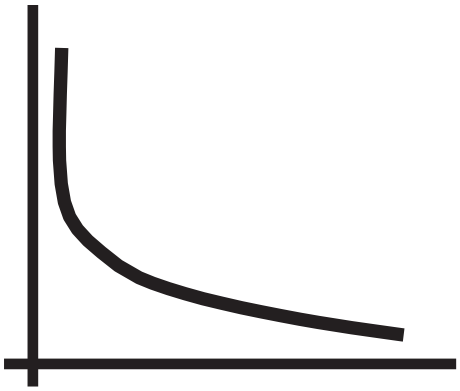
# F-PRO

## Directional Multifunction & UV / OV Protection Relay

## Model 235



**User Manual**

Version 2.6 Rev 0

# Preface

Information in this document is subject to change without notice.

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

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# Using This Guide

This User Manual describes the installation and operation of the F-PRO Multifunction 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 Set - tings 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 |
| DNP | - Distributed Network Protocol |
| SG | - Setting Group |
| TCP | - Transmission Control Protocol |
| UI | - User Interface |
| VI | - Virtual Input |

# Version compatibility

This chart indicates the versions of Offliner Settings, Relay Control Panel, RecordGraph and this User Manual was created using the following software and firmware versions.

Record Graph and Offliner Settings are backward compatible with all earlier versions of records and setting files. Use Record Graph to view records produced by any version of F-PRO firmware and Offliner Settings can create and edit older setting file versions.

| F-PRO Firmware / Software Compatibility Guide | | | | | |
|---|---|---|---|---|---|
| **F-PRO Firmware** | **Setting Version** | **Compatible Offliner Settings** | **RCP Version** | **RG Version** | **ICD File Version** |
| v2.6 | 5 | v2.6 | v2.9 | v5.4a | v3.1 |

*Please contact ERL Technical support for complete Revision History.*

# 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 and Ethernet port (RJ45)
- Serial communication port

## Operating System

One of following Operating System must be installed and functional prior to installing the applications:

- Microsoft Windows 7
- Microsoft Windows 10

ERL & ERLPhase Softwares requires a minimum of Windows 7 OS (RCP/Offliner/RG/IED Configurator will not work on earlier versions of Windows).

## Software Installation

All required software for user interface, setting and record analysis are available directly from the ERL website http://www.easunreyrolle.com/product.php?id=60T. The following relevant software and documentation is available:

- F-PRO Offliner : Software
- Relay Control Panel : Software
- USB Gadget Driver : Software
- Record Graph : Software
- ERL 61850 Configurator Tool : Software
- Relay Control Panel User Manual : Manual in PDF format
- Relay User manual : Manual in PDF format

## To Install Software on the Computer

To install the software on the computer, click the desired item on the screen. The installation program launches automatically. Installation may take a few minutes to start.

USB Gadget driver also to be installed.

## Anti-virus/Anti-spyware Software

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

# 1 Overview

## 1.1 Introduction

The F-PRO is a microprocessor-based relay providing comprehensive Directional Overcurrent, Earth Fault Protection, UnderVoltage/OverVoltage, Auto Reclosing, Circuit Breaker Failure, Broken Conductor, Thermal Overload, Negative Sequence Overcurrent, Inrush Restraint, Trip Circuit Supervision, Metering, Breaker Monitoring and Recording Functions suitable for transmission, sub transmission and distribution applications.

ERL GUI 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 records.

F-PRO Offliner is the offline tool which enables the user to:

- Create and review relay settings

RecordGraph will enable the user to:

- Analyze fault waveforms (Disturbance Records)

In addition to the protection functions F-PRO 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 Directional and Non-Directional overcurrent. A library for these overcurrent 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 provides other functions such as:

- Breaker Failure Protection (50BF)
- Multi-shot Auto Recloser (79)
- Under Voltage / Over Voltage (27 / 59)
- CT Fail Supervision (60CTS)
- VT Fail Supervision (60VTS)
- 20 ProLogic statements
- 30 Virtual Inputs
- 4 Setting Groups

Relay Control Panel (RCP) is the Windows graphical user interface software tool provided with ERL relays. RCP is used to:

- Retrieve and manage records, event logs and fault logs
- Manage settings
- Display real-time metering values
- Export records to COMTRADE format

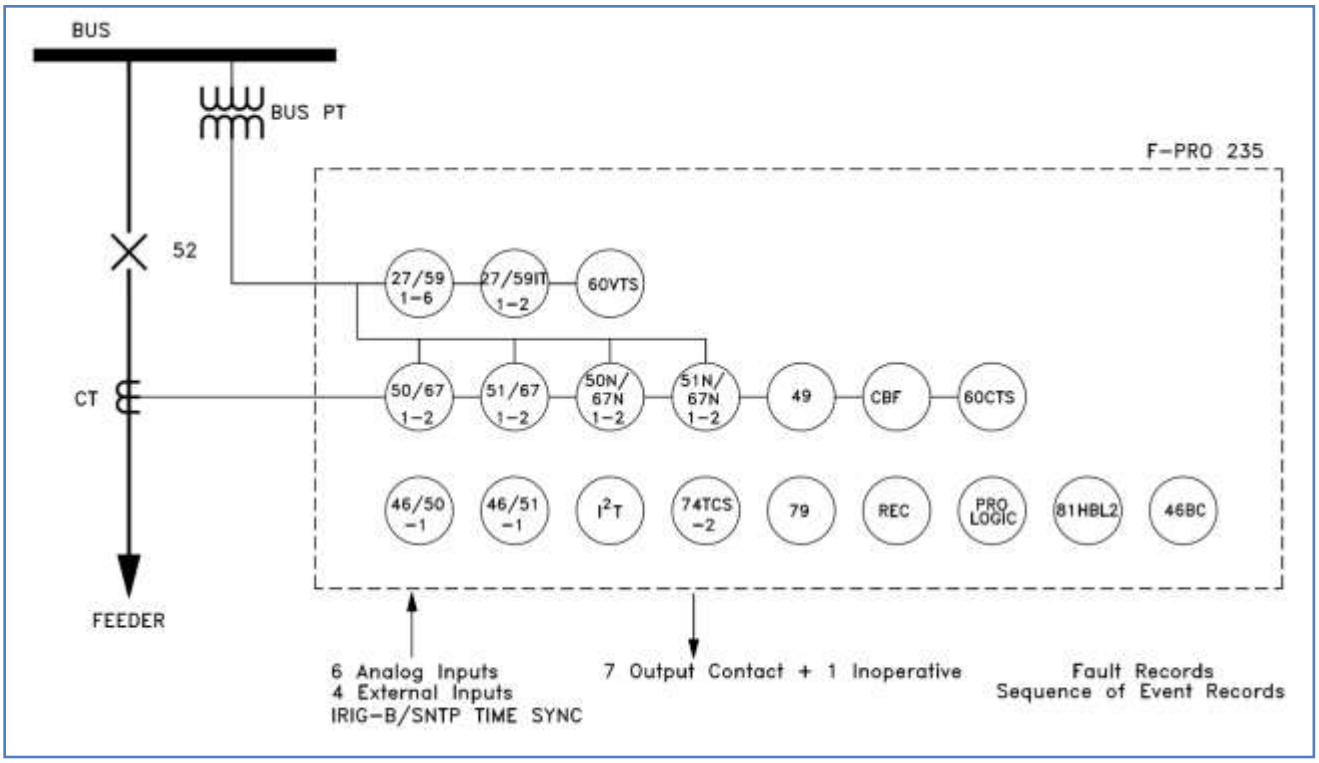



**Figure 1.1: F-PRO Relay Function Line Diagram**

## 1.2 Front View


**Figure 1.2: F-PRO Front View**

## 1.3 Rear View

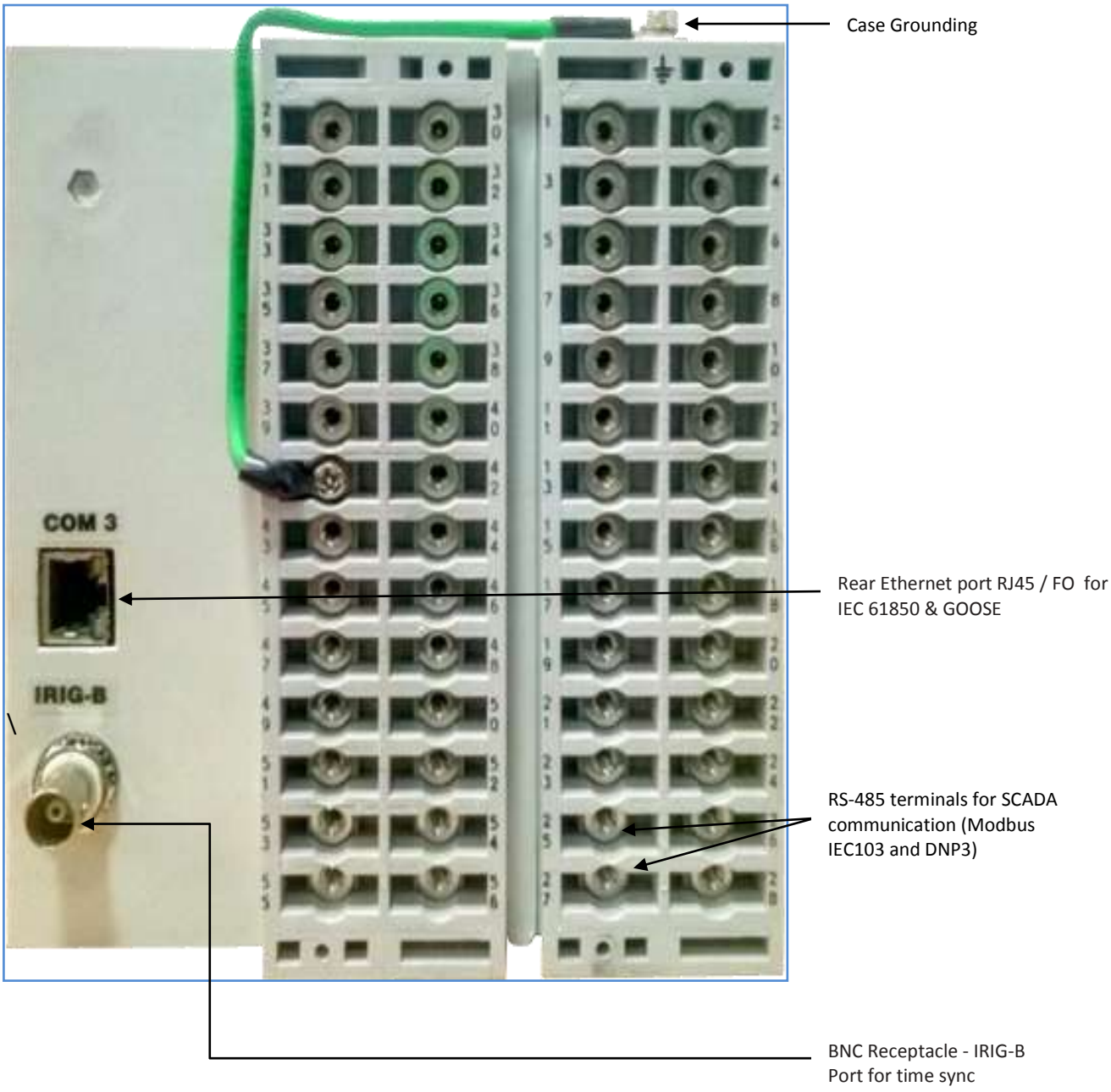
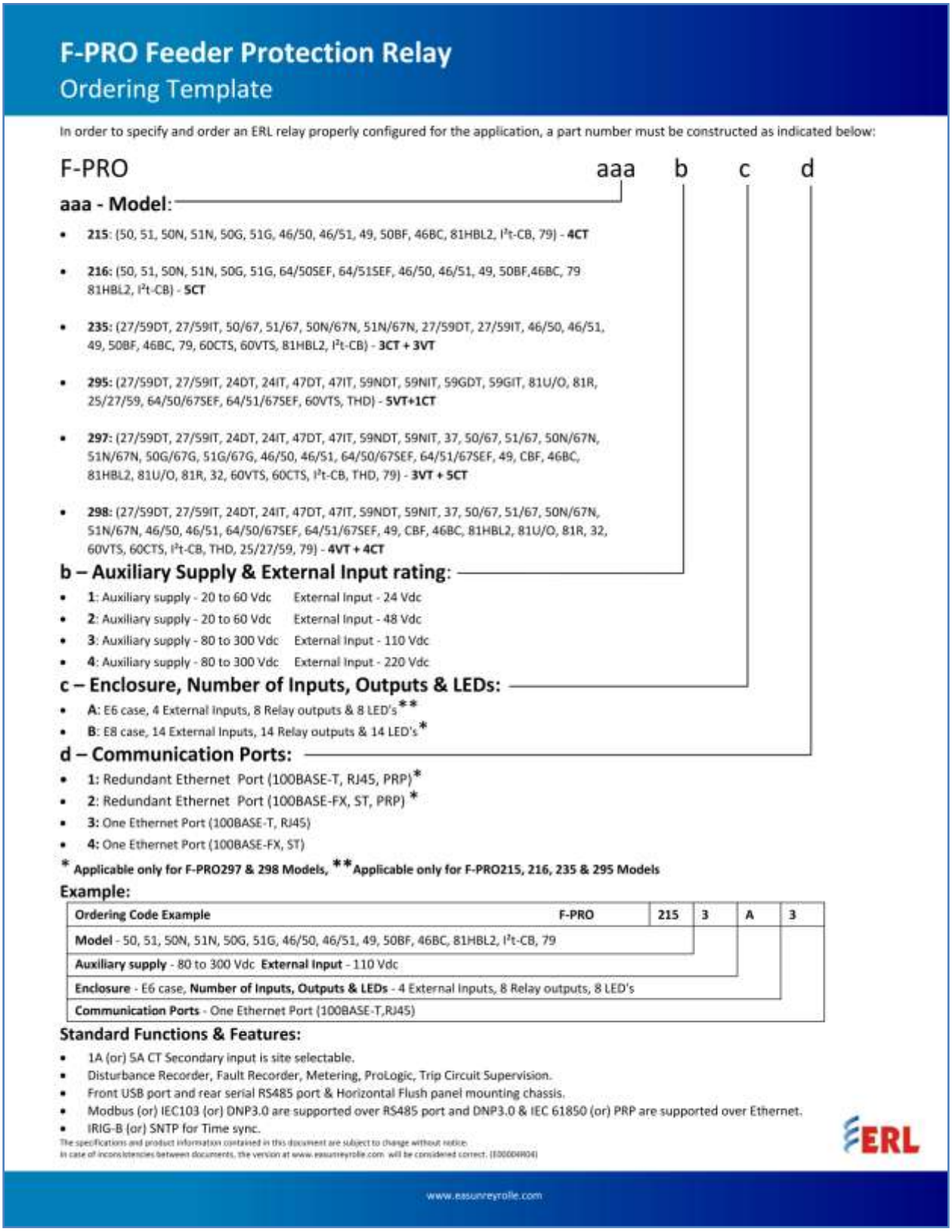



**Figure 1.3: F-PRO Rear View**

| | |
|---|---|
| **AC Current / Voltage Inputs** | F-PRO is provided with terminal blocks for up to 3 AC currents and 3 AC Voltage Inputs. 1A and 5A terminals are provided with isolated neutral and CT Secondary is Site Selectable.<br><br>To refer the complete schematic circuits; see "AC Schematic Drawing" in Appendix-I & "DC Schematic Drawing" in Appendix-J |
| **External Inputs** | F-PRO relay has 4 external inputs with a factory selectable voltage level. External DC voltages of either 24 volts, 48 volts, 110 volts, 220 volts nominal are available depending on the ordering code. |
| **Relay Inoperative Alarm Output** | If the relay becomes inoperative, then the Relay Inoperative Alarm output contact closes. Output Contact 1 and/or 6 may be configured as Relay Inoperative Alarm Contacts. During the relay inoperative period, all tripping functions are blocked. |
| **Output Relay Contacts** | The F-PRO relay has 8 output relay 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) - applicable for self reset.<br><br>If function reset time & the output contact reset time both are set in the IED; then, the higher value will be taken for relay drop out. ***Example:*** 51N function is chosen with reset DTL delay 0.5 sec and the output contact dropout time is 0.8 sec, then 0.8 sec will be the dropout time of the output contact. |

## 1.4 Model Options/Ordering Template

- The relay is available in E6 size and flush mount type along with standard IRIG-B / SNTP time sync. For details see "Mechanical Drawings" in Appendix H.
- The relay is available with an optional Ethernet port (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.



# F-PRO Feeder Protection Relay

## Ordering Template

In order to specify and order an ERL relay properly configured for the application, a part number must be constructed as indicated below:

F-PRO aaa b c d

**aaa - Model:**

- **215**: (50, 51, 50N, 51N, 50G, 51G, 46/50, 46/51, 49, 50BF, 46BC, 81HBL2, I²t-CB, 79) - **4CT**
- **216:** (50, 51, 50N, 51N, 50G, 51G, 64/50SEF, 64/51SEF, 46/50, 46/51, 49, 50BF,46BC, 79 81HBL2, I²t-CB) - **5CT**
- **235:** (27/59DT, 27/59IT, 50/67, 51/67, 50N/67N, 51N/67N, 27/59DT, 27/59IT, 46/50, 46/51, 49, 50BF, 46BC, 79, 60CTS, 60VTS, 81HBL2, I²t-CB) - **3CT + 3VT**
- **295:** (27/59DT, 27/59IT, 24DT, 24IT, 47DT, 47IT, 59NDT, 59NIT, 59GDT, 59GIT, 81U/O, 81R, 25/27/59, 64/50/67SEF, 64/51/67SEF, 60VTS, THD) - **5VT+1CT**
- **297:** (27/59DT, 27/59IT, 24DT, 24IT, 47DT, 47IT, 59NDT, 59NIT, 37, 50/67, 51/67, 50N/67N, 51N/67N, 50G/67G, 51G/67G, 46/50, 46/51, 64/50/67SEF, 64/51/67SEF, 49, CBF, 46BC, 81HBL2, 81U/O, 81R, 32, 60VTS, 60CTS, I²t-CB, THD, 79) - **3VT + 5CT**
- **298:** (27/59DT, 27/59IT, 24DT, 24IT, 47DT, 47IT, 59NDT, 59NIT, 37, 50/67, 51/67, 50N/67N, 51N/67N, 46/50, 46/51, 64/50/67SEF, 64/51/67SEF, 49, CBF, 46BC, 81HBL2, 81U/O, 81R, 32, 60VTS, 60CTS, I²t-CB, THD, 25/27/59, 79) - **4VT + 4CT**

**b – Auxiliary Supply & External Input rating:**

- **1**: Auxiliary supply - 20 to 60 Vdc External Input - 24 Vdc
- **2**: Auxiliary supply - 20 to 60 Vdc External Input - 48 Vdc
- **3**: Auxiliary supply - 80 to 300 Vdc External Input - 110 Vdc
- **4**: Auxiliary supply - 80 to 300 Vdc External Input - 220 Vdc

**c – Enclosure, Number of Inputs, Outputs & LEDs:**

- **A**: E6 case, 4 External Inputs, 8 Relay outputs & 8 LED's**
- **B**: E8 case, 14 External Inputs, 14 Relay outputs & 14 LED's*

**d – Communication Ports:**

- **1:** Redundant Ethernet Port (100BASE-T, RJ45, PRP)*
- **2**: Redundant Ethernet Port (100BASE-FX, ST, PRP) *
- **3:** One Ethernet Port (100BASE-T, RJ45)
- **4:** One Ethernet Port (100BASE-FX, ST)

* **Applicable only for F-PRO297 & 298 Models,** ** **Applicable only for F-PRO215, 216, 235 & 295 Models**

**Example:**

| **Ordering Code Example** | **F-PRO** | **215** | **3** | **A** | **3** |
|---|---|---|---|---|---|
| **Model** - 50, 51, 50N, 51N, 50G, 51G, 46/50, 46/51, 49, 50BF, 46BC, 81HBL2, I²t-CB, 79 | | | | | |
| **Auxiliary supply** - 80 to 300 Vdc **External Input** - 110 Vdc | | | | | |
| **Enclosure** - E6 case, **Number of Inputs, Outputs & LEDs** - 4 External Inputs, 8 Relay outputs, 8 LED's | | | | | |
| **Communication Ports** - One Ethernet Port (100BASE-T,RJ45) | | | | | |

**Standard Functions & Features:**

- 1A (or) 5A CT Secondary input is site selectable.
- Disturbance Recorder, Fault Recorder, Metering, ProLogic, Trip Circuit Supervision.
- Front USB port and rear serial RS485 port & Horizontal Flush panel mounting chassis.
- Modbus (or) IEC103 (or) DNP3.0 are supported over RS485 port and DNP3.0 & IEC 61850 (or) PRP are supported over Ethernet.
- IRIG-B (or) SNTP for Time sync.

The specifications and product information contained in this document are subject to change without notice.
In case of inconsistencies between documents, the version at www.eaunreyrolle.com will be considered correct. (E00004R04)

ERL

www.eaunreyrolle.com

**Figure 1.4: F-PRO Ordering Options**

# 2 Setup and Communications

## 2.1 Introduction

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

- Power supply
- Simple Network Time Protocol (SNTP) & Inter-Range Instrumentation Group time codes (IRIG-B) for time input
- Communicating with the relay using a network link and a direct serial link
- Using Relay Control Panel to access the relay's user interface
- Accessing the relay's Supervisory Control and Data Acquisition (SCADA) service

## 2.2 Power Supply

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

- 20 to 60Vdc
- 80 to 300Vdc / 80 to 240 Vac, 50/60 Hz

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 and glowing the green LED for relay functional.

### Case Grounding

**WARNING**!

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

## 2.3 Time Sources

The F-PRO 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 and in the absence of any external time source, will become the default mode of time synchronization.

### IRIG –B SYNC

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 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.

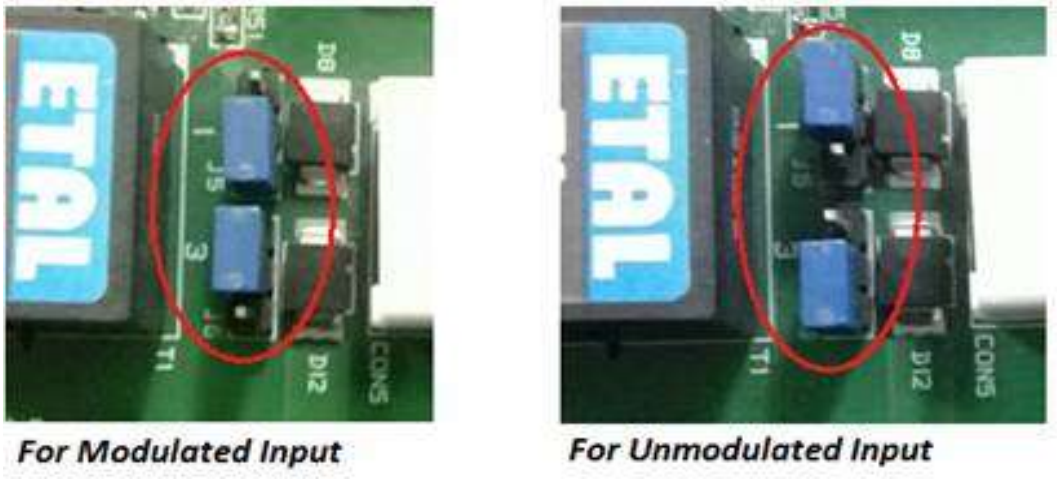



**Figure 2.1: IRIG-B port for modulated and un-modulated input**

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

## SNTP SYNC

An SNTP time source has a lower order of precedence from a valid IRIG-B source. SNTP operation (primary and secondary) requires network access and the selection and configuration of suitable SNTP network sources. The SNTP time may be configured for re-synchronization cycles ranging from 15 minutes to 36 hours, adjusting the F-PRO 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.

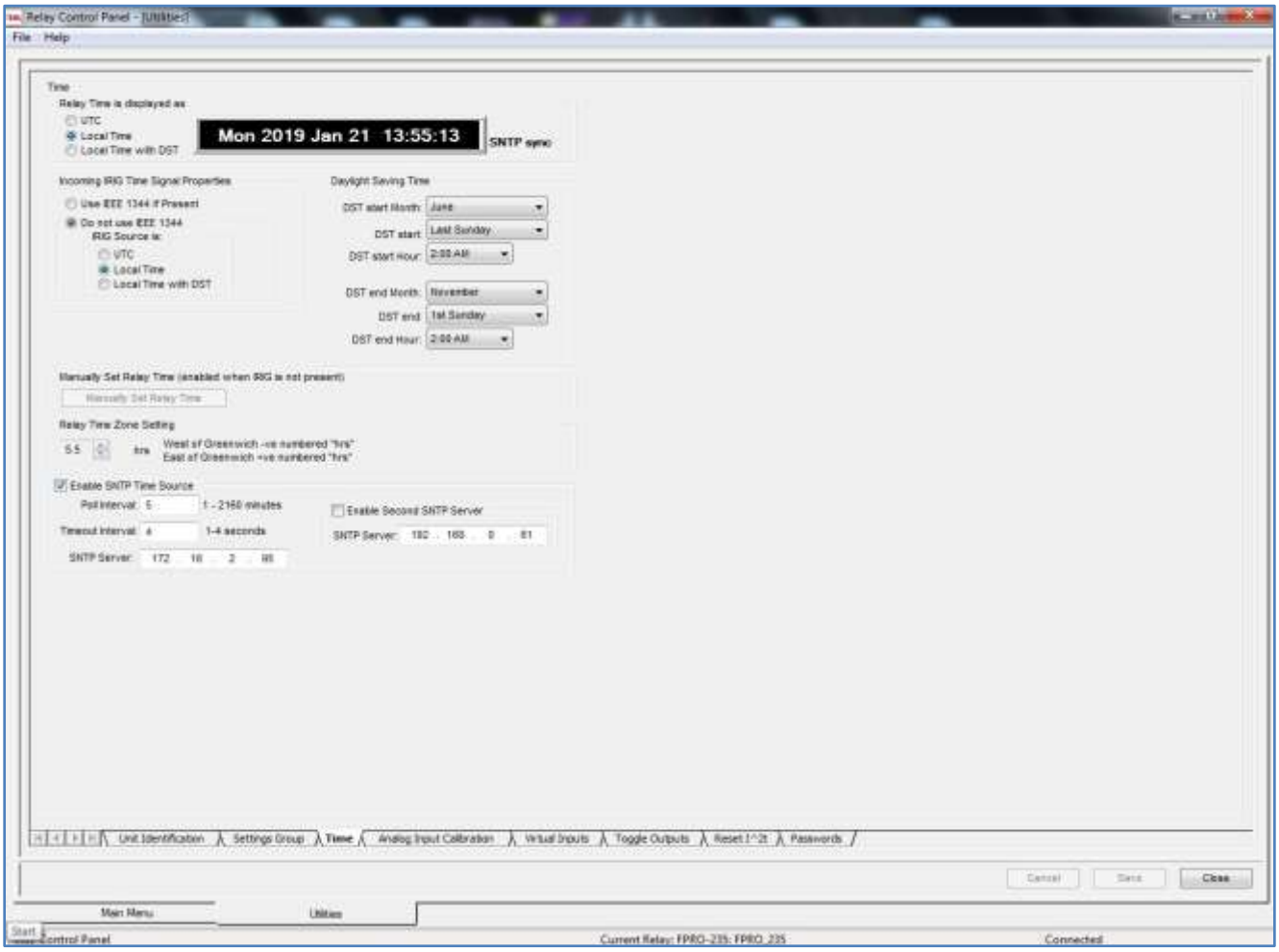



**Figure 2.2: SNTP sync settings in RCP**

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.

## 2.4 Communicating with the F-PRO Relay

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

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

The relay has a front panel USB port (COM 1) and 1 Rear Ethernet Port (Copper / FO COM 3) for user interface and SCADA, 1 rear RS485 Port (COM 2) to provide direct access to SCADA services.

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

## 2.5 USB Link

The PC must be appropriately configured for USB communication.

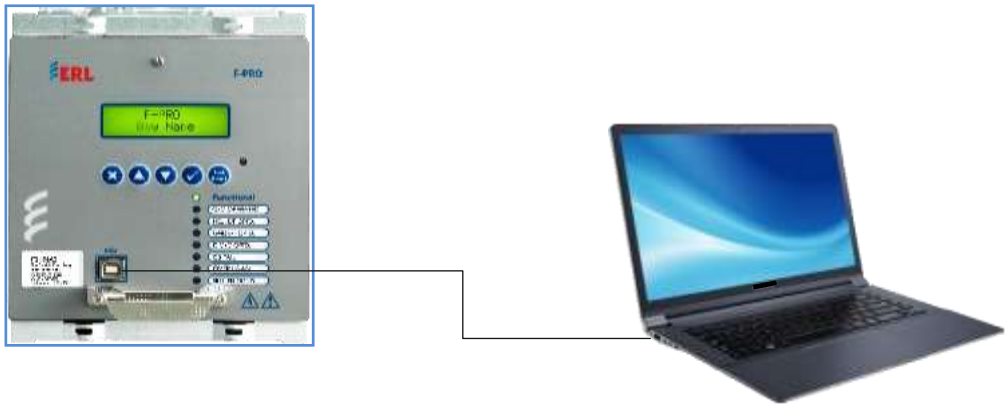



**Figure 2.3: USB Link**

## 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:
Gadget Driver can be downloaded from ERL website.
http://www.easunreyrolle.com/product.php?id=60

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)

Can find "F-PRO2000 Series Relay" port, note COM port number which is installed Ex: COM 6.

Now Open the Relay Control panel

Start > All Programs > ERLPhase > Relay Control Panel

In that Click the Add new Button. Add New Relay Window will open. In that select the "Add New Modem/Serial Link" Button.

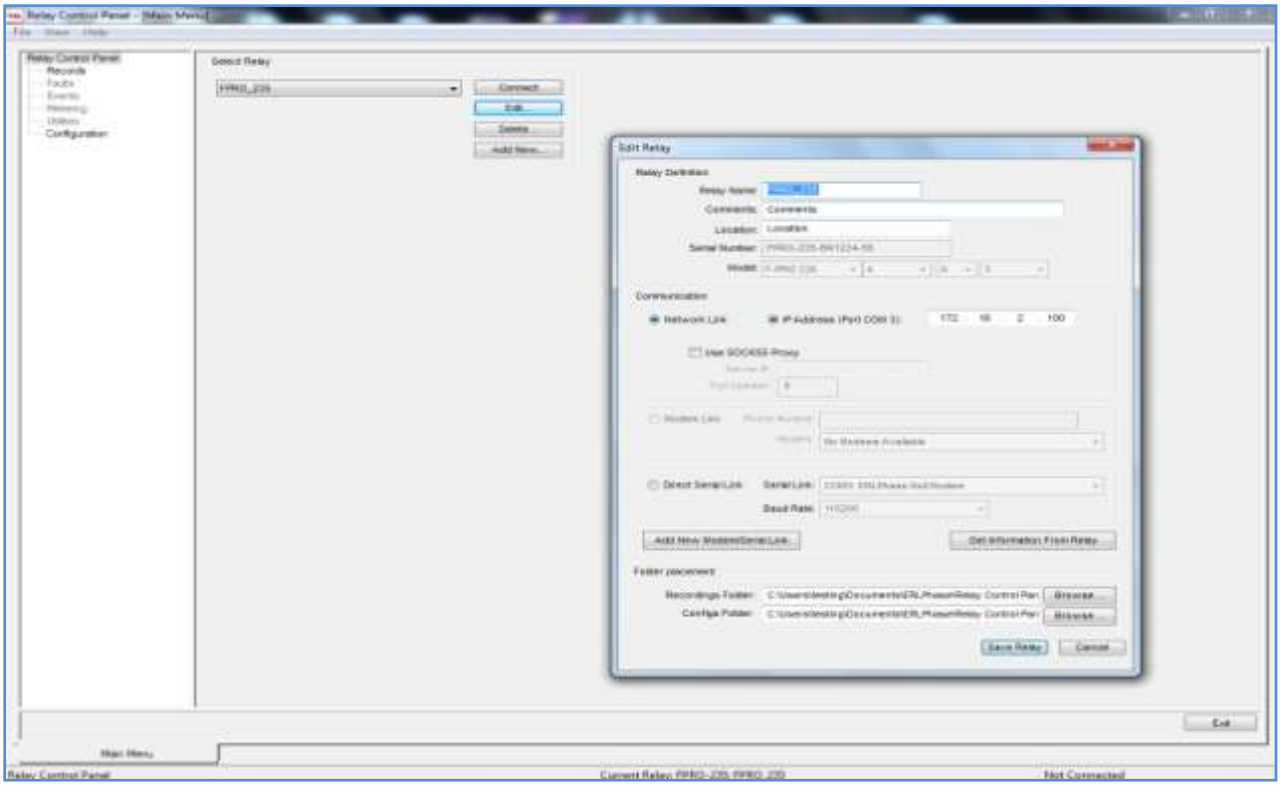


**Figure 2.4: USB com port configuration**

A Window will appear in that select the "Add" Button.

"Add Hardware Wizard" Window will open, Now 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.

## 2.6 Network Link

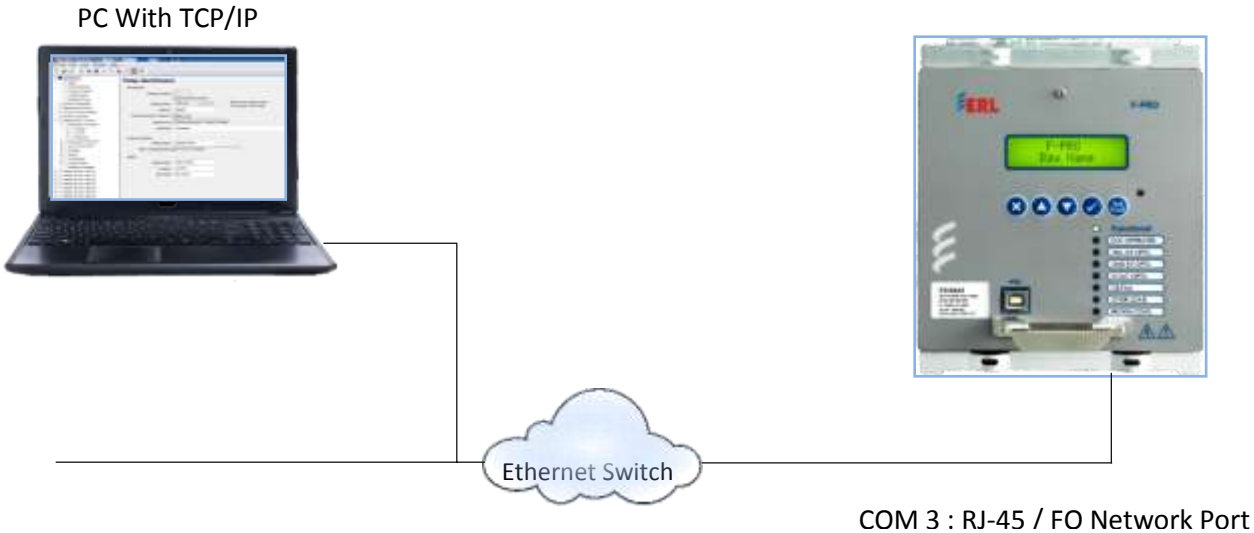



**Figure 2.5: Network Link**

Access both the relay's user interface and 61850 SCADA services simultaneously with the Ethernet TCP/IP LAN link through the rear network port COM 3. The rear Port 3 is 100BASE-T copper interface with an RJ-45 connector or FO with ST interface.

DNP3 SCADA services can also be accessed over the LAN, for details see "Communication Port Details" Table 2.1.

Connect to the Ethernet LAN using a Cat 5 or above cable with an RJ-45 connector on both ends in straight fashion or 100BASE-FX 1300 nm, multi-mode optical fiber with an ST style connector

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 COM 3 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 Relay Control Panel or Front LCD display in 'Change/Service mode. If IP address is changed, then the relay will restart automatically.

## 2.7 Firmware Update

The relay has an update login that can be accessed by a connection through any file transfer protocol. This login is available only from the rear Ethernet COM 3 Port. Login user in to "update" and password is "proup" and transfer the below files in to /usr/apt folder:

a) erl_update.sh
b) fpro2k_update
c) relay_fw_update_msg
d) relay_restart_msg
e) rmnologin

Then close the ftp window and Firmware update through LCD-HMI in service mode as shown in figure 2.6.: The relay gets restarted after firmware update.

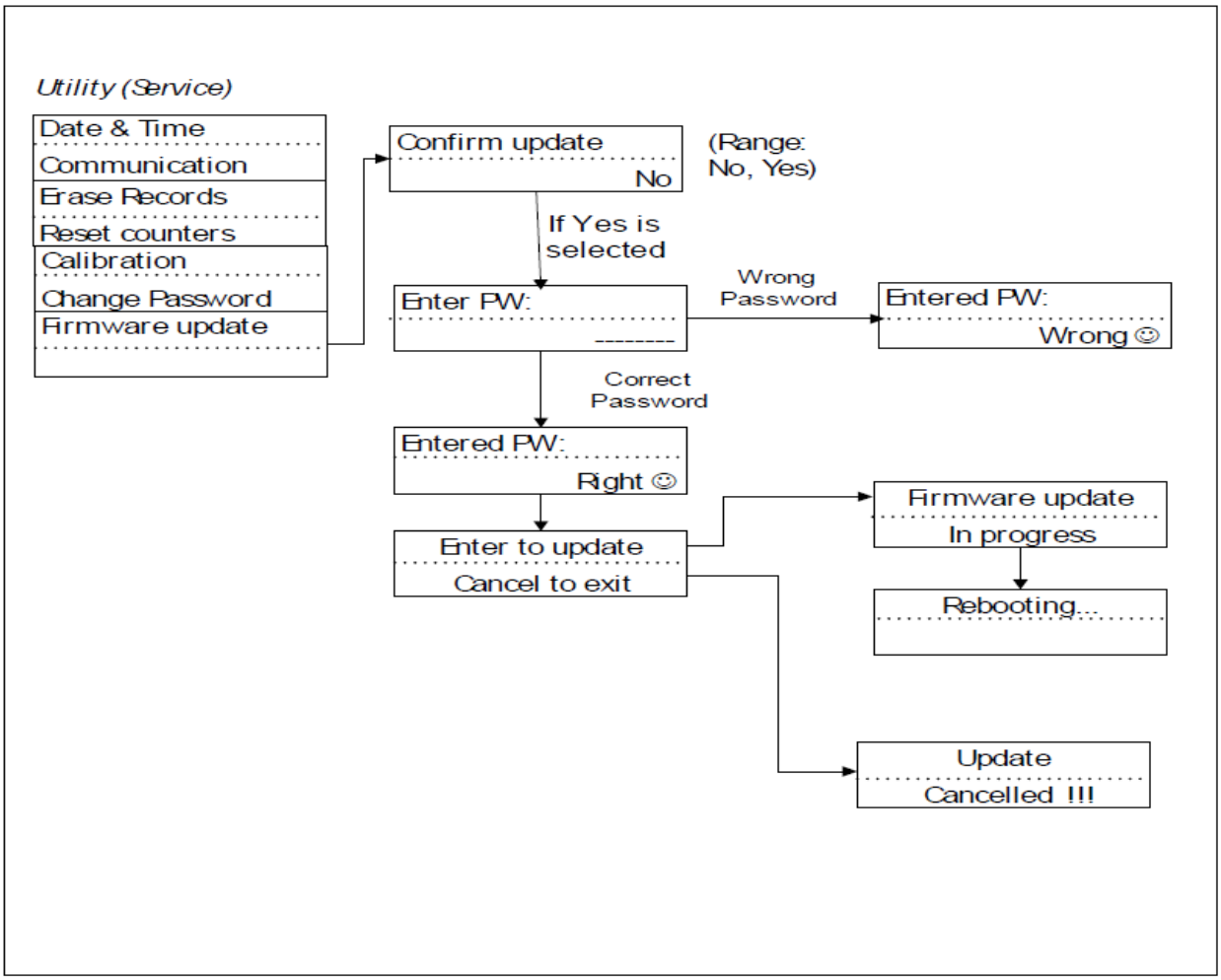



**Figure 2.6: Firmware Update**

## 2.8 Accessing the Relay's SCADA Services

The relay supports IEC 60870-5-103 slave, DNP3(Level 2) 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 Port COM 2 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.

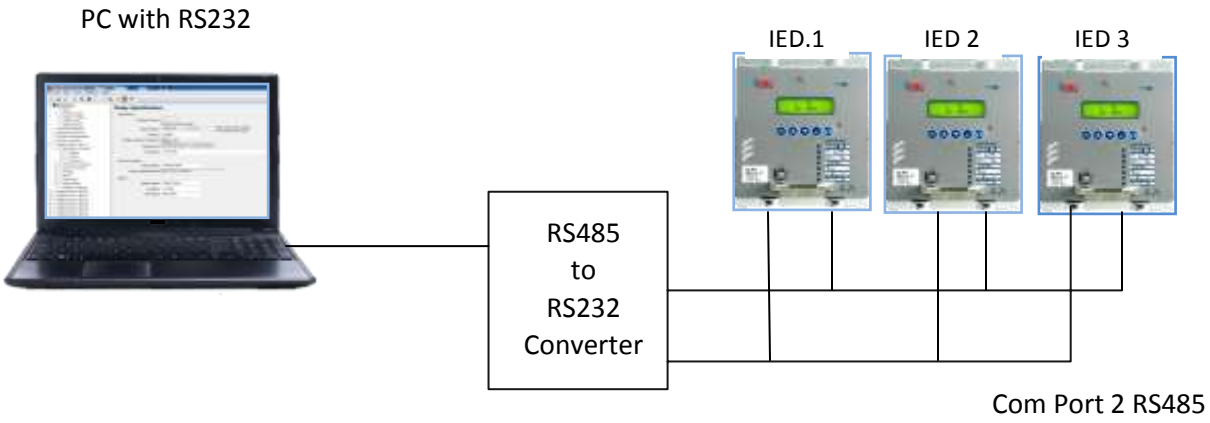



**Figure 2.7: RS485 Connection diagram**

The DNP3 protocol can also be run across the Ethernet LAN. Both DNP over TCP and DNP over UDP are supported. For details on connecting to the Ethernet LAN see "Network Link" on page 2-7.

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" in Appendix E ,"IEC 103 Device Profile" in Appendix F and DNP3 Device Profile in Appendix G

### 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.

## 2.9 Communication Port Details

| Table 2.1: Communication Port Details | | |
|---|---|---|
| **Location** | **Port** | **Function** |
| Front Panel | COM 1 | USB-B receptacle, High speed USB 2.0 interface<br>Used for user interface access<br>Default fixed baud rate 115200 N 8 1 (no parity, 8 data bits, 1 stop bit). |
| Rear Panel | COM 2 | RS-485.<br>Used for SCADA communication (MODBUS or IEC103 or DNP3).<br>Default Setting: 9600 N 7 1 (no parity, 7 data bits, 1 stop bit) |
| Rear Panel | COM 3 | RJ-45 receptacle or ST type optical receptacle(factory Configured). 100BASE-T or 100BASE-FX(1300nm, multimode) Ethernet interface.<br>Used for user interface access or IEC61850 or DNP3 SCADA access through Ethernet LAN.<br>SNTP time sync is also selectable. |
| Rear panel | IRIG-B | BNC receptacle, IRIG-B Interface. Modulated or un-modulated, 65 ohm impedance. |

| Table 2.2: RS485 Connections to Pins on Relay Port | | |
|---|---|---|
| **Signal Name** | **Direction PC<-> Relay** | **Pin # on the Relay Port** |
| A+ | ↔ | 26 |
| B- | ↔ | 27 |
| Common | | 28 |

***Notes:*** *01) Pins 25 and 27 are tied together internal to the relay with resistor.*
*02) If no. of IED's connected in daisy chain method, the end unit can be connected with 120Ω load resistance which is in built in the relay (refer wiring diagram Appendix L).*

# 3 Using the IED (Getting Started)

## 3.1 Introduction

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

## 3.2 Start-up sequence

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

- After 5 seconds "Booting…" displayed in the LCD
- At 70th second "Loading…" displayed in the LCD
- At 80th second all the LED's 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.

## 3.3 Interfacing with the Relay

The following ways can be used to interface with the relay:

- Front panel display
- Relay Control Panel

# 3.4 Front Panel Display

The front panel display is the fastest and easiest way of getting information from the relay.


**Figure3.1: Front Panel Display**

The display, the 8 LED lights and the 5 push buttons, provide selective information about the relay.

## LED Indications

| Table 3.1: Description of LED Indications | |
|---|---|
| LED 1 | Indicates the relay is functional. When the Relay Functional green LED comes on, the rear Relay Inoperative contact change to: open and the protective functions become functional. |
| LED 2 to 8 | Programmable for any protection functions, ProLogic, Virtual Inputs and external inputs. |

*Target LED assignments are the default function but are configurable by the user through the Offliner settings (output matrix configuration →LED Output).*

## Push Buttons

| Table 3.2 Identification of Push Buttons | |
|---|---|
| Up, Down, Cancel, Enter, Test or Target Reset | Used to Navigate the front panel LCD Screen |

## Display

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

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| Main Screen | | |
| View / Change / Service : Choice Menu | | |
| Enter Password | | |
| Main Menu | | (V,C,S) |
| Configuration | | (V,C,S) |
| System Parameters | | (V,C,S) |
| System Freq. | | (V,C,S) |
| System Freq. | | (V,C,S) |
| CT Config. | | (V,C,S) |
| Phase CT Sec. | | (V,C,S) |
| Phase CT Ratio | | (V,C,S) |
| VT Config. | | (V,C,S) |
| Phase VT Sec. | | (V,C,S) |
| Phase VT Ratio | | (V,C,S) |
| VT Sec Conn | | (V,C,S) |
| General | | (V,C,S) |
| Min Volt Thold | | (V,C,S) |
| Display Backlight Timeout | | (V,C,S) |
| Duration | | (V,C,S) |
| Setting Group | | (V,C,S) |
| Active: | | (V,C,S) |
| Edit / View | | (V,C,S) |
| Functions | | (V,C,S) |
| Phase U/O Voltage | | (V,C,S) |
| Fn. 27/59DT-1 | | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Hysteresis | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59DT-2 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |
| | Hysteresis | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59DT-3 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |
| | Hysteresis | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59DT-4 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Hysteresis | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59DT-5 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |
| | Hysteresis | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59DT-6 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |
| | Hysteresis | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59IT-1 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Hysteresis | (V,C,S) |
| | Curve Type | (V,C,S) |
| | TMS | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant P | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Fn. 27/59IT-1 | (V,C,S) |
| | Function | (V,C,S) |
| | Fn. Selection | (V,C,S) |
| | Measurement I/P | (V,C,S) |
| | Input Type | (V,C,S) |
| | Output Gate | (V,C,S) |
| | Pickup V | (V,C,S) |
| | Hysteresis | (V,C,S) |
| | Curve Type | (V,C,S) |
| | TMS | (V,C,S) |
| | Pickup DTL Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant P | (V,C,S) |
| | VTS Blocking | (V,C,S) |
| | Direction | (V,C,S) |
| | Fn. 67 | (V,C,S) |
| | Angle | (V,C,S) |
| | Voltage | (V,C,S) |
| | 2 Out of 3 Logic | (V,C,S) |
| | VTS Block | (V,C,S) |
| | Fn. 67N | (V,C,S) |
| | Angle | (V,C,S) |
| | Voltage | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Input | (V,C,S) |
| | VTS Block | (V,C,S) |
| Phase OC | | (V,C,S) |
| Fn. 50/67-1 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Fn. 50/67-2 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Fn. 51/67-1 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Curve | (V,C,S) |
| | TMS | (V,C,S) |
| | Pickup DTL delay | (V,C,S) |
| | Reset Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant p | (V,C,S) |
| | Constant TR | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Fn. 51/67-2 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Curve | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | TMS | (V,C,S) |
| | Pickup DTL delay | (V,C,S) |
| | Reset Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant p | (V,C,S) |
| | Reset TR | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Neutral OC | | (V,C,S) |
| Fn. 50N/67N-1 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Fn. 50N/67N-2 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Fn. 51N/67N-1 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Curve | (V,C,S) |
| | TMS | (V,C,S) |
| | Pickup DTL delay | (V,C,S) |
| | Reset Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant p | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Constant TR | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Fn. 51N/67N-2 | | (V,C,S) |
| | Function | (V,C,S) |
| | Direction | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Curve | (V,C,S) |
| | TMS | (V,C,S) |
| | Pickup DTL delay | (V,C,S) |
| | Reset Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant p | (V,C,S) |
| | Constant TR | (V,C,S) |
| | Inrush Blocking | (V,C,S) |
| Neg. Seq. OC | | (V,C,S) |
| Fn. 46/50 | | (V,C,S) |
| | Function | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| Fn. 46/51 | | (V,C,S) |
| | Function | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Curve | (V,C,S) |
| | TMS | (V,C,S) |
| | Pickup DTL delay | (V,C,S) |
| | Reset Delay | (V,C,S) |
| | Reset DTL Delay | (V,C,S) |
| | Constant A | (V,C,S) |
| | Constant B | (V,C,S) |
| | Constant p | (V,C,S) |
| | Constant TR | (V,C,S) |
| Thermal OL | | (V,C,S) |
| Fn. 49 | | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Function | (V,C,S) |
| | Therm. OL | (V,C,S) |
| | Time Constant | (V,C,S) |
| | NegSeq. weighing | (V,C,S) |
| | Therm. OL Alarm | (V,C,S) |
| | Alarm % Th | (V,C,S) |
| CB Fail | | (V,C,S) |
| Fn. 50 BF | | (V,C,S) |
| | Function | (V,C,S) |
| | Pickup Current | (V,C,S) |
| | Pickup Delay-1 | (V,C,S) |
| | Pickup Delay-2 | (V,C,S) |
| Broken Conductor | | (V,C,S) |
| Fn. 46BC | | (V,C,S) |
| | Function | (V,C,S) |
| | I2/I1 Pickup | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| Supervision | | (V,C,S) |
| Fn. 60 CTS | | (V,C,S) |
| | Function | (V,C,S) |
| | VNPS Pickup | (V,C,S) |
| | INPS Pickup | (V,C,S) |
| | Pickup Delay | (V,C,S) |
| Fn. 60 VTS | | (V,C,S) |
| | Function | (V,C,S) |
| | I1 Blocking | (V,C,S) |
| | 310 Blocking | (V,C,S) |
| | NegSeq. Monitor | (V,C,S) |
| | VNPS | (V,C,S) |
| | INPS | (V,C,S) |
| Trip Circuit Supervision | | (V,C,S) |
| Fn. 74 TCS-1 | | (V,C,S) |
| | Function | (V,C,S) |
| | Name | (V,C,S) |
| | Drop-Off Delay | (V,C,S) |
| Fn. 74 TCS-2 | | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Function | (V,C,S) |
| | Name | (V,C,S) |
| | Drop-Off Delay | (V,C,S) |
| Inrush Detection | | (V,C,S) |
| Fn. 81HBL2 | | (V,C,S) |
| | Function | (V,C,S) |
| | Cross Blocking | (V,C,S) |
| | Pickup I2nd | (V,C,S) |
| Auto Reclose | | (V,C,S) |
| Fn. 79 | | (V,C,S) |
| | Function | (V,C,S) |
| | Number of Shots | (V,C,S) |
| | 1st Reclose--T1 | (V,C,S) |
| | 2nd Reclose--T2 | (V,C,S) |
| | 3rd Reclose--T3 | (V,C,S) |
| | 4th Reclose--T4 | (V,C,S) |
| | Close Time Tp | (V,C,S) |
| | Reclaim Time Td | (V,C,S) |
| | Init. Rst. TDI | (V,C,S) |
| | Block Rst. TDB | (V,C,S) |
| CB Monitoring | | (V,C,S) |
| Fn. I^2t | | (V,C,S) |
| | Function | (V,C,S) |
| | I^2t Limit | (V,C,S) |
| Disturbance Record Settings | | (V,C,S) |
| Record Length | | (V,C,S) |
| Pre--trigger | | (V,C,S) |
| Meters | | (V,C,S) |
| Meter Display Option | | (V,C,S) |
| Display Option | | (V,C,S) |
| Analog | | (V,C,S) |
| Va Mag: | | (V,C,S) |
| Va Ang: | | (V,C,S) |
| Vb Mag: | | (V,C,S) |
| Vb Ang: | | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | | |
|---|---|---|---|
| | | Vc Mag: | (V,C,S) |
| | | Vc Ang: | (V,C,S) |
| | | Vn Mag: | (V,C,S) |
| | | Vn Ang: | (V,C,S) |
| | | Ia Mag: | (V,C,S) |
| | | Ia Ang: | (V,C,S) |
| | | Ib Mag: | (V,C,S) |
| | | Ib Ang: | (V,C,S) |
| | | Ic Mag: | (V,C,S) |
| | | Ic Ang: | (V,C,S) |
| | | In Mag: | (V,C,S) |
| | | In Ang: | (V,C,S) |
| | | V1 Mag: | (V,C,S) |
| | | V2 Mag: | (V,C,S) |
| | | V0 Mag: | (V,C,S) |
| | | I1 Mag: | (V,C,S) |
| | | I2 Mag: | (V,C,S) |
| | | I0 Mag: | (V,C,S) |
| | | Real Power | (V,C,S) |
| | | Reactive Power | (V,C,S) |
| | | Frequency | (V,C,S) |
| | | Power factor | (V,C,S) |
| | | Thermal State | (V,C,S) |
| | | I^2t Accumulated | (V,C,S) |
| | | I^2t Last Operation | (V,C,S) |
| | Digital | | (V,C,S) |
| | | EI Status | (V,C,S) |
| | | EI1- EI1 | (V,C,S) |
| | | EI2- EI2 | (V,C,S) |
| | | EI3- EI3 | (V,C,S) |
| | | EI4- EI4 | (V,C,S) |
| | | DO Status | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | RL1- RL 1 | (V,C,S) |
| | RL2- RL 2 | (V,C,S) |
| | RL3- RL 3 | (V,C,S) |
| | RL4- RL 4 | (V,C,S) |
| | RL5- RL 5 | (V,C,S) |
| | RL6- RL 6 | (V,C,S) |
| | RL7- RL 7 | (V,C,S) |
| | RL8- RL 8 | (V,C,S) |
| Records | | (V,C,S) |
| View Events | | (V,C,S) |
| Events | | (V,C,S) |
| View Faults | | (V,C,S) |
| Faults | | (V,C,S) |
| Utilities | | (V,C,S) |
| Time | | (V,C,S) |
| Date | | (V,C,S) |
| Date: DD/MM/YYYY | | (V,C,S) |
| Time | | (V,C,S) |
| Time: HH:MM:SS | | (V,C,S) |
| Display Time As | | (V,C,S) |
| Display Time as | | (V,C,S) |
| DST | | (V,C,S) |
| DST start Month | | (V,C,S) |
| DST start | | (V,C,S) |
| DST start Hour | | (V,C,S) |
| DST end Month | | (V,C,S) |
| DST end | | (V,C,S) |
| DST end Hour | | (V,C,S) |
| UTC Offset | | (V,C,S) |
| UTC Offset | | (V,C,S) |
| SNTP | | (V,C,S) |
| Enable SNTP | | (V,C,S) |
| Poll Interval | | (V,C,S) |
| Timeout | | (V,C,S) |
| SNTP Server | | (V,C,S) |
| Enable 2nd SNTP | | (V,C,S) |
| 2nd SNTP Server | | (V,C,S) |
| Communication | | (V,C,S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | USB | (V,C,S) |
| | Host: Serial Dadget | (V,C,S) |
| | RS485(COM 2) | (V,C,S) |
| | Protocol | (V,C,S) |
| | Baud Rate | (V,C,S) |
| | Parity | (V,C,S) |
| | Relay Address | (V,C,S) |
| | Ethernet(COM 3) | (V,C,S) |
| | IP Address | (V,C,S) |
| | Port | (V,C,S) |
| | Subnet Mask | (V,C,S) |
| | Default Gateway | (V,C,S) |
| | MAC Address | (V,C,S) |
| | Protocol Selection | (V,C,S) |
| | Protocol | (V,C,S) |
| | Modbus-RTU/ASCII | (V,C,S) |
| | Relay Address | (V,C,S) |
| | Baud Rate | (V,C,S) |
| | Protocol | (V,C,S) |
| | IEC-103 Slave | (V,C,S) |
| | Relay Address | (V,C,S) |
| | Class 2 Update | (V,C,S) |
| | Measurand Max Range | (V,C,S) |
| | Baud Rate | (V,C,S) |
| | Parity | (V,C,S) |
| | Protocol | (V,C,S) |
| | DNP3 Level2 - Ser | (V,C,S) |
| | Relay Address | (V,C,S) |
| | Baud Rate | (V,C,S) |
| | Parity | (V,C,S) |
| | Data Link Time Out | (V,C,S) |
| | Protocol | (V,C,S) |
| | DNP3 Level2 - TCP | (V,C,S) |
| | Relay Address | (V,C,S) |
| | Keep-Alive Time Out | (V,C,S) |
| | No. Of Masters | (V,C,S) |
| | Connection Based On | (V,C,S) |
| | Master 1 IP Address | (V,C,S) |

| | | |
|---|---|---|
| | Master 1 Port | (V,C,S) |
| | Master 2 IP Address | (V,C,S) |
| | Master 2 Port | (V,C,S) |
| | Master 3 IP Address | (V,C,S) |
| | Master 3 Port | (V,C,S) |
| | Protocol | (V,C,S) |
| | DNP3 Level2 - UDP | (V,C,S) |
| | Relay Address | (V,C,S) |
| | UDP Response | (V,C,S) |
| | Master 1 IP Address | (V,C,S) |
| | Master 1 Port | (V,C,S) |
| | Erase Records | (C,S) |
| | Erase Event Rec | (C,S) |
| | Erase Fault Rec | (C,S) |
| | Erase DR | |
| | Reset Counters | (C,S) |
| | Present Value | (C,S) |
| | New Value | (C,S) |
| | Calibration | (C,S) |
| | Voltage Channels | (C,S) |
| | Calibrate VA? | (C,S) |
| | Calibrate VB? | (C,S) |
| | Calibrate VC? | (C,S) |
| | Current Channels | (C,S) |
| | Information Ensure 1A AC is applied | (C,S) |
| | Calibrate IA? | (C,S) |
| | Calibrate IB? | (C,S) |
| | Calibrate IC? | (C,S) |
| | Password Settings | (V,C,S) |
| | Change PW | (S) |
| | New Change PW | (S) |
| | New Service PW | (S) |
| | PW Access Timer | (V,S) |
| | PW Access Timer | (V,S) |
| | PW Enable / Disable | (V,S) |
| | PW Enable | (V,S) |
| | Firmware Update | (S) |
| | Confirm Update | (S) |
| | Test Mode | (S) |
| | Test Mode Selection | (S) |

| Table 3.3: Navigation of the LCD Screen | | |
|---|---|---|
| | Unit Identification | (V,C,S) |
| | Product Version | (V,C,S) |
| | Serial Number | (V,C,S) |
| | Unit ID | (V,C,S) |
| | Firmware Ver. | (V,C,S) |
| | Settings Date | (V,C,S) |
| | Settings Ver. | (V,C,S) |
| | RCP Ver. | (V,C,S) |
| | Comments | (V,C,S) |
| | Station Name | (V,C,S) |
| | Location | (V,C,S) |
| | Bay name | (V,C,S) |
| | Load Date | (V,C,S) |

Where the access levels required to access each are indicated

V: view

C: change

S: service

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


**Figure 3.2: Main Screen**

In the Main Screen, Press *Enter Key*.


**Figure 3.3: View / Change / Service: Choice Menu**

In the View / Change / Service: Choose Menu screen, choose desired access level, and Press *Enter key.*


**Figure 3.4: Enter Password**

In the Enter PW screen, enter appropriate six digit password and Press Enter key on the return character (right bottom one)

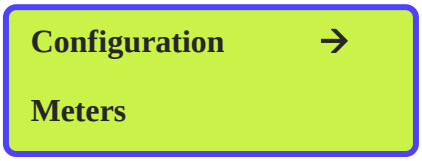



**Figure 3.5: Main Menu**

The Main Menu screen should appear.
**Note:** The default passwords are below ( Don't include the quotation marks):

| Access Level | Password |
|---|---|
| View | no password for View access in LCD |
| Change | Change |
| Service | Service |

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

## 3.5 Relay Control Panel

RCP is used for all user interfaces with IED online. 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. 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.*
Select correct serial link and baud rate.
*Click Get Information from Relay.*
Then RCP will communicate with the F-PRO-235 and retrieve information to fill required fields.
When this is done, hit *Save Relay.*
If the window "Relay already exists..." pops up, user 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 (Don't include 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 3.4: Relay Control Panel Structure | | | | |
|---|---|---|---|---|
| | | **View** | **Change** | **Service** |
| Relay Control Panel | | | | |
| | Records | View | Trigger Fault | Trigger Fault |
| | | View | Trigger Event | Trigger Event |
| | Faults | View | Clear Faults | Clear Faults |
| | Events | View | Clear Faults | Clear Faults |
| | Metering | | | |
| | Analog Input | View | View | View |
| | I^2t | View | View | View |
| | Status (EI) | View | View | View |
| | Protection status | View | View | View |
| | Outputs (Status DO) | View | View | View |
| | ProLogic | | | |
| | Virtual | | | |
| | Utilities | | | |
| | Unit Identification | View | View | View |
| | Settings Group | N/A | Save | Save |
| | Time | N/A | Save | Save |
| | Analog Input Calibration | N/A | Calibrate offset and gain | Calibrate offset and gain |
| | Virtual Inputs | N/A | Latch/Pulse | Latch/Pulse |
| | Toggle Outputs | N/A | N/A | Close/Open |
| | Set/Reset I^2t | N/A | Save | Save |
| | Password | N/A | N/A | Save |
| | Configuration | | | |
| | Present Settings | (Get From Relay) | (Get From Relay) | (Get From Relay) |
| | Saved Settings | View | (Load to Relay) | (Load to Relay) |

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

# 4 Protection Functions and Specifications

## 4.1 Protection and Recording functions

### Introduction

This section describes the equations and algorithms that are defined in the F-PRO235 relay Protection functions.
The available functions are 67, 67N, 27/59DT (1-6), 27/59IT (1-2), 50/67 (1-2), 51/67 (1-2), 50N/67N (1-2), 51N/67N (1-2), 46/50, 46/51, 49, 50BF, 46BC, 60CTS, 60VTS, 74TCS (1-2) 81HBL2, I^2t and 79. 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.

### 67 Phase Directional Element

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.

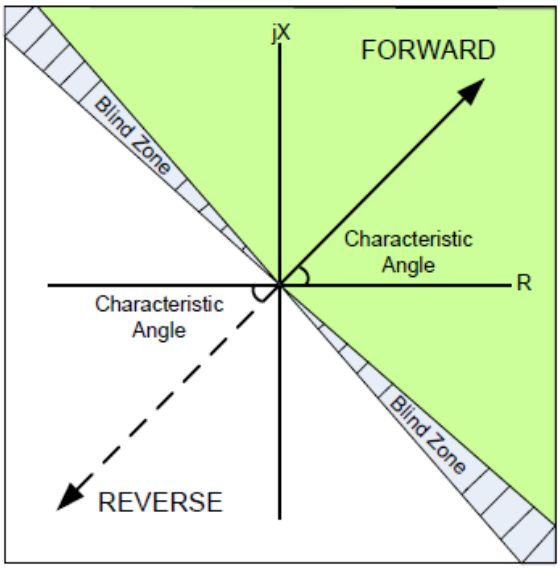



**Figure 4.1: Directional Forward/Reverse Zone**

## 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

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.

## 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 may be set to time delayed or instantaneous operations. The third and fourth stages may be set to have IDMTL, time delayed or instantaneous operations.

| Table 4.1: Directional Over current Element 67 | |
|---|---|
| **Setting Description** | **Range** |
| Characteristic Angle | +95 to -95 degrees |
| Minimum Voltage | 1.0 to 40 V |
| 2 Out of 3 Logic | Enable/Disable |
| VTS Blocking | Enable/disable/Non Directional |

## 67N Directional Function for Neutral Overcurrent

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

In an interconnected system, where fault current can flow in either direction, directional earth fault relays are applied. The 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 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 $3V_0$ 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.

### 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.

**Table 4.2: Directional Overcurrent Element 67N**

| Setting Description | Range |
|---|---|
| Characteristic Angle | +95 to -95 degrees |
| Minimum Voltage | 0.3 to 40 V |
| Measurement Input | ZPS/NPS |
| VTS Blocking | Enable/disable/Non Directional |

## 27/59 DT Phase Definite Time Under / Over Voltage

The Phase Definite time (instantaneous) Under/Over voltage function has six stages. Each individual stage consists of both time delayed and instantaneous protection.
This relay provides protection against under or over voltage from bus/line PT's.

**Under Voltage** Whenever the injected voltage value reaches the **same** or **below** 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** Whenever the injected voltage value reaches the **same** or a**bove** 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.

**Note:** Both of these functions should satisfy the logic gates (ie. OR, AND). 60VTS function can block the UV or OV functions when defined in settings.

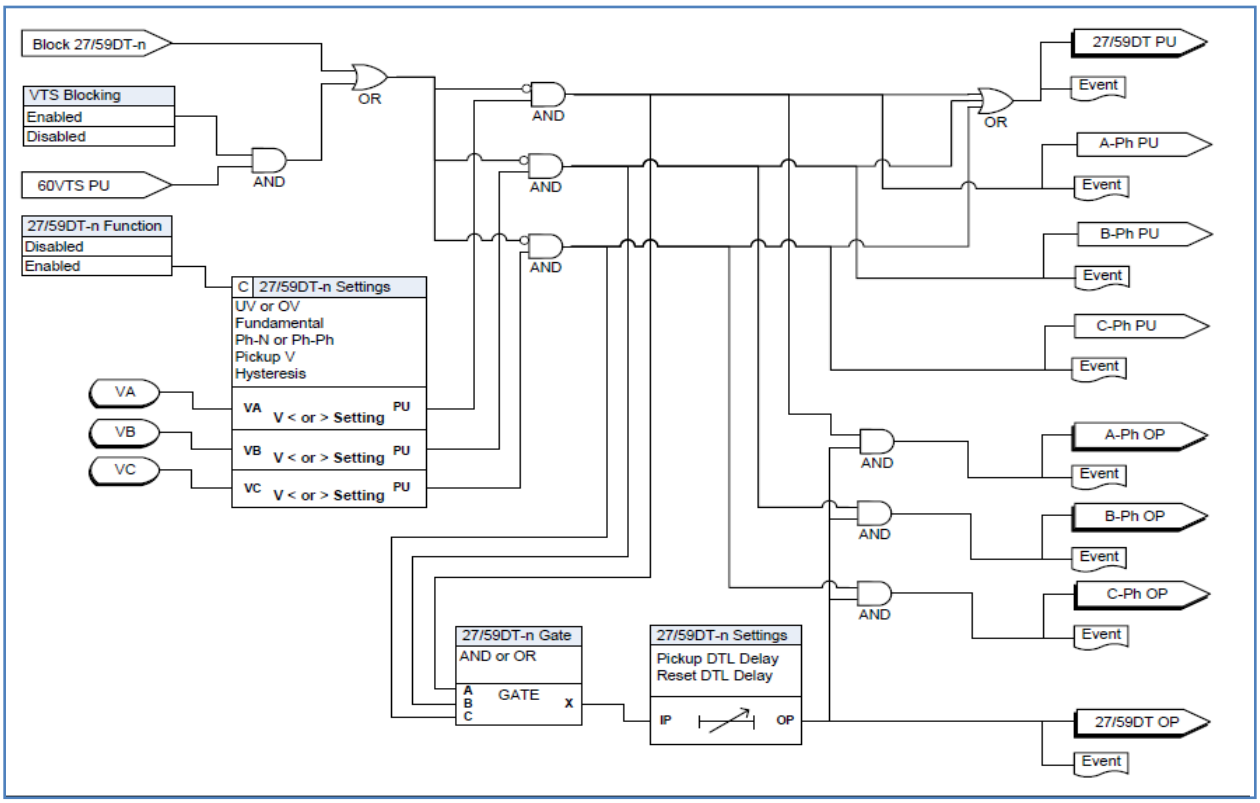



**Figure 4.2: Logic Diagram of 27/59 DT Function**

| Table 4.3: 27/59DT Definite Time Under/Over Voltage Settings (No. of Stages - 2) | |
|---|---|
| **Setting Description** | **Range** |
| Function Activation | Enable/Disable |
| Function Selection | UV / OV |
| Measurement Input | Fundamental |
| Input Type | Ph-N / Ph-Ph |
| Output Gate | AND / OR |
| Pickup V | 3.0 to 250.0V |
| Hysteresis | 1% to 80% |
| Pickup DTL Delay | 0.00 to 999.99 Seconds |
| Reset DTL Delay | 0.00 to 999.99 Seconds |
| VTS Blocking | Enable/Disable |

## 27/59 IT Phase Inverse Time Under /Over Voltage

The Phase inverse time Under/Over voltage function has two stages. Each individual stage consists of both time delayed and instantaneous protection.

This relay provides protection against under or over voltage from bus/line PT's. It is comprised of DTL, IEC standard, extreme, long time inverse curve and user defined curve.

**Under Voltage** Whenever the injected voltage value reaches the **same** or **below** the precise pick-up value, this function gets operated based on curve settings. The drop-out value of this function mainly depends on the % hysteresis.

**Over Voltage** Whenever the injected voltage value reaches the **same** or **above** the precise pick-up value, this function gets operated based on curve settings. The drop-out value of this function mainly depends on the % hysteresis.

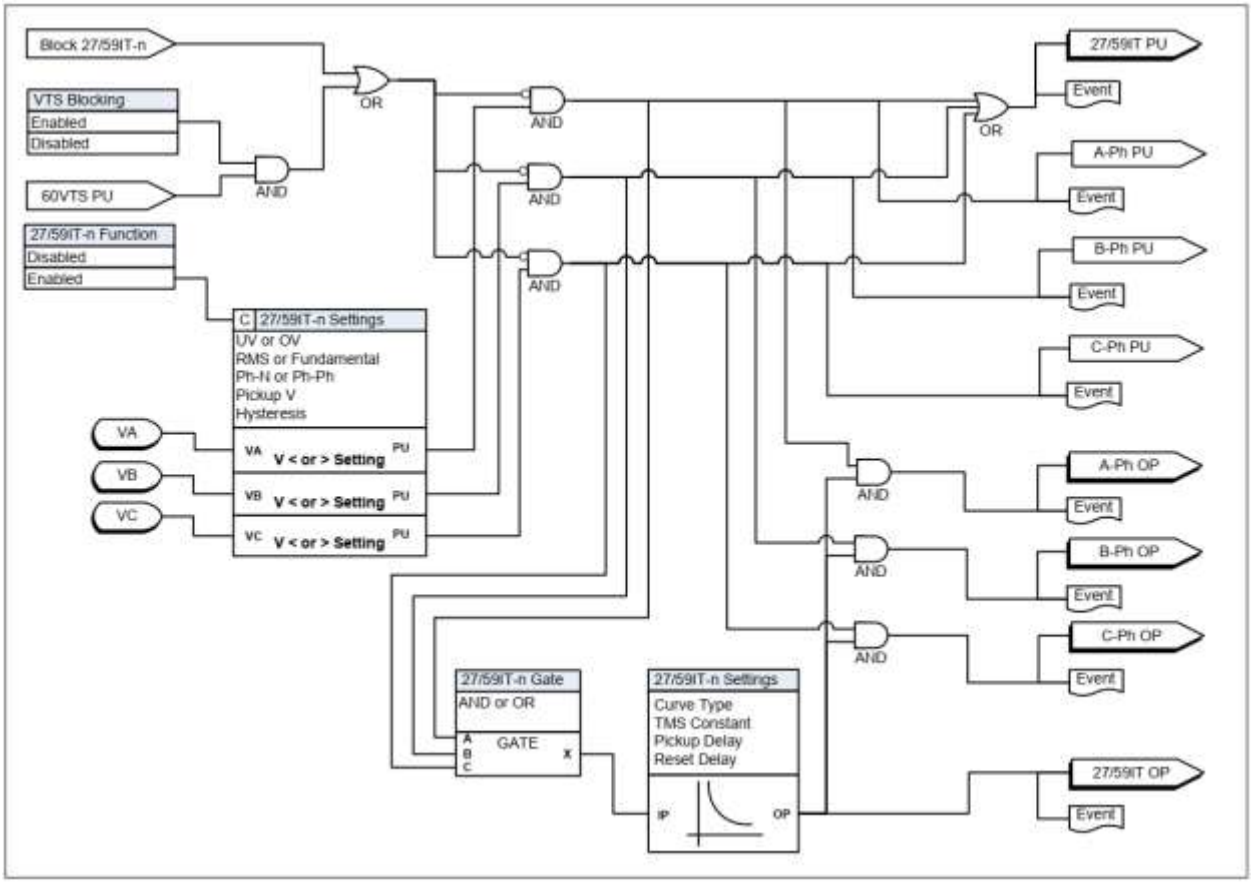



**Figure 4.3: Logic Diagram of 27/59 IT Function**

**27IT(UV)**

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

**59IT(OV)**

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

Operate & Reset time of the inverse characteristics can be calculated using the respective formulas presented above.

**Table 4.3: IEC Curves**

| Sl.No. | Characteristic | A | B | p |
|---|---|---|---|---|
| 1 | Definite Time Lag | 1.0 | 1.0 | 1.0 |
| 2 | IEC Standard Inverse | 1.0 | 0.0 | 1.0 |
| 3 | IEC Extreme Inverse | 40.0 | 1.0 | 2.0 |
| 4 | IEC Long Time Inverse | 5.0 | 2.0 | 2.0 |
| 5 | User-defined | 0.10 to 50.0 | 0.0 to 10.0 | 0.1 to 10.0 |

**Table 4.4: 27/59 IT Inverse Time Under / Over Voltage Settings (No. of Stages - 2)**

| Setting Description | Range |
|---|---|
| Function Activation | Enable / Disable |
| Function Selection | UV / OV |
| Measurement Input | Fundamental |
| Input Type | Ph-N / Ph-Ph |
| Output Gate | AND / OR |
| Pickup V | 3.0 to 250.0 V |
| Hysteresis | 1% to 80% |
| Curve Type | For details see Table 4.9 “IEC Curves” |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00 to 999.99 seconds |
| Reset DTL Delay | 0.0 to 999.99 seconds (applicable if DTL reset is chosen) |
| A | 0.1 to 50.0 (applicable only for user defined characteristics) |
| B | 0.0 to 10.0 (applicable only for user defined characteristics) |
| P | 0.1 to 10.0 (applicable only for user defined characteristics) |
| VTS Blocking | Enable/disable |

## 50/67 Phase Overcurrent

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

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

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

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

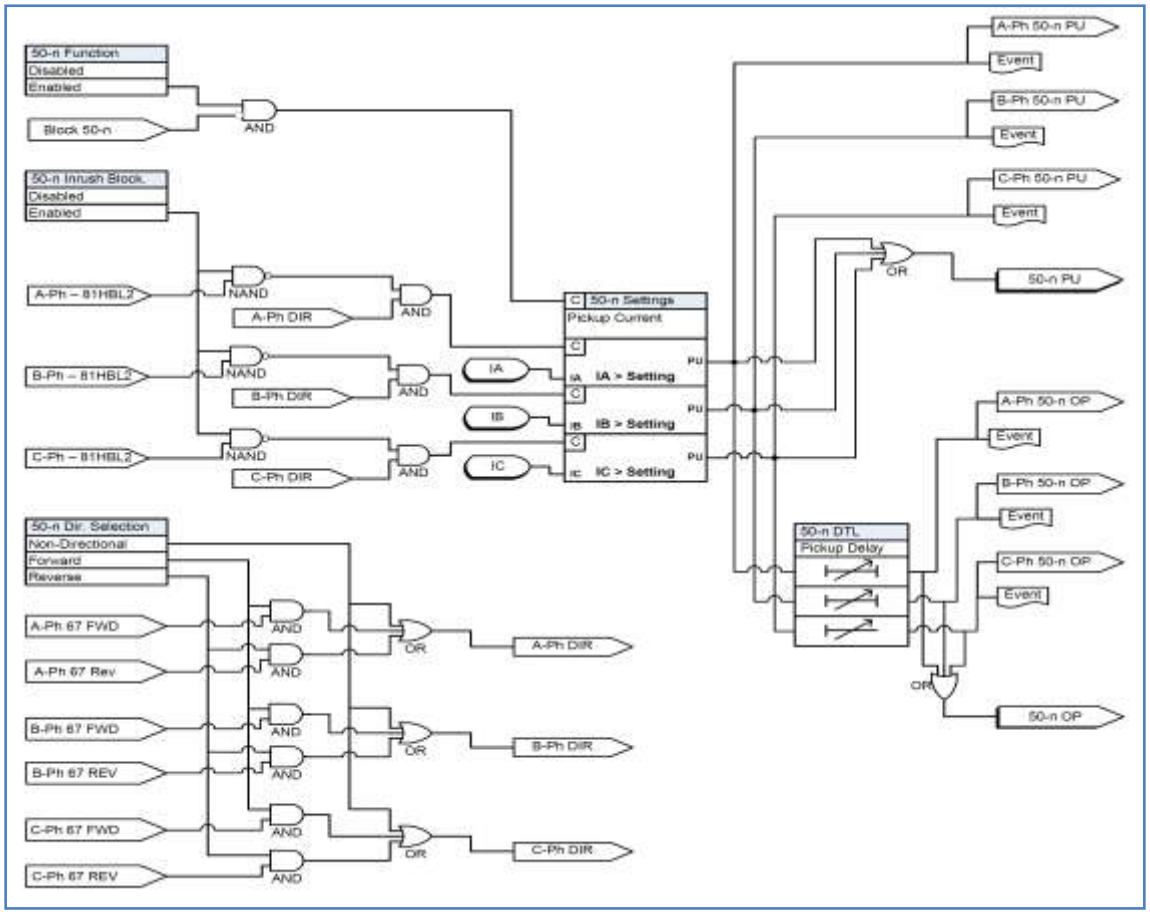



**Figure 4.4: Logic Diagram of 50/67 Function**

| Table 4.5: 50/67 Phase Over current Settings (No. of Stages - 2) | |
|---|---|
| **Setting Description** | **Range** |
| 50/67-1 and 50/67-2 | Enable/disable |
| Direction Selection | Forward/ Reverse/ Non Dir |
| Pickup current, I | 0.25 to 125.00 (5 A) / 0.05 to 25 (1 A) |
| Pickup DTL Delay | 0.00 (0.01 if FWD/REV) to 999.99 seconds |
| Inrush Blocking | Enable/disable |

## 51/67 IDMTL Phase Overcurrent

Relay co-ordination can be achieved by means of adjusting Time Multiplier Settings (TMS), current setting or a combination of both time and current. Based on the fault, the relay can be used with current grading. If fault current is approximately constant then time grading can be used. For grid connected stations combination of both is used. When $Z_{source}$ (the impedance between the relay and the power source) is small compared to that of the protected section $Z_L$, there is an appreciable difference between the current for a fault at the far end of the section ($E_{source}$ / ($Z_{source}$+$Z_{line}$), and the current for a fault at the near end ($E_{source}/Z_{source}$). When operating time is inversely proportional to the current, the relay operates faster for a fault nearer the power source, and the operating time is more for a fault at far end. Grading by time is used in rare cases since it can often lead to excessive fault clearance time at substations where the fault level is high. For these reasons the most commonly applied characteristic in coordinating Overcurrent relays is the IDMTL type.
Each function has independent setting for direction selection – Non Direction / Forward / Reverse. Function 51/67 provides five IEC inverse time curve types, three IEEE inverse time curve types of Overcurrent protection and one user- defined curve as well as definite time delayed protection also i.e. DTL. The equation and the parameters of Function 51/67-1and 51/67-2 are listed in following tables. Each element (51/67-1, 51/67-2) can be independently inhibited via external input status which can be configured from input matrix. This will help in achieving comprehensive blocking schemes.

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

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

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

| Table 4.6: IEC and IEEE Curves | | | | | |
|---|---|---|---|---|---|
| **Sl. No** | **Characteristic** | **A** | **B** | **p** | **TR** |
| 1 | Definite Time Lag (DTL) | - | - | - | - |
| 2 | IEC Standard Inverse-3 | 0.14 | 0 | 0.02 | 13.50 |
| 3 | IEC Standard Inverse-1 | 0.0613 | 0 | 0.02 | 6.00 |
| 4 | IEC Very Inverse | 13.5 | 0 | 1.0 | 47.30 |
| 5 | IEC Extremely Inverse | 80.0 | 0 | 2.0 | 80.00 |
| 6 | IEC Long Time Inverse | 120.0 | 0 | 1.0 | 120.00 |
| 7 | IEEE Moderately Inverse | 0.0103 | 0.0228 | 0.02 | 0.97 |
| 8 | IEEE Very Inverse | 3.9220 | 0.0982 | 2.0 | 4.32 |
| 9 | IEEE Extremely Inverse | 5.6400 | 0.0243 | 2.0 | 5.82 |
| 10 | User-defined | 0.0010 to 1000.000 | 0.0 to 10.0 | 0.01 to 100.0 | 0.1 to 150.0 |

| Table 4.7: 51/67 Phase Overcurrent Settings(No. of Stages - 2) | |
|---|---|
| **Setting Description** | **Range** |
| 51/67-1 and 51/67-2 | Enable/disable |
| Direction Selection | Forward/ Reverse/ Non Dir |
| Pickup Current, I | 0.25 to 50 (5 A) / 0.05 to 10 (1 A) |
| Curve Type | For details see “IEC and IEEE Curves” Table |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00 (0.01 if FWD/REV) to 999.99 seconds |
| Reset Delay | DTL/ANSI Decay |
| Reset DTL Delay | 0.0 to 99.9 seconds (applicable if DTL reset is chosen) |
| Constant A | 0.0010 to 1000.0000 (applicable only for user defined characteristics) |
| Constant B | 0.0000 to 10.0000 (applicable only for user defined characteristics) |
| Constant P | 0.01 to 100.00 (applicable only for user defined characteristics) |
| TR | 0.10 to 150.00 (applicable only for user defined characteristics) |
| Inrush Block | Enable/disable |

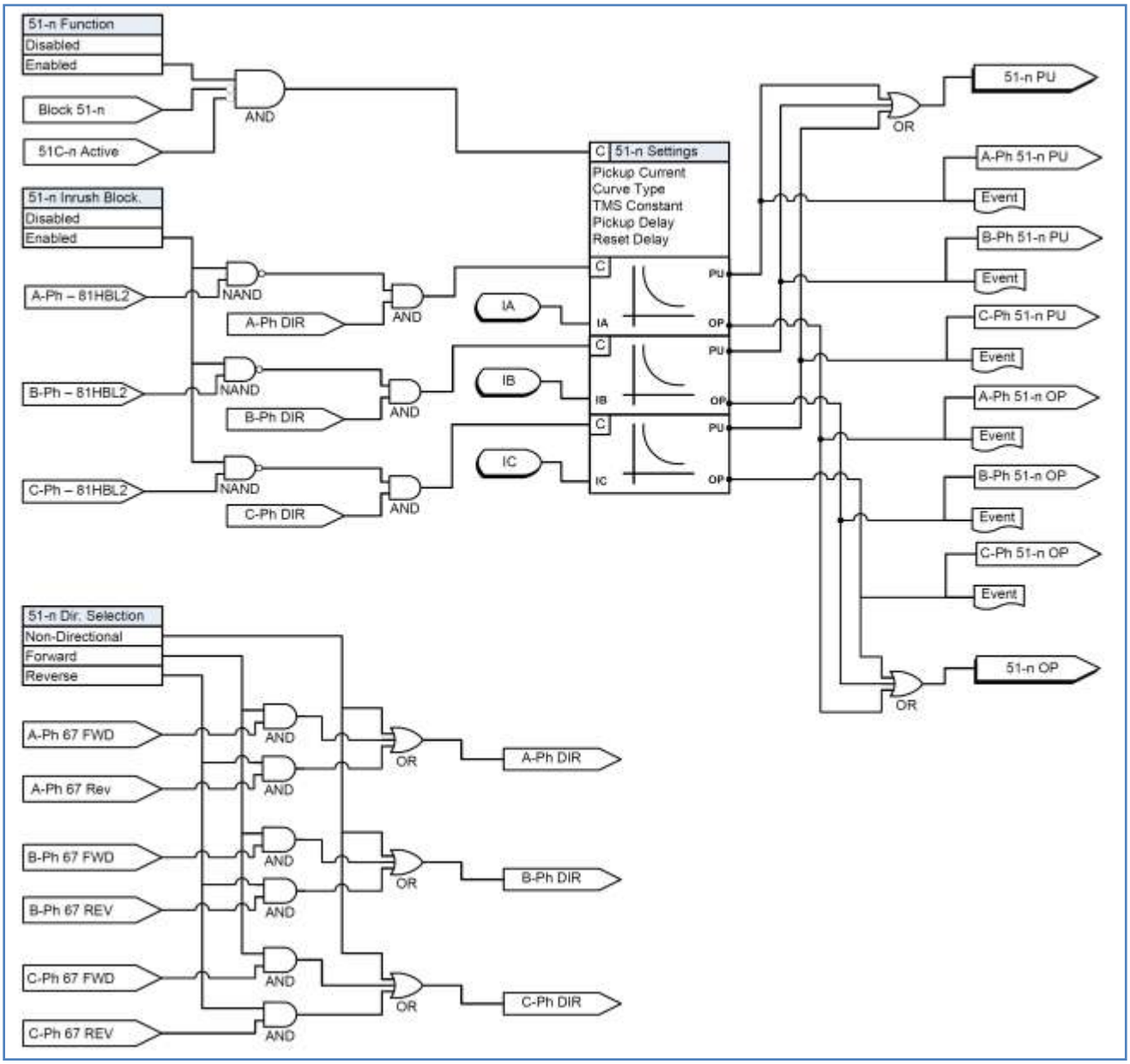



**Figure 4.5: Logic Diagram of 51/67 Function**

## 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 summates all the three phase currents and calculates 3Io 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, i.e. instantaneous or definite time

Derived neutral current is compared with the set value of current after filtering. If calculated current is greater than the set current with the function enabled relay will go for the operation after the set time delay. Relay is provided with the additional feature of “Inrush Blocking”. This is the 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 rightness of the polarity of directional over current element is to be verified in metering.

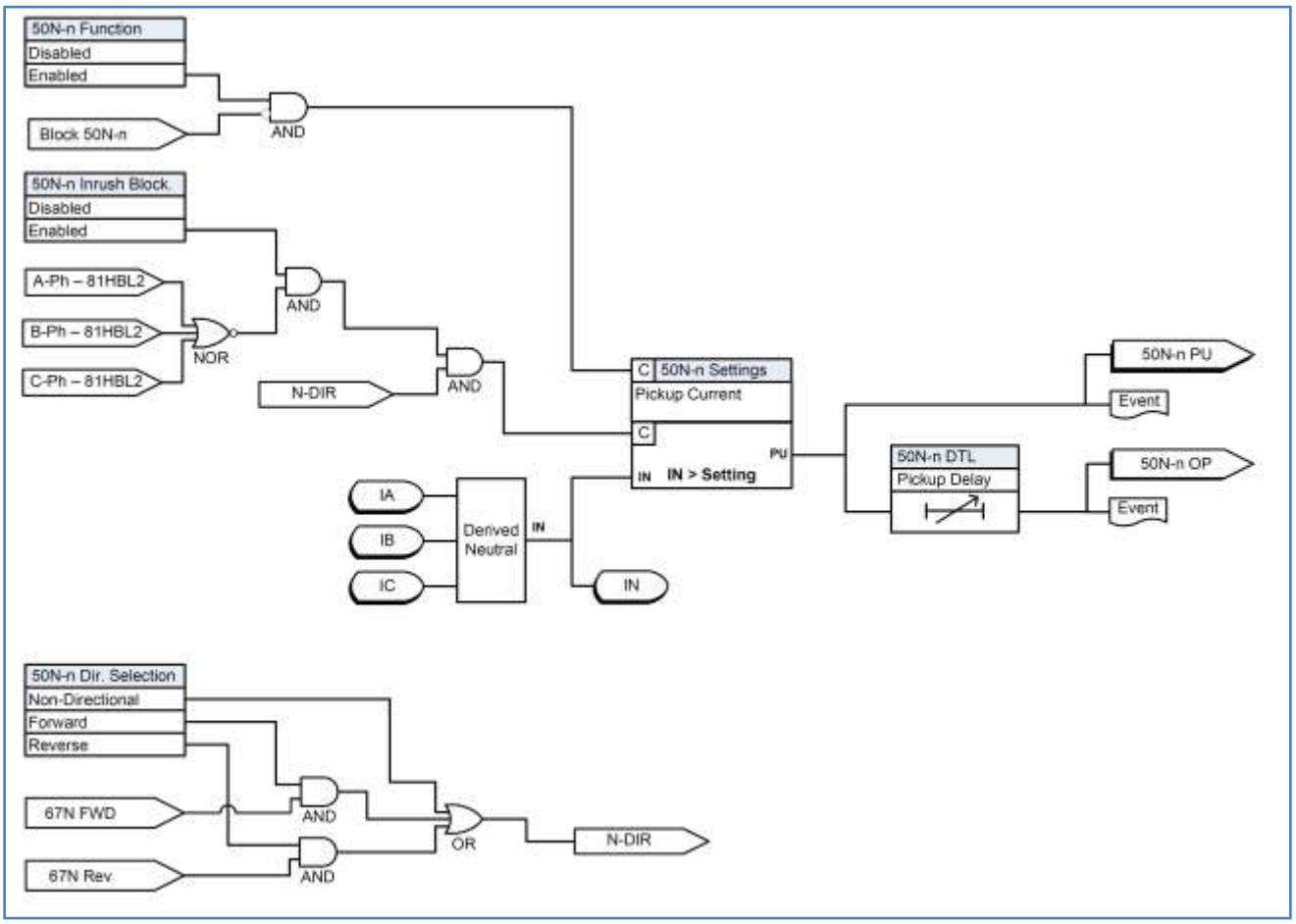



**Figure 4.6: Logic Diagram of 50N/67N Function**

| Table 4.8: 50N/67N Derived Neutral Overcurrent Settings(No. of Stages - 2) | |
|---|---|
| **Setting Description** | **Range** |
| 50N/67N-1 and 50N/67N-2 | Enable/disable |
| Directional Selection | Non Dir/ FWD/ REV |
| Pickup $I_N$ | 0.25 to 125 (5 A) / 0.05 to 25 (1 A) |
| Pickup DTL Delay | 0.00 (0.01 if FWD/REV 0.01) to 999.99 seconds |
| Inrush Block | Enable/disable |
| Inrush Block | Enable/disable |

## 51N/67N IDMTL Derived Neutral Overcurrent

Neutral Overcurrent provides protection for line-to-ground faults. All the curve definitions are the same as the phase Overcurrent except that this function uses $3I_0$ rather than phase current. The equation is:

**Pickup:**

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

**Reset:**

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

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 as shown. If user- selectable curve is chosen, it can be created using the parameters A, B and p.
For 46-51 (IDMTL), the curve definitions are same as for Phase Overcurrent 51(IDMTL), except in case of Standard Inverse wherein only Standard Inverse 3 is used. In the characteristic of the Overcurrent function can be rescaled by clicking on the graph. By using the right mouse key and by making a box around the area of interest; the zoomed graph will be shown. The characteristic can be printed by pressing the Print Graph option.

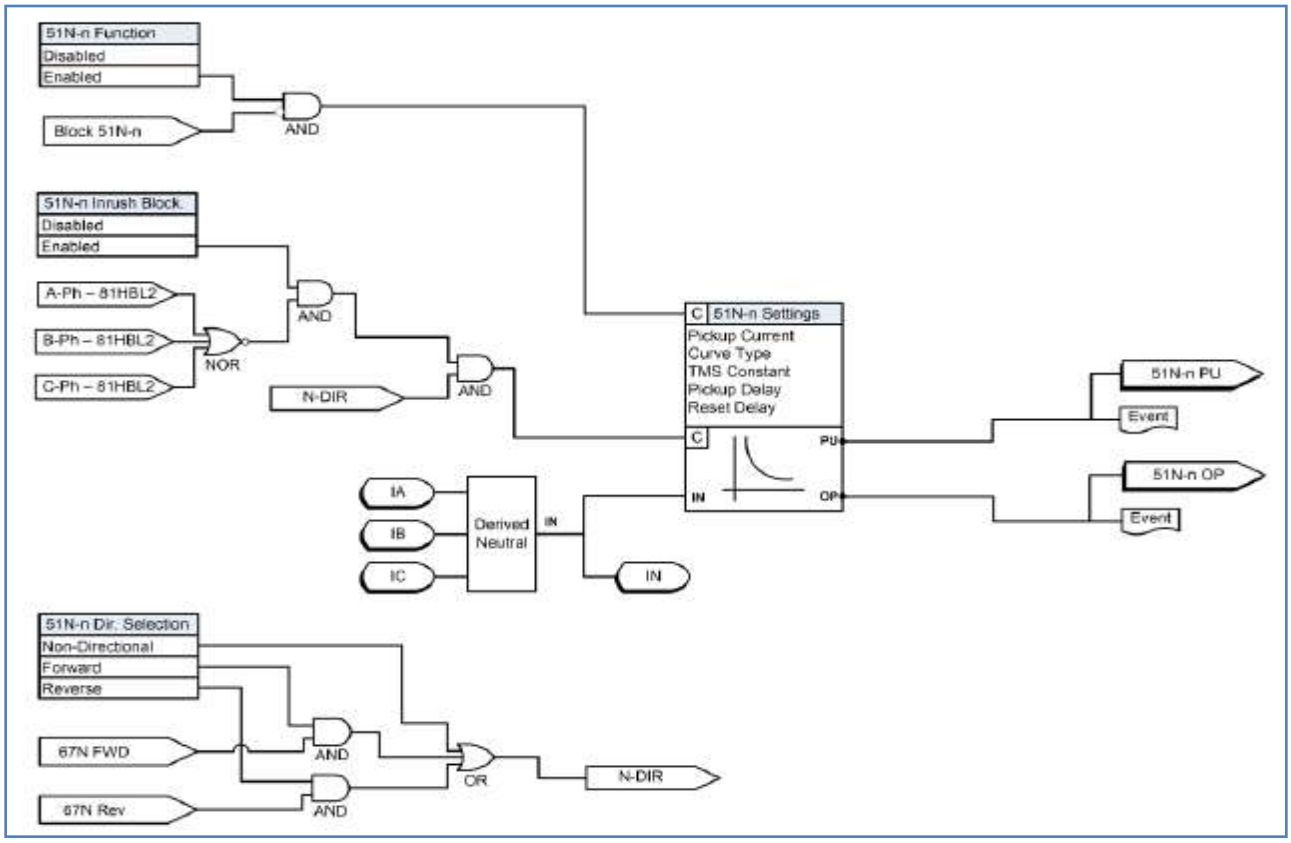



**Figure 4.7: Logic Diagram of 51N/67N Function**

| Table 4.8: 51N/67N Derived Neutral Over current Settings (No. of Stages - 2) | |
|---|---|
| **Setting Description** | **Range** |
| 51N/67N-1 and 51N/67N-2 | Enable/disable |
| Direction Selection | Forward/ Reverse/ Non-Dir |
| Pickup $I_N$ | 0.25 to 50 (5 A) / 0.05 to 10 (1 A) |
| Curve Type | For details see “IEC and IEEE Curves” Table |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00 (0.01 if FWD/REV) to 999.99 seconds |
| Reset Delay | DTL/ANSI Decay |
| Reset DTL Delay | 0.0 to 99.9 seconds (applicable if DTL reset is chosen) |
| A | 0.0010 to 1000.0000 (applicable only for user defined characteristics) |
| B | 0.0000 to 10.0000 (applicable only for user defined characteristics) |
| P | 0.01 to 100.00 (applicable only for user defined characteristics) |
| TR | 0.10 to 150.00 (applicable only for user defined characteristics) |
| Inrush Block | Enable/disable |

## 46-50/51 Negative Sequence Over current

Negative Sequence Overcurrent provides protection for any unbalanced loading which may occur during phase to phase faults and also in detecting asymmetrical faults with magnitude lower than the maximum load current. Function 46-50, 46-51 is similar to 50 or 51 except derived negative sequence current is utilized to drive the algorithm.

User can define the reset delay for the relay; It can be set as DTL or by ANSI delay. Setting of the timer to a value other than zero, delays the resetting of the protection element timers for this period. IDMTL equation, negative sequence current ($I_2$) is used instead of I.

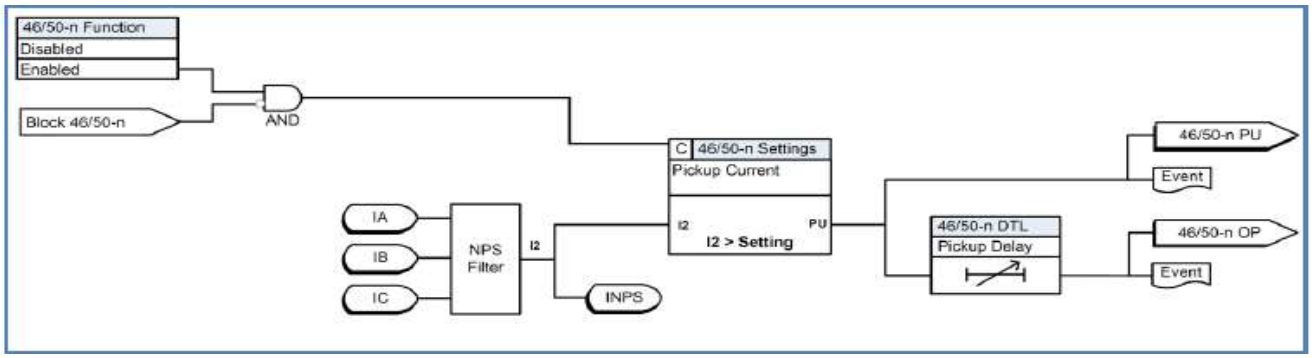



**Figure 4.8: Logic Diagram of 46/50 Function**

| Table 4.9: 46/50 Negative Sequence Over current Settings | |
|---|---|
| **Setting Description** | **Range** |
| Function Activation | Enable/disable |
| Pickup | 0.05 to 0.95 (1 A) / 0.25 to 4.75 (5 A) |
| Pickup Delay | 0.00 to 999.99 |

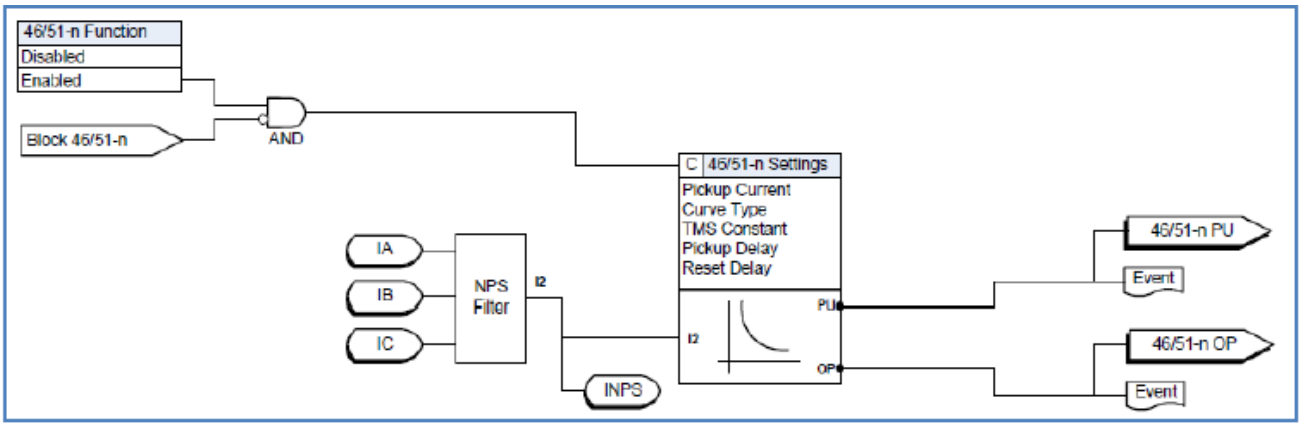



**Figure 4.9: Logic Diagram of 46/51 Function**

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

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

| Table 4.10: 46/51 (IDMTL) Negative Sequence Overcurrent Settings | |
|---|---|
| **Setting Description** | **Range** |
| Function Activation | Enable/Disable |
| Pickup | 0.05 to 0.95 (1 A) / 0.25 to 4.75 (5 A) |
| Curve Type | For details see Table "IEC and IEEE Curves" |
| TMS | 0.01 to 10.00 |
| Pickup DTL Delay | 0.00 to 999.99 seconds if chosen for DTL characteristics |
| Reset Delay | DTL / ANSI Decay |
| Reset DTL Delay | 0.0 to 99.9 seconds (applicable if DTL reset is chosen) |
| A | 0.0010 to 1000.0000 (applicable only for user defined characteristics) |
| B | 0.0000 to 10.0000 (applicable only for user defined characteristics) |
| p | 0.01 to 100.00 (applicable only for user defined characteristics) |
| TR | 0.10 to 150.00 (applicable only for user defined characteristics) |

## 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:

$$t = \tau . \mathrm{Ln} \frac{I^2 - I_P^2}{I^2 - I_B^2}$$

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 |
| $I_{RMS}$ | = 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:

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

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

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

Where

θ = Thermal state in percentage at time t

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

I = Effective relay current.

Iθ = Thermal overload setting

τ = Thermal time constant in minutes.

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

$\theta = I^2/I_\theta^2 * 100\%$

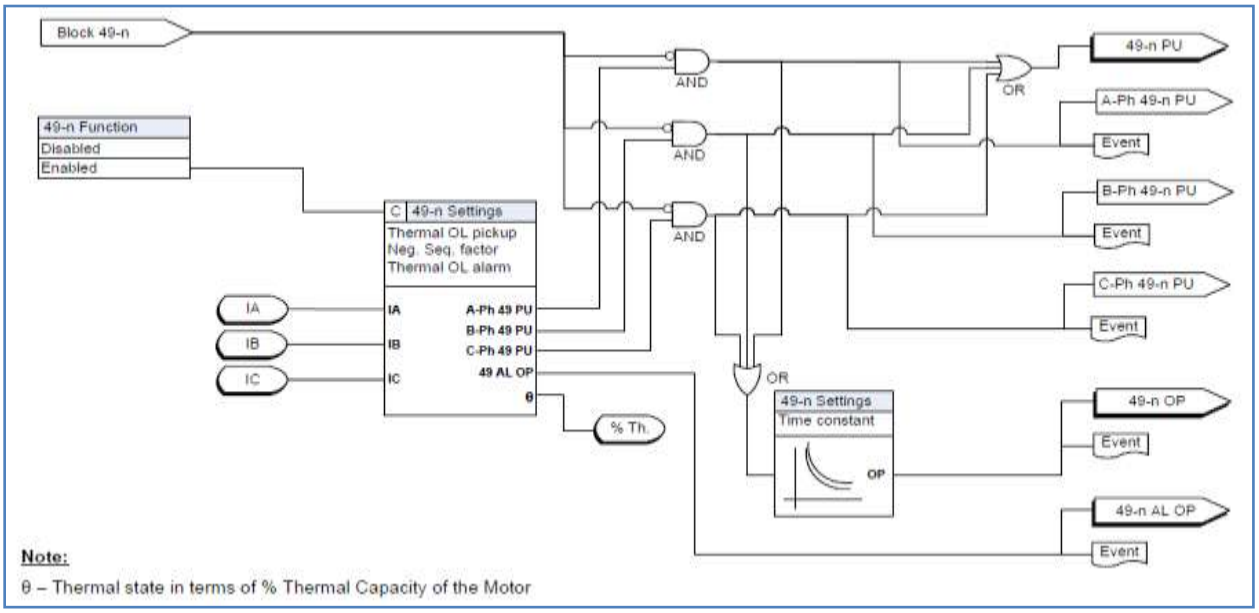



**Figure 4.10: Logic Diagram of 49 Function**

| **Table 4.11: 49 Thermal Overload Settings** | |
|---|---|
| **Setting Description** | **Range** |
| Function Activation | Enable/disable |
| Thermal Overload Pick up | 0.2 to 2.0A (1A) / 1.0 to 10.0 A (5A) |
| Time constant(τ) | 0.5 to 100 Min. |
| Negative Sequence Weighing Factor(K) | 0.0 to 10 |
| Thermal Overload Alarm | Enable/Disable |
| Pickup % th | 50% to 100% |

## 50BF Breaker Failure

There are two sets of breaker failure protection functions. When breaker failure is initiated by an external trip or other internal logic (user-settable through the output matrix) and the breaker current still exists, two timers (T1 and T2 – user-settable) are started. After these timers are timed out, and if the current still exists indicating a breaker failure, the output of this function is set high. Use the two outputs of this function to trip another trip coil or the next level of breakers, such as bus breakers. The breaker failure protection logic diagram is shown below. Phase current supervision is fixed at 4% of I nominal.

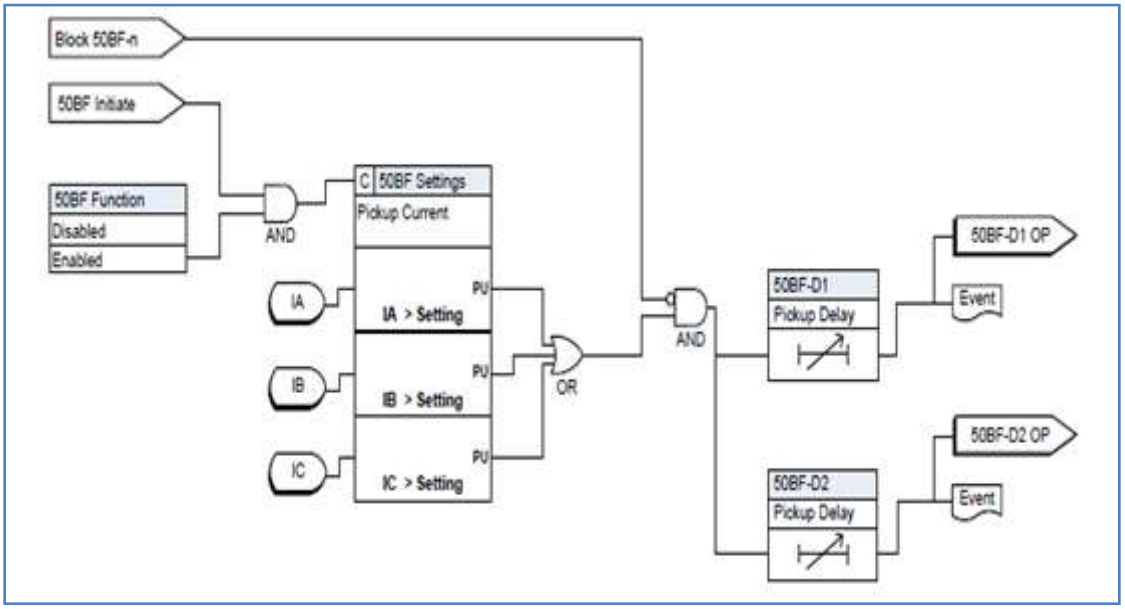



**Figure 4.11: Logic Diagram of 50BF Function**

| Table 4.12: 50BF Breaker Failure Settings | |
|---|---|
| **Setting Description** | **Range** |
| Function Activation | Enable/Disable |
| Pick up I | 0.05 to 2.0A (1A) / 0.25 to 10.0A (5A) |
| Pickup Delay 1 | 0.00 to 999.99 seconds |
| Pickup Delay 2 | 0.00 to 999.99 seconds |

## 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.

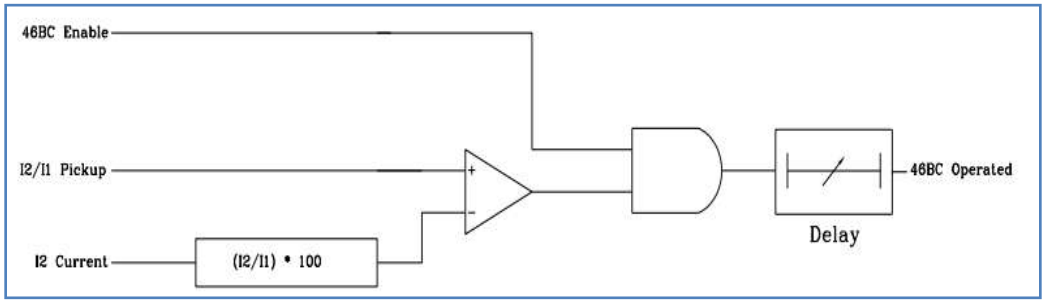



**Figure 4.12: Logic Diagram of 46BC Function**

| Table 4.13 46BC Broken Conductor | |
|---|---|
| **Setting Description** | **Range** |
| Function Activation | Enable/Disable |
| Pickup I2/I1 | 20.0% to 100.0 % |
| Pickup Delay | 0.02 to 999.99 seconds |

## 60CTS- CT Supervision

Current Supervision function is employed to detect failure of the current inputs to the relay. The function operates based on the condition that 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.

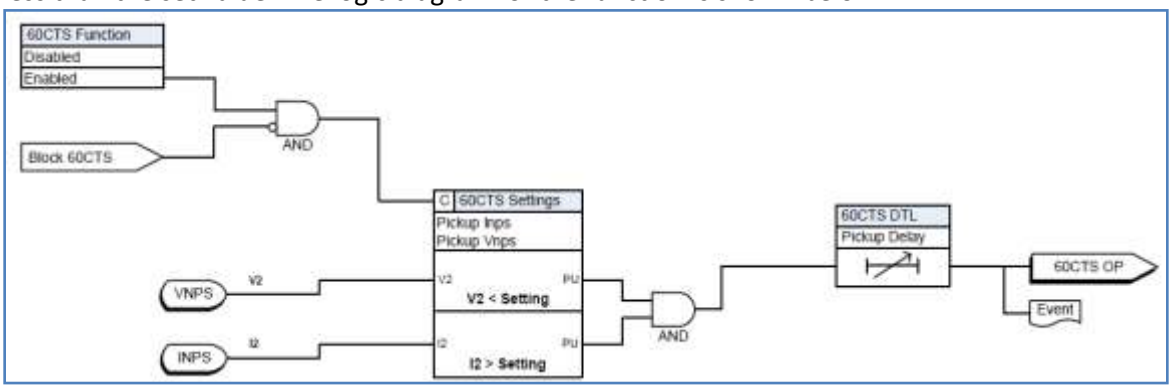



**Figure 4.13: Logic Diagram of 60 CTS Function**

| Table 4.14: 60CTS – CT Supervision | |
|---|---|
| Setting Description | Range |
| Function | Enable/Disable |
| Vnps Pickup | 7.0 to 110.0 V |
| Inps Pickup | 0.25 to 5.00 A (5A)<br>0.05 to 1.00 A (1A) |
| Pickup delay | 0.03 to 999.99 seconds |

## 60VTS – VT Supervision

Voltage Supervision function is to detect loss of one, two or even all there phases voltage inputs to 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. This causes mal-operation of directional elements and the consequence is instability of power system. Thus the VT Supervision function is incorporated in the directional relay. On detection of VT failure, the function blocks the other 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. If the negative and positive sequence voltage exceeds the set value, the function is blocked as it will increase on a fault only.

**Operation**:

**Condition 1:** Whenever the Injected neutral voltage (Vn) is less than the Pickup value, the function operates.

**Condition 2:** Whenever the Injected Phase - Phase voltage (V3ph) is more than the Pickup value, the function operates.

**Condition 3:** Whenever there is no potential in any one of the phases, the function operates.

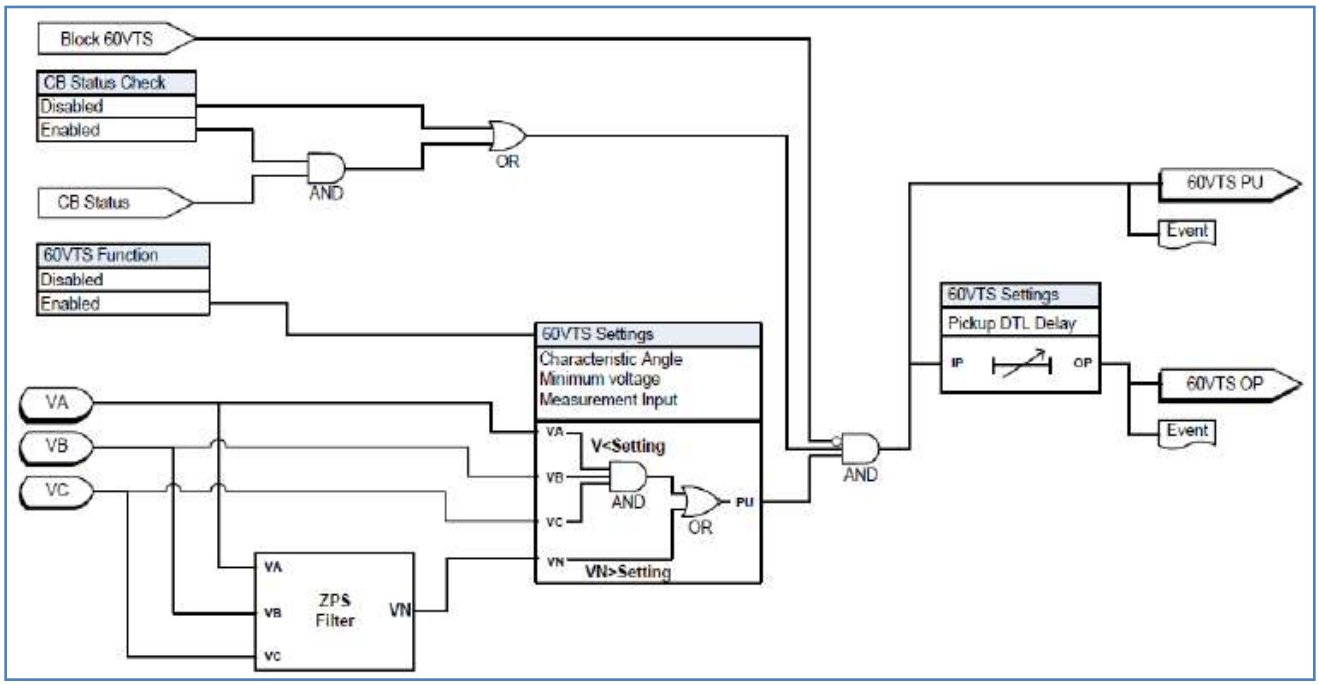



**Figure 4.14: Logic Diagram of 60 VTS Function**

| Table 4.15: 60VTS- VT Supervision Settings | |
|---|---|
| **Setting Description** | **Range** |
| Function | Enable / Disable |
| I1 Blocking | 0.1 to 10A |
| 3Io Blocking | 0.1 to 10A |
| Negative Sequence Monitoring | Enable / Disable |
| Vnps | 7.0 to 110.0 volts |
| Inps | 0.05 to 1.00 A |

## 74TCS Trip Circuit Supervision

74TCS function detects trip circuit failure when 74 TCS 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. User has to configure one of the external inputs to 74TCS for Trip Circuit Supervision purpose.

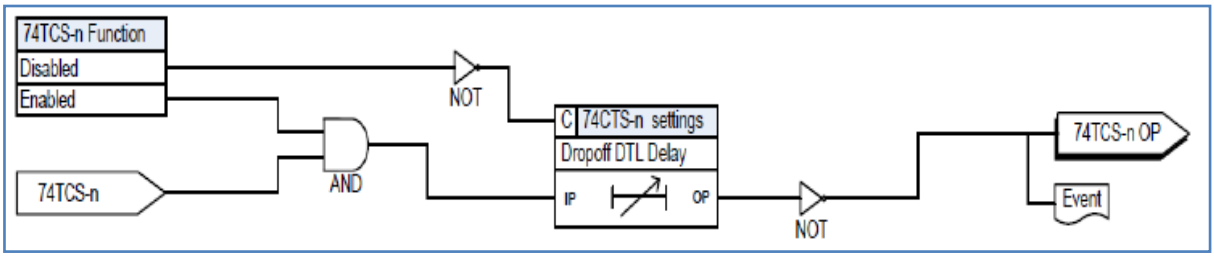



**Figure 4.15: Logic Diagram of 74TCS Function**

| Table 4.16: 74TCS Trip Circuit Supervision (No. of Stages - 2) | |
|---|---|
| **Setting Description** | **Range** |
| 74TCS-1 | Enable/Disable |
| Name | TCS-1 (The name is editable up to 12 characters) |
| Drop Off Delay | 0.00 to 9.99 seconds |

## 81HBL2 Inrush Block

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

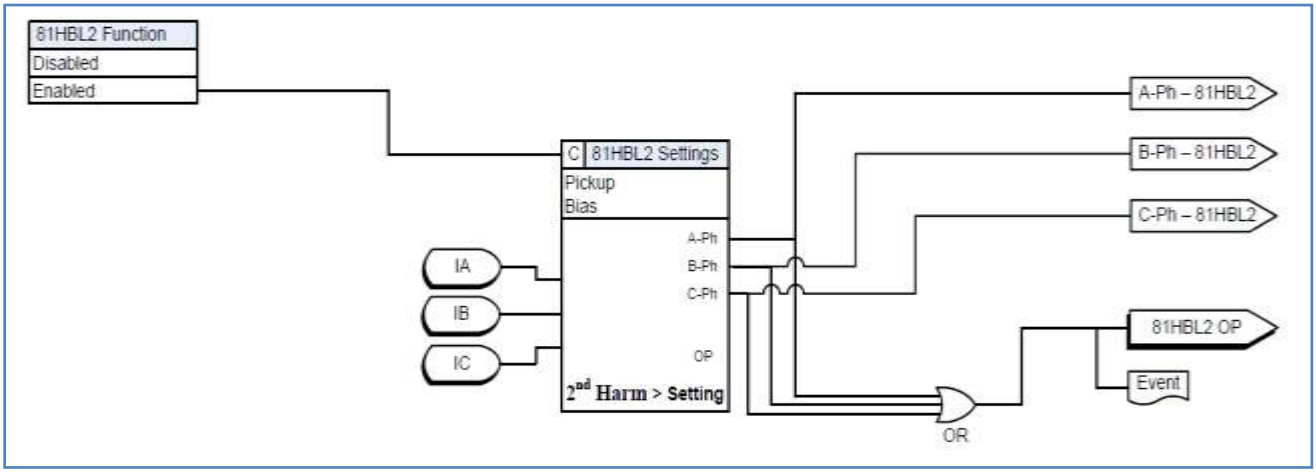



**Figure 4.16: Logic Diagram of 81HBL2 Function**

| Table 4.17: 81HBL2 Inrush Block | |
|---|---|
| **Setting Description** | **Range** |
| 81HBL2 | Enable/Disable |
| Cross Blocking | Enable/Disable |
| Percentage of second harmonic current I2nd | 5 to 50 % |

## 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.

| Table 4.18: 79 Recloser | |
|---|---|
| **Setting Description** | **Range** |
| 79 Recloser | 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 |

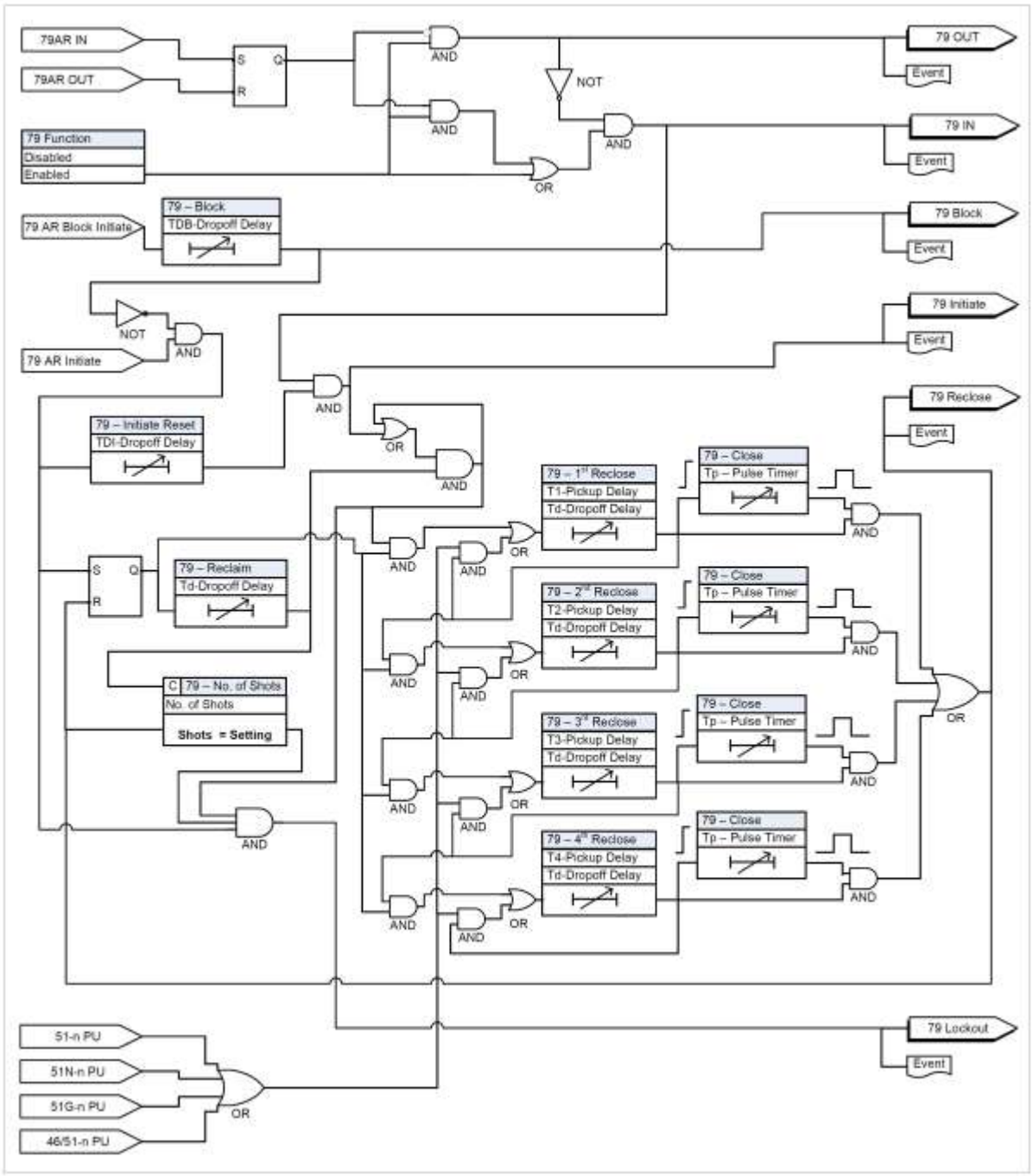



**Figure 4.17: Logic Diagram of 79 Function**

## Breaker Monitoring

The F-PRO breaker monitoring feature allows user to monitor the feeder breaker in detail. An accumulated $I^2t$ function can be used to determine the status of breaker wear and tear and breaker performance.

Breaker monitoring can be configured for measuring the clearing time, mechanism time, trip coil energized time, operations count, fault operations or other user-defined conditions. Different users may require different feature sets to monitor the breaker. The breaker monitoring functions are realized through the Breaker Logic functions.

All associated breaker monitoring values are available in the terminal UI and SCADA interfaces. User can reset or preset all associated breaker monitoring values from the terminal UI or SCADA interface.

## $I^2t$

F-PRO has an accumulated $I^2t$ function used for monitoring the wear and tear of the breaker due to fault interruption. This function is available for the breaker. 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 $I^2t$ function is only be 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 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.

**Table 4.19: $I^2t$ CB**

| Setting Description | Range |
|---|---|
| $I^2t$ CB | Enable/disable |
| $I^2t$ limit | 0.1 to 99999.9 kA^2 seconds |

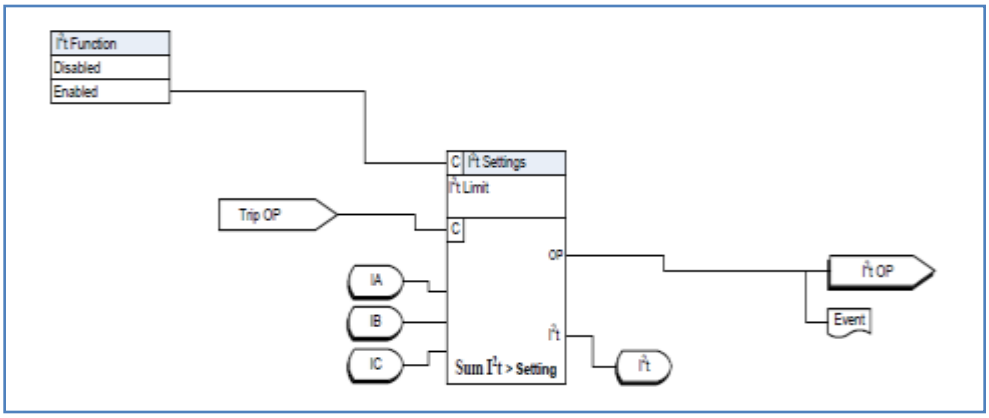



**Figure 4.18: Logic Function of $I^2t$ Function**

## ProLogic

ProLogic is used to create an output based on qualified multiple inputs. 20 User Programmable ProLogic control statements can be utilized to create custom logic which may be mapped to output contacts.

User can define or name the function being created and set a pickup and dropout delay. Each ProLogic statement can be used with internal relay functions and external inputs (up to 5 possible inputs) to create the logic output by using Boolean logics such as AND, OR, NAND, NOR, EX-OR, EX-NOR and LATCH.

The output of ProLogic 1 can be nested into ProLogic 2 and so on. If desired, user can illuminate the front target LED on operation of this function by enabling this feature in the LED Output Matrix.. The operations of the ProLogic statements are logged on the events listing. The status of the Prologic can be seen from the record graph by selecting the recorder in the output matrix.

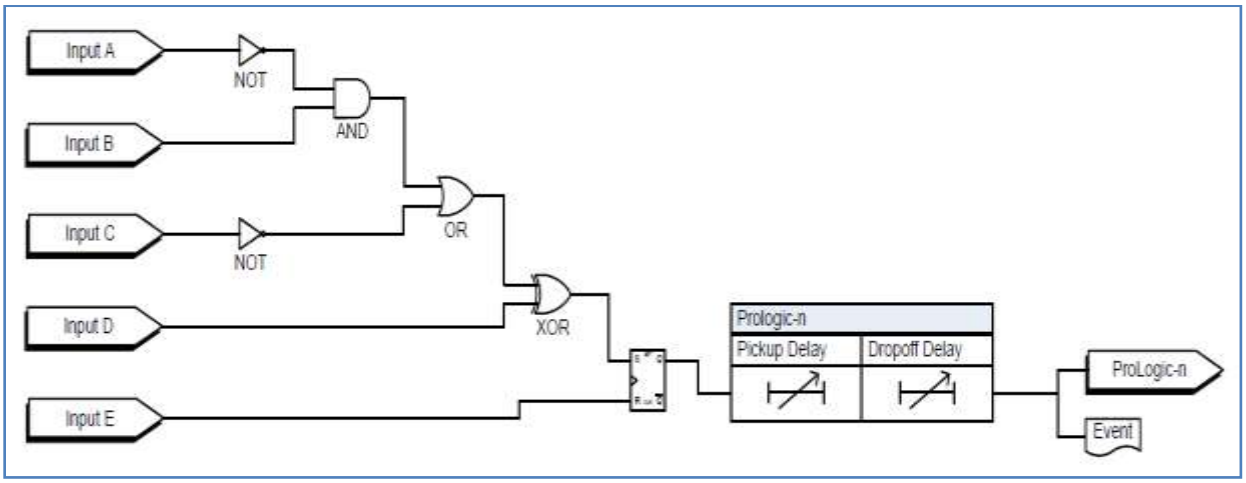



**Figure 4.19: ProLogic Function**

| Table 4.20: ProLogic Setting | |
|---|---|
| Name | ProLogic (The name is editable up to 12 characters) |
| Pickup Delay | 0.00 to 999.00 seconds |
| Dropout Delay | 0.00 to 999.00 seconds |
| A, B, C, D, E | Relay elements as input statements |
| Operators | Boolean-type logic gates |

## Group Change Control Statement

The F-PRO235 relay has Four setting groups (SG1 to SG4). 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 4 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 configuration changes during a user-initiated manual setting; the change does not disrupt the relay protection functions. 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 to the protection processor. 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.

# 4.2 Recording Functions

## Introduction

The relay has high speed fault recording and logging functions to allow the user to analyze faults and to review the operation of the overall protection scheme. Event recordings provides storage for the event log. If the relay has reached its recording capacity, new records overwrite the oldest records.

## Fault Recording

F-PRO provides DFR-quality fault recording, capturing input signal waveforms and external digital input states at a rate of 32 samples per cycle. Each record also contains the timing of the internal logic picked up by the relay (e.g. 51 trip). Obtain this information by uploading the records from the relay via the Relay Control Panel file transfer process and view them with RecordGraph software.

The quantities recorded are:

- 6 analog channels: 3 Phase voltage and 3 Phase current.
- 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 inputs.

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

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

## Record Duration and Extension

The length of each record is determined by the Record Length setting. Fault record lengths can be set between 1 and 20 seconds. Pre-trigger times can be settable from 0.1 to 0.5 seconds for fault records and are included as part of the normal record length.

F-PRO 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 20 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, for which new over- lapping 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*

## Event Recording

The event recording provides permanent storage of the event logs. An event record can be created automatically or manually.

## 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 can store up to 400 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.

## Retrieval Analysis

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. 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*. The Relay Control Panel's default *Recordings folder* can be set when the relay is initially connected to the PC, as shown in the following image.

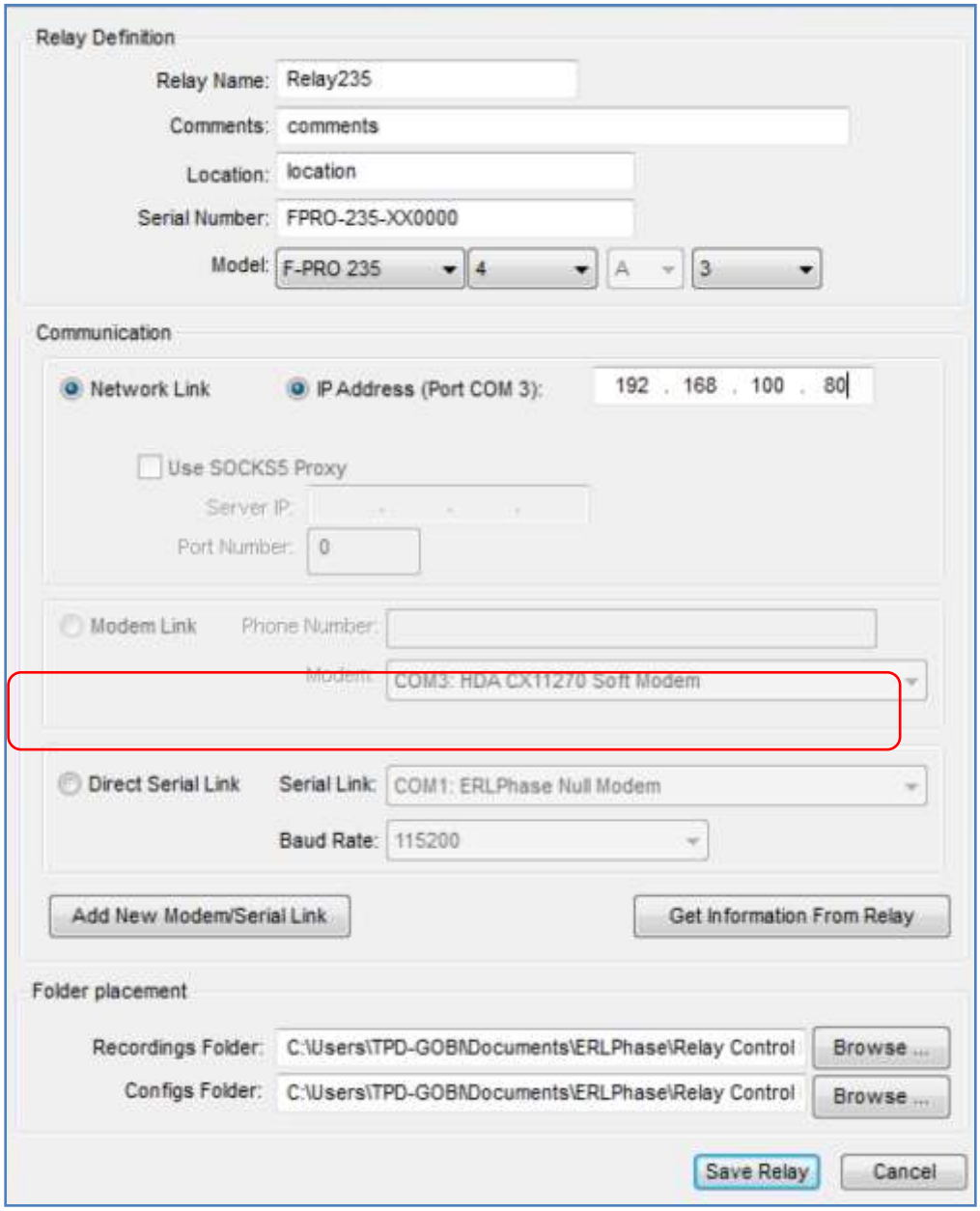



**Figure 4.20: Recording Folder Location**

When transferred to user computer, the record name remains unchanged and the file extension indicates the record type:

1. **.fpr** for transient recording,
2. .**fpe** for an event recording.

## 4.3 Logging Functions

**Event Log**

The F-PRO maintains a log of events in a 1000 entry circular log. Each entry contains the time Logged events include trips, alarms, external input assertions 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 MAR 21, 15:34:19.832: 51/67-1 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 master 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, Record Base View* and *Record Graph*. 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 the F-PRO event messages. For details see “Event Messages” in Appendix D.

**Fault Log**

The F-PRO stores a log of faults in a 20 entry circular log. Each entry contains the time of the fault, fault type, faulted phase, fault quantities as per the below table. Fault log will be triggered only for trip condition and it won't log for an alarm condition.

| Table 4.21: Fault Log | |
|---|---|
| **Fault Type** | **Fault Quantities** |
| 27DT Under Voltage | - VA / VB / VC / VN Phasors |
| 27IT Inverse time Under Voltage | - VA / VB / VC / VN Phasors |
| 59DT Over Voltage | - VA / VB / VC / VN Phasors |
| 59IT Inverse Time Over Voltage | - VA / VB / VC / VN Phasors |
| 50/67-1 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 50/67-2 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 51/67-1 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 51/67-2 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 50/67N-1 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 50/67N-2 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 51/67N-1 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 51/67N-2 | - Main VA/ VB/ VC/ VN/ IA/ IB/ IC/ IN Phasors |
| 46/50 | - Main IA/ IB/ IC/ I2 Phasors |
| 46/51 | - Main IA/ IB/ IC/ I2 Phasors |
| 49 | - Phase Indication (digital indication of A/B/C phases)<br>- Main IA/ IB/ IC/ IN Phasors |
| 50BF-1 | - Phase Indication (digital indication of A/B/C phases)<br>- Main IA/ IB/ IC/ IN Phasors |
| 50BF-2 | - Phase Indication (digital indication of A/B/C phases)<br>- Main IA/ IB/ IC/ IN Phasors |
| 46 BC | -Main IA/ IB/ IC/ I2/ I1 Phasors |

The fault log can be viewed in three ways:

- Relay Front HMI
- Relay Control Panel interface is in the Events tab
- IEC61850 SCADA protocol included in the F-PRO allows the SCADA client access to Trip event data.

# 5 Data Communications

## 5.1 Introduction

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

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

## 5.2 SCADA Protocol

**Modbus Protocol**

The relay supports either a Modbus RTU or Modbus ASCII SCADA connection. Modbus is available exclusively via a direct serial link. Serial Modbus communications can be utilized exclusively via serial COM 2 (RS485 port), which is located on the rear of the relay. An external RS-485 to RS-232 converter is required to connect the relay to an RS-232 port of PC. For details on connecting to serial Port, see "Communicating with IED" and "Communication Port Details".

Complete details regarding the Modbus protocol emulation and data point lists can be found in "Modbus RTU Communication Protocol" in Appendix E on page Appendix E-1

**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 COM 2. The 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 IED" and "Communication Port Details".

Complete details regarding the IEC 103 protocol emulation and data point lists can be found in "Event Messages" in Appendix D.

**DNP3 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 COM 2. COM 2 is an RS485 port located on the rear of the relay. For details on connecting to serial Port, see "Communicating with the Relay Intelligent Electronic Device (IED)" on page 2-2 and "Communication Port Details" on page 2-10.
Network DNP communications can be utilized via physical LAN COM 3.

COM 3 is available as an RJ-45 or ST fiber optic port on the rear. COM 3 located on the rear of the relay is available as an RJ-45 or ST fiber optic port. DNP communications can be used with multiple masters when it is utilized with TCP. For details on connecting to the Ethernet LAN, see "Network Link" on page 2-7.

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 "DNP3.0 Device Profile" in Appendix G.

**Offliner SCADA Configuration**

Details on using the Offliner software are available in "*To Install Software on the Computer*" on page -viii. Details on downloading a completed settings file to the relay are available in "*Sending a New Setting File to the Relay*" on page 6-7.

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

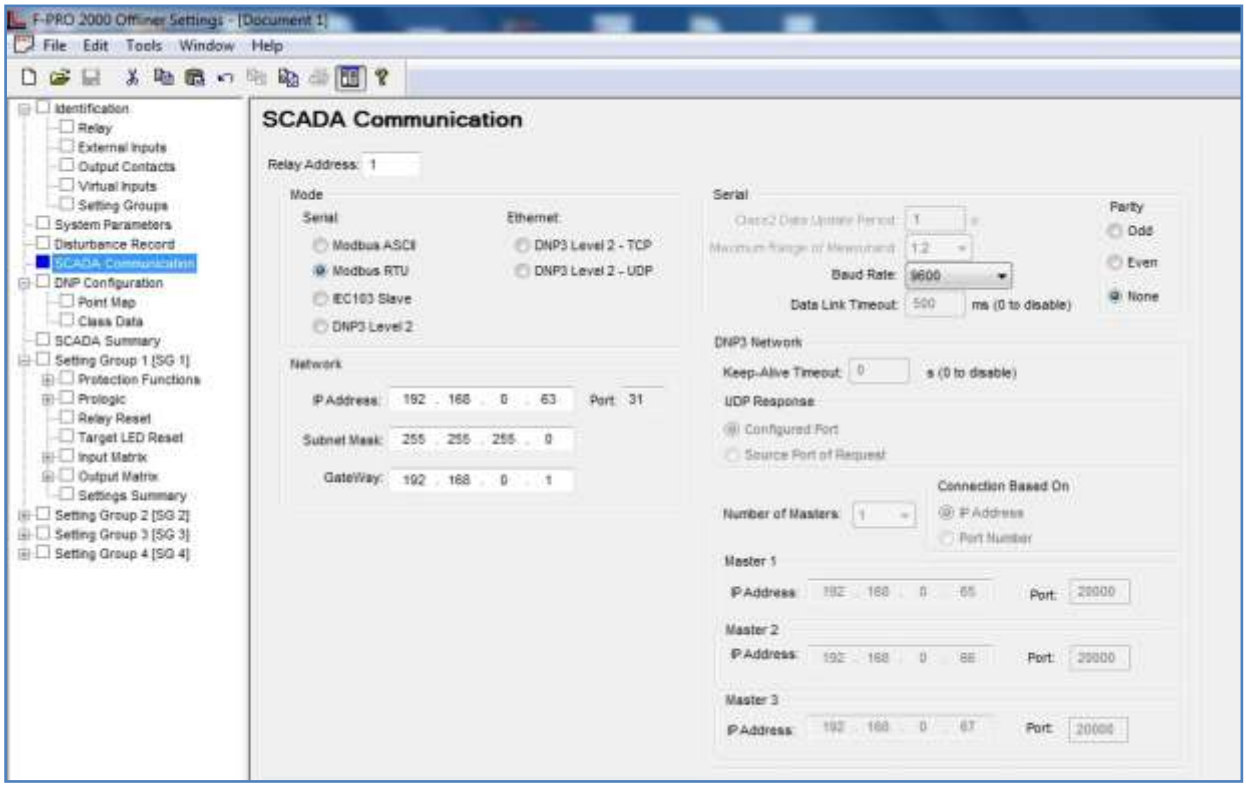



**Figure 5.1: SCADA Communications**

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
- IEC 60870-5-103 Serial – 8 data bits, 1 stop bit
- DNP3 Serial – 8 data bits, 1 stop bit

## 5.3 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 the electrical networks.

The IEC 61850 standard defines a new method that permits substation equipment to communicate with each other. Like many other well-known manufacturers, ERL also dedicated for using IEC 61850 - 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 devices for protection, measurement, detection, alarms, and monitoring. System implementation is often slowed down by the fact that the devices produced by different manufacturers are incompatible, since they do not support the same communication protocols. The problems associated with this incompatibility are quite serious, and result in increased costs for protocol integration and system maintenance.

**Implementation Details**

The F-PRO conforms to IEC 61850-8-1, commonly referred as Station Bus Protocol. Implementation includes the following documents “IEC 61850 Implementation” in Appendix N on page Appendix N-1:

- 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 IED Configurator” on the page 6-22.

# 6 Settings and Analysis Software

## 6.1 Introduction

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

F-PRO Offliner is used to configure all of the protection and system parameter variables on the IED. Setting files are created locally on a personal computer with the Offliner software and then are sent to the IED through Relay Control Panel (see "Relay Control Panel" on page 3-18) via a communication link (see "Communicating with the Relay Intelligent Electronic Device (IED)" on page 2-4).

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

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

## 6.2 Offliner Setting Software

### Introduction

F-PRO Offliner is used to configure all of the protection and system parameter variables on the IED. The following section provides a full breakdown of the user interface and all of the features available within the software.
More detailed information about relay settings and protection functions are provided in Chapter 4.

This is followed by a lengthy description of the main branches from the Tree View. This section provides all information for Identification, System Parameters, SCADA Communication, IEC 103 Configuration, SCADA Settings summary, Record Length, Setting Groups, ProLogic, Breaker Logic, LED Matrix, Output Matrix, reset type for Led and output contact and Settings summary.

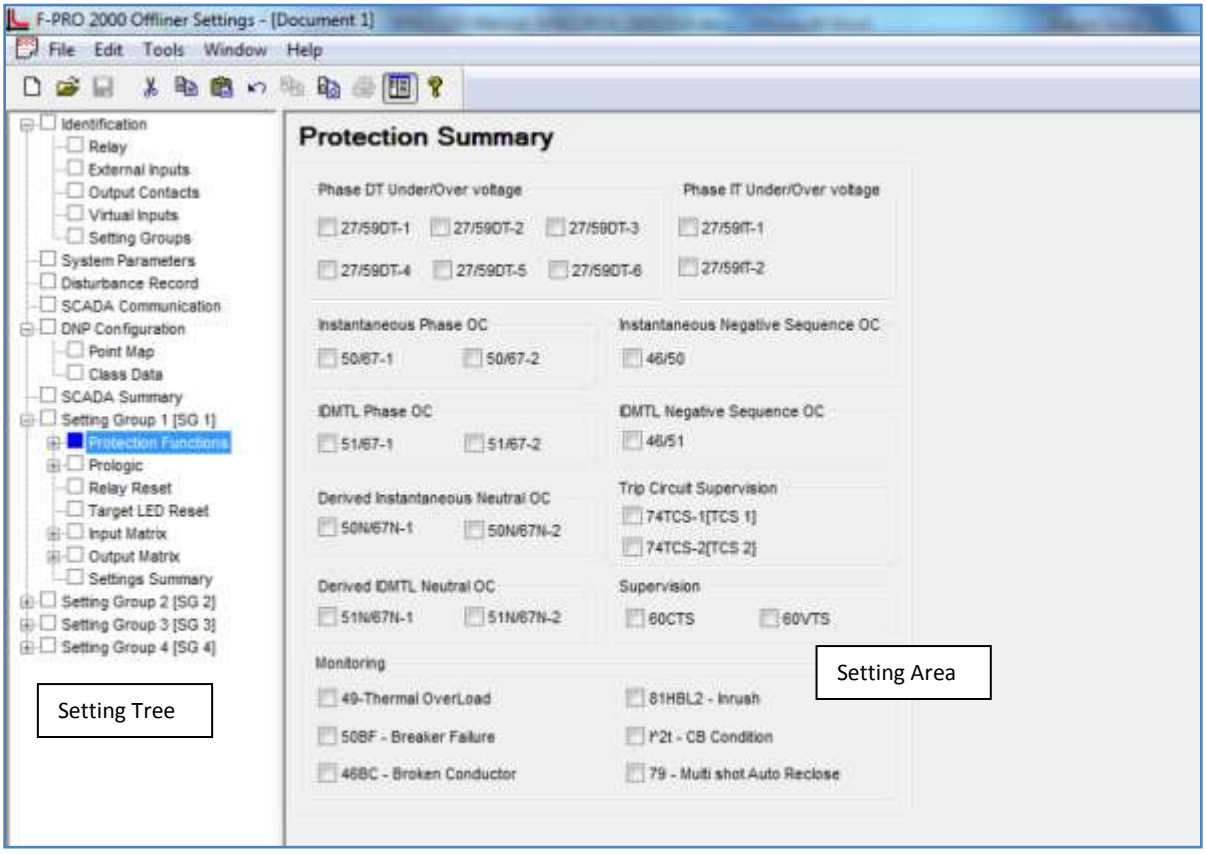



**Figure 6.1: Protection Summary**

## 6.3 Offliner Features

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

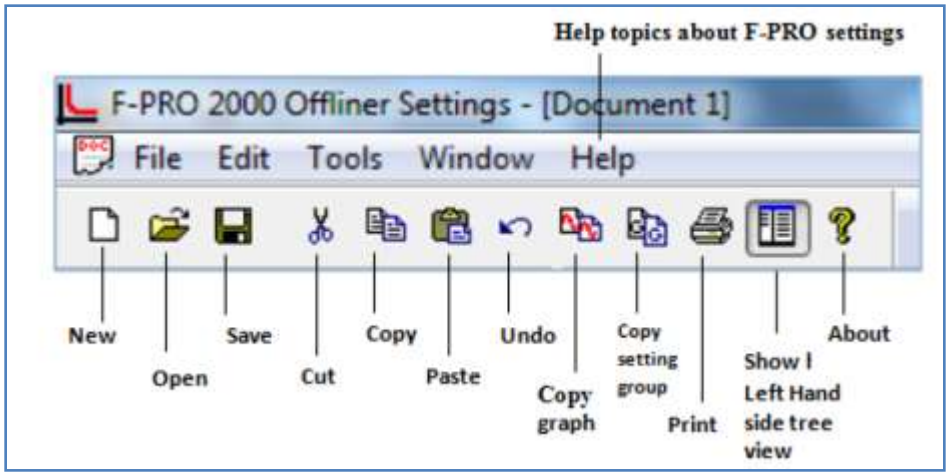



**Figure 6.2: Offliner Features**

| Table 6.1: 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. |
| **File** | 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 to a new location |
| | 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 8 most recently accessed setting files |
| | Exit | Quits the program and prompts to save the document if it is not saved |
| **Edit** | Undo | Undo last action |
| | Cut | Cut the selection and puts it on the clipboard |
| | Copy | Copy the selection and puts it on the clipboard |
| | Paste | Paste the copied contents |
| | Copy Graph | Copy the graph for the active screen to the clipboard |

| Table 6.1: Windows Menu | | |
|---|---|---|
| | Copy Setting Group | Copy values from one Setting Group to another |
| **Tools** | Options | Print settings for only enabled settings Summary sheet |
| **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 | On clicking Displays the user manual |
| | About Offliner | Displays the Offliner version |
| **Toolbar** | New | Create a new document of the most recent setting version |
| | Open | Open an existing document |
| | Save | Save the active document |
| | Cut | Cut selection |
| | Copy | Copy the selection |
| | Paste | Insert clipboard contents |
| | Undo | Undo last action |
| | Copy Graph | Copy the graph for the active screen to the clipboard |
| | Copy Setting | Brings up the Copy Inputs dialog box |
| | Print | Prints Graphs or the setting summary, depending on which seen is selected |
| | Show/Hide LHS Tree | If this option is checked then the LHS Tree view will be hidden or shown |
| | About | Displays the Offliner version |

# 6.4 Offliner Keyboard Shortcuts

The following table lists the keyboard shortcuts that Offliner provides.

| Table 6.2: 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/off by clicking the Grid On / Grid Off button. A right-click on the trace of the curve gives user the x and y coordinates.

**Print Graph**

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

**Refresh**

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

**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 user release 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.

# 6.5 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 Settings File**

1. Open the setting file user wish to convert.

2. In the *File* menu, select *Convert to...* 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.

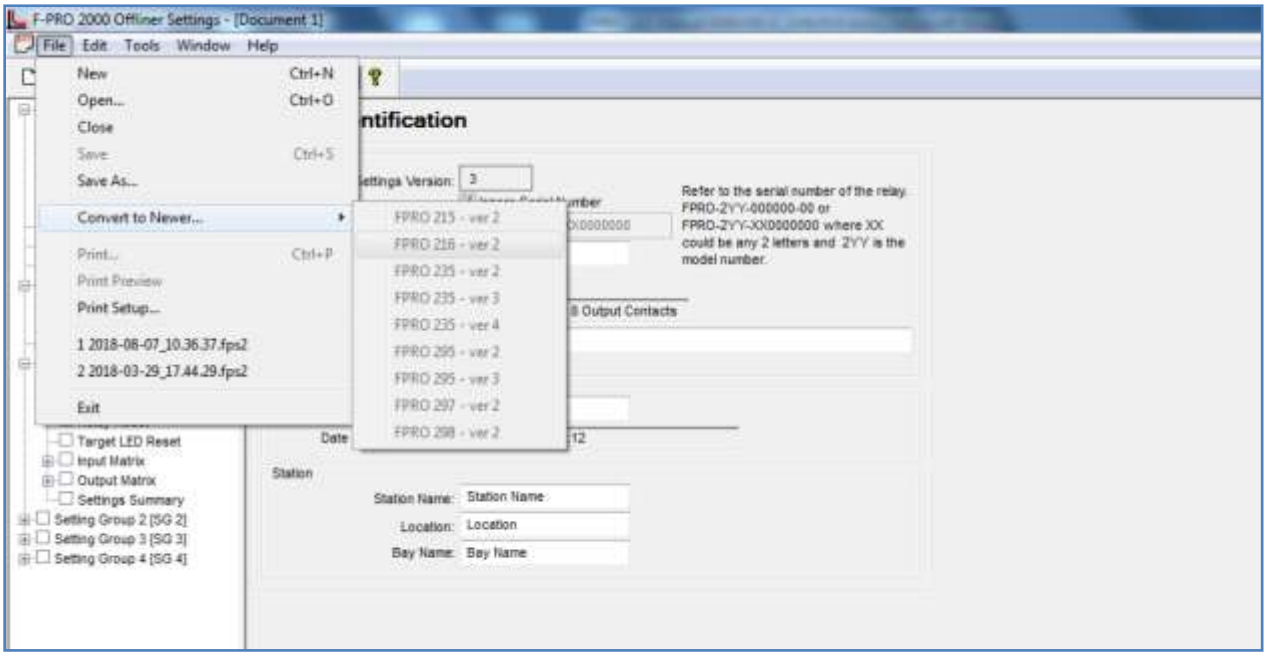



**Figure 6.3: Converting Setting Files**

### 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 does not match.

> A "serial number discrepancy" message may appear. This is to ensure that 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 Serial No.box in the Identification tab display area of Offliner Settings. Alternately 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.

### Creating a Setting File from an Older Version

1. Offliner Settings displays a default setting version on start up in the bottom status bar. As an example F-PRO Offliner is shipped with a set of default sample files of older settings versions. The sample file is "v1 sample.fps". The sample file contains default values of an older settings version.
   For a new installation these sample files are placed in the default directory C:\Program Files\ERL\F-PRO Offliner Settings or user can choose the path during the Offliner software installation. If an older version of F-PRO Offliner was previously installed on user PC, then the default directory may be C:\Program Files\apt\F-PRO Offliner Settings.

2. Open a sample file of the desired version. Use *File/Save As* to save the sample file to a new file name. Then edit the setting file and the serial number, save it and load it into the relay.

# 6.6 Main Branches from the Tree View

### Identification

This section will describe the tree view, which provides 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 3.

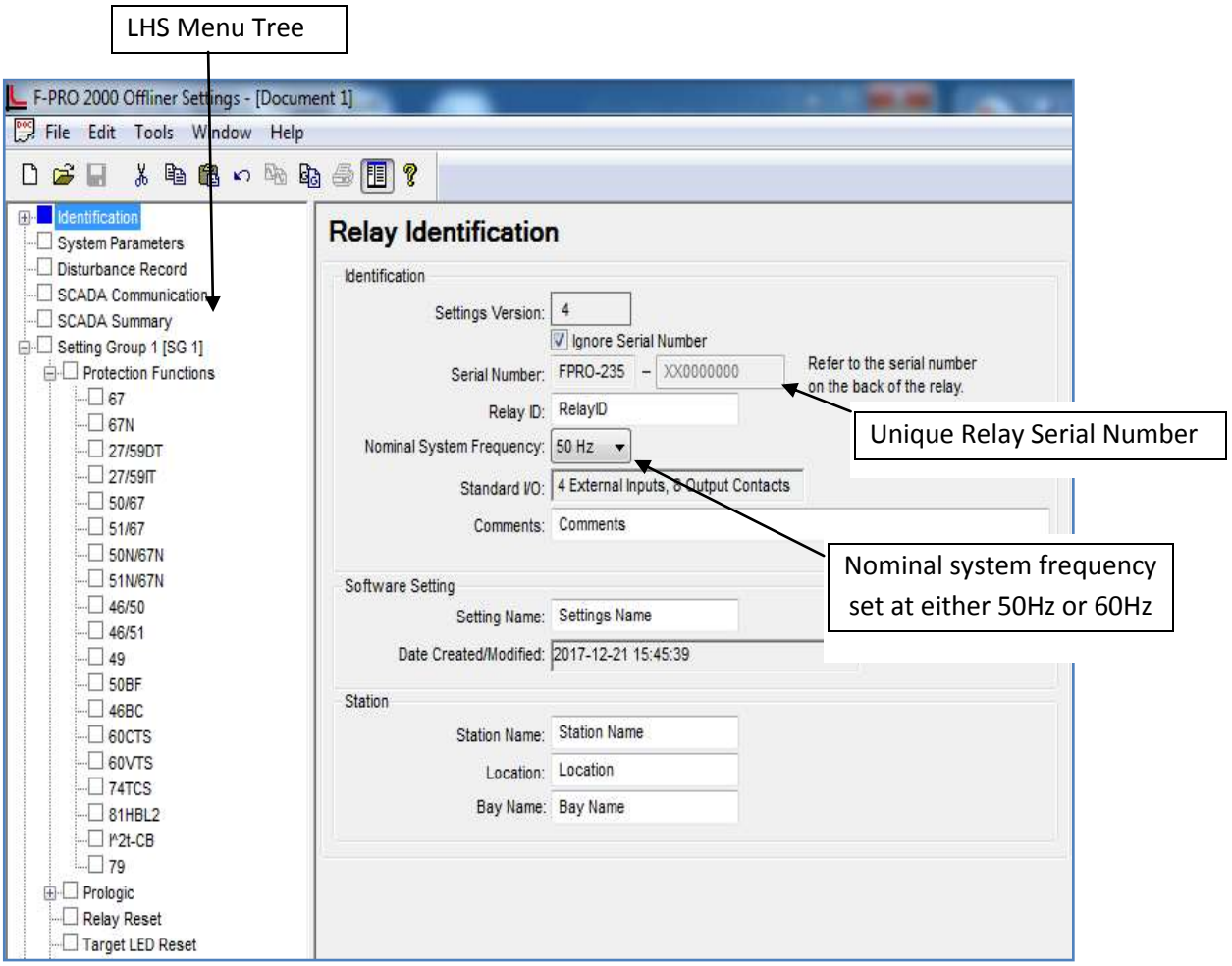



**Figure 6.4: Relay identification**

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 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 leftmenu tree.

| Table 6.3: Relay Identification | |
|---|---|
| **Relay Identification** | |
| **Identification** | |
| Settings Version | Indicates the settings version number, fixed. |
| Ignore Serial Number | Bypass serial number check, if enabled. |
| Serial Number | Available at the back of each relay. |
| Relay ID | User-defined up to 16 characters. |
| Nominal System Frequency | 60 Hz or 50 Hz |
| Comments | User-defined up to 78 characters. |
| **Setting Software** | |
| Setting Name | User-defined up to 16 characters. |
| Date Created/Modified | Indicates the last time settings were entered. |
| **Station** | |
| Station Name | User-defined up to 16 characters. |
| Location | User-defined up to 16 characters. |
| Bay Name | User-defined up to 16 characters. |

**Important Note**

***Nominal CT Sec. Current can be set to either 1 A or 5 A. Nominal System Frequency can be set to either 50 Hz or 60 Hz. Ensure setting selection matches that of target F-PRO***

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

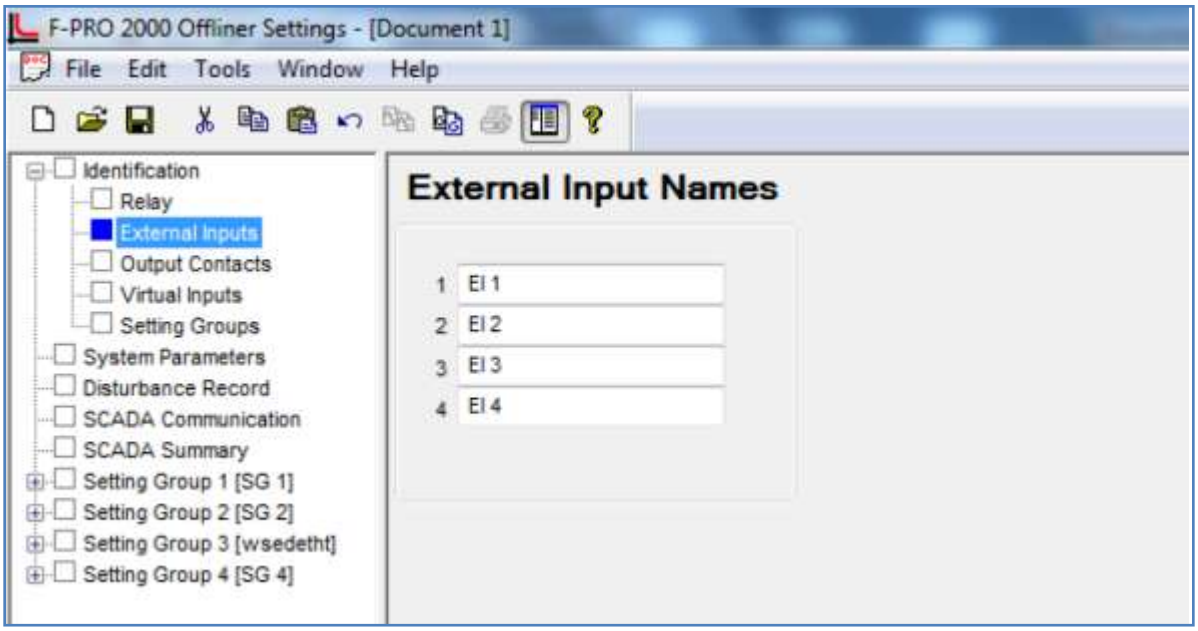



**Figure 6.5: External Inputs**

The External Inputs screen allows user to define Applicable names for four external inputs.

| Table 6.4: External Input Names | |
|---|---|
| 1 to 4 | User-defined |

## Output Contacts

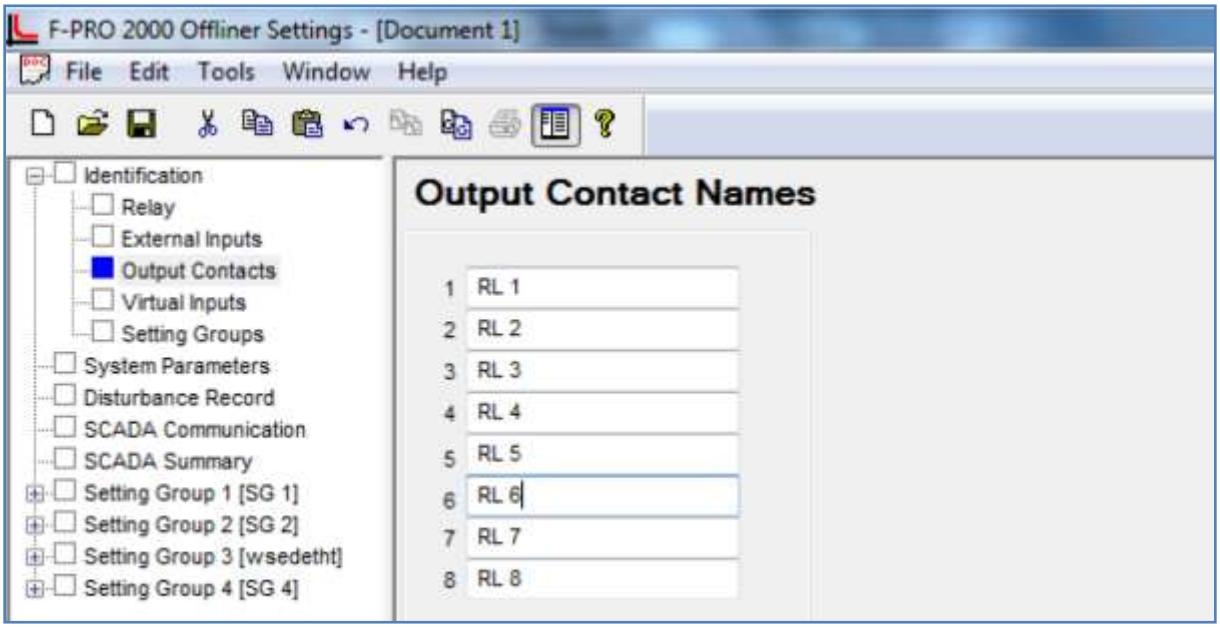



**Figure 6.6: Output Contacts**

The Output Contact Names screen allows user to define Applicable names to the 8 output contacts.

| Table 6.5: Output Contact Names | |
|---|---|
| Outputs 1 to 8 | User-defined |

## Virtual Inputs

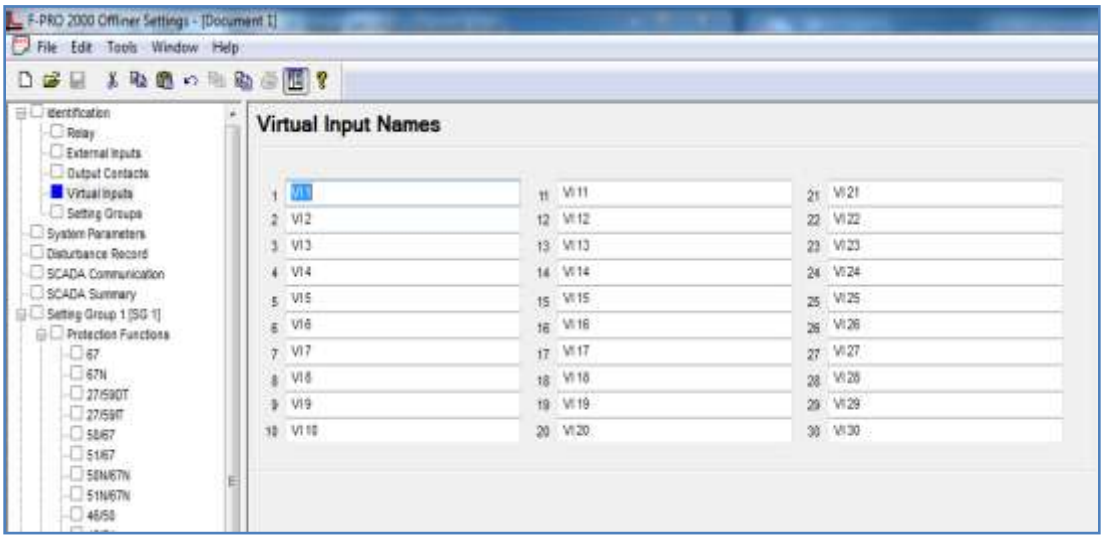



**Figure 6.7: Virtual Inputs**

| Table 6.6: 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 IEC 61850 and the terminal VI. The 30 virtual inputs are individually controlled and include a set / reset and pulse function through RCP. The latch state is retained during setting changes and relay power down conditions. The 30 virtual inputs conform to IEC 61850 standards.

Use virtual inputs are used for:

- Logic functions
- Enable or disable reclosing
- Enable or disable under-frequency load shedding
- Change setting groups
- Provide interlocking between local/remote supervisory control

## Setting Groups


**Figure 6.8: Setting Groups**

The relay has four setting groups (1 to 4). User can change all relay setting parameters except the physical connections such as input or output parameters in each setting group. Use any one of the 4 available Group change inputs per setting group to perform Setting Group changes.

| Table 6.7: Setting Groups | |
|---|---|
| Setting Groups 1 to 4 | User-defined |

## System Parameters

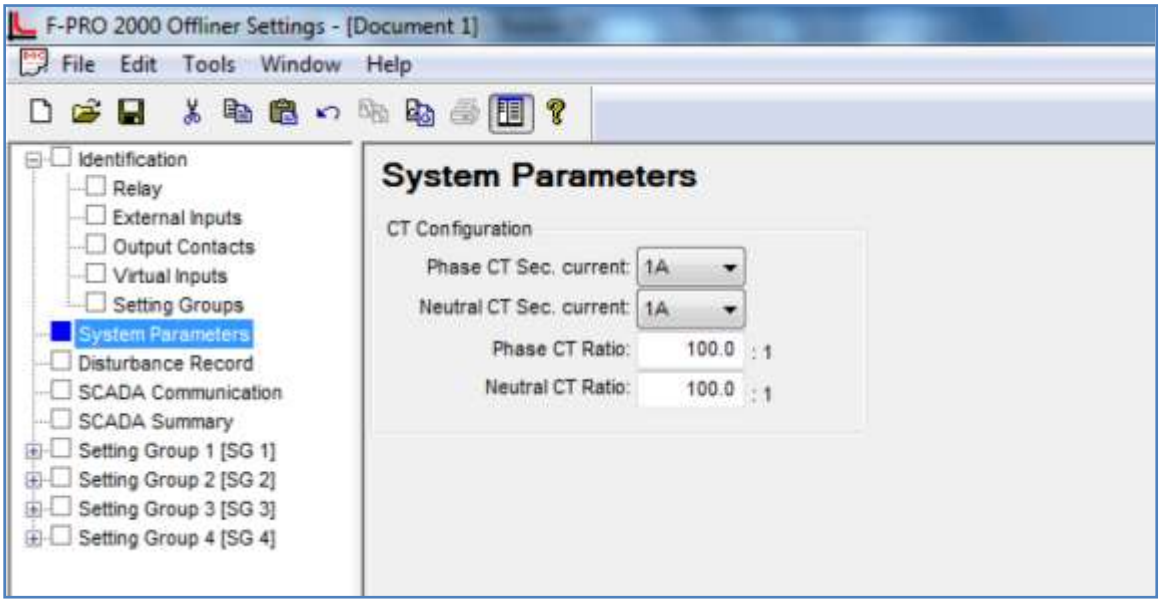



**Figure 6.9: System Parameters**

The System Parameters screen allows user to define CT Secondary, VT Secondary and VT Ratio for the respective bays.

| Table 6.8: System Parameters | |
|---|---|
| **CT Configuration** | |
| Phase CT Sec. Current | 1A/ 5A |
| Phase CT ratio | 1.0 to 30000.0 |
| Phase VT Sec | 40.0 to 160.0 |
| Phase VT Ratio | 1.0 tp 10000.0 |

### Record Length

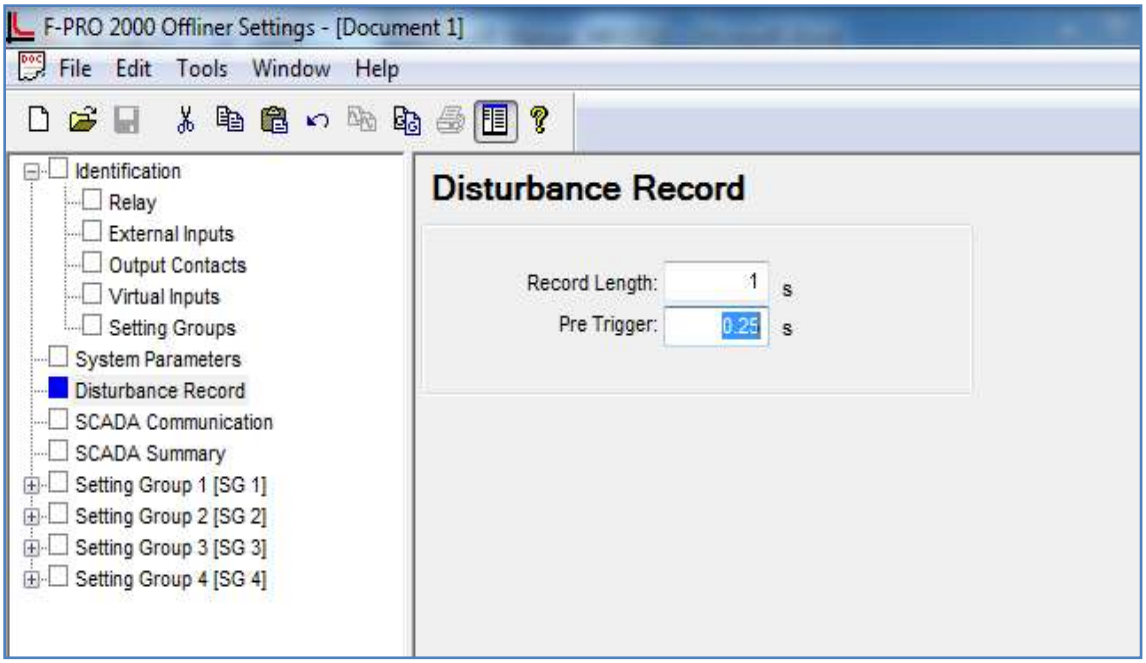



**Figure 6.10: Record Length**

| Table 6.9: Record Length | |
|---|---|
| Fault Record Length | 1 to 20 seconds |
| Pre-trigger | 0.10 to 0.50 seconds |

The relay has recording and logging functions to analyze faults and to review the operation of the overall protection scheme and has flexible pre-fault & Record Length timing option.

## SCADA Communication

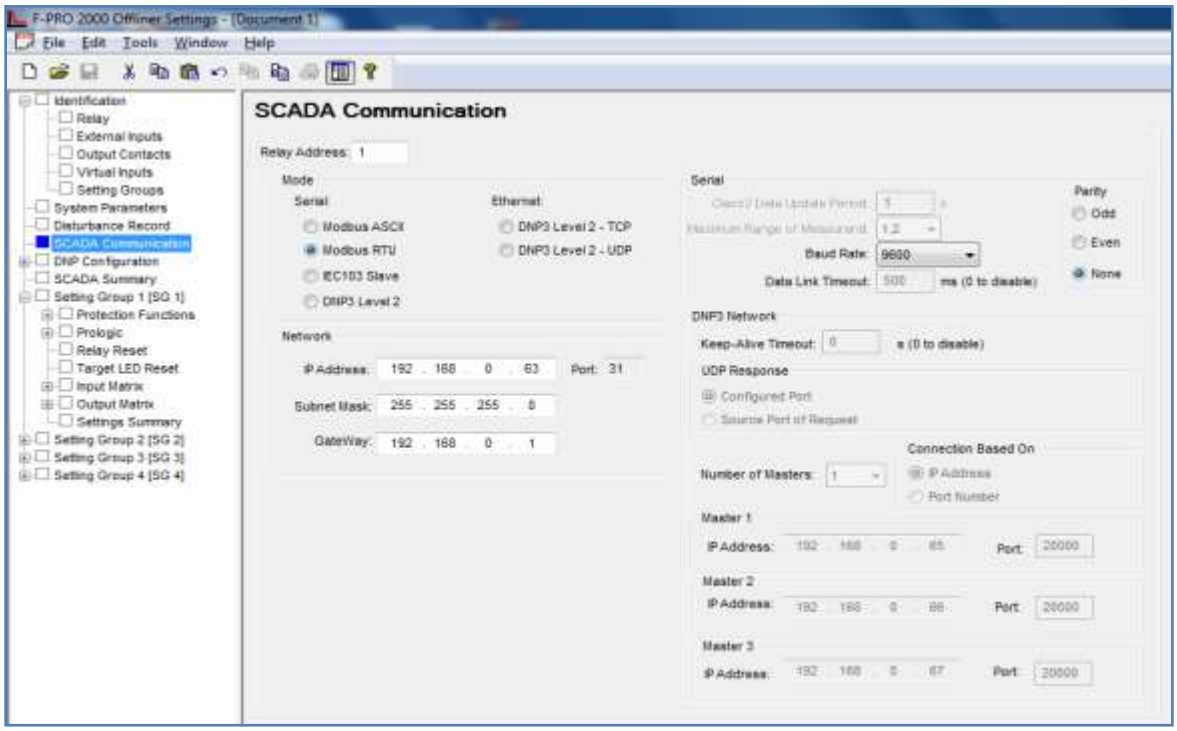



**Figure 6.11 SCADA communication**

The SCADA Communication screen allows user to configure both Serial protocols (Modbus ASCII/ Modbus RTU / IEC103 Slave / DNP3 Level2) and Ethernet (TCP & UDP). For DNP3 Level2 up to 3 independent masters are supported.

Also the SCADA Communication screen allows to change the network information like IP Address, Subnet Mask and Gateway. If the new setting file is loaded in to the relay with different IP address, then the relay connection will be disconnected and reboot.

## DNP Configuration-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.

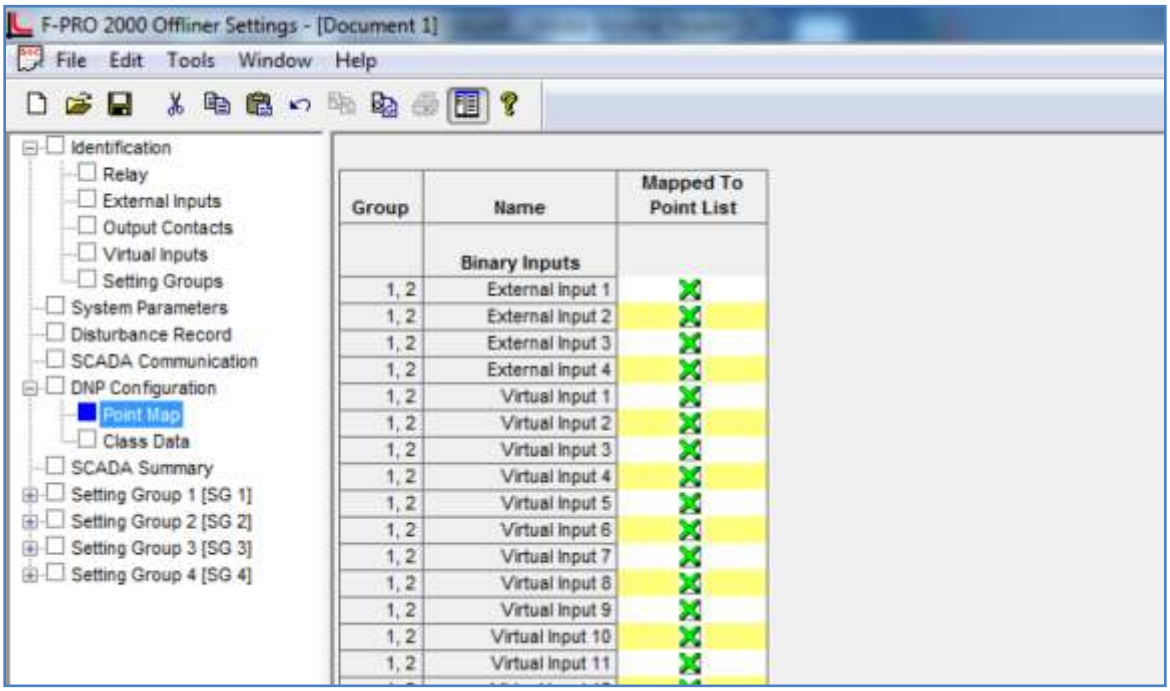



**Figure 6.12: Point Map**

## DNP Configuration Class Data

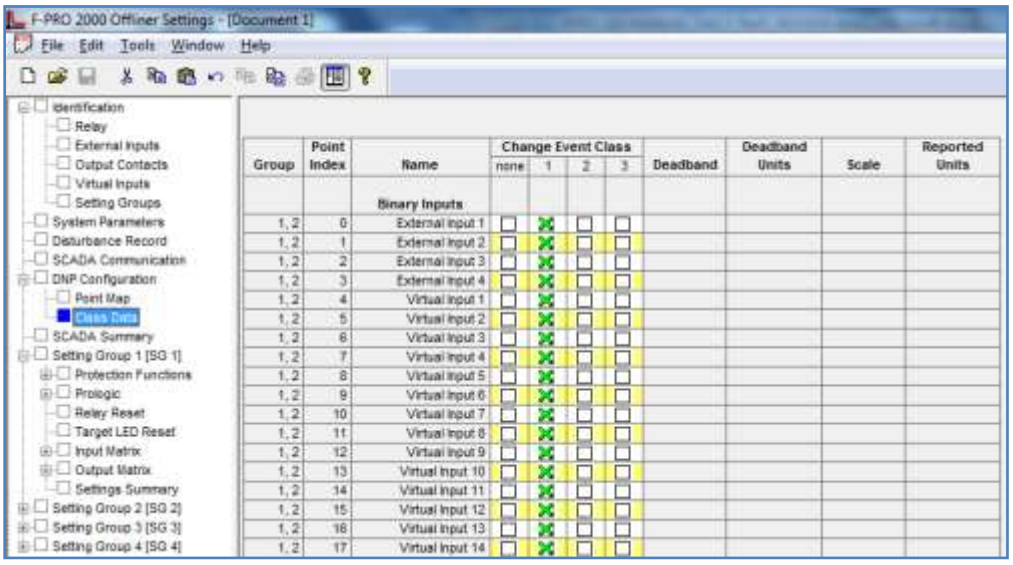
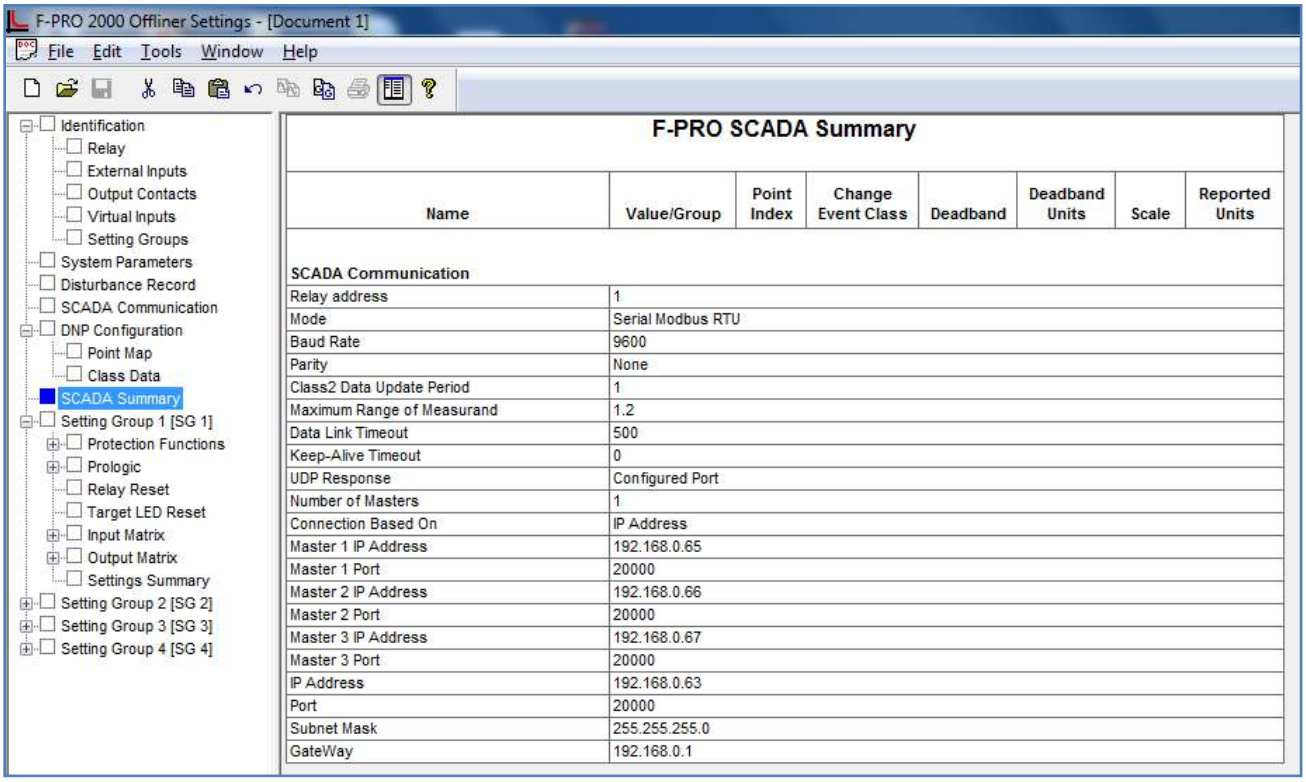



**Figure 6.13: Class Data**

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.

## SCADA Summary




**F-PRO SCADA Summary**

| Name | Value/Group | Point Index | Change Event Class | Deadband | Deadband Units | Scale | Reported Units |
|---|---|---|---|---|---|---|---|
| **SCADA Communication** | | | | | | | |
| Relay address | 1 | | | | | | |
| Mode | Serial Modbus RTU | | | | | | |
| Baud Rate | 9600 | | | | | | |
| Parity | None | | | | | | |
| Class2 Data Update Period | 1 | | | | | | |
| Maximum Range of Measurand | 1.2 | | | | | | |
| Data Link Timeout | 500 | | | | | | |
| Keep-Alive Timeout | 0 | | | | | | |
| UDP Response | Configured Port | | | | | | |
| Number of Masters | 1 | | | | | | |
| Connection Based On | IP Address | | | | | | |
| Master 1 IP Address | 192.168.0.65 | | | | | | |
| Master 1 Port | 20000 | | | | | | |
| Master 2 IP Address | 192.168.0.66 | | | | | | |
| Master 2 Port | 20000 | | | | | | |
| Master 3 IP Address | 192.168.0.67 | | | | | | |
| Master 3 Port | 20000 | | | | | | |
| IP Address | 192.168.0.63 | | | | | | |
| Port | 20000 | | | | | | |
| Subnet Mask | 255.255.255.0 | | | | | | |
| GateWay | 192.168.0.1 | | | | | | |

**Figure 6.14 SCADA summary**

The relay address can be set from 1 to 247 for serial mode of communication either Modbus RTU / Modbus ASCII and can be set from 0 to 254 for IEC103 Slave and can be set from 1 to 65519 for DNP3 and also possible to set baud rate & parity. The relay IP address can be set for the purpose of relay configuration as well as IEC61850 and DNP3 communication (SCADA).

**Setting Groups**

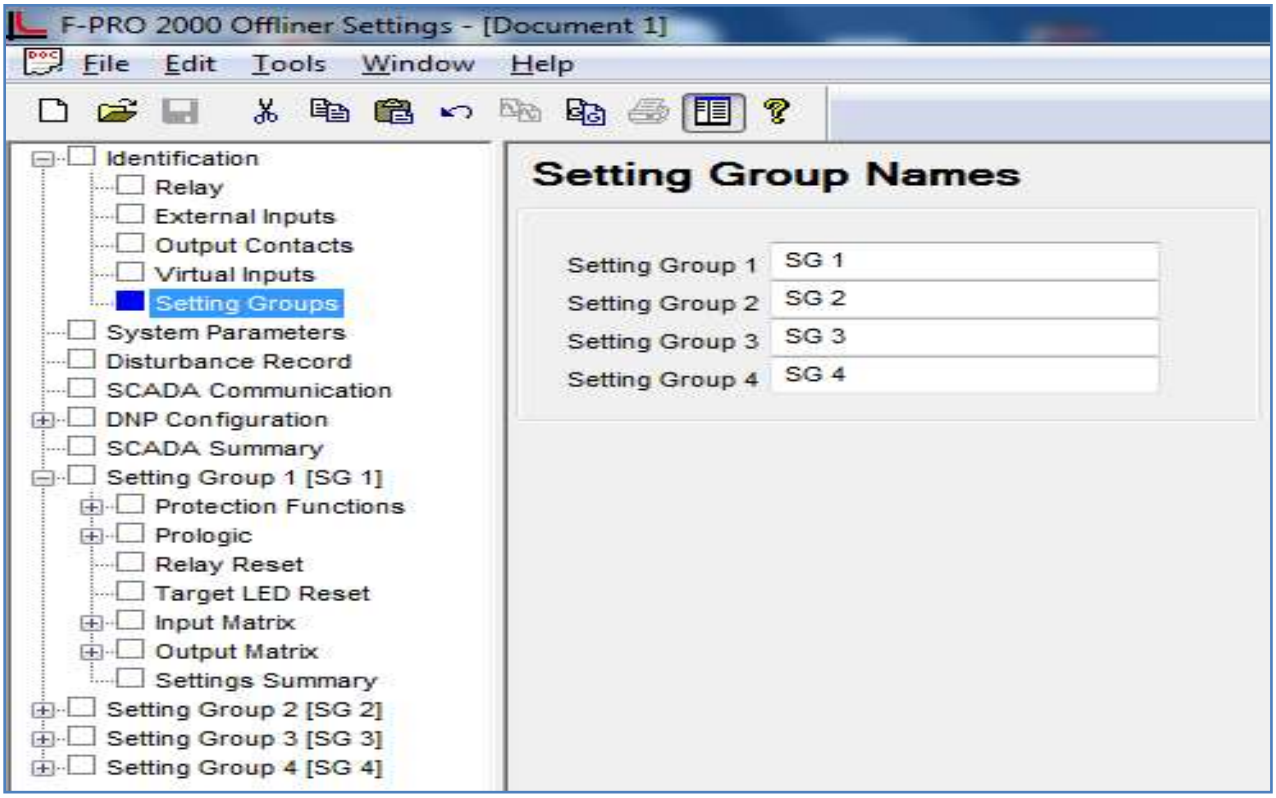



**Figure 6.15: Setting Groups Comments**

The relay has four setting groups (1 to 4). User can change all relay setting parameters except the physical connections such as input or output parameters in each setting group. Use any one of the 4 available Group change inputs per group.

## Protection Functions


**Figure 6.16: Protection Functions**

F-PRO provides multifunction protection; for detailed descriptions on protection functions see “Protection Functions and Specifications” on page 4-1.

## ProLogic

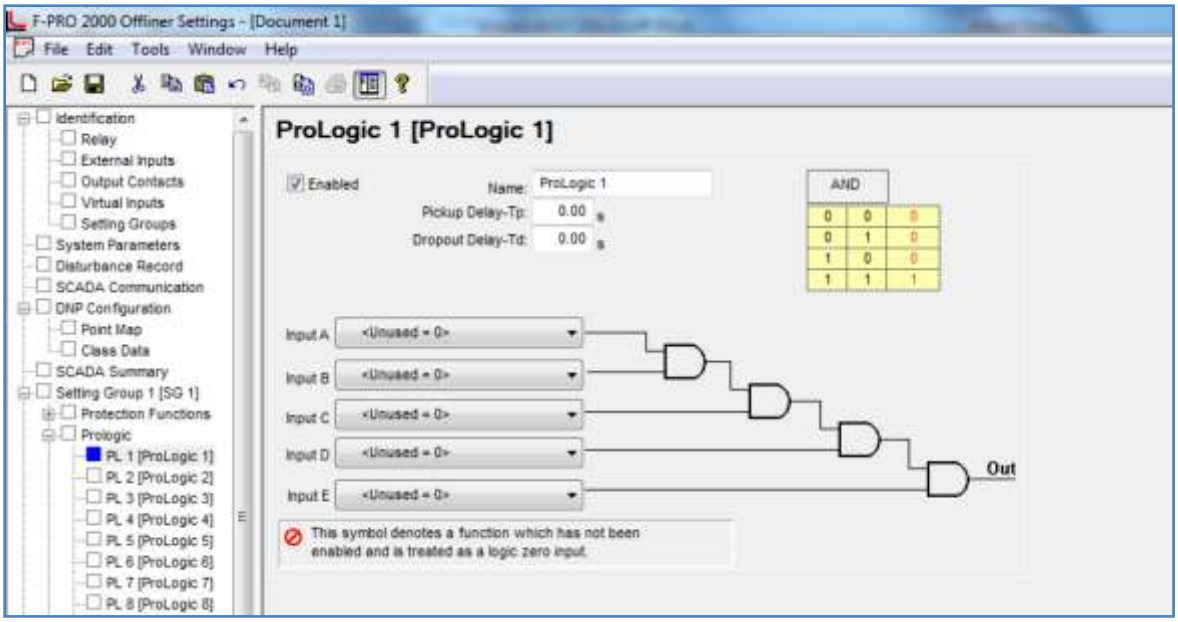



**Figure 6.17: ProLogic**

ProLogic is used to create an output based on qualified multiple inputs. Twenty User Programmable ProLogic control statements can be utilized to create custom logic and operate output contacts.
User can define or name the function being created and set a pickup and dropout delay. Each ProLogic statement can be used with internal relay functions and external inputs (up to 5 possible inputs) to create the logic output by using Boolean logics such as AND, OR, NAND, NOR, EX-OR, EX-NOR and LATCH.

The output of ProLogic 1 can be nested into ProLogic 2 and so on. If desired, user can illuminate the front target LED on operation of this function by disabling this feature in output matrix. The operations of the ProLogic statements are logged on the events listing. The status of the Prologic can be seen from the record graph by selecting the recorder in the output matrix.

### Output Matrix

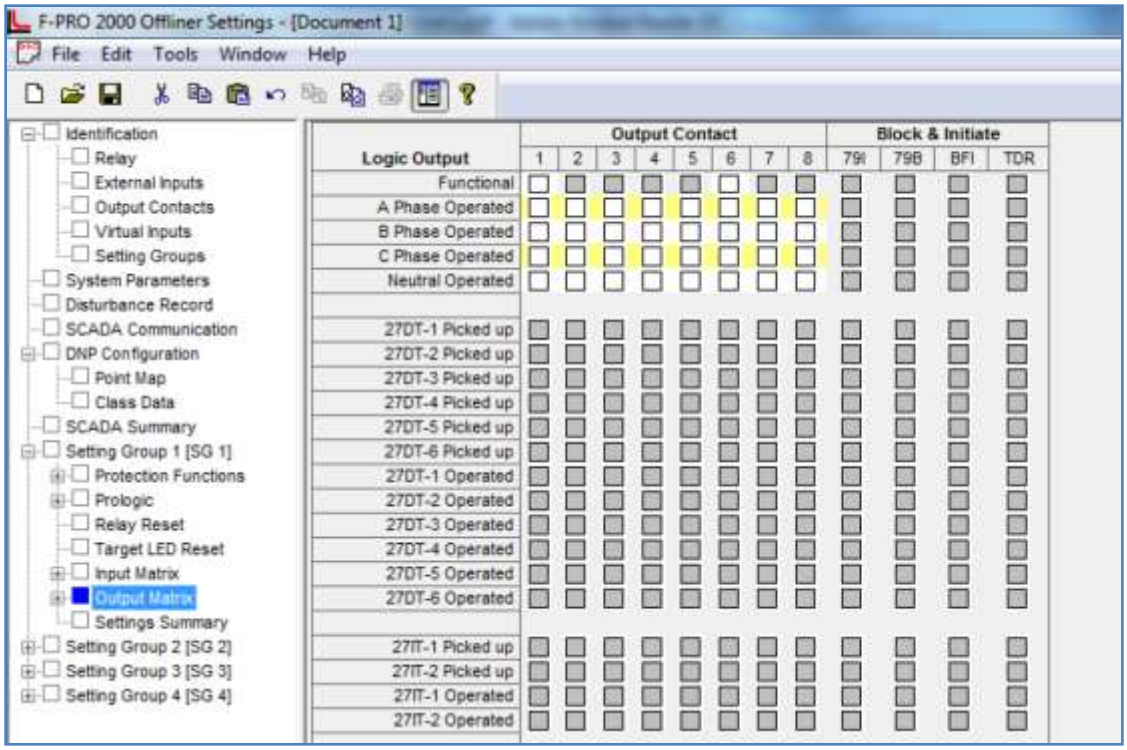



**Figure 6.18: Output Matrix**

The output contact matrix determines which function to initiate which output contact of the relay. All output relays have a settable delay (0 to 1 second).
Functions can also initiate fault recording, recloser blocking, recloser initiation and/or breaker failure initiation.

> 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 *File>Print Summary*. This printout is produced on two pages.

**Settings Summary**

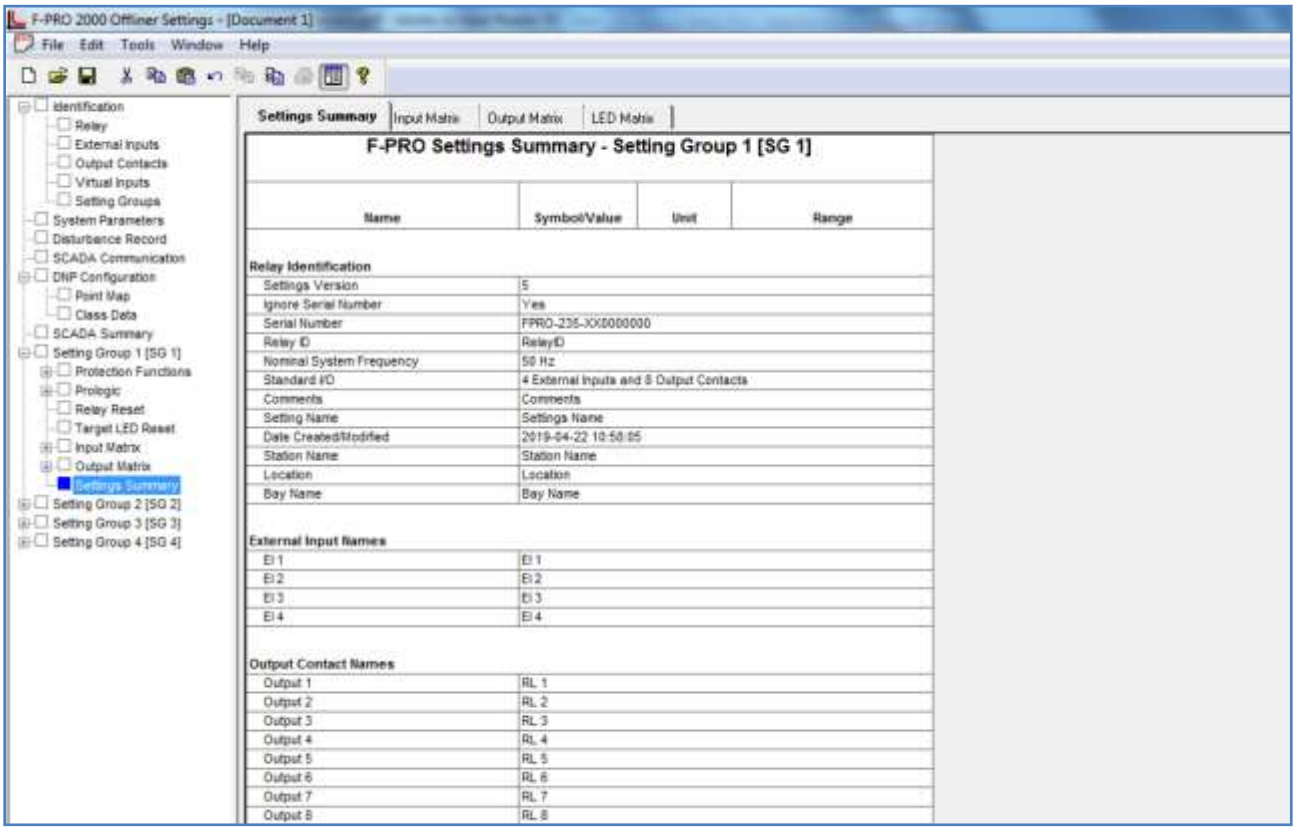



**Figure6.19: Settings Summary**

Select *Settings Summary* to view and print the relay settings in text form. For details see "IED Settings and Ranges" in Appendix B. Print the entire Settings Summary by selecting *File>Print Summary*.

## 6.7 Settings from a Record

The settings on the relay at the time of a recording are included in every record and can be viewed through the RecordGraph analysis software. While viewing a recording in RecordGraph, select the *View Setting* button to display the settings. RecordGraph will automatically launch F-PRO Offliner to display the settings in summary form if installed in the same PC.

If the record contains multiple Setting Groups, the Offliner displays all Setting Groups in the summary. Bold text in the tree view indicates an active Setting Group (the Setting Group used at the time the record was captured). The setting summary is read-only. To edit the setting file associated with the summary, user must use *File/Save As* to save the summary to a file. Then close the summary screen and open the setting file for editing in F-PRO Offliner.

## 6.8 Record Graph Software

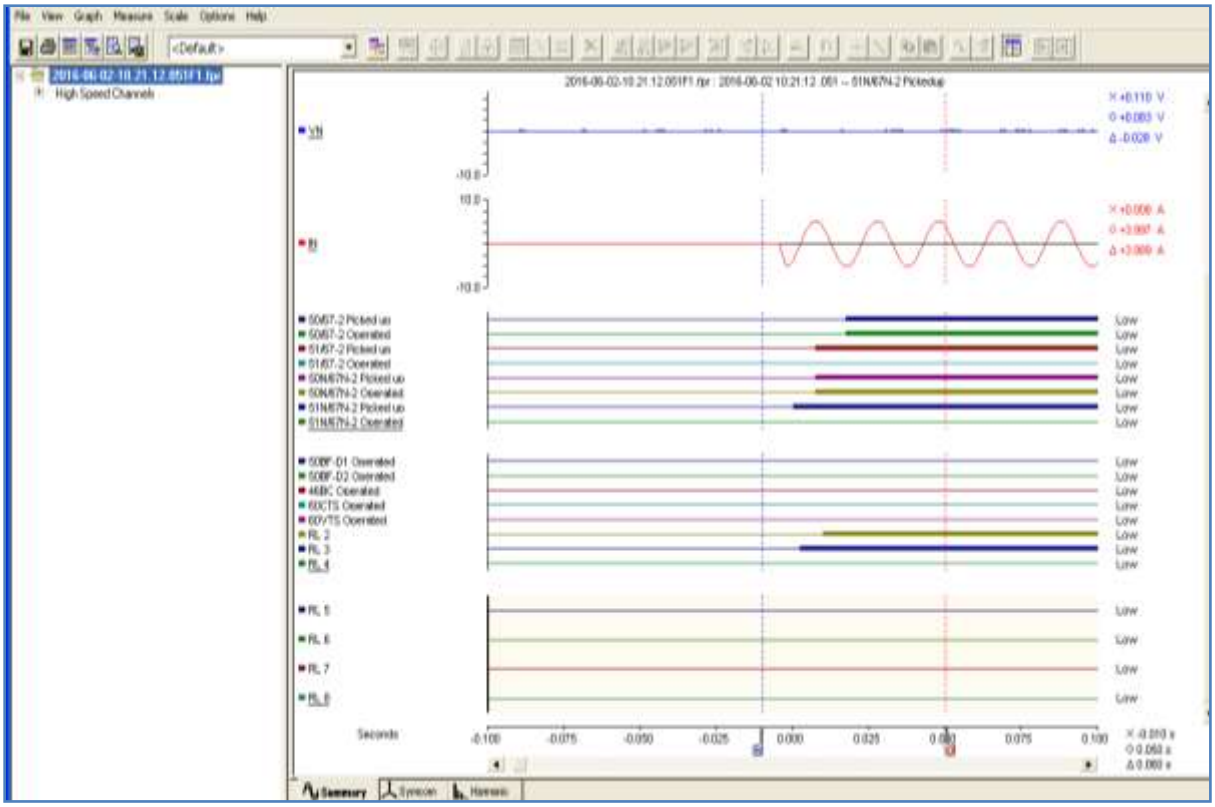


**Figure 6.20 Record Graph View**

Use RecordGraph to analyze the records from a relay.

1 . Set the receive directory on user RCP to point to a convenient directory on user PC's hard disk or network. For example with Relay Control Panel, Select Add New>Folder Placement>Browse. It will be by default in this path *C:\DocumentsandSettings\user\MyDocuments\ERL\RelayControlPanel\Records.*
2. Select one or more records on the relay using the *List* function in the terminal Mode's *Records* menu.
3. Initiate transfer of the selected record by selecting *GET* from Relay tab in the RCP or by double clicking the selected record.
4. Start the RecordBase View program and use the *ADD* tab to open the downloaded record files located in the receive directory specified in step

# 6.9 ERL 61850 IED Configurator

## Introduction

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

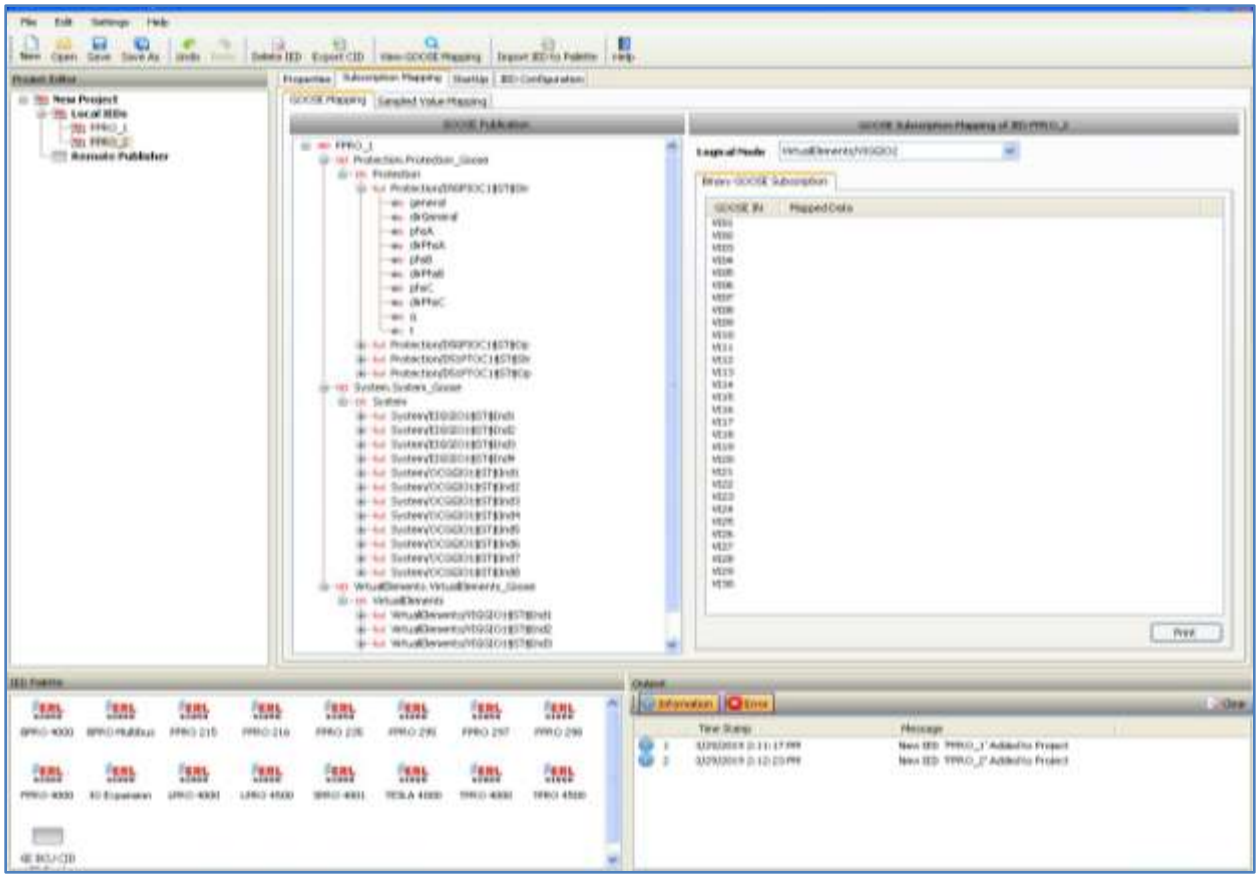


**Figure 6.21: ERL 61850 IED Configurator**

For further instructions refer to the ERL 61850 IED Configurator Manual.

# 7 Acceptance / Peripheral Test Guide

## 7.1 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.

The acceptance testing describes the test equipment requirements, calibration methods, testing the external inputs and testing the output relay contacts.

## 7.2 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 phase ac voltage sources (variable frequency capability)
- 3 phase ac current sources
- 1 ohmmeter
- 1 – 300 Vdc source

Set nominal CT secondary current to either 1 A or 5 A, and nominal system frequency to either 50 Hz or 60 Hz.

## Calibration

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

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

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

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

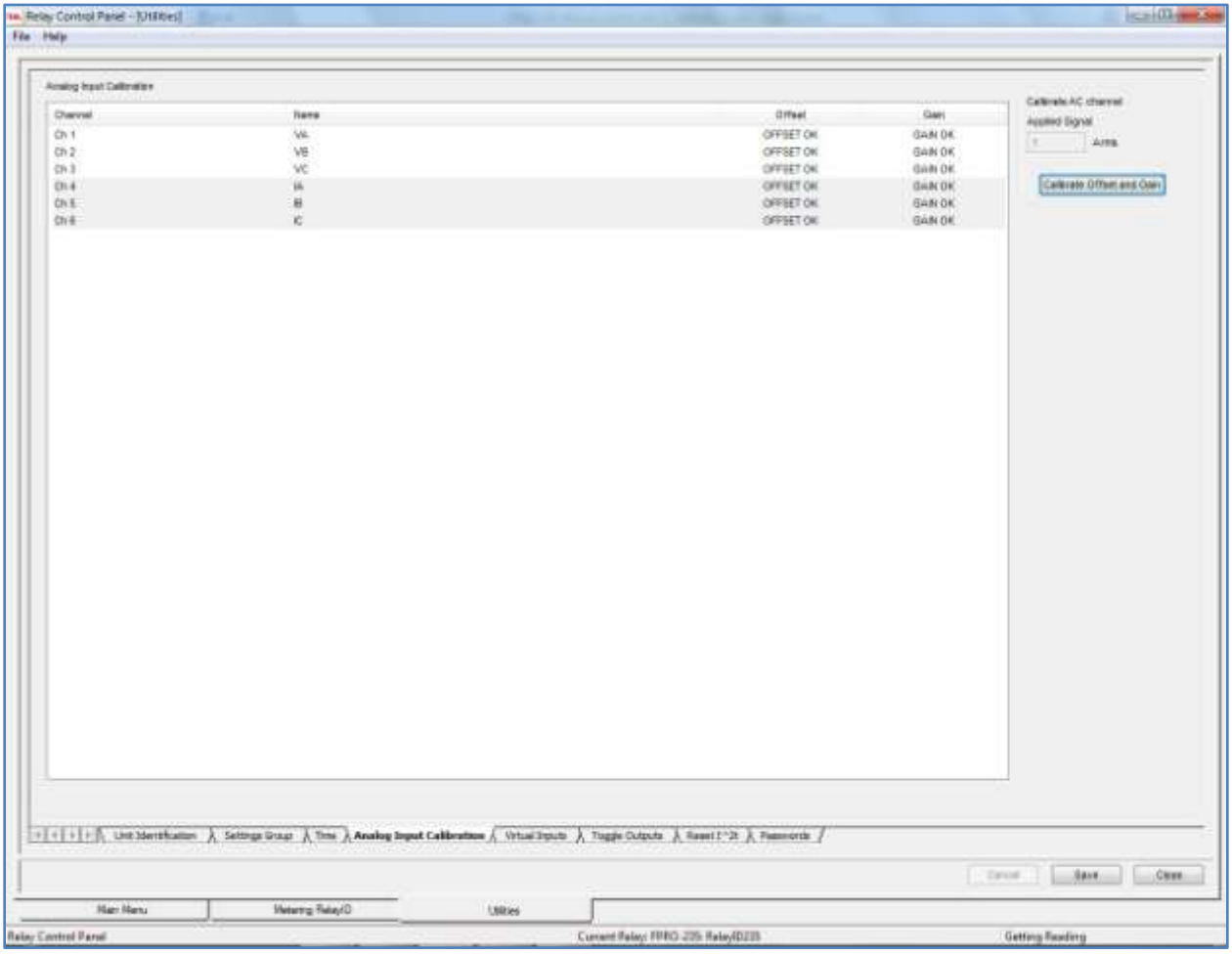



**Figure 7.1: Enter actual applied signal level**

If the applied test signal is not reasonable, an error will be displayed and the calibration will not be applied. For example, in Figure 7.2: on page 7-3, the displayed calibration error message indicates that we tried to calibrate a 63.5 V level with no voltage applied, which is not reasonable.

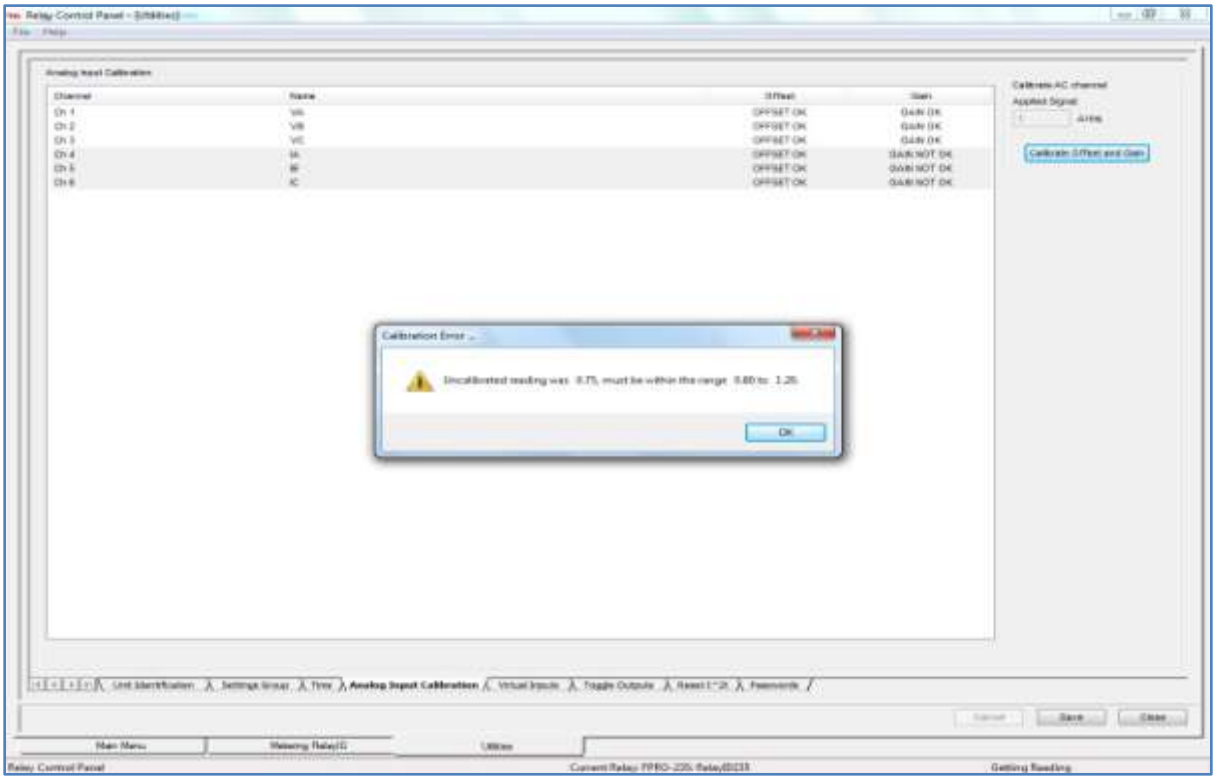


**Figure 7.2: Calibration error – out of range**

| |
|---|
| Only the magnitude (Gain ) and offset are calibrated, space not the angle |

When an analog input channel is calibrated, you can verify the quantity measured by selecting the Metering menu and the Analog Quantity submenu.

.

## Testing the External Inputs

External Inputs are polarity sensitive !

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>Toggle 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.

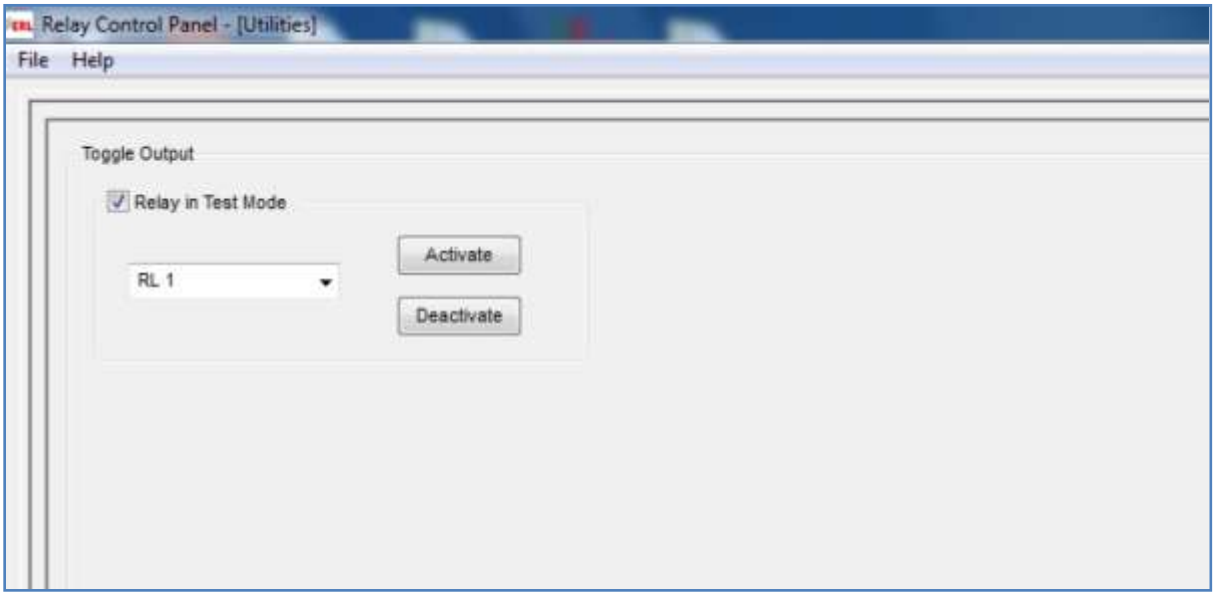



**Figure 7.3: Test output Contacts**

# 8 Installation

## 8.1 Introduction

This section details the installation of the F -PRO relay. The section covers the physical mounting, AC and DC wiring and the Communication wiring.

## 8.2 Physical Mounting

**Standard E6**

The relay is 177 mm height and 242.5mm depth (Approximately). The standard relay is designed for a 155 mm width. A complete mechanical drawing is shown, for details see "Mechanical Drawings" in Appendix H

To install the relay the following is needed:

- E6 cutout (159 x 150 mm)
- M4 screws & Nuts

## 8.3 AC and DC Wiring

For details see "AC Schematic Drawing" in Appendix I and "DC Schematic Drawing" in Appendix J.

## 8.4 Communication Wiring

**EIA-485**

The relay's serial port (COM 2) 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 convertor. RS 485 cable can work for maximum 1.2kM with single IED. Shielded cable is recommended, for pin -out see "Communication Port Details"

**Ethernet Port**

100BASE Ethernet Port (COM 3) 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 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.

# Appendix A IED Specifications

| F-PRO 235 Specifications | | |
|---|---|---|
| **Item** | **Quantity/Specs** | **Note** |
| **General:** | | |
| Nominal Frequency | 50 or 60 Hz | |
| Operating Time | Less than 30 ms | Including output relay operation. |
| Memory | Settings and records are stored in non-volatile memory | Records are stored in a circular buffer |
| Power Supply | 20 to 60Vdc<br>80 to 300Vdc / 80 to 240Vac , 50/60Hz | Power Consumption: 5 – 6 VA (ac)<br>4.5 – 5 W (dc) |
| **Protection Functions:** | | |
| 27/59DT (1-6), 27/59IT (1-2), 50/67 (1-2), 51/67 (1-2), 50N/67N (1-2), 51N/67N (1-2), 46/50, 46/51, 49, 50BF, 46BC, 60CTS, 60VTS, 74TCS (1-2) 81HBl2, I^2t, 79 | 1 x 3-phase current inputs<br>1 x 3-phase voltage inputs | |
| ProLogic | 20 statements per setting group | 5 inputs per ProLogic™ statement |
| Setting Groups | 4 | |
| **Recording:** | | |
| Transient (Fault) | 32 s/c oscillography of all analog and external input digital channels | User-configurable 1 to 20 seconds Record length and 0.1 to 0.5 pre-fault length |
| A/D Resolution | 6 bits, 65536 counts full scale peak | |
| Events | 1000 events circular log with 1ms resolution<br>I^2t: trigger by user defined event and/or trip | A compressed event record can be created 1000 events with manual trigger. |
| Record Capacity | 20 records of transient and optionally event records. | |

| F-PRO 235 Specifications | | |
|---|---|---|
| **Input & Output:** | | |
| Analog Current Inputs<br>1 set of 3-phase current inputs | Nominal Current<br>Continuous<br>Maximum full-scale<br>Thermal rating<br>Burden | In = 1 Amp or 5 Amps<br>4x In = 4 Amps or 20 Amps<br>40x In for 3 second symmetrical<br>100 Amps for 1 second<br><0.1 VA @ 1 Amp<br><0. 5 VA @ 5 Amps |
| Analog Voltage Inputs<br>1 set of 3-phase voltage inputs | Nominal Voltage<br>Continuous<br>Maximum full-scale<br>Burden | Vn = 3-139Vac<br>139 Vrms<br>200 Vrms for 10 seconds<br><0.15 VA @ 63.5 Vrms |
| Analog Sampling Rate | 32 samples/cycle for recording<br>8 samples/cycle for protection | Records up to 8$^{th}$ harmonic |
| External Inputs (digital) | 4 isolated inputs | Optional 24, 48, 110, 220 V dc Nominal, externally wetted |
| Isolation | 2 KV optical isolation | |
| External Input Turn-on Voltage | 24Vdc nominal = 19 Vdc<br>48Vdc nominal = 38 Vdc<br>110Vdc nominal = 88 Vdc<br>220Vdc nominal = 175 Vdc | |
| Output Relays (contacts) | 8 programmable outputs (6NO +2CO) | Externally wetted<br>Make: 30 A as per IEEE C37.90<br>Carry: 8 A<br>Break: 0.9 A at 125 Vdc resistive<br>0.35 A at 250 Vdc resistive |
| Virtual Inputs | 30 Virtual Inputs | |
| **Interface & Communication:** | | |
| Front Display | 2 row 16 character Alpha Numeric LCD | |
| Front Panel Indicators | 8 LEDs: 7 programmable, 1 fixed | |
| Front User Interface | USB port | Full Speed USB 2.0 480Mbps |
| Rear User Interface | COM 3: 100Mbps-T,RJ45/ 100Mbps-Fx,ST<br>COM 2: RS-485 (2400bps to 57600bps) | 100Mbps Copper/FO Ethernet port<br>Serial RS485 port |
| SCADA Interface | IEC61850/DNP3 (Ethernet) 100 Mbps or Modbus (RS-485) or IEC 60870-5-103(RS-485) or DNP3(RS-485) | Rear port |
| Time Sync | IRIG-B, BNC connector<br>SNTP | Modulated or un-modulated |
| Self Checking/Relay Inoperative | 2CO contact configurable | Closed NC when relay inoperative |

| F-PRO 235 Specifications | | |
|---|---|---|
| **Physical:** | | |
| Weight | 4.50 Kgs | |
| Overall Dimensions | E6 case:<br>177mm(H) x 155mm(W) x 242.5mm(D) | |
| Cutout Dimensions – Flush Mount | E6 case : 159mm High x 150mm Wide | |
| **Time Synchronization and Accuracy** | | |
| External Time Source | Synchronized using IRIG-B input (modulated or un-modulated)<br><br>1PPM<br><br>SNTP | In the absence of an external time source, the relay maintains time with internal RTC. 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 ($I_n$) | |
| | ±1.0% of inputs from 1.0 to 4.0 x nominal current ($I_n$) | |
| Voltage | ±1.0% of input of nominal voltage ($V_n$) | |
| 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 | |

**Detailed Environmental Tests**

| Standard | Description of the Test | Test Points | Test Level |
|---|---|---|---|
| IEC 60255-26:2013<br>Cl.No.7.2.3 | Electrostatic Discharge | Enclosure Air<br>Enclosure contact | +/- 8 kV<br>+/- 6 kV |
| IEC 60255-26:2013<br>Cl.No.7.2.4 | Radiated interference<br>(Electromagnetic Field Immunity) | Enclosure ports | 10 v/m : 80-1000 MHz<br>: 1.4 GHz – 2.7 GHz |
| IEC 60255-26:2013<br>Cl.No.7.2.5 | Electrical Fast Transient | AC/DC power ports<br>AC voltage & current ports External I/P & O/P ports | +/- 4 kV |
| IEC 60255-26:2013<br>Cl.No.7.2.6 | Slow Damped Oscillatory /<br>High Frequency Disturbance /<br>1 MHz Burst Disturbance | AC/DC power ports<br>AC voltage & current ports<br>External I/P & O/P ports | +/- 2.5kV (CM)<br>+/-1kV (DM) |
| IEC 60255-27:2013<br>Cl.No.10.6.4.2 | Impulse Voltage | AC/DC power ports<br>AC voltage & current ports<br>External I/P & O/P ports | +/- 5 kV |
| IEC 60255-27:2013<br>Cl.No.10.6.4.3 | AC Dielectric Voltage | AC/DC power ports<br>AC voltage & current ports<br>External I/P & O/P ports | 2kV / min |
| IEC 60255-27:2013<br>Cl.No.10.6.4.4 | Insulation Resistance Test | AC/DC power ports<br>AC voltage & current ports<br>External I/P & O/P ports | 500V / min |
| IEC 60255-21-1<br>Class 1 | Vibration | | 10Hz to 150Hz, 1.0g<br>1.0 Octave/min, 20 Sweep cycle/axis |
| IEC 60255-21-2<br>Class 1 | Shock and Bump | | 5g and 15g |
| IEC 60255-21-3<br>Siesmic | Siesmic | | 5Hz to 35Hz, 1.0g<br>1.0 Octave/min, 1 Sweep cycle/axis |

# A.1 IDMTL Element Operating Time Curves

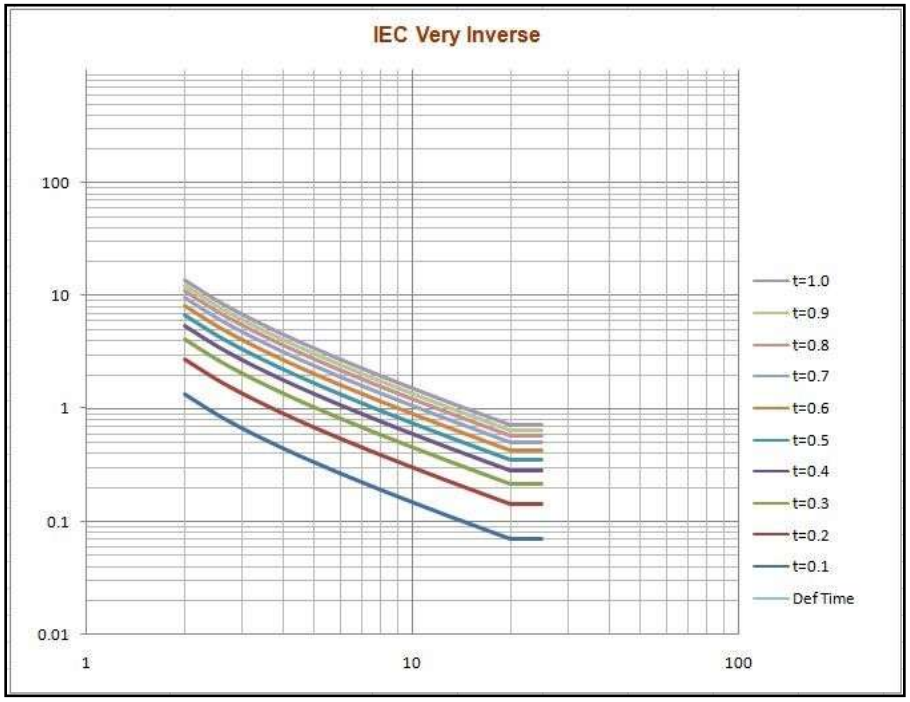



**Figure A.1: IDMTL IEC very inverse curve**

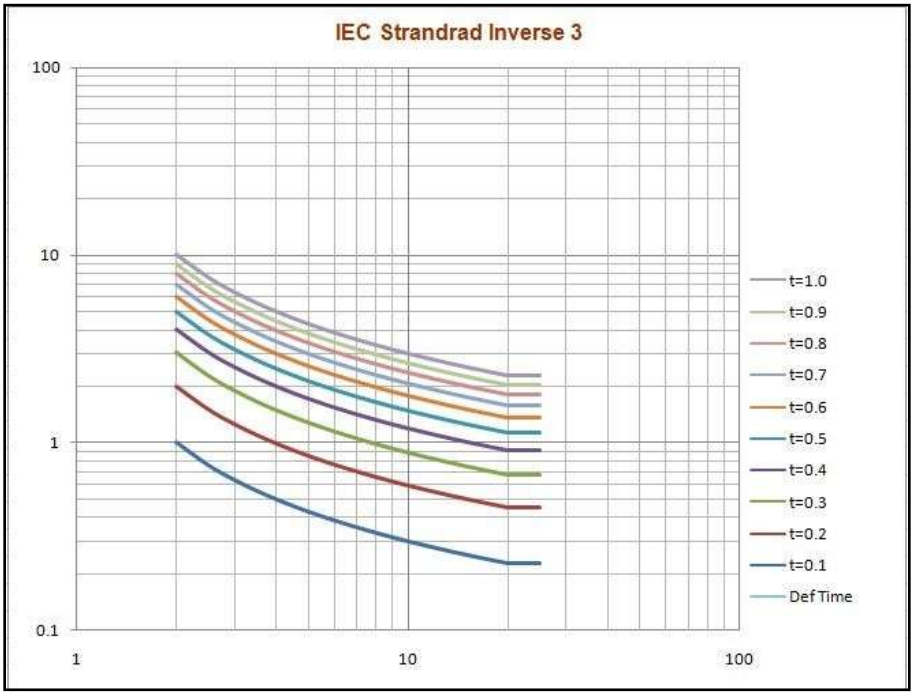



**Figure A.2: IDMTL IEC Standard inverse curve 3**

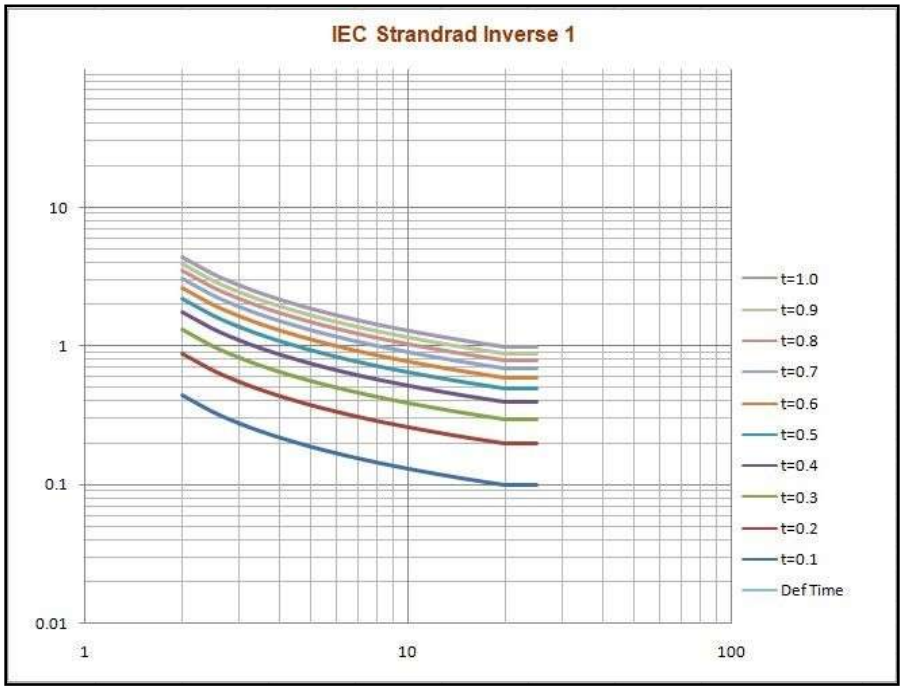



**Figure A.3: IDMTL IEC Standard inverse curve 1**

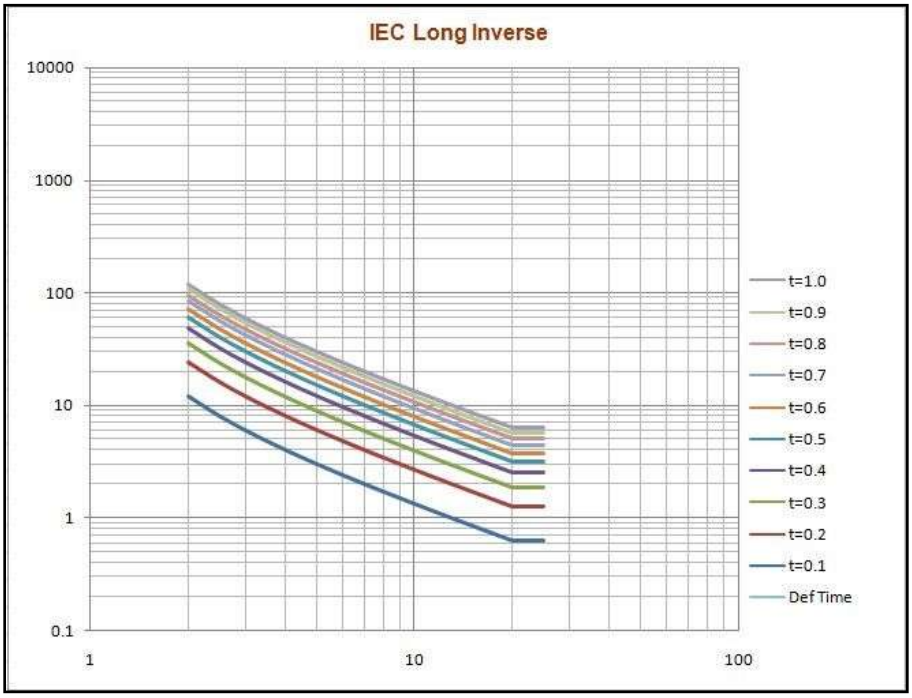



**Figure A.4: IDMTL IEC Long inverse curve**

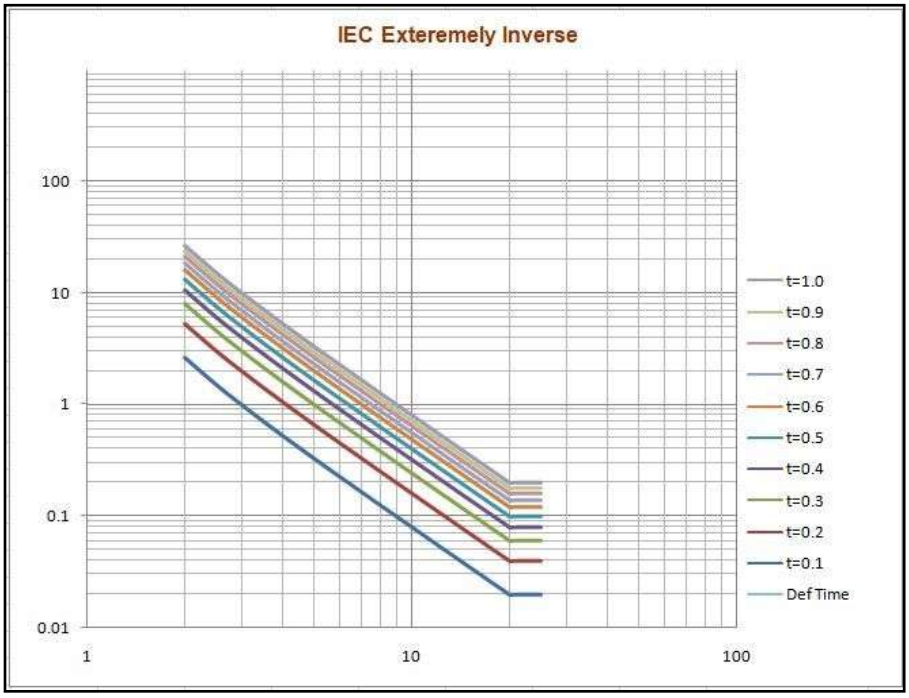



**Figure A.5: IDMTL IEC Extremely inverse curve**

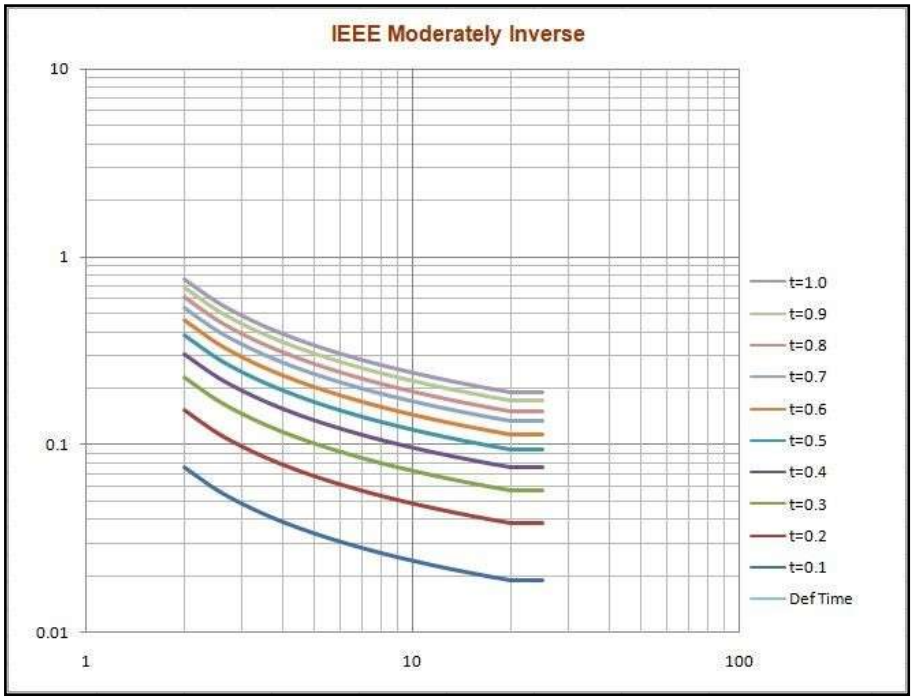



**Figure A.6: IDMTL IEEE Moderately inverse curve**

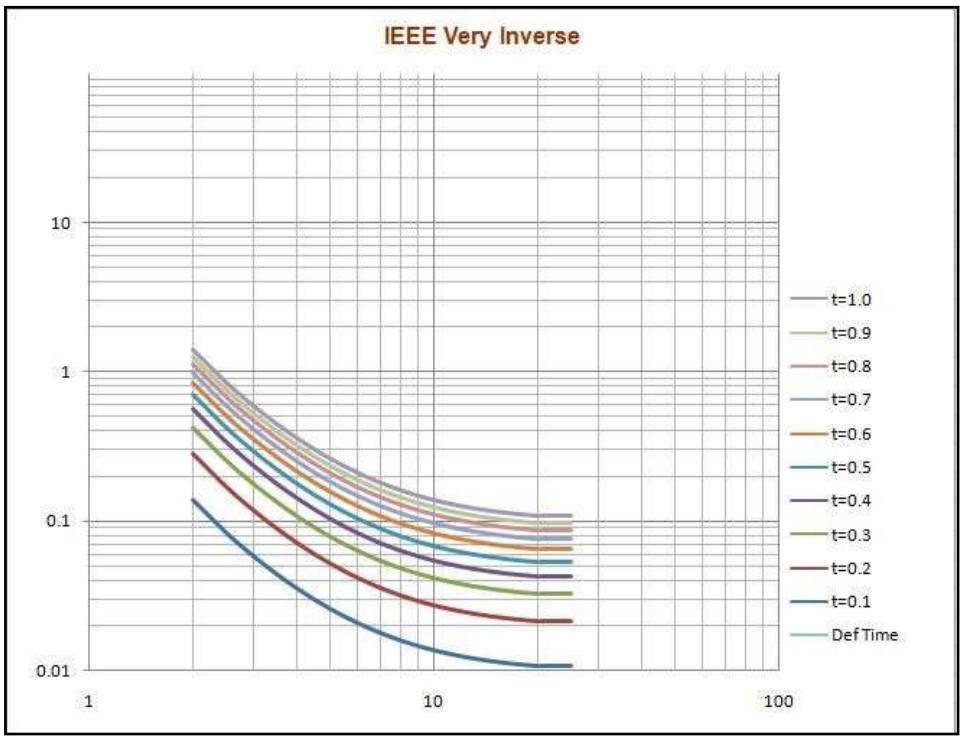



**Figure A.7: IDMTL IEEE very inverse curve**

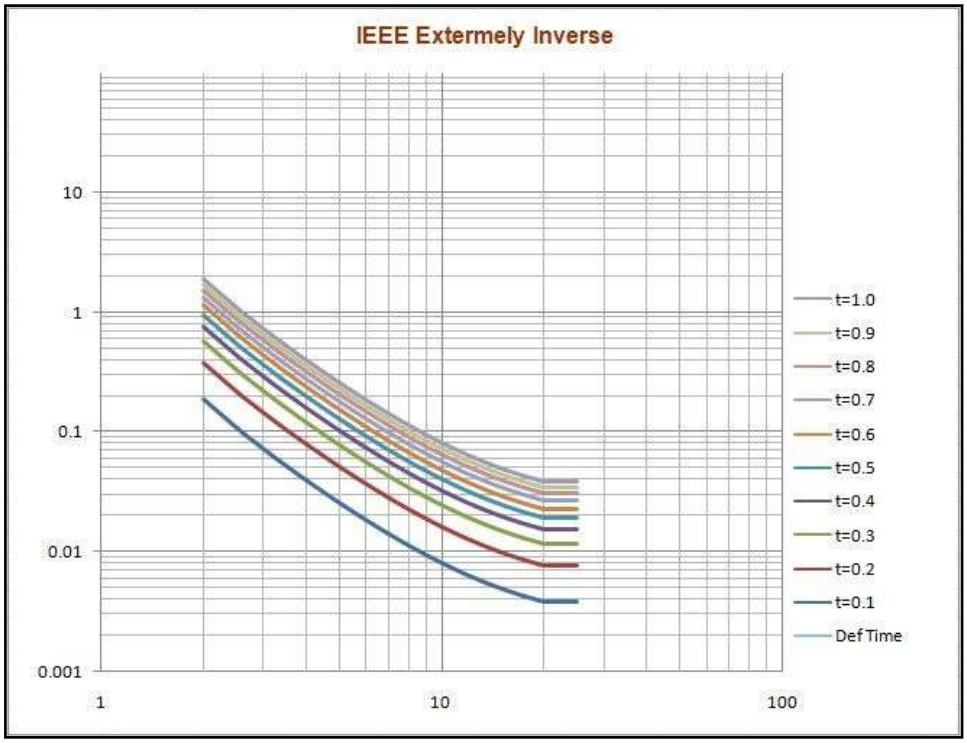



**Figure A.8: IDMTL IEEE Extremely inverse curve**

# Appendix B IED Settings and Ranges

This topic describes the settings and its ranges of F-PRO 235 relay. When a setting has been completed in the F –PRO Offliner software, it can be printed along with the ranges available for these settings. This summary is however, a quick way of having a look at all the settings in a very compact form.

The top part of the settings summary identifies the date that the settings were done, the relay identification, the station that the relay is applied and location.

The setting summary provides a list of all the current and voltage analog input quantity names used for the protection and recording. External Inputs and Output are also identified on this summary.

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **Relay Identification** | | | |
| Settings Version | 5 | | |
| Ignore Serial Number | Yes | | |
| Serial Number | FPRO-235 | | |
| Relay ID | RelayID | | |
| Nominal System Frequency | 50 Hz | | |
| Standard I/O | 4 External Inputs and 8 Output Contacts | | |
| Comments | Comments | | |
| Setting Name | Settings Name | | |
| Date Created/Modified | 2019-03-04 20:45:39 | | |
| Station Name | Station Name | | |
| Location | Location | | |
| Bay Name | Bay Name | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **External Input Names** | | | |
| EI 1 | EI 1 | | |
| EI 2 | EI 2 | | |
| EI 3 | EI 3 | | |
| EI 4 | EI 4 | | |
| **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 | | |
| **Virtual Input Names** | | | |
| VI 1 | VI 1 | | |
| VI 2 | VI 2 | | |
| VI 3 | VI 3 | | |
| VI 4 | VI 4 | | |
| VI 5 | VI 5 | | |
| VI 6 | VI 6 | | |
| VI 7 | VI 7 | | |
| VI 8 | VI 8 | | |

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

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **Setting Group Names** | | | |
| Setting Group 1 | SG 1 | | |
| Setting Group 2 | SG 2 | | |
| Setting Group 3 | SG 3 | | |
| Setting Group 4 | SG 4 | | |
| **System Parameters** | | | |
| CT Configuration | | | |
| Phase CT Sec. current | 1A | | |
| Phase CT Ratio | 100.0 | - | 1.0 to 30000.0 |
| VT Configuration | | | |
| Phase VT Sec. voltage | 63.5 | V | 40.0 to 160.0 |
| Phase VT Ratio | 1000.0 | - | 1.0 to 10000.0 |
| Phase VT Secondary Connection | Ph-N | | |
| **Disturbance Record** | | | |
| Record Length | 1 | s | 1 to 20 |
| Pre Trigger | 0.25 | s | 0.10 to 0.50 |
| **Setting Group 1 [SG 1]** | | | |
| Setting Group Comments: No Comments | | | |
| **Protection Functions** | | | |
| 27/59DT-1 | Enabled | | |
| 27/59DT-2 | Enabled | | |
| 27/59DT-3 | Enabled | | |
| 27/59DT-4 | Disabled | | |
| 27/59DT-5 | Disabled | | |
| 27/59DT-6 | Disabled | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 27/59IT-1 | Enabled | | |
| 27/59IT-2 | Disabled | | |
| 50/67-1 | Enabled | | |
| 50/67-2 | Disabled | | |
| 51/67-1 | Enabled | | |
| 51/67-2 | Disabled | | |
| 50N/67N-1 | Enabled | | |
| 50N/67N-2 | Disabled | | |
| 51N/67N-1 | Enabled | | |
| 51N/67N-2 | Disabled | | |
| 46/50 | Enabled | | |
| 46/51 | Enabled | | |
| 49 | Enabled | | |
| 50BF | Enabled | | |
| 46BC | Enabled | | |
| 60CTS | Enabled | | |
| 60VTS | Enabled | | |
| 74TCS-1 | Enabled | | |
| 74TCS-2 | Enabled | | |
| 81HBL2 | Enabled | | |
| I^2t-CB | Enabled | | |
| 79 | Enabled | | |

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

| 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 | | |
| 27/59DT-4 | Disabled | | |
| 27/59DT-5 | Disabled | | |
| 27/59DT-6 | Disabled | | |
| **27/59IT – Phase Inverse Time Under/Over Voltage** | | | |
| 27/59IT-1 | Enabled | | |
| 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 | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 27/59IT-2 | Disabled | | |
| **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 | | |
| **67N-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 | | |
| **50/67 – Instantaneous Phase Overcurrent** | | | |
| 50/67-1 | Enabled | | |
| 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 | | |
| 50/67-2 | Disabled | | |
| **51/67 – IDMTL Phase Overcurrent** | | | |
| 51/67-1 | Enabled | | |
| 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 |

| 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 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| Inrush Block | Enabled | | |
| 51/67-2 | Disabled | | |
| **50N/67N – Derived Instantaneous Neutral Overcurrent** | | | |
| 50N/67N-1 | Enabled | | |
| 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 | | |
| **51N/67N – Derived IDMTL Neutral Overcurrent** | | | |
| 51N/67N-1 | Enabled | | |
| Direction Selection | Non-Directional | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 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 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| Inrush Block | Enabled | | |
| 51N/67N-2 | Disabled | | |
| **46/50 – Instantaneous Negative Sequence Overcurrent** | | | |
| 46/50 | Enabled | | |
| 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 | Enabled | | |
| 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 |
| Reset Delay | ANSI Decay | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Reset DTL Delay | 0.0 | s | 0.0 to 99.9 |
| A | 0.1400 | - | - |
| B | 0.0000 | - | - |
| p | 0.02 | - | - |
| Reset Delay(TR) | 13.50 | - | 0.10 to 150.00 |
| **49 – Thermal Overload** | | | |
| 49 | Enabled | | |
| 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 |
| **50BF – Breaker Failure Protection** | | | |
| 50BF | Enabled | | |
| 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 |
| **46BC – Broken Conductor** | | | |
| 46BC | Enabled | | |
| Pickup I2/I1> | 30.00 | % | 20.00 to 100.00 |
| Pickup Delay | 10.00 | s | 0.02 to 999.99 |
| **60CTS – CT Supervision** | | | |
| 60CTS | Enabled | | |
| Vnps Pickup | 20.00 | V | 7.00 to 110.00 |
| Inps Pickup | 0.10 | A | 0.05 to 1.00 |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Pickup Delay | 10.00 | s | 0.03 to 999.99 |
| **60VTS – VT Supervision** | | | |
| 60VTS | Enabled | | |
| 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 |
| **74TCS – Trip Circuit Supervision** | | | |
| 74TCS-1[TCS 1] | Enabled | | |
| Drop off Delay | 0.40 | s | 0.00 to 9.99 |
| 74TCS-2[TCS 2] | Enabled | | |
| Drop off Delay | 0.40 | s | 0.00 to 9.99 |
| **81HBL2 – Inrush** | | | |
| 81HBL2 | Enabled | | |
| Cross Blocking | Enabled | | |
| Pickup I2nd> | 15 | % | 5 to 50 |
| **I^2t-CB Condition** | | | |
| I^2t-CB | Enabled | | |
| I^2t Limit | 99999.9 | kA^2s | 0.1 to 99999.9 |
| **79 – Recloser** | | | |
| 79 | Enabled | | |
| 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 |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| 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 | Enabled | | |
| Pickup Delay-Tp | 0.00 | s | 0.00 to 999.00 |
| Dropout Delay-Td | 0.00 | s | 0.00 to 999.00 |
| Operator 1 | | | |
| Input A | <Unused = 0> | | |
| Operator 2 | | | |
| Input B | <Unused = 0> | | |
| Operator 3 | | | |
| Input C | <Unused = 0> | | |
| Operator 4 | | | |
| Input D | <Unused = 0> | | |
| Operator 5 | | | |
| Input E | <Unused = 0> | | |
| **PL 2 [ProLogic 2]** | | | |
| ProLogic 2 | Disabled | | |
| **PL 3 [ProLogic 3]** | | | |
| ProLogic 3 | Disabled | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **PL 4 [ProLogic 4]** | | | |
| ProLogic 4 | Disabled | | |
| **PL 5 [ProLogic 5]** | | | |
| ProLogic 5 | Disabled | | |
| **PL 6 [ProLogic 6]** | | | |
| ProLogic 6 | Disabled | | |
| **PL 7 [ProLogic 7]** | | | |
| ProLogic 7 | Disabled | | |
| **PL 8 [ProLogic 8]** | | | |
| ProLogic 8 | Disabled | | |
| **PL 9 [ProLogic 9]** | | | |
| ProLogic 9 | Disabled | | |
| **PL 10 [ProLogic 10]** | | | |
| ProLogic 10 | Disabled | | |
| **PL 11 [ProLogic 11]** | | | |
| ProLogic 11 | Disabled | | |
| **PL 12 [ProLogic 12]** | | | |
| ProLogic 12 | Disabled | | |
| **PL 13 [ProLogic 13]** | | | |
| ProLogic 13 | Disabled | | |
| **PL 14 [ProLogic 14]** | | | |
| ProLogic 14 | Disabled | | |
| **PL 15 [ProLogic 15]** | | | |
| ProLogic 15 | Disabled | | |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| **PL 16 [ProLogic 16]** | | | |
| ProLogic 16 | Disabled | | |
| **PL 17 [ProLogic 17]** | | | |
| ProLogic 17 | Disabled | | |
| **PL 18 [ProLogic 18]** | | | |
| ProLogic 18 | Disabled | | |
| **PL 19 [ProLogic 19]** | | | |
| ProLogic 19 | Disabled | | |
| **PL 20 [ProLogic 20]** | | | |
| ProLogic 20 | Disabled | | |
| **Relay Reset** | | | |
| Reset Type[RL 1] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | - |
| Reset Type[RL 2] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | 0.00 to 1.00 |
| Reset Type[RL 3] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | 0.00 to 1.00 |
| Reset Type[RL 4] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | 0.00 to 1.00 |
| Reset Type[RL 5] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | 0.00 to 1.00 |
| Reset Type[RL 6] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | 0.00 to 1.00 |
| Reset Type[RL 7] | Self Reset | | |
| Minimum Energize Delay | 0.10 | s | 0.00 to 1.00 |

| F-PRO Settings Summary – Setting Group 1 [SG 1] | | | |
|---|---|---|---|
| **Name** | **Symbol/Value** | **Unit** | **Range** |
| Reset Type[RL 8] | Self Reset | | |
| **Target LED Reset** | | | |
| Reset Type[Target LED 2] | Self Reset | | Self / Hand Reset |
| Reset Type[Target LED 3] | Self Reset | | Self / Hand Reset |
| Reset Type[Target LED 4] | Self Reset | | Self / Hand Reset |
| Reset Type[Target LED 5] | Self Reset | | Self / Hand Reset |
| Reset Type[Target LED 6] | Self Reset | | Self / Hand Reset |
| Reset Type[Target LED 7] | Self Reset | | Self / Hand Reset |
| Reset Type[Target LED 8] | Self Reset | | Self / Hand 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 has System on Module and it contains high speed dual core processor which performs the entire relay operation. The FB is interfaced to Carrier Board, which manages the protection features of the relay. The dual core processor manages the user interface and system control features of the relay. It also has 5 keys (The keypad is used to navigate the menus on the display to control relay operation by a local user), 2 row X 16 character alphanumerical LCD, RTC backup battery, LED's and USB interface.

The FB 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.
- High speed inbuilt link is provided between the DSP and ARM processor subsystems.
- Sophisticated fault detection.

**Carrier Board (CB):**

This board contains SMPS, 2 digital input channels (Inputs are optically isolated, externally wetted and ordering option with the voltage level of 24 / 48 / 110 / 220 Vdc selection), 4 normally open contact outputs, 1 form A contact output for relaying, alarms & control, RS485 interface, 5 channel analog input. This board is interfaced to the FB Board.

CB has 6 channel analog inputs (3 current transformer inputs and 3 voltage transformer inputs). It provides the analog to digital conversion of 5 ac analog current 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 FB for processing of protection algorithms

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.

**Add On Board:**

This board contains 2 digital input channels(Inputs are optically isolated, externally wetted and ordering option with the voltage level of 24 / 48 / 110 / 220 Vdc selection),2 normally open contact outputs, 1 form A contact output for relaying, alarms & control, IRIG-B(Modulated and Un-modulated input selection through jumper) & 100Mbps Ethernet. This board is interfaced to the Carrier Board. SNTP Time sync is connected through Ethernet.

# Appendix D Event Messages

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

| Event Log Message | Notes |
|---|---|
| 50/67-1 ABC: Picked up | The possible phase information will be:<br>• A<br>• B<br>• C<br>• AB<br>• BC<br>• CA<br>• ABC |
| 50/67-1 ABC: Operated | |
| 50/67-2 ABC: Picked up | |
| 50/67-2 ABC: Operated | |
| 51/67-1 ABC: Picked up | |
| 51/67-1 ABC: Operated | |
| 51/67-2 ABC: Picked up | |
| 51/67-2 ABC: Operated | |
| 50N/67N-1 :Picked up | |
| 50N/67N-1 : Operated | |
| 50N/67N-2 :Picked up | |
| 50N/67N-2 : Operated | |
| 51N/67N-1 :Picked up | |
| 51N/67N-1 : Operated | |
| 51N/67N-2 :Picked up | |
| 51N /67N-2: Operated | |
| 60CTS operated | |
| 60 VTS operated | |
| 46/50: Picked up | |
| 46/50: Operated | |
| 46/51: Picked up | |
| 46/51 : Operated | |
| 49 ABC: Pickup | |
| 49 ABC: Operated | |
| 49 AL: Operated | |
| 50BF-D1 Operated | |
| 50BF-D2 Operated | |
| 46BC Operated | |
| 60 CTS Operated | |
| 60 VTS Operated | |
| 74TCS-1 Operated | |
| 74TCS-2 Operated | |

| Event Log Message | Notes |
|---|---|
| 81HBL2 Operated | The possible phase information will be:<br>• A<br>• B<br>• C<br>• AB<br>• BC<br>• CA<br>• ABC |
| 79 IN | |
| 79 OUT | |
| 79 Reclose | |
| 79 AR Initiate | |
| 79 Block | |
| 79 Lockout | |
| I^2T Limit Operated | |
| ProLogic Name: PL*n* | ProLogic outputs names are user assigned (Where n=20) |
| Extern Input Name: EI*n* | External input names are user assigned (Where n = 8) |
| New Settings loaded, Active group n. | Where n = 1-4 |
| Manual Settings Load request, activate SGn | Where n = 1-4 |
| Manual Settings Load request completed | Manual or user initiated settings change. (Only when settings loaded from HMI) |
| Changed Active Group from x to y | Completion of user initiated settings change. |
| Logic n | This happens when relay changes setting group. Automatic group logic initiated setting group change |
| User changed Active Group from x to y | This happens when the relay changes setting group. User initiated setting group change |
| Unit Recalibrated | |
| Unit restarted | |

# Appendix E Modbus RTU Communication Protocol

F-PRO COM 2 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, alarm events and also includes fault information.

A "Hold Readings" function is available to freeze all metering readings into a snapshot (see Force Single Coil function, address 0).

**Table 13.1 Relay Coil Status (Function Code 1)**

| 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 |

| Table 13.2 Relay Coil Status (Function Code 1) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | |
| 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 |
| 50/67-1 Picked up | 545 | 0: OFF | 1: ON |
| 50/67-2 Picked up | 546 | 0: OFF | 1: ON |
| 50/67-1 Operated | 547 | 0: OFF | 1: ON |
| 50/67-2 Operated | 548 | 0: OFF | 1: ON |
| 51/67-1 Picked up | 549 | 0: OFF | 1: ON |
| 51/67-2 Picked up | 550 | 0: OFF | 1: ON |
| 51/67-1 Operated | 551 | 0: OFF | 1: ON |
| 51/67-2 Operated | 552 | 0: OFF | 1: ON |
| 50N/67N-1 Picked up | 553 | 0: OFF | 1: ON |
| 50N/67N -2 Picked up | 554 | 0: OFF | 1: ON |
| 50N/67N -1 Operated | 555 | 0: OFF | 1: ON |
| 50N/67N -2 Operated | 556 | 0: OFF | 1: ON |
| 51N/67N -1 Picked up | 557 | 0: OFF | 1: ON |
| 51N/67N -2 Picked up | 558 | 0: OFF | 1: ON |
| 51N/67N -1 Operated | 559 | 0: OFF | 1: ON |
| 51N/67N -2 Operated | 560 | 0: OFF | 1: ON |
| 46/50 Picked up | 561 | 0: OFF | 1: ON |
| 46/50 Operated | 562 | 0: OFF | 1: ON |
| 46/51 Picked up | 563 | 0: OFF | 1: ON |
| 46/51 Operated | 564 | 0: OFF | 1: ON |
| 49 Picked up | 565 | 0: OFF | 1: ON |
| 49 Operated | 566 | 0: OFF | 1: ON |
| 49AL Operated | 567 | 0: OFF | 1: ON |
| 50BF-D1 Operated | 568 | 0: OFF | 1: ON |
| 50BF- D2 Operated | 569 | 0: OFF | 1: ON |
| 46BC Operated | 570 | 0: OFF | 1: ON |
| 74TCS-1 Operated | 571 | 0: OFF | 1: ON |
| 74TCS-2 Operated | 572 | 0: OFF | 1: ON |
| 81HBL2 Operated | 573 | 0: OFF | 1: ON |
| 79 IN | 574 | 0: OFF | 1: ON |
| 79 OUT | 575 | 0: OFF | 1: ON |
| 79 Reclose | 576 | 0: OFF | 1: ON |
| 79 AR Initiate | 577 | 0: OFF | 1: ON |
| 79 Block | 578 | 0: OFF | 1: ON |
| 79 Lockout | 579 | 0: OFF | 1: ON |
| I2t Limit Operated | 580 | 0: OFF | 1: ON |
| 60CTS Operated | 581 | 0: OFF | 1: ON |
| 60VTS Operated | 582 | 0: OFF | 1: ON |

| Table 13.3 Read Coil Status (Function Code 01) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | |
| ProLogic1 | 583 | 0: OFF | 1: ON |
| ProLogic2 | 584 | 0: OFF | 1: ON |
| ProLogic3 | 585 | 0: OFF | 1: ON |
| ProLogic4 | 586 | 0: OFF | 1: ON |
| ProLogic5 | 587 | 0: OFF | 1: ON |
| ProLogic6 | 588 | 0: OFF | 1: ON |
| ProLogic7 | 589 | 0: OFF | 1: ON |
| ProLogic8 | 590 | 0: OFF | 1: ON |
| ProLogic9 | 591 | 0: OFF | 1: ON |
| ProLogic10 | 592 | 0: OFF | 1: ON |
| ProLogic11 | 593 | 0: OFF | 1: ON |
| ProLogic12 | 594 | 0: OFF | 1: ON |
| ProLogic13 | 595 | 0: OFF | 1: ON |
| ProLogic14 | 596 | 0: OFF | 1: ON |
| ProLogic15 | 597 | 0: OFF | 1: ON |
| ProLogic16 | 598 | 0: OFF | 1: ON |
| ProLogic17 | 599 | 0: OFF | 1: ON |
| ProLogic18 | 600 | 0: OFF | 1: ON |
| ProLogic19 | 601 | 0: OFF | 1: ON |
| ProLogic20 | 602 | 0: OFF | 1: ON |
| Relay O/P1 | 603 | 0: OFF | 1: ON |
| Relay O/P2 | 604 | 0: OFF | 1: ON |
| Relay O/P3 | 605 | 0: OFF | 1: ON |
| Relay O/P4 | 606 | 0: OFF | 1: ON |
| Relay O/P5 | 607 | 0: OFF | 1: ON |
| Relay O/P6 | 608 | 0: OFF | 1: ON |
| Relay O/P7 | 609 | 0: OFF | 1: ON |
| Relay O/P8 | 610 | 0: OFF | 1: ON |

| Table 13.4 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 |

| Table 13.5 Read Discrete Inputs (Function Code 02) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | |
| 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 |
| 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 |
| 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 |

| Table 13.6 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 |
| IA Magnitude | 40265 | A | 100 |
| IA Angle | 40266 | Degrees | 1 |
| IB Magnitude | 40267 | A | 100 |
| IB Angle | 40268 | Degrees | 1 |
| IC Magnitude | 40269 | A | 100 |
| IC Angle | 40270 | Degrees | 1 |
| IN Magnitude | 40271 | A | 100 |
| IN Angle | 40272 | Degrees | 1 |
| V1 Magnitude | 40273 | kV | 100 |
| V2 Magnitude | 40274 | kV | 100 |
| V0 Magnitude | 40275 | kV | 100 |
| I1 Magnitude | 40276 | A | 100 |
| I2 Magnitude | 40277 | A | 100 |
| I0 Magnitude | 40278 | A | 100 |
| Frequency | 40281 | Hz | 10 |
| Power Factor | 40282 | - | 100 |
| Thermal state (%) | 40283 | % | 100 |
| $I^2t$ Accumulated | 40284 | $kA^2s$ | 1 |
| $I^2t$ for last operation | 40285 | $kA^2s$ | 1 |

***<u>Note:</u> In the above table, Scale value should be divided with the metering data obtained from Modbus.***

| Table 13.7 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 |
| *Time of Acquisition (UTC) – Note: Read all in same query to ensure consistent time reading data* | | | |
| Milliseconds now | 40008 | 0 – 999 | 1 |
| Seconds now | 40009 | 0 – 59 | 1 |
| Minutes now | 40010 | 0 – 59 | 1 |
| Hours now | 40011 | 0 – 23 | 1 |
| Day of year now | 40012 | 1 – 365 | 1 |
| Year since 1900 | 40013 | 90 – 137 | 1 |
| Time Synchronization | 40014 | 0: No Sync ,<br>1: IRIG-B Sync &<br>2:SNTP Sync | 1 |
| Local time offset | 40015 | 2's compliment half hours,<br>North America is negative | 1 |

| Table 13.8 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** | **Value** |
| Hold Readings | Read/Write | 01 | 0000: Readings update normally (inactive)<br>FF00: Hold readings (active) |

| Table 13.9 Write Single Register (Function Code 06) | | | |
|---|---|---|---|
| **Channel** | **Address** | **Value** | **Scaled Up By** |
| *Event Message Control (See given below tables for details of use)* | | | |
| Refresh event list | 40513 | No data required | Not Applicable |
| Acknowledge the cur- rent event and get the next event | 40514 | No data required | Not Applicable |
| Get the next event (without acknowledge) | 40515 | No data required | Not Applicable |

| Table 13.10 Diagnostic Sub functions (Function Code 08) | |
|---|---|
| Return Query Data (Subfunction00) | This provides an echo of the submitted message. |
| Restart Communication Option (Subfunction01) | This restarts the Modbus communications process. |
| 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. |

| Table 13.11 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 |

| Table 13.11 Report Slave ID (Function Code 17) | | | |
|---|---|---|---|
| A fixed response is returned by the IED, including system mo del, version and issue numbers. | | | |
| **Channel** | **Type** | **Bytes** | **Value** |
| Model Number | Read Only | 0 and 1 | 0 x 00Eb = 235 decimal |
| Version Number | Read Only | 2 and 3 | Version number |
| Issue Number | Read Only | 4 and 5 | Issue number |

- The F-PRO IED model number is 235.
- Version and issue will each be positive integers, say X and Y.

| Table 13.12 Accessing F-PRO Event Information | |
|---|---|
| All F-PRO detector event messages displayed in the Event Log are available via Modbus. The following controls are available. | |
| Refresh Event List | (Function Code 6, address 40513): 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 40514): Clears the current event from the read registers and places the next event into them. An acknowledged event is no longer available for reading. |
| Get Next Event | (Function Code 6, address 40515): Places the next event in the read registers without acknowledging the current event. The current event will reappear in the list when Refresh Event List is used. |
| Size of Current Event Message | (Function Code 3, address 40516): 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.<br>(Note: The Refresh Event List function can be used to check for new events that have occurred since the last Refresh Event List.) |
| Read Event Message | (Function Code 3, addresses 40517 – 40576): Contains the current event message. Two ASCII characters are packed into each 16 bit register. All unused registers in the set are set to 0. |

| Table 13.13 Sample Event Record | | | |
|---|---|---|---|
| **Register** | **Value** | | **Meaning** |
| | High Byte | Low Byte | |
| 40516 | 0x00 | 0x14 | Event text size = 20 (0x14 hex) |
| 40517 | 0x32 | 0x30 | '2', '0' |
| 40518 | 0x31 | 0x33 | '1', '3' |
| 40519 | 0x53 | 0x65 | 'S', 'e' |
| 40520 | 0x70 | 0x31 | 'p', '1' |
| 40521 | 0x32 | 0x20 | '2', ' ' |
| 40522 | 0x30 | 0x38 | '0', '8' |
| 40523 | 0x3A | 0x31 | ':', '1' |
| 40524 | 0x36 | 0x3A | '6', ':' |
| 40525 | 0x31 | 0x36 | '1', '6' |
| 40526 | 0x2E | 0x39 | '.', '9' |
| 40527 | 0x36 | 0x36 | '6', '6' |
| 40528 | 0x20 | 0x3A | ' ', ':' |
| 40529 | 0x20 | 0x35 | ' ', '5' |
| 40530 | 0x30 | 0x2D | '0', '-' |
| 40531 | 0x31 | 0x65 | '1', 'A' |
| 40532 | 0x66 | 0x20 | 'B', ' ' |
| 40533 | 0x4F | 0x70 | 'O', 'p' |
| 40534 | 0x65 | 0x72 | 'e', 'r' |
| 40535 | 0x61 | 0x74 | 'a ', 't' |
| 40536 | 0x65 | 0x64 | 'e', 'd ' |

# Appendix F IEC 103 Device Profile

### Device Properties

This document shows the device capabilities and the analog value of each parameter in IEC 103 nodes.

### IEC60870-5-103 Function Type & COT Descriptions

| Function Type | Description |
|---|---|
| 160 | IEC Overcurrent 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 in IEC60870-5-103 section 7.2.5.2

**KEY:-**

**FUN** Function Type (defined in [1] IEC60870-5-103 section 7.2.5.1)

**INF** Information Number (defined in [1] IEC60870-5-103 section 7.2.5.2)

**GI** Event supports General Interrogation x = supported (defined in [1] IEC60870-5-103 section 7.2.5.2)

**TYP** ASDU Type (defined in [1] IEC60870-5-103 sections 7.3.1 and 7.3.2)

**COT** Cause of Transmission (defined in [1] IEC60870-5-103 section 7.2.3, table 5)

**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 |
|---|---|---|---|---|---|---|
| 160 | 2 | Reset FCB | - | 5 | 3 | RO |
| 160 | 3 | Reset CU | - | 5 | 4 | RO |
| 160 | 4 | Start/Restart | - | 5 | 5 | RO |
| 160 | 5 | Power ON | - | 5 | 6 | RO |
| | | | | | | |
| 160 | 16 | ARC in progress | x | 1 | 1, 9 | RC |
| | | | | | | |
| 160 | 19 | LEDs reset | - | 1 | 1, 11, 12, 20, 21 | RO |
| | | | | | | |
| 160 | 22 | Settings changed | x | 1 | 1, 9, 11, 12 | RC |
| 160 | 23 | Setting G1 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 160 | 24 | Setting G2 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 160 | 25 | Setting G3 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| 160 | 26 | Setting G4 selected | x | 1 | 1, 9, 11, 12, 20, 21 | RC |
| | | | | | | |
| 160 | 27 | External Input1 | x | 1 | 1, 9 | RC |
| 160 | 28 | External Input2 | x | 1 | 1, 9 | RC |
| 160 | 29 | External Input3 | x | 1 | 1, 9 | RC |
| 160 | 30 | External Input4 | x | 1 | 1, 9 | RC |
| | | | | | | |
| 160 | 36 | Trip Circuit Supervision (TCS-1) | x | 1 | 1,9 | RC |
| 160 | 64 | A-Starter | x | 2 | 1, 9 | RC |
| 160 | 65 | B-Starter | x | 2 | 1, 9 | RC |
| 160 | 66 | C-Starter | x | 2 | 1, 9 | RC |
| 160 | 67 | E-Starter | x | 2 | 1, 9 | RC |
| 160 | 68 | General trip | - | 2 | 1 | RO |
| 160 | 69 | A-General trip | - | 2 | 1 | RO |
| 160 | 70 | B-General trip | - | 2 | 1 | RO |
| 160 | 71 | C-General trip | - | 2 | 1 | RO |
| | | | | | | |
| 160 | 84 | General starter | x | 2 | 1,9 | RC |
| 160 | 85 | Circuit Breaker Fail (50BF) | - | 2 | 1 | RO |

| | | | | | | |
|---|---|---|---|---|---|---|
| 160 | 91 | P/F-General HS trip (50/67) | - | 2 | 1 | RO |
| 160 | 92 | E/F-General trip | - | 2 | 1 | RO |
| 160 | 93 | E/F-General HS trip (50N/67N) | - | 2 | 1 | RO |
| | | | | | | |
| 160 | 128 | CB on by Auto-reclose | x | 1 | 1,9 | RC |
| 160 | 130 | Reclose Blocked | x | 1 | 1,9 | RC |
| | | | | | | |
| 160 | 148 | Measurand IL1,2,3, VL1,2,3, P, | x | 9 | 2 | - |
| | | | | | | |
| 164 | 160 | 27DT-1 Picked up | - | 2 | 1 | RC |
| 164 | 161 | 27DT-2 Picked up | - | 2 | 1 | RC |
| 164 | 162 | 27DT-3 Picked up | - | 2 | 1 | RC |
| 164 | 163 | 27DT-4 Picked up | - | 2 | 1 | RC |
| 164 | 164 | 27DT-5 Picked up | - | 2 | 1 | RC |
| 164 | 165 | 27DT-6 Picked up | - | 2 | 1 | RC |
| 164 | 166 | 27DT-1 Operated | - | 2 | 1 | RO |
| 164 | 167 | 27DT-2 Operated | - | 2 | 1 | RO |
| 164 | 168 | 27DT-3 Operated | - | 2 | 1 | RO |
| 164 | 169 | 27DT-4 Operated | - | 2 | 1 | RO |
| 164 | 170 | 27DT-5 Operated | - | 2 | 1 | RO |
| 164 | 171 | 27DT-6 Operated | - | 2 | 1 | RO |
| 164 | 172 | 27IT-1 Picked up | - | 2 | 1 | RC |
| 164 | 173 | 27IT-2 Picked up | - | 2 | 1 | RC |
| 164 | 174 | 27IT-1 Operated | - | 2 | 1 | RO |
| 164 | 175 | 27IT-2 Operated | - | 2 | 1 | RO |
| 164 | 176 | 59DT-1 Picked up | - | 2 | 1 | RC |
| 164 | 177 | 59DT-2 Picked up | - | 2 | 1 | RC |
| 164 | 178 | 59DT-3 Picked up | - | 2 | 1 | RC |
| 164 | 179 | 59DT-4 Picked up | - | 2 | 1 | RC |
| 164 | 180 | 59DT-5 Picked up | - | 2 | 1 | RC |
| 164 | 181 | 59DT-6 Picked up | - | 2 | 1 | RC |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 164 | 182 | 59DT-1 Operated | - | 2 | 1 | RO |
| 164 | 183 | 59DT-2 Operated | - | 2 | 1 | RO |
| 164 | 184 | 59DT-3 Operated | - | 2 | 1 | RO |
| 164 | 185 | 59DT-4 Operated | - | 2 | 1 | RO |
| 164 | 186 | 59DT-5 Operated | - | 2 | 1 | RO |
| 164 | 187 | 59DT-6 Operated | - | 2 | 1 | RO |
| 164 | 188 | 59IT-1 Picked up | - | 2 | 1 | RC |
| 164 | 189 | 59IT-2 Picked up | - | 2 | 1 | RC |
| 164 | 190 | 59IT-1 Operated | - | 2 | 1 | RO |
| 164 | 191 | 59IT-2 Operated | - | 2 | 1 | RO |
| 164 | 192 | 50/67-1 Picked up | - | 2 | 1 | RC |
| 164 | 193 | 50/67-2 Picked up | - | 2 | 1 | RC |
| 164 | 194 | 50/67-1 Operated | - | 2 | 1 | RO |
| 164 | 195 | 50/67-2 Operated | - | 2 | 1 | RO |
| 164 | 196 | 51/67-1 Picked up | - | 2 | 1 | RC |
| 164 | 197 | 51/67-1 Operated | - | 2 | 1 | RO |
| 164 | 198 | 50N/67N-1 Picked up | - | 2 | 1 | RC |
| 164 | 199 | 50N/67N-2 Picked up | - | 2 | 1 | RC |
| 164 | 200 | 50N/67N-1 Operated | - | 2 | 1 | RO |
| 164 | 201 | 50N/67N-2 Operated | - | 2 | 1 | RO |
| 164 | 202 | 51N/67N-1 Picked up | - | 2 | 1 | RC |
| 164 | 203 | 51N/67N-1 Operated | - | 2 | 1 | RO |
| 164 | 204 | 46/50 Picked up | - | 2 | 1 | RC |
| 164 | 205 | 46/50 Operated | - | 2 | 1 | RO |
| 164 | 206 | 46/51 Picked up | - | 2 | 1 | RC |
| 164 | 207 | 46/51 Operated | - | 2 | 1 | RO |
| 164 | 208 | 49 Picked up | - | 2 | 1 | RC |
| 164 | 209 | 49 Operated | - | 2 | 1 | RO |
| 164 | 210 | 49AL Operated | - | 2 | 1 | RO |
| 164 | 211 | 50BF-D1 Operated | - | 2 | 1 | RO |
| 164 | 212 | 50BF-D2 Operated | - | 2 | 1 | RO |
| 164 | 213 | 46BC Operated | - | 1 | 1 | RO |
| 164 | 214 | I2t Limit Operated | - | 1 | 1 | RO |
| 164 | 215 | 81HBL2 Operated | - | 1 | 1 | RO |
| 164 | 216 | 60CTS Operated | - | 1 | 1 | RO |
| 164 | 217 | 60VTS Operated | - | 1 | 1 | RO |
| 164 | 218 | 51/67-2 Picked up | - | 2 | 1 | RC |
| 164 | 219 | 51/67-2 Operated | - | 2 | 1 | RO |
| 164 | 220 | 51N/67N-2 Picked up | - | 2 | 1 | RC |
| 164 | 221 | 51N/67N-2 Operated | - | 2 | 1 | RO |
| 164 | 222 | Trip Circuit Supervision (TCS-2) | x | 1 | 1,9 | RC |

| FUN | INF | Description | GI | TYP | COT | DIR |
|---|---|---|---|---|---|---|
| 164 | 223 | Output1 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 224 | Output2 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 225 | Output3 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 226 | Output4 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 227 | Output5 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 228 | Output6 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 229 | Output7 | x | 1 | 1, 9, 12, 20, 21 | RC |
| 164 | 230 | Output8 | x | 1 | 1, 9, 12, 20, 21 | RC |
| | | | | | | |
| 164 | 231 | Disturbance record stored | - | 1 | 1, 12, 20, 21 | RO |
| | | | | | | |
| 164 | 241 | $I_A$ Fault current | x | 4 | 1,9 | - |
| 164 | 242 | $I_B$ Fault current | x | 4 | 1,9 | - |
| 164 | 243 | $I_C$ Fault current | x | 4 | 1,9 | - |
| 164 | 244 | $I_N$ Fault current | x | 4 | 1,9 | - |
| | | | | | | |
| 164 | 247 | $V_A$ Fault Voltage | x | 4 | 1,9 | - |
| 164 | 248 | $V_B$ Fault Voltage | x | 4 | 1,9 | - |
| 164 | 249 | $V_C$ Fault Voltage | x | 4 | 1,9 | - |
| 164 | 250 | $V_N$ Fault Voltage | x | 4 | 1,9 | - |
| | | | | | | |
| 164 | 251 | IRIG_B Synchronization | x | 1 | 1,9 | RC |
| 164 | 252 | SNTP Synchronization | x | 1 | 1,9 | RC |
| | | | | | | |
| 255 | 0 | Time Synchronization | - | 6 | 8 | - |

# Appendix G DNP3.0 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: | 0. Master<br>1. Outstation | Outstation | |
| **1.1.2** | Vendor Name: | | ERL | |
| **1.1.3** | Device Name: | | F-PRO235 | |
| **1.1.4** | Device manufacturer's hardware version string: | | v1.0 | |
| **1.1.5** | Device manufacturer's software version string: | | V2.6 | |
| **1.1.6** | Device Profile Document Version Number: | | V1.0., Feb13, 2019 | |
| **1.1.7** | DNP Levels Supported for: | Masters Only<br>Requests Responses<br>☐ ☐ None<br>☐ ☐ Level 1<br>☐ ☐ Level 2<br>☐ ☐ Level 3<br><br>Outstations Only<br>Requests and Responses<br>☐ None<br>☐ Level 1<br>☒ Level 2<br>☐ Level 3 | | |
| ***1.1.8*** | Supported Function Blocks:<br>. | ☐ Self-Address Reservation<br>☐ ☐ Object 0 – attribute objects<br>☐ Data Sets<br>☐ File Transfer<br>☐ Virtual Terminal<br>☐ Mapping to IEC 61850 Object Models defined in a DNP3 XML file | | |

| | | | |
|---|---|---|---|
| **1.1.9** Notable Additions: | 1. Start-stop (qualifier codes 0x00 and 0x01), limited quantity (qualifier codes 0x07 and 0x08) and indices (qualifier codes 0x17 and 0x28) for Binary Inputs, Binary Outputs and Analog Inputs (object groups 1, 10 and 30)<br>2. 32-bit and 16-bit Analog Inputs with and without flag (variations 1, 2, 3 and 4)<br>3. 2-bit and 16-bit Analog Input events with time (variations 3 and 4) | | |
| **1.1.10** Methods to set Configurable Parameters: | ☐ XML – Loaded via DNP3 File Transfer<br>☐ XML – Loaded via other transport mechanism<br>☐ Terminal – ASCII Terminal Command Line<br>☒ Software – Vendor software named **F-PRO 2000 Offliner**<br>☐ Proprietary file loaded via DNP3 file transfer<br>☐ Proprietary file loaded via other transport mechanism<br>☐ Direct – Keypad on device front panel<br>☐ Factory – Specified when device is ordered<br>☐ Protocol – Set via DNP3 (e.g. assign class)<br>☐ Other – explain<br>_____ | | |

| | | | | |
|---|---|---|---|---|
| **1.1.11** | DNP3 XML files available On-Line: | Rd Wr Filename Description of Contents<br>☐ dnpDP.xml Complete Device Profile<br>☐ dnpDPcap.xml Device Profile Capabilities<br>☐ dnpDPcfg.xml Device Profile config. values<br>☐ ☐ _____*.xml<br>_____<br>* The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns.<br>* The Device Profile Capabilities contains only the capabilities and configurable methods columns.<br>* The Device Profile Config. Values contains only the Current Value column. | Not supported | |
| **1.1.12** | External DNP3 XML files available Off-line: | Rd Wr Filename Description of Contents<br>☐ ☐ dnpDP.xml Complete Device Profile<br>☐ ☐ dnpDPcap.xml Device Profile Capabilities<br>☐ ☐ dnpDPcfg.xml Device Profile config. values<br>☐ ☐ _____*.xml<br>_____<br>* The Complete Device Profile Document contains the capabilities, Current Value, and configurable methods columns.<br>* The Device Profile Capabilities contains only the capabilities and configurable methods columns.<br>* The Device Profile Config. Values contains only the Current Value column. | Not supported | |
| **1.1.13** | Connections Supported: | ☒ Serial (complete section 1.2)<br>☒ IP Networking (complete section 1.3)<br>☐ Other, explain<br>_____ | | |

| 1.2 SERIAL CONNECTIONS | | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.2.1** | Port Name | CON 2 | | |
| **1.2.2** | Serial Connection Parameters: | ☐ Asynchronous - 8 Data Bits, 1 Start Bit, 1 Stop Bit, No Parity<br>☒ Other, explain – Asynchronous with selectable parity | Parity - –one | F-PRO 2000 Offliner |
| **1.2.3** | Baud Rate: | ☐ Fixed at _____<br>☐ Configurable, range _____ to _____<br>☒ Configurable, selectable from 2400, 4800, 9600, 19200, 38400 and 57600<br>☐ Configurable, other, describe_____ | 9600 | F-PRO 2000 Offliner |

| | | | |
|---|---|---|---|
| **1.2.4** Hardware Flow Control (Handshaking):<br>*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<br>**RS-232 / V.24 / V.28 Options:**<br>Before Tx, Asserts: ☐ RTS ☐ DTR<br>Before Rx, Asserts: ☐ RTS ☐ DTR<br>Always Asserts: ☐ RTS ☐ DTR<br>Before Tx, Requires: Asserted Deasserted<br>☐ ☐ CTS<br>☐ ☐ DCD<br>☐ ☐ DSR<br>☐ ☐ RI<br>☐ Rx Inactive<br>Before Rx, Requires: Asserted Deasserted<br>☐ ☐ CTS<br>☐ ☐ DCD<br>☐ ☐ DSR<br>☐ ☐ RI<br>Always Ignores: ☐ CTS ☐ DCD ☐ DSR ☐ RI<br>☐ Other, explain _____<br>**RS-422 / V.11 Options:**<br>☐ Requires Indication before Rx<br>☐ Asserts Control before Tx<br>☐ Other, explain _____<br>**RS-485 Options:**<br>☐ Requires Rx inactive before Tx<br>☐ Other, explain _____ | Not supported | |
| **1.2.5** Interval to Request Link Status: | ☒ Not Supported<br>☐ Fixed at_____ seconds<br>☐ Configurable, range _____ to _____ seconds<br>☐ Configurable, selectable from ___,___,___ seconds<br>☐ Configurable, other, describe_____ | | |
| **1.2.6** Supports DNP3 Collision Avoidance: | ☒ No<br>☐ Yes, explain _____ | | |

| | | | | |
|---|---|---|---|---|
| **1.2.7** | Receiver Inter-character Timeout: | ☒ Not checked<br>☐ No gap permitted<br>☐ Fixed at _____ bit times<br>☐ Fixed at _____ ms<br>☐ Configurable, range ____ to ____ bit times<br>☐ Configurable, range ____ to ____ ms<br>☐ Configurable, Selectable from ___,___,___bit times<br>☐ Configurable, Selectable from ____, ____, ____ ms<br>☐ Configurable, other, describe _____<br>☐ Variable, explain ____ | | |
| **1.2.8** | Inter-character gaps in transmission: | ☒ None (always transmits with no inter-character gap)<br>☐ Maximum _____ bit times<br>☐ Maximum _____ ms | | |

| 1.3 | IP NETWORKING | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.3.1** | Port Name | CON 1 Network | | |
| **1.3.2** | Type of End Point: | ☐ TCP Initiating (Master Only)<br>☒ TCP Listening (Outstation Only)<br>☐ TCP Dual (required for Masters)<br>☒ UDP Datagram (required) | Not configured for DNP | F-PRO 2000 Offliner |
| **1.3.3** | IP Address of this Device: | | 192.168.100.80 | F-PRO 2000 Offliner |
| **1.3.4** | Subnet Mask: | | 255.255.255.0 | F-PRO 2000 Offliner |
| **1.3.5** | Gateway IP Address: | | 192.168.100.1 | F-PRO 2000 Offliner |
| **1.3.6** | Accepts TCP Connections or UDP Datagrams from: | ☒ Allows all (show as *.*.*.* in 1.3.7)<br>☒ Limits based on an IP address<br>☒ Limits based on list of IP addresses<br>☐ Limits based on a wildcard IP address<br>☐ Limits based on list of wildcard IP addresses<br>☐ Other validation, explain_____ | Limits based on an IP address | F-PRO 2000 Offliner |
| **1.3.7** | IP Address(es) from which TCP Connections or UDP Datagrams are accepted: | | 192.168.100.65 | F-PRO 2000 Offliner |
| **1.3.8** | TCP Listen Port Number: | ☐ Not Applicable (Master w/o dual end point)<br>☐ Fixed at 20,000<br>☒ Configurable, range 1025 to 32737<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 20,000 | F-PRO 2000 Offliner |

| | | | | |
|---|---|---|---|---|
| **1.3.9** | TCP Listen Port Number of remote device: | ☒ Not Applicable (Outstation w/o dual end point)<br>☐ Fixed at 20,000<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | NA | |
| **1.3.10** | TCP Keep-alive timer: | ☐ Fixed at _____ms<br>☒ Configurable, range 5 to 3,600 s and 0 to disable<br>☐ Configurable, selectable from ____,____,____ms<br>☐ Configurable, other, describe_____ | Disabled | F-PRO 2000 Offliner |
| **1.3.11** | Local UDP port: | ☐ Fixed at 20,000<br>☒ Configurable, range 1025 to 32737<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____<br>☐ Let system choose (Master only) | 20,000 | F-PRO 2000 Offliner |
| **1.3.12** | Destination UDP port for DNP3 Requests (Master Only): | | NA | |
| **1.3.13** | Destination UDP port for initial unsolicited null responses (UDP only Outstations): | ☒ None<br>☐ Fixed at 20,000<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | NA | |
| **1.3.14** | Destination UDP port for responses: | ☐ None<br>☐ Fixed at 20,000<br>☒ Configurable, range 1025 to 32737<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____<br>☐ Use source port number | 20,000 | F-PRO 2000 Offliner |

| | | | | |
|---|---|---|---|---|
| **1.3.15** | Multiple master connections (Outstations Only): | ☒ Supports multiple masters (Outstations only)<br><br>If supported, the following methods may be used:<br>☒ Method 1 (based on IP address) - –equired<br>☒ Method 2 (based on IP port number) - –ecommended<br>☒ Method 3 (browsing for static data) - –ptional | Method 1 (based on IP address) | F-PRO 2000 Offliner |
| **1.3.16** | Time synchronization support: | ☐ DNP3 LAN procedure (function code 24)<br>☐ DNP3 Write Time (not recommended over LAN)<br>☐ Other, explain<br><br>_____<br>☒ Not Supported | | |

| 1.4 | LINK LAYER | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.4.1** | Data Link Address: | ☐ Fixed at_____<br>☒ Configurable, range 1 to 65519<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 1 | F-PRO 2000 Offliner |
| **1.4.2** | DNP3 Source Address Validation: | ☒ Never<br>☐ Always, one address allowed (shown in 1.4.3)<br>☐ Always, any one of multiple addresses allowed (each selectable as shown in 1.4.3)<br>☐ Sometimes, explain_____ | | |
| **1.4.3** | DNP3 Source Address(es) expected when Validation is Enabled: | ☐ Configurable to any 16 bit DNP Data Link Address value<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | NA | |
| **1.4.4** | Self Address Support using address 0xFFFC: | ☐ Yes (only allowed if configurable)<br>☒ No | NA | |
| **1.4.5** | Sends Confirmed User Data Frames: | ☐ Always<br>☐ Sometimes, explain _____<br>☐ Never<br>☒ Configurable, either always or never | | F-PRO 2000 Offliner<br>(to disable, set Data Link Timeout to 0) |
| **1.4.6** | Data Link Layer Confirmation Timeout: | ☐ None<br>☐ Fixed at _ ms<br>☒ Configurable, range 0 to 2,000ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | 500 ms | F-PRO 2000 Offliner |

| | | | | |
|---|---|---|---|---|
| **1.4.7** | Maximum Data Link Retries: | ☐ Never Retries<br>☒ Fixed at 3<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 3 | |
| **1.4.8** | Maximum number of octets Transmitted in a Data Link Frame: | ☒ Fixed at 292<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 292 | |
| **1.4.9** | Maximum number of octets that can be Received in a Data Link Frame: | ☒ Fixed at 292<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 292 | |

| 1.5 | APPLICATION LAYER | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.5.1** | Maximum number of octets Transmitted in an Application Layer Fragment other than File Transfer: | ☒ Fixed at 2048<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 2048 | |
| **1.5.2** | Maximum number of octets Transmitted in an Application Layer Fragment containing File Transfer: | ☐ Fixed at _____<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | NA | |
| **1.5.3** | Maximum number of octets that can be Received in an Application Layer Fragment: | ☒ Fixed at 2048<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____ | 2048 | |
| **1.5.4** | Timeout waiting for Complete Application Layer Fragment: | ☐ None<br>☒ Fixed at 2,000 ms<br>☐ Configurable, range _____ to _____ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | 2,000 ms | |
| **1.5.5** | Maximum number of objects allowed in a single control request for CROB (group 12): | ☒ Fixed at 16<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | 16 | |

| | | | | |
|---|---|---|---|---|
| **1.5.6** | Maximum number of objects allowed in a single control request for Analog Outputs (group 41): | ☐ Fixed at _<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | Analog Outputs not supported | |
| **1.5.7** | Maximum number of objects allowed in a single control request for Data Sets (groups 85,86,87): | ☐ Fixed at __<br>☐ Configurable, range _____ to _____<br>☐ Configurable, selectable from ____,____,____<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | Data Sets not supported | |
| **1.5.8** | Supports mixing object groups (AOBs, CROBs and Data Sets) in the same control request: | ☐ Not applicable – controls are not supported<br>☐ Yes<br>☒ No | Analog Outputs not supported | |

| 1.6 | FILL OUT THE FOLLOWING ITEMS FOR OUTSTATIONS | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.6.1** | Timeout waiting for Application Confirm of solicited response message: | ☐ None<br>☒ Fixed at 5,000 ms<br>☐ Configurable, range _____ to _____ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | 5,000 ms | |
| **1.6.2** | How often is time synchronization required from the master? | ☒ Never needs time<br>☐ Within _____ seconds after IIN1.4 is set<br>☐ Periodically every _____ seconds | | |
| **1.6.3** | Device Trouble Bit IIN1.6: | ☐ Never used<br>☒ Reason for setting: Unable to access requested data or execute CROB, assuming a valid request has been received | | |
| **1.6.4** | File Handle Timeout: | ☒ Not applicable, files not supported<br>☐ Fixed at_____ ms<br>☐ Configurable, range _____ to _____ms<br>☐ Configurable, selectable from ___,___,___ms<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____ | | |
| **1.6.5** | Event Buffer Overflow Behavior: | ☐ Discard the oldest event<br>☒ Discard the newest event<br>☐ Other, explain _____ | | |
| **1.6.6** | Event Buffer Organization: | i. Single buffer for the Object Groups 2 and 32, size 200. | | |
| **1.6.7** | Sends Multi-Fragment Responses: | ☒ Yes<br>☐ No | | |
| **1.6.8** | DNP Command Settings preserved through a device reset: | ☐ Assign Class<br>☐ Analog Deadbands<br>☐ Data Set Prototypes<br>☐ Data Set Descriptors | Not supported | |

| 1.7 | OUTSTATION UNSOLICITED RESPONSE SUPPORT | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| 1.7.1 | Supports Unsolicited Reporting: | ☒ Not Supported<br>☐ Configurable, selectable from On and Off | NA | |

| 1.8 | OUTSTATION PERFORMANCE | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.8.1** | Maximum Time Base Drift (milliseconds per minute): | | NA, not synchronized by DNP | |
| **1.8.2** | When does outstation set IIN1.4? | ☒ Never<br>☐ Asserted at startup until first Time Synchronization request received<br>☐ Periodically, range ____to____ seconds<br>☐ Periodically, selectable from ____,____,___ seconds<br>☐ Range ____to____ seconds after last time sync<br>☐ Selectable from___,___,___seconds after last time sync<br>☐ When time error may have drifted by range ____to____ ms<br>☐ When time error may have drifted by selectable from ____,____,___ | NA | |
| **1.8.3** | Maximum Internal Time Reference Error when set via DNP (ms): | | NA | |
| **1.8.4** | Maximum Delay Measurement error (ms): | | NA | |
| **1.8.5** | Maximum Response time (ms): | | 300 ms – TCP mode<br>(for the case all supported points mapped to the DNP point lists) | F-PRO 2000 Offliner |
| **1.8.6** | Maximum time from start-up to IIN 1.4 assertion (ms): | | NA | |

| | | | | |
|---|---|---|---|---|
| **1.8.7** | Maximum Event Time-tag error for local Binary and Double-bit I/O (ms): | | – 0.5208 ms for 60Hz systems<br>– 0.6250 ms for 50 Hz systems | |
| **1.8.8** | Maximum Event Time-tag error for local I/O other than Binary and Double-bit data types (ms): | | – 0.5208 ms for 60Hz systems<br>– 0.6250 ms for 50 Hz systems | |

# CAPABILITIES AND CURRENT SETTINGS FOR DEVICE DATABASE

The following tables identify the capabilities and current settings for each DNP3 data type. Each data type also provides a table defining the data points available in the device, default point lists configuration and a description of how this information can be obtained in case of customized point configuration.

| 1.9 SINGLE-BIT BINARY INPUTS<br>Static (Steady-State) Group Number: **1**<br>Event Group Number: **2** | | Capabilities | Current Value | If configurable, list methods |
|---|---|---|---|---|
| **1.9.1** | Static Variation reported when variation 0 requested: | ☒ Variation 1 – Single-bit Packed format<br>☐ Variation 2 – Single-bit with flag<br>☐ Based on point Index (add column to table below) | | |
| **1.9.2** | Event Variation reported when variation 0 requested: | ☐ Variation 1 – without time<br>☒ Variation 2 – with absolute time<br>☐ Variation 3 – with relative time<br>☐ Based on point Index (add column to table below) | | |
| **1.9.3** | Event reporting mode: | ☐ Only most recent<br>☒ All events | | |
| **1.9.4** | Binary Inputs included in Class 0 response: | ☒ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | | F-PRO 2000 Offliner |
| **1.9.5** | Definition of Binary Input Point List: | ☐ Fixed, list shown in table below<br>☒ Configurable<br>☐ Other, explain_____ | **Complete list is shown in the table below; points excluded from the default configuration are marked with '*'** | F-PRO 2000 Offliner |

| *NOTES* | 1. Binary Inputs are scanned with 1 ms resolution.<br>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** | Virtual Input 1 | 1 | Inactive | Active | |
| **5** | Virtual Input 2 | 1 | Inactive | Active | |
| **6** | Virtual Input 3 | 1 | Inactive | Active | |
| **7** | Virtual Input 4 | 1 | Inactive | Active | |
| **8** | Virtual Input 5 | 1 | Inactive | Active | |
| **9** | Virtual Input 6 | 1 | Inactive | Active | |
| **10** | Virtual Input 7 | 1 | Inactive | Active | |
| **11** | Virtual Input 8 | 1 | Inactive | Active | |
| **12** | Virtual Input 9 | 1 | Inactive | Active | |
| **13** | Virtual Input 10 | 1 | Inactive | Active | |
| **14** | Virtual Input 11 | 1 | Inactive | Active | |
| **15** | Virtual Input 12 | 1 | Inactive | Active | |
| **16** | Virtual Input 13 | 1 | Inactive | Active | |
| **17** | Virtual Input 14 | 1 | Inactive | Active | |
| **18** | Virtual Input 15 | 1 | Inactive | Active | |
| **19** | Virtual Input 16 | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **20** | Virtual Input 17 | 1 | Inactive | Active | |
| **21** | Virtual Input 18 | 1 | Inactive | Active | |
| **22** | Virtual Input 19 | 1 | Inactive | Active | |
| **23** | Virtual Input 20 | 1 | Inactive | Active | |
| **24** | Virtual Input 21 | 1 | Inactive | Active | |
| **25** | Virtual Input 22 | 1 | Inactive | Active | |
| **26** | Virtual Input 23 | 1 | Inactive | Active | |
| **27** | Virtual Input 24 | 1 | Inactive | Active | |
| **28** | Virtual Input 25 | 1 | Inactive | Active | |
| **29** | Virtual Input 26 | 1 | Inactive | Active | |
| **30** | Virtual Input 27 | 1 | Inactive | Active | |
| **31** | Virtual Input 28 | 1 | Inactive | Active | |
| **32** | Virtual Input 29 | 1 | Inactive | Active | |
| **33** | Virtual Input 30 | 1 | Inactive | Active | |
| **34** | ProLogic 1 | 1 | Inactive | Active | |
| **35** | ProLogic 2 | 1 | Inactive | Active | |
| **36** | ProLogic 3 | 1 | Inactive | Active | |
| **37** | ProLogic 4 | 1 | Inactive | Active | |
| **38** | ProLogic 5 | 1 | Inactive | Active | |
| **39** | ProLogic 6 | 1 | Inactive | Active | |
| **40** | ProLogic 7 | 1 | Inactive | Active | |
| **41** | ProLogic 8 | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **42** | ProLogic 9 | 1 | Inactive | Active | |
| **43** | ProLogic 10 | 1 | Inactive | Active | |
| **44** | ProLogic 11 | 1 | Inactive | Active | |
| **45** | ProLogic 12 | 1 | Inactive | Active | |
| **46** | ProLogic 13 | 1 | Inactive | Active | |
| **47** | ProLogic 14 | 1 | Inactive | Active | |
| **48** | ProLogic 15 | 1 | Inactive | Active | |
| **49** | ProLogic 16 | 1 | Inactive | Active | |
| **50** | ProLogic 17 | 1 | Inactive | Active | |
| **51** | ProLogic 18 | 1 | Inactive | Active | |
| **52** | ProLogic 19 | 1 | Inactive | Active | |
| **53** | ProLogic 20 | 1 | Inactive | Active | |
| **54** | 27DT-1 Operated | 1 | Inactive | Active | |
| **55** | 27DT-1 Operated A | 1 | Inactive | Active | |
| **56** | 27DT-1 Operated B | 1 | Inactive | Active | |
| **57** | 27DT-1 Operated C | 1 | Inactive | Active | |
| **58** | 27DT-2 Operated | 1 | Inactive | Active | |
| **59** | 27DT-2 Operated A | 1 | Inactive | Active | |
| **60** | 27DT-2 Operated B | 1 | Inactive | Active | |
| **61** | 27DT-2 Operated C | 1 | Inactive | Active | |
| **62** | 27DT-3 Operated | 1 | Inactive | Active | |
| **63** | 27DT-3 Operated A | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **64** | 27DT-3 Operated B | 1 | Inactive | Active | |
| **65** | 27DT-3 Operated C | 1 | Inactive | Active | |
| **66** | 27DT-4 Operated | 1 | Inactive | Active | |
| **67** | 27DT-4 Operated A | 1 | Inactive | Active | |
| **68** | 27DT-4 Operated B | 1 | Inactive | Active | |
| **69** | 27DT-4 Operated C | 1 | Inactive | Active | |
| **70** | 27DT-5 Operated | 1 | Inactive | Active | |
| **71** | 27DT-5 Operated A | 1 | Inactive | Active | |
| **72** | 27DT-5 Operated B | 1 | Inactive | Active | |
| **73** | 27DT-5 Operated C | 1 | Inactive | Active | |
| **74** | 27DT-6 Operated | 1 | Inactive | Active | |
| **75** | 27DT-6 Operated A | 1 | Inactive | Active | |
| **76** | 27DT-6 Operated B | 1 | Inactive | Active | |
| **77** | 27DT-6 Operated C | 1 | Inactive | Active | |
| **78** | 27IT-1 Operated | 1 | Inactive | Active | |
| **79** | 27IT-1 Operated A | 1 | Inactive | Active | |
| **80** | 27IT-1 Operated B | 1 | Inactive | Active | |
| **81** | 27IT-1 Operated C | 1 | Inactive | Active | |
| **82** | 27IT-2 Operated | 1 | Inactive | Active | |
| **83** | 27IT-2 Operated A | 1 | Inactive | Active | |
| **84** | 27IT-2 Operated B | 1 | Inactive | Active | |
| **85** | 27IT-2 Operated C | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **86** | 59DT-1 Operated | 1 | Inactive | Active | |
| **87** | 59DT-1 Operated A | 1 | Inactive | Active | |
| **88** | 59DT-1 Operated B | 1 | Inactive | Active | |
| **89** | 59DT-1 Operated C | 1 | Inactive | Active | |
| **90** | 59DT-2 Operated | 1 | Inactive | Active | |
| **91** | 59DT-2 Operated A | 1 | Inactive | Active | |
| **92** | 59DT-2 Operated B | 1 | Inactive | Active | |
| **93** | 59DT-2 Operated C | 1 | Inactive | Active | |
| **94** | 59DT-3 Operated | 1 | Inactive | Active | |
| **95** | 59DT-3 Operated A | 1 | Inactive | Active | |
| **96** | 59DT-3 Operated B | 1 | Inactive | Active | |
| **97** | 59DT-3 Operated C | 1 | Inactive | Active | |
| **98** | 59DT-4 Operated | 1 | Inactive | Active | |
| **99** | 59DT-4 Operated A | 1 | Inactive | Active | |
| **100** | 59DT-4 Operated B | 1 | Inactive | Active | |
| **101** | 59DT-4 Operated C | 1 | Inactive | Active | |
| **102** | 59DT-5 Operated | 1 | Inactive | Active | |
| **103** | 59DT-5 Operated A | 1 | Inactive | Active | |
| **104** | 59DT-5 Operated B | 1 | Inactive | Active | |
| **105** | 59DT-5 Operated C | 1 | Inactive | Active | |
| **106** | 59DT-6 Operated | 1 | Inactive | Active | |
| **107** | 59DT-6 Operated A | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **108** | 59DT-6 Operated B | 1 | Inactive | Active | |
| **109** | 59DT-6 Operated C | 1 | Inactive | Active | |
| **110** | 59IT-1 Operated | 1 | Inactive | Active | |
| **111** | 59IT-1 Operated A | 1 | Inactive | Active | |
| **112** | 59IT-1 Operated B | 1 | Inactive | Active | |
| **113** | 59IT-1 Operated C | 1 | Inactive | Active | |
| **114** | 59IT-2 Operated | 1 | Inactive | Active | |
| **115** | 59IT-2 Operated A | 1 | Inactive | Active | |
| **116** | 59IT-2 Operated B | 1 | Inactive | Active | |
| **117** | 59IT-2 Operated C | 1 | Inactive | Active | |
| **118** | 50/67-1 Operated | 1 | Inactive | Active | |
| **119** | 50/67-1 Operated A | 1 | Inactive | Active | |
| **120** | 50/67-1 Operated B | 1 | Inactive | Active | |
| **121** | 50/67-1 Operated C | 1 | Inactive | Active | |
| **122** | 50/67-2 Operated | 1 | Inactive | Active | |
| **123** | 50/67-2 Operated A | 1 | Inactive | Active | |
| **124** | 50/67-2 Operated B | 1 | Inactive | Active | |
| **125** | 50/67-2 Operated C | 1 | Inactive | Active | |
| **126** | 51/67-1 Operated | 1 | Inactive | Active | |
| **127** | 51/67-1 Operated A | 1 | Inactive | Active | |
| **128** | 51/67-1 Operated B | 1 | Inactive | Active | |
| **129** | 51/67-1 Operated C | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **130** | 51/67-2 Operated | 1 | Inactive | Active | |
| **131** | 51/67-2 Operated A | 1 | Inactive | Active | |
| **132** | 51/67-2 Operated B | 1 | Inactive | Active | |
| **133** | 51/67-2 Operated C | 1 | Inactive | Active | |
| **134** | 50N/67N-1 Operated | 1 | Inactive | Active | |
| **135** | 50N/67N-2 Operated | 1 | Inactive | Active | |
| **136** | 51N/67N-1 Operated | 1 | Inactive | Active | |
| **137** | 51N/67N-2 Operated | 1 | Inactive | Active | |
| **138** | 46/50 Operated | 1 | Inactive | Active | |
| **139** | 46/51 Operated | 1 | Inactive | Active | |
| **140** | 49 Operated | 1 | Inactive | Active | |
| **141** | 49 Alarm Operated | 1 | Inactive | Active | |
| **142** | 50BF-D1 Operated | 1 | Inactive | Active | |
| **143** | 50BF-D2 Operated | 1 | Inactive | Active | |
| **144** | 46BC Operated | 1 | Inactive | Active | |
| **145** | 81HBL2 Operated | 1 | Inactive | Active | |
| **146** | 74TCS-1 Operated | 1 | Inactive | Active | |
| **147** | 74TCS-2 Operated | 1 | Inactive | Active | |
| **148** | 79 Initiate | 1 | Inactive | Active | |
| **149** | 79 Reclose | 1 | Inactive | Active | |
| **150** | 79 Lockout | 1 | Inactive | Active | |
| **151** | 79 Block | 1 | Inactive | Active | |

| | | | | | |
|---|---|---|---|---|---|
| **152** | I2T Limit Operated | 1 | Inactive | Active | |
| **153** | 60VTS Operated | 1 | Inactive | Active | |
| **154** | 60CTS Operated | 1 | Inactive | Active | |
| **155** | Output Contact 1 | 1 | Open | Closed | |
| **156** | Output Contact 2 | 1 | Open | Closed | |
| **157** | Output Contact 3 | 1 | Open | Closed | |
| **158** | Output Contact 4 | 1 | Open | Closed | |
| **159** | Output Contact 5 | 1 | Open | Closed | |
| **160** | Output Contact 6 | 1 | Open | Closed | |
| **161** | Output Contact 7 | 1 | Open | Closed | |
| **162** | Output Contact 8 | 1 | Open | Closed | |

| **1.10 BINARY OUTPUT STATUS AND CONTROL RELAY OUTPUT BLOCK**<br>Binary Output Status Group Number: **10**<br>CROB Group Number: **12** | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| **1.10.1** Minimum pulse time allowed with Trip, Close, and Pulse On commands: | ☒ Fixed at 0,000 ms (hardware may limit this further)<br>☐ Based on point Index (add column to table below) | | |
| **1.10.2** Maximum pulse time allowed with Trip, Close, and Pulse On commands: | ☒ Fixed at 0,000 ms (hardware may limit this further)<br>☐ Based on point Index (add column to table below) | | |
| **1.10.3** Binary Output Status included in Class 0 response: | ☒ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | | |
| **1.10.4** Reports Output Command Event Objects: | ☒ Never<br>☐ Only upon a successful Control<br>☐ Upon all control attempts | Not supported | |
| **1.10.5** Event Variation reported when variation 0 requested: | ☐ Variation 1 – without time<br>☐ Variation 2 – with absolute time<br>☐ Based on point Index (add column to table below) | Not supported | F-PRO 2000 Offliner<br>(See Note 2 below) |
| **1.10.6** Command Event Variation reported when variation 0 requested: | ☐ Variation 1 – without time<br>☐ Variation 2 – with absolute time<br>☐ Based on point Index (add column to table below) | Not supported | F-PRO 2000 Offliner<br>(See Note 2 below) |
| **1.10.7** Event reporting mode: | ☐ Only most recent<br>☐ All events | Not supported | F-PRO 2000 Offliner<br>(See Note 2 below) |

| | | | | |
|---|---|---|---|---|
| **1.10.8** | Command Event reporting mode: | ☐ Only most recent<br>☐ All events | Not supported | |
| **1.10.9** | Maximum Time between Select and Operate: | ☐ Not Applicable<br>☒ Fixed at 10 seconds<br>☐ Configurable, range _____ to _____ seconds<br>☐ Configurable, selectable from___,___,___seconds<br>☐ Configurable, other, describe_____<br>☐ Variable, explain _____<br>☐ Based on point Index (add column to table below) | 10 s | |
| **1.10.10** | Definition of Binary Output Status/Control relay output block (CROB) Point List: | ☐ Fixed, list shown in table below<br>☒ Configurable<br>☐ Other, explain_____ __ | Complete list is shown in the table below; points excluded from the default configuration are marked with '*' | F-PRO 2000 Offliner |

| | |
|---|---|
| *NOTES* | 1. Binary Outputs are scanned with 500 ms resolution.<br>2. Events are not supported for Binary Outputs (group 10), but most of Binary Output points can be mapped to Binary Inputs (group 2) with full Event and Class Data support. See F-PRO 2000 Offliner/DNP Configuration/Point Map screen for complete point lists and configuration options.<br>3. Virtual Inputs (default Binary Output points 14-43) can be used to control relay output contacts. See F-PRO 2000 Offliner/Setting Group X/Output Matrix screen for configuration options.<br>4. Binary Output data points are user selectable; the data points available in the device for any given Binary Output point selection can be obtained through the F-PRO 2000 Offliner software (see SCADA Setting Summary). |

| Point Index | Name | Supported Control Operations | | | | | | | | | | | Name for State when value is 0 | Name for State when value is 1 | Default Class Assigned to Events (1, 2, 3 or none) | | Description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Select/Operate | Direct Operate | Direct Operate – No Ack | Pulse On / NUL | Pulse Off | Latch On / NUL | Latch Off / NUL | Trip | Close | Count > 1 | Cancel Currently Running Operation | | | Change | Command | |
| 0 | Output Contact 1 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 1 | Output Contact 2 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 2 | Output Contact 3 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 3 | Output Contact 4 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 4 | Output Contact 5 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 5 | Output Contact 6 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 6 | Output Contact 7 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 7 | Output Contact 8 | - | - | - | - | - | - | - | - | - | - | - | Open | Closed | None | None | |
| 8 | Virtual Input 1 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 9 | Virtual Input 2 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 10 | Virtual Input 3 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 11 | Virtual Input 4 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 12 | Virtual Input 5 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 13 | Virtual Input 6 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 14 | Virtual Input 7 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 15 | Virtual Input 8 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 16 | Virtual Input 9 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 17 | Virtual Input 10 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 18 | Virtual Input 11 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 19 | Virtual Input 12 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | Virtual Input 13 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 21 | Virtual Input 14 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 22 | Virtual Input 15 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 23 | Virtual Input 16 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 24 | Virtual Input 17 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 25 | Virtual Input 18 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 26 | Virtual Input 19 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 27 | Virtual Input 20 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 28 | Virtual Input 21 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 29 | Virtual Input 22 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 30 | Virtual Input 23 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 31 | Virtual Input 24 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 32 | Virtual Input 25 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 33 | Virtual Input 26 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 34 | Virtual Input 27 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 35 | Virtual Input 28 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 36 | Virtual Input 29 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |
| 37 | Virtual Input 30 | Y | Y | Y | Y | - | Y | Y | - | - | - | - | Inactive | Active | None | None | Pulse duration fixed at 1 s |

| **1.11 ANALOG INPUT POINTS**<br>Static (Steady-State) Group Number: **30**<br>Event Group Number: **32** | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| **1.11.1** Static Variation reported when variation 0 requested: | ☐ Variation 1 – 32-bit with flag<br>☐ Variation 2 – 16-bit with flag<br>☒ Variation 3 – 32-bit without flag<br>☒ Variation 4 – 16-bit without flag<br>☐ Variation 5 – single-precision floating point with flag<br>☐ Variation 6 – double-precision floating point with flag<br>☐ Based on point Index (add column to table below) | | |
| **1.11.2** Event Variation reported when variation 0 requested: | ☒ Variation 1 – 32-bit without time<br>☒ Variation 2 – 16-bit without time<br>☐ Variation 3 – 32-bit with time<br>☐ Variation 4 – 16-bit with time<br>☐ Variation 5 – single-precision floating point w/o time<br>☐ Variation 6 – double-precision floating point w/o time<br>☐ Variation 7 – single-precision floating point with time<br>☐ Variation 8 – double-precision floating point with time<br>☐ Based on point Index (add column to table below) | | |
| **1.11.3** Event reporting mode: | ☐ Only most recent<br>☒ All events | | |
| **1.11.4** Analog Inputs Included in Class 0 response: | ☒ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | | |
| **1.11.5** How Deadbands are set: | ☐ A. Global Fixed<br>☐ B. Configurable through DNP<br>☒ C. Configurable via other means<br>☐ D. Other, explain<br>_____<br>☐ Based on point Index - –olumn specifies which of the options applies, B, C, or D | | F-PRO 2000 Offliner |

| **1.11 ANALOG INPUT POINTS**<br>Static (Steady-State) Group Number: **30**<br>Event Group Number: **32** | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| **1.11.6** Analog Deadband Algorithm:<br>*simple - just compares the difference from the previous reported value* | ☒ Simple<br>☐ Integrating<br>☐ Other, explain<br>_____ | | |
| **1.11.7** Definition of Analog Input Point List: | ☐ Fixed, list shown in table below<br>☒ Configurable<br>☐ Other, explain_____ | **Default list is shown in table below** | F-PRO 2000 Offliner |

| | |
|---|---|
| *NOTES* | 1. Analog Inputs are scanned with 500 ms resolution.<br>2. Nominal values in calculations for the following table are based on Secondary voltage * PT ratio for voltage channels, and either 1 A or 5A secondary current * CT ratio for current channels dependent upon the format of CT installed in the F-PRO.<br>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). |

| Point Index | Name | Default Class Assigned to Events (1, 2, 3 or none) | Transmitted Value[1] | | Scaling[2] | | Scale Units | Resolution[3] (default/ maximal) | Dead band (default / (range)) | Dead band Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum | Multiplier (default / (range)) | Offset | | | | |
| 0. | Va Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 1. | Va Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 2. | Vb Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 3. | Vb Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 4. | Vc Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 5. | Vc Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 6. | Vn Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 7. | Vn Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 8. | Ia Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 9. | Ia Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 10 | Ib Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 11 | Ib Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 12 | Ic Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 13 | Ic Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 14 | In Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |

*1 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*

*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.*

*2 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.*

*3 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.*

| Point Index | Name | Default Class Assigned to Events (1, 2, 3 or none) | Transmitted Value[1] | | Scaling[2] | | Scale Units | Resolution[3] (default/ maximal) | Dead band (default / (range)) | Dead band Units |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Minimum | Maximum | Multiplier (default / (range)) | Offset | | | | |
| | | | | | 10.0) | | | | | |
| 15 | In Angle | 2 | -18,000 | 18,000 | 0.1 / (0.01 – 1.0) | 0.0 | degrees | 0.1 / 0.01 | 0.5 / (0.1 to 180.0) | degrees |
| 16 | V1 Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 17 | V2 Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 18 | V0 Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001- 1.0) | 0.0 | kV | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 19 | I1 Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 20 | I2 Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 21 | I0 Magnitude | 2 | 0 | Configurable | 0.01 / (0.00001 – 10.0) | 0.0 | A | 0.01 / 0.00001 | 2.0 / (0.1 to 100.0) | % of nominal |
| 22 | Real Power | 2 | 0 | Configurable | 0.001 / (0.00001 – 1.0) | 0.0 | MW | 0.001 / 0.00001 | 4.0 / (0.1 to 100.0) | % of nominal |
| 23 | Reactive Power | 2 | 0 | Configurable | 0.001 / (0.00001 – 1.0) | 0.0 | MVAr | 0.001 / 0.00001 | 4.0 / (0.1 to 100.0) | % of nominal |
| 24 | Frequency | 2 | 0 | Max F x 100 | 0.01 / (0.01 – 1.0) | 0.0 | Hz | 0.01 / 0.01 | 0.05 / (0.01 to 50.0 / 60.0) | Hz |
| 25 | Power Factor | 2 | 0 | 1,000 | 0.01 / (0.001 – 0.1) | 0.0 | N/A | 0.01 / 0.001 | 5.0 / (1.0 to 100.0) | % of nominal |
| 26 | Thermal State | 2 | 0 | 10,000 | 0.1 / (0.01 – 1.0) | 0.0 | % | 0.1 / 0.01 | 1.0 / (0.1 to 100.0) | % of nominal |
| 27 | I2t Accumulated | 2 | 0 | Configurable | 1.0 / (0.1 – 10.0) | 0.0 | kA^2s | 1.0 / 0.1 | 1000.0 / (0.1 to 99999.9) | kA^2s |
| 28 | I2t for Last Operation | 2 | 0 | Configurable | 1.0 / (0.1 – 10.0) | 0.0 | kA^2s | 1.0 / 0.1 | 100.0 / (0.1 to 99999.9) | kA^2s |

| **1.12 OCTET STRING POINTS**<br>Static (Steady-State) Group Number: **110**<br>Event Group Number: **111** | **Capabilities** | **Current Value** | **If configurable, list methods** |
|---|---|---|---|
| **1.12.1** Event reporting mode *: | ☐ Only most recent<br>☐ All events | Not supported | |
| **1.12.2** Octet Strings Included in Class 0 response: | ☐ Always<br>☐ Never<br>☐ Only if point is assigned to Class 1, 2, or 3<br>☐ Based on point Index (add column to table below) | Not supported | |
| **1.12.3** Definition of Octet String Point List: | ☐ Fixed, list shown in table below<br>☐ Configurable (current list may be shown in table below)<br>☐ Other, explain Used for Event Log access as described below | | |

* Object 110 and 111 are Octet String Object used to provide access to the Event Log text of the relay. Object 110 always contains the most recent event in the relay. Object 111 is the corresponding change event object.
As stated in the DNP specifications, the variation of the response object represents the length of the string. The string represents the ASCII values of the event text.

# Implementation Table

The following implementation table identifies which object groups and variations, function codes and qualifiers the device supports in both requests and responses. The *Request* columns identify all requests that may be sent by a Master, or all requests that must be parsed by an Outstation. The *Response* columns identify all responses that must be parsed by a Master, or all responses that may be sent by an Outstation.

| | |
|---|---|
| *NOTE* | The implementation table must list all functionality required by the device whether Master or Outstation as defined within the DNP3 IED Conformance Test Procedures. Any functionality beyond the highest subset level supported is indicated by highlighted rows. Any Object Groups not provided by an outstation or not processed by a Master are indicated by ~~strikethrough~~ (note these Object Groups will still be parsed). |

| DNP OBJECT GROUP & VARIATION | | | REQUEST Outstation parses | | RESPONSE Outstation can issue | |
|---|---|---|---|---|---|---|
| **Group Num** | **Var Num** | **Description** | **Function Codes (dec)** | **Qualifier Codes (hex)** | **Function Codes (dec)** | **Qualifier Codes (hex)** |
| 1 | 0 | Binary Input – Any Variation | **1** (read) | **06** (no range, or all)<br>**00, 01** (start-stop)<br>**07, 08** (limited qty)<br>**17, 28** (index) | **129** (response) | **00, 01** (start-stop) |
| 1 | 1 | Binary Input – Packed format | **1** (read) | **06** (no range, or all)<br>**00, 01** (start-stop)<br>**07, 08** (limited qty)<br>**17, 28** (index) | **129** (response) | **00, 01** (start-stop) |
| 1 | 2 | Binary Input – With flags | **1** (read) | **06** (no range, or all)<br>**00, 01** (start-stop)<br>**07, 08** (limited qty)<br>**17, 28** (index) | **129** (response) | **00, 01** (start-stop) |
| 2 | 0 | Binary Input Event – Any Variation | **1** (read) | **06** (no range, or all)<br>**07, 08** (limited qty) | **129** (response) | **17, 28** (index) |
| 2 | 1 | Binary Input Event – Without time | **1** (read) | **06** (no range, or all)<br>**07, 08** (limited qty) | **129** (response)<br>~~**130** (unsol. resp)~~ | **17, 28** (index) |
| 2 | 2 | Binary Input Event – With absolute time | **1** (read) | **06** (no range, or all)<br>**07, 08** (limited qty) | **129** (response)<br>~~**130** (unsol. resp)~~ | **17, 28** (index) |
| 2 | 3 | Binary Input Event – With relative time | **1** (read) | **06** (no range, or all)<br>**07, 08** (limited qty) | **129** (response)<br>~~**130** (unsol. resp)~~ | **17, 28** (index) |
| 10 | 0 | Binary Output – Any Variation | **1** (read) | **06** (no range, or all)<br>**00, 01** (start-stop)<br>**07, 08** (limited qty)<br>**17, 28** (index) | **129** (response) | **00, 01** (start-stop) |
| 10 | 2 | Binary Output – Output Status with flag | **1** (read) | **06** (no range, or all)<br>**00, 01** (start-stop)<br>**07, 08** (limited qty)<br>**17, 28** (index) | **129** (response) | **00, 01** (start-stop) |
| 12 | 1 | Binary Command – Control relay output block (CROB) | **3** (select)<br>**4** (operate)<br>**5** (direct op)<br>**6** (dir. op, no ack) | **17, 28** (index) | **129** (response) | Echo of request |
| 20 | 0 | ~~Counter – Any Variation~~ | **1** (read)<br>**7** (freeze)<br>**8** ( freeze noack) | **06** (no range, or all) | **129** (response) | |

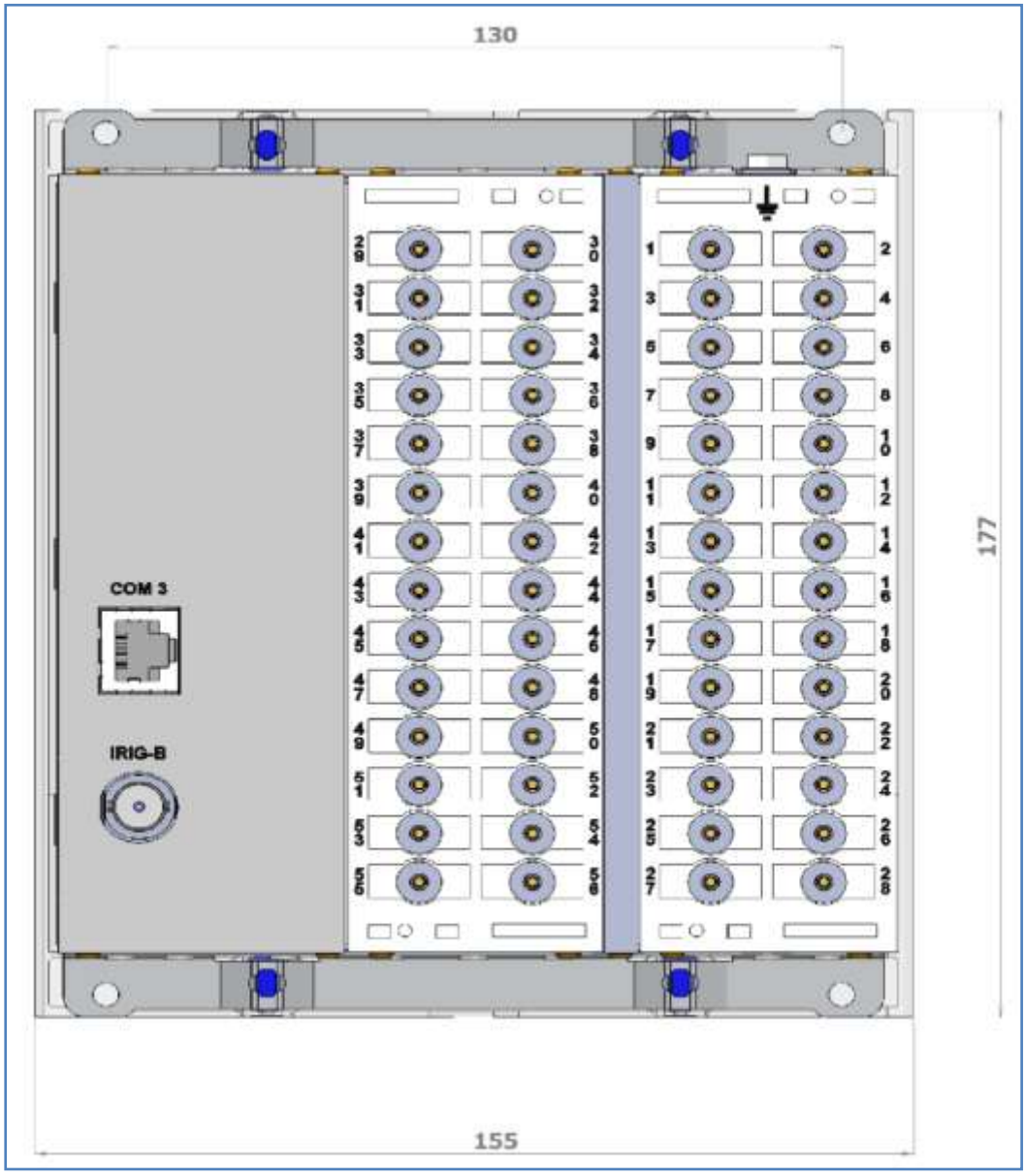
| DNP OBJECT GROUP & VARIATION | | | REQUEST Outstation parses | | RESPONSE Outstation can issue | |
|---|---|---|---|---|---|---|
| **Group Num** | **Var Num** | **Description** | **Function Codes (dec)** | **Qualifier Codes (hex)** | **Function Codes (dec)** | **Qualifier Codes (hex)** |
| | | | **9**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

| | | | | | | |
|---|---|---|---|---|---|---|
| 40 | 0 | ~~Analog Output Status – Any Variation~~ | **1** (read) | **06** (no range, or all) | **129** (response) | |
| 40 | 2 | ~~Analog Output Status – 16-bit with flag~~ | | | **129** (response) | **00, 01** (start-stop) |
| 41 | 2 | ~~Analog Output – 16-bit~~ | **3** (select)<br>**4** (operate)<br>**5** (direct op)<br>**6** (dir. op, no ack) | **17, 28** (index) | **129** (response) | ~~Echo of request~~ |
| 50 | 1 | ~~Time and Date – Absolute time~~ | **2** (write) | **07** (limited qty = 1) | **129** (response) | |
| 51 | 1 | ~~Time and Date CTO – Absolute time, synchronized~~ | | | **129** (response)<br>**130** (unsol. resp) | **07** (limited qty) (qty = 1) |
| 51 | 2 | Time and Date CTO – Absolute time, unsynchronized | | | **129** (response)<br>**130** (unsol. resp) | **07** (limited qty) (qty = 1) |
| 52 | 1 | Time Delay – Coarse | | | **129** (response) | **07** (limited qty) (qty = 1) |
| 52 | 2 | ~~Time delay – Fine~~ | | | **129** (response) | **07** (limited qty) (qty = 1) |
| 60 | 1 | Class Objects – Class 0 data | **1** (read) | **06** (no range, or all) | **129** (response) | **00, 01** (start-stop) |
| 60 | 2 | Class Objects – Class 1 data | **1** (read) | **06** (no range, or all) | **129** (response) | **17, 28** (index) |
| 60 | 3 | Class Objects – Class 2 data | **1** (read) | **06** (no range, or all) | **129** (response) | **17, 28** (index) |
| 60 | 4 | Class Objects – Class 3 data | **1** (read) | **06** (no range, or all) | **129** (response) | **17, 28** (index) |
| 80 | 1 | Internal Indications – Packet format | **2** (write) | **00** (start-stop) (index = 7) | **129** (response) | |
| 110 | 0 | ~~Octet string~~ | **1** (read) | **06** (no range, or all) | **129** (response) | **07** (limited qty) |
| 111 | 0 | ~~Octet string event~~ | **1** (read) | **06** (no range, or all) | **129** (response) | **07** (limited qty) |
| No Object (function code only) | | | **13** (cold restart) | | **129** (response) | |
| No Object (function code only) | | | **14** (warm restart) | | **129** (response) | |
| No Object (function code only) | | | **23** (delay meas.) | | **129** (response) | |

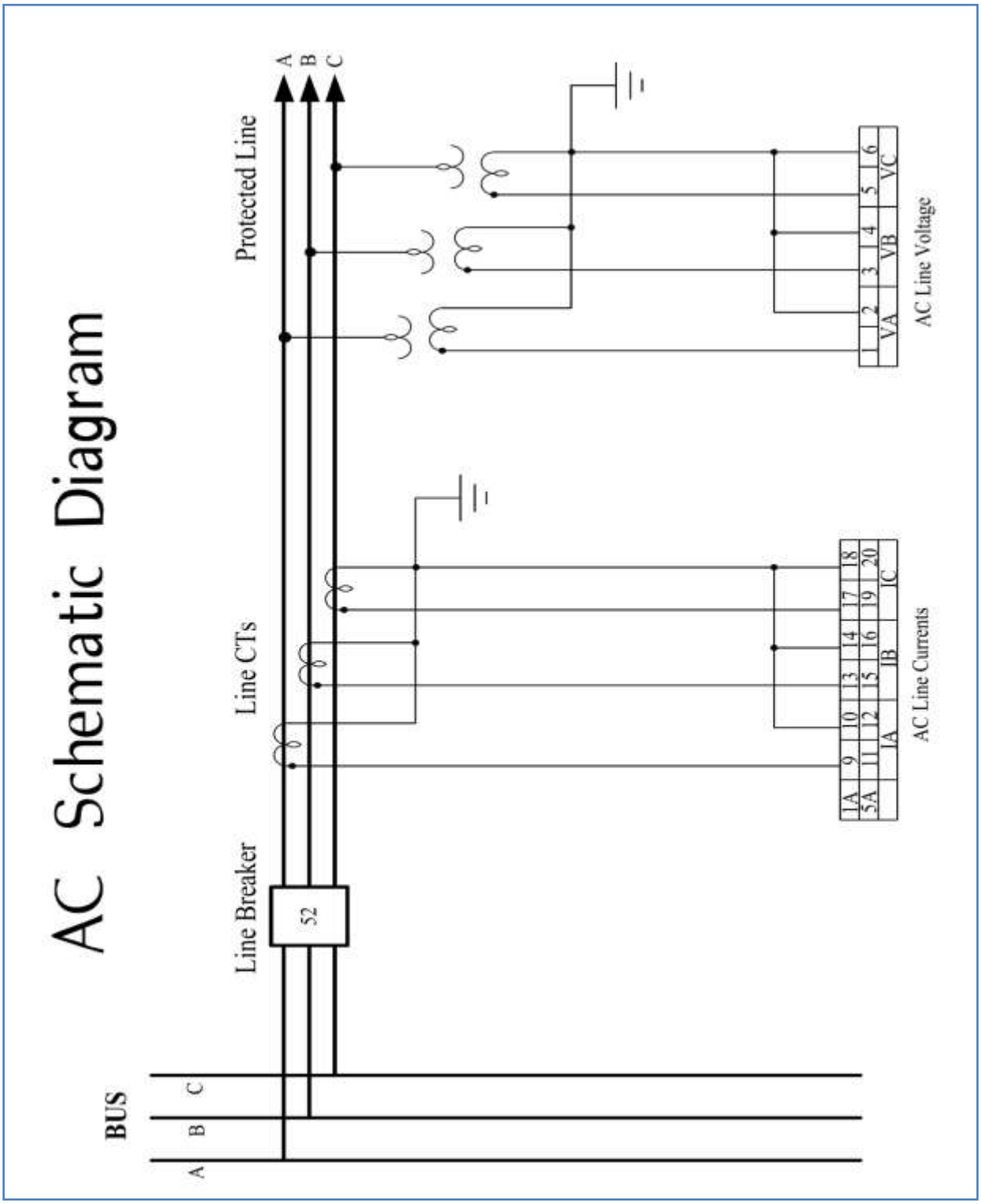
# Appendix H Mechanical Drawings

## H.1 Front View

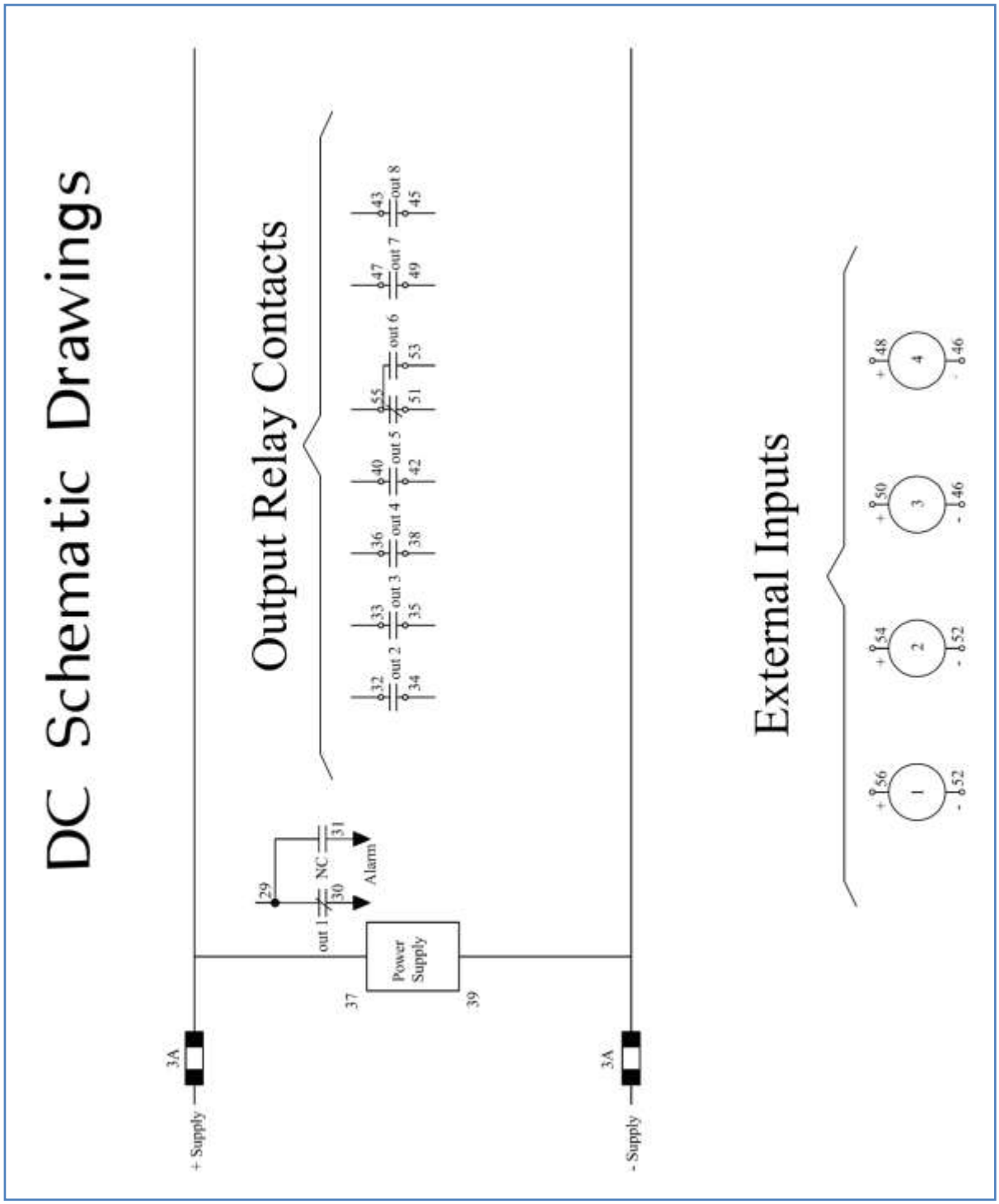
## H.2 Rear View



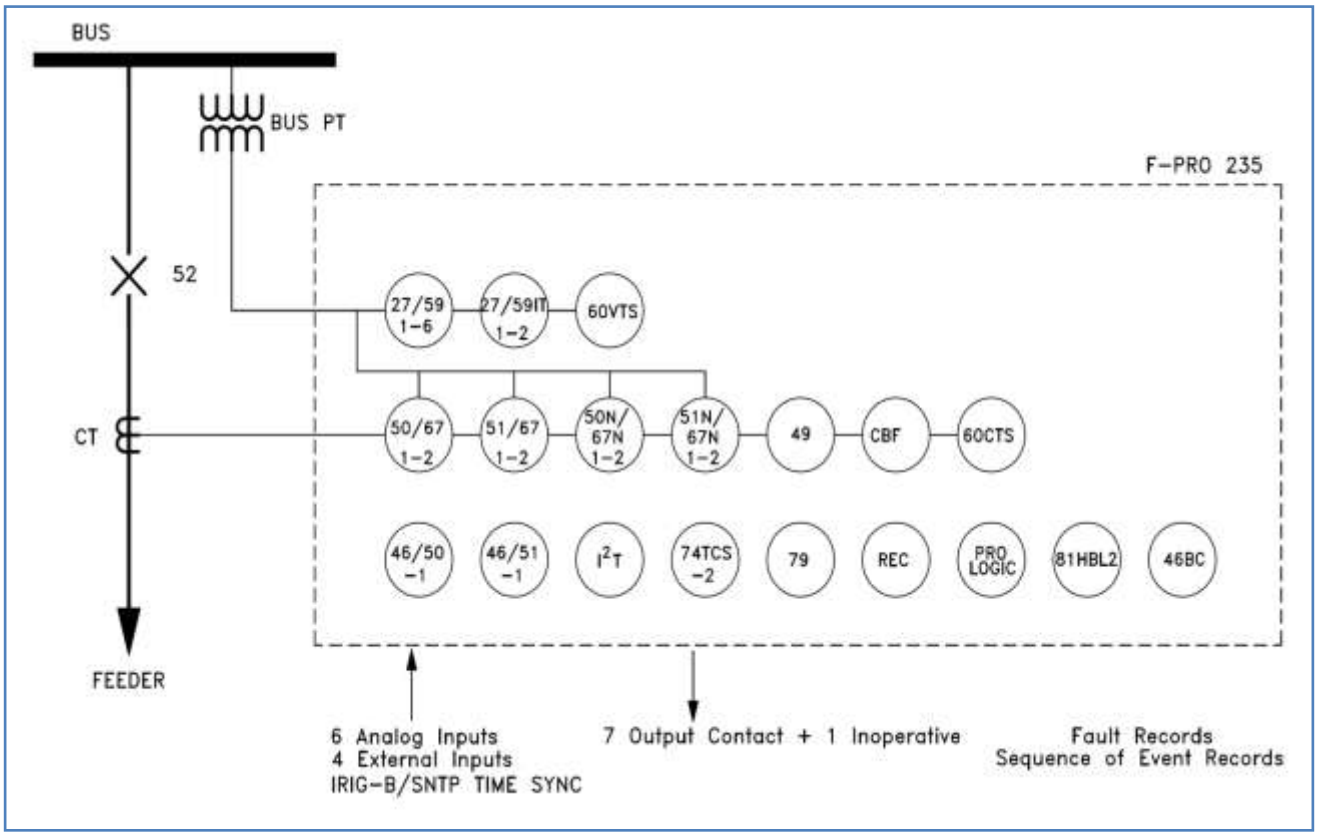
# Appendix I AC Schematic Drawing



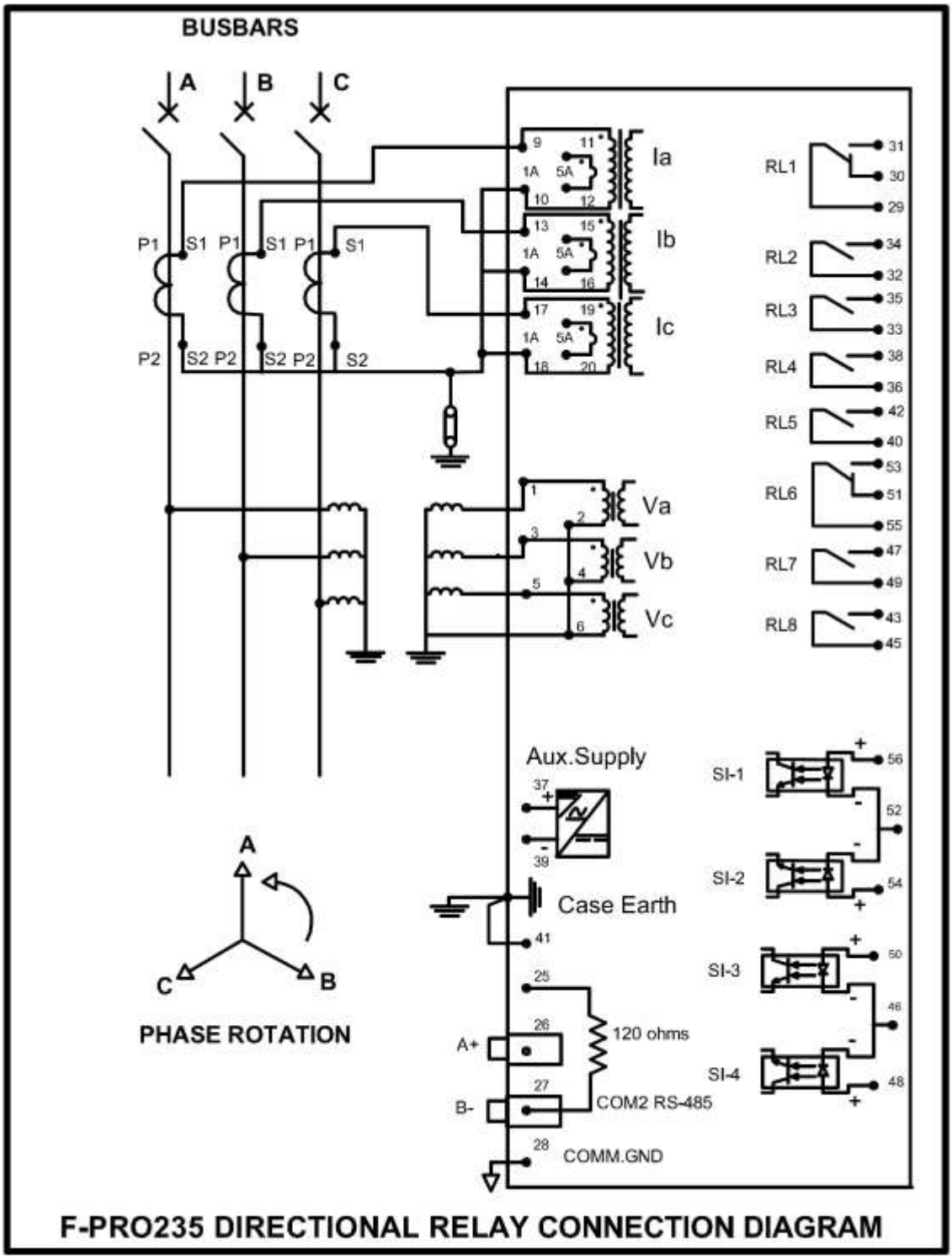
# Appendix J DC Schematic Drawing



# Appendix K Function Logic Diagram



# Appendix L Connection Diagram



# Appendix-M F-PRO Setting Example

## Protection, Timers and I/O Status

The relay does not block any protection functions or external inputs during the setting save or active group change, but the external output contacts are reset for one cycle.
The relay applies the setting parameters, resets all protection functions, resets all timers and continues to process the protection algorithms but does not apply any action to the output contacts for one cycle. For close -in (heavy) fault conditions that occur at the time of a setting change the relay performance has a maximum increase in output delay of o ne cycle. For light fault conditions the relay performance does not have a noticeable change. There is normally a one cycle decision making process. The relay algorithms have been processing and when the one cycle blocking ends and the contacts are closed immediately.

## Latch Status

The relay does not reset any ProLogic or Virtual Input latch functions during the setting save or active group change. Retaining latch status allows the relay continuous access to specific latched logic states. This is useful when t he relay has ProLogic, Group Logic or Virtual Input functions used to block protection or ancillary functions for specific operating conditions.

## Event Status Reset

The relay resets all the events that are currently high and reports states of all the events that remain high after a setting change.

## Viewing Active Setting Group

To view active setting group via the RCP, go to *Utilities > Setting Group*. It is configurable only through Service/Change access level.

## Front Panel Active Setting Group

View the active setting group with the relay front panel display. The active setting group can be changed through the front panel of the relay.

To view the active setting group enter

*View>Configuration>Setting Group> Active*

The same can be changed when accessed through Change or Service access

level only. We can also edit and/or view the other setting groups while active setting group is different.

# Failure Modes

## A – DSP System Fail:

When a DSP system fails, the relay functional LED (Green) goes OFF. The RL1 (Form C) contact on the rear panel closes to activate a remote alarm. All other contacts are forced inactive. The relay restarts automatically and becomes functional, which lit up functional LED (Green) and opens RL1.

## B – Microprocessor Self-Check Fail:

The software watchdog monitors all the modules and if one or more modules fail(s), the processor restarts the Relay. At this moment, the relay functional LED goes OFF and RL1 (Form C) contact on the rear panel closes to activate a remote alarm. The relay restarts automatically and becomes functional, which lit up functional LED (Green) and opens RL1.

# Appendix N IEC 61850 Data Mapping Specifications

This chapter describes IEC 61850 logical devices and nodes defined in ICD file of F-PRO 235 relay.

## 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 N.1.

**Table N.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 | |

| | | Client/ Subscriber | Server/ Publisher | Value/ Comments |
|---|---|---|---|---|
| B23 | **SCSM**: IEC 6185-9-2 used | — | N | |
| B24 | **SCSM**: other | — | N | |
| | | | | |
| **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 | |
| – <br> Y = supported <br> N or empty = not supported | | | | |

## ACSI models conformance statement

The ACSI models conformance statement is defined in Table N.2.

**Table N.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 | |

| | | Client/ Subscriber | Server/ Publisher | Value/ Comments |
|---|---|---|---|---|
| M7-1 | sequence-number | | Y | |
| M7-2 | report-time-stamp | | Y | |
| M7-3 | reason-for-inclusion | | Y | |
| M7-4 | data-set-name | | Y | |
| M7-5 | data-reference | | Y | |
| M7-6 | buffer-overflow | | Y | |
| M7-7 | entryID | | Y | |
| M7-8 | BufTm | | Y | |
| M7-9 | IntgPd | | Y | |
| M7-10 | GI | | Y | |
| 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 N.3 (depending on the statements in Table N.1).

**Table N.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 | |

| | Services | AA: TP/MC | Client (C) | Server (S) | Comments |
|---|---|---|---|---|---|
| **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 | |
| 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 | |
| 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<br>(1 ms) | nearest negative power of 2 in seconds |
| T2 | Time accuracy of internal clock | | | 10<br>(1 ms) | T0 |
| | | | | | T1 |
| | | | | | T2 |
| | | | | | T3 |
| | | | | | T4 |
| | | | | | T5 |
| T3 | Supported TimeStamp resolution | - | | 10<br>(1 ms) | nearest negative power of 2 in seconds |

# N.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) |
| **PIOC** (Instantaneous overcurrent) |

| |
|---|
| **PTOC** (Time overcurrent) |
| **NPIOC**( Instantaneous neutral overcurrent) |
| **NPTOC**(Time neutral overcurrent) |
| **PTTR** (Thermal overload) |
| **PHAR** (Harmonic restraint) |
| **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 ) |
| **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 table 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 Explanation

New logical nodes have the descriptions in the Name plate.

**LPHD**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| LPHD1 | | Physical device information | | |
| **Data** | | | | |
| **Common Logical Node Information** | | | | |
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | |
| phyHealth | INS_2_ phyHealth | Physical device health | M | |
| proxy | SPS_1_Proxy | Indicate if this device is proxy | M | |
| phyNam | DPL_2_phyNam | Device physical name plate | M | |

**LLN0**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| LLN0 | | Logic node 0 | | |
| **Data** | | | | |
| **Common Logical Node Information** | | | | |
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | |
| Mod | INC | Mode | M | Mod |
| Beh | INS | Behaviour | M | Beh |
| Health | INS | Health | M | Health |
| NamPlt | LPL | Name plate | M | NamPlt |

**PHAR Harmonic Restraint**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D81H2PHAR | | Inrush blocking | | |
| **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** | | | | |
| Str | ACD | 81HBL2 inrush operated | M | |

**PTTR Thermal Overload**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D49PTTR | | Thermal overload | | |
| **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** | | | | |
|---|---|---|---|---|
| Str | ACD | 49- Pickedup | O | |
| Op | ACT | 49 – Operated | M | |
| ALm Thm | ACT | 49 Alarm Operated | O | |

**NPIOC Instantaneous Neutral Overcurrent**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D50NPIOC | | Instantaneous neutral overcurrent | | |
| **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** | | | | |
| Str | ACD | 50N- Pickedup | O | |
| Op | ACT | 50N – Operated | M | |

**NPTOC Time Neutral Overcurrent**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D51NPTOC | | Time neutral overcurrent | | |
| **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** | | | | |
| Str | ACD | 51N- Pickedup | M | |
| Op | ACT | 51N – Operated | M | |

**PTOC Time Over Current**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D51PTOC | | IDMTL phase over current | | |
| **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** | | | | |
| Str | ACD | 51- Pickedup | M | |
| Op | ACT | 51 – Operated | M | |

**PIOC Instantaneous Over Current**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D50PIOC | | Instantaneous phase over current | | |
| **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** | | | | |
| Str | ACD | 50- Pickedup | O | |
| Op | ACT | 50 – Operated | M | |

**PTOV Over Voltage**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| DT59PTOV | | Over Voltage | | |
| **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** | | | | |
| Str | ACD | 59DT-Over Voltage Pickedup | M | |
| Op | ACT | 59DT – Over Voltage Operated | O | |

**PTUV Under Voltage**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| DT27PTUV | | Under voltage | | |
| **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** | | | | |
| Str | ACD | 27DT-Under Voltage Pickedup | M | |
| Op | ACT | 27DT – Under Voltage Operated | M | |

**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 | |

**RBRF Breaker Failure**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D50BFRBRF | | Breaker failure | | |
| **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** | | | | |
| OpEx | ACT | 50BF delay2 Operated | C | |
| Opln | ACT | 50BF delay1 Operated | C | |

**RREC Auto Reclose**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| D79RREC | | Multi shot auto reclose | | |
| **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** | | | | |
| Auto | ACT | 79IN External Switch Status | O | |
| Op | ACT | 79 Auto reclosure Operated | M | |
| AuroRecSt | ACT | 79AR Lockout Information | M | |
| BlkRec | ACT | 79AR Block | O | |

**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 | |

**MMXU1**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| ANAMMXU1 | | Physical device information | | |
| **Data** | | | | |
| **Common Logical Node Information** | | | | |
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | |
| Mod | INC_2_Mod | Mode | M | |
| Beh | INS_1_Beh | Behaviour | M | |
| Health | INS_1_Health | Health | M | |
| NamPlt | LPL_4_NamPlt | Name Plate | M | |
| TotW | MV_1_TotW | Total Active Power (Total P) | M | |
| TotVAr | MV_1_TotW | Total Reactive Power (Total Q) | M | |
| TotPF | MV_1_TotW | Average Power Factor (Total PF) | M | |
| Hz | MV_1_TotW | Frequency | M | |
| PhV | WYE_1_Z | Phase to Ground Voltage | M | |
| A | WYE_1_Z | Phase Currents | M | |

**MSQI**

| **LN class** | | | | |
|---|---|---|---|---|
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | **Remarks** |
| SEQMSQI1 | | Physical device information | | |
| **Data** | | | | |
| **Common Logical Node Information** | | | | |
| **Attribute** | **Attribute Type** | **Explanation** | **M/O/E** | |
| Mod | INC_2_Mod | Mode | M | |
| Beh | INS_1_Beh | Behaviour | M | |
| Health | INS_1_Health | Health | M | |
| NamPlt | LPL_4_NamPlt | Name Plate | M | |
| SeqV | WYE_1_Z | V1,V2,V0 | M | |
| SeqA | WYE_1_Z | I1,I2,I0 | M | |

# N.3 Data Mapping Specifications

### F-PRO logical devices

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

1. Protection
2. Measurements
3. Records
4. System
5. FaultData
6. VirtualElements

### F-PRO logical nodes

Below table 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 | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| Protection | DT27PTUV1 | 27-1 DTL Under Voltage | Dev 27_1 | DTL Under Voltage_1 | PTUV |
| Protection | DT27PTUV2 | 27-2 DTL Under Voltage | Dev 27_2 | DTL Under Voltage_2 | PTUV |
| Protection | DT27PTUV3 | 27-3 DTL Under Voltage | Dev 27_3 | DTL Under Voltage_3 | PTUV |
| Protection | DT27PTUV4 | 27-4 DTL Under Voltage | Dev 27_4 | DTL Under Voltage_4 | PTUV |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| Protection | DT27PTUV5 | 27-5 DTL Under Voltage | Dev 27_5 | DTL Under Voltage_5 | PTUV |
| Protection | DT27PTUV6 | 27-6 DTL Under Voltage | Dev 27_6 | DTL Under Voltage_6 | PTUV |
| Protection | IT27PTUV1 | 27-1 IDMTL Under Voltage | Dev 27_1 | IDMTL Under Voltage_1 | PTUV |
| Protection | IT27PTUV2 | 27-2 IDMTL Under Voltage | Dev 27_2 | IDMTL Under Voltage_2 | PTUV |
| Protection | DT59PTOV1 | 59-1 DTL Over Voltage | Dev 59_1 | DTL Over Voltage_1 | PTOV |
| Protection | DT59PTOV2 | 59-2 DTL Over Voltage | Dev 59_2 | DTL Over Voltage_2 | PTOV |
| Protection | DT59PTOV3 | 59-3 DTL Over Voltage | Dev 59_3 | DTL Over Voltage_3 | PTOV |
| Protection | DT59PTOV4 | 59-4 DTL Over Voltage | Dev 59_4 | DTL Over Voltage_4 | PTOV |
| Protection | DT59PTOV5 | 59-5 DTL Over Voltage | Dev 59_5 | DTL Over Voltage_5 | PTOV |
| Protection | DT59PTOV6 | 59-6 DTL Over Voltage | Dev 59_6 | DTL Over Voltage_6 | PTOV |
| Protection | IT59PTOV1 | 59-1 IDMTL Over Voltage | Dev 59_1 | IDMTL Over Voltage_1 | PTOV |
| Protection | IT59PTOV2 | 59-2 IDMTL Over Voltage | Dev 59_2 | IDMTL Over Voltage_2 | PTOV |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| Protection | D50PIOC1 | Instantaneous Overcurrent (directional) | Dev 50/67_1 | Inst. Phase Overcurrent_1 | PIOC |
| Protection | D50PIOC2 | Instantaneous Overcurrent (directional) | Dev 50/67_2 | Inst. Phase Overcurrent_2 | PIOC |
| Protection | D50NPIOC1 | Instantaneous Overcurrent (directional) | Dev 50/67N_1 | Inst. Phase Overcurrent_1 (Derived) | PIOC |
| Protection | D50NPIOC2 | Instantaneous Overcurrent (directional) | Dev 50N/67_2 | Inst. Phase Overcurrent_2 (Derived) | PIOC |
| Protection | D4650PIOC1 | Instantaneous Overcurrent | Dev 46_50 | Inst. Negative Sequence Overcurrent | PIOC |
| Protection | D51PTOC1 | Time Overcurrent (directional) | Dev 51/67_1 | IDMTL Phase Overcurrent | PTOC |
| Protection | D51PTOC2 | Time Overcurrent (directional) | Dev 51/67_2 | IDMTL Phase Overcurrent | PTOC |
| Protection | D51NPTOC1 | Time Overcurrent (directional) | Dev 51/67N_1 | IDMTL Neutral Overcurrent (Derived) | PTOC |
| Protection | D51NPTOC2 | Time Overcurrent (directional) | Dev 51/67N_2 | IDMTL Neutral Overcurrent (Derived) | PTOC |
| Protection | D4651PTOC1 | Time Overcurrent | Dev 46_51 | IDMTL Negative Sequence Overcurrent | PTOC |
| Protection | D49PTTR1 | Thermal Overload | Dev 49 | Thermal Overload | PTTR |
| Protection | D50BFRBRF1 | Breaker Failure | Dev 50BF | Breaker Failure | RBRF |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| Protection | D79RREC1 | Auto Reclosing | Dev 79 | Auto Reclose | RREC |
| Protection | D81H2PHAR1 | Harmonic Restraint | Dev 81HBL2 | 2nd Harmonic Inrush Block | PHAR |
| Protection | D46BCRBCD1 | **New LN**: **R-**LN Group; **B-** Broken; **C-** Conductor; **D-** Detection | Dev 46BC | Broken Conductor Detection | RBCD |
| Protection | D74TCSRTCS1 | **New LN**: **R**-LN Group; **T**-Trip; **C**-Circuit; **S**-Supervision | Dev 74TCS (for 2 stages) | Trip Circuit Supervision | RTCS |
| Protection | I2TRCBC1 | **New LN**: **R**-LN Group; **C**-Circuit; **B**-Breaker; **C**-Condition | Dev I2T | CB Monitoring | RCBC |
| Protection | D60RVTS1 | **New LN**: **R**-LN Group; **V**-Voltage; **T**-Trip; **S**-Supervision | Dev VTS | VT Supervision | RVTS |
| Protection | D60RCTS1 | **New LN**: **R**-LN Group; **C**-Current; **T**-Trip; **S**-Supervision | Dev CTS | CT Supervision | RCTS |
| Protection | TRCALH1 | Alarm Handling | NA | Status of Starter/Trip Elements | CALH |
| Measurements | ANAMMXU1 | Measurements | NA | Analog Channel Input Measurement (3 Phase Current(s) & Voltage(s)) | MMXU |
| Measurements | SEQMSQI1 | Sequence & Imbalance | NA | Sequence Components of Voltage & Current (V1, V2, V0, I1,I2,I0) | MSQI |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| Records | DRRDRE1 | Disturbance Recorder | Disturbance Record | Transient Records | RDRE |
| FaultData | FLTDATA1 | **New LN**: DATA | NA | Fault Voltage & Current Details | DATA |
| System | LLNO/..(SGCB) (predefined) | Logical Node Zero | Setting Group | Used for Control of Setting Group | LLNO |
| System | EIGGIO1 | Generic Process I/O | External Inputs | Status of External Inputs (1-4) | LLNO |
| System | OCGGIO1 | Generic Process I/O | Output Contacts | Status of Output Contacts(1-8) | GGIO |
| System | PLGGIO1 | Generic Process I/O | Prologics | Status of Prologics (1-20) | GGIO |

| LD Name | LN Name | LN Description | FPRO Protection Function Reference | Comments | Data Reference |
|---|---|---|---|---|---|
| System | LEDGGIO1 | Generic Process I/O | HMI LED Monitoring | LED Status (1-8) | GGIO |
| System | HEALTHGGIO1 | Generic Process I/O | Relay Health, IRIG-B, SNTP Monitoring | Relay Health Status (1-3) | GGIO |
| VirtualElements | VIGGIO1 | Generic Process I/O | Virtual Input Status | Virtual Inputs Status (1-30) | GGIO |
| VirtualElements | VIGGIO2 | Generic Process I/O | Virtual Input Control | Virtual Inputs Status (1-30) | GGIO |
| VirtualElements | VIGGIO3 | Generic Process I/O | Virtual Outputs Control | Virtual Inputs Status (1-30) | GGIO |

# Logical Node Specifications

The following section provides the detailed information on each of the logical nodes for the variant FPRO 235xAy as defined in the previous section.

## Logical Nodes for Protection Functions

**DT27PTUV1** This section defines the logical node data of DT27PTUV1

| 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-1 Operated) 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 of DT27PTUV2

| 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 of DT27PTUV3

| 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 of DT27PTUV4

| 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 of DT27PTUV5

| 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 of DT27PTUV6

| 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 of IT27PTUV1

| 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 of IT27PTUV2

| 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 of DT59PTOV1

| 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 of DT59PTOV2

| 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 of DT59PTOV3

| 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 of DT59PTOV4

| 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 of DT59PTOV5

| 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 of DT59PTOV6

| 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 of IT59PTOV1

| 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 of IT59PTOV2

| 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 |

**D50PIOC1** This section defines the logical node data of D50PIOC1

| 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 of D50PIOC2

| 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 |

**D50NPIOC1** This section defines the logical node data of D50NPIOC1

| 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 of D50NPIOC2

| 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) |

**D4650PIOC1** This section defines the logical node data of D4650PIOC1

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

**D51PTOC1** This section defines the logical node data of D51PTOC1

| 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 of D51PTOC2

| 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 |
| D51PIOC2.ST.Str.dirPhsA | Direction Phase A |
| D51PTOC2.ST.Str.phsB | Start (51-2 Picked up) Phase B |
| D51PIOC2.ST.Str.dirPhsB | Direction Phase B |
| D51PTOC2.ST.Str.phsC | Start (51-2 Picked up) Phase C |
| D51PIOC2.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 |

**D51NPTOC1** This section defines the logical node data of D51NPTOC1

| 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 of D51NPTOC2

| 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) |

**D4651PTOC1** This section defines the logical node data of D4651PTOC1

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

**D49PTTR1** This section defines the logical node data of D49PTTR1

| Data Name | Description |
|---|---|
| D49PTTR1.MX.Tmp.mag.f | % 49 ( % 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) |

**D81H2PHAR1** This section defines the logical node data of D81H2PHAR1

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

**D50BFRBRF1** This section defines the logical node data of D50BFRBRF1

| 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) |

**D79RREC1** This section defines the logical node data of D79RREC1

| 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 |

**D46BCRBCD1** This section defines the logical node data of D46BCRBCD1

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

**D74TCSRTCS1** This section defines the logical node data of D74TCSRTCS1

| Data Name | Description |
|---|---|
| D74TCSRTCS1.ST.Op1.general | Operate (74TCS-1 Operated) |
| D74TCSRTCS1.ST.Op2.general | Operate (74TCS-2 Operated) |

**D60RVTS1** This section defines the logical node data of D60RVTS1

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

**D60RCTS1** This section defines the logical node data of D60RCTS1

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

**I2TRCBC1** This section defines the logical node data of I2TRCBC1

| 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) |

**TRCALH1** This section defines the logical node data of TRCALH1

| 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 of ANAMMXU1

| 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.ang.f | VC – Angle |
| ANAMMXU1.MX.PhV.neut.cVal.mag.f | VN – Magnitude |
| ANAMMXU1.MX.PhV.neut.cVal.ang.f | VN – 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.TotPF.mag.f | Power Factor |
| ANAMMXU1.MX.Hz.mag.f | Frequency |

**SEQMSQI1** This section defines the logical node data of SEQMSQI1

| 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 |

**DRRDRE1** This section defines the logical node data of DRRDRE1

| Data Name | Description |
|---|---|
| DRRDRE1.ST.RcdStr.stVal | Disturbance Recording Started |
| DRRDRE1.ST.RcdMade.stVal | Disturbance Recording Made |
| DRRDRE1.ST.FltNum.stVal | Fault Number |
| DRRDRE1.ST.MemUsed.stVal | % Memory Used to store DR |

**LLNO** This section defines the logical node data of LLNO

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

**EIGGIO1** This section defines the logical node data of EIGGIO1

| 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 |

**OCGGIO1** This section defines the logical node data of OCGGIO1

| 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 |

**PLGGIO1** This section defines the logical node data of PLGGIO1

| 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 |

**LEDGGIO1** This section defines the logical node data of LEDGGIO1

| 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 |

**HEALTHGGIO1** This section defines the logical node data of HEALTHGGIO1

| 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. |

**VIGGIO1** This section defines the logical node data of VIGGIO1

| 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 of VIGGIO2

| 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 |

**VIGGIO3** This section defines the logical node data of VIGGIO3

| Data Name | Description |
|---|---|
| VIGGIO3.ST.Ind1.stVal | Virtual Output Control– 1 |
| VIGGIO3.ST.Ind2.stVal | Virtual Output Control– 2 |
| VIGGIO3.ST.Ind3.stVal | Virtual Output Control– 3 |

| Data Name | Description |
|---|---|
| VIGGIO3.ST.Ind4.stVal | Virtual Output Control– 4 |
| VIGGIO3.ST.Ind5.stVal | Virtual Output Control– 5 |
| VIGGIO3.ST.Ind6.stVal | Virtual Output Control– 6 |
| VIGGIO3.ST.Ind7.stVal | Virtual Output Control– 7 |
| VIGGIO3.ST.Ind8.stVal | Virtual Output Control– 8 |
| VIGGIO3.ST.Ind9.stVal | Virtual Output Control– 9 |
| VIGGIO3.ST.Ind10.stVal | Virtual Output Control– 10 |
| VIGGIO3.ST.Ind11.stVal | Virtual Output Control– 11 |
| VIGGIO3.ST.Ind12.stVal | Virtual Output Control– 12 |
| VIGGIO3.ST.Ind13.stVal | Virtual Output Control– 13 |
| VIGGIO3.ST.Ind14.stVal | Virtual Output Control– 14 |
| VIGGIO3.ST.Ind15.stVal | Virtual Output Control– 15 |
| VIGGIO3.ST.Ind16.stVal | Virtual Output Control– 16 |
| VIGGIO3.ST.Ind17.stVal | Virtual Output Control– 17 |
| VIGGIO3.ST.Ind18.stVal | Virtual Output Control– 18 |
| VIGGIO3.ST.Ind19.stVal | Virtual Output Control– 19 |
| VIGGIO3.ST.Ind20.stVal | Virtual Output Control– 20 |
| VIGGIO3.ST.Ind21.stVal | Virtual Output Control– 21 |
| VIGGIO3.ST.Ind22.stVal | Virtual Output Control– 22 |
| VIGGIO3.ST.Ind23.stVal | Virtual Output Control– 23 |
| VIGGIO3.ST.Ind24.stVal | Virtual Output Control– 24 |
| VIGGIO3.ST.Ind25.stVal | Virtual Output Control– 25 |
| VIGGIO3.ST.Ind26.stVal | Virtual Output Control– 26 |
| VIGGIO3.ST.Ind27.stVal | Virtual Output Control– 27 |
| VIGGIO3.ST.Ind28.stVal | Virtual Output Control– 28 |
| VIGGIO3.ST.Ind29.stVal | Virtual Output Control– 29 |
| VIGGIO3.ST.Ind30.stVal | Virtual Output Control– 30 |

# Fault Data Logical Nodes

This section defines the logical node data under FAULT DATA. All the protection functions are grouped as 3 Logical Nodes below.

| Data Name | Description |
|---|---|
| FLTDATA1.MX.A | Fault Currents ( IA, IB, IC, IN) |
| FLTDATA1.MX.PhV | Fault Currents ( VA, VB, VC, VN) |
| FLTDATA1.MX.SeqA | Fault Current (I2, I2/I1) |

**FLTDATA1** This section defines the logical node data of FLTDATA1

| Data Name | Description |
|---|---|
| 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.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.SeqA.c2.cVal.mag.f | I2 – Neg. Seq. Magnitude (46/50, 46/51) |
| FLTDATA1.MX.SeqA.c2.cVal.ang.f | I2 – Neg. Seq. Angle (46/50, 46/51) |
| FLTDATA1.MX.SeqA.c1.cVal.mag.f | Ratio 46BC (I2/I1) |