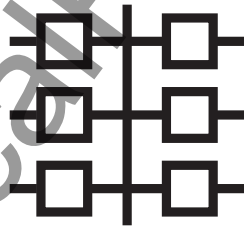




B-PRO

Single Phase Bus Protection

Model 8701/BUS



User Manual

Version 1.0 Rev 4

www.ElectricalPartManuals.com

Preface

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Version Compatibility and Release History

This chart indicates the versions of *Offliner* Settings, RecordBase View and the User Manual which are compatible with different versions of B-PRO firmware.

RecordBase View and *Offliner* Settings are backward compatible with all earlier versions of records and setting files. You can use RecordBase View to view records produced by any version of B-PRO firmware and *Offliner* Settings can create and edit older setting file versions.

Minor releases (designated with a letter suffix - e.g. v1.0a) maintain the same compatibility as their base version. For example, B-PRO firmware v1.0b and *Offliner* Settings v1.0a are compatible.

B-PRO 8701/BUS Firmware/Software Compatibility Guide

B-PRO Firmware	Record Version	Setting Version	Compatible <i>Offliner</i> Settings	Compatible RecordBase View
v1.0	9	1	v1.0 or greater	v1.1 or greater

B-PRO 8701 Firmware Revision History

Date	Version	Changes from Previous Version
2004 May 7	v1.0b	Added Self Check algorithm to detect DC offset on analog input channels. Prevented operation of 87B and 50LS functions on power up when latched through ProLogic. Fixed reporting of time synchronization status in records. Fixed handling of user-specified IP addresses with leading zeros. Corrected Modbus protocol errors
2003 Jan 17	v1.0a	PT Turns Ratio on the System Parameters screen expanded to allow a setting up to 10000:1.
2002 Jul 30	v1.0	First release.

B-PRO 8701 Offliner Settings Revision History

Date	Offliner Settings Version	Changes from Previous Version
2003 Jan 17	v1.0a	PT Turns Ratio on the System Parameters screen expanded to allow a setting up to 10000:1.
2002 Jul 30	v1.0	First release.


B-PRO 8701 User Manual Revision History

Date	Manual Version	Changes from Previous Version
2008 Feb 29	v1.0 Rev 4	Branded to ERLPhase.
2004 May 7	v1.0 Rev 3	Updated format of manual Updated to reflect v1.0b firmware changes
2003 Jan 17	v1.0 Rev 2	PT Turns Ratio on the System Parameters screen expanded to allow a setting up to 10000:1.
2002 Jul 30	v1.0	First release.

Using This Guide

This User Manual describes the installation and operation of the B-PRO bus protection relay user interface software and is intended to support the first time user and to clarify the details of the equipment.

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

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

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1 Overview

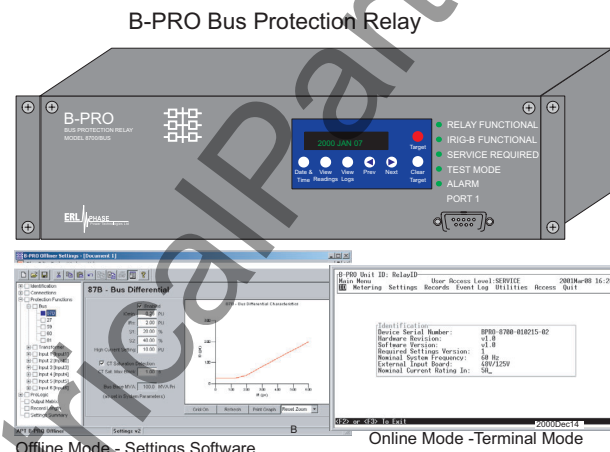
The B-PRO (model 8701/BUS) is a microprocessor-based relay providing bus differential protection, integrated breaker failure and overcurrent protection functions, metering and fault oscillography.

B-PRO has two working modes—online and offline. In the online mode you can use any communication software package (e.g. Procomm or HyperTerminal) to connect to the B-PRO using VT100 terminal emulation. In online mode you can:

- change and review relay settings
- view event and metering information
- initiate and retrieve recordings, and retrieve settings

In offline mode you can use *Offliner* Settings and RecordBase View software to:

- create and review relay settings
- analyze fault waveforms
- store records



The B-PRO relay provides bus differential protection (low impedance) for 2 to 18 input connections using 3 single phase relays.

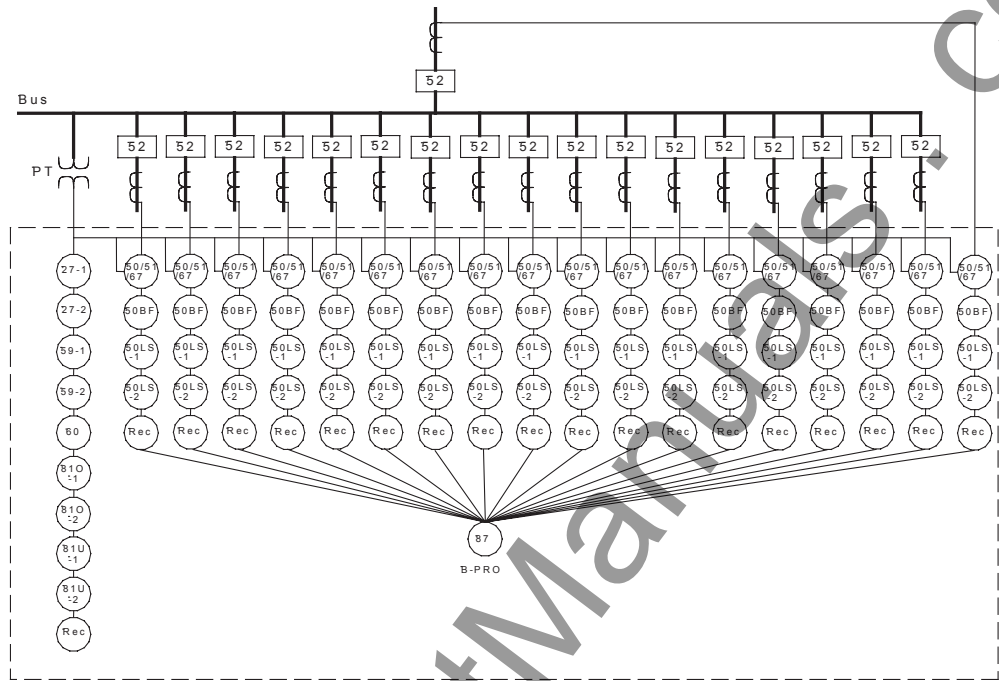
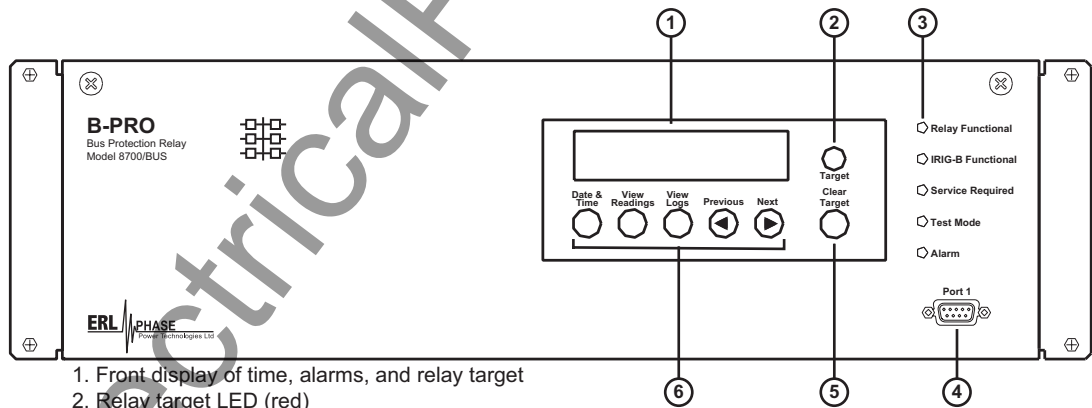


Figure 1.1: B-PRO Function Line Diagram

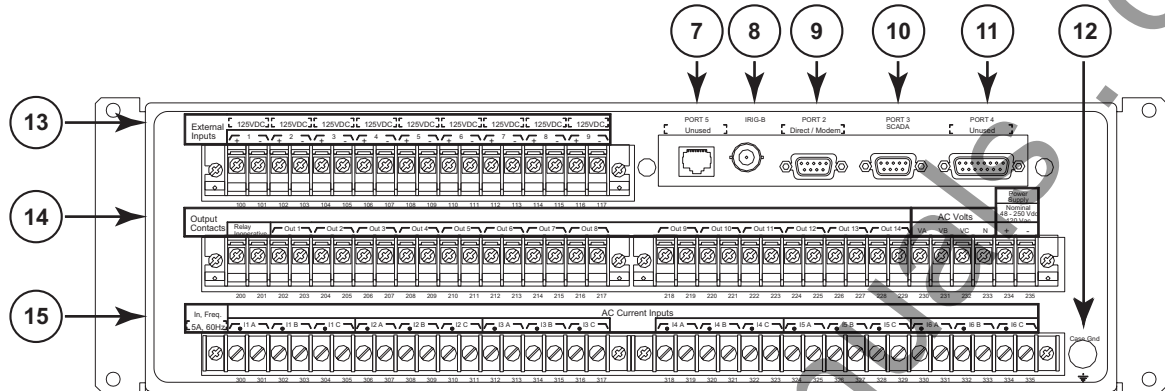
Front View



1. Front display of time, alarms, and relay target
2. Relay target LED (red)
3. LEDs indicating status of relay
4. Communications serial port 1 for laptop computer
5. Clear target push button
6. Push buttons to manipulate information on LCD display

Figure 1.2: B-PRO Front View

Back View



7. Port 5 - 10BaseT Ethernet Port/Internal Modem (optional)
8. External clock, IRIG-B modulated or unmodulated
9. Port 2 - Direct/Modem RS-232 Port
10. Port 3 - SCADA
11. Port 4 - unused
12. Case ground
13. 9 programmable inputs (1-9)
14. This row contains 4 distinct areas from left to right:
 - Relay Inoperative contact
 - 14 programmable output contacts
 - 3 ac voltage inputs
 - power supply
15. This row contains 18 ac current inputs

Figure 1.3: B-PRO Back View

AC Current and Voltage Inputs

B-PRO is provided with terminal blocks for up to 18 ac currents and 3 phase to neutral voltages.

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

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

External Inputs

The B-PRO relay contains 9 programmable external inputs. External dc voltage of either 48/125 volts or 125/250 volts nominal are possible depending on the range provided.

Output Relay Contacts

The B-PRO relay has 14 output relay contacts. Each contact is programmable and has breaker tripping capability. All output contacts are isolated from each other. The output contacts are closed for a minimum of 100 ms after operation.

Relay Inoperative Alarm Output

If the relay is in self check program or becomes inoperative, then the Relay Inoperative Alarm output contact closes and all tripping functions are blocked.

Model Options/Ordering

B-PRO is available as a horizontal mount, for details see “Mechanical Drawings” in Appendix G.

B-PRO is available with an internal modem card or internal network card.

The CT inputs are 1 A nominal or 5 A nominal. The external inputs are 48/125 Vdc or 125/250 Vdc. The system base frequency is either 50 Hz or 60 Hz.

All of the above options must be specified at the time of ordering.

2 Setup and Communications

Power Supply

A wide range power supply is standard. The nominal operating range is 48 to 250 Vdc, 120 Vac, 50/60 Hz. To protect against a possible short circuit in the supply use an inline fuse or circuit breaker with a 5 A rating. Make the chassis ground connection to ensure 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 40 seconds to complete showing the green Relay Functional LED.

Case Grounding

You must ground the relay to the station ground using the case-grounding terminal at the back of the relay, for details see for details see Figure 1.3: B-PRO Back View on page 1-3.

WARNING!

To ensure safety and proper operation you must connect the relay to the station ground using the rear grounding terminal on the relay.

Ground the relay even when testing.

Do not rely on the rack mounting screws to provide case grounding.



IRIG-B Time Input

The relay is equipped to handle modulated or unmodulated GPS satellite time IRIG-B signals. The IRIG-B time signal is connected to the BNC connection on the back of the relay. When the IRIG-B signal is provided to the relay and is enabled in the settings through the user interface, the IRIG-B functional LED comes on and the relay clock is referenced to this signal. No settings are required to differentiate between modulated or unmodulated signals; this is automatically detected by the relay.

You can enable or disable the IEEE 1344 extension in the terminal mode settings *Utilities>Setup>Time*. The enabled mode receives the year from the IRIG-B signal. Disable this setting, if the available IRIG-B signal has no year extension.

Communicating with the Relay (IED)

You can connect to the relay to access its user interface and SCADA services by:

- direct serial link (user interface and SCADA)
- external or internal modem link (user interface only)
- ethernet network link (user interface and SCADA)

Direct Serial Link

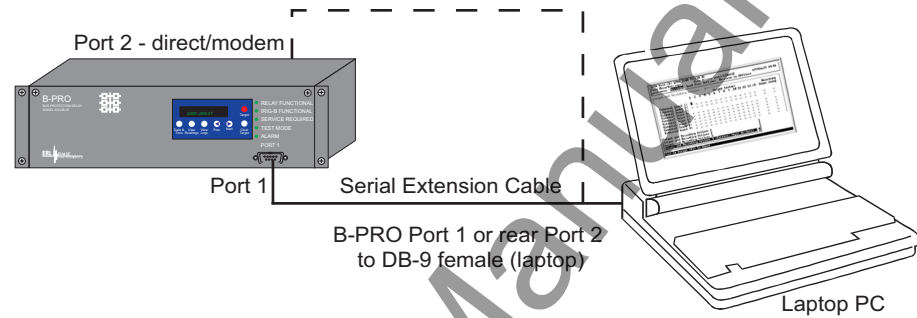


Figure 2.1: Direct Serial Link

The relay has three serial ports that provide direct access to its user interface and SCADA services.

All of the relay's serial ports (Ports 1, 2 and 3) are configured as EIA RS-232 Data Communications Equipment (DCE) devices with female DB9 connectors. This connects them directly to a PC serial port with a standard straight-through male-to-female serial cable for pin-out, for details see "Communication Port Details" on page 2-9.

The relay's user interface is accessed through a standard VT-100 terminal emulation program running on a PC. To create a direct serial link between the relay and your computer, connect the serial cable (provided) between your computer's serial port and Port 1 on the relay's front panel. Port 2 on the relay's back panel can also be used for direct serial access provided the port is not configured for modem use. When connected, run the terminal emulation software on your computer to establish the communication link, for details see "Using HyperTerminal to Access the Relay's User Interface" on page 2-5.

The relay's Modbus and DNP3 SCADA services can be accessed via a direct serial link to Port 3 on the relay's back panel, for details see "Accessing the SCADA Services" on page 2-8.

Modem Link - External

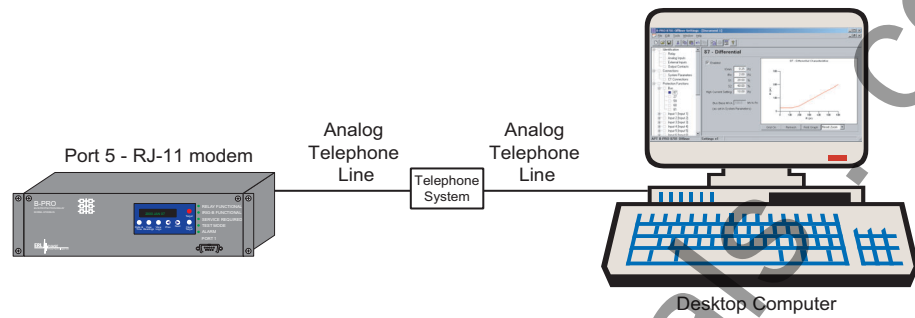


Figure 2.2: External Modem Link

Using an external modem, you can also access the relay's user interface through a telephone link between the relay and your computer.

Connect the serial port on the external modem to Port 2 on the relay's back panel. Both devices are configured as RS-232 DCE devices with female connectors, so the cable between the relay and the modem requires a crossover and a gender change. Alternatively, you can use the ERLPhase modem port adapter provided with the relay to make Port 2 appear the same as a PC's serial port. A standard modem-to-PC serial cable can then be used to connect the modem and the relay. For pin-out details see "Communication Port Details" on page 2-9. Connect the modem to an analog telephone line or switch using a standard RJ-11 connector.

You must appropriately configure the relay's Port 2 to work with a modem. Log into the relay through a direct serial link, go to the *Utilities>Setup>Ports* screen, and set *Port 2 Modem* option to *Yes*. Set the *Baud Rate* as high as possible — most modems handle 57,600 bps. The *Initialize* setting allows you to set the control codes sent to the modem at the start of each connection session. The factory defaults are: "M0S0=0&B1" for an external modem and "M0S0=0" for an internal modem.

Modem Link - Internal

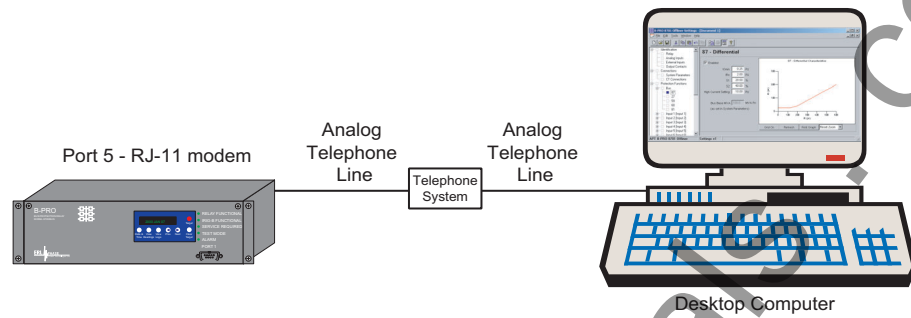


Figure 2.3: Internal Modem Link

You can access the relay's user interface through a telephone link between the relay and your computer using an optional internal modem. If the modem has been installed, Port 5 on the rear panel is labelled "INTERNAL MODEM." Connect the relay's Port 5 to an analog telephone line or switch using a standard RJ-11 connector.

When an internal modem is installed, the relay's Port 2 is used to interface to the modem internally. Appropriate Port 2 settings are configured at the factory when the internal modem is installed. The factory defaults are: "M0S0=0&B1" for an external modem and "M0S0=0" for an internal modem.

Network Link

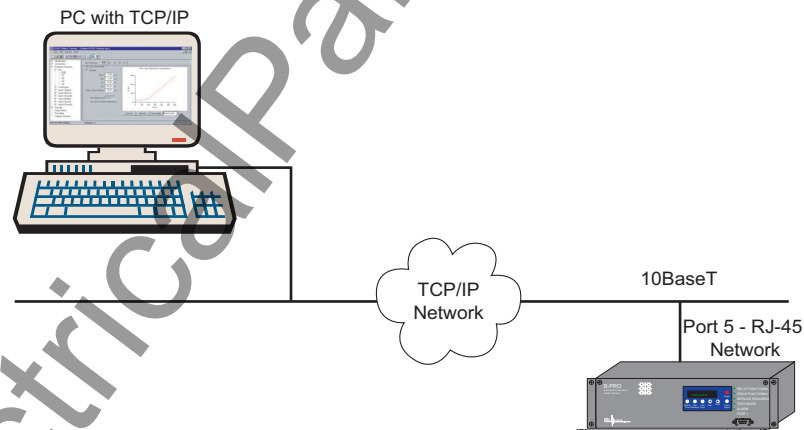


Figure 2.4: Network Link

You can access both the relay's user interface and DNP3 SCADA services simultaneously through the same network port with an optional Ethernet TCP/IP LAN link. If the Ethernet option has been installed, Port 5 on the rear panel will be labelled "NETWORK."

The user interface accessed through the LAN is the same as that available through a direct serial connection or a modem link, but requires the use of a Telnet client on your PC. The HyperTerminal program included with Microsoft Windows provides Telnet services. To select Telnet, go to HyperTerminal's Properties dialog box and set the *Connect Using* field to *TCP/IP (Winsock)*. If this option is not available in the pick list, you require a newer version of HyperTerminal (v1.2 or greater). Alternatively, you can use any

Telnet program that fully supports VT-100 terminal emulation and z-modem file transfer.

DNP3 SCADA services can also be accessed over the LAN, for details see “Accessing the SCADA Services” on page 2-8.

Connect Port 5 to the Ethernet LAN using an appropriate 10BaseT cable with an RJ-45 connector. The relay supports 10 Mbit Ethernet, although a dual speed 10/100 Ethernet hub or switch can be used.

By default, the relay is assigned an IP address of 192.168.1.100. If this address is not suitable, it may be modified using the relay’s Maintenance Menu. For details see “Using HyperTerminal to Access the Relay’s User Interface” on page 2-5.

Using HyperTerminal to Access the Relay’s User Interface

Change settings, view measured values and retrieve data from the relay using its user interface. This section describes how to configure a standard Windows VT-100 terminal program on your PC for use with the relay.

The computer must be connected to the relay by one of its serial, modem or Ethernet communication ports, for details see “Communicating with the Relay (IED)” on page 2-2.

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

Configure your terminal program as described in the table below and link it to the appropriate serial port, modem or TCP/IP socket on your computer.

Terminal Program Setup	
Baud rate	For a direct serial link the baud rate must match that of the relay serial port. For a modem link the baud rate refers only to the link between your computer and its own modem. Refer to “Setting the Baud Rate” on page 2-7 for further information.
Data bits	8
Parity	None
Stop bits	1
Flow control	Hardware or Software. Hardware flow control is recommended. The relay automatically supports both on all its serial ports.
Function, arrow and control keys	Terminal keys
Emulation	VT100
Font	Use a font that supports line drawing (e.g. Terminal or MS Line Draw). If the menu appears outlined in odd characters, the font you have selected is not supporting line drawing characters.

To initiate a connection with the relay use HyperTerminal's *Call>Connect* function.

When the connection is established, press *Enter* in the terminal window to bring up the following login prompt.

```
----- NxtPhase B-PRO 8701 Terminal User Interface login -----  
  
Log in using one of the following usernames:  
'view' - read-only access to settings and readings  
'change' - read/write access to settings and readings  
'service' - full access to all functions (Port 1 access only)  
'maintenance' - access to the maintenance menu  
'update' - to load a firmware update  
  
Notes:  
- Serial and modem connections have a 60 minute inactivity timeout  
- Usernames and passwords are case sensitive  
  
login:
```

Instructions for logging in and running the user interface are given in “Terminal Mode” on page 3-5.

If you see incorrect characters on a direct serial connection, it may mean there is a mismatch between the relay's baud rate and that of the PC.

Ending a User Interface Session

Use the *Quit* function in the relay's user menu to end a session. This closes the interface and requires the next user to login to the relay.

The relay automatically ends a session when it detects the disconnecting of a direct serial cable or a modem hang-up. For other types of connections (e.g. serial switches or Ethernet) use the *Quit* function to ensure the interface is closed and login protection is activated.

Setting the Baud Rate

The baud rate of the relay's serial ports can be shown on the relay's front panel display. From the main *Date & Time* display, press the *Next* button.

Direct Serial Link

For a direct serial connection both the relay and your computer must be set to the same baud rate.

To change the baud rate of a relay serial port:

- 1 Access the relay's user interface through any of the available ports.
- 2 Login to the user interface and go to the *Utilities>Setup>Ports* menu, for details see "Terminal Mode" on page 3-5.
- 3 Select the desired baud rate for the appropriate port by toggling through the options using the Space or Enter keys. Save the new setting with the F2 key. The message "New communications settings loaded" will appear.

The new baud rate will be used on that port the next time you login to it.

To change the baud rate on your computer's serial port:

- 1 From HyperTerminal bring up the *Properties* dialog box, press the *Configure* button and set the baud rate field to the desired value.
- 2 Save the changes.

Modem Link

Unlike a direct serial link, the baud rates for a modem link do not have to be the same on your computer and on the relay. The modems automatically negotiate an optimal baud rate for their communication.

The baud rate set on the relay only affects the rate at which the relay communicates with the modem. Similarly, the baud rate set in HyperTerminal only affects the rate at which your computer communicates with its modem. Details on how to set these respective baud rates are described in "Modem Link - External" on page 2-3, except that you modify the Port 2 baud rate on the relay and the properties of the modem in HyperTerminal.

Accessing the SCADA Services

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

The relay's Port 3 is dedicated for use with Modbus or DNP3 serial protocols. Port 3 uses standard RS-232 signalling. An external RS-232<->RS-485 converter can also be used to connect to an RS-485 network.

For details on connecting to serial Port 3 see "Communicating with the Relay (IED)" on page 2-2 and "Communication Port Details" on page 2-9.

The DNP3 protocol can also be run across the optional 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 2-4.

Complete details on the Modbus and DNP3 protocol services can be found in "Modbus RTU Communication Protocol" in Appendix E and "DNP3 Communication Protocol" in Appendix F.

Protocol Selection

To select the desired SCADA protocol, login to the relay's user interface and access the *Utilities>Setup>SCADA* menu. Select the protocol and set the corresponding parameters.

The DNP3 LAN/WAN - TCP and UDP options are only available if the unit has an optional Ethernet LAN port installed.

Communication Parameters

Port 3's communication parameters are set using the *Utilities>Setup>Ports* menu in relay's user interface. Both the baud rate and the parity bit can be configured. The number of data bits and stop bits are determined automatically by the selected SCADA protocol. Modbus ASCII uses 7 data bits. Modbus RTU and DNP Serial use 8 data bits. All protocols use 1 stop bit except in the case where either Modbus protocol is used with no parity; this uses 2 stop bits, as defined in the Modbus standard.

Diagnostics

Protocol monitor utilities are available to assist in resolving SCADA communication difficulties such as incompatible baud rate or addressing. The utilities can be accessed through the Maintenance user interface, for details see "Maintenance Menu" on page 2-12.

Communication Port Details

Port	Location	Function
1	Front Panel	RS-232 Data Communication Equipment (DCE) female DB9. Used for user interface access through a direct serial connection. Default Setting: 38,400 baud, 8 data bits, no parity, 1 stop bit.
2	Rear Panel	RS-232 DCE female DB9. Used for: <ul style="list-style-type: none"> • User interface access through a direct serial connection. • User interface access through an external modem. The optional ERLPhase Modem Adapter converts this port to a Data Terminal Equipment (DTE) to simplify connection to an external modem. Default Setting: 9,600 baud, 8 data bits, no parity, 1 stop bit. Port 2 is disabled if the relay is equipped with an internal modem (see Port 5).
3	Rear Panel	RS-232 DCE female DB9. Used for SCADA communication. Default Setting: 9,600 baud, 8 data bits, no parity, 1 stop bit.
4	Rear Panel	Not used
5	Rear Panel	RJ-11/RJ-45 receptacle. When equipped with optional internal modem: <ul style="list-style-type: none"> • Used for user interface access through modem. When equipped with optional internal Ethernet card: <ul style="list-style-type: none"> • User interface access. • DNP SCADA access. Default Ethernet IP address: 192.168.1.100.

Signal Name	Direction PC<-> Relay	Pin # on the Relay Port
DCD	←	1
RxD	←	2
TxD	→	3
DTR	→	4
Common		5
DSR	←	6
RTS	→	7
CTS	←	8
No connection		9

Notes:

- Relay is DCE, PC is DTE
- Pins 1 and 6 are tied together internal to the relay

Male DB-9 Cable End for Relay Port	Female DB-9 Cable End for Computer Port
Pin # on Cable	Pin # on Cable
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Signal Name	Direction Modem <-> Relay	Pin # on the Modem Adapter
DCD	→	1
RxD	→	2
TxD	←	3
DTR	←	4
Common		5
DSR	→	6
RTS	←	7
CTS	→	8
No connection		9

Notes:

- Relay (with modem adapter) is DTE, modem is DCE
- Pins 1 and 6 are tied together internal to the relay

Maintenance Menu

The relay has a Maintenance Menu that can be accessed by connection through a VT-100 terminal emulator (such as the HyperTerminal program that comes with MS Windows). Using either direct serial or modem connection:

- 1 Use the terminal program to connect to the serial port, either through direct serial link or modem.
- 2 Select *Enter*, the relay responds with a login prompt.
- 3 Login as “maintenance” in lower case.

A menu appears as below.

```
NxtPhase System Utility v1.3

NxtPhase
Customer support : (204) 477-0591, support@nxtphase.com

1 : Modify IP Address, subnet mask and default gateway (if applicable)
2 : View system diagnostics
3 : Retrieve system diagnostics
4 : Restore ALL default settings, including calibration
5 : Restore only default configuration settings (channel definitions, device se)
6 : Restore only default system setup (ports, time settings)
7 : Force hardware reset
8 : View network statistics (if applicable)
9 : Monitor SCADA
10 : Enable/Disable Internal Modem (if one exists)
11 : Exit

Please enter a command:
[1-11] # _
```

Commands 1, 4, 5, 6, 7 and 10 are Port 1 access only.

Modify IP address	Modifies the LAN IP address when equipped with an optional internal 10BaseT Ethernet card.
View system diagnostic	Displays the internal status log.
Retrieve system diagnostics	Automatically packages up the internal status log plus setting and setup information and downloads it in compressed form to your computer. This file can then be sent to our customer support to help diagnose a problem.
Restore settings	Use this menu to force the system back to default values, if you suspect a problem due to the unit's settings, calibration and/or setup parameters.
Force hardware reset	Manually initiates a hardware reset. Note that the communication link is immediately lost and cannot be re-established until the unit completes its start-up.

View network statistics	View IP, TCP and UDP statistics when equipped with internal 10BaseT Ethernet card.
Monitor SCADA	Shows real time display of SCADA data.
Enable/disable Modem	Enables or disables the internal modem.

Firmware Update

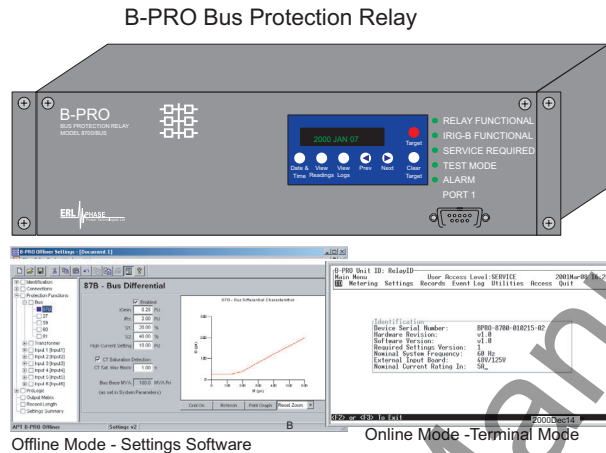
The relay has an update login that can be accessed by a connection through a VT100 terminal emulator (such as HyperTerminal). This login is available only from Port 1.

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

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

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3 Using the IED (Getting Started)



Start-up Sequence

The following initialization sequence takes place:

Test Mode—red LED on	2 seconds after power applied
Relay Functional—green LED on	5 seconds after power applied
Front Display—on	30 seconds after power applied
Test Mode—red LED off	40 seconds after power applied

When the relay is powered up, the normal sequence of LED operation is Test Mode followed by Relay Functional and IRIG-B Functional (if available), display on, then Test Mode off. The entire sequence takes about 40 seconds.

Ways to interface with the relay:

- Front panel display
- Terminal Mode
- *Offliner* Settings

Front Panel Display

View or change settings using Terminal Mode or loading a setting file from *Offliner* Setting.

The front panel display is the fastest and easiest way of getting information from the relay. The user defined phase designation will appear on the upper right-hand corner of the display to indicate which phase is configured.

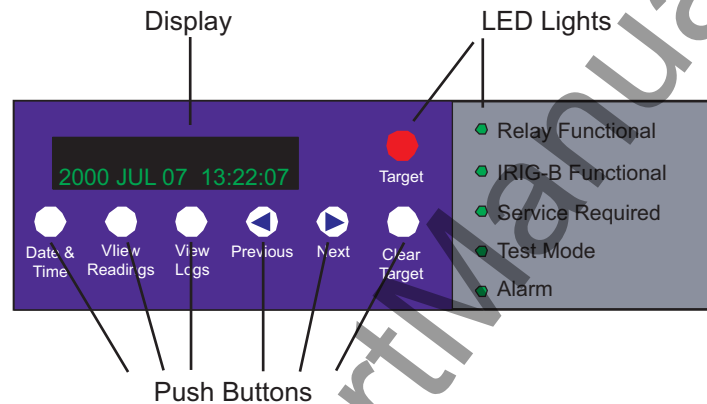


Figure 3.1: Front Panel Display

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

LED Lights

Relay Functional	Indicates when the relay is functional. When the Relay Functional green LED goes on, the rear Relay INOPERATIVE contact changes to open and the protective functions become functional.
IRIG-B Functional	Indicates the presence of a valid IRIG-B time signal.
Service Required	Indicates the relay needs service. This LED can be the same state as the Relay Functional LED or can be of the opposite state depending on the nature of the problem. The following items bring up this LED: <ul style="list-style-type: none"> • DSP failure—protection difficulties within the relay. • Communication failure within the relay. • Internal relay problems.
Test Mode	Occurs when the relay output contacts are intentionally blocked. Possible reasons are: <ul style="list-style-type: none"> • Relay initialization on startup • User interface processor has reset and is being tested. You cannot communicate with the relay through the ports until the front display becomes active and the Test Mode LED goes out. Normally, the red Target LED remains off after this start-up unless the relay had unviewed target messages.

Alarm	Occurs when an enabled relay function picks up. The red Alarm LED should be off if there are no inputs to the relay. If the Alarm LED is on, check the event log messages on the front display by pressing the <i>View Logs</i> button.
Target	Indicates that a fault has taken place. In the output matrix select which output contacts you want to activate when an alarm occurs.

Push Buttons

Date & Time	Pressing the Date & Time button displays the date and time stored on the relay. If the time is incorrect, connect to a PC in Terminal Mode and go to <i>Utilities>Setup>Time</i> to make the change or connect to the IRIG-B plug at the back of the relay. The front display time and date is automatically updated. The green IRIG-B Functional LED comes on. The relay accepts either modulated or unmodulated IRIG-B signals automatically. Options using IRIG-B such as time skew for different time zones are available when you establish communication with the PC.
View Readings	Pressing the View Readings button obtains metering information about the line, "Front Panel Display" on page 3-2.
View Logs	Pressing the View Logs button displays the target information, if a relay operation has occurred, "Front Panel Display" on page 3-2.
Previous/Next	Scroll through the menu by pressing Previous and Next.
Clear Target	Use the Clear Target button to view all target information. When a fault takes place, the red target light appears. You can select a setting option to reset the target light after a short time delay. If many faults have been stored, you may need to push this button several times. Clearing the target light does not clear the target information from the relay log. The relay holds all target messages during a power supply shutdown and restart. Pressing the Clear Target push button displays any targets not previously viewed on the front display and clears the Target LED after the last target has been viewed.

Display

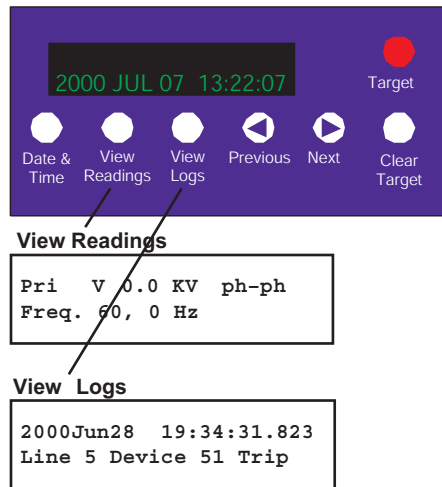


Figure 3.2: Display Examples

Primary quantities unless specified

Front Panel Display Messages
Voltage and Frequency
Va, Vb, Vc magnitude and angle of bus PT
Current magnitude and angle of each CT input
P and Q of each CT input
Tripping device targets, times and dates

Terminal Mode

- 1 Establish terminal mode connection, “Using HyperTerminal to Access the Relay’s User Interface” on page 2-5.
- 2 Login as one of **view**, **change** or **service** (lower case). These three login names provide differing levels of permission, “Access” on page 3-12.

The relay supports the optional use of passwords. A pop-up dialog box appears after login has taken place.

If you have forgotten the password, go to `Access>Passwords` in Terminal Mode, “Passwords” on page 3-6.

- 3 When the connection is established and the terminal mode program appears on your screen, the following prompt should appear. If it doesn’t appear, press *Enter*.

```

----- NxtPhase B-PRO 8701 Terminal User Interface login -----

Log in using one of the following usernames:
'view' - read-only access to settings and readings
'change' - read/write access to settings and readings
'service' - full access to all functions (Port 1 access only)
'maintenance' - access to the maintenance menu
'update' - to load a firmware update

Notes:
- Serial and modem connections have a 60 minute inactivity timeout
- Usernames and passwords are case sensitive

login:

```

- 4 If login is successful, the Main Menu appears:

```

BPRO Unit ID: Your ID entered earlier
Main Menu      User Access Level: VIEW      2001 Jan 08 11:53
ID Metering Settings Records Event Log Utilities Access Quit

```

view, change or service
(depends on how you log in)

If the box around the menu does not appear as above, change the font in your terminal program to one that supports line draw characters, e.g. terminal fonts. Also ensure that emulation is set to VT100 (not VT100J).

If there are incorrect characters in the display, improper line feeds or unerased portions, the baud rate is too high for the quality of the communication link. Use the `Utilities>Setup>Ports` menu to reduce the relay’s baud rate. The new rate is in effect at the next connection.

Access Levels

The relay supports three user access levels to control what relay functions are available to you. The current access level is always shown in the centre of the Main Menu heading.

To change the Access Level either login again using the desired access level as your login name or use the *Main Menu*>*Access* menu.

Access	Level	Allowed actions
view	lowest	View settings, online readings and logs. List and retrieve records. At this level you cannot affect the operation of the controller.
change	middle	Do all of the above, plus change the settings and delete records.
service	highest	Do all of the above two categories, plus calibrate the analog inputs, manually control output auxiliary relays and modify passwords.

Service access is only available through a local, front port connection.

Passwords

Individual passwords for the view and change access levels are available to prevent or limit remote access to the relay. Passwords are not required for the service level. This level is only available at the front of the local relay through serial port 1.

You can only change the passwords from the service level through the Access menu minimizing the chance that a password is changed casually and provides a means of resolving situations where a password has been forgotten.

Terminal Mode Menus

Use the right and left arrow keys and the Enter key to move around in the terminal mode screen. The mouse does not work in VT100 terminal mode. Items from the menu are selected by moving the highlight to the desired item and activating it using the Enter key. As a short-cut, use the first letter of the menu item to access it directly.

Key	Function
<F2>	Accept or Freeze or Execute
<F3>	Quit or Exit
<Esc>	Back to previous menu level

The menu tree consists of a series of sub-menus, for details see Figure 3.3: Terminal Mode Menus on page 3-8.

The Enter key allows you to toggle through a list of selections, i.e. enabled/disabled. The Enter key toggles forward through the list, while the space bar moves backward through the list. In this manner you do not have to scroll through the entire list to get back to a previous selection, you can use the space bar.

For certain lists a pick box appears when there is a long list of selections to choose from, for example, ProLogic inputs. You can scroll through these boxes with the arrow keys or the Enter key. Use the F2 key to make a selection or F3 to leave.

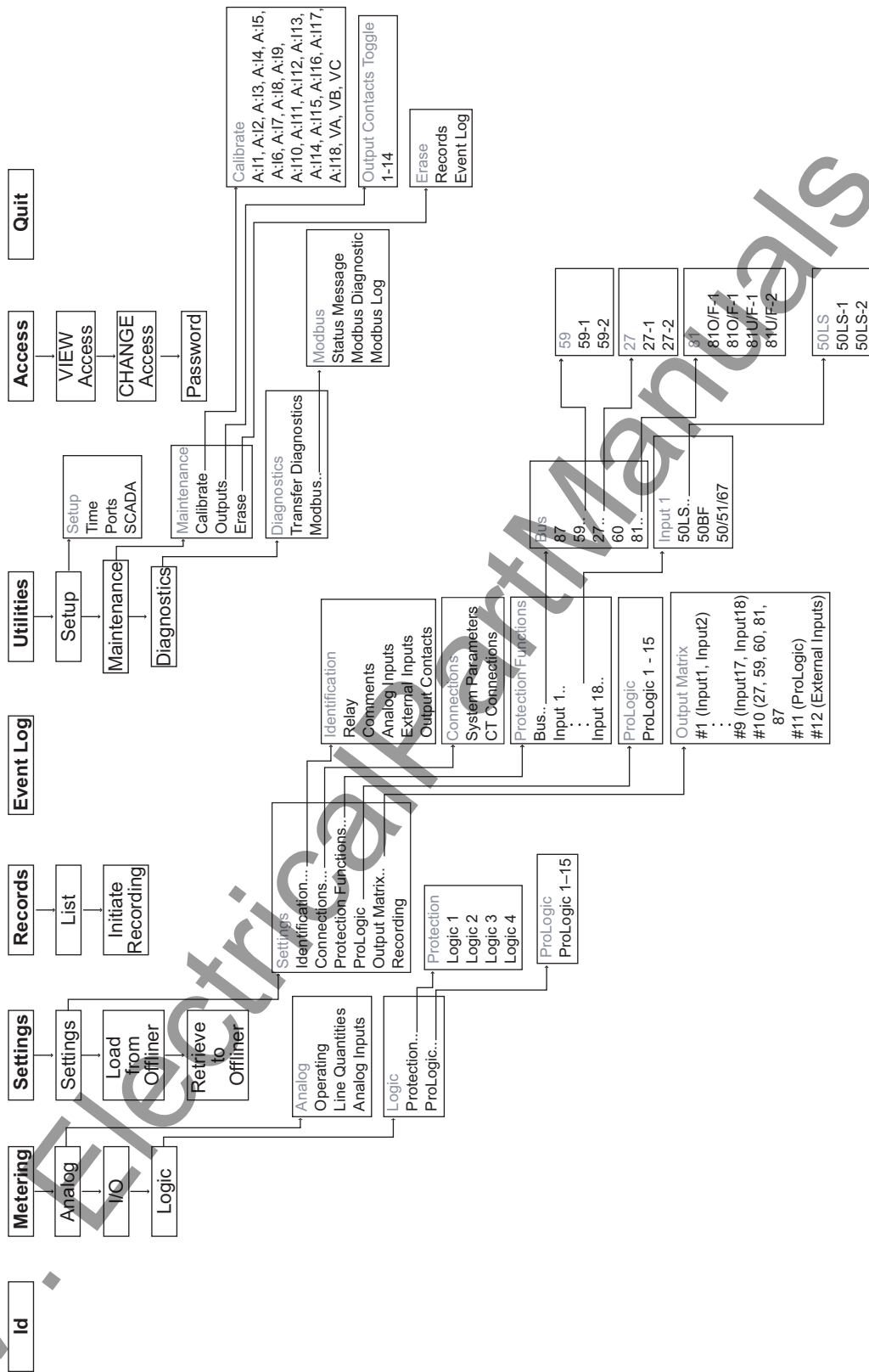


Figure 3.3: Terminal Mode Menus

The Main Menu display is

ID	Metering	Settings	Records	Event Log	Utilities	Access	Quit
----	----------	----------	---------	-----------	-----------	--------	------

ID

Provides the device serial number, hardware revision, software version, required settings version, nominal system values and external input board rating. There are no user settings here.

Metering

Submenus: Analog, I/O, Logic

Analog

Submenus: Operating, Line Quantities, Analog Inputs

Operating	Provides information about operating and restraint current.
Line Quantities	Provides primary MW and MVar of each CT input.
Analog Inputs	Provides secondary values of the ac analog voltages and currents.

I/O

I/O	Displays the state of the external inputs and the output contacts.
-----	--

Logic

Submenus: Protection, ProLogic

Protection Submenus: Logic 1 to Logic 4

Logic1 to Logic4	Provides the present status of the internal logic states.
------------------	---

ProLogic Submenus: ProLogic 1 to ProLogic 15

ProLogic 1 to ProLogic 15	Provides the present status of the internal logic states. When a logic level becomes active, its state changes from low to high.
---------------------------	--

Settings

Submenus: Settings, Load from *Offliner*, Retrieve to *Offliner*

Settings

Settings includes all the submenus pertaining to protection functions used to create a relay setting. When these settings are made or changed, you can load them into the relay allowing input of all settings information for the relay.

Settings submenus: Identification, Nameplate Data, Connections, Protection Functions, ProLogic, Output Matrix and Recording.

Identification..	
Relay	Serial Number, Software Version, Relay ID, Line Name, Station Name, Station Number and Location.
Comments	Enter any appropriate comment.

When using HyperTerminal use Z-modem (no crash recovery), files are received and auto incremented.

Records

Submenus - List, Initiate, Initiate Recording.

Contains the means for initiating and examining recordings.

List	Lists all transient records.
Initiate Recording	Creates one transient record.

Retrieve Records from the Relay

To retrieve records from the relay do the following:

- 1 Navigate to *Records>List* and press *Enter*; a records list appears.
- 2 Select *Records* using the space bar and select *R*. (You can also press *Enter* to retrieve a record directly.) The record will be saved in the directory specified by the terminal emulation program.

When using HyperTerminal if "Use receiving protocol:" is set to "Z modem with Crash Recovery", file transfers are skipped by HyperTerminal if the record already exists in the downloads folder.

When using HyperTerminal use Z-modem (no crash recovery), files are received and auto incremented.

Delete Records from the Relay

To delete records from the relay do the following:

- 1 Navigate to *Records>List* and press *Enter*.
- 2 Select the records for deletion with the space bar and select *D*. The selected records will be deleted.

Event Log

The event log lists events stored in the relay. A complete list of the types of events logged is available, for details see "Event Messages" in Appendix D.

If an event triggered a record, then an (R) is displayed by the event.

Utilities

Sub-menus: Setup, Maintenance, Diagnostics.

Setup	
Time	Sets manual time, IRIG-B skew control. Requires change or service access level.
Ports	Changes Baud rates on communication ports. Requires change or service access level.
SCADA	Selects which SCADA protocol (modbus or DNP3) to run on the SCADA port. Configures parameters for the selected protocol such as address or timeout. Requires change or service access level.

Maintenance	
Calibrate	Calibrates all 21 analog ac. Requires service access level.
Outputs	Closes and opens output contacts independent of the associated relay functions. Requires service access level.
Erase	Uses submenus Records and Event Logs to erase these records from the relay memory. Requires service access level.

Diagnostics	
Transfer Diagnostics	Transfers relay diagnostic file to the PC. You can send the diagnostic file to ERLPhase for analysis.
Modbus	Allows Modbus communications to enter its Diagnostic Mode. Follow directions on the screen. Programming done using the Modicon Modbus Protocol Reference Guide PI-MBUS-300 Rev. G published by Modicon, Inc., dated November 1994, "Modbus RTU Communication Protocol" in Appendix E.

Access

Submenus: View Access, Change Access, Service Access and Password.

View	Changes the access level to view. Allows you read-only access to relay information.
Change	Changes the access level to change. Allows you to modify settings and delete records.
Service	Changes the access level to service. Allows you to do everything, including calibration, manual control of the auxiliary relays and modification of passwords (available via local Port 1 connection only).
Passwords	Allows you to read and change passwords. Requires service access level.

Quit

Selecting this option ends serial port communication with the relay.

Metering Data

Front Panel Metering

The quantities provided on the front panel display include:

- Positive sequence L-L voltage
- Positive sequence frequency
- Phase to neutral bus voltage
- Inputs 1 to 18 currents
- P and Q for each input

All quantities are in primary unless otherwise noted.

TUI Metering

The TUI provides the following metering quantities.

Analog/Operating

Provides the values of IO and IR for the 87. It also displays the enabled/disabled status of the 87 protection function. All P and Q values are single-phase values.

Analog/Line Quantities

Displays the P/Q information for each input, as well as the positive sequence L-L voltage and positive sequence frequency. All quantities are in primary values unless otherwise stated.

Analog/Analog Inputs

Displays all secondary values of the voltage and current inputs.

I/O

Displays the status of all external inputs and output contacts.

Logic/ProLogic

Displays the status of all ProLogic.

Logic/Protection/Logic 1

Displays the High/Low status of the 87 tripping/blocking/restraining functions and the 59, 27, 60 alarm, 81 High/Low status.

Logic/Protection/Logic 2, Logic 3, Logic 4

Displays the High/Low status of the 50LS, 50BF and 50/51/67 for each input.

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4 Protection Functions

Protection Function Descriptions

Bus Protection

87 Bus Differential

Device 87 the main protection of the bus operates for the internal faults and restrains for external faults. The external inputs can control and configure up to 18 CT inputs for function 87. If digital control is enabled and the corresponding external input is turned on, the ac analog current is excluded from all relay protection, metering and recording functions. There is no harmonic restraint for this function. Restraint quantities are summed; the magnitude sum is then divided by two. Operating quantities are summed vectors.

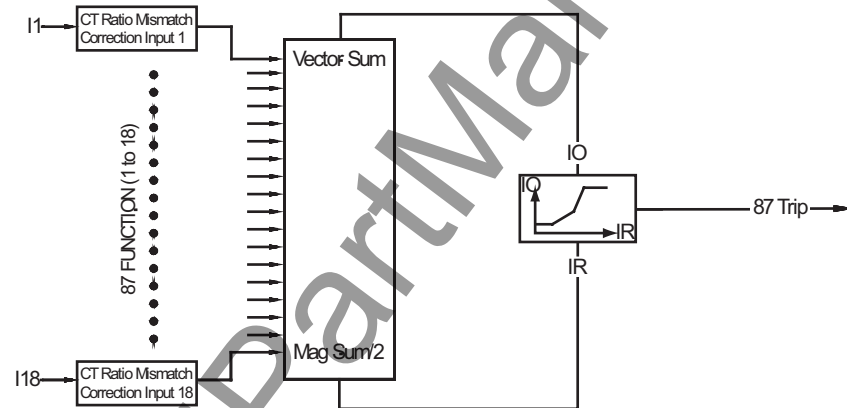


Figure 4.1: 87 Bus Differential

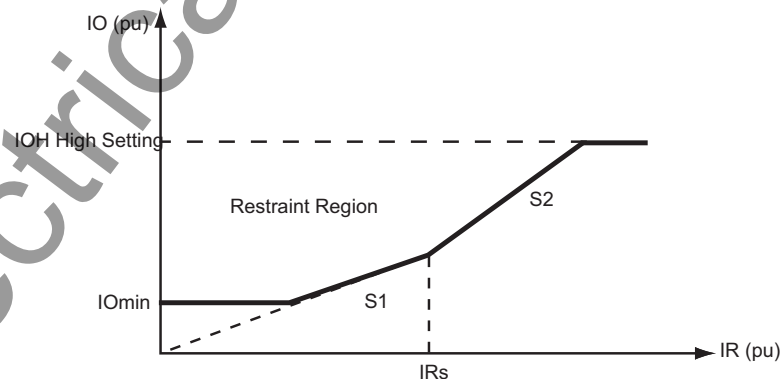


Figure 4.2: Bus Differential Characteristic

The B-PRO bus protection includes a significant improvement to the traditional two slope differential characteristic that provides immunity to CT mismatch and minimal CT saturation sensitivity for external faults. The CT saturation detector detects all CT saturation conditions for external faults and blocks the differential protection from operating. The algorithm is immune to partial or fully offset waveforms, harmonics, fault arcing resistance, capacitive or inductive

loads, severity of saturation, speed at which saturation occurs, and CT saturation occurring during only a portion of the fault. The saturation detection does not interfere with internal faults (with or without saturation), does not affect the operating speed of the differential function, and does not require any special settings.

The CT saturation detector is simple to use and can be enabled or disabled. Once enabled, you set a timer to control how long you want an external CT saturation condition to block the differential protection. Normally you would set this timer to be slightly longer than your maximum clearing time for an external fault.

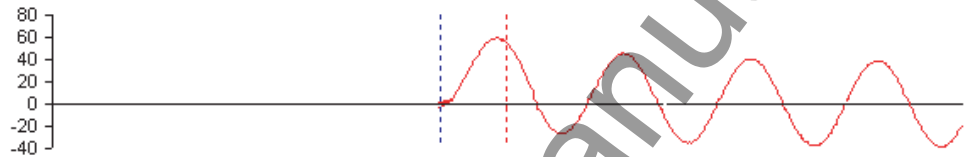


Figure 4.3: External Fault – Fully Offset Source Current

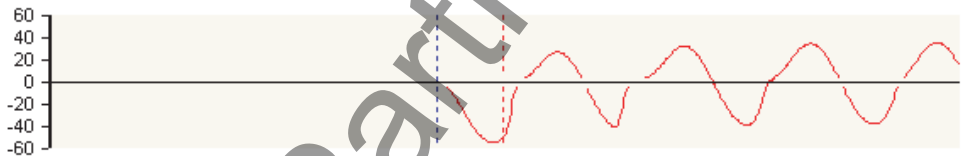


Figure 4.4: External Fault – CT saturation

IOmin	Minimum level that device 87 operates
IRs	Point of intersection between slope 1 and slope 2 of the characteristic
S1	Slope of first part of characteristic meeting IOmin and slope 2
S2	Slope of second part of characteristic meeting slope 1 and high current unrestrained setting
IOH High Set	Heavy fault trip irrespective of restraint current.

The differential relay setting parameters are defined in for details see Figure 4.2: Bus Differential Characteristic on page 4-1, the restraint quantity for the bus differential is the sum of the restraint quantities divided by two.

87 Bus Differential	
I _{Omin} (pu)	0.20 to Max $\left(\frac{IR_s \times S1}{100}, 1.00\right)$
I _R s (pu)	$\left(I_{Omin} \times \frac{100}{S1}\right)$ to 50.00
S1 (%)	$\left(I_{Omin} \times \frac{100}{IR_s}\right)$ to Min (S2, 100)
S2 (%)	Max (S1, 30) to 200.00
High Current Setting (pu)	$I_{Omin} \times 3$ to 100.00
CT Saturation Detection	Enable/disable
CT Sat. Max Block (seconds)	0.10 to 99.99
Bus Base MVA	Set in System parameters

59 Overvoltage

The relay provides two sets of overvoltage protection elements to monitor the bus voltage. The 59-1 and 59-2 functions are identical in terms of operation. Use the gate switch to select between an “AND” or an “OR” gate to detect a three-phase overvoltage or a single-phase overvoltage condition. You can set the definite time delay to 0.0 for an instantaneous output.

Gate Switch (Setting)

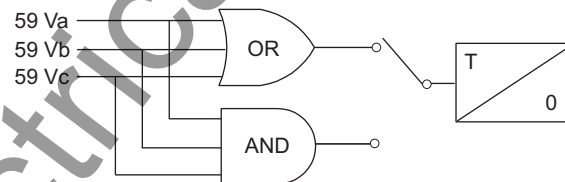


Figure 4.5: 59 Overvoltage

59 Overvoltage	
Gate Switch	AND or OR
Pickup (Volts Sec.)	60.0 to 140.0
Pickup Delay (seconds)	0.00 to 99.99

27 Undervoltage

The relay provides two sets of undervoltage protection elements to monitor the bus voltage. The 27-1 and 27-2 functions are identical in terms of operation. Use the gate switch to select between an “AND” or an “OR” gate to detect a three-phase undervoltage or a single-phase undervoltage condition. You can set the definite time delay to 0.0 for an instantaneous output.

Gate Switch (Setting)

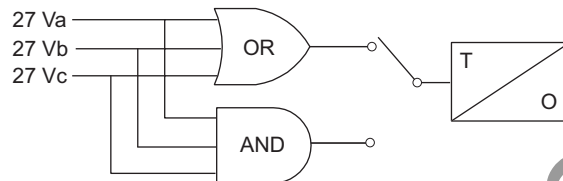


Figure 4.6: 27 Undervoltage

27 Undervoltage	
Gate Switch	AND or OR
Pickup (Volts Sec.)	1.0 to 120.0
Pickup Delay (seconds)	0.00 to 99.99

60 Loss of Potential

This protection detects the loss of potential from either one or two phases and issues an alarm.

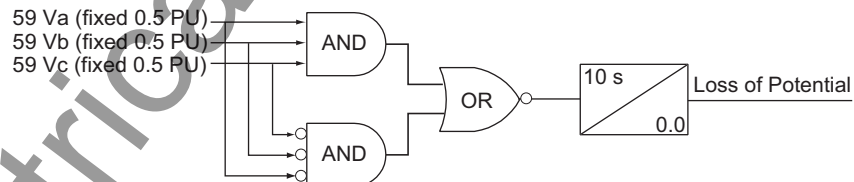


Figure 4.7: 60 Loss of Potential

Where $Va_Exist = 1$ if $Va > 0.5$ per unit, similar for Vb_Exist and Vc_Exist . Pickup time (= 10.0 seconds) and drop-out time (= 0.0 seconds) are fixed parameters.

60 Loss of Potential	
Pickup Delay	10 seconds (fixed)

81 Over/Under Frequency

The relay provides two sets of over frequency protection elements to monitor the bus frequency. The 81 O/F-1 and 81 O/F-2 functions are identical in terms of operation. Any positive sequence overfrequency condition produces an output. Undervoltage inhibit is provided and fixed at 0.25 per unit of nominal system voltage.

The relay provides two sets of under frequency protection elements to monitor the bus frequency. The 81 U/F-1 and 81 U/F-2 functions are identical in terms of operation. Any positive sequence underfrequency condition produces an output. Undervoltage inhibit is provided and fixed at 0.25 per unit of nominal system voltage.

The 81 frequency elements operate and produce an output using a definite time delay function. The overall time delay will be the user setting, an additional inherent delay from 1.25 cycles to 1.75 cycles, and an additional ± 3 ms operate time for the output contact. The element will have a total operate time of under 5 cycles when set to the minimum time delay setting of 0.05 seconds.

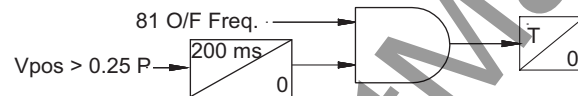


Figure 4.8: 81 O/F Over Frequency

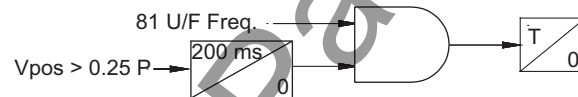


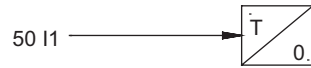
Figure 4.9: 81 U/F Under Frequency

81 Over/Under Frequency	
Pickup (Hz)	60.0 to 70.0 / 50.0 to 60.0 (60 Hz) 50.0 to 60.0 / 40.0 to 50.0 (50 Hz)
Pickup Delay (seconds)	0.05 to 99.99 (inherent delay of 1.25 to 1.75 cycles, depending on frequency step change)

Inputs 1 to 18

50LS Low Set Overcurrent

The relay provides two sets of definite time delay overcurrent protection functions on each CT input for non-directional current detection. The 50LS-1 and 50LS-2 functions are identical in terms of operation. You can set the definite time delay to 0.0 for an instantaneous output.



50LS-1 Over Current for Input 1

Figure 4.10: 50LS Low Set

50LS Low Set Overcurrent	
Pickup (Amps Sec.)	0.1 to 50.0 (5A) 0.02 to 10.00 (1A)
Pickup Delay (seconds)	0.00 to 99.99

50BF Breaker Failure

The relay uses the breaker failure protection function to detect breaker failures and to react correspondingly on all the current inputs. When breaker failure is initiated by a trip (user-settable: includes 87, ProLogic, an external input or its own O/C) and the breaker current still exists, two timers (T1 and T2, user-settable) are started. After these timers are timed out, if the current still exists (which indicates breaker failure), the output of this function will be high.

You can use the two outputs of this function to energize another trip coil or the next level of breakers, such as adjacent zone breakers. For example if you set T1 to 0 ms and T2 to 200 ms, and then using the output of T1 to you can send a another trip to the associated circuit breaker before sending the output of T2 to the adjacent zone protections. If the output of T1 tripped the circuit breaker before T2 timed out the current input will dropout and you will not clear the adjacent zones.

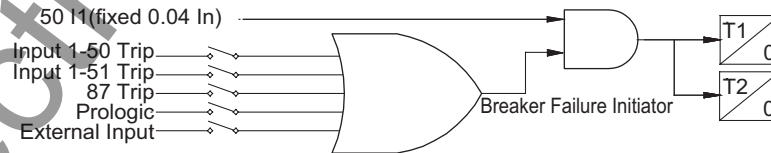


Figure 4.11: 50BF Breaker Failure

50BF Breaker Fail	
Breaker Failure Initiated by 87	enabled or disabled
Breaker Failure Initiated by ProLogic	ProLogic 1 to ProLogic 15
Breaker Failure Initiated by External Input	External Input 1 to External Input 9
Pickup Delay 1 (seconds)	0.01 to 99.99

Pickup Delay 2 (seconds)	0.01 to 99.99
--------------------------	---------------

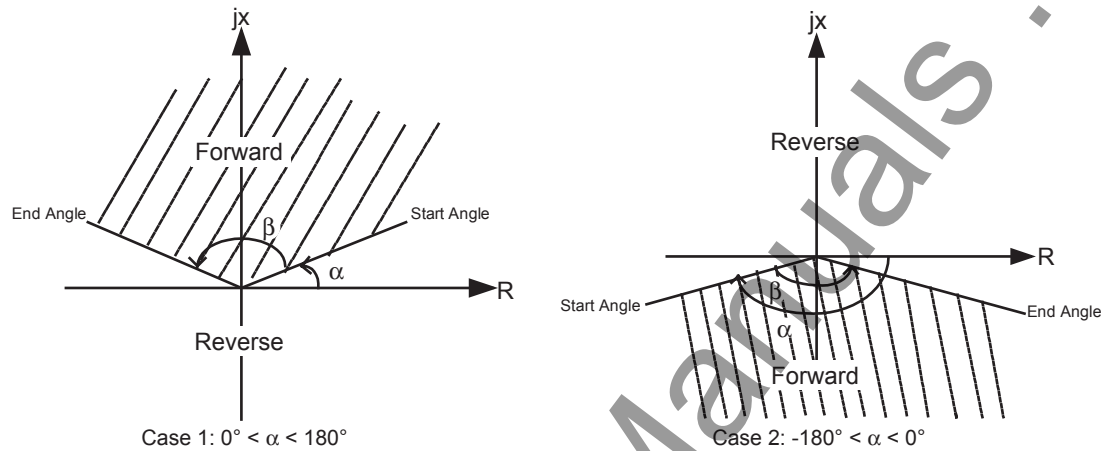
67 Directional Element

Figure 4.12: 67 Directional Element

Two user-defined parameters, Alpha (-179.9° to 180.0°) and Beta (0.1° to 360.0°), set in the system parameters setting area (see “System Parameters” on page 5-11) define the directional element where Alpha is the start angle and Beta is the angle range (always positive), i.e. the end angle is Alpha + Beta. The forward direction is defined in the region where the line originates, the start angle, and rotates anti-clockwise completing at the end angle. for details see Figure 4.12: 67 Directional Element on page 4-7 illustrates the definition of the directional element. You can flexibly define the forward trip region by setting Alpha and Beta properly based on your needs.

When Beta is set to 360° the forward trip region becomes the whole complex range ($R + jx$), making the element fully non-directional, i.e. the fault is always declared as a forward fault even if the actual fault is not a forward fault.

Positive sequence memory voltage (V_{posMem}) and positive sequence current (I_{pos}) are used to decide the directionality of the fault, i.e. if the calculated positive sequence impedance through V_{posMem} and I_{pos} falls into the forward trip region as shown above, the fault is declared as a forward fault.

50/51/67 Phase Overcurrent

Phase overcurrent provides backup protection to the differential protection and operates on the fundamental quantities of phase current. The relay provides two sets of phase time overcurrent protection functions on each CT input, directional or non-directional current detection. There is a definite time overcurrent element (50) and an inverse time overcurrent element (51). You can configure both 50 and 51 to be non-directional, forward direction or reverse direction sensitive. You can also configure both 50 and 51 outputs to initiate the 50BF protection element. Device 51 provides three predefined IEEE, three IEC inverse time curves and one user-defined curve. The equation and the parameters of device 51 are listed below. You can select the user-defined curve type and the parameters in the equation are settable otherwise they are fixed and determined by the curve type.

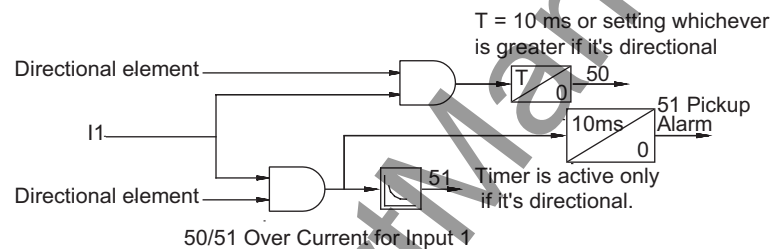


Figure 4.13: 50/51/67 Phase Overcurrent

When the threshold for pickup of the relay is exceeded, the function 51 alarm picks up indicating the relay has commenced timing.

Table 4.1: IEC and IEEE Curves

#	Characteristic	A	B	p	TR*
1	IEC Standard Inverse	0.14	0	0.02	4.85*
2	IEC Very Inverse	13.5	0	1.0	21.6*
3	IEC Extremely Inverse	80.0	0	2.0	29.1*
4	IEEE Moderately Inverse	0.0103	0.0228	0.02	0.97
5	IEEE Very Inverse	3.922	0.0982	2.0	4.32
6	IEEE Extremely Inverse	5.64	0.0243	2.0	5.82
7	User-defined	0.0010 to 1000.0	0.0000 to 10.000	0.01 to 10.0	0.10 to 100.00

* These constants are copied from the IEEE standards; they are not given in the IEC standard.

Pickup: For $I > \text{Pickup}$

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

Reset: For $I < \text{Pickup}$

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

50/51/67 Phase Overcurrent	
Directional	non-directional, forward, reverse
Pickup	0.5 to 50.0 (5A) 0.1 to 10.0 (1A)
Pickup Delay	0.00 to 99.99
50 Breaker Failure Initiated	enabled or disabled
51 Enabled	enabled or disabled
Directional	non-directional, forward, reverse
Pickup	0.5 to 50.0 (5A) 0.1 to 10.0 (1A)
Curve Type	For details see IEC and IEEE Curves " on page 4-8
TMS	0.01 to 10.00
A	0.0010 to 1000.0000
B	0.0000 to 10.0000
p	0.01 to 10.00
TR	0.01 to 100.00
51 Breaker Failure Initiated	enabled or disabled

ProLogic

The ProLogic control statements are used to create Boolean-like logic. The relay uses the protection functions or external inputs combined with logic gates to create a ProLogic control statement. The possible gates are AND, NAND, OR, NOR, XOR, XNOR, and LATCH. You can control the time delay pickup and/or the time delay dropout and drive the front panel target LED. Fifteen ProLogic control statements are available and you can use them in the output matrix to customize the relay to your specific needs. Inputs to ProLogic include all the elements and the previous ProLogic statements and can be used for logic nesting.

The example shows that A to E inputs are status points of devices that are user-selectable. You can give each ProLogic output a specific name, pickup and rest time delay.

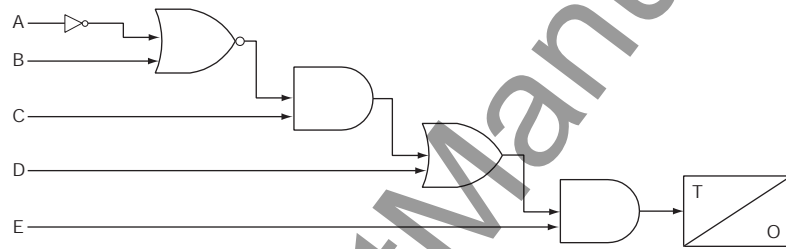


Figure 4.14: ProLogic

Recording Functions

The relay has high speed fault recording and logging functions which allow you to analyze faults and to review the operation of the overall protection scheme. When the relay reaches its recording capacity, new records overwrite the oldest records.

Fault Recording

The relay provides DFR-quality fault recording, capturing input signal waveforms and external input states at a rate of 96 samples per cycle. Each record also contains the timing of the internal logic produced by the relay (e.g. Device 51 trip. Obtain this information by uploading the records from the relay via the terminal mode file transfer process and view them with RecordBase View software.

The quantities recorded are:

- 21 analog channels (3 voltages and 18 currents) @ 96 samples/cycle up to the 25th harmonic
- operating current and restraint current @ 8 samples/cycle
- 9 external inputs @ 1 ms resolution
- up to 154 internal logic signals @ 8 samples/cycle
- 15 ProLogic signals @ 8 samples/cycle.

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

- Record length (0.2–2.0 seconds => 12 – 120 cycles @ 60 Hz Base) with automatic extension to capture successive triggers
- Recorder triggering by any internal logic or external digital input signal

Record Initiation

The relay initiates recording automatically when a fault or abnormal condition is detected. You can set the relay to initiate a fault record on activation of any of its trip or alarm functions or on assertion of any external digital inputs.

The relay's output matrix settings create the assignment of fault record initiation to the various relay functions.

A recording can also be initiated manually through the terminal user interface. The command *Initiate Recording* is available under the *Records* menu.

Record Duration and Extension

The length of each record is determined by the Record Length setting. You can set fault record lengths between 0.2 and 2.0 seconds. Pre-trigger times are fixed at 10 cycles for fault records and are included as part of the normal record length.

The relay automatically extends a record as required to capture consecutive triggers that are close together. If a trigger occurs while a recording is in progress, the record is stretched to include the full post-trigger time of subsequent trigger—up to a maximum length 2.0 seconds for fault records. A new overlapping record is created 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.

Set the normal settings record lengths from either the terminal user interface or the *Offliner* Settings software.

Record Storage

The relay compresses records on the fly, achieving a typical lossless compression rate of 4:1. As a result, the relay stores up to 30 seconds of fault recordings. If the storage is full, new records automatically overwrite the oldest, ensuring that the recording function is always available.

Record Retrieval and Deletion

A listing of stored records is available through the terminal user interface under the *Records>List* menu. The listing transfers records to a connected PC and deletes them from storage.

Example:

BPRO-8701-010306-04-2002-05-15 13.17.16.000(Transient)

Records are named by combining the Relay ID setting with the date and time of the initiating record trigger. The record list shows the record type (transient).

To delete a record from storage, use the up/down cursor keys to select the record, then select *<D>*. You can also do group deleting and group transferring.

To select multiple records:

- 1 Select a record.
- 2 Press the space bar, an asterisk appears to the left of the record to indicate it is selected.
- 3 Continue selecting and pressing the space bar until all desired records are selected.
- 4 Select *<D>*. A message asks "Delete all selected files?". Select *Y* for Yes and the files are deleted.

To transfer a record to your PC, use the up/down cursor keys to select the record, then select *r*. The record is automatically transferred to your PC using the PC terminal program's z-modem file transfer protocol. The record is placed in your terminal program's default to receive the directory which was set before transfer to, (e.g. Windows HyperTerminal's default receive directory is set through the its Transfer menu). When transferred, the record name remains unchanged and the file extension indicates the record type: ".bpr" for transient.

When the transfer has taken place, you can delete the record or leave a copy on the relay.

Event Log

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

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

2002May13 08:44:19.867 A:Input 18 51 Trip

The event log can be viewed in two ways:

Front Panel	The front panel display shows events in abbreviated form (Trip and Alarm events only).
Terminal User Interface	The full event log is available through the Event Log menu of the terminal user interface.
SCADA	The protocols included in the B-PRO allow all the SCADA master access to the event data from the relay.

This display is a snapshot of the event list and you must manually refresh it to show new events occurring while the display is up. If an event initiates, a generation of a record the "(R)" suffix is added to the end of the event log only in terminal user interface.

There is a list of Event Messages, "Event Messages" in Appendix D.

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5 Offliner Settings Software

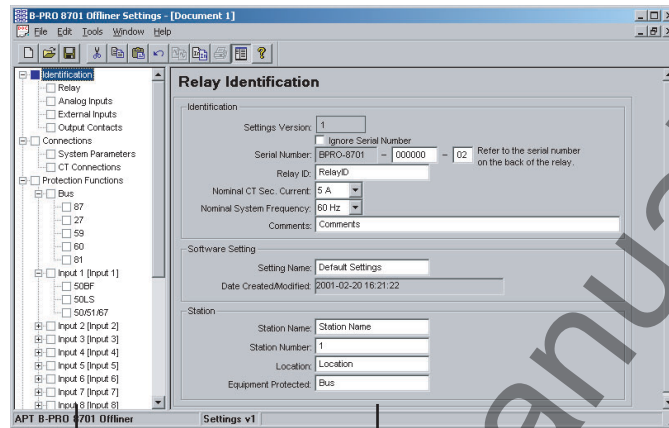


Figure 5.1: Opening Screen

Introduction

Use the *Offliner* Settings software to create relay settings on a PC. *Offliner* Settings provides an easy way to view and manipulate settings.

PC System Requirements

Hardware

The minimum hardware requirements are:

- Pentium processor
- 64 MB of available RAM
- 400 MB of available hard-disk space recommended
- VGA monitor
- CD-ROM drive
- Serial communication port

Operating System

The following software must be installed and functional prior to installing *Offliner* and RecordBase View software:

- Microsoft Windows 95, 98, ME, NT 4.0, 2000 or XP

Installing PC Software

Insert the CD-ROM in your drive. The CD-ROM should open automatically. If the CD-ROM does not open automatically, go to Windows Explorer and find the CD-ROM (usually on D drive). Open the B-PRO.exe file to launch the CD-ROM.

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

To view the B-PRO User Manual you must have Adobe Acrobat on your computer. If you need a copy, download a copy by clicking on Download Adobe Acrobat.

Offliner Features

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

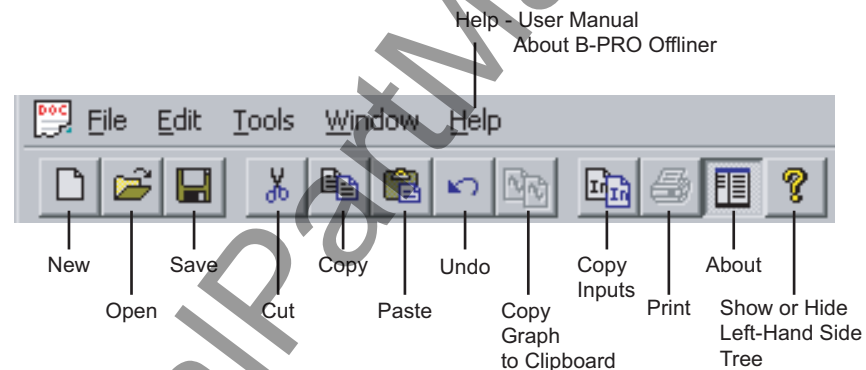


Figure 5.2: Top Tool Bar

Tool Bar	
Windows Menu	
Icon	Restore, minimize, close.
File	New, open, close, save, save as, convert to print, print setup and exit.
Edit	Undo, cut, copy, paste.
Tools	Options
Window	Cascade, tile.
Help	User Manual, About B-PRO Offliner.
Settings Program Icons	
New	Create a new document.
Open	Open an existing document.
Save	Save the active document.

Cut	Cut the selection.
Copy	Copy the selection.
Paste	Insert clipboard contents.
Copy graph to clipboard	Copy graph to clipboard.
Copy Inputs	Copy inputs.
Print	Print active document.
About	Display program information.
Show or Hide Left-Hand Side Tree	Show or Hide the Tree View.
Undo	Undo last action.

Graphing Protection Functions

Grid On/Grid Off

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

Print Graph

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

Zoom on Graphs

Graphs can be zoomed to bring portions of the traces into clearer display. Left-click on any graph and drag to form a small box around the graph area. When you 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.

Copying Input Protection

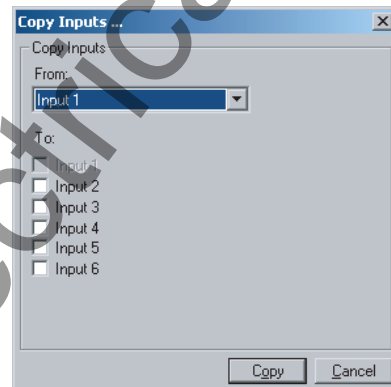


Figure 5.3: Copy Input Protection Functions

Copy inputs by clicking the *Copy Inputs* tool bar button or by selecting the Copy Inputs from the Edit menu option on the main menu bar. This is useful when you want to set each CT connection with the same protection characteristics.

Handling Backward Compatibility

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

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

Converting a Settings File

- 1 Open the setting file you 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 5.4: 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 do not match.

A “serial number discrepancy” message may appear. This is to ensure that you are 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 B-PRO Serial No. box in the Identification tab display area of *Offliner* Settings. Alternately you 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, for details see “ID” on page 3-9. 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 B-PRO *Offliner* is shipped with a set of default sample files of older settings versions. The sample files is “v1 sample.bps”. Each 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\NxtPhase\B-PRO Offliner Settings, or you can choose the path during the *Offliner* software installation. If an older version of B-PRO *Offliner* was previously installed on your PC, then the default directory may be C:\Program Files\APT\B-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.

RecordBase View Software

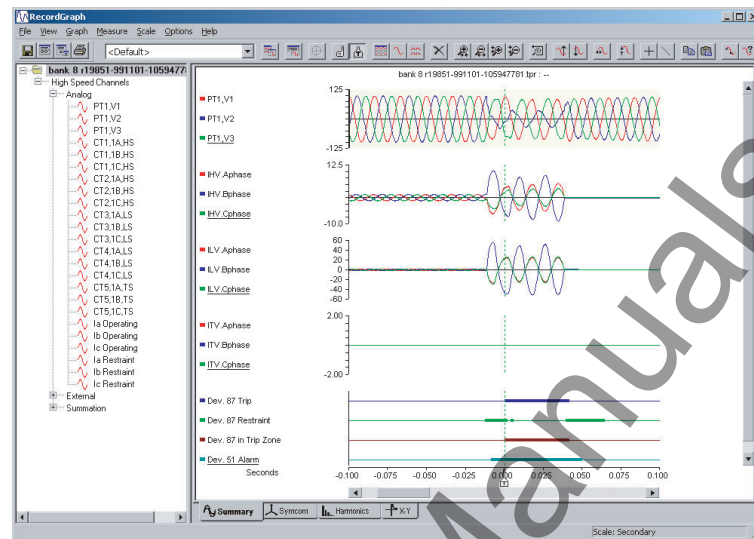


Figure 5.5: RecordBase View

Use RecordBase View to analyze the records from a relay.

- 1 Set the receive directory on your terminal program to point to a convenient directory on your PC's hard disk or network. For example with Windows HyperTerminal, select *Transfer>Receive File* to set the receive directory.
- 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 records by selecting *R* on the keyboard.
- 4 Start the RecordBase View program and use the *File>Open* menu command to open the downloaded record files located in the receive directory specified in step 1.

For further instructions refer to the RecordBase View Manual at the back of the printed version of this manual.

Main Branches from the Tree View

Identification

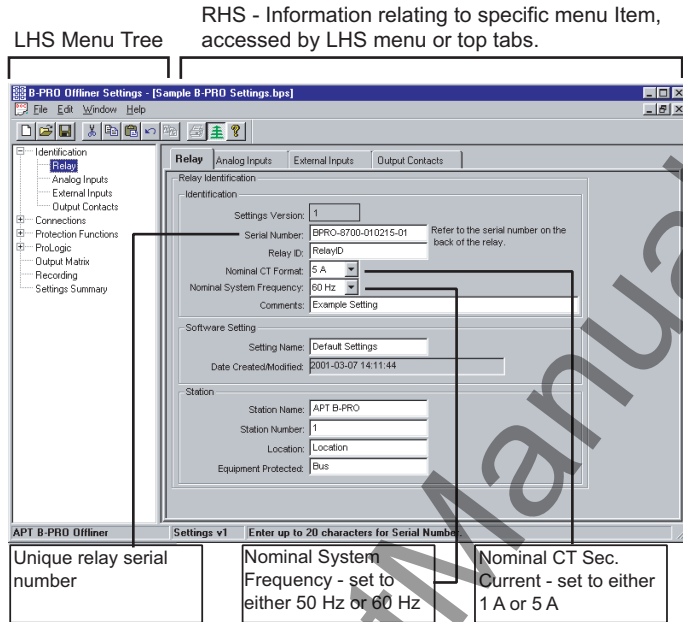


Figure 5.6: Relay Identification

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

Identification	
Settings Version	Indicates the version number.
Ignore Serial Number	Enable/disable
Serial Number	Available at back of each relay.
Unit ID	User-defined up to 20 characters.
Nominal CT Sec. Current	5 A or 1 A
Nominal System Frequency	60 Hz or 50 Hz
Comments	User-defined up to 78 characters.
Setting Software	
Setting Name	User-defined up to 20 characters.
Date Created/Modified	Indicates the last time settings were entered.
Station	
Station Name	User-defined up to 20 characters.
Station Number	User-defined up to 20 characters.
Location	User-defined up to 20 characters.
Bank Name	User-defined up to 20 characters.

Important Note

Nominal CT Sec. Current can be set to either 1 A or 5 A.

Nominal System Frequency can be set to either 50 Hz or 60 Hz.

Ensure setting selection matches that of target B-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.

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

Analog Inputs

The screenshot shows a software window titled "Analog Input Names". It is divided into two main sections: "Voltage Inputs" and "Current Inputs".

Voltage Inputs: This section contains four text input fields:

- "Voltage Input Name:" with the value "BUS PT 1".
- "VA:" with the value "Voltage A".
- "VB:" with the value "Voltage B".
- "VC:" with the value "Voltage C".

Current Inputs: This section contains a grid of 18 text input fields, arranged in three columns and six rows. Each field is labeled with a number from 1 to 18 followed by "Input":

- Column 1: 1: Input 1, 2: Input 2, 3: Input 3, 4: Input 4, 5: Input 5, 6: Input 6
- Column 2: 7: Input 7, 8: Input 8, 9: Input 9, 10: Input 10, 11: Input 11, 12: Input 12
- Column 3: 13: Input 13, 14: Input 14, 15: Input 15, 16: Input 16, 17: Input 17, 18: Input 18

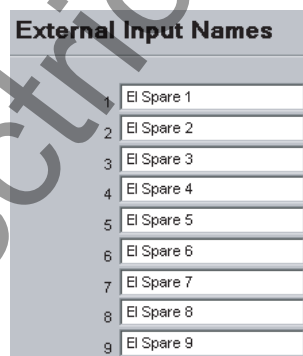
Figure 5.7: Analog Inputs

Identify all ac voltage and current inputs to the relay. These names appear in any fault disturbance records the relay produces.

Analog Input Names	
Voltage Input	Voltage Input Name, VA, VB, VC
Current Inputs	Input 1 to 18
Input 1	Name, I1

Input 2	Name, I2
Input 3	Name, I3
Input 4	Name, I4
Input 5	Name, I5
Input 6	Name, I6
Input 7	Name, I7
Input 8	Name, I8
Input 9	Name, I9
Input 10	Name, I10
Input 11	Name, I11
Input 12	Name, I12
Input 13	Name, I13
Input 14	Name, I14
Input 15	Name, I15
Input 16	Name, I16
Input 17	Name, I17
Input 18	Name, I18

External Inputs



External Input Names

1	EI Spare 1
2	EI Spare 2
3	EI Spare 3
4	EI Spare 4
5	EI Spare 5
6	EI Spare 6
7	EI Spare 7
8	EI Spare 8
9	EI Spare 9

Figure 5.8: External Inputs

Define meaningful names for the nine external inputs.

External Input Names	
1 to 9	User-defined

Output Contacts

Output Contact Names	
Output 1	Out Spare 1
Output 2	Out Spare 2
Output 3	Out Spare 3
Output 4	Out Spare 4
Output 5	Out Spare 5
Output 6	Out Spare 6
Output 7	Out Spare 7
Output 8	Out Spare 8
Output 9	Out Spare 9
Output 10	Out Spare 10
Output 11	Out Spare 11
Output 12	Out Spare 12
Output 13	Out Spare 13
Output 14	Out Spare 14

Figure 5.9: Output Contacts

Define meaningful names for the 14 output contacts.

Output Contact Names	
Outputs 1 to 14	User-defined

Connections

System Parameters

System Parameters		
Bus Base MVA:	<input type="text" value="100.0"/>	MVA Pri
Bus Voltage:	<input type="text" value="230.0"/>	kV Pri
PT Turns Ratio:	<input type="text" value="2000.0"/>	:1
Phase Rotation:	<input type="text" value="ABC"/>	
Directional Control Alpha:	<input type="text" value="0.0"/>	deg
Directional Control Beta:	<input type="text" value="180.0"/>	deg

Figure 5.10: System Parameter

System Parameters	
Bus Base MVA	1.0 to 1000.0 MVA (primary)
Bus Voltage	1.0 to 1000.0 kV (primary)
PT Turns Ratio	1.0 to 10000.0:1
Phase Rotation	ABC or ACB
Directional Control Alpha	-179.0 to 180.0 degrees
Directional Control Beta	0.1 to 360.0 degrees

CT Connections

CT Connections				
Current Inputs	Connected To Bus	CT Turns Ratio (:1)	Digital Control	External Input
1 [Input 1]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
2 [Input 2]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
3 [Input 3]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
4 [Input 4]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
5 [Input 5]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
6 [Input 6]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
7 [Input 7]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
8 [Input 8]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
9 [Input 9]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
10 [Input 10]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
11 [Input 11]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
12 [Input 12]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
13 [Input 13]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
14 [Input 14]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
15 [Input 15]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
16 [Input 16]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
17 [Input 17]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None
18 [Input 18]	<input checked="" type="checkbox"/>	100.0	<input checked="" type="checkbox"/>	None

Figure 5.11: CT Connections

This setting provides the relay with the information related to CT ratios. All CTs used for bus protection must be wired in wye.

Assign up to 18 sets of ac currents to the relay. Assigning a current to NC (no connection) makes it available to recording and overcurrent functions.

The relay allows assignment of digital control to the ac input; the ac current input is automatically shut off internally when the corresponding external input is high. The relay's 9 digital inputs control each of 18 ac current inputs. In this way, the differential protection and overcurrent protection automatically adapt to the different bus configurations in real time.

CT Connections	
Current Inputs	Input 1 to Input 18
Connected to Bus	Enabled or not enabled
CT Turns Ratio (:1)	1.0 to $\text{Min} \left(10000.0, \frac{\text{BusBaseMVA}}{0.5\sqrt{3} \times \text{BusVoltage}} \right)$
Digital Control	Enabled or not enabled
External Input	External Input 1 to 9

The CT turns ratio upper limit is based on the system primary base current multiplied by 2. For example, if the system base current is 250 amps, the CT turns ratio upper limit will be 500.

Protection Functions

The protection function features are described in detail, see “Protection Function Descriptions” on page 4-1.

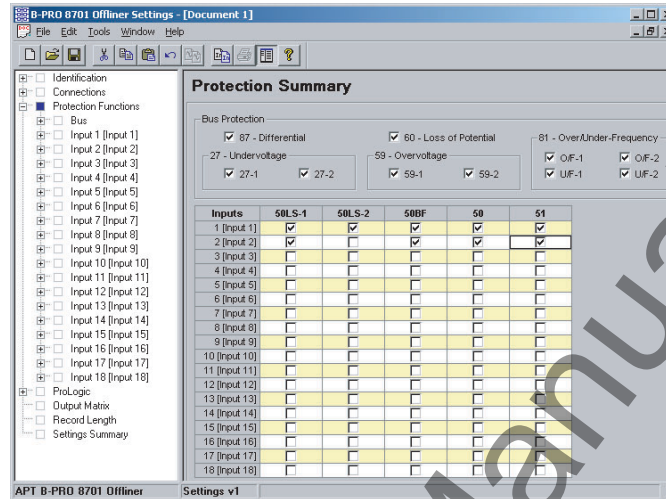


Figure 5.12: Protection Functions

ProLogic

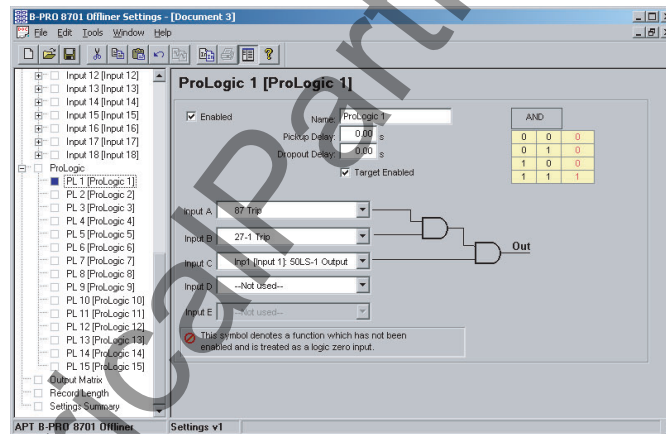


Figure 5.13: ProLogic Example - Lockout Trip

The relay’s integrated ProLogic feature provides Boolean control logic (graphic-driven) with multiple inputs to create an output based on qualified inputs. ProLogic enables up to 10 ProLogic control statements and allows those logics to be programmed to output contacts. Name the function being created and set a pickup and dropout delay. Start with input A by selecting any of the relay functions or digital inputs using the drop-down list. Repeat for up to 5 possible inputs. Put these inputs into AND/OR, NAND/NOR and exclusive logics by clicking on the gate. Invert the input by clicking on the input line.

The output of ProLogic 1 can be nested into ProLogic 2 and so forth. If Target Enabled is selected, you can illuminate the front target LED on operation of this function. The operation of the ProLogic statements are logged on the events listing. ProLogic statements are shown on the view fault records.

Output Matrix

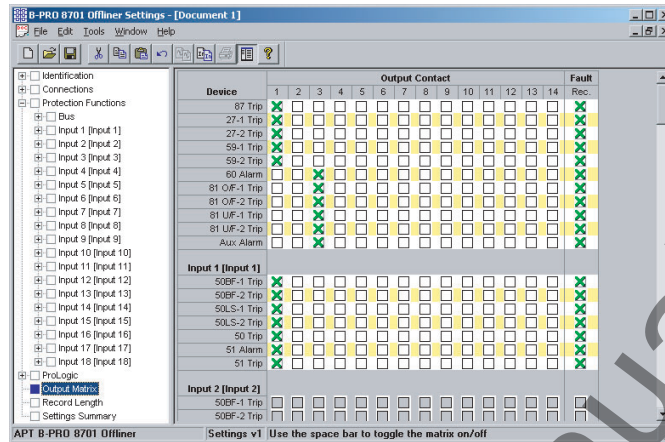


Figure 5.14: Output Matrix

The Output Matrix assigns protective functions to specific output relays and allows these internal protection functions to initiate fault recording. Clicking the check box toggles between checked and unchecked. A scroll bar on the right shows all the protection functions. The recording column on the extreme right allows the protection function to initiate a fault record. The alarm functions for time delay elements and refers to options that are selectable to determine when the threshold level of that function has been exceeded. All output relays have a 0.1 second stretch time.

At this stage the basic differential offline settings of the relay are complete. Save the settings to a file and then load this file into the relay after the terminal connection with the relay is established.

The output contact matrix determines which function initiates which output relay. Functions also initiate recording as required.

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

Print the entire output matrix by selecting the printer icon. This printout is produced on 2 pages.

Record Length

Record Length

Pre-fault time fixed at 10 cycles.
Sample rate fixed at 96 samples per cycle.

Fault Record Length: seconds

Figure 5.15: Record Length

Record Length	
Pre fault time fixed at 10 cycles	
Sample rate fixed at 96 samples per cycle	
Fault Record Length (seconds)	0.2 to 2.0

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

The record length identifies the amount of time of each fault record. Prefault is fixed at 10 cycles.

Setting Summary

The screenshot shows the 'B-PRO 8701 Offliner Settings - [Document 3]' window. The 'Settings Summary' tab is active, displaying a table of settings. The table has columns for Name, Symbol/Value, Unit, and Range. The settings are organized into sections: Relay Identification and Analog Input Names.

Name	Symbol/Value	Unit	Range
Relay Identification			
Settings Version	1		
Ignore Serial Number	No		
Serial Number	BPRO-8701-000000-02		
Nominal CT Secondary Current	5 A		
Nominal System Frequency	60 Hz		
Relay ID	RelayID		
Comments	Comments		
Date Created-Modified	2001-02-20 16:21:22		
Station Name	Station Name		
Station Number	1		
Location	Location		
Equipment Protected	Bus		
Analog Input Names			
Voltage Input Name	BUS PT 1		
VA	Voltage A		
VB	Voltage B		
Vc	Voltage C		
Input 1	Input 1		
Input 2	Input 2		
Input 3	Input 3		
Input 4	Input 4		
Input 5	Input 5		

Figure 5.16: Settings Summary

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

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6 Testing the B-PRO Functions

You can set Nominal CT Secondary Current to either 5 A or 1 A and Nominal System Frequency to either 60 Hz or 50 Hz. For this example the setting is 5 A/60 Hz.

Relay testing is required to determine if the relay performs correctly after the settings are complete or to determine verification of relay settings as needed. In most cases a simple test using three voltage sources and two current sources is adequate. Testing the bus differential element requires up to 18 single phase current sources when used in full capability. Use all the available metering functions during testing to verify issues such as polarities of voltage and current signals.

Calibration

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

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

To perform a calibration, you must be logged into the relay in Terminal Mode at the Service access level. Proceed to the *Utilities>Maintenance>Calibrate*. The Calibrate menu leads you through every analog input and prompts you to apply the appropriate quantity.

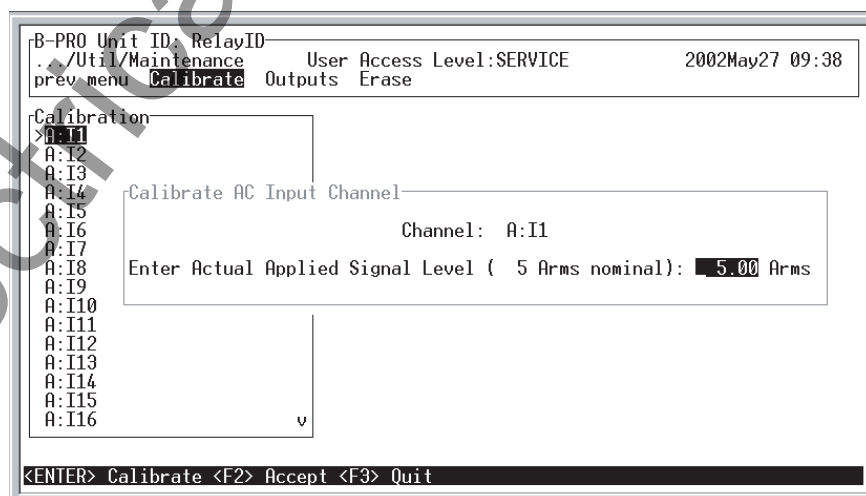


Figure 6.1: Enter actual applied signal level

```

B-PRO Unit ID: RelayID
.../Util/Maintenance      User Access Level:SERVICE      2002May27 09:40
prev menu Calibrate      Outputs Erase

rCalibration
>A:I1
A:I2
A:I3
A:I4      rCalibrate AC Input Channel
A>Status Message
A
A Calibrate error. Gain reading +0.00 out of range ( +4.00 to +6.00)
A
A
A
A
A:I11
A:I12
A:I13
A:I14
A:I15
A:I16
v

<ENTER> Calibrate <F2> Accept <F3> Quit

```

Figure 6.2: Calibration error – out of range

For example, when you select voltage V_A for calibration, a prompt appears asking you which quantity the relay should try to calibrate. If a 66 volt phase to neutral quantity is applied to the back V_A terminals, 66.0 volts would be indicated as the desired calibration.

In a similar way, you are prompted to go through all 21 ac analog quantities and to provide the information about the injected calibration quantities. You must have a test source to perform the function. Only the magnitude of the analog input requires calibration, not the angle.

When an input analog channel is calibrated, you can verify the quantity measured by selecting the *Metering* menu and the *Analog Quantity* submenu. The V_A of the ac voltage input is used as a reference quantity by the relay. Therefore, if it is absent, there is no locked, valid relationship among all of the analog quantities.

Testing the External Inputs

To test the external inputs, connect the relay to a laptop in Terminal Mode at Service level, *Metering>I/O*. This screen displays the status of the input and output contacts. Placing a voltage of 125 Vdc nominal, (150 V maximum) to each of the external inputs in turn causes the input to change from low to high status. These inputs are polarity sensitive and this screen has a 0.5 seconds update rate. The inputs should reset when the dc voltage drops below 80 volts. Testing requires application of a correct voltage polarity.

Testing the Output Relay Contacts

Test the output relay contacts to verify their integrity using *Utilities>Maintenance>Outputs*. Use the *Enter* key to toggle the output contacts from open to closed. Verify the output contact status using an ohmmeter. When you exit this sub-menu, all contact status reverts to the open position.

When you enter this screen the protection functions are blocked from operating the output contacts. If you close your communications program without logging out properly the relay will revert back to normal operation enabling the protection functions to operate the output contacts.

Testing the Bus Differential Characteristic

B-PRO bus differential function 87 uses five settings to create a two slope percentage differential characteristic. The settings IOmin, S1, IRs, S2, and IOh create a no tripping zone, a restrained tripping zone and an un-restrained tripping zone. The relay differential function calculates two currents, one is I operate (IO) and the other is I restraint (IR). These two currents determine whether the 87 is in the trip or no trip zone. You can calculate three other currents from the characteristic curve to test the differential function.

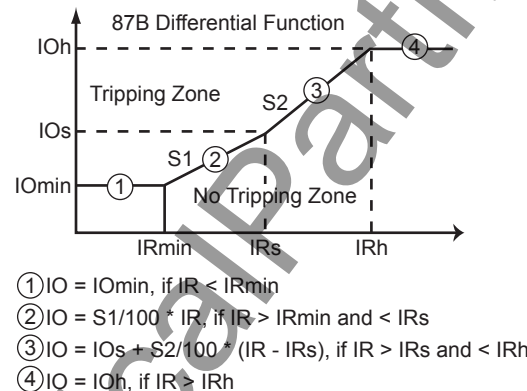


Figure 6.3: Differential Function

$$\text{Equation 1: } IR_{min} = IO_{min} * 100/S1$$

$$\text{Equation 2: } IO_s = IR_s * S1/100$$

$$\text{Equation 3: } IO = IO_s + S2/100 * (IR - IR_s)$$

Testing the IOmin Pickup Setting

First test the IO min value of the relay. The IO min setting is 0.25 per unit and is related to the protected bus. By injecting secondary current into terminals I1, and I2 you represent currents that are connected to the 50 MVA bus. Using the bus base MVA and bus voltage 230 kV, the per unit current (per unit) becomes 125 A primary, or $125 \times 5/600 = 1.046$ secondary amps, therefore, $0.25 \times 1.046 = 0.131$ secondary amps.

Testing the IRmin Pickup Setting

The IRmin pickup value is determined from Equation 1 and becomes $(0.25 \times 100)/20 = 1.25$ per unit.

To test this point, we need an IO value of 0.25 per unit and a IR value of 1.25 per unit.

This becomes:

$$IO = 0.25 \text{ per unit} = \text{vectors } (I1) - (I2)$$

$$IR = 1.25 \text{ per unit} = (I1 + I2)/2$$

Solving for I1 test current produces, $I1 = 1.375$ per unit or $1.375 \times 1.046 = 1.44$ secondary amps into I1.

Using this value of I1 substitute into the IO or IR equation to solve for the I2 test current.

Solving for I2 test current produces, $I2 = 1.125$ per unit or $1.125 \times 1.046 = 1.18$ secondary amps into I2.

$$\text{Test current into I1} = 1.375 \times 1.046 = 1.44 \text{ secondary amps}$$

$$\text{Test current into I2} = 1.125 \times 1.046 = 1.18 \text{ secondary amps}$$

Test currents I1 and I2 have a 180 degrees phase shift. Set I2 equal to the test value of I1 and decrease I2 until the relay operates. The resulting value equals the calculated test current.

Testing the IOs Breakpoint

The IOs breakpoint exists between slope 1 and slope 2 of the differential characteristic. In this example, the setting for IRs = 2.0 per unit. From Equation 2 we can calculate $IO = 0.40$ per unit.

Therefore,

$$IO = 0.40 \text{ per unit} = \text{vectors } (I1) - (I2)$$

$$IR = 2.00 \text{ per unit} = (I1 + I2)/2$$

Solving for I1 and I2 produces:

$$\text{Test current into I1} = 2.2 \times 1.046 = 2.301 \text{ secondary amps}$$

$$\text{Test current into I2} = 1.8 \times 1.046 = 1.883 \text{ secondary amps}$$

Testing the IRs Breakpoint

The IRh breakpoint exists between slope 2 and the IOh setting of the differential characteristic. In this example, the setting for IRs = 2.0 per unit, IOh = 4.0 per unit, and IOs = 0.40 per unit. From Equation 3 we can substitute IO for the IOh setting and solve for IRh.

Solving for IRh results in the following formula:

$$IRh = IRs + 100/S2 * (IOh - IOs), \text{ when solved } IRh = 11.0 \text{ per unit}$$

Therefore,

$$IO = 4.0 \text{ per unit} = \text{vectors } (I1) - (I2)$$

$$IR = 11.00 \text{ per unit} = (I1 + I2)/2$$

Solving for I1 and I2 produces:

Test current into I1 = $13.0 \times 1.046 = 13.597$ secondary amps

Test current into I2 = $9.0 \times 1.046 = 9.413$ secondary amps

Testing the High Set Unrestrained Setting

Test the high set unrestrained function by calculating an expected IO based on an IR greater than the IRh knee point previously calculated.

Use Equation 3 and substitute IR with a value greater than the IRh. We are using a value of 11.5 per unit.

Solving for I1 and I2 produces:

Test current into I1 = $13.6 \times 1.046 = 14.225$ secondary amps

Test current into I2 = $9.4 \times 1.046 = 9.832$ secondary amps

When you inject the test currents, the 87 function operates with a higher value of I2 than what was calculated. Checking the *Metering>Analog>Operating* screen shows that the relay operates as soon as IO reaches the IOh setting of 4.0 per unit.

Testing the Inverse Time Overcurrent Function

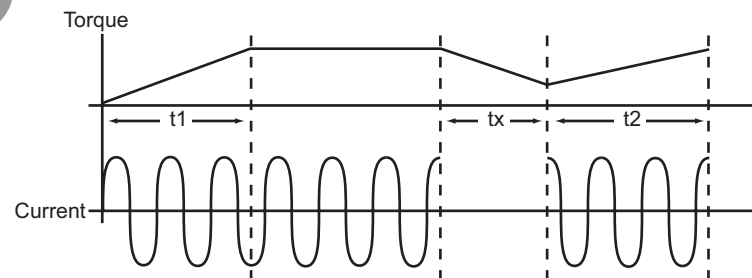
Test function 51 by injecting current into the relay. The setting pickup of function 51 is done on a secondary current basis.

The equation for the IEEE overheating curves is displayed in the B-PRO *Offliner* Settings program and can be used to determine how long it takes to operate the overcurrent function for a given input current. The overcurrent curve function is equation-driven and uses fixed constants to generate the operation curves. See “50/51/67 Phase Overcurrent” on page 4-8 for details on the equations and constants.

Test the 51 reset time by using the following example and equations. Use your test software to setup an appropriate test sequence and measure time t1, tx and t2 to determine the relay’s performance with your setting parameters.

Equation 1

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



If $(t_x > t_{(I)})$ then $t_2 = t_1$

$$t_2 = \frac{t_x}{t_m} \cdot t_1$$

Where t_1 equals the time to operate for the applied current and t_m equals the value of solving *Equation 1*.

Testing the Loss of Potential Function

There are no user settings for device 60. If one or two of the voltages go below 0.5 per unit or below 33.2 secondary volts, a loss of potential alarm will take place after a definite 10 second delay. You can test this by dropping all combinations of one and two voltages and waiting 10 seconds

Some Additional Points to Consider

In all of the test cases, you can set the relay to trigger a fault record. You can view the fault record and the location where the operation point crosses into the trip region. Also, you can perform any combination of injected currents to test all the functions of the relay. That is, the differential function between any two inputs can be performed. You can perform a test using all 18 currents, presuming that 18 synchronized currents are available. A verification of the operate (IO) and restraint (IR) quantities is possible through the Terminal Mode by selecting the Operating Quantities sub-menu which indicates the current per unit quantity relationship in the relay.

Most protection functions have pickup level outputs available which can be programmed to produce outputs by enabling them in the Output Matrix screens. These functions are useful during testing, especially time delayed functions where you are trying to determine where the function is starting to pickup.

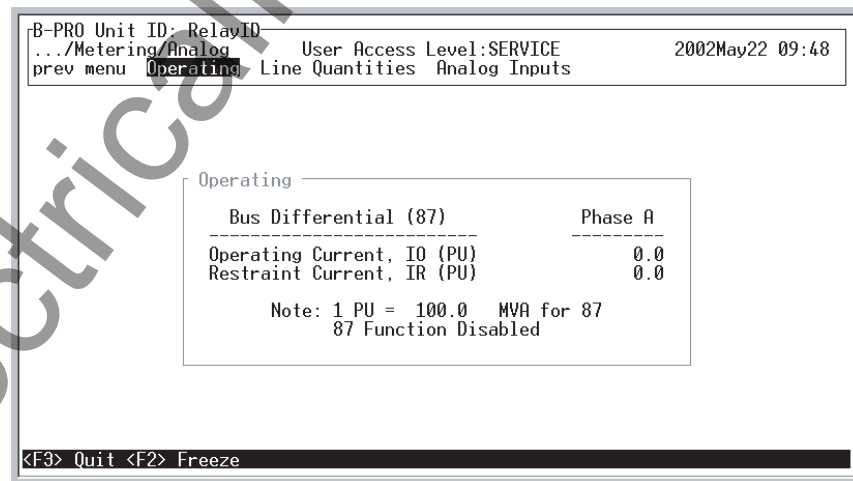


Figure 6.4: Operating Quantities

7 Installation

Physical Mounting

Standard 3U

The relay is 3 rack units or 5.25 inches high and approximately 12.25 inches deep. The standard relay is designed for a 19-inch rack. A complete mechanical drawing is shown, for details see “Mechanical Drawings” in Appendix G.

To install the relay you need the following:

- 19 inch rack
- 4 - #10 screws

AC and DC Wiring

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

Communication Wiring

EIA-232

The relay’s three serial ports (Ports 1, 2 and 3) are configured as EIA RS-232 Data Communications Equipment (DCE) devices with female DB9 connectors. This allows them to be connected directly to a PC serial port with a standard straight-through male-to-female serial cable. For pin-out details see “Communication Port Details” on page 2-9.

An adapter is available for connecting an external modem to Port 2. For details, see “Modem Link - External” on page 2-3.

RJ-45

The relay may have an optional internal modem or an optional internal 10BaseT Ethernet port. Connection to either of these is via the relay’s Port 5 RJ-45 receptacle. Labeling above the port will indicate which option, if any, has been installed.

IRIG-B Wiring

The relay accepts both modulated and unmodulated IRIG-B standard time signals with or without the IEEE 1344 extensions. The IRIG-B connector on the back of the relay is BNC type.

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Appendix A IED Specifications

B-PRO Model 8701/BUS Specification		
Item	Quantity/Specs	Note
General:		
Nominal Frequency	50 or 60 Hz	
Operate Time	8–20ms for 87 function	Including relay output operation.
Sampling Rate	96 samples/cycle for recording 8 samples/cycle for protection	
Power Supply	Nominal Range: 48–250 Vdc, 120 Vac Full Operating Range: 40–300 Vdc	
Memory	Settings and records are stored in non-volatile memory.	Records are stored in a circular buffer.
Protection Functions:		
IEEE Dev. 27, 59, 60, 81, 87, 50BF, 50LS, 50/51/67	Overcurrent protection on each CT input	15 ProLogic statements provide flexible solutions.
Recording:		
Transient	96 s/c oscillography of all analog and external input channels. Capacity: up to 15 x 2 second records	Records up to the 25th harmonic. Viewing software provides waveform, symmetrical components and harmonic analysis.
A/D Resolution	13 bits, 8192 counts full scale, peak–peak	
Events	250	
Input and Output:		
Analog Input Channels	18 currents and 3 voltages	Rating: $I_n = 5 \text{ A}$ or 1 A $V_n = 69 \text{ V}$ Continuous: $3 \times I_n$, $2 \times V_n$ One Second: $20 \times I_n$ without distortion One Minute: $3 \times V_n$, once/hour
Sampling Resolution	12 bits plus sign, amplitude measurement accuracy: $\pm 0.5\%$ for 54 to 66 Hz	
Burden	ac input voltage: $< 0.15 \text{ VA @ } 67 \text{ V}$ ac input current: $< 0.50 \text{ VA @ } 5 \text{ A}$	
Analog Input Sampling	Sample rate: 96 samples/cycle for recording, 8x/cycle for protection.	
External Inputs	9 isolated inputs.	Optional 48–125 or 125–250 Vdc nominal, externally wetted.
Burden	Burden resistance: $> 10 \text{ k ohms}$	
Isolation	Internal optical isolation	

B-PRO Model 8701/BUS Specification		
Sample Rate	1 ms	
Output Relays (contacts)	14 programmable outputs plus relay inoperative contact	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
Interface & Communication:		
Front Display	2 lines x 24 characters, fluorescent	Exceptional visibility in all ambient light conditions.
Front Panel Indicators	6 LEDs	Target, Relay Functional, IRIG-B Functional, Service Required, Test Mode, Alarm.
Serial User Interface	Front and rear RS-232 ports to 57.6 K baud	Rear port can support an external modem
Internal Modem	33.6 Kbps, V.32 bis	Optional internal modem
Network	10 Base T Ethernet port	Optional Ethernet card
SCADA Interface	DNP3 (RS-232 or Ethernet) or Modbus (RS-232)	Rear port
Time Sync	IRIG-B, BNC connector	Modulated or unmodulated, auto-detect
Self Checking/Relay Inoperative	1 contact	Closed when relay inoperative.
Terminal User Interface	VT100 terminal emulation	Accessible via serial, modem or network interface.
Environmental:		
Ambient Temperature Range	-40°C to 85°C	IEC 60068-2-1/IEC 60068-2-2
Humidity	Up to 95% without condensation	IEC 60068-2-30
Insulation Test (Hi-Pot)	Power supply, analog inputs, external inputs, output contacts – 1.5 kV, 50/60 Hz, 1 minute.	IEC 60255-5
Electrical Fast Transient		ANSI/IEEE C37.90.1 - 1989
Oscillatory Transient		ANSI/IEEE C37.90.1 - 1989
RFI Susceptibility		ANSI/IEEE C37.90.2, IEC 255-22-3
Shock and Bump		IEC 60255-21-2 Class 1
Sinusoidal Vibration	10Hz to 150Hz, 0.15mm or 20m/s ² 10 sweep cycles	IEC 60068-2-6
Physical:		
Weight	11.52 kg	25.40 lbs
Dimensions	13.3 cm	3U high, 5.25"
	48.3 cm rack mount	19" rack mount
	30.5 cm deep	12" deep

B-PRO Model 8701/BUS Specification		
Mounting	vertical or horizontal	Specified at time of order.
Time Synchronization and Accuracy:		
External Time Source	The B-PRO relay is synchronized using IRIG-B input (modulated or unmodulated) auto detect.	Free Running Accuracy: In the absence of an external time source, the relay maintains time with a maximum ± 15 minutes drift per year over the full operating temperature range, and maximum ± 90 seconds drift per year at a constant temperature of 25°C. The relay can detect loss or re-establishment of external time source and automatically switch between internal and external time.
Synchronization Accuracy	Sampling clocks synchronized with the time source (internal or external).	
Overall B-PRO Accuracies:		
Current	$\pm 2.5\%$ of inputs from 0.1 to 1.0 x nominal current (In)	
	$\pm 1.0\%$ of inputs from 1.0 to 20.0 x nominal current (In)	
Voltage	$\pm 1.0\%$ of inputs from 0.01 to 2.0 x nominal voltage (Vn)	
Directional Phase Angle	$\pm 2.0^\circ$ of set value of Positive Sequence Line Angle value from 25.0° to 89.0°	
Timers	± 3 ms of set value	
Inverse Overcurrent Times	$\pm 2.5\%$ or ± 1 cycle of selected curve	
Definite Overcurrent Times	$\pm 2.5\%$ or ± 1 cycle non-directional	
	$\pm 2.5\%$ or ± 1.5 cycle directional	
Frequency Timers	± 3 ms of set value plus 1.25 cycles to 1.75 cycles of inherent delay	
Burden	AC Voltage Inputs, < 0.15 VA @ 69 volts	
	AC Current Inputs, < 0.50 VA @ 5 amps	

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Appendix B IED Settings Summary

Settings Summary - B-PRO 8701			
Name	Symbol/Value	Unit	Range
Relay Identification			
Settings Version	1		
Ignore Serial Number	No		
Serial Number	BPRO-8701-000000-02		
Nominal CT Secondary Current	5 A		
Nominal System Frequency	60 Hz		
Relay ID	RelayID		
Comments	Comments		
Date Created-Modified	2001-02-20 16:21:22		
Station Name	Station Name		
Station Number	1		
Location	Location		
Equipment Protected	Bus		
Analog Input Names			
Voltage Input Name	BUS PT 1		
VA	Voltage A		
VB	Voltage B		
VC	Voltage C		
Input 1	Input 1		
Input 2	Input 2		
Input 3	Input 3		
Input 4	Input 4		
Input 5	Input 5		
Input 6	Input 6		
Input 7	Input 7		
Input 8	Input 8		
Input 9	Input 9		
Input 10	Input 10		
Input 11	Input 11		
Input 12	Input 12		
Input 13	Input 13		
Input 14	Input 14		
Input 15	Input 15		
Input 16	Input 16		

Settings Summary - B-PRO 8701			
Input 17	Input 17		
Input 18	Input 18		
External Input Names			
1	EI Spare 1		
2	EI Spare 2		
3	EI Spare 3		
4	EI Spare 4		
5	EI Spare 5		
6	EI Spare 6		
7	EI Spare 7		
8	EI Spare 8		
9	EI Spare 9		
Output Contact Names			
Output 1	Out Spare 1		
Output 2	Out Spare 2		
Output 3	Out Spare 3		
Output 4	Out Spare 4		
Output 5	Out Spare 5		
Output 6	Out Spare 6		
Output 7	Out Spare 7		
Output 8	Out Spare 8		
Output 9	Out Spare 9		
Output 10	Out Spare 10		
Output 11	Out Spare 11		
Output 12	Out Spare 12		
Output 13	Out Spare 13		
Output 14	Out Spare 14		
System Parameters			
Bus MVA	100.0	MVA Primary	1.0 to 1000.0
Bus Voltage	230.0	kV Primary	1.0 to 1000.0
PT Turns Ratio	10000.0	:1	1.0 to 10000.0
Phase Rotation	ABC		
Directional Control Alpha	0.0	degrees	-179.9 to 180.0
Directional Control Beta	180.0	degrees	0.1 to 360.0
CT Connections			
Input 1 [Input 1]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		

Settings Summary - B-PRO 8701			
External Input	None		
Input 2 [Input 2]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 3 [Input 3]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 4 [Input 4]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 5 [Input 5]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 6 [Input 6]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 7 [Input 7]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 8 [Input 8]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 9 [Input 9]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0

Settings Summary - B-PRO 8701			
Digital Control	Enabled		
External Input	None		
Input 10 [Input 10]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 11 [Input 11]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 12 [Input 12]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 13 [Input 13]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 14 [Input 14]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 15 [Input 15]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 16 [Input 16]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 17 [Input 17]			
Connected To Bus	Yes		

Settings Summary - B-PRO 8701			
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Input 18 [Input 18]			
Connected To Bus	Yes		
CT Turns Ratio	100.0	:1	1.0 to 502.0
Digital Control	Enabled		
External Input	None		
Protection Summary			
87	Enabled		
59-1	Enabled		
59-2	Disabled		
27-1	Enabled		
27-2	Enabled		
60	Enabled		
81 O/F-1	Enabled		
81 O/F-2	Enabled		
81 U/F-1	Enabled		
81 U/F-2	Enabled		
Input 1 [Input 1] Protection			
50LS-1	Enabled		
50LS-2	Enabled		
50BF	Enabled		
50	Enabled		
51	Enabled		
Input 2 [Input 2] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 3 [Input 3] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 4 [Input 4] Protection			
50LS-1	Disabled		

Settings Summary - B-PRO 8701			
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 5 [Input 5] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 6 [Input 6] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 7 [Input 7] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 8 [Input 8] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 9 [Input 9] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 10 [Input 10] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		

Settings Summary - B-PRO 8701			
51	Disabled		
Input 11 [Input 11] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 12 [Input 12] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 13 [Input 13] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 14 [Input 14] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 15 [Input 15] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 16 [Input 16] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 17 [Input 17] Protection			
50LS-1	Disabled		

Settings Summary - B-PRO 8701			
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
Input 18 [Input 18] Protection			
50LS-1	Disabled		
50LS-2	Disabled		
50BF	Disabled		
50	Disabled		
51	Disabled		
87 - Differential			
87	Enabled		
I _{Omin}	0.25	p. u.	0.20 to 0.40
IRs	2.00	p. u.	1.25 to 50.00
S1	20.00	%	12.50 to 40.00
S2	40.00	%	30.00 to 200.00
High Curr. Setting	10.00	p. u.	0.75 to 100.00
CT Saturation Detection			
CT Saturation Max Block	1.00	-	0.10 to 99.99
59 - Overvoltage			
59-1	Enabled		
Gate Switch	OR		
Pickup	70.0	volts	60.0 to 140.0
Pickup Delay	1.00	seconds	0.00 to 99.99
59-2	Disabled		
Gate Switch	OR		
Pickup	70.0	volts	60.0 to 140.0
Pickup Delay	1.00	seconds	0.00 to 99.99
27 - Undervoltage			
27-1	Enabled		
Gate Switch	OR		
Pickup	20.0	volts	1.0 to 120.0
Pickup Delay	1.00	seconds	0.00 to 99.99
27-2	Enabled		
Gate Switch	OR		
Pickup	20.0	volts	1.0 to 120.0
Pickup Delay	1.00	seconds	0.00 to 99.99
60 - Loss of Potential Alarm			
60	Enabled		

Settings Summary - B-PRO 8701			
81 - Over-Frequency			
81 O/F-1	Enabled		
Pickup	61.00	Hz	60.00 to 70.00
Pickup Delay	2.00	seconds	0.05 to 99.99
81 O/F-2			
81 O/F-2	Enabled		
Pickup	62.00	Hz	60.00 to 70.00
Pickup Delay	2.00	seconds	0.05 to 99.99
81 - Under-Frequency			
81 U/F-1			
81 U/F-1	Enabled		
Pickup	59.50	Hz	50.00 to 60.00
Pickup Delay	2.00	seconds	0.05 to 99.99
81 U/F-2			
81 U/F-2	Enabled		
Pickup	59.00	Hz	50.00 to 60.00
Pickup Delay	2.00	seconds	0.05 to 99.99
Input 1 [Input 1], 50LS - Low Set Overcurrent			
50LS-1			
50LS-1	Enabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2			
50LS-2	Enabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 1 [Input 1], 50BF - Breaker Failure			
50BF			
50BF	Enabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 1 [Input 1], 50/51/67 - Phase Overcurrent			
50			
50	Enabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51			
51	Enabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		

Settings Summary - B-PRO 8701			
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	
TMS	0.50	-	0.01 to 10.00
Input 2 [Input 2], 50LS - Low Set Overcurrent			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 2 [Input 2], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 2 [Input 2], 50/51/67 - Phase Overcurrent			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 3 [Input 3], 50LS - Low Set Overcurrent			

Settings Summary - B-PRO 8701			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 3 [Input 3], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 3 [Input 3], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 4 [Input 4], 50LS - Low Set Overcurrent			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 4 [Input 4], 50BF - Breaker Failure			
50BF	Disabled		

Settings Summary - B-PRO 8701			
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 4 [Input 4], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 5 [Input 5], 50LS - Low Set Overcurrent			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 5 [Input 5], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 5 [Input 5], 50/51/67 - Phase Over-current			
50	Disabled		

Settings Summary - B-PRO 8701			
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 6 [Input 6], 50LS - Low Set Overcurrent			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 6 [Input 6], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 6 [Input 6], 50/51/67 - Phase Overcurrent			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		

Settings Summary - B-PRO 8701			
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	
TMS	0.50	-	0.01 to 10.00
Input 7 [Input 7], 50LS - Low Set Overcurrent			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 7 [Input 7], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 7 [Input 7], 50/51/67 - Phase Overcurrent			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 8 [Input 8], 50LS - Low Set Overcurrent			

Settings Summary - B-PRO 8701			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 8 [Input 8], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 8 [Input 8], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 9 [Input 9], 50LS - Low Set Overcurrent			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 9 [Input 9], 50BF - Breaker Failure			
50BF	Disabled		

Settings Summary - B-PRO 8701			
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 9 [Input 9], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 10 [Input 10], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 10 [Input 10], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 10 [Input 10], 50/51/67 - Phase Over-current			
50	Disabled		

Settings Summary - B-PRO 8701			
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 11 [Input 11], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 11 [Input 11], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 11 [Input 11], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		

Settings Summary - B-PRO 8701			
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	
TMS	0.50	-	0.01 to 10.00
Input 12 [Input 12], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 12 [Input 12], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 12 [Input 12], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 13 [Input 13], 50LS - Low Set Over-current			

Settings Summary - B-PRO 8701			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 13 [Input 13], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 13 [Input 13], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	seconds	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 14 [Input 14], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 14 [Input 14], 50BF - Breaker Failure			
50BF	Disabled		

Settings Summary - B-PRO 8701			
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 14 [Input 14], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 15 [Input 15], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 15 [Input 15], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 15 [Input 15], 50/51/67 - Phase Over-current			
50	Disabled		

Settings Summary - B-PRO 8701			
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 16 [Input 16], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 16 [Input 16], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 16 [Input 16], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		

Settings Summary - B-PRO 8701			
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	
TMS	0.50	-	0.01 to 10.00
Input 17 [Input 17], 50LS - Low Set Over-current			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 17 [Input 17], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 17 [Input 17], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	amperes	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Input 18 [Input 18], 50LS - Low Set Over-current			

Settings Summary - B-PRO 8701			
50LS-1	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
50LS-2	Disabled		
Pickup	1.0	amperes	0.1 to 50.0
Pickup Delay	0.00	seconds	0.00 to 99.99
Input 18 [Input 18], 50BF - Breaker Failure			
50BF	Disabled		
BF Initiated By 87	Disabled		
BF Initiated By ProLogic	Disabled		
BF Initiated By Ext. Input	Disabled		
Pickup Delay 1	0.50	seconds	0.01 to 99.99
Pickup Delay 2	1.50	seconds	0.01 to 99.99
Input 18 [Input 18], 50/51/67 - Phase Over-current			
50	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Pickup Delay	1.00	seconds	0.00 to 99.99
Breaker Failure Initiated	Disabled		
51	Disabled		
Directional Control	forward		
Pickup	10.0	amperes	0.5 to 50.0
Breaker Failure Initiated	Disabled		
Curve Type	IEC very inverse		
A	13.5	-	-
B	0.0	-	-
p	1.0	-	-
TR	47.30	-	-
TMS	0.50	-	0.01 to 10.00
Record Length			
Fault Record Length	0.5	seconds	0.2 to 2.0
PL 1 [ProLogic 1]			
ProLogic 1	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		

Settings Summary - B-PRO 8701			
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 2 [ProLogic 2]			
ProLogic 2	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 3 [ProLogic 3]			
ProLogic 3	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 4 [ProLogic 4]			

Settings Summary - B-PRO 8701			
ProLogic 4	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 5 [ProLogic 5]			
ProLogic 5	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 6 [ProLogic 6]			
ProLogic 6	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			

Settings Summary - B-PRO 8701			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 7 [ProLogic 7]			
ProLogic 7	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 8 [ProLogic 8]			
ProLogic 8	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 9 [ProLogic 9]			
ProLogic 9	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00

Settings Summary - B-PRO 8701			
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 10 [ProLogic 10]			
ProLogic 10	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 11 [ProLogic 11]			
ProLogic 11	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		

Settings Summary - B-PRO 8701			
Operator 5			
Input E	<Not Used>		
PL 12 [ProLogic 12]			
ProLogic 12	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 13 [ProLogic 13]			
ProLogic 13	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 14 [ProLogic 14]			
ProLogic 14	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		

Settings Summary - B-PRO 8701			
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		
PL 15 [ProLogic 15]			
ProLogic 15	Disabled		
Target	Enabled		
Pickup Delay	0.00	seconds	0.00 to 999.00
Dropout Delay	0.00	seconds	0.00 to 999.00
Operator 1			
Input A	<Not Used>		
Operator 2			
Input B	<Not Used>		
Operator 3			
Input C	<Not Used>		
Operator 4			
Input D	<Not Used>		
Operator 5			
Input E	<Not Used>		

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Appendix C Hardware Description

The B-PRO is a complete bus protection relay package designed and manufactured with high quality features and components.

External Input and Comm Board

The B-PRO relay has 9 channels of external input provided by the external input and comm board. Inputs are optically isolated, factory preset to the customer's requested voltage level. Two dual-range user-selectable external-input voltage-level model of the external input and comm board are available. This allows you to select between 48 Vdc and 125 Vdc or 125 Vdc and 250 Vdc (nominal) on a per-input basis.

The external input and comm board also provides the B-PRO relay with two rear-panel RS-232 ports, IRIG-B time synchronization input, and optional network or telephone connection. The RS-232 ports are female DB-9S connectors, IRIG-B is a male BNC, and network or telephone is a female RJ-45 modular jack.

Relay Output

The relay output board provides 14 normally open contact outputs for relaying, alarms and control, one normally closed output contact for indicating proper relay operation.

Power Supply Board

The power supply operates from 40 to 300 Vdc or 120 Vac +/- 20% at 50/60 HZ. This wide operating range provides easier installation by eliminating power supply ordering options.

AC Analog Input Board

The ac analog input board has 18 current transformer inputs and 3 potential transformer inputs for ac current and voltage inputs. On-board anti-aliasing filters provide accurate and secure digitization of the ac input signals.

Main Processor Board (MPB)

The MPB has analog data acquisition, high-speed digital signal processing for triggering and data conversion, communications, and interface logic, to perform the core functions of the B-PRO relay.

The digital signal processor (DSP) on a MPB performs the protective relaying functions of the B-PRO, separate from the 486 CPU. It has its own flash memory and self-checking, for fully independent operation.

The main processor board has:

- 24 channels of high-speed 12 bit-plus-sign analog-to-digital conversion
- Re-programmable flash memory for the DSP, allows independent relay operation and field software upgrades. Settings stored in non-volatile memory.
- Floating point DSP for fast capture and manipulation of data
- Standard RS-232 serial communications ports
- High speed link between DSP and 486 processors
- Time synchronism processor with automatic detection of modulated and unmodulated IRIG-B
- Sophisticated fault detection and “watchdog” recovery hardware

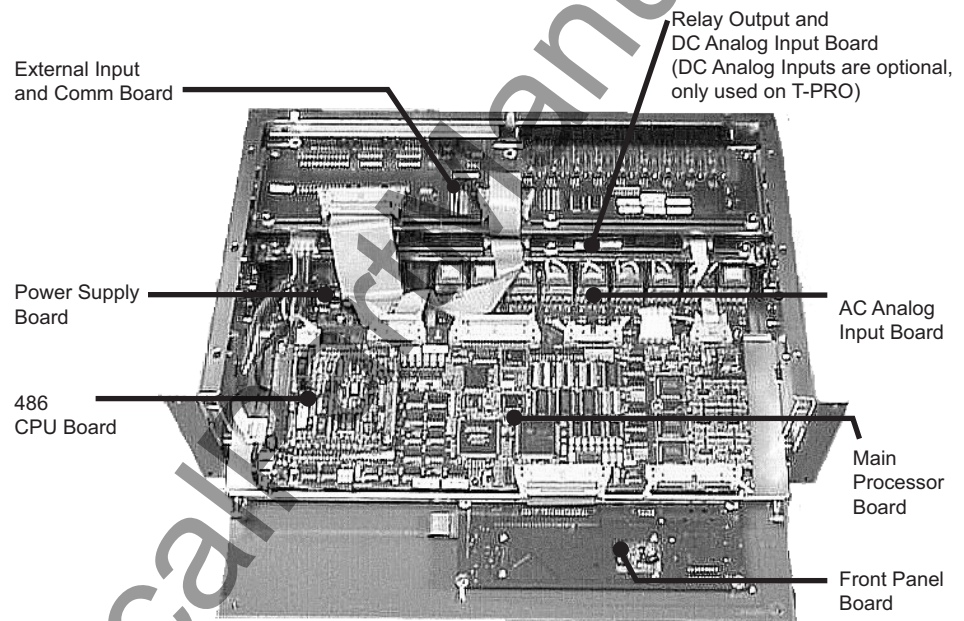
486 CPU Board

A 486-class CPU provides data storage, information management, housekeeping, and communications for the B-PRO. The 486 runs a real-time operating system optimized for high speed, high precision computing. The 486 provides sophisticated facilities for communications and field software updates. Optional ethernet or modem cards make connectivity simple by providing built-in dial-up or lan/wan support.

A highly reliable solid-state flash disk on the CPU board provides the operating software for the 486, and stores the B-PRO's recordings.

Front Panel Board

The front panel board provides visual indication of the status of the B-PRO relay, an alphanumeric display and keypad for system monitoring, and a front-panel RS-232 port.



Appendix D Event Messages

The following shows phase A only, phase B and C work in a similar manner.

A: (Input Name) 50LS-1 High
A: (Input Name) 50LS-2 High
A: (Input Name) 50BF-1 Trip
A: (Input Name) 50BF-2 Trip
A: (Input Name) 50 Trip
A: (Input Name) 51 Alarm
A: (Input Name) 51 Trip
A: 87 Trip
A: 87 Trip (IOH)
A: 87 Block via CT Sat.
A: 59 O/V-1 Trip
A: 59 O/V-2 Trip
A: 27 U/V-1 Trip
A: 27 U/V-2 Trip
A: 60 Alarm
A: 81 O/F-1 Trip
A: 81 O/F-2 Trip
A: 81 U/F-1 Trip
A: 81 U/F-2 Trip
A: (ProLogic Name): PL (1–15)
A: (Ext. Input Name): EI (1–9)

Details of Failure Modes

energized. Two of its contacts open, disconnecting all power to the other auxiliary relays. A separate contact labelled "RELAY INOPERATIVE" on the rear panel closes to activate a remote alarm.

contacts close.

↓
The watch-dog repeatedly attempts to re-start the DSP for diagnostic purposes. The green light stays off and the relays remain de-energized, even for a successful re-start. Only a power-down/power-up will reset the LED to green and re-energize the relays.

Note: For either of the above cases the DSP controller functions continue with normal auxiliary relay outputs provided that DSP failure or Self Check Fail: Block has not occurred.

Self Check Fail due to DC Offset Detector

The DSP has an algorithm that detects continuous dc levels on the analog inputs and initiates alarms and relay output contact blocking when the measured dc level exceeds the Alarm or Block level. The Alarm level is intended to provide an early indication of a problem. The Block level blocks the relay from false-tripping by preventing any output contact from closing. The Relay Functional LED turns off, but the protection functions will operate normally, with the exception that the output contacts will not be allowed to close. The Relay Inoperative contact will close for a Block condition. The following table describes all the Alarm/Block indication functions

Action	Condition	
	Alarm	Block
Relay Functional LED off		X
Service Required LED on	X	X
Self Check Fail Signal high	X	X
Relay Inoperative Contact closed		X
Output Contacts held open		X
Event Log Message	X	X
Status available through SCADA	X	X

The Self Check Fail signal, which is available in the Output Matrix, TUI metering and SCADA, can be used to signal an alarm. Note that if this signal is mapped to an output contact, the contact which it is mapped to will only be closed for an alarm condition. If the relay is in the Block condition, the Relay Inoperative contact must be used to signal an alarm.

The status of the Self Check Fail is available through the SCADA services provided by the B-PRO. The digital signal Self Check Fail will indicate that DSP has detected a continuous dc level and the analog metering value Self Check Fail Parameter is used to indicate which condition, Alarm or Block. The failure types and which analog values they are associated with are described in the table below. Both signals are available in DNP and Modbus.

Point Value	Condition
0	Normal
1	Alarm
2	Block
3	Alarm has evolved to block

The Alarm condition is allowed to reset if the continuous dc level drops below the pickup level. The Block condition has no reset level. If power is cycled to the relay it will go into its normal state until the continuous dc level is detected again.

Note: Self Check Fail appears as "Aux. Failure Alarm" in the settings versions of firmware v1.0a and below and *Offliner* Settings v1.0b and below.

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Appendix E Modbus RTU Communication Protocol

The SCADA port supports DNP3 and Modicon Modbus protocols. All metering values available through the terminal user interface are also available via the modbus protocol. Additionally, the modbus protocol support the reading of the unit time and time of the readings and provides access to trip and alarm events, include fault location information.

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

Read Coil Status (Function Code 01)			
Channel	Address	Value	
Hold Readings	00001	0: Readings not held	1: Readings held
Reserved	00257	Reserved	Reserved
Output Contact 1	00513	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 2	00514	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 3	00515	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 4	00516	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 5	00517	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 6	00518	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 7	00519	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 8	00520	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 9	00521	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 10	00522	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 11	00523	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 12	00524	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 13	00525	0: Contact Open (inactive)	1: Contact Closed (active)
Output Contact 14	00526	0: Contact Open (inactive)	1: Contact Closed (active)
Input 1 50LS-1 Output	00769	0: Off (inactive)	1: On (active)
Input 1 50LS-2 Output	00770	0: Off (inactive)	1: On (active)
Input 1 50BF-1 Trip	00771	0: Off (inactive)	1: On (active)
Input 1 50BF-2 Trip	00772	0: Off (inactive)	1: On (active)
Input 1 50 Trip	00773	0: Off (inactive)	1: On (active)
Input 1 51 Alarm	00774	0: Off (inactive)	1: On (active)
Input 1 51 Trip	00775	0: Off (inactive)	1: On (active)
Input 2 50LS-1 Output	00776	0: Off (inactive)	1: On (active)
Input 2 50LS-2 Output	00777	0: Off (inactive)	1: On (active)
Input 2 50BF-1 Trip	00778	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
Input 2 50BF-2 Trip	00779	0: Off (inactive)	1: On (active)
Input 2 50 Trip	00780	0: Off (inactive)	1: On (active)
Input 2 51 Alarm	00781	0: Off (inactive)	1: On (active)
Input 2 51 Trip	00782	0: Off (inactive)	1: On (active)
Input 3 50LS-1 Output	00783	0: Off (inactive)	1: On (active)
Input 3 50LS-2 Output	00784	0: Off (inactive)	1: On (active)
Input 3 50BF-1 Trip	00785	0: Off (inactive)	1: On (active)
Input 3 50BF-2 Trip	00786	0: Off (inactive)	1: On (active)
Input 3 50 Trip	00787	0: Off (inactive)	1: On (active)
Input 3 51 Alarm	00788	0: Off (inactive)	1: On (active)
Input 3 51 Trip	00789	0: Off (inactive)	1: On (active)
Input 4 50LS-1 Output	00790	0: Off (inactive)	1: On (active)
Input 4 50LS-2 Output	00791	0: Off (inactive)	1: On (active)
Input 4 50BF-1 Trip	00792	0: Off (inactive)	1: On (active)
Input 4 50BF-2 Trip	00793	0: Off (inactive)	1: On (active)
Input 4 50 Trip	00794	0: Off (inactive)	1: On (active)
Input 4 51 Alarm	00795	0: Off (inactive)	1: On (active)
Input 4 51 Trip	00796	0: Off (inactive)	1: On (active)
Input 5 50LS-1 Output	00797	0: Off (inactive)	1: On (active)
Input 5 50LS-2 Output	00798	0: Off (inactive)	1: On (active)
Input 5 50BF-1 Trip	00799	0: Off (inactive)	1: On (active)
Input 5 50BF-2 Trip	00800	0: Off (inactive)	1: On (active)
Input 5 50 Trip	00801	0: Off (inactive)	1: On (active)
Input 5 51 Alarm	00802	0: Off (inactive)	1: On (active)
Input 5 51 Trip	00803	0: Off (inactive)	1: On (active)
Input 6 50LS-1 Output	00804	0: Off (inactive)	1: On (active)
Input 6 50LS-2 Output	00805	0: Off (inactive)	1: On (active)
Input 6 50BF-1 Trip	00806	0: Off (inactive)	1: On (active)
Input 6 50BF-2 Trip	00807	0: Off (inactive)	1: On (active)
Input 6 50 Trip	00808	0: Off (inactive)	1: On (active)
Input 6 51 Alarm	00809	0: Off (inactive)	1: On (active)
Input 6 51 Trip	00810	0: Off (inactive)	1: On (active)
Input 7 50LS-1 Output	00811	0: Off (inactive)	1: On (active)
Input 7 50LS-2 Output	00812	0: Off (inactive)	1: On (active)
Input 7 50BF-1 Trip	00813	0: Off (inactive)	1: On (active)
Input 7 50BF-2 Trip	00814	0: Off (inactive)	1: On (active)
Input 7 50 Trip	00815	0: Off (inactive)	1: On (active)
Input 7 51 Alarm	00816	0: Off (inactive)	1: On (active)
Input 7 51 Trip	00817	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
Input 8 50LS-1 Output	00818	0: Off (inactive)	1: On (active)
Input 8 50LS-2 Output	00819	0: Off (inactive)	1: On (active)
Input 8 50BF-1 Trip	00820	0: Off (inactive)	1: On (active)
Input 8 50BF-2 Trip	00821	0: Off (inactive)	1: On (active)
Input 8 50 Trip	00822	0: Off (inactive)	1: On (active)
Input 8 51 Alarm	00823	0: Off (inactive)	1: On (active)
Input 8 51 Trip	00824	0: Off (inactive)	1: On (active)
Input 9 50LS-1 Output	00825	0: Off (inactive)	1: On (active)
Input 9 50LS-2 Output	00826	0: Off (inactive)	1: On (active)
Input 9 50BF-1 Trip	00827	0: Off (inactive)	1: On (active)
Input 9 50BF-2 Trip	00828	0: Off (inactive)	1: On (active)
Input 9 50 Trip	00829	0: Off (inactive)	1: On (active)
Input 9 51 Alarm	00830	0: Off (inactive)	1: On (active)
Input 9 51 Trip	00831	0: Off (inactive)	1: On (active)
Input 10 50LS-1 Output	00832	0: Off (inactive)	1: On (active)
Input 10 50LS-2 Output	00833	0: Off (inactive)	1: On (active)
Input 10 50BF-1 Trip	00834	0: Off (inactive)	1: On (active)
Input 10 50BF-2 Trip	00835	0: Off (inactive)	1: On (active)
Input 10 50 Trip	00836	0: Off (inactive)	1: On (active)
Input 10 51 Alarm	00837	0: Off (inactive)	1: On (active)
Input 10 51 Trip	00838	0: Off (inactive)	1: On (active)
Input 11 50LS-1 Output	00839	0: Off (inactive)	1: On (active)
Input 11 50LS-2 Output	00840	0: Off (inactive)	1: On (active)
Input 11 50BF-1 Trip	00841	0: Off (inactive)	1: On (active)
Input 11 50BF-2 Trip	00842	0: Off (inactive)	1: On (active)
Input 11 50 Trip	00843	0: Off (inactive)	1: On (active)
Input 11 51 Alarm	00844	0: Off (inactive)	1: On (active)
Input 11 51 Trip	00845	0: Off (inactive)	1: On (active)
Input 12 50LS-1 Output	00846	0: Off (inactive)	1: On (active)
Input 12 50LS-2 Output	00847	0: Off (inactive)	1: On (active)
Input 12 50BF-1 Trip	00848	0: Off (inactive)	1: On (active)
Input 12 50BF-2 Trip	00849	0: Off (inactive)	1: On (active)
Input 12 50 Trip	00850	0: Off (inactive)	1: On (active)
Input 12 51 Alarm	00851	0: Off (inactive)	1: On (active)
Input 12 51 Trip	00852	0: Off (inactive)	1: On (active)
Input 13 50LS-1 Output	00853	0: Off (inactive)	1: On (active)
Input 13 50LS-2 Output	00854	0: Off (inactive)	1: On (active)
Input 13 50BF-1 Trip	00855	0: Off (inactive)	1: On (active)
Input 13 50BF-2 Trip	00856	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
Input 13 50 Trip	00857	0: Off (inactive)	1: On (active)
Input 13 51 Alarm	00858	0: Off (inactive)	1: On (active)
Input 13 51 Trip	00859	0: Off (inactive)	1: On (active)
Input 14 50LS-1 Output	00860	0: Off (inactive)	1: On (active)
Input 14 50LS-2 Output	00861	0: Off (inactive)	1: On (active)
Input 14 50BF-1 Trip	00862	0: Off (inactive)	1: On (active)
Input 14 50BF-2 Trip	00863	0: Off (inactive)	1: On (active)
Input 14 50 Trip	00864	0: Off (inactive)	1: On (active)
Input 14 51 Alarm	00865	0: Off (inactive)	1: On (active)
Input 14 51 Trip	00866	0: Off (inactive)	1: On (active)
Input 15 50LS-1 Output	00867	0: Off (inactive)	1: On (active)
Input 15 50LS-2 Output	00868	0: Off (inactive)	1: On (active)
Input 15 50BF-1 Trip	00869	0: Off (inactive)	1: On (active)
Input 15 50BF-2 Trip	00870	0: Off (inactive)	1: On (active)
Input 15 50 Trip	00871	0: Off (inactive)	1: On (active)
Input 15 51 Alarm	00872	0: Off (inactive)	1: On (active)
Input 15 51 Trip	00873	0: Off (inactive)	1: On (active)
Input 16 50LS-1 Output	00874	0: Off (inactive)	1: On (active)
Input 16 50LS-2 Output	00875	0: Off (inactive)	1: On (active)
Input 16 50BF-1 Trip	00876	0: Off (inactive)	1: On (active)
Input 16 50BF-2 Trip	00877	0: Off (inactive)	1: On (active)
Input 16 50 Trip	00878	0: Off (inactive)	1: On (active)
Input 16 51 Alarm	00879	0: Off (inactive)	1: On (active)
Input 16 51 Trip	00880	0: Off (inactive)	1: On (active)
Input 17 50LS-1 Output	00881	0: Off (inactive)	1: On (active)
Input 17 50LS-2 Output	00882	0: Off (inactive)	1: On (active)
Input 17 50BF-1 Trip	00883	0: Off (inactive)	1: On (active)
Input 17 50BF-2 Trip	00884	0: Off (inactive)	1: On (active)
Input 17 50 Trip	00885	0: Off (inactive)	1: On (active)
Input 17 51 Alarm	00886	0: Off (inactive)	1: On (active)
Input 17 51 Trip	00887	0: Off (inactive)	1: On (active)
Input 18 50LS-1 Output	00888	0: Off (inactive)	1: On (active)
Input 18 50LS-2 Output	00889	0: Off (inactive)	1: On (active)
Input 18 50BF-1 Trip	00890	0: Off (inactive)	1: On (active)
Input 18 50BF-2 Trip	00891	0: Off (inactive)	1: On (active)
Input 18 50 Trip	00892	0: Off (inactive)	1: On (active)
Input 18 51 Alarm	00893	0: Off (inactive)	1: On (active)
Input 18 51 Trip	00894	0: Off (inactive)	1: On (active)
87 Trip	00895	0: Off (inactive)	1: On (active)

Read Coil Status (Function Code 01)			
87 Fast Trip	00896	0: Off (inactive)	1: On (active)
87 Block via Saturation	00897	0: Off (inactive)	1: On (active)
59 1 Trip	00898	0: Off (inactive)	1: On (active)
59 2 Trip	00899	0: Off (inactive)	1: On (active)
27 1 Trip	00900	0: Off (inactive)	1: On (active)
27 2 Trip	00901	0: Off (inactive)	1: On (active)
60 Alarm	00902	0: Off (inactive)	1: On (active)
81O 1 Trip	00903	0: Off (inactive)	1: On (active)
81O 2 Trip	00904	0: Off (inactive)	1: On (active)
81U 1 Trip	00905	0: Off (inactive)	1: On (active)
81U 2 Trip	00906	0: Off (inactive)	1: On (active)
ProLogic 1	00907	0: Off (inactive)	1: On (active)
ProLogic 2	00908	0: Off (inactive)	1: On (active)
ProLogic 3	00909	0: Off (inactive)	1: On (active)
ProLogic 4	00910	0: Off (inactive)	1: On (active)
ProLogic 5	00911	0: Off (inactive)	1: On (active)
ProLogic 6	00912	0: Off (inactive)	1: On (active)
ProLogic 7	00913	0: Off (inactive)	1: On (active)
ProLogic 8	00914	0: Off (inactive)	1: On (active)
ProLogic 9	00915	0: Off (inactive)	1: On (active)
ProLogic 10	00916	0: Off (inactive)	1: On (active)
ProLogic 11	00917	0: Off (inactive)	1: On (active)
ProLogic 12	00918	0: Off (inactive)	1: On (active)
ProLogic 13	00919	0: Off (inactive)	1: On (active)
ProLogic 14	00920	0: Off (inactive)	1: On (active)
ProLogic 15	00921	0: Off (inactive)	1: On (active)
Self check Fail	00922	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
Channel	Address	Value	
External I/P 1	10001	0: Off (inactive)	1: On (active)
External I/P 2	10002	0: Off (inactive)	1: On (active)
External I/P 3	10003	0: Off (inactive)	1: On (active)
External I/P 4	10004	0: Off (inactive)	1: On (active)
External I/P 5	10005	0: Off (inactive)	1: On (active)
External I/P 6	10006	0: Off (inactive)	1: On (active)
External I/P 7	10007	0: Off (inactive)	1: On (active)

Read Input Status (Function Code 02)			
External I/P 8	10008	0: Off (inactive)	1: On (active)
External I/P 9	10009	0: Off (inactive)	1: On (active)

Read Holding Registers (Function Code 03)			
Channel	Address	Units	Scale
B-PRO Clock Time (UTC). 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 (up to 366 if leap year)	1
Years since 1900	40006	90-137	1
Sync'd to IRIG-B	40007	0: No 1: Yes	1
Time of Acquisition (UTC). Read all in same query to ensure consistent time reading data			
Milliseconds Now	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 (up to 366 if leap year)	1
Years since 1900	40013	90-137	1
Sync'd to IRIG-B	40014	0: No 1: Yes	1
Offset of UTC to IED local time.	40015	2's complement half hours, North America is negative	1
VA Magnitude	40257	KV	10
VA Angle	40258	Degrees	10
VB Magnitude	40259	KV	10
VB Angle	40260	Degrees	10
VC Magnitude	40261	KV	10
VC Angle	40262	Degrees	10
I1 Magnitude	40263	A	1
I1 Angle	40264	Degrees	10
I2 Magnitude	40265	A	1
I2 Angle	40266	Degrees	10
I3 Magnitude	40267	A	1
I3 Angle	40268	Degrees	10
I4 Magnitude	40269	A	1
I4 Angle	40270	Degrees	10
I5 Magnitude	40271	A	1

Read Holding Registers (Function Code 03)			
I5 Angle	40272	Degrees	10
I6 Magnitude	40273	A	1
I6 Angle	40274	Degrees	10
I7 Magnitude	40275	A	1
I7 Angle	40276	Degrees	10
I8 Magnitude	40277	A	1
I8 Angle	40278	Degrees	10
I9 Magnitude	40279	A	1
I9 Angle	40280	Degrees	10
I10 Magnitude	40281	A	1
I10 Angle	40282	Degrees	10
I11 Magnitude	40283	A	1
I11 Angle	40284	Degrees	10
I12 Magnitude	40285	A	1
I12 Angle	40286	Degrees	10
I13 Magnitude	40287	A	1
I13 Angle	40288	Degrees	10
I14 Magnitude	40289	A	1
I14 Angle	40290	Degrees	10
I15 Magnitude	40291	A	1
I15 Angle	40292	Degrees	10
I16 Magnitude	40293	A	1
I16 Angle	40294	Degrees	10
I17 Magnitude	40295	A	1
I17 Angle	40296	Degrees	10
I18 Magnitude	40297	A	1
I18 Angle	40298	Degrees	10
Bus I Operating	40299	A	1
Bus I Restraint	40300	A	1
Input 1 P	40301	MW	10
Input 1 Q	40302	Mvars	10
Input 2 P	40303	MW	10
Input 2 Q	40304	Mvars	10
Input 3 P	40305	MW	10
Input 3 Q	40306	Mvars	10
Input 4 P	40307	MW	10
Input 4 Q	40308	Mvars	10
Input 5 P	40309	MW	10
Input 5 Q	40310	Mvars	10

Read Holding Registers (Function Code 03)			
Input 6 P	40311	MW	10
Input 6 Q	40312	Mvars	10
Input 7 P	40313	MW	10
Input 7 Q	40314	Mvars	10
Input 8 P	40315	MW	10
Input 8 Q	40316	Mvars	10
Input 9 P	40317	MW	10
Input 9 Q	40318	Mvars	10
Input 10 P	40319	MW	10
Input 10 Q	40320	Mvars	10
Input 11 P	40321	MW	10
Input 11 Q	40322	Mvars	10
Input 12 P	40323	MW	10
Input 12 Q	40324	Mvars	10
Input 13 P	40325	MW	10
Input 13 Q	40326	Mvars	10
Input 14 P	40327	MW	10
Input 14 Q	40328	Mvars	10
Input 15 P	40329	MW	10
Input 15 Q	40330	Mvars	10
Input 16 P	40331	MW	10
Input 16 Q	40332	Mvars	10
Input 17 P	40333	MW	10
Input 17 Q	40334	MW	10
Input 18 P	40335	MW	10
Input 18 Q	40336	MW	10
Positive Sequence V	40337	KV	10
Frequency	40338	Hz	100
Self check Fail Parameter	40339	N/A	1

Read Input Register (Function Code 04)
--

No input registers supported. Response from IED indicates "ILLEGAL FUNCTION."

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

Preset Single Register (Function Code 06)			
Channel	Address	Value	Scaled Up By
Event Message Control (See below for details of use)			
Refresh event list	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 (Subfunction 00)	This provides an echo of the submitted message.
Restart Comm. Option (Subfunction 01)	This restarts the Modbus communications process.
Force Listen Only Mode (Subfunction 04)	No response is returned. IED enters "Listen Only" mode. This mode can only be exited by the "Restart Comm. Option" command.

Report Slave ID (Function Code 17/0x11)			
A fixed response is returned by the IED, including system model, version and issue numbers.			
Channel	Type	Bytes	Value
Model Number	Read Only	0 and 1	21FD = 8701 decimal
Version Number	Read Only	2 and 3	Version number
Issue Number	Read Only	4 and 5	Issue number

- The B-PRO IED model number is 8701/BUS.
- Version and issue will each be positive integers, say X and Y.
- The B-PRO is defined as "Model 8701/BUS, Version X Issue Y"

Accessing B-PRO Event Information	
All B-PRO detector event messages displayed in the Event Log are available via Modbus. This includes fault location information. The following controls are available.	
Refresh Event List	(Function Code 6, address 40513): Fetches the latest events from the B-PRO's event log and makes them available for Modbus access. The most recent event becomes the current event available for reading.
Acknowledge Current Event and Get Next Event	(Function Code 6, address 40514): Clears the current event from the read registers and places the next event into them. An acknowledged event is no longer available for reading.
Get Next Event	(Function Code 6, address 40515): Places the next event in the read registers without acknowledging the current event. The current event will reappear in the list when Refresh Event List is used.
Size of Current Event Message	(Function Code 3, address 40516): Indicates the number of 16 bit registers used to contain the current event. Event data is stored with two characters per register. A reading of zero indicates that there are no unacknowledged events available in the current set. (NB. The Refresh Event List function can be used to check for new events that have occurred since the last Refresh Event List.)
Read Event Message	(Function Code 3, addresses 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.

Modbus Event Message Example			
" 2002May15 16:45:07.848 : 27-1 (U/V) on ABC: Trip"			
Register	Value		Meaning
	High Byte	Low Byte	
40516	0x00	0x19	Event text size = 25 (0x19 hex)
40517	0x20	0x20	'<sp>', '<sp>'
40518	0x32	0x30	'2', '0'
40519	0x30	0x32	'0', '2'
40520	0x40	0x61	'M', 'a'
40521	0x79	0x31	'y', '1'
40522	0x35	0x20	'5', '<sp>'
40523	0x31	0x36	'1', '6'
40524	0x3A	0x34	':', '4'
40525	0x35	0x3A	'5', ':'
40526	0x30	0x37	'0', '7'
40527	0x2E	0x38	':', '8'
40528	0x34	0x38	'4', '8'
40529	0x20	0x3A	'<sp>', ':'
40530	0x20	0x32	'<sp>', '2'
40531	0x37	0x2D	'7', '-'
40532	0x31	0x20	'1', '<sp>'
40533	0x28	0x55	'(', 'U'
40534	0x2F	0x56	',' , 'V'
40535	0x29	0x20	'),' , '<sp>'
40536	0x6F	0x6E	'o', 'n'
40537	0x20	0x41	'<sp>', 'A'
40538	0x42	0x43	'B', 'C'
40539	0x3A	0x20	':', '<sp>'
40540	0x54	0x72	'T', 'r'
40541	0x69	0x70	'i', 'p'

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Appendix F DNP3 Communication Protocol

Device Profile

The SCADA port supports DNP3. All metering values available through the terminal user interface are available by DNP3 protocol. Included are the device profile, implementation table and the point list for the DNP3 protocol.

Vendor Name: ERLPhase Corporation	Device Name: Relay Model #
Highest DNP Level Supported: For Requests: 2 For Responses: 2	Device Function: _ Master x Slave
Maximum Data Link Frame Size (octets): Transmitted: 292 Received: 292	Maximum Application Fragme Size (octets): Transmitted: 2048 Received: 2048
Maximum Data Link Re-tries: _ None x Fixed at 3 _ Configurable, range ___ to ___	Maximum Application Layer Re-tries: x None _ Configurable, range ___ to ___
Requires Data Link Layer Confirmation: _ Never _ Always _ Sometimes x Configurable, either always or never	Requires Application Layer Confirmation: _ Never _ Always (not recommended) x When reporting Event Data (Slave) x When sending multi-fragment responses (Slave) _ Sometimes _ Configurable
Timeouts (in seconds) while waiting for: Data Link Confirm ___None Complete Application Fragment x None Application Confirm ___None Complete Application Response x None Others _____ Select to execute delay ___None	x Fixed at 2 ___Fixed at 2 x Fixed at 5 ___Fixed at 2 x Fixed at 10
Sends/Executes Control Operations: WRITE Binary Outputs x Never ___Always SELECT/OPERATE ___Never x Always DIRECT OPERATE ___Never x Always DIRECT OPERATE No ACK ___Never x Always Count > 1 x Never ___Always Pulse On ___Never x Always Pulse Off x Never ___Always Latch On ___Never x Always Latch Off ___Never x Always Queue x Never ___Always Clear Queue x Never ___Always Maximum number of control objects per request: 16 Notes: Control Trip/Close - Code Combination supported: Latch On/NUL Latch Off/NUL Pulse On/NUL (Pulse duration fixed at 1 s)	
Report Binary Input Change Events when no specific variation requested: ___Never ___Only time-tagged x Only non-time-tagged _ Configurable to send both, one or the other	Reports time-tagged Binary Input Change Events when no specific variation requested ___Never x Binary Input Change with Time _ Binary Input Change with Relative Time _ Configurable
Sends Unsolicited Response: x Never _ Configurable _Only certain objects _ Sometimes	Sends Static Data in Unsolicited Responses: x Never _ When Device Restarts _ When Status Flags Change No other options are permitted.

_ ENABLE/DISABLE UNSOLICITED Function codes supported	
Default Counter Object/Variation: x No Counter Reported _ Configurable _ Default Object _____ _ Default Variation _____ _ Point-by-point list attached	Counters Roll Over at: x No Counters Reported _ Configurable _ 16 Bits _ 32 Bits _ Other Value _____ _ Point-by-point list attached

Implementation Table						
Object			Request		Response	
Grp	Var	Description	Function Code	Qualifier Codes (hex)	Function Code	Qualifier Codes (hex)
1	0	Binary Input - All Variations	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x00
1	1	Binary Input (default)	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x00
1	2	Binary Input with Status	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x00
2	0	Binary Input Change - All Variations	1 (read)	0x06, 0x07, 0x08	129 (response)	0x17
2	1	Binary Input Change without Time	1 (read)	0x06, 0x07, 0x08	129 (response)	0x17
2	2	Binary Input Change with Time (default)	1 (read)	0x06, 0x07, 0x08	129 (response)	0x17
2	3	Binary Input Change with Relative Time	1 (read)	0x06, 0x07, 0x08	129 (response)	0x17
10	0	Binary Output - All Variations	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x00
10	2	Binary Output Status (default)	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x00
30	0	Analog Input - All Variations	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x01
30	1	32-bit Analog Input	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x01
30	2	16-bit Analog Input	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x01
30	3	32-bit Analog Input without flag	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x01
30	4	16-bit Analog Input without flag (default)	1 (read)	0x00, 0x01, 0x06, 0x07, 0x08, 0x17, 0x28	129 (response)	0x01
32	0	Analog Input Change Event - All Variations	1 (read)	0x06, 0x07, 0x08	129 (response)	0x28
32	1	Analog Input Change Event - 32-bit without Time	1 (read)	0x06, 0x07, 0x08	129 (response)	0x28
32	2	Analog Input Change Event - 16-bit without Time (default)	1 (read)	0x06, 0x07, 0x08	129 (response)	0x28
32	3	Analog Input Change Event - 32-bit with Time	1 (read)	0x06, 0x07, 0x08	129 (response)	0x28
32	4	Analog Input Change Event - 16-bit with Time	1 (read)	0x06, 0x07, 0x08	129 (response)	0x28
51	1	Time and Data CTO			129 (response)	0x07, quantity=1
52	1	Time Delay Coarse			129 (response)	0x07, quantity=1
60	1	Class 0 Data	1 (read)	0x06		
60	2	Class 1 Data	1 (read)	0x06, 0x07, 0x08		

Implementation Table						
60	3	Class 2 Data	1 (read)	0x06, 0x07, 0x08		
80	1	Internal Indications	2 (write)	0x00, index=7		
110	0	Octet String	1 (read)	0x06	129 (response)	0x07
111	0	Octet String Change Event	1 (read)	0x06	129 (response)	0x07
		No Object	14 (warm restart)			

Point List

Binary Inputs (Obj 1, 2)		
	Static Points	Change Event Points
Object Group	1	2
Object Variation	1 – Binary Input (default)	1 – Binary Input Change without Time
	2 – Binary Input with Status	1 – Binary Input Change with Time (default)
		3 – Binary Input Change with Relative Time
Class	0	1
Note: Binary inputs are scanned with 1 ms resolution.		
Change Event Buffer Size		100

Binary Inputs	Point Index	Change Event Class
External Input 1	0	1
External Input 2	1	1
External Input 3	2	1
External Input 4	3	1
External Input 5	4	1
External Input 6	5	1
External Input 7	6	1
External Input 8	7	1
External Input 9	8	1

Binary Outputs (Obj 10)		
	Static Points	Change Event Points
Object Group	10	Not Applicable
Object Variation	2 – Binary Output Status (default)	Not Applicable
Class	0	Not Applicable
Note: Binary outputs are scanned with 500 ms resolution.		

No change buffer

Binary Outputs	Point Index	Change Event Class			
Output Contact 1	0	N/A			
Output Contact 2	1	N/A			
Output Contact 3	2	N/A			
Output Contact 4	3	N/A			
Output Contact 5	4	N/A			
Output Contact 6	5	N/A			
Output Contact 7	6	N/A			
Output Contact 8	7	N/A			
Output Contact 9	8	N/A			
Output Contact 10	9	N/A			
Output Contact 11	10	N/A			
Output Contact 12	11	N/A			
Output Contact 13	12	N/A			
Output Contact 14	13	N/A			
Input 1 50LS-1 Output	14	N/A			
Input 1 50LS-2 Output	15	N/A			
Input 1 50BF-1 Trip	16	N/A			
Input 1 50BF-2 Trip	17	N/A			
Input 1 50 Trip	18	N/A			
Input 1 51 Alarm	19	N/A			
Input 1 51 Trip	20	N/A			
Input 2 50LS-1 Output	21	N/A			
Input 2 50LS-2 Output	22	N/A			
Input 2 50BF-1 Trip	23	N/A			
Input 2 50BF-2 Trip	24	N/A			
Input 2 50 Trip	25	N/A			
Input 2 51 Alarm	26	N/A			
Input 2 51 Trip	27	N/A			
Input 3 50LS-1 Output	28	N/A			
Input 3 50LS-2 Output	29	N/A			
Input 3 50BF-1 Trip	30	N/A			
Input 3 50BF-2 Trip	31	N/A			
Input 3 50 Trip	32	N/A			
Input 3 51 Alarm	33	N/A			
Input 3 51 Trip	34	N/A			

Binary Outputs	Point Index	Change Event Class			
Input 4 50LS-1 Output	35	N/A			
Input 4 50LS-2 Output	36	N/A			
Input 4 50BF-1 Trip	37	N/A			
Input 4 50BF-2 Trip	38	N/A			
Input 4 50 Trip	39	N/A			
Input 4 51 Alarm	40	N/A			
Input 4 51 Trip	41	N/A			
Input 5 50LS-1 Output	42	N/A			
Input 5 50LS-2 Output	43	N/A			
Input 5 50BF-1 Trip	44	N/A			
Input 5 50BF-2 Trip	45	N/A			
Input 5 50 Trip	46	N/A			
Input 5 51 Alarm	47	N/A			
Input 5 51 Trip	48	N/A			
Input 6 50LS-1 Output	49	N/A			
Input 6 50LS-2 Output	50	N/A			
Input 6 50BF-1 Trip	51	N/A			
Input 6 50BF-2 Trip	52	N/A			
Input 6 50 Trip	53	N/A			
Input 6 51 Alarm	54	N/A			
Input 6 51 Trip	55	N/A			
Input 7 50LS-1 Output	56	N/A			
Input 7 50LS-2 Output	57	N/A			
Input 7 50BF-1 Trip	58	N/A			
Input 7 50BF-2 Trip	59	N/A			
Input 7 50 Trip	60	N/A			
Input 7 51 Alarm	61	N/A			
Input 7 51 Trip	62	N/A			
Input 8 50LS-1 Output	63	N/A			
Input 8 50LS-2 Output	64	N/A			
Input 8 50BF-1 Trip	65	N/A			
Input 8 50BF-2 Trip	66	N/A			
Input 8 50 Trip	67	N/A			
Input 8 51 Alarm	68	N/A			
Input 8 51 Trip	69	N/A			
Input 9 50LS-1 Output	70	N/A			
Input 9 50LS-2 Output	71	N/A			
Input 9 50BF-1 Trip	72	N/A			

Binary Outputs	Point Index	Change Event Class			
Input 9 50BF-2 Trip	73	N/A			
Input 9 50 Trip	74	N/A			
Input 9 51 Alarm	75	N/A			
Input 9 51 Trip	76	N/A			
Input 10 50LS-1 Output	77	N/A			
Input 10 50LS-2 Output	78	N/A			
Input 10 50BF-1 Trip	79	N/A			
Input 10 50BF-2 Trip	80	N/A			
Input 10 50 Trip	81	N/A			
Input 10 51 Alarm	82	N/A			
Input 10 51 Trip	83	N/A			
Input 11 50LS-1 Output	84	N/A			
Input 11 50LS-2 Output	85	N/A			
Input 11 50BF-1 Trip	86	N/A			
Input 11 50BF-2 Trip	87	N/A			
Input 11 50 Trip	88	N/A			
Input 11 51 Alarm	89	N/A			
Input 11 51 Trip	90	N/A			
Input 12 50LS-1 Output	91	N/A			
Input 12 50LS-2 Output	92	N/A			
Input 12 50BF-1 Trip	93	N/A			
Input 12 50BF-2 Trip	94	N/A			
Input 12 50 Trip	95	N/A			
Input 12 51 Alarm	96	N/A			
Input 12 51 Trip	97	N/A			
Input 13 50LS-1 Output	98	N/A			
Input 13 50LS-2 Output	99	N/A			
Input 13 50BF-1 Trip	100	N/A			
Input 13 50BF-2 Trip	101	N/A			
Input 13 50 Trip	102	N/A			
Input 13 51 Alarm	103	N/A			
Input 13 51 Trip	104	N/A			
Input 14 50LS-1 Output	105	N/A			
Input 14 50LS-2 Output	106	N/A			
Input 14 50BF-1 Trip	107	N/A			
Input 14 50BF-2 Trip	108	N/A			
Input 14 50 Trip	109	N/A			
Input 14 51 Alarm	110	N/A			

Binary Outputs	Point Index	Change Event Class			
Input 14 51 Trip	111	N/A			
Input 15 50LS-1 Output	112	N/A			
Input 15 50LS-2 Output	113	N/A			
Input 15 50BF-1 Trip	114	N/A			
Input 15 50BF-2 Trip	115	N/A			
Input 15 50 Trip	116	N/A			
Input 15 51 Alarm	117	N/A			
Input 15 51 Trip	118	N/A			
Input 16 50LS-1 Output	119	N/A			
Input 16 50LS-2 Output	120	N/A			
Input 16 50BF-1 Trip	121	N/A			
Input 16 50BF-2 Trip	122	N/A			
Input 16 50 Trip	123	N/A			
Input 16 51 Alarm	124	N/A			
Input 16 51 Trip	125	N/A			
Input 17 50LS-1 Output	126	N/A			
Input 17 50LS-2 Output	127	N/A			
Input 17 50BF-1 Trip	128	N/A			
Input 17 50BF-2 Trip	129	N/A			
Input 17 50 Trip	130	N/A			
Input 17 51 Alarm	131	N/A			
Input 17 51 Trip	132	N/A			
Input 18 50LS-1 Output	133	N/A			
Input 18 50LS-2 Output	134	N/A			
Input 18 50BF-1 Trip	135	N/A			
Input 18 50BF-2 Trip	136	N/A			
Input 18 50 Trip	137	N/A			
Input 18 51 Alarm	138	N/A			
Input 18 51 Trip	139	N/A			
87 Trip	140	N/A			
87 Fast Trip	141	N/A			
87 Block via Saturation	142	N/A			
59-1 Trip	143	N/A			
59-2 Trip	144	N/A			
27-1 Trip	145	N/A			
27-2 Trip	146	N/A			
60 Alarm	147	N/A			
81O-1 Trip	148	N/A			

Binary Outputs	Point Index	Change Event Class			
81O-2 Trip	149	N/A			
81U-1 Trip	150	N/A			
81U-2 Trip	151	N/A			
ProLogic 1	152	N/A			
ProLogic 2	153	N/A			
ProLogic 3	154	N/A			
ProLogic 4	155	N/A			
ProLogic 5	156	N/A			
ProLogic 6	157	N/A			
ProLogic 7	158	N/A			
ProLogic 8	159	N/A			
ProLogic 9	160	N/A			
ProLogic 10	161	N/A			
ProLogic 11	162	N/A			
ProLogic 12	163	N/A			
ProLogic 13	164	N/A			
ProLogic 14	165	N/A			
ProLogic 15	166	N/A			
Self check Fail	167	N/A			

Analog Inputs (Obj 30, 32)		
	Static Points	Change Event Points
Object Group	30	32
Object Variation	1 - 32-bit Analog Input	1 - Analog Input Change - 32-bit without Time
	2 - 16-bit Analog Input	2 - Analog Input Change - 16-bit without Time (default)
	3 - 32-bit Analog Input without flag	3 - Analog Input Change - 32-bit with Time
	4 - 16-bit Analog Input without flag (default)	4 - Analog Input Change - 16-bit with Time
Class	0	2
Note: Analog Inputs are scanned with 500 ms resolution. Note: Nominal is based on 69 V secondary voltage * PT ratio for voltage channels, and either 1A or 5A secondary current * CT ratio for current channels dependent upon the format of CT installed in the B-PRO.		

Analog Inputs	Point Index	Units	Scale	Change Event Class	Deadband
VA Magnitude	0	KV	10	2	2% Nominal
VA Angle	1	Degrees	10	2	0.5 Degrees
VB Magnitude	2	KV	10	2	2% Nominal
VB Angle	3	Degrees	10	2	0.5 Degrees
VC Magnitude	4	KV	10	2	2% Nominal
VC Angle	5	Degrees	10	2	0.5 Degrees
I1 Magnitude	6	A	1	2	2% Nominal
I1 Angle	7	Degrees	10	2	0.5 Degrees
I2 Magnitude	8	A	1	2	2% Nominal
I2 Angle	9	Degrees	10	2	0.5 Degrees
I3 Magnitude	10	A	1	2	2% Nominal
I3 Angle	11	Degrees	10	2	0.5 Degrees
I4 Magnitude	12	A	1	2	2% Nominal
I4 Angle	13	Degrees	10	2	0.5 Degrees
I5 Magnitude	14	A	1	2	2% Nominal
I5 Angle	15	Degrees	10	2	0.5 Degrees
I6 Magnitude	16	A	1	2	2% Nominal
I6 Angle	17	Degrees	10	2	0.5 Degrees
I7 Magnitude	18	A	1	2	2% Nominal
I7 Angle	19	Degrees	10	2	0.5 Degrees
I8 Magnitude	20	A	1	2	2% Nominal
I8 Angle	21	Degrees	10	2	0.5 Degrees
I9 Magnitude	22	A	1	2	2% Nominal
I9 Angle	23	Degrees	10	2	0.5 Degrees
I10 Magnitude	24	A	1	2	2% Nominal
I10 Angle	25	Degrees	10	2	0.5 Degrees
I11 Magnitude	26	A	1	2	2% Nominal
I11 Angle	27	Degrees	10	2	0.5 Degrees
I12 Magnitude	28	A	1	2	2% Nominal
I12 Angle	29	Degrees	10	2	0.5 Degrees
I13 Magnitude	30	A	1	2	2% Nominal
I13 Angle	31	Degrees	10	2	0.5 Degrees
I14 Magnitude	32	A	1	2	2% Nominal
I14 Angle	33	Degrees	10	2	0.5 Degrees
I15 Magnitude	34	A	1	2	2% Nominal
I15 Angle	35	Degrees	10	2	0.5 Degrees
I16 Magnitude	36	A	1	2	2% Nominal

Analog Inputs	Point Index	Units	Scale	Change Event Class	Deadband
I16 Angle	37	Degrees	10	2	0.5 Degrees
I17 Magnitude	38	A	1	2	2% Nominal
I17 Angle	39	Degrees	10	2	0.5 Degrees
I18 Magnitude	40	A	1	2	2% Nominal
I18 Angle	41	Degrees	10	2	0.5 Degrees
Bus I Operating	42	A	1	2	2% Nominal
Bus I Restraint	43	A	1	2	2% Nominal
Input 1 P	44	A	1	2	2% Nominal
Input 1 Q	45	A	1	2	2% Nominal
Input 2 P	46	A	1	2	2% Nominal
Input 2 Q	47	A	1	2	2% Nominal
Input 3 P	48	A	1	2	2% Nominal
Input 3 Q	49	A	1	2	2% Nominal
Input 4 P	50	A	1	2	2% Nominal
Input 4 Q	51	A	1	2	2% Nominal
Input 5 P	52	A	1	2	2% Nominal
Input 5 Q	53	A	1	2	2% Nominal
Input 6 P	54	MW	10	2	1.0 MW
Input 6 Q	55	Mvar	10	2	0.5 Mvar
Input 7 P	56	MW	10	2	1.0 MW
Input 7 Q	57	Mvar	10	2	0.5 Mvar
Input 8 P	58	MW	10	2	1.0 MW
Input 8 Q	59	Mvar	10	2	0.5 Mvar
Input 9 P	60	MW	10	2	1.0 MW
Input 9 Q	61	Mvar	10	2	0.5 Mvar
Input 10 P	62	MW	10	2	1.0 MW
Input 10 Q	63	Mvar	10	2	0.5 Mvar
Input 11 P	64	MW	10	2	1.0 MW
Input 11 Q	65	Mvar	10	2	0.5 Mvar
Input 12 P	66	MW	10	2	1.0 MW
Input 12 Q	67	Mvar	10	2	0.5 Mvar
Input 13 P	68	MW	10	2	1.0 MW
Input 13 Q	69	Mvar	10	2	0.5 Mvar
Input 14 P	70	MW	10	2	1.0 MW
Input 14 Q	71	Mvar	10	2	0.5 Mvar
Input 15 P	72	MW	10	2	1.0 MW
Input 15 Q	73	Mvar	10	2	0.5 Mvar
Input 16 P	74	MW	10	2	1.0 MW

Analog Inputs	Point Index	Units	Scale	Change Event Class	Deadband
Input 16 Q	75	Mvar	10	2	0.5 Mvar
Input 17 P	76	MW	10	2	1.0 MW
Input 17 Q	77	Mvar	10	2	0.5 Mvar
Input 18 P	78	MW	10	2	1.0 MW
Input 18 Q	79	Mvar	10	2	0.5 Mvar
Positive Sequence V	80	KV	10	2	2% Nominal
Frequency	81	Hz	100	2	0.05 Hz
Self check Fail Parameter	82	N/A	1	2	0.5

Object 110, 111 - Octet String for Event Log access

Object 110 and Object 111 are Octet String objects used to provide access to the Event Log text of the B-PRO. These objects are described in Technical Bulletin 9701-004.zip_71 available from the DNP user group web page (www.dnp.org). Object 110 always contains the most recent event in the B-PRO. Object 111 is the corresponding change event object. As stated in the DNP technical bulletin, the variation of the response object represents the length of the string. The string represents the ASCII values of the event text. The following example shows an event returned through either of the octet string objects.

DNP Example: Event Message

“1999Dec08 07:27:55.248: 27-2 (U/V) on ABC: Trip”

DNP Octet string object contents:				
0x20	0x20	0x31	0x39	0x39
0x39	0x44	0x65	0x63	0x30
0x38	0x20	0x30	0x37	0x3A
0x32	0x37	0x3A	0x35	0x35
0x2E	0x32	0x34	0x38	0x20
0x3A	0x20	0x32	0x37	0x2D
0x32	0x20	0x28	0x55	0x2F
0x56	0x29	0x20	0x6F	0x6E
0x20	0x41	0x42	0x43	0x3A
0x20	0x54	0x72	0x69	0x70

Appendix G Mechanical Drawings

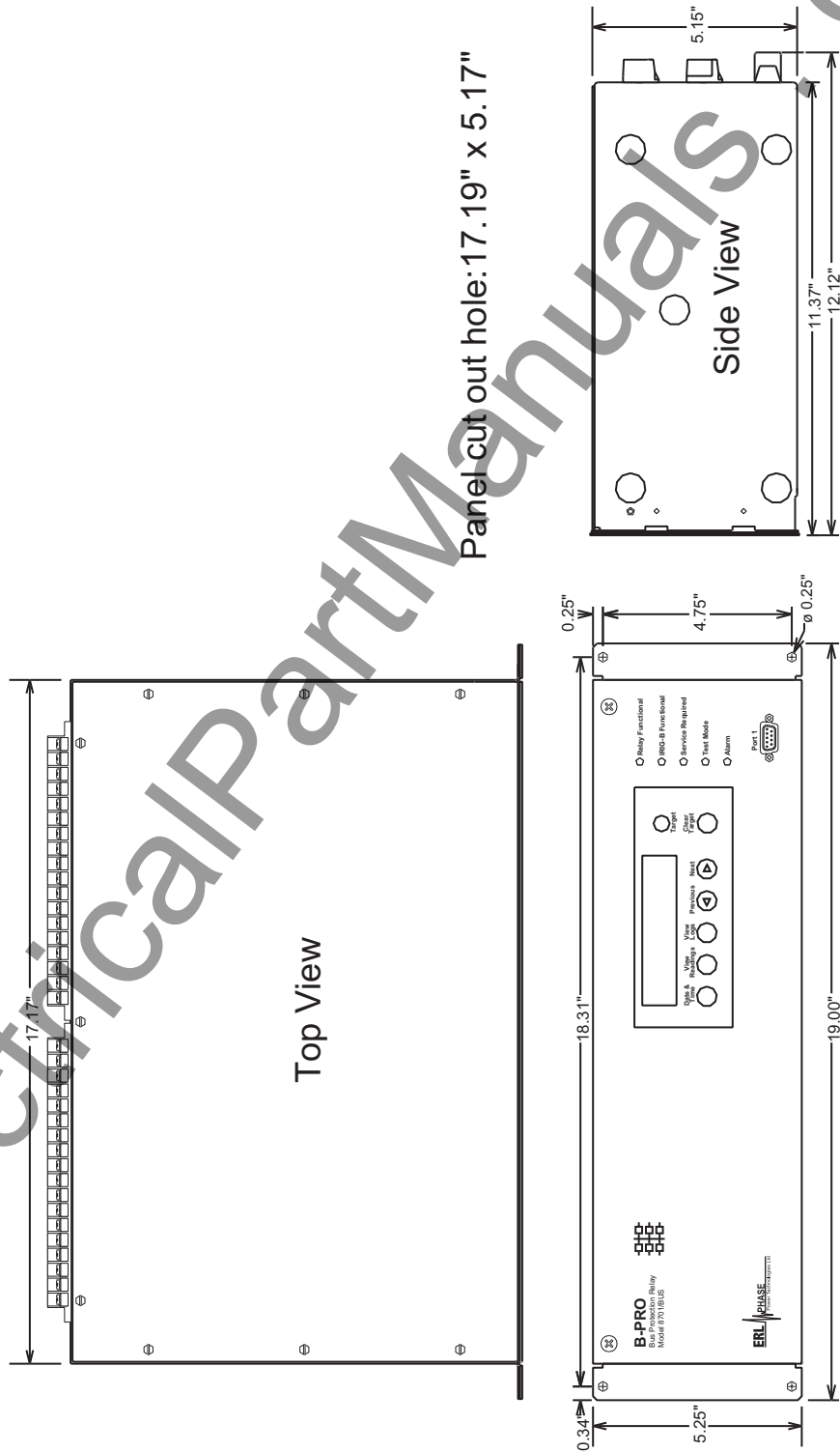


Figure G.1: Mechanical Drawing

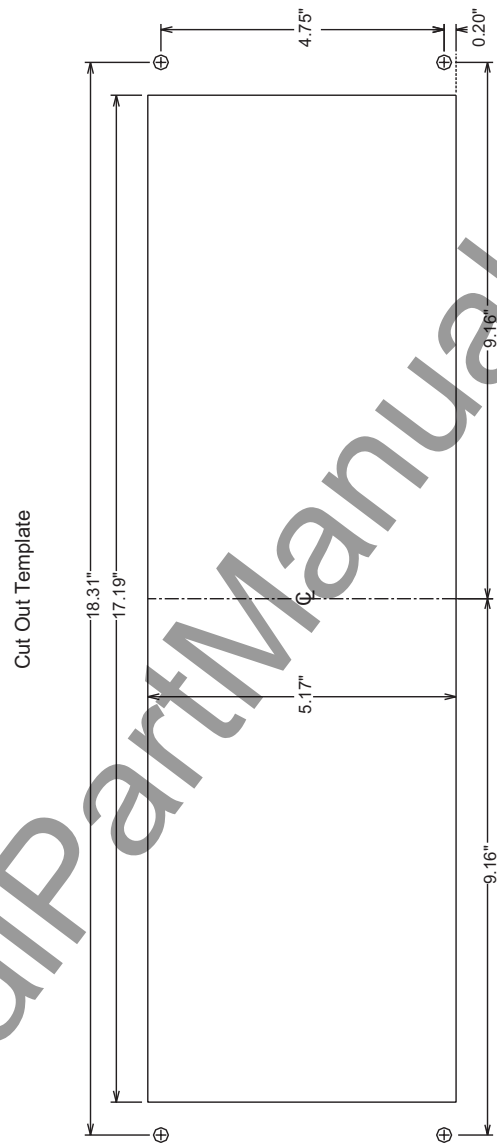


Figure G.2: Cut-out Template

Appendix H Rear Panel Drawings

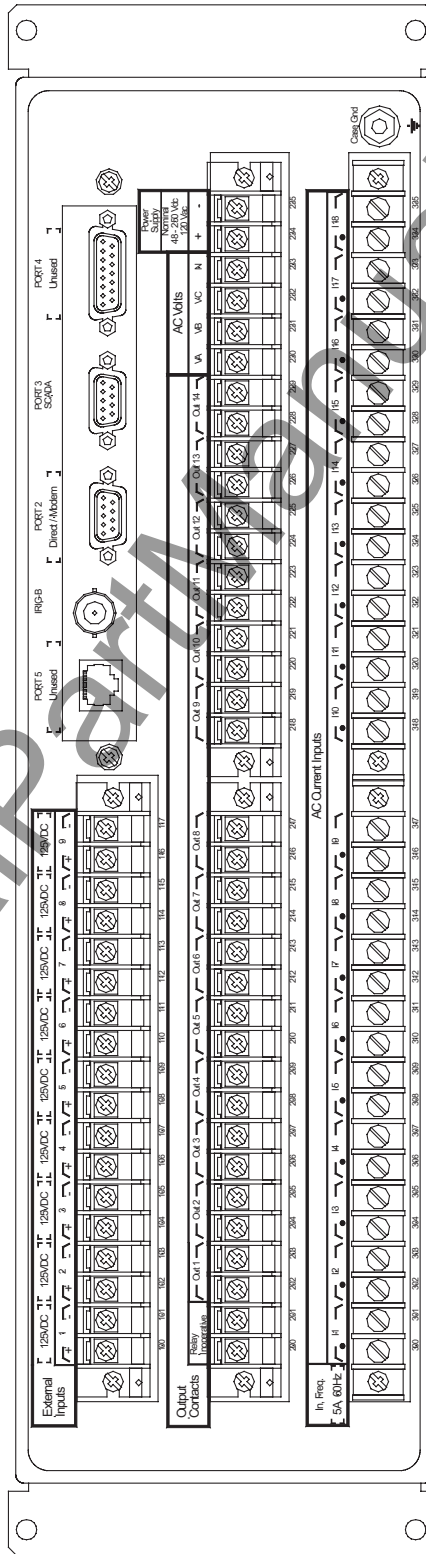


Figure H.1: Rear Panel

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Appendix I AC Schematic Drawings

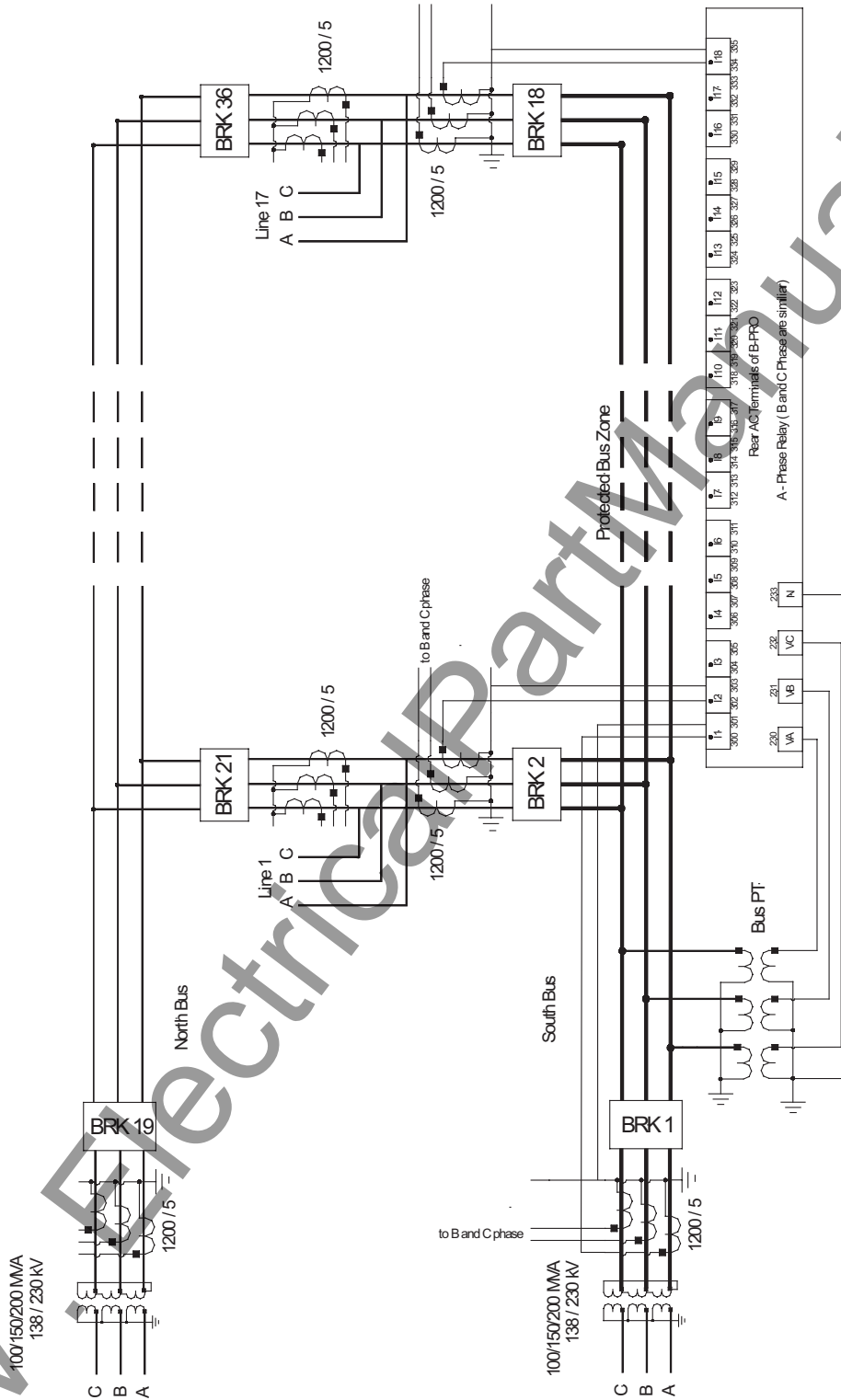


Figure I.1: AC Schematic

Notes:

1. All CT's on lines connected GRD WYE.
2. Lines 2 to 16 connected similarly to line 1.
3. CT and PT isolation blocks not shown, CT neutral is formed with other phase relays.

Bus Differential AC schematic

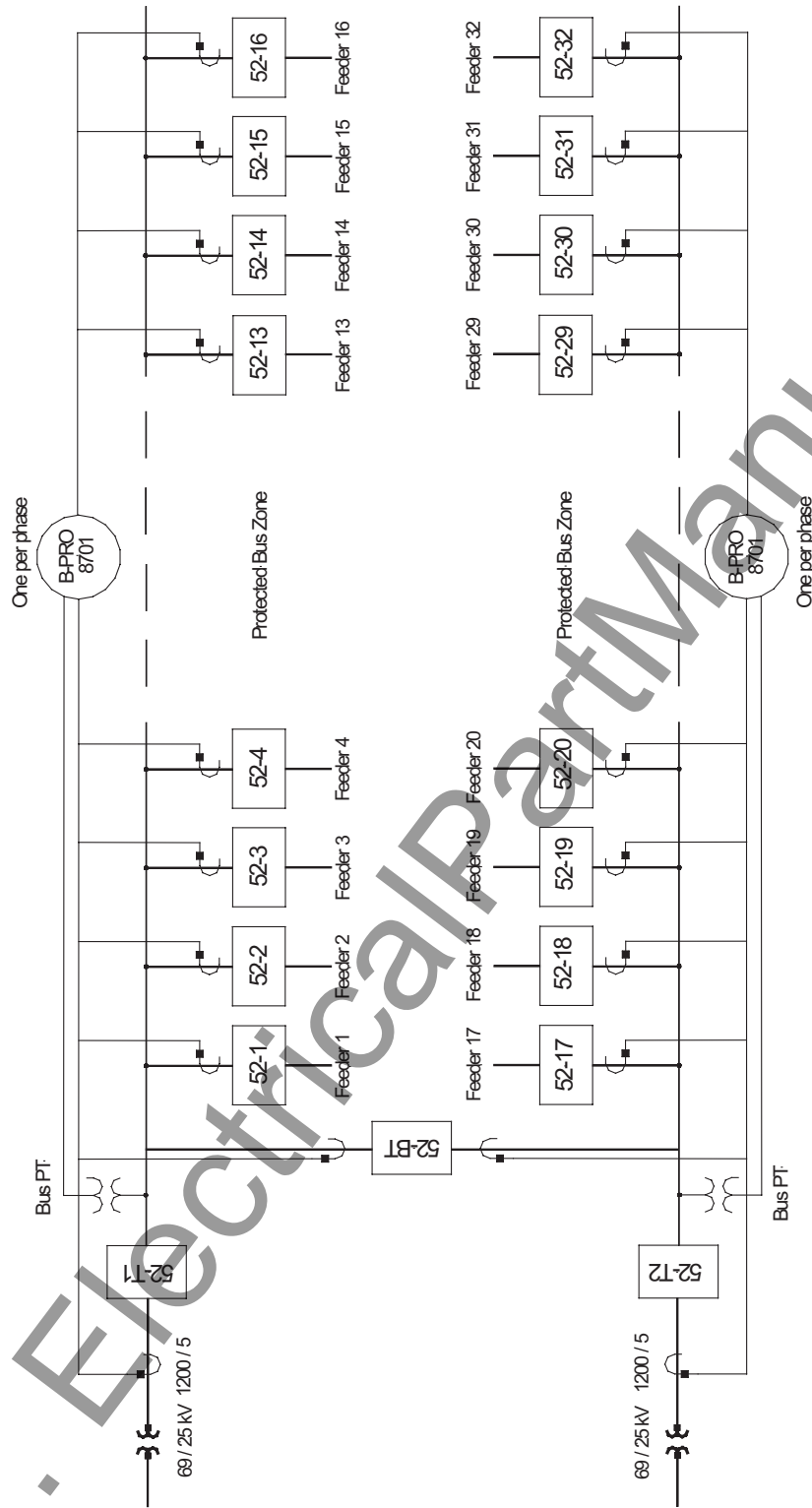


Figure I.2: Single Line AC Schematic

AC Schematic Bus Differential (one-line)

All CT's on lines connected GRD WYE.
 Feeders 1 to 32 have backup overcurrent protection from each phase B-PRO relay.
 B-PRO 8701 shown with optional 4U extended I/O board
 CT and PT isolation blocks not shown, CT neutral is formed with other phase relays.

Appendix J DC Schematic Drawing

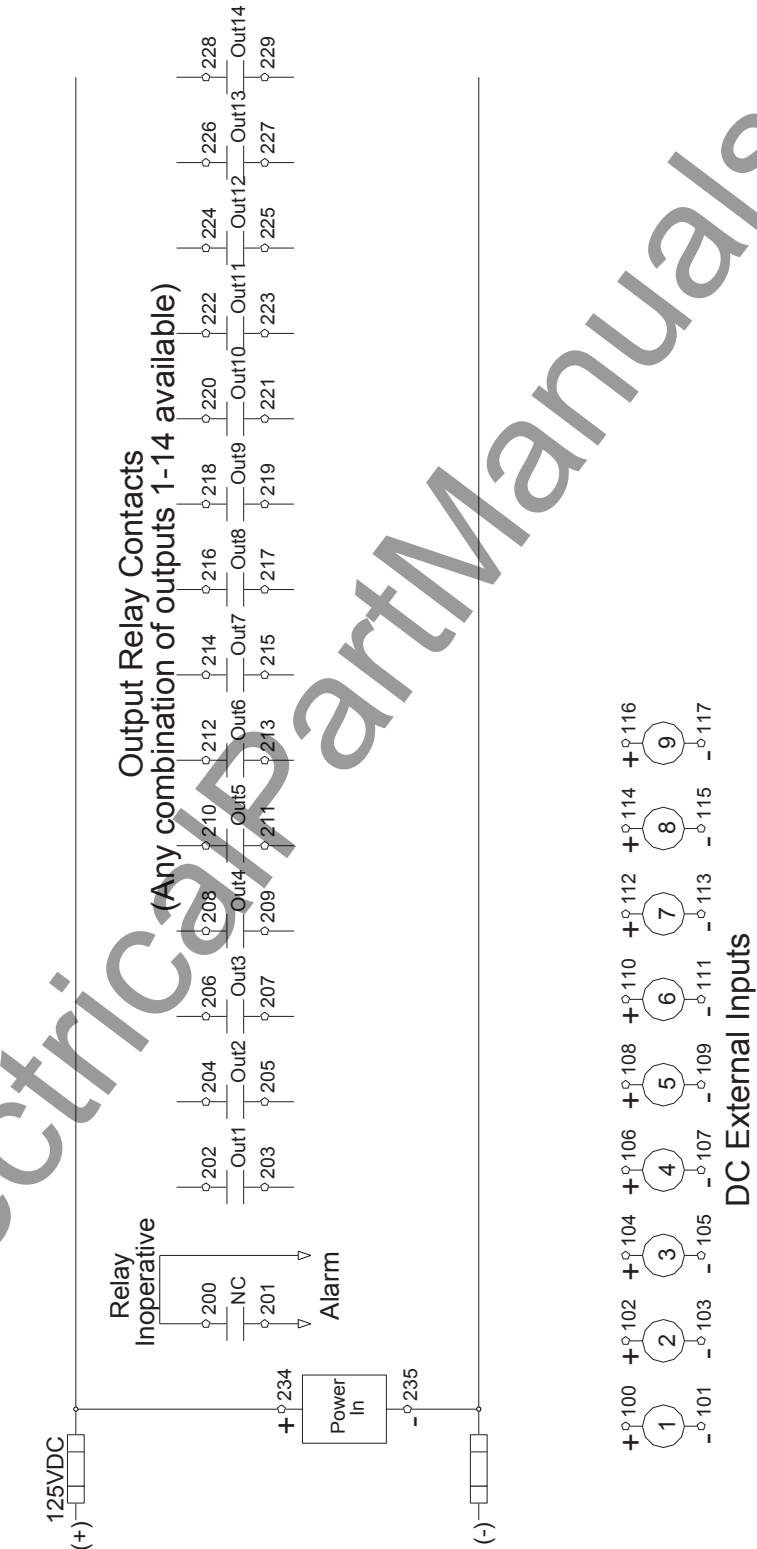


Figure J.1: DC Schematic

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Appendix K Function Logic Diagram

Diagram in plastic sleeve.

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Appendix L Application Examples

Example 1: B-PRO Bus Differential Protection Settings

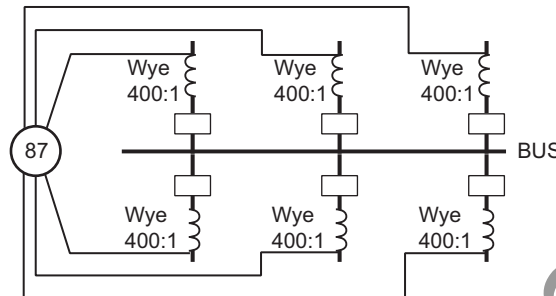


Figure L.1: Bus Differential Protection Example

Apply a B-PRO bus differential relay to the bus shown.

Operating Principle

The B-PRO bus protection relay is a low impedance type of differential protection suitable for the protection of ac bus configurations at all voltages.

The differential protection operates with existing line CTs. The differential equation is based on a minimum plus two slope characteristics in the current restraint and operating regions. This characteristic adds security to the relay even if some CT saturation is present.

I Operate

(IO) = vector sum of all line per unit (per unit) currents on a phase by phase basis.

I Restraint

(IR) = absolute sum of all line per unit currents divided by 2.

To relate all the line currents to their actual currents, IR and IO are shown in per unit quantities. A base MVA quantity must be entered in the B-PRO setting process.

Presetting Overview

To successfully set and apply the B-PRO bus differential relay you must make preliminary checks to determine relay stability for external faults.

Do the following:

- 1 Determine the maximum fault current at the bus with the contributions from each of the connected lines. Check to see if any of the line CTs saturate for a bus fault. Determine the worst case for this, for example three phase or single line to ground with a fully offset waveform.
- 2 Determine the maximum fault current possible of each line for a fault just outside each of the line CTs.
- 3 Determine if any saturation occurs for any line fault. Use our CT Saturation calculator software to determine any CT saturation curves conditions, see “How to Start the CT Saturation Calculator” in Appendix M. When the de-

gree of any saturation is known, the bus differential relay setting can be determined.

Obtain our CT Saturation calculator software from the software installation CD or the website at www.erlphase.com/sub-downloads.htm.

For instructions on how to use the CT Saturation calculator software see "How to Start the CT Saturation Calculator" in Appendix M.

You should use the highest fault values specific to the fault type, for this example assume the maximum fault current is a symmetrical single line to ground fault with a magnitude of 20 kA, Bus Base MVA = 100 MVA, and Bus Voltage = 230 kV. With the maximum fault current equal to 20 kA symmetrical, the CTs must be capable of producing a fully offset waveform equivalent to 40 kA asymmetrical.

Most CTs are capable of producing 20 times their nominal rated current into a standard ohm burden with a specified error.

For instance a 10L800 (C800) rated CT can output 100 A secondary into an 8 ohm burden with a maximum error of 10 percent.

To set the CT ratio properly allowing for 20 times nominal secondary current, where I nominal = 5 A, and I primary = 40 kA we end up with:

$I_{\text{primary}} / I_{\text{nominal}} * 20 = 40000 / 5 * 20 = 400:1$ CT ratio.

Line	Bus Fault	Bus Fault Per Unit	Bus Fault Secondary	External Line Fault	Line Fault Per Unit	Line Fault Secondary
Line 1	3 kA	12.0 pu	7.5 amps	17 kA	68.0 pu	42.5 amps
Line 2	3	12.0	7.5	17	68.0	42.5
Line 3	5	20.0	12.5	15	60.0	37.5
Line 4	2	8.0	5.0	18	72.0	45.0
Line 5	7	28.0	17.5	13	52.0	32.5
Line 6	0	0.0	0.0	20	80.0	50.0

Note: CT ratio for all lines is 400:1. The CT ratio can be different, but must be all wye connected.

- 1 Determining the maximum fault currents for a bus fault from the above table shows the maximum faults from 0.0 to 3.5 times nominal secondary current (0.0-17.5A).
- 2 Determining the fault currents for a line fault just outside the line CTs from the above table shows the maximum faults from 6.5 to 10.0 times nominal secondary current (32.5-50.0A).

3 The next step is to determine whether any CT saturation will occur for any of the external line fault conditions. You can use our CT Saturation program, or any other method to determine your CT response. The ERLPhase CT Saturation program was used to determine Line 6 CT (which will be exposed to the highest fault levels) response for 0 percent offset and 100 percent offset.

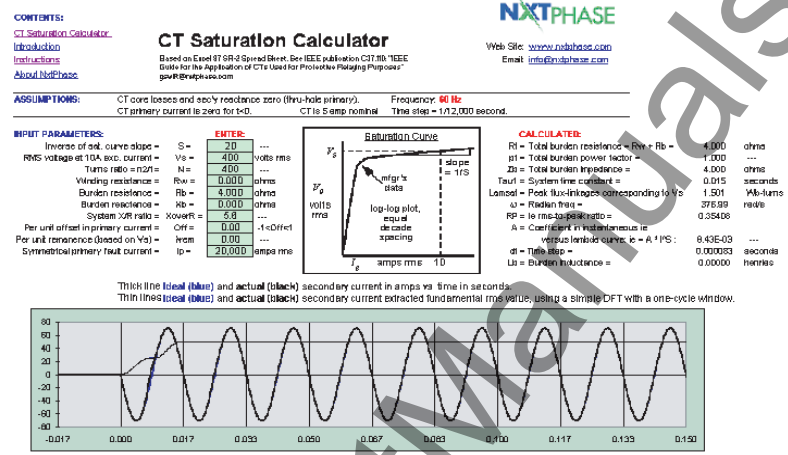


Figure L.2: 0% Offset

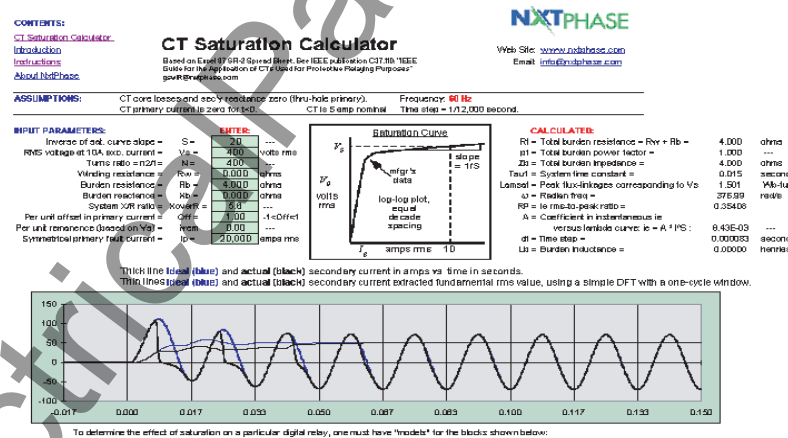


Figure L.3: 100% Offset

The ERLPhase CT Saturation program plots the ideal and actual CT response curve. The first plot shows the CT response with zero percent offset and the second plot shows the CT response with one hundred percent offset. With the 20 kA fault level, the assumptions made about the burden and the system X/R ratio, we can determine that the Line 6 CT will have some error in its secondary current. The heavy lines on the first plot indicate the ideal versus the actual response of the CT. The light lines on the first plot indicate the magnitude of the fundamental component with ideal response versus the actual fundamental component magnitude with CT response as indicated.

The CT response near the 0.033 ms time period shows the fundamental response to be 80 percent of the ideal value (0.8). The CT phase angle error near

the 0.033 time period is about 20 degrees. (Phase error information is available in the calculation listing, below the plot.)

We can establish the performance of Line 6 CT as 0.8×80 per unit = 64 per unit with a 20 degree phase angle error. The effective IO of Line 6 CT can now be established as 0.8×80 per unit \times Cosine 20 degrees = 60 per unit. For the Line 6 external fault we can see that CT is not producing enough IO to compensate for the remaining line CTs. The effective IO can be established as IOcombined - IOline 6. Therefore $80 - 60 = 20$ per unit IO. The effective IR can be established as $\text{IOcombined} / 2 + \text{IOline 6} / 2$. Therefore $80/2 + 60/2 = 70$ per unit IR.

Therefore IR = 70 per unit, and IO = 20 per unit for an external fault on Line 6. Continuing with this example we will show how to determine the IOmin, IRs, S1, S2, and High Current Settings for the 87 differential function.

Setting The 87 Function

IOmin

After the values of IO and IR have been determined for the application, the device 87 can be set. The IOmin setting determines the maximum sensitivity of the bus differential relay under light load conditions. If a 100 A minimum bus fault level is desired, we would set IOmin to 0.40 per unit ($100/250$). I per unit = $\text{MVA base} / 1.732 \times \text{V base}$, I per unit = $100 \text{ MVA} / 1.732 \times 230 \text{ kV}$, I per unit = 250 amps.

IRs

As the bus load increases IR increases. For the case where lines 1 through 6 become loaded to 5 A secondary, the bus load would be 2000 A primary on each line. The IRcombined becomes $(2000 \times 6) / (2 \times 250) = 24$ per unit, we would set IRs to 24.00.

S1

For the case where lines 1 through 6 become loaded to 5 A secondary, with a 10 percent CT error we set IO combined \times 10 percent = 48 per unit \times 10 percent = 4.8 or about 5 per unit. With IO = 5 per unit and IR = 24 per unit setting S1 = 22.00, this criterion is met.

S2

When entering the bus fault region, IR and IO become larger. The calculations from step 3 determined the IR = 72 per unit and IO = 60 per unit. To add some security we will assume a 10 percent error in line CTs 1 through 5 and then add a 25 percent margin to IO. The IOcombined then becomes 88 per unit and the IRcombined becomes 44 per unit.

- The effective IO can be established as $IO_{combined} - IO_{line\ 6} = 88 - 60 = 28$ per unit.
- The effective IR can be established as $IO_{combined} / 2 + IO_{line\ 6} / 2 = 88 / 2 + 60 / 2 = 74$ per unit.

Therefore IR = 74 per unit, and IO = 28 per unit for an external fault on Line 6 with a 10 percent CT error on Lines 1 through 6. You can add a 25 percent margin to the IO value for stability during through fault conditions. With IO = 35 per unit and IR = 74 per unit setting S2 = 60.00, this criterion is met.

High Current Setting

The final setting is for the unrestrained value. In this example we will set the value to operate for bus faults and provide stability for external faults. A setting of 2 times the maximum IO per unit value for the external line fault case on Line 6 is appropriate, setting High Current Setting = 56.00 per unit, this criterion is met.

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Appendix M How to Start the CT Saturation Calculator

The CT Saturation Calculator will assist you with setting the B-PRO relay. This program is a Microsoft Excel spread sheet. It is available from the downloads page on ERLPhase's website (www.erlphase.com/sub-downloads.htm). The CT Saturation Calculator tool is also included on the B-PRO software CD. Refer to "Application Examples" in Appendix L of this manual for a setting example.

Run from the CD

- 1 Insert the B-PRO CD into your CD-ROM drive.
- 2 If the CD does not open automatically, browse the CD and locate the "CD.exe" file in the root of the CD. Double-click on the file to run it.
- 3 Select either the text "B-PRO Bus Protection", located below the image of the relay, or the "B-PRO" text in the upper right hand corner of the start page.
- 4 Select the text "Install CT Saturation Software". This will launch Microsoft Excel either directly or from within your default WEB browser. Refer to the instructions at the top of the spreadsheet for further descriptions.

Copy to your hard drive

- 1 Use Windows File Manager to copy "CT_Sat.xls" from the B-PRO CD to a directory on your local hard drive.
- 2 When you need to access the program either double-click on the file or launch Microsoft Excel and use the standard "File" "Open" menu items to start the spreadsheet. You can also create a short cut icon on your desktop to run the CT program for your convenience.

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Software Installation Instructions

The CD-ROM contains software and the User Manual for the B-PRO Bus Protection Relay.

Software is installed directly from the CD-ROM to a Windows PC.

The CD-ROM contains the following:

- B-PRO *Offliner* Settings: Offline settings program for the B-PRO relay
- B-PRO Firmware: Firmware and installation instructions
- B-PRO User Manual: B-PRO manual in PDF format

To Install Software on your Computer

Insert the CD-ROM in your drive. The CD-ROM should open automatically. If the CD-ROM does not open automatically, go to Windows Explorer and find the CD-ROM (usually on D drive). Open the B-PRO.exe file to launch the CD-ROM.

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

To view the B-PRO User Manual you must have Adobe Acrobat on your computer. If you need a copy, download a copy by clicking on Download Adobe Acrobat.

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