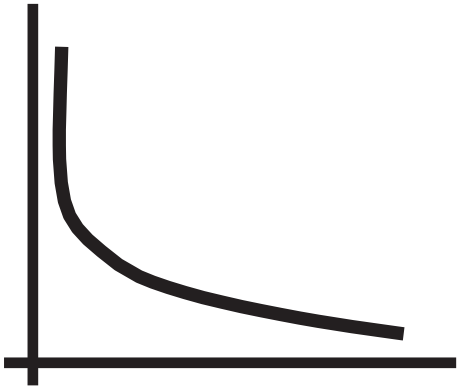
F-PRO

Non-Directional Multifunction & SEF / REF Protection Relay

Model 216



User Manual

Version 1.4 Rev 0

Preface

Information in this document is subject to change without notice.

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

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

Table of Contents

Acronyms

ASG	- Active Setting Group
CT	- Current Transformer
DCE	- Data Communication Equipment
GPS	- Global Positioning System
GUI	- Graphical User Interface
HMI	- Human Machine Interface
ICD	- file extension (.ICD) for IED Capability Description
IEC	- International Electro-technical Commission
IED	- Intelligent Electronic Device
IP	- Internet Protocol (IP) address
IRIG-B	- Inter-Range Instrumentation Group time codes
LED	- Light-emitting Diode
LCD	- Liquid Crystal Display
LHS	- Left Hand Side
RHS	- Right Hand Side
RTU	- Remote Terminal Unit
SCADA	- Supervisory Control And Data Acquisition
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**
V1.4	3	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
- Serial communication port

Operating System

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

- Microsoft Windows 7
- Microsoft Windows 10

ERL and 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=60. 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 Overcurrent/Earth Fault Protection, Sensitive Earth Fault / Restricted Earth Fault, 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 recordings

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

- Create and review relay settings

Record Graph 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 overcurrent based. 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)
- 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

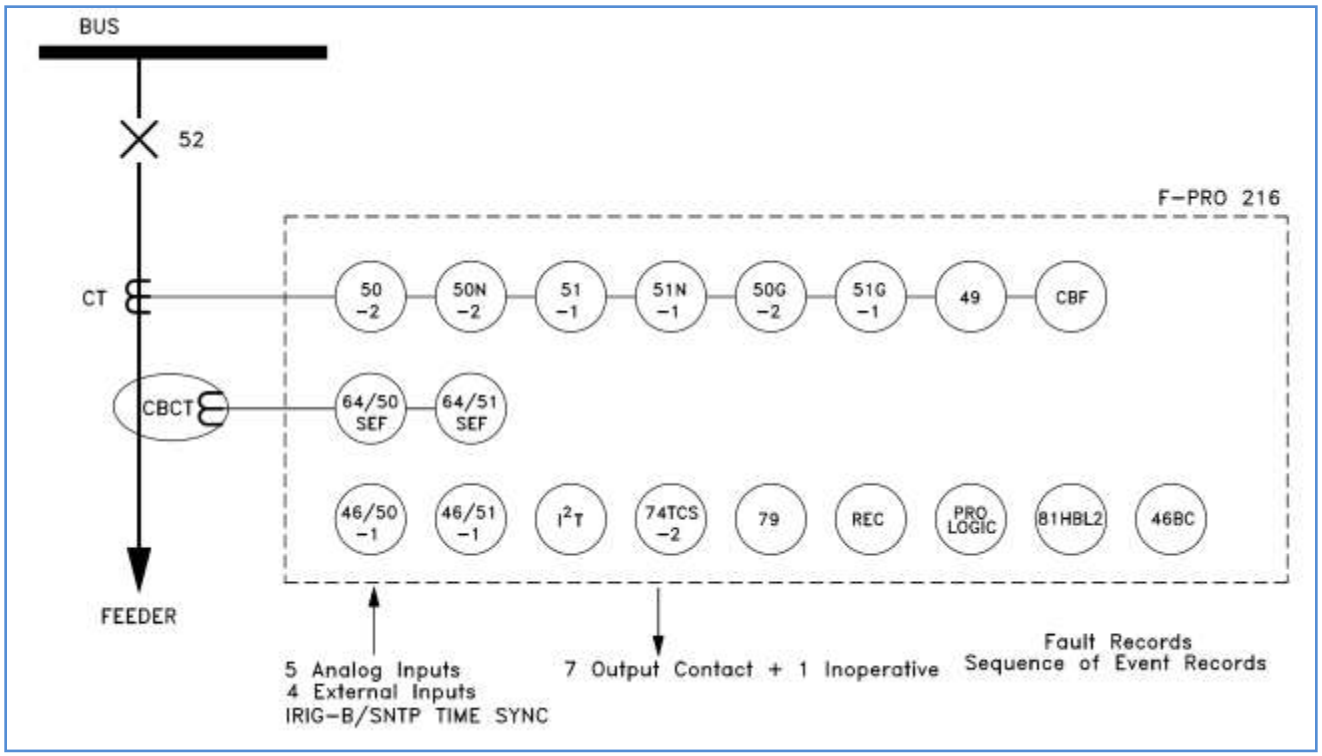


Figure 1.1: F-PRO Relay Function Line Diagram

1.2 Front View

Figure 1.2: F-PRO Front View

1.3 Rear View

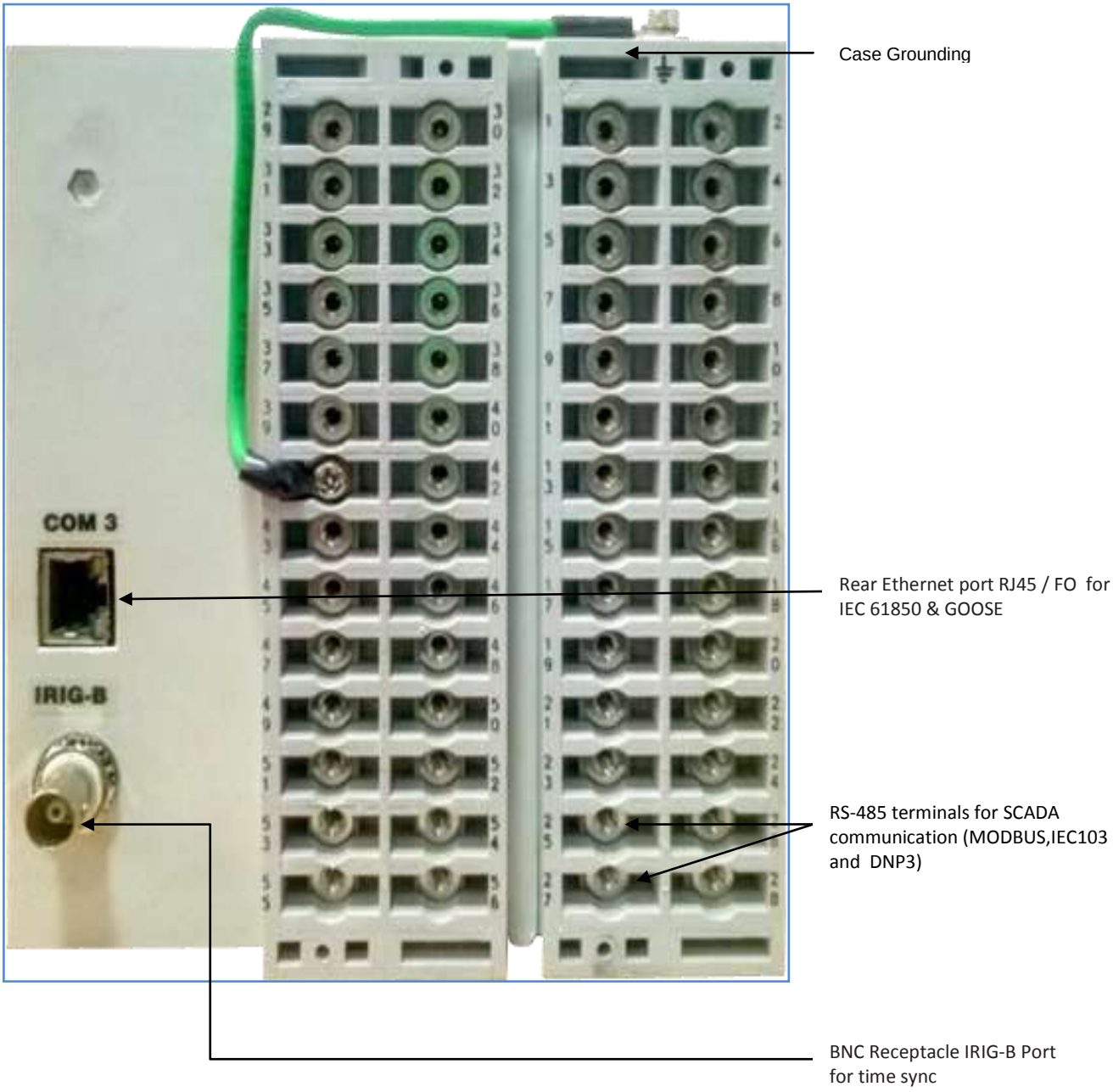


Figure 1.3: F-PRO Rear View

AC Current Inputs	F-PRO is provided with terminal blocks for up to 5 AC currents (3 Phase Current, 1 Neutral and 1 SEF / REF). 1A and 5A terminals are provided with isolated neutral, 1A or 5A CT Secondary is Site Selectable. To refer the complete schematic circuits; see "AC Schematic Drawing" in Appendix-I & "Connection Drawing" in Appendix-J
External Inputs	The 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. 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

- 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.easunreyrolle.com will be considered correct. (E00004R04)

ERL

www.easunreyrolle.com

Figure 1.4: Ordering Template

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.

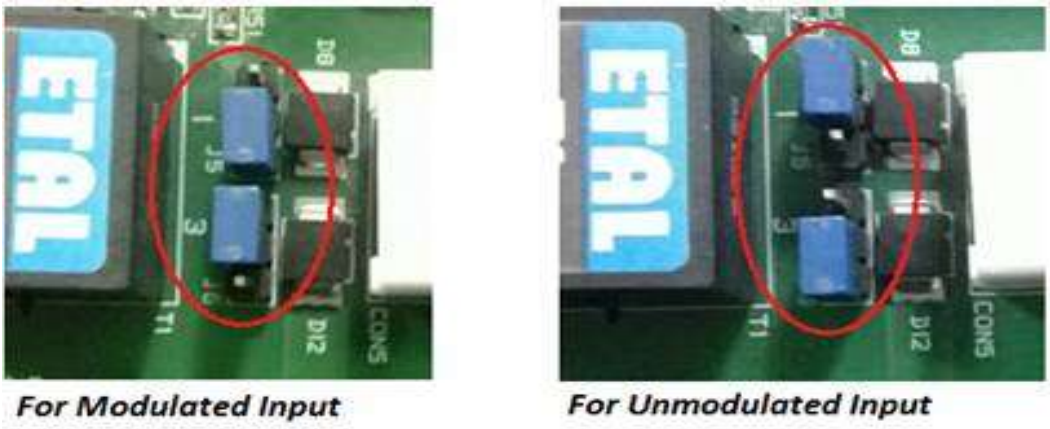


Figure 2.1: IRIG-B port for modulated and un-modulated input

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.

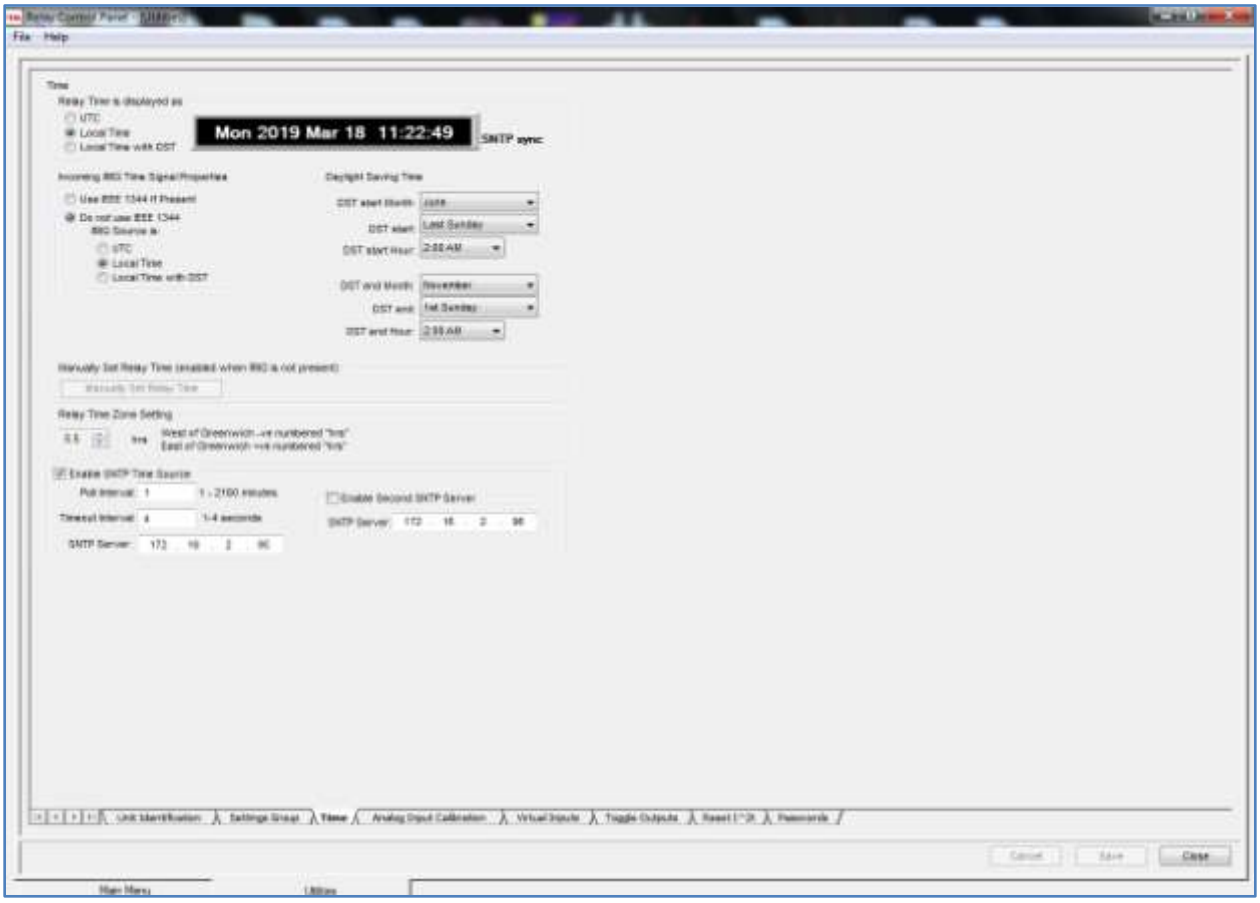


Figure 2.2: SNTP sync settings in RCP

If neither 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 IED for access 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 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.

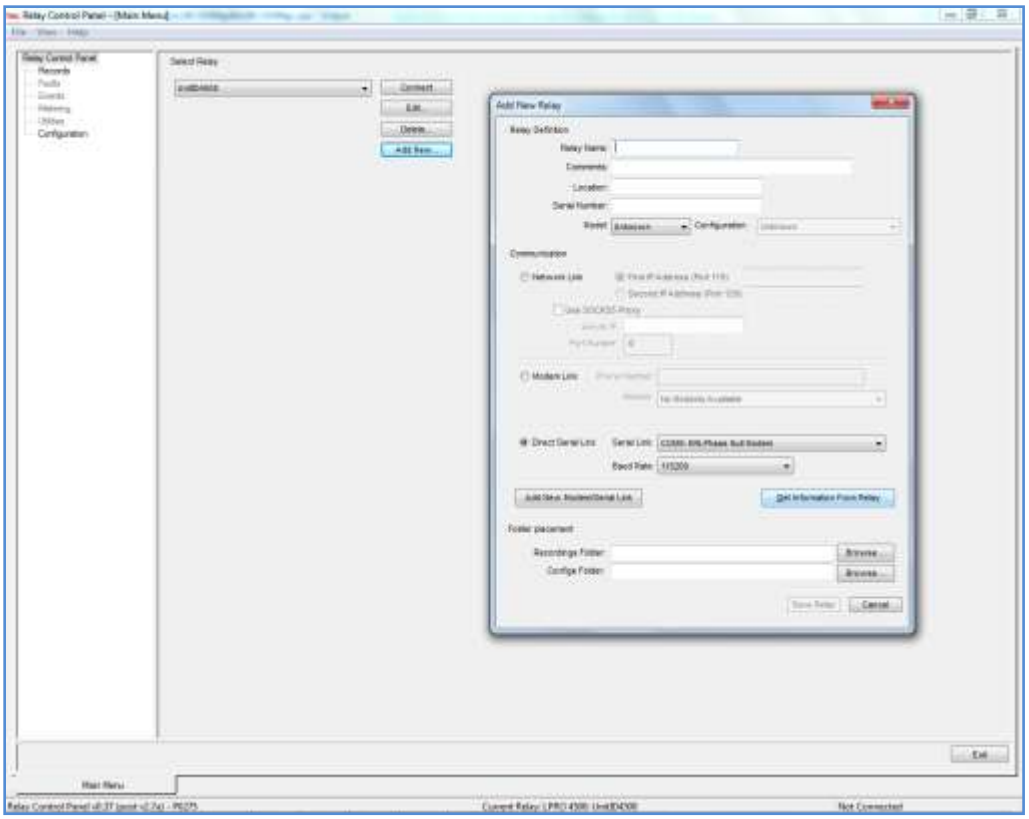


Figure 2.4 com port configuration

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

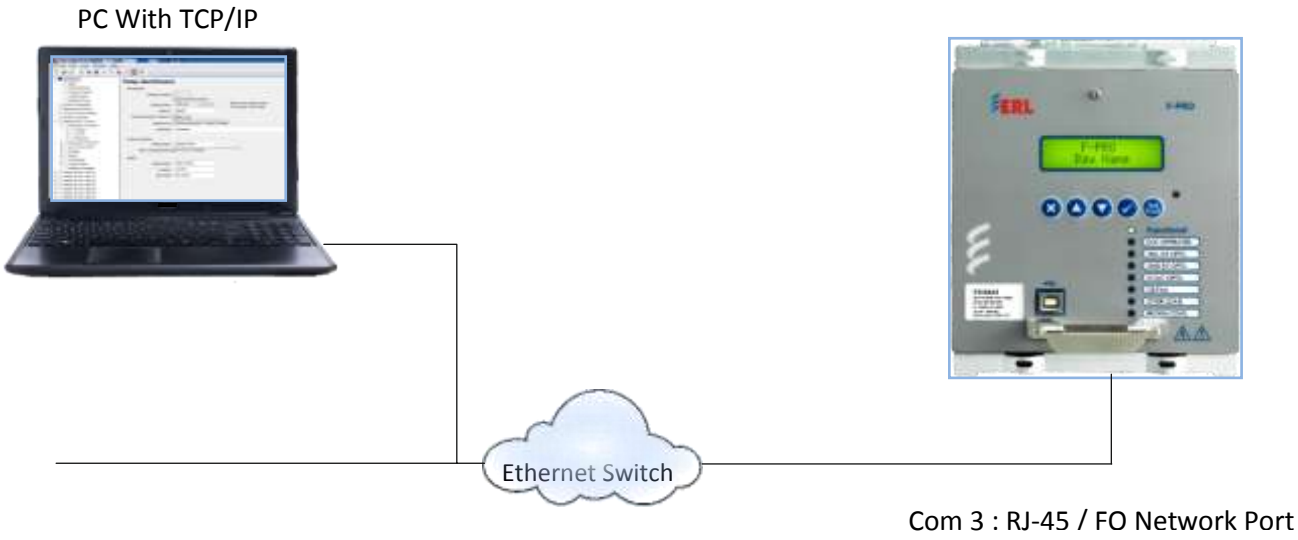


Figure 2.5: Network Link

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 fig 2.6. The relay gets restarted after firmware update.

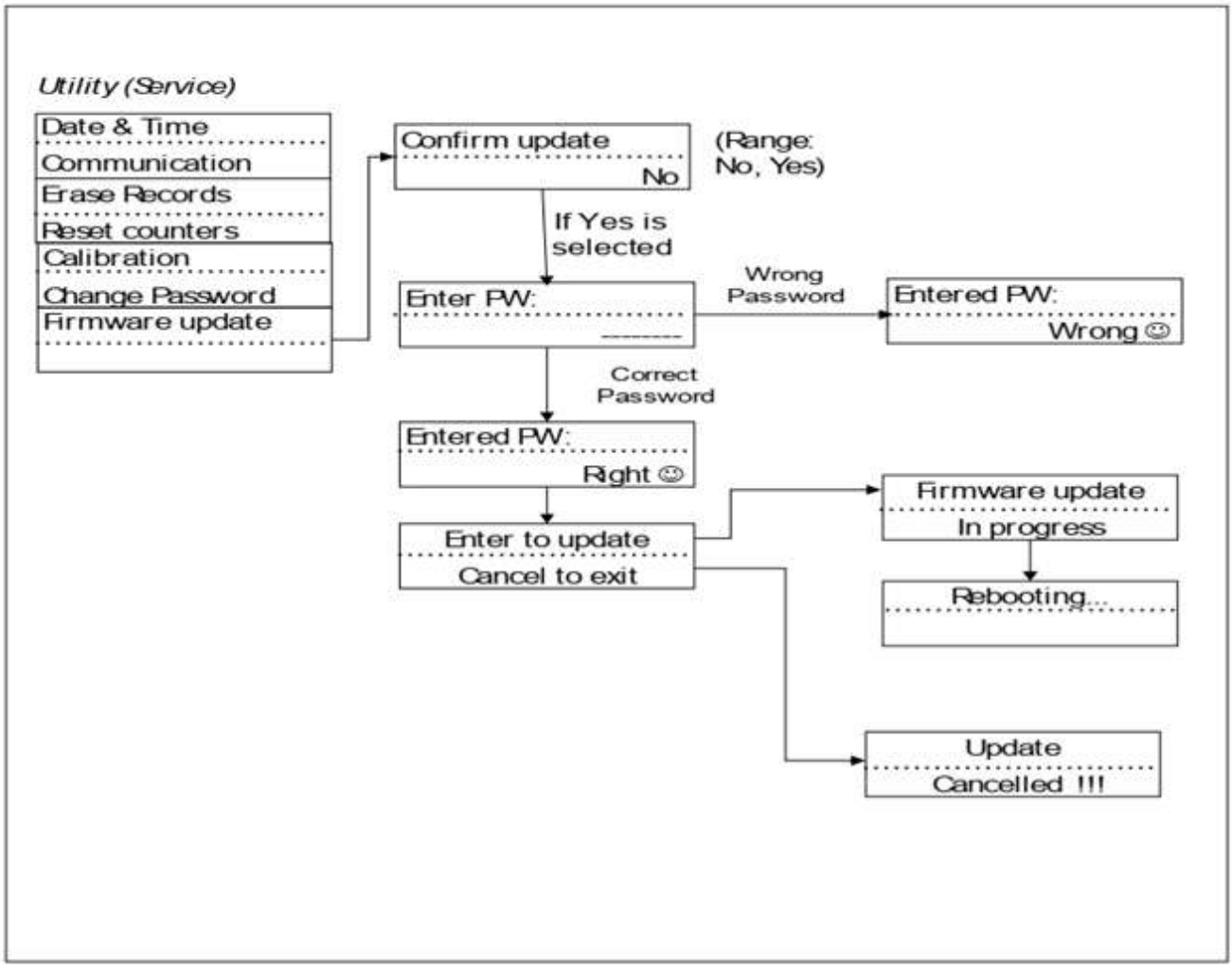


Figure 2.6: Firmware Update

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 2 is dedicated for use with Modbus slave, IED 60870-5-103 slave or DNP3 serial protocols. The serial Port uses standard RS-485 signaling. An external RS-485 <-> RS-232 converter has be used to connect to an RS-232 network.

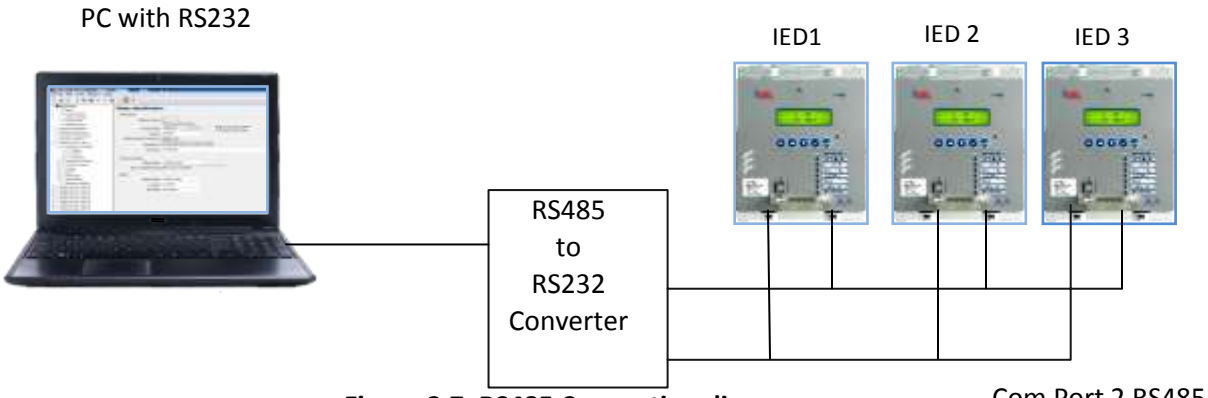


Figure 2.7: RS485 Connection diagram

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 and "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 Used for user interface access Default fixed baud rate 115200 N 8 1 (no parity, 8 data bits, 1 stop bit).
Rear Panel	COM 2	RS-485. Used for SCADA communication (MODBUS or IEC103 or DNP3). 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. Used for user interface access or IEC61850 / DNP3 SCADA access through Ethernet LAN. 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 deisy 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.

3.4 Front Panel Display

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

Navigation controls allow for an easy experience through settings, maintenance, service and view menus

Programmable target LEDs provide tripping information to expedite Response to systems events.

Unique front panel USB port provides easy and fast access to settings and set up

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 opens 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 to go to Change / Service Menu		
→ 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)
→ Neut. CT Sec.		(V,C,S)
→ SEF CT Sec.		(V,C,S)
→ Phase CT Ratio		(V,C,S)
→ Neut. CT Ratio		(V,C,S)
→ SEF CT Ratio		(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 OC		(V,C,S)
→ Fn. 50-1		(V,C,S)
→	Function	(V,C,S)
→	Pickup Current	(V,C,S)
→	Pickup Delay	(V,C,S)
→	Inrush Blocking	(V,C,S)
→ Fn. 50-2		(V,C,S)
→	Function	(V,C,S)
→	Pickup Current	(V,C,S)
→	Pickup Delay	(V,C,S)
→	Inrush Blocking	(V,C,S)

Table 3.3: Navigation of the LCD Screen		
	Fn. 51	(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)
	Curve	(V,C,S)
	TMS	(V,C,S)
	Pick Up 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)
	Measured Neutral OC	(V,C,S)
	Fn. 50G-1	(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)
	Pickup Delay	(V,C,S)
	Inrush Blocking	(V,C,S)
	Fn. 50G-2	(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)
	Pickup Delay	(V,C,S)
	Inrush Blocking	(V,C,S)
	Fn. 51G	(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)

Table 3.3: Navigation of the LCD Screen		
	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)
Neutral OC		(V,C,S)
Fn. 50N-1		(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)
	Pickup Delay	(V,C,S)
	Inrush Blocking	(V,C,S)
Fn. 50N-2		(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)
	Pickup Delay	(V,C,S)
	Inrush Blocking	(V,C,S)
Fn. 51N		(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)
	Inrush Blocking	(V,C,S)
SEF/REF		(V,C,S)
Fn. 64/50SEF-1		(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)

Table 3.3: Navigation of the LCD Screen		
	Pickup Delay	(V,C,S)
	Inrush Blocking	(V,C,S)
Fn. 64/50SEF-2		(V,C,S)
	Function	(V,C,S)
	Pickup Current	(V,C,S)
	Pickup Delay	(V,C,S)
	Inrush Blocking	(V,C,S)
Fn. 64/51SEF		(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)
	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)*
	Pick Up DTL Delay	*(V,C,S)*
	Reset 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		
	Pickup I2nd	(V,C,S)
	Constant TR	(V,C,S)
Thermal Overload		(V,C,S)
Fn. 49		(V,C,S)
	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. 50BF		(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)
Trip Circuit Supervision		(V,C,S)
Fn. 74TCS_1		(V,C,S)
	Function	(V,C,S)
	Name	(V,C,S)
	Drop-Off Delay	(V,C,S)
Fn. 74TCS_2		(V,C,S)
	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)

Table 3.3: Navigation of the LCD Screen			
		Ig Mag: IgAng:	(V,C,S)
		Isef Mag: Isef Ang:	(V,C,S)
		I1Mag	(V,C,S)
		I2 Mag:	(V,C,S)
		I0 Mag:	(V,C,S)
		Thermal State	(V,C,S)
		I^2t Accumulated	(V,C,S)
		Last Operation	(V,C,S)
	Digital		(V,C,S)
	EI Status		(V,C,S)
		EI1- El 1	(V,C,S)
		EI2- EI 2	(V,C,S)
		EI3- EI 3	(V,C,S)
		EI4- EI 4	(V,C,S)
	DO Status		(V,C,S)
		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)

Table 3.3: Navigation of the LCD Screen			
	Events		(V,C,S)
	View Faults		(V,C,S)
	Faults		(V,C,S)
	Utility		(V,C,S)
	Time & Date		(V,C,S)
	Date		(V,C,S)
		Date: YYYY/MM/DD	(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)
	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)
	USB		(V,C,S)
		Host: For RCP use	(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)

Table 3.3: Navigation of the LCD Screen		
	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)
	Network Settings	(V,C,S)
	IP Address	(V,C,S)
	Port	(V,C,S)

Table 3.3: Navigation of the LCD Screen			
		Subnet Mask	(V,C,S)
		Default Gateway	(V,C,S)
		MAC Address	(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)
	Current Channels		(C,S)
		Information Ensure 1A AC is applied	(C,S)
		Calibrate IA?	(C,S)
		Calibrate IB?	(C,S)
		Calibrate IC?	(C,S)
		Calibrate IG?	(C,S)
		Calibrate ISEF?	(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 Identifications	(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)

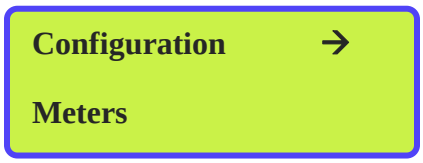


Figure 3.5: Main Menu

The Main Menu screen should appear.

Note: The default passwords are below:

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-216 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	Erase	Erase
	Events		View	Erase	Erase
	Metering				
		Analog Input	View	View	View
		I^2t	View	View	View
		Status (DI)	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)

Note: 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 define the F-PRO216 relay Protection functions.

The available functions are 50-1, 50-2, 51, 50N-1, 50N-2, 51N, 50G-1, 50G-2,51G, 64/50SEF-1, 64/50SEF-2, 51SEF, 46/50, 46/51, 74TCS-1, 74TCS-2, 49, 50BF, 46BC, 81HBL2, I^2t, 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.

50/51 Phase Overcurrent

The Phase overcurrent has 2 stages of time delayed or instantaneous (50) and one stage of IDMTL or time delayed or instantaneous (51).

Phase overcurrent protection is provided for feeders, transformers, reactors, capacitor banks and as back-up protection for bus-bars depending on application needs. The user can apply inverse (51), selectable definite time (51) and/or instantaneous overcurrent protection (50).

Each phase's current, after the necessary filtering, is compared with the set pickup current value. When the measured current is greater than the set pickup value, the enabled function will operate after the pickup delay, according to the set inverse curve (51) or instantaneously (50).

The function is provided with the additional feature of "Inrush Blocking". This is provided to block the function from operation when second harmonic current is present along with the fundamental (when used in transformers application). At the time of transformer charging, there is high magnitude of inrush current because of which relay may pick up for the particular function if inrush blocking is not enabled.

Each stage (50-1, 50-2 and 51) can be independently blocked via external input status which can be configured from the input matrix

50 – Overcurrent Logic diagram

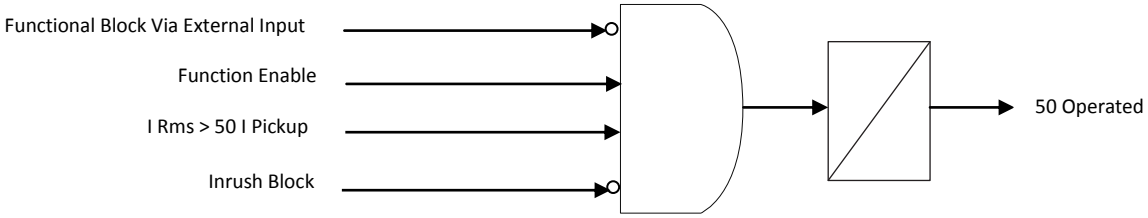


Figure 4.1: Logic Diagram of 50 Function

Table 4.1 50 - Phase Overcurrent Settings (No. of Stages – 2)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup	0.05 to 25 A (1 A) / 0.25 to 125 A (5 A)
Pickup Delay	0.00 to 999.99 seconds
Inrush Blocking	Enable/disable

Table 4.2: IEC and IEEE Curves

Sl.No	Characteristic	A	B	P	TR
1	IEC Standard Inverse-3	0.14	0	0.02	13.50
2	IEC Standard Inverse-1	0.0613	0	0.02	6.0
3	IEC Very Inverse	13.5	0	1.0	47.30
4	IEC Extremely Inverse	80.0	0	2.0	80.0
5	IEC Long Time Inverse	120.0	0	1.0	120.0
6	IEEE Moderately Inverse	0.0103	0.0228	0.02	0.97
7	IEEE Very Inverse	3.9220	0.0982	2.0	4.32
8	IEEE Extremely Inverse	5.6400	0.0243	2.0	5.82
9	User-defined	0.0010 to 1000.0	0.0 to 10.0	0.01 to 100.0	0.1 to 150.0

Operate & Reset time of the inverse characteristics can be calculated using the respective formulas presented below:

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

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

51 - IDMTL Overcurrent Logic Diagram

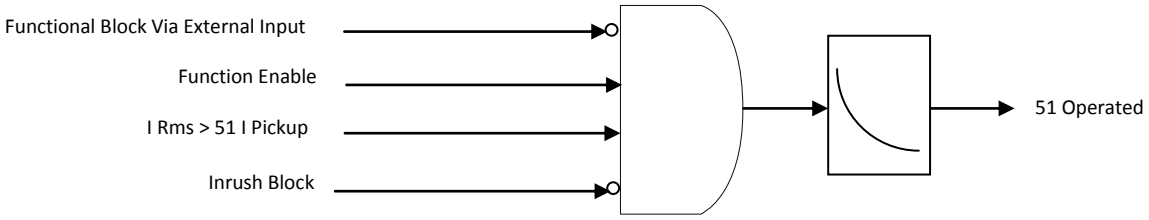


Figure 4.2: Logic Diagram of 51 Function

Table 4.3: 51 (IDMTL) Phase Overcurrent Settings (No. of Stages – 1)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup	0.05 to 10 (1 A) / 0.25 to 50 (5 A)
Curve Type	For details see Table 4.2 “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 (other than DTL selection)
Reset DTL Delay	0.0 to 99.9 seconds if DTL is chosen
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Inrush Blocking	Enable/disable

50N/51N Derived Neutral Overcurrent

Neutral Overcurrent Protection is provided for detection & clearance of Ground faults. Though Phase Overcurrent can also detect Line to Ground faults, for high resistance Ground faults, Neutral Overcurrent protection will be more sensitive than Phase Overcurrent Protection. User can define either 50N or 51N functions. User can apply inverse (51N), definite time (51N) and/or and instantaneous Overcurrent protection (50N).

Inverse time Function 51N provides selectable IEC or IEEE curves and one user-defined curve. The equation for 51N (IDMTL) is same as that used for 51(IDMTL) except in this case $3I_0$ is used in instead of I.

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 definite time function (51N) is governed by the time delay set after the pickup of the function & the instantaneous Overcurrent function (50N) has no time delay.

Derived Neutral current is greater than the set current the enabled function will go for the operation after the set delay (51N) or as per the set Inverse curve (51N) or instantaneous (50N).

The function 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 along with the fundamental (when used in transformers application). Each stage (50N-1, 50N-2 & 51N) can be independently inhibited via external input status which can be configured from input matrix, in case blocking of any stage is required depending on application needs.

50N - Derived Neutral Overcurrent Logic diagram

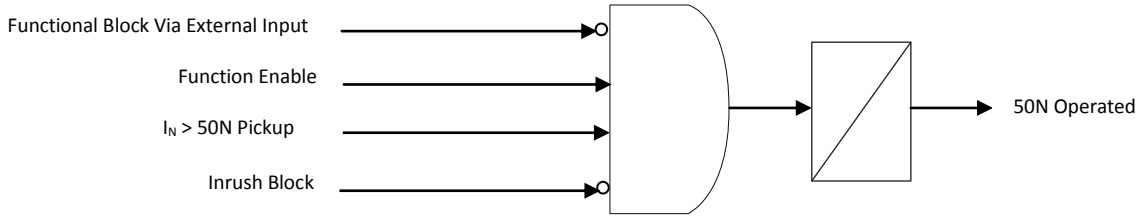


Figure 4.3: Logic Diagram of 50N Function

Table 4.4 50N Neutral Overcurrent Settings (No. of Stages – 2)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup	0.05 to 25 A (1 A) / 0.25 to 125 A (5 A)
Pickup Delay	0.00 to 999.99 seconds
Inrush Blocking	Enable/disable

51N – IDMTL Derived Neutral Overcurrent Logic diagram

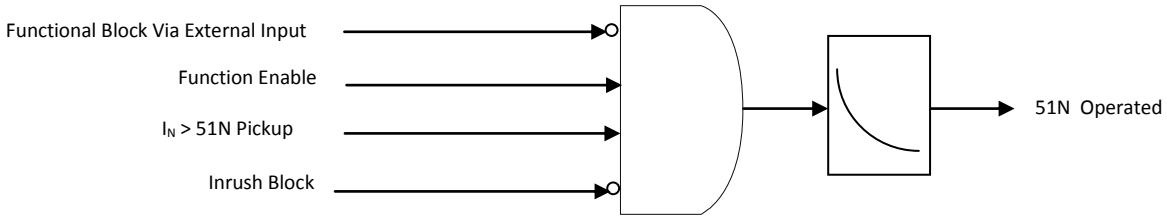


Figure 4.4: Logic Diagram of 51N Function

Table 4.5 51N (IDMTL) Neutral Overcurrent Settings (No. of Stages – 1)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup	0.05 to 10 (1 A) / 0.25 to 50 (5 A)
Curve Type	For details see Table 4.2 “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 (other than DTL selection)
Reset DTL Delay	0.0 to 99.9 seconds if DTL is chosen
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Inrush Blocking	Enable/disable

50G/51G Measured Neutral Overcurrent

Measured Neutral Overcurrent Protection is provided for detection & clearance of Ground faults. Though Phase Overcurrent can also detect Line to Ground faults, for high resistance Ground faults, Neutral Overcurrent protection will be more sensitive than Phase Overcurrent Protection. User can define either 50G or 51G functions. User can apply inverse (51G), definite time (51G) and/or and instantaneous Overcurrent protection (50G).

Inverse time Function 51G provides selectable IEC or IEEE curves and one user-defined curve. The definite time function (51G) is governed by the time delay set after the pickup of the function & the instantaneous overcurrent function (50G) has no time delay.

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

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

Measured Neutral current is processed after filtering; if the current measured is greater than the set current the enabled function will go for the operation after the set delay (51G) or as per the set Inverse curve (51G) or instantaneous (50G). The function is provided with the additional feature of “Inrush Blocking”. This is provided to block the function from operation when second harmonic current is present along with the fundamental (when used in transformers application).

Each stage (50G-1, 50G-2 & 51G) can be independently inhibited via external input status which can be configured from input matrix, in case blocking of any stage is required depending on application needs.

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

50G - Neutral Overcurrent Logic diagram

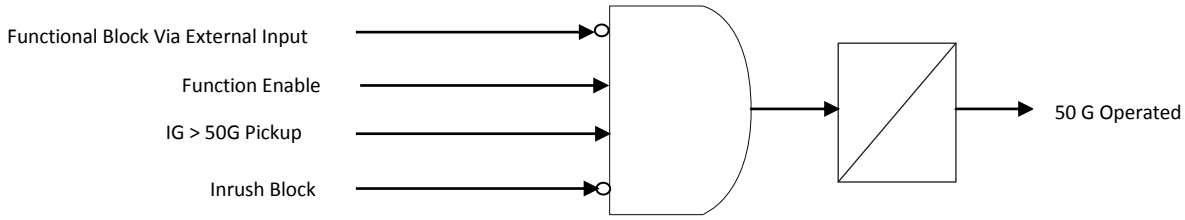


Figure 4.5: Logic Diagram of 50G Function

Table 4.6: 50G Neutral Overcurrent Settings (No. of Stages – 2)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup	0.05 to 25 A (1 A) / 0.25 to 125 A (5 A)
Pickup Delay	0.00 to 999.99 seconds
Inrush Blocking	Enable/disable

51G – IDMTL Neutral Overcurrent Logic diagram

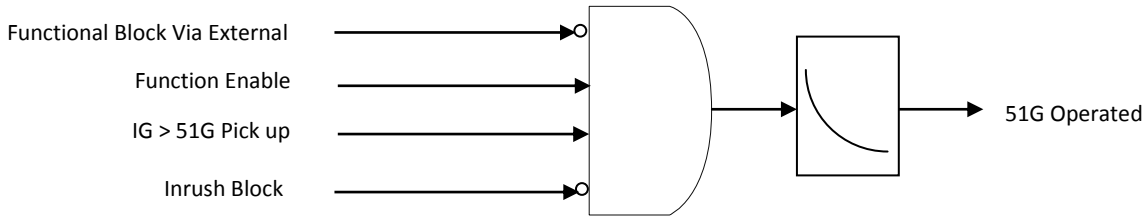


Figure 4.6: Logic Diagram of 51G Function

Table 4.7: 51G (IDMTL) Neutral Overcurrent Settings (No. of Stages – 1)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup	0.05 to 10 (1 A) 0.25 to 50 (5 A)
Curve Type	For details see Table 4.2 “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(other than DTL selection)
Reset DTL Delay	0.0 to 99.9 seconds if DTL is chosen
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Inrush Blocking	Enable/disable

64/50/51 Instantaneous SEF / REF

The sensitive earth fault protection works by measuring the residual current across the three phases in a system. This is done using a Core balanced current transformer (CBCT). In the event of a fault, the residual current over the three phases will not be equal to zero as the current from the faulted phase flows through the earth.

The sensitive earth fault protection is usually used in alternators and transformers with high resistance grounding. High resistance grounding restricts the earth fault current to less than 10A. High resistance grounding enables electrical systems to continue running when one of the phases is faulted. This prevents interruptions to the power supply. This kind of earthing system provides time to identify and isolate the fault.

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

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

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

The sensitive earth fault protection, as the name suggests, is a highly sensitive function. It can sense currents as low as 0.5% of the CT secondary current. The sensitive earth fault relay may be configured to either generate an alarm or a trip signal.
The main purpose of the Restricted Earth fault is to sense the internal earth fault in the transformer. For external earth fault REF relay will not operate. But in case of internal fault, the unbalanced fault current has been taking over by the neutral C.T, at this certain point of time REF function will operate. In the star side of the transformer, whenever the external fault occurs, the current will flows through the affected phase of the line current transformer and simultaneously the balancing current flows in the neutral transformer as a result of this, the net current in the relay will be zero.

64/50 – Instantaneous SEF/REF Protection Logic diagram

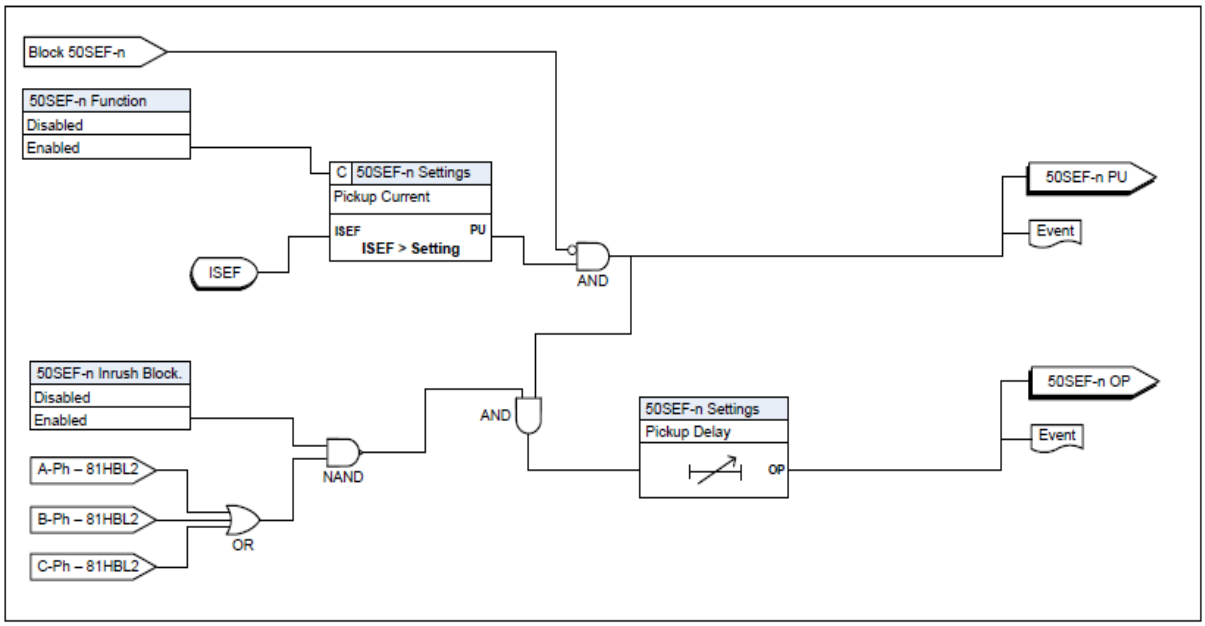


Figure 4.7: Logic Diagram of 64/50 Function

Table4.8: 64/50SEF Instantaneous SEF/REF Settings (No. of Stages – 2)	
Setting Description	**Range**
Function Activation	Enable/disable
Pickup ISEF>>	0.005 to 2.5 A (1 A) / 0.025 to 12.5 A (5 A)
Pickup Delay	0.00 to 999.99 seconds
Inrush Blocking	Enable/disable

64/51 – IDMTL SEF Protection Logic diagram

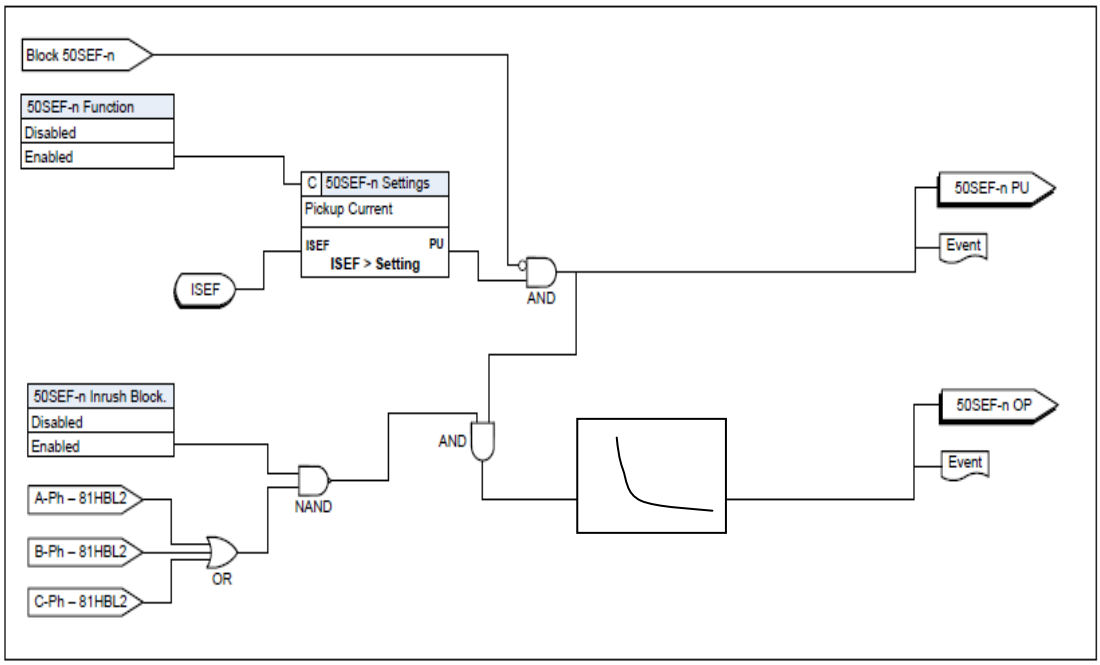


Figure 4.8: Logic Diagram of 64/51 Function

Table 4.9 64/51SEF - Inverse Time Sensitive /Restricted Earth Fault	
Setting Description	Range
Function Activation	Enable/Disable
Pickup ISEF	0.005 to 1.000 (1 A) / 0.025 to 5.000 (5 A)
Curve Type	For details see Table 4.2 “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(other than DTL selection)
Reset DTL Delay	0.0 to 99.9 seconds if DTL is chosen
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics
Inrush Blocking	Enable/disable

46-50/51 Negative Sequence Overcurrent

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.

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

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

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.

46 / 50 – Negative Sequence Overcurrent Logic diagram

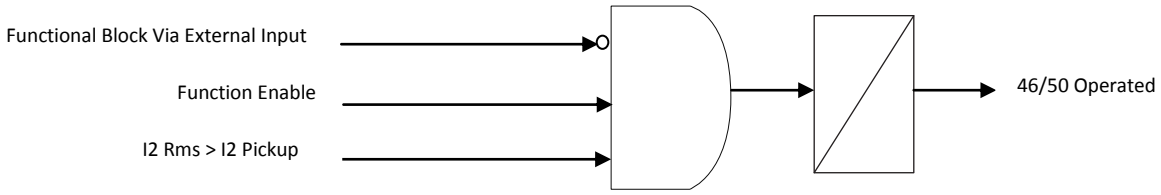


Figure 4.9: Logic Diagram of 46/50 Function

Table 4.10 46-50 Negative Sequence Overcurrent settings (No. of Stages – 1)	
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

46 / 51 – IDMTL Negative Sequence Overcurrent Logic diagram

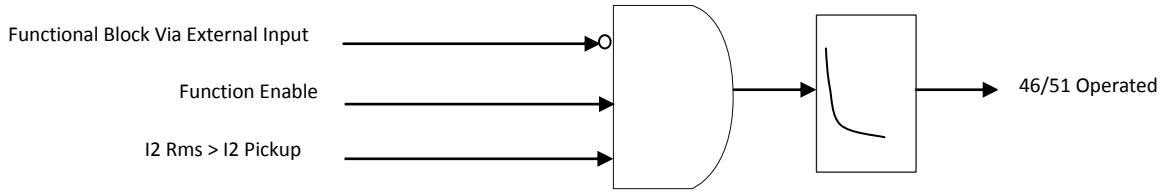


Figure 4.10: Logic Diagram of 46/51 Function

Table 4.11 46-51 (IDMTL) Negative Sequence Overcurrent Settings (No. of Stages -1)	
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 4.2 “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(other than DTL selection)
Reset DTL Delay	0.0 to 99.9 seconds if DTL is chosen
A	0.0010 to 1000.0000 settable if chosen for user defined characteristics
B	0.0000 to 10.0000 settable if chosen for user defined characteristics
p	0.01 to 100.00 settable if chosen for user defined characteristics
TR	0.10 to 150.00 settable if chosen for user defined characteristics

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:

$$t = \tau . \mathrm{Ln} \frac{\mathrm{I}^2 - \mathrm{I}_\mathrm{P}^2}{\mathrm{I}^2 - \mathrm{I}_\mathrm{B}^2}$$

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
IRMS = 3 phase RMS current
I2 = Negative sequence current
K = Negative sequence weighing factor

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

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

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

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

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

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

Where

θ = Thermal state in percentage at time t

θ_F = Final thermal state before disconnection of feeder

I = Effective relay current.

I_θ = Thermal overload setting

τ = Thermal time constant in minutes.

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

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

49 – Thermal Overload Logic diagram

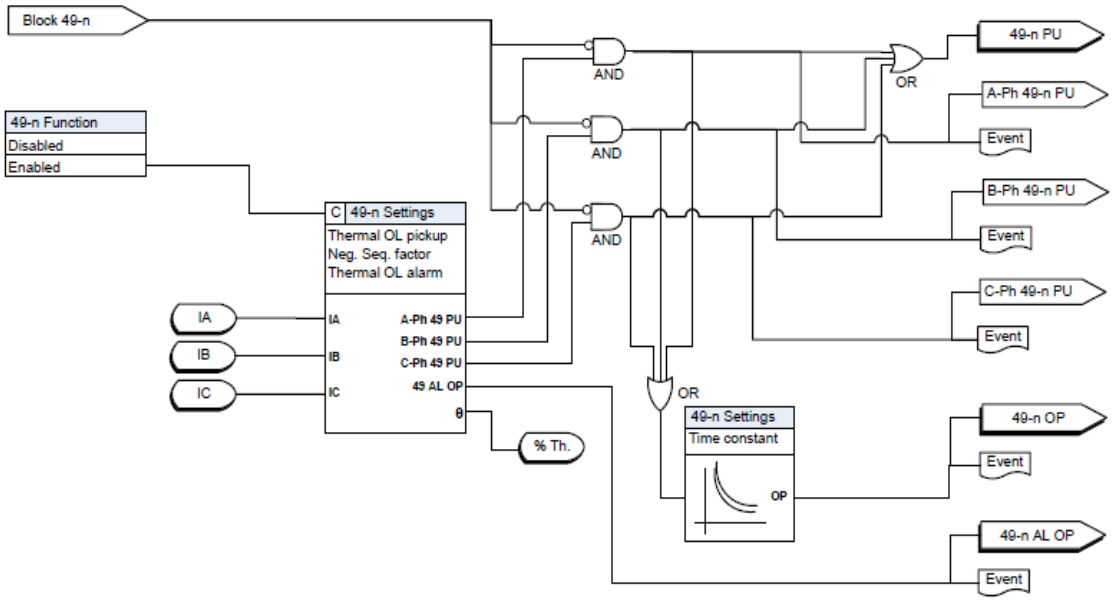


Figure 4.11: Logic Diagram of 49 Function

Table 4.12: 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.

50 – Breaker Failure Logic diagram

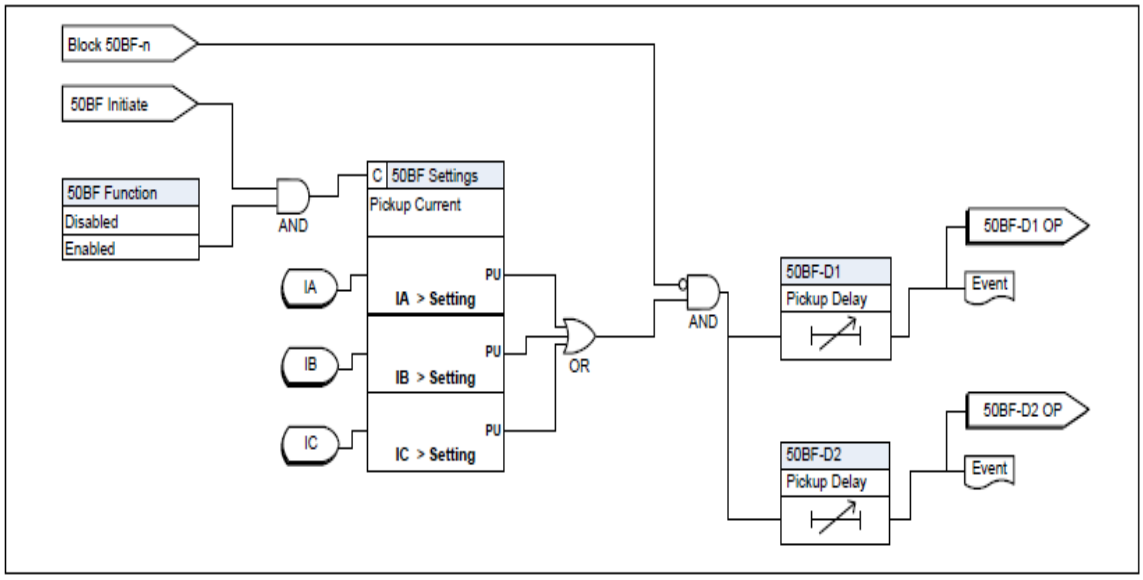


Figure 4.12: Logic Diagram of 50BF Functions

Table 4.13: 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	0.005 to 999.99 seconds
Pickup Delay 2	0.005 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.

46BC – Broken conductor Logic diagram

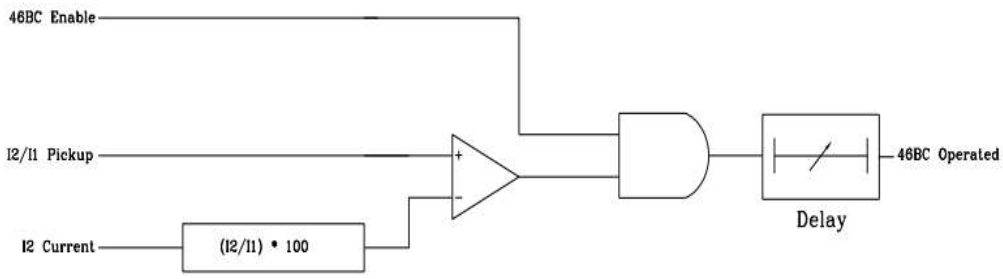


Figure 4.13: Logic Diagram of 46BC Functions

Table 4.14 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

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.

74TCS – Trip Circuit Supervision Logic Diagram

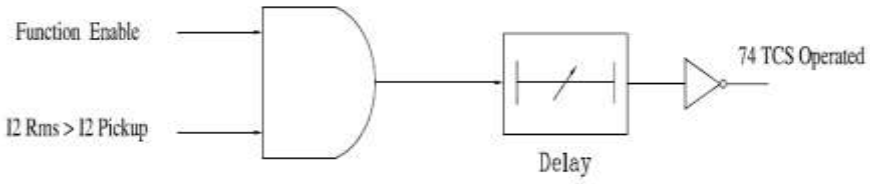


Figure 4.14: Logic Diagram of 74TCS Functions

Table 4.15: 74TCS Trip Circuit Supervision	
Setting Description	**Range**
74TCS-1	Enable/Disable
Name	TCS-1 (The name can have 12 characters)
Drop Off Delay	0.00 to 9.99 seconds
74TCS-2	Enable/Disable
Name	TCS-2 (The name can have 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.

81HBL2 – Inrush Block Logic diagram

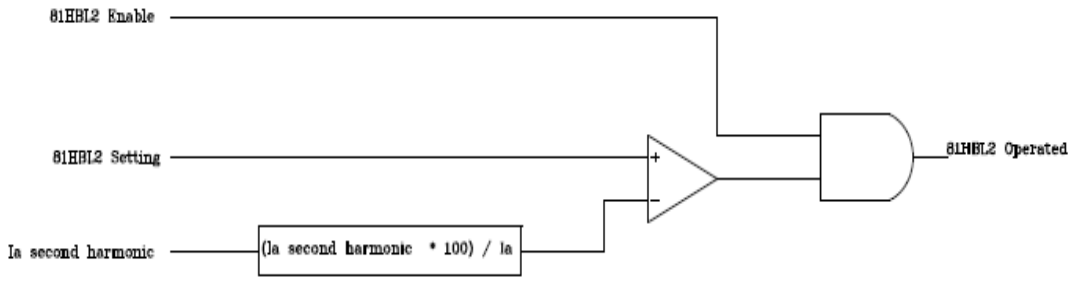


Figure 4.15: Logic Diagram of 81HBL2 Functions

Table 4.16: 81HBL2 Inrush Block	
Setting Description	**Range**
81HBL2	Enable/Disable
Cross Blocking	Enable/Disable
Percentage of second harmonic current I_{2nd}	5 to 50 %

79Reclose

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.

79 – Auto reclose Logic diagram

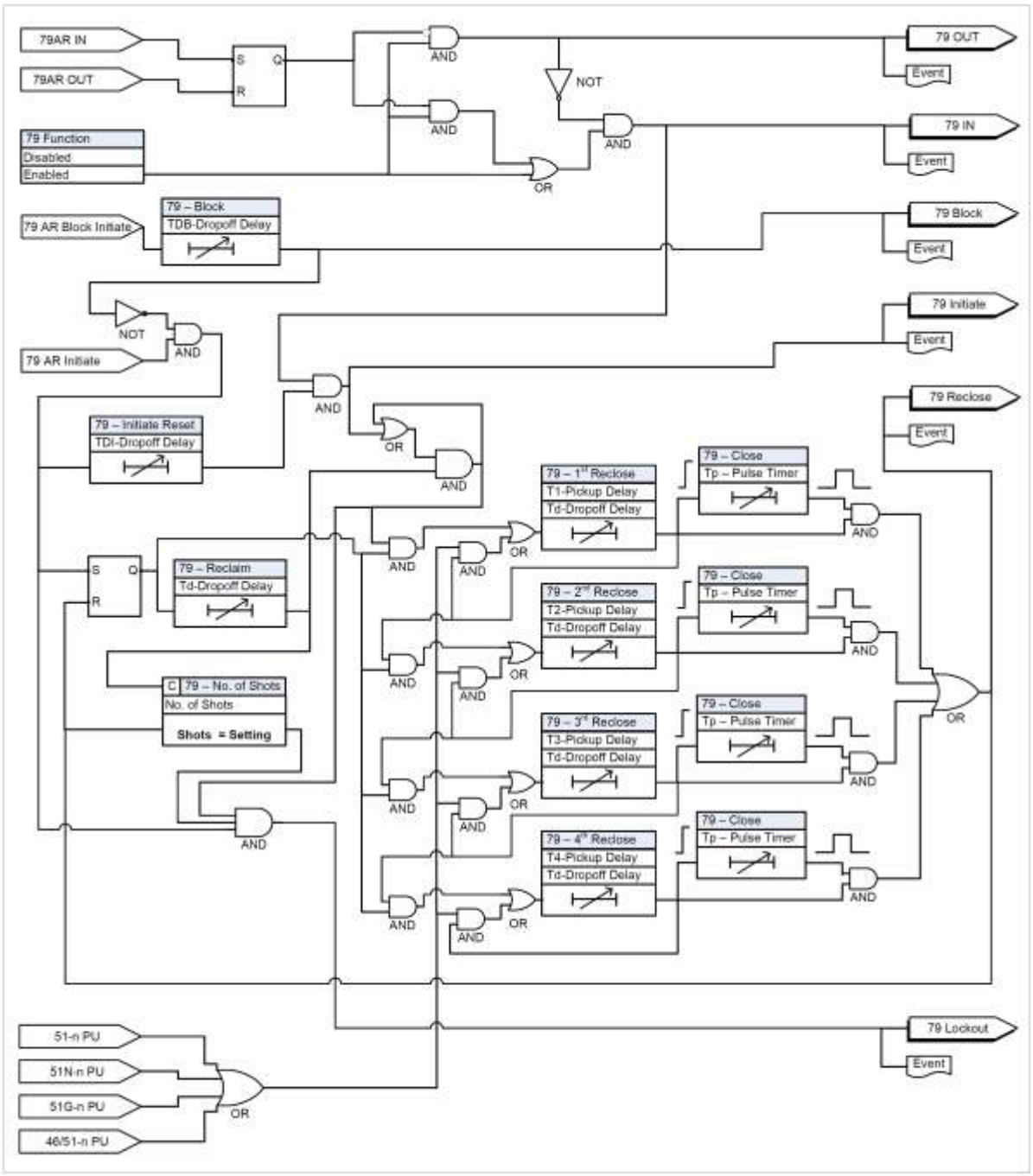


Figure 4.16: Logic Diagram of 79 Functions

Table 4.17: 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

Breaker Monitoring

The F-PRO breaker monitoring feature allows user to monitor the feeder breaker(s) 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 interface. User can only reset all associated breaker monitoring values from the terminal SCADA interfaces.

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 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 cur- rent 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 4.18: I^2t CB Condition	
Setting Description	**Range**
I^2t CB	Enable/disable
I^2t limit	0.1 to 99999.9 kA^2 seconds

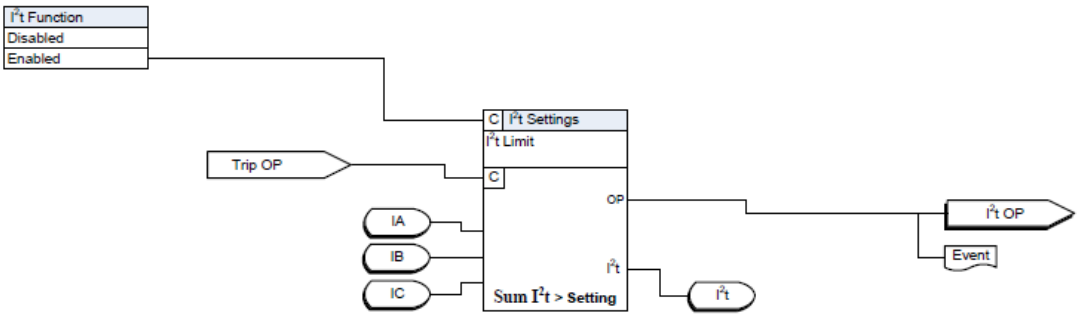


Figure 4.17: Logic Diagram of I2t Functions

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, XOR, EX0-OR 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.

Logic diagram of Prologic function

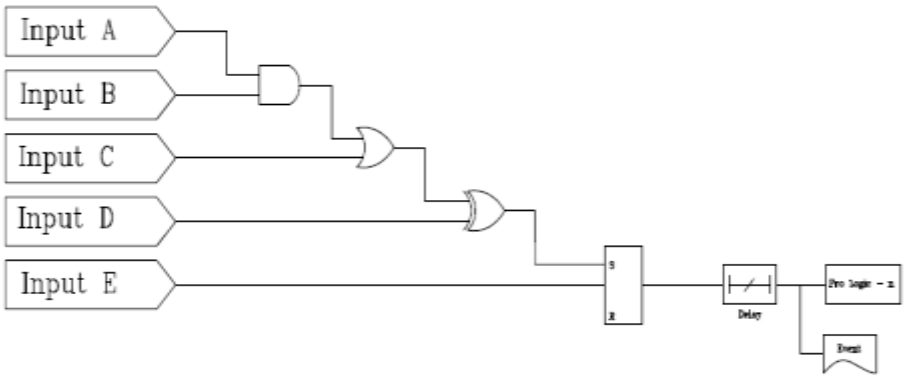


Figure 4.18: Logic Diagram of ProLogic Functions

Table 4.19: ProLogic Setting Functions	
Name	ProLogic (The name can have 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-PRO 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 initiates 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.
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 provide 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:

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

Record Initiation

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

The assignment of fault record initiation to the various relay functions is done through the relay's Output Matrix settings.
Recording can also be initiated manually through the Relay Control Panel interface in the *Records* tab and the command is *Trigger Event.*

Record Duration and Extension

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

F-PRO 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, a 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 log. 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

A list of stored records is available through the Relay Control Panel in the *Records* tab. From Relay Control Panel user can retrieve the record and delete or leave on the relay, graph the record, export the record to COMTRADE/ PTI & MS Excel 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 you sure you 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.

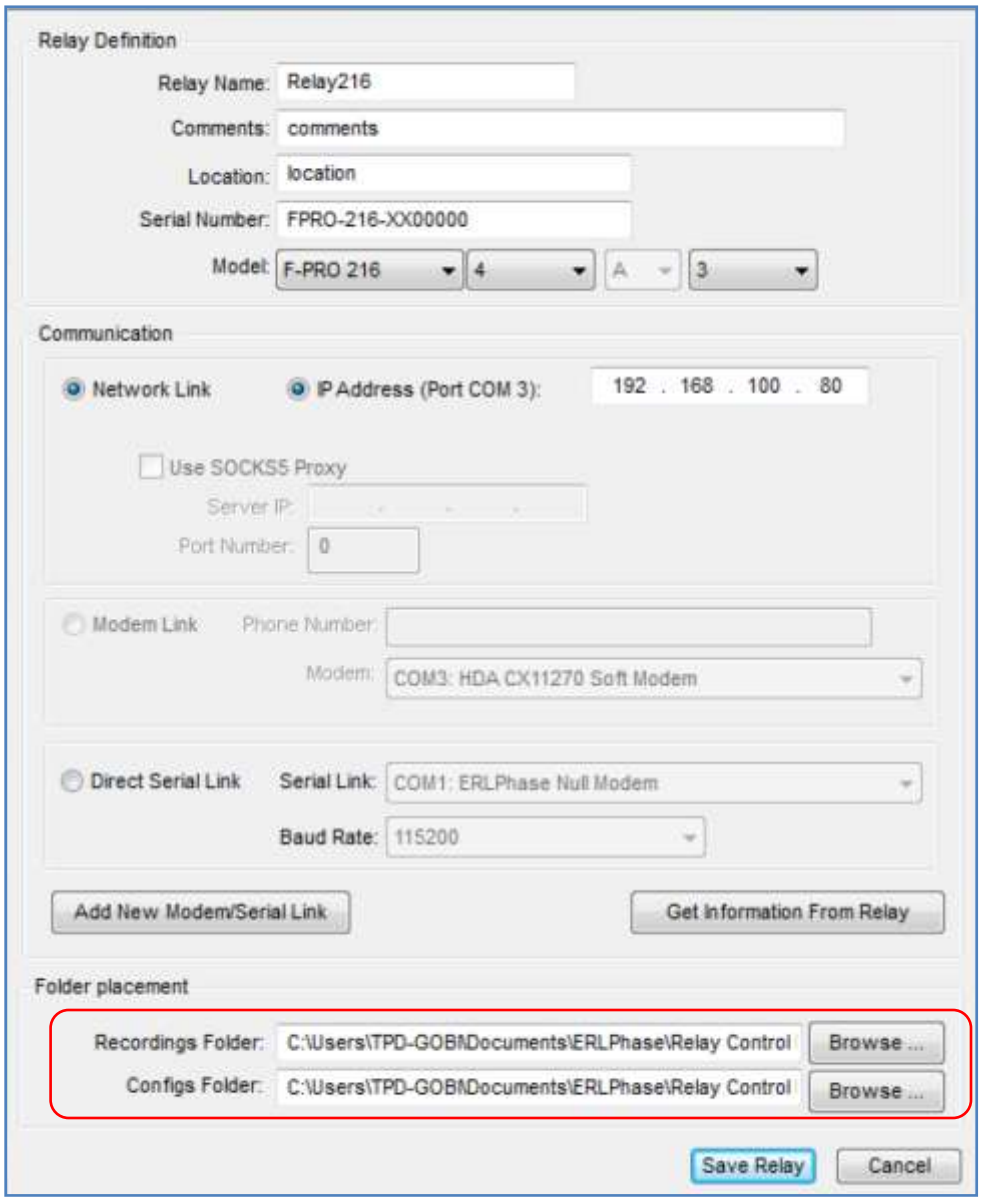


Figure 4.19: Record folder location

When transferred to your 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: 51-1 ABC Operated.

The event log can be viewed in three ways:

- Relay Front HMI
- Relay Control Panel interface is in the *Events* tab
- SCADA protocols included in the F-PRO allow the SCADA server/client access to Trip and Alarm event data.

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

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

There is a list of 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 4.20: Fault Log	
Fault Type	**Fault Quantities**
50-1	- Phase Indication (digital indication of A/B/C phases) - Main I1A/I1B/I1C/IN Phasors
50-2	- Phase Indication (digital indication of A/B/C phases) - Main I1A/I1B/I1C/IN Phasors
51-1	- Phase Indication (digital indication of A/B/C phases) - Main I1A/I1B/I1C/IN Phasors

Table 4.21: Fault Log	
50N-1	- Main IA/IB/IC/IN Phasors
50N-2	- Main IA/IB/IC/IN Phasors
51N	- Main IA/IB/IC/IN Phasors
50G-1	-Main IG Phasor
50G-2	-Main IG Phasor
51G	-Main IG Phasor
64/50SEF-1	-Main ISEF Phasor
64/50-SEF-2	-Main ISEF Phasor
51SEF	-Main ISEF Phasor
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) - Main IA/IB/IC/IN Phasors
50BF-1	- Phase Indication (digital indication of A/B/C phases) - Main IA/IB/IC/IN Phasors
50BF-2	- Phase Indication (digital indication of A/B/C phases) - 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 allow 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 and IEC 60870-5-103 protocols. The SCADA configuration and settings are described. The parameters for SCADA communications are defined using F-PRO Offliner software. Finally, details on how to monitor SCADA communications are given for maintenance and troubleshooting of the relay.

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-485 network. 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.

DNP3.0 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.

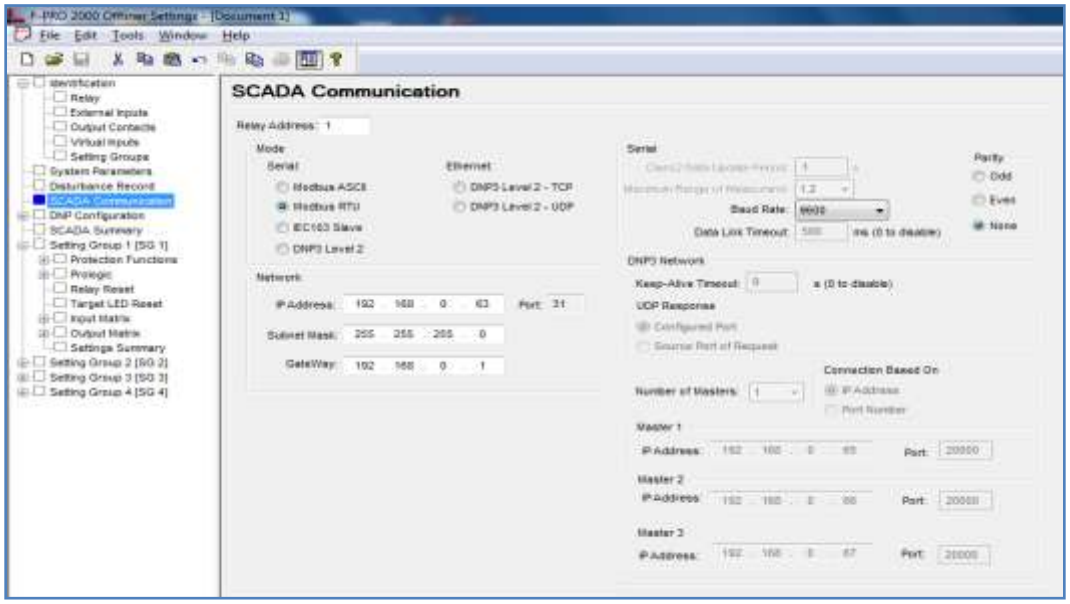


Figure 5.1: SCADA Communications

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
- DNP3.0 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 IEC61850 parameters are edited by using the ERL 61850 IED configurator. For more details on the ERL 61850 IED Configurator, see “ERL IED configurator” on 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 3-15) 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 Settings 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.

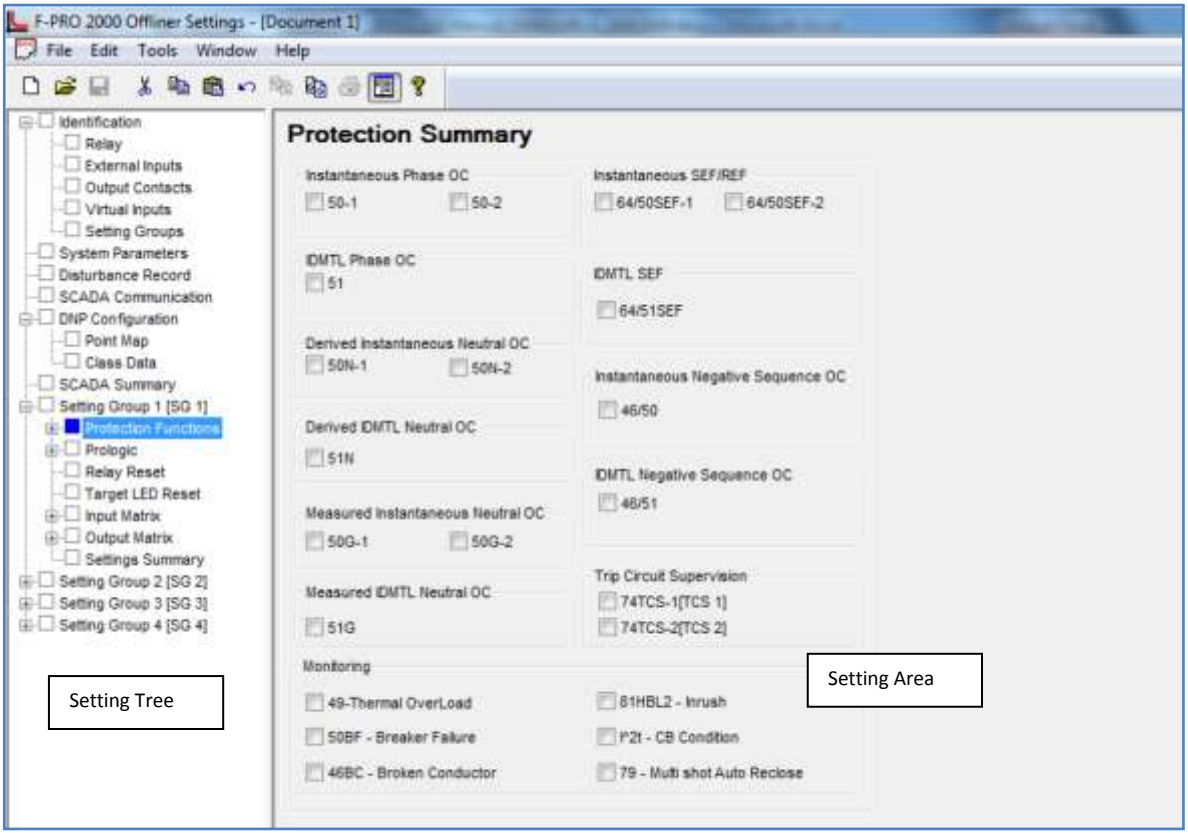


Figure 6.1: Protection Summary

6.3 Offliner Features

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

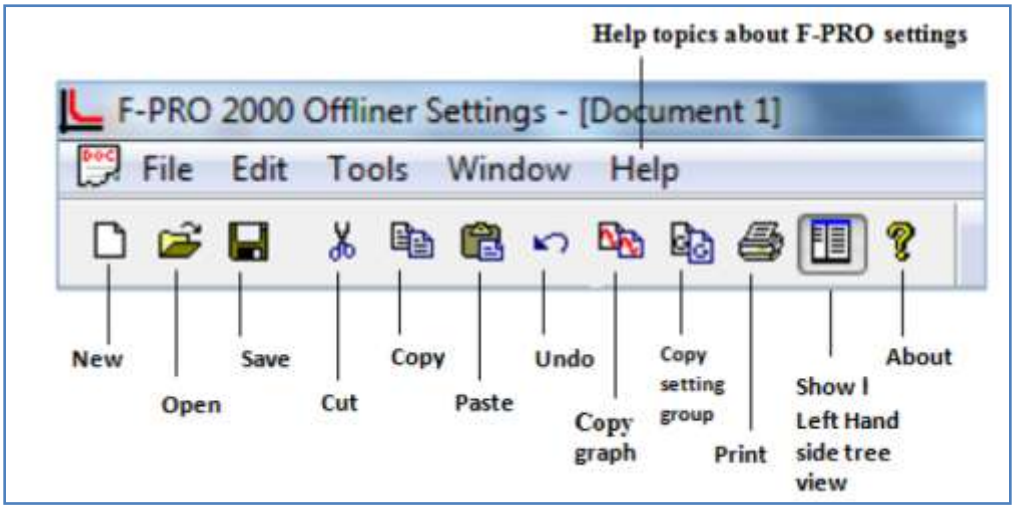


Figure 6.2: Offliner Features

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.

Table 6.1: Windows Menu		
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

Table 6.1: Windows Menu		
Edit	Paste	Insert clipboard contents
	Copy Graph	Copy the graph for the active screen to the clipboard
	Copy Setting Group	Copy values from one Setting Group to another
Tools	Options	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

Table 6.1: Windows Menu		
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 Group	Brings up the Copy Inputs dialog box
	Print	Prints Graphs or the setting summary, depending on which
	Show/Hide LHS Tree	If this option is checked then the LHS Tree view will be hidden or
	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 you 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.

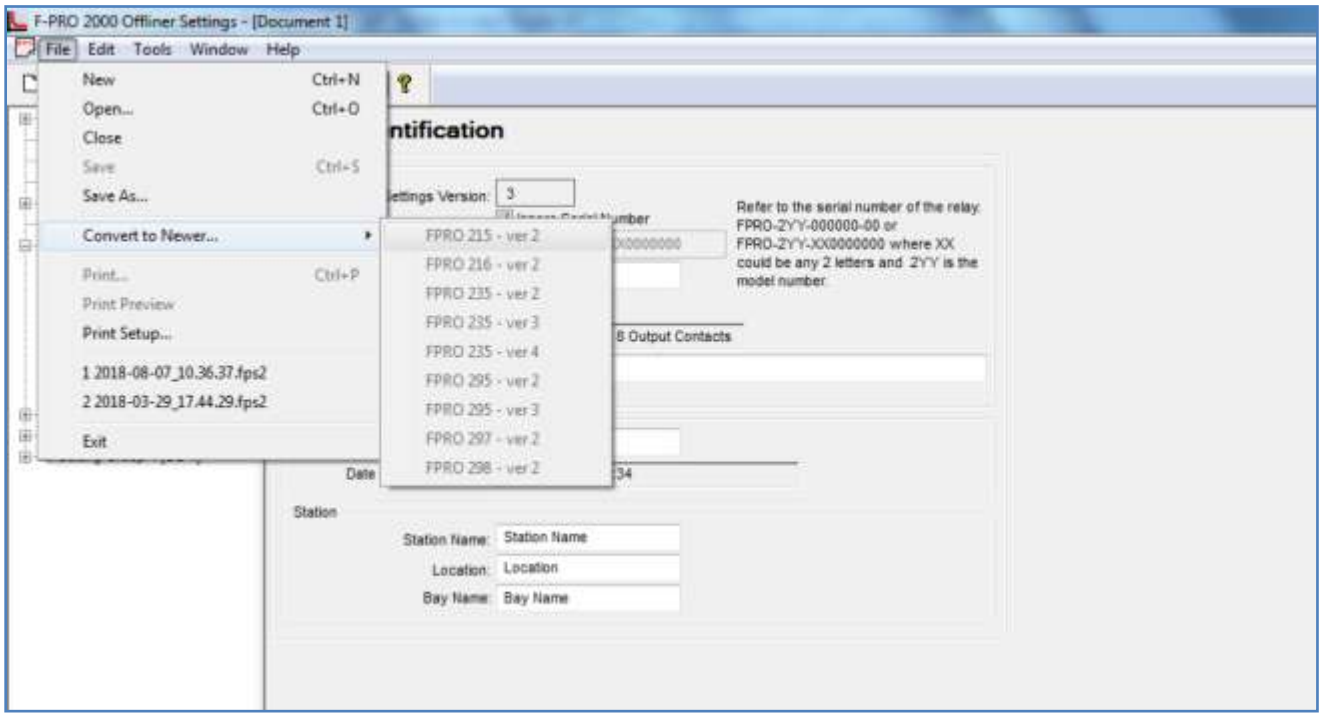


Figure 6.3: Converting Setting Files

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 en- sure 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 file on start up showing the settings version 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\ERLPhase\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 your 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.

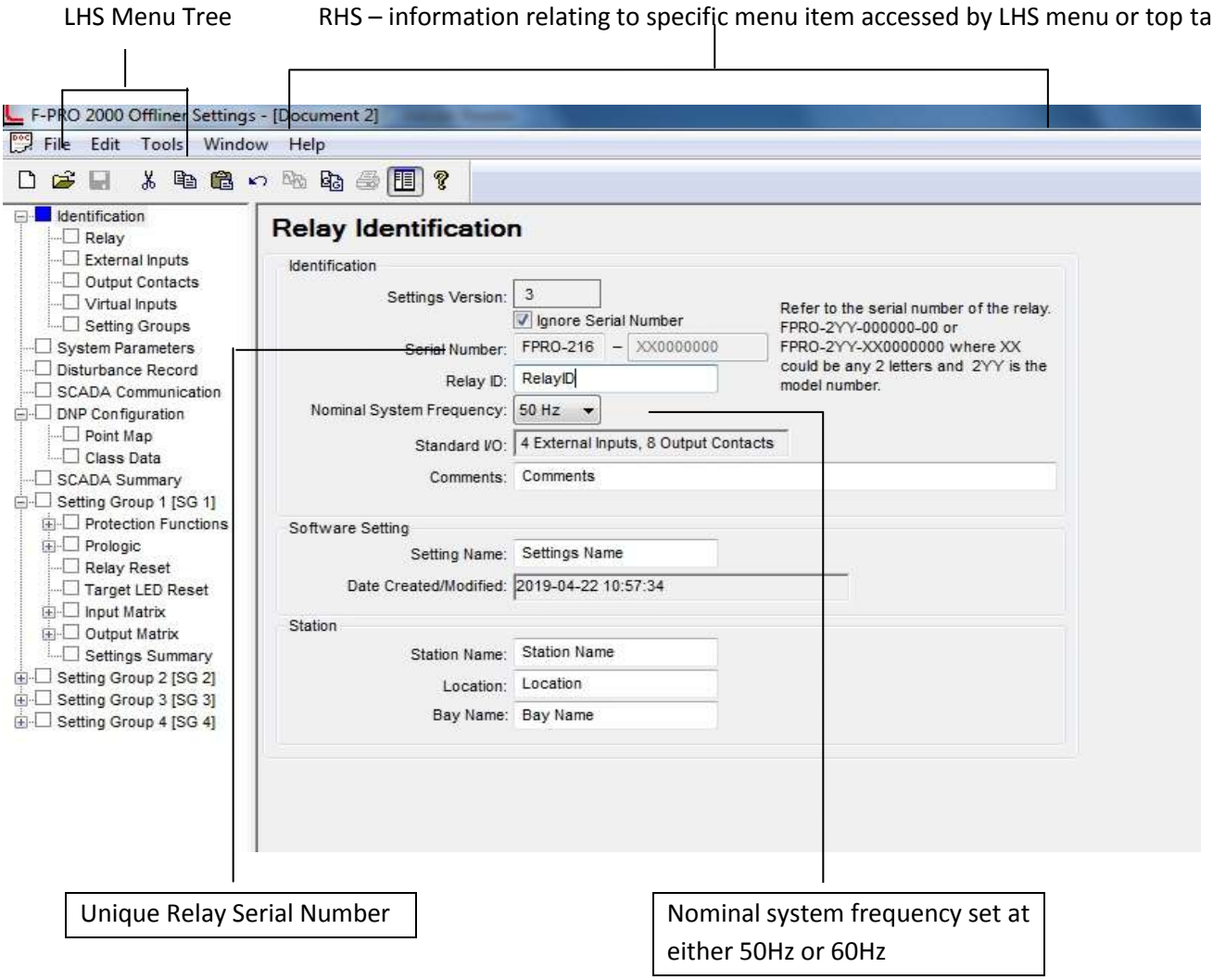


Figure 6.4: Relay identification

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 left menu 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 5 A or 1 A.
Nominal System Frequency can be set to either 60 Hz or 50 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

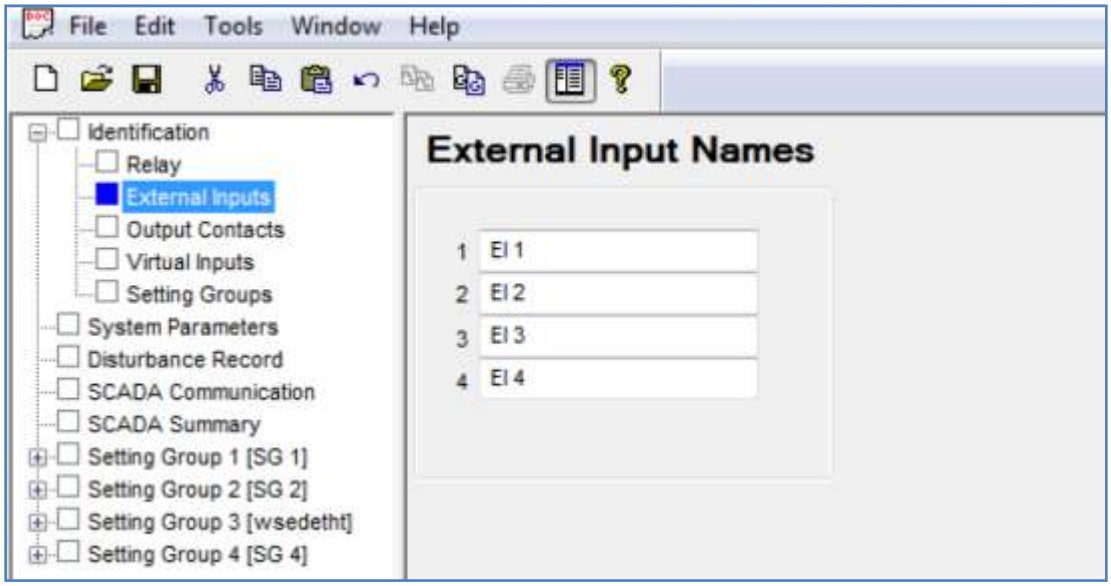


Figure 6.5: External Inputs

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

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

Output Contacts

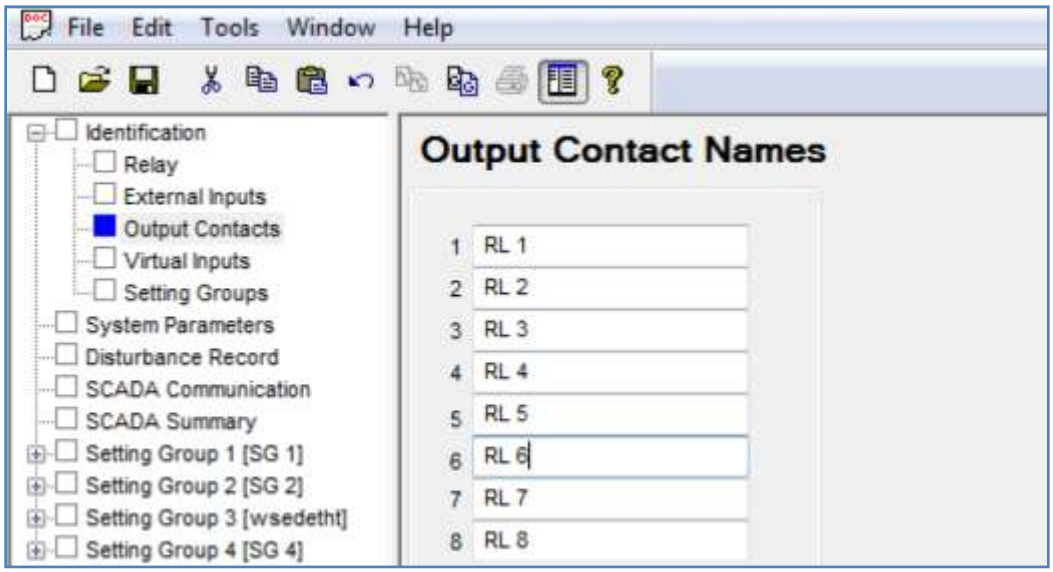


Figure 6.6: Output Contacts

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

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

Virtual Inputs

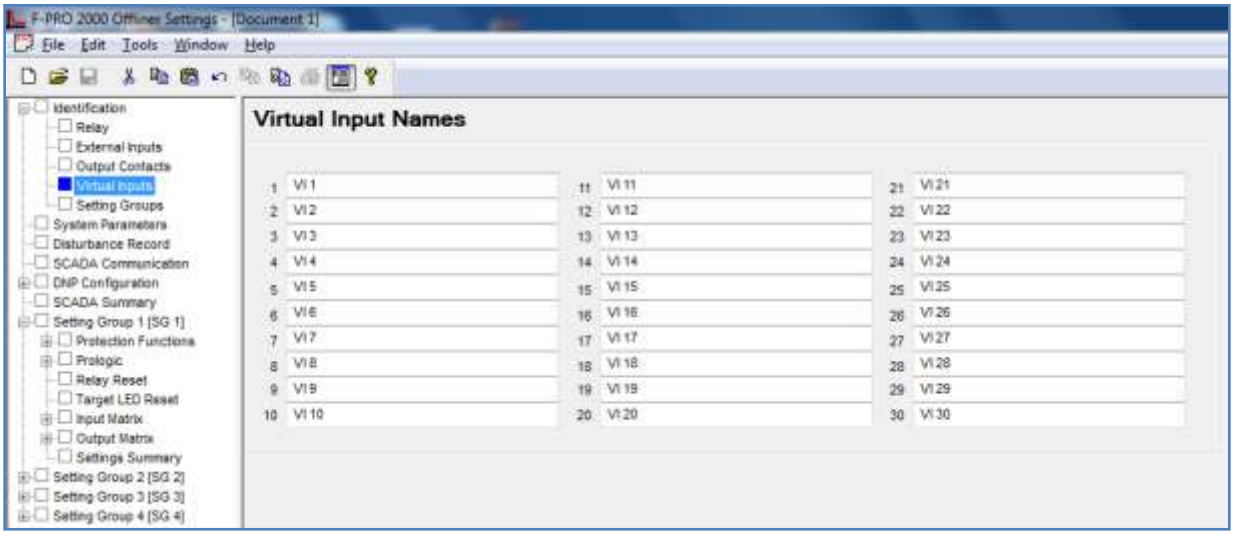


Figure 6.7: Virtual Inputs

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 103 and the terminal UI. The 30 virtual inputs are individually controlled and include a set, reset and pulse function. The latch state is retained during setting changes and relay power down conditions. The 30 virtual inputs conform to IEC 103 standards. Use the IEC 103 functions such as SBO (Select before Operate), Direct Operate, or Direct Operate with no acknowledge to control virtual inputs.

Virtual inputs are used for:

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

Setting Groups

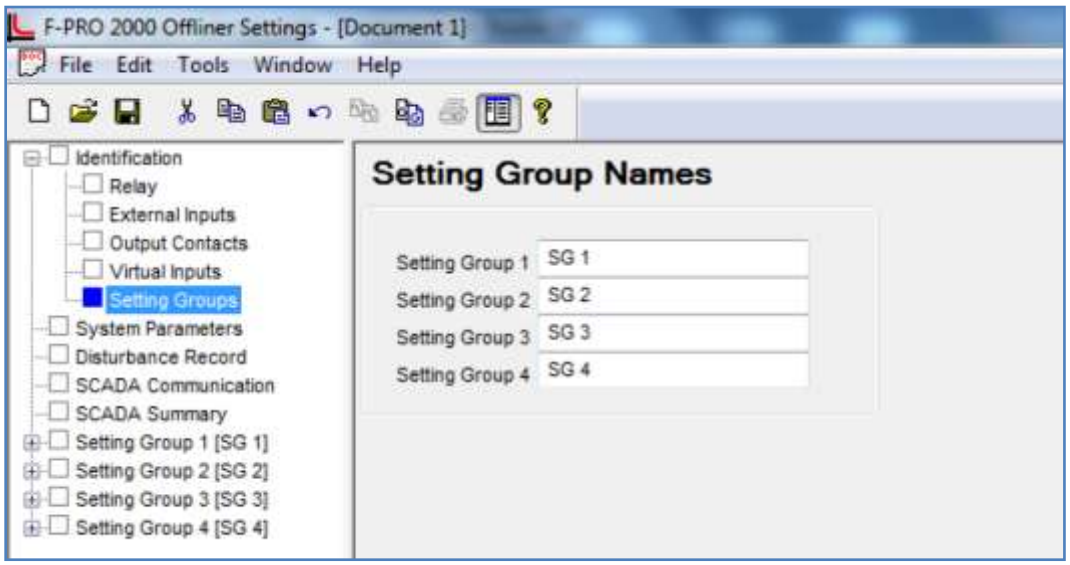


Figure 6.8: Setting Groups

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 group. Logic Statements per setting group to perform Setting Group changes.

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

System Parameters

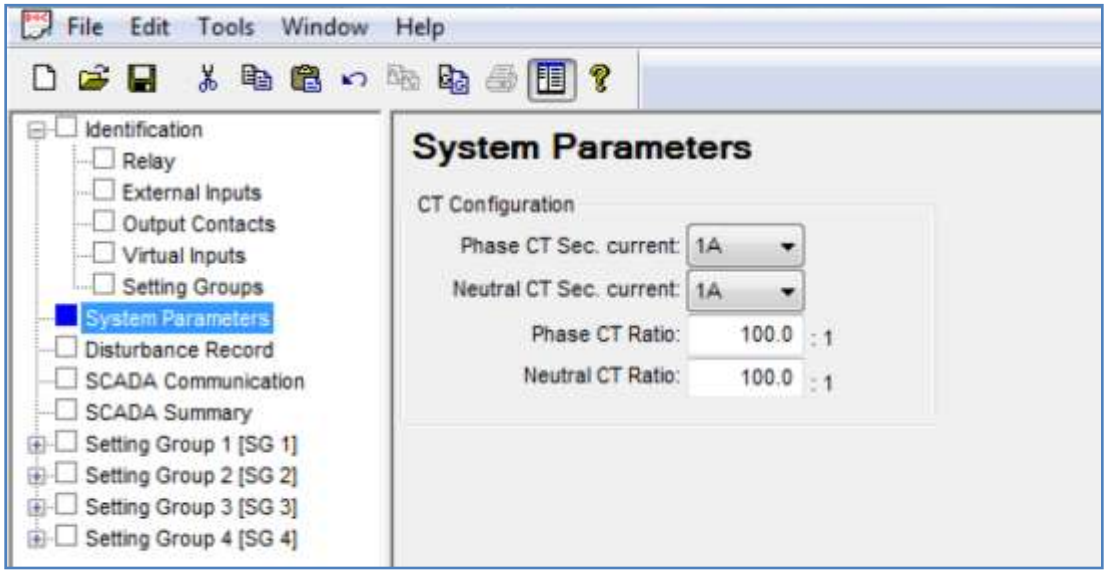


Figure 6.9: System Parameters

The System Parameters screen allows user to define CT Secondary Ratio for the respective bays

Table 6.8: System Parameters	
CT Configuration	
Phase CT Sec. Current	1A/ 5A
Neutral CT Sec. Current	1A/ 5A
SEF/REF CT Sec. Current	1A/ 5A
Phase CT ratio	1.0 to 30000.0
Neutral CT ratio	1.0 to 30000.0
SEF/REF CT ratio	1.0 to 30000.0

Record Length

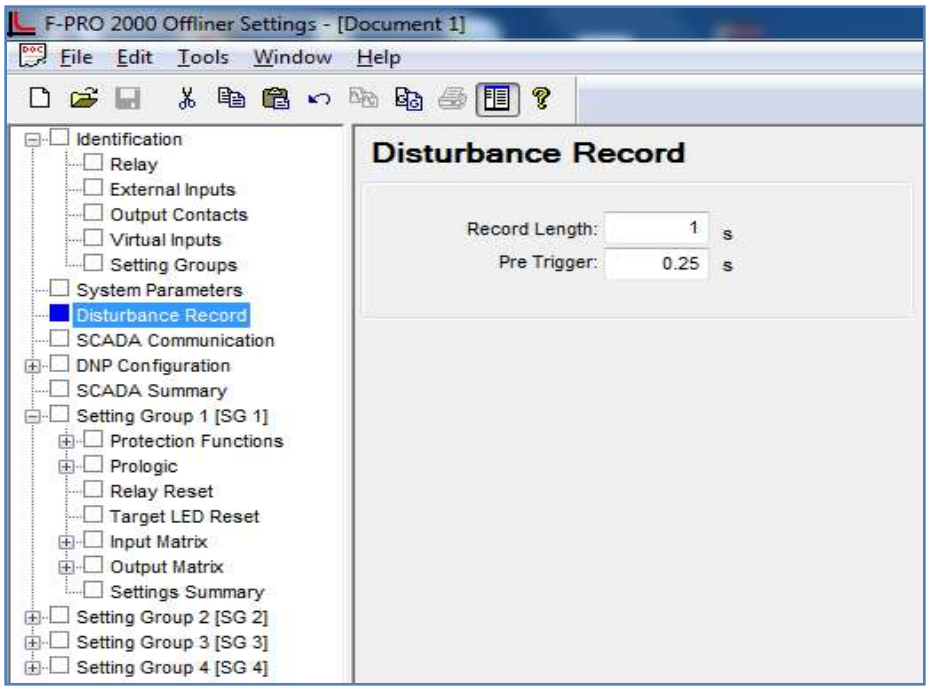


Figure 6.10: Record Length

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

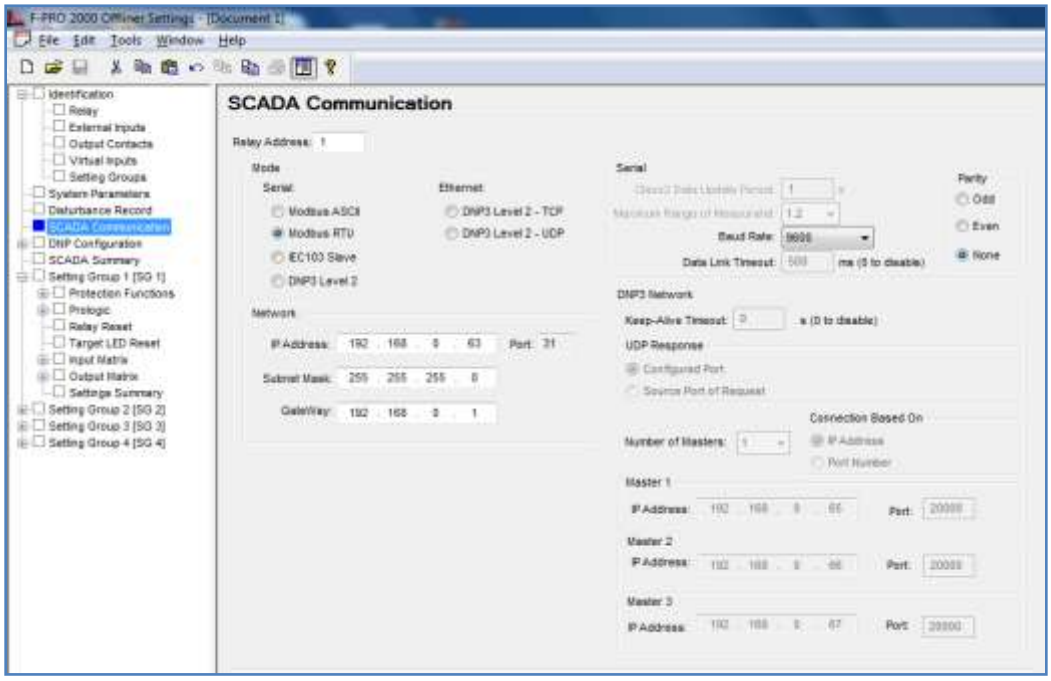


Figure 6.11 SCADA communication

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.

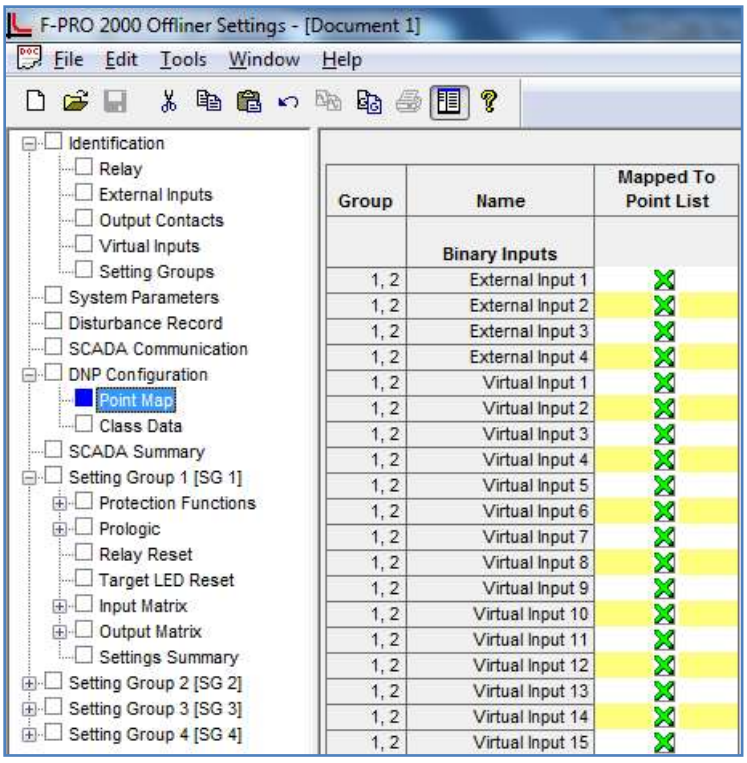


Figure 6.12: Point Map

DNP Configuration Class Data

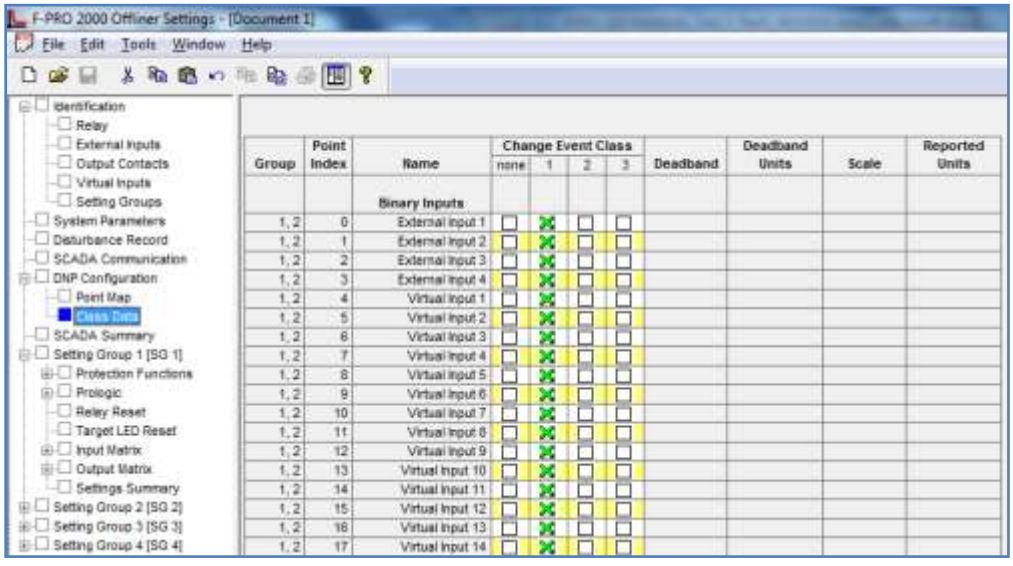
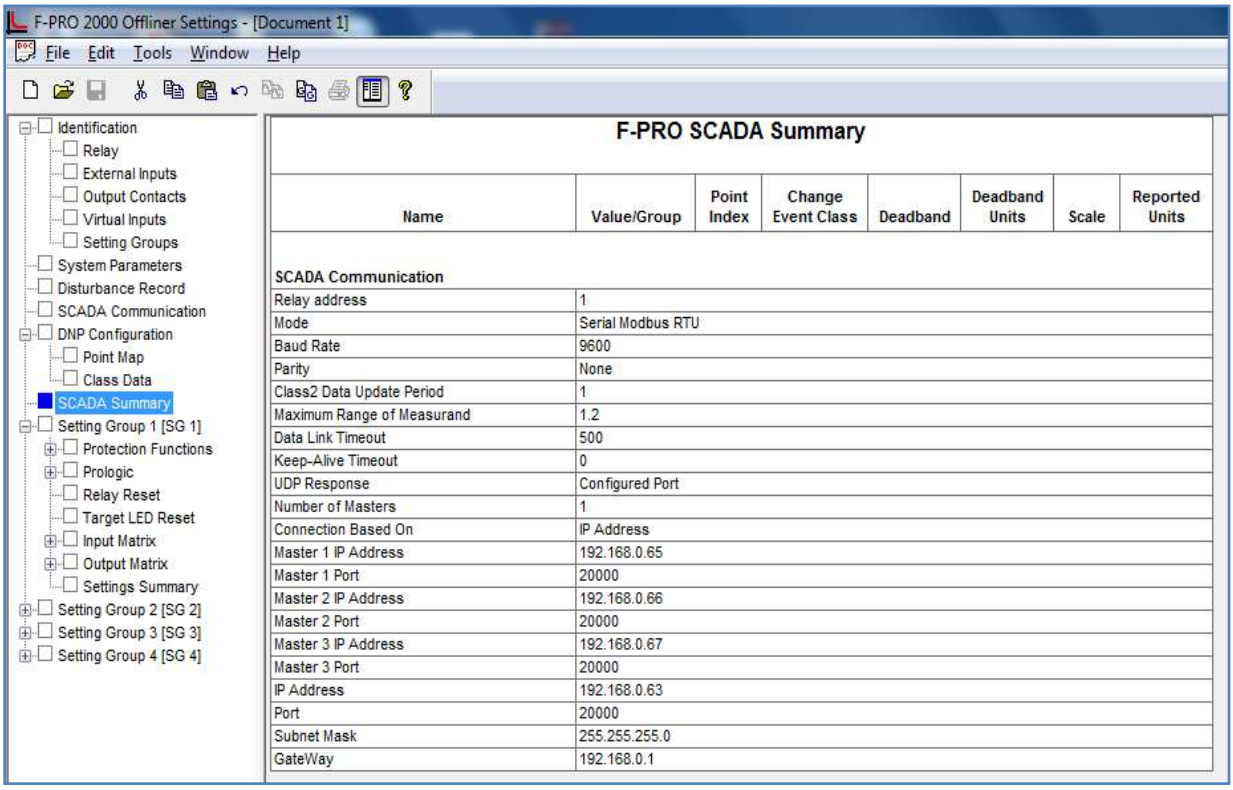


Figure 6.13: Class Data

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

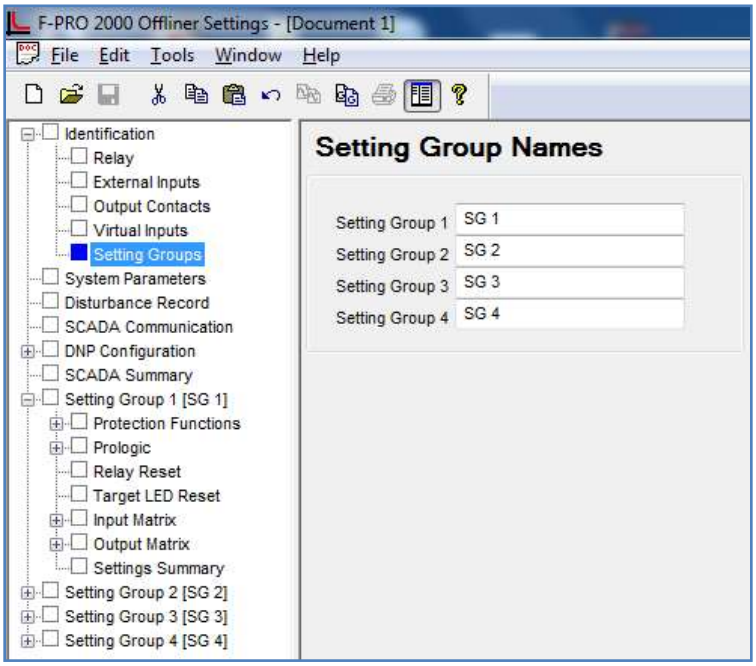


Figure 6.15: Setting Groups Comments

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. Logic Statements per setting group to perform Setting Group changes.

Protection Functions

For detailed descriptions of the protection functions see "Protection Functions and Specifications" on page 4-1.

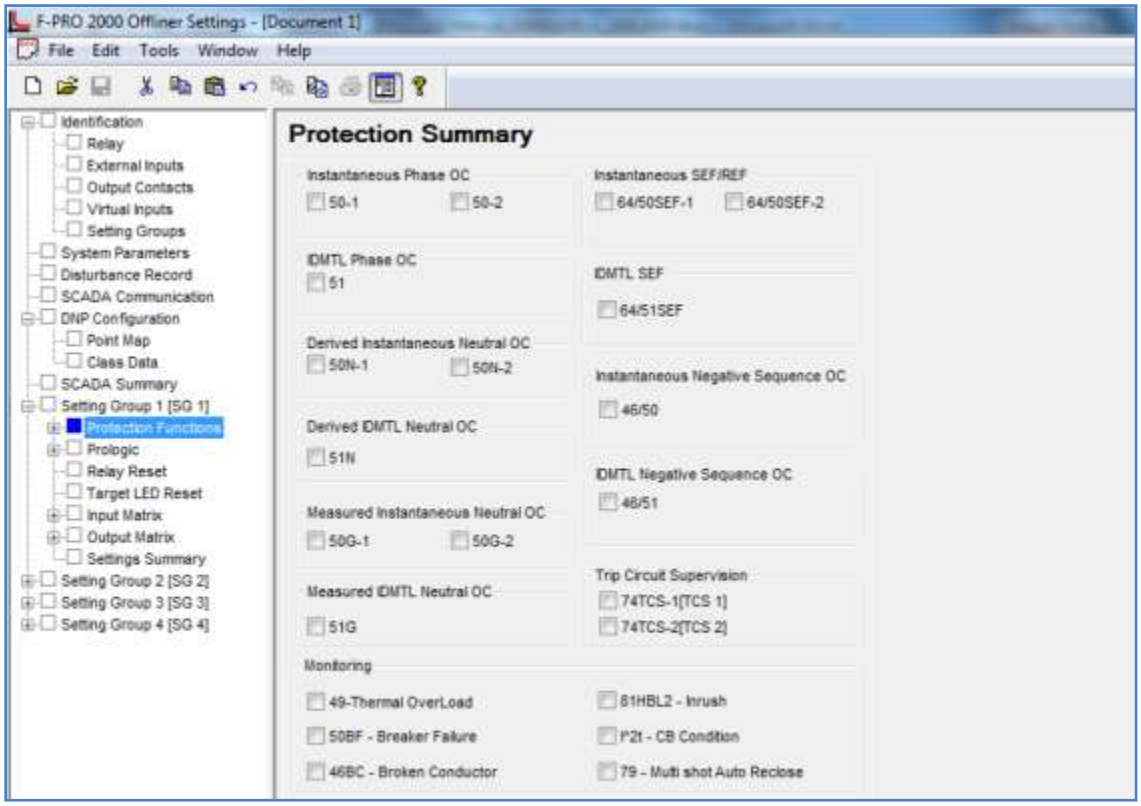


Figure 6.16: Protection Functions

ProLogic

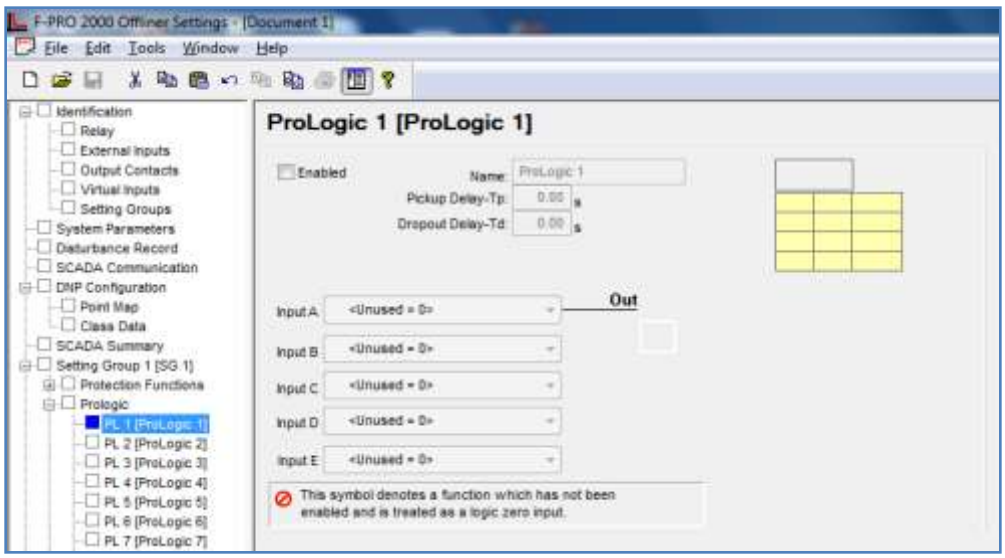


Figure 6.17: ProLogic

ProLogic is used to create an output based on qualified multiple inputs. Twenty User Programmable ProLogic control statements can be utilized 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, XOR/NXOR 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

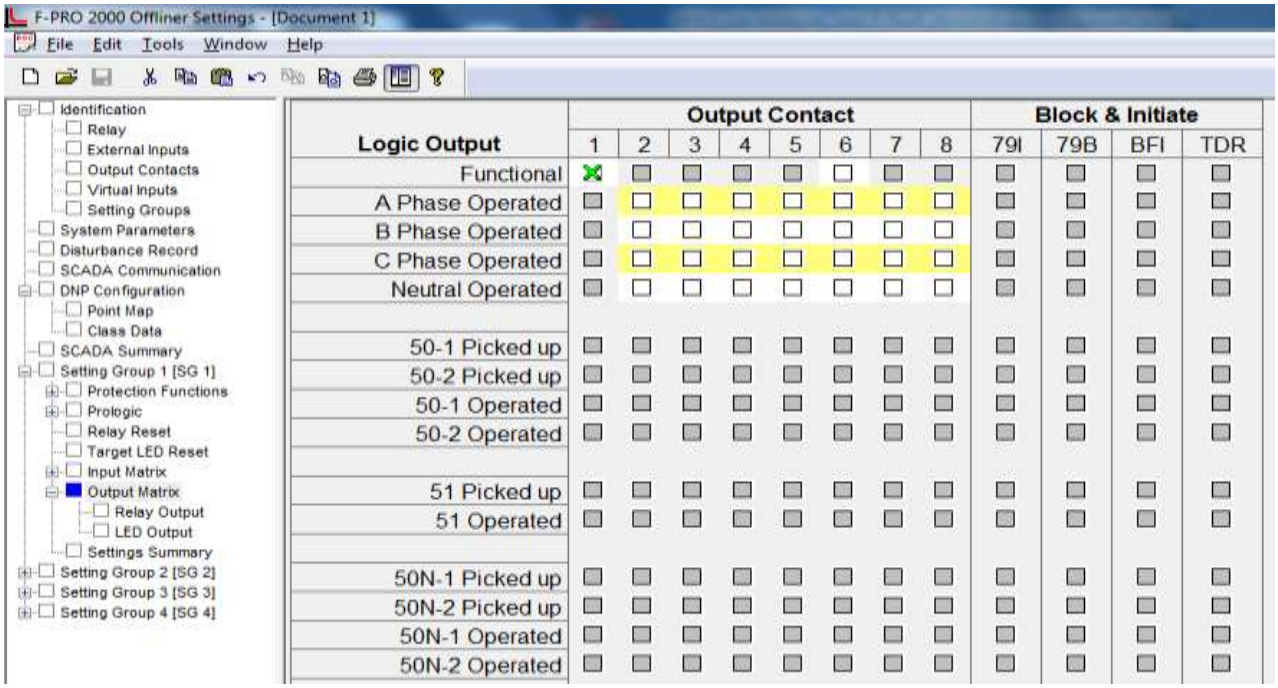


Figure 6.18: Output Matrix

The output contact matrix determines which function initiates which output contact of the relay. All output relays have a fixed settable delay (0 to 1 seconds).

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

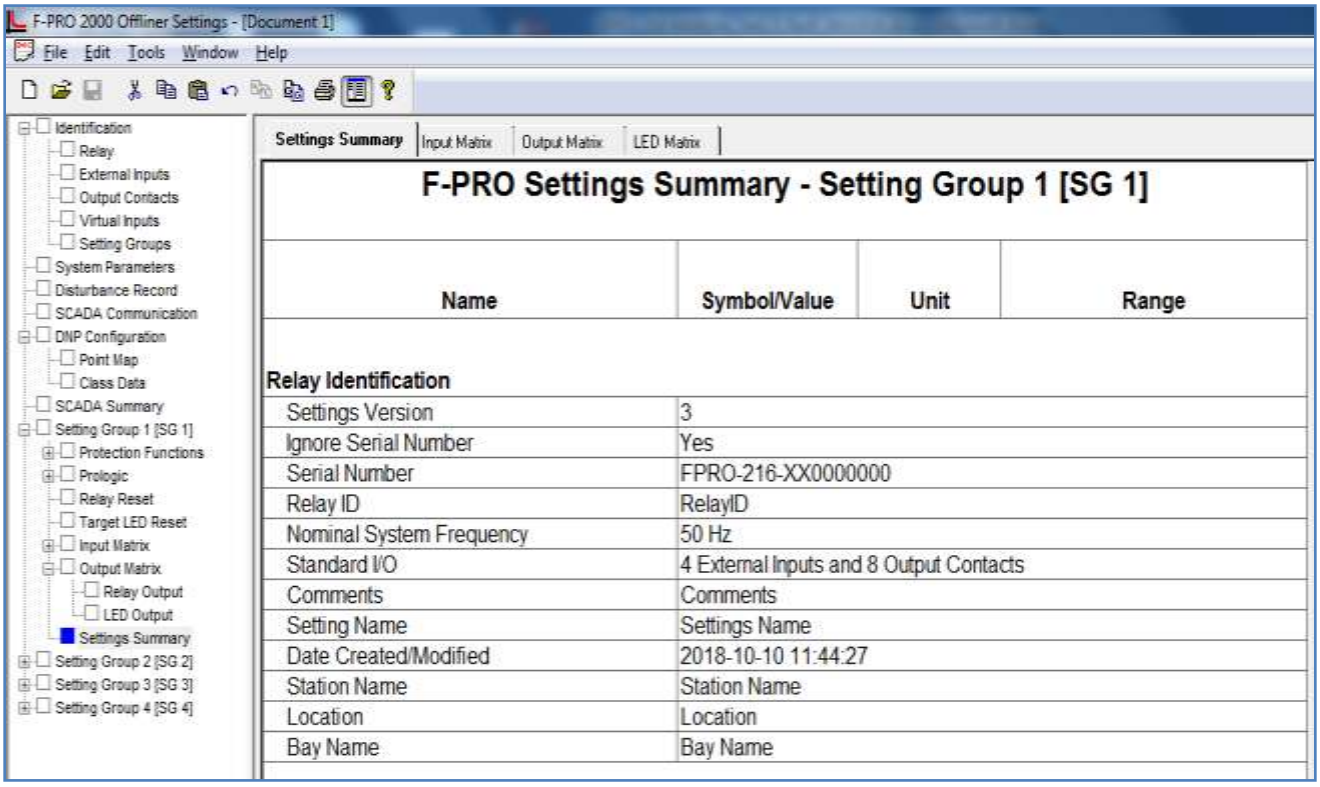


Figure6.19: Settings Summary

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 RecordBase View analysis software. While viewing a recording in RecordBase View, select the *View Setting* button to display the settings. RecordBase View will automatically launch F-PRO Offliner to display the settings in summary form if installed in the same PC.

If the record contains 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

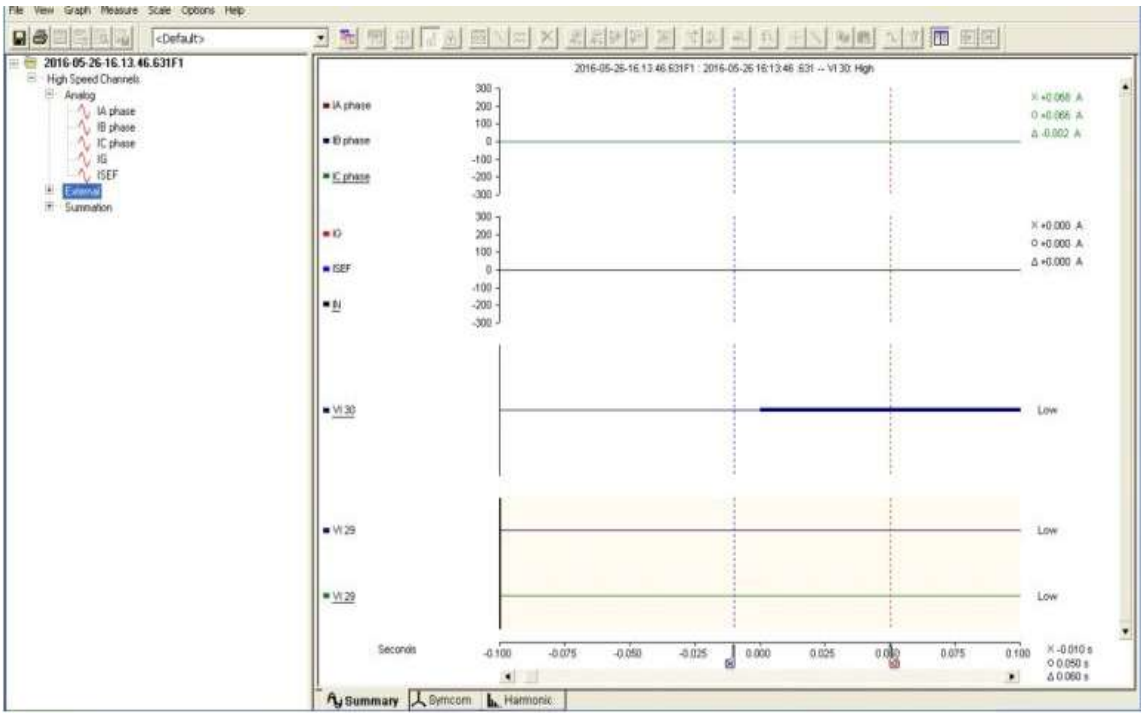


Figure 6.20: Record Graph

Use RecordGraph to analyze the records from a relay.

1 . Set the receive directory on your 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:\Documents and Settings\user\My Documents\ERL\Relay Control Panel\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 RecordGraph 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 ERLPhase IEC 61850 based devices for substation automation. This tool helps the user to map data from remote GOOSE into ERLPhase IED data, to perform GOOSE mapping from ERLPhase IEDs to other devices and to map the required RCB (Report Control Block) datasets for SCADA.

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.

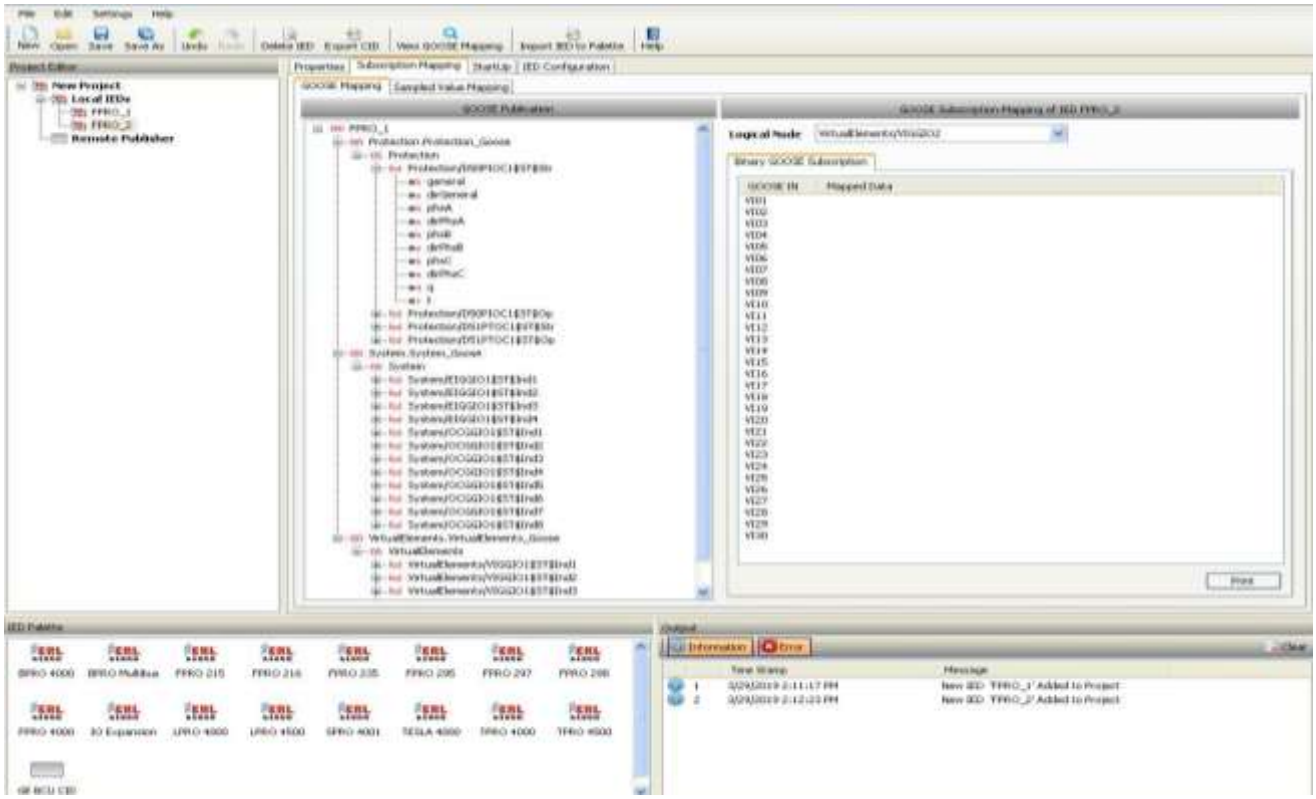


Figure 6.21: ERL 61850 IED Configurator

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 ac voltage sources (variable frequency capability)
- 3 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 60 Hz or 50 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. 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.

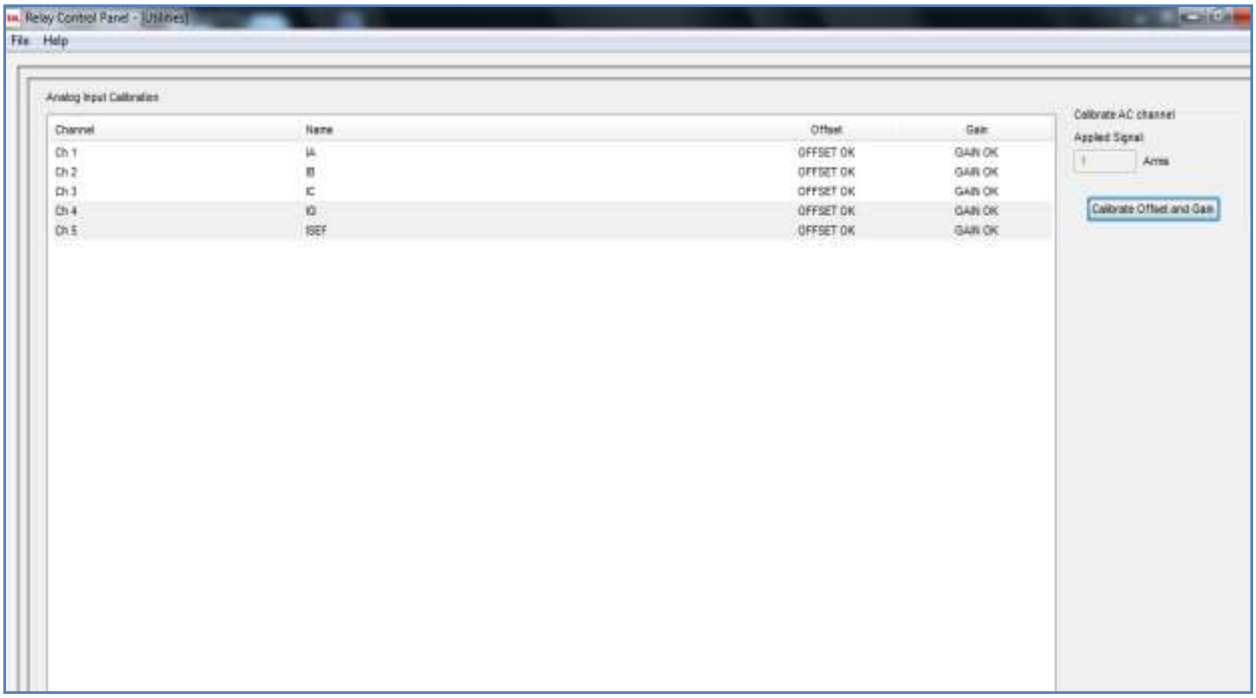


Figure 7.1: Enter actual applied signal level

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.

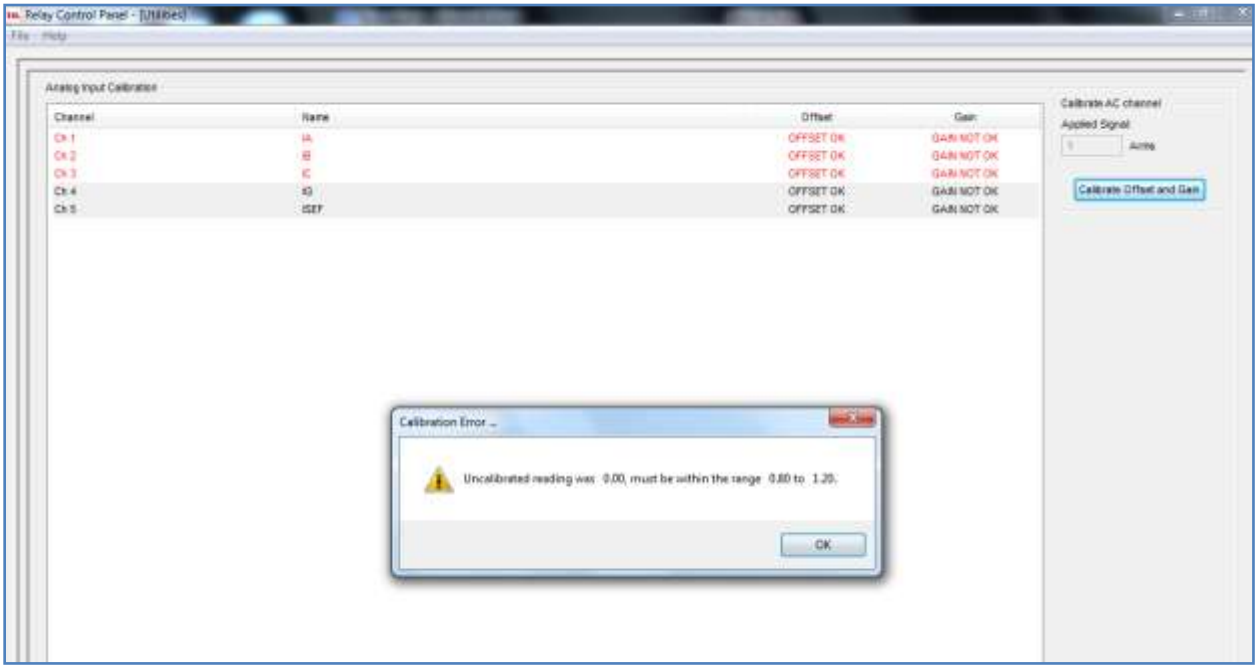


Figure 7.2: Calibration error – out of range

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

When an analog input channel is calibrated, 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.

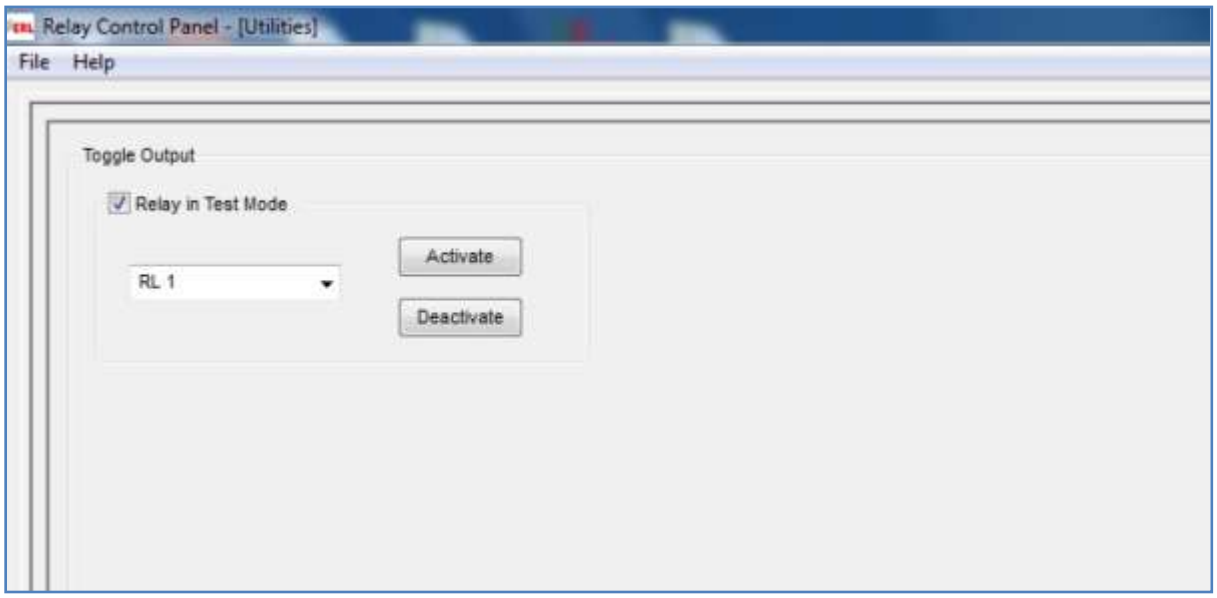


Figure 7.3: Test output Contacts

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 G

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 "connection 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 216 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 80-300Vdc / 80 – 240Vac , 50/60Hz	Power Consumption: 5 – 6 VA (ac) 4.5 – 5 W (dc)
Protection Functions:		
50-1, 50-2, 51, 50N-1, 50N-2, 51N, 50G-1, 50G-2, 51G, 64/50 SEF-1,64/50 SEF-2, 51SEF, 46/50, 46/51, 49, 50BF, 46BC, 74TCS-1, 74TCS-2, 81HBL2, I^2t, 79	1 x 3-phase current inputs 1 x 1- measured neutral input 1 x 1- SEF	
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 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 216 Specifications		
Input & Output:		
Analog Current Inputs 1 set of 3-phase current inputs (3 current channels) ,1 current input to measure neutral current	Nominal Current Full Scale/Continuous Maximum full-scale Thermal rating Burden	In = 1 Amp or 5 Amps 4x In = 4 Amps or 20 Amps 40x In for3 second symmetrical 100 Amps for 1 second <0.1 VA @ 1 Amp <0.5 VA @ 5 Amps
1 current input to measure SEF/REF	Nominal Current Full Scale/Continuous Maximum full-scale Thermal rating Burden	In = 1 Amp or 5 Amps 2x In = 2 Amps or 10 Amps 20x In for3 second symmetrical 50 Amps for 1 second <0.1 VA @ 1 Amp <0.5 VA @ 5 Amps
Analog Sampling Rate	32 samples/cycle for recording 8 samples/cycle for protection	Records up to 8th 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 48Vdc nominal = 38 Vdc 110Vdc nominal = 88 Vdc 220Vdc nominal = 175 Vdc	
Output Relays (contacts)	8 programmable outputs (6NO +2CO)	Externally wetted Make: 30 A as per IEEE C37.90 Carry: 8 A Break: 0.9 A at 125 Vdc resistive 0.35 A at 250 Vdc resistive
Virtual Inputs	30 Virtual Inputs	
Interface & Communication:		
Front Display	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 COM 2: RS-485 (2400bps to 57600bps)	100Mbps Copper/FO Ethernet port 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, SNTP	Modulated or un-modulated
Self Checking/Relay Inoperative	2CO contact configurable	Closed NC when relay inoperative

F-PRO 216 Specifications		
Physical:		
Weight	4.50 Kgs	
Overall Dimensions	E6 case:177mm High x 155 mm Wide x 242.5mm Depth	
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 unmodulated) 1PPM 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 (In)	
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 Cl.No.7.2.3	Electrostatic Discharge	Enclosure Air Enclosure contact	+/- 8 kV +/- 6 kV
IEC 60255-26:2013 Cl.No.7.2.4	Radiated interference (Electromagnetic Field Immunity)	Enclosure ports	10 v/m : 80-1000 MHz : 1.4 GHz - 2.7 GHz
IEC 60255-26:2013 Cl.No.7.2.5	Electrical Fast Transient	Ac/Dc power ports AC voltage & current ports External I/P & O/P ports	+/- 4 kV
IEC 60255-26:2013 Cl.No.7.2.6	Slow Damped Oscillatory / High Frequency Disturbance / 1 MHz Burst Disturbance	Ac/Dc power ports AC voltage & current ports External I/P & O/P ports	+/- 2.5kV (CM) +/-1kV (DM)
IEC 60255-27:2013 Cl.No.10.6.4.2	Impulse Voltage	Ac/Dc power ports AC voltage & current ports External I/P & O/P ports	+/- 5 kV
IEC 60255-27:2013 Cl.No.10.6.4.3	AC Dielectric Voltage	Ac/Dc power ports AC voltage & current ports External I/P & O/P ports	2kV / min
IEC 60255-27:2013 Cl.No.10.6.4.4	Insulation Resistance Test	Ac/Dc power ports AC voltage & current ports External I/P & O/P ports	500V / min
IEC 60255-21-1 Class 1	Vibration		10Hz to 150Hz, 1.0g 1.0 Octave/min, 20 Sweep cycle/axis
60255-21-2 Class 1	Shock and Bump		5g and 15g
IEC 60255-21-3 Siesmic	Siesmic		5Hz to 35Hz, 1.0g 1.0 Octave/min, 1 Sweep cycle/axis

A.1 IDMTL Element Operating Time Curves

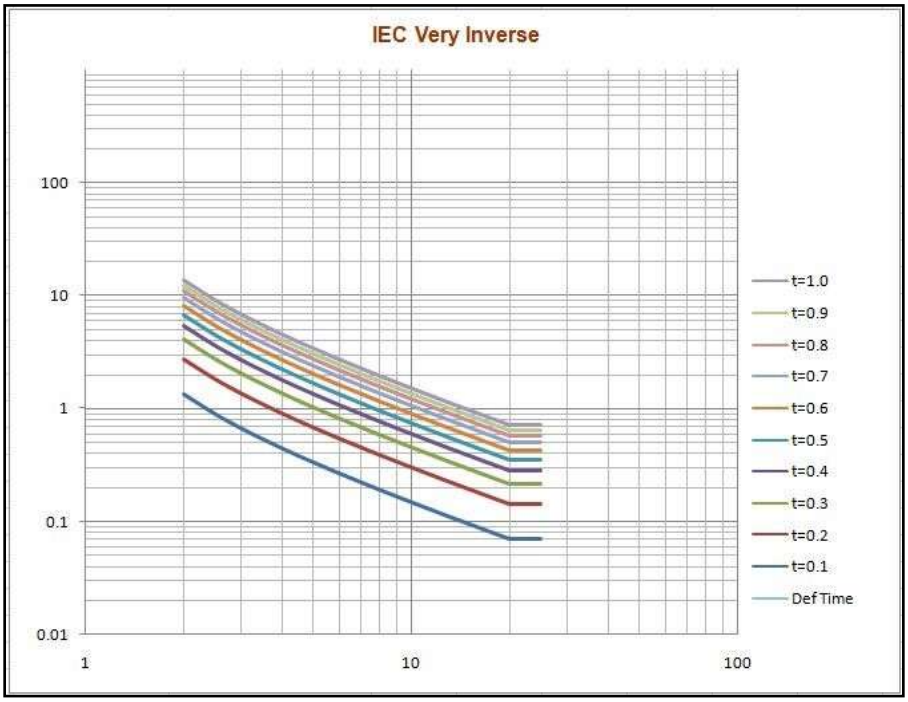


Figure A.1: IDMTL IEC very inverse curve.

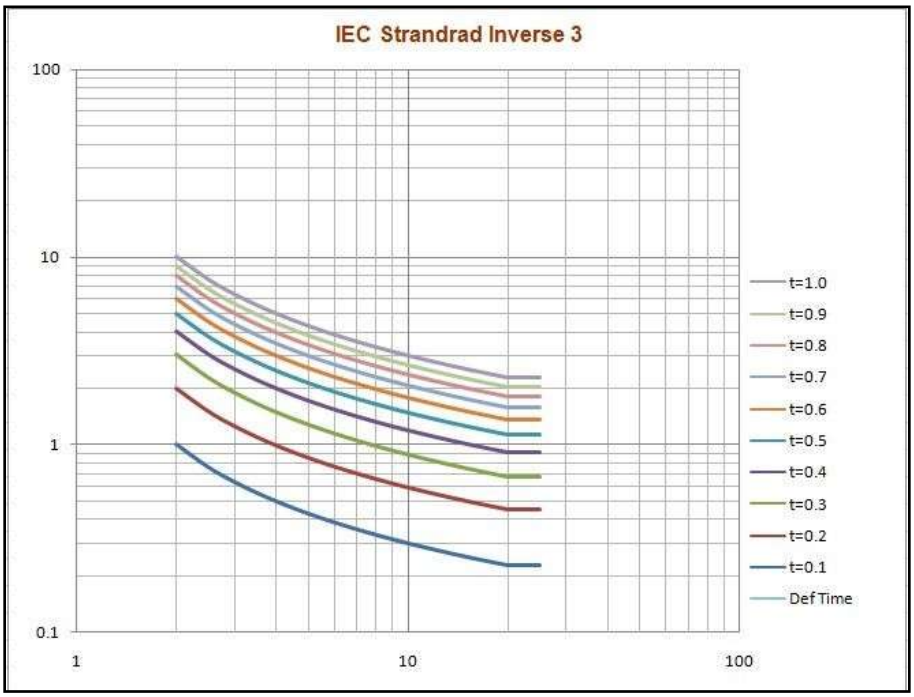


Figure A.2: IDMTL IEC Standard inverse curve 3.

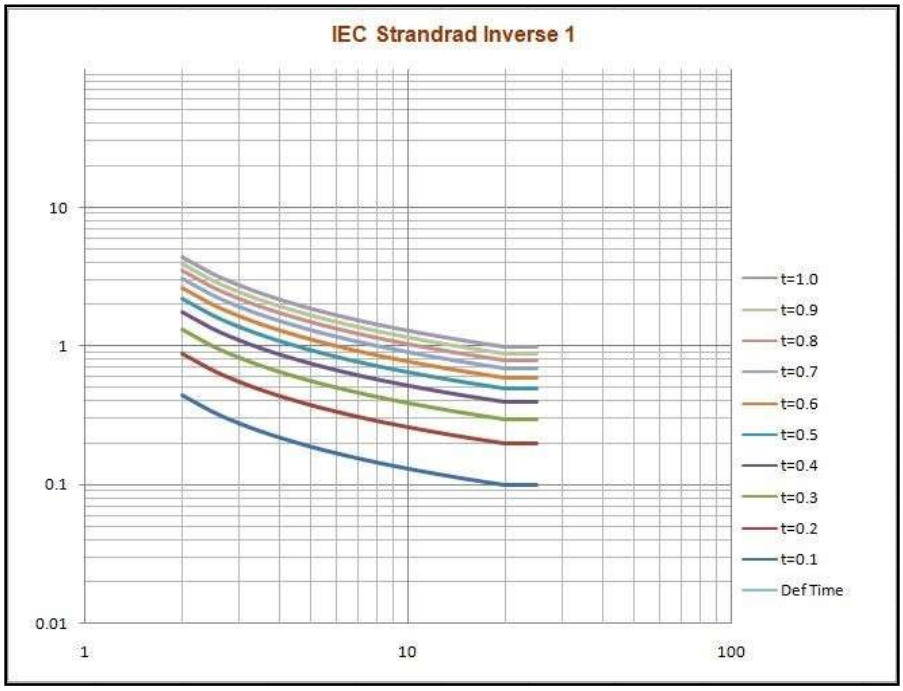


Figure A.3: IDMTL IEC Standard inverse curve 1.

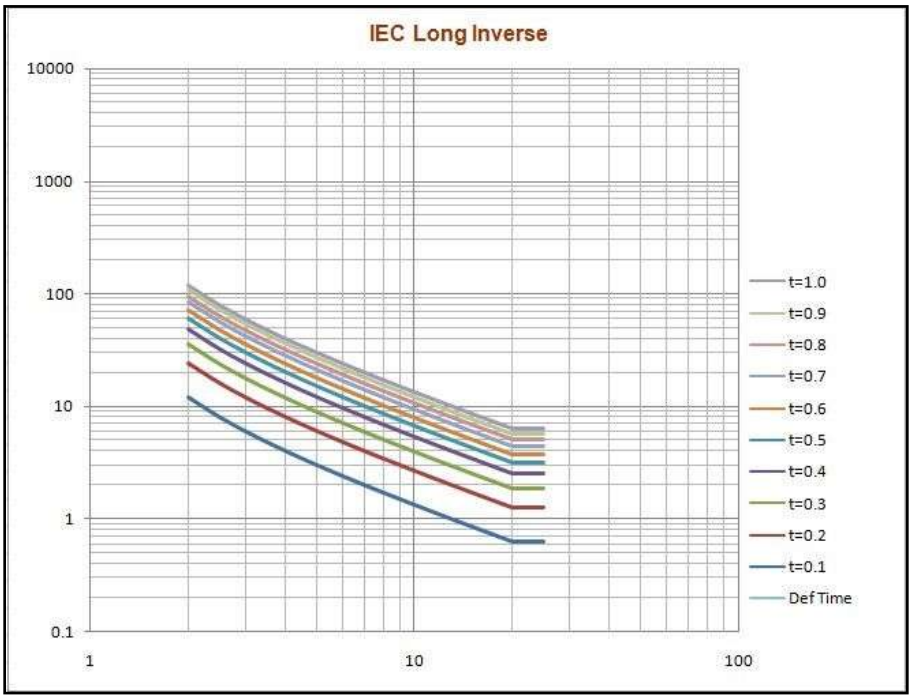


Figure A.4: IDMTL IEC Long inverse curve

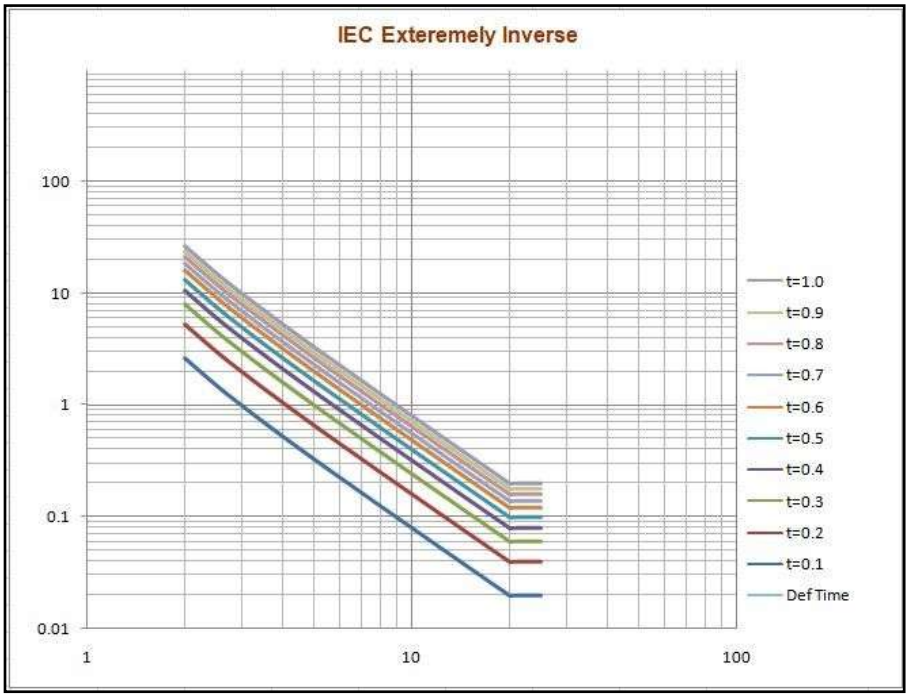


Figure A.5: IDMTL IEC Extremely inverse curve.

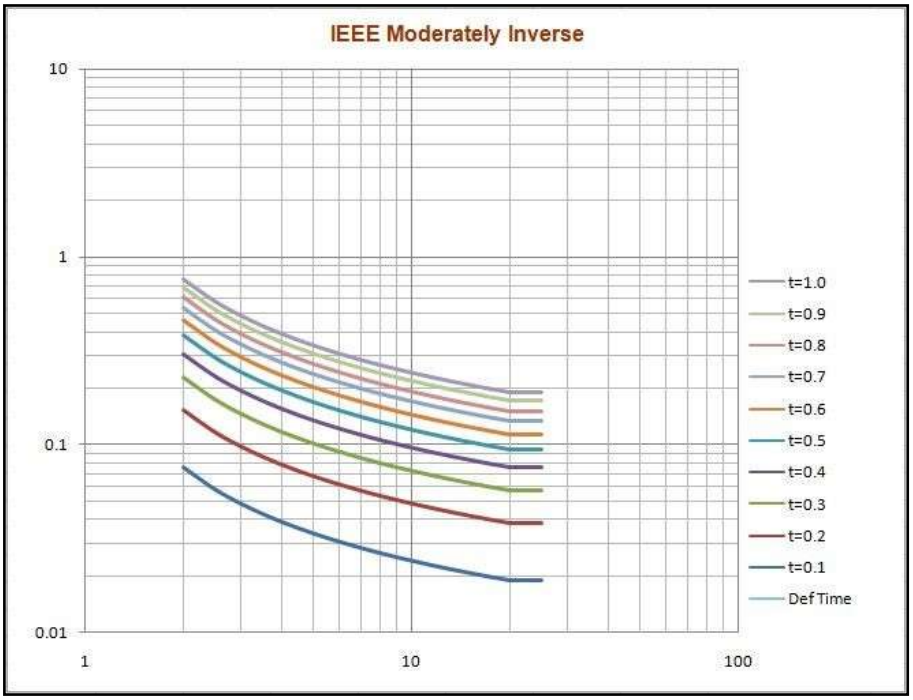


Figure A.6: IDMTL IEEE Moderately inverse curve.

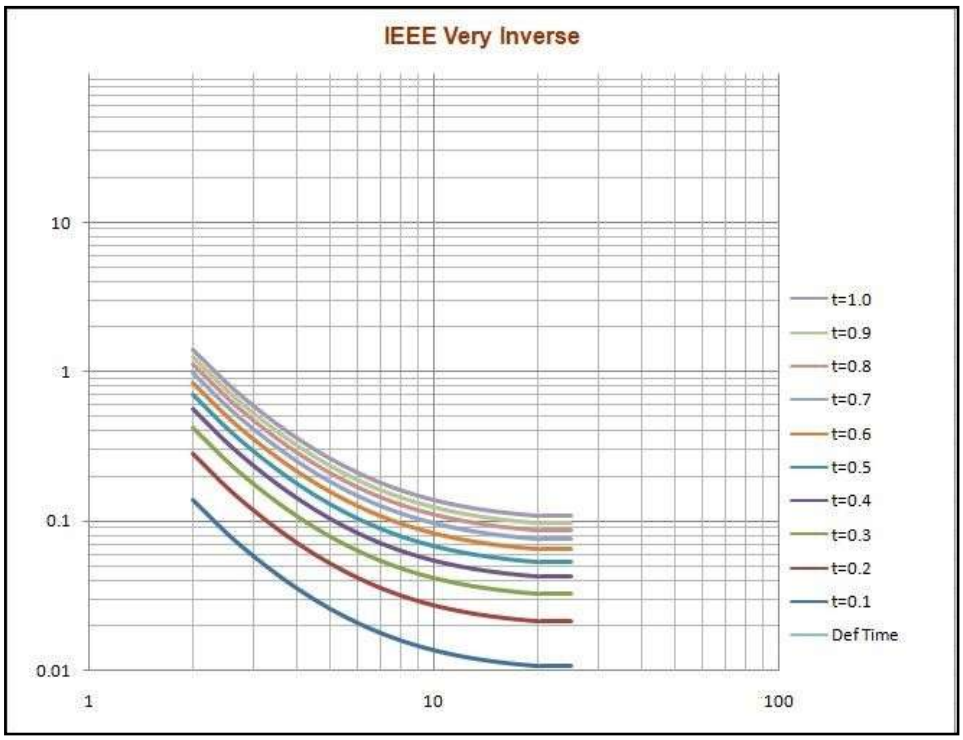


Figure A.7: IDMTL IEEE very inverse curve.

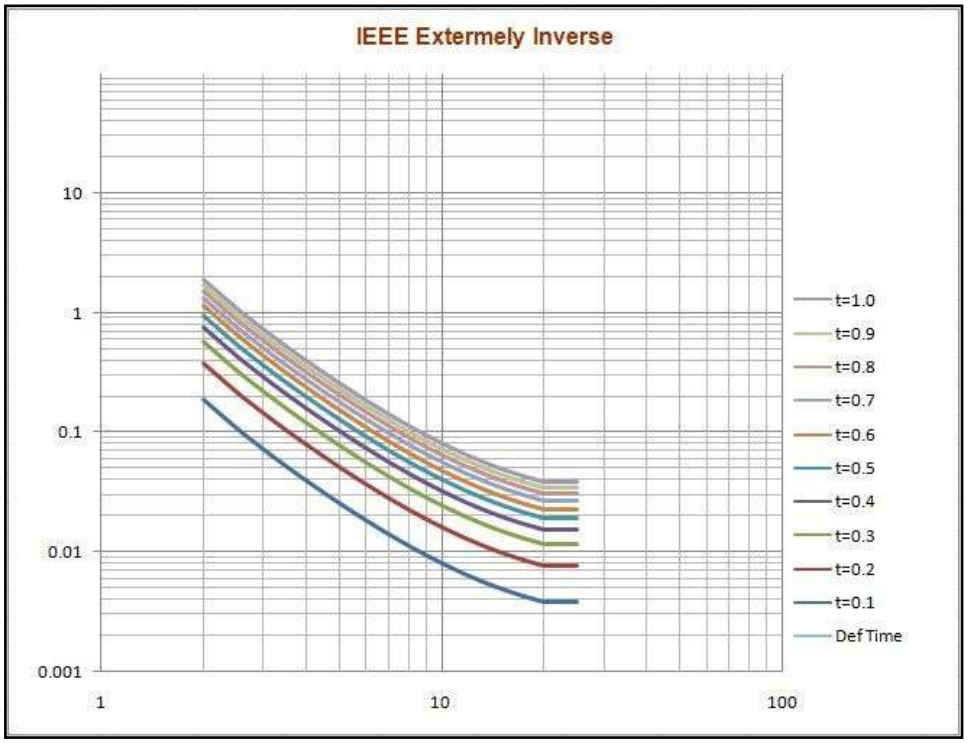


Figure A.8: IDMTL IEEE Extremely inverse curve.

Appendix B IED Settings and Ranges

This topic describes the settings and its ranges of F-PRO 216 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	3		
Ignore Serial Number	Yes		
Serial Number	F-PRO-216-XX000000000		
Relay ID	RelayID		
Nominal System Frequency	50 Hz	Hz	50/60 Hz
Standard I/O	4 External Inputs and 8 Output Contacts		
Comments	Comments		
Setting Name	Settings Name		
Date Created/Modified	2019-04-09 16:17:07		
Station Name	Station Name		
Location	Location		
Bay Name	Bay Name		
External Input Names			
EI 1	EI 1		
EI 2	EI 2		
EI 3	EI 3		
EI 4	EI 4		
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		

F-PRO Settings Summary Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
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		
VI 9	VI 9		
VI 10	VI 10		
VI 11	VI 11		
VI 12	VI 12		
VI 13	VI 13		
VI 14	VI 14		
VI 15	VI 15		
VI 16	VI 16		
VI 17	VI 17		
VI 18	VI 18		
VI 19	VI 19		
VI 20	VI 20		
VI 21	VI 21		
VI 22	VI 22		
VI 23	VI 23		
VI 24	VI 24		
VI 25	VI 25		
VI 26	VI 26		
VI 27	VI 27		
VI 28	VI 28		
VI 29	VI 29		
VI 30	VI 30		
Setting Group Names			
Setting Group 1	SG 1		
Setting Group 2	SG 2		
Setting Group 3	SG 3		
Setting Group 4	SG 4		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
System Parameters			
Phase CT Sec. current	1	A	1/5
Neutral CT Sec	1	A	1/5
SEF/REF CT Sec	1	A	1/5
Phase CT Ratio	100.0		1 to 30000
Neutral CT Ratio	100.0		1 to 30000
SEF/REF CT Ratio	100.0		1 to 30000
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			
50-1	Enabled		0.05 to 25
50-2	Disabled		0.05 to 25
51	Enabled		0.05 to 10
50N-1	Disabled		0.05 to 25
50N-2	Enabled		0.05 to 25
51N	Disabled		0.05 to 10
50G-1	Enabled		0.05 to 25
50G-2	Disabled		0.05 to 25
51G	Disabled		0.05 to 10
64/50 SEF - 1	Disabled		0.005 to 2.500(1A) 0.025 to 12.500(5A)
64/50 SEF - 1	Disabled		0.005 to 2.500(1A) 0.025 to 12.500(5A)
51 SEF	Disabled		0.005 to 1.000(1A) 0.025 to 5.000(5A)
46/50	Disabled		0.05 to 0.95
46/51	Disabled		0.05 to 0.95
49	Disabled		0.2 to 2
50BF	Disabled		0.05 to 2
46BC	Disabled		20 to 100%
74TCS-1	Disabled		
74TCS-2	Disabled		
81HBL2	Disabled		5 to 50%
I^2t-CB	Disabled		0.1 to 99999.9
79	Disabled		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
50 Phase Instantaneous Overcurrent			
50-1	Enabled		
Pickup I>>	1.1	A	0.05 to 25.00
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
50-2	Disabled		
Pickup I>>	10	A	0.05 to 25.00
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
51- IDMTL Phase Overcurrent			
51	Enabled		
Pickup I>	1.2	A	0.05 to 10.00
Curve Type	IEC standard inverse-3		
TMS	1	-	0.01 to 10.00
Pickup DTL Delay	10	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0	s	0.0 to 99.9
A	0.14	-	-
B	0	-	-
p	0.02	-	-
Reset Delay(TR)	13.5	-	0.10 to 150.00
Inrush Block	Enabled		
50N - Derived Instantaneous Neutral Overcurrent			
50N-1	Enabled		
Pickup IN>>	1	A	0.05 to 25.00
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
50N-2	Enabled		
Pickup IN>>	0.1	A	0.05 to 25.00
Pickup Delay	20	S	0.00 to 999.99
Inrush Block	Enbaled		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
51N Derived IDMTL Neutral Overcurrent			
51N	Enabled		
Pickup I>	0.2	A	0.05 to 10.00
Curve Type	IEC standard inverse-3		
TMS	1	-	0.01 to 10.00
Pickup DTL Delay	10	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0	s	0.0 to 99.9
A	0.14	-	-
B	0	-	-
p	0.02	-	-
Reset Delay(TR)	13.5	-	0.10 to 150.00
Inrush Block	Enabled		
50G – Measured Instantaneous Neutral Overcurrent			
50G-1			
Pickup IG>>	1	A	0.05 to 25.00
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
50G-2			
Pickup IG>>	1	A	0.05 to 25.00
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
51G – Measured IDMTL Neutral Overcurrent			
51G			
Pickup I>	1.2	A	0.05 to 10.00
Curve Type	IEC standard inverse-3		
TMS	1	-	0.01 to 10.00
Pickup DTL Delay	10	s	0.00 to 999.99
Reset Delay	DTL		
Reset DTL Delay	0	s	0.0 to 99.9
A	0.14	-	-
B	0	-	-
p	0.02	-	-
Reset Delay(TR)	13.5	-	0.10 to 150.00
Inrush Block	Enabled		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
64/50SEF – Instantaneous SEF/REF			
64/50SEF – 1	Disabled		
Pickup Isef>	1	A	0.005 to 2.500(1A) 0.025 to 12.500(5A)
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
64/50SEF – 1	Disabled		
Pickup Isef>	1	A	0.005 to 2.500(1A) 0.025 to 12.500(5A)
Pickup Delay	0	s	0.00 to 999.99
Inrush Block	Enabled		
51SEF – IDMTL SEF Protection			
51SEF	Disable		
Pickup Isef>>	2.5	A	0.005 to 1.000(1A) 0.025 to 5.000(5A)
Curve Type	IEC standard inverse - 3		
TMS	1	-	0.01 to 10.00
Pickup DTL Delay	10	s	0.00 to 999.99
Reset Delay	ANSI Decay		
Reset DTL Delay	0	s	0.0 to 99.9
A	0.14	-	
B	0	-	
p	0.02	-	
Reset Delay(TR)	13.5	-	0.10 to 150.00
Inrush Block	Enabled		
46/50 - Instantaneous Negative Sequence Overcurrent			
46/50	Disabled		
Pickup I2>>	0.25	A	0.05 to 0.95
Pickup Delay	0	s	0.00 to 999.99
46/51 - IDMTL Negative Sequence Overcurrent			
46/51	Disabled		
Pickup I2>	0.25	A	0.05 to 0.95
Curve Type	IEC standard inverse		
TMS	1	-	0.01 to 10.00
Pickup DTL Delay	10	s	0.00 to 999.99

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Reset Delay	ANSI Decay		
Reset DTL Delay	0	s	0.0 to 99.9
A	0.14	-	-
B	0	-	-
p	0.02	-	-
Reset Delay(TR)	13.5	-	0.10 to 150.00
49-Thermal overload			
49	Enabled		
Thermal Overload	1.05	A	0.20 to 2.00
Time Constant	10	min	0.50 to 100.00
Neg. Seq. Weighing Factor	0	-	0.00 to 10.00
Thermal OL Alarm	Enabled		
Alarm % Th	80	%	50 to 100
50BF - Breaker Failure Protection			
50BF	Disabled		
Pickup I>>	0.2	A	0.05 to 2.00
Pickup Delay 1	0.2	s	0.00 to 999.99
Pickup Delay 2	0.4	s	0.00 to 999.99
46BC - Broken Conductor			
46BC	Disabled		
Pickup I2/I1>	30	%	20.00 to 100.00
Pickup Delay	10	s	0.02 to 999.99
74TCS - Trip Circuit Supervision			
74TCS-1[TCS 1]	Disabled		
Dropoff Delay	0.4	s	0.00 to 9.99
74TCS-2[TCS 2]	Disabled		
Dropoff Delay	0.4	s	0.00 to 9.99
I^2t-CB Condition			
I^2t-CB	Disabled		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
81HBL2 - Inrush			
81HBL2	Disabled		
Cross Blocking	Enabled		
Pickup I2nd>	15	%	5 to 50
79 - Recloser			
79	Disabled		
Number Of Shots	1	-	1 to 4
First Reclose - T1	1	s	0.10 to 999.99
Second Reclose - T2	5	s	1.00 to 999.99
Third Reclose - T3	10	s	1.00 to 999.99
Fourth Reclose - T4	20	s	1.00 to 999.99
Close Time - Tp	0.2	s	0.01 to 1.00
Reclaim Time - Td	25	s	0.00 to 999.99
Initiate Reset - TDI	1	s	0.00 to 999.99
Block Reset - TDB	0.5	s	0.00 to 999.99
PL 1 [ProLogic 1]			
ProLogic 1	Enabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2	AND		
Input B	<Unused = 0>		
Operator 3	NOR		
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 2 [ProLogic 2]			
ProLogic 2	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		

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

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 4			
Input D	<Unused = 0>		
Operator 5			
PL 6 [ProLogic 6]			
ProLogic 6	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 7 [ProLogic 7]			
ProLogic 7	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 8 [ProLogic 8]			
ProLogic 8	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 3			
Input C	<Unused = 0>		
Operator 4			
PL 9 [ProLogic 9]			
ProLogic 9	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	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 10 [ProLogic 10]			
ProLogic 10	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 11 [ProLogic 11]			
ProLogic 11	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
PL 12 [ProLogic 12]			
ProLogic 12	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 13 [ProLogic 13]			
ProLogic 13	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 14 [ProLogic 14]			
ProLogic 14	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
PL 15 [ProLogic 15]			
ProLogic 15	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 16 [ProLogic 16]			
ProLogic 16	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 17 [ProLogic 17]			
ProLogic 17	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
PL 18 [ProLogic 18]			
ProLogic 18	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 19 [ProLogic 19]			
ProLogic 19	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00
Dropout Delay-Td	0	s	0.00 to 999.00
Operator 1			
Input A	<Unused = 0>		
Operator 2			
Input B	<Unused = 0>		
Operator 3			
Input C	<Unused = 0>		
Operator 4			
Input D	<Unused = 0>		
Operator 5			
Input E	<Unused = 0>		
PL 20 [ProLogic 20]			
ProLogic 20	Disabled		
Pickup Delay-Tp	0	s	0.00 to 999.00

F-PRO Settings Summary - Setting Group 1 [SG 1]			
Name	**Symbol/Value**	**Unit**	**Range**
Dropout Delay-Td	0	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			
ResetTime	0.1	s	-
Reset Type[RL 2]	Self Reset		
ResetTime	0.1	s	-
Reset Type[RL 3]	Self Reset		
ResetTime	0.1	s	-
Reset Type[RL 4]	Self Reset		
ResetTime	0.1	s	-
Reset Type[RL 5]	Self Reset		
ResetTime	0.1	s	-
Reset Type[RL 6]	Self Reset		
ResetTime	0.1	s	-
Reset Type[RL 7]	Self Reset		
ResetTime	0.1	s	-
Reset Type[RL 8]	Self Reset		
ResetTime	0.1	s	-
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 Requirements

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 recordings stored in non-volatile memory.
- Runs a Real Time Operating System (RTOS).
- Provides Ethernet ports, RS-485 port and USB interface.
- Time synchronism co-processor with modulated and un-modulated IRIG-B.
- High speed inbuilt link is provided between the DSP and ARM processor subsystems.
- Sophisticated fault detection.
- Provides the relay with one RS-485 port (COM2) and IRIG-B time synchronization input (Modulated & UnModulated, male BNC).

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 5 channel analog inputs (4 current transformer inputs and 1 sensitive earth fault current transformer input). 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 Unmodulated input selection through jumper) & 100Mbps Ethernet. This board is interfaced to the Carrier Board.

Appendix D Event Messages

F-PRO Event Messages	
Event Log Message	**Notes**
50-1 : Picked up	The possible phase information will be: • A • B • C • AB • BC • CA • ABC
50-1: Operated	
50-2 : Picked up	
50-2 : Operated	
51-1 : Picked up	
51-1 : Operated	
50N-1 :Picked up	
50N-1 : Operated	
50N-2 :Picked up	
50N-2 : Operated	
51N :Picked up	
51N : Operated	
50G-1 Picked Up	
50G-1: Operated	
50G-2: Picked Up	
50G-2: Operated	
51G Picked Up	
51G Operated	
64/50SEF-1-Picked up	
64/50SEF-1-Operated	
64/50SEF-2-Picked up	
64/50SEF-2-Operated	
51SEF-Picked up	
51SEF-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	
74TCS-1 Operated	
74TCS-2 Operated	
81HBL2 Operated	
79 IN	

F-PRO Event Messages	
79 Reclose	
79 AR Initiate	
79 Block	
79 Lockout	
I^2t Limit Operated	
ProLogic Name: PL*n*	ProLogic outputs names are user- assigned
Extern Input Name: EI*n*	External input names are user-assigned Where n = 1-4
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 Logic n	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 set- ting 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).

Channel	**Address**	**Value**	
Hold Readings	1	0: Readings not held	1: Readings held
Reserved	257	Reserved	Reserved
50-1 Picked up	513	0: OFF	1: ON
50-2 Picked up	514	0: OFF	1: ON
50-1 Operated	515	0: OFF	1: ON
50-2 Operated	516	0: OFF	1: ON
51 Picked up	517	0: OFF	1: ON
51 Operated	518	0: OFF	1: ON
50N-1 Picked up	519	0: OFF	1: ON
50N-2 Picked up	520	0: OFF	1: ON
50N-1 Operated	521	0: OFF	1: ON
50N-2 Operated	522	0: OFF	1: ON
51N Picked up	523	0: OFF	1: ON
51N Operated	524	0: OFF	1: ON
50G-1 Picked up	525	0: OFF	1: ON
50G-2 Picked up	526	0: OFF	1: ON
50G-1 Operated	527	0: OFF	1: ON
50G-2 Operated	528	0: OFF	1: ON
51G Picked up	529	0: OFF	1: ON
51G Operated	530	0: OFF	1: ON
64/50SEF-1 Picked up	531	0: OFF	1: ON
64/50SEF-2 Picked up	532	0: OFF	1: ON
64/50SEF-1 Operated	533	0: OFF	1: ON
64/50SEF-2 Operated	534	0: OFF	1: ON
51SEF Picked up	535	0: OFF	1: ON
51SEF Operated	536	0: OFF	1: ON
46/50 Picked up	537	0: OFF	1: ON
46/50 Operated	538	0: OFF	1: ON
46/51 Picked up	539	0: OFF	1: ON
46/51 Operated	540	0: OFF	1: ON
49 Picked up	541	0: OFF	1: ON
49 Operated	542	0: OFF	1: ON
49AL Operated	543	0: OFF	1: ON
50BF-D1 Operated	544	0: OFF	1: ON
50BF-D2 Operated	545	0: OFF	1: ON
46BC Operated	546	0: OFF	1: ON
74TCS-1 Operated	547	0: OFF	1: ON

Channel	Address	Value	
74TCS-2 Operated	548	0: OFF	1: ON
81HBL2 Operated	549	0: OFF	1: ON
79 IN	550	0: OFF	1: ON
79 OUT	551	0: OFF	1: ON
79 Reclose	552	0: OFF	1: ON
79 AR Initiate	553	0: OFF	1: ON
79 Block	554	0: OFF	1: ON
79 Lockout	555	0: OFF	1: ON
I2t Limit Operated	556	0: OFF	1: ON
ProLogic1	557	0: OFF	1: ON
ProLogic2	558	0: OFF	1: ON
ProLogic3	559	0: OFF	1: ON
ProLogic4	560	0: OFF	1: ON
ProLogic5	561	0: OFF	1: ON
ProLogic6	562	0: OFF	1: ON
ProLogic7	563	0: OFF	1: ON
ProLogic8	564	0: OFF	1: ON
ProLogic9	565	0: OFF	1: ON
ProLogic10	566	0: OFF	1: ON
ProLogic11	567	0: OFF	1: ON
ProLogic12	568	0: OFF	1: ON
ProLogic13	569	0: OFF	1: ON
ProLogic14	570	0: OFF	1: ON
ProLogic15	571	0: OFF	1: ON
ProLogic16	572	0: OFF	1: ON
ProLogic17	573	0: OFF	1: ON
ProLogic18	574	0: OFF	1: ON
ProLogic19	575	0: OFF	1: ON
ProLogic20	576	0: OFF	1: ON
Relay O/P1	577	0: OFF	1: ON
Relay O/P2	578	0: OFF	1: ON
Relay O/P3	579	0: OFF	1: ON
Relay O/P4	580	0: OFF	1: ON
Relay O/P5	581	0: OFF	1: ON
Relay O/P6	582	0: OFF	1: ON
Relay O/P7	583	0: OFF	1: ON
Relay O/P8	584	0: OFF	1: ON

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

Read Holding Registers (Function Code 03)			
Channel	**Address**	**Units**	**Scale**
IA Magnitude	40257	A	100
IA Angle	40258	Degrees	1
IB Magnitude	40259	A	100
IB Angle	40260	Degrees	1
IC Magnitude	40261	A	100
IC Angle	40262	Degrees	1
IN Magnitude	40263	A	100

Read Holding Registers (Function Code 03)			
IN Angle	40264	Degrees	1
IG Magnitude	40265	A	100
IG Angle	40266	Degrees	1
ISEF Magnitude	40267	A	100
ISEF Angle	40268	Degrees	1
I1 Magnitude	40269	A	100
I2 Magnitude	40270	A	100
I0 Magnitude	40271	A	100
Thermal state (%)	40272	%	100
I2t Accumulated	40273	kA2s	1
I2t for last operation	40274	kA2s	1

Read Discrete Inputs (Function Code 02)			
Channels	**Address**	**Values**	
Status I/P 1- Present state	10001	0: Off (inactive)	1: On (active)
Status I/P 2- Present state	10002	0: Off (inactive)	1: On (active)
Status I/P 3- Present state	10003	0: Off (inactive)	1: On (active)
Status I/P 4- Present state	10004	0: Off (inactive)	1: On (active)
Status I/P 1- Change of state	10257	0: Off (inactive)	1: On (active)
Status I/P 2- Change of state	10258	0: Off (inactive)	1: On (active)
Status I/P 3- Change of state	10259	0: Off (inactive)	1: On (active)
Status I/P 4- Change of state	10260	0: Off (inactive)	1: On (active)
Virtual Input1	10513	0: Off (inactive)	1: On (active)
Virtual Input2	10514	0: Off (inactive)	1: On (active)
Virtual Input3	10515	0: Off (inactive)	1: On (active)
Virtual Input4	10516	0: Off (inactive)	1: On (active)
Virtual Input5	10517	0: Off (inactive)	1: On (active)
Virtual Input6	10518	0: Off (inactive)	1: On (active)
Virtual Input7	10519	0: Off (inactive)	1: On (active)
Virtual Input8	10520	0: Off (inactive)	1: On (active)
Virtual Input9	10521	0: Off (inactive)	1: On (active)
Virtual Input10	10522	0: Off (inactive)	1: On (active)
Virtual Input11	10523	0: Off (inactive)	1: On (active)
Virtual Input12	10524	0: Off (inactive)	1: On (active)
Virtual Input13	10525	0: Off (inactive)	1: On (active)

Read Discrete Inputs (Function Code 02)			
Virtual Input14	10526	0: Off (inactive)	1: On (active)
Virtual Input15	10527	0: Off (inactive)	1: On (active)
Virtual Input16	10528	0: Off (inactive)	1: On (active)
Virtual Input17	10529	0: Off (inactive)	1: On (active)
Virtual Input18	10530	0: Off (inactive)	1: On (active)
Virtual Input19	10531	0: Off (inactive)	1: On (active)
Virtual Input20	10532	0: Off (inactive)	1: On (active)
Virtual Input21	10533	0: Off (inactive)	1: On (active)
Virtual Input22	10534	0: Off (inactive)	1: On (active)
Virtual Input23	10535	0: Off (inactive)	1: On (active)
Virtual Input24	10536	0: Off (inactive)	1: On (active)
Virtual Input25	10537	0: Off (inactive)	1: On (active)
Virtual Input26	10538	0: Off (inactive)	1: On (active)
Virtual Input27	10539	0: Off (inactive)	1: On (active)
Virtual Input28	10540	0: Off (inactive)	1: On (active)
Virtual Input29	10541	0: Off (inactive)	1: On (active)
Virtual Input30	10542	0: Off (inactive)	1: On (active)

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 , 1: IRIG-B Sync & 2:SNTP Sync	1
Local time offset	40015	2's compliment half hours, North America is negative	1

Read Holding Registers (Function Code 03)			
Channel	**Address**	**Units**	**Scale**
IA Magnitude	40257	A	100
IA Angle	40258	Degrees	1
IB Magnitude	40259	A	100
IB Angle	40260	Degrees	1
IC Magnitude	40261	A	100
IC Angle	40262	Degrees	1
IN Magnitude	40263	A	100
IN Angle	40264	Degrees	1
IG Magnitude	40265	A	100
IG Angle	40266	Degrees	1
ISEF Magnitude	40267	A	100
ISEF Angle	40268	Degrees	1
I1 Magnitude	40269	A	100
I2 Magnitude	40270	A	100
I0 Magnitude	40271	A	100
Thermal state (%)	40272	%	100
I^2t Accumulated	40273	kA^2s	1
I^2t for last operation	40274	kA^2s	1

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

Force Single Coil (Function Code 05)			
Only the “hold readings” coil can be forced. When active, this coil locks all coil, input and holding register readings simultaneously at their present values. When inactive, coil, input and holding register values will read their most recently available state.			
Channel	**Type**	**Address**	**Value**
Hold Readings	Read/Write	01	0000: Readings update normally (inactive) FF00:

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

Diagnostic Subfunctions (Function Code 08)	
Return Query Data (Subfunction00)	This provides an echo of the submitted message.
Restart Communication Option (Subfunction01)	This restarts the Modbus communications
Force Listen Only Mode (Subfunction04)	No response is returned. IED enters "Listen Only" mode. This mode can only be excited by the "Restart Communication Option"

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

Report Slave ID (Function Code 17)			
A fixed response is returned by the IED, including system model, version and issue numbers.			
Channel	**Type**	**Bytes**	**Value**
Model Number	Read Only	0 and 1	0 x 00D8 = 216 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 216.
- Version and issue will each be positive integers, say X and Y.
- The F-PRO is defined as "Model, Version X Issue B"

Accessing F-PRO Event Information	
All F-PRO 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
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. (Note: The Refresh Event List function can be used to check for new
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.

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 current value of each parameter for the default unit configuration as defined in the default configuration file

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IEC60870 Function Type & COT Descriptions

Function Type	Description
160	IEC Overcurrent Protection
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	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
1	Termination of General Interrogation
1	Local Operation
1	Remote Operation
2	Positive Command Acknowledge
2	Negative Command Acknowledge

This section contains the event & command codes defined

KEY:-

FUN Function Type

INF Information Number

GI Event supports General Interrogation x = supported

TYP ASDU Type

COT Cause of Transmission

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

x Supported

\- Not supported

FUN	INF	Description	GI	TYP	COT	DIR	F-PRO216
160	2	Reset FCB	-	5	3	RO	x
160	3	Reset CU	-	5	4	RO	x
160	4	Start/Restart	-	5	5	RO	x
160	5	Power ON	-	5	6	RO	x
160	16	ARC in progress	x	1	1, 9	RC	x
160	19	LEDs reset	-	1	1, 11, 12, 20, 21	RO	x
160	22	Settings changed	x	1	1, 9, 11, 12	RC	x
160	23	Setting G1 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
160	24	Setting G2 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
160	25	Setting G3 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
160	26	Setting G4 selected	x	1	1, 9, 11, 12, 20, 21	RC	x
160	27	Status Input1	x	1	1, 9	RC	x
160	28	Status Input2	x	1	1, 9	RC	x
160	29	Status Input3	x	1	1, 9	RC	x
160	30	Status Input4	x	1	1, 9	RC	x
160	36	Trip Circuit Supervision (TCS-	x	1	1,9	RC	x
160	64	A-starter	x	2	1, 9	RC	x
160	65	B-starter	x	2	1, 9	RC	x
160	66	C-starter	x	2	1, 9	RC	x
160	67	E-starter	x	2	1, 9	RC	x
160	68	General trip	-	2	1	RO	x
160	69	A-general trip	-	2	1	RO	x
160	70	B-general trip	-	2	1	RO	x
160	71	C-general trip	-	2	1	RO	x
160	84	General starter	x	2	1,9	RC	x
160	85	Circuit Breaker Fail (50BF)	-	2	1	RO	x
160	91	P/F-general HS trip (50)	-	2	1	RO	x
160	92	E/F-general trip	-	2	1	RO	x
160	93	E/F-general HS trip (50G, 50N)	-	2	1	RO	x
160	128	CB on by Auto-reclose	x	1	1,9	RC	x

FUN	INF	Description	GI	TYP	COT	DIR	F-PRO216
160	130	Reclose Blocked	x	1	1,9	RC	x
160	148	*Measurand $I_{L1,2,3,}$ P, Q, F*	x	9	2	-	x
164	160	50-1 Picked up	-	2	1	RC	x
164	161	50-2 Picked up	-	2	1	RC	x
164	162	50-1 Operated	-	2	1	RO	x
164	163	50-2 Operated	-	2	1	RO	x
164	164	51-1 Picked up	-	2	1	RC	x
164	165	51-1 Operated	-	2	1	RO	x
164	166	50N-1 Picked up	-	2	1	RC	x
164	167	50N-2 Picked up	-	2	1	RC	x
164	168	50N-1 Operated	-	2	1	RO	x
164	169	50N-2 Operated	-	2	1	RO	x
164	170	51N-1 Picked up	-	2	1	RC	x
164	171	51N-1 Operated	-	2	1	RO	x
164	172	50G-1 Picked up	-	2	1	RC	x
164	173	50G-2 Picked up	-	2	1	RC	x
164	174	50G-1 Operated	-	2	1	RO	x
164	175	50G-2 Operated	-	2	1	RO	x
164	176	51G Picked up	-	2	1	RC	x
164	177	51G Operated	-	2	1	RO	x
164	178	46/50 Picked up	-	2	1	RC	x
164	179	46/50 Operated	-	2	1	RO	x
164	180	46/51 Picked up	-	2	1	RC	x
164	181	46/51 Operated	-	2	1	RO	x
164	182	49 Picked up	-	2	1	RC	x
164	183	49 Operated	-	2	1	RO	x
164	184	49AL Operated	-	2	1	RO	x
164	185	50BF-D1 Operated	-	2	1	RO	x
164	186	50BF-D2 Operated	-	2	1	RO	x
164	187	46BC Operated	-	1	1	RO	x
164	188	I2t Limit Operated	-	1	1	RO	x
164	189	81HBL2 Operated	-	1	1	RO	x
164	190	60CTS Operated	-	1	1	RO	-
164	191	60VTS Operated	-	1	1	RO	-
164	192	51-2 Picked up	-	2	1	RC	-
164	193	51-2 Operated	-	2	1	RO	-
164	194	51N-2 Picked up	-	2	1	RC	-
164	195	51N-2 Operated	-	2	1	RO	-
164	196	Trip Circuit Supervision (TCS-2)	x	1	1,9	RC	x
164	197	64/50SEF-1 Picked up	-	2	1	RC	x
164	198	64/50SEF-2 Picked up	-	2	1	RC	x
164	199	64/50SEF-1 Operated	-	2	1	RO	x
164	200	64/50SEF-2 Operated	-	2	1	RO	x

FUN	INF	Description	GI	TYP	COT	DIR	F-PRO216
164	201	64/51SEF Picked up	-	2	1	RC	x
164	202	64/51SEF Operated	-	2	1	RO	x
164	210	Output1	x	1	1, 9, 12, 20, 21	RC	x
164	211	Output2	x	1	1, 9, 12, 20, 21	RC	x
164	212	Output3	x	1	1, 9, 12, 20, 21	RC	x
164	213	Output4	x	1	1, 9, 12, 20, 21	RC	x
164	214	Output5	x	1	1, 9, 12, 20, 21	RC	x
164	215	Output6	x	1	1, 9, 12, 20, 21	RC	x
164	216	Output7	x	1	1, 9, 12, 20, 21	RC	x
164	217	Output8	x	1	1, 9, 12, 20, 21	RC	x
164	230	Disturbance record stored	-	1	1, 12, 20, 21	RO	x
164	241	*I_A Fault current*	x	4	1,9	-	x
164	242	*I_B Fault current*	x	4	1,9	-	x
164	243	*I_C Fault current*	x	4	1,9	-	x
164	244	*I_N Fault current*	x	4	1,9	-	x
164	245	*I_G Fault current*	x	4	1,9	-	x
164	246	*ISEF Fault current*	x	4	1,9	-	x
164	251	IRIG_B Synchronization	x	1	1,9	RC	x
164	252	SNTP Synchronization	x	1	1,9	RC	x
255	0	Time Synchronization	-	6	8	-	x

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 t he default configuration file.

1.1	DEVICE IDENTIFICATION	Capabilities	Current Value	If configurable, list methods
1.1.1	Device Function:	• Master • Outstation	Outstation	
1.1.2	Vendor Name:		ERL	
1.1.3	Device Name:		F-PRO216	
1.1.4	Device manufacturer's hardware version string:		v1.0	
1.1.5	Device manufacturer's software version string:		V1.4	
1.1.6	Device Profile Document Version Number:		V1.0, Feb 13, 2019	
1.1.7	DNP Levels Supported for:	Masters Only Requests Responses ☐ ☐ None ☐ ☐ Level 1 ☐ ☐ Level 2 ☐ ☐ Level 3 Outstations Only Requests and Responses ☐ None ☐ Level 1 ☒ Level 2 ☐ Level 3		
1.1.8	Supported Function Blocks:	☐ Self-Address Reservation ☐ Object 0 – attribute objects ☐ Data Sets ☐ File Transfer ☐ Virtual Terminal ☐ Mapping to IEC 61850 Object Models defined in a DNP3 XML file		

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1.1 DEVICE IDENTIFICATION		Capabilities	Current Value	If configurable, list methods
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) 2. 32-bit and 16-bit Analog Inputs with and without flag (variations 1, 2, 3 and 4) 3. 32-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 ☐ XML – Loaded via other transport mechanism ☐ Terminal – ASCII Terminal Command Line ☒ Software – Vendor software named **F-PRO 2000 Offliner** ☐ Proprietary file loaded via DNP3 file transfer ☐ Proprietary file loaded via other transport mechanism ☐ Direct – Keypad on device front panel ☐ Factory – Specified when device is ordered ☐ Protocol – Set via DNP3 (e.g. assign class) ☐ Other – explain _____		

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

1.2	SERIAL CONNECTIONS	Capabilities	Current Value	If configurable, list methods
1.2.1	Port Name	CON 2		
1.2.2	Serial Connection Parameters:	☐ Asynchronous - 8 Data Bits, 1 Start Bit, 1 Stop Bit, No Parity ☒ Other, explain – Asynchronous with selectable parity	Parity - None	F-PRO 2000 Offliner
1.2.3	Baud Rate:	☐ Fixed at _____ ☐ Configurable, range _____ to _____ ☒ Configurable, selectable from 2400, 4800, 9600, 19200, 38400 and 57600 ☐ Configurable, other, describe_____	9600	F-PRO 2000 Offliner

1.2 SERIAL CONNECTIONS	Capabilities	Current Value	If configurable, list methods
1.2.4 Hardware Flow Control (Handshaking): *Describe hardware signaling requirements of the interface.* *Where a transmitter or receiver is inhibited until a given control signal is asserted, it is considered to require that signal prior to sending or receiving characters.* *Where a signal is asserted prior to transmitting, that signal will be maintained active until after the end of transmission.* *Where a signal is asserted to enable reception, any data sent to the device when the signal is not active could be discarded.*	☐ None **RS-232 / V.24 / V.28 Options:** Before Tx, Asserts: ☐ RTS ☐ DTR Before Rx, Asserts: ☐ RTS ☐ DTR Always Asserts: ☐ RTS ☐ DTR Before Tx, Requires: Asserted Deasserted ☐ ☐ CTS ☐ ☐ DCD ☐ ☐ DSR ☐ ☐ RI ☐ Rx Inactive Before Rx, Requires: Asserted Deasserted ☐ ☐ CTS ☐ ☐ DCD ☐ ☐ DSR ☐ ☐ RI Always Ignores: ☐ CTS ☐ DCD ☐ DSR ☐ RI ☐ Other, explain _____	Not supported	

1.2 SERIAL CONNECTIONS		Capabilities	Current Value	If configurable, list methods
		RS-422 / V.11 Options: ☐ Requires Indication before Rx ☐ Asserts Control before Tx ☐ Other, explain _____ **RS-485 Options:** ☐ Requires Rx inactive before Tx ☐ Other, explain _____		
1.2.5	Interval to Request Link Status:	☒ Not Supported ☐ Fixed at_____ seconds ☐ Configurable, range _____ to _____ seconds ☐ Configurable, selectable from ___,___,___ seconds ☐ Configurable, other, describe_____		
1.2.6	Supports DNP3 Collision Avoidance:	☒ No ☐ Yes, explain _____		
1.2.7	Receiver Inter-character Timeout:	☒ Not checked ☐ No gap permitted ☐ Fixed at _____ bit times ☐ Fixed at _____ ms ☐ Configurable, range ____ to ____ bit times ☐ Configurable, range ____ to ____ ms ☐ Configurable, Selectable from ___,___,___bit times ☐ Configurable, Selectable from ____, ____, ____ ms ☐ Configurable, other, describe _____ ☐ Variable, explain ____		
1.2.8	Inter-character gaps in transmission:	☒ None (always transmits with no inter-character gap) ☐ Maximum _____ bit times ☐ Maximum _____ ms		

1.3	IP NETWORKING	Capabilities	Current Value	If configurable, list methods
1.3.1	Port Name	CON 1 Network		
1.3.2	Type of End Point:	☐ TCP Initiating (Master Only) ☒ TCP Listening (Outstation Only) ☐ TCP Dual (required for Masters) ☒ UDP Datagram (required)	Not configured for DNP	F-PRO 2000 Offliner
1.3.3	IP Address of this Device:		192.168.0.63	F-PRO 2000 Offliner
1.3.4	Subnet Mask:		255.255.255.0	F-PRO 2000 Offliner
1.3.5	Gateway IP Address:		192.168.0.1	F-PRO 2000 Offliner
1.3.6	Accepts TCP Connections or UDP Datagrams from:	☒ Allows all (show as *.*.*.* in 1.3.7) ☒ Limits based on an IP address ☒ Limits based on list of IP addresses ☐ Limits based on a wildcard IP address ☐ Limits based on list of wildcard IP addresses ☐ Other validation, explain_____	Limits based on an IP address	F-PRO 2000 Offliner
1.3.7	IP Address(es) from which TCP Connections or UDP Datagrams are accepted:		192.168.1.1	F-PRO 2000 Offliner
1.3.8	TCP Listen Port Number:	☐ Not Applicable (Master w/o dual end point) ☐ Fixed at 20,000 ☒ Configurable, range 1025 to 32737 ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe_____	20,000	F-PRO 2000 Offliner

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

1.3 IP NETWORKING		Capabilities	Current Value	If configurable, list methods
1.3.15	Multiple master connections (Outstations Only):	☒ Supports multiple masters (Outstations only) If supported, the following methods may be used: ☒ Method 1 (based on IP address) - required ☒ Method 2 (based on IP port number) - recommended ☒ Method 3 (browsing for static data) - optional	Method 1 (based on IP address)	F-PRO 2000 Offliner
1.3.16	Time synchronization support:	☐ DNP3 LAN procedure (function code 24) ☐ DNP3 Write Time (not recommended over LAN) ☐ Other, explain _____ ☒ Not Supported		

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

1.4 LINK LAYER		Capabilities	Current Value	If configurable, list methods
1.4.7	Maximum Data Link Retries:	☐ Never Retries ☒ Fixed at 3 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe_____	3	
1.4.8	Maximum number of octets Transmitted in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe_____	292	
1.4.9	Maximum number of octets that can be Received in a Data Link Frame:	☒ Fixed at 292 ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe_____	292	

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

1.5 APPLICATION LAYER		Capabilities	Current Value	If configurable, list methods
1.5.6	Maximum number of objects allowed in a single control request for Analog Outputs (group 41):	☐ Fixed at _ ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe_____ ☐ Variable, explain _____	Analog Outputs not supported	
1.5.7	Maximum number of objects allowed in a single control request for Data Sets (groups 85,86,87):	☐ Fixed at __ ☐ Configurable, range _____ to _____ ☐ Configurable, selectable from ____,____,____ ☐ Configurable, other, describe_____ ☐ Variable, explain _____	Data Sets not supported	
1.5.8	Supports mixing object groups (AOBs, CROBs and Data Sets) in the same control request:	☐ Not applicable – controls are not supported ☐ Yes ☒ No	Analog Outputs not supported	

1.6	FILL OUT THE FOLLOWING ITEMS FOR OUTSTATIONS ONLY	Capabilities	Current Value	If configurable, list methods
1.6.1	Timeout waiting for Application Confirm of solicited response message:	☐ None ☒ Fixed at 5,000 ms ☐ Configurable, range _____ to _____ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe_____ ☐ Variable, explain _____	5,000 ms	
1.6.2	How often is time synchronization required from the master?	☒ Never needs time ☐ Within _____ seconds after IIN1.4 is set ☐ Periodically every _____ seconds		
1.6.3	Device Trouble Bit IIN1.6:	☐ Never used ☒ Reason for setting: Unable to access requested data or execute CROB, assuming a valid request has been received		
1.6.4	File Handle Timeout:	☒ Not applicable, files not supported ☐ Fixed at_____ ms ☐ Configurable, range _____ to _____ms ☐ Configurable, selectable from ___,___,___ms ☐ Configurable, other, describe_____ ☐ Variable, explain _____		
1.6.5	Event Buffer Overflow Behavior:	☐ Discard the oldest event ☒ Discard the newest event ☐ Other, explain _____		

1.6 FILL OUT THE FOLLOWING ITEMS FOR OUTSTATIONS ONLY		Capabilities	Current Value	If configurable, list methods
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 ☐ No		
1.6.8	DNP Command Settings preserved through a device reset:	☐ Assign Class ☐ Analog Deadbands ☐ Data Set Prototypes ☐ Data Set Descriptors	Not supported	

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

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

1.8 OUTSTATION PERFORMANCE		Capabilities	Current Value	If configurable, list methods
1.8.6	Maximum time from start-up to IIN 1.4 assertion (ms):		NA	
1.8.7	Maximum Event Time-tag error for local Binary and Double-bit I/O (ms):		– 0.5208 ms for 60Hz systems – 0.6250 ms for 50 Hz systems	
1.8.8	Maximum Event Time-tag error for local I/O other than Binary and Double-bit data types (ms):		– 0.5208 ms for 60Hz systems – 0.6250 ms for 50 Hz systems	

CAPABILITIES AND CURRENT SETTINGS FOR DEVICE DATABASE

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

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

NOTES	1. Binary Inputs are scanned with 1 ms resolution. 2. Binary Input data points are user selectable; the data points available in the device for any given Binary Input point selection can be obtained through the F-PRO 2000 Offliner software (see SCADA Setting Summary).

Point Index	Name	Default Class Assigned to Events (1, 2, 3 or none)	Name for State when value is 0	Name for State when value is 1	Description
0	External Input 1	1	Inactive	Active	
1	External Input 2	1	Inactive	Active	
2	External Input 3	1	Inactive	Active	
3	External Input 4	1	Inactive	Active	
4	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	

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
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	

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
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	50-1 Operated	1	Inactive	Active	
55	50-1 Operated A	1	Inactive	Active	
56	50-1 Operated B	1	Inactive	Active	
57	50-1 Operated C	1	Inactive	Active	
58	50-2 Operated	1	Inactive	Active	
59	50-2 Operated A	1	Inactive	Active	
60	50-2 Operated B	1	Inactive	Active	
61	50-2 Operated C	1	Inactive	Active	

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
62	51 Operated	1	Inactive	Active	
63	51 Operated A	1	Inactive	Active	
64	51 Operated B	1	Inactive	Active	
65	51 Operated C	1	Inactive	Active	
66	50N-1 Operated	1	Inactive	Active	
67	50N-2 Operated	1	Inactive	Active	
68	51N Operated	1	Inactive	Active	
69	50G-1 Operated	1	Inactive	Active	
70	50G-2 Operated	1	Inactive	Active	
71	51G Operated	1	Inactive	Active	
72	46/50 Operated	1	Inactive	Active	
73	46/51 Operated	1	Inactive	Active	
74	64/50SEF-1 Operated	1	Inactive	Active	
75	64/50SEF-2 Operated	1	Inactive	Active	
76	64/51SEF Operated	1	Inactive	Active	
77	49 Operated	1	Inactive	Active	
78	49 Alarm Operated	1	Inactive	Active	
79	50BF-D1 Operated	1	Inactive	Active	
80	50BF-D2 Operated	1	Inactive	Active	
81	46BC Operated	1	Inactive	Active	
82	81HBL2 Operated	1	Inactive	Active	

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
83	74TCS-1 Operated	1	Inactive	Active	
84	74TCS-2 Operated	1	Inactive	Active	
85	I2T Limit Operated	1	Inactive	Active	
86	79 Initiate	1	Inactive	Active	
87	79 Reclose	1	Inactive	Active	
88	79 Lockout	1	Inactive	Active	
89	79 Block	1	Inactive	Active	
90	Output Contact 1	1	Open	Closed	
91	Output Contact 2	1	Open	Closed	
92	Output Contact 3	1	Open	Closed	
93	Output Contact 4	1	Open	Closed	
94	Output Contact 5	1	Open	Closed	
95	Output Contact 6	1	Open	Closed	
96	Output Contact 7	1	Open	Closed	
97	Output Contact 8	1	Open	Closed	

1.10 **BINARY OUTPUT STATUS AND CONTROL RELAY OUTPUT BLOCK** Binary Output Status Group Number: **10** 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) ☐ 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) ☐ Based on point Index (add column to table below)		
1.10.3 Binary Output Status included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		
1.10.4 Reports Output Command Event Objects:	☒ Never ☐ Only upon a successful Control ☐ Upon all control attempts	Not supported	
1.10.5 Event Variation reported when variation 0 requested:	☐ Variation 1 – without time ☐ Variation 2 – with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO 2000 Offliner (See Note 2 below)
1.10.6 Command Event Variation reported when variation 0 requested:	☐ Variation 1 – without time ☐ Variation 2 – with absolute time ☐ Based on point Index (add column to table below)	Not supported	F-PRO 2000 Offliner (See Note 2 below)
1.10.7 Event reporting mode:	☐ Only most recent ☐ All events	Not supported	F-PRO 2000 Offliner (See Note 2 below)

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

Point Index	Name	Supported Control Operations											Name for State when value is 0	Name for State when value is 1	Default Class Assigned to Events (1, 2, 3 or none)		Description
		Select/Operate	Direct Operate	Direct Operate – No Ack	Pulse On / NUL	Pulse Off	Latch On / NUL	Latch Off / NUL	Trip	Close	Count > 1	Cancel Currently Running Operation			Change	Command	
0	Output Contact 1	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
1	Output Contact 2	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
2	Output Contact 3	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
3	Output Contact 4	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
4	Output Contact 5	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
5	Output Contact 6	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
6	Output Contact 7	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
7	Output Contact 8	-	-	-	-	-	-	-	-	-	-	-	Open	Closed	None	None	
8	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** Static (Steady-State) Group Number: **30** 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 ☐ Variation 2 – 16-bit with flag ☒ Variation 3 – 32-bit without flag ☒ Variation 4 – 16-bit without flag ☐ Variation 5 – single-precision floating point with flag ☐ Variation 6 – double-precision floating point with flag ☐ Based on point Index (add column to table below)		
1.11.2 Event Variation reported when variation 0 requested:	☒ Variation 1 – 32-bit without time ☒ Variation 2 – 16-bit without time ☐ Variation 3 – 32-bit with time ☐ Variation 4 – 16-bit with time ☐ Variation 5 – single-precision floating point w/o time ☐ Variation 6 – double-precision floating point w/o time ☐ Variation 7 – single-precision floating point with time ☐ Variation 8 – double-precision floating point with time ☐ Based on point Index (add column to table below)		
1.11.3 Event reporting mode:	☐ Only most recent ☒ All events		
1.11.4 Analog Inputs Included in Class 0 response:	☒ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)		

1.11 ANALOG INPUT POINTS Static (Steady-State) Group Number: **30** Event Group Number: **32**	**Capabilities**	**Current Value**	**If configurable, list methods**
1.11.5 How Deadbands are set:	☐ A. Global Fixed ☐ B. Configurable through DNP ☒ C. Configurable via other means ☐ D. Other, explain _____ ☐ Based on point Index - column specifies which of the options applies, B, C, or D		F-PRO 2000 Offliner
1.11.6 Analog Deadband Algorithm: *simple - just compares the difference from the previous reported value*	☒ Simple ☐ Integrating ☐ Other, explain _____		
1.11.7 Definition of Analog Input Point List:	☐ Fixed, list shown in table below ☒ Configurable ☐ Other, explain_____	**Default list is shown in table below**	F-PRO 2000 Offliner

NOTES	1. Analog Inputs are scanned with 500 ms resolution. 2. Nominal values in calculations for the following table are based on Secondary either 1 A or 5A secondary current * CT ratio for current channels dependent upon the format of CT installed in the F-PRO. 3. Analog Input data points are user selectable; the data points available in the device for any given Analog Input point selection can be obtained through the F-PRO 2000 Offliner software (see SCADA Setting Summary).

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				
1.	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
2.	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
3.	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
4.	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
5.	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
6.	Ic Angle	2	-18,000	18,000	0.1 / (0.01 –	0.0	degrees	0.1 / 0.01	0.5 / (0.1 to	degrees

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 capable of transmitting both integers and floating-point, then integer and floating-point values are required for the minimums and maximums.

For example, a pressure sensor is able to measure 0 to 500 kPa. The outstation provides a linear conversion of the sensor's output signal to integers in the range of 0 to 25000 or floating-point values of 0 to 500.000. The sensor and outstation are used in an application where the maximum possible pressure is 380 kPa. For this input, the minimum transmitted value would be stated as 0 / 0.0 and the maximum transmitted value would be stated as 19000 / 380.000.

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				
					1.0)				180.0)	
7.	In 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
8.	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
9.	Ig 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
10.	Ig 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
11.	Isef 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
12.	Isef 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
13.	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
14.	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
15.	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
16.	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
17.	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
18.	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** Static (Steady-State) Group Number: **110** Event Group Number: **111**	**Capabilities**	**Current Value**	**If configurable, list methods**
1.12.1 Event reporting mode *:	☐ Only most recent ☐ All events	Not supported	
1.12.2 Octet Strings Included in Class 0 response:	☐ Always ☐ Never ☐ Only if point is assigned to Class 1, 2, or 3 ☐ Based on point Index (add column to table below)	Not supported	
1.12.3 Definition of Octet String Point List:	☐ Fixed, list shown in table below ☐ Configurable (current list may be shown in table below) ☐ Other, explain Used for Event Log access as described below		

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

IMPLEMENTATION TABLE

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

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

DNP OBJECT GROUP & VARIATION			**REQUEST Outstation parses**		**RESPONSE Outstation can issue**	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
1	0	Binary Input – Any Variation	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
1	1	Binary Input – Packed format	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
1	2	Binary Input – With flags	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
2	0	Binary Input Event – Any Variation	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response)	**17, 28** (index)
2	1	Binary Input Event – Without time	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response) ~~**130** (unsol. resp)~~	**17, 28** (index)
2	2	Binary Input Event – With absolute time	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response) ~~**130** (unsol. resp)~~	**17, 28** (index)
2	3	Binary Input Event – With relative	**1** (read)	**06** (no range, or	**129** (response)	**17, 28** (index)

DNP OBJECT GROUP & VARIATION			REQUEST Outstation parses		RESPONSE Outstation can issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
		time		all) **07, 08** (limited qty)	~~**130** (unsol. resp)~~	
10	0	Binary Output – Any Variation	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
10	2	Binary Output – Output Status with flag	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
12	1	Binary Command – Control relay output block (CROB)	**3** (select) **4** (operate) **5** (direct op) **6** (dir. op, no ack)	**17, 28** (index)	**129** (response)	Echo of request
20	0	~~Counter – Any Variation~~	**1** (read) **7** (freeze) **8** (freeze noack) **9** (freeze clear) **10** (frz. Cl noack)	**06** (no range, or all)	**129** (response)	
20	1	~~Counter – 32-bit with flag~~			**129** (response)	~~**00, 01** (start-stop)~~
20	2	~~Counter – 16-bit with flag~~			**129** (response)	~~**00, 01** (start-stop)~~
20	5	~~Counter – 32-bit without flag~~			**129** (response)	~~**00, 01** (start-stop)~~
20	6	~~Counter – 16-bit without flag~~			**129** (response)	~~**00, 01** (start-stop)~~
21	0	~~Frozen Counter – Any Variation~~	**1** (read)	**06** (no range, or all)		
21	1	~~Frozen Counter – 32-bit with flag~~			**129** (response)	~~**00, 01** (start-stop)~~
21	2	~~Frozen Counter – 16-bit with flag~~			**129** (response)	~~**00, 01** (start-stop)~~
21	9	~~Frozen Counter – 32-bit without flag~~			**129** (response)	~~**00, 01** (start-stop)~~

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)**
21	10	~~Frozen Counter – 16-bit without flag~~			**129** (response)	~~**00, 01** (start-stop)~~
22	0	~~Counter Event – Any Variation~~	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)		
22	1	~~Counter Event – 32-bit with flag~~			**129** (response) ~~**130** (unsol. resp)~~	~~**17, 28** (index)~~
22	2	~~Counter Event – 16-bit with flag~~			**129** (response) ~~**130** (unsol. resp)~~	~~**17, 28** (index)~~
30	0	Analog Input – Any Variation	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
30	1	Analog Input – 32-bit with flag	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
30	2	Analog Input – 16-bit with flag	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
30	3	Analog Input – 32-bit without flag	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
30	4	Analog Input – 16-bit without flag	**1** (read)	**06** (no range, or all) **00, 01** (start-stop) **07, 08** (limited qty) **17, 28** (index)	**129** (response)	**00, 01** (start-stop)
32	0	Analog Input Event – Any Variation	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response)	**17, 28** (index)

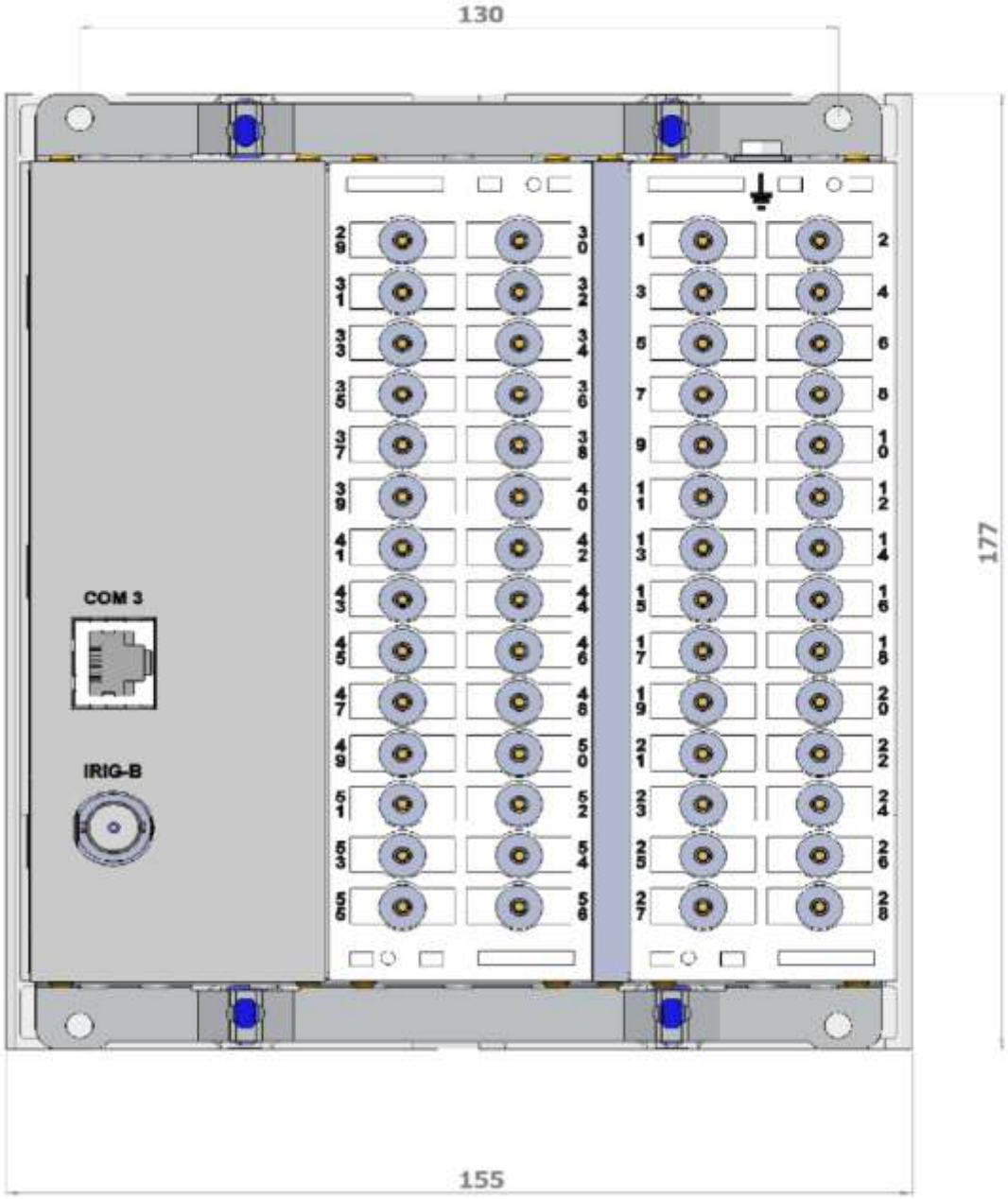
DNP OBJECT GROUP & VARIATION			REQUEST Outstation parses		RESPONSE Outstation can issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
32	1	Analog Input Event – 32-bit without time	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response) ~~**130** (unsol. resp)~~	**17, 28** (index)
32	2	Analog Input Event – 16-bit without time	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response) ~~**130** (unsol. resp)~~	**17, 28** (index)
32	3	Analog Input Event – 32-bit with time	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response)	**17, 28** (index)
32	4	Analog Input Event – 16-bit with time	**1** (read)	**06** (no range, or all) **07, 08** (limited qty)	**129** (response)	**17, 28** (index)
40	0	~~Analog Output Status – Any Variation~~	**1** (read)	**06** (no range, or all)	**129** (response)	
40	2	~~Analog Output Status – 16-bit with flag~~			**129** (response)	~~**00, 01** (start-stop)~~
41	2	~~Analog Output – 16-bit~~	**3** (select) **4** (operate) **5** (direct op) **6** (dir. op, no ack)	**17, 28** (index)	**129** (response)	~~Echo of request~~
50	1	~~Time and Date – Absolute time~~	**2** (write)	**07** (limited qty = 1)	**129** (response)	
51	1	~~Time and Date CTO – Absolute time, synchronized~~			~~**129** (response)~~ ~~**130** (unsol. resp)~~	~~**07** (limited qty) (qty = 1)~~
51	2	Time and Date CTO – Absolute time, unsynchronized			**129** (response) ~~**130** (unsol. resp)~~	**07** (limited qty) (qty = 1)
52	1	Time Delay – Coarse			**129** (response)	**07** (limited qty) (qty = 1)
52	2	~~Time delay – Fine~~			~~**129** (response)~~	~~**07** (limited qty) (qty = 1)~~
60	1	Class Objects – Class 0 data	**1** (read)	**06** (no range, or all)	**129** (response)	**00, 01** (start-stop)
60	2	Class Objects – Class 1 data	**1** (read)	**06** (no range, or all)	**129** (response)	**17, 28** (index)
60	3	Class Objects – Class 2 data	**1** (read)	**06** (no range, or all)	**129** (response)	**17, 28** (index)

DNP OBJECT GROUP & VARIATION			REQUEST Outstation parses		RESPONSE Outstation can issue	
Group Num	**Var Num**	**Description**	**Function Codes (dec)**	**Qualifier Codes (hex)**	**Function Codes (dec)**	**Qualifier Codes (hex)**
60	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)	

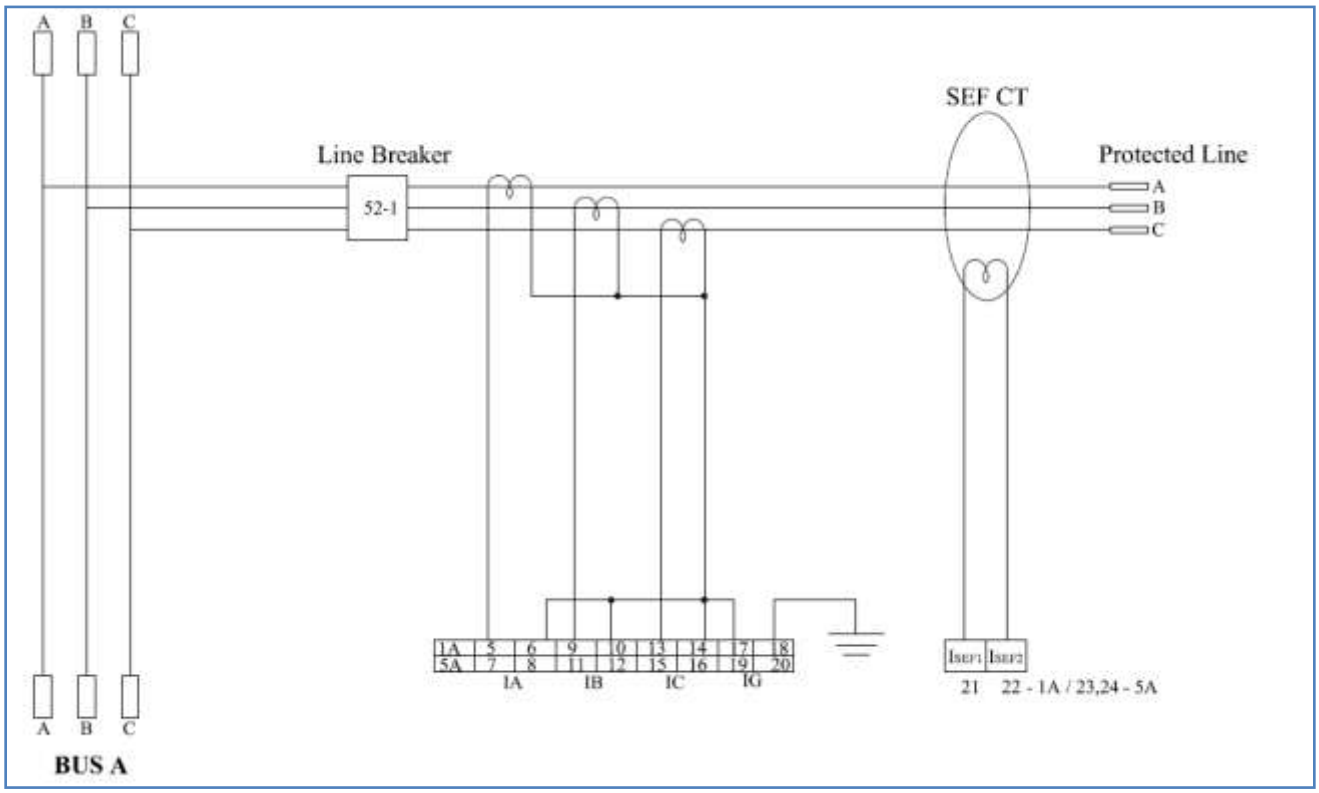
Appendix H Mechanical Drawings

H.1 Front View

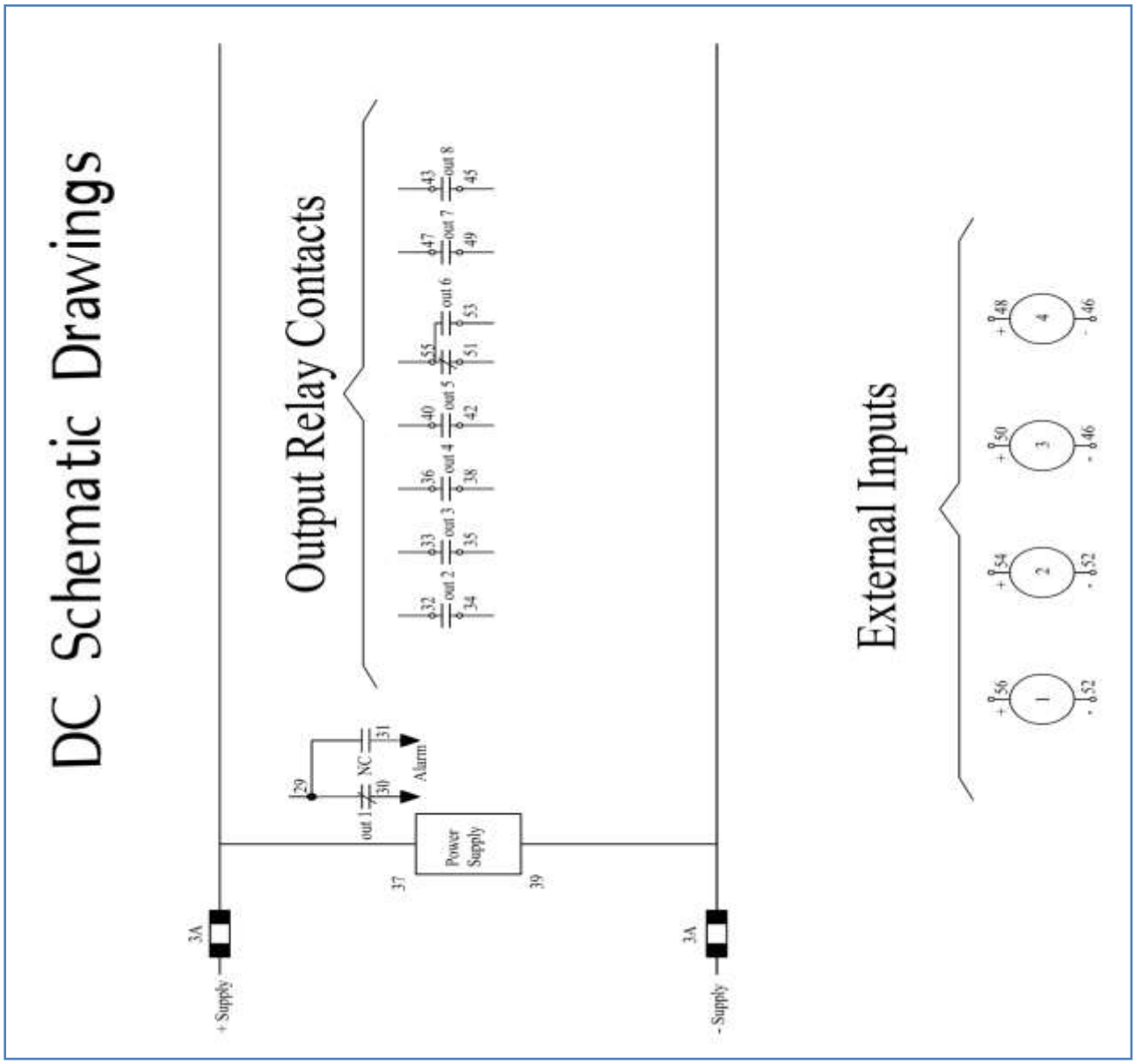
H.2 Rear View



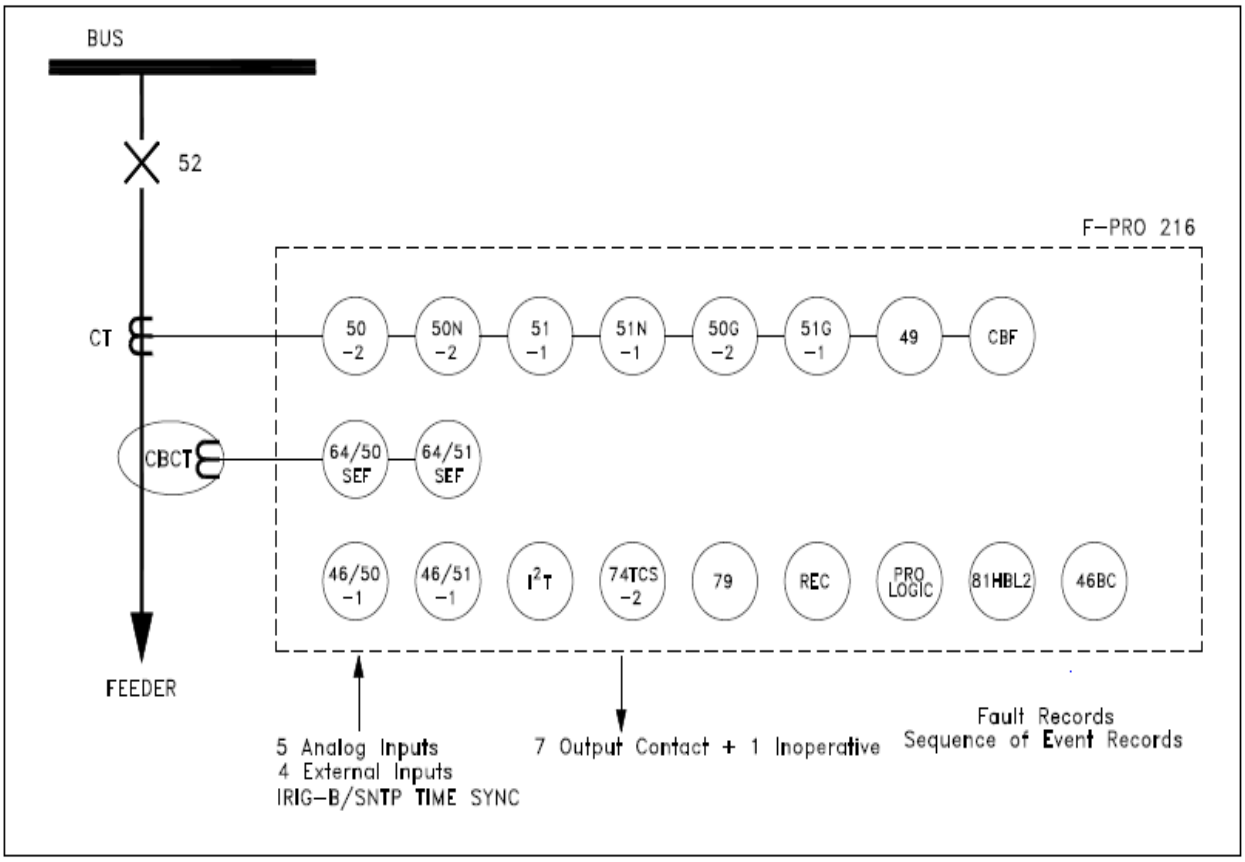
Appendix I AC Schematic Drawing



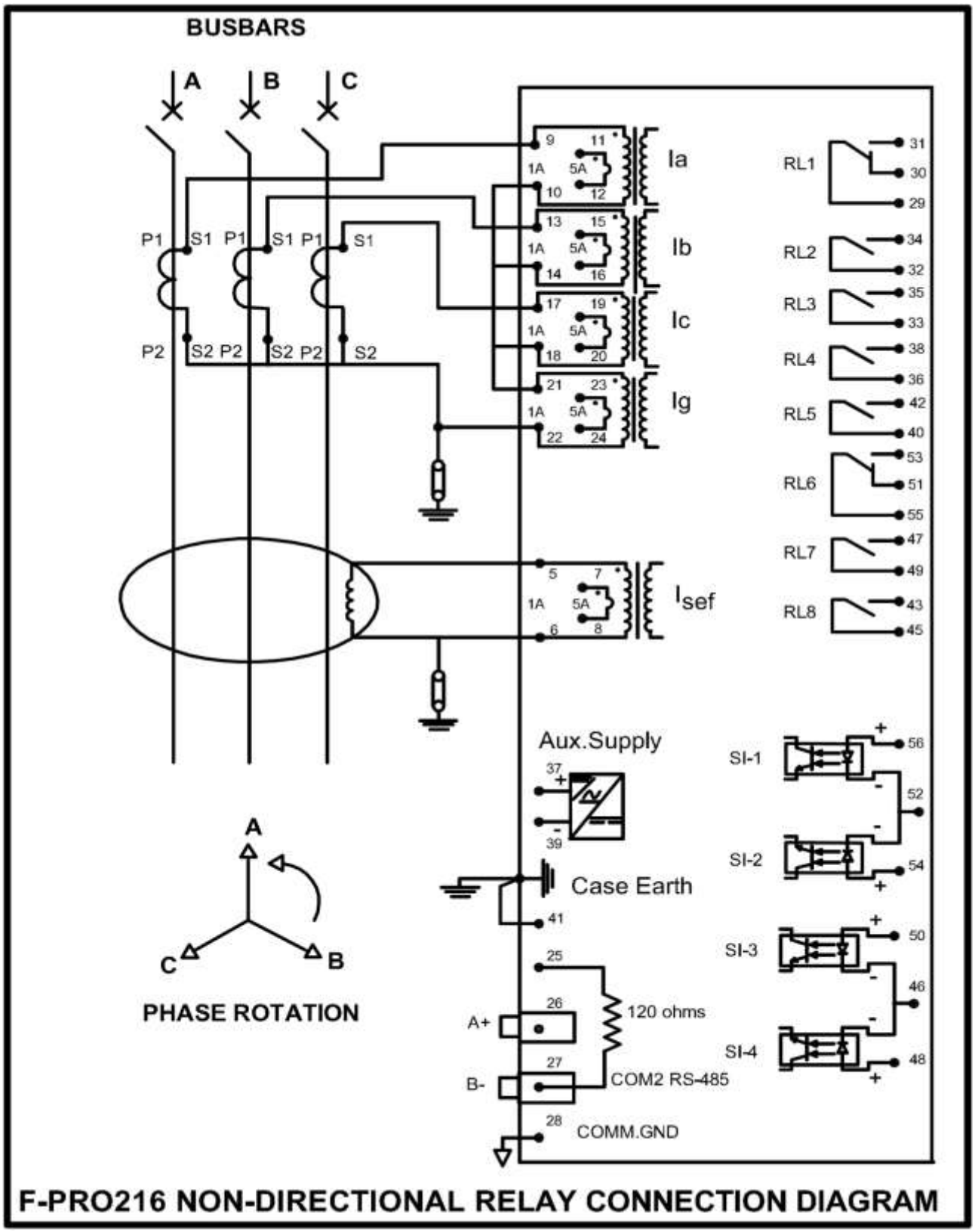
Appendix J DC Schematic Drawing



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.

M.1 Failure Modes

A – DSP System Fail:

When a DSP system fails, the relay functionalLED(Green)goes OFF. The RL14(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 RL14.

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 andRL14(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 RL14.

Appendix N IEC 61850 Data Mapping Specification

This chapter describes IEC 61850 logical devices and nodes defined in ICD file of F-PRO 216 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	
B23	**SCSM**: IEC 6185-9-2 used	—	N	

		Client/ Subscriber	Server/ Publisher	Value/ Comments
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	
– Y = supported 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	
M7-1	sequence-number		Y	

		Client/ Subscriber	Server/ Publisher	Value/ Comments
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	
Logical node (Clause 9)					
S6	LogicalNodeDirectory	TP		Y	
S7	GetAllDataValues	TP		Y	
Data (Clause 10)					
S8	GetDataValues	TP		Y	
S9	SetDataValues	TP		N	

	Services	AA: TP/MC	Client (C)	Server (S)	Comments
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	
S5	DeleteFile	TP		Y	

9					
S60	GetFileAttributeValues	TP		Y	
Time					
T1	Time resolution of internal clock			10 (1 ms)	nearest negative power of 2 in seconds
T2	Time accuracy of internal clock			10 (1 ms)	T0
					T1
					T2
					T3
					T4
					T5
T3	Supported TimeStamp resolution	-		10 (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 V1.4.

This MICS document specifies the modeling 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 V1.4

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
PIOC (Instantaneous overcurrent)
PTOC (Time overcurrent)
NPIOC(Instantaneous neutral overcurrent)
NPTOC(Time neutral overcurrent)
GPIOC(Measured Instantaneous neutral overcurrent)
GPTOC(Measured Time neutral overcurrent)
PSDE (Sensitive directional earthfault)
PSDE (Time Sensitive directional earthfault)
PTTR (Thermal overload)
PHAR (Harmonic restraint)
R: Logical nodes for protection related functions
RBRF (Breaker failure)
RREC (Auto reclosing)
RBCD (Broken conductor detection)

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 Nodes

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	

PSDE Sensitive Directional Earthfault

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
D6450PSDE		Sensitive directional earthfault		
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	64/50SEF- Pickedup	M	
Op	ACT	64/50SEF – Operated	O	

PSDE Time Sensitive Directional Earthfault

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
D6451PSDE		Time Sensitive directional earthfault		
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	64/51SEF- Pickedup	M	
Op	ACT	64/51SEF – Operated	O	

PIOC 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	

GPIOC Measured Instantaneous Neutral Overcurrent

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
D50GPIOC		Measured 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	50G- Pickedup	O	
Op	ACT	50G – UOperated	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	

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	
A	WYE_1_Z	Phase Currents	M	

MMXU2

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
ANAMMXU2		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	
A	WYE_1_Z	Netural Current	M	

MMXU3

LN class				
Attribute	**Attribute Type**	**Explanation**	**M/O/E**	**Remarks**
ANAMMXU2		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	
A	WYE_1_Z	Isef Current	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	
SeqA	WYE_1_Z	I1,I2,I0	M	

N.3 Data Mapping Specifications

F-PRO Logical Device

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

1. Protection
2. Measurements
3. Records
4. System
5. Fault Data
6. Virtual Elements

F-PRO logical nodes

Table 1 defines the list of logical nodes (LN) for the F-PRO logical devices.

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

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
F-PROMeasurements	ANAMMXU1	Measurements	Metering Data	Analog Channel Input Measurement(IA,IB,IC and IN)
F-PROMeasurements	ANAMMXU2	Measurements	Metering Data	Analog Channel Input Measurement(IG)
F-PROMeasurements	ANAMMXU3	Measurements	Metering Data	Analog Channel Input Measurement(ISEF)
F-PROMeasurements	SEQMSQI1	Sequence & Imbalance	Metering Data	Sequence components of and I1, I2, I0)
F-PROProtection	D50PI OC1	Instantaneous Overcurrent	Dev 50-1	Instantaneous Overcurrent stage-1
F-PROProtection	D50PI OC2	Instantaneous Overcurrent	Dev 50-2	Instantaneous Overcurrent stage-2
F-PROProtection	D51PTOC1	Time Overcurrent	Dev 51-1	IDMTL Phase Overcurrent Stage-1
F-PROProtection	D50NPI OC1	Instantaneous Overcurrent	Dev 50N-1	Instantaneous Neutral Overcurrent stage-1 (Derived)
F-PROProtection	D50NPI OC2	Instantaneous Overcurrent	Dev 50N-2	Instantaneous Neutral Overcurrent stage-2 (Derived)
F-PROProtection	D51NP TOC1	Time Overcurrent	Dev 51N-1	IDMTL Neutral Overcurrent Stage-1 (Derived)
F-PROProtection	D50GPI OC1	Instantaneous Overcurrent	Dev 50G-1	Instantaneous Neutral Overcurrent stage-
F-PROProtection	D50GPI OC2	Instantaneous Overcurrent	Dev 50G-2	Instantaneous Neutral Overcurrent stage-2
F-PROProtection	D51GP TOC1	Time Overcurrent	Dev 51G-1	IDMTL Neutral Overcurrent Stage-1(Measured)
F-PROProtection	D4650P IOC1	Instantaneous Overcurrent	Dev 46/50	Instantaneous Negative Sequence Overcurrent
F-PROProtection	D4651P TOC1	Time Overcurrent	Dev 46/51	IDMTL Negative Sequence Overcurrent
F-PROProtection	D49PTTR1	Thermal	Dev 49	Thermal overload
F-PROProtection	D50BFRBRF1	Breaker Failure	Dev 50BF	Breaker Failure
F-PROProtection	D50RPIOC1	Instantaneous	Dev 50R_1	Inst REF/SEF Overcurrent_1
F-PROProtection	D50RPIOC2	Instantaneous	Dev 50R_1	Inst REF/SEF Overcurrent_1

LD Name	LN Name	LN Description	F-PRO Protection Function	Comments
F-PROProtection	D51RPTOC1	Time	Dev 51R	IDMTL REF/SEF Overcurrent
F-PROProtection	D46BCRBCD1	Broken Conductor	Dev 46BC	Broken conductor
F-PROProtection	D74TCSRTCS1	Trip Circuit Supervision	Dev 74TCS	Trip Circuit Supervision
F-PROProtection	D81H2PHAR1	Harmonic Restraint	Dev 81HBL2	2nd Harmonic Inrush Block
F-PROProtection	I2TRCBC1	Thermal Overload	Dev I2t	CB Monitoring
F-PROProtection	D79RREC1	Auto reclosing	Dev 79	Auto reclose
F-PROProtection	TRCALH1	General Alarm	NA	General Alarm
F-PRORecords	DRRDRE1	Disturbance Recorder	Disturbance Record	Transients Records
F-PROFaultData	FLTDATA1	DATA	NA	Fault Current Details
F-PROSystem	LLNO/..(SGCB) (predefined)	Logical Node Zero	Setting Group	Used for Control of Setting Group
F-PROSystem	EIGGIO1	Generic Process I/O	External Inputs	Status of External Inputs (1-4)
F-PROSystem	OCGGIO1	Generic Process I/O	Output Contacts	Status of Output Contacts (1-8)
F-PROSystem	PLGGIO1	Generic Process I/O	Prologics	Status of Protection Logics (1-20)
F-PROSystem	LEDGGIO1	Generic Process I/O	HMI LED Monitoring	LED status (1-8)
F-PROSystem	HEALTHGGIO 1	Generic Process I/O	Relay Health & IRIGB Monitoring	Relay Health Status (1-2)
F-PROVirtualElements	VIGGIO1	Generic Process I/O	Virtual Input Status	Virtual Inputs status (1-30)
F-PROVirtualElements	VIGGIO2	General Process I/O	Virtual Inputs control	Virtual Inputs status (1-30)
F-PROVirtualElements	VIGGIO3	General Process I/O	Virtual outputs control	Virtual Inputs status(1-30)

Logical Node specifications

The following sections provide detailed information on the F-PRO logical nodes of the F-PRO logical Functions as defined in the previous section.

ANAMMXU1

This section defines logical node data for the logical node ANAMMXU1 of the F- PRO Measurements logical device.

> **Note:**
> Common Logical Node information is n ot shown here. Only the data that are provided from the F-PRO application to the IEC 61850 subsystem are listed here.

Data Name	Description
MMXU1.MX.A.phsA.cVal.mag.f	IA- Magnitude
MMXU1.MX.A.phsA.cVal.ang.f	IA- Angle
MMXU1.MX.A.phsB.cVal.mag.f	IB- Magnitude
MMXU1.MX.A.phsB.cVal.ang.f	IB- Angle
MMXU1.MX.A.phsC.cVal.mag.f	IC- Magnitude
MMXU1.MX.A.phsC.cVal.ang.f	IC- Angle
MMXU1.MX.A.neut.cVal.mag.f	IN- Magnitude
MMXU1.MX.A.neut.cVal.ang.f	IN- Angle

ANAMMXU2

This section defines logical node data for the logical node ANAMMXU2 of the F- PRO Measurements logical device.

Data Name	Description
MMXU2.MX.A.neut.cVal.mag.f	IG- Magnitude
MMXU2.MX.A.neut.cVal.ang.f	IG- Angle

ANAMMXU3

This section defines logical node data for the logical node ANAMMXU3 of the F- PRO Measurements logical device.

Data Name	Description
MMXU3.MX.A.res.cVal.mag.f	IR- Magnitude
MMXU3.MX.A.res.cVal.ang.f	IR- Angle

SEQMSQI1

This section defines logical node data for the logical node SEQMSQI1 of theF-PRO measurements logical device.

Data Name	Description
MHAI1MXseqA$C1$cValmagf	Positive Sequence Current magnitude
MHAI1MXseqA$C2$cValmagf	Negative Sequence Current magnitude
MHAI1MXseqA$C3$cValmagf	Zero Sequence Current magnitude

D50PIOC1

This section defines logical node data for the logical node D50PIOC1 of the F-PRO Protection logical device.

Data Name	Description
D50PIOC1.ST.Str.General	Starter(50-1 Picked up)
D50PIOC1.ST.Str.phsA	Starter(50-1 Picked up)Phase A
D50PIOC1.ST.Str.phsB	Starter(50-1 Picked up)Phase B
D50PIOC1.ST.Str.phsC	Starter(50-1 Picked up)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 logical node data for the logical node D50PIOC2 of the F-PRO Protection logical device

Data Name	Description
D50PIOC2.ST.Str.General	Starter(50-2 Picked up)
D50PIOC2.ST.Str.phsA	Starter(50-2 Picked up)Phase A
D50PIOC2.ST.Str.phsB	Starter(50-2 Picked up)Phase B
D50PIOC2.ST.Str.phsC	Starter(50-2 Picked up)Phase C
D50PIOC2.ST.Op.General	Operate(50-2 Operated)
D50PIOC2.ST.Op.phsA	Operate(50-2 Operated)Phase A
D50PIOC2.ST.Op.phsB	Operate(50-2 Operated)Phase B
D50PIOC2.ST.Op.phsC	Operate(50-2 Operated)Phase C

D51PTOC1

This section defines logical node data for the logical node D51POTOC1 of the F-PRO Protection logical device.

Data Name	Description
D51PTOC1.ST.Str.general	Starter(51 Picked up)
D51PTOC1.ST.Str.phsA	Starter(51 Picked up)Phase A
D51PTOC1.ST.Str.phsB	Starter(51 Picked up)Phase B
D51PTOC1.ST.Str.phsC	Starter(51 Picked up)Phase C
D51PTOC1.ST.Op.general	Operate(51 Operated)
D51PTOC1.ST.Op.phsA	Operate(51 Operated)Phase A
D51PTOC1.ST.Op.phsB	Operate(51 Operated)Phase B
D51PTOC1.ST.Op.phsC	Operate(51 Operated)Phase C

D50NPIOC1

This section defines logical node data for the logical node D50NPIOC1 of the F-PRO Protection logical device

Data Name	Description
D50NPIOC1.ST.Str.general	Starter(50N-1 Picked up)
D50NPIOC1.ST.Op.general	Operate(50N-1 Operated)

D50NPIOC2

This section defines logical node data for the logical node D50NPIOC2 of the F-PRO Protection logical device.

Data Name	Description
D50NPIOC2.ST.Str.general	Starter(50N-2 Picked up)
D50NPIOC2.ST.Op.general	Operate(50N-2 Operated)

D51NPTOC1

This section defines logical node data for the logical node D51NPTOC1 of the F-PRO Protection logical device.

Data Name	Description
D51NPTOC1.ST.Str.general	Starter(51N Picked up)
D51NPTOC1.ST.Op.general	Operate(51N Operated)

D50GPIOC1

This section defines logical node data for the logical node D50NPIOC1 of the F-PRO Protection logical device.

Data Name	Description
D50GPIOC1.ST.Str.general	Starter(50G-1 Picked up)
D50GPIOC1.ST.Op.general	Operate(50G-1 Operated)

D50GPIOC2

This section defines logical node data for the logical node D50NPIOC2 of the F-PRO Protection logical device.

Data Name	Description
D50GPIOC2.ST.Str.general	Starter(50G-2 Picked up)
D50GPIOC2.ST.Op.general	Operate(50G-2 Operated)

D51GPTOC1

This section defines logical node data for the logical node D51GPTOC1 of the F-PRO Protection logical device.

Data Name	Description
D51GPTOC1.ST.Str.general	Starter(51G Picked up)
D51GPTOC1.ST.Op.general	Operate(51G Operated)

D50RPIOC1

This section defines logical node data for the logical node D50RPIOC1 of the F-PRO Protection logical device.

Data Name	Description
D50RPIOC1STStr$general	Starter(D6450-1Picked up)
D50RPIOC1STOp$general	Starter(D6450-1Operated)

D50RPIOC2

This section defines logical node data for the logical node D50RPIOC2 of the F-PRO Protection logical device.

Data Name	Description
D50RPIOC2STStr$general	Starter(D6450-2Picked up)
D50RPIOC2STOp$general	Starter(D6450-2Operated)

D51RPTOC1

This section defines logical node data for the logical node D51RPTOC1 of the F-PRO Protection logical device.

Data Name	Description
D51RPTOC1STStr$general	Starter(D6451-1Picked up)
D51RPTOC1STOp$general	Operate(D6451-1Operated)

D4650PIOC1

This section defines logical node data for the logical node D4650PIOC1 of the F-PRO Protection logical device.

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

D4651PTOC1

This section defines logical node data for the logical node D4651PTOC3 of the F-PRO Protection logical device.

Data Name	Description
D4651PIOC1.ST.Str.general	Starter(46/51 Starter)
D4651PIOC1.ST.Op.general	Operate (46/51 Trip)

D49PTTR1

This section defines logical node data for the logical node D49PTTR1 of the F-PRO Protection logical device.

Data Name	Description
D49PTTR1STStr$general	Starter(49 Starter)
D49PTTR1STStr$dirGeneral	Directional Starter(49 Starter)
D49PTTR1STStr$phsA	Starter(49 Starter)Phase A
D49PTTR1STStr$dirphsA	Directional Starter(49 Starter) Phase A
D49PTTR1STStr$phsB	Starter(49 Starter)Phase B
D49PTTR1STStr$dirphsB	Directional Starter(49 Starter) Phase B
D49PTTR1STStr$phsC	Starter(49 Starter)Phase C
D49PTTR1STStr$dirphsC	Directional Starter(49 Starter) Phase C
D49PTTR1STOp$general	Operate(49 Trip)
D49PTTR1STOp$phsA	Operate(49 Trip)Phase A
D49PTTR1STOp$phsB	Operate(49 Trip)Phase B
D49PTTR1STOp$phsC	Operate(49 Trip)Phase C

D50BFRBRF1

This section defines logical node data for the logical node D50BFRBRF1 of the F-PRO Protection logical device.

Data Name	Description
D50BFRBRF1STOpEx$general	Operate(50BF D-1 Trip)
D50BFRBRF1STOpEx$PhsA	Operate (5BF D-1 Trip) Phase A
D50BFRBRF1STOpEx$PhsB	Operate (50BF D-1 Trip) Phase B
D50BFRBRF1STOpEx$PhsC	Operate (50BF D-1 Trip) Phase C
D50BFRBRF1STOp$general	Operate(50BF D-2 Trip)
D50BFRBRF1STOp$PhsA	Operate (5BF D-2 Trip) Phase A
D50BFRBRF1STOp$PhsB	Operate (50BF D-2 Trip) Phase B
D50BFRBRF1STOp$PhsC	Operate (50BF D-2 Trip) Phase C

D46BCRBCD1

This section defines logical node data for the logical node D46BCRBCD1 of the F-PRO Protection logical device.

Data Name	Description
D46BCRBCD1STOp$general	Operate(46BC Trip)

D74TCSRTCS1

This section defines logical node data for the logical node D74TCSRTCS1 of the F-PRO Protection logical device.

Data Name	Description
D74TCSRTCS1STOp1$general	Operate(74TCS1)
D74TCSRTCS1STOp2$general	Operate(74TCS2)

D81H2PHAR1

This section defines logical node data for the logical node D81H2PHAR1 of the F-PRO Protection logical device.

Data Name	Description
D81H2PHAR1STOp$general	Operate(81HBL2 Trip)
D81H2PHAR1STOp$dirgeneral	Operate(81HBL2 Trip)

I2TRCBC1

This section defines logical node data for the logical node I2TRCBC1 of the F-PRO Protection logical device.

Data Name	Description
I2TRCBC1STOp$general	Operate (i^2 OPERATED)

D79RREC1

This section defines logical node data for the logical node D79RREC1 of the F-PRO Protection logical device

Data Name	Description
D79RREC1STBlkRec$stVal	79AR Block
D79RREC1STAuto$stVal	79AR External Switch Status
D79RREC1STOp$general	79AR operated
D79RREC1STAutoRecSt$stVal	79AR shot

TRCALH1

This section defines logical node data for the logical node TRCALH1 of the F-PRO Protection logical device.

Data Name	Description
TRCALH1STGrAlm$stVal	General function operated
TRCALH1STGrWrn$stVal	General function Pickup

EIGGIO1

This section defines logical node data for the logical node EIGGIO1 of the F-PRO Protection logical device.

Data Name	Description
EIGGIO1STInd1$stVal	General Indication (binary input) – External Input 1
EIGGIO1STInd2$stVal	General Indication (binary input) – External Input 2
EIGGIO1STInd3$stVal	General Indication (binary input) – External Input 3
EIGGIO1STInd4$stVal	General Indication (binary input) – External Input 4

OCGGIO1

This section defines logical node data for the logical node OCGGIO1 of the F-PRO Protection logical device.

Data Name	Description
OCGGIO1STInd1$stVal	General Indication (binary input) – Output Contact 1
OCGGIO1STInd2$stVal	General Indication (binary input) – Output Contact 2
OCGGIO1STInd3$stVal	General Indication (binary input) – Output Contact 3
OCGGIO1STInd4$stVal	General Indication (binary input) – Output Contact 4
OCGGIO1STInd5$stVal	General Indication (binary input) – Output Contact 5
OCGGIO1STInd6$stVal	General Indication (binary input) – Output Contact 6
OCGGIO1STInd7$stVal	General Indication (binary input) – Output Contact 7
OCGGIO1STInd8$stVal	General Indication (binary input) – Output Contact 8

PLGGIO1

This section defines logical node data for the logical node PLGGIO1 of the F-PRO Protection logical device.

Data Name	Description
PLGGIO1STInd1$stVal	General Indication (binary input) – ProLogic 1
PLGGIO1STInd2$stVal	General Indication (binary input) – ProLogic 2
PLGGIO1STInd3$stVal	General Indication (binary input) – ProLogic 3
PLGGIO1STInd4$stVal	General Indication (binary input) – ProLogic 4
PLGGIO1STInd5$stVal	General Indication (binary input) – ProLogic 5
PLGGIO1STInd6$stVal	General Indication (binary input) – ProLogic 6
PLGGIO1STInd7$stVal	General Indication (binary input) – ProLogic 7
PLGGIO1STInd8$stVal	General Indication (binary input) – ProLogic 8
PLGGIO1STInd9$stVal	General Indication (binary input) – ProLogic 9
PLGGIO1STInd10$stVal	General Indication (binary input) – ProLogic 10
PLGGIO1STInd11stVal	General Indication (binary input) – ProLogic 11
PLGGIO1STInd12$stVal	General Indication (binary input) – ProLogic 12
PLGGIO1STInd13$stVal	General Indication (binary input) – ProLogic 13
PLGGIO1STInd14$stVal	General Indication (binary input) – ProLogic 14
PLGGIO1STInd15$stVal	General Indication (binary input) – ProLogic 15

Data Name	Description
PLGGIO1STInd16$stVal	General Indication (binary input) – ProLogic 16
PLGGIO1STInd17$stVal	General Indication (binary input) – ProLogic 17
PLGGIO1STInd18$stVal	General Indication (binary input) – ProLogic 18
PLGGIO1STInd19$stVal	General Indication (binary input) – ProLogic 19
PLGGIO1STInd20$stVal	General Indication (binary input) – ProLogic 20

LEDGGIO1

This section defines logical node data for the logical node LEDGGIO1 of the F-PRO Protection logical device.

Data Name	Description
LEDGGIO1STInd1$stVal	General Indication (binary input) –LED 1
LEDGGIO1STInd2$stVal	General Indication (binary input) –LED 2
LEDGGIO1STInd3$stVal	General Indication (binary input) –LED 3
LEDGGIO1STInd4$stVal	General Indication (binary input) –LED 4
LEDGGIO1STInd5$stVal	General Indication (binary input) –LED 5
LEDGGIO1STInd6$stVal	General Indication (binary input) –LED 6
LEDGGIO1STInd7$stVal	General Indication (binary input) –LED 7
LEDGGIO1STInd8$stVal	General Indication (binary input) –LED 8

VIGGIO1

This section defines logical node data for the logical node VIGGIO1 of the F-PRO Protection logical device.

Data Name	Description
VIGGIO1STInd1$stVal	General Indication (binary input) – Virtual Input 1
VIGGIO1STInd2$stVal	General Indication (binary input) – Virtual Input 2
VIGGIO1STInd3$stVal	General Indication (binary input) – Virtual Input 3
VIGGIO1STInd4$stVal	General Indication (binary input) – Virtual Input 4
VIGGIO1STInd5$stVal	General Indication (binary input) – Virtual Input 5
VIGGIO1STInd6$stVal	General Indication (binary input) – Virtual Input 6
VIGGIO1STInd7$stVal	General Indication (binary input) – Virtual Input 7
VIGGIO1STInd8$stVal	General Indication (binary input) – Virtual Input 8
VIGGIO1STInd9$stVal	General Indication (binary input) – Virtual Input 9

Data Name	Description
VIGGIO1STInd10$stVal	General Indication (binary input) – Virtual Input 10
VIGGIO1STInd11$stVal	General Indication (binary input) – Virtual Input 11
VIGGIO1STInd12$stVal	General Indication (binary input) – Virtual Input 12
VIGGIO1STInd13$stVal	General Indication (binary input) – Virtual Input 13
VIGGIO1STInd14$stVal	General Indication (binary input) – Virtual Input 14
VIGGIO1STInd15$stVal	General Indication (binary input) – Virtual Input 15
VIGGIO1STInd16$stVal	General Indication (binary input) – Virtual Input 16
VIGGIO1STInd17$stVal	General Indication (binary input) – Virtual Input 17
VIGGIO1STInd18$stVal	General Indication (binary input) – Virtual Input 18
VIGGIO1STInd19$stVal	General Indication (binary input) – Virtual Input 19
VIGGIO1STInd20$stVal	General Indication (binary input) – Virtual Input 20
VIGGIO1STInd21$stVal	General Indication (binary input) – Virtual Input 21
VIGGIO1STInd22$stVal	General Indication (binary input) – Virtual Input 22
VIGGIO1STInd23$stVal	General Indication (binary input) – Virtual Input 23
VIGGIO1STInd24$stVal	General Indication (binary input) – Virtual Input 24
VIGGIO1STInd25$stVal	General Indication (binary input) – Virtual Input 25
VIGGIO1STInd26$stVal	General Indication (binary input) – Virtual Input 26
VIGGIO1STInd27$stVal	General Indication (binary input) – Virtual Input 27
VIGGIO1STInd28$stVal	General Indication (binary input) – Virtual Input 28
VIGGIO1STInd29$stVal	General Indication (binary input) – Virtual Input 29
VIGGIO1STInd30$stVal	General Indication (binary input) – Virtual Input 30

VIGGIO2

This section defines logical node data for the logical node VIGGIO2 of the F-PRO Protection logical device.

Data Name	Description
VIGGIO2STInd1$stVal	General Indication (binary input) – Virtual Input 1
VIGGIO2STInd2$stVal	General Indication (binary input) – Virtual Input 2
VIGGIO2STInd3$stVal	General Indication (binary input) – Virtual Input 3
VIGGIO2STInd4$stVal	General Indication (binary input) – Virtual Input 4
VIGGIO2STInd5$stVal	General Indication (binary input) – Virtual Input 5
VIGGIO2STInd6$stVal	General Indication (binary input) – Virtual Input 6

Data Name	Description
VIGGIO2STInd7$stVal	General Indication (binary input) – Virtual Input 7
VIGGIO2STInd8$stVal	General Indication (binary input) – Virtual Input 8
VIGGIO2STInd9$stVal	General Indication (binary input) – Virtual Input 9
VIGGIO2STInd10$stVal	General Indication (binary input) – Virtual Input 10
VIGGIO2STInd11$stVal	General Indication (binary input) – Virtual Input 11
VIGGIO2STInd12$stVal	General Indication (binary input) – Virtual Input 12
VIGGIO2STInd13$stVal	General Indication (binary input) – Virtual Input 13
VIGGIO2STInd14$stVal	General Indication (binary input) – Virtual Input 14
VIGGIO2STInd15$stVal	General Indication (binary input) – Virtual Input 15
VIGGIO2STInd16$stVal	General Indication (binary input) – Virtual Input 16
VIGGIO2STInd17$stVal	General Indication (binary input) – Virtual Input 17
VIGGIO2STInd18$stVal	General Indication (binary input) – Virtual Input 18
VIGGIO2STInd19$stVal	General Indication (binary input) – Virtual Input 19
VIGGIO2STInd20$stVal	General Indication (binary input) – Virtual Input 20
VIGGIO2STInd21stVal	General Indication (binary input) – Virtual Input 21
VIGGIO2STInd22$stVal	General Indication (binary input) – Virtual Input 22
VIGGIO2STInd23$stVal	General Indication (binary input) – Virtual Input 23
VIGGIO2STInd24$stVal	General Indication (binary input) – Virtual Input 24
VIGGIO2STInd25$stVal	General Indication (binary input) – Virtual Input 25
VIGGIO2STInd26$stVal	General Indication (binary input) – Virtual Input 26
VIGGIO2STInd27$stVal	General Indication (binary input) – Virtual Input 27
VIGGIO2STInd28$stVal	General Indication (binary input) – Virtual Input
VIGGIO2STInd29$stVal	General Indication (binary input) – Virtual Input
VIGGIO2STInd30$stVal	General Indication (binary input) – Virtual Input

VIGGIO3

This section defines logical node data for the logical node VIGGIO3 of the F-PRO Protection logical device.

Data Name	Description
VIGGIO3STInd1$stVal	General Indication (binary input) – Virtual Input 1
VIGGIO3STInd2$stVal	General Indication (binary input) – Virtual Input 2
VIGGIO3STInd3$stVal	General Indication (binary input) – Virtual Input 3
VIGGIO3STInd4$stVal	General Indication (binary input) – Virtual Input 4

VIGGIO3STInd5$stVal	General Indication (binary input) – Virtual Input 5
VIGGIO3STInd6$stVal	General Indication (binary input) – Virtual Input 6
VIGGIO3STInd7$stVal	General Indication (binary input) – Virtual Input 7
VIGGIO3STInd8$stVal	General Indication (binary input) – Virtual Input 8
VIGGIO3STInd9$stVal	General Indication (binary input) – Virtual Input 9
VIGGIO3STInd10$stVal	General Indication (binary input) – Virtual Input 10
VIGGIO3STInd11$stVal	General Indication (binary input) – Virtual Input 11
VIGGIO3STInd12$stVal	General Indication (binary input) – Virtual Input 12
VIGGIO3STInd13$stVal	General Indication (binary input) – Virtual Input 13
VIGGIO3STInd14$stVal	General Indication (binary input) – Virtual Input 14
VIGGIO3STInd15$stVal	General Indication (binary input) – Virtual Input 15
VIGGIO3STInd16$stVal	General Indication (binary input) – Virtual Input 16
VIGGIO3STInd17$stVal	General Indication (binary input) – Virtual Input 17
VIGGIO3STInd18$stVal	General Indication (binary input) – Virtual Input 18
VIGGIO3STInd19$stVal	General Indication (binary input) – Virtual Input 19
VIGGIO3STInd20$stVal	General Indication (binary input) – Virtual Input 20
VIGGIO3STInd21stVal	General Indication (binary input) – Virtual Input 21
VIGGIO3STInd22$stVal	General Indication (binary input) – Virtual Input 22
VIGGIO3STInd23$stVal	General Indication (binary input) – Virtual Input 23
VIGGIO3STInd24$stVal	General Indication (binary input) – Virtual Input 24
VIGGIO3STInd25$stVal	General Indication (binary input) – Virtual Input 25
VIGGIO3STInd26$stVal	General Indication (binary input) – Virtual Input 26
VIGGIO3STInd27$stVal	General Indication (binary input) – Virtual Input 27
VIGGIO3STInd28$stVal	General Indication (binary input) – Virtual Input 28
VIGGIO3STInd29$stVal	General Indication (binary input) – Virtual Input 29
VIGGIO3STInd30$stVal	General Indication (binary input) – Virtual Input 30