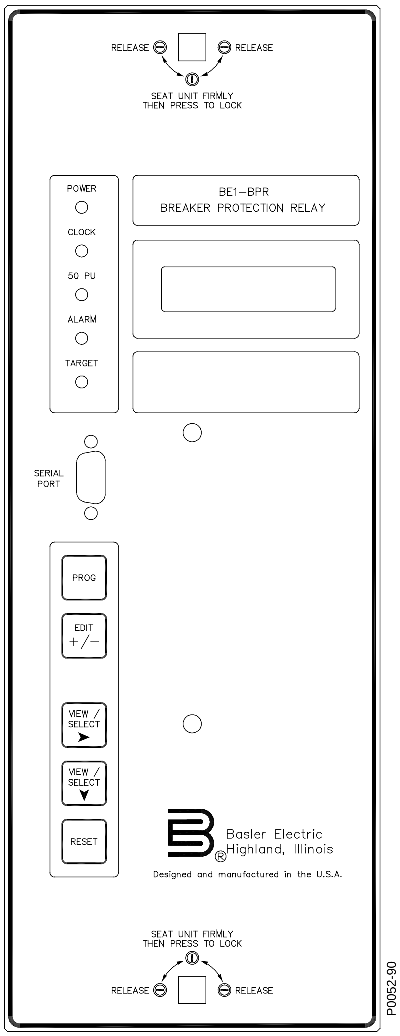
INSTRUCTION MANUAL

FOR

BE1-BPR
Breaker Protection Relay



Basler Electric®

Publication: 9272000990
Revision: L Jul-17

Preface

This instruction manual provides information about the installation and operation of the BE1-BPR Breaker Protection Relay. To accomplish this, the following information is provided:

- General information
- Human-Machine Interface
- Functional Description
- Installation and Maintenance
- Application
- Calibration and Testing

Conventions Used in this Manual

Important safety and procedural information is emphasized and presented in this manual through warning, caution, and note boxes. Each type is illustrated and defined as follows.

Warning!
Warning boxes call attention to conditions or actions that may cause personal injury or death.

Caution
Caution boxes call attention to operating conditions that may lead to equipment or property damage.

Note
Note boxes emphasize important information pertaining to installation or operation.

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First printing: December 1994

Warning!
READ THIS MANUAL. Read this manual before installing, operating, or maintaining the BE1-BPR. Note all warnings, cautions, and notes in this manual as well as on the product. Keep this manual with the product for reference. Only qualified personnel should install, operate, or service this system. Failure to follow warning and cautionary labels may result in personal injury or property damage. Exercise caution at all times.

Contents

Introduction

BE1-BPR Breaker Protection Relays are three-phase and neutral, microprocessor based relays designed to provide power systems with protection and security against monitored breaker failure or to initiate multiple shot breaker reclosings.

These relays incorporate a powerful means of programming internal relay logic to satisfy a wide range of user requirements without making any relay hardware changes. Microprocessor-based design provides the basic features of a programmable logic controller (PLC) combined with an instantaneous overcurrent module. Cased in a 19 inch rack-mount or a vertical panel mount, the relay offers installation versatility. A wide temperature, 2 lines by 16 character display provides diagnostic and setup information. Two RS-232 serial ports (one each front and rear) and one RS-485 serial port (rear) provide remote communication and relay control.

Built-in diagnostics and monitoring features provide information for both the health of the relay and the health of the breaker being monitored. Relay diagnostics include continuous background monitoring of the power supplies, analog-to-digital (A/D) converter, random-access memory (RAM), read-only memory (ROM), and electrically-erasable programmable ROM (EEPROM). A dedicated alarm (ALM) relay output provides power supply, microprocessor, and software alarm status. Breaker diagnostics include a timing diagnostic log, breaker contact duty monitoring, breaker resistor protection, and breaker arc detection. Other monitoring features include oscillographic fault records and fault summary logs. BE1-BPR relays use the Inter-Range Instrumentation Group (IRIG), Format B for high timing accuracy and resolution.

Application - Standard Models

Breaker Failure

BE1-BPR relays are intended to provide a preprogrammed solution for most breaker failure relaying applications. Breaker failure relaying is the use of a current monitoring relay to determine whether or not current continues to flow into a faulted circuit after a breaker has been instructed to interrupt the circuit. If current continues to flow into the faulted circuit after a defined period of time has elapsed (sufficient for the breaker to have interrupted the current), the circuit breaker is considered to have failed. Steps must then be taken to trip the next set of breakers in the power system to prevent system damage. Breaker failure schemes must be designed to isolate both the faulted circuit and the failed breaker.

Several reasons why a breaker fails to clear a fault are:

- Trip circuit is open (broken wire, blown fuse, open trip coil).
- Interrupting mechanism stuck, leaving a single phase of a three-phase circuit connected.
- Interrupter flash-over due to the loss of dielectric strength through contamination or damage.
- Operating mechanism failed to operate.

Breaker failure relays detect these conditions and initiate backup procedures.

Breaker failure relays are applied on a per breaker basis. That is, one breaker failure relay for each breaker in the substation. BE1-BPR relay outputs must be arranged to initiate the tripping of all the circuit breakers necessary to isolate the fault if the protected circuit breaker fails to operate. The relay may also need to initiate transfer tripping of remote breakers to accomplish this task. Transfer tripping of the remote line end for a breaker failure should also block reclosing of the remote circuit breakers. External lockout relays are typically used to trip and block reclosing of the backup breakers because they normally require a positive operator action to reset them.

Typically, breaker failure protection is applied to transmission and sub-transmission systems. However, breaker failure protection may be applied to any portion of the power system where failure of a circuit breaker to operate properly could result in severe system damage or instability. Breaker failure protection can also be used to selectively clear a failed breaker in a station with multiple buses without clearing the entire station.

Breaker Reclosing

BE1-BPR relays can be configured as multiple shot reclosing relays that operate in parallel and independently from the breaker failure function.

Three major factors should be considered when establishing a reclosing philosophy.

- Desired number or reclosure attempts.
- Time delay between breaker opening and reclosure.
- Supervisory control.

The first major factor is the desired number of reclosure attempts. Where most faults are attributable to heavy tree exposure, as in distribution networks, multiple reclosure attempts are common. This is possible because of low voltage levels and is desirable considering customer inconvenience during outages. BE1-BPR relays are programmable for up to three reclosure attempts per sequence. This allows tailoring of the reclosing sequence to the specific needs of the circuit.

The second major factor is the time delay between breaker opening and reclosure. On sub-transmission and distribution networks, it is necessary to ensure that motors are no longer running and that local generation is off-line prior to attempting reclosure. At the same time, a rapid reclosure minimizes damage, ionization, and system shock in transmission networks. After the first reclosure attempt, additional attempts are generally delayed to allow for de-ionization of the interrupter. BE1-BPR relays have three reclosing shots and each shot has a programmable time delay. Three outputs are available. They are CLOSE, RECLOSE FAIL, and LOCKOUT.

A third major factor to be considered in reclosing is supervisory control. Supervisory control allows the operator to maintain control of the system at all times. BE1-BPR relays have two supervisory inputs (WAIT and LOCKOUT). WAIT stops the reclose sequence at any point and allows the sequence to continue when the WAIT input is removed. LOCKOUT drives the reclose function immediately to lockout status and takes precedence over all other inputs.

Timing Diagnostics

To perform the typical breaker failure operation previously described, the breaker failure relay must be informed by a breaker failure initiate (BFI) contact that the breaker is being opened. One or more timers, in conjunction with the overcurrent element, determine if the breaker failure output (BFO) picks up.

Typically one or more delay timers are used to delay the BFO until the primary protection scheme has had enough time to operate. A control timer may be also be used to turn off the BFO after the backup protection has had enough time to operate.

Calculation of the correct timer values is an important part of setting up the relay. You must know how long it takes for the internal and external devices to operate. Typical timing sequences are listed in the following paragraphs and shown in Figure 1. Parentheses in the listed timing information indicate related times in Figure 1. Specific timing data for BE1-BPR relays is provided in the latter part of this section.

Normal Breaker Operation Required Timing Information

(1) Time for protective relays to operate — (this includes sending a trip signal to the breaker and sending a BFI signal to the BE1-BPR).

(2) Time required for the breaker to open.

(3) Time required for the BE1-BPR overcurrent detector to drop out.

(4) Margin to allow for variations in normal sequence timing plus a safety factor.

(12) Control timer setting = the length of time to maintain the breaker failure operating window. Control timer setting must coordinate with the high speed reclose delay (13).

(13) Time to allow for arc de-ionization.

Failed Breaker Operation Required Timing Information

(5) Time for the BFI overcurrent detector to pickup.

(6) Time required for the BFI contact to be recognized by the BE1-BPR.

(7) Time for the BF logic to operate.

(8) Time for the BFO relay to operate.

(9) Time for the external lockout relay to pickup.

(10) Time for the backup breakers to operate.

(11) Delay timer setting = the sum of (breaker operate time (2) + BF current detector dropout time (3) + margin (4)) minus BFI contact pickup time (6).

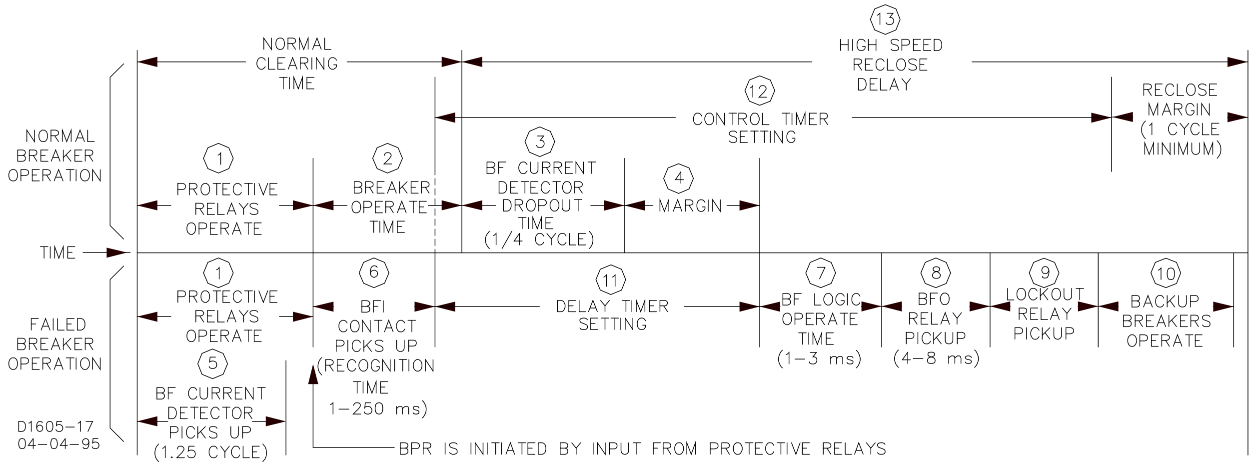


Figure 1. Breaker Failure Timing Diagram

Because timing is such an important part of breaker failure protection, the BE1-BPR relay provides timing diagnostics to assist in determining if the timer settings are optimal and to allow other aspects of the protection system to be checked. This timing diagnostic is a Timer Log or TLOG. An example of its use is to create a log of the margin remaining between when a fault is cleared and when a breaker failure would occur. After a normal breaker operation clears a fault, the time remaining from when the BE1-BPR overcurrent fault detector drops out and the breaker failure delay timer would have timed out is the MARGIN. This time can be recorded by saving the time left on the delay timer when the fault detector drops out by using the program timer log alarm (PTLOG) command. The time logged will correspond to the MARGIN value in Figure 1. If there is a discrepancy between the calculated and actual margin value stored in the TLOG, corrective action can be taken to correct the protection timing before a serious problem occurs. If the MARGIN is too small or too large, the delay timer setting can be adjusted for optimal operation. The PTLOG command also allows an alarm time to be programmed so that if the MARGIN drops below a pre-determined value, the Alarm output (ALM) can be automatically closed to signal the operator that immediate attention is required. Timing diagnostics can be programmed for each of the six timers available.

Breaker Arc Detector

An important breaker diagnostic feature is the detection of low level arcing across an open breaker (flashover). Flashover might occur because lightning struck and a surge suppressor failed or air pressure in an air blast circuit breaker is lost. If left undetected, severe damage to the breaker contacts could result. BE1-BPR relays can detect this type of fault using an extra low level phase overcurrent pickup and a long moving average filter. These features have been provided as standard features in the BE1-BPR relays. Used with the programmable logic, a breaker arc detector can be programmed to provide a breaker close output to close the breaker and extinguish the arc. Additional interlocks may be added to the logic to inhibit the breaker close signal if the breaker is isolating a faulted line.

IRIG Standard Time Format

The IRIG function allows the BE1-BPR relay to synchronize the on-board real time clock with a standard IRIG demodulated time signal. Synchronization is automatic and the BE1-BPR initiates synchronization at regular intervals (approximately 20 seconds) in order to maintain the one millisecond overall accuracy.

Application - Enhanced Models

Enhanced BE1-BPR models have all of the features of standard models plus the additional features described in the following paragraphs.

Breaker Contact Maintenance and Resistor Protection

Enhanced model BE1-BPR relays can perform two protection diagnostic functions other than the breaker failure function. One, they can estimate breaker contact duty (wear) and signal when preventative maintenance is needed. Two, they can estimate breaker opening resistor heating and provide a block reclose signal to protect the breaker resistor when the resistor heating could exceed the maximum resistor rating.

Fault Recording

Enhanced model BE1-BPR relays can also be configured to record and save digital fault data for all three phases plus neutral (0 to 200 amperes) and the digital state of each input and output contact. Analog waveforms are digitized by sampling the waveforms at a periodic rate and converting the measured signals to digital values. When a fault occurs, the digital data is stored as a fault record. Multiple fault records can be stored and recalled through the serial port by an operator. To display the fault waveform for analysis, recalled data can be imported into a data base file and converted into a graph. Standard programs that read and display ASCII data (in accordance with IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems) can also be used. BESTview™ application software provides a simple terminal interface to communicate with the relay, retrieve COMTRADE oscillographic fault data, and provide a remote front panel interface. This software is not required to communicate with the relay. However, it combines the functions of a number of separate packages into one program that is optimized for the BE1-BPR relay. To order this software free of charge, contact the Customer Service Department of the Power Systems Group, Basler Electric, and request the BESTview Software Package.

Model Numbers

Tables 1 and 2 provide information for the nominal current input to the current transformers, part number, options, mounting style, and operating power supply voltage. Standard BE1-BPR relays do not have oscillography, fault records, contact duty logs, or two calibration levels (current metering is limited to 10 amperes).

Table 1. BE1-BPR Relays, 5 Aac CT Secondary

Part Number	Options	Mounting Style	IRIG	Power Supply
9272000300	Standard	19” Rack Mount	Yes	48/125 Vac/Vdc
9272000301	Standard	19” Rack Mount	Yes	125/250 Vac/Vdc
9272000302	Enhanced	19” Rack Mount	Yes	48/125 Vac/Vdc
9272000303	Enhanced	19” Rack Mount	Yes	125/250 Vac/Vdc
9272000309	Standard	Vertical Mount	Yes	48/125 Vac/Vdc
9272000310	Standard	Vertical Mount	Yes	125/250 Vac/Vdc
9272000311	Enhanced	Vertical Mount	Yes	48/125 Vac/Vdc
9272000312	Enhanced	Vertical Mount	Yes	125/250 Vac/Vdc
9272000328	Enhanced	Vertical Mount	Yes	48/125 Vac/Vdc
9272000329	Enhanced	19” Rack Mount	Yes	48/125 Vac/Vdc
9272000330	Enhanced	Vertical Mount	Yes	125/250 Vac/Vdc
9272000331	Enhanced	19” Rack Mount	Yes	125/250 Vac/Vdc

Table 2. BE1-BPR Relays, 1 Aac CT Secondary

Part Number	Options	Mounting Style	IRIG	Power Supply
9272000304	Standard	19” Rack Mount	Yes	48/125 Vac/Vdc
9272000305	Standard	19” Rack Mount	Yes	125/250 Vac/Vdc
9272000306	Enhanced	19” Rack Mount	Yes	48/125 Vac/Vdc
9272000307	Enhanced	19” Rack Mount	Yes	125/250 Vac/Vdc

Human-Machine Interface

This chapter illustrates and describes the BE1-BPR human-machine interface (HMI). The HMI consists of controls, indicators, and communication connectors located on the front and rear panels of the relay.

Front Panel

Figure 2 shows the front panel HMI components of the vertical-mount BE1-BPR. Horizontal-mount relays share the same HMI components and differ only in component layout. Table 3 describes the function of each component called out in Figure 2.

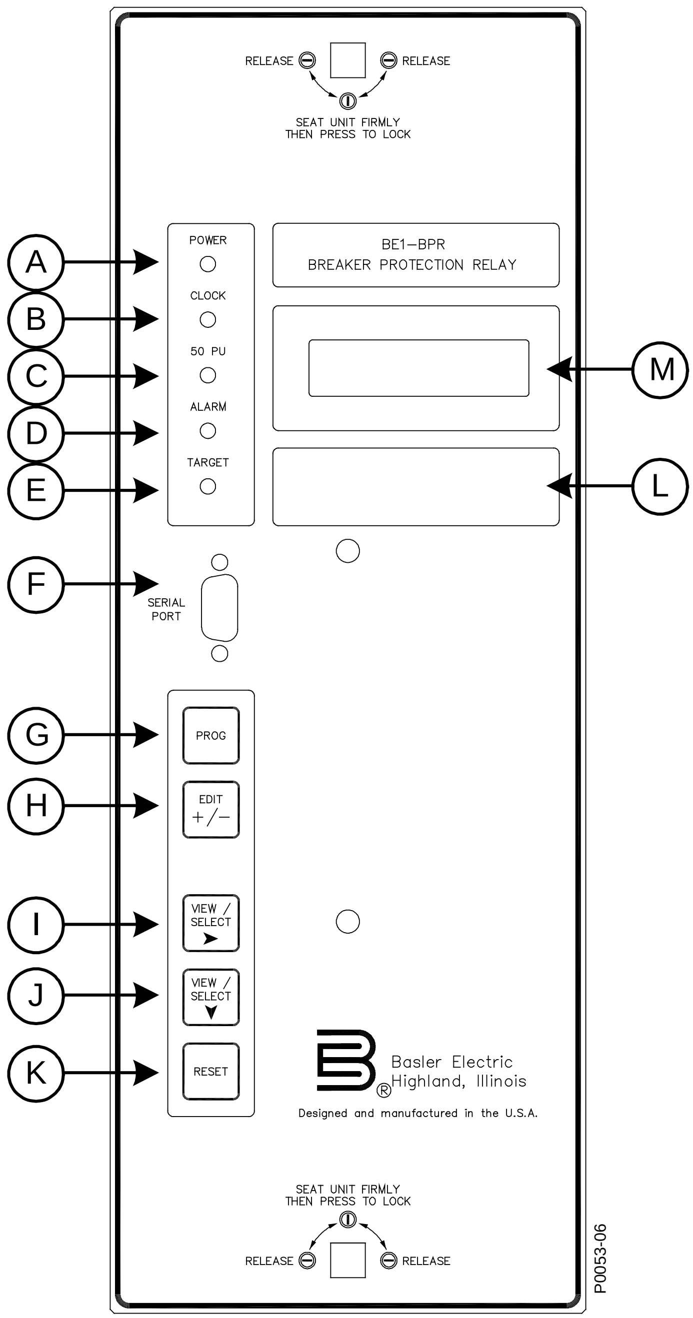


Figure 2. Front Panel HMI

Table 3. Front Panel HMI Component Descriptions

Locator	Description
A	**Power Indicator.** This green LED lights when operating power is applied to the relay.
B	**Clock Indicator.** This red LED lights to indicate that the real-time clock has not been set.
C	**50PU Indicator.** This red LED lights when one or more instantaneous overcurrent pickup settings are exceeded.
D	**Alarm Indicator.** This red LED lights when a diagnostic problem occurs within the relay.
E	**Target Indicator.** This red LED lights when one or more output relays are energized and target information has been saved to nonvolatile memory. Detailed target information is available through the *Target* menu of the display (Locator M).
F	**Communication Port 0 (COM 0).** Communication with the relay can be achieved by connecting a communication cable between this female RS-232 serial port and a computer terminal or PC. Simple ASCII commands can be transmitted and received by using terminal emulation software. The front port is provided for local, temporary communication with the relay. A rear RS-232 port (Port 1A) and a rear RS-485 port (Port 1B) are intended as remote, long-term communication connections. The *Communications* chapter provides detailed information about using the communication ports to communicate with the relay.
G	**Program Key (PROG).** Pressing this pushbutton enters the Program mode which allows you to make settings changes. If password protection is enabled, a password may need to be entered before settings changes are allowed. Settings changes are saved by pressing and holding the Program key for two seconds. The *Save* screen is then displayed and you are prompted to save your changes to nonvolatile memory or exit the Program mode without saving changes.
H	**Edit Key (+/-).** This pushbutton enters the Program mode. Pressing the Edit key increments a setting number or character to the next higher value in the sequence. Pressing the Program key followed by the Edit key reverses the direction of settings changes so that pressing the Edit key decrements a setting to the next lower value in the sequence. The direction of change is reversed until any key other than the Edit key is pressed.
I	**View/Select (►) Key.** This pushbutton selects the top level of the next menu branch for viewing. Pressing the View/Select key when the last available menu branch is reached, returns the display to the first available menu branch. When operating in Program mode, pressing the View/Select key selects the next number or string to change.
J	**View/Select (▼) Key.** This pushbutton selects the next lower screen of the current menu branch for viewing. Pressing the View/Select key when the last available screen is reached, returns the display to the top screen of the menu branch. When operating in Program mode, pressing the View/Select key selects a different screen for making settings changes.
K	**Reset Key.** Pressing this pushbutton displays the top screen of the menu branch that you are viewing. Pressing the Reset key while viewing targets or a diagnostic screen resets (clears) the target or diagnostic information. When operating in Program mode, pressing and holding the Reset key for two seconds exits the Program mode without saving any settings changes.
L	**Identification Label.** This label lists the relay part number, serial number, rated sensing input current, and power supply voltage.
M	**Display.** The display consists of a two line by 16 character liquid crystal display (LCD) with backlighting. Information such as targets, metering values, communication parameters, the active logic scheme name, and diagnostic information is displayed by the LCD. The LCD is also used when making settings changes at the relay front panel. The *Functional Description* chapter provides more information about obtaining information and making settings changes through the display.

Functional Description

BE1-BPR Breaker Protection Relays are microprocessor-based devices that provide breaker failure protection, optional fault recording, and diagnostic monitoring of breaker wear and breaker resistor overheating. This chapter describes the hardware and software functional descriptions.

Hardware Functional Description

BE1-BPR relays are available in a horizontal, 19-inch, rack-mount configuration or a vertical, panel-mount configuration. Two latches secure the chassis assembly in the case. The chassis assembly can be removed from the case by releasing the two latches and pulling the spring loaded, retracting handle on the front panel. It is not necessary to disturb system wiring when removing a BE1-BPR relay from the case. A transparent front cover protects the relay but allows access to frequently used front panel controls.

The hardware functional description is divided into three categories: inputs, circuit operation, and outputs.

Inputs

There are five types of inputs to the BE1-BPR relay. They are:

- Operating Power
- Contact Sensing
- Current Sensing
- Keyboard
- Serial Ports RS-232/RS-485

Operating Power

Operating power for the internal circuitry is applied to the internal, isolated, switching power supply. Nominal operating power is either 48/125 Vdc or 125/250 Vdc and is determined by the relay part number shown in the *Specifications* chapter.

Contact Sensing

Seven external contact sensing inputs accept external stimulus to initiate BE1-BPR relay actions. Voltage applied to the contact sensing inputs must fall within the relay DC power supply input voltage range. If the power supply of the relay has an ac source, a separate dc source must be used for the contact sensing input voltage. Three contact sensing inputs (IN1 through IN3) are individually isolated. IN4 and IN5 are isolated from other circuits but share a common return. IN6 and IN7 are also isolated from other circuits but share a common return.

Current Sensing

Monitored line and neutral currents are applied to internal current transformers (CTs) and stepped down to internal circuit levels. The internal CTs provide isolation from the monitored line currents.

Keyboard

A keyboard (illustrated in the *Human-Machine Interface* chapter) provides limited local programming capability and the ability to select a number of status and diagnostic menu screens.

Serial Ports RS-232/RS-485

Serial communication ports at the front and rear of the BE1-BPR relay provide complete programming capability and remote access for diagnostics, relay setup, and relay control.

Circuit Operation

The microprocessor continually monitors itself to ensure proper operation. Separate, independent circuitry monitors the power supply and the microprocessor to ensure that any problem in these areas automatically takes the BE1-BPR off-line and activates the alarm output. Relay circuit functions illustrated in Figure 3 are described in the following paragraphs.

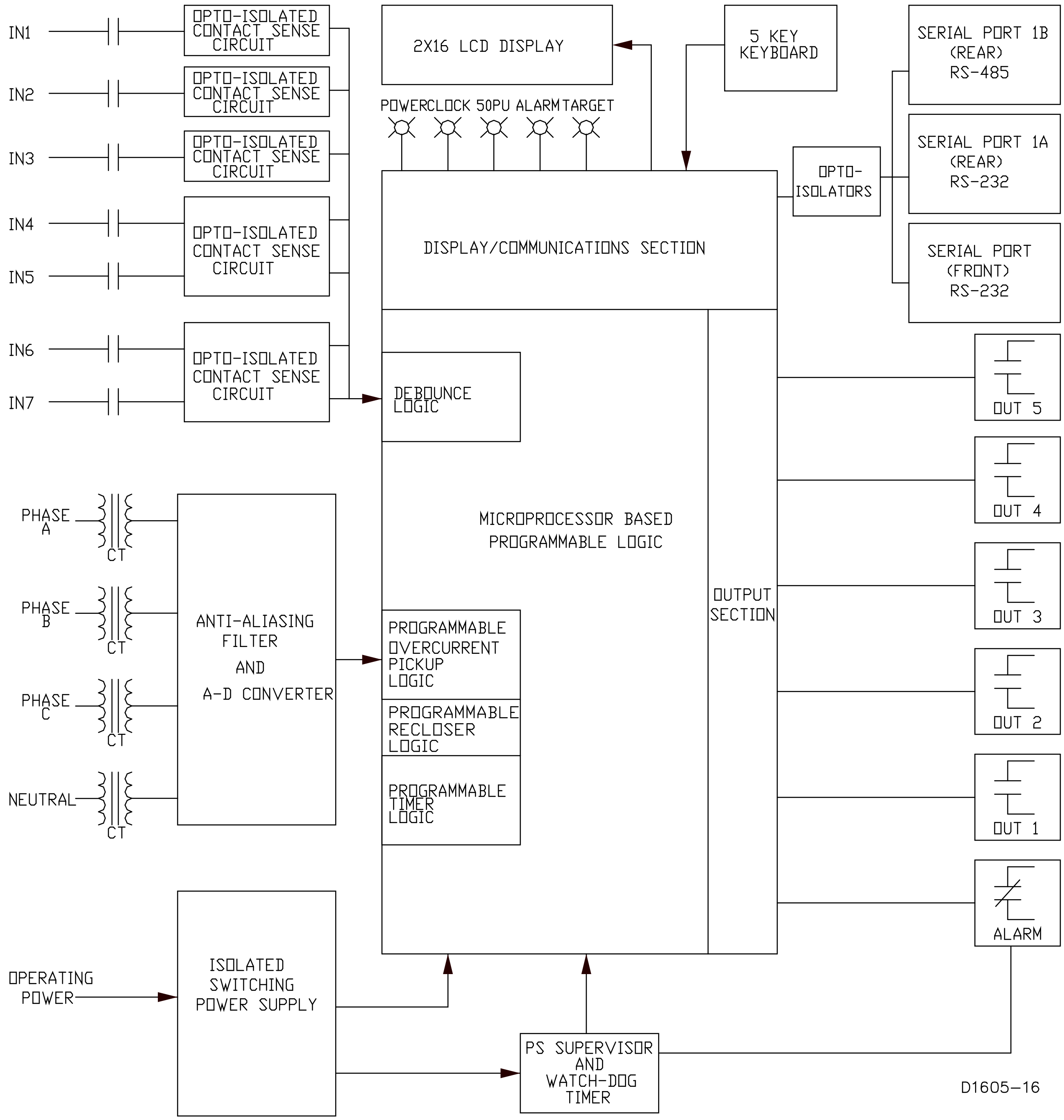


Figure 3. Functional Block Diagram

Power Supply

The isolated, switching power supply generates ±12 Vdc, +5 Vdc, and an isolated +5 Vdc. If the +5 Vdc digital supply falls outside the defined tolerance, then the microprocessor is reset by the power supply supervisory circuit. This reset takes the relay off-line and lights the Alarm LED. High capacitance on the 5 Vdc supply maintains oscillography and fault record data stored in RAM (enhanced units only) for 24 hours (at 25°C) when operating power is lost or removed.

Watchdog Timer

If the microprocessor fails for any reason, output pulses to the watchdog timer stop. The watchdog timer will then take the relay offline, light the Alarm LED, and close the alarm output.

Opto-Isolators

Opto-isolators in the contact sensing input circuits provide isolation from the external power supply which provides power to the contact input circuits.

Debounce Logic

Outputs from the contact sensing circuits are debounced by the microprocessor using programmable recognition and debounce times. Debounce logic is programmable only through the communication ports.

Anti-Aliasing Filter and Analog to Digital Converter

Stepped-down inputs from each CT are converted to a voltage signal and filtered by a low-pass anti-aliasing filter. The digitized input signal is then passed to the microprocessor for processing.

Programmable Fault Detector Logic

Each monitored current is digitized, digitally filtered, and the 50/60 hertz rms value for each input is calculated. The filtered value is compared to the appropriate pickup setting. If the filtered value is greater than the pickup setting, then a fault detector logic flag (F1, F2, or F3) is set for use by the output logic section. If the fault detector logic is programmed as an instantaneous overcurrent pickup (filter type 1 or 3), the 50PU LED is turned on. If the fault detector logic is programmed as a moving average current detector, (filter type 2), the 50PU LED is not turned on.

Programmable Timer Logic

Up to six programmable, independent timers are available in the breaker fail logic. The timers can be programmed to act as a control timer or delay timer.

Programmable Recloser Logic

A one to three shot recloser function is available with separate timers for reset, reclose fail, and maximum cycle time.

Microprocessor Based Programmable Logic

Microprocessor software provides the capability of a programmable logic controller (PLC) to control the outputs. Output control equations take the form of simple Boolean equations. Contact inputs (Ix), fault detectors (Fx), timer outputs (Tx), and outputs relays (Ox) act as variables in the equations. The microprocessor based programmable logic is covered in detail in the *BESTlogic*™ chapter.

Outputs

There are five types of BE1-BPR outputs:

- Alarm relay
- Output relays
- Targets
- Liquid crystal display (LCD)
- Serial ports RS-232/RS-485

Alarm Relay

Output relay OA is operated (energized) by the programmable logic section when logic equation LOA is false. Table 4 lists the two LOA states and the corresponding hardware states.

Table 4. Alarm States

Logic Equation LOA	HMI Alarm LED	Alarm Relay OA	Alarm Contacts
0	Off	Energized	Open
1	On	De-Energized	Closes

The normally-closed configuration of output relay OA holds the Alarm output contacts in the open state when LOA=false (coil energized) and closes the contacts when LOA=true (coil de-energized). If the power supply voltage decreases below a predetermined level or the microprocessor watchdog times out, the output contacts close (coil de-energizes). The software Alarm output (OA) is logically ORed with the hardware logic power sensor and watchdog timer. Either input can trigger the Alarm output independently from the software logic. The microprocessor-based relay logic cannot disable this hardware protection.

Output Relays

Output relays O1 through O5 are operated (energized) by the programmable logic section when the corresponding logic equation is true. Table 5 lists the two logic equation states and the corresponding hardware states.

Table 5. Output States

Logic Equation LO1 - LO5	Output Relay O1 - O5	O1 - O5 Contacts
0	De-energized	Open
1	Energized	Closed

Output relay O1 is a high-speed output with maximum operate time of 5 milliseconds.

Targets

Detailed target information about the inputs and outputs is displayed by the Targets menu screen. Whenever any of the target output relays energize, the front panel Target LED lights. Target information is latched in non-volatile memory if the output is programmed as latching. To reset the Target LED, operate the front panel Reset pushbutton or enter the RESET command through a serial communication port. The PTARGET command programs output relays as target relays.

Liquid Crystal Display (LCD)

A two line by 16 character, LCD shows targets, setup, status, and diagnostic information and allows provides programming capability. LED backlighting illuminates the LCD screen.

Serial Ports RS-232/RS-485

Serial communication ports at the front and rear of the BE1-BPR provide total programming capability and remote access for diagnostic, relay setup, and relay control.

Software Functional Description

Most relay settings may be adjusted using the front panel keyboard and display. However, to program the relay logic, change the breaker configuration data, time and date format, CT data, and request reports, the front or rear communications port must be used. In general, tasks that are not easily performed at the front panel should be done through the communication ports.

Introduction

Relay diagnostic and setup information is organized in a menu format when viewed using the front panel display. Figure 4 shows the menu progression from startup to maintenance for an enhanced BE1-BPR. Figure 5 shows the menu progression for a standard BE1-BPR. The right arrow key is used to scroll through the available menu screens and the down arrow key is used to access menu sub-screens. When using a communication port, the relay is programmed using ASCII software commands. Information about software commands is available by using the HELP command. The HELP command provides a list of available commands or information and syntax regarding a specific command along with an example of its use.

HELP	Commands Information	HMI Menu Branch: N/A
Parameter	**Comments**	
Cmd	HELP or H returns information about using the HELP command. HELP1 or H1 provides a list of relay commands. HELP<cmd> or H<cmd>, where <cmd> is a specific command, returns information on the usage and format of the command and an example of its use.	

HELP Command

Purpose: Obtains helpful information about communication port commands.

Syntax: HELP [x/<cmd>]

Comments: No access area password is required to use the HELP command.

Note
Relay responses in all examples are displayed in a `Courier` typeface.

HELP Command Example:

Obtain information about using the PU command.

```
HELP PU
Purpose: Read/Change fault detector Pickup level and cycles
Syntax:  PU[#[=<level (A)>[,<cycles>]]]
Example: PU1 or PU1=6.2 or PU3=0.5,10
```

Startup and Menu Selection

When the relay is turned on, the startup screen is displayed for two seconds and then defaults to the TARGETS menu screen. At this time, the relay is at the menu level. Operating the front panel right arrow key causes each menu screen to be displayed in succession. The display order is:

0. TARGETS
1. RELAY SETUP
2. RELAY STATUS
3. BREAKER STATUS
4. TIMER LOG
5. FAULT LOG (enhanced units only)
6. MAINTENANCE

After MAINTENANCE, the menu returns to the TARGETS screen.

Viewing Screens

All display menu screens are easily viewed using the right and down arrow keys. For example, there are three sub-screens under the RELAY SETUP screen. Delay settings for timers T4, T5, and T6 (TD4, TD5, and TD6) are shown in the third sub-screen. To view these settings, use the right arrow key until you see the RELAY SETUP menu screen on the front panel display. Use the down arrow key until you see the third sub-screen. Follow this same procedure to view any sub-screen in any menu.

Default Screen

Default screens are automatically displayed if no keys have been pressed for five minutes. The standard default screen is the target screen. The user has the option to default to another screen (such as current display, breaker operations counter, time/date) when no targets are active by using the PDISPLAY command. More information about the PDISPLAY command is provided in the *Maintenance* sub-section.

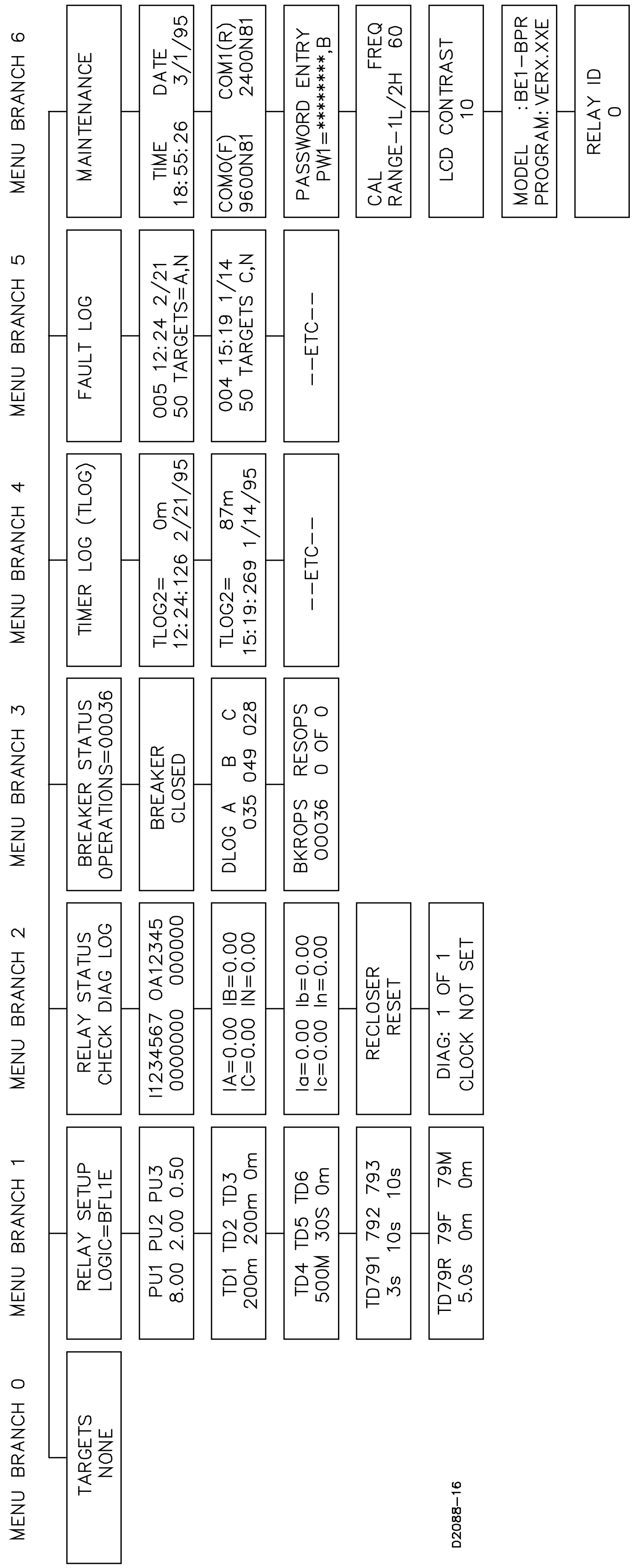


Figure 4. Enhanced BE1-BPR Menu Display Screens

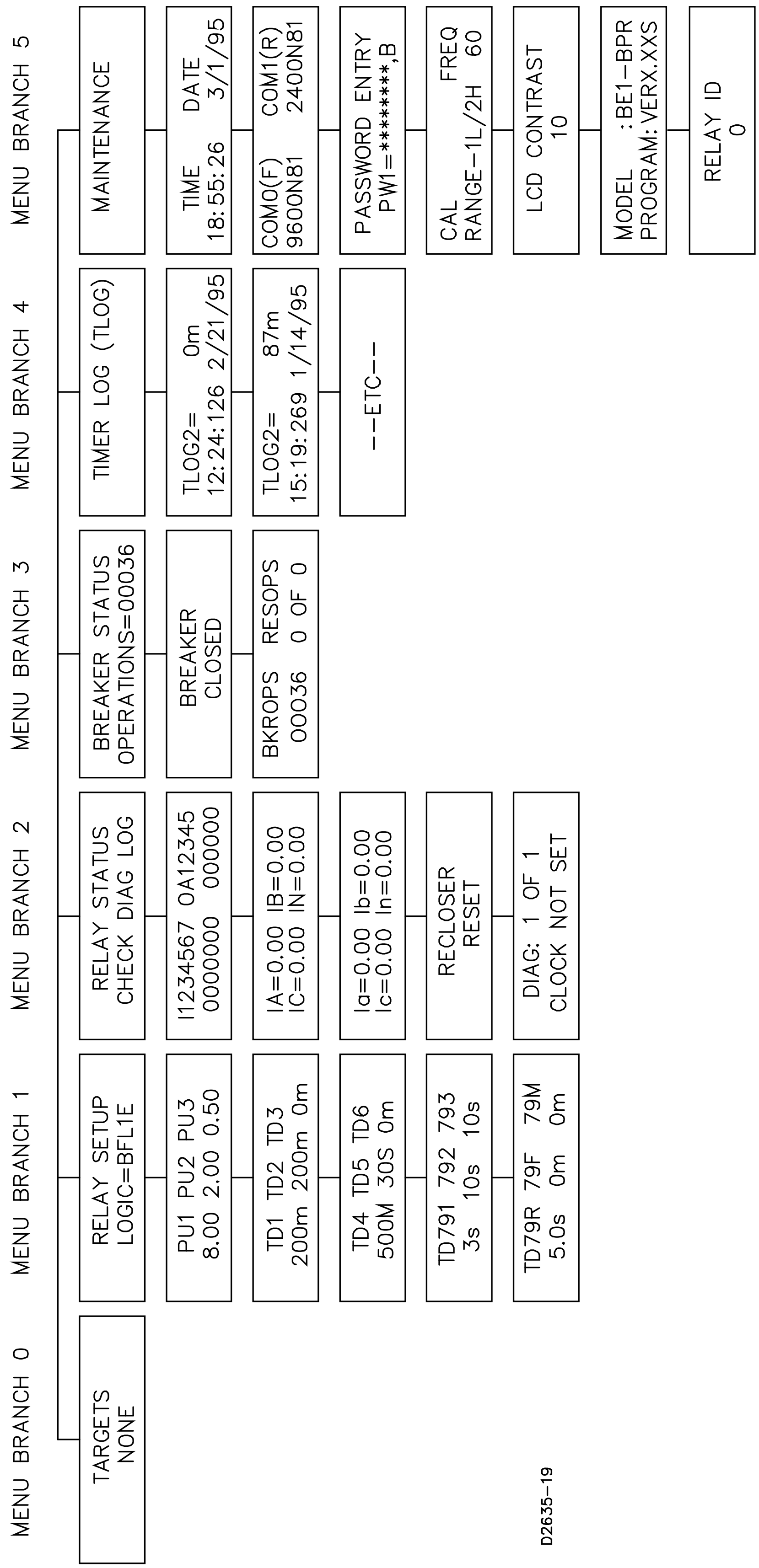


Figure 5. Standard BE1-BPR Menu Display Screens

Changing Parameters Using the Front Panel

Changing settings through the front panel consists of an ACCESS-CHANGE-SAVE-CONFIRM cycle. Changing parameters requires that you access the programming mode, select the appropriate screen(s), program (make) the change(s), save new relay setting(s), and confirm that the programming is completed before the changes are actually made. The relay continues to use the previous setting parameters until all changes are made and the new settings are saved. It is important to change all relay parameters and then execute the SAVE command. Doing this prevents partial or incomplete protection schemes from being implemented.

As an example, in order to change the overcurrent pickup setting for PU2 from 4.4 amperes to 6.3 amperes, the following procedures would be used.

Accessing PROGRAM Mode

To access the PROGRAM mode, press the PROG key. If password protection is enabled, you will be prompted to enter the password before continuing. For now, let's assume that we have not enabled password protection. An access level screen will be displayed momentarily showing your programming access level and then the original display will return and a cursor will be visible.

Selecting the Menu Screen

To change a parameter (relay setting), select the menu screen by using the right arrow key until the appropriate menu screen is shown. With the RELAY SETUP screen displayed, press the down arrow key once to display the pickup sub-screen. If PROGRAM mode has been enabled, the cursor will be under the first digit for the PU1 setting. Figure 6 illustrates entering the PROGRAM mode.

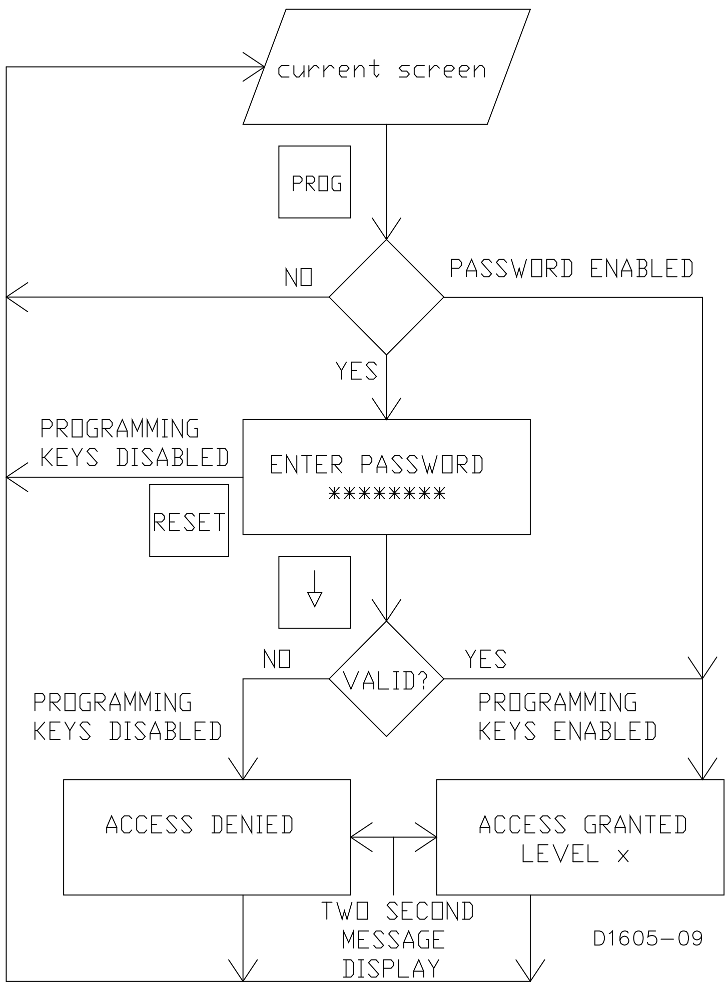


Figure 6. Accessing PROGRAM Mode from HMI

Making the Change

Press the right arrow key. The cursor moves to the second digit for PU1. Continue to press the right arrow key until the cursor is under the units digit for PU2. To change the 4 to a 6, press the EDIT +/- key two times. With the 6 displayed, press the right arrow key to position the cursor under the tenths digit. To change the 4 to a 3, two methods are available. The quickest method is to press the PROG key to make the EDIT +/- key decrement. Now press the EDIT +/- key and the 4 changes to a 3. The next key that is pressed, other than the EDIT +/- key, changes the EDIT +/- key back to the increment function. Another method is to press (increment) the EDIT +/- key nine times until the 3 is displayed. With 6.3 displayed for PU2, we now need to exit the PROGRAM mode and save the changes. While in the PROGRAM mode, the BE1-BPR relay remains on-line and the changes do not take effect until the PROGRAM mode is exited and the changes are saved.

Saving Changes and Exiting PROGRAM Mode

To save the settings and exit the PROGRAM mode, press and hold the PROG key for two seconds. The SAVE CHANGES? (Y/N) - N screen appears and the cursor is under the N (see Figure 7). Press the EDIT +/- key to select Y for yes. Press the PROG key and the relay will go off-line briefly while the new settings are saved and the BE1-BPR relay reinitializes.

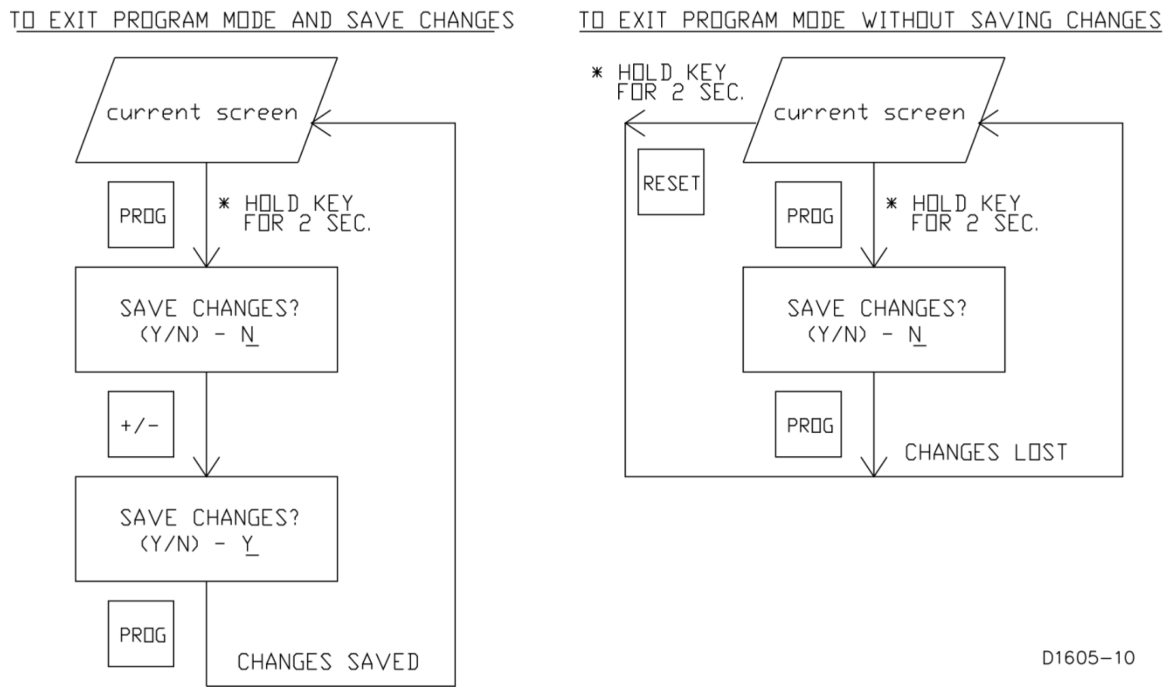


Figure 7. Exiting PROGRAM Mode from HMI

Changing Parameters Using Communication Ports

Changing settings through a communication port requires an ACCESS-CHANGE-SAVE-CONFIRM cycle. The operator uses the ACCESS command to obtain a program (change) access level. Different passwords give access to change different parameters.

ACCESS Command

Purpose: Reads or changes access area so that programming or settings changes can be made.

Syntax: ACCESS[=<password>]

ACCESS Command Examples:

1. Obtain area two access.
   ACCESS=OPENUP

ACCESS GRANTED
AREA 2

2. Read the current programming access area.
ACCESS
AREA 2

ACCESS	Programming changes access	HMI Menu Branch: N/A
Comments		
This command is used to gain access to an access area before making programming or settings changes. The access areas are available: ACCESS AREA 1: Access is provided by password 1 (PW1). PW1 allows write access to all setting and operating registers with no restrictions. ACCESS AREA 2: Access is provided by password 2 (PW2). PW2 permits changes to be made to relay protection settings. ACCESS AREA 3: Access is provided by password 3 (PW3). PW3 allows breaker related settings changes to be made. ACCESS AREA 4: Access is provided by password 4 (PW4). PW4 allows control or relay outputs for testing purposes. Access to an area is granted when the appropriate password is entered. If password protection is disabled in one or more areas, then no password is required to gain access to the unprotected levels. If a valid password is entered, the relay responds with the access area provided by that password. If an invalid password is entered, an error message is returned.		

After changes are made, the new data must be saved with the SAVE command. The operator must confirm that the programming is completed before the changes are actually made. If no password protection is used, it is still necessary to obtain programming/change access in order to protect against accidental changes. If password protection is disabled, then ACCESS=BPR or any other string will be accepted in place of a password.

SAVE	Exit programming mode and save changes	HMI Menu Branch: N/A
Comments		
This command is used at the end of a programming or settings changing session to save the changes made. When the SAVE command is entered, the relay responds with a confirmation message (ARE YOU SURE (Y/N)?). If Y is entered, programming or settings changes are saved to non-volatile memory, the programming mode is exited, and the relay is returned to an on-line condition. Entering N exits the programming mode without saving changes and returns the relay to an on-line condition.		

SAVE Command

Purpose: Saves programming or settings changes, exits the programming mode, and returns the relay to an on-line condition.

Syntax: SAVE

Comments: Once the SAVE command is executed, password access is lost.

SAVE Command Example:

Change the PU2 setting from 4.4 amperes to 6.3 amperes using the following sequence of commands.

ACCESS=BPR<CR>	Provides access to programming mode.
ACCESS GRANTED LEVEL 1	Relay response.
PU2=6.3<CR>	Changes the pickup setting.

SAVE<CR>	End programming.
ARE YOU SURE (Y/N)?	Relay verification.
Y<CR>	Enter Y to save the data.
RELAY OFF_LINE	
CHANGES SAVED	The new pickup setting for PU2 is now 6.3A.
RELAY ON_LINE	

The <CR> character at the end of typed lines stands for carriage return and represents pressing the Enter key. For simplicity, it will no longer be shown in the examples, but each line must be terminated with a carriage return.

The relay will typically respond with a '>' if the command entered was received and executed. A '?' is returned and possibly an error message if the command could not be executed.

It is important to make all changes to relay parameters before executing the SAVE command. Doing this prevents a partial or incomplete protection scheme from being implemented.

Settings changes made during a programming session can be discarded by using the QUIT command. The QUIT command will restore all settings, exit the programming mode, and return the relay to the on-line condition.

QUIT	Exit programming mode without saving changes	HMI Menu Branch: N/A
Comments		
This command causes all changes performed in the programming mode to be lost and the previous parameters to be restored. When the QUIT command is entered, the relay responds with a confirmation message (ARE YOU SURE (Y/N)?). If Y is entered, programming or settings changes are lost, the programming mode is exited, and the relay is returned to an on-line condition. Entering N returns the relay to the programming mode.		

QUIT Command

Purpose: Exits the programming mode and returns the relay on-line without saving any changes.

Syntax: QUIT

Comments: Once the QUIT command is executed, password access is lost.

QUIT Command Example:

Exit the programming mode without saving any setting changes made.

```
QUIT
ARE YOU SURE (Y/N)?
Y
RELAY OFF-LINE
CHANGES LOST
RELAY ON-LINE
```

Password Protection

BE1-BPR relays provide password protection against unauthorized changes to relay setting parameters and operating registers. Four different passwords of one to eight characters may be used. Each password provides a different access capability.

Gaining write access in an access area with password protection requires that the correct password be entered. If password protection is enabled and no password has been entered or if an incorrect password has been entered, you will be prompted to enter a new password before any changes can be made.

If a different access area password is entered while another area password is already in effect, the new access area will replace the current one. If a password is reprogrammed, it will not become effective until a SAVE command is given. When a password is entered, the relay looks for matching passwords. Access is granted to all areas with passwords that match the entered password.

The password for access area 1 allows write access to all setting and operating registers with no restrictions. The access area 2 password permits changes to be made to relay protection settings. The password for access area 3 allows breaker related settings changes to be made. The access area 4 password allows control of relay outputs for testing purposes. General access settings can be accessed by using passwords for areas 1, 2, or 3. Table 6 provides a summary of the write commands associated with each access area. Table 6 also lists the menu branch of the equivalent functions that are accessible through the front panel HMI. When password protection is enabled, the correct password is required to make changes associated with each command. A password is never required to read information associated with a command.

Table 6. Password Write Access Areas

NA = Not Applicable ∗ = Enhanced units only			HMI Menu Branch	
Access Area	**Command**	**Function**	**Standard Models**	**Enhanced Models**
0 - 4	DATE	Set clock date	5	6
0 - 4	DIAG	Reset alarms	2	2
0 - 4	FLOG	Reset fault log ∗	NA	5
0 - 4	RESET	Reset targets or reset other logs if specified	0	0
0 - 4	TIME	Set time clock	5	6
1, 2, 3	TRIGGER	Set trigger logic	NA	NA
0 - 4	TRIGGER	Trigger oscillography record ∗	NA	NA
1	CAL	Calibrate relay	5	6
1	FREQ	Set the nominal system frequency	5	6
1	ID	Set the multi-drop communications address	NA	NA
1	LF	Set fault detector function block logic	NA	NA
1	LI	Set input conditioning logic	NA	NA
1	LN	Set user programmable logic name	NA	NA
1	LO	Set output logic expressions	NA	NA
1	LOGIC	Set which logic scheme is active	NA	NA
1	LR	Set recloser function block logic	NA	NA
1	LT	Set timer function block logic	NA	NA
1	PW	Set password security	5	6
1, 2	PTARGET	Set targeting function	NA	NA
1, 2	PU	Set fault detector pickups	1	1
1, 2	TD	Set timer delays	1	1
1, 2	TD79	Set recloser time delays	1	1
1, 3	BKRCON	Set up breaker contact duty monitoring ∗	NA	NA
1, 3	BKROPS	Set up breaker operations monitoring	NA	NA
1, 3	BKRRES	Set up breaker resistor monitoring	NA	NA
1, 3	DLOG	Reset breaker contact duty registers ∗	NA	3
1, 2, 3	COM	Set up communications	5	6
1	CT	Set CT ratios	NA	NA
1, 2, 3	PCLK	Set clock display format	NA	NA
1, 2	PDIAG	Set alarm diagnostics	NA	NA
1, 2, 3	PDISPLAY	Set default HMI display	NA	NA

1, 2, 3	PHOLD	Set output hold timers	NA	NA
1, 2, 3	POSC	Set number of oscillographic fault records *	NA	NA
1, 2, 3	PTLOG	Set timer log operation	NA	NA
1, 2, 3	SNAME	Set substation and circuit name for COMTRADE reports *	NA	NA
1, 4	OUT	Override output logic and pulse output contacts	NA	NA

A second dimension of security is provided. Passwords may be configured to operate at different access ports. An access port designation of F allows access only at the front panel (COM 0 serial port and the front panel display/keyboard). An access port designation of R allows access only at the rear panel (COM 1 serial port). An access port designation of B allows access at both the front and rear panels. Password protection for a specific access area may be disabled by programming the password to be 0 (zero). Password protection for all passwords may be disabled by programming PW1 as a 0. If a particular password is disabled, then no prompts to "ENTER PASSWORD" will be given when programming the protected functions for that password.

Password Protection Example:

If the following password protection is desired:

- Area 1 changes to only be performed from the front panel by personnel with the password OPENUP.
- Area 2 changes to be performed with no password required but only from the front panel.
- Area 3 changes to be performed from either the front or rear panels by personnel with the password BKRGRP.
- Area 4 control to be accessed from the front panel by personnel with the password TEST.

The passwords are programmed as follows:

ACCESS=BPR	
ACCESS GRANTED LEVEL 1	
PW1=OPENUP,F	Password for Area 1.
PW2=0,F	Password for Area 2.
PW3=BKRGRP,B	Password for Area 3.
PW4=TEST,F	Password for Area 4.
SAVE	
ARE YOU SURE (Y/N)?	Relay verification.
Y	Enter Y to save the data.
RELAY OFF_LINE	
CHANGES SAVED	The new passwords are now operational.
RELAY ON_LINE	

The *Programming a New Password* sub-section provides another example of changing password protection.

Entering an Access Password at the Front Panel

To change settings at the front panel, first enter the PROGRAM mode by pressing the PROG key. The password prompt appears as shown.

ENTER PASSWORD
****

In the password prompt, "********" represents the password and the cursor is under the first (leftmost) character. To enter a password, press the +/- key until the correct character is displayed. Press the right arrow key to move to the next password character and press the +/- key until the correct character is displayed. Continue to enter password characters until the correct password is entered. If the password is less than eight characters, use the down arrow key to end the entry. After the eighth character is entered, the password entry screen is automatically ended. One of three possible screens appears for two seconds before the original menu screen reappears. The three screen possibilities are:

If password is accepted:	If password is rejected:	If programming conflict:
ACCESS GRANTED LEVEL_	**ACCESS DENIED**	**ACCESS DENIED ACCESS CONFLICT**

The programming conflict message will appear if program mode has already been entered through one of the rear serial ports. The relay allows programming only at one source at a time.

Entering an Access Password through Communication Ports

When entering a password through communication ports, you must enter the password using the ACCESS command (Example ACCESS=OPENUP). Passwords entered through a terminal keyboard are not case sensitive. If a valid password is entered, an ACCESS GRANTED LEVEL x message is displayed. If an invalid password is entered, an ACCESS DENIED message is displayed.

Target Data

The Targets screen is usually the most often viewed screen. Because of this, the TARGETS screen is the default screen. Viewing order or progression through the menu screens is based on the expected frequency of use.

TARGETS Screen

The TARGETS screen shows the status of the input and output targets that are latched in memory at the time a target output closes. When the front panel TARGET LED is lit, the TARGETS screen will show the latched target data. The display will show an "I" and the numbers of any contact inputs ON at the time the output occurred and an O and the numbers of the outputs that were on.

An example of a TARGETS screen with inputs 1, 4, and 5 closed and output contacts 2 and 3 closed is shown below.

TARGETS
I-145 O-23

The targets reset if the inputs or outputs are no longer active when the RESET key is pressed. Target data is saved in nonvolatile memory, so target data is retained when relay operating power is lost.

Target information may be programmed, viewed, or reset through the communications port. Targets can be viewed using the TARGET command.

TARGET	Target information	HMI Menu Branch: 0
Comments		
This command reports target data for inputs 1 through 7 and outputs 1 through 5. Output target data must be programmed to latch by the PTARGET command. Once an output target has latched, the inputs associated with the output will be shown as targets. Pressing the HMI Reset key or entering TARGET=0 will clear the latched target data.		

TARGET HMI Screen Example:

TARGETS	
I-6	**O-2**

TARGET Command

Purpose: Reads input and output target information.

Syntax: TARGET

Comments: No access area password is required to view or reset target data.

TARGET Command Examples:

1. Read the target information.
   TARGET
   `I-6, O-2`
2. Reset the targets.
   TARGET=0

Targets are reset using the RESET command.

RESET	Data erasure	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Comments**
log	none (targets) tar (targets) flog (fault log) tlog (timer log) diag (relay diagnostics)	This command clears data once the source of the target has been cleared. Data can be cleared through the HMI by viewing the data on the HMI screen and pressing the Reset key.

RESET Command

Purpose: Clears latched data.

Syntax: RESET[<log>]

Comments: No access area password is required to clear latched data. Entering RESET without a log parameter will clear the target information.

Inputs and outputs may be programmed as targets through the communication port with the PTARGET command. Inputs and outputs not included in the PTARGET mask will not give a target indication when the input or output is active.

PTARGET	Target operation and display	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Comments**
iiiiiii	0 (no target) 1 (target)	Input target status for I1 through I7. Leftmost digit represents the status for I1. Rightmost digit represents the status for I7. An input target status will not latch unless the related input target is programmed active. Inputs may be targeted for diagnostic purposes when an output target is latched.
ooooo	0 (no target) 1 (target)	Output target status for OUT1 through OUT5. Leftmost digit represents the status for OUT1. Rightmost digit represents the status for OUT5.

PTARGET Command

Purpose: Reads or programs the target operation and display.

Syntax: PTARGET[=<iiiiiii>,Kooooo>]

Comments: Access area 1 or 2 password is required to change settings.

PTARGET Command Example:

Program outputs 1, 2, and 3 to target.

PTARGET=0000000,11100

Relay Setup

BE1-BPR protective functions are controlled by the operational logic that is programmed into the relay and the setting values associated with that logic. BE1-BPR relays with standard options have three preprogrammed breaker failure logic schemes that are stored in nonvolatile program memory. BE1-BPR relays with enhanced options have six preprogrammed breaker failure logic schemes that are stored in non-volatile program memory. A logic scheme can be selected using the front panel controls or through serial port communications.

The RELAY SETUP menu screen shows the unique name of the protection logic scheme selected. Other schemes may be selected pressing the EDIT +/- key with the cursor under the logic name. The relay will scroll through the logic names stored in memory. The fault detector pickup and timer delay settings are displayed on the RELAY SETUP sub-screens. To change the relay pickup or timer settings, use the same techniques described in this section, under *Changing Parameters.*

Example of typical RELAY SETUP menu screens:

RELAY SETUP menu screen:

RELAY SETUP **LOGIC = BFL1**

Sub-screen 1:

PU1	**PU2**	**PU3**
6.00	**1.50**	**0.05**

Sub-screen 2:

TD1	**TD2**	**TD3**
150m	**50m**	**600m**

Sub-screen 3:

TD4	**TD5**	**TD6**
30s	**1.0s**	**10s**

Sub-screen 4:

TD791	**792**	**793**
100m	**1.0s**	**5.0s**

Sub-screen 5:

TD79R	**79F**	**79M**
10.0s	**0m**	**0m**

RELAY SETUP information can be reviewed or programmed through the communications ports as well.

- The operational logic may be viewed or changed using the LOGIC command. A custom logic scheme can be defined using the LN, LI, LF, LR, LT, and LO commands. The equations defining an existing logic scheme may be reviewed using the LINFO command. All relay settings can be reviewed using the SHOWSET command.
- Pickup settings can be viewed or changed using the PU command. The PU command can also be used to view or set the number of cycles used for the moving average filter if digital filter 2 operation is selected when defining the fault detector logic (LF).
- Time delay settings can be viewed or changed using the TD command.
- Recloser timer delay settings can be viewed or changed using the TD79 command.
- The CT ratios for phase and neutral CTs can be viewed or changed using the CT command.
- The 200 millisecond minimum hold time for the output contacts can be enabled or disabled.

Transformer Ratios

The CT command allows the relay to be matched to your system's external current transformers. Separate settings are provided for the phase and neutral CTs. CT ratio adjustment is not provided through the HMI.

CT	Current transformer ratio information		HMI Menu Branch: N/A	
Parameter	**Parameter Selection**	**Range**	**Increment**	**Default**
t	P (phase CT) N (neutral CT)	N/A	N/A	CTP=1 CTN=1
ratio	pri:sec or pri/sec or calculated ratio	1 - 65535 for pri, sec, and calculated ratio	1	

CT Command

Purpose: Read or change the current transformer ratio settings.

Syntax: CT[t][=<ratio>]

Comments: An access area 1, 2, or 3 password is required to change settings. The CT ratio can be entered in three different formats but is always reported as the calculated ratio. The CTP and CTN values affect the primary current metering values, the contact duty log (DLOG) calculations, and the COMTRADE fault record current levels.

CT Command Examples:

1. Enter a neutral CT ratio of 400:5.
   CTN=80 or CTN=400/5 or CTN=400:5
2. Read the CT ratios.
   CT

```
CTP=50;        CTN=80
```

__Fault Detectors__

Three fault detectors, F1, F2, and F3, are provided in the BE1-BPR. Each fault detector can be configured for phase or neutral current sensing and the type of filtering. Three filtering options are available: Instantaneous (type 1), Moving Average (type 2), and Instantaneous Three-Phase (type 3).

Type 1 Fault Detector. The type 1 fault detector provides high speed operation with a typical pickup time of one cycle and a typical dropout time of ¼ cycle. Fault detectors F1 and F2 are programmed as Type 1 fault detectors in the preprogrammed logic schemes. Refer to Section 2, *Application* for a detailed description of the Type 1 fault detector.

Type 2 Fault Detector. The type 2 fault detector provides a slower but more consistent pickup. This type of fault detector is appropriate for applications where fault detector sensitivity of less than 0.25 amperes (relays with 5 A current sensing) is desirable. When a Type 2 fault detector is used, the pickup (PU) command includes a parameter for entering the number of cycles to be averaged before pickup or dropout occurs. Refer to Section 2, *Application* for a detailed description of the Type 2 fault detector.

Type 3 Fault Detector. The type 3 fault detector performance is identical to the type 1 fault detector except that all three-phase currents must be above the pickup threshold to trigger an output. Refer to Section 2, *Application* for a detailed description of the type 3 fault detector.

The LF command configures each fault detector for phase or neutral protection and for high-speed or moving- average filtering.

LF	Fault detector logic	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Defaults**
type	PI (phase overcurrent) NI (neutral overcurrent)	LF1=PI,1 LF2=NI,1 LF3=PI,2
filter	1 (1cycle RMS filter) 2 (moving average filter) 3 (1 cycle RMS 3-phase filter	

LF Command

Purpose: Read or change the fault detector logic of the active logic scheme.

Syntax: LF[x][=<type>,<filter>]

Comments: An access area one password is required to change settings.

LF Command Examples:

1. Program fault detector 1 as a phase overcurrent fault detector using digital filter 1.
   LF1=PI,1
2. Program fault detector 2 as a neutral overcurrent fault detector using digital filter 1.
   LF2=NI,1
3. Program fault detector 3 as a phase overcurrent pickup using the moving average filter (filter 2).
   LF3=PI,2

Caution
A pickup setting range check is made each time logic settings are changed that affect the fault detector pickup settings. For example, if PU1=5.00 and LF1 setting is changed from PI,1 to PI,2, the PU1 setting will automatically change from 5.00 to 1.00 (the maximum allowable setting for a Type 2 fault detector on a 5 A unit). This kind of pickup setting adjustment can also occur if the active relay logic is replaced with logic that has different LF settings.

The PU command sets the trip value of each fault detector and the moving average filter cycles for type 2 fault detectors.

PU	Fault detector pickup levels		HMI Menu Branch: 1	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
level 5 A CT LFx=type,1 or 3 ∗	Amperes	0.25 to 9.99	0.01	PU1=8.00 PU2=2.00 PU3=0.50,10
level 5 A CT LFx=type,2	Amperes	0.05 to 1.00	0.01	
level 1 A CT LFx=type,1 or 3 ∗	Amperes	0.05 to 2.00	0.01	PU1=2.00 PU2=2.00 PU3=0.20,10
level 1 A CT LFx=type,2	Amperes	0.01 to 0.10	0.01	
cycles	cycles	1 to 100	1	N/A

∗ Types 1 and 3 PU settings can be set below the stated minimum settings. However, specified accuracies will not be maintained when PU settings are set outside the setting range.

PU HMI Screen Example:

PU1	**PU2**	**PU3**
8.00	**2.00**	**0.50**

PU Command

Purpose: Read or change fault detector pickup levels.

Syntax: PU[x][=<level>,<cycles>]

Comments: x = 1 (fault detector 1), 2 (fault detector 2), or 3 (fault detector 3)

level = pickup level in amperes for fault detector x

cycles = number of moving average filter cycles

Cycles parameter is used only if an analog channel is programmed to have a moving average filter (Lfx=type,2). See LF command information in BESTlogic™ Functions section. An access area 1 or 2 password is required to change settings.

PU Command Examples:

1. Set the analog channel pickup level at 6.2 amperes.
   PU1=6.2
2. Read the pickup setting for all channels.
   PU
   `PU1=6.2;        PU2=0.5;          PU3=0.1,10`

Timers

Six independent timers are provided in the BE1-BPR. Each timer consists of a time delay setting (TD[x]), a start input, a reset input, and an output (T[x]). Timing starts when the start input is true and the reset input is false. The timer runs for the duration of the time delay setting unless the reset input becomes true. When the time delay expires, the output changes state. A timer can be configured as a delay or control timer with independent or dependent start and reset conditions. Timers can be used to provide a diagnostic log and/or alarm. Figure 8 illustrates the timer circuit components.

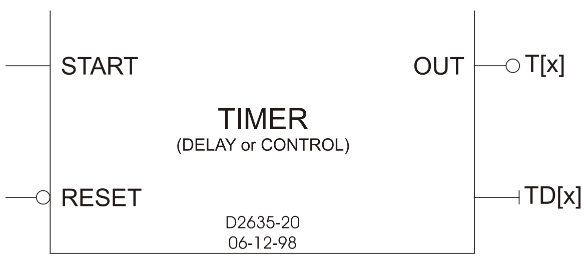


Figure 8. Timer Circuit

The LT command is used to configure timers for control or delay operation and define the start and reset logic.

LT	Timer logic	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Defaults**
type	C (control timer) D (delay timer) 0 (disabled)	LT1=D,O8,/O8 LT2=D,O9,/O9 LT3=0,0,0 LT4=D,O6,/O6 LT5=D,O12,/O12 LT6=0,0,0
start	any logic variable	
reset	any logic variable	

LT Command

Purpose: Read or change timer logic.

Syntax: LT[x][=<type>,<start>,<reset>]

Comments: x = the number of the timer being read or changed (1, 2, 3, 4, 5, or 6). An access area 1 password is required to change settings.

LT Command Example:

Configure timer 1 as a delay timer that is started when contact input 1 is energized and stopped when output 6 is de-energized. Configure timer 2 as a control timer that is started when input 2 is energized and stopped when input 2 is de-energized.

LT1=D,I1,/O6; LT2=C,I2,/I2

The TD command is used to read or enter the delay settings for each of the six timers.

TD HMI Screen Example:

TD1	**TD2**	**TD3**
150m	**200m**	**1.0s**

TD	Timer delays ∗		HMI Menu Branch: 1	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
delay	cycles (c) milliseconds (m) seconds (s)	1 to 3,600 cycles 10 to 60,000 ms 1 to 60 seconds	1 cycle 1 ms 0.1 s	TD1=150m TD2=200m TD3=1.0s TD4=500m TD5=30.0s TD6=0m

∗ All timer settings greater than or equal to 1 second are rounded to 0.1 second resolution.

TD Command

Purpose: Read or change timer delay settings.

Syntax: TD[x][=<delay>]]

Comments: x = the number of the timer being read or changed (1, 2, 3, 4, 5, or 6)

Delay = the time delay in cycles (c), milliseconds (m), or seconds (s)

A setting of zero disables a timer. An access area 1 or 2 password is required to change settings.

TD Command Example:

Set time delay 2 at 100 milliseconds and time delay 5 at 30 seconds.

TD2=100

TD5=30S

Delay Timer. When a delay timer is started, a preprogrammed time delay (TD[x]) is loaded and the timer starts timing out. If the reset input remains false for the duration of the time delay, output T[x] will become true and remain true until the reset input becomes true.

This type of timer is useful in a breaker failure application where the breaker failure output is delayed to allow the primary protection elements to operate the breaker and open the circuit.

Control Timer. When a control timer is started, a preprogrammed time delay (TD[x]) is loaded and the timer starts timing out. Output T[x] is true for the duration of the time delay setting unless the reset input becomes true. If the reset input remains false for the duration of the time delay, the time delay will time out and the output will become false. The timer output will remain false until the timer is reset and a new start input is received.

A control timer can provide a window of opportunity for an operation to occur or ensure input latch-in for a specified time.

Reclosing

The BE1-BPR reclosing function can operate in parallel with the breaker failure logic. All inputs are programmed using the BESTlogic LR command. When reclosing is enabled, virtual output 13 (O13) is used for the 79 Close output of the recloser function block. If reclosing is disabled, O13 is used for the breaker resistor protection function output that is described in the *Breaker Status* sub-section. Figure 4-7 illustrates how the recloser and breaker resistor protection function operate if both are enabled. O13 can be connected to any physical output by using the LO command.

Separate time delays are programmable through the front panel or serial port by using the TD79 command. Time delay settings are available for each shot (TD791, TD792, and TD793), for the reset timer (TD79R), reclose fail timer (TD79F) and a maximum reclose cycle timer (TD79M). Lockout and reclose fail diagnostic flags are set/reset by the recloser diagnostics and by using the command PDIAG to program the diagnostic outputs. Separate outputs for lockout and reclose fail can be programmed. Reclosed state (RESET, WAIT, TIMING, or LOCKOUT) can be viewed at the front panel recloser status screen in the relay status menu or by using the STATUS command.

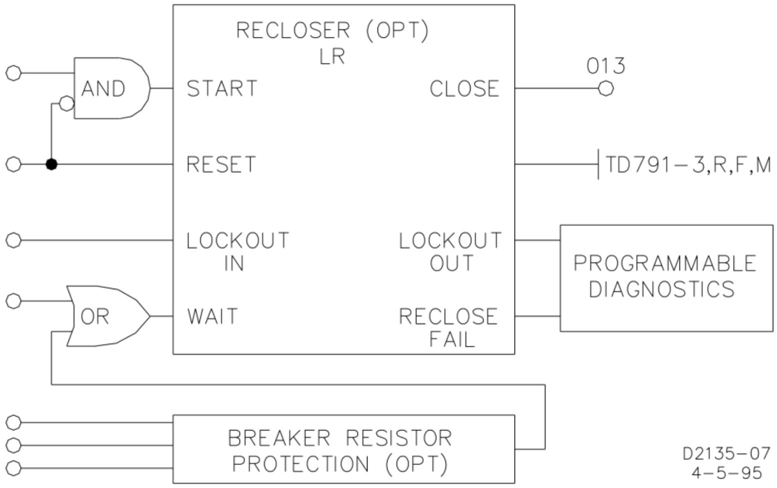


Figure 9. Reclosing Logic Circuit

TD79	Reclose timer delays *		HMI Menu Branch: 2	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
delay	milliseconds (m) seconds (s) cycles (c)	10 - 999 ms 1 - 600 seconds 1 - 36014 (60 Hz) 1 - 30000 (50 Hz)	1 ms 0.1 s (1-100 s) 1.0 s (100-600 s) 1 cy	TD791=50m TD792=1.0s TD793=5.0s TD79R=120s TD79F=0m TD79M=0m

* All timer settings greater than or equal to 1 second are rounded to 0.1 second resolution.

TD79 HMI Screen Examples:

TD791	792	793
50m	1.0s	5.0s

TD79R	79F	79M
120m	0m	0m

TD79 Command

Purpose: Read or change recloser (79) time delay settings.

Syntax: TD[x][=<delay>]

Comments: x = the number of the timer being read or changed where:
1 = TD791, the reclose shot 1 time delay
2 = TD792, the reclose shot 2 time delay
3 = TD793, the reclose shot 3 time delay
R = TD79R, the reset time delay
F = TD79F, the reclose fail time delay
M = TD79M, the maximum reclose operation time
Delay = the time delay in cycles, milliseconds, or seconds
A setting of zero disables a timer. An access area 1 or 2 password is required to change settings.

TD79 Command Example:

Set reclose shot 1 at 3 cycles to allow for arc de-ionization. Set reclose shot 2 at 2.5 seconds and disable reclose shot 3. Set the reset time at 30 seconds, the fail time at 2 minutes, and the maximum reclose time at 2.5 minutes.

TD791=3C; TD792=2.5S; TD793=0; TD79R=30S; TD79F=120S; TD79M=150S

There are four inputs to a reclose function, three outputs, and one mode programmable feature (TYPE). The inputs and outputs are shown in Figure 9.

Recloser Inputs. Each input is fully programmable using the logic recloser command (LR) which allows each input to be defined as a BESTlogic™ logic term. The function of each input is:

START: Starts the reclose sequence if the RESET input is not true.

RESET: Begins reset timing and opens the CLOSE output. If RESET remains true for the reset time delay (TD79R), the recloser goes to the reset state and the recloser shot counter is reset.

WAIT: Stops the reclose sequence at any point. The reclose sequence is inhibited as long as the wait input is present. When the wait input is removed, the sequence continues from the point that it was stopped.

DTL: Drives the reclose function immediately to the lockout state. Lockout has precedence over all other inputs. When lockout is removed and the breaker is closed, the recloser begins reset timing. When lockout is removed and the breaker is open, the recloser remains in the lockout state.

LR	Recloser input logic	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Defaults**
type	0 (disabled) 1 (standard recloser) 2 (power-up reclose)	The recloser is enabled only when the type selection is 1 or 2 and the start and reset logic is programmed.
start	any logic variable	
reset	any logic variable	
wait	any logic variable	
lockout	any logic variable	

LR Command

Purpose: Reads or programs the recloser input logic.

Syntax: LR[=<type>,<start>,<reset>,<wait>,<lockout>]

Comments: Access area 1 password is required to change setting.

Example 1: Define a recloser that is initiated by any true signal to the breaker and reset when the 52a contact closes. Given: Previous BESTlogic definitions have defined a logic scheme that has all BFI TRIP signals driving O5 for a retrip function, and have defined I1 to be a 52a input, I6 to be a wait input, and I7 to be a drive to lockout input.

LR=1,O5,I1,I6,I7

Example 2: Define the same logic except that a 52b input is connected to I1 instead of the 52a and there is no wait input.

LR=1,O5,/I1,0,I7

R*ecloser Outputs.* There is a CLOSE output on O13 and diagnostic status flags for reclose fail and lockout. Output O13 and the diagnostics for reclose fail and lockout can be programmed to drive output relay contacts by using the LO and PDIAG commands.

The function of each output or flag is defined as:

CLOSE: The reclose output contacts close at the end of each reclose time delay. They open when the RESET input shows that the breaker has closed, when the reclose fail timer times out, or when the recloser goes to LOCKOUT or the WAIT input is asserted.

RECLOSE FAIL: The reclose fail diagnostic flag is set when the reclose fail timer times out and remains set until the recloser goes to the reset state.

LOCKOUT: The lockout flag is set when the recloser goes to LOCKOUT and remains set until the recloser goes to the reset state. The recloser goes to LOCKOUT if more than the maximum number of shots programmed is initiated before the recloser returns to the reset state, if the Drive to Lockout (DTL) input is true, or if RECLOSE FAIL is true.

Reclosing Mode (TYPE). Reclosing mode controls the reclosing sequence on powerup. There are three modes of operation and one is selected by setting the TYPE in the LR command to 0, 1, or 2.

Note
After the programmable logic is changed or the time delay settings are changed, the recloser initializes as described in the *Reclosing Mode, TYPE 1 or TYPE 2*.

TYPE 0 disables the reclosing function.

TYPE 1 requires that after power-up, the RESET input logic stay true for the reset time delay (TD79R) or the recloser automatically goes to LOCKOUT.

TYPE 2 allows the recloser to initiate the first programmed reclose operation after power-up if power was lost when the recloser was in the reset state and at power-up, the RESET logic is false and the START logic is true. If RESET goes true and stays true for the reset time delay (TD79R), the recloser automatically goes to RESET. This type of reclosing mode may be appropriate if the BE1-BPR relay is powered-up from the station service.

Recloser Operation. There are a maximum of three reclose shots, each with a programmable time delay. The three time delays can be set from 10 to 999 milliseconds in 1 milliseconds increments, 1 to 99 seconds in 0.1 second increments, or 100 to 600 seconds in 1 second increments. A setting of zero for reclose shot 1, 2, or 3 will send the relay to lockout when that reclose shot is reached in the reclosing sequence.

If the recloser is in the reset state upon receiving a START input signal (RI) and RESET is false (52a or /52b), the reclose logic issues a reclose output (O13). The output occurs after the TD791 time delay setting. If the breaker closes and then opens again before the reset timer is timed out, a reclose output occurs after the second time delay. The third reclose output occurs in a similar manner. The recloser goes immediately to the lockout state on the fourth breaker trip.

Reset timer (TD79R) begins timing out when the RESET logic becomes true (breaker closes). The reset timer is reset when the breaker trips. If the reset timer times out while the breaker is closed, the recloser goes to the reset state. Setting the reset time delay at zero will give an instantaneous reset and eliminate reclose shots 2 and 3 from the reclose sequence.

If enabled, the reclose fail timer (TD79F) starts whenever a reclose output is given and stops when the RESET logic indicates the breaker has closed. It is used to limit the duration of the reclose output signal. If the reclose fail timer times out before the RESET logic becomes true, the recloser sets the reclose fail diagnostic flag. The reclose fail function can be inhibited by setting the RECLOSE FAIL time delay (TD79F) to zero (0).

If the total reclosing time between reset states exceeds the maximum reclose cycle timer (TD79M) setting (excluding time while in the WAIT state), the recloser goes to the lockout state. The lockout alarm diagnostic flag is set whenever the recloser goes to the lockout state. A time delay setting of zero will inhibit the maximum reclose timer functions.

Output Hold Function

Protection outputs will usually have a minimum hold time to ensure that the protective relay contact does not interrupt the trip coil current and the breaker close output will stay closed until the recloser shows that the breaker has closed. The PHOLD command provides a 200-millisecond output hold time that can be enabled or disabled for each output.

PHOLD	Output hold timers	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Defaults**
#####	0 = no minimum hold time 1 = 200 ms minimum hold time	Each digit of the PHOLD parameter represents an output. The leftmost digit represents OUT1. The right-most digit represents OUT5. Typically, the 200 millisecond hold time will be enabled for all outputs except those used for reclosing.

PHOLD Command

Purpose: Read or program the output hold timer mask.

Syntax: PHOLD [=<#####>]

Comments: Access area password 1, 2, or 3 required to change settings. Default setting is 11111.

PHOLD Command Example:

Disable the minimum hold time for output 3. Enable the minimum hold time for outputs 1, 2, 4, and 5.

PHOLD=11011

Relay Status

For diagnostic purposes, the RELAY STATUS menu screen provides a means of checking the status of the current inputs, contact sensing inputs, output contacts, recloser, and relay diagnostics. This information can also be obtained using the STATUS, I, and DIAG commands.

Typical RELAY STATUS screens are shown below on the left. An example of a report obtained using the STATUS command is shown below on the right.

RELAY STATUS menu screen	**RELAY STATUS**
Sub-screen 1 Input and Output Contact Status	**I1234567 OA12345** **0000000 000000**
Sub-screen 2 Primary Current Metering Values	**IA=1.28K IB=1.28K** **IC=1.28K IN=0.00K**
Sub-screen 3 Secondary Current Metering Values	**Ia=2.13 Ib=2.13** **Ic=2.13 In=0.00**
Sub-screen 4 Recloser Status	**RECLOSER RESET**
Sub-screen 5+ Diagnostic Message Screen(s)	**DIAG: NONE**

```
IA=3.00KA;  IB=3.00KA
IC=3.00KA;  IN=0.00KA
I (1-7) = 0100000
T (1-6) = 000000
F (1-3) = 001
O (A,1-15) = 0000000000000000
RECLOSER RESET
BREAKER CLOSED
DIAG: 1 to 1 TIMER ALARM
```

The RELAY STATUS menu branch shows the status of all inputs and outputs as well as any diagnostic alarms detected by the relay. Sub-screen 1 indicates the status of all input contacts and output contacts. Zeroes are shown for input contacts that are open and outputs that are de-energized. Ones are shown for input contacts that are closed and outputs that are energized. Sub-screen 2 indicates the primary current values of phase A, B, C and Neutral. Sub-screen 3 indicates the secondary current values of all phases and neutral. Sub-screen 4 provides the recloser status. RESET, TIMING, LOCKOUT, or WAIT is displayed if the recloser is active. RECLOSER OFF is displayed when the recloser is disabled. Sub-screen 5 shows any diagnostic alarms recorded by the relay. Once the alarms are viewed and corrected, they can be cleared by pressing the Reset key or by entering DIAG=0 or RESET DIAG. A listing and description of all diagnostic alarms is provided in the DIAG and PDIAG command summary tables.

The STATUS command provides status information about the primary current values, contact sensing inputs, timer/counters, fault detectors, hardware and virtual outputs, recloser, and active diagnostic flags.

STATUS	Relay status report	HMI Menu Branch: 2, 3
Comments		
This command returns all current input values and system status registers. The status registers indicate the state of contact sensing inputs I1 through I7, timers/counters T1 through T6, fault detectors F1 through F3, outputs OA, and O1 through O15, recloser status, breaker status, and any active diagnostic flags.		

STATUS Command

Purpose: Returns a report of inputs, outputs, and internal relay status.

Syntax: STATUS

Comments: No access area password is required for reporting functions.

STATUS Command Example:

Obtain a relay status report.

STATUS

```
IA=3.00KA; IB=3.00KA; IC=3.00KA; IN=0.00KA
I (1-7) = 0100000
T (1-6) = 000000
F (1-3) = 001
O (A,1-15) = 0000000000000000
RECLOSER RESET
BREAKER CLOSED
DIAG: 1 to 1 TIMER ALARM
```

The I command returns the primary current values of the phase A, B, C, and neutral inputs.

I	Measured current values	HMI Menu Branch: 2
Comments		
This command returns the primary value of all current inputs. The primary current value is calculated using the transformer ratio entered using the CT command. Individual currents can be read by entering I<phase>, where <phase> is A, B, C, or N.		

I HMI Screen Examples:

Primary Current

IA=1.28K	**IB=1.28K**
IC=1.28K	**IN=0.00K**

Secondary Current

Ia=2.13	**Ib=2.13**
Ic=2.13	**In=0.00**

I Command

Purpose: Reads the primary current value of all or individual phases.

Syntax: I[<phase>]

Comments: No access area password is required for reporting functions. Primary and secondary current values are available through HMI menu branch 2.

I Command Examples:

1. Read Phase B current.

   IB

   `3.23KA`

2. Read all primary currents.
   I
   `IA=3.23KA; IB=3.23KA; IC=3.23KA; IN=0.00KA`

The DIAG command reads or resets any diagnostic alarms recorded by the relay.

DIAG	Diagnostic alarms	HMI Menu Branch: 2
Parameter	**Description**	
Non-Maskable Alarms	RAM ERROR: Static RAM read/write error ROM ERROR: EPROM program memory checksum error uP ERROR: Microprocessor self-test error EEPROM ERROR: EEPROM read/write error EEDATA ERROR: EEPROM data checksum error ADC ERROR: Analog to digital converter error CALIBRATION ERROR: Relay not calibrated or calibration checksum error POWER SUPPLY ERROR: Power supply out of tolerance	
Maskable Alarms	ALARM LOGIC (OA): Alarm logic (OA equation) was true TIMER ALARM (TL): Timer alarm setting exceeded (refer to PTLOG Command) CONTACT DUTY ALM (DL): Contact duty maximum (DMAX) exceeded (refer to BKRCON Command) BKROP >1 SEC (BKR): Breaker operation (clearing) time was greater than 1 second POWER RESET (RST): Power supply to microprocessor has been reset CLOCK NOT SET (CLK): Real time clock not set RECLOSE FAIL (RF): Reclose attempt failed	

DIAG Command

Purpose: Reads or resets diagnostic information.

Syntax: DIAG[=0]

Comments: No access area password is required to read or reset diagnostic information. Entering DIAG=0 will reset all diagnostics that can be reset.

DIAG Command Example:

View any diagnostic alarms.

```
DIAG
TIMER ALARM
```

The PDIAG command is used to configure the diagnostic alarms.

PDIAG Command

Purpose: Reads or programs service diagnostic alarms.

Syntax: PDIAG[=<DIAG1 mask>,<DIAG2 mask>]

Comments: Access area level password 1, 2, or 3 is required to change settings. A diagnostic flag is enabled by a 1 and disabled by a 0. DIAG1 drives virtual output 14 (O14) AND DIAG2 drives virtual output 15 (O15). Entering PDIAG returns the diagnostic mask for O14 and O15.

<table>
<tr><th>PDIAG</th><td>Programmable diagnostic alarms</td><td colspan="2">HMI Menu Branch: N/A</td></tr>
<tr><th>Parameter</th><th>Range</th><th colspan="2">Parameter Selections</th></tr>
<tr><td>DIAG1 mask</td><td>0 or 1</td><td colspan="2" rowspan="2"><(OA)(TL)(DL)(BKR)(RST)(CLK)(RF)(LO)>
where:
OA - Flag is set when LOA logic becomes true. Flag is reset when the diagnostic alarms are cleared and the DIAG=0 command is sent. Allows a logic expression written to LOA to be latched and reported.
TL - Flag is set when any TLOG alarms occur. Flag is reset using the DIAG=0 command.
DL - Flag is set when any DLOG is ≥ 100% of DMAX. Flag is reset when the DLOG value is reset.
BKR - Flag is set when the breaker takes more than 1 second to interrupt the phase current after the breaker is opened. Flag is reset when the DIAG=0 command is used.
RST - Flag is set when the microprocessor is reset due to a loss of power or watchdog timer operation. Flag is reset when the DIAG=0 command is used.
CLK - Flag is set when the time and date have not been set. Flag is reset when either the time or date is set.
RF - Flag is set when the Reclose Fail Alarm occurs. Flag is reset when the breaker closes.
LO - Flag is set when the recloser goes to lockout. Flag is reset when the recloser comes out of lockout.</td></tr>
<tr><td>DIAG2 mask</td><td>0 or 1</td></tr>
</table>

PDIAG Command Example:

Program virtual output 14 to go high if the recloser lockout (LO) flag is set. Program virtual output 15 to go high if the alarm logic (OA), timer log (TLOG), duty log (DL), or reclose fail (RF) flags are set.

PDIAG=00000001,11100010

The TEST command provides the same diagnostic information as the DIAG command plus the software checksum and relay on-line/off-line status.

<table>
<tr><th>TEST</th><td>Diagnostic data</td><td>HMI Menu Branch: N/A</td></tr>
<tr><th colspan="3">Comments</th></tr>
<tr><td colspan="3">This command retrieves diagnostic data from the relay. This data includes diagnostic alarms, the software checksum, and whether the relay is on or off line. The diagnostic alarm information retrieved by the TEST command is the same information displayed by the DIAG command. The TEST command is read only; diagnostic alarms should be reset using the DIAG command.</td></tr>
</table>

TEST Command

Purpose: Reads diagnostic data.

Syntax: TEST

Comments: No access area password is required to read diagnostic data.

TEST Command Example:

Verify the software checksum.

```
TEST
RELAY ON-LINE
DIAG: 1 OF 2 CLOCK NOT SET
PROGRAM CHECKSUM: 3C7E
```

Breaker Status

Breaker status information is contained in three diagnostic logs. They are the breaker operations log, the breaker resistor operations log, and the breaker contact duty log (enhanced relays only). Breaker status information may also be viewed or configured through a communication port using the DLOG, BKRCON, BKRRES, BKROPS, and STATUS commands.

Breaker Status Menu Screens

An example of typical breaker status screens are provided below.

BREAKER STATUS menu screen	**BREAKER STATUS** **OPERATIONS=00345**	
Sub-screen 1 Breaker Status Screen	**BREAKER** **CLOSED**	
Sub-screen 2 Log Contact Duty	**DLOG A B C** **102 63 25**	(Enhanced Relays Only)
Sub-screen 3 Breaker Operations and Breaker Resistor Operations	**BKROPS RESOPS** **000345 0 of 0**	

Breaker Status Screen

The breaker status screen shows the current position of the breaker (OPEN/CLOSED) based on the logic defined by the BKROPS command. Breaker position is also reported by the STATUS command.

BKROPS	Breaker operations status		HMI Menu Branch: 3	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
# operations	breaker operations	0 to 99,999	1	00,000
52a/b contact logic	N/A	N/A	N/A	/I1

BKROPS HMI Screen Example:

BREAKER STATUS
OPERATIONS=00345

BKROPS Command

Purpose: Read or change breaker operations data.

Syntax: BKROPS[=<#operations>,<breaker close logic>]

Comments: An access area 1 or 3 password is required to change settings. Breaker close logic is defined using any contact sensing input that is true when the breaker is closed. True logic indicates a closed breaker; false logic indicates an open breaker. # operations increments when the breaker closes.

BKROPS Command Example:

Set the breaker operations counter at zero and use contact input 1 to sense the breaker status (52a contact finger).

BKROPS=0,I1

Breaker Contact Duty Diagnostics (Enhanced Relays Only)

Breaker contact duty log, DLOG, is stored in nonvolatile memory and contains the approximate duty or contact wear on each pole (phase) of the breaker represented as a percentage of a maximum, DMAX. A 52a or 52b input is required for this diagnostic and the timing relationship between the auxiliary contact finger and the main breaker contacts should be known for maximum accuracy. The duty percentage value for each pole can be programmed through the front panel controls or through a communication port using the DLOG command. The log may be reset to zero after maintenance or set at a specific percentage value when the relay is put into service by using the DLOG command.

The duty value for each pole of the breaker, D[p], is compared against a maximum value, DMAX. If D[p] for any pole of the breaker exceeds DMAX, a diagnostic alarm is set to true and remains set until the D[p] value for the appropriate pole(s) are reset. Using the programmable logic, a virtual output can drive an output relay to provide an indication that the breaker needs service. To do this, use the PDIAG command to enable the DLOG diagnostic alarm to turn on O14 or O15 when DLOG[p] exceeds 100 percent. Then use the LO command to use O14 or O15 to drive output O1 - O5.

DMAX is programmable in amperes-squared seconds (A^2-S) in exponential notation. For example, 2 times 10^6 A^2-S would be entered as 2.0E6). DMAX is an approximation that can be refined as further experience with a particular type of breaker is obtained. Changing DMAX will automatically update the value in the DLOG to a new percentage based on the new DMAX value.

Users may find it difficult to obtain a setting for DMAX since no standard recommends the interrupting duty limits for breakers. The following formula is offered as a guide and should be superseded by manufacturers data when available.

If a breaker manufacturer published the maximum number of safe operations (N), at the full-rated interrupting current value (Ir), assume that the average arcing time (ta) is ½ cycle.

The duty limit setting is then calculated as $DMAX = N \cdot \left(I_r\right)^n \cdot \frac{1}{2} \cdot \frac{1}{F}$

For example, if I_r equals 50 kA, N equals 10, n equals 2, and the frequency equals 60 Hz, DMAX is calculated as follows.

$$DMAX = 10 \cdot 50{,}000^2 \cdot \frac{1}{2} \cdot \frac{1}{60} \qquad DMAX = 208 \cdot 10^6$$

A lower value of DMAX may be selected until a reliable correlation is found between contact wear and the accumulated interrupted duty.

The duty on each pole is accumulated and calculated as follows for each breaker opening:

where:

D[p]	=	$\sum_{N=1}^{\infty}(CTP \bullet I[p][n])^2(Tbo)$
D[p]	=	Breaker duty for pole p
p	=	Phase identification number where 1/2/3=a/b/c
CTP	=	Phase current transformer step-down ratio
n	=	Accumulated number of breaker operation
Ti	=	Time delay in msec, adjustable from 0 to ±50 msec, used to compute I[p][n]

I[p][n]	=	The filtered RMS value of the secondary phase p current in microprocessor memory at the time the nth breaker operation is recognized by the microprocessor. I[p][n] will correspond to the RMS current through the breaker for the cycle ending at Ti msec from the time that the breaker 52a or b finger contact was recognized. See NOTE under Breaker Resistor Diagnostics.
Tbo	=	Breaker operate time calculate as Tbo
T	=	Time in msec measured by the relay from when 52a or b contact closure is recognized to when the fault detector(s) drop out.
Tc	=	Fixed time in msec, adjustable for 0 to ±50 msec, entered into the relay representing the time from when the 52a or b contact changes state to when the main breaker contacts begin to part. A negative Tc value is entered when the 52a or b contacts change state <u>after</u> the main breaker contacts begin to part. A positive Tc value is entered when the 52a or b contacts change state <u>before</u> the main breaker contacts part.
contact	=	Input contact and logic used to define breaker in open position

Breaker Duty is reported and set in terms of percent of DMAX using the DLOG command through a communications port or using the contact duty log sub-screen on the front panel.

DLOG	Breaker contact duty log data		HMI Menu Branch: 3	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
YY	percent	0.00 to 101.00	0.01	0.00

DLOG HMI Screen Example:

```
DLOG  A   B   C
     035 049 028
```

DLOG Command

Purpose: Read or change breaker contact duty log data.

Syntax: DLOG[P}[=<YY>]

Comments: P = breaker pole A, B, or C

YY = accumulated breaker pole duty as a percent of the DMAX setting

This function is available on enhanced BE1-BPR relays only. An access area 1 or 3 password is required to change settings.

DLOG Command Examples:

1. Read the contact duty log values.
   DLOG
   `DLOGA= 92; DLOGB= 22; DLOGC= 27`
2. Reset the Phase A duty log after maintenance was performed.
   DLOGA=0

The breaker information used in computing the breaker contact duty is programmed through the communication ports using the BKRCON, BKROPS, and CTP commands. Parameters for BKROPS and

CTP commands are as defined in the previous paragraphs. If DMAX is programmed as 0 (zero) the breaker duty feature is disabled.

BKRCON	Breaker duty monitoring		HMI Menu Branch: N/A	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
DMAX	Primary A^2 seconds	0 to 6.8E38	0.001	0.000E00
Tc	Milliseconds	0 to ±200	1	0
Ti	Milliseconds	0 to ±200	1	0

BKRCON Command

Purpose: Read or change breaker contact duty monitoring settings.

Syntax: BKRCON[=<DMAX>,<Tc>,<Ti>]

Comments: Tc is a negative value when the 52b contacts change state after the main contacts open. Tc is a positive value when the 52b contacts change state before the main contacts open. Ti sets the point where the last full cycle of current calculations ends and is taken relative to the 52b status. Positive Ti is after the 52b.

This function is available on enhanced BE1-BPR relays only. An access area 1 or 3 password is required to change settings.

BKRCON Command Examples:

1. Set Tc at 6 milliseconds, Ti at 8 milliseconds, and DMAX at 10 kA-seconds.

   BKRCON=1.0E4,6,8

2. Read breaker contact information

   BKRCON

   `BKRCON=1.0E4,8,8`

3. Set the Tc parameter of the BKRCON command for a breaker whose 52b contact closes 3 milliseconds after the main contacts part. Recognition time for the 52b contact has been set at 4 milliseconds using the LI command. Note that Tc is set as the sum of the 52b recognition time setting and the 52b contact delay. (–3–4=7 ms). Set Ti for 5 milliseconds after the 52b contact is recognized. The timing diagram is shown in Figure 10.

   BKRCON=1.0E4,-7,5

   Both Tc and Ti are referenced to that instant in time when the 52b contact is recognized. If Tc or Ti occurs after the 52b contact is recognized, they are positive time values. Otherwise, they are negative time values. Be sure to offset Tc and Ti by the 52b recognition time (LI command, see the *BESTlogic* chapter.

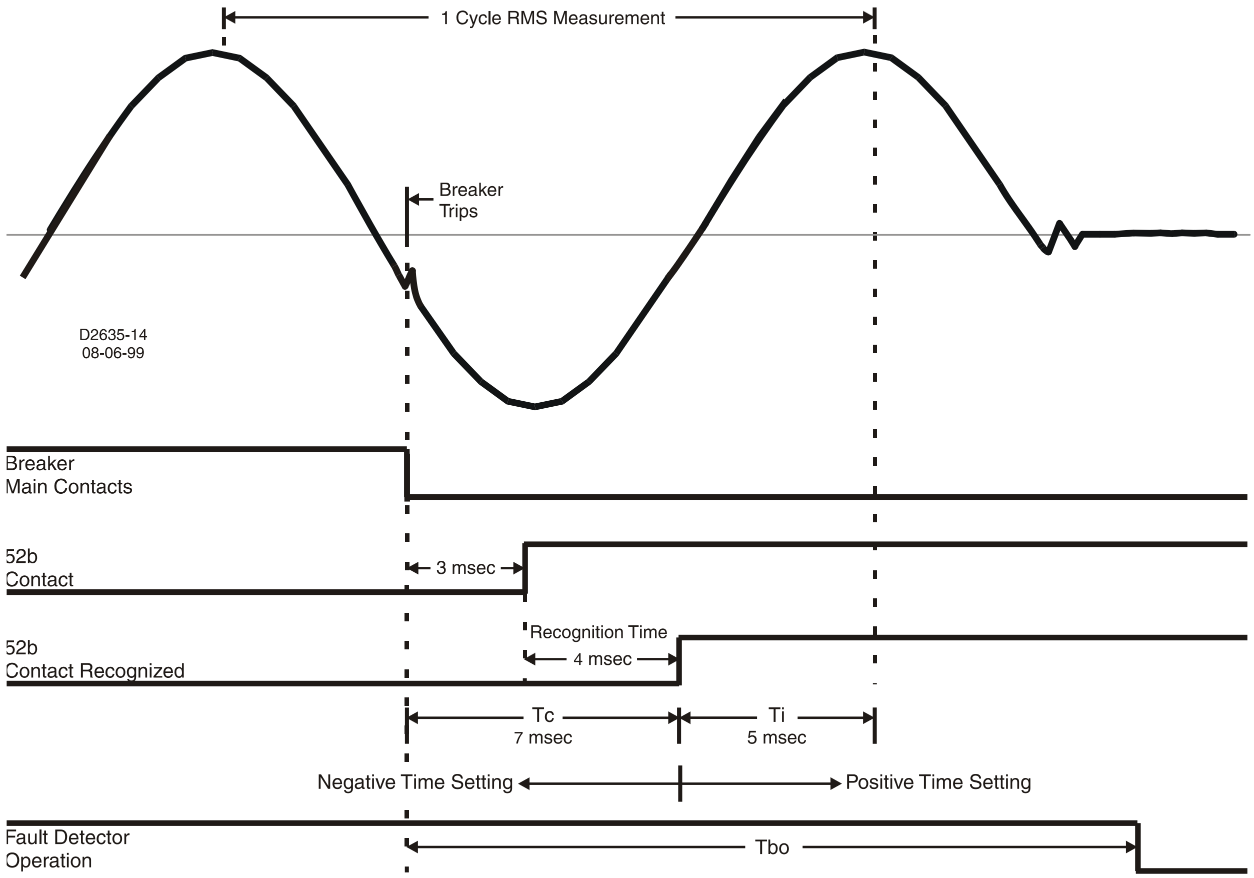


Figure 10. Tc and Ti Timing Diagram

An effective Tc setting can only be made if you know when the main contacts and the 52 contacts change state in the breaker opening cycle. Figure 11 shows some 52 contact designations and timing references that may be found in some manufacturers' literature. Typically, large variations can be found in 52a/b designs. To obtain the highest arcing time accuracy, the time relationship between the breaker main contacts opening and the 52 contact changes of state should be measured using a travel analyzer.

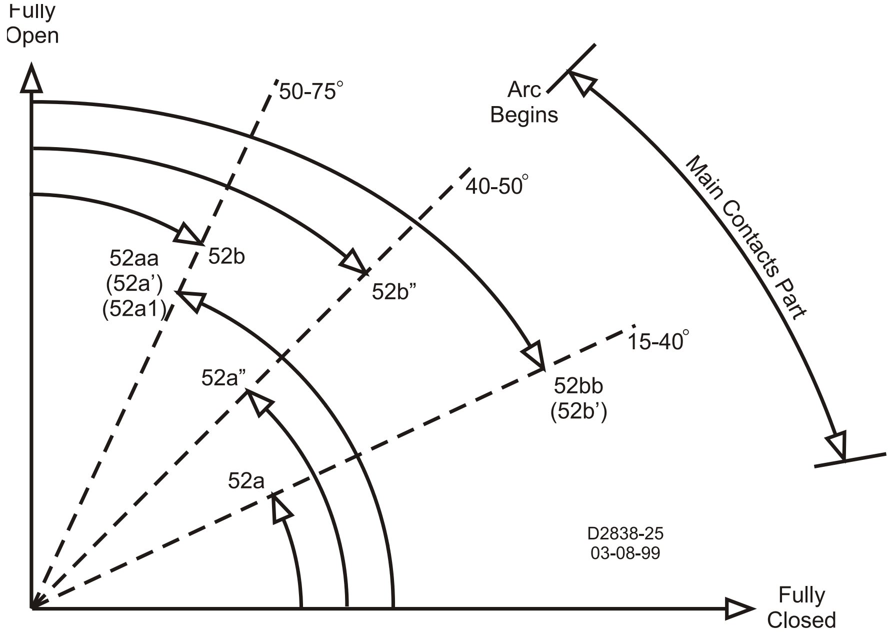


Figure 11. 52 Contact Designation

Breaker Operations Counter

The breaker operations counter logs the number of open and close cycles of the circuit breaker. The counter increments when the breaker closes. The number of breaker operations can be viewed or set through the communications ports using the BKROPS command or through the HMI using Breaker Status sub-screen 3. Breaker operations can also be viewed on the Breaker Status Menu Screen. The BKROPS command also defines the logic for determining the breaker position (open or closed). Refer to the *Breaker Status Screen* sub-section for information about using the BKROPS command.

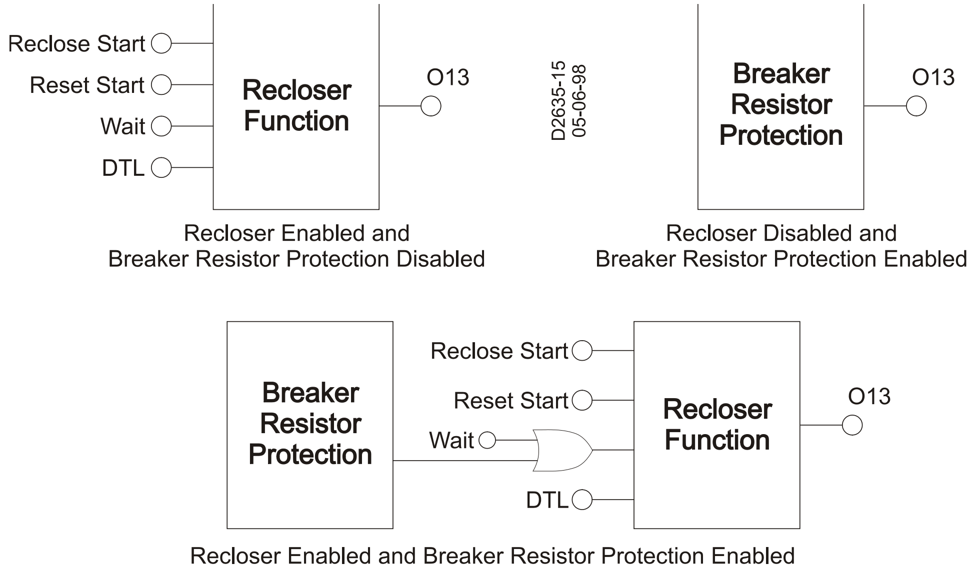
Breaker Resistor Diagnostics

Breaker-opening resistors are used on some high voltage breakers to limit the maximum interrupting current during fault conditions. This resistor is mechanically linked to the main breaker contact so that when the main breaker contact opens, the opening resistor is placed in series with the phase current approximately one-half cycle before the breaker opens. Since the breaker resistor is usually much larger than the fault resistance, the breaker resistor will tend to limit the fault current to a value based on the primary circuit voltage divided by the breaker resistor value ($Ires = V_{LN} / R$). This value, Ires, will be less than the maximum short circuit rating (I_{SC}) for the breaker.

Typically, a breaker-opening resistor will be rated to allow a maximum number of operations (MAXOPS) before waiting a defined reset or cooling off period. This reset period must occur before another operation can safely be allowed. The BE1-BPR keeps track of the accumulated resistor heating by adding one operation to the RESOPS counter for every breaker opening and subtracting one from the RESOPS counter, <reset> minutes after the operation was logged.

The breaker resistor counter, RESOPS, stores in volatile memory the accumulated breaker operations that are not reset. The current status of this counter is displayed on BREAKER STATUS menu, sub_screen 2.

If reclosing is disabled and the accumulated operations equals MAXOPS, virtual output 13 (O13) becomes true. This virtual output may be connected to an actual output by programming the logic. This output contact can provide a block reclose output (BRO) to prevent another operation and overheating the opening resistors. If the reclosing function is enabled, and the accumulated operations equals MAXOPS, the block reclose signal is internally ORed with the defined WAIT logic input. This action delays reclosing to protect the opening resistors from overheating. Figure 12 illustrates the logic that controls virtual output 13 (O13) when breaker resistor protection and/or reclosing is enabled.



NOTE

If Ires is programmed, then the DUTY LOG uses that value in current (I) calculations instead of (CTP∗I[p][n]) because it would be difficult to separate the arcing current from the fault current prior to the resistor being inserted.

Figure 12. Output 13 Logic

Breaker information used in the breaker resistor diagnostics is programmed using the BKRRES command. If MAXOPS is programmed to zero, the resistor heating diagnostic is disabled.

BKRRES	Breaker resistor monitoring data		HMI Menu Branch: 3	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
MAXOPS	breaker operations	0 to 10	1	00,000
reset	minutes	0 to 255	1	0
Ires	primary amperes	0.000 to 6.8E38	0.001	0.000E+00

BKRRES HMI Screen Example:

BKROPS	**RESOPS**
00036	**0 OF 0**

BKRRES Command

Purpose: Read or change breaker resistor monitoring data.

Syntax: BKRRES[=<MAXOPS>,<reset>,<Ires>]

Comments: An access area 1 or 3 password is required to change settings.

BKRRES Command Example:

Set Ires at 500 amperes, reset_time at 15 minutes, and MAXOPS at 4.

BKRRES=4,15,500

Timer Log

The timer log provides timing diagnostics to aid in evaluating the relay settings or external timing. Logs for the last 40 events are stored in volatile memory. A log stores the time remaining on a timer/counter when the logic programmed for the timer log alarm, using the PTLOG command, becomes true (an event). PTLOG alarm logic is programmable using simple Boolean AND logic. Appropriate values must be chosen for the logic variables in order for the time recorded to correspond to the timing diagnostic desired.

A margin log is a typical timing diagnostic. A delay timer is typically used to delay the breaker failure output (BFO) until sufficient time has elapsed for the primary protection scheme to operate. The time left on the timer when the BF logic is cleared is the margin value (refer to the Introduction chapter for a detailed timing diagram discussion and illustration). Knowing the time remaining on that timer provides feedback on the suitability of the time delay and margin allowed for the protection scheme to operate. If there is a large discrepancy between the calculated and actual margin, corrective action can be taken before a problem occurs.

Other timers may be set to measure some other parameter at the operator's discretion.

Use the PDIAG command to configure the timer log to set O14 or O15 (the software diagnostic alarm outputs), if the timer value recorded is less than or greater than a programmed alarm value. A separate alarm time can be set for each timer using the PTLOG command through the communications port. O14 or O15 can then be used to drive an output such as the ALARM output in order to provide an immediate indication of a potential problem. The operator, upon receiving the alarm signal can query the relay through the communication port or look at the DIAG screen in the RELAY STATUS MENU to identify the problem. TLOG entries that exceed the alarm threshold are marked by an asterisk in the timer log (TLOG).

The timer log alarm is reset when the diagnostic alarms are cleared by the "DIAG=0" command or reset by using the RESET key when the TLOG alarm is displayed on the diagnostic alarm screen.

Timer log data is saved in volatile memory and may be viewed on a terminal connected to a communications port or at the TIMER LOG menu screen of the HMI. TLOG events are displayed in reverse chronological order (last in, first out) and sorted by timer number. Examples of TIMER LOG HMI screens are shown below on the left. An example of a timer log ASCII report is shown below on the right.

TIMER LOG menu screen	**TIMER LOG (TLOG)**
Sub-screen 1	**10:31:31 12/12/07** **TLOG2=92m**
Sub-screen 2	**5:51:09 12/11/07** **TLOG2=0m ***
Sub-screen 40	**15:22:54 8/20/07** **TLOG2=105m**

```
TLOG2= 92m 10:31:31.091 08/08/07
TLOG2= 0m* 05:51:09.254 08/07/07
TLOG2= 96m 03:33:11.669 08/07/07
TLOG2= 8m* 12:45:26.405 08/06/07
TLOG2= 47m 20:08:58.883 08/01/07
TLOG2= 8m* 17:10:07.259 08/01/07
TLOG2= 88m 16:44:12.855 08/01/07
TLOG2= 85m 17:01:23.307 07/25/07
TLOG2= 77m 18:29:55.697 07/17/07
TLOG2= 6m* 15:15:20.101 07/03/07
TLOG2= 55m 14:57:10.550 07/03/07
TLOG2= 94m 19:07:32.667 06/24/07
TLOG2= 70m 12:59:02.029 06/15/07
```

Example:

A margin log is created using the following settings. The timing sequence and timer log are illustrated in Figure 4-11. A logic diagram (using pre-programmed logic BFL1) for the margin log is shown in Figure 4-12.

LT1=D,I2,/I2	Starts timer TD1 when input IN2 goes high.
PTLOG1=/O7,L,10	Time entry is logged when output 7 (O7) goes low. Margins of 10 milliseconds or less are marked with an asterisk (*) in the log.
TD1=100	Sets timer TD1 at 100 milliseconds.

TD1 starts timing when IN2 is energized. When O7 goes low, the difference in time between the TD1 setting and O7 going low is recorded in the timer log.

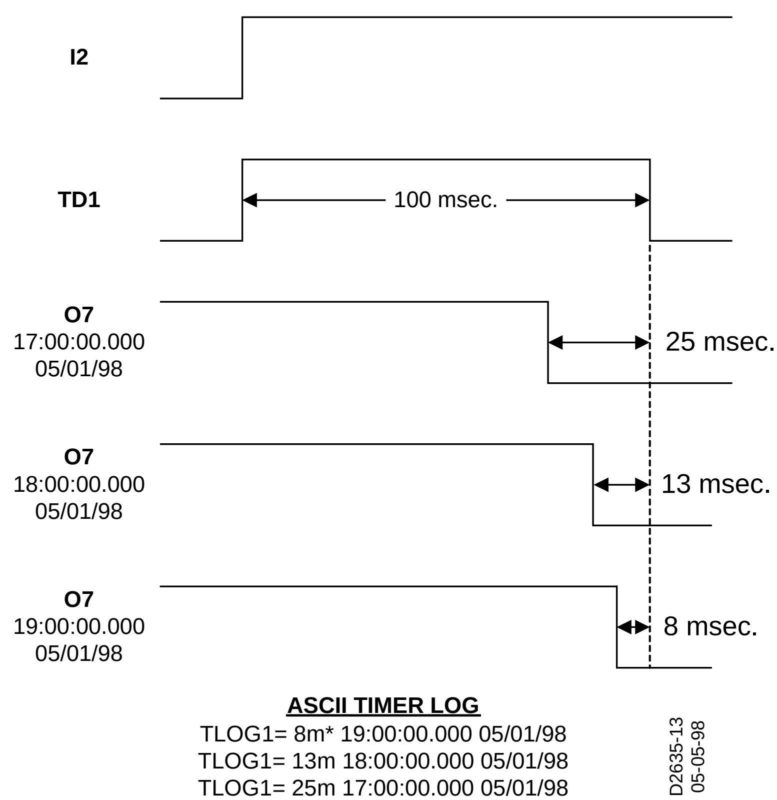


Figure 13. Margin Log Timing Sequence

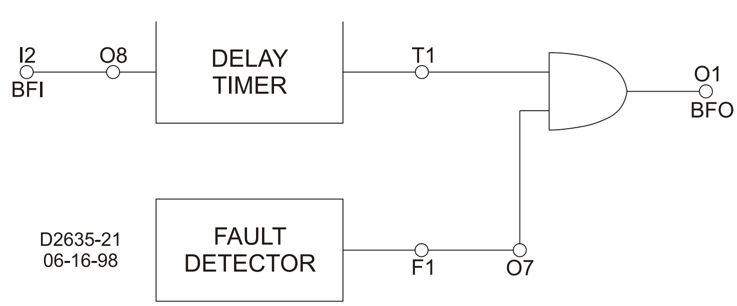


Figure 14. Margin Log Logic

PTLOG	Timer log and alarm log	HMI Menu Branch: N/A
Parameter	**Range**	**Comments**
logic term	N/A	AND and NOT(/) logic variables can be used to specify when timer log is triggered.
alm_type	H, L, or 0	**H:** Alarm occurs when the remaining time at the point the timer logic becomes true is higher than the alarm_time setting. **L:** Alarm occurs when logic becomes true inside the alm_time margin. **0:** Disables the alarm function.
alm_time	0 - 65 seconds	A diagnostic alarm is logged if logic becomes true inside (alm_type L) or outside (alm_type H) this time window. alm_time units can be milliseconds (default), seconds (s), or cycles (c). Figure 4-13 illustrates an example of an H alarm and L alarm condition.

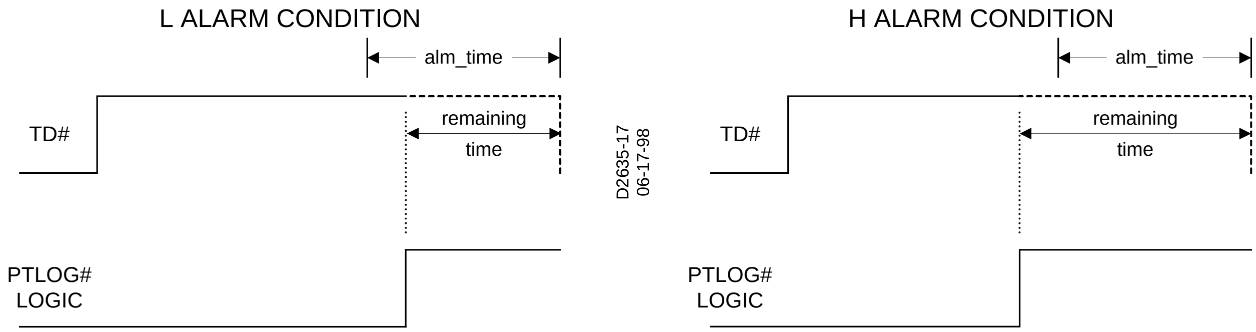


Figure 15. H, L Alarm Conditions

PTLOG Command

Purpose: Reads or changes timer log and alarm logic

Syntax: PTLOG [#[=<logic term>,<alm_type>,<alm_time>]]

Comments: # = Timer 1, 2, 3, 4, 5, or 6

Access area level 1, 2, or 3 password is required to change settings. Default settings are 0,0,0 for each of the six timer logs.

PTLOG Command Example:

Check the margin by setting up a log for timer 1 to record the time remaining after the fault detectors (O7) drop out. Set an alarm if the margin drops below one cycle.

PTLOG1=/O7,L,1C

TLOG	Timer logs	HMI Menu Branch: 4
Parameter	**Comments**	
#	# corresponds to the timer that logic and alarm time are compared against. A maximum of 40 logs can reside in memory. If more than 40 logs are generated, then the oldest log is overwritten. Each entry gives the time remaining on the timer and the time and date it was logged. If a logged time has triggered a timer log alarm, then that time is marked with an asterisk (∗) in the time log. Entering TLOG lists all entries for all timers. Entering TLOG# lists the entries for timer log # (T#). Entering TLOG-0 or TLOG#=0 resets all timer logs. All timers logs are also reset when any access mode changes are made (saved).	

TLOG Command

Purpose: Reads or resets the timer logs

Syntax: TLOG[#]

Comments: No access area password is required to view or reset timer logs.

TLOG Command Example:

Read the log entries for timer1.

```
TLOG1
TLOG1=40m  11:45:12.008 01/17/07
TLOG1=38m  11:31:44.633 07/17/07
TLOG1=14m* 07:28:13.812 07/06/07
TLOG1=55m  16:15:16.589 07/05/07
```

Fault Log (Enhanced Relays Only)

The fault log provides information about recent events that generated oscillograph data records. A record is generated when the TRIGGER command logic expression becomes true. Events are numbered from 1 to 255 and are accessed in reverse chronological order (last in, first out). The number of an oscillograph record corresponds to the number of the fault log. After fault log number 255 is recorded, fault log numbering automatically starts over at fault log number 1. When the fault memory becomes full, the oldest record is overwritten by the latest record acquired.

Fault Log Listing

A list of fault log records can be viewed through the HMI menu screens or through a communications port using the FLOG command. Each fault log listing shows the fault number, fault time and date, and the protective elements that were active at the time the fault occurred. Examples of HMI and ASCII fault log listings follow.

FAULT LOG menu screen	**FAULT LOG (FLOG)**
Sub-screen 1	**129 8:33 2/22** **50 TARGETS: AN**
Sub-screen 2	**129 8:33 2/22** **50 TARGETS: AN**

```
129 08:33:22.751 02/22/07, 50 TARGETS=A,N
128 08:33:09.796 02/22/07, 50 TARGETS=A,N
127 19:34:48.467 01/30/07, 50 TARGETS=A,N
126 14:25:09.663 12/20/06, 50 TARGETS=A,N
125 12:26:41.653 11/25/06, 50 TARGETS=A,N
124 11:19:19.684 11/01/06, 50 TARGETS=A,N
123 11:19:15.176 11/01/06, 50 TARGETS=A,N
122 12:08:23.488 10/09/06, 50 TARGETS=A,N
```

Sub-screen 10

120 23:55 7/22
50 TARGETS: AN

```
121 00:00:22.758 09/18/06, 50 TARGETS=A,N
120 23:55:09.896 07/22/06, 50 TARGETS=A,N
119 18:34:58.367 07/03/06, 50 TARGETS=A,N
118 13:25:06.613 05/20/06, 50 TARGETS=A,N
```

FLOG	Fault log information.	HMI Menu Branch: 5
Parameter	**Range**	**Comments**
#	*0:* clears all fault records *1-255:* provides summary information about any one of 255 fault records	Entering FLOG with no parameter will provide a dated listing of the fault records stored in memory.

FLOG Command

Purpose: Reads a listing of all fault records, reads summary information about any individual fault record, or clears all fault records.

Syntax: FLOG[#][=0]

Comments: This function is available on enhanced BE1-BPR relays only. No access area password required to read or reset fault log data.

FLOG Command Example:

Read fault log 125.

```
FLOG125
FAULT LOG #125
DATE = 11/25/07
TIME = 12:26:41.653
LOGIC=BFL1
I (1-7) =0111000
T (1-6) =100000
F (1-3) =111
O (A,1-15) =0111101000011001
50 TARGETS=NONE
IA = 1.25 KA
IB = 38.31 KA
IC = 1.28 KA
IN = 37.13 KA
FAULT CLEARING TIME = 0.164 SEC
```

Fault Summary

Detailed information about specific faults is available through the communication ports by using the FLOG command. Entering FLOGx, where x is the fault number, provides a detailed summary of fault x. The information listed below is provided in each fault summary.

- Fault timing is provided to millisecond resolution.
- Fault current for each phase is provided.
- Status of all inputs and outputs at the time the fault occurred.
- Fault clearing time. (Defined as the time from when the fault was triggered to when the instantaneous fault detector(s) drop out.)

An example of a fault log report is shown below:

```
FAULT LOG #125
DATE  =11/25/07
TIME  =12:26:41.653
LOGIC =BFL1
I(1-7)=0111000
T(1-6)=100000
F(1-3)=111
O(A,1-15)=0111101000011001
50 TARGETS= B,N
IA =1.25 KA
IB =38.31 KA
IC =1.28 KA
IN =37.13 KA
FAULT CLEARING TIME = 0.164 sec
```

Oscillographic Data Acquisition

An oscillographic data record is triggered when the trigger logic defined by the TRIGGER command becomes true. Typically, a fault record is taken whenever a contact input is recognized that could trigger the BFO. The fault trigger is reset and rearmed after the TRIGGER definition becomes false.

The fault data recorded is as follows:

- Fault log number (1 to 255).
- Date and time of the start of fault data to one millisecond resolution.
- Twenty cycles of sampled data (four cycles pre-fault and sixteen cycles post-fault) consisting of the A/D data values of phase and neutral currents and status of all contact inputs and outputs, virtual outputs and timer/counters. The fault data sampling rate is twelve samples per cycle. Analog data is bandwidth limited to 200 Hz because of the anti-aliasing low-pass filter.
- Fault data format follows the COMTRADE Standard (*IEEE C37.111-1991: Common Format for Transient Data Exchange (COMTRADE) for Power Systems*).

TRIGGER	Oscillographic trigger.	HMI Menu Branch: N/A
Parameter	**Comments**	
logic term	Any logic term can be used to define the logic conditions that will automatically trigger a fault record.	
Y	Entering TRIGGER=Y will trigger a fault record through a communication port. No password access is required.	

TRIGGER Command

Purpose: Reads or changes the trigger logic or triggers a fault record.

Syntax: TRIGGER[=<logic term>/Y]

Comments: This function is available on enhanced BE1-BPR relays only. Access area password one, two, or three is required to change settings. No password access is needed to trigger a fault record.

TRIGGER Command Examples:

1. Trigger a fault record when output 6 becomes true.
   TRIGGER=O6
2. Trigger a fault record manually.
   TRIGGER=Y

COMTRADE FAULT data is read through the communications port using the FLT command.

FLT	COMTRADE fault reports	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Comments**
#	*1 - 255:* fault number corresponds to fault log record number	Only one fault report may be requested at a time. Fault reports are transmitted in IEEE COMTRADE format. Binary transfer allows quicker data transmission and the files are smaller. ASCII data is human readable and allows the fault data to be analyzed by standard, commercially available software. The download protocol may be either XMODEM or XMODEM CRC format.
Type	A/B.CFG/DAT where: A (ASCII) B (binary) CFG (configuration file) DAT (data file)	

FLT Command

Purpose: Obtains a COMTRADE fault report.

Syntax: FLT<#><type>

Comments: This function is available on enhanced BE1-BPR relays only. No access area password is required to retrieve a COMTRADE fault report.

FLT Command Examples:

1. Initiate the transfer of the configuration file for fault 155.
   FLT155B.CFG (for binary) or FLT155A.CFG (for ASCII)
2. Initiate the transfer of the data file for fault 155.
   FLT155B.DAT (for binary) or FLT155A.DAT (for ASCII)

The SNAME command can be used to assign an identifying name and number to a relay for use with COMTRADE files.

SNAME	Identification for COMTRADE reports	HMI Menu Branch: N/A
Parameter	**Parameter Description**	**Range**
#	station number	0 to 65535
name	station name	1 to 29 characters

SNAME Command

Purpose: Reads or changes the station name and number for COMTRADE reports.

Syntax: SNAME[=<#>,<name>]

Comments: This function is available on enhanced BE1-BPR relays only. Access area password one, two, or three required to change settings. Default setting is 1,BE1-BPR. Note that <name> con contain numbers but may not begin with a number and must not contain any commas.

SNAME Command Example:

For COMTRADE reporting, assign a relay identification number of 1 and a station name of Highland.
SNAME=1,HIGHLAND

Downloading COMTRADE Files

COMTRADE oscillographic fault records consist of a configuration file and a data file. COMTRADE files can be downloaded in binary or ASCII format using commercially available communication software such as Windows® Terminal. Note that the data word must be set at eight bits (see COM command) to download COMTRADE commands. The following paragraphs provide the procedure for downloading COMTRADE files.

1. Determine which fault records are available for downloading by entering the FLOG command. The relay will report which fault records are stored in memory.
2. Select a fault record from the list of fault records available; e.g., 001.
3. Begin transfer of the fault 001 configuration record by entering FLT001B.CFG for a binary download or FLT001A.CFG for an ASCII download.
4. The relay will respond: `START XMODEM DOWNLOAD`.
5. Prior to downloading, the communication software will prompt you to enter a file name for the transferred file. Typically, this would be the same as the data file. For example, if transferring Fault 001, you would enter FLT1B or FLT1A. It is not necessary to include the zeros in the file name as long as the same file naming convention is used for the CFG and DATA files.
6. Once the file has been named, select start (if necessary) to begin transfer.
7. Once the configuration file has transferred, begin transfer of the data record for fault 001 by entering FLT001B.DAT or FLT001A.DAT. The relay will respond: `START XMODEM DOWNLOAD`.
8. Prior to downloading, the communication software will prompt you to enter a file name for the transferred file. Typically, this would be the same as the configuration file.
9. Once the file has been named, select start (if necessary) to begin transfer.

Fault Log Configuration

The maximum number of fault records saved by the relay is adjustable and can be set at 6, 8, 10, or 12. The number of fault records selected affects the length of each record. A maximum setting of 6 records will provide longer record lengths. A maximum setting of 12 records will provide shorter record lengths. Each fault record contains four cycles of pre-fault data. This value is independent of the maximum value of fault records selected. The POSC command is used to select the maximum number of oscillograph fault records desired.

Fault log records are preserved for approximately 24 hours after relay operating power is removed. The risk of losing records is high if operating power is removed for more than 24 hours. Fault log records are cleared when the FLOG=0 command is given.

POSC Command

Purpose: Reads or programs the number of oscillographic fault records saved.

Syntax: POSC[=x]

Comments: x=6, 8, 10, or 12 (default)

Area one, two, or three password access is required to change the maximum number of oscillographic records.

POSC	Maximum number of oscillographic records		HMI Menu Branch: N/A	
Parameter	**Setting Range**	**Pre-Fault Cycles**	**Post-Fault Cycles**	**Cycles Per Record**
x	6	4	36	40
	8	4	26	30
	10	4	20	24
	12	4	16	20

Caution

Changing the POSC command setting will delete all existing fault records stored in RAM. Fault records can be downloaded and saved prior to making a POSC command setting change. The *Functional Description* chapter provides information about using the FLT command to download and save fault records.

POSC Command Examples:

1. Read the maximum number of fault records that the relay is able to record.
   POSC
   6
2. Configure the relay to record 30 cycles of oscillography data in each fault record.
   POSC=8

Maintenance

Maintenance involves configuring and verifying essential features of the relay. These features may be programmed through the front panel controls or through the communications ports. The following list of these features includes the corresponding commands in parenthesis. LCD contrast cannot be adjusted through the communications ports. Output contact testing cannot be performed through the HMI.

- Time and date settings (TIME, DATE, PCLK)
- Communication port settings (COM)
- Password settings (PW)
- Fault detector calibration settings (CAL, FREQ)
- HMI liquid crystal display (LCD) contrast
- Default HMI display screen (PDISPLAY)
- Output contact testing (OUT)
- Software version reporting (VER)

Examples of typical MAINTENANCE menu screens are shown below.

MAINTENANCE menu screen	**MAINTENANCE**
Sub-screen 1	**TIME DATE** **11:45A22 8/22/07**
Sub-screen 2	**COM0(F) COM1(R)** **12008N1 96008N1**
Sub-screen 3	**PASSWORD ENTRY** **PW1 = ********, B**
Sub-screen 4	**CAL FREQ** **RANGE-1L/2H 60**

Sub-screen 5

```
LCD CONTRAST
10
```

Sub-screen 6

```
MODEL    :BE1-BPR
PROGRAM:VER2.23E
```

Time and Date

The time and date can be set from the front panel keyboard or from a communication port using the TIME and DATE commands.

TIME	Time clock setting	HMI Menu Branch: 5 (Standard), 6 (Enhanced)
Parameter	**Parameter Description**	**Default**
hr	hours	0:00:00
mn	minutes	
f	A (AM), P (PM), or : (24 hour clock)	
sc	seconds	
msc	milliseconds	

TIME HMI Screen Example:

```
TIME        DATE
23:59:59   12/31/99
```

TIME Command

Purpose: Reads or changes the time clock.

Syntax: TIME[=<hr>:<mn><f><sc>.<msc>]

Comments: No access is required to change settings.

TIME Command Examples:

1. Read the current time (12-hour format).
   TIME
   `11:24P45.339`
2. Set the time clock at 11:24 pm.
   TIME=11:24P00

DATE	Calendar date setting	HMI Menu Branch: 5 (Standard), 6 (Enhanced)
Parameter	**Parameter Description**	**Default**
dm	day or month (based on PCLK setting)	01/01/07
md	month or day (based on PCCLK setting)	
yr	last two digits of year	

DATE HMI Screen Example:

TIME	**DATE**
23:59:59	**12/31/99**

DATE Command

Purpose: Reads or changes the date setting.

Syntax: DATE[=<dm>/<md>/<yr>]

Comments: No access is required to change settings.

DATE Command Examples:

1. Read the date.
   DATE
   `01/24/07`
2. Enter a date of June 1, 2007
   DATE=06/01/07

The PCLK command allows the time and date format to be changed. The date can be displayed with the day followed by the month or vice versa. The time can be displayed in a 12- or 24-hour format.

PCLK Command

Purpose: Reads or changes the time clock time/date format.

Syntax: PCLK[=<date_format(M/D)>,<time_format(12/24)>]

Comments: Access area password one, two, or three required to change settings.

PCLK	Clock display mode	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Defaults**
d	date format: D (day first) M (month first)	M,24
hr	hour format: 12 (12 hour format) 24 (24 hour format)	

PCLK Command Examples:

1. Read the clock format.
   PCLK
   `PCLK=D,12`
2. Program the clock format so that the date is displayed with the month preceding the date and time is displayed in the 24 hour format.
   PCLK=M,24

BE1-BPR relays that are connected to an IRIG-B source will automatically synchronize the time and date with the IRIG-B source. However, the year must be set manually since it is not included in the IRIG-B data stream. Once all components of the time and date are received by the relay, the front panel CLOCK LED will turn off to indicate that the clock has been set.

Communication Settings

Two communication ports are available, but only one port can be used at a time. Priority is given to the front panel port. If data is received from both parts at the same time, an error response is generated.

Communication settings can be set through the front panel keyboard or a communication port using the COM command. The default setting is 9600N1 for both ports.

COM HMI Screen Example:

COM0(F)	**COM1(R)**
19K 8N1	**9600 8N1**

COM Command

Purpose: Read or change the serial port communication settings.

Syntax: COM[x][=<ratedps>][,Ay][,Ey][,Hy][,Pyy][Xy]

Comments: x = 0 (front) or 1 (rear)

Access area password one, two, or three required to change settings. The default setting for COM0 and COM1 is 9600,A1,E0,H0,P24,X1.

COM	Communication port settings	HMI Menu Branch: 5 (Standard), 6 (Enhanced) ∗
Parameter	**Parameter Selections**	**Comments**
rate	300, 600, 900, 1200, 2400, 4800, 9600, or 19K	Not all combinations of d, p, and s are allowed. Allowed combinations are 7O1, 7E1, 7N2, 8O1, 8E1, 8N1, and 8N2. Note: d must be in order for COMTRADE fault data to be transmitted.
d	7 or 8 (number of data bits)	
p	parity: O (odd) E (even) N (none)	
s	1 or 2 (stop bits)	
Ay	acknowledge mode: A1 (acknowledge on) A0 (acknowledge off)	
Ey	echo mode: E1 (on) E0 (off)	Echo must be turned off (E0) to enable the RS-485 output at COM1.
Hy	hardware handshake mode: H1 (on) H0 (off)	Handshaking must be turned off (H0) to enable the RS-485 output at COM1.
Pyy	page mode: P0 (no pagination) Pyy (set page length)	Pyy setting range is P05 to P99. When the page mode setting is not zero, then any command whose output exceeds length Pyy will pause after the given number of lines is printed. The operator will be prompted to press any key to continue the output.
Xy	handshake mode: X1 (on) X0 (off)	

∗ HMI allows only the rate, d, p, and s parameters to be viewed or changed.

COM Command Examples:

1. Program the front communications port for 1200 baud, 8 data bits, no parity, and 1 stop bit.
   COM0=12008N1
2. Read the protocol settings for the rear panel communications ports.
   COM1
   `96008N1,A1,E0,H1,P24,X1`
3. Read the settings for all communications ports.
   COM
   `COM0=19.2K8N1,A1,E0,H1,P24,X1`
   `COM1=96008N1,A1,E0,H1,P24,X1`

If polled communication is used with the rear RS-485 port, the ID command can be used to assign an ID number to the relay.

ID Command

Purpose: Reads or programs a relay ID number for polled communication.

Syntax: ID[=<id(0-254)>]

Comments: Access area one required to change setting. Default setting is zero.

ID	Polled communication ID number	HMI Menu Branch: N/A
Parameter	**Parameter Setting**	**Comments**
id	0 (disable polled operation) 1 to 254 (unique relay ID number)	Polling is only active through the rear ports (COM1). An ID number does not need to be entered for communication through the front port (COM0).

ID Command Examples:

1. Read the relay identification number.
   ID
   `0`
2. Enter a relay identification number of 3 and enable polled communication. (Assigning a relay identification number other than zero will enable polled communication.)
   ID=3

Sub-screen two under the MAINTENANCE menu screen shows the communications settings for the relay. Communication ports are identified as COM0 and COM1; COM0 is the front port and COM1 is the rear port.

Programming a New Password

If password protection is enabled, only password level one holders can program a new password. To program a new password from the front panel, use the right arrow key to move to the MAINTENANCE menu. Press the down arrow key until the password entry screen appears. Press the PROG key and enter password 1 if password protection is enabled. Enter the new password number (1/2/3), the new password (one to eight characters) and the desired access area (F/R/B). Press and hold the PROG key to exit the programming mode. At the SAVE screen, release PROG and enter Y to save the changes. Press PROG again to return to the MAINTENANCE menu.

To program a new password through a communication port, you must first obtain access level one by entering Password 1 if password protection is enabled. Use the ACCESS command to obtain programming access. Enter the new password using the PW command. Enter the SAVE command and answer Y at the prompt. The new password is now in effect.

PW Command

Purpose: Reads or changes password settings.

Syntax: PW[<#>[=<password>,<access(F/R/B)>]]

Comments: Access area one password is required to change password settings.

PW	Password settings	HMI Menu Branch: 5 (Standard), 6 (Enhanced)
Parameter	**Parameter Setting**	**Default**
#	1, 2, 3, or 4	PW1=0,B PW2=0,B PW3=0,B PW4=0,B
password	alphanumeric string of 1 to 8 characters	
access	F (front), R (rear), or B (both)	

PW HMI Screen Example:

PASSWORD ENTRY
PW1=ABC,B

PW Command Examples:

1. Read the current passwords, assuming that the area one password has already been entered using the ACCESS=<password> command.

   PW

   `PW1=ABC,B;    PW2=123,    PW3=XYZ,F;    PW4=BPR,F`

2. Change Password 2 from front access and no password to front and rear access with a password of RELAYGRP.

   >ACCESS=OPENUP — Password level one entered.

   >PW2=RELAYGRP,B — Password level two changed.

   >SAVE — Save data.

   `ARE YOU SURE (Y/N) ?` Y — `Relay verification.`

   RELAY OFF_LINE

   `CHANGES SAVED` — The new password takes effect.

   `RELAY ON_LINE`

   >

The password Protection sub-section, located earlier in this chapter, provides more information about passwords and the functions they control.

Calibrating the Analog Channels

The Analog (current input) channels may be calibrated from the front panel using the CAL menu screen or through the communications port using the CAL command. For proper calibration, the power line frequency must be known and set before calibration. The power system frequency can be read or changed from the CAL menu or by using the FREQ command through the communications port.

The *Calibration and Testing* chapter provides detailed information about analog channel calibration.

CAL	Calibration values	HMI Menu Branch: 5 (Standard), 6 (Enhanced)
Parameter	**Parameter Selections**	**Comments**
amps	1 ampere units: 2 (low range) 8 (high range) ∗ 5 ampere units: 10 (low range) 40 (high range) ∗	After calibration, the calibration results are reported as "CAL OK" or "CAL FAIL <reason for failure>". Entering CAL by itself will return the calibration values for each calibration range and phase. The calibration values represent the number of A/D bits per ampere for each current input.

∗ High range values are to be used only with enhanced units.

CAL HMI Screen Example:

```
CAL            FREQ
RANGE-1L/2H     60
```

CAL Command

Purpose: Read or change calibration values.

Syntax: CAL[x][=<amps>]

Comments: x = 1 (low range, 2 (high range)

Access area one password is required to make calibration changes.

CAL Command Example:

Read the relay calibration values.

CAL

```
CAL1A=140.766;   CAL1B=141.110;   CAL1C=143.237;   CAL1N=141.543
CAL2A=7.076;     CAL2B=7.070;     CAL2C=7.083;     CAL2N=7.064
```

FREQ	Power system frequency	HMI Menu Branch: 5 (Standard), 6 (Enhanced)
Parameter	**Parameter Setting**	**Default**
freq	50 or 60	60

FREQ HMI Screen Example:

```
CAL            FREQ
RANGE-1L/2H     60
```

FREQ Command

Purpose: Reads or changes the nominal power system frequency information used by the relay.

Syntax: FREQ[=<freq(hz)>]

Comments: Access area password one is required to change the setting.

FREQ Command Examples:

1. Read the frequency setting.
   FREQ
   `60`
2. Change the frequency setting to 50 hertz.
   FREQ=50

LCD Contrast Adjustment

The LCD contrast may be adjusted from the front panel using the LCD CONTRAST menu screen. Pressing the EDIT +/- key will scroll through an adjustment range of 1 to 20 with 10 being the nominal setting.

Default HMI Display Screen

The default HMI screen is displayed when there are no targets and no HMI key has been pressed for more than four minutes. Unless programmed differently, the default HMI screen is the TARGETS screen. Using the PDISPLAY command, any display screen can be set as the default screen. Refer to Figure 4 (enhanced relays) or Figure 5 (standard relays) for menu display maps.

PDISPLAY	Default HMI display screen	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Comments**
default_menu	Menu branch 0, 1, 2, 3, 4, 5, or 6 for Enhanced relays. Menu branch 0, 1, 2, 3, 4, or 5 for Standard relays.	The default screen is programmed by entering the number of screens to the right of the target screen (default_menu) and down from the top of screen of the menu branch (default_screen).
default_screen	number of screens down from the top screen (0) of the menu branch	

PDISPLAY Command

Purpose: Read or program the default HMI display screen.

Syntax: PDISPLAY[=<default_menu>,<default_screen>]

Comments: Access area password one, two, or three required to change settings. Default setting is 0,0.

PDISPLAY Command Examples:

1. Set the primary current display screen (menu branch 2, screen 2) as the default display.
   PDISPLAY=2,2
2. Set the target display screen (menu branch 0, screen 0) as the default display.
   PDISPLAY=0,0

Note
Assigning any continuously updated HMI screen (2,1 / 2,2 / 2,3 / 6,1) as the default display will result in slower serial port communication.

Output Contact Testing

The OUT command provides the means to test the relay outputs by pulsing the outputs either on or off. Outputs are pulsed on or off for 200 to 250 milliseconds and can be tested individually or collectively.

OUT	Output testing	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	**Comments**
1/0	1 (on) 0 (off) enable (enables test) disable (disables test)	1 pulses OUTx for 200 to 250 ms 0 pulses OUTx off for 200 to 250 ms OUT=ENABLE enables OUT testing OUT=DISABLE disables OUT testing Default setting is OUT=DISABLE

OUT Command

Purpose: Pulses outputs on or off for testing purposes.

Syntax: OUT[x=<1/0>/DISABLE]

Comments: x = A (OUTA, 1 (OUT1), 2 (OUT2), 3 (OUT3), 4 (OUT4), or 5 (OUT5)
Entering OUT=1 or OUT=0 will pulse on or pulse off all outputs.
Access area one or four password is required to test outputs.

OUT Command Examples:

1. Enable the output test feature.
   ACCESS=<password> (access area 1 or 4 password)
   OUT=ENABLE;SAVE;Y
2. Test output 1 by closing it momentarily.
   ACCESS=<password> (access area 1 or 4 password)
   OUT1=1

When testing complete, disable the OUT command by entering OUT=DISABLE;SAVE;Y

Firmware Version Display

The firmware version may be viewed on the front panel HMI and through the communications ports. When power is first applied to the relay, the firmware version is briefly displayed on the front panel LCD. The firmware version can also be viewed at HMI Maintenance menu sub-screen 6. These screens are for viewing only; the displayed firmware version cannot be altered.

The VER command will return the software version number as well as the relay model, part, and serial number.

VER	Relay version information	HMI Menu Branch: 5 (Standard), 6 (Enhanced)
Comments		
This command returns the relay model number, the program version number, the relay part number, and the relay serial number.		

VER HMI Screen Example:

MODEL: BE1-BPR
PROGRAM: VER X.XX

VER Command

Purpose: Returns information about relay hardware and software.

Syntax: VER

Comments: No access area password is required for reporting functions. Version information provided through HMI is limited to the relay model number and software version number.

VER Command Example:

Obtain the program version, part number, and serial number of the relay.

```
VER
Model   : BE1-BPR
Program : VER 3.29E
PN      : 9 2720 00 301
SN      : H12345678
```

Installation

When not shipped as part of a control or switchgear panel, BE1-BPR Breaker Protection Relays are shipped in sturdy cartons to prevent damage during transit. Upon receipt, check the part number against the requisition and packing list to see that they agree. Visually inspect it for damage that may have occurred during shipment. If there is evidence of damage, immediately file a claim with the carrier and notify your Regional Sales Office, or contact Basler Electric Technical Support Department at +1 618-654-2341.

If the unit will not be installed immediately, store it in its original shipping carton in a moisture- and dust-free environment. It is strongly recommended that an operational test (described in the *Calibration and Testing* chapter) always be performed prior to installation.

Operating Precautions

Before installation or operation, note the following precautions:

1. Always be sure that external operating (monitored) conditions are stable before removing a BE1-BPR unit for inspection, testing, or servicing.
2. BE1-BPR relays are solid-state devices and have been type tested in accordance with the requirements defined below under *Dielectric Test.* If a wiring insulation test is required on the switching or panel assembly of which this unit is a part, see *Dielectric Test* below.
3. Be sure that the BE1-BPR case is hard wired to earth ground using the ground terminal on the rear of the unit.
4. When the unit is in service, the controls should be protected by the plastic cover supplied. This limits access to the control settings.

Dielectric Test

All output and power supply terminals have MOV suppressors. Maximum applied voltage must be no greater than 300 volts where MOV suppressors are used. Surge suppression capacitors are installed between terminal pairs and between terminals and chassis ground. When testing with 1,500 Vac, leakage current (approximately 8 mA per terminal) is expected. 1,500 Vac (rms) at 45 to 65 hertz or 2,121 Vdc for one minute may be applied between circuit groups, and between circuit groups and chassis ground in accordance with IEC 255-5 and ANSI/IEEE C37.90-1989 (*Dielectric Tests*).

Mounting

General

BE1-BPR relays are designed to be mounted in either 19-inch racks or conventional panels. Overall dimensions for the rack unit are shown in Figure 16. The rack unit may be panel mounted at any convenient angle, using the cutout dimensions of Figure 17 as a guide. Figures 18 and 19 show the dimensions for the vertical panel mount. The cutout dimensions for the vertical panel mount are shown in Figure 20. When panel mounting the rack unit, an optional escutcheon plate can be installed to cover variations in panel cutouts.

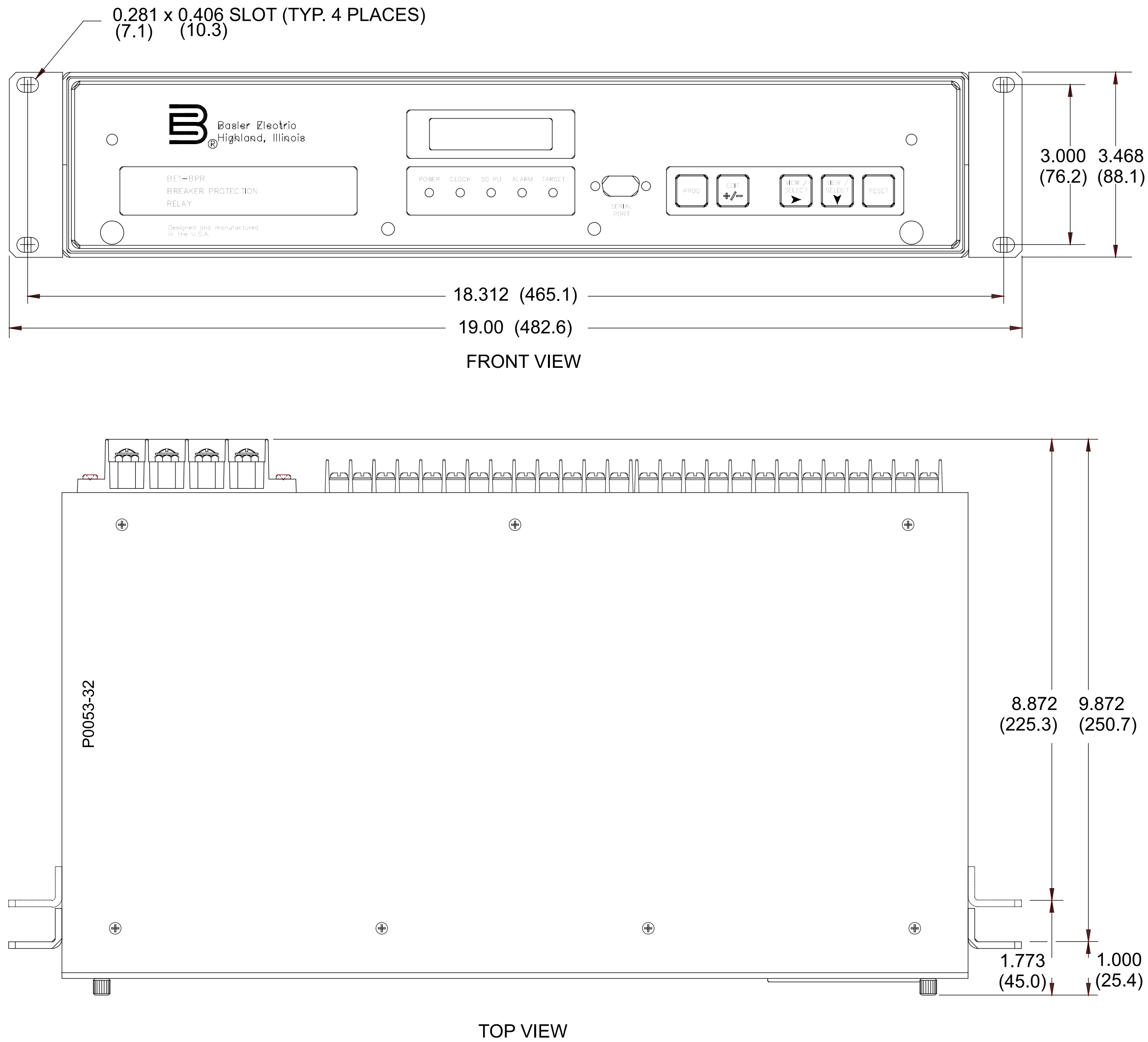


Figure 16. Overall Dimensions (Horizontal Rack Mount)

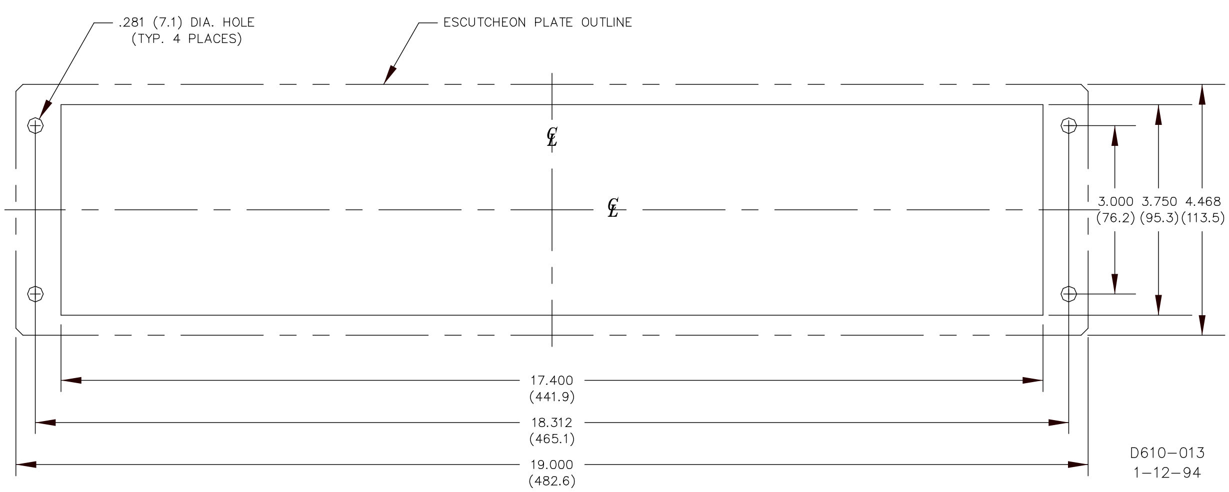


Figure 17. Cutout Dimensions (Panel Mount)

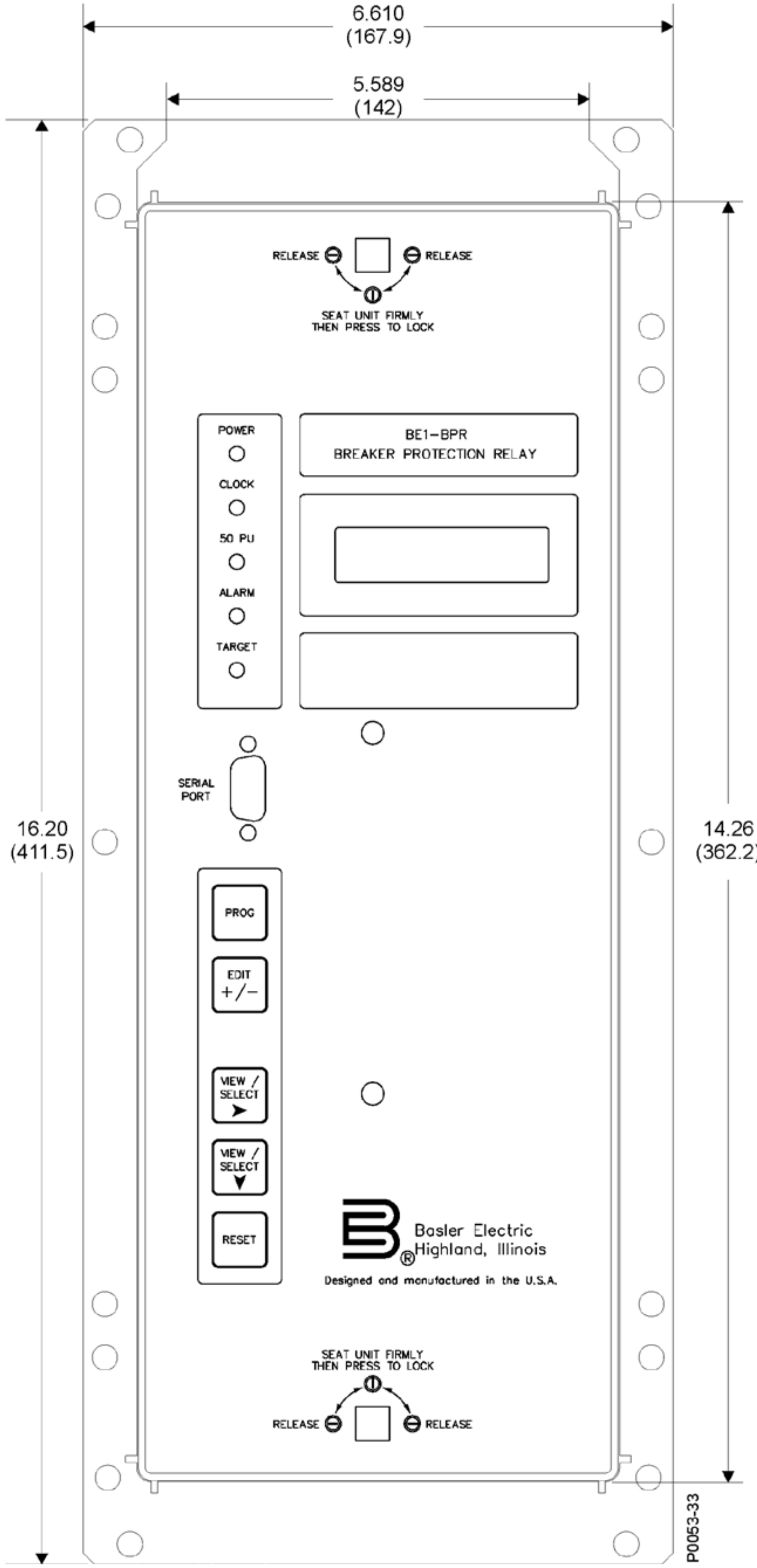


Figure 18. Overall Dimensions (Vertical Mount)

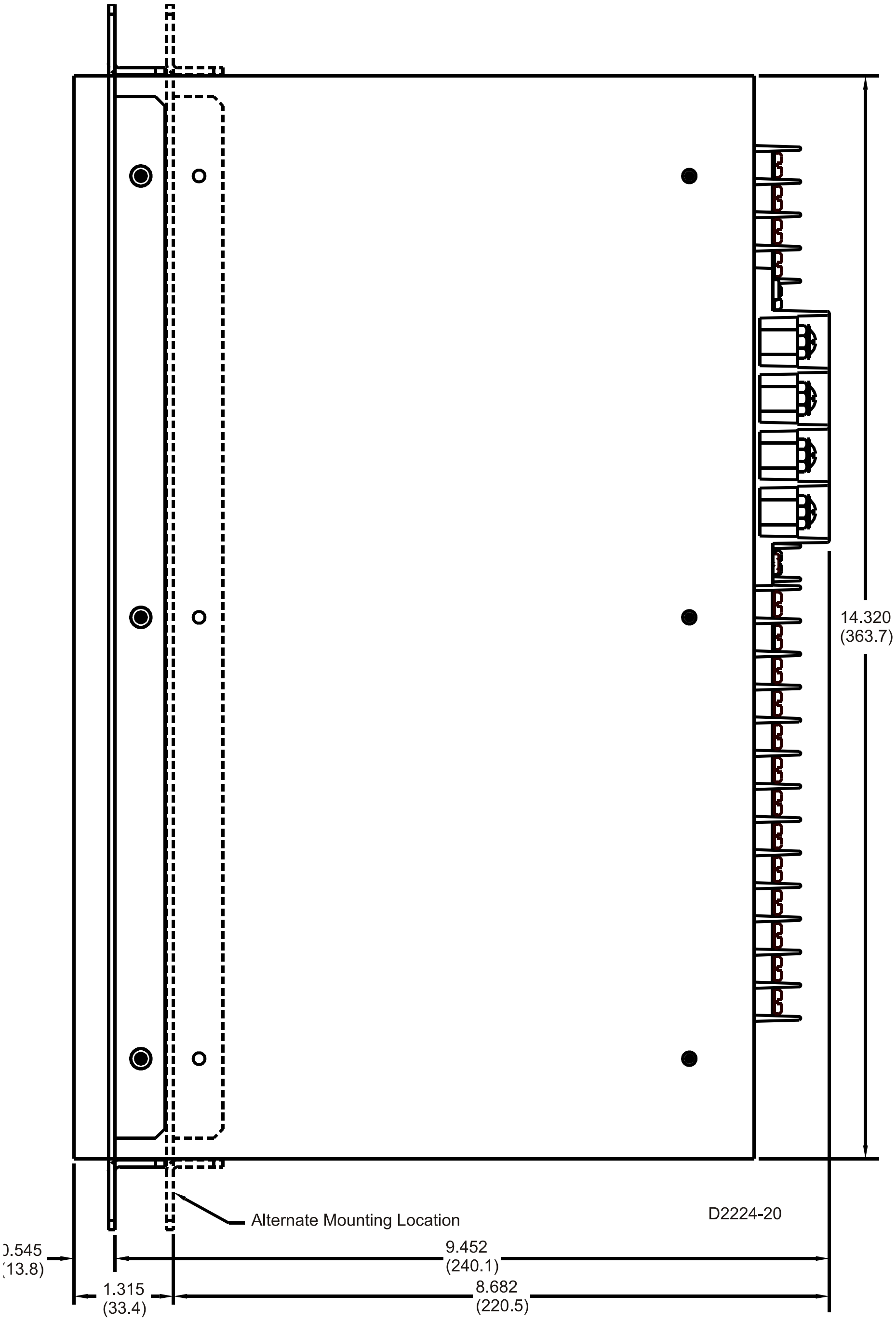


Figure 19. Overall Dimensions, Side View (Vertical Mount)

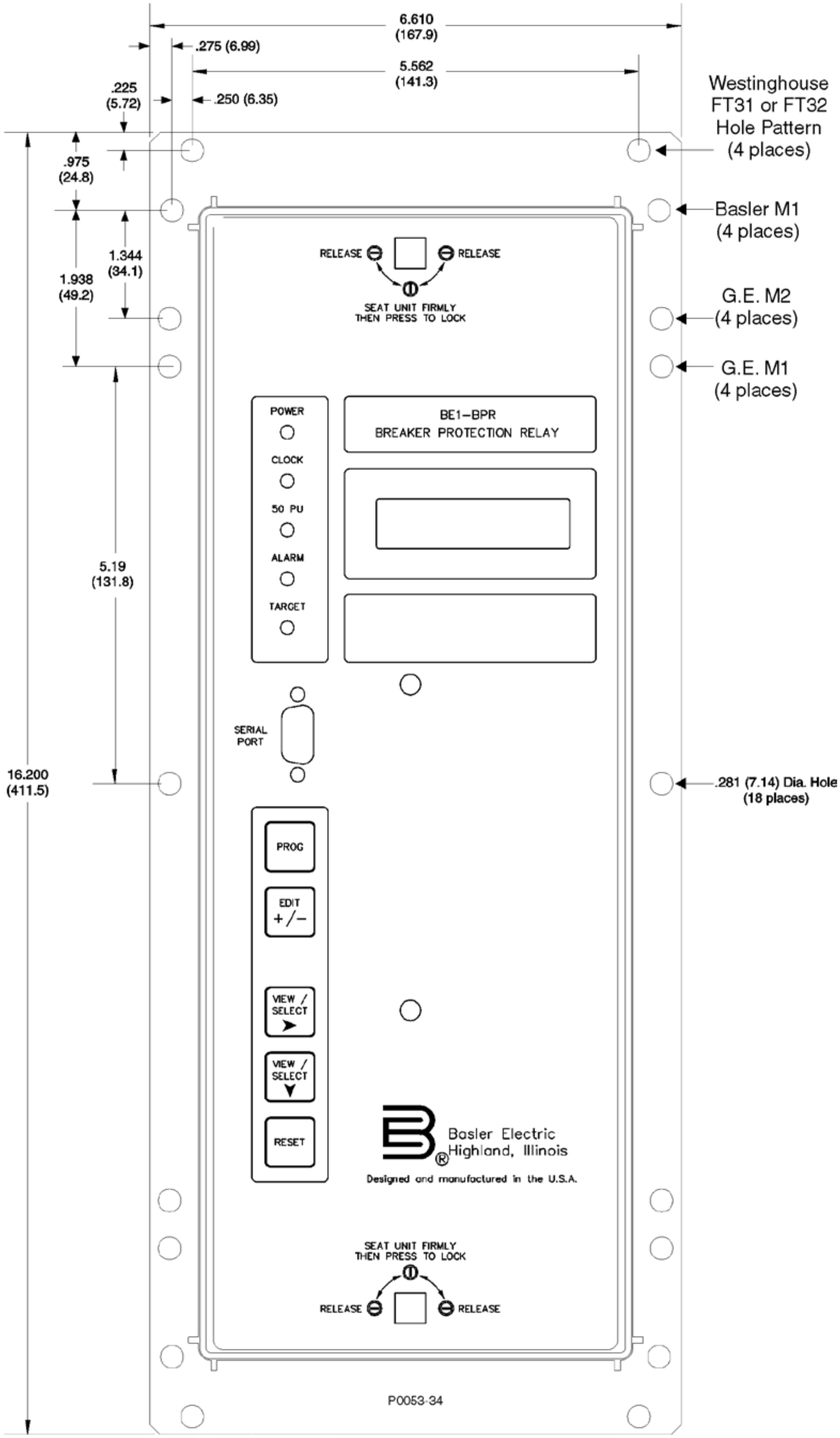


Figure 20. Panel Drilling Diagram (Vertical Mount)

Installing Escutcheon Plates

Horizontal Mount

To install the escutcheon plate kit (Basler part number, 9272013100) you must first remove the mounting flanges by removing the four screws from the relay (two from each side). To allow the escutcheon plate to slide onto the relay, remove the four screws from the relay (two from each side).

To install the escutcheon plate in the standard location, it is also necessary to remove four screws, two each from the relay top and bottom. Position the escutcheon plate at the standard location and reinstall the attaching hardware.

When installing the escutcheon plate at the alternate location (requires less space behind the mounting panel), position the escutcheon plate in the alternate location and install the four screws that are provided with the optional escutcheon plate kit. Reinstall four screws. Reinstall the four screws through the escutcheon plate into the relay at the alternate location.

Vertical Mount

Vertical mount relays come with a standard adjustable escutcheon/mounting plate. The escutcheon/mounting plate is pre-installed to the 9.452 inch depth. This can be easily adjusted to the alternate location by removing ten screws (two from the top, two from the bottom, and three from each side), sliding the plate to the alternate location, and fastening with the ten screws. Placement of the plate in the alternate location requires 8.682 inches of space behind the mounting panel.

Vertical mount relays are designed to fit into existing panel cutouts for the following case types. No drilling is necessary.

- Basler M1 cases
- GE M1 cases
- Westinghouse FT31 and FT32 cases

Connections

BE1-BPR relay connections are dependent on the application and protective scheme. Incorrect wiring may result in damage to the unit.

Note
Be sure that the BE1-BPR is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the BE1-BPR is configured in a system with other devices, connect a separate lead from the ground bus to each device.

Terminations

Terminal layout and assignments are shown in Figures 21 and 22. Figure 21 illustrates the terminals of a horizontal-mount unit and Figure 22 illustrates the terminals of a vertical-mount unit.

Typical Connections

Typical ac sensing connections are shown in Figure 23. Typical dc control connections are shown in Figure 24.

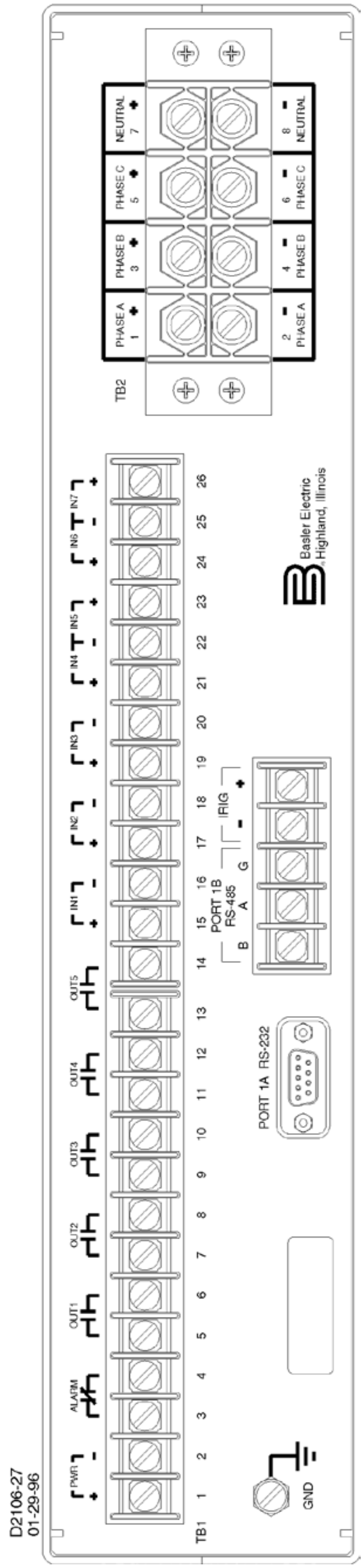


Figure 21. Terminals, Horizontal-Mount Unit

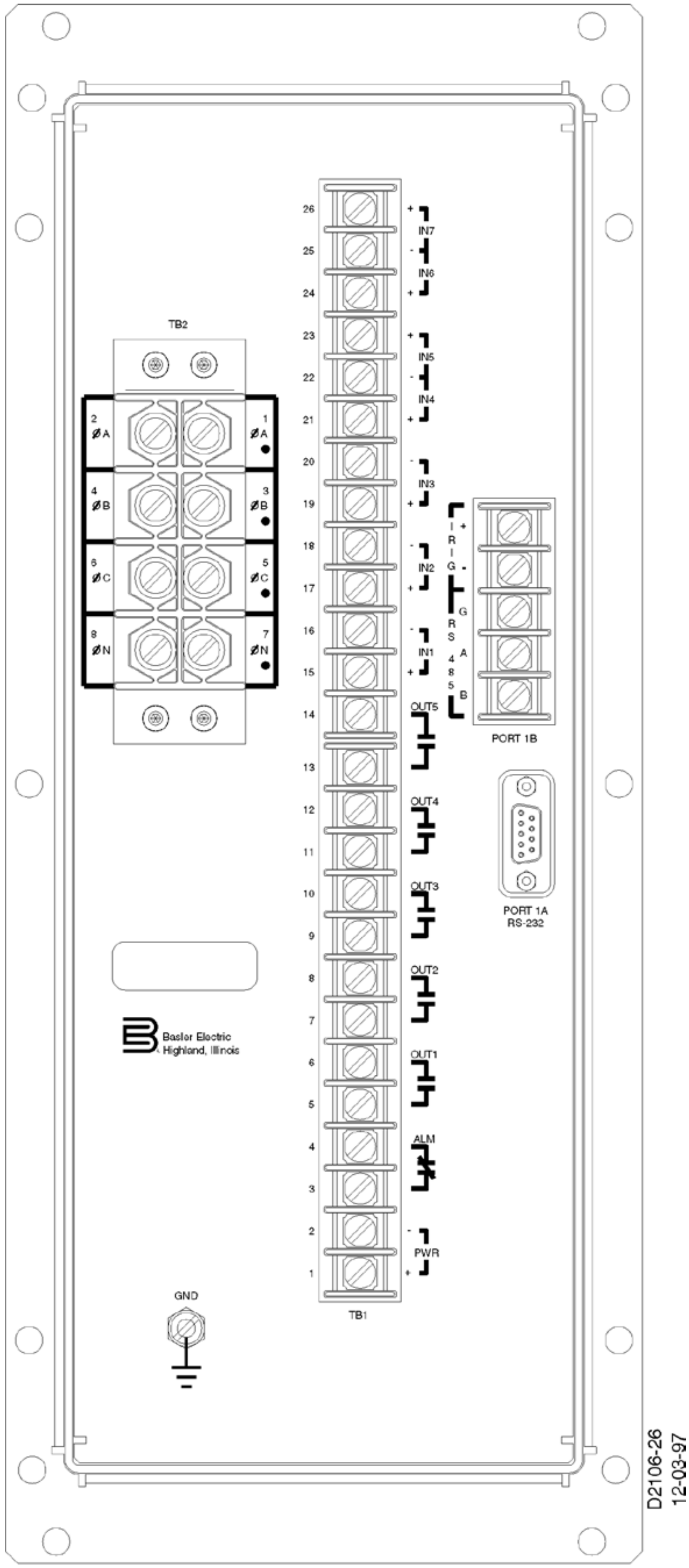


Figure 22. Terminals, Vertical-Mount Unit

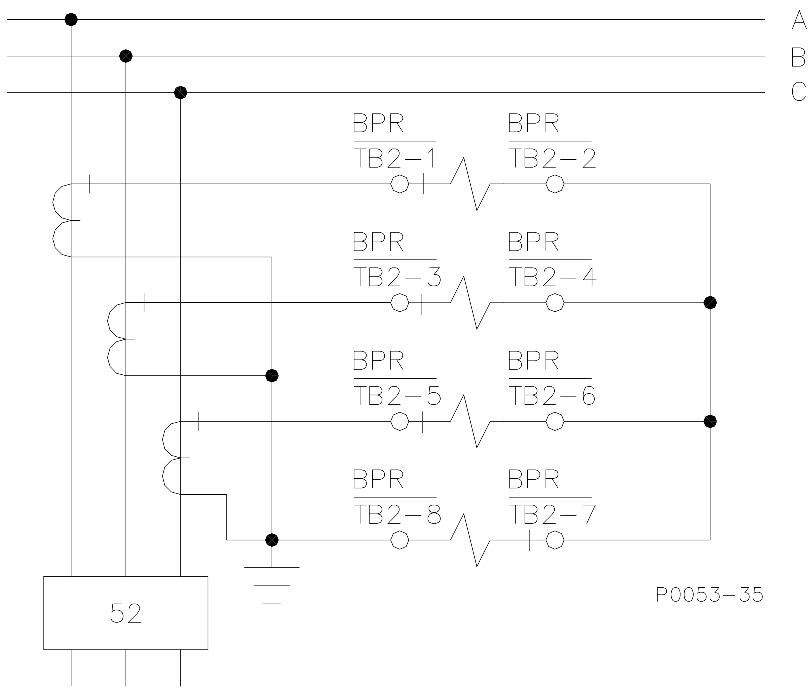


Figure 23. Typical AC Sensing Connections

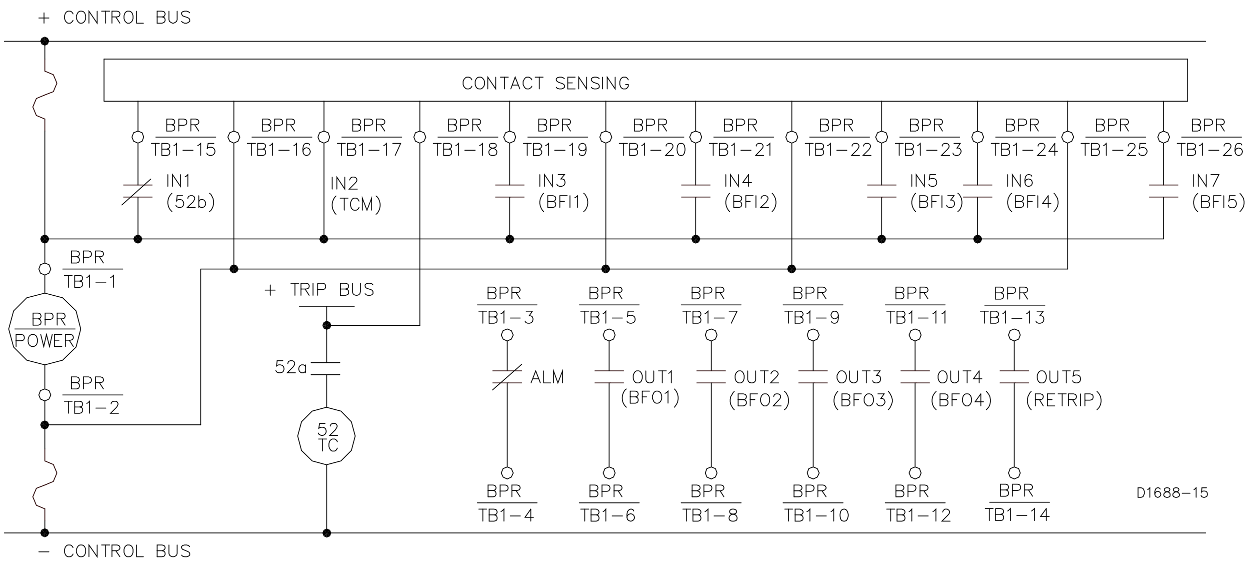


Figure 24. Typical DC Control Connections

Contact Sensing Inputs

Six contact sensing inputs provide external stimulus to initiate BE1-BPR actions. An external wetting voltage is required for the contact sensing inputs. The nominal voltage level of the external dc source must comply with the dc power supply input voltage ranges listed in the *Specifications* chapter. To enhance flexibility, the BE1-BPR uses wide range ac/dc power supplies that cover several common control voltages. The contact sensing circuits are designed to respond to voltages at the lower end of the control voltage range, while not overheating at the high end of the range.

The energizing level for the contact sensing inputs is jumper selectable for a minimum of 26 Vdc for 48 Vdc nominal sensing voltage, 69 Vdc for 125 Vdc nominal sensing voltage, or 138 Vdc for 250 Vdc nominal sensing voltage.

Each BE1-BPR is delivered with the contact sensing jumpers installed for operation in the lower end of the control voltage range. If the contact sensing inputs are to be operated at the upper end of the control voltage range, the jumpers must be changed or removed.

Table 7 lists the turn-on voltage range for each control voltage range and jumper position.

The contact sensing jumpers are used to select the lower or upper sensing range for each contact input circuit. These jumpers ensure that the input will be off below 55 percent of nominal battery voltage and on above 80 percent of nominal battery voltage.

Table 7. Contact Sensing Turn-On Voltage

Nominal Control Voltage	Turn-On Range	
	Pin 1 - Pin 2	Pin 2 - Pin 3
48/125 Vac/Vdc	26 to 38 V	69 to 100 V
125/250 Vac/Vdc	69 to 100 V	138 to 200 V

The following paragraphs describe how to locate and remove or change the contact sensing input jumpers.

1. Remove the drawout assembly by rotating the two captive, front panel screws counterclockwise and then sliding the assembly out of the case. Observe all electrostatic discharge (ESD) precautions when handling the drawout assembly.
2. Locate the seven jumper terminal blocks (JP200 through JP206) that are mounted on the Logic Circuit Board. The jumper terminal blocks are located on the component side of the circuit board near the left hand side (right-hand side when looking at the unit from the rear). Each terminal block has three pins and each jumper is installed at the factory on pins 1 and 2. Figure 25 illustrates the location of jumpers placed for operation in the lower end of the control voltage range.
3. To select operation at 125 Vdc, remove the jumper entirely from the unit or position it on pins 2 and 3.
4. When all jumpers are positioned for operation in the desired sensing voltage range, prepare to place the drawout assembly back into the case.
5. Align the drawout assembly with the case guides and slide the assembly into the case.
6. Rotate the two captive front-panel screws clockwise to secure the drawout assembly in the case.

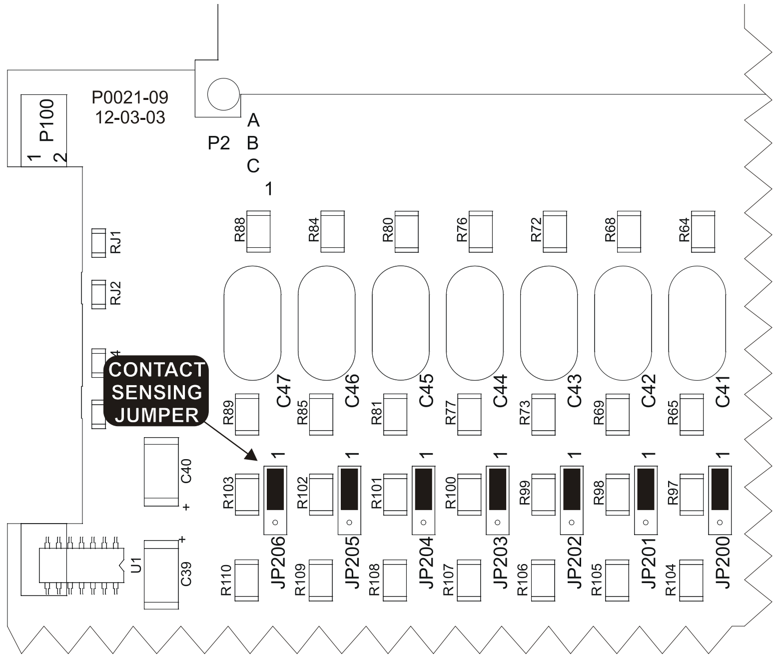


Figure 25. Contact Sensing Jumpers Location

Communication Connectors and Settings

Front/Rear RS-232 Connectors

Front and rear RS-232 connectors are DB-9 female connectors. Connector pin numbers, functions, names, and signal directions are shown in Table 8. RS-232 pin-outs are shown in Figure 26. Figures 27 through 30 provide RS-232 cable connection diagrams. Each connection diagram shows the gender of the device or relay connector that the cable mates with. Asterisks (*) in each diagram mark optional Clear to Send (CTS) and Request to Send (RTS) connections. These connections are required only if hardware handshaking is enabled.

Table 8. RS-232 Pinouts (Port0 and Port1A)

Pin	Function	Name	Direction
1	Shield	—	N/A
2	Transmit Data	TXD	From Relay
3	Receive Data	RXD	Into Relay
4	N/C	—	N/A
5	Signal Ground	GND	N/A
6	DCE Ready	DSR	From Relay
7	Clear to Send	CTS	Into Relay
8	Request to Send	RTS	From Relay
9	N/C	—	N/A

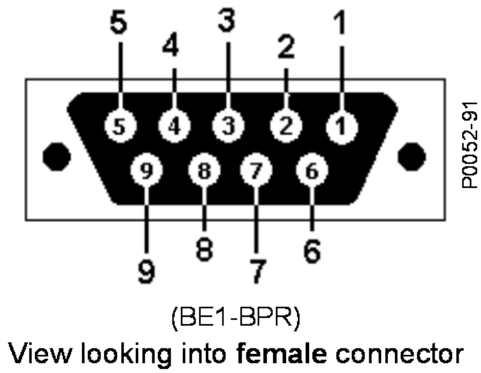


Figure 26. RS-232 Pin-Outs

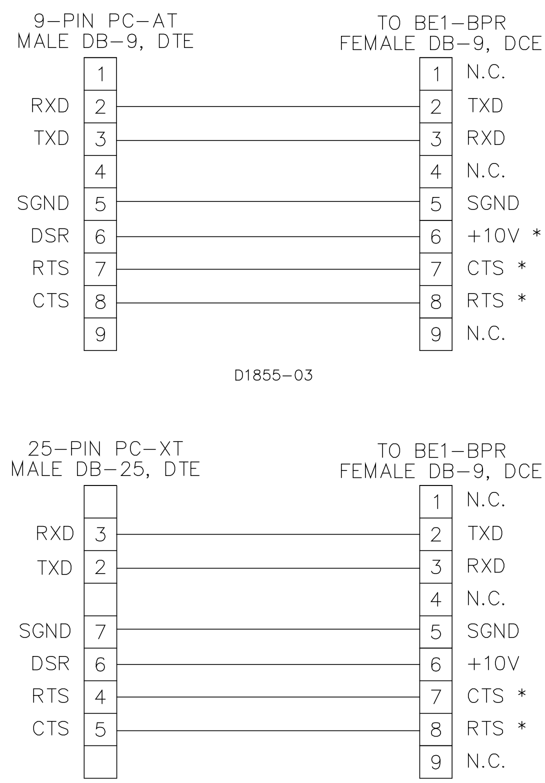


Figure 27. PC to BE1-BPR (Straight Cable)

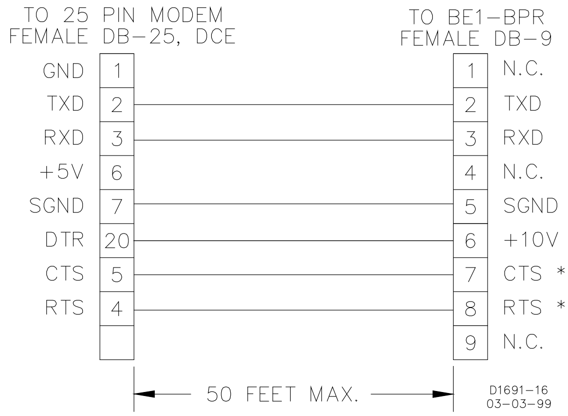


Figure 28. Modem to BE1-BPR (Null Modem Cable)

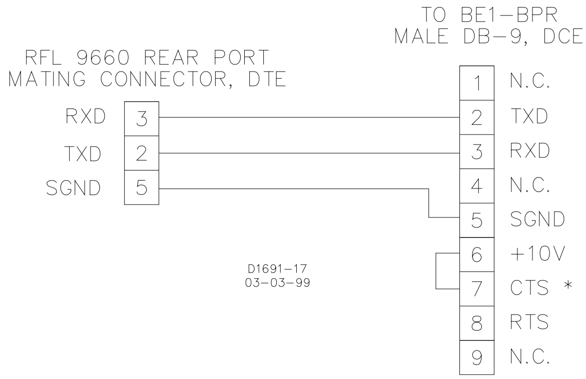


Figure 29. RFL 9660 Protective Relay Switch to BE1-BPR (Null Modem Cable)

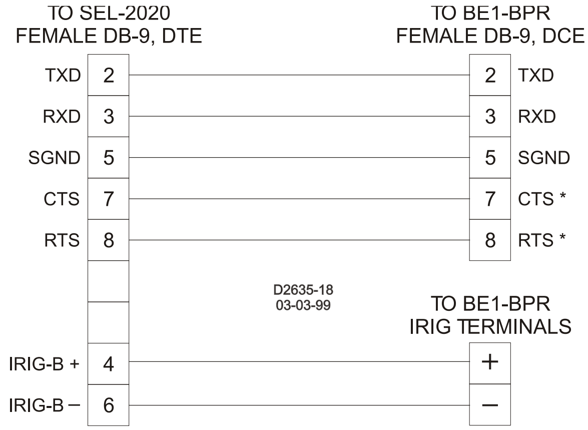


Figure 30. SEL-2020 Communications Processor to BE1-BPR (Straight Cable)

RS-485 Connections

The RS-485 connections are located on a terminal block shared with the IRIG-B terminals. The three RS-485 terminals will mate with a standard communication cable. A twisted-pair cable is recommended. Connector pin numbers, functions, names, and signal directions are shown in Table 9. A cable connection diagram is provided in Figure 31.

Table 9. RS-485 Pinouts (Port1B)

Terminal	Function	Name	Direction
A	Send/Receive A	(SDA/RDA)	In/Out
B	Send/Receive B	(SDB/RDB)	In/Out
G	Signal Ground	(GND)	N/A

Communication Settings

Communication settings are the formal set of conventions controlling the format and relative timing of message exchange between two communications terminals. Relay settings are stored as RATEDPS, where RATE = baud rate (300 to 19.2k), D = number data bits (7 or 8), P = parity (O, E, or N), and S = stop bits (1 or 2). The default protocol is 96008N1.

Setup

To initially prepare the relay for communications, go to the MAINTENANCE menu and set the proper settings for the front and rear port or use the COMx command through the communication port with the initial settings set for the proper mode as shown in the front panel maintenance menu.

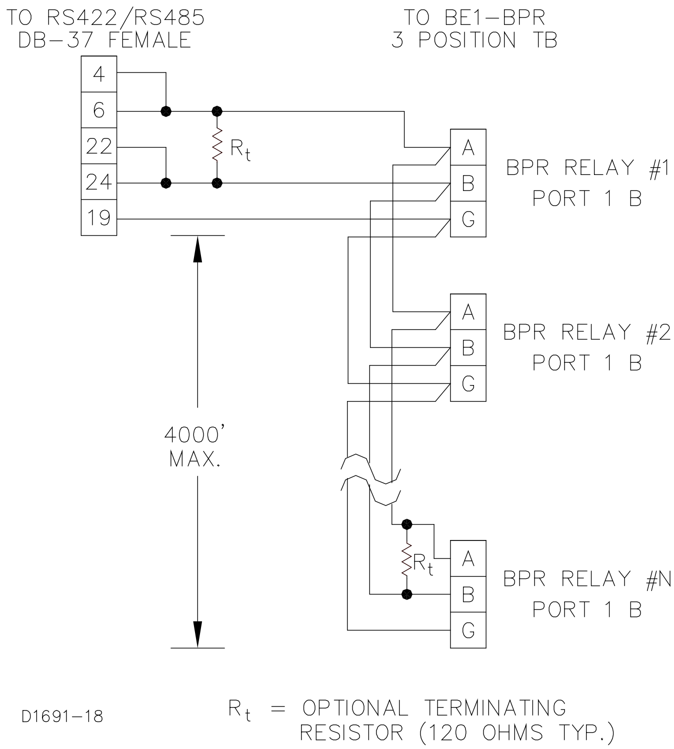


Figure 31. RS-422/RS-485 DB-37 to BE1-BPR Cable Connection

IRIG Input and Connections

The IRIG input is fully isolated and accepts a demodulated (dc level-shifted) signal. The input signal must be 4.5 volts or higher to be recognized as a high logic level. Maximum input signal level is 25 volts. Input burden is nonlinear and rated at 4 kΩ at 5 Vdc.

IRIG connections are located on a terminal clock shared with the RS-485 terminals. Terminal designations and functions are shown in Table 10.

Table 10. IRIG Pinouts

Terminal	Function
–	Reference
+	Signal

Maintenance

BE1-BPR relays are fully numeric and require no calibration at the circuit board level.

The design of the relay allows it to be fully drawn out of the case. The current transformer input circuits are automatically shorted by the case when the relay is removed. All critical components are contained in the draw-out assembly; suppression capacitors are the only electrical components located in the case assembly. When removing the draw-out assembly from the case, care should be taken to prevent electrostatic discharge and mechanical damage.

There is no need to disturb the circuit interconnections within the draw-out assembly. Repair of the draw-out assembly by replacement of individual circuit boards is not recommended. The printed circuit boards are constructed using surface-mount technology and are not designed to be field serviceable.

Should the relay require service, the draw-out assembly should be returned to the factory for repair. Contact the Power Systems Group of Basler Electric at 618/654-2341 for a return authorization number prior to shipping.

Depending on the criticality of the application, and the redundancy of the protection system, a draw-out assembly from a spare BE1-BPR relay can be inserted into the mounted and wired case assembly to restore protection. The relay requiring service can then be returned to the factory in the case from the spare relay. If a spare relay case is not available, care should be taken in packing the draw-out assembly for shipment. The packing material should be anti-static and prevent mechanical damage during transit.

Caution
Substitution of printed circuit boards or individual components does not guarantee that the relay will operate properly. Always test the relay before placing it in operation.

Storage

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

Application

BE1-BPR relays have seven inputs and five outputs plus an alarm output. There are three general purpose overcurrent fault detectors, six multipurpose timers, a three-shot recloser, and special outputs that are internally generated by the microprocessor. Using simple Boolean expressions, the user can logically connect the various functional blocks to create a custom, application specific, logic scheme to handle special protection requirements.

Standard model relays have the following special features:

- Three shot recloser.
- Pre-insertion breaker resistor operations counter with programmable reset and block reclose signal.
- Six configurable timing diagnostic logs each with an optional alarm setting. This feature can be used to monitor the various protection system parameters such as the margin between normal breaker operation and breaker fail.

Enhanced model relays have the standard model features plus these special features:

- Twelve entry fault log detailing the system and relay status at the time the fault trigger occurred
- Twelve entry COMTRADE fault record consisting of configuration (CFG) and data (DAT) files. The COMTRADE data contains 4 cycles of pre-fault and 16 cycles of post-fault data sampled at 12 samples per cycle. Each sample consists of the analog-to-digital converter values for each current channel as well as 32 digital channels (a digital channel is for the digital status of an input, output, or alarm).
- Integrated I^2t breaker contact duty monitor with alarm.

A minimum of three basic breaker failure schemes are pre-programmed into nonvolatile memory. These schemes take full advantage of the special features available in this relay without requiring the user to program. The user only selects the scheme desired and enters the pickup and timer settings.

Application Data

Contact Sensing Inputs

Each BE1-BPR relay provides seven opto-isolated contact sensing inputs. Three inputs (IN1-3) are each completely isolated. Inputs 4 and 5 (IN4, IN5) share one common terminal and inputs 6 and 7 (IN6, IN7) share another common terminal. Each input has programmable recognition and debounce (time allowed for the external contacts to stabilize) times. Typically the default setting of four milliseconds recognition and twelve millisecond debounce should be used unless extremely slow or irregular contacts are applied. The default setting assures that the signal be present on at least two consecutive scans of the input status before recognition can occur.

It is recommended that for protective functions, a positive true logic be used to enable protective outputs. This prevents a broken wire or loose connection from causing a protective trip. For example, a 52b input would be preferred for protection logic that is enabled when the breaker opens (i.e. block reclose or breaker arcing/flash over) and a 52a input would be preferred for protection logic that should be enabled when the breaker closes. On the other hand, for a diagnostic alarm, a negative true logic may be preferred since it will give an alarm if the checked diagnostic occurs and also give an alarm (depending on the logic) for a bad or broken connection.

Fault Detectors

BE1-BPR relays provide three independent fault detectors. Each fault detector can be programmed for phase or neutral input sensing. Also, each fault detector can be setup to operate as an instantaneous (50) or moving average filter (MAF) fault detector.

Instantaneous (50) Fault Detector Type 1

An instantaneous fault detector provides a typical one cycle pickup and one-quarter cycle dropout for high speed operation. A three cycle software delay is imposed on any Type 1 fault detector when the current level is less than 40 milliamperes above the pickup setting. This prevents noise induced trips from occurring. The Type 1 is used in breaker failure (BF) logic schemes and is programmed by setting the fault detector logic (LF) type to PI (phase overcurrent) or NI (neutral overcurrent) and the digital filter selection to 1.

For the fault detector to pickup, the rms value of the last cycle of current must be above the pickup setting. Due to the analog input circuitry design, the rms value is clamped (limited) at approximately 13 amperes. As the multiple of pickup level increases, the pickup time decreases. Because of the limiting above 13 amperes, the pickup time does not appreciably decrease at high multiples of pickup. Also, the pickup may be delayed up to one-quarter cycle because the rms current is calculated every quarter cycle. However, in no case will the pickup be slower than one and one-quarter cycles.

Figure 32 shows maximum pickup timing versus current input levels.

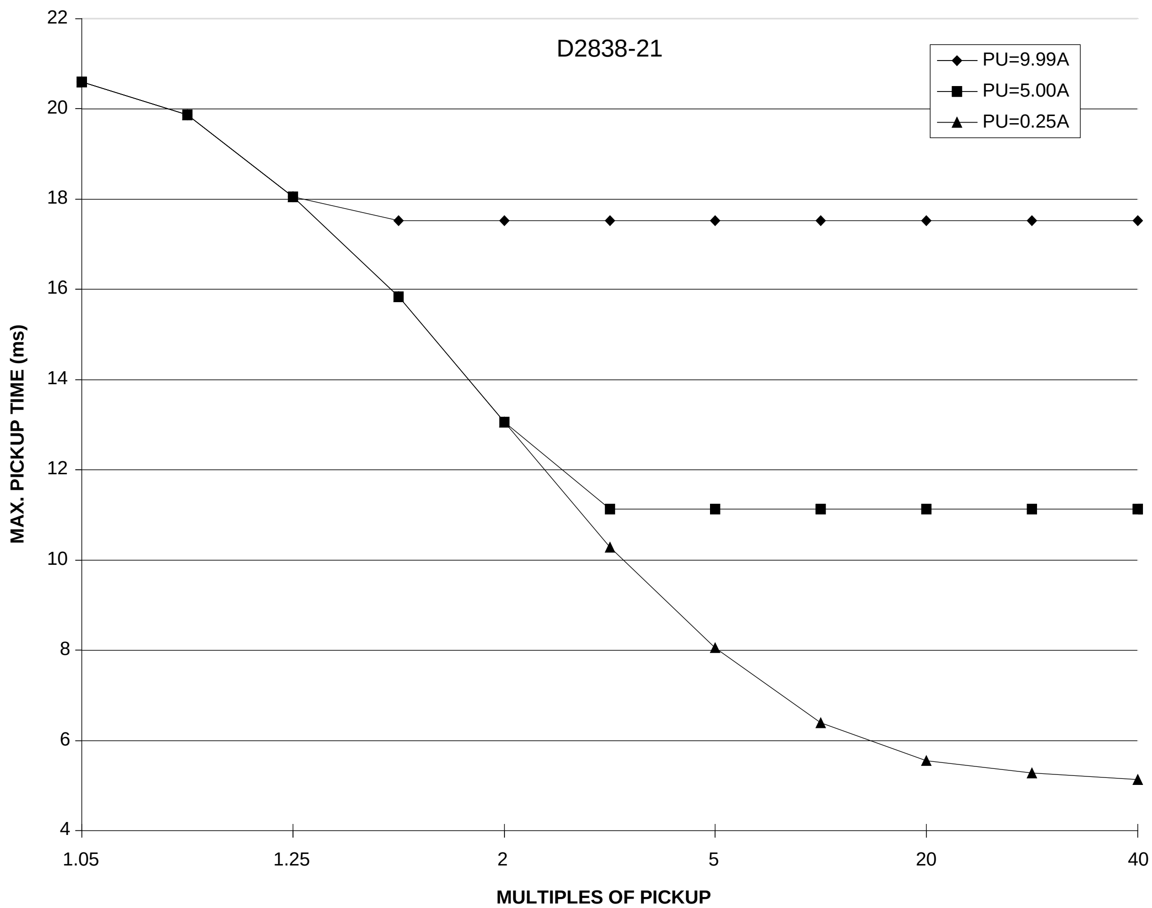


Figure 32. Maximum Instantaneous Pickup Timing

For the Type 1 fault detector to dropout, one of two conditions must occur. One, three sequential analog-to-digital (A/D) samples must be less than one-fourth of the rms current level for the last quarter-cycle calculation. Two, the rms current signal level must decrease to less than 75% of pickup. Samples are made twelve times per line cycle and rms current is calculated four times per line cycle. Three samples are used to compensate for zero crossings and noise. A short dropout delay is advantageous for BF logic in order to allow for the minimum timing margin in critical applications.

Figure 33 shows maximum dropout timing versus current input levels.

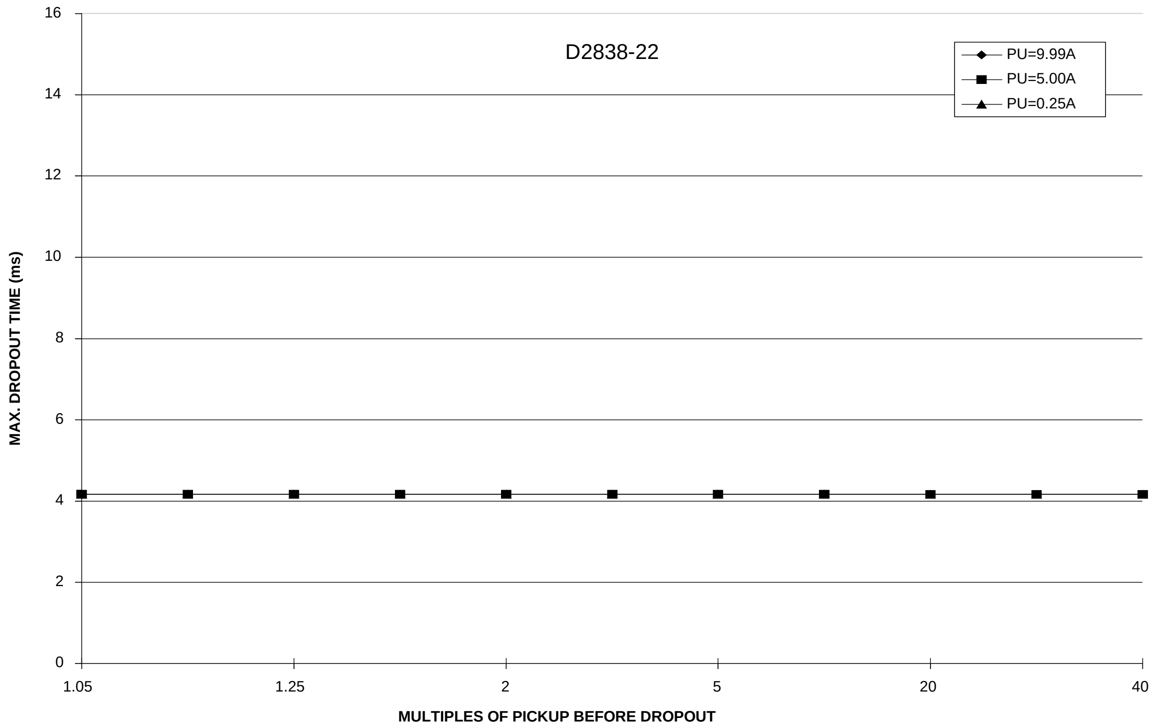


Figure 33. Maximum Instantaneous Dropout Timing

Moving Average Filter Fault Detector Type 2

A moving average filter (MAF) fault detector provides for a slower but more consistent pickup at low current levels. A MAF fault detector should be used in applications where the current to be detected is less than 0.25 ampere. Typically, the response time for pickup and dropout depends on the number of cycles averaged and how high the input current is above pickup.

Figure 34 shows maximum pickup timing versus current input levels for a 10 cycle MAF fault detector.

This MAF fault detector is programmed by setting the fault detector digital filter selection to 2 (DFLTR2). For the MAF fault detector to pick up (or dropout), the rms value of the average of the last 'n' cycles of current must be above (or below) the pickup setting. Typically, this filter is slow to pickup and slow to dropout but it is intended for use in low current applications where speed is not critical.

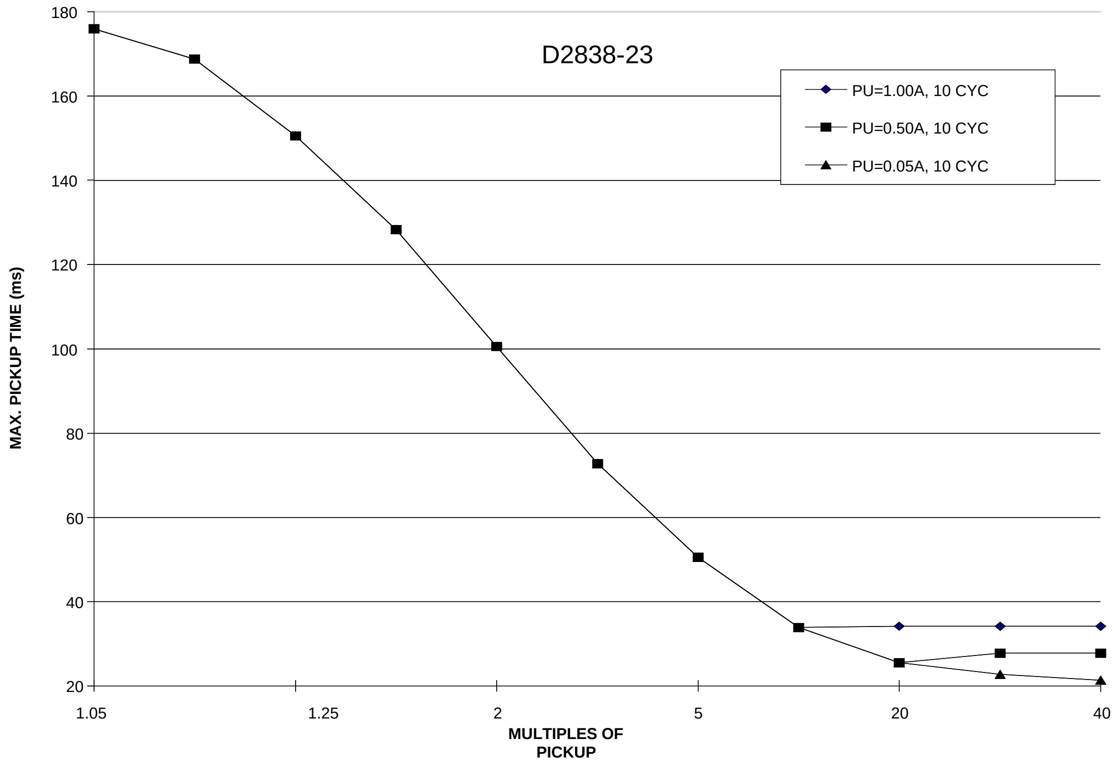


Figure 34. Maximum Pickup Timing with 10 Cycle MAF FD

Figure 35 shows maximum dropout timing versus current input levels for a 10 cycle MAF fault detector.

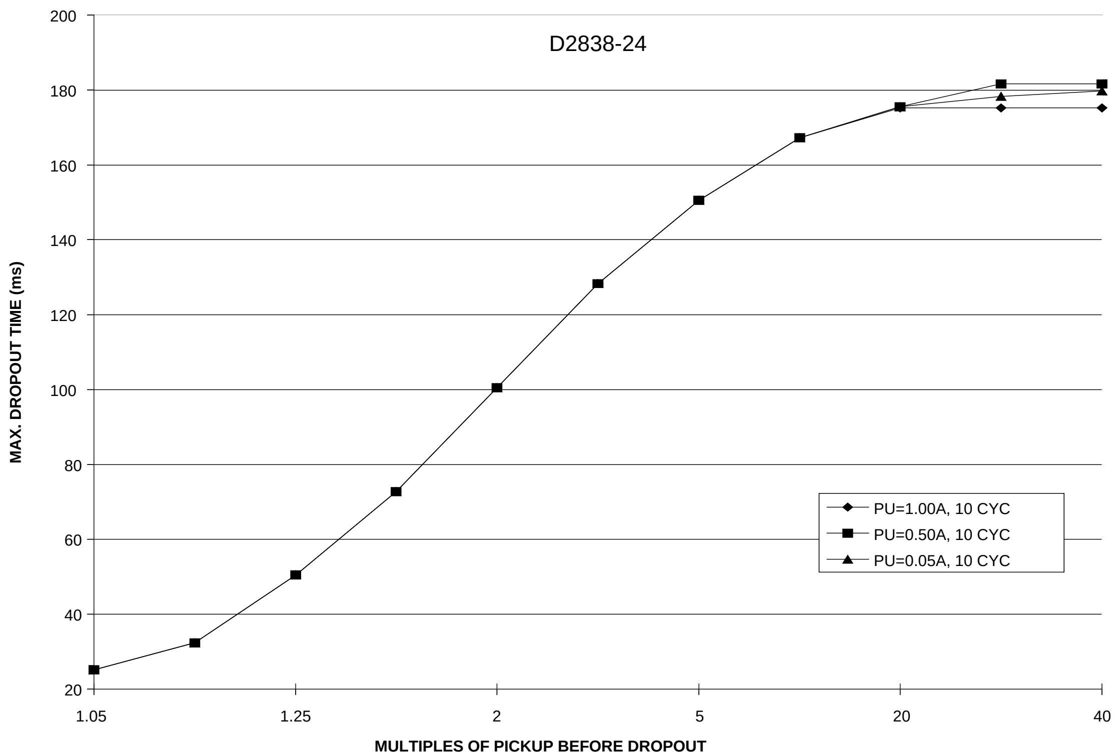


Figure 35. Maximum Dropout Timing with 10 Cycle MAF Fault Detector

Three-Phase Fault Instantaneous (50) Fault Detector Type 3

This fault detector has the same characteristics as the Type 1 instantaneous fault detector with the exception that all three phases must be picked up before the fault detector will pick up. This fault detector can be used in BF logic schemes and is programmed by setting the fault detector logic (LF) type to PI (phase overcurrent) and the digital filter selection to 3.

A 3-phase fault is the worst case fault for system stability and requires fast clearing times with small margins. A 3-phase fault detector and a separate timer could be used in addition to the 3-phase fault detector and timer to allow BF protection for both worst case faults and normal faults.

Application of Fault Detectors

Phase and Ground Instantaneous Fault Detectors

Normally, it is adequate to monitor the three phase currents as they represent the current in the poles of the protected breaker. However, if the sensitivity of the ground relays is significantly higher than the sensitivity of the phase relays, it may be desirable to apply a ground fault detector so that you can be assured that the breaker failure protection will pick up for any fault that is sensed by the initiating relays. Each fault detector can be independently set to monitor either the three phase current inputs or the neutral current input. Fault detector F1 is programmed as a phase instantaneous fault detector and fault detector F2 is programmed as a neutral instantaneous fault detector in all of the preprogrammed logic schemes.

Three-Phase Instantaneous Fault Detectors

For system stability, a three-phase fault is the worst case. The dynamic stability of the system is not affected as much by the other fault combinations. Since three-phase faults are generally rarer than the other fault combinations, it may be desirable to enhance security by treating three-phase faults differently. One of the fault detectors can be set up as a PI, 3 (phase current, Type 3) fault detector to supervise a timer set at the three phase fault, dynamic stability limit. The normal timer supervised by the other fault detectors would then be set with a longer time delay (with more margin) set at the two phase and ground fault (the next worst case), dynamic stability limit.

Low Level Current Detector

If the breaker fails while being opened for normal load switching or due to re-strike after the line has been isolated, the currents flowing across the failed interrupter may be too low to reliably detect by conventional means. The Type 2 fault detector's moving average filter allows the BE1-BPR to discern the low level line charging current from random noise. The application of this fault detector is described in detail in the *Breaker Arc Detector* sub-section. Fault detector F3 is programmed as a phase MAF fault detector in all pre-programmed logic schemes.

Multiple Breaker Arrangements

In ring bus and breaker and half bus applications, CTs from two breakers are often connected in parallel. If the BE1-BPR is connected to these CTs as shown in Figure 36, low fault detector pickup settings should be used with caution. In this arrangement, the CT feeding the BE1-BPR can be energized on the secondary side from the CT on the adjacent circuit breaker. This results in current flowing in the BE1-BPR even when the protected circuit breaker has successfully interrupted the fault. This secondary excitation current is generally negligible except when flux remnants or high current/burden causes the CT to saturate.

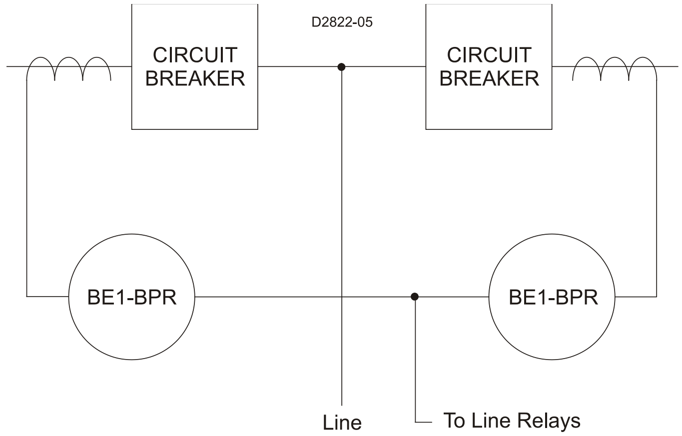


Figure 36. Multiple Breaker Arrangement

General Purpose Timers

Each BE1-BPR relay provides six independent timers for breaker failure timing and diagnostics. Each timer can be programmed as a delay or a control timer and can have independent Start and Reset conditions. Each timer can also provide a diagnostic log and/or alarm. These features are explained in the following paragraphs.

Delay Timer

A Delay timer has two inputs Start and Reset, and one output T[n]. The timer will not start until the start condition becomes true and the Reset input is false. Once the timer is started, a pre-programmed time delay, TD[n], is loaded and the timer starts timing out. Toggling of the Start input has no effect once the timer is started. The timer times out TD[n] time after the timer is started unless the timer is reset before the time expires. If the timer times out, then the T[n] output becomes true. After timeout, T[n] remains true until the timer is reset. Delay timer operation is illustrated in Figure 37.

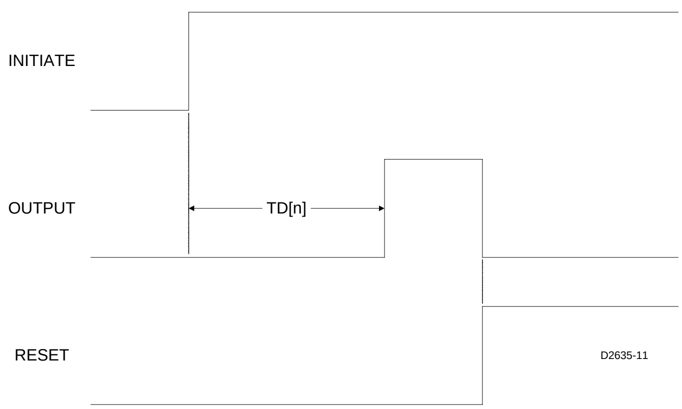


Figure 37. Delay Timer Operation

This type of timer is used to delay an operation in order to allow time for other processes to occur. For example, in breaker failure applications, a delay timer is user to delay the breaker failure output until the primary protection scheme has sufficient time to operate the breaker and open the circuit.

Control Timer

A Control timer has two inputs Start and Reset, and one output T[n]. The timer will not start until the start condition becomes true and the Reset input is false. Once the timer is started, a pre-programmed time delay, TD[n], is loaded and the timer starts timing out. The timer times out TD[n] time after the timer is started unless the timer is reset before the time expires. During the entire period the timer is ON (i.e. not timed out and not reset), the output T[n] is true. If the timer times out, then the T[n] output becomes false. After timeout, the T[n] remains false until the timer is reset and a new Start input is received. Control timer operation is illustrated in Figure 38.

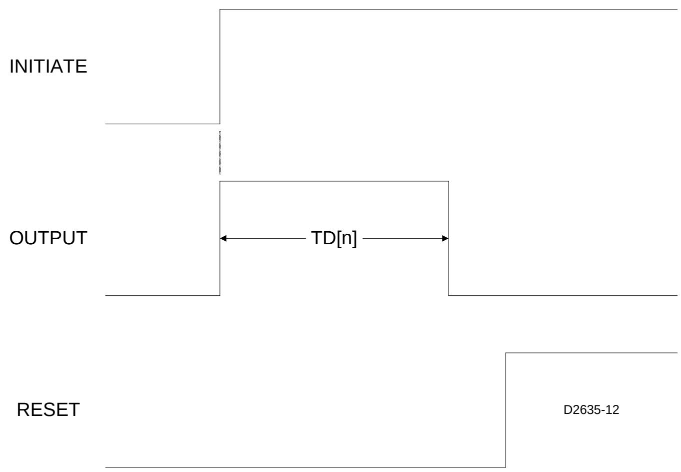


Figure 38. Control Timer Operation

This type of timer is used to provide a limited window of time for an operation to occur or to provide a feedback signal to latch-in an input for a predetermined time. For example, in breaker failure applications, a control timer can be used to latch-in a breaker failure initiate (BFI) input to ensure that once a BFI occurs a premature opening of the BFI for whatever reason does not disable the BF logic.

Another application is to prevent a BF operation due to stuck contacts on the BFI input. BFI input stuck contacts would cause a false trip any time the fault detector picks up. This problem can be minimized by using a control timer to limit the window of opportunity for which the input can cause a trip output.

Timer Diagnostics

In many applications it is desirable to have a record of the timing relationship between different events. In order to acquire this record, data must be available and accumulated over a period of time. A method to obtain and collect this data has been incorporated into the BE1-BPR relays. This method allows relative or absolute timing between any input, output or internal operation (i.e. timers, fault detectors) to be logged into a circular 40 event record. The data can be retrieved for analysis using the TLOG[n] command. In addition, because some timing requirements are critical to proper system operation, an optional alarm output can be automatically triggered if the time logged is outside a predetermined level. The logic used to save a timer value to the log and the optional alarm time is programmable using the PTLOG[n] command.

Refer to *Timing Diagnostics* in the *Introduction* chapter for detailed information on BF timing and an example of using the timing diagnostics to create a Margin log.

Reclosing Timers

Each BE1-BPR relay provides six independent reclosing timers. Three reclosing timers (TD791, TD792, and TD793) provide time delays for the multiple shots (one, two, and three). TD79R is the reset time delay, TD79F is the reclose fail time delay, and TD79M is the maximum cycle timer.

Reclosing timer delay settings are programmable from the front panel or the serial port using the TD79 command. The three reclosing time delays can be set at zero or from 10 to 999 milliseconds in 1 millisecond increments, 1 to 99 seconds in 0.1 second increments, or 100 to 600 seconds in 1 second increments. Each of the reclosing timers may be disabled by a setting of zero. When a reclosing timer set at zero is reached in the reclosing sequence, the reclosing sequence is interrupted and the relay will enter lockout.

Reset timer (TD79R) begins timing out when the Reset logic becomes true (breaker closes). The reset timer is reset when the breaker trips. If the reset timer times out while the breaker is closed, the recloser goes to Reset.

If enabled, the reclose fail timer (TD79F) starts whenever a reclose output is given and stops when the Reset logic indicates the breaker has closed. If the reclose fail timer times out before the Reset logic becomes true, the recloser sets the reclose fail diagnostic flag. The reclose fail diagnostic flag can be inhibited by setting the time delay to zero. The reclose fail function can be inhibited by setting the reclosing mode (Type) in the LR command to zero (0).

If the total reclosing time between reset states exceeds the maximum reclose cycle timer (TD79M) setting (excluding time while in the Wait state), the recloser goes to the lockout state. The maximum reclose cycle timer can be inhibited by setting the time delay to zero.

Output Contacts

Each BE1-BPR relay has five isolated normally open (NO) output contacts (OUT1-OUT5) plus one isolated normally closed (NC) alarm output (ALM). Output contact OUT1 is a high speed contact with a maximum operating time of ¼ cycle. By using the PTARGET command, output relays can be programmed to latch target data into memory.

Output contacts OUT1 through OUT5 are controlled by the status of the internal logic of signals O1 through O5. If O[n] becomes true, then the corresponding output relay is energized and closes the normally open contacts. If the PHOLD feature is enabled, the output contacts are held in an energized state for 200 to 250 milliseconds when O[n] becomes true. Each output contact then resumes following the internal logic. The PHOLD function ensures that the TRIP output doesn't interrupt the trip coil current but allows the trip coil current to be interrupted by the 52A contact. The *Functional Description* chapter provides more information about the PHOLD command.

All output contacts are factory set to NO. However, OUT1 - OUT4 may be changed to NC by changing a soldered jumper next to the output relays on the printed circuit board. NO contacts are typically used in trip circuits and using this type of contact allows the relay electronics to be drawn out without activating the trip logic. If a NC contact is desired, such as for a block reclose signal, then external shorting switches or a low cost auxiliary relay with NC contacts should be used to allow the electronics to be drawn out.

The Alarm output is a NC contact that is energized to provide a NO signal during normal operation. If the relay fails or an internal diagnostic signals that an alarm condition exists, the Alarm output de-energizes and closes the output contacts to signal an alarm condition. If the electronics are drawn out of the case, the Alarm output also opens.

Trip Circuit Monitor Logic

Logic for monitoring the trip circuit and alarming for loss of voltage (open fuse) or loss of continuity (open trip coil) is provided in the preprogrammed breaker fail schemes. Figure 39 shows input 2 (I2) being used as a trip circuit monitor (TCM) sensing element. It is placed in parallel with the retrip output of the relay. Figure 40 shows a diagram of the logic. If the breaker has multiple trip circuits, an additional input can be used for TCM sensing with trip circuit 2. For example, if the trip circuit 2 TCM input were input 3 (I3), the expression for virtual output 6 (O6) would be changed to /I1∗/I2+/I1∗/I3.

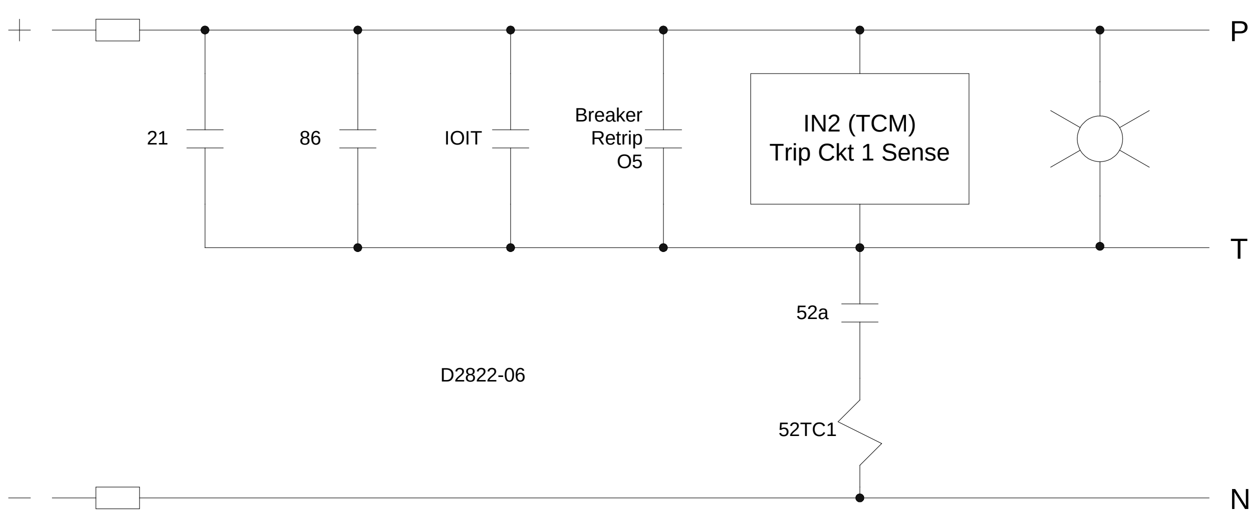


Figure 39. Trip Circuit Monitor Schematic Diagram

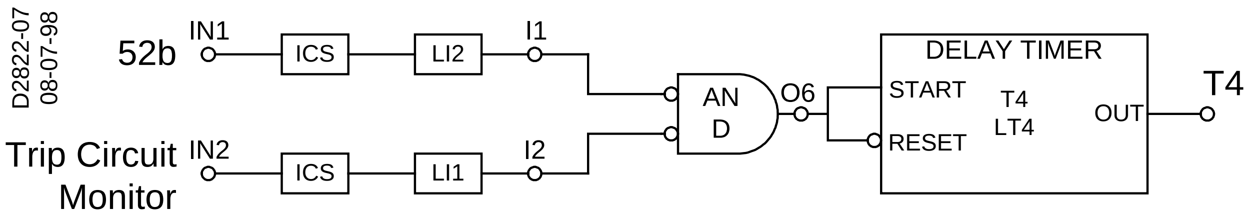


Figure 40. Trip Circuit Monitor Logic Diagram

When the breaker is closed, the trip bus T, is at negative potential through the low impedance path of the trip coil and the TCM senses logic 1. Figure 41 illustrates the timing of this logic. When a trip occurs, the trip bus is at positive potential, the voltage across the TCM is shorted, and it senses logic 0. When the breaker opens, the 52a contact is series with the trip coil opens, the protective relay drops out, the trip bus is at positive potential through the high impedance of the sensing element or the indicating light (if used), and the TCM continues to sense a logic 0. The breaker status input (IN1) in the logic diagram is used to block the function while the breaker, and therefore, the trip circuit are open. The timer is used to prevent an alarm output during the transition between the closed and open states.

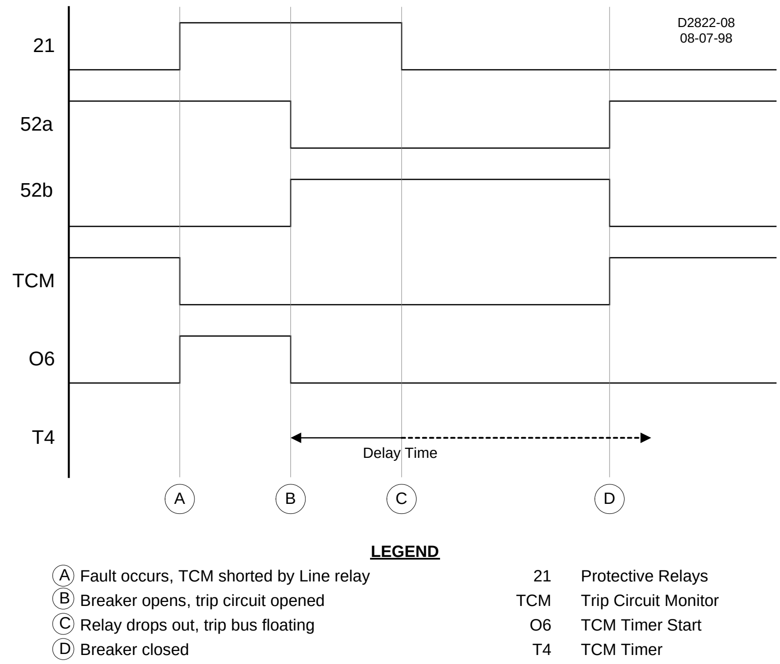


Figure 41. Trip Circuit Monitor Timing Diagram

Figure 42 illustrates a problem that can occur when using the trip circuit monitor feature. If the BFI sensing is connected directly to the breaker trip bus as shown in Figure 42a, the equivalent circuit shown in Figure 42b occurs. If the diode of the circuit is not included, a voltage divider circuit will be created between the BFI sensing and the TCM sensing when the 52a contact or the trip coil is open.

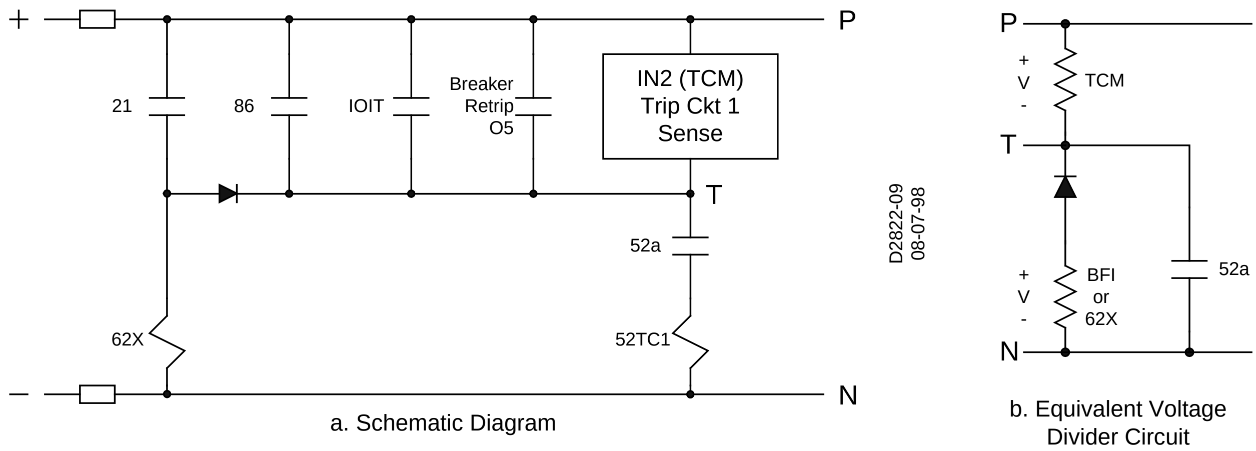


Figure 42. Trip Circuit Monitor with BFI Sensing

In Figure 42a, a 62x BFI auxiliary relay is shown. In this case, the impedance of the 62x coil will be small compared to the impedance of the TCM circuit so the TCM will always be at logic 1. This will prevent the TCM logic from working, even if the trip coil is open. In the case that the high impedance BFI sensing input of the BE1-BPR is connected directly to the trip bus, the TCM and the BFI impedances will be of similar magnitude causing the voltage to be divided nearly equally. This can result in spurious BFI signals to the breaker failure protection scheme when the breaker is open. Normally, when redundant systems are used, each relay system will be on its own circuit and the BFI sensing for each relay system will be isolated from the tripping circuit so this is not a problem.

Breaker Arc Detector

Once a breaker is open, an arc or flashover from a lightning strike may occur if the surge suppressors fail or air pressure is lost in an air blast circuit breaker. If this arc is not extinguished, the breaker can be damaged or destroyed. If the breaker was opened due to a fault on the line, then protective relays on the line will operate. If the line is not cleared, the relay logic will trip the backup breakers to clear the line and save the breaker.

If both ends of the line are open with no fault, then the breaker may just be carrying low level, line charging current. This current will not operate the protective relays because it is well below the normal loading levels. However, it is enough to destroy the breaker if not cleared. To provide protection for this situation, a very sensitive fault detector is needed that operates at line charging current levels and is only enabled when the breaker is open. When the fault is detected, the arc can be cleared by reclosing the breaker or operating backup protection for breaker failures. Reclosing will not affect safety of personnel if normal working practices are followed to disconnect any sections of the line being worked on (the line would be energized by the arc in any case). If the breaker reclosed into a faulted line, the normal protection devices would immediately re-open the line.

The BE1-BPR relay has a sensitive low level pickup for this application (MAF fault detector). Figure 43 shows the breaker arc detector circuits with the three-phase MAF fault detector (F3). It is easy to inhibit the relay based on the breaker status by programming the relay logic. As discussed previously in the fault detector application paragraphs, the MAF fault detector filter is slow to pick up and dropout. Therefore, the fault detector response must be delayed to allow time for normal load or fault current to clear the filter section. For example, if a 60 cycle MAF fault detector is used and set at 0.1 ampere (below line charging current levels), then the MAF fault detector remains picked-up for 1 second after the breaker opens because it takes that long for the filter buffer to clear. Therefore, the MAF fault detector output must be delayed for a time longer than the filter length to ensure that only a sustained current signal causes an output. This delay time could be 20 to 30 seconds longer.

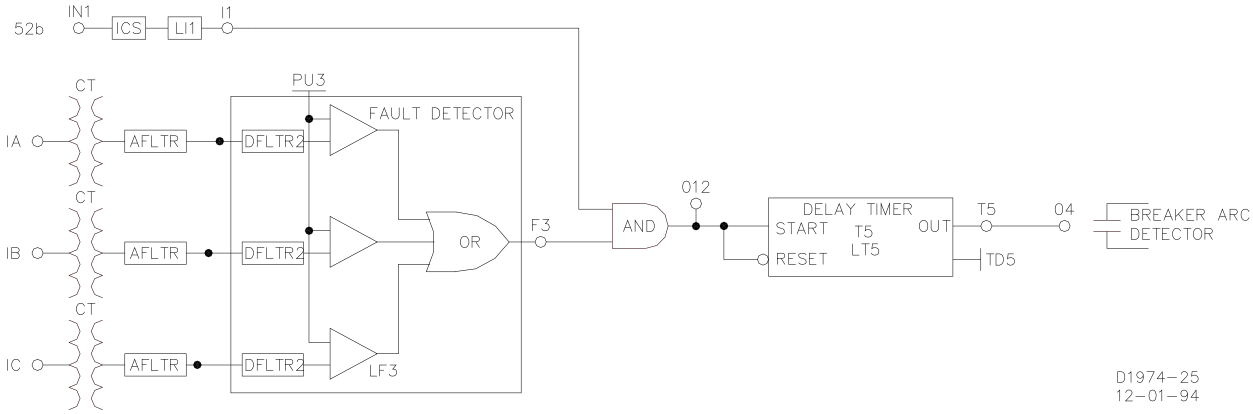


Figure 43. Breaker Arc Detector Circuits

The breaker arc detector logic employed in the preprogrammed schemes logically ANDs the MAF fault detector (F3) and the 52b input (I1) to start a delay timer (T5). Timer delay can be as long as 60 seconds. The timer delay should be set to 1.5 to 2.0 times the MAF window time. Both the fault detector and breaker status must stay unchanged for the entire length of the time delay or the timer is reset. If the timer does time out, the breaker arc output (O4) closes. This output could be used to reclose the breaker, extinguish the arc, prevent secondary circuit switcher failure, externally parallel the breaker failure operate (BFO), or to give an alarm.

Breaker Resistor Protection

Breaker resistor protection is a BE1-BPR relay feature that monitors the number of times a breaker opening resistor has been used and the amount of elapsed time between operations. If additional openings (operations) would exceed the resistor maximum power rating, the breaker resistor protection feature operates output 13 (O13), which can be used as a block reclose output. Breaker resistors are typically rated to handle X operations (i.e. - 5 operations) in T time (i.e. - 15 minutes cooling time for each operation). The resistor protection is a self-contained module (Figure 44) that counts and time tags each operation then decrements the count T time after it occurred. If the count reaches the limit, an internal output becomes true. In the enhanced logic schemes, the programmable logic output (O13) drives the block reclose output. (If a reclosing function is enabled, programmable logic output (O13) is driven by the reclose output, and the block reclose signal is internally ORed with the defined reclose Wait logic input.) This output is intended to block reclosing until the count has dropped below the limit. This action allows the resistors to cool sufficiently and protects the opening resistors.

Refer to *Output Contacts* in this chapter for additional information if your requirements call for a NC contact for this purpose. Also see the *Functional Description* chapter for a detailed functional description on how to program the resistor protection function module.

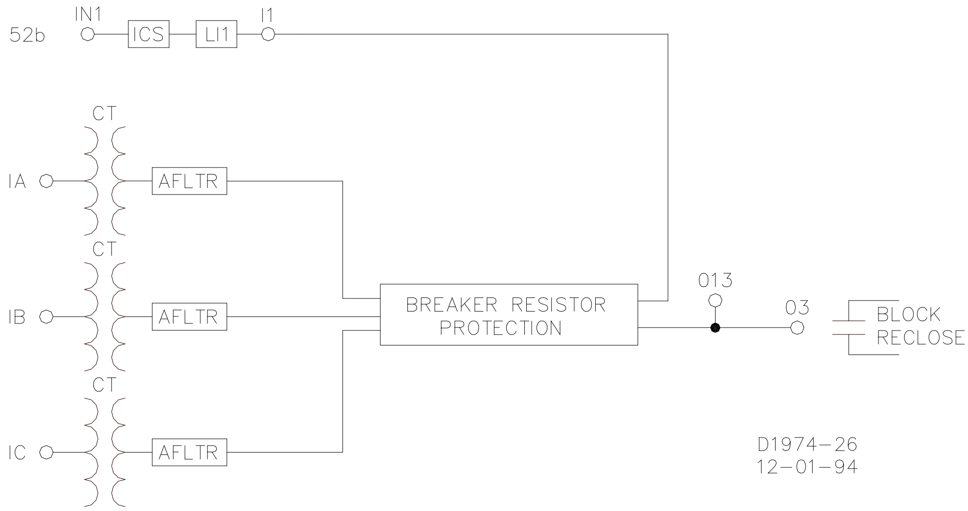


Figure 44. Breaker Resistor Protection Circuits

Breaker Failure Protection with Pre-Insertion Resistors

Breakers that will be exposed to fault currents above the maximum rated interrupting capacity are normally equipped with pre-insertion resistors. Pre-insertion resistors are mechanically placed in series with the breaker interrupting contacts when the breaker opens. This reduces the current magnitude until the fault is cleared a cycle or more later.

Typically, the BE1-BPR fault detector is set to pickup below the minimum pre-insertion resistor current level to insure that the breaker has opened and the fault cleared. Sometimes, system stability requires faster clearing times and closer margins on breaker failure timing. The BE1-BPR can be configured to provide a faster BF clearing time for an initial higher fault current level, and slower BF clearing time for lower level fault currents that are limited by the pre-insertion resistors.

This adaptive breaker failure logic can be configured by making use of the additional fault detectors and timers available in the BE1-BPR. One BF delay timer would be set to the maximum time allowed for the higher fault current level to be cleared and maintain system stability. The output would be ANDed with a fault detector set to detect this higher fault current level. This fault detector will drop out when the current is reduced because the pre-insertion resistor is inserted. Another BF delay timer would be set for a longer time based on the maximum time allowed for the lower current level fault to be cleared. This timer output would be ANDed with a different fault detector set to pick up on pre-insertion resistor current levels. The output of both AND gates would be ORed so that either one would drive the BF output.

This logic provides improved security and protection for breaker failure by providing two timing margins and two different fault current levels. See BFRES logic in *BE1-BPR Custom Application Schemes,* in the *BESTlogic* chapter, for a specific application example.

Note that the preprogrammed breaker failure logic schemes in the BE1-BPR relay do not provide breaker failure protection for the single-pole tripping of breakers with pre-insertion resistors. This is because the fault detector level would have to be set at a level that is less than the normal load current. Therefore, the phase fault detector would stay picked up because of the load current on the non-faulted phases.

Breaker Contact Duty Log

Breaker contact duty log is a diagnostic feature to monitor the number of times a breaker has operated and accumulate the total contact duty or wear based on the current interrupted. The log is contained in the form of a ΣI^2t for each pole of the breaker. The total is reported as a percent of maximum for simplicity. If the total exceeds the maximum programmed for any breaker pole, an internal diagnostic flag, Figure 45 becomes true. In the preprogrammed logic schemes, the programmable diagnostic output (O14 or O15) can be enabled using the PDIAG command to turn on the Alarm output to signal the operator that maintenance is needed.

See the *Functional Description* chapter for a detailed functional description on how to program the duty log diagnostic feature.

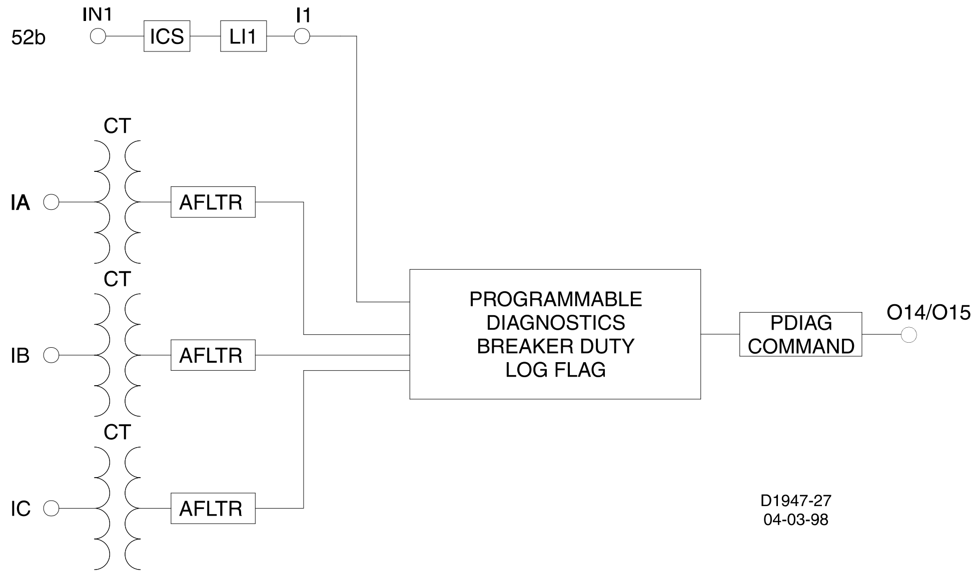


Figure 45. Breaker Contact Duty Log Circuits

Reclosing Functions

A Reclosing Function is available in the BE1-BPR relay that can operate in parallel with the breaker failure logic. All inputs are programmable using the BESTlogic LR command. When reclosing is enabled, output 13 (O13) is designated at the reclose (close) output and can be connected to any physical output by using the LO command. Three reclosing shots are available.

Separate time delays are programmable through the front panel or serial port by using the TD79 command. Time delay settings are available for each shot (TD791, TD792, and TD793), for the reset timer (TD79R), reclose fail timer (TD79F) and a maximum reclose cycle timer (TD79M). Lockout and reclose fail diagnostic flags are set/reset by the programmable diagnostics. Use the PDIAG command to program separate outputs for lockout and reclose fail. The reclosing state (Reset, Wait, Timing, or Lockout) can be viewed from the front panel recloser status screen in the relay status menu or by using the STATUS command.

There are four reclose function inputs, three available outputs, and one mode programmable feature (Type). The inputs and outputs are shown in Figure 46.

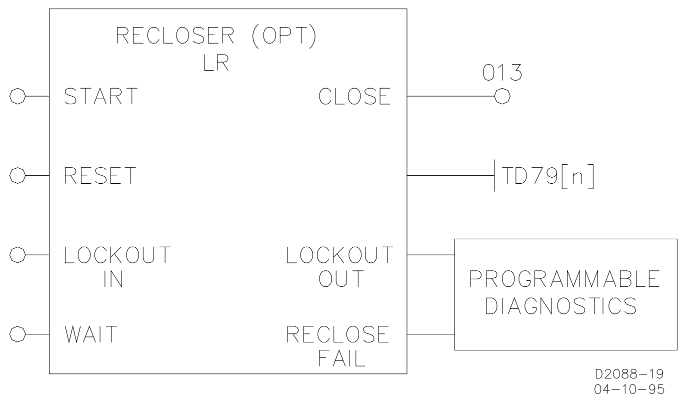


Figure 46. Reclosing Logic Circuit

Preprogrammed Logic Description

BE1-BPR relays are factory programmed with protection schemes that provide breaker failure protection for most systems. These preprogrammed breaker failure logic schemes are described in the following paragraphs. The programmable logic equations are not provided in this description. See the *BESTlogic* chapter for information on the description and use of the programmable logic as well as application hints for programming custom logic.

Breaker Failure Logic 1 for Standard Relays (BFL1)

BFL1 logic (shown in Figure 47) provides the following application features.

1. Three-Pole Tripping BF Logic (No input or output latch-in provided). Three BFI inputs are available at IN3, IN4, and IN5 to start delay timer T1. If the BFI inputs are not reset by the time timer 1 times out and either the phase (F1) or neutral (F2) fault detector is picked up, then BFO1 and BFO3 will close (OUT1 and OUT3), tripping the backup breakers. Refer to the breaker failure timing diagram in Section 1 for information on setting the delay timer.
2. No Current BF Logic (No input or output latch-in provided). Some faults may not provide current to the CTs (i.e. internal transformer failures). In that case two additional BFI inputs are available (IN6 and IN7) to start delay timer T2. These inputs are not supervised by a fault detector. If the BFI input is not reset by the time the timer times out, BFO2 (OUT2) will close tripping the backup breakers. Refer to the breaker failure timing diagram in Section 1 for information on setting the delay timer.
3. Trip Coil Status Monitor. Preprogrammed logic is provided using IN1 to provide breaker status and IN2 for trip coil continuity. Refer to *Application Data* in this chapter for further details on the circuit operation.
4. Breaker Arc Protection. Preprogrammed logic is provided using fault detector 3 (F3) for the MAF fault detector, IN1 for breaker status, and OUT4 for the arc detector output. Refer to *Application Data* in this chapter for further details on the circuit operation.
5. Retrip Output. A Retrip output is provided to give a backup trip signal to the breaker trip coil. This can either provide a separate path to a single trip coil or be hooked to the backup trip coil if available.
6. Alarm Output. An Alarm output is provided to signal relay failure or diagnostic alarm.

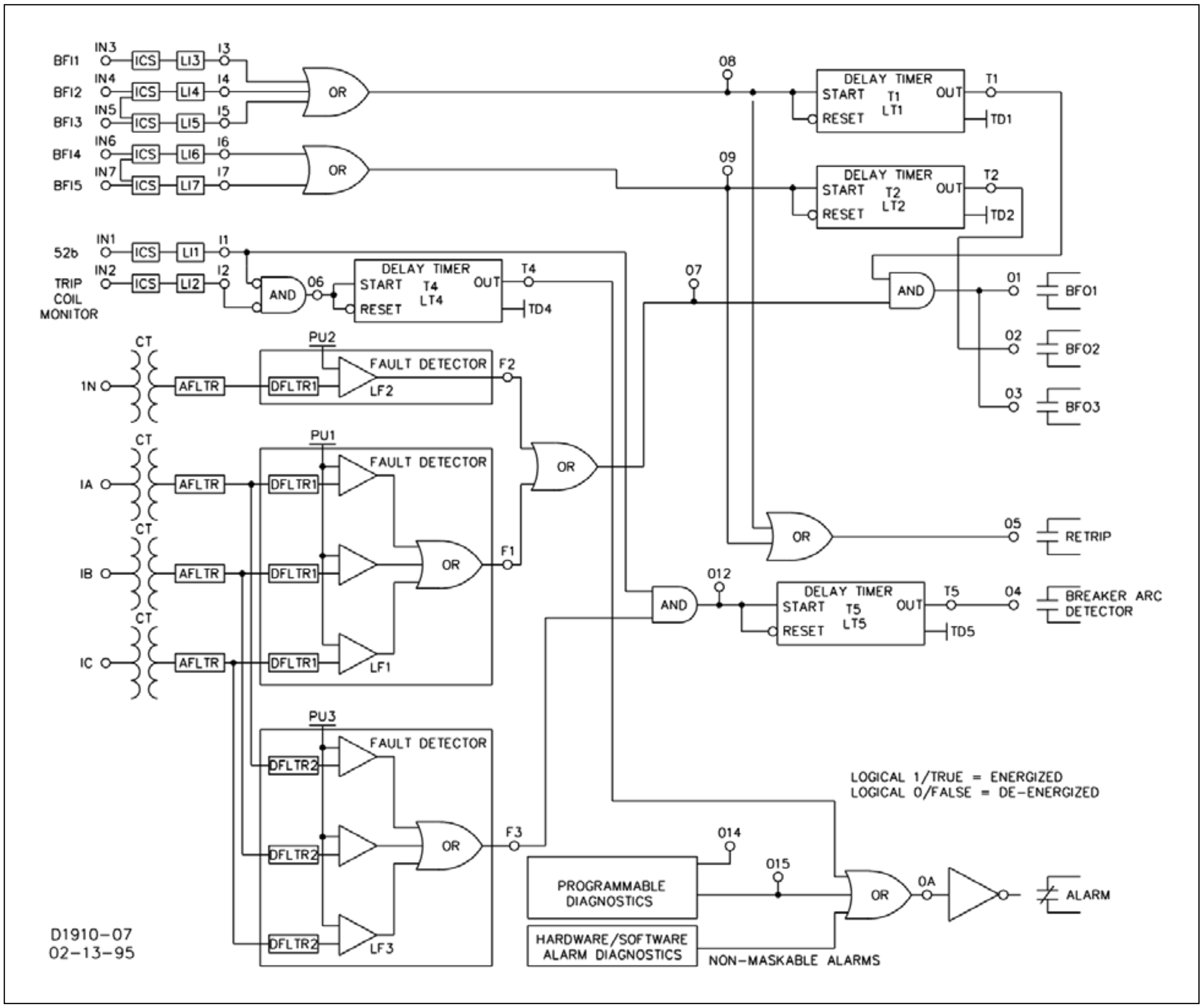


Figure 47. BFL1 Logic

Breaker Failure Logic 2 for Standard Relays (BFL2)

BFL2 logic (shown in Figure 48) provides the following application features.

1. Three-Pole Tripping BF Logic (Features: Output latch-in provided and Control timer limits operational window). Three BFI inputs are available at IN3, IN4, and IN5 to start delay timer T1. If the BFI inputs are not reset by the time timer 1 times out and either the phase (F1) or neutral (F2) fault detector is picked up, BFO1-3 will close (OUT1-3), tripping the backup breakers. A control timer (T3) is used to limit the breaker failure window of opportunity. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.
2. Single-Pole Tripping BF Logic (Features: Output latch-in provided and Control timer limits operational window). If single-pole tripping is used, two additional BFI inputs are available (IN6 and IN7) to start delay timer T2. These inputs are only supervised by the phase fault detector (F1). If the BFI (IN6 and IN7) inputs are not reset by the time the timer T2 times out and the phase fault detector (F1) is still picked up, the BFO outputs (OUT1-3) will close, tripping the backup breakers. Control timer, T3 is used to limit the breaker failure window of opportunity. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.
3. Neutral fault detector F2 is not used to supervise the single-pole BF logic because F2 is still picked up by the phase imbalance after the fault clears. Three-phase BF logic is inhibited during

this period because there is no 3-phase BFI input active. For single-pole tripping, the phase pickup (PU1) must be set above maximum load levels.

4. Trip Coil Status Monitor. Preprogrammed logic is provided using IN1 to provide breaker status and IN2 for trip coil continuity. Refer to *Application Data* in this chapter information for further details on the circuit operation.

5. Breaker Arc Protection. Preprogrammed logic is provided using fault detector 3 (F3) for the MAF fault detector, IN1 for breaker status, and OUT4 for the arc detector output. Refer to *Application Data* in this chapter for further details on the circuit operation.

6. Retrip Output. A Retrip output is provided to give a backup trip signal to the breaker trip coil. This can either provide a separate path to a single trip coil or be hooked to the backup trip coil if available.

7. Alarm Output. An Alarm output is provided to signal relay failure or diagnostic alarm.

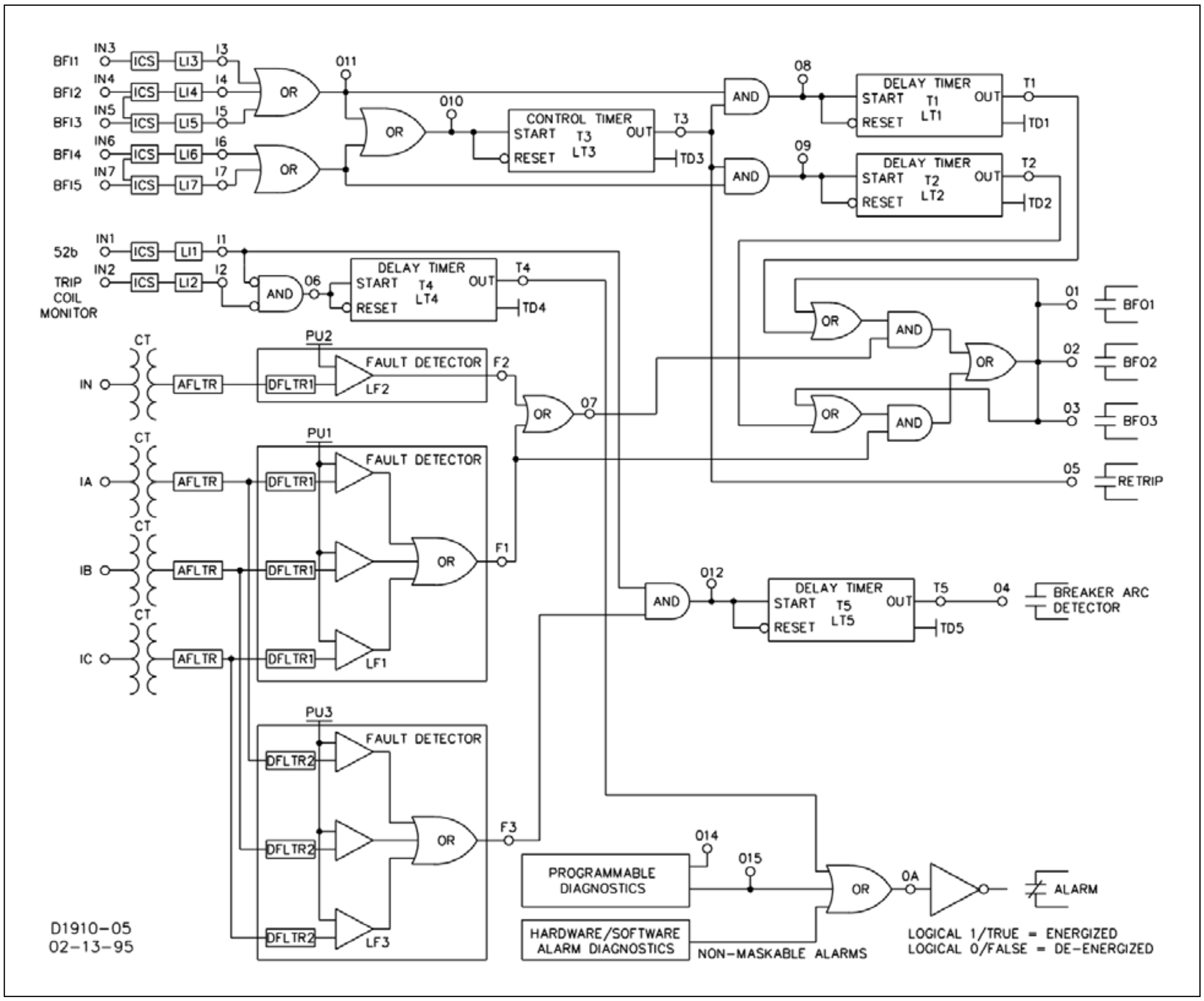


Figure 48. BFL2 Logic

Breaker Failure Logic 3 for Standard Relays (BFL3)

BFL3 logic (shown in Figure 49) provides the following application features.

1. Three-Pole Tripping BF Logic (Features: Input/output latch-in provided and Control timer limits operational window). Three BFI inputs are available at IN3, IN4, and IN5 to start delay timer T1. If the BFI inputs are not reset by the time timer 1 times out and either the phase (F1) or neutral fault detector (F2) is picked up, then BFO1-3 closes (OUT1-3), tripping the backup breakers. A control

timer (T3) is used to limit the breaker failure window of opportunity and latch-in the BFI inputs. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.

2. Single-Pole Tripping BF Logic (Features: Input/Output latch-in provided and Control timer limits operational window). If single-pole tripping is used, two additional BFI inputs are available (IN6 and IN7) to start delay timer T2. These inputs are only supervised by the phase fault detector (F1). If the BFI (IN6 and IN7) inputs are not reset by the time the timer T2 times out and the phase fault detector (F1) is still picked up, the BFO outputs (OUT1-3) will close, tripping the backup breakers. Control timer, T3 is used to limit the breaker failure window of opportunity. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.
3. Neutral fault detector (F2) is not used to supervise the single-pole BF logic because F2 is still picked up by the phase imbalance after the fault clears. Three-phase BF logic is inhibited during this period because there is no 3-phase BFI input active. For single-pole tripping, the phase pickup (PU1) must be set above maximum load levels.
4. Trip Coil Status Monitor. Preprogrammed logic is provided using IN1 to provide breaker status and IN2 for trip coil continuity. Refer to *Application Data* in this chapter information for further details on the circuit operation.
5. Breaker Arc Protection. Preprogrammed logic is provided using fault detector 3 (F3) for the MAF fault detector, IN1 for breaker status, and OUT4 for the arc detector output. Refer to *Application Data* in this chapter for further details on the circuit operation.
6. Retrip Output. A retrip output is provided to give a backup trip signal to the breaker trip coil. This can either provide a separate path to a single trip coil or be hooked to the backup trip coil if available.
7. Alarm Output. An Alarm output is provided to signal relay failure or diagnostic alarm.

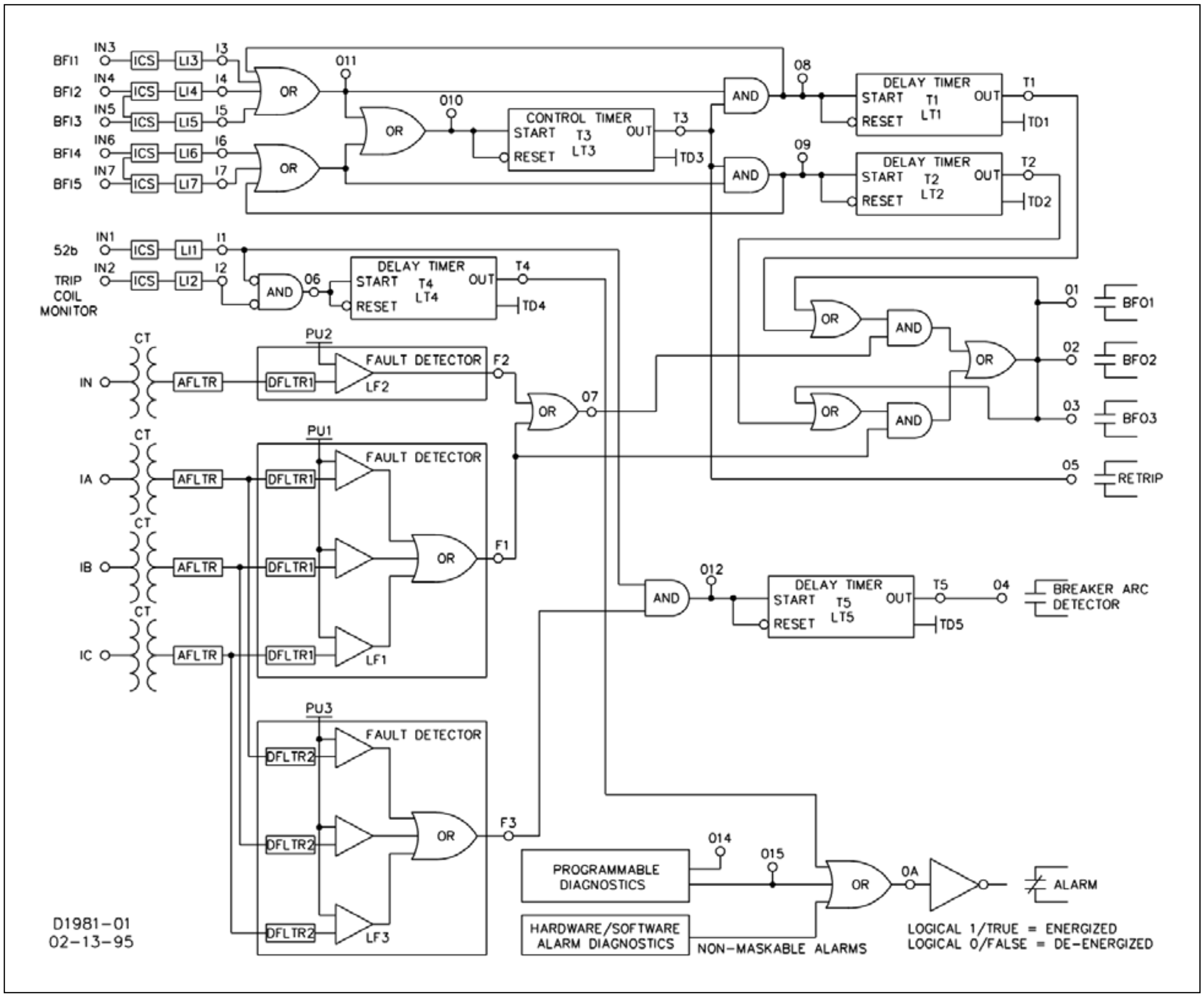


Figure 49. BFL3 Logic

Breaker Failure Logic 1 for Enhanced Relays (BFL1E)

BFL1E logic (shown in Figure 50) provides the following application features.

1. Three-Pole Tripping BF Logic (No input or output latch-in provided). Three BFI inputs are available at IN3, IN4, and IN5 to start delay timer T1. If the BFI inputs are not reset by the time timer 1 times out and either the phase fault detector (F1) or neutral fault detector (F2) is picked up, then BFO1 (OUT1) closes, tripping the backup breakers. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.

2. No Current BF Logic (No input or output latch-in provided). Some faults may not provide current to the CTs (i.e. internal transformer failures). In this case, a BFI input is available (IN6) to start delay timer T2. This input is not supervised by a fault detector. If the BFI input is not reset by the time the timer times out, BFO2 (OUT2) closes, tripping the backup breakers. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.

3. Trip Coil Status Monitor. Preprogrammed logic is provided using IN1 to provide breaker status and IN2 for trip coil continuity. Refer to *Application Data* in this chapter for further details on the circuit operation.

4. Breaker Arc Protection. Preprogrammed logic is provided using fault detector 3 (F3) for the MAF fault detector, IN1 for breaker status and OUT4 for the arc detector output. Refer to *Application Data* in this chapter for further details on the circuit operation.

5. Block Reclose Output. Preprogrammed logic is provided using breaker resistor protection output (O13) to drive the block reclose (BR) output (OUT3). Refer to *Application Data* in this chapter for further details on the circuit operation.
6. Retrip Output. A retrip output is provided to give a backup trip signal to the breaker trip coil. This can either provide a separate path to a single trip coil or be hooked to the backup trip coil if available.
7. External Fault Trigger. The enhanced BE1-BPR relay provides the ability to save the COMTRADE fault records for twelve events in memory at one time. An external fault trigger is provided to allow other multiple units to record the same event.
8. Alarm Output. An alarm output is provided to signal relay failure or diagnostic alarm.

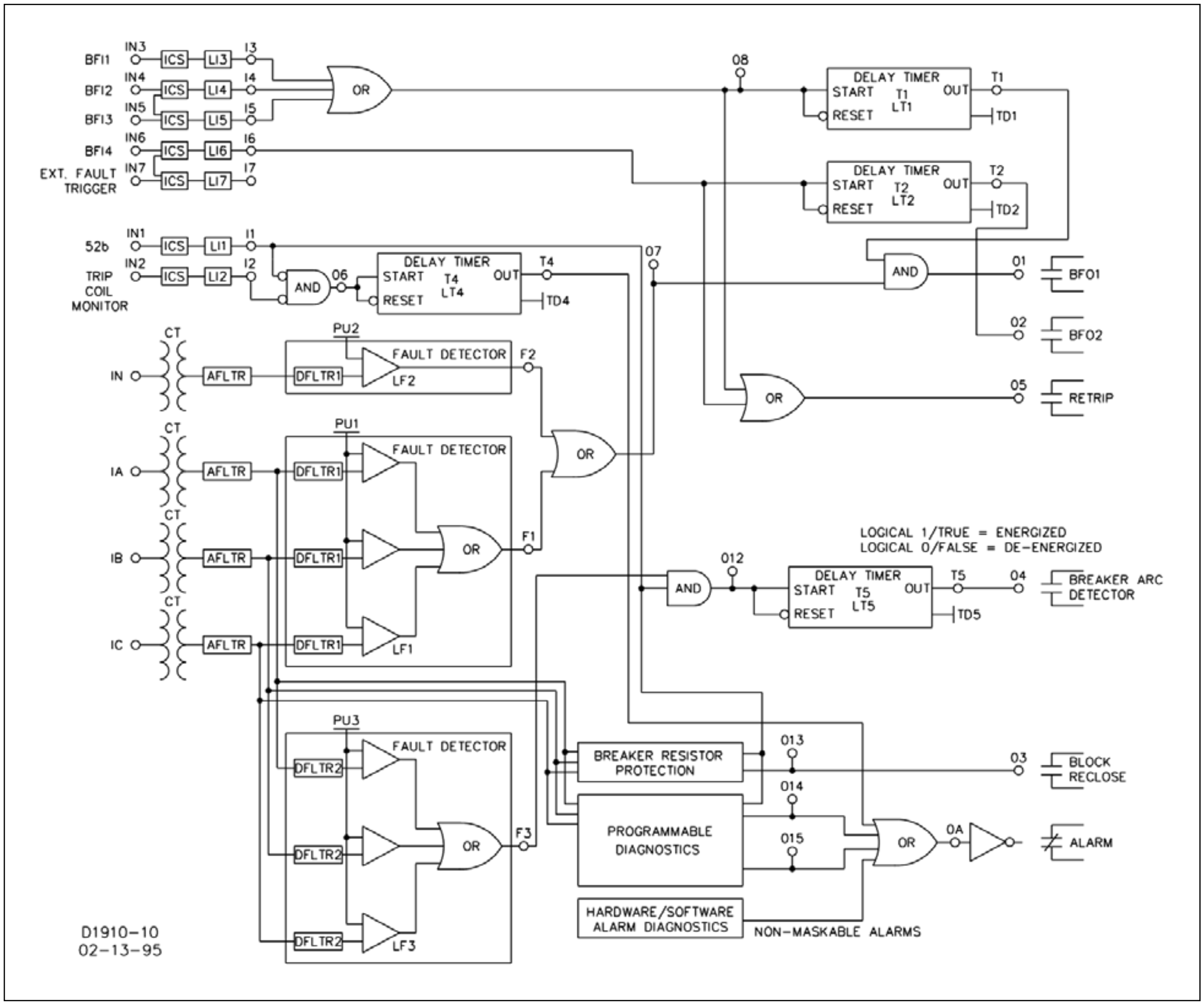


Figure 50. BFL1E Logic

Breaker Failure Logic 2 for Enhanced Relays (BFL2E)

BFL2E logic (shown in Figure 51) provides the following application features.

1. Three-Pole Tripping BF Logic (Output latch-in provided and Control timer limits operational window) Three BFI inputs are available at IN3, IN4, and IN5 to start delay timer T1. If the BFI inputs are not reset by the time Timer 1 times out and either the phase (F1) or neutral (F2) fault detector is still picked up, then BFO1-2 will close (OUT1-2), tripping the backup breakers. Control timer (T3) is used to limit the breaker failure window of opportunity. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.

2. Single-Pole Tripping BF Logic (Features: Output latch-in provided and Control timer limits operational window). If single-pole tripping is used, a BFI input is available (IN6) to start delay timer T2. This input is only supervised by the phase fault detector (F1). If the BFI input (IN6) is not reset by the time the timer T2 times out and the phase fault detector (F1) is picked up, the BFO outputs (OUT1-2) closes, tripping the backup breakers. Control timer, T3 is used to limit the breaker failure window of opportunity. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.
3. Neutral fault detector F2 is not used to supervise the single-pole BF logic because F2 is still picked up by the phase imbalance after the fault clears. Three-phase BF logic is inhibited during this period because there is no 3-phase BFI input active. For single-pole tripping, the phase pickup (PU1) must be set above maximum load levels.
4. Trip Coil Status Monitor. Preprogrammed logic is provided using IN1 to provide breaker status and IN2 for trip coil continuity. Refer to *Application Data* in this chapter for further details on the circuit operation.
5. Breaker Arc Protection. Preprogrammed logic is provided using FD3 (F3) for the MAF fault detector, IN1 for breaker status and OUT4 for the arc detector output. Refer to *Application Data* in this chapter for further details on the circuit operation.
6. Block Reclose Output. Preprogrammed logic is provided using breaker resistor protection output (O13) to drive the block reclose (BR) output (OUT3). Refer to *Application Data* in this chapter for further details on the circuit operation.
7. Retrip Output. A Retrip output is provided to give a backup trip signal to the breaker trip coil. This can either provide a separate path to a single trip coil or be hooked to the backup trip coil if available.
8. External Fault Trigger. The enhanced BE1-BPR relay provides the ability to save COMTRADE fault records for twelve events in memory at one time. An external fault trigger is provided to allow other multiple units to record the same event.
9. Alarm Output. An Alarm output is provided to signal relay failure or diagnostic alarm.

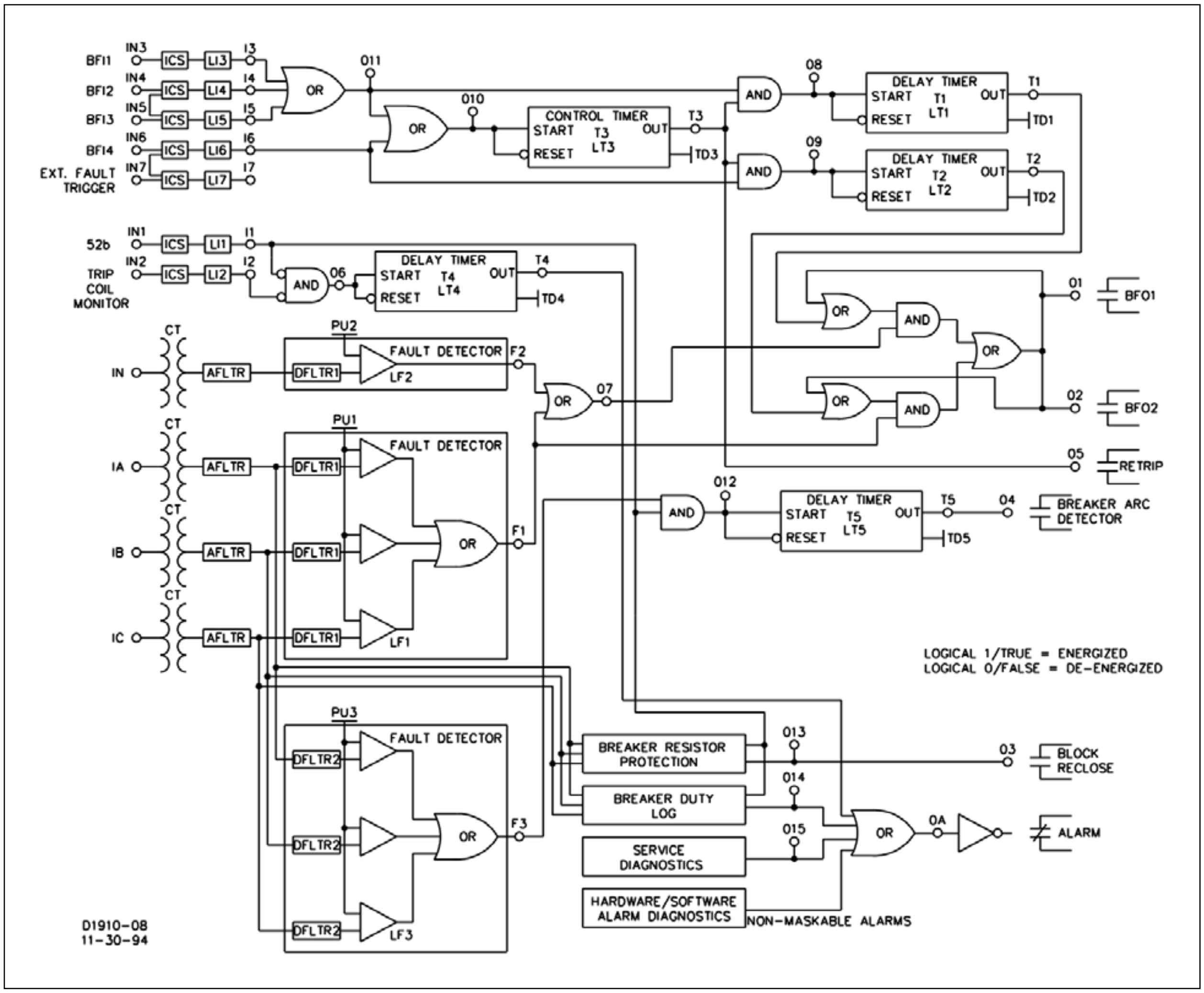


Figure 51. BFL2E Logic

Breaker Failure Logic 3 for Enhanced Relays (BFL3E)

BFL3E logic (shown in Figure 52) provides the following application features.

1. Three-Pole Tripping BF Logic (Features: Input/Output latch-in provided and Control timer limits operational window). Three BFI inputs are available at IN3, IN4, and IN5 to start delay timer T1. If the BFI inputs are not reset by the time timer 1 times out and either the phase (F1) or neutral (F2) fault detector is picked up, BFO1-2 (OUT1-2) closes, tripping the backup breakers. A control timer (T3) is used to limit the breaker failure window of opportunity and latch-in the BFI inputs. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.

2. Single-Pole Tripping BF Logic (Features: Input/Output latch-in provided and Control timer limits operational window). If single-pole tripping is used, a BFI input is available (IN6) to start delay timer T2. This input is only supervised by the phase fault detector (F1). If the BFI input (IN6) is not reset by the time the timer T2 times out and the phase fault detector (F1) is picked up, BFO2 output closes, tripping the backup breakers. Control timer, T3 is used to limit the breaker failure window of opportunity. Refer to the breaker failure timing diagram in the *Introduction* chapter for information on setting the delay and control timers.

3. Neutral fault detector (F2) is not used to supervise the single-pole BF logic because F2 is still picked up by the phase imbalance after the fault clears. Three-phase BF logic is inhibited during this period because there is no 3-phase BFI input active. For single-pole tripping, the phase pickup (PU1) must be set above maximum load levels.

4. Trip Coil Status Monitor. Preprogrammed logic is provided using IN1 to provide breaker status and IN2 for trip coil continuity. Refer to *Application Data* in this chapter for further details on the circuit operation.
5. Breaker Arc Protection. Preprogrammed logic is provided using fault detector 3 (F3) for the MAF fault detector, IN1 for breaker status, and OUT4 for the arc detector output. Refer to *Application Data* in this chapter for further details on the circuit operation.
6. Block Reclose Output. Preprogrammed logic is provided using breaker resistor protection output (O13) to drive the block reclose (BR) output (OUT3). Refer to *Application Data* in this chapter for further details on the circuit operation.
7. Retrip Output. A retrip output is provided to give a backup trip signal to the breaker trip coil. This can either provide a separate path to a single trip coil or be hooked to the backup trip coil if available.
8. External Fault Trigger. The enhanced BE1-BPR relay provides the ability to save COMTRADE fault records for twelve events in memory at one time. An external fault trigger is provided to allow other multiple units to record the same event.
9. Alarm Output. An alarm output is provided to signal relay failure or diagnostic alarm.

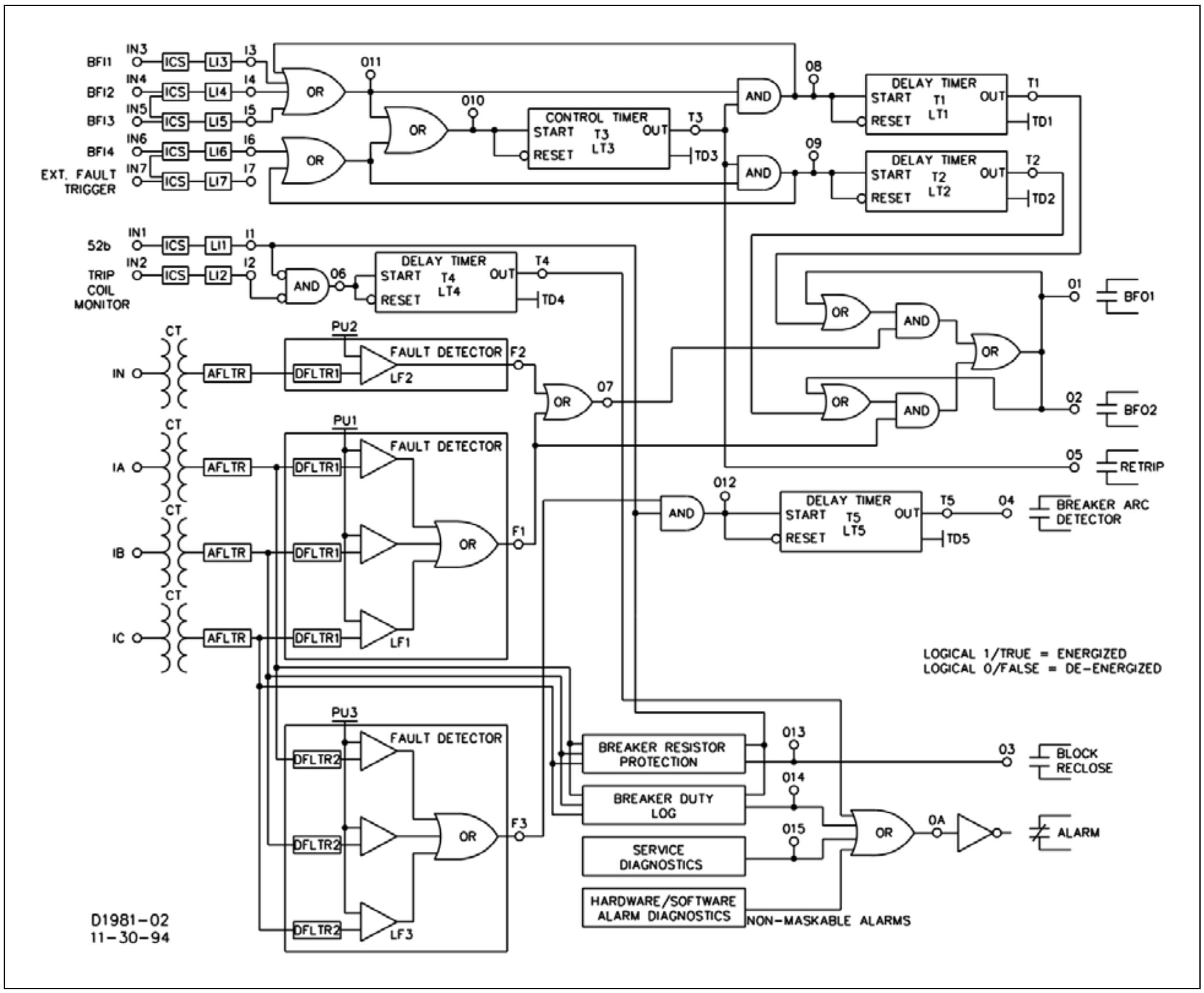


Figure 52. BFL3 Logic

BESTlogic™

Basler Electric Standard Trip_logic (BESTlogic) is a flexible and user-friendly programming language for controlling specific BE1-BPR relay outputs based on combinations of inputs, timers, and outputs. It is not necessary to change logic circuits in the relay hardware to meet changing needs in your system environment. Just change the existing logic scheme or create an entire new one using BESTlogic.

Each logic scheme is given a unique name (one to eight characters). The operating characteristics of each contact input, fault detector (analog input) and timer can be customized based on the application requirements. Each output is then defined using simple Boolean logic equations with the inputs, outputs, and timers used as logic variables. The logic defines how each internal functional block operates and how the blocks are internally connected to achieve the desired output. The unique logic name enables the operator to change schemes and still be confident that the functions are correct without having to check the individual equations associated with the logic.

Parameters that do not affect the basic operation or the internal connections of the logic, such as fault detector pickup settings or timer delay settings, are programmed separately from the logic. These are programmed settings and a new logic name is not required to change these parameters.

Relay response time is controlled by the internal sample analog-to-digital (A/D) converter (ADC) rate of 12 samples per cycle. At 60 hertz, the sample interval is 1.389 milliseconds. At 50 hertz, the sample interval is 1.667 milliseconds. After each sample, the status of all inputs, timers, and other functions are updated and then the output status is updated by evaluating logic equations associated with each output.

Standard BE1-BPR relays have three preprogrammed logic schemes in memory to configure the relay for common breaker failure applications. Enhanced BE1-BPR relays have six preprogrammed logic schemes. Not all features of these preprogrammed logics need to be used in order to use a logic scheme. Typically, inputs and outputs can be disabled by simply leaving them disconnected. Unused CT inputs should be shorted to minimize noise pickup.

If one of the preprogrammed logic schemes does not meet your needs, a new set of logic equations can be made. This custom logic scheme is stored in nonvolatile EEPROM. This custom scheme may be revised or changed completely many times, but only one custom scheme may be stored at one time.

Caution
This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 1,000,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

To find out what schemes are in memory, use the LINFO command. Entering LINFO by itself will list the preprogrammed logics stored in memory, with the first listing being the custom logic scheme stored in EEPROM. If the LINFO command is followed by the name of one of these schemes, then all logic equations associated with that logic name will be listed.

OUT	Logic scheme names and equations	HMI Menu Branch: N/A
Parameter	**Comments**	
name	LINFO reports the logic scheme names in memory. LINFO<name> reports the equations associated with logic scheme <name>	

LINFO Command

Purpose: Reads the names of all logic schemes in memory or the equations associated with the named logic scheme.

Syntax: LINFO[<name>]

Comments: No access is required to read logic scheme names and equations.

LINFO Command Example:

Read the available logic schemes.

LINFO

```
TEST, BFL1, BFL2, BFL3, BFL1E, BFL2E, BFL3E
```

The active logic scheme is viewed or selected by using the LOGIC command or through HMI menu branch 1.

LOGIC	Logic scheme name	HMI Menu Branch: 1
Parameter	**Comments**	
existing name	LOGIC returns the name of the currently active logic scheme. LOGIC=<existing name> changes the active logic to <existing name>	

LOGIC HMI Screen Example:

RELAY SETUP
LOGIC = BFL1

LOGIC Command

Purpose: Read or change the active logic of the relay.

Syntax: LOGIC[=<existing name>]

Comments: An access area one password is required to change settings.

LOGIC Command Examples:

1. Read the active logic.
   LOGIC
   BFL3E
2. Change the active logic to BFL1E
   LOGIC=BFL1E

Logic Variables

Logic variables entered in equation form control the actual relay outputs. Names assigned to the inputs, timers, and outputs represent these variables in the equations. Table 11 lists the variable names and what they represent. Figure 53 illustrates the logic variables in the form of function modules.

Table 11. Logic Variable Names, Descriptions, and Terminals

Variable Name	Description	Terminal Name	Terminals
I1	Input Contact 1	IN1	TB1: 15, 16
I2	Input Contact 2	IN2	TB1: 17, 18
I3	Input Contact 3	IN3	TB1: 19, 20
I4	Input Contact 4	IN4	TB1: 21, 22

Variable Name	Description	Terminal Name	Terminals
I5	Input Contact 5	IN5	TB1: 22, 23
I6	Input Contact 6	IN6	TB1: 24, 25
I7	Input Contact 7	IN7	TB1: 25, 26
T1	Timer 1	N/A	N/A
T2	Timer 2	N/A	N/A
T3	Timer 3	N/A	N/A
T4	Timer 4	N/A	N/A
T5	Timer 5	N/A	N/A
T6	Timer 6	N/A	N/A
F1	Fault Detector Output 1	∗	∗
F2	Fault Detector Output 2	∗	∗
F3	Fault Detector Output 3	∗	∗
OA	Virtual Output A	ALM	TB1: 3, 4
O1	Virtual Output 1	OUT1	TB1: 5, 6
O2	Virtual Output 2	OUT2	TB1: 7, 8
O3	Virtual Output 3	OUT3	TB1: 9, 10
O4	Virtual Output 4	OUT4	TB1: 11, 12
O5	Virtual Output 5	OUT5	TB1: 13, 14
O6	Virtual Output 6	OUT6	N/A
O7	Virtual Output 7	OUT7	N/A
O8	Virtual Output 8	OUT8	N/A
O9	Virtual Output 9	OUT9	N/A
O10	Virtual Output 10	OUT10	N/A
O11	Virtual Output 11	OUT11	N/A
O12	Virtual Output 12	OUT12	N/A
O13	Virtual Output 13	OUT13	N/A
O14	Virtual Output 14	OUT14	N/A
O15	Virtual Output 15	OUT15	N/A

∗ Fault Detector Outputs are controlled by the CT phase inputs, IA (terminals 1, 2), IB (terminals 3, 4), IC (terminals 5, 6), or by the CT neutral input, IN (terminals 7, 8).

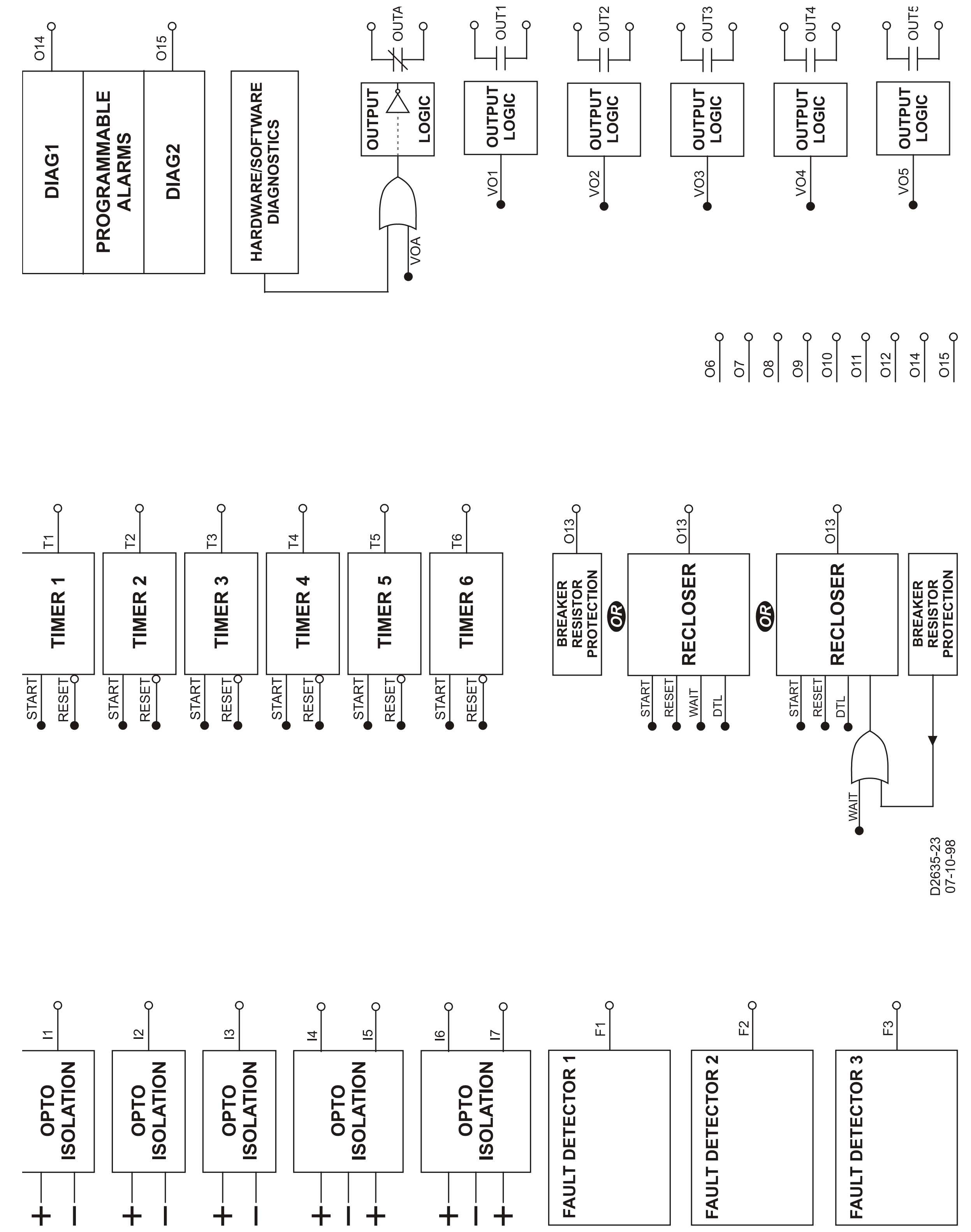


Figure 53. BESTlogic Function Blocks

Logic Names

In order to easily identify the logic scheme that is operational in memory, each logic scheme is named. The name is shown on the RELAY SETUP menu screen. For the custom logic scheme, the operator must enter a name (a maximum of eight characters) identifying the logic scheme. When naming a custom logic scheme, the standard logic scheme names cannot be used. Only a unique name can be assigned to a custom logic scheme. Custom logic schemes are programmed through the communication ports. Preprogrammed logic schemes are selected through the front panel or the communication ports. A logic scheme is selected by using the command LOGIC = <name> where <name> is the defined name of the logic scheme.

If a custom logic scheme is to be used, it is defined starting with the command LN = <name> where <name> is the user-selected name for the logic scheme.

To simplify making minor changes to an existing logic scheme, all logic equations for an existing scheme can be copied over to the custom scheme by typing LN=<existing name>. Then the custom logic scheme must be given a unique name by entering LN=<custom name>. Once the logic name is changed, the changes can be made. (Changing the name does not affect the other logic definitions.) If changes are attempted prior to changing the logic name, the relay will respond with an error message: `CUSTOM LOGIC NAME NOT SELECTED.`

LN	Custom logic scheme	HMI Menu Branch: 1
Parameter	**Range**	**Comments**
existing name	1 to 8 characters	Defined name must be different from the standard logic names. An existing logic scheme can be copied into memory for editing by using LN=<existing command>.

LN HMI Screen Example:

RELAY SETUP
LOGIC = BFL1

LN Command

Purpose: Read the name of the active logic or program a new set of logic equations called <name>.

Syntax: LN[=<name>]

Comments: An access area one password is required to change settings.

LN Command Example:

Read the name of the active logic.

```
LN
BFL1
```

Output Operations

The BE1-BPR relay provides two types of outputs: virtual outputs and hardware outputs. The following paragraphs provide information about the function and characteristics of virtual and hardware outputs.

Virtual Outputs

A virtual output exists only as a logical state inside the relay. Output operation for virtual outputs OA through O12 is defined by Boolean logic equations. Each variable in the equation corresponds to the current state of an input, output, or timer. Any time a logic variable changes state, the outputs are reevaluated as True or False. If a logical output corresponding to a physical output changes state, then the corresponding output relay contact also changes state.

Logic equations are defined by the logic variables, logical operators, and their position in the equation. The logical operators are AND (*), OR (+), and NOT (/). Logical operator AND (*) is assumed between adjacent variables or parentheses; i.e., (F1+F2)I1O1 is the same as (F1+F2)*I1*O1. The logical NOT operator (/) is applied to the variable immediately following the symbol /. A logical NOT operator may be applied to a single variable or to a group enclosed in parentheses. When NOT is used with parenthesis, the number of operators is limited to four. Internally, the logic equations defined are reduced to a *canonical sum-of-products form;* i.e., groups of ANDed terms separated by ORs with parenthesis eliminated. When the logic equation is read back, the internal format is given. The number of terms when expanded to a canonical sum-of products form must not exceed four. In other words, when the equation is expanded by removing all parentheses, the number of OR symbols in the equation must be three or less. If a larger number of terms are needed, this limitation may be bypassed by using a virtual output as an intermediate expression.

During power-up, all logic outputs are disabled. When the logic is running and logic equation LO[n] is false, then Output O[n] = false, where O[n] corresponds to terminals for OUT[n] as shown in BE1-BPR. When the logic is running and logic equation LO[n] is True, then O[n] = 1.

Virtual Outputs 13 through 15 (O13-O15) are dedicated outputs that are controlled by a function instead of an equation. Output O13 is controlled by the Recloser (79) function block. If the Recloser function is not used, O13 is controlled by the Breaker Resistor Protection Module. The Recloser function is defined when the LR command is entered. The logic scheme will then display O13 as a RECLOSER. The Breaker Resistor Protection Module is defined when the BKRRES command is entered. The logic equation for O13 is displayed as ROP_LIMIT if the Recloser function is not used and BKRRES is defined. Outputs O14 and O15 are programmable diagnostic outputs that allow one or more diagnostic alarms to be annunciated.

The *Application* chapter provides more information about the application of these functions. The *Functional Description* chapter provides information about the settings associated with these functions.

Hardware Outputs

A hardware output is a physical relay contact that can be used for protection or control. The BE1-BPR relay has five isolated, normally open (N.O.) output contacts (OUT1-OUT5) and one isolated normally closed (N.C.) alarm output. Output contacts OUT1 through OUT5 are controlled by the status of virtual outputs VO1 through VO5. If VO[n] becomes true, then the corresponding output relay (OUT[n]) is energized and closes the N.O. contacts. If VOA becomes true, the ALARM output relay de-energizes and the contacts close.

When an output changes state, internal logic can hold the relay in the new state for 200 to 250 milliseconds. Following this holdup time, the output resumes following the internal VO[n] logic. The 200 to 250 millisecond minimum ON time is used to ensure that once a trip contact closes, it does not interrupt the breaker trip coil current, but does allow the trip coil current to be interrupted by the 52A contact. In some instances, such as a recloser module breaker close contact, the output hold logic may not be desired. The hold logic can be disabled on any contact by the PHOLD command. The *Functional Description* chapter provides information about using the PHOLD command.

Programming Output Operational Characteristics

Each output, O[n], has a logical mode of operation defined in terms of a standard Boolean expression, LO[n]. Variables can be any contact input (I[n]), fault detector output (F[n]), output (O[n]), or timer (T[n]).

LO	Output logic	HMI Menu Branch: N/A
Parameter	**Parameter Selections**	
#	A (OUTA) 1 - 12 (OUT1 - OUT12)	
Boolean Equation	Variables: Ix (contact inputs) Fx (fault detector outputs) Tx (timer outputs) Ox (virtual outputs)	Operators: * (AND) + (OR) / (NOT)

LO Command

Purpose: Reads or programs output logic.

Syntax: LO[#[=<Boolean equation>]]

Comments: Access area one password is required to change setting.

LO Command Example:

Turn on output 1 when fault detector 1 or 2 is picked up, the output of timer 1 is true, and the output of timer 3 is false.

LO1=(F1+F2)T1/T3

Output Programming Examples

Example 1: Using AND/OR logic

Output one (LO1) is true if contact input 1 or 2 (I1 or I2) are closed (true) and fault detector 1 or 2 (F1 or F2) are picked-up (true) and timer 1 (T1) is also true.

Boolean equation: LO1 = (I1+I2)*(F1+F2)*T1

Internal format: LO2=F1T1T2/I2+F2T1T2/I2

Example 2: Using AND/OR/NOT logic

Logical output two (LO2) is true if contact input two is false and timer one (T1) is true and timer two (T2) is true and fault detector one (F1) or fault detector two (F2) is true.

Boolean equation: LO2=/I2T1T2(F1+F2)

Internal format: LO2=F1T1T2/I2+F2T1T2/I2

Example 3: Using feedback to latch an output

Logical output one (LO1) is true if timer three (T3) is true and contact input 1 (I1) is true or logical output one (O1) is true. Therefore, when output 1 turns true, it will remain true, latching itself on independently of I1, until timer T3 turns off.

Boolean equation: LO1=T3(I1+O1)

Internal format: LO1=T3I1+T3O1

Example 4: Overcoming 4 OR Term Limit

Logical Output 1 is TRUE if input contact I1, I2, or I3 are closed (true) and fault detector F1 or F2 are picked-up (true).

Initial Boolean equation: LO1=(I1+I2+I3)(F1+F2)

Internal format: LO1=I1F1+I1F2+I2F1+I2F2+I3F1+I3F2 (ERROR: >4 Terms)

To correct the error, the equation will be rewritten using a virtual output as an intermediate expression. In this way, the original 6 term equation can be reduced to one two term and one three term equation.

Initial Boolean equations: LO1=O11(F1+F2) LO11=I1+I2+I3
Internal formats: LO1=F1O11+F2O11 L011=I1+I2+I3

Contact Input Logic

Contact Sensing Input Operation

Adjustable recognition and debounce timer logic monitors the contact sensing inputs and determines when contact input changes of state are recognized. An example of the function blocks that process and control contact input logic is shown in Figure 54.

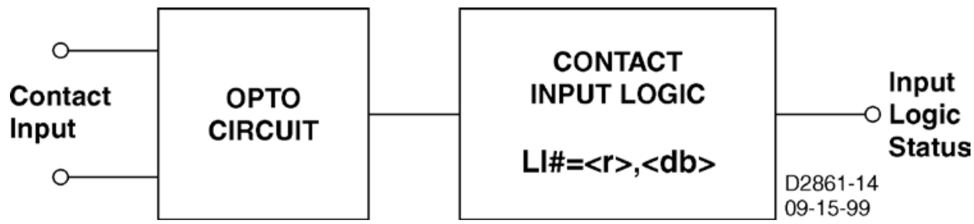


Figure 54. Contact Input Logic Function Blocks

When a contact input changes state for the duration of the recognition time (r), then the input logic status changes to the new state. The input logic status changes only if it does not match the contact input status when the recognition timer expires. After being recognized (changing state), the contact input must stay in a stable state for the defined debounce time (db) before another contact input state is recognized. If the contact input status and input logic status match when the recognition timer expires, the debounce timer is not started. The debounce timer delays further input logic status updates once the input logic status changes for the duration of the debounce setting.

Recognition and debounce timer operation is illustrated in Figure 55 and summarized in the following numbered paragraphs. The paragraph numbers correspond to the callouts in Figure 55.

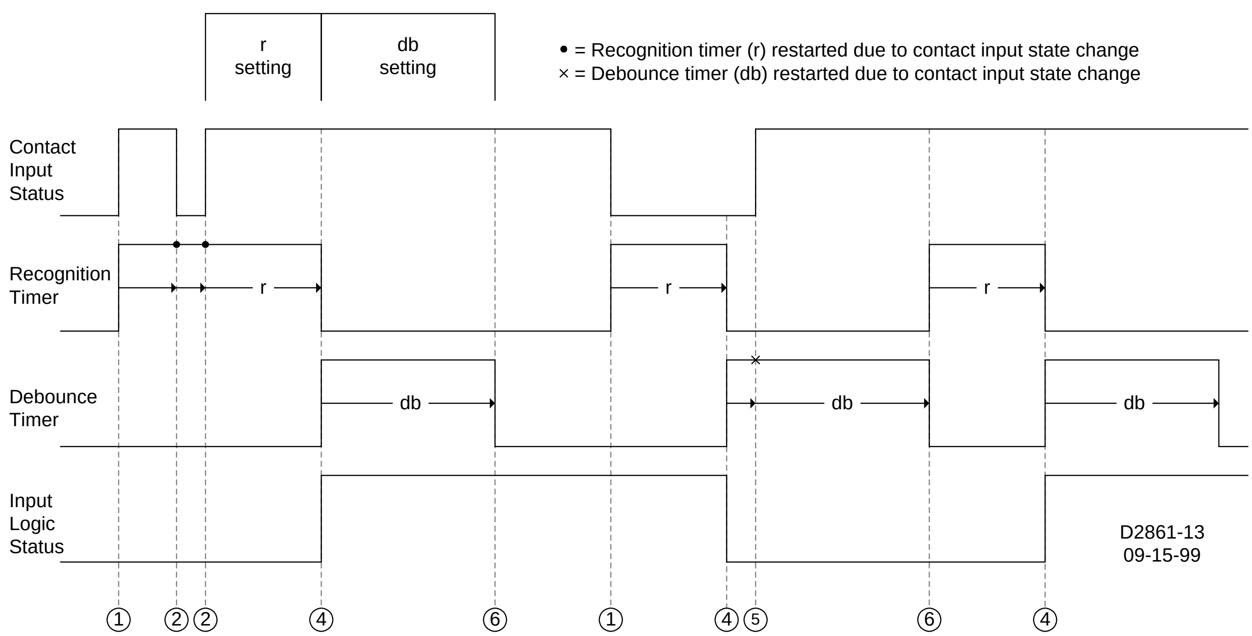


Figure 55. Recognition and Debounce Timer Operation

1. Recognition timer starts when the contact input changes state.
2. Recognition timer restarts if the contact input changes state while the timer is running.
3. If the contact input status and input logic status matches when the recognition timer expires, then no action is required. (This occurrence is not illustrated in Figure 55.)
4. If the contact input status and input logic status does not match when the recognition timer expires, the input logic status is updated, and the debounce timer is started.
5. Debounce timer restarts if the contact input changes state while the timer is running.
6. Go to (1) when the debounce timer expires.

Recognition and debounce values are read or programmed using the LI command.

LI	Contact input logic		HMI Menu Branch: N/A	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
#	N/A	1, 2, 3, 4, 5, 6, or 7	N/A	LI#=4,12
r	milliseconds	4 - 255	1	
db	milliseconds	4 - 255	1	

LI Command

Purpose: Reads or programs contact input logic.

Syntax: LI[#[=<r>,<db>]]

Comments: Access area one password is required to change settings.

LI Command Example:

Configure input 3 for a contact recognition time of 10 milliseconds and a debounce time of 20 milliseconds.

LI3=10,20

The state of the contact sensing inputs is scanned twelve times per cycle. The time settings are converted to the nearest multiple of the scan interval, which is determined by the nominal frequency setting (1.39 milliseconds at 60 hertz or 1.67 milliseconds at 50 hertz). For example, if the nominal frequency is 60 hertz, a recognition time setting of 4 milliseconds is rounded to 4.17 milliseconds, which is the nearest multiple of the scan interval. In this case, a contact closure must be present on three consecutive scans of the input state for it to be recognized and the BESTlogic input variable to change state from a 0 to 1.

BESTlogic™ Application Hints

Preprogrammed protection schemes may provide additional inputs, outputs, or features that are not needed for all applications. This is done so that a few schemes can be used in a large number of applications with no special programming required. The unneeded inputs or outputs may be left open to disable the function. Unused CT inputs should be shorted to minimize noise pickup.

Additional Breaker Failure inputs have been provided in many schemes for diagnostic reasons. Target information can be provided for inputs as well as outputs, therefore the relay that caused the breaker operation may be identified by requesting target information through the communications port. This is especially useful when trying to remotely determine the cause of a problem when the relay that tripped the breaker is an older, non-communicating relay.

When designing new protection schemes, avoid unnecessary confusion by maintaining consistency wherever possible between function of the inputs and outputs in the new scheme and the preprogrammed schemes. The preprogrammed schemes are consistent in the following functions:

IN1 (I1)	=	Breaker status contact (isolated input)
IN3 (I3)	=	Primary BFI (isolated input)
IN7 (I7)	=	External fault trigger to record fault records on enhanced relays
F1	=	Always associated with phase fault detector
F2	=	Always associated with neutral fault detector
ALM (OA)	=	Alarm output
OUT1 (O1)	=	Primary BFO - high speed (1/4 cycle pickup)
OUT2 (O2)	=	Secondary BFO
OUT3 (O5)	=	Retrip Output
TIMER1 (T1)	=	Always associated with primary BFO delay timer
TIMER2 (T2)	=	Always associated with alternate BFO delay timer
TIMER3 (T3)	=	Always associated with the control timer

Outputs may be programmed to be normally energized (Alarm output) or de-energized; e.g., BFO. Outputs OUT1 through OUT4 are jumper selectable for normally open (NO) or normally closed (NC) contacts. Changing an output contact's configuration requires moving a soldered jumper located on the printed circuit board. Caution should be taken with NC outputs because there are no shorting bars to maintain the closed condition if the electronics are removed from the chassis. In situations where a NC contact is required even when the electronics are removed, it is recommended that a NO output be used to drive an external low cost auxiliary relay. The NC output of the auxiliary relay can then be used and the electronics can still be drawn out. Alternately, an external switch can be used to short across the NC output when the electronics are removed. Extra care is required to make sure this is done and that the short is removed once the electronics are reinstalled.

BE1-BPR Preprogrammed Protection Schemes

Each BE1-BPR relay comes with a number of preprogrammed breaker failure logic schemes that are preprogrammed into non-volatile memory. The *Application* chapter contains descriptions of the logic schemes and their applications.

For reference, each of the preprogrammed schemes and their corresponding logic equations are provided on the following pages.

Breaker Failure Logic 1 for Standard Relays (BFL1)

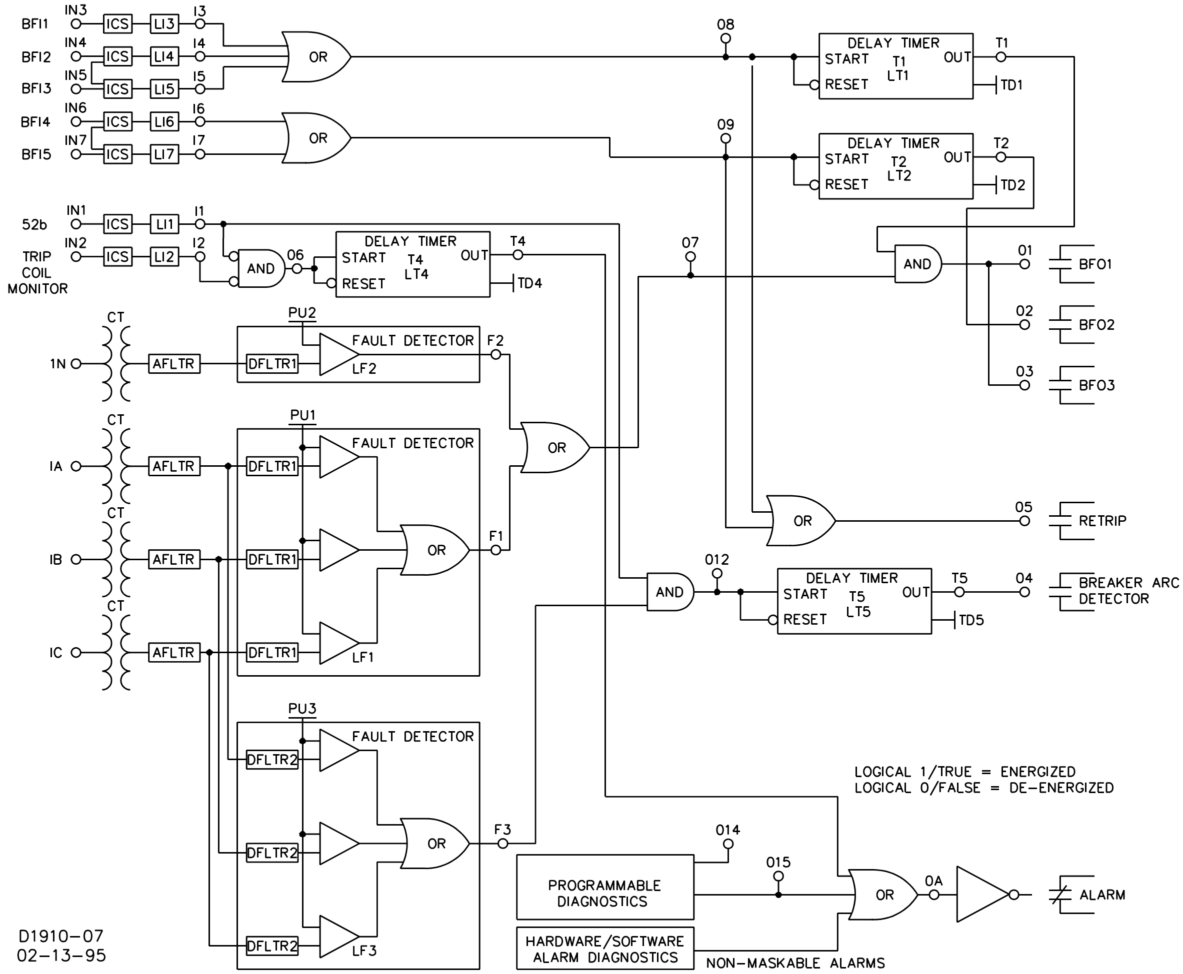


Figure 56. BFL1 Logic Diagram

LN=BFL1	LI6=4,12	LOA=T4+O15 ∗	LO9=I6+I7
LF1=PI,1	LI7=4,12	LO1=T1O7	LO10=0
LF2=NI,1	LR=0,0,0,0,0	LO2=T2	LO11=0
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7	LO12=F3I1
LI1=4,12	LT2=D,O9,/O9	LO4=T5	
LI2=4,12	LT3=0,0,0	LO5=O8+O9	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=I3+I4+I5	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 2 for Standard Relays (BFL2)

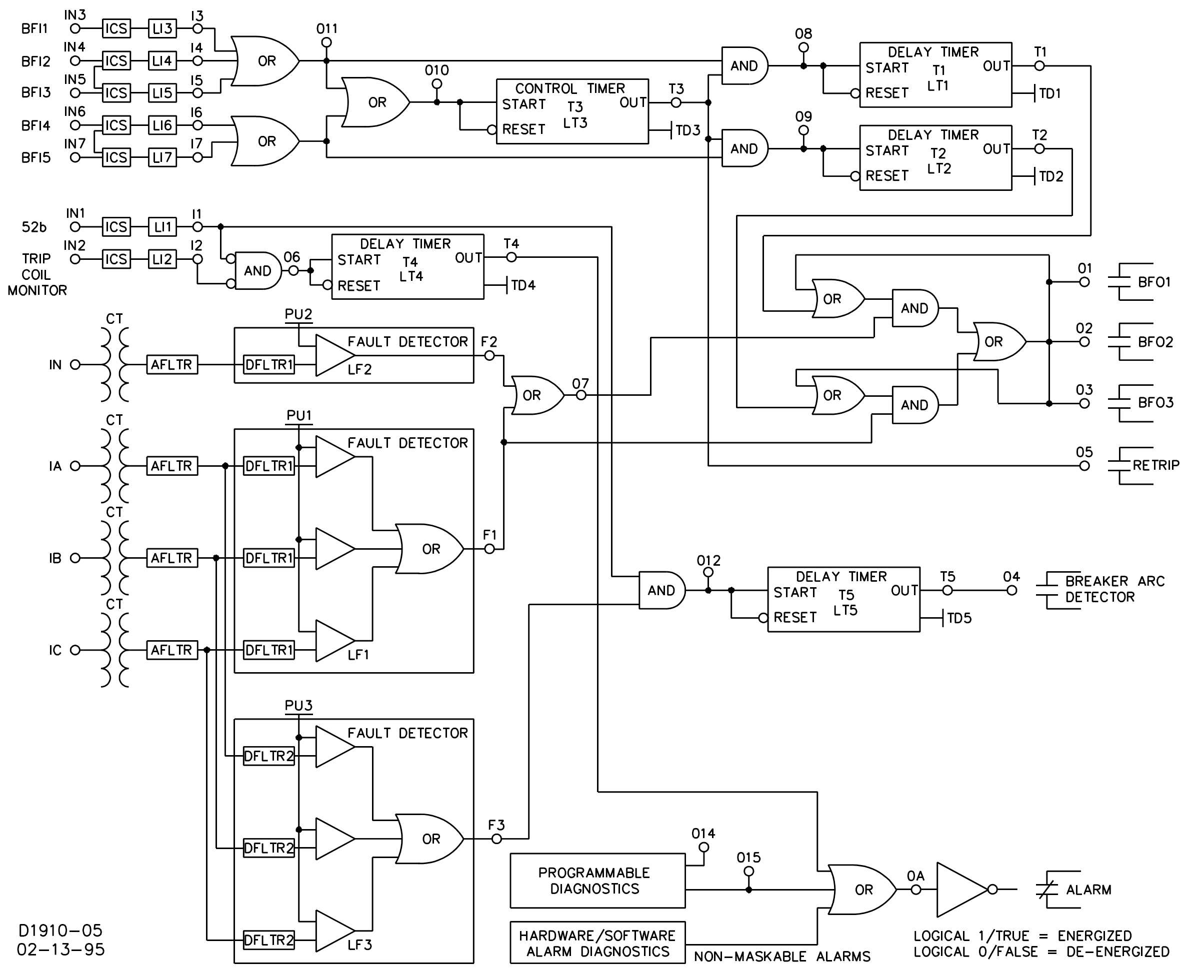


Figure 57. BFL2 Logic Diagram

LN=BFL2	LI6=4,12	LOA=T4+O15 ∗	LO9=T3I6+T3I7
LF1=PI,1	LI7=4,12	LO1=O3	LO10=I6+I7+O11
LF2=NI,1	LR=0,0,0,0,0	LO2=O3	LO11=I3+I4+I5
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7+F1T2+O1O7	LO12=F3I1
LI1=4,12	LT2=D,O9,/O9	LO4=T5	
LI2=4,12	LT3=C,O10,/O10	LO5=T3	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=T3O11	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 3 for Standard Relays (BFL3)

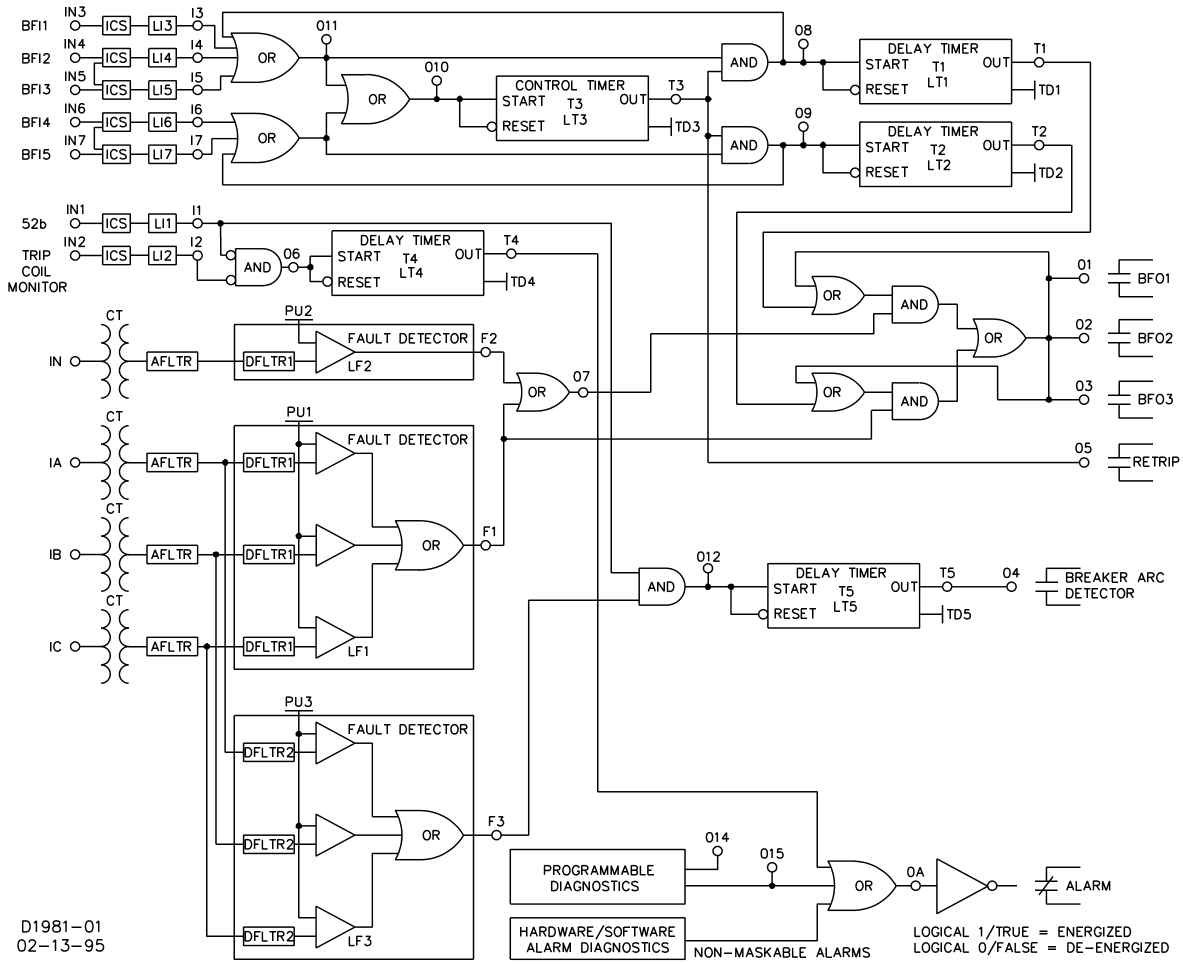


Figure 58. BFL3 Logic Diagram

LN=BFL3	LI6=4,12	LOA=T4+O15 ∗	LO9=T3I6+T3I7+T3O9
LF1=PI,1	LI7=4,12	LO1=O3	LO10=I6+I7+O9+O11
LF2=NI,1	LR=0,0,0,0,0	LO2=O3	LO11=I3+I4+I5+O8
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7+F1T2+O1O7	LO12=F3I1
LI1=4,12	LT2=D,O9,/O9	LO4=T5	
LI2=4,12	LT3=C,O10,/O10	LO5=T3	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=T3O11	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 1 for Enhanced Relays (BFL1E)

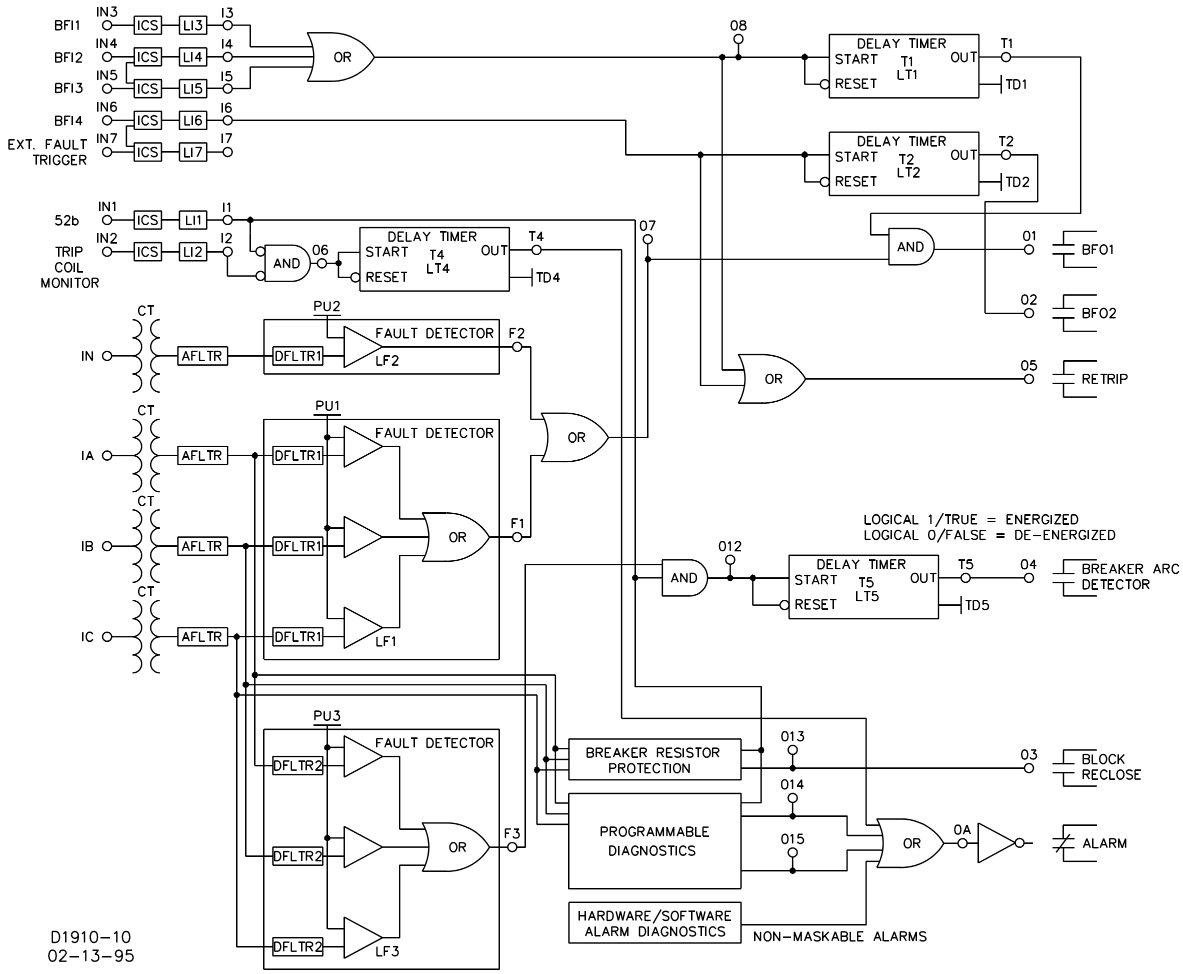


Figure 59. BFL1E Logic Diagram

LN=BFL1E	LI6=4,12	LOA=T4+O14+O15 ∗	LO9=0
LF1=PI,1	LI7=4,12	LO1=O3	LO10=0
LF2=NI,1	LR=0,0,0,0,0	LO2=O3	LO11=0
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7+F1T2+O1O7	LO12=F3I1
LI1=4,12	LT2=D,I6,/I6	LO4=T5	
LI2=4,12	LT3=0,0,0	LO5=T3	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=T3O11	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 2 for Enhanced Relays (BFL2E)

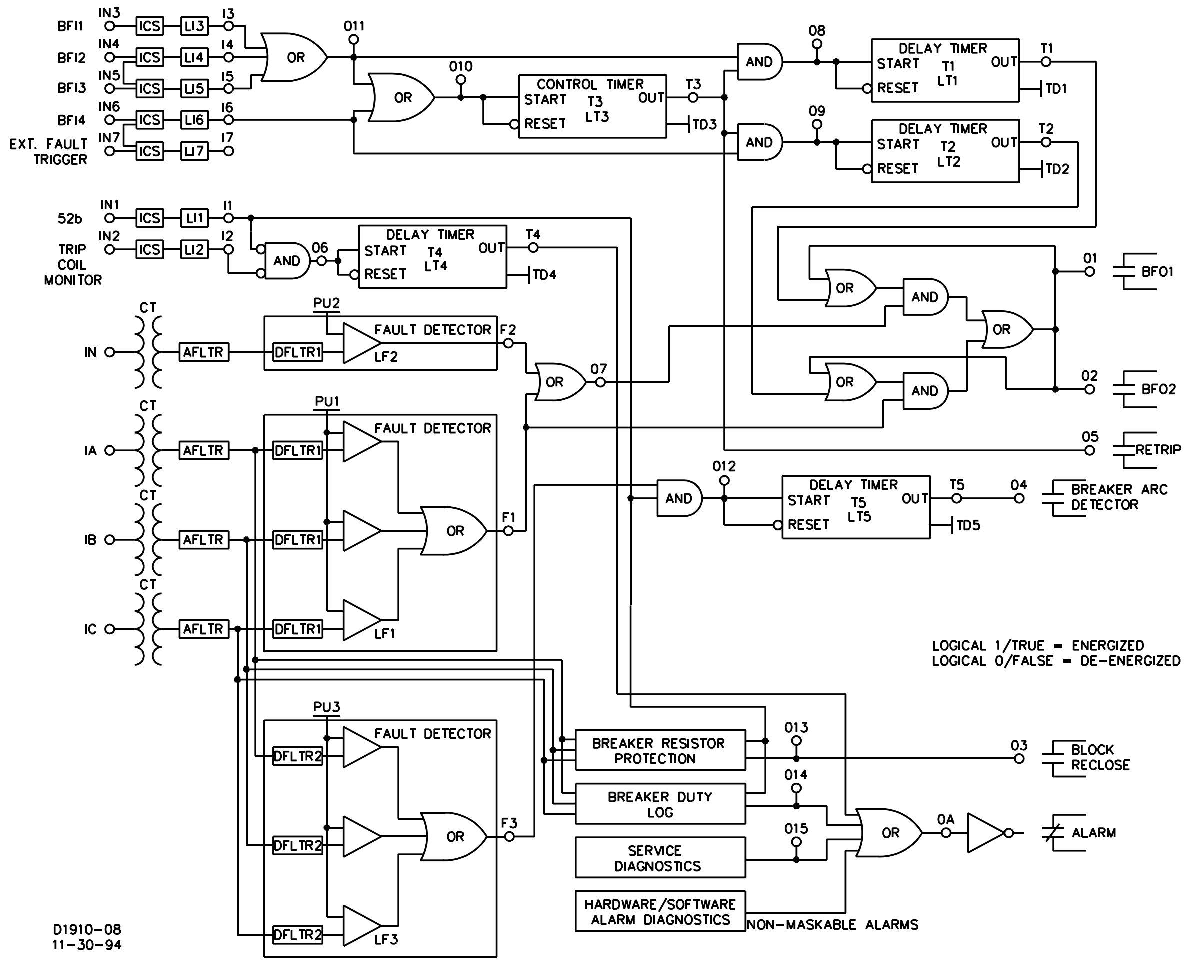


Figure 60. BFL2E Logic Diagram

LN=BFL2E	LI6=4,12	LOA=T4+O14+O15 ∗	LO9=T3I6
LF1=PI,1	LI7=4,12	LO1=O2	LO10=I6+O11
LF2=NI,1	LR=0,0,0,0,0	LO2=T1O7+F1T2+O1O7	LO11=I3+I4+I5
LF3=PI,2	LT1=D,O8,/O8	LO3=O13	LO12=F3I1
LI1=4,12	LT2=D,O9,/O9	LO4=T5	
LI2=4,12	LT3=C,O10,/O10	LO5=T3	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=T3O11	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 3 for Enhanced Relays (BFL3E)

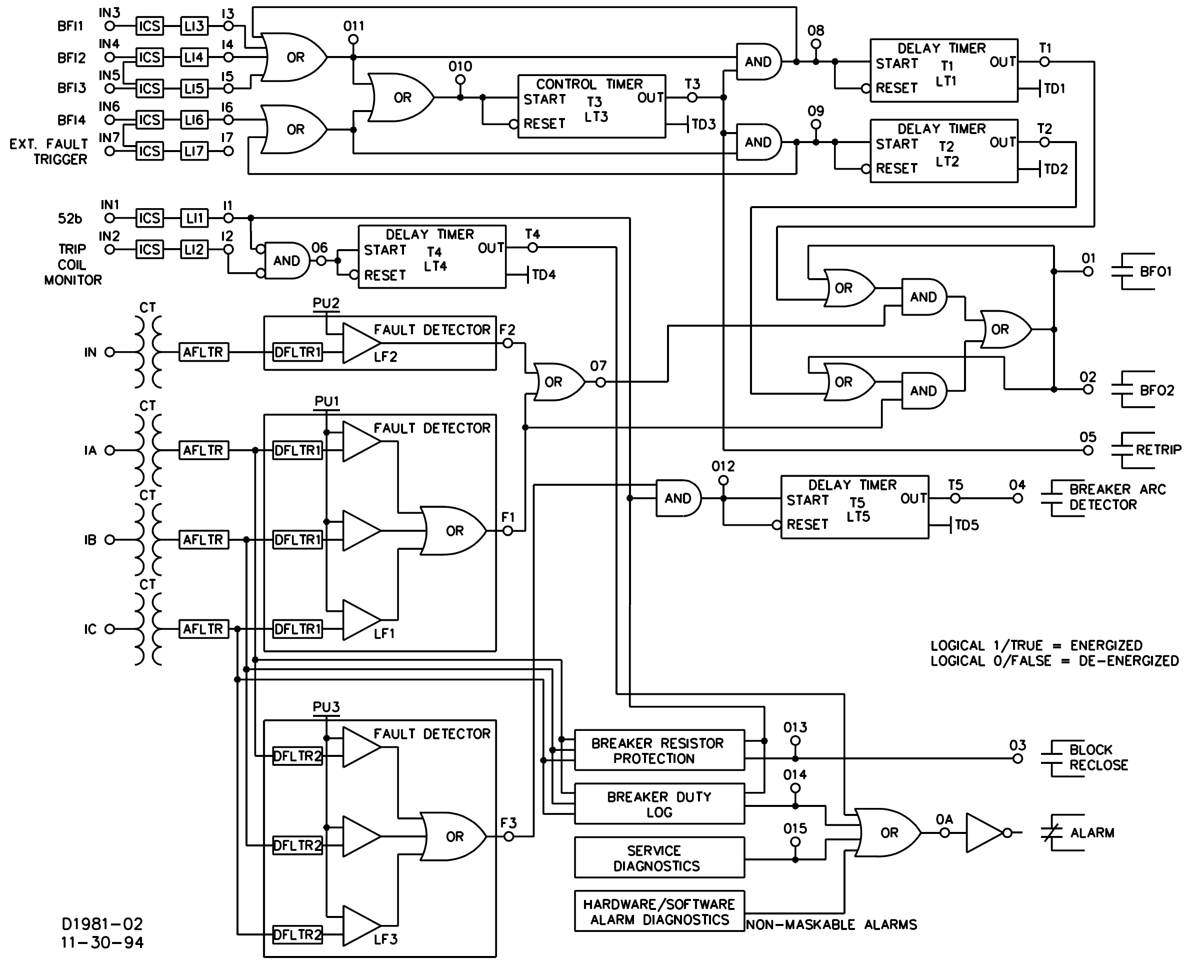


Figure 61. BFL3E Logic Diagram

LN=BFL3E	LI6=4,12	LOA=T4+O14+O15 *	LO9=T3I6+T3O9
LF1=PI,1	LI7=4,12	LO1=O2	LO10=I6+O9+O11
LF2=NI,1	LR=0,0,0,0,0	LO2=T1O7+F1T2+O1O7	LO11=I3+I4+I5+O8
LF3=PI,2	LT1=D,O8,/O8	LO3=O13	LO12=F3I1
LI1=4,12	LT2=D,O9,/O9	LO4=T5	
LI2=4,12	LT3=C,O10,/O10	LO5=T3	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=T3O11	

* The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Programming Custom Protection Schemes

Groups of commands can be saved to an ASCII text file and then uploaded as a group. However, care should be taken to ensure that every command is terminated with either a carriage return or a semi-colon and that the length for any line does not exceed 40 characters. Some common method of handshaking must be enabled at both the relay and the computer uploading the commands. Handshaking such as XON/XOFF (X1) or RTS/CTS (H1) should be used. Information about configuring handshaking can be found in the Communication Settings sub-section of the *Functional Description* chapter.

Customizing Preprogrammed Schemes

To customize a preprogrammed scheme, follow these steps:

1. Copy the preprogrammed scheme logic equations to custom memory by using the LN=<preprogrammed_logic_name> command. All previous equations assigned to the custom logic are overwritten with the equations from the preprogrammed logic scheme.
2. Rename the scheme to a unique, non-preprogrammed name by using the LN=<new_name> command. This allows the scheme to be programmable.
3. Change the logic equations as needed using the LF, LI, LT, and LO commands. Any equations not changed will be left as they were.
4. Review the changes using LINFO<new_name> or the LF, LI, LT, and LO commands.
5. If the new logic is to become the active logic, then type LOGIC=<new_name>.
6. Save the customized scheme using the SAVE command.
7. Example: Modify the pre-programmed BFL1A logic scheme so that breaker status is defined by the 52A contact instead of the 52B contact. Give this custom logic scheme the name of BFL1-25A. The following commands change the equations that use the 52b logical input and rename the logic scheme.
8. LN=BFL1
9. LN=BFL1-52A
10. LO6=I1/I2
11. LO12=F3/I1
12. LOGIC=BFL1-52A
13. SAVE;Y

Programming Custom Schemes

To program a new scheme, follow these steps:

1. Name the scheme with a unique, non-preprogrammed name by using the LN=<new_name> command. This allows the scheme to be programmable.
2. Disable the outputs or function modules not needed by setting them equal to 0. (i.e. LO12=0). All equations in a group can be programmed or disabled at once by not using a number.
3. Example 1: LI=8,12 changes all input logic to 8,12.
4. Example 2: LO=0 clears all output equations before writing new ones.
5. Change the logic equations using LINFO<new_name> or the LF, LI, LT, and LO commands.
6. Review the changes using LINFO<new_name> or the LF, LI, LT, and LO commands.
7. If the new logic is to become the active logic, then type LOGIC=<new_name>.
8. Use the SAVE command to save the customized logic scheme.

Custom Application Examples

Breaker Failure Logic for Breakers with Pre-Insertion Resistors (BFRES)

BFRES logic is an example of an adaptive breaker resistor protection scheme that allows more time for the fault to clear once the breaker resistor has reduced the fault current. For more information, refer to *Breaker Failure Protection with Pre-Insertion Resistors* in the *Application* chapter.

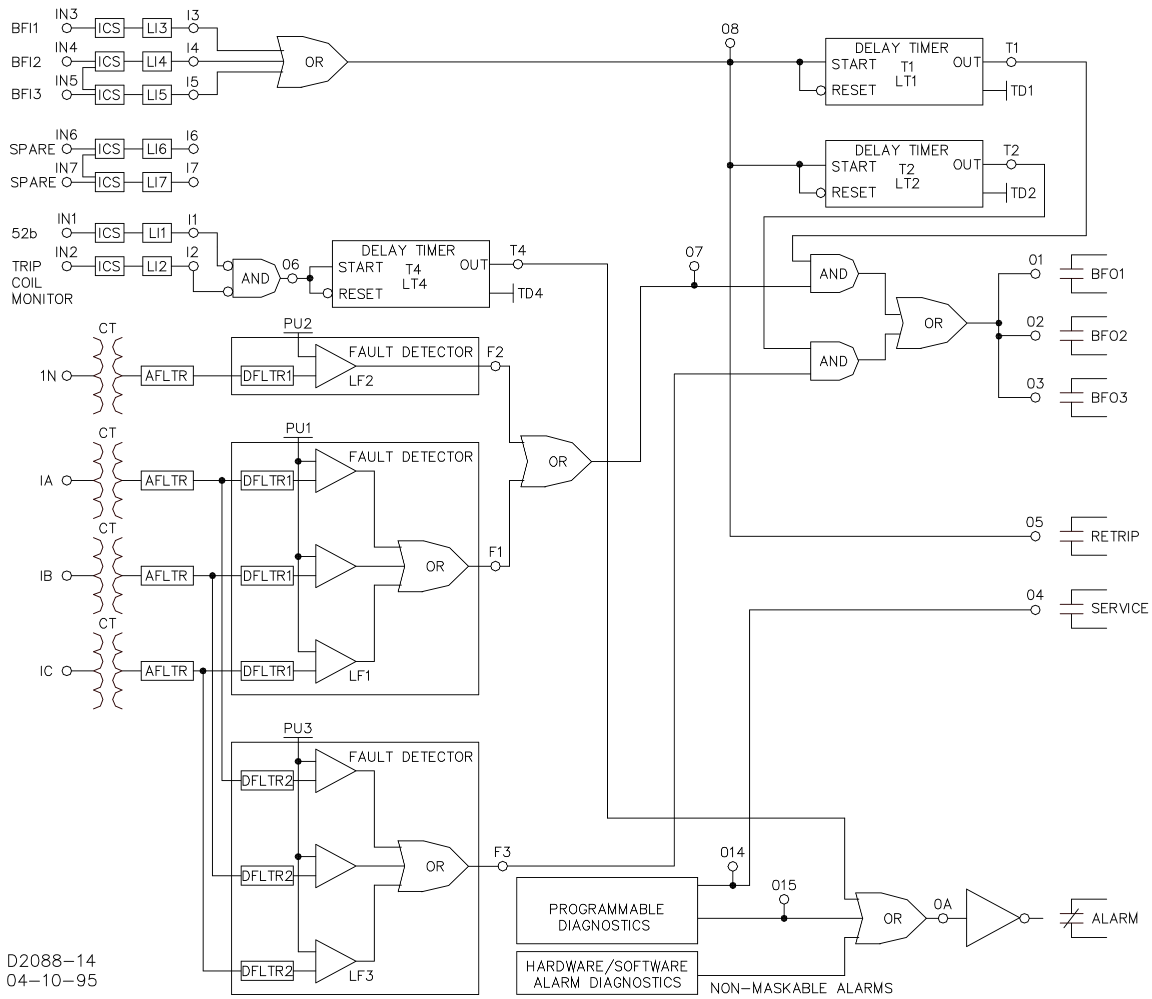


Figure 62. BFRES Logic Diagram

LN=BFRES	LI6=4,12	LOA=T4+O15 ∗	LO9=0
LF1=PI,1	LI7=4,12	LO1=T1O7+T2F3	LO10=0
LF2=NI,1	LR=0,0,0,0,0	LO2=T1O7+T2F3	LO11=0
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7+T2F3	LO12=F3I1
LI1=4,12	LT2=D,O8,/O8	LO4=O14	
LI2=4,12	LT3=0,0,0	LO5=O8	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=0,0,0	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=I3+I4+I5	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic with Reclosing (BF+79)

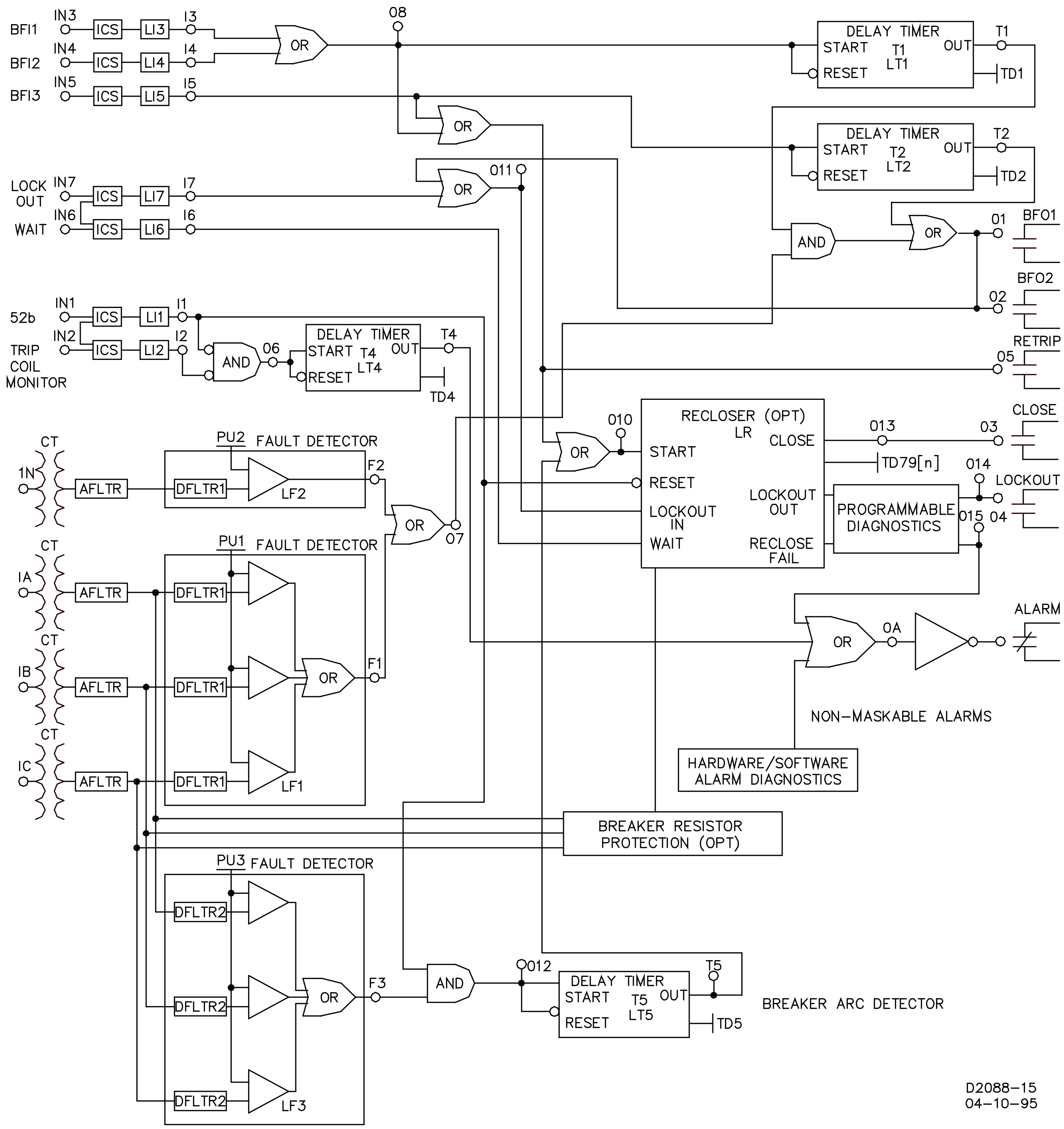


Figure 63. BF+79 Logic Diagram

LN=BF+79	LI6=4,12	LOA=T4+O15 ∗	LO9=0
LF1=PI,1	LI7=4,12	LO1=T1O7+T2	LO10=0
LF2=NI,1	LR=1,O10,/I1,I6,O11	LO2=T1O7+T2F3	LO11=0
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7+T2F3	LO12=F3I1
LI1=4,12	LT2=D,I5,/I5	LO4=O14	
LI2=4,12	LT3=0,0,0	LO5=O8	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=4,12	LT6=0,0,0	LO8=I3+I4+I5	

∗ The non-maskable alarms ORed with the programmable diagnostics to provide an alarm output.

Communications

Communications allow the operator to retrieve information about the relay or power system from a remote location and to request special reports. It also allows the operator to select a specific system protection scheme or to completely reprogram the relay for a new scheme. A communication port on the front of the relay provides a temporary, local interface for all communication functions. Rear ports provide a permanent interface for communications to other areas.

Interface

Communication capability is provided on the relay front and rear panels. The front panel interface mates with standard RS-232 (DB-9, male) connectors. The rear panel interface uses standard RS-232 (DB-9) and RS-485 (Terminal Block) connections. The relay communications protocol is compatible with readily available modem/terminal software. The RS-232 communication ports use the DCE (data circuit-terminating equipment) type interface and support full duplex operation. The RS-485 communication port supports half-duplex multi-drop operation. Only one port, front or rear, may be used at a time. The rear port is the default port, but operation will automatically switch to the front port if a hardware handshake line (CTS) is asserted. If the rear communication port is active when the front port is enabled, the current command is completed and the handshake (CTS) line at the rear port will be de-asserted. As soon as communication ceases, the relay will switch to the front port and assert the front panel handshake line (RTS). Only one rear port interface (RS-232 or RS-485) may be used at a time.

Applications

The front panel communication port, COM0, is intended for short-term local communication. Hardware security is provided by a wire seal on the front panel, which limits unauthorized access. Password protection provides additional security if required.

Rear panel communications ports, COM1A and COM1B, are intended for continuous operation. They support either RS-232 (COM1A) or RS-485 (COM1B) communications. The RS-485 port (COM1B) and RS-232 port (COM1A) use the same address so that they can be multi-dropped (polled mode). Although not intended for multi-dropping, COM1A can be used this way with a RS-232 splitter. COM1A and COM1B ports are located on physically separate connectors but are internally connected to the same data stream. The rear panel communication ports have no hardware security other than the mounting panel enclosure. Password protection provides additional security if required.

Front and rear panel communication ports may be used to interface terminals, computers, serial printers, modems, and intermediate communication/control interfaces such as RS-232 serial multiplexors. Relay communications protocols support ASCII and binary data transmissions. ASCII data is used to send and receive human readable data and commands. Binary data is used for transmission of raw oscillograph fault data.

BESTview™ for Windows®

BESTview for Windows is a software application program that enables communication between personal computers and BE1-BPR relays. Through BESTview, you can retrieve and display COMTRADE oscillograph fault data, access the front panel from a remote location to change settings, retrieve a computer file of the relay settings, or send a computer file to the relay to perform all relay settings.

BESTview can be downloaded from www.basler.com.

Command Format

Each command consists of an ASCII string terminated by a carriage return, <CR>. A line feed <LF> is optional. A semicolon may be used to separate multiple commands on a single line, however, the total line length cannot exceed the size of the communication buffer (40 characters).

Command Format: [<ID>]<CMD1>[<;>CMD2<;>…<;>CMDn]<CR>[<LF>]

where

[ ]	=	Brackets identify optional parameters - brackets themselves are not part of command.
< >	=	Separator used for clarity - not an actual part of the command.
ID	=	Relay identifier used for RS-485 multi-drop (polled) communications.
CMDn	=	<Name>[#][<=><Setting-1>…[<,><Setting-n>]]
Name	=	Command name (1 to 8 characters)
#	=	Numeric or phase identifier to limit command to a specific item.
=	=	Used to indicate that the command is to change data/settings not to recall data.
Setting-n	=	Command setting(s).
,	=	Comma used as setting separator.
;	=	Semicolon used to separate multiple commands on the same line.
CR	=	Carriage return used to end command and start execution.
LF	=	Line feed may be used for clarity. Ignored by relay.
Spaces	=	One or more spaces may be added between entries for clarity if desired.

Commands received by the BE1-BPR relay consist of two general types: requests for information and changes to operating parameters. Requests for information will always be accepted and executed, however changes to operating parameters may be limited to access from personnel with the proper password. Commands to change parameters are identified by an equals sign, '=', being included in the command. The new operating parameters to the right of the equals sign are intended to replace the current operating parameters related to the command.

Some commands may pertain to multiple items. In that case, a numeric or phase identifier is used after the command name to specify a single item. If the identifier is left off, the command applies to all possible items. For example, the IA command could be used to read the current on phase A or the I command without the phase identifier would read the current on all inputs.

Multi-Drop (Polled) Command Operation

Note

For polled operation over the RS-485 interface, the hardware handshake (RTS/CTS), software handshake (XON/XOFF), and echo options must be disabled on COM1 (i.e. COM1=,H0,E0,X0).

Each relay can have a unique identification number programmed from 1-254. If the Relay internal ID is set to 0 (zero), then polled operation is disabled and the ID prefix is not required as part of the command. If a non-zero ID is programmed for the relay, the relay ID number must preface each command sent to the relay through either of the rear communications ports. The command ID is never required from the front panel communications port.

In polled mode, the relay waits until it is polled (i.e. - receives a command identified for it), then it responds. Any data string that does not start with the proper ID will be ignored.

A unique ID is reserved to communicate with ALL relays operating in multi-drop mode and connected to the same network. Any command prefaced by an ID of '!' will cause all Relays receiving the command to execute the command but not to respond (BROADCAST OPERATION - NO RESPONSE). This type of operation allows commands to be executed simultaneously by multiple relays. For example, 17TIME would read the current time setting of Relay 17 and !TIME=12:05:37 would simultaneously set all relays on network to the new time entered.

Creating Settings Files

A settings file is useful because one of the standard logic schemes can be modified to suit an application and then uploaded to several relays. The SHOWSET command allows relay settings to be read, edited, and then uploaded to BE1-BPR relays.

SHOWSET	Relay settings report	HMI Menu Branch: N/A
Comments		
This command returns a report of relay settings and logic equations. SHOWSET can be used at the end of a programming session to make a record of relay settings. If saved to a file, the record can be used to set up another relay with the same protection scheme by sending the data to the other relay.		

SHOWSET Command Example:

Obtain a report of the current relay settings.

SHOWSET

```
PW1=AREA1PW,B; PW2=AREA2PW,B; PW3=AREA3PW,B; PW4=AREA4PW,B
LN=USER
LF1=PI,1;       LF2=NI,1;       LF3=PI,2
LI1=4,12;       LI2=4,12;       LI3=4,12;       LI4=4,12;       LI5=4,12
LI6=4,12;       LI7=4,12
LR=0,0,0,0,0
LT1=D,O8,/O8;   LT2=D,O9,/O9;   LT3=C,O10,/O10; LT4=D,O6,/O6;   LT5=D,O12,/O12
LT6=0,0,0
LOA=T4+O15
LO1=O3
LO2=O3
LO3=T1O7+F1T2+O1O7
LO4=T5
LO5=T3
LO6=/I1/I2
LO7=F1+F2
LO8=T3O11
LO9=T3I6+T3I7
LO10=I6+I7+O11
LO11=I3+I4+I5
LO12=F3I1
LOGIC=USER
FREQ=60
ID=0
PU1=1.00;       PU2=1.00;       PU3=1.00,10
TD1=  20m;      TD2=  20m;      TD3=  20m;      TD4=  20m;      TD5=  20m
TD6=  20m
TD791= 111m;    TD792= 111m;    TD793= 111m;    TD79R= 111m;    TD79F= 111m
TD79M= 111m
CTP=1;          CTN=1
PHOLD=11111
SNAME=5,SUBSTATION_1
PCLK=M,24
PDISPLAY=0,0
COM0=96008N1,A0,E0,H0,P0,X0
COM1=96008N1,A0,E0,H0,P0,X0
PTARGET=0011111,11110
TRIGGER=O5
PTLOG1=0,L,0m;  PTLOG2=0,H,11m; PTLOG3=0,L,11m; PTLOG4=0,H,12m; PTLOG5=0,L,13m
PTLOG6=0,H,14m
PDIAG=00000000,00000000
BKRCON=0.000E+00,0,0
BKROPS=,I1
BKRRES=0,0,0.000E+00
```

The following procedure describes how relay settings can be read, modified, saved to a file, and uploaded to BE1-BPR relays. Any commercially available communications software may be used.

1. Obtain password access to area one and use the SHOWSET command to obtain a report of all relay settings. Getting password access to area one before using the SHOWSET command will ensure that all passwords are displayed in the settings report. If password access is not obtained, passwords will be displayed as asterisks (********).
2. Once the settings are displayed, copy the settings to a text editor such as Microsoft® Notepad®.
3. Edit the settings by making changes and deletions where required. You should ensure that each command is terminated with a carriage return or semicolon and that line length does not exceed 40 characters. An example of settings that were read using the SHOWSET command and then copied to a text editor is shown below. Text and settings that must be removed prior to uploading are shown shaded in gray. The `PRESS ANY KEY TO CONTINUE…` message can be avoided by setting the page mode at P0 in the BE1-BPR communication settings. This setting is recommended if your terminal emulation software included a scroll buffer.

```
PW1=AREA1PW,B; PW2=AREA2PW,B; PW3=AREA3PW,B; PW4=AREA4PW,B
LN=USER
LF1=PI,1;       LF2=NI,1;       LF3=PI,2
LI1=4,12;       LI2=4,12;       LI3=4,12;       LI4=4,12;       LI5=4,12
LI6=4,12;       LI7=4,12
LR=0,0,0,0,0
LT1=D,O8,/O8;   LT2=D,O9,/O9;   LT3=C,O10,/O10; LT4=D,O6,/O6;   LT5=D,O12,/O12
LT6=0,0,0
LOA=T4+O15
LO1=O3
LO2=O3
LO3=T1O7+F1T2+O1O7
LO4=T5
LO5=T3
LO6=/I1/I2
LO7=F1+F2
LO8=T3O11
LO9=T3I6+T3I7
LO10=I6+I7+O11
LO11=I3+I4+I5
LO12=F3I1
LOGIC=USER
FREQ=60
ID=0
PU1=1.00;       PU2=1.00;       PU3=1.00,10
TD1=  20m;      TD2=  20m;      TD3=  20m;      TD4=  20m;      TD5=  20m
TD6=  20m
TD791= 111m;    TD792= 111m;    TD793= 111m;    TD79R= 111m;    TD79F= 111m
TD79M= 111m
CTP=1;          CTN=1
PHOLD=11111
SNAME=5,SUBSTATION_1
PCLK=M,24
PDISPLAY=0,0
COM0=96008N1,A0,E0,H0,P0,X0
COM1=96008N1,A0,E0,H0,P0,X0
PTARGET=0011111,11110
TRIGGER=O5
PTLOG1=0,L,0m;  PTLOG2=0,H,11m; PTLOG3=0,L,11m; PTLOG4=0,H,12m; PTLOG5=0,L,13m
PTLOG6=0,H,14m
PDIAG=00000000,00000000
BKRCON=0.000E+00,0,0
BKROPS=,I1
BKRRES=0,0,0.000E+00
```

4. Once all changes are made, save the settings as a text file (.txt). It is recommended that the settings saving process can be automated by ending the settings list with the command string SAVE;Y followed by a carriage return.
5. The text file containing the settings can be uploaded to any BE1-BPR relay using the communications software that was used to view the relay settings.

Note
Settings files created from relays with software 2.23 or 3.23 and earlier will cause error messages when uploaded to relays with software version 3.26 or later. When the SHOWSET command is used to retrieve a settings report from relays with software version 2.23 or 3.23 and earlier, some settings are reported that are not adjustable. These settings include the CTI command (current sensing selection) and logic output equations LO13, LO14, and LO15. These settings are not reported or accepted by relays with software version 3.26 or later. Settings files from earlier software versions can be made compatible with all BE1-BPR relays by deleting the CTI command and the LO13, LO14, and LO15 equations.

Commands

The following paragraphs briefly summarize the function and syntax of each command and provide a reference where information that is more detailed can be found.

ACCESS

Purpose: Reads or changes access area so that programming or settings changes can be made.

Syntax: ACCESS[=<password>]

Reference: *Functional Description, Software Functional Description, Changing Parameters Using Communication Ports*

BKRCON (Enhanced Relays Only)

Purpose: Reads or changes data on the breaker contacts used by breaker diagnostic routines.

Syntax: BKRCON[=<DMAX>,<Tc>,<Ti>]

Reference: *Functional Description, Software Functional Description, Breaker Status, Breaker Contact Duty Diagnostics (Enhanced Relays Only)*

BKROPS

Purpose: Reads or changes breaker operations data.

Syntax: BKROPS[=<#operations>,<52a/b contact logic>]

Reference: *Functional Description, Software Functional Description, Breaker Status, Breaker Status Screens*

BKRRES

Purpose: Reads or changes data on the breaker resistor used by breaker diagnostic routines.

Syntax: BKRRES[=<MAXOPS>,<reset>,<Ires>]

Reference: *Functional Description, Software Functional Description, Breaker Status, Breaker Resistor Diagnostics*

CAL

Purpose: Read or change calibration values.

Syntax: CAL[x][=<amps>]

Reference: *Functional Description, Software Functional Description, Maintenance, Calibrating the Analog Channels*

COM

Purpose: Reads or changes the communications protocol

Syntax: COM[x][=<ratedps>][,Ay][,Ey][,Hy][,Pyy][Xy]

Reference: *Functional Description, Software Functional Description, Maintenance, Communication Settings*

CT

Purpose: Reads or changes the current transformer ration settings.

Syntax: CT[t][=<ratio>]

Reference: *Functional Description, Relay Setup, Transformer Ratios*

DATE

Purpose: Reads or changes the date setting.

Syntax: DATE[=<dm>/<md>/<yr>]

Reference: *Functional Description, Maintenance, Time and Date*

DIAG

Purpose: Reads or resets diagnostic information.

Syntax: DIAG[=0]

Reference: *Functional Description, Relay Status*

DLOG (Enhanced Relays Only)

Purpose: Reads or changes breaker contact duty log data.

Syntax: DLOG[P][=<YY>]

Reference: *Functional Description, Breaker Status, Breaker Contact Duty Diagnostics (Enhanced Relays Only)*

FLOG (Enhanced Relays Only)

Purpose: Reads a listing of all fault records, reads summary information about any individual fault record or clears all fault records.

Syntax: FLOG[#][=0]

Reference: *Functional Description, Fault Log (Enhanced Relays Only), Fault Log Listing*

FLT (Enhanced Relays Only)

Purpose: Obtains a COMTRADE report.

Syntax: FLT<#><type>

Reference: *Functional Description, Fault Log , Oscillographic Data Acquisition*

FREQ

Purpose: Reads or changes the nominal power system frequency information used by the relay.

Syntax: FREQ[=<freq(hz)>]

Reference: *Functional Description, Maintenance, Calibrating the Analog Channels*

HELP

Purpose: Obtains helpful information about communication port commands.

Syntax: HELP[x/<cmd>]

Reference: *Functional Description, Software Functional Description, Introduction*

I

Purpose: Reads the primary current value of all or individual phases.

Syntax: I[<phase>]

Reference: *Functional Description, Software Functional Description, Relay Status*

ID

Purpose: Reads or programs a relay ID number for polled communication.

Syntax: ID [=<id(0-255)>]

Reference: *Functional Description, Software Functional Description, Maintenance, Communication Settings*

LF

Purpose: Reads or changes the fault detector logic of the active logic scheme.

Syntax: LF[x][=<type>,<filter>]

Reference: *Functional Description, Software Functional Description, Relay Setup, Fault Detectors*

LI

Purpose: Reads or programs contact input logic.

Syntax: LI [#[=<r>,<db>]]

Reference: *BESTLOGIC Programmable Logic, Contact Input Logic, Definition of Input Contact Operation*

LINFO

Purpose: Reads the names of all logic schemes in memory or the equations associated with the named logic scheme.

Syntax: LINFO[<name>]

Reference: *BESTLOGIC Programmable Logic, General*

LN

Purpose: Reads the name of the active logic or program a new set of logic equations called <name>.

Syntax: LN[=<name>]

Reference: *BESTLOGIC Programmable Logic, Logic Names*

LO

Purpose: Reads or programs output logic.

Syntax: LO [#[=<Boolean equation>]]

Reference: *BESTLOGIC Programmable Logic, Programming Output Operational Characteristics*

LOGIC

Purpose: Reads or changes the active logic of the relay.

Syntax: LOGIC[=<existing name>]

Reference: *BESTLOGIC Programmable Logic, General*

LR

Purpose: Reads or programs the recloser input logic.
Syntax: LR [=<type>,<start>,<reset>,<wait>,<lockout>]
Reference: *BESTLOGIC, Recloser Logic, Programming Definition Characteristics*

LT

Purpose: Reads or changes timer logic.
Syntax: LT[x][=<type>,<start>,<reset>]
Reference: *Functional Description, Relay Setup, Timers*

OUT

Purpose: Pulses outputs on or off for testing purposes.
Syntax: OUT[x=<1/0>/DISABLE]
Reference: *Functional Description, Maintenance, Output Contact Testing*

PCLK

Purpose: Reads or changes the time clock time/date format.
Syntax: PCLK[=<date_format(M/D)>,<time_format(12/24)>]
Reference: *Functional Description, Software Functional Description, Maintenance, Time And Date*

PDIAG

Purpose: Reads or programs service diagnostic alarms.
Syntax: PDIAG[=<DIAG1 mask>,<DIAG2 mask>]
Reference: *Functional Description, Software Functional Description, Relay Status*

PDISPLAY

Purpose: Reads or programs the default HMI display screen.
Syntax: PDISPLAY[=<default_menu>,<default_screen>]
Reference: *Functional Description, Software Functional Description, Maintenance, Default HMI Display Screen*

PHOLD

Purpose: Reads or programs the output hold timer mask.
Syntax: PHOLD[=<#####>]
Reference: *Functional Description, Software Functional Description, Relay Setup, Reclosing*

POSC

Purpose: Reads or programs the number of oscillograph fault records saved.
Syntax: POSC[=x]
Reference: *Functional Description, Software Functional Description, Fault Log*

PTARGET

Purpose: Reads or programs the target operation and display.
Syntax: PARGET[=<iiiiiii>,<ooooo>]
Reference: *Functional Description, Software Functional Description, Target Data, TARGETS Screen*

PTLOG

Purpose: Reads or changes timer log and alarm logic.
Syntax: PTLOG [#[=<logic term>,<alm_type>,<alm_time>]]
Reference: *Functional Description, Software Functional Description, Timer Log*

PU

Purpose: Reads or changes the fault detector pickup levels

Syntax: PU[x] [=<level>[,<cycles>]]

Reference: *Functional Description, Software Functional Description, Relay Setup, Fault Detector*

PW

Purpose: Reads or changes password settings.

Syntax: PW [<#>[=<password>,<access(F/R/B)>]]

Reference: *Functional Description, Software Functional Description, Maintenance, Programming A New Password*

QUIT

Purpose: Exits the programming mode and returns the relay to on-line without saving any changes.

Syntax: QUIT

Reference: *Functional Description, Software Functional Description, Changing Parameters Using Communication Ports*

RESET

Purpose: Clears latched target data.

Syntax: RESET

Reference: *Functional Description, Software Functional Description, Target Data, TARGETS Screen*

SAVE

Purpose: Saves programming or settings changes, exits the programming mode, and returns the relay to an on-line condition.

Syntax: SAVE

Reference: *Functional Description, Software Functional Description, Changing Parameters Using Communication Ports*

SHOWSET

Purpose: Returns a report of relay settings and logic equations.

Syntax: SHOWSET

Reference: *BESTLOGIC Programmable Logic, Miscellaneous Commands*

SNAME (Enhanced Relays Only)

Purpose: Reads or changes the station name and number for COMTRADE reports.

Syntax: SNAME [=<#>,<name>]

Reference: *Functional Description, Software Functional Description, Fault Log (Enhanced Relays Only), Data Acquisition*

STATUS

Purpose: Returns a report of inputs, outputs, and internal relay status.

Syntax: STATUS

Reference: *Functional Description, Software Functional Description, Relay Status*

TARGET

Purpose: Reads input and output target information

Syntax: TARGET

Reference: *Functional Description, Software Functional Description, Target Data, TARGETS Screen*

TD

Purpose: Reads or changes timer delay settings.

Syntax: TD[x][=<delay>]]

Reference: *Functional Description, Software Functional Description, Relay Setup, Timers*

TD79

Purpose: Reads or changes recloser (79) time delay changes.

Syntax: TD[x][=<delay>]]

Reference: *Functional Description, Software Functional Description, Relay Setup, Reclosing*

TEST

Purpose: Reads diagnostic data.

Syntax: TEST

Reference: *Functional Description, Relay Status*

TIME

Purpose: Reads or changes the time clock.

Syntax: TIME [=<hr>:<mn><f><sc>.<msc>]

Reference: *Functional Description, Software Functional Description, Maintenance, Time And Date*

TLOG

Purpose: Reads or reset the timer logs.

Syntax: TLOG[#]

Reference: *Functional Description, Software Functional Description, Timer Log*

TRIGGER (Enhanced Relays Only)

Purpose: Reads or changes the trigger logic or triggers a fault record.

Syntax: TRIGGER[=<logic term>/Y]

Reference: *Functional Description, Software Functional Description, Fault Log (Enhanced Relays Only), Oscillographic Data Acquisition*

VER

Purpose: Returns information about relay hardware and software.

Syntax: VER

Reference: *Functional Description, Software Functional Description, Maintenance, Software Version Display*

Calibration and Testing

BE1-BPR calibration and an operational test procedure are described in this chapter.

Calibration

Test equipment required - ac current source.

To calibrate the relay, perform the following steps.

Calibration Using a Communications Port

Step 1. Connect all current inputs (A, B, C, and N) in series with the ac current source and apply power to the relay.

Step 2. Connect a terminal to the front or rear communications port configured for the protocol shown in sub-screen 2 of the HMI MAINTENANCE menu branch. (The factor default protocol is 96008N1.) Use the ACCESS command to obtain access to area one.

Step 3. Use the FREQ command to review or change the power system frequency information as required. This information determines the sampling rate and filter characteristics and must be set for the proper frequency (50/60 Hz) before calibrating the A/D converter.

Step 4. Using Table 12 as a guide, apply the appropriate value of current and enter the corresponding calibration command.

Table 12. Low Range Calibration Parameters

Current Sensing	Current	Command
1 ampere CT	2 amperes	CAL1=2
5 ampere CT	10 amperes	CAL1=10

The relay will perform the required calibration and verify that the ADC counts per ampere are within the acceptable accuracy range. If the calibration is acceptable, the relay will respond with CAL OKAY.

Step 5. This step applies only to enhanced model relays (high range capability). Using Table 13 as a guide, apply the appropriate value of current and enter the corresponding calibration command.

Table 13. High Range Calibration Parameters

Current Sensing	Current	Command
1 ampere CT	8 amperes	CAL2=8
5 ampere CT	40 amperes	CAL2=40

The relay will perform the required calibration and verify that the ADC counts per ampere are within the acceptable accuracy range. I the calibration is acceptable, the relay will respond with CAL OKAY.

Step 6. Use the SAVE command to save the calibration data in nonvolatile memory.

Calibration Using the Front Panel Display and Keyboard

The following steps show values for calibrating relays with 5 ampere CTs. Relays with 1 ampere CTs can be calibrated with the same procedure by applying the 1 ampere current sensing values listed in Tables 12 and 13.

Step 1. Connect all current inputs (A, B, C, and N) in series with the AC current source and apply power to the relay.

Step 2. Use the front panel keys to select the fourth sub-screen of the MAINTENANCE menu branch. Adjust the system frequency for 50 or 60 Hz.

```
CAL            FREQ
RANGE-1L/2H    60
```

Step 3. Select the low range calibration screen and verify that the power system frequency (shown under the FREQ heading) is correct. Examples of low range, 50 hertz and 60 hertz calibration screens for a relay with 5 ampere CTs are shown below. This information determines the sampling rate and filter characteristics and must be set for the proper frequency (50 or 60 Hz) before calibrating the relay.

```
CAL            FREQ
1      10.00    50
```

50 Hertz Calibration

```
CAL            FREQ
1      10.00    60
```

60 Hertz Calibration

Step 4. Using Table 12 as a guide, apply the appropriate current value to the relay. Start the calibration process by pressing the right arrow key until calibration begins. The relay will perform the required calibration and verify that the ADC counts per ampere are within the acceptable accuracy range. While the calibration is in progress, the display will show WORKING. If the calibration is acceptable, the relay will respond with CAL OK.

Step 5. This step applies only to enhanced model relays (high range capability). Select the high range calibration screen. Examples of high range, 50 hertz and 60 hertz calibration screens for a relay with 5 ampere CTs are shown below. Using Table 13 as a guide, apply the appropriate current value to the relay. Start the calibration process by pressing the right arrow key until calibration begins. The relay will perform the required calibration and verify that the ADC counts per ampere are within the acceptable accuracy range. While the calibration is in progress, the display will show WORKING. If the calibration is acceptable, the relay will respond with CAL OK.

```
CAL            FREQ
2      40.00    50
```

```
CAL            FREQ
2      40.00    60
```

Step 6. Once the calibration is completed, the calibration data must be saved to nonvolatile memory by pressing and holding the PROG key until the SAVE screen appears. Use the +/- key to select Y and press the PROG key to save the calibration data.

Operational Test Procedure

Preliminary Setup Procedure

Step 1. Apply nominal power supply voltage to the relay PWR terminals.

Step 2. Connect a terminal or computer operating in terminal mode to the front (COM0) or rear (COM1) serial port. Use the front panel right and down arrow buttons to select the communication settings screen of the MAINTENANCE menu branch. Verify that the protocol shown is correct for the terminal or computer connected. If it is incorrect, enter PROGRAM mode by pressing the PROG key and change to the desired setting, using the EDIT, +/-, and right arrow keys. When change is complete, exit program mode by holding down the PROG key for two seconds, change the prompt to Y by pressing the EDIT, +/- key, and then press the PROG key briefly.

Select Operational Logic

Step 1. Select the logic scheme desired from the standard schemes available or define and select a new scheme as required.

A. Selecting preprogrammed (pre-defined) scheme by entering the following commands:

>ACCESS=<password> or ACCESS=BPR if password not used.

>LOGIC=<name of preprogrammed scheme>
>SAVE
`ARE YOU SURE (Y/N)?` **- Y**
```
RELAY OFF-LINE
CHANGES SAVED
RELAY ON-LINE
>
```

B. Define custom logic by changing a preprogrammed scheme with the following commands:

>ACCESS=<password> or ACCESS=BPR if password not used.

>LN=<name of preprogrammed scheme to modify> (copies preprogrammed scheme to custom logic memory)

>LN=<name of new scheme> (allows scheme to be changed)

Use **LO, LF, LI, LT** commands as required to change logic.

>LOGIC=<name of new scheme>
>SAVE
`ARE YOU SURE (Y/N)?` **- Y**
```
RELAY OFF-LINE
CHANGES SAVED
RELAY ON-LINE
>
```

C. Define a custom logic scheme without copying any previous file.

>ACCESS=<password> or ACCESS=BPR if password not used.

>LN=<name of new scheme> (allows scheme to be changed)

Use **LO, LF, LI, LT** commands as required to change logic.

Disable the outputs or function modules not needed by setting them equal to 0.
(I.E. LO12=0)

All equations in a group can be programmed or disabled at once by not using a number.

Example 1: LI=4,12 changes all input logic to 4,12.

Example 2: LO=0 clears all output equations before writing new ones.

>LOGIC=<name of new scheme>
>SAVE
`ARE YOU SURE (Y/N)?` **- Y**
```
RELAY OFF-LINE
CHANGES SAVED
RELAY ON-LINE
>
```

Entering Settings

Step 1. Perform the preliminary setup procedure and select the operational logic.

Note
Steps 3 through 16 of this procedure can be automated by using any word processor to type all required commands into an ASCII file. This file would then be uploaded to the relay using any standard communications software package or by printing the file to the serial port. This procedure requires that the communications program or the computer serial port communication mode supports handshaking (flow control).

Step 2. Calibrate the A/D section of the relay using the A/D calibration procedure described above.

Step 3. Enter program mode from the communication port by entering:
>ACCESS=<password> or ACCESS=BPR if password not used.

Step 4. Enter the CT ratios, using the CT command.

Step 5. Enter the Pickup settings, using the PU command.

Step 6. Enter the Time Delay settings, using the TD and TD79 commands.

Step 7. Program the format of the real-time clock by using the PCLK command.

Step 8. Program the service diagnostic alarms by using the PDIAG command.

Step 9. Program the primary display screen (default screen when no targets are latched) by using the PDISPLAY command.

Step 10. Program the Target operation by using the PTARGET command.

Step 11. Program the Timer Log settings by using the PTLOG command.

Step 12. Enter the communication settings using the COM command.

Step 13. Enter Passwords using the PW command.

Step 14. If the breaker status is monitored, enter the breaker close logic and initial operations count by using the BKROPS command.

Step 15. If the fault recording option is installed, enter the station name and number in the relay by using the SNAME command and enter the fault trigger logic using the TRIGGER command.

Step 16. If the relay is monitoring a breaker with an opening resistor then enter the breaker resistor information by using the BKRRES commands.

Step 17. If the relay has the breaker contact duty log option, then enter the breaker contact data by using the BKRCON command and enter the initial breaker contact duty by using the DLOG command.

Step 18. Save the new settings using the SAVE command.

Step 19. Verify the new commands are correct by using the SHOWSET command.

Operational Testing

Step 1. Use the PDIAG command to check for any diagnostic problems.

Use DIAG=0 to clear diagnostic log.

Step 2. Connect a current source to any current input.

Step 3. Verify that the logic scheme selected is operating as desired by simulating fault conditions with the current source and input contacts.

Step 4. Record the relay serial number, part number, logic, and operational settings for future reference. This can be done easily with any standard communication program by opening a file and then saving the relay response to the VER and SHOWSET commands.

Commands Summary

Table 14 provides an alphabetical list of communication commands. Refer to the *Functional Description* chapter for HMI menu branch numbering and screen locations.

Table 14. Communication Commands

∗ = Enhanced Relays Only			**HMI Menu Branch**	
Command		**Function**	**Standard Models**	**Enhanced Models**
ACCESS[=<password>]		Read/change access area in order to change settings.	N/A	N/A
BKRCON[=<DMAX>,<Tc>,<Ti>]	∗	Read/change breaker contact data.	3	3
BKROPS[=<#operations>,<52a/b contact logic>]		Read/change breaker operations data.	3	3
BKRRES[=<MAXOPS>,<reset>,<lres>]		Read/change breaker resistor data.	N/A	N/A
CAL[x[=<level>]]		Read/change ADC channel calibration.	5	6
COM[x[=<ratedps>[,Ay][,Ey][,Hy][,Pyy][,Xy]]		Read/change the serial communications protocol.	5	6
CT[P/N][=<ratio>]		Read/change the Phase or Neutral CT ratio.	N/A	N/A
DATE[=<dm>/<md>/<yr>]		Read/change the date.	5	6
DIAG[=0]		Read/reset diagnostic log information.	2	2
DLOG[p[=<yy>]]	∗	Read/change the contact duty log.	N/A	3
FLOG[x][=0]	∗	Read fault log or clear FLOG and FAULT data.	N/A	5
FLT<#.<type>	∗	Read COMTRADE report for fault <xxx>.	N/A	N/A
FREQ[=<freq>]		Read/change power system frequency.	5	6
HELP/H or HELP/H<cmd> or HELP1/H1		HELP/H returns information about using HELP. HELP/H<cmd> returns help on a specific command. HELP1/H1 returns a complete list of commands.	N/A	N/A
I[<phase>		Read phase current in primary units.	2	2
ID[=<id>]		Read/change relay ID number for polled communications.	N/A	N/A
LF[x][=<type>,<dflt>]		Read/change logic for fault detector operation.	N/A	N/A
LI[x][=<r>,<db>]		Read/change logic for contact inputs.	N/A	N/A
LINFO[<name>]		Read logics available or <name> logic equations.	N/A	N/A
LN[=<name>]		Read/change custom logic name.	1	1
LO[#[=<Boolean equation>]]		Read/change program operation for an output.	N/A	N/A
LOGIC[=<existing name>]		Read/change the name of the active logic scheme.	1	1
LR[=<type>,<start>,<reset>,<wait>,<lockout>]		Read/program the logical inputs to the recloser function block.	N/A	N/A
LT[x[=<type>,<start>,<reset>]]		Read/change logic for timer/counter operation.	N/A	N/A
OUT[x][=<1/0>/DISABLE]		Pulse output ON (1) OR OFF (0) for test.	N/A	N/A
PCLK[=[<date_format>,<time_format>]		Read/program date/time format.	N/A	N/A
PDIAG[=<DIAG1 mask>,<DIAG2 mask>]		Read/program diagnostic alarms as ON (1) or OFF (0).	N/A	N/A
PDISPLAY[=<default_menu>,<default_screen>]		Read/program the default display screen.	N/A	N/A

* = Enhanced Relays Only			HMI Menu Branch	
Command		**Function**	**Standard Models**	**Enhanced Models**
PHOLD[=<#####>]		Read/program the 200 msec output hold mask.	N/A	N/A
POSC[=x]	*	Read/program the number of fault records saved.	N/A	N/A
PTARGET[=<iiiiii>,<ooooo>]		Read/program the target data format.	N/A	N/A
PTLOG[x[=<logic>[<alarm_type>,<alarm_time>]]]		Read/program timer log logic, alarm type, and alarm time.	N/A	N/A
PU[x][=<level>[,<cycles>]]		Read/change an overcurrent pickup level.	1	1
PW[<#>[=<password>,<access>]]		Used to change the password.	5	6
QUIT		Exit programming mode w/o saving changes.	N/A	N/A
RESET		Reset latched target data.	0	0
SAVE		Exit programming mode and save changes.	N/A	N/A
SHOWSET		Read relay setup parameters.	N/A	N/A
SNAME[=<#>,<name>]	*	Read/change station name for the COMTRADE report.	N/A	N/A
STATUS		Read status of inputs and outputs.	2, 3	2, 3
TARGET		Read target data.	0	0
TD[x][=<delay>]		Read/change timer delay setting.	1	1
TD79[n][=<delay>]		Reads/changes a recloser (79) timer delay setting.	1	1
TEST		Read diagnostic data.	N/A	N/A
TIME[=<hr>:<mn><f><sc>.<msc>]		Read/change the time.	5	6
TLOG[#]		Read timer log.	4	4
TRIGGER[=<logic term>/Y]	*	Read/change trigger logic or trigger a fault record.	N/A	N/A
VER		Read Model, SN, PN, and program data.	5	6

Specifications

BE1-BPR Breaker Protection Relays electrical and physical specifications are described below.

Current

Sensing

Four isolated inputs with a maximum burden of less than 0.1 ohm.

5 Ampere CT .... Maximum continuous current: 20 Aac
Maximum one second current: 500 Aac
1 Ampere CT .... Maximum continuous current: 4 Aac
Maximum one second current: 80 Aac

Current Detector Pickup Time

Instantaneous Fault Detector (50/60 Hz RMS Filter Type 1 and 3)

1 ¼ cycle maximum for current 125% greater than pickup.

Moving Average Window Fault Detector (50/60 Hz RMS Filter Type 2)

Maximum pickup time is (Window_size/C_PM + 1 ¼ (cy)), where Window_size = Filter window size in cycles (Range 1 - 100) and C_PM = Current Pickup Multiple

Current Detector Dropout Time

Instantaneous Fault Detector (50/60 Hz RMS Filter Type 1 and 3)

Dropout/pickup ratio: 90%, typical. One-quarter cycle (4.2 milliseconds @ 60 hertz) from the time the current falls below and stays below 25% of the RMS level or 1 ¼ cycle from the time the RMS current signal decreases to less than 75% of pickup.

Moving Average Window Fault Detector (50/60 Hz RMS Filter Type 2)

Maximum dropout time is (Window_size-(Window_size/C_PM) + 1 ¼ (cy)), where Window_size = Filter window size in cycles (Range 1 - 100) and C_PM = Current Pickup Multiple level before dropout.

Pickup Range

Three independent settings, selectable as three-phase or neutral.

Instantaneous Fault Detector (50/60 Hz RMS Filter Type 1 and 3)

5 ampere CT .... 0.25 to 9.99 amperes selectable in 0.01 increments
1 ampere CT .... 0.05 to 2.00 amperes selectable in 0.01 increments

Moving Average Window Fault Detector (50/60 Hz RMS Filter Type 2)

5 ampere CT .... 0.05 to 1.00 amperes selectable in 0.01 increments
1 ampere CT .... 0.01 to 0.20 amperes selectable in 0.01 increments

Accuracy

Instantaneous Fault Detector (50/60 Hz RMS Filter Type 1 and 3)

5 ampere CT .... ±2% of pickup setting or ±0.05 Aac (whichever is greater)
1 ampere CT .... ±2% of pickup setting or ±0.01 Aac (whichever is greater)

Moving Average Window Fault Detector (50/60 Hz RMS Filter Type 2):

5 ampere CT .... ±25% with window of 10 cycles or larger
1 ampere CT .... ±25% with window of 10 cycles or larger

Sample Rate

12 samples per cycle (720 samples per second at 60 hertz, 600 samples per second at 50 hertz).

Oscillography Records

Recording Range

5 ampere CT ....0 - 200 amperes, rms
1 ampere CT ....0 - 40 amperes, rms

Data Accuracy

±0.2% of full scale or 5% of reading, whichever is greater

Recording Format

IEEE C37.111-1991, IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems.

Contact Sensing Inputs

Recognition Time

User programmable 4 - 255 milliseconds ±0.01% of setting to closest sample time (one-twelfth cycle = 1.4 milliseconds at 60 hertz or 1.7 milliseconds at 50 hertz).

Range

Energizing levels for contact sensing inputs are jumper selectable. Table 15 lists the turn-on range for each control voltage range and jumper position. Refer to the *Installation* chapter for jumper location.

Table 15. Contact Sensing Turn-On Voltage

Nominal Control Voltage	Turn-On Range (JP200 through JP206)	
	Pin 1 - Pin 2	Pin 2 - Pin 3
48/125 Vac/Vdc	26 V to 38 V	69 V to 100 V
125/250 Vac/Vdc	69 V to 100 V	138 V to 200 V

Burden

Burden per contact for sensing depends on the power supply model and the input voltage. The input sensing range is the same as the dc power supply range. Table 16 provides appropriate burden specifications.

Table 16. Contact Sensing Burden

Nominal Control Voltage	Turn-On Range (JP200 through JP206)	
	Pin 1 - Pin 2	Pin 2 - Pin 3
48/125 Vac/Vdc	16 kΩ	28 kΩ
125/250 Vac/Vdc	56 kΩ	92 kΩ

IRIG Input

Signal .... The IRIG input accepts a demodulated (dc level-shifted) signal. Maximum input signal level is 25 volts.
Burden.. Nonlinear and rated at 4 kΩ at 5 Vdc.

Timers

Standard (TD[n]) .... Six microprocessor controlled timers. Programmable in milliseconds, seconds, or cycles. Ranges and increments are: 10 to 999 milliseconds in 1 millisecond increments; 1 to 60 seconds in 0.1 second increments; or 1 to 3,600 cycles in 1 cycle increments. A setting of 0 will disable the timer. If programmed in cycles, the BE1-BPR relay will display the equivalent time in milliseconds.
Reclosing (TD79[n]) .... Six microprocessor controlled timers. Programmable in milliseconds, seconds, or cycles. Ranges and increments are: 10 to 999 milliseconds in 1 millisecond increments; 1 to 99 seconds in 0.1 second increments; 100 to 600 seconds in 1 second increments; or 1 to 9,999 in 1 cycle increments.

Accuracy

Standard (TD[n]) .... +4 and –1 milliseconds ±0.01% of setting
Reclosing (TD79[n]) .... +20 and –1 milliseconds ±0.01% of setting

Real-Time Clock

Set Ability .... ±1 second
Resolution .... ±1 second
Stability.. ±30 ppm typical
Accuracy.. Relays with IRIG, ±1 millisecond. If IRIG signal is lost, accuracy defaults to the real time clock stability.

BESTlogic Operate Time

Operate time is 1.4 milliseconds typical, 2.8 milliseconds maximum at 60 hertz.

Output Relays

Any output contact closed by the relay logic will be held closed for 200 to 250 milliseconds even if the initial cause of the closing goes away. After 200 to 250 milliseconds, the relay close time is determined by the state of the relay logic. This minimum hold time may be disabled by using the PHOLD command.

Factory Presets

ALARM Output .... Output contacts close when ALARM logic (LOA) is true or power is lost.
Outputs 1 - 5 .... Output contacts close when the corresponding logic equation (LO1 - LO5) is true.

Pickup Time (All models except 9272000328, 9272000329, 9272000330, and 9272000331)

ALARM .... 8 milliseconds typical, 10 milliseconds maximum
OUTPUT 1.. 4 milliseconds typical, 5 milliseconds maximum
OUTPUT 2, 3, 4, 5 .... 8 milliseconds typical, 10 milliseconds maximum

Pickup Time (Models 9272000328, 9272000329, 9272000330, and 9272000331 only)

ALARM .... 8 milliseconds typical, 10 milliseconds maximum
OUTPUT 1, 2 .... 4 milliseconds typical, 5 milliseconds maximum
OUTPUT 3, 4, 5 .... 8 milliseconds typical, 10 milliseconds maximum

Resistive Ratings

120 Vac .... Make, break, and carry 7 Aac continuously
250 Vdc .... Make and carry 30 Adc for 0.2 s, carry 7 Adc continuously, break 0.3 Adc
500 Vdc .... Make and carry 15 Adc for 0.2 s, carry 7 Adc continuously, break 0.3 Adc

Inductive Ratings

120 Vac, 125/250 Vdc .... Break 0.3 A (L/R = 0.04)

Display

Two-line, 16-character alphanumeric LCD (liquid crystal display) with LED (light emitting diode) backlight.

Operating Temperature .... –40°C to +70°C (–40°F to +158°F)
Display contrast may be impaired at temperatures below –20°C (–4°F).

Targets/Indicators

Five diagnostic LED indicators are provided.

POWER .... Green LED (normally ON) to indicate power supply is operating.
CLOCK .... Green LED (normally OFF) turns ON to indicate that the clock needs to be set.
50PU .... Red LED (normally OFF) turns ON to indicate one or more of the inputs has exceeded the pickup level(s).
ALARM .... Red LED (normally OFF) turns ON to indicate problems. Output A (ALARM) de-energizes (closes) when ALARM LED is ON.
TARGET .... Red LED (normally OFF) turns ON if one or more of the relay outputs has been energized. (If programmed by the PTARGET command.)

Keypad

Five keys are used to access information on the display and enter settings.

Communications

Only one communication port can be active at any time.

Front panel connector .... RS-232, 9-pin, female, D-sub DCE
Rear panel connectors .... RS-232, 9-pin, female, D-sub DCE
RS-485, 3-position terminal block
Baud Rate .... 300, 600, 1200, 2400, 4800, 9600, and 19200
Buffer Size .... 40 characters
Protocol .... ASCII and binary data transmissions

Power Supply

Power for the internal circuitry may be derived from ac or dc external power sources. Power supply data is provided in Table 17.

Table 17. Power Supply Specifications

Power Supply Range	Nominal Input Voltage	Input Voltage Range	Burden at Nominal (Maximum)
48/125 V	48 Vdc 125 Vdc 120 Vac	40 to 60 Vdc 90 to 150 Vdc 100 to 130 Vac	8 W (10 W) 8 W (10 W) 8 W (10 W)
125/250 V	125 Vdc 120 Vac 250 Vdc 240 Vac	90 to 150 Vdc 100 to 130 Vac 180 to 300 Vdc 200 to 260 Vac	8 W (10 W) 8 W (10 W) 8 W (10 W) 8 W (10 W)

Isolation

All output and power supply terminals have MOV suppressors. Maximum applied voltage must be no greater than 300 volts where MOV suppressors are used. Surge suppression capacitors are installed between terminal pairs and between terminals and chassis ground. When testing with 1,500 Vac, leakage current (approximately 8 milliamperes per terminal) is expected. 1.500 Vac (RMS) at 45 to 65 hertz for one minute or 2,121 Vdc may be applied between circuit groups, and between circuit group and chassis ground in accordance with IEC 255-5 and ANSI/IEEE C37.90-1989 (Dielectric Tests).

Surge Withstand Capability

Qualified to ANSI/IEEE C37.90.1-1989, *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.* Note: This qualification does not include the front RS-232 communication port.

Radio Frequency Interference (RFI)

Field tested using a 5-watt, hand-held transceiver operating at random frequencies centered around 144 MHz and 440 MHz, with the antenna located six inches from the relay in both horizontal and vertical planes.

Temperature

Operating..–40°C to +70°C (–40°F to +158°F)
Storage...–40°C to +70°C (–40°F to +158°F)

Shock

Type tested to withstand 15 G in each of three mutually perpendicular planes, swept over the range of 10 to 500 Hz for a total of 6 sweeps; 15 minutes each sweep, without structural damage or degradation of performance.

Vibration

Type tested to withstand 2 G in each of three mutually perpendicular planes, swept over the range of 10 to 500 Hz for a total of 6 sweeps; 15 minutes each sweep, without structural damage or degradation of performance.

Weight

12 lb. (5.44 kg) maximum

Relay Settings Record

This appendix provides a complete listing of all BE1-BPR settings. This listing is in the form of a settings record that you may use to record information relative to your protection system. These settings sheets may be removed and photocopied. This listing is grouped in the following order with a reminder at the end to exit with the save settings procedure.

- Security Settings
- BESTlogic™ Settings for User Programmable Logic Scheme
- Active Protection and Control Logic
- Power System Settings
- Rear Communication Port Address Settings
- Protection Settings
- Breaker Monitoring Settings

SETTINGS RECORD FOR BE1-BPR

Substation ID ________ **Relay ID** ________ **Date** ________ **Page** ____ **of** ____

BE1-BPR Part Number ________ **Serial Number** ________ **Version Number** ________

The following settings require global access (PW1).

SECURITY SETTINGS

Global PW and Access Ports	= Password, 8 Char	, Ports, F,R,B	
PW1	=	,	
Protection Functions	= Password, 8 Char	, Ports, F,R,B	
PW2	=	,	
Breaker Monitoring Functions	= Password, 8 Char	, Ports, F,R,B	
PW3	=	,	
Control Functions	= Password, 8 Char	, Ports, F,R,B	
PW4	=	,	

BESTLOGIC SETTINGS FOR USER PROGRAMMABLE LOGIC SCHEME

Name for User Prog Logic	= Name			
LN	=			
Function Blk Logic Settings				
Fault Detectors	= Mode, 0,PI,NI	, Filter, 1,2,3		
LF2	=	,		
LF2	=	,		
LF3	=	,		
Contact Sensing Inputs	= Recognition Time	, Debounce Time		
LI1	=	,		
LI2	=	,		
LI3	=	,		
LI4	=	,		
LI5	=	,		
LI6	=	,		
LI7	=	,		
Recloser	= Mode, 0,1,2	, Start Rcl TD Input	, Start Reset TD Input	, Wait Input
LR	=	,	,	,
Recloser-2nd Line	= Delimiters	, DTL/Blk Input		
LR	= ,,,	,		
General Purpose Logic Timer	= Mode, 0,C,D	, Start Input	, Reset Input	
LT1	=	,	,	
LT2	=	,	,	
LT3	=	,	,	
LT4	=	,	,	
LT5	=	,	,	

LT6 = [ ] , [ ] , [ ]

Virtual Output Logic Settings

Programmable VO w/ HW Outputs = Output Expression--AND *, OR +, NOT /, PARENTHESIS ( )

LOA = [ ]

LO1 = [ ]

LO2 = [ ]

LO3 = [ ]

LO4 = [ ]

LO5 = [ ]

Additional Programmable VO.

LO6 = [ ]

LO7 = [ ]

LO8 = [ ]

LO9 = [ ]

LO10 = [ ]

LO11 = [ ]

LO12 = [ ]

ACTIVE PROTECTION AND CONTROL LOGIC

Active Logic Scheme = Name

LOGIC = [ ]

POWER SYSTEM SETTINGS

Nominal Frequency = Hz, 50, 60

FREQ = [ ]

REAR COM PORT ADDRESS SETTINGS

Rear RS232/RS485 Port Address = ID,0=disabled,1-25

ID = [ ]

The following settings require protection access (PW1, PW2).

PROTECTION SETTINGS

Fault Detectors = Pick Up, Sec A , Moving Avg. Filter Window Time, Cycles

PU1 = [ ] , [ ]

PU2 = [ ] , [ ]

PU3 = [ ] , [ ]

Timers = Time Delay, mSec

TD1 = [ ]

TD2 = [ ]

TD3 = [ ]

TD4 = [ ]

TD5 = [ ]

TD6 = [ ]

Recloser	=	Time, mSec			
TD791	=				
TD792	=				
TD793	=				
TD79R	=				
TD79F	=				
TD79M	=				

The following settings require any access (PW1, PW2, PW3).

Global I/O Settings

CT Ratio	=	Ratio, Turns			
CTP	=				
CTN	=				
Output Hold Attribute	=	Hold, 0,1 Mask xxxxx			
PHOLD	=				

Display and Communication Settings

Identifier Information	=	Relay #, 0-65535--Used in COMTRADE file as "rec_dev_id" field			
SNAME	=				
ID Information-2nd Line	=	,Station ID, 30 Char--Used in COMTRADE file as "station_name" field			
SNAME	=	,			
Clock Display Mode	=	Date, M or D	Time, 12 or 24		
PCLK	=				
LCD Default Display	=	Menu Branch #	Screen #		
PDISPLAY	=				

Communications

Front RS232 Port	=	Baud DPS	Reply Ack, A0,1	Echo Mode, E0,1	HW Handshake,
COM0	=				
Front RS232 Port--2nd Line	=		Page Length,P0-99	SW Handshake, X0,1	
COM0	=				
Rear RS232/RS485 Port	=	Baud DPS	Reply Ack, A0,1	Echo Mode, E0,1	HW Handshake,
COM1	=				
Rear RS232/RS485 Port-2nd Line	=		Page Length,P0-99	SW Handshake, X0,1	
COM1	=				

Fault Recording Settings

Targets	=	IN, 0,1 Mask xxxxxxx	OUT, 0,1 Mask xxxxx		
PTARGET	=				
Oscillography Trigger	=	Logic Variable			
TRIGGER	=				

Alarm Settings

Timer Log Settings	=	Timer Stop Logic	Type,L=under,H=over	Remaining Time Threshold, mSec.	
PTLOG1	=				

PTLOG2	=		,		,	
PTLOG3	=		,		,	
PTLOG4	=		,		,	
PTLOG5	=		,		,	
PTLOG6	=		,		,	
Alarm Masks	=	DIAG1 (O14)	,	DIAG2 (O15)		
POSC	=					
PDIAG	=		,			

The following settings require breaker access (PW1, PW3).

BREAKER MONITORING SETTINGS

Breaker Contact Duty Settings	=	DMAX, x.xxxE+xx,A^2t	,	Delta t, Contact,	,	Delta t, Current,
BKRCON	=		,		,	
Breaker Status & Op Counter	=		,	Breaker Open Logic		
BKROPS	=		,			
Breaker Pre-insertion Resister	=	Reset Time, Min	,	Max Ops to Blk	,	Res Current V_{PN}/R
BKRRES	=		,		,	

SAVE SETTINGS; YES

SAVE; Y

Revision History

Application firmware changes are listed in Table 18. The corresponding revisions made to this instruction manual are summarized in Table 19. Revisions are listed in chronological order.

Table 18. Firmware Revision History

Firmware Version and Date	Change
3.00, Dec-94	• Initial release
3.02, Jun-96	• Resolved communication errors during RS-485 multidrop operation
3.03, Jun-96	• Eliminated sporadic LO command errors
3.21, Nov-96	• Improved pickup and dropout performance at very low pickup settings • Added Model/Program screen to the list of Maintenance screens available at the front panel HMI
3.22, Feb-97	• Corrected PHOLD command operation in regard to the recloser (79) Close output
3.23, Aug-97	• Changed time delay setting (TD command) range and recloser time delay setting (TD79 command) range from 0 to 60 seconds to 10 milliseconds to 60 seconds. A setting of 0 disables the timer • Changed the minimum input contact recognition and debounce timer (LI command) from 1 millisecond to 4 milliseconds
3.26, Nov-98	• Added fourth password level for OUT command • Modified ACCESS command so that password access can be obtained in multiple access areas simultaneously • Added ID screen to front panel HMI • Removed extraneous text from settings reported by the SHOWSET command
3.27, Jan-99	• Implemented new device serial number format
3.29, Jun-99	• Corrected operation of Ti parameter in BKRCON setting
3.30, Oct-99	• Added POSC command
3.31, Feb-02	• Corrected over-range display error for primary current above 10 Aac and a CT ratio less than 99.
3.32, Feb-04	• Corrected PW command operation when used with B, F, or R command suffix • Eliminated fault log data errors • Corrected HMI LCD flickering and the skipping of DIAG records when certain diagnostic alarms are present • Corrected fault log data errors
3.33, Jul-11	• Improved production testing at the factory

Table 19. Manual Revision History

Manual Revision and Date	Change
—, Dec-94	• Initial release
A, Apr-95	• Added a description of the reclosing functions

Manual Revision and Date	Change
B, Jul-95	• Made revisions throughout manual to reflect the vertical mounting option. Added Figures 3-4, 7-3, 7-4, and 7-5 • Minor corrections were made in *Reclosing Mode* and *FLOG Command* • Corrected Figure 4-2
C, Jan-96	• Revised manual to include added IRIG-B functions
D, Jul-98	• Manual was revised to provide a more complete functional description • Communication command information was summarized in table form and missing command information was added • Panel drilling diagram of Figure 7-5 was updated and connection diagram of Figure 7-13 was added • Appendix A, *Terminal Emulation* was added • Testing procedures of Section 8, *Calibration and Testing* were updated and clarified • The manual style was updated
E, Dec-98	• Output relay pickup time for OUT1 was changed to 4 ms typical, 5 ms maximum
F, Aug-04	• Text was added to describe the contact sensing circuitry with jumper-selectable turn-on and turn-off points. A procedure and diagram for configuring the contact sensing jumpers was added to Section 7 • Power supply holdup time specification was increased • Where applicable, drawings were modified to reflect new front panel design for horizontal- and vertical- units • Call-outs were added to Figure 7-5 to identify mounting hole locations for vertical-mount units used in retrofit installations. M2 panel openings were added • More data about the IRIG input was added to Section 1, *General Information,* and Section 7, *Installation* • POSC command and description was added to Section 4, Functional Description • BKRCON command information was altered because of an expanded Tc and Ti setting range • CTI parameter was removed from CT command text and all settings lists • A note box discussing the need to modify older settings files for use with newer versions of the BE1-BPR was added to Section 6, *Communications* • Diagrams and text were added to Section 5, *BESTlogic Programmable Logic, Contact Input Logic* to better explain the recognition and debounce settings of the LI command • A detailed table of contents was placed at the beginning of appropriate sections. The table of contents at the beginning of the manual was simplified by listing only section numbers and titles • Manual style was updated
G, Jan-08	• Added GOST-R to Section 1, *General Information, Specifications* • Added manual part number and revision to footers • Updated front panel drawings

Manual Revision and Date	Change
H, May-08	• Added information for model numbers 9272000328, 9272000329, 9272000330, and 9272000331 • Updated Table 1-4, *Contact Sensing Burden*
I	• This revision letter not used
J, Apr-12	• Minor text edits
K, Jul-15	• Updated manual to latest style • Removed GOST-R certification • Updated Storage statement • Moved Maintenance and Storage to the *Installation* chapter • Minor text edits
L, Jul-17	• Corrected the mounting depths shown in Figure 16 • Added caution statement about nonvolatile memory

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