-1, commonly referred to as Station Bus Protocol.

Implementation includes the following documents “IEC 61850 Conformance Statements and Data Mapping Specification” in Appendix L:

- Protocol Implementation Conformance Statement (PICS)
- Model Implementation Conformance Statement (MICS)
- Data Mapping Specifications

Note that unit’s IP address can be used on the IEC61850 client side for unique unit identification instead of a physical device “PD Name”. The publisher configuration is fixed and defined in the ICD file and available for reading to any IEC61850 client. Subscriber functionality is also fixed and supported for the Virtual Inputs only. The IEC 61850 parameters are edited by using the ERL 61850 IED Configurator. For more details on the ERL 61850 IED Configurator, see “ERL 61850 IED Configurator” on page 7-28.

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.

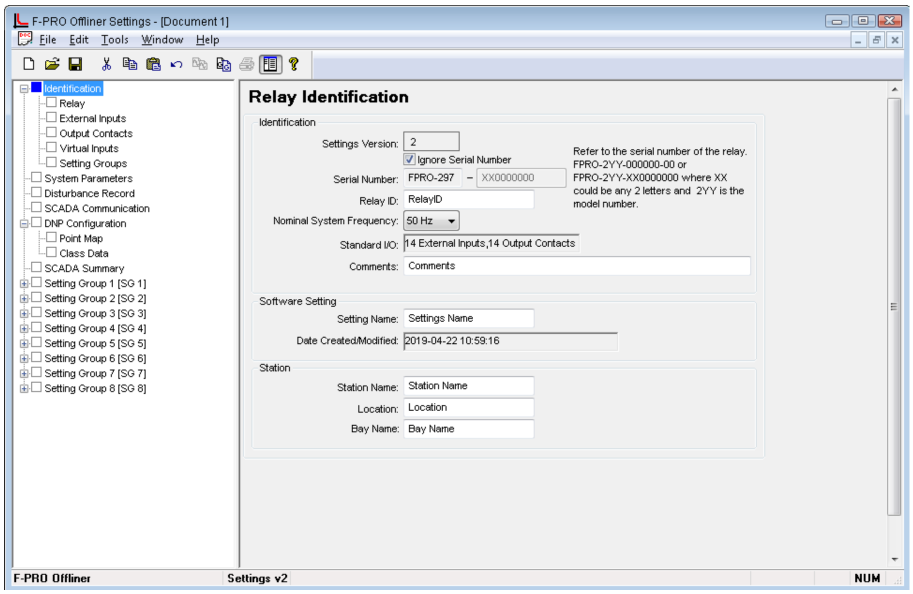


Figure 7.1: F-PRO 297 Offliner Software

Menu and Toolbar

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

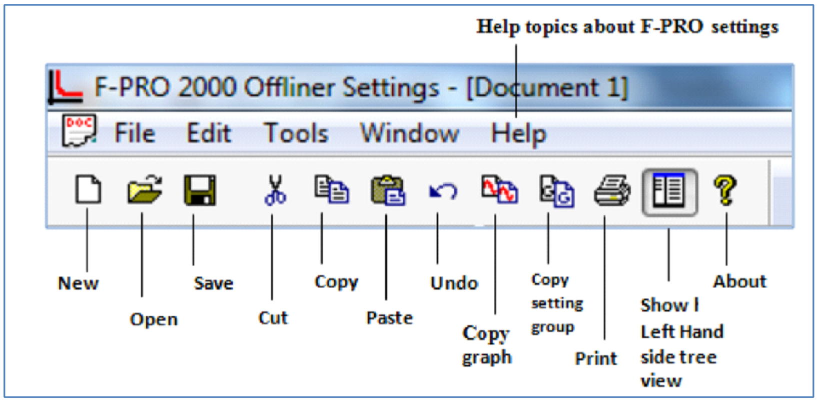


Figure 7.2: Top Tool Bar

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 297 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.

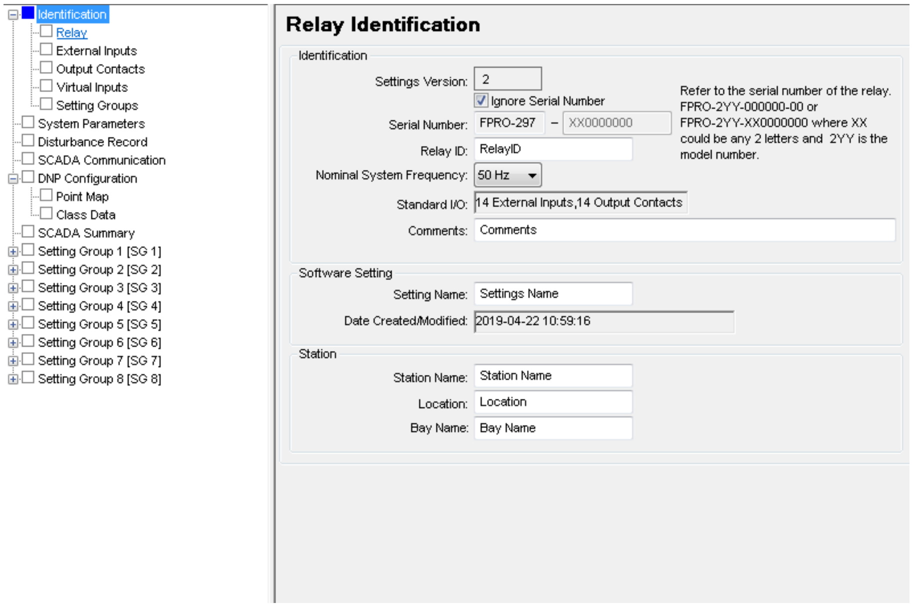


Figure 7.3: Relay Identification

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

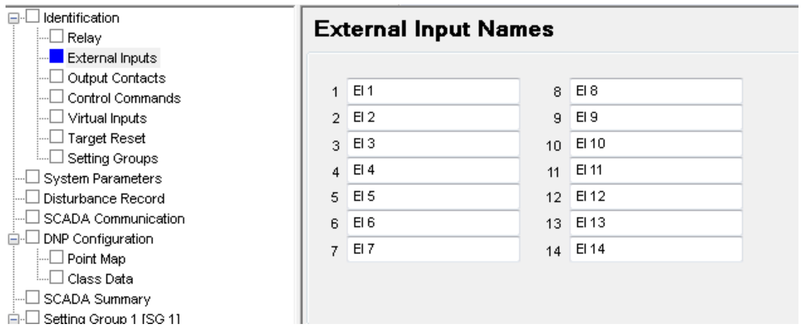


Figure 7.4: External Inputs

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

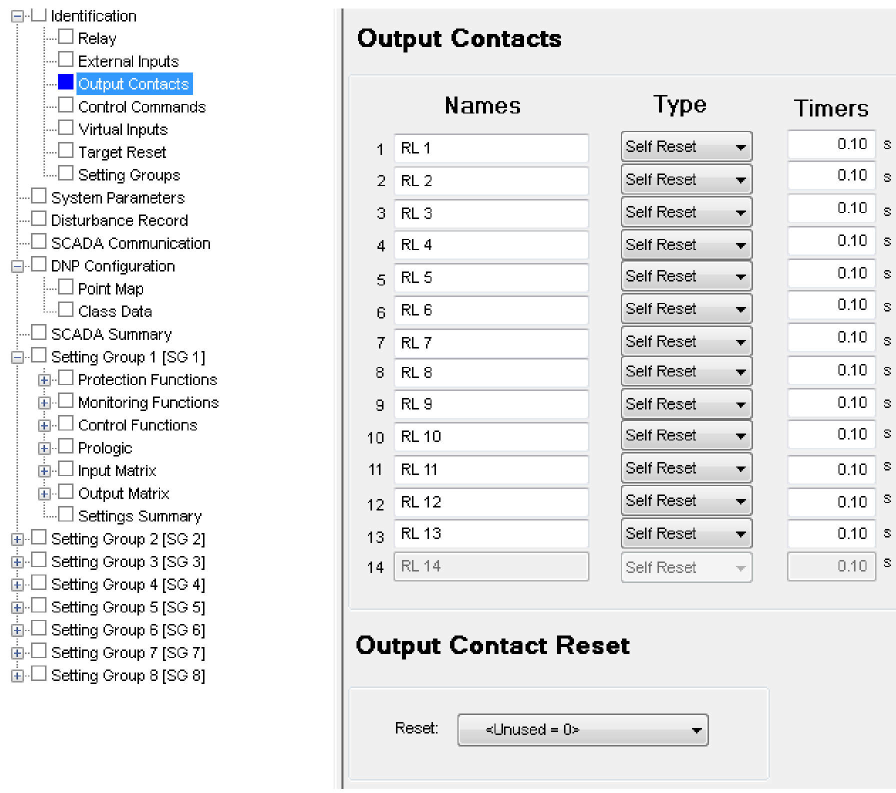


Figure 7.5: Output Contacts

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 (see "Output

Contact Reset” on page 4-14), 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.

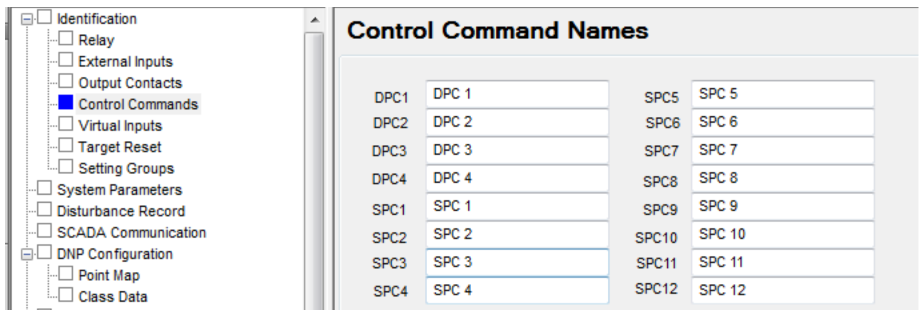


Figure 7.6: Control Command name configuration

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

Virtual Inputs

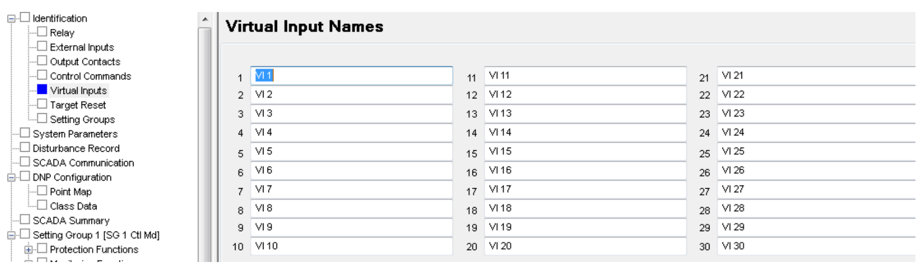


Figure 7.7: Virtual Inputs

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. For more details see “Target Test and Reset” on page 4-12.

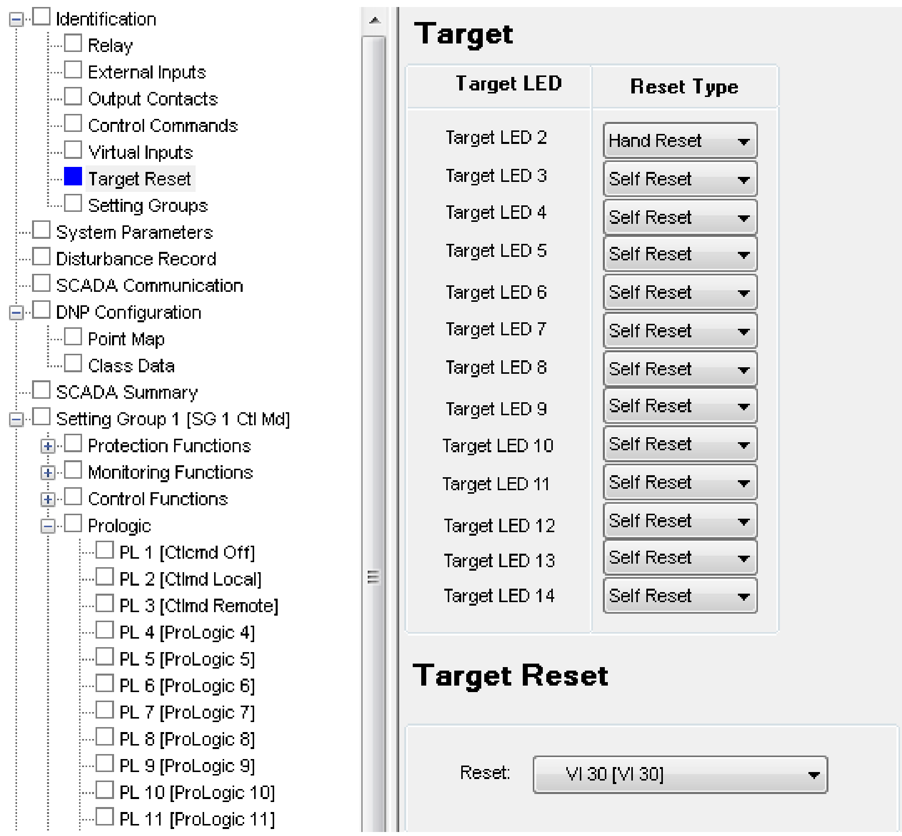


Figure 7.8: Target Reset

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

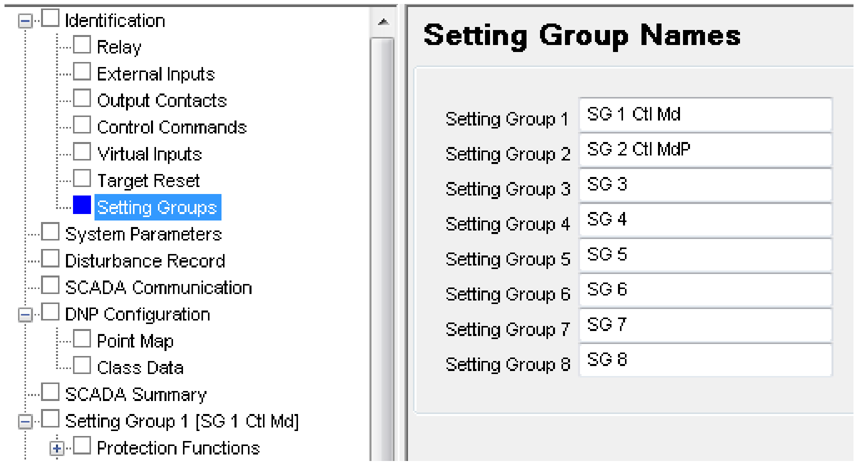


Figure 7.9: Setting Groups

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

System Parameters

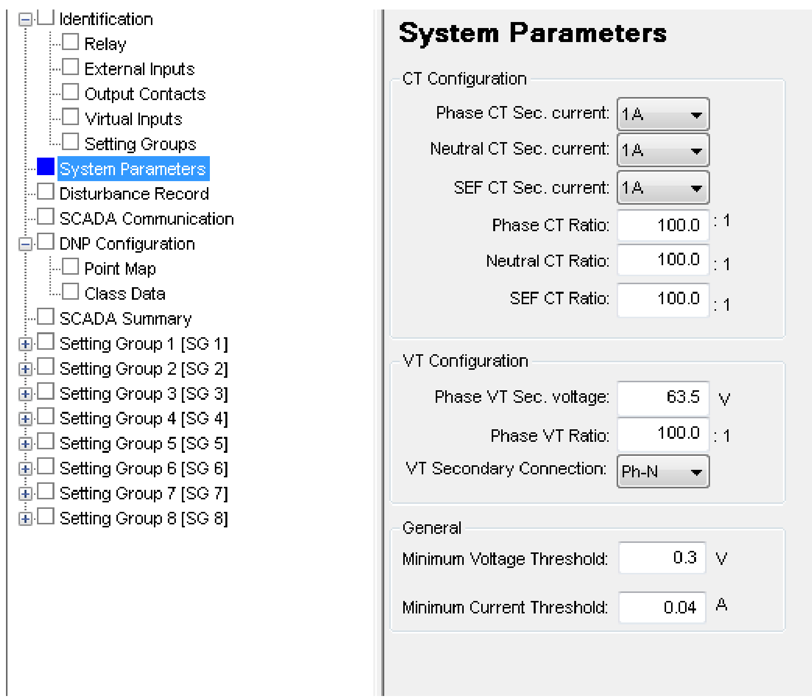


Figure 7.10: System Parameters

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
Neutral 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

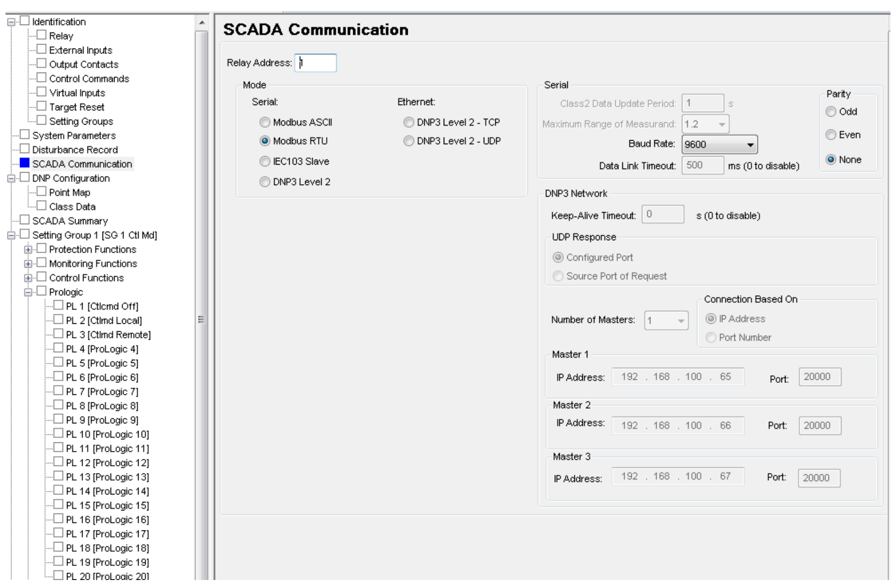


Figure 7.11: SCADA Communication

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

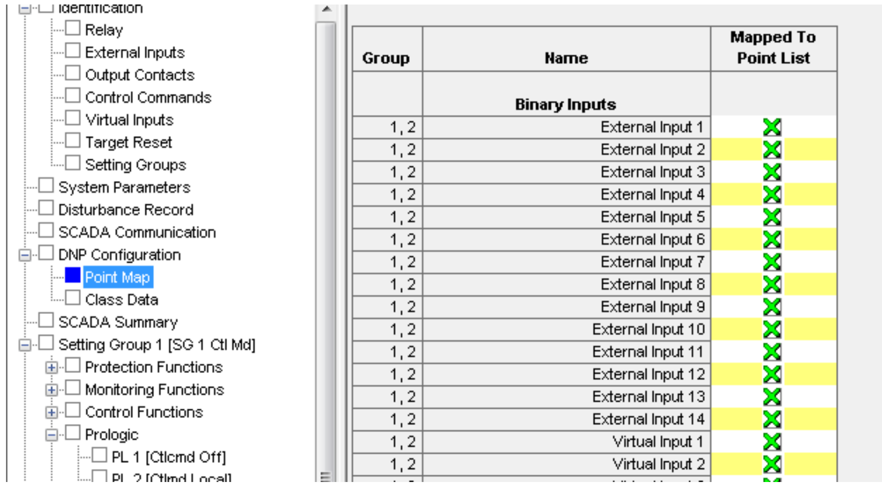


Figure 7.12: Point Map

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

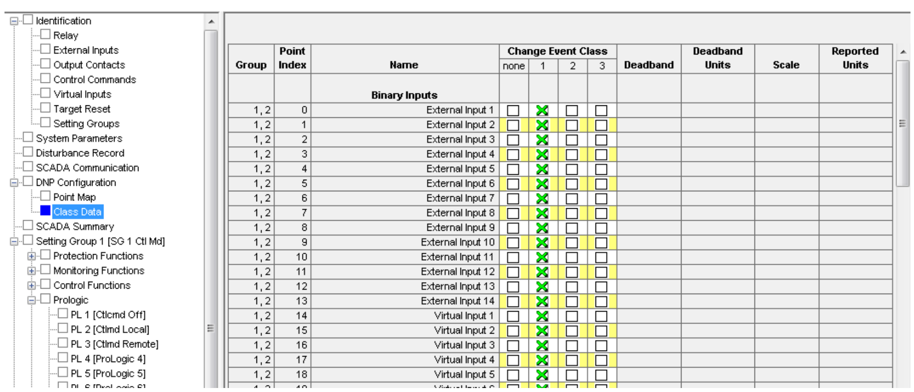


Figure 7.13: Class Data

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

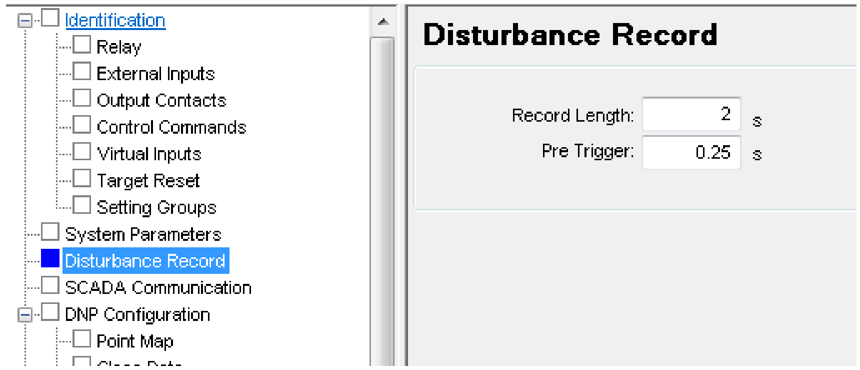


Figure 7.14: Record Length

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

SCADA Settings Summary

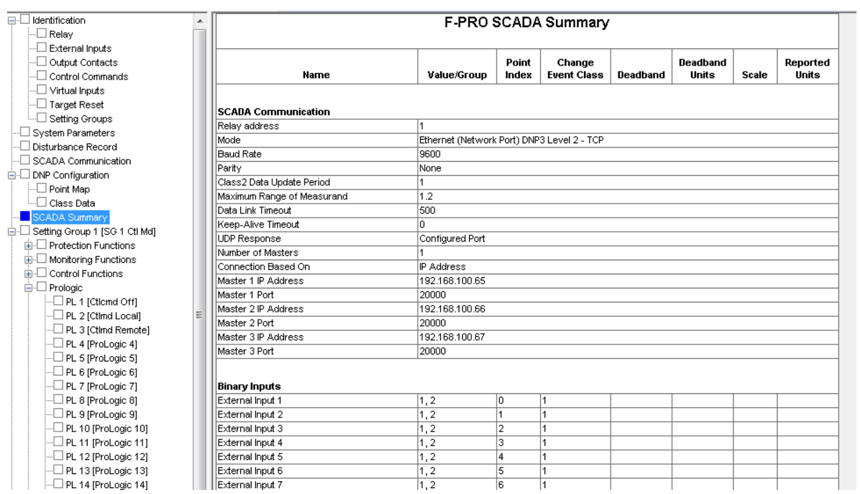


Figure 7.15: SCADA Settings Summary

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

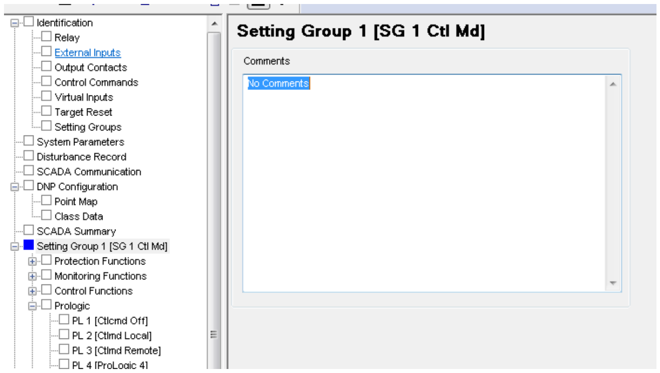


Figure 7.16: Setting Groups Comments

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.

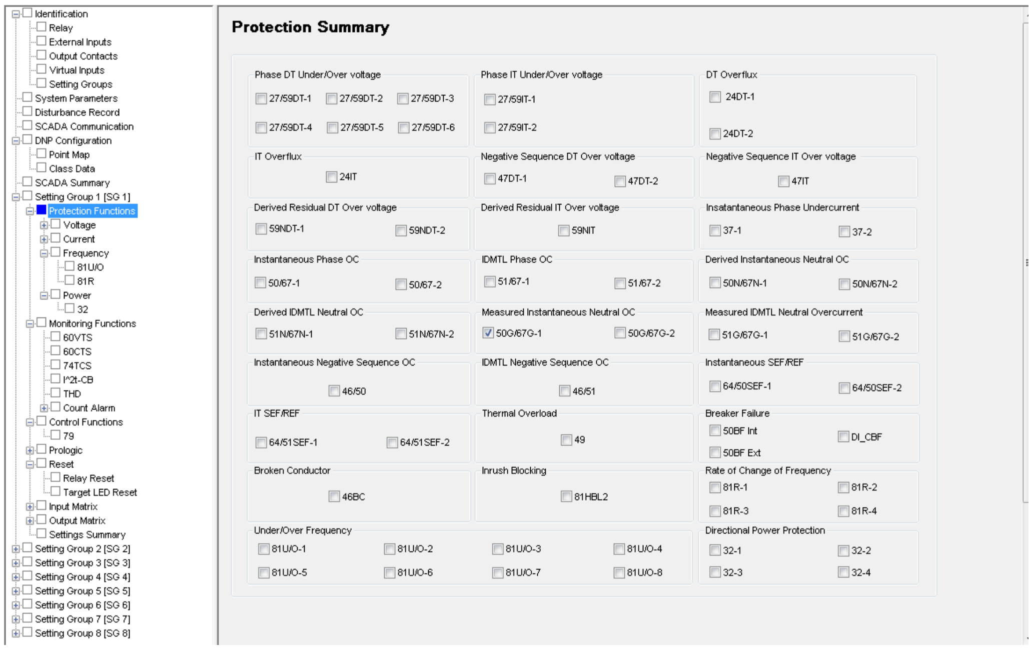


Figure 7.17: Protection Functions

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

ProLogic

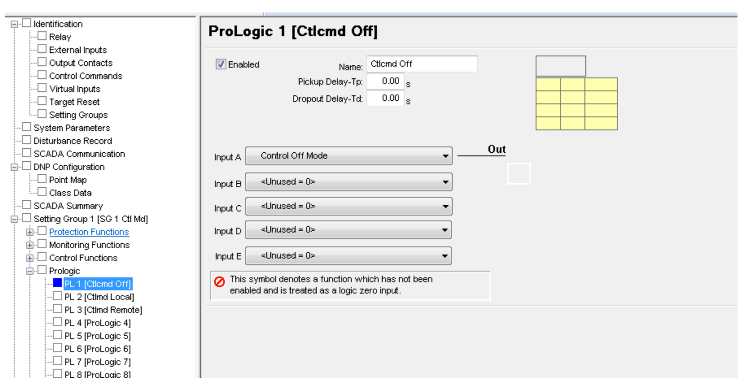


Figure 7.18: ProLogic

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

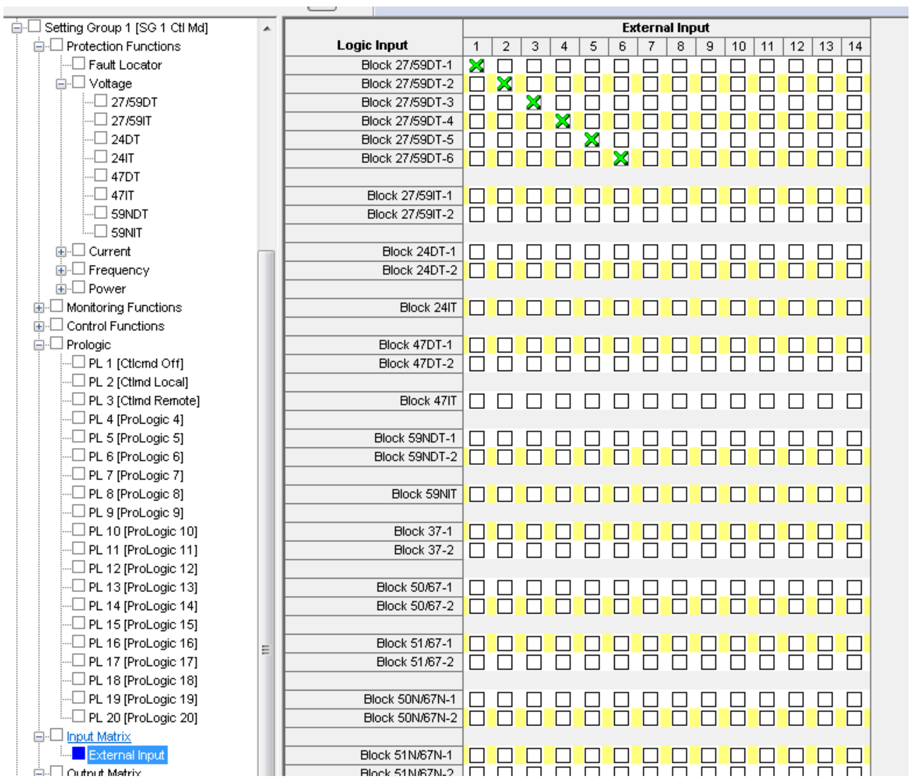


Figure 7.19: Input Matrix

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

Output Matrix

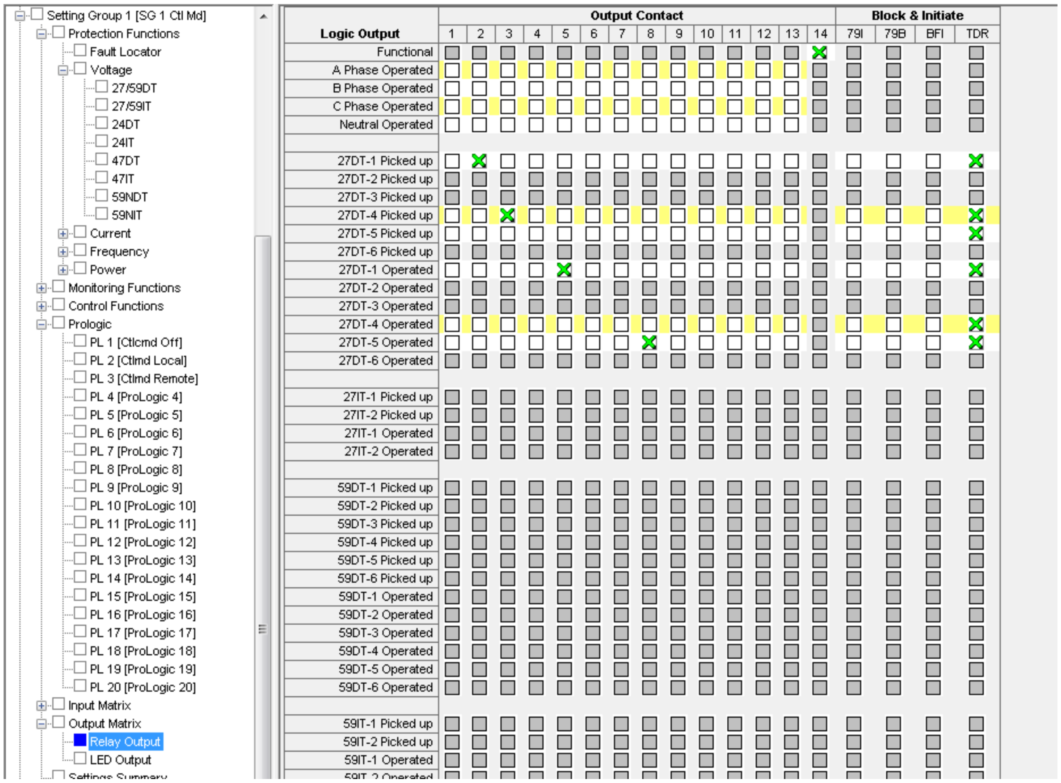


Figure 7.20: Relay Output Matrix

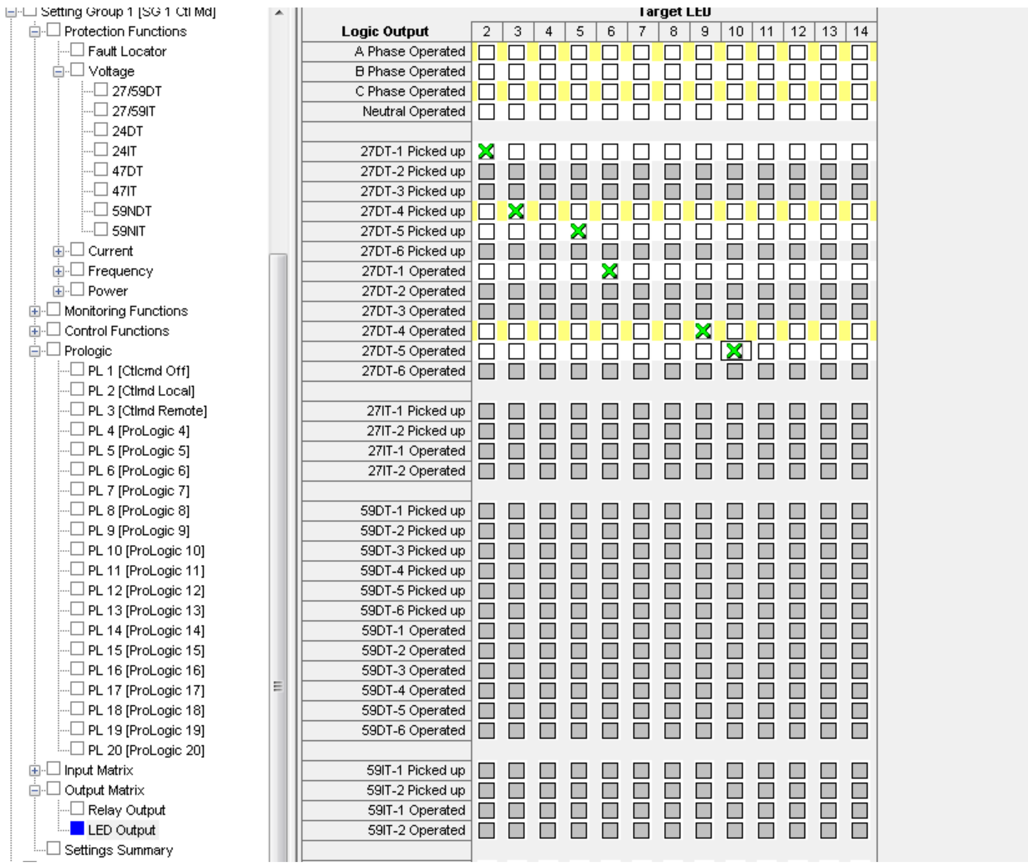


Figure 7.21: LED Output Matrix

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

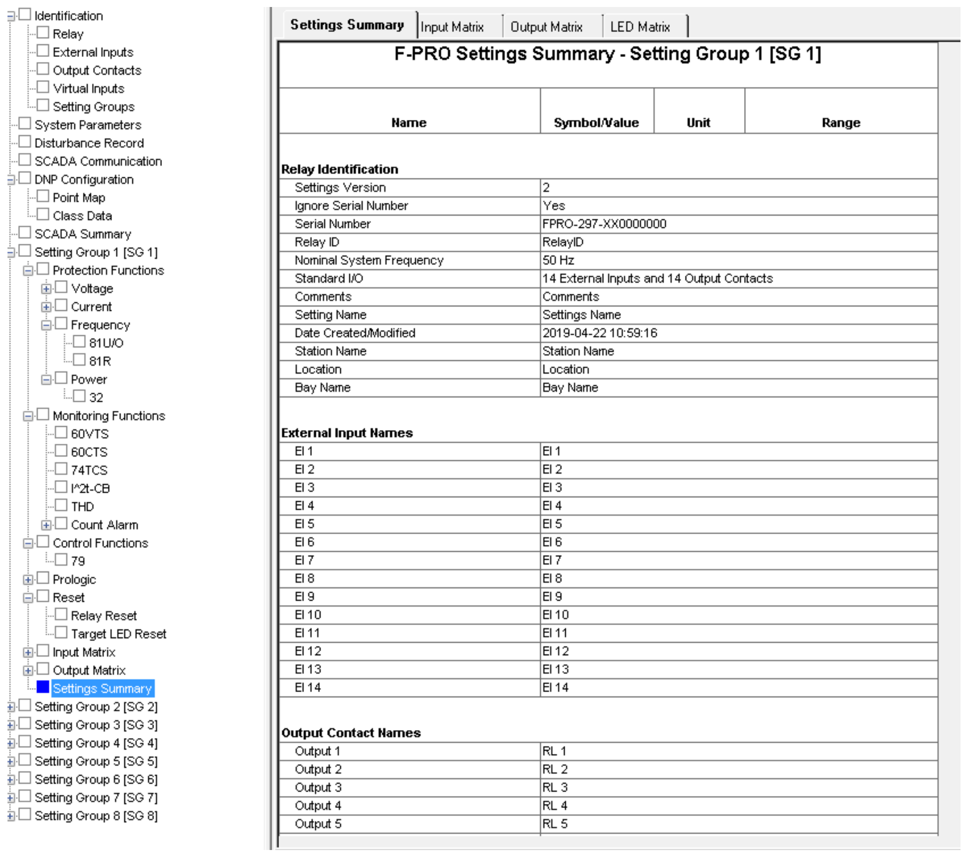


Figure 7.22: Settings Summary

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

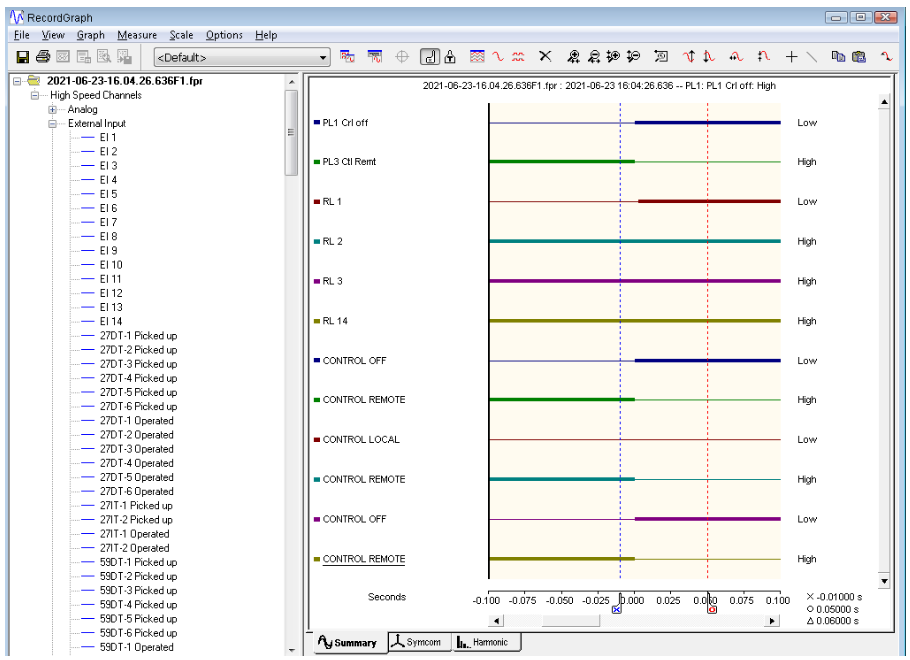


Figure 7.23: RecordGraph

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

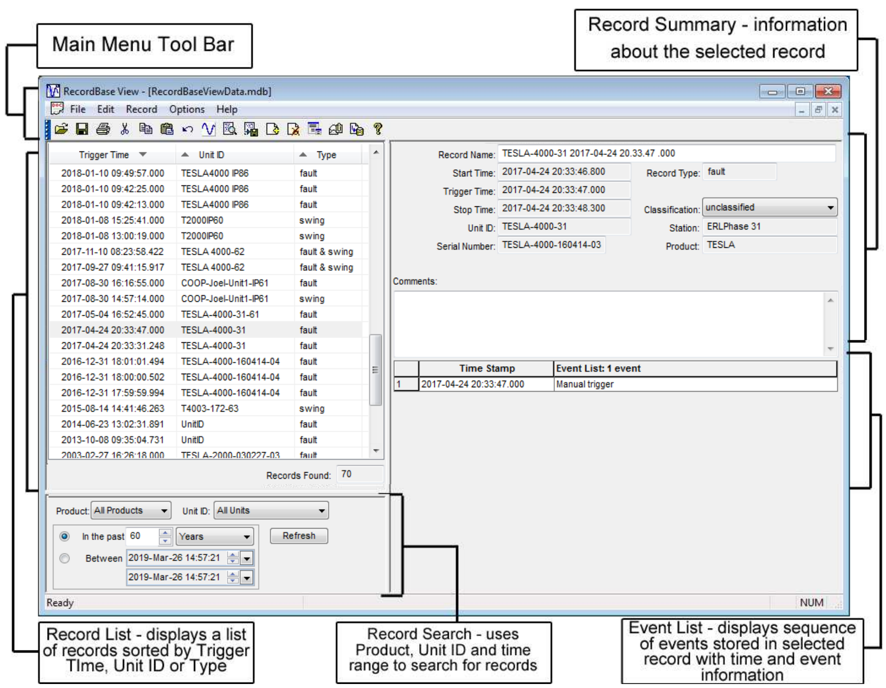


Figure 7.24: RecordBase View

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

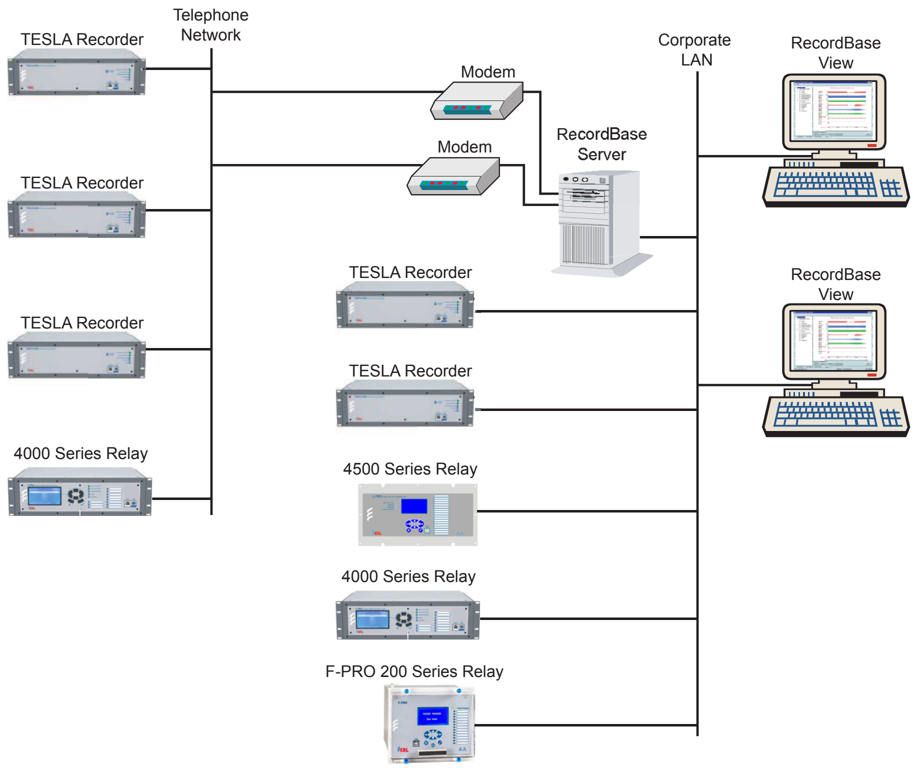


Figure 7.25: RecordBase System Overview

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

7.5 ERL 61850 IED Configurator

Introduction

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

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

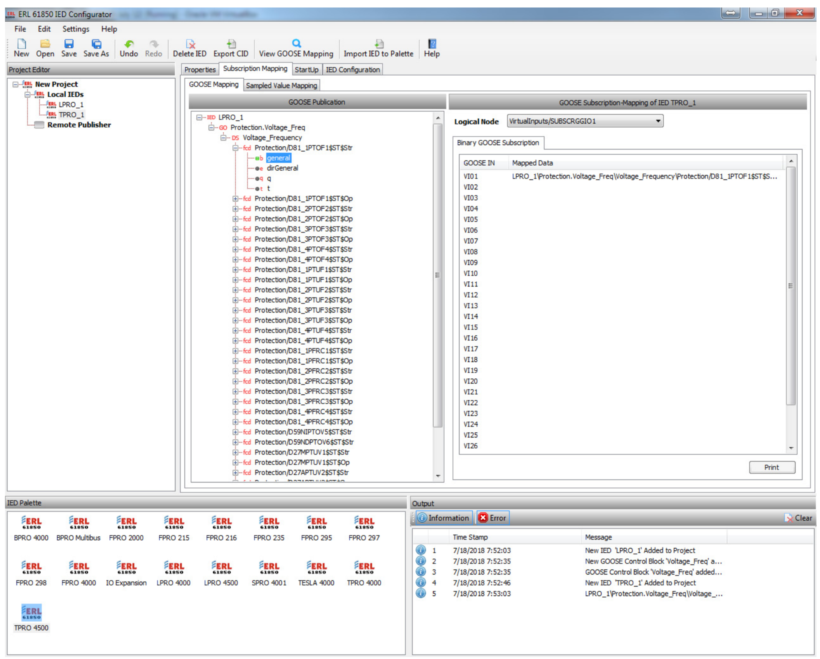


Figure 7.26: ERL 61850 IED Configurator

For further details refer to the ERL 61850 IED Configurator 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 297 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 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.

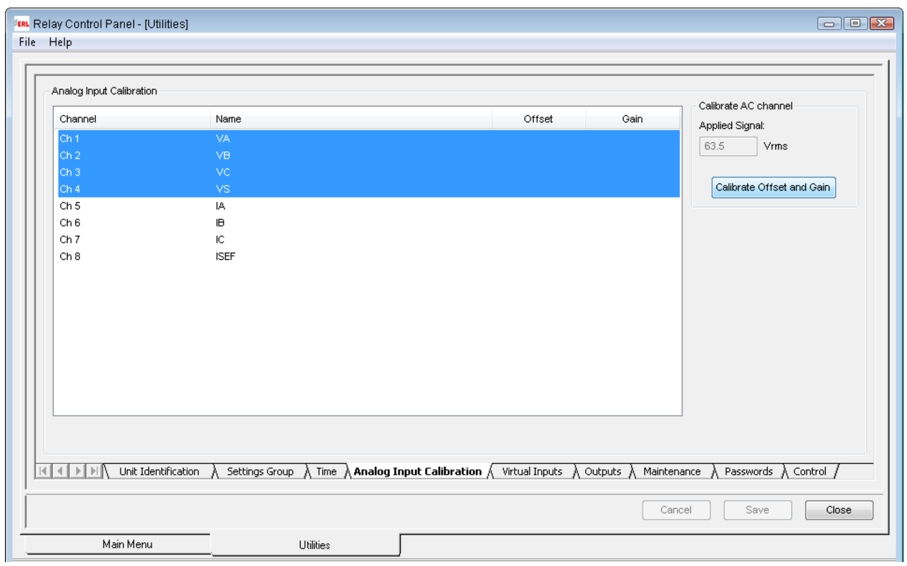


Figure 8.1: Enter actual applied signal level

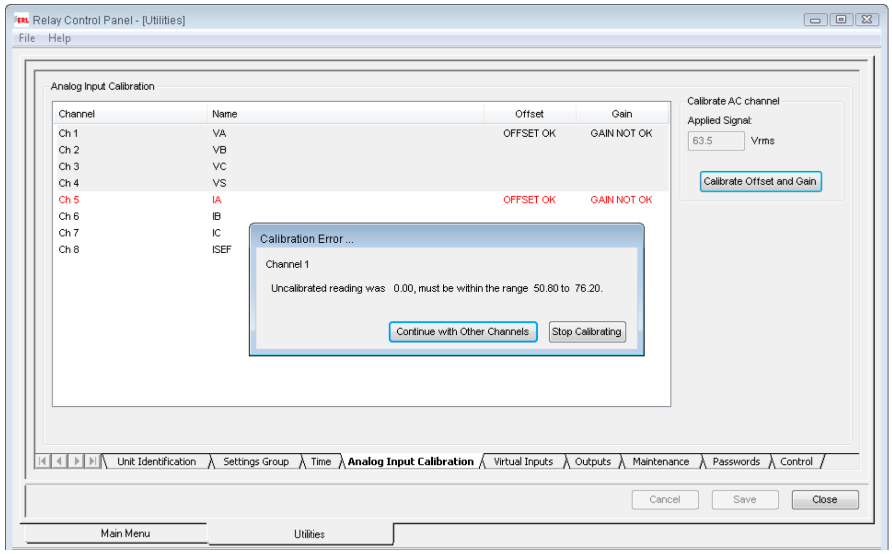


Figure 8.2: Calibration error - out of range

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.

Appendix A IED Specifications

F-PRO 297 Specifications

Item	Quantity/Specs	Note
General		
Overvoltage Category	Overvoltage Category III	
Pollution Degree	Pollution Degree 2	
Insulation Class	Class I	
Ingress Protection	IP 1X (Front) IP 5X (Rear)	
Nominal Frequency	50 or 60 Hz	
Operate Time	Less than 35ms	Including output relay operation
Power Supply	Nominal Voltage: High Range Supply Option: 110 - 250 Vdc, 100 - 240 Vac Low Range Supply Option: 24 - 48 Vdc Voltage Tolerance: High Range Supply Option: ±20% for Vdc, -10%/+5% for Vac Low Range Supply Option: -15%/+20% Power Consumption: <8VA (AC) <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 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), 50G/67G (1 to 2), 51G/67G (1 to 2), 50N/67N (1 to 2), 51N/67N (1 to 2), 46/50, 46/51, 64/50SEF (1 to 2), 67SEF, 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 and ProLogic	5 current inputs 3 voltage inputs	

F-PRO 297 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 1 set of 3-phase voltage inputs	Nominal Voltage - across input channel: Vn = 63.5 Vrms (Ph-n) or 110 Vrms (Ph-Ph) Full Scale/Continuous: 175 Vrms (Ph-n) or 247 Vrms (Ph-Ph) Burden: <0.15VA @ Vn	
Analog Current Inputs 1 set of 3-phase current inputs, 1 current input to measure neutral current, 1 single phase current input for SEF (5 current channels)	Phase CTs and Neutral CT Nominal Current: In = 1 Arms or 5 Arms Full Scale/Continuous: 4x In = 4 Arms or 20 Arms Maximum full-scale rating: 40x In for 1 second symmetrical Burden: <0.1 VA @ 1 Arms, <0.5VA @ 5 Arms	
	SEF CT Nominal Current: In = 1 Arms or 5 Arms Full Scale/Continuous: 2x In = 2 Arms or 10 Arms Maximum full-scale rating: 4x In for 1 second symmetrical Burden: <1 VA @ 1 Arms, <2VA @ 5 Arms	

F-PRO 297 Specifications		
Item	**Quantity/Specs**	**Note**
External Inputs	14 isolated inputs Isolation: 2kV optical isolation Burden: <0.2W @ 110V DC Turn-on Voltage: 24Vdc nominal = 19 Vdc 48 Vdc nominal = 38 Vdc 110 Vdc nominal = 88 Vdc 220 Vdc nominal = 175 Vdc	Optional 24, 48, 110 or 220 Vdc nominal, externally wetted. All inputs can be on continuously. Specified voltages are over full ambient temperature range.
Output Relays (contacts)	14 programmable outputs (13NO and 1NC) Make: 30 A as per IEEE C37.90 Carry (all outputs active): 8 A Break: 0.9 A at 125 Vdc resistive 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 Port 31B: 100Mbps-T,RJ45/100Mbps-Fx, ST (PRP) Port 32: RS-485 (2400bps to 57600bps)	100 Mbps Copper/FO Ethernet port 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 E8 case: 159mm Height x 201.5mm Width	
Time Synchronization		

F-PRO 297 Specifications		
Item	**Quantity/Specs**	**Note**
External Time Source	Synchronized using IRIG-B input (modulated or unmodulated) 1PPM 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 Distur-bance / 1 MHz Burst Distur-bance	AC/DC power ports	+/- 2.5kV (CM) +/- 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 Frequency: (10-150)Hz	Vibration Response Test		Displacement:0.035mm(peak) Acceleration: 0.5 g Sweep rate: 1octave/min No. of Axis:3(X,Y & Z) No. of Sweep Cycles:1/axis
IEC 60255-21-2, class 1	Shock Response Test		Acceleration: 5 g Pulse Width:11ms Pulse Sweep:1/2 sine wave No. of Shocks:3/direction No. of Directions:2/axis No. of Axis:3(X,Y & Z) Total No. of Shocks:18 + 18
IEC 60255-21-3, class 1 Frequency: (5-35)Hz	Seismic Test		For X-axis: Displacement:3.5mm(peak) Acceleration: 1.0 g Sweep rate: 1octave/min For Y-axis: Displacement:1.5mm(peak) Acceleration: 0.5 gn Sweep rate:1 octave/min
Safety			
IEC 60255-27:2013 Cl.No.10.6.4.2	Impulse Voltage	AC/DC power ports AC voltage & current ports External I/P & O/P ports	+/- 5 kV

Type Tests

Test	Description		Test Level
	Type Test	Test Points	
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

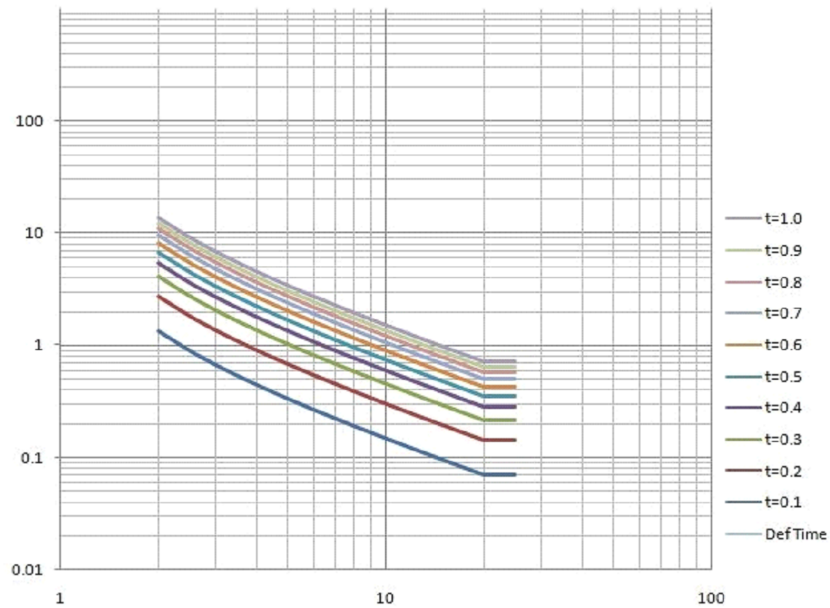


Figure A.3: IEC Very Inverse

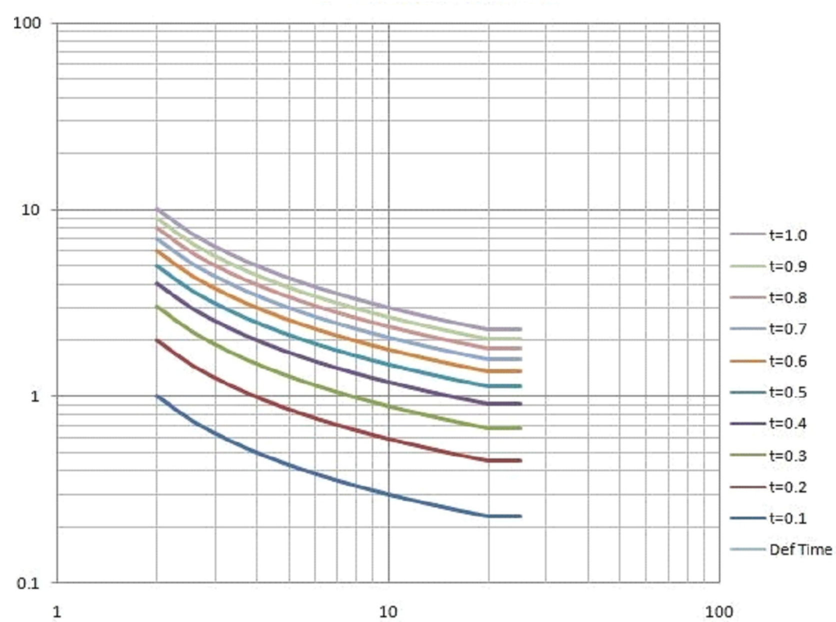


Figure A.4: IEC Standard Inverse 3

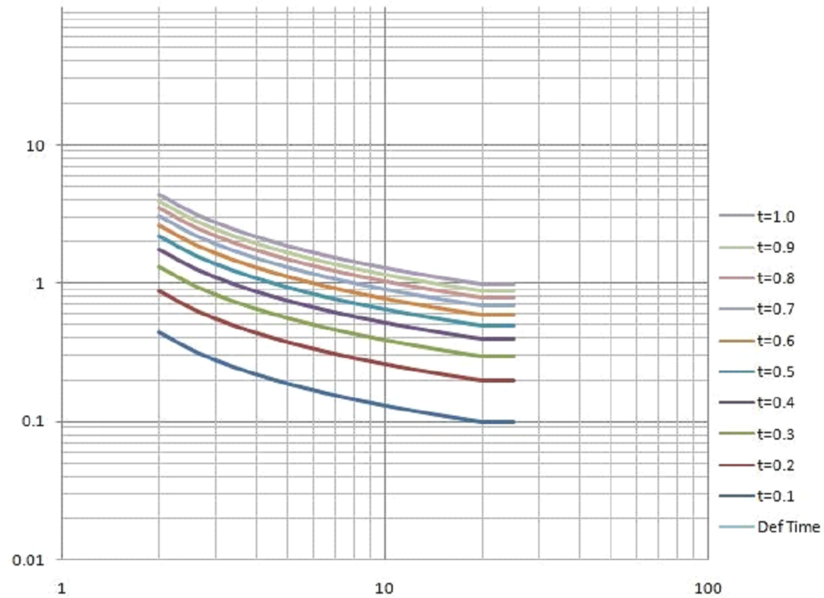


Figure A.5: IEC Standard Inverse 1

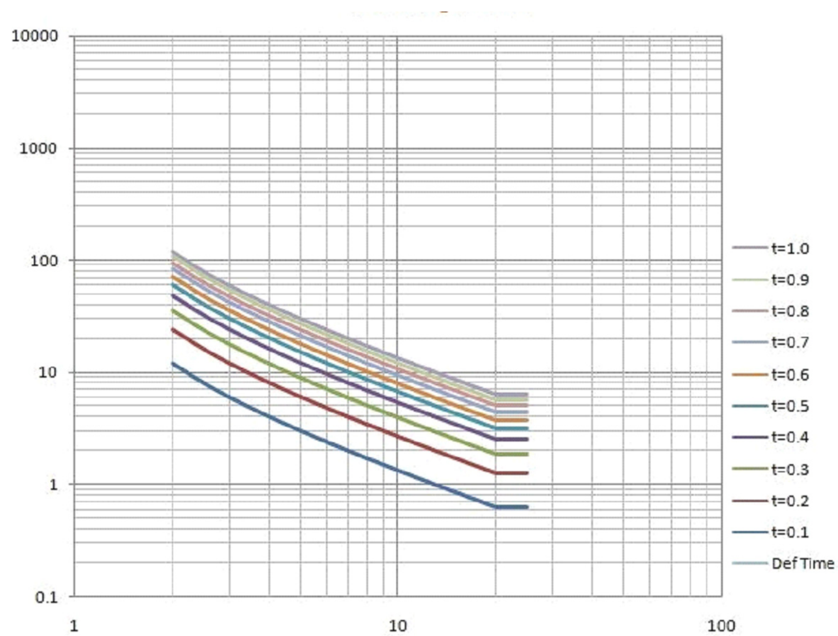


Figure A.6: IEC Long Inverse

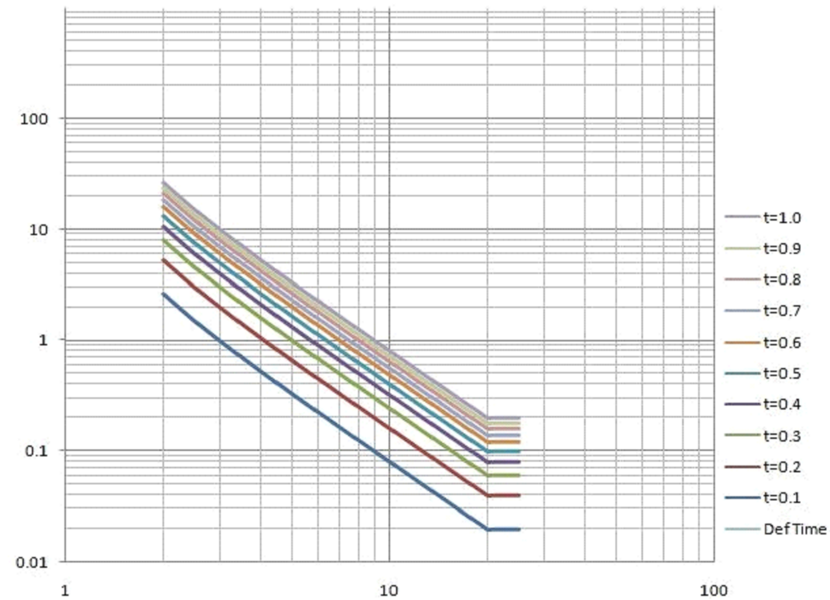


Figure A.7: IEC Extremely Inverse

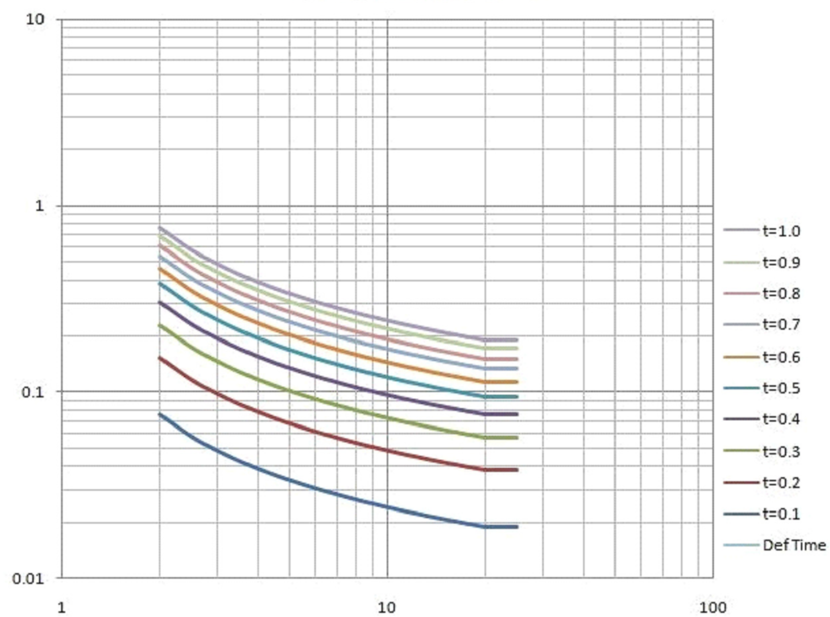


Figure A.8: IEEE Moderately Inverse

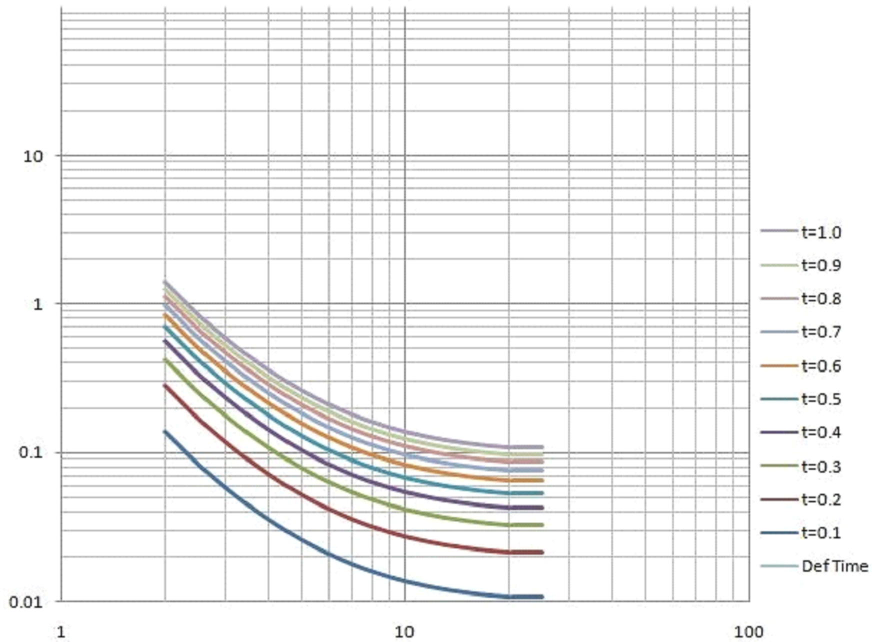


Figure A.9: IEEE Very Inverse

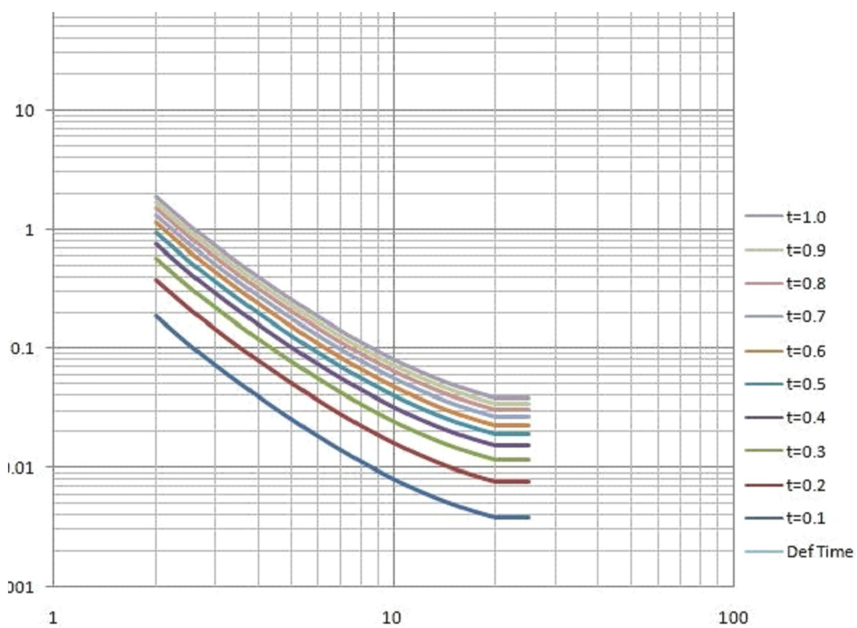


Figure A.10: IEEE Extremely Inverse

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	3		
Ignore Serial Number	Yes		
Serial Number	FPRO-297-XX0000000		
Relay ID	RelayID		
Nominal System Frequency	50 Hz		
Standard I/O	14 External Inputs and 14 Output Contacts		
Comments	Comments		
Setting Name	Settings Name		
Date Created/Modified	2019-04-22 10:59:16		
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		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
EI 5	EI 5		
EI 6	EI 6		
EI 7	EI 7		
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		
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		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
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		
Setting Group Names			
Setting Group 1	SG 1		
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			

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
VT Configuration			
Phase VT Sec.voltage	63.5	V	
Phase VT Ratio	100.0	-	
Phase VT Sec Conn	Ph-N		
CT Configuration			
Phase CT Sec	1A		
Neutral CT Sec	1A		
SEF CT Sec.current	1A		
Phase CT Ratio	100.0	-	
Neutral CT Ratio	100.0	-	
SEF CT Ratio	100.0	-	
Disturbance Record			
Record Length	1	s	
Pre Trigger	0.25	s	
Setting Group 1 [SG 1]			
Setting Group Comments: No Comments			
Protection Summary			
27/59DT-1	Disabled		
27/59DT-2	Disabled		
27/59DT-3	Disabled		
27/59DT-4	Disabled		
27/59DT-5	Disabled		
27/59DT-6	Disabled		
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		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
50G/67G-1	Disabled		
50G/67G-2	Disabled		
51G/67G-1	Disabled		
51G/67G-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		
46BC	Disabled		
81HBL2	Disabled		
81U/O-1	Disabled		
81U/O-2	Disabled		
81U/O-3	Disabled		
81U/O-4	Disabled		
81U/O-5	Disabled		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
27/59DT – Phase Definite Time Under/Over Voltage			
27/59DT-1	Disabled		
Function Selection	UV		
Measurement Input	Fundamental		
Input Type	Ph-N		
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-2	Disabled		
Function Selection	UV		
Measurement Input	Fundamental		
Input Type	Ph-N		
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		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Function Selection	UV		
Measurement Input	Fundamental		
Input Type	Ph-N		
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		
Measurement Input	Fundamental		
Input Type	Ph-N		
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		
Measurement Input	Fundamental		
Input Type	Ph-N		
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-6	Disabled		
Function Selection	UV		
Measurement Input	Fundamental		
Input Type	Ph-N		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
Measurement Input	Fundamental		
Input Type	Ph-N		
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		
Measurement Input	Fundamental		
Input Type	Ph-N		
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

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
24DT – Definite Time Overflux			
24DT-1	Disabled		
Measurement Input	Fundamental		
Input Type	Ph-N		
Output Gate	AND		
Pickup V/F	1.1	pu	1.0 to 2.0
Hysteresis	1	%	1 to 80
Pick DTL Delay	0.20	s	0.05 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTS Blocking	Disable		
24DT-2	Disabled		
Measurement Input	Fundamental		
Input Type	Ph-N		
Output Gate	AND		
Pickup V/F	1.1	pu	1.0 to 2.0
Hysteresis	1	%	1 to 80
Pick DTL Delay	0.20	s	0.05 to 999.99
Reset DTL Delay	0.00	s	0.00 to 999.99
VTS Blocking	Disable		
24IT – Inverse Time Overflux			
24IT	Disabled		
Measurement Input	Fundamental		
Input Type	Ph-N		
Output Gate	AND		
Pickup V/F	1.1	pu	1.0 to 1.5
Hysteresis	1	%	1 to 80
TMS	1.00	-	0.01 to 10.00
A	108.75	-	0.00 to 999.99
B	1.00	-	0.01 to 10.00

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Curve Type	ANSI Extremely Inverse-3		
Pickup DTL Delay	10.00	s	0.05 to 999.99
K	131.2500		
C	2.4490		
Inverse of K	0.1000		
Reset Delay	DTL		
Reset DTL Delay	0.00	s	0.00 to 99.90
X1	1.10	s	1.00 to 3.00
X2	1.15	s	1.00 to 3.00
X3	1.20	s	1.00 to 3.00
X4	1.25	s	1.00 to 3.00
X5	1.30	s	1.00 to 3.00
X6	1.35	s	1.00 to 3.00
X7	1.40	s	1.00 to 3.00
Y1	70.00	s	0.00 to 9999.99
Y2	60.00	s	0.00 to 9999.99
Y3	50.00	s	0.00 to 9999.99
Y4	40.00	s	0.00 to 9999.99
Y5	30.00	s	0.00 to 9999.99
Y6	20.00	s	0.00 to 9999.99
Y7	10.00	s	0.00 to 9999.99
VTS Blocking	Disable		
47DT – Negative Sequence Definite Time Over Voltage			
47DT-1	Disabled		
Measurement Input	Fundamental		
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

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
VTS Blocking	Disable		
47DT-2	Disabled		
Measurement Input	Fundamental		
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		
Measurement Input	Fundamental		
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		
Measurement Input	Fundamental		
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		
59NDT-2	Disabled		
Measurement Input	Fundamental		
Pickup VN	10.0	V	1.0 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		
59NIT – Derived Residual Inverse Time Over	Voltage		
59NIT	Disabled		
Measurement Input	Fundamental		
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			
Characteristic Angle	45	Deg	-95 to 95
Minimum Voltage	1.00	V	1.00 to 40.00
2 out of 3 Logic	Disabled		
VTS Blocking	Disabled		
50/67 – Instantaneous Phase Overcurrent			
50/67-1	Disabled		
Direction Selection	Non-Directional		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup I>>	10.00	A	0.05 to 25.00
Pickup Delay	0.00	s	0.00 to 999.99
Inrush Block	Enabled		
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	Enabled		
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 99.9
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
Reset Delay(TR)	13.50	-	0.10 to 150.00
Inrush Block	Enabled		
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 99.9
A	0.1400	-	-
B	0.0000	-	-

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
p	0.02	-	-
Reset Delay(TR)	13.50	-	0.10 to 150.00
Inrush Block	Enabled		
67N/67G-Directional element for Neutral Overcurrent			
Characteristic Angle	-45	Deg	-95 to 95
Minimum Voltage	0.30	V	0.30 to 40.00
Measurement Input	NPS		
VTS Blocking	Disabled		
50N/67N – Derived Instantaneous Neutral Overcurrent			
50N/67N-1	Disabled		
Direction Selection	Non-Directional		
Pickup IN>>	1.00	A	0.05 to 25.00
Pickup Delay	0.00	s	0.00 to 999.99
Inrush Block	Enabled		
50N/67N-2	Disabled		
Direction Selection	Non-Directional		
Pickup IN>>	1.00	A	0.05 to 25.00
Pickup Delay	0.00	s	0.00 to 999.99
Inrush Block	Enabled		
51N/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 99.9
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Reset Delay(TR)	13.50	-	0.10 to 150.00
Inrush Block	Enabled		
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 99.9
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
Reset Delay(TR)	13.50	-	0.10 to 150.00
Inrush Block	Enabled		
50G/67G – Measured Instantaneous Neutral Overcurrent			
50G/67G-1	Disabled		
Direction Selection	Non-Directional		
Pickup IG>>		A	0.05 to 25.00
Pickup Delay	0.00	s	0.00 to 999.99
Inrush Block	Enabled		
50G/67G-2	Disabled		
Direction Selection	Non-Directional		
Pickup IG>>	1.00	A	0.05 to 25.00
Pickup Delay	0.00	s	0.00 to 999.99
Inrush Block	Enabled		
51G/67G – Measured IDMTL Neutral Overcurrent			
51G/67G-1	Disabled		
Direction Selection	Non-Directional		
Pickup IG>	0.50	A	0.05 to 10.00
Curve Type	IEC standard inverse-3		
TMS	1.00	-	0.01 to 10.00

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup DTL Delay	10.00	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0.0	s	0.0 to 99.9
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
Reset Delay(TR)	13.50	-	0.10 to 150.00
Inrush Block	Enabled		
51G/67G-2	Disabled		
Direction Selection	Non-Directional		
Pickup IG>	0.50	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 99.9
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
Reset Delay(TR)	13.50	-	0.10 to 150.00
Inrush Block	Enabled		
46/50 – Instantaneous Negative Sequence Overcurrent			
46/50	Disabled		
Pickup I2>>	0.25	A	0.05 to 0.95
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 0.95
Curve Type	IEC standard inverse		
TMS	1.00	-	0.01 to 10.00
Pickup DTL Delay	10.00	s	0.00 to 999.99

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Reset Delay	ANSI Decay		
Reset DTL Delay	0.0	s	0.0 to 99.9
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
Reset Delay(TR)	13.50	-	0.10 to 150.00
67SEF-Directional Function for SEF			
Characteristic Angle	-15	Deg	-95 to 95
Minimum Voltage	10.0	V	0.3 to 40.0
Measurement Input	VN		
VTS Blocking	Disabled		
64/50SEF – Instantaneous SEF/REF			
64/50SEF-1	Disabled		
Direction Selection	Non-Dir		
Measurement Input	Fundamental		
Pickup ISEF	0.200	A	0.005 to 3.000
Pick Delay	0.00	s	0.00 to 999.99
Current Compensation	0.000	A	0.000 to 0.500
64/50SEF-2	Disabled		
Direction Selection	Non-Dir		
Measurement Input	Fundamental		
Pickup ISEF	0.200	A	0.005 to 3.000
Pick 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			
64/51SEF-1	Disabled		
Direction Selection	Non-Dir		
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

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Reset Delay	DTL		
Reset DTL Delay	0.0	s	0.0 to 99.9
Reset delay(TR)	13.50	-	0.10 to 150.00
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
TR	0.10	s	0.10 to 150.00
Current Compensation	0.000	A	0.000 to 0.500
64/51SEF-2	Disabled		
Direction Selection	Non-Dir		
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 99.9
Reset delay(TR)	13.50	-	0.10 to 150.00
A	0.1400	-	0.0010 to 1000.0000
B	0.0000	-	0.0000 to 10.0000
p	0.02	-	0.01 to 100.00
TR	0.10	s	0.10 to 150.00
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	Enabled		
Pickup % 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	0.20	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		UF, OF
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-2	Disabled		
Function Selection	UF		UF, OF
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-3	Disabled		
Function Selection	UF		UF, OF

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-4	Disabled		
Function Selection	UF		UF, OF
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-5	Disabled		
Function Selection	UF		UF, OF
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-6	Disabled		
Function Selection	UF		UF, OF
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-7	Disabled		
Function Selection	UF		UF, OF
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
Pickup Delay	2.00	s	0.05 to 999.99
VTS Blocking	Disable		
81U/O-8	Disabled		
Function Selection	UF		UF, OF

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Pickup F	49.0	Hz	40.0 to 50.0, 50.1 to 60.0
Hysteresis	1	%	1 to 80
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	-10.0 to 10.0
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	-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	-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	-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

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
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		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
THD-1	Disabled		
THD-2	Disabled		
U/V	Disabled		
O/V	Disabled		
U/F	Disabled		
O/F	Disabled		
S/I	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
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	99999.9	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	Enable		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
THD-2	Disabled		
Pickup THD-V	3	%	1 to 100
Pickup Delay	5.00	s	0.00 to 999.99
VTS Blocking	Enable		
U/V – Under Voltage Count Alarm			
U/V	Disabled		
Pickup V	40.0	V	1.0 to 220.0
U/V Count	100	-	1 to 1000
Count Accumulation Period	1	days	1 to 31
O/V – Over Voltage Count Alarm			
O/V	Disabled		
Pickup V	70.0	V	1.0 to 220.0
O/V Count	100	-	1 to 1000
Count Accumulation Period	1	days	1 to 31
U/F – Under Frequency Count Alarm			
U/F	Disabled		
Pickup F	49.90	Hz	40.00 to 50.00
U/F Count	100	-	1 to 1000
Count Accumulation Period	1	days	1 to 31
O/F – Over Frequency Count Alarm			
O/F	Disabled		
Pickup F	50.10	Hz	50.00 to 60.00
O/F Count	100	-	1 to 1000
Count Accumulation Period	1	days	1 to 31
E/I – External Input Count Alarm			
E/I	Disabled		
Pickup Delay	0.10	s	0.00 to 99.99
E/I Count	100	-	1 to 1000
Count Accumulation Period	1	days	1 to 31
Control Summary			
79	Disabled		
79 – Recloser			

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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>		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
PL 5 [ProLogic 5]			
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			

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 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>		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 4			
Input D	<Unused = 0>		
Operator 5			
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]			

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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			
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>		

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 15 [ProLogic 15]			
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			

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 17 [ProLogic 17]			
ProLogic 17	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 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]			

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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			
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		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 2]	Self Reset		Self Reset, Hand Reset

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 3]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 4]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 5]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 6]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 7]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 8]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 9]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 10]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 11]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 12]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 13]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Reset Type[RL 14]	Self Reset		Self Reset, Hand Reset
Dropout Timers	0.10	s	0.00 to 1.00
Target LED Reset			

F-PRO Settings Summary – Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Reset Type[Target LED 2]	Self Reset		
Reset Type[Target LED 3]	Self Reset		
Reset Type[Target LED 4]	Self Reset		
Reset Type[Target LED 5]	Self Reset		
Reset Type[Target LED 6]	Self Reset		
Reset Type[Target LED 7]	Self Reset		
Reset Type[Target LED 8]	Self Reset		
Reset Type[Target LED 9]	Self Reset		
Reset Type[Target LED 10]	Self Reset		
Reset Type[Target LED 11]	Self Reset		
Reset Type[Target LED 12]	Self Reset		
Reset Type[Target LED 13]	Self Reset		
Reset Type[Target LED 14]	Self Reset		

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 14 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 13 normally open contact outputs for relaying, alarms & control, and one change over contact for relay healthy indication. 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: • A • B • C • AB • BC • CA • 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	

Event	Notes
59DT-5 Operated	The possible phase information will be: • A • B • C • AB • BC • CA • ABC
59DT-6 Operated	
59IT-1 Picked up	
59IT-2 Picked up	
59IT-1 Operated	
59IT-2 Operated	
24DT-1 Picked up	
24DT-2 Picked up	
24DT-1 Operated	
24DT-2 Operated	
24IT Picked up	
24IT Operated	
47DT-1 Picked up	
47DT-2 Picked up	
47DT-1 Operated	
47DT-2 Operated	
47IT Picked up	
47IT Operated	
59NDT-1 Picked up	
59NDT-2 Picked up	
59NDT-1 Operated	
59NDT-2 Operated	
59NIT Picked up	
59NIT Operated	

Event	Notes
37-1 Picked up	The possible phase information will be: • A • B • C • AB • BC • CA • 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	
50G-1 Picked up	
50G-2 Picked up	
50G-1 Operated	
50G-2 Operated	
51G-1 Picked up	
51G-2 Picked up	
51G-1 Operated	

Event	Notes
51G-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	
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	
81U-1 Operated	
81U-2 Operated	
81U-3 Operated	
81U-4 Operated	
81U-5 Operated	
81U-6 Operated	
81U-7 Operated	
81U-8 Operated	
81O-1 Picked up	

Event	Notes
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	
81O-1 Operated	
81O-2 Operated	
81O-3 Operated	
81O-4 Operated	
81O-5 Operated	
81O-6 Operated	
81O-7 Operated	
81O-8 Operated	
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	
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	

Event	Notes
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	
79 IN Operated	
79 OUT Operated	
79 Reclose Operated	
79 AR Initiate Operated	
79 Block Operated	
79 Lockout Operated	

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
50G-1 Picked up	583	0: OFF	1: ON
50G-2 Picked up	584	0: OFF	1: ON
50G-1 Operated	585	0: OFF	1: ON
50G-2 Operated	586	0: OFF	1: ON
51G-1 Picked up	587	0: OFF	1: ON
51G-2 Picked up	588	0: OFF	1: ON
51G-1 Operated	589	0: OFF	1: ON
51G-2 Operated	590	0: OFF	1: ON
46/50 Picked up	591	0: OFF	1: ON
46/50 Operated	592	0: OFF	1: ON
46/51 Picked up	593	0: OFF	1: ON
46/51 Operated	594	0: OFF	1: ON
64/50SEF-1 Picked up	595	0: OFF	1: ON
64/50SEF-2 Picked up	596	0: OFF	1: ON
64/50SEF-1 Operated	597	0: OFF	1: ON
64/50SEF-2 Operated	598	0: OFF	1: ON

Read Coil Status (Function Code 01)			
Channel	Address	Value	
64/51SEF-1 Picked up	599	0: OFF	1: ON
64/51SEF-2 Picked up	600	0: OFF	1: ON
64/51SEF-1 Operated	601	0: OFF	1: ON
64/51SEF-2 Operated	602	0: OFF	1: ON
49 Picked up	603	0: OFF	1: ON
49 Operated	604	0: OFF	1: ON
49AL Operated	605	0: OFF	1: ON
50BF-D1 Operated	606	0: OFF	1: ON
50BF-D2 Operated	607	0: OFF	1: ON
DI_CBF-D1 Operated	608	0: OFF	1: ON
DI_CBF-D2 Operated	609	0: OFF	1: ON
46BC Operated	610	0: OFF	1: ON
81HBL2 Operated	611	0: OFF	1: ON
81U-1 Picked up	612	0: OFF	1: ON
81U-2 Picked up	613	0: OFF	1: ON
81U-3 Picked up	614	0: OFF	1: ON
81U-4 Picked up	615	0: OFF	1: ON
81U-5 Picked up	616	0: OFF	1: ON
81U-6 Picked up	617	0: OFF	1: ON
81U-7 Picked up	618	0: OFF	1: ON
81U-8 Picked up	619	0: OFF	1: ON
81U-1 Operated	620	0: OFF	1: ON
81U-2 Operated	621	0: OFF	1: ON
81U-3 Operated	622	0: OFF	1: ON
81U-4 Operated	623	0: OFF	1: ON
81U-5 Operated	624	0: OFF	1: ON
81U-6 Operated	625	0: OFF	1: ON
81U-7 Operated	626	0: OFF	1: ON
81U-8 Operated	627	0: OFF	1: ON
81O-1 Picked up	628	0: OFF	1: ON
81O-2 Picked up	629	0: OFF	1: ON
81O-3 Picked up	630	0: OFF	1: ON
81O-4 Picked up	631	0: OFF	1: ON
81O-5 Picked up	632	0: OFF	1: ON
81O-6 Picked up	633	0: OFF	1: ON
81O-7 Picked up	634	0: OFF	1: ON
81O-8 Picked up	635	0: OFF	1: ON
81O-1 Operated	636	0: OFF	1: ON
81O-2 Operated	637	0: OFF	1: ON
81O-3 Operated	638	0: OFF	1: ON
81O-4 Operated	639	0: OFF	1: ON
81O-5 Operated	640	0: OFF	1: ON
81O-6 Operated	641	0: OFF	1: ON
81O-7 Operated	642	0: OFF	1: ON
81O-8 Operated	643	0: OFF	1: ON
81R-1 Picked up	644	0: OFF	1: ON
81R-2 Picked up	645	0: OFF	1: ON
81R-3 Picked up	646	0: OFF	1: ON
81R-4 Picked up	647	0: OFF	1: ON
81R-1 Operated	648	0: OFF	1: ON
81R-2 Operated	649	0: OFF	1: ON

Read Coil Status (Function Code 01)			
Channel	Address	Value	
81R-3 Operated	650	0: OFF	1: ON
81R-4 Operated	651	0: OFF	1: ON
32-1 Picked up	652	0: OFF	1: ON
32-2 Picked up	653	0: OFF	1: ON
32-3 Picked up	654	0: OFF	1: ON
32-4 Picked up	655	0: OFF	1: ON
32-1 Operated	656	0: OFF	1: ON
32-2 Operated	657	0: OFF	1: ON
32-3 Operated	658	0: OFF	1: ON
32-4 Operated	659	0: OFF	1: ON
60VTS Operated	660	0: OFF	1: ON
60CTS Operated	661	0: OFF	1: ON
74TCS-1 Operated	662	0: OFF	1: ON
74TCS-2 Operated	663	0: OFF	1: ON
I2t Limit Operated	664	0: OFF	1: ON
THD-1 Operated	665	0: OFF	1: ON
THD-2 Operated	666	0: OFF	1: ON
UV Count Operated	667	0: OFF	1: ON
OV Count Operated	668	0: OFF	1: ON
UF Count Operated	669	0: OFF	1: ON
OF Count Operated	670	0: OFF	1: ON
EI Count Operated	671	0: OFF	1: ON
79 IN	672	0: OFF	1: ON
79 OUT	673	0: OFF	1: ON
79 RECLOSE	674	0: OFF	1: ON
79 AR Initiate	675	0: OFF	1: ON
79 Block	676	0: OFF	1: ON
79 LockOut	677	0: OFF	1: ON
ProLogic1	678	0: OFF	1: ON
ProLogic2	679	0: OFF	1: ON
ProLogic3	680	0: OFF	1: ON
ProLogic4	681	0: OFF	1: ON
ProLogic5	682	0: OFF	1: ON
ProLogic6	683	0: OFF	1: ON
ProLogic7	684	0: OFF	1: ON
ProLogic8	685	0: OFF	1: ON
ProLogic9	686	0: OFF	1: ON
ProLogic10	687	0: OFF	1: ON
ProLogic11	688	0: OFF	1: ON
ProLogic12	689	0: OFF	1: ON
ProLogic13	690	0: OFF	1: ON
ProLogic14	691	0: OFF	1: ON
ProLogic15	692	0: OFF	1: ON
ProLogic16	693	0: OFF	1: ON
ProLogic17	694	0: OFF	1: ON
ProLogic18	695	0: OFF	1: ON
ProLogic19	696	0: OFF	1: ON
ProLogic20	697	0: OFF	1: ON
Relay O/P1	698	0: OFF	1: ON
Relay O/P2	699	0: OFF	1: ON
Relay O/P3	700	0: OFF	1: ON
Relay O/P4	701	0: OFF	1: ON
Relay O/P5	702	0: OFF	1: ON
Relay O/P6	703	0: OFF	1: ON

Read Coil Status (Function Code 01)			
Channel	Address	Value	
Relay O/P7	704	0: OFF	1: ON
Relay O/P8	705	0: OFF	1: ON
Relay O/P9	706	0: OFF	1: ON
Relay O/P10	707	0: OFF	1: ON
Relay O/P11	708	0: OFF	1: ON
Relay O/P12	709	0: OFF	1: ON
Relay O/P13	710	0: OFF	1: ON
Relay O/P14	711	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
V1 Magnitude	40271	KV	100
V2 Magnitude	40272	KV	100
V0 Magnitude	40273	KV	100
%V/F	40274	%	100
%THD	40275	%	100
IA Magnitude	40276	A	100
IA Angle	40277	Degrees	1
IB Magnitude	40278	A	100
IB Angle	40279	Degrees	1
IC Magnitude	40280	A	100
IC Angle	40281	Degrees	1
IN Magnitude	40282	A	100
IN Angle	40283	Degrees	1
IG Magnitude	40284	A	100
IG Angle	40285	Degress	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
A Phase Real Power	40294	MW	100
B Phase Real Power	40295	MW	100
C Phase Real Power	40296	MW	100
A Phase Reactive Power	40297	MVAR	100
B Phase Reactive Power	40298	MVAR	100
C Phase Reactive Power	40299	MVAR	100
Frequency	40300	HZ	10
Power Factor	40301	-	100
Thermal Capacity	40302	%	100
I2t Accumulated	40303	kA^2s	1
I2t for last operation	40304	kA^2s	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
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

Read Discrete Inputs (Function Code 02)			
Channel	**Address**	**Value**	
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 297.
- 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. ***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.
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***.)

Accessing F-PRO Event Information	
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. The following type bitmap: 0x0001 – Phase A 0x0002 – Phase B 0x0004 – Phase C 0x0008 – Ground 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 ● Outstation	○ Master ● Outstation	
1.1.2 Vendor Name:		ERLPhase Power Technologies	
1.1.3 Device Name:		F-PRO 297	
1.1.4 Device manufacturer's hardware version string:		NA	
1.1.5 Device manufacturer's software version string:		NA	
1.1.6 Device Profile Document Version Number:		V1.1, Jun 14, 2019	
1.1.7 DNP Levels Supported for:	Outstations Only Requests and Responses ☐ None ☐ Level 1 ☒ Level 2 ☐ Level 3		
1.1.8 Supported Function Blocks:	☐ Self-Address Reservation ☐ Object 0 - attribute objects ☐ Data Sets ☐ File Transfer ☐ Virtual Terminal ☐ Mapping to IEC 61850 Object Models defined in a DNP3 XML file		
1.1.9 Notable Additions:	• Start-stop (qualifier codes 0x00 and 0x01), limited quantity (qualifier codes 0x07 and 0x08) and indices (qualifier codes 0x17 and 0x28) for Binary Inputs, Binary Outputs and Analog Inputs (object groups 1, 10 and 30) • 32-bit and 16-bit Analog Inputs with and without flag (variations 1, 2, 3 and 4) • 32-bit and 16-bit Analog Input events with time (variations 3 and 4) • Fault Location information as analog readings • Event log messages as Object groups 110 and 111		

1.1 Device Identification	Capabilities	Current Value	If configurable, list methods
1.1.10 Methods to set Configurable Parameters:	☐ XML - Loaded via DNP3 File Transfer ☐ XML - Loaded via other transport mechanism ☐ Terminal - ASCII Terminal Command Line ☒ Software - Vendor software named F-PRO 2000 Offliner ☐ Proprietary file loaded via DNP3 file transfer ☐ Proprietary file loaded via other transport mechanism ☐ Direct - Keypad on device front panel ☐ Factory - Specified when device is ordered ☐ Protocol - Set via DNP3 (e.g. assign class) ☐ Other - explain _________________		
1.1.11 DNP3 XML files available On-Line:	RdWrFilenameDescription of Contents ☐ dnpDP.xml Complete Device Profile ☐ dnpDPcap.xml Device Profile Capabilities ☐ dnpDPcfg.xml Device Profile config. values ☐ ☐ _____*.xml ___________________ *The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns. *The Device Profile Capabilities contains only the capabilities and configurable methods columns. *The Device Profile Config. Values contains only the Current Value column.	Not supported	
1.1.12 External DNP3 XML files available Off-line:	Rd WrFilenameDescription of Contents ☐ ☐ dnpDP.xml Complete Device Profile ☐ ☐ dnpDPcap.xml Device Profile Capabilities ☐ ☐ dnpDPcfg.xml Device Profile config. values ☐ ☐ _______*.xml ___________________ *The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns. *The Device Profile Capabilities contains only the capabilities and configurable methods columns. *The Device Profile Config. Values contains only the Current Value column.	Not supported	
1.1.13 Connections Supported:	☒ Serial (complete section 1.2) ☒ IP Networking (complete section 1.3) ☐ Other, explain ______________________		

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

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

1.3 IP Networking	Capabilities	Current Value	If configurable, list methods
1.3.1 Port Name	CON 1 Network		
1.3.2 Type of End Point:	☐ TCP Initiating (Master Only) ☒ TCP Listening (Outstation Only) ☐ TCP Dual (required for Masters) ☒ UDP Datagram (required)	Not configured for DNP	F-PRO 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:		192.168.100.1	F-PRO 2000 Offliner
1.3.6 Accepts TCP Connections or UDP Datagrams from:	☒ Allows all (show as *.*.*.* in 1.3.7) ☒ Limits based on an IP address ☒ Limits based on list of IP addresses ☐ Limits based on a wildcard IP address ☐ Limits based on list of wildcard IP addresses ☐ Other validation, explain_________________	Limits based on an IP address	F-PRO 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) ☐ Fixed at 20,000 ☒ Configurable, range 1025 to 32737 ☐ Configurable, selectable from ____,____,____ ☐ 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) ☐ Fixed at 20,000 ☐ Configurable, range _______ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	F-PRO 2000 Offliner
1.3.10 TCP Keep-alive timer:	☐ Fixed at ___________ms ☒ Configurable, range 5 to 3,600 s ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________	Disabled	F-PRO 2000 Offliner
1.3.11 Local UDP port:	☐ Fixed at 20,000 ☒ Configurable, range 1025 to 32737 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ 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 ☐ Fixed at 20,000 ☐ Configurable, range _______ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	

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

1.4 Link Layer	Capabilities	Current Value	If configurable, list methods
1.4.1 Data Link Address:	☐ Fixed at______ ☒ Configurable, range 1 to 65519 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	1	F-PRO 2000 Offliner
1.4.2 DNP3 Source Address Validation:	☒ Never ☐ Always, one address allowed (shown in 1.4.3) ☐ Always, any one of multiple addresses allowed ☐ (each selectable as shown in 1.4.3) ☐ Sometimes, explain________________		
1.4.3 DNP3 Source Address(es) expected when Validation is Enabled:	☐ Configurable to any 16 bit DNP Data Link Address value ☐ Configurable, range _______ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	
1.4.4 Self Address Support using address 0xFFFC:	☐ Yes (only allowed if configurable) ☒ No	NA	
1.4.5 Sends Confirmed User Data Frames:	☐ Always ☐ Sometimes, explain _____________________ ☐ Never ☒ Configurable, either always or never		F-PRO 2000 Offliner (to disable, set Data Link Time-out to 0)
1.4.6 Data Link Layer Confirmation Timeout:	☐ None ☐ Fixed at __ ms ☒ Configurable, range 0 to 2,000 ms ☐ Configurable, selectable from____________ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	500	F-PRO 2000 Offliner
1.4.7 Maximum Data Link Retries:	☐ Never Retries ☒ Fixed at 3 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	3	
1.4.8 Maximum number of octets Transmitted in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	292	
1.4.9 Maximum number of octets that can be Received in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	292	

1.5 Application Layer		Capabilities	Current Value	If configurable, list methods
1.5.1	Maximum number of octets Transmitted in an Application Layer Fragment other than File Transfer:	☒ Fixed at 2048 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	2048	
1.5.2	Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer:	☐ Fixed at ___________ ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	NA	
1.5.3	Maximum number of octets that can be Received in an Application Layer Fragment:	☒ Fixed at 2048 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________	2048	
1.5.4	Timeout waiting for Complete Application Layer Fragment:	☐ None ☒ Fixed at 2,000 ms ☐ Configurable, range _______ to _______ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	2,000 ms	
1.5.5	Maximum number of objects allowed in a single control request for CROB (group 12):	☒ Fixed at 16 ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	16	
1.5.6	Maximum number of objects allowed in a single control request for Analog Outputs (group 41):	☐ Fixed at _ ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	Analog Outputs not supported	
1.5.7	Maximum number of objects allowed in a single control request for Data Sets (groups 85,86,87):	☐ Fixed at __ ☐ Configurable, range ________ to _______ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	Data Sets not supported	
1.5.8	Supports mixing object groups (AOBs, CROBs and Data Sets) in the same control request:	☐ Not applicable - controls are not supported ☐ Yes ☒ No	Analog Outputs not supported	

1.6 Fill Out The Following Items For Outstations Only	Capabilities	Current Value	If configurable, list methods
1.6.1 Timeout waiting for Application Confirm of solicited response message:	☐ None ☒ Fixed at 5,000 ms ☐ Configurable, range _______ to _______ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________	5,000 ms	
1.6.2 How often is time synchronization required from the master?	☒ Never needs time ☐ Within ______ seconds after IIN1.4 is set ☐ Periodically every _______ seconds		
1.6.3 Device Trouble Bit IIN1.6:	☐ Never used ☒ Reason for setting: 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 ☐ Fixed at______ ms ☐ Configurable, range _______ to _______ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe______________ ☐ Variable, explain _______________________		
1.6.5 Event Buffer Overflow Behaviour:	☐ Discard the oldest event ☒ Discard the newest event ☐ Other, explain _________________________		
1.6.6 Event Buffer Organization:	• Single buffer for the Object Groups 2 and 32, size 200. • Separate buffer for the Object Group 111, size 100. • Separate buffer for the Fault Locator events, size 100.		
1.6.7 Sends Multi-Fragment Responses:	☒ Yes ☐ No		
1.6.8 DNP Command Settings preserved through a device reset:	☐ Assign Class ☐ Analog Deadbands ☐ Data Set Prototypes ☐ Data Set Descriptors	Not supported	

1.7 Outstation Unsolicited Response Support	Capabilities	Current Value	If configurable, list methods
1.7.1 Supports Unsolicited Reporting:	☒ Not Supported ☐ Configurable, selectable from On and Off	NA	

1.8 Outstation Performance	Capabilities	Current Value	If configurable, list methods
1.8.1 Maximum Time Base Drift (milliseconds per minute):		NA, not synchronized by DNP	
1.8.2 When does outstation set IIN1.4?	☒ Never ☐ Asserted at startup until first Time Synchronization request received ☐ Periodically, range ____to____ seconds ☐ Periodically, selectable from ____,____,___ seconds ☐ Range ____to____ seconds after last time sync ☐ Selectable from___,___,___seconds after last time sync ☐ When time error may have drifted by range ____to____ ms ☐ When time error may have drifted by selectable from ____,____,___	NA	
1.8.3 Maximum Internal Time Reference Error when set via DNP (ms):		NA	
1.8.4 Maximum Delay Measurement error (ms):		NA	
1.8.5 Maximum Response time (ms):		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 • 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 • 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 Static (Steady-State) Group Number: 1 Event Group Number: 2	**Capabilities**	**Current Value**	**If configurable, list methods**
2.1.1 Static Variation reported when variation 0 requested:	☒ Variation 1 - Single-bit Packed format ☐ Variation 2 - Single-bit with flag ☐ Based on point Index (add column to table below)		
2.1.2 Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☒ Variation 2 - with absolute time ☐ Variation 3 - with relative time ☐ Based on point Index (add column to table below)		
2.1.3 Event reporting mode:	☐ Only most recent ☒ All events		
2.1.4 Binary Inputs included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		F-PRO 2000 Offliner
2.1.5 Definition of Binary Input Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain______________________	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO 2000 Offliner

Notes	1. Binary Inputs are scanned with 1 ms resolution. 2. Binary Input data points are user selectable; the data points available in the device for any given Binary Input point selection can be obtained through the F-PRO 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	Virtual Input 1	1	Inactive	Active	
10	Virtual Input 2	1	Inactive	Active	
11	Virtual Input 3	1	Inactive	Active	
12	Virtual Input 4	1	Inactive	Active	
13	Virtual Input 5	1	Inactive	Active	
14	Virtual Input 6	1	Inactive	Active	
15	Virtual Input 7	1	Inactive	Active	
16	Virtual Input 8	1	Inactive	Active	
17	Virtual Input 9	1	Inactive	Active	
18	Virtual Input 10	1	Inactive	Active	
19	Virtual Input 11	1	Inactive	Active	
20	Virtual Input 12	1	Inactive	Active	
21	Virtual Input 13	1	Inactive	Active	
22	Virtual Input 14	1	Inactive	Active	
23	Virtual Input 15	1	Inactive	Active	
24	Virtual Input 16	1	Inactive	Active	
25	Virtual Input 17	1	Inactive	Active	
26	Virtual Input 18	1	Inactive	Active	
27	Virtual Input 19	1	Inactive	Active	
28	Virtual Input 20	1	Inactive	Active	
29	Virtual Input 21	1	Inactive	Active	
30	Virtual Input 22	1	Inactive	Active	
31	Virtual Input 23	1	Inactive	Active	

32	Virtual Input 24	1	Inactive	Active	
33	Virtual Input 25	1	Inactive	Active	
34	Virtual Input 26	1	Inactive	Active	
35	Virtual Input 27	1	Inactive	Active	
36	Virtual Input 28	1	Inactive	Active	
37	Virtual Input 29	1	Inactive	Active	
38	Virtual Input 30	1	Inactive	Active	
39	ProLogic 1	1	Inactive	Active	
40	ProLogic 2	1	Inactive	Active	
41	ProLogic 3	1	Inactive	Active	
42	ProLogic 4	1	Inactive	Active	
43	ProLogic 5	1	Inactive	Active	
44	ProLogic 6	1	Inactive	Active	
45	ProLogic 7	1	Inactive	Active	
46	ProLogic 8	1	Inactive	Active	
47	ProLogic 9	1	Inactive	Active	
48	ProLogic 10	1	Inactive	Active	
49	ProLogic 11	1	Inactive	Active	
50	ProLogic 12	1	Inactive	Active	
51	ProLogic 13	1	Inactive	Active	
52	ProLogic 14	1	Inactive	Active	
53	ProLogic 15	1	Inactive	Active	
54	ProLogic 16	1	Inactive	Active	
55	ProLogic 17	1	Inactive	Active	
56	ProLogic 18	1	Inactive	Active	
57	ProLogic 19	1	Inactive	Active	
58	ProLogic 20	1	Inactive	Active	
59	27DT-1 Operated	1	Inactive	Active	
60	27DT-1 Operated A	1	Inactive	Active	
61	27DT-1 Operated B	1	Inactive	Active	
62	27DT-1 Operated C	1	Inactive	Active	
63	27DT-2 Operated	1	Inactive	Active	
64	27DT-2 Operated A	1	Inactive	Active	
66	27DT-2 Operated B	1	Inactive	Active	
67	27DT-2 Operated C	1	Inactive	Active	
68	27DT-3 Operated	1	Inactive	Active	

69	27DT-3 Operated A	1	Inactive	Active	
70	27DT-3 Operated B	1	Inactive	Active	
71	27DT-3 Operated C	1	Inactive	Active	
72	27DT-4 Operated	1	Inactive	Active	
73	27DT-4 Operated A	1	Inactive	Active	
74	27DT-4 Operated B	1	Inactive	Active	
75	27DT-4 Operated C	1	Inactive	Active	
76	27DT-5 Operated	1	Inactive	Active	
77	27DT-5 Operated A	1	Inactive	Active	
78	27DT-5 Operated B	1	Inactive	Active	
79	27DT-5 Operated C	1	Inactive	Active	
80	27DT-6 Operated	1	Inactive	Active	
81	27DT-6 Operated A	1	Inactive	Active	
82	27DT-6 Operated B	1	Inactive	Active	
83	27DT-6 Operated C	1	Inactive	Active	
84	27IT-1 Operated	1	Inactive	Active	
85	27IT-1 Operated A	1	Inactive	Active	
86	27IT-1 Operated B	1	Inactive	Active	
87	27IT-1 Operated C	1	Inactive	Active	
88	27IT-2 Operated	1	Inactive	Active	
89	27IT-2 Operated A	1	Inactive	Active	
90	27IT-2 Operated B	1	Inactive	Active	
91	27IT-2 Operated C	1	Inactive	Active	
92	59DT-1 Operated	1	Inactive	Active	
93	59DT-1 Operated A	1	Inactive	Active	
94	59DT-1 Operated B	1	Inactive	Active	
95	59DT-1 Operated C	1	Inactive	Active	
96	59DT-2 Operated	1	Inactive	Active	
97	59DT-2 Operated A	1	Inactive	Active	
98	59DT-2 Operated B	1	Inactive	Active	
99	59DT-2 Operated C	1	Inactive	Active	
100	59DT-3 Operated	1	Inactive	Active	
101	59DT-3 Operated A	1	Inactive	Active	
102	59DT-3 Operated B	1	Inactive	Active	
103	59DT-3 Operated C	1	Inactive	Active	
104	59DT-4 Operated	1	Inactive	Active	

105	59DT-4 Operated A	1	Inactive	Active	
106	59DT-4 Operated B	1	Inactive	Active	
107	59DT-4 Operated C	1	Inactive	Active	
108	59DT-5 Operated	1	Inactive	Active	
109	59DT-5 Operated A	1	Inactive	Active	
110	59DT-5 Operated B	1	Inactive	Active	
111	59DT-5 Operated C	1	Inactive	Active	
112	59DT-6 Operated	1	Inactive	Active	
113	59DT-6 Operated A	1	Inactive	Active	
114	59DT-6 Operated B	1	Inactive	Active	
115	59DT-6 Operated C	1	Inactive	Active	
116	59IT-1 Operated	1	Inactive	Active	
117	59IT-1 Operated A	1	Inactive	Active	
118	59IT-1 Operated B	1	Inactive	Active	
119	59IT-1 Operated C	1	Inactive	Active	
120	59IT-2 Operated	1	Inactive	Active	
121	59IT-2 Operated A	1	Inactive	Active	
122	59IT-2 Operated B	1	Inactive	Active	
123	59IT-2 Operated C	1	Inactive	Active	
124	24DT-1 Operated	1	Inactive	Active	
125	24DT-2 Operated	1	Inactive	Active	
126	24IT Operated	1	Inactive	Active	
127	47DT-1 Operated	1	Inactive	Active	
128	47DT-2 Operated	1	Inactive	Active	
129	47IT Operated	1	Inactive	Active	
130	59NDT-1 Operated	1	Inactive	Active	
131	59NDT-2 Operated	1	Inactive	Active	
132	59NIT Operated	1	Inactive	Active	
133	37-1 Operated	1	Inactive	Active	
134	37-1 Operated A	1	Inactive	Active	
135	37-1 Operated B	1	Inactive	Active	
136	37-1 Operated C	1	Inactive	Active	
137	37-2 Operated	1	Inactive	Active	
138	37-2 Operated A	1	Inactive	Active	
139	37-2 Operated B	1	Inactive	Active	
140	37-2 Operated C	1	Inactive	Active	

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

177	46BC Operated	1	Inactive	Active	
178	81HBL2 Operated	1	Inactive	Active	
179	81U-1 Operated	1	Inactive	Active	
180	81U-2 Operated	1	Inactive	Active	
181	81U-3 Operated	1	Inactive	Active	
182	81U-4 Operated	1	Inactive	Active	
183	81U-5 Operated	1	Inactive	Active	
184	81U-6 Operated	1	Inactive	Active	
185	81U-7 Operated	1	Inactive	Active	
186	81U-8 Operated	1	Inactive	Active	
187	81O-1 Operated	1	Inactive	Active	
188	81O-2 Operated	1	Inactive	Active	
189	81O-3 Operated	1	Inactive	Active	
190	81O-4 Operated	1	Inactive	Active	
191	81O-5 Operated	1	Inactive	Active	
192	81O-6 Operated	1	Inactive	Active	
193	81O-7 Operated	1	Inactive	Active	
194	81O-8 Operated	1	Inactive	Active	
195	81R-1 Operated	1	Inactive	Active	
196	81R-2 Operated	1	Inactive	Active	
197	81R-3 Operated	1	Inactive	Active	
198	81R-4 Operated	1	Inactive	Active	
199	32-1 Operated	1	Inactive	Active	
200	32-1 Operated A	1	Inactive	Active	
201	32-1 Operated B	1	Inactive	Active	
202	32-1 Operated C	1	Inactive	Active	
203	32-2 Operated	1	Inactive	Active	
204	32-2 Operated A	1	Inactive	Active	
205	32-2 Operated B	1	Inactive	Active	
206	32-2 Operated C	1	Inactive	Active	
207	32-3 Operated	1	Inactive	Active	
208	32-3 Operated A	1	Inactive	Active	
209	32-3 Operated B	1	Inactive	Active	
210	32-3 Operated C	1	Inactive	Active	
211	32-4 Operated	1	Inactive	Active	
212	32-4 Operated A	1	Inactive	Active	

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

2.2 Binary Output Status And Control Relay Output Block Binary Output Status Group Number: 10 Binary Output Event Group Number: 11 CROB Group Number: 12 Binary Output Command Event Object Num: 13	**Capabilities**	**Current Value**	**If configurable, list methods**
2.2.1 Minimum pulse time allowed with Trip, Close, and Pulse On commands:	☒ Fixed at 0.000 ms (hardware may limit this further) ☐ Based on point Index (add column to table below)		
2.2.2 Maximum pulse time allowed with Trip, Close, and Pulse On commands:	☒ Fixed at 0.000 ms (hardware may limit this further) ☐ Based on point Index (add column to table below)		

2.2 Binary Output Status And Control Relay Output Block Binary Output Status Group Number: 10 Binary Output Event Group Number: 11 CROB Group Number: 12 Binary Output Command Event Object Num: 13		**Capabilities**	**Current Value**	**If configurable, list methods**
2.2.3	Binary Output Status included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.2.4	Reports Output Command Event Objects:	☒ Never ☐ Only upon a successful Control ☐ Upon all control attempts	Not supported	
2.2.5	Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☐ Variation 2 - with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO 2000 Offliner (See Note 2 below)
2.2.6	Command Event Variation reported when variation 0 requested:	☐ Variation 1 - without time ☐ Variation 2 - with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO 2000 Offliner (See Note 2 below)
2.2.7	Event reporting mode:	☐ Only most recent ☐ All events	Not supported	F-PRO 2000 Offliner (See Note 2 below)
2.2.8	Command Event reporting mode:	☐ Only most recent ☐ All events	Not supported	
2.2.9	Maximum Time between Select and Operate:	☐ Not Applicable ☒ Fixed at 10 seconds ☐ Configurable, range ______ to ______ seconds ☐ Configurable, selectable from___,___,___seconds ☐ Configurable, other, describe______________ ☐ Variable, explain ______________________ ☐ Based on point Index (add column to table below)	10 s	
2.2.10	Definition of Binary Output Status/Control relay output block (CROB) Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain_____________________	Complete list is shown in the table below; points excluded from the default configuration are marked with ‘*’	F-PRO 2000 Offliner

NOTES	1. Binary Outputs are scanned with 500 ms resolution. 2. Events are not supported for Binary Outputs (group 10), but most of Binary Output points can be mapped to Binary Inputs (group 2) with full Event and Class Data support. See F-PRO 2000 Offliner/DNP Configuration/Point Map screen for complete point lists and configuration options. 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. 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 Static (Steady-State) Group Number: 30 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 ☐ Variation 2 - 16-bit with flag ☒ Variation 3 - 32-bit without flag ☒ Variation 4 - 16-bit without flag ☐ Variation 5 - single-precision floating point with flag ☐ Variation 6 - double-precision floating point with flag ☐ 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 ☒ Variation 2 - 16-bit without time ☐ Variation 3 - 32-bit with time ☐ Variation 4 - 16-bit with time ☐ Variation 5 - single-precision floating point w/o time ☐ Variation 6 - double-precision floating point w/o time ☐ Variation 7 - single-precision floating point with time ☐ Variation 8 - double-precision floating point with time ☐ Based on point Index (add column to table below)		
2.3.3 Event reporting mode:	☐ Only most recent ☒ All events		
2.3.4 Analog Inputs Included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
2.3.5 How Deadbands are set:	☐ A. Global Fixed ☐ B. Configurable through DNP ☒ C. Configurable via other means ☐ D. Other, explain ________________________ ☐ 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: simple - just compares the difference from the previous reported value	☒ Simple ☐ Integrating ☐ Other, explain ________________________		
2.3.7 Definition of Analog Input Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain_____________________	Complete list is shown in the table below; points excluded from the default configuration are marked with '*'	F-PRO 2000 Offliner

NOTES	1. Analog Inputs are scanned with 500 ms resolution. 2. Nominal values in calculations for the following table are based on 69V secondary voltage * PT ratio for voltage channels, and either 1 A or 5A secondary current * CT ratio for current channels dependent upon the format of CT installed in the F-PRO. 3. Analog Input data points are user selectable; the data points available in the device for any given Analog Input point selection can be obtained through the F-PRO 2000 Offliner software (see SCADA Setting Summary). 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. 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. The following bitmap id used for the fault information Type points: 0x0001 Phase A 0x0002 Phase B 0x0004 Phase C 0x0008 Ground

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Transmitted Value[a]		Scaling[b]		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	V1 Magnitude	2	0	Configurable	0.01 / (0.000001- 1.0)	0.0	kV	0.1 / 0.00001	
15	V2 Magnitude	2	0	Configurable	0.01 / (0.000001- 1.0)	0.0	kV	0.1 / 0.00001	
16	V0 Magnitude	2	0	Configurable	0.01 / (0.000001- 1.0)	0.0	kV	0.1 / 0.00001	
17	V/F	2	0	Configurable	0.01 / (0.0001- 1.0)	0.0	pu		
18	%THD Voltage	2	0	10,000	0.1 / (0.01- 1.0)	0.0	%		
19	Ia Magnitude	2	0	Configurable	0.01 / (0.00001 – 10.0)	0.0	A	1.0 / 0.01	
20	Ia Angle	2	-18,000	18,000	0.1 / (0.01 – 1.0)	0.0	Degrees	0.1 / 0.01	
21	Ib Magnitude	2	0	Configurable	0.01 / (0.00001 – 10.0)	0.0	A	1.0 / 0.01	
22	Ib Angle	2	-18,000	18,000	0.1 / (0.01 – 1.0)	0.0	Degrees	0.1 / 0.01	
23	Ic Magnitude	2	0	Configurable	0.01 / (0.00001 – 10.0)	0.0	A	1.0 / 0.01	
24	Ic Angle	2	-18,000	18,000	0.1 / (0.01 – 1.0)	0.0	Degrees	0.1 / 0.01	
25	In Magnitude	2	0	Configurable	0.01 / (0.000001 – 10.0)	0.0	A	1.0 / 0.01	
26	In Angle	2	-18,000	18,000	0.1 / (0.01 – 1.0)	0.0	Degrees	0.1 / 0.01	
27	Ig Magnitude	2	0	Configurable	0.01 / (0.000001 – 10.0)	0.0	A	1.0 / 0.01	
28	Ig 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	

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

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) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
1	1	Binary Input - Packed format	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
1	2	Binary Input - With flags	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
2	0	Binary Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
2	1	Binary Input Event - Without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
2	2	Binary Input Event - With absolute time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
2	3	Binary Input Event - With relative time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
10	0	Binary Output - Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
10	2	Binary Output - Output Status with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
12	1	Binary Command - Control relay output block (CROB)	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	Echo of request
40	2	~~Analog Output Status - 16-bit with flag~~			129 (response)	~~00, 01 (start-stop)~~

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)**
20	0	~~Counter - Any Variation~~	1 (read) 7 (freeze) 8 (freeze noack) 9 (freeze clear) 10 (frz. cl. noack)	06 (no range, or all)	129 (response)	
20	1	~~Counter - 32-bit with flag~~			129 (response)	~~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) 07, 08 (limited qty)		
22	1	~~Counter Event - 32-bit with flag~~			129 (response) ~~130 (unsol. resp)~~	~~17, 28 (index)~~
22	2	~~Counter Event - 16-bit with flag~~			129 (response) ~~130 (unsol. resp)~~	~~17, 28 (index)~~
30	0	Analog Input - Any Variation	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	1	Analog Input - 32-bit with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	2	Analog Input - 16-bit with flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	3	Analog Input - 32-bit without flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
30	4	Analog Input - 16-bit without flag	1 (read)	06 (no range, or all) 00, 01 (start-stop) 07, 08 (limited qty) 17, 28 (index)	129 (response)	00, 01 (start-stop)
32	0	Analog Input Event - Any Variation	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	1	Analog Input Event - 32-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
32	2	Analog Input Event - 16-bit without time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response) ~~130 (unsol. resp)~~	17, 28 (index)
32	3	Analog Input Event - 32-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
32	4	Analog Input Event - 16-bit with time	1 (read)	06 (no range, or all) 07, 08 (limited qty)	129 (response)	17, 28 (index)
40	0	~~Analog Output Status - Any Variation~~	1 (read)	06 (no range, or all)	129 (response)	

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)**
41	2	~~Analog Output - 16-bit~~	3 (select) 4 (operate) 5 (direct op) 6 (dir. op, no ack)	17, 28 (index)	129 (response)	~~Echo of request~~
50	1	~~Time and Date - Absolute time~~	2 (write)	07 (limited qty = 1)	129 (response)	
51	1	~~Time and Date CTO - Absolute time, synchronized~~			~~129 (response)~~ ~~130 (unsol. resp)~~	~~07 (limited qty)~~ ~~(qty = 1)~~
51	2	Time and Date CTO - Absolute time, unsynchronized			129 (response) ~~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.

.

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
163	2	Reset FCB	-	5	3	RO
163	3	Reset CU	-	5	4	RO
163	4	Start/Restart	-	5	5	RO
163	5	Power ON	-	5	6	RO
163	19	LEDs reset	-	1	1, 11, 12, 20, 21	RO
163	22	Settings changed	x	1	1, 9, 11, 12	RC
163	23	Setting G1 selected	x	1	1, 9, 11, 12, 20, 21	RC
163	24	Setting G2 selected	x	1	1, 9, 11, 12, 20, 21	RC

FUN	INF	Description	GI	TYP	COT	DIR
163	25	Setting G3 selected	x	1	1, 9, 11, 12, 20, 21	RC
163	26	Setting G4 selected	x	1	1, 9, 11, 12, 20, 21	RC
163	27	Status Input1	x	1	1, 9	RC
163	28	Status Input2	x	1	1, 9	RC
163	29	Status Input3	x	1	1, 9	RC
163	30	Status Input4	x	1	1, 9	RC
163	147	*Measurand I (IG,ISEF, VN)*	x	3	2	-
163	148	*Measurand II (IL1,2,3, VL1,2,3, P, Q, f)*	x	9	2	-
163	160	Output1	x	1	1, 9, 12, 20, 21	RC
163	161	Output2	x	1	1, 9, 12, 20, 21	RC
163	162	Output3	x	1	1, 9, 12, 20, 21	RC
163	163	Output4	x	1	1, 9, 12, 20, 21	RC
163	164	Output5	x	1	1, 9, 12, 20, 21	RC
163	165	Output6	x	1	1, 9, 12, 20, 21	RC
163	166	Output7	x	1	1, 9, 12, 20, 21	RC
163	167	Output8	x	1	1, 9, 12, 20, 21	RC
163	168	Output9	x	1	1, 9, 12, 20, 21	RC
163	169	Output10	x	1	1, 9, 12, 20, 21	RC
163	170	Output11	x	1	1, 9, 12, 20, 21	RC
163	171	Output12	x	1	1, 9, 12, 20, 21	RC
163	172	Output13	x	1	1, 9, 12, 20, 21	RC
163	173	Output14	x	1	1, 9, 12, 20, 21	RC
163	174	Setting G5 selected	x	1	1, 9, 11, 12, 20, 21	RC
163	175	Setting G6 selected	x	1	1, 9, 11, 12, 20, 21	RC
163	176	Setting G7 selected	x	1	1, 9, 11, 12, 20, 21	RC

FUN	INF	Description	GI	TYP	COT	DIR
163	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
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	-	1	1, 12, 20, 21	RO
163	189	*V_A Fault Voltage*	x	4	1,9	-
163	190	*V_B Fault Voltage*	x	4	1,9	-
163	191	*V_C Fault Voltage*	x	4	1,9	-
163	192	*V_N Fault Voltage*	x	4	1,9	-
163	193	*V_{AB} Fault Voltage*	x	4	1,9	-
163	194	*V_{BC} Fault Voltage*	x	4	1,9	-
163	195	*V_{CA} Fault Voltage*	x	4	1,9	-
163	196	*V_2 Fault Voltage*	x	4	1,9	-
163	197	*%V/F Fault Voltage*	x	4	1,9	-
163	198	*I_A Fault current*	x	4	1,9	-
163	199	*I_B Fault current*	x	4	1,9	-
163	200	*I_C Fault current*	x	4	1,9	-
163	201	*I_N Fault current*	x	4	1,9	-

FUN	INF	Description	GI	TYP	COT	DIR
163	202	*I_G Fault current*	x	4	1,9	-
163	203	*I_{SEF} Fault current*	x	4	1,9	-
163	204	*Frequency*	x	4	1,9	-
163	205	*dF/dT*	x	4	1,9	-
164	16	ARC in progress	x	1	1, 9	RC
164	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-general trip	-	2	1	RO
164	71	C-general trip	-	2	1	RO
164	84	General starter	x	2	1,9	RC
164	85	Circuit Breaker Failure (50BF-D1, 50BF-D2, DI-	-	2	1	RO
164	90	P/F General LS Trip (51)	-	2	1	RO
164	91	P/F General HS Trip (50)	-	2	1	RO
164	92	E/F General LS Trip (51N, 51G)	-	2	1	RO
164	93	E/F General HS Trip (50N, 50G)	-	2	1	RO

FUN	INF	Description	GI	TYP	COT	DIR
164	128	CB on by Auto reclose	x	1	1,9	RC
164	130	Reclose Blocked	x	1	1,9	RC
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	RC
164	166	51-1 Operated	-	2	1	RO
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	RC
164	174	51N-1 Operated	-	2	1	RO
164	175	51N-2 Operated	-	2	1	RO
164	176	50G-1 Picked up	-	2	1	RC
164	177	50G-2 Picked up	-	2	1	RC
164	178	50G-1 Operated	-	2	1	RO

FUN	INF	Description	GI	TYP	COT	DIR
164	179	50G-2 Operated	-	2	1	RO
164	180	51G-1 Picked up	-	2	1	RC
164	181	51G-2 Picked up	-	2	1	RC
164	182	51G-1 Operated	-	2	1	RO
164	183	51G-2 Operated	-	2	1	RO
164	184	46/50 Picked up	-	2	1	RC
164	185	46/50 Operated	-	2	1	RO
164	186	46/51 Picked up	-	2	1	RC
164	187	46/51 Operated	-	2	1	RO
164	188	49 Picked up	-	2	1	RC
164	189	49 Operated	-	2	1	RO
164	190	49AL Operated	-	2	1	RO
164	191	50BF-D1 Operated	-	2	1	RO
164	192	50BF-D2 Operated	-	2	1	RO
164	193	DI-CBF-D1 Operated	-	2	1	RO
164	194	DI-CBF-D2 Operated	-	2	1	RO
164	195	46BC Operated	-	1	1	RO
164	196	I2t Limit Operated	-	1	1	RO
164	197	81HBL2 Operated	-	1	1	RO
164	198	60CTS Operated	-	1	1	RO
164	199	60VTS Operated	-	1	1	RO
164	200	Trip Circuit Supervision (TCS-2)	x	1	1,9	RC
164	201	64/50SEF-1 Picked up	-	2	1	RC
164	202	64/50SEF-2 Picked up	-	2	1	RC
164	203	64/50SEF-1 Operated	-	2	1	RO
164	204	64/50SEF-2 Operated	-	2	1	RO
164	205	64/51SEF-1 Picked up	-	2	1	RC

FUN	INF	Description	GI	TYP	COT	DIR
164	206	64/51SEF-2 Picked up	-	2	1	RC
164	207	64/51SEF-1 Operated	-	2	1	RO
164	208	64/51SEF-2 Operated	-	2	1	RO
165	64	A-starter	x	2	1, 9	RC
165	65	B-starter	x	2	1, 9	RC
165	66	C-starter	x	2	1, 9	RC
165	67	E-starter	x	2	1, 9	RC
165	68	General trip	-	2	1	RO
165	69	A-general trip	-	2	1	RO
165	70	B-general trip	-	2	1	RO
165	71	C-general trip	-	2	1	RO
165	84	General starter	x	2	1,9	RC
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
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

FUN	INF	Description	GI	TYP	COT	DIR
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

FUN	INF	Description	GI	TYP	COT	DIR
165	201	47DT-2 Operated	-	2	1	RO
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	U/V Count Operated	-	1	1	RO
165	213	O/V Count Operated	-	1	1	RO
166	68	General trip	-	2	1	RO
166	84	General starter	x	2	1,9	RC
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

FUN	INF	Description	GI	TYP	COT	DIR
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
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	194	81R-3 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

FUN	INF	Description	GI	TYP	COT	DIR
166	199	81R-4 Operated	-	2	1	RO
166	200	U/F Count Operated	-	1	1	RO
166	201	O/F 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
163	220	32-4 operated	-	2	1	RO
163	206	S/I Count Operated	-	1	1	RO
163	206	IRIG_B Synchronization	x	1	1,9	RC
163	207	SNTP Synchronization	x	1	1,9	RC
255	0	Time Synchronization	-	6	8	-

Appendix H Mechanical Drawings

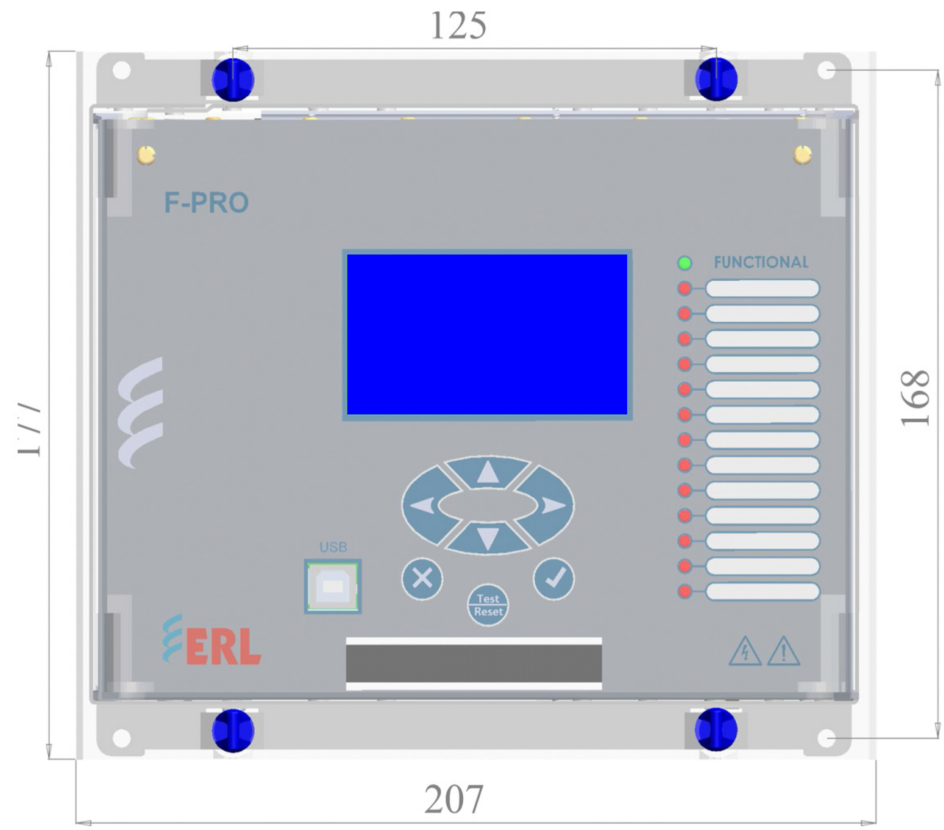


Figure H.1: Front View Drawing

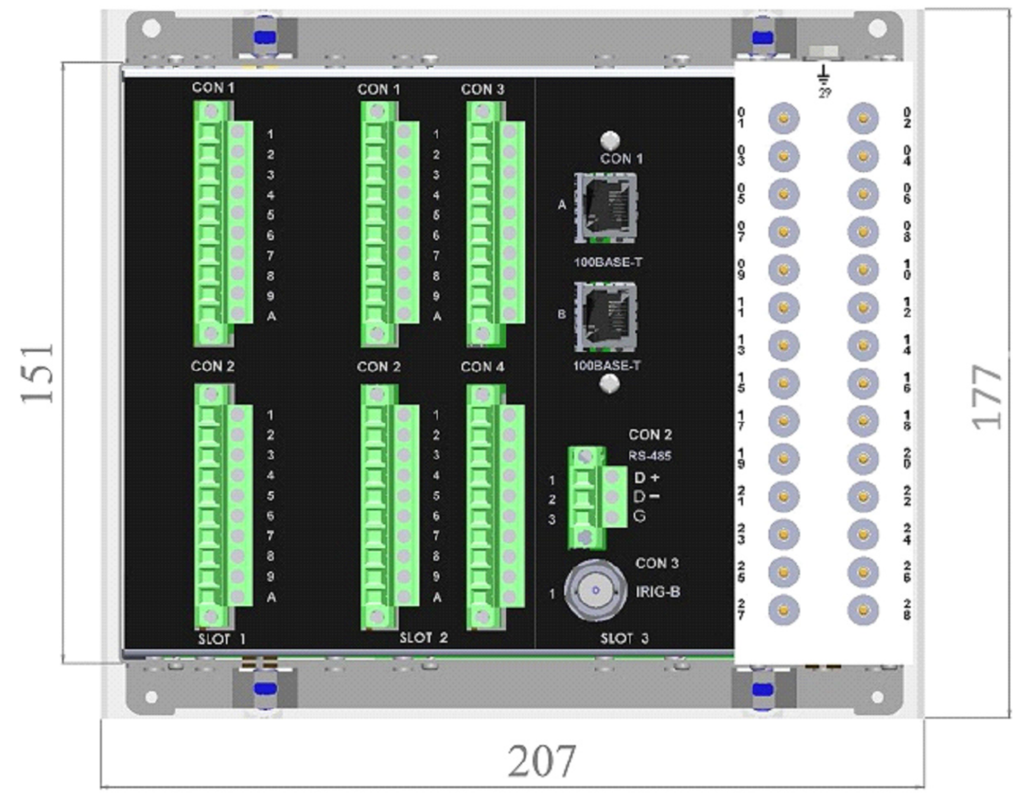


Figure G.1: Rear Panel Drawing

Appendix I AC Schematic Drawings

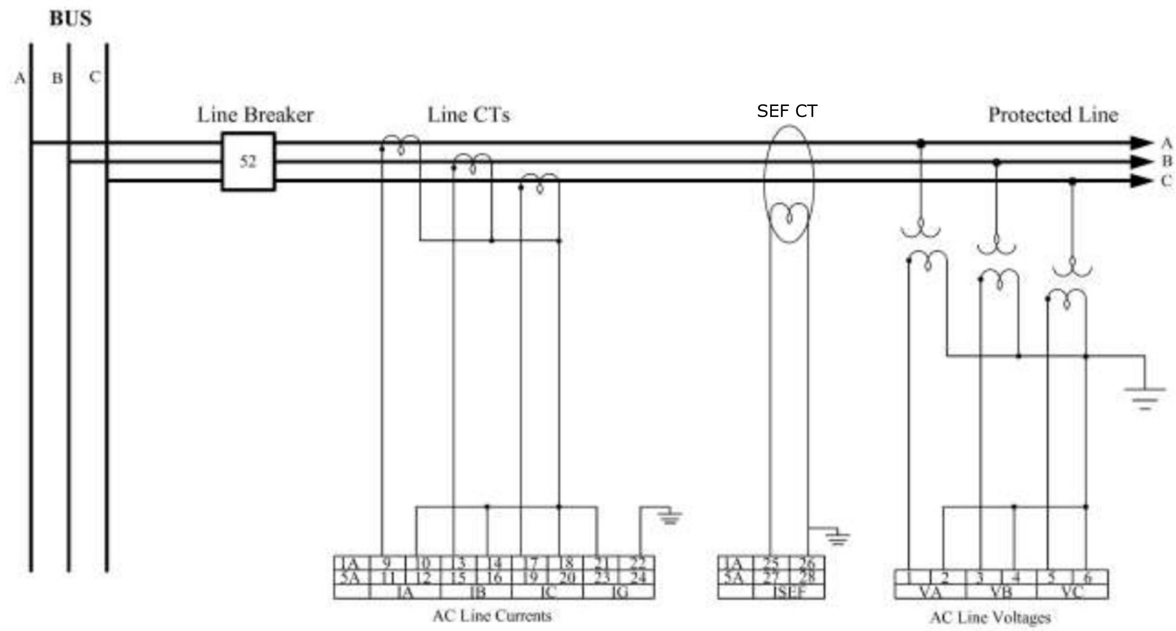


Figure I.1: F-PRO 297 AC Schematic

Appendix J DC Schematic Drawings

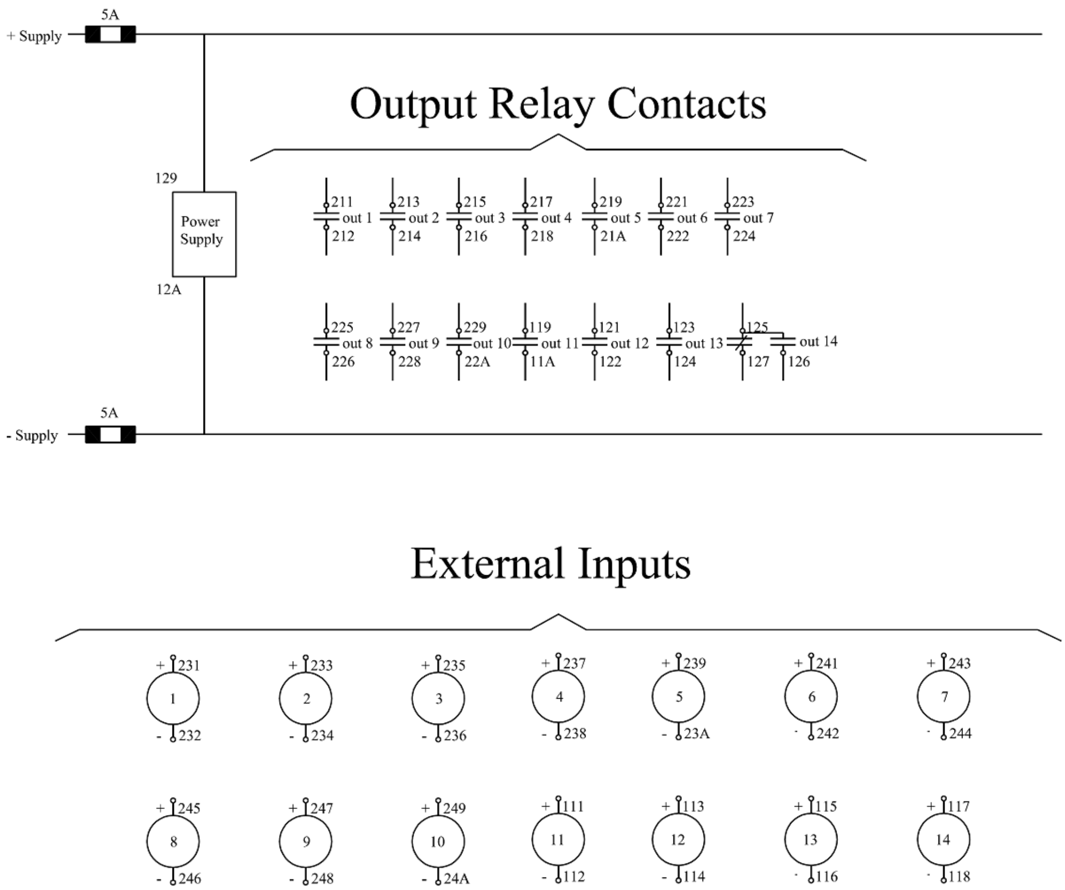


Figure J.1: F-PRO 297 DC Schematic

Appendix K Connection Diagram

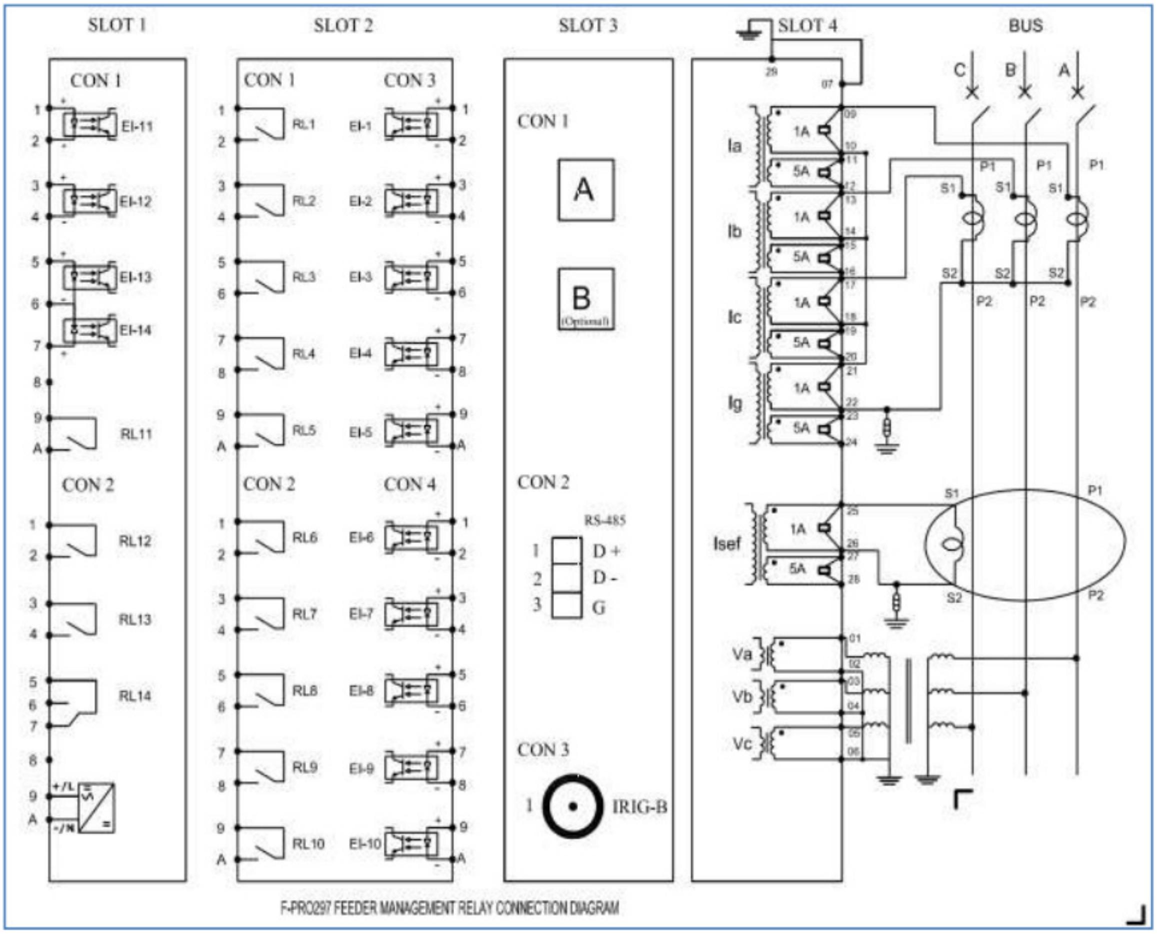


Figure K.1: F-PRO 297 Connection Diagram

Appendix L IEC 61850 Conformance Statements and Data Mapping Specification

This chapter describes IEC 61850 logical devices and nodes defined in ICD file of F-PRO 297 relay.

L.1 N.1 Protocol Implementation Conformance Statement (PICS)

Introduction

General

The following ACSI conformance statements are used to provide an overview and details about <FPRO, Feeder Protection System>, with firmware <V1.0>:

- ACSI basic conformance statement,
- ACSI models conformance statement,
- ACSI service conformance statement

The statements specify the communication features mapped to IEC 61850-8-1.

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)	-	Y	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	-	N	
SCSMs supported				
B21	**SCSM**: IEC 6185-8-1 used	-	Y	
B22	**SCSM**: IEC 6185-9-1 used	-	N	
B23	**SCSM**: IEC 6185-9-2 used	-	N	
B24	**SCSM**: other	-	N	

Table L.1: Basic conformance statement				
		Client/ Subscriber	**Server/ Publisher**	**Value/ Comments**
Generic substation event model (GSE)				
B31	**Publisher** side	-	Y	
B32	**Subscriber** side	-	Y	
Transmission of sampled value model (SVC)				
B41	**Publisher** side	-	N	
B42	**Subscriber** side	-	N	
Y = supported N or empty = not supported				

ACSI models conformance statement

The ACSI models conformance statement is defined in table below.

Table L.2: ACSI models conformance statement				
		Client/ Subscriber	**Server/ Publisher**	**Value/ Comments**
If **Server or Client** side (B11) supported				
M1	Logical device		Y	
M2	Logical node		Y	
M3	Data		Y	
M4	Data set		Y	
M5	Substitution		N	
M6	Setting group control		N	
	Reporting			
M7	Buffered report control		Y	
M7-1	sequence-number		Y	
M7-2	report-time-stamp		Y	
M7-3	reason-for-inclusion		Y	
M7-4	data-set-name		Y	
M7-5	data-reference		Y	
M7-6	buffer-overflow		Y	

Table L.2: ACSI models conformance statement

		Client/ Subscriber	Server/ Publisher	Value/ Comments
M7-7	entryID		Y	
M7-8	BufTm		Y	
M7-9	IntgPd		Y	
M7-10	GI		Y	
M8	Unbuffered report control		Y	
M8-1	sequence-number		Y	
M8-2	report-time-stamp		Y	
M8-3	reason-for-inclusion		Y	
M8-4	data-set-name		Y	
M8-5	data-reference		Y	
M8-6	BufTm		Y	
M8-7	IntgPd		Y	
M8-8	GI		Y	
	Logging		N	
M9	Log control		N	
M9-1	IntgPd		N	
M10	Log		N	
M11	Control		N	
If **GSE** (B31/32) is supported				
M12	GOOSE		Y	
M12-1	entryID		Y	
M12-2	DataRefInc		Y	
M13	GSSE		N	
If **SVC** (B41/42) is supported				
M14	Multicast SVC		N	
M15	Unicast SVC		N	
If **Server or Client** side (B11/12) supported				
M16	Time		Y	
M17	File Transfer		Y	
Y = service is supported N or empty = service is not supported				

ACSI service conformance statement

The ACSI service conformance statement is defined in table below (depending on the statements in L.1).

Table L.3: ACSI service Conformance statement

	Services	**AA: TP/MC**	**Client (C)**	**Server (S)**	**Comments**
Server (Clause 6)					
S1	ServerDirectory	TP		Y	
Application association (Clause 7)					
S2	Associate			Y	
S3	Abort			Y	
S4	Release			Y	
Logical device (Clause 8)					
S5	LogicalDeviceDirectory	TP		Y	
Logical node (Clause 9)					
S6	LogicalNodeDirectory	TP		Y	
S7	GetAllDataValues	TP		Y	
Data (Clause 10)					
S8	GetDataValues	TP		Y	
S9	SetDataValues	TP		N	
S10	GetDataDirectory	TP		Y	
S11	GetDataDefinition	TP		Y	
Data set (Clause 11)					
S12	GetDataSetValues	TP		Y	
S13	SetDataSetValues	TP		N	
S14	CreateDataSet	TP		N	
S15	DeleteDataSet	TP		N	
S16	GetDataSetDirectory	TP		Y	
Substitution (Clause 12)					
S17	SetDataValues	TP		N	
Setting group control (Clause 13)					
S18	SelectActiveSG	TP		N	
S19	SelectEditSG	TP		N	
S20	SetSGValues	TP		N	

Table L.3: ACSI service Conformance statement					
	Services	**AA: TP/MC**	**Client (C)**	**Server (S)**	**Comments**
S21	ConfirmEditSGValues	TP		N	
S22	GetSGValues	TP		Y	
S23	GetSGCBValues	TP		N	
Reporting (Clause 14)					
Buffered report control block (BRCB)					
S24	Report	TP		Y	
S24-1	data-change (dchg)			Y	
S24-2	quality-change (qchg)			N	
S24-3	data-update (dupd)			N	
S25	GetBRCBValues	TP		Y	
S26	SetBRCBValues	TP		Y	
Unbuffered report control block (URCB)					
S27	Report	TP		Y	
S27-1	data-change (dchg)			Y	
S27-2	quality-change (qchg)			N	
S27-3	data-update (dupd)			N	
S28	GetURCBValues	TP		Y	
S29	SetURCBValues	TP		Y	
Logging (Clause 14)					
Log control block					
S30	GetLCBValues	TP		N	
S31	SetLCBValues	TP		N	
Log					
S32	QueryLogByTime	TP		N	
S33	QueryLogAfter	TP		N	
S34	GetLogStatusValues	TP		N	
Generic substation event model (GSE)					
GOOSE-CONTROL-BLOCK					
S35	SendGOOSEMessage	MC		Y	
S36	GetGoReference	TP		N	
S37	GetGOOSEElementNumber	TP		N	
S38	GetGoCBValues	TP		Y	

Table L.3: ACSI service Conformance statement					
	Services	**AA: TP/MC**	**Client (C)**	**Server (S)**	**Comments**
S39	SetGoCBValues	TP		Y	
GSSE-CONTROL-BLOCK					
S40	SendGSSEMessage	MC		N	
S41	GetReference	TP		N	
S42	GetGSSEElementNumber	TP		N	
S43	GetGsCBValues	TP		N	
S44	SetGsCBValues	TP		N	
Transmission of sampled value model (SVC) (Clause 16)					
Multicast SVC					
S45	SendMSVMessage	MC		N	
S46	GetMSVCBValues	TP		N	
S47	SetMSVCBValues	TP		N	
Unicast SVC					
S48	SendUSVMessage	TP		N	
S49	GetUSVCBValues	TP		N	
S50	SetUSVCBValues	TP		N	
Control					
S51	Select			N	
S52	SelectWithValue	TP		N	
S53	Cancel	TP		N	
S54	Operate	TP		N	
S55	CommandTermination	TP		N	
S56	TimeActivatedOperate	TP		N	
File transfer (Clause 20)					
S57	GetFile	TP		Y	
S58	SetFile	TP		Y	
S59	DeleteFile	TP		Y	
S60	GetFileAttributeValues	TP		Y	
Time					
T1	Time resolution of internal clock			10 (1 ms)	nearest negative power of 2 in seconds
T2	Time accuracy of internal clock			10 (1 ms)	T0

Table L.3: ACSI service Conformance statement					
	Services	**AA: TP/MC**	**Client (C)**	**Server (S)**	**Comments**
					T1
					T2
					T3
					T4
					T5
T3	Supported TimeStamp resolution	-		10 (1 ms)	nearest negative power of 2 in seconds

L.2 Model Implementation Conformance Statement (MICS)

Introduction

This model implementation conformance statement is applicable for FPRO, Feeder Protection System, with firmware V1.0.

This MICS document specifies the modelling extensions compared to IEC 61850 edition 1. For the exact details on the standardized model please compare the ICD substation configuration file: “ERLFPRO2xx.icd”, Version V1.0

Clause 2 contains the list of implemented logical nodes.

Clause 3 describes the new and extended logical nodes.

Logical Nodes List

The following table contains the list of logical nodes implemented in the device:

L: System Logical Nodes
LPHD (Physical device information)
LLN0 (Logical node zero)
P: Logical Nodes for protection functions
PTUV (Undervoltage)
PTOV (Overvoltage)
PVPH (Volts per Hz)
NPTOV (Derived residual over voltage)
PTUC(Under current)
PIOC (Instantaneous overcurrent)
PTOC (Time overcurrent)
NPIOC (Instantaneous neutral overcurrent)
NPTOC (Time neutral overcurrent)
GPIOC (Measured Instantaneous Neutral Overcurrent)
GPTOC (Measured Time Neutral Overcurrent)
PSDE (Sensitive directional earthfault)
PSDE (Time Sensitive directional earthfault)
PTTR (Thermal overload)
PHAR (Harmonic restraint)
PTUF (Underfrequency)
PTOF (Overfrequency)
PFRC (Rate of change of frequency)
PDUP (Under power)
PDOP (Over power)
R: Logical nodes for protection related functions
RBRF (Breaker failure)

RREC (Autoreclosing)
RBCD (Broken conductor detection)
RVTS (VT supervision)
RCTS (CT supervision)
RTCS (Trip circuit supervision)
RCBC (Circuit breaker condition)
RTHD (Total harmonic distortion)
RUVC (Undervoltage count)
ROVC (Overvoltage count)
RUFC (Underfrequency count)
ROFC (Overfrequency count)
REIC (External Input count)
G: Logical Nodes for generic references
GGIO (Generic process I/O)
M: Logical Nodes for metering and measurement
MMXU (Measurement)
MSQI (Sequence and imbalance)

Logical Node Extensions

The following tables use

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

.

New Logical Nodes

New logical nodes have the descriptions in the Name plate.

RBCD Broken Conductor Detection

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
D46BCRBCD		Broken conductor detection		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	46BC - Broken Conductor Operated	E	

RVTS VT Supervision

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
D60VTRVTS		VT supervision		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	60VTS Fail Operated	E	

RCTS CT Supervision

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
D60CTRCTS		CT supervision		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	60CTS Operated	E	

RTCS Trip Circuit Supervision

LN class				
Attribute	Attribute Type	Explanation	M/O/E	Remarks
D74TCSRTCS		Trip circuit supervision		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	74TCS Operated	E	

RCBC Circuit Breaker Condition

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
I2TRCBC		Circuit breaker condition		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Measured Values				
I2TAcc	MV	I2T Accumulated	E	
I2TLstOp	MV	I2T Value - Last Operation	E	
Status Information				
Op	ACT	I2T Operated	E	

RTHD Total Harmonic Distortion

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
THDRTHD		Total harmonic distortion		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	THD Operated	E	

RUVC Undervoltage Count

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
UVCRUVC		Undervoltage count		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	Under Voltage Counter Operated	E	

ROVC Overvoltage Count

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
OVCROVC		Overvoltage count		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	Over Voltage Counter Operated	E	

RUFC Underfrequency Count

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
UFCRUFC		Physical device information		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	Under Frequency Counter Operated	E	

ROFC Overfrequency Count

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
OFCROFC		Overfrequency count		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	Over Frequency Counter Operated	E	

REIC External Input Count

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
EICREIC		External input count		
Data				
Common Logical Node Information				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	
Mod	INC	Mode	M	
Beh	INS	Behaviour	M	
Health	INS	Health	M	
NamPlt	LPL	Name plate	M	
Status Information				
Op	ACT	External Input Counter Operated	E	

L.3 N.3 Data Mapping Specifications

F-PRO Logical Device

F-PRO has the following IEC 61850 logical devices defined in its ICD file:

- Protection
- Measurements
- Records
- System
- Fault Data
- Virtual Element

F-PRO Logical Nodes

Table below defines the list of logical nodes (LN) for the F-PRO logical devices.

Note: System logical nodes (group L) are not shown here.

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
Measurements	ANAMMXU1	Measurements	Metering Data	Analog Channel Input Measurement (Neutral Current, Voltage & 3 Phase Voltage(s))
Measurements	ANAMMXU2	Measurements	Metering Data	Analog Channel Input Measurement (IG & ISEF)
Measurements	SEQMSQI1	Sequence & Imbalance	Metering Data	Sequence Components of Voltage (V1, V2, V0) Sequence Components of Voltage (V1, V2, V0)
Protection	DT27PTUV1	27-1 DTL Under Voltage	Dev 27_1	DTL Under Voltage_1
Protection	DT27PTUV2	27-2 DTL Under Voltage	Dev 27_2	DTL Under Voltage_2
Protection	DT27PTUV3	27-3 DTL Under Voltage	Dev 27_3	DTL Under Voltage_3
Protection	DT27PTUV4	27-4 DTL Under Voltage	Dev 27_4	DTL Under Voltage_4
Protection	DT27PTUV5	27-5 DTL Under Voltage	Dev 27_5	DTL Under Voltage_5

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
Protection	DT27PTUV6	27-6 DTL Under Voltage	Dev 27_6	DTL Under Voltage_6
Protection	IT27PTUV1	27-1 IDMTL Under Voltage	Dev 27_1	IDMTL Under Voltage_1
Protection	IT27PTUV2	27-2 IDMTL Under Voltage	Dev 27_2	IDMTL Under Voltage_2
Protection	DT59PTOV1	59-1 DTL Over Voltage	Dev 59_1	DTL Over Voltage_1
Protection	DT59PTOV2	59-2 DTL Over Voltage	Dev 59_2	DTL Over Voltage_2
Protection	DT59PTOV3	59-3 DTL Over Voltage	Dev 59_3	DTL Over Voltage_3
Protection	DT59PTOV4	59-4 DTL Over Voltage	Dev 59_4	DTL Over Voltage_4
Protection	DT59PTOV5	59-5 DTL Over Voltage	Dev 59_5	DTL Over Voltage_5
Protection	DT59PTOV6	59-6 DTL Over Voltage	Dev 59_6	DTL Over Voltage_6
Protection	IT59PTOV1	59-1 IDMTL Over Voltage	Dev 59_1	IDMTL Over Voltage_1
Protection	IT59PTOV2	59-2 IDMTL Over Voltage	Dev 59_2	IDMTL Over Voltage_2
Protection	DT24PVPH1	24-1 DTL Over Flux	Dev 24_1	DTL Over Flux_1
Protection	DT24PVPH2	24-2 DTL Over Flux	Dev 24_2	DTL Over Flux_2
Protection	IT24PVPH1	24-1 IDMTL Over Flux	Dev 24_1	IDMTL Over Flux_1
Protection	DT47PTOV1	47-1 DTL Neg. Seq. Over Voltage	Dev 47_1	DTL Negative Sequence Over Voltage_1
Protection	DT47PTOV2	47-2 DTL Neg. Seq. Over Voltage	Dev 47_2	DTL Negative Sequence Over Voltage_2
Protection	IT47PTOV1	47-1 IDMTL Neg. Seq. Over Voltage	Dev 47_1	IDMTL Negative Sequence Over Voltage_1
Protection	DT59NPTOV1	59-1 DTL Derived Residual Over Voltage	Dev 59N_1	DTL Derived Ground Over Voltage_1
Protection	DT59NPTOV2	59-2 DTL Derived Residual Over Voltage	Dev 59N_2	DTL Derived Ground Over Voltage_1

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
Protection	IT59NPTOV1	59-1 IDMTL Dervied Residual Over Voltage	Dev 59N_1	IDMTL Derived Ground Over Voltage_1
Protection	D37PTUC1	37-1 DTL Phase Undercurrent	Dev 37_1	Inst. Phase Undercurrent_1
Protection	D37PTUC2	37-2 DTL Phase Undercurrent	Dev 37_2	Inst. Phase Undercurrent_2
Protection	D50PIOC1	50-1 DTL Phase Overcurrent (directional)	Dev 50/67_1	Inst. Phase Overcurrent_1
Protection	D50PIOC2	50-2 DTL Phase Overcurrent (directional)	Dev 50/67_2	Inst. Phase Overcurrent_2
Protection	D51PTOC1	51-1 IDMTL Phase Overcurrent (directional)	Dev 51/67_1	IDMTL Phase Overcurrent_1
Protection	D51PTOC2	51-2 IDMTL Phase Overcurrent (directional)	Dev 51/67_2	IDMTL Phase Overcurrent_2
Protection	D50NPIOC1	50N-1 DTL Derived Neutral Overcurrent (directional)	Dev 50N/67N_1	Inst. Neutral Overcurrent_1 (Derived)
Protection	D50NPIOC2	50N-2 DTL Derived Neutral Overcurrent (directional)	Dev 50N/67N_2	Inst. Neutral Overcurrent_2 (Derived)
Protection	D51NPTOC1	51N-1 IDMTL Derived Neutral Overcurrent (directional)	Dev 51N/67N_1	IDMTL Neutral Overcurrent_1 (Derived)
Protection	D51NPTOC2	51N-2 IDMTL Derived Neutral Overcurrent (directional)	Dev 51N/67N_2	IDMTL Neutral Overcurrent_2 (Derived)
Protection	D50GPIOC1	50G-1 DTL Measured Neutral Overcurrent (directional)	Dev 50G/67G_1	Inst. Phase Overcurrent_1 (Measured)
Protection	D50GPIOC2	50G-2 DTL Measured Neutral Overcurrent (directional)	Dev 50G/67G_2	Inst. Phase Overcurrent_2(Measured)

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
Protection	D51GPTOC1	51G-1 IDMTL Measured Neutral Overcurrent (directional)	Dev 51G_1	IDMTL Neutral Overcurrent (Measured)
Protection	D51GPTOC2	51G-2 IDMTL Measured Neutral Overcurrent (directional)	Dev 51G_2	IDMTL Neutral Overcurrent (Measured)
Protection	D4650PIOC1	46/50 DTL Neg. Seq. Overcurrent	Dev 46_50	Inst. Negative Sequence Overcurrent
Protection	D4651PTOC 1	46/51 IDMTL Neg. Seq. Overcurrent	Dev 46_51	IDMTL Negative Sequence Overcurrent
Protection	D6450PSDE1	64/50-1 DTL SEF/REF Overcurrent (directional)	Dev 6450_1	Inst. REF/SEF Overcurrent_1
Protection	D6450PSDE2	64/50-2 DTL SEF/REF Overcurrent (directional)	Dev 6450_2	Inst. REF/SEF Overcurrent_2
Protection	D6451PSDE1	64/51-1 IDMTL SEF/REF Overcurrent (directional)	Dev 6451_1	IDMTL REF/SEF Overcurrent_1
Protection	D6451PSDE2	64/51-2 IDMTL SEF/REF Overcurrent (directional)	Dev 6451_2	IDMTL REF/SEF Overcurrent_2
Protection	D49PTTR1	Thermal Overload	Dev 49	Thermal Overload
Protection	D81H2PHAR 1	Harmonic Restraint	Dev 81HBL2	2nd Harmonic Inrush Block
Protection	D81UPTUF1	Under Frequency	Dev 81UF_1	Under Frequency_1
Protection	D81UPTUF2	Under Frequency	Dev 81UF_2	Under Frequency_2
Protection	D81UPTUF3	Under Frequency	Dev 81UF_3	Under Frequency_3
Protection	D81UPTUF4	Under Frequency	Dev 81UF_4	Under Frequency_4
Protection	D81UPTUF5	Under Frequency	Dev 81UF_5	Under Frequency_5
Protection	D81UPTUF6	Under Frequency	Dev 81UF_6	Under Frequency_6
Protection	D81UPTUF7	Under Frequency	Dev 81UF_7	Under Frequency_7
Protection	D81UPTUF8	Under Frequency	Dev 81UF_8	Under Frequency_8
Protection	D81OPTOF1	Over Frequency	Dev 81OF_1	Over Frequency_1

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
Protection	D81OPTOF2	Over Frequency	Dev 81OF_2	Over Frequency_2
Protection	D81OPTOF3	Over Frequency	Dev 81OF_3	Over Frequency_3
Protection	D81OPTOF4	Over Frequency	Dev 81OF_4	Over Frequency_4
Protection	D81OPTOF5	Over Frequency	Dev 81OF_5	Over Frequency_5
Protection	D81OPTOF6	Over Frequency	Dev 81OF_6	Over Frequency_6
Protection	D81OPTOF7	Over Frequency	Dev 81OF_7	Over Frequency_7
Protection	D81OPTOF8	Over Frequency	Dev 81OF_8	Over Frequency_8
Protection	D81RPFRC1	Rate Of Change Of Frequency	Dev 81ROCOF_1	Rate Of Change Of Frequency_1
Protection	D81RPFRC2	Rate Of Change Of Frequency	Dev 81ROCOF_2	Rate Of Change Of Frequency_2
Protection	D81RPFRC3	Rate Of Change Of Frequency	Dev 81ROCOF_3	Rate Of Change Of Frequency_3
Protection	D81RPFRC4	Rate Of Change Of Frequency	Dev 81ROCOF_4	Rate Of Change Of Frequency_4
Protection	D32PDOP1	32-1 Directional Power	Dev 32_1	Directional Power_1
Protection	D32PDOP2	32-2 Directional Power	Dev 32_2	Directional Power_2
Protection	D32PDOP3	32-3 Directional Power	Dev 32_3	Directional Power_3
Protection	D32PDOP4	32-4 Directional Power	Dev 32_4	Directional Power_4
Protection	D50BFR-	Breaker Failure	Dev 50BF	Breaker Failure
Protection	D46BCRB-CD1	Broken Conductor Detection	Dev 46BC	Broken Conductor Detection
Protection	D60RVTS1	VT Supervision	Dev VTS	VT Supervision
Protection	D60RCTS1	CT Supervision	Dev CTS	CT Supervision
Protection	D74TCS-RTCS1	Broken Conductor	Dev 74TCS1	Trip Circuit Supervision
Protection	D74TCS-RTCS2	Trip Circuit Supervision	Dev 74TCS2	Trip Circuit Supervision
Protection	I2TRCBC1	Harmonic Restraint	Dev I2T	CB Monitoring
Protection	THDRTHD1	Thermal Overload	Dev THD_1	Total Harmonic Distortion_1
Protection	THDRTHD2	Auto reclosing	Dev THD_2	Total Harmonic Distortion_2
Protection	UVCRUVC1	General Alarm	Dev UVC_1	Under Voltage Counter

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
Protection	OVCROVC1	Over Voltage Counter	Dev OVC_1	Over Voltage Counter
Protection	UFCRUFC1	Under Frequency Counter	Dev UFC_1	Under Frequency Counter
Protection	OFCROFC1	Over Frequency Counter	Dev OFC_1	Over Frequency Counter
Protection	EICREIC1	External Input Counter	Dev EIC_1	External Input Counter
Protection	D79RREC1	Auto Reclose	Dev 79	Auto Reclose
Protection	TRCALH1	Status of Starter/ Trip Elements		Status of Starter/Trip Elements
System	LLNO/ ..(SGCB)	Logical Node Zero	Setting Group	Used for Control of Setting Group
System	EIGGIO1	Generic Process I/O	External Inputs	Status of External Inputs (1-4)
System	OCGGIO1	Generic Process I/O	Output Contacts	Status of Output Contacts (1-8)
System	PLGGIO1	Generic Process I/O	Prologics	Status of Protection Logics (1-20)
System	LEDGGIO1	Generic Process I/O	HMI LED Monitoring	LED status(1-8)
System	HEALTHGGIO1	Generic Process I/O	Relay Health, IRIG-B, SNTP Monitoring	Relay Health Status (1-3)
Virtual Elements	VIGGIO1	Generic Process I/O	Virtual Input Status	Virtual Inputs status(1-30)
Virtual Elements	VIGGIO2	Generic Process I/O	Virtual Inputs control	Virtual Inputs status(1-30)
Virtual Elements	VIGGIO3	Generic Process I/O	Virtual Output s control	Virtual Inputs status(1-30)
FaultData	FLTMMXU1	New LN: DATA	NA	Fault Frequency AB, BC, CA Voltage and A,B,C, & Neutral Current Fault Details

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
FaultData	FLTMXQI2	New LN: DATA	NA	Positive Sequence Fault current, Voltage

Logical Node Specifications

The following section provides the detailed information on each of the logical nodes for the variant FPRO 381xAy as defined in the previous section.

Logical Nodes for Protection Functions (LN Group P...)

DT27PTUV1

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

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

DT27PTUV2

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

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

DT27PTUV3

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

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

DT27PTUV4

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

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

DT27PTUV5

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

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

DT27PTUV6

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

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

IT27PTUV1

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

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

IT27PTUV2

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

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

DT59PTOV1

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

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

DT59PTOV2

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

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

DT59PTOV3

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

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

DT59PTOV4

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

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

DT59PTOV5

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

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

DT59PTOV6

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

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

IT59PTOV1

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

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

IT59PTOV2

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

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

DT24PVPH1

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

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

DT24PVPH2

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

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

IT24PVPH1

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

Data Name	Description
IT24PVPH1.ST.Str.general	Start (24IT-1 Picked up)
IT24PVPH1ST.Str.dirGeneral	Direction General
IT24PVPH1.ST.Str.PhsA	Start (24IT-1 Picked up) Phase A
IT24PVPH1.ST.Str.PhsB	Start (24IT-1 Picked up) Phase B
IT24PVPH1.ST.Str.PhsC	Start (24IT-1 Picked up) Phase C
IT24PVPH1.ST.Op.general	Operate (24IT-1 Operated)
IT24PVPH1.ST.Op.PhsA	Operate(24IT-1 Operated) Phase A
IT24PVPH1.ST.Op.PhsB	Operate(24IT-1 Operated) Phase B
IT24PVPH1.ST.Op.PhsC	Operate(24IT-1 Operated) Phase C

DT47PTOV1

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

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

DT47PTOV2

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

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

IT47PTOV1

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

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

DT59NPTOV1

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

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

DT59NPTOV2

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

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

IT59NPTOV1

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

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

D37PTUC1

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

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

D37PTUC2

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

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

D50PIOC1

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

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

D50PIOC2

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

Data Name	Description
D50PIOC2.ST.Str.general	Start (50-2 Picked up)
D50PIOC2.ST.Str.dirGeneral	Direction General
D50PIOC2.ST.Str.phsA	Start (50-2 Picked up) Phase A
D50PIOC2.ST.Str.dirPhsA	Direction Phase A
D50PIOC2.ST.Str.phsB	Start (50-2 Picked up) Phase B
D50PIOC2.ST.Str.dirPhsB	Direction Phase B
D50PIOC2.ST.Str.phsC	Start (50-2 Picked up) Phase C
D50PIOC2.ST.Str.dirPhsC	Direction Phase C
D50PIOC2.ST.Op.general	Operate (50-2 Operated)
D50PIOC2.ST.Op.phsA	Operate (50-2 Operated) Phase A
D50PIOC2.ST.Op.phsB	Operate (50-2 Operated) Phase B
D50PIOC2.ST.Op.phsC	Operate (50-2 Operated) Phase C

D51PTOC1

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

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

D51PTOC2

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

Data Name	Description
D51PTOC2.ST.Str.general	Start (51-2 Picked up)
D51PTOC2.ST.Str.dirGeneral	Direction General
D51PTOC2.ST.Str.phsA	Start (51-2 Picked up) Phase A
D51PTOC2.ST.Str.dirPhsA	Direction Phase A
D51PTOC2.ST.Str.phsB	Start (51-2 Picked up) Phase B
D51PTOC2.ST.Str.dirPhsB	Direction Phase B
D51PTOC2.ST.Str.phsC	Start (51-2 Picked up) Phase C
D51PTOC2.ST.Str.dirPhsC	Direction Phase C
D51PTOC2.ST.Op.general	Operate (51-2 Operated)
D51PTOC2.ST.Op.phsA	Operate (51-2 Operated) Phase A
D51PTOC2.ST.Op.phsB	Operate (51-2 Operated) Phase B
D51PTOC2.ST.Op.phsC	Operate (51-2 Operated) Phase C

D50NPIOC1

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

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

D50NPIOC2

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

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

D51NPTOC1

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

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

D51NPTOC2

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

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

D50GPIOC1

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

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

D50GPIOC2

This section defines the logical node data for the logical node D50GPIOC2 of

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

D51GPTOC1

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

Data Name	Description
D51GPTOC1.ST.Str.general	Start (51G-1 Picked up)
D51GPTOC1.ST.Str.dirGeneral	Direction General
D51GPTOC1.ST.Op.general	Operate (51G-1 Operated)

D51GPTOC2

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

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

D4650PIOC1

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

Data Name	Description
D4650PIOC1.ST.Str.general	Start (46-50 Picked up)
D4650PIOC1.ST.Op.general	Operate (46-50 Operated)

D4651PTOC1

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

Data Name	Description
D4651PTOC1.ST.Str.general	Start (46-51 Picked up)
D4651PTOC1.ST.Op.general	Operate (46-51 Operated)

D6450PSDE1

This section defines the logical node data for the logical node D6450PSDE1 of the FPROProtection logical device.

Data Name	Description
D6450PSDE1.ST.Str.general	Start (6450 Picked up)
D6450PSDE1.ST.Str.dirGeneral	Direction General
D6450PSDE1.ST.Op.general	Operate (6450 Operated)

D6450PSDE2

This section defines the logical node data for the logical node D6450PSDE2 of the FPROProtection logical device.

Data Name	Description
D6450PSDE2.ST.Str.general	Start (6450 Picked up)
D6450PSDE2.ST.Str.dirGeneral	Direction General
D6450PSDE2.ST.Op.general	Operate (6450 Operated)

D6451PSDE1

This section defines the logical node data for the logical node D6451PSDE1 of the FPROProtection logical device.

Data Name	Description
D6451PSDE1.ST.Str.general	Start (6451 Picked up)
D6451PSDE1.ST.Str.dirGeneral	Direction General
D6451PSDE1.ST.Op.general	Operate (6451 Operated)

D6451PSDE2

This section defines the logical node data for the logical node D6451PSDE2 of the FPROProtection logical device.

Data Name	Description
D6451PSDE2.ST.Str.general	Start (6451 Picked up)
D6451PSDE2.ST.Str.dirGeneral	Direction General
D6451PSDE2.ST.Op.general	Operate (6451 Operated)

D49PTTR1

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

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

D81H2PHAR1

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

Data Name	Description
D81H2PHAR1.ST.Str.general	Operate (81HBL2 Operated)

D81UPTUF1

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

Data Name	Description
D81UPTUF1.ST.Str.general	Start (81UF-1 Picked up)
D81UPTUF1.ST.Str.dirGeneral	Direction General
D81UPTUF1.ST.Op.general	Operate (81UF-1 Operated)

D81UPTUF2

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

Data Name	Description
D81UPTUF2.ST.Str.general	Start (81UF-2 Picked up)
D81UPTUF2.ST.Str.dirGeneral	Direction General
D81UPTUF2.ST.Op.general	Operate (81UF-2 Operated)

D81UPTUF3

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

Data Name	Description
D81UPTUF3.ST.Str.general	Start (81UF-3 Picked up)
D81UPTUF3.ST.Str.dirGeneral	Direction General
D81UPTUF3.ST.Op.general	Operate (81UF-3 Operated)

D81UPTUF4

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

Data Name	Description
D81UPTUF4.ST.Str.general	Start (81UF-4 Picked up)
D81UPTUF4.ST.Str.dirGeneral	Direction General
D81UPTUF4.ST.Op.general	Operate (81UF-4 Operated)

D81UPTUF5

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

Data Name	Description
D81UPTUF5.ST.Str.general	Start (81UF-5 Picked up)
D81UPTUF5.ST.Str.dirGeneral	Direction General
D81UPTUF5.ST.Op.general	Operate (81UF-5 Operated)

D81UPTUF6

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

Data Name	Description
D81UPTUF6.ST.Str.general	Start (81UF-6 Picked up)
D81UPTUF6.ST.Str.dirGeneral	Direction General
D81UPTUF6.ST.Op.general	Operate (81UF-6 Operated)

D81UPTUF7

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

Data Name	Description
D81UPTUF7.ST.Str.general	Start (81UF-7 Picked up)
D81UPTUF7.ST.Str.dirGeneral	Direction General
D81UPTUF7.ST.Op.general	Operate (81UF-7 Operated)

D81UPTUF8

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

Data Name	Description
D81UPTUF8.ST.Str.general	Start (81UF-8 Picked up)
D81UPTUF8.ST.Str.dirGeneral	Direction General
D81UPTUF8.ST.Op.general	Operate (81UF-8 Operated)

D81OPTOF1

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

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

D81OPTOF2

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

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

D81OPTOF3

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

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

D81OPTOF4

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

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

D81OPTOF5

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

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

D81OPTOF6

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

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

D81OPTOF7

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

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

D81OPTOF8

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

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

D81RPFRC1

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

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

D81RPFRC2

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

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

D81RPFRC3

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

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

D81RPFRC4

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

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

D32PDOP1

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

Data Name	Description
D32PDOP1.ST.Str.general	Start (32-1 Picked up)
D32PDOP1.ST.Str.dirgeneral	Direction General
D32PDOP1.ST.Str.phsA	Start (32-1 Picked up) Phase A
D32PDOP1.ST.Str.dirphsA	Direction Phase A
D32PDOP1.ST.Str.phsB	Start (32-1 Picked up) Phase B
D32PDOP1.ST.Str.dirphsB	Direction Phase B
D32PDOP1.ST.Str.PhsC	Start (32-1 Picked up) Phase C
D32PDOP1.ST.Str.dirphsC	Direction Phase C
D32PDOP1.ST.Op.general	Operate (32-1 Operated)
D32PDOP1.ST.Op.phsA	Operate (32-1 Operated) Phase A
D32PDOP1.ST.Op.phsB	Operate (32-1 Operated) Phase B
D32PDOP1.ST.Op.phsC	Operate (32-1 Operated) Phase C

D32PDOP2

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

Data Name	Description
D32PDOP2.ST.Str.general	Start (32-2 Picked up)
D32PDOP2.ST.Str.dirgeneral	Direction General
D32PDOP2.ST.Str.phsA	Start (32-2 Picked up) Phase A
D32PDOP2.ST.Str.dirphsA	Direction Phase A
D32PDOP2.ST.Str.phsB	Start (32-2 Picked up) Phase B
D32PDOP2.ST.Str.dirphsB	Direction Phase B
D32PDOP2.ST.Str.PhsC	Start (32-2 Picked up) Phase C
D32PDOP2.ST.Str.dirphsC	Direction Phase C
D32PDOP2.ST.Op.general	Operate (32-2 Operated)
D32PDOP2.ST.Op.phsA	Operate (32-2 Operated) Phase A
D32PDOP2.ST.Op.phsB	Operate (32-2 Operated) Phase B
D32PDOP2.ST.Op.phsC	Operate (32-2 Operated) Phase C

D32PDOP3

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

Data Name	Description
D32PDOP3.ST.Str.general	Start (32-3 Picked up)
D32PDOP3.ST.Str.dirgeneral	Direction General
D32PDOP3.ST.Str.phsA	Start (32-3 Picked up) Phase A
D32PDOP3.ST.Str.dirphsA	Direction Phase A
D32PDOP3.ST.Str.phsB	Start (32-3 Picked up) Phase B
D32PDOP3.ST.Str.dirphsB	Direction Phase B
D32PDOP3.ST.Str.PhsC	Start (32-3 Picked up) Phase C
D32PDOP3.ST.Str.dirphsC	Direction Phase C
D32PDOP3.ST.Op.general	Operate (32-3 Operated)
D32PDOP3.ST.Op.phsA	Operate (32-3 Operated) Phase A
D32PDOP3.ST.Op.phsB	Operate (32-3 Operated) Phase B
D32PDOP3.ST.Op.phsC	Operate (32-3 Operated) Phase C

D32PDOP4

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

Data Name	Description
D32PDOP4.ST.Str.general	Start (32-4 Picked up)
D32PDOP4.ST.Str.dirgeneral	Direction General
D32PDOP4.ST.Str.phsA	Start (32-4 Picked up) Phase A
D32PDOP4.ST.Str.dirphsA	Direction Phase A
D32PDOP4.ST.Str.phsB	Start (32-4 Picked up) Phase B
D32PDOP4.ST.Str.dirphsB	Direction Phase B
D32PDOP4.ST.Str.PhsC	Start (32-4 Picked up) Phase C
D32PDOP4.ST.Str.dirphsC	Direction Phase C
D32PDOP4.ST.Op.general	Operate (32-4 Operated)
D32PDOP4.ST.Op.phsA	Operate (32-4 Operated) Phase A
D32PDOP4.ST.Op.phsB	Operate (32-4 Operated) Phase B
D32PDOP4.ST.Op.phsC	Operate (32-4 Operated) Phase C

D50BFRBRF1

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

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

DICBFRBRF2

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

Data Name	Description
DDICBFRBRF2.ST.OpIn.general	Operate (CBF D1 Operated)
DDICBFRBRF2.ST.OpEx.general	Operate (CBF D2 Operated)

D46BCRBCD1

This section defines the logical node data for the logical node D46BCRBCD1 of the FPROProtection logical device.

Data Name	Description
D46BCRBCD1.ST.Op.general	Operate (46BC Operated)

D60RVTS1

This section defines the logical node data for the logical node D60RVTS1 of the FPROProtection logical device.

Data Name	Description
D60RVTS1.ST.Op.general	Operate (60VTS Operated)

D60RCTS1

This section defines the logical node data for the logical node D60RCTS1 of the FPROProtection logical device.

Data Name	Description
D60RCTS1.ST.Op.general	Operate (60CTS Operated)

74TCSRTCS1

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

Data Name	Description
74TCSRTCS1.ST.Op.general	Operate (74TCSRTCS-1 Operated)

74TCSRTCS2

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

Data Name	Description
74TCSRTCS2.ST.Op.general	Operate (74TCSRTCS-2 Operated)

I2TRCBC1

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

Data Name	Description
I2TRCBC1.MX.I2TAcc.mag.f	I2T Accumulated
I2TRCBC1.MX.I2TLstOp.mag.f	I2T Value – (Last Operation)
I2TRCBC1.ST.Op.general	Operate (I2T Operated)

THDRTHD1

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

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

THDRTHD2

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

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

UVCRUVC1

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

Data Name	Description
UVCRUVC1.ST.Op.general	Operate (Under Voltage Counter exceeded)
UVCRUVC1.MX.UVCAcc.mag.f	

OVCROVC1

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

Data Name	Description
OVCROVC1.ST.Op.general	Operate (Under Voltage Counter exceeded)
OVCROVC1.MX.OVCAcc.mag.f	

UFCRUFC1

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

Data Name	Description
UFCRUFC1.ST.Op.general	Operate (Under Frequency Counter exceeded)
UFCRUFC1.MX.UFCAcc.mag.f	

OFCROFC1

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

Data Name	Description
OFCROFC1.ST.Op.general	Operate (Over Frequency Counter exceeded)
OFCROFC1.MX.OFCAcc.mag.f	

EICREIC1

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

Data Name	Description
EICREIC1.ST.Op.general	Operate (External Input Counter exceeded)
EICREIC1.MX.OFCAcc.mag.f	

D79RREC1

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

Data Name	Description
D79RREC1.ST.BlkRec.stVal	79 Block Status
D79RREC1.ST.Auto.stVal	External Switch Status (79 IN function output)
D79RREC1.ST.Op.general	AR Operation (79 Operated)
D79RREC1.ST.AutoRecSt.stVal	AR Multiple Operation

TRCALH1

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

Data Name	Description
TRCALH1.ST.GrWrn.stVal	Function(s) Starter Picked up
TRCALH1.ST.GrAlm.stVal	Function(s) Trip Operated

ANAMMXU1

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

Data Name	Description
ANAMMXU1.MX.PhV.phsA.cVal.mag.f	VA – Magnitude
ANAMMXU1.MX.PhV.phsA.cVal.ang.f	VA – Angle
ANAMMXU1.MX.PhV.phsB.cVal.mag.f	VB – Magnitude
ANAMMXU1.MX.PhV.phsB.cVal.ang.f	VB – Angle
ANAMMXU1.MX.PhV.phsC.cVal.mag.f	VC – Magnitude
ANAMMXU1.MX.PhV.phsC.cVal.ng.f	VC – Angle
ANAMMXU1.MX.PhV.neut.cVal.mag.f	VN – Magnitude
ANAMMXU1.MX.PhV.neut.cVal.ang.f	VN – Angle
ANAMMXU1.MX.PPV.phsAB.cVal.mag.f	VAB – Magnitude
ANAMMXU1.MX.PPV.phsAB.cVal.ang.f	VAB – Angle
ANAMMXU1.MX.PPV.phsBC.cVal.mag.f	VBC – Magnitude
ANAMMXU1.MX.PPV.phsBC.cVal.ang.f	VBC – Angle
ANAMMXU1.MX.PPV.phsCA.cVal.mag.f	VCA – Magnitude
ANAMMXU1.MX.PPV.phsCA.cVal.ang.f	VCA – Angle
ANAMMXU1.MX.A.phsA.cVal.mag.f	IA – Magnitude
ANAMMXU1.MX.A.phsA.cVal.ang.f	IA – Angle
ANAMMXU1.MX.A.phsB.cVal.mag.f	IB – Magnitude
ANAMMXU1.MX.A.phsB.cVal.ang.f	IB – Angle
ANAMMXU1.MX.A.phsC.cVal.mag.f	IC – Magnitude
ANAMMXU1.MX.A.phsC.cVal.ang.f	IC – Angle
ANAMMXU1.MX.A.neut.cVal.mag.f	IN – Magnitude
ANAMMXU1.MX.A.neut.cVal.ang.f	IN – Angle
ANAMMXU1.MX.TotW.mag.f	Real Power
ANAMMXU1.MX.TotVAr.mag.f	Reactive Power

ANAMMXU1.MX.Hz.mag.f	Frequency
ANAMMXU1.MX.TotPF.mag.f	Power Factor

ANAMMXU2

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

Data Name	Description
ANAMMXU2.MX.A.neut.cVal.mag.f	IG - Magnitude
ANAMMXU2.MX.A.neut.cVal.ang.f	IG – Angle
ANAMMXU2.MX.A.res.cVal.ang.f	ISEF – Magnitude
ANAMMXU2.MX.A.res.cVal.ang.f	ISEF – Angle

SEQMSQI1

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

Data Name	Description
SEQMSQI1.MX.SeqV.c1.cVal.mag.f	V1 – Pos. Seq. Magnitude
SEQMSQI1.MX.SeqV.c2.cVal.mag.f	V2 – Neg. Seq. Magnitude
SEQMSQI1.MX.SeqV.c3.cVal.mag.f	V0 – Zero Seq. Magnitude
SEQMSQI1.MX.SeqA.c1.cVal.mag.f	I1 – Pos. Seq. Magnitude
SEQMSQI1.MX.SeqA.c2.cVal.mag.f	I2 – Neg. Seq. Magnitude
SEQMSQI1.MX.SeqA.c3.cVal.mag.f	I0 – Zero Seq. Magnitude

LLN0

This section defines part of the logical node data for the logical node LLN0 of the FPROSystem logical device.

Data Name	Description
LLN0.SP.SGCB.NumofSG	Total no: of Setting Groups
LLN0.SP.SGCB.ActSG	Active Setting Group
LLN0.SP.SGCB.EditSG	Edit Setting Group
LLN0.SP.SGCB.CnfEdit	Confirm Edit Setting Group
LLN0.SP.SGCB.LActTm	Last Time Edited (Time Stamp)

HEALTHGGIO1

This section defines the logical node data for the logical node HEALTHGGIO1 of the FPROSystem logical device.

Data Name	Description
HEALTHGGIO1.ST.Ind1.stVal	Relay Healthy Status Info.
HEALTHGGIO1.ST.Ind2.stVal	IRIG-B Functional Status Info.
HEALTHGGIO1.ST.Ind3.stVal	SNTP Functional Status Info.

LEDGGIO1

This section defines the logical node data for the logical node LEDGGIO1 of the FPROSystem logical device.

Data Name	Description
LEDGGIO1.ST.Ind1.stVal	LED Status- 1
LEDGGIO1.ST.Ind2.stVal	LED Status- 2
LEDGGIO1.ST.Ind3.stVal	LED Status- 3
LEDGGIO1.ST.Ind4.stVal	LED Status- 4
LEDGGIO1.ST.Ind5.stVal	LED Status- 5
LEDGGIO1.ST.Ind6.stVal	LED Status- 6
LEDGGIO1.ST.Ind7.stVal	LED Status- 7
LEDGGIO1.ST.Ind8.stVal	LED Status- 8
LEDGGIO1.ST.Ind9.stVal	LED Status- 9
LEDGGIO1.ST.Ind10.stVal	LED Status- 10
LEDGGIO1.ST.Ind11.stVal	LED Status- 11
LEDGGIO1.ST.Ind12.stVal	LED Status- 12
LEDGGIO1.ST.Ind13.stVal	LED Status- 13
LEDGGIO1.ST.Ind14.stVal	LED Status- 14

EIGGIO1

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

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

OCGGIO1

This section defines the logical node data for the logical node OCGGIO1 of the FPROSystem logical device.

Data Name	Description
OCGGIO1.ST.Ind1.stVal	Output Contact - 1
OCGGIO1.ST.Ind2.stVal	Output Contact - 2
OCGGIO1.ST.Ind3.stVal	Output Contact - 3
OCGGIO1.ST.Ind4.stVal	Output Contact - 4
OCGGIO1.ST.Ind5.stVal	Output Contact - 5
OCGGIO1.ST.Ind6.stVal	Output Contact - 6
OCGGIO1.ST.Ind7.stVal	Output Contact - 7
OCGGIO1.ST.Ind8.stVal	Output Contact - 8
OCGGIO1.ST.Ind9.stVal	Output Contact – 9
OCGGIO1.ST.Ind10.stVal	Output Contact – 10
OCGGIO1.ST.Ind11.stVal	Output Contact – 11
OCGGIO1.ST.Ind12.stVal	Output Contact – 12
OCGGIO1.ST.Ind13.stVal	Output Contact – 13
OCGGIO1.ST.Ind14.stVal	Output Contact - 14

PLGGIO1

This section defines the logical node data for the logical node PLGGIO1 of the FPROSystem logical device.

Data Name	Description
PLGGIO1.ST.Ind1.stVal	Prologic - 1
PLGGIO1.ST.Ind2.stVal	Prologic – 2
PLGGIO1.ST.Ind3.stVal	Prologic – 3
PLGGIO1.ST.Ind4.stVal	Prologic – 4
PLGGIO1.ST.Ind5.stVal	Prologic – 5
PLGGIO1.ST.Ind6.stVal	Prologic – 6
PLGGIO1.ST.Ind7.stVal	Prologic – 7
PLGGIO1.ST.Ind8.stVal	Prologic – 8
PLGGIO1.ST.Ind9.stVal	Prologic – 9
PLGGIO1.ST.Ind10.stVal	Prologic – 10
PLGGIO1.ST.Ind11.stVal	Prologic – 11
PLGGIO1.ST.Ind12.stVal	Prologic – 12
PLGGIO1.ST.Ind13.stVal	Prologic – 13
PLGGIO1.ST.Ind14.stVal	Prologic – 14
PLGGIO1.ST.Ind15.stVal	Prologic – 15
PLGGIO1.ST.Ind16.stVal	Prologic – 16
PLGGIO1.ST.Ind17.stVal	Prologic – 17
PLGGIO1.ST.Ind18.stVal	Prologic – 18
PLGGIO1.ST.Ind19.stVal	Prologic – 19
PLGGIO1.ST.Ind20.stVal	Prologic – 20

VIGGIO1

This section defines the logical node data for the logical node VIGGIO1 of the FPROVirtualElements logical device.

Data Name	Description
VIGGIO1.ST.Ind1.stVal	Virtual Input – 1
VIGGIO1.ST.Ind2.stVal	Virtual Input – 2
VIGGIO1.ST.Ind3.stVal	Virtual Input – 3
VIGGIO1.ST.Ind4.stVal	Virtual Input – 4
VIGGIO1.ST.Ind5.stVal	Virtual Input – 5
VIGGIO1.ST.Ind6.stVal	Virtual Input – 6
VIGGIO1.ST.Ind7.stVal	Virtual Input – 7
VIGGIO1.ST.Ind8.stVal	Virtual Input – 8
VIGGIO1.ST.Ind9.stVal	Virtual Input – 9
VIGGIO1.ST.Ind10.stVal	Virtual Input – 10
VIGGIO1.ST.Ind11.stVal	Virtual Input – 11
VIGGIO1.ST.Ind12.stVal	Virtual Input – 12
VIGGIO1.ST.Ind13.stVal	Virtual Input – 13
VIGGIO1.ST.Ind14.stVal	Virtual Input – 14
VIGGIO1.ST.Ind15.stVal	Virtual Input – 15
VIGGIO1.ST.Ind16.stVal	Virtual Input – 16
VIGGIO1.ST.Ind17.stVal	Virtual Input – 17
VIGGIO1.ST.Ind18.stVal	Virtual Input – 18
VIGGIO1.ST.Ind19.stVal	Virtual Input – 19
VIGGIO1.ST.Ind20.stVal	Virtual Input – 20
VIGGIO1.ST.Ind21.stVal	Virtual Input – 21
VIGGIO1.ST.Ind22.stVal	Virtual Input – 22
VIGGIO1.ST.Ind23.stVal	Virtual Input – 23
VIGGIO1.ST.Ind24.stVal	Virtual Input – 24
VIGGIO1.ST.Ind25.stVal	Virtual Input – 25
VIGGIO1.ST.Ind26.stVal	Virtual Input – 26
VIGGIO1.ST.Ind27.stVal	Virtual Input – 27
VIGGIO1.ST.Ind28.stVal	Virtual Input – 28

VIGGIO1.ST.Ind29.stVal	Virtual Input – 29
VIGGIO1.ST.Ind30.stVal	Virtual Input – 30

VIGGIO2

This section defines the logical node data for the logical node VIGGIO2 of the FPROVirtualElements logical device.

\

Data Name	Description
VIGGIO2.ST.Ind1.stVal	Virtual Input Control– 1
VIGGIO2.ST.Ind2.stVal	Virtual Input Control– 2
VIGGIO2.ST.Ind3.stVal	Virtual Input Control– 3
VIGGIO2.ST.Ind4.stVal	Virtual Input Control– 4
VIGGIO2.ST.Ind5.stVal	Virtual Input Control– 5
VIGGIO2.ST.Ind6.stVal	Virtual Input Control– 6
VIGGIO2.ST.Ind7.stVal	Virtual Input Control– 7
VIGGIO2.ST.Ind8.stVal	Virtual Input Control– 8
VIGGIO2.ST.Ind9.stVal	Virtual Input Control– 9
VIGGIO2.ST.Ind10.stVal	Virtual Input Control– 10
VIGGIO2.ST.Ind11.stVal	Virtual Input Control– 11
VIGGIO2.ST.Ind12.stVal	Virtual Input Control– 12
VIGGIO2.ST.Ind13.stVal	Virtual Input Control– 13
VIGGIO2.ST.Ind14.stVal	Virtual Input Control– 14
VIGGIO2.ST.Ind15.stVal	Virtual Input Control– 15
VIGGIO2.ST.Ind16.stVal	Virtual Input Control– 16
VIGGIO2.ST.Ind17.stVal	Virtual Input Control– 17
VIGGIO2.ST.Ind18.stVal	Virtual Input Control– 18
VIGGIO2.ST.Ind19.stVal	Virtual Input Control– 19
VIGGIO2.ST.Ind20.stVal	Virtual Input Control– 20
VIGGIO2.ST.Ind21.stVal	Virtual Input Control– 21
VIGGIO2.ST.Ind22.stVal	Virtual Input Control– 22
VIGGIO2.ST.Ind23.stVal	Virtual Input Control– 23
VIGGIO2.ST.Ind24.stVal	Virtual Input Control– 24

VIGGIO2.ST.Ind25.stVal	Virtual Input Control– 25
VIGGIO2.ST.Ind26.stVal	Virtual Input Control– 26
VIGGIO2.ST.Ind27.stVal	Virtual Input Control– 27
VIGGIO2.ST.Ind28.stVal	Virtual Input Control– 28
VIGGIO2.ST.Ind29.stVal	Virtual Input Control– 29
VIGGIO2.ST.Ind30.stVal	Virtual Input Control– 30

Logical Nodes for Fault Data (LN Group G…)

This section defines the logical nodes available for fault data under the FPRO-FaultData logical device. All the protection functions are grouped under **3** no: of Logical Nodes detailed as below:

Logical Node Data Objects	Functions Defined
FLTDATA1.MX.PhV	Fault Voltages (VA, VB, VC, VN)
FLTDATA1.MX.PhV	Fault Voltages (VAB, VBC, VCA)
FLTDATA1.MX.A	Fault Currents (IA, IB, IC, IG, ISEF,IN)
FLTMMXU1.MX.Hz	Fault Frequency
FLTDATA2.MX.SeqV	Fault Voltage(C1,C2,C3)
FLTDATA2.MX.SeqA	Fault Currents (C1,C2,C3)

FAULTDATA1

This section defines the logical node data for the logical node FLTDATA1 of the FPROFaultData logical device.

Data Name	Description
FLTDATA1.MX.PhV. phsA.cVal.mag.f	VA – Magnitude
FLTDATA1.MX.PhV. phsA.cVal.ang.f	VA – Angle
FLTDATA1.MX.PhV. phsB.cVal.mag.f	VB – Magnitude
FLTDATA1.MX.PhV. phsB.cVal.ang.f	VB – Angle
FLTDATA1.MX.PhV. phsC.cVal.mag.f	VC – Magnitude
FLTDATA1.MX.PhV. phsC.cVal.ang.f	VC – Angle
FLTDATA1.MX.PhV.neut.cVal.mag.f	VN – Magnitude
FLTDATA1.MX.PhV.neut.cVal.ang.f	VN – Angle
FLTDATA1.MX.PhV. phsAB.cVal.mag.f	VAB – Magnitude
FLTDATA1.MX.PhV. phsAB.cVal.ang.f	VAB – Angle
FLTDATA1.MX.PhV. phsBC.cVal.mag.f	VBC – Magnitude
FLTDATA1.MX.PhV. phsBC.cVal.ang.f	VBC – Angle
FLTDATA1.MX.PhV. phsCA.cVal.mag.f	VCA – Magnitude
FLTDATA1.MX.PhV. phsCA.cVal.ang.f	VCA – Angle
FLTDATA1.MX.A.phsA.cVal.mag.f	IA - Magnitude
FLTDATA1.MX.A.phsA.cVal.ang.f	IA - Angle
FLTDATA1.MX.A.phsB.cVal.mag.f	IB - Magnitude
FLTDATA1.MX.A.phsB.cVal.ang.f	IB - Angle
FLTDATA1.MX.A.phsC.cVal.mag.f	IC - Magnitude
FLTDATA1.MX.A.phsC.cVal.ang.f	IC - Angle
FLTDATA1.MX.A.neut.cVal.mag.f	IN – Magnitude
FLTDATA1.MX.A.neut.cVal.ang.f	IN – Angle
FLTDATA1.MX.A.res.cVal.mag.f	IG – Magnitude
FLTDATA1.MX.A.res.cVal.ang.f	IG – Angle

FLTDATA1.MX.A.res.cVal.mag.f	ISEF – Magnitude
FLTDATA1.MX.A.res.cVal.ang.f	ISEF – Angle
FLTMMXU1$MX.Hz.mag.f	Frequency

FAULTDATA2

This section defines the logical node data for the logical node FLTDATA2 of the FPROFaultData logical device.

Data Name	Description
FLTDATA2.MX.SeqV.c1.cVal.mag.f	Positive Sequence Fault Voltage
FLTDATA2.MX.SeqV.c2.cVal.mag.f	Negative Sequence Fault Voltage
FLTDATA2.MX.SeqV.c3.cVal.mag.f	Zero Sequence Fault Voltage
FLTDATA2.MX.SeqA.c1.cVal.mag.f	Positive Sequence Fault Current
FLTDATA2.MX.SeqA.c2.cVal.mag.f	Negative Sequence Fault Current
FLTDATA2.MX.SeqA.c3.cVal.mag.f	Zero Sequence Fault Current