INSTRUCTION MANUAL

for
BE1-BPR
BREAKER PROTECTION RELAY

RELEASE — ⊖ ⊖ — RELEASE

SEAT UNIT FIRMLY
THEN PRESS TO LOCK

POWER
○

CLOCK
○

50 PU
○

ALARM
○

TARGET
○

BE1-BPR
BREAKER PROTECTION RELAY

SERIAL
PORT

PROG

EDIT
+/-

VIEW /
SELECT
➤

VIEW /
SELECT
▼

RESET

B Basler Electric
Highland, Illinois

Designed and manufactured in the U.S.A.

SEAT UNIT FIRMLY
THEN PRESS TO LOCK

RELEASE — ⊖ ⊖ — RELEASE
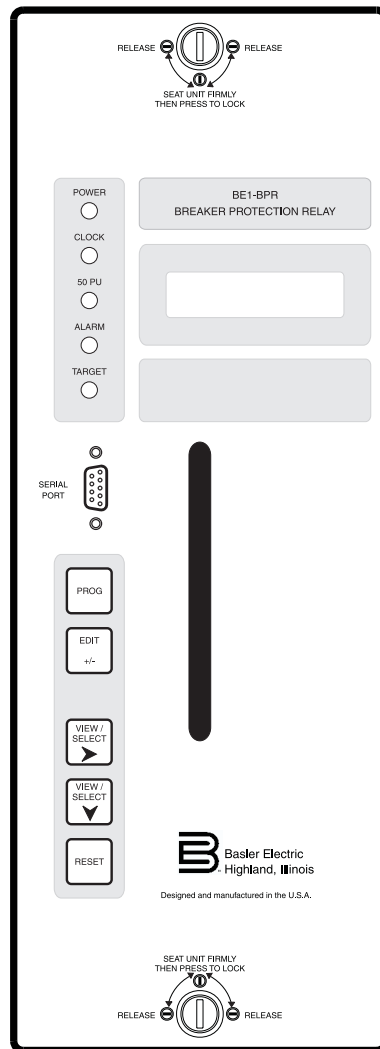
B Basler Electric

INTRODUCTION

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

- Specifications

- Functional Description

- Installation Information

- Testing Procedures

W A R N I N G !
TO AVOID PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED PERSONNEL SHOULD PERFORM THE PROCEDURES PRESENTED IN THIS MANUAL.

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric Company.

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

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 either a 19 inch rack-mount or a vertical panel mount , the relay offers installation versatility. A wide temperature, 2 line 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 subtransmission 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

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 subtransmission 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, determines 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 1-1. Parentheses in the listed timing information indicate related times in Figure 1-1. 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.

(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).
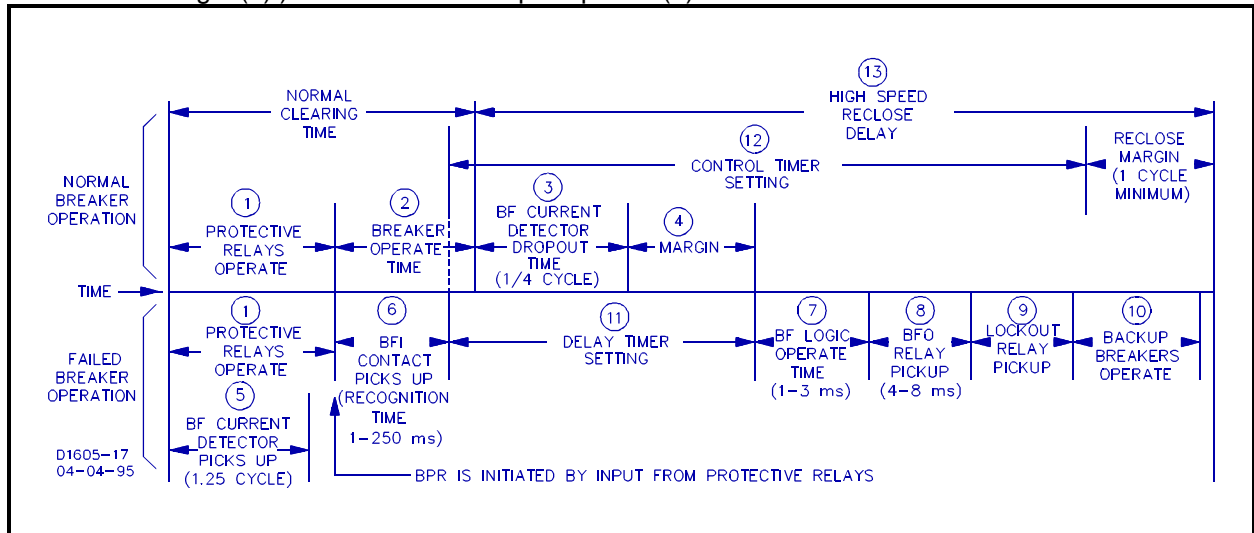
Figure 1-1. Breaker Failure Timing Diagram

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 1-1. 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 airblast 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-B Standard Time Format

The IRIG-B function allows the BE1-BPR relay to synchronize the on-board real time clock with a standard IRIG-B 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 and display 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 *BESTView Software Package*, part number 9 2720 17 10.

MODEL NUMBERS

Tables 1-1 and 1-2 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 1-1. BE1-BPR Relays, Five-Ampere CT Secondary

Part Number	Options	Mounting Style	IRIG-B	Power Supply
9 2720 00 300	Standard	19" Rack Mount	Yes	48/125 V ac/dc
9 2720 00 301	Standard	19" Rack Mount	Yes	125/250 V ac/dc
9 2720 00 302	Enhanced	19" Rack Mount	Yes	48/125 V ac/dc
9 2720 00 303	Enhanced	19" Rack Mount	Yes	125/250 V ac/dc
9 2720 00 309	Standard	Vertical Mount	Yes	48/125 V ac/dc
9 2720 00 310	Standard	Vertical Mount	Yes	125/250 V ac/dc
9 2720 00 311	Enhanced	Vertical Mount	Yes	48/125 V ac/dc
9 2720 00 312	Enhanced	Vertical Mount	Yes	125/250 V ac/dc

Table 1-2. BE1-BPR Relays, One-Ampere Secondary

Part Number	Options	Mounting Style	IRIG-B	Power Supply
9 2720 00 304	Standard	19" Rack Mount	Yes	48/125 V ac/dc
9 2720 00 305	Standard	19" Rack Mount	Yes	125/250 V ac/dc
9 2720 00 306	Enhanced	19" Rack Mount	Yes	48/125 V ac/dc
9 2720 00 307	Enhanced	19" Rack Mount	Yes	125/250 V ac/dc

SPECIFICATIONS

BE1-BPR Breaker Protection Relays have the following features and capabilities.

Current Sensing Four isolated inputs with a maximum burden of less than 0.1 ohm.
   5 Ampere CT Maximum continuous current: 20 amperes. Maximum one second current: 500 amperes.
   1 Ampere CT Maximum continuous current: 4 amperes. Maximum one second current: 80 amperes.

Current Detector Pickup Time **Instantaneous Fault Detector (50/60 Hz RMS Filter Type 1 and 3):**
1¼ 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 + 1¼(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 1¼ 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) +1¼ (cy)), where Window_size = Filter window size in cycles (Range 1 - 100) and C_PM = Current Pickup Multiple level before dropout.

Current 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

Current Pickup Accuracy **Instantaneous Fault Detector (50/60 Hz RMS Filter Type 1 and 3):**
   (5 ampere CT) - ±2% of pickup setting or ±0.05 ampere (whichever is greater)
   (1 ampere CT) - ±2% of pickup setting or ±0.01 ampere (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 @ 60 hertz, 600 samples per second @ 50 hertz).

Oscillograph Recording Range

(5 ampere CT) 0 - 200 amperes, RMS.
(1 ampere CT) 0 - 40 amperes, RMS.

Oscillograph Data Accuracy

±0.2% of full scale or 5% of reading - whichever is greater

Oscillograph Recording Format

IEEE C37.111-1991, IEEE Standard Common Format for Transient Data Exchange (COMTRADE) for Power Systems.

Input Contact Sensing 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).

Contact Sensing Input Range

Contact input circuits require an applied sensing voltage within the relay dc power supply input rating range. Energizing levels for contact sensing inputs are jumper selectable. Table 1-3 lists the turn-on range for each control voltage range and jumper position.

Input Contact Sensing 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 1-3 provides appropriate burden specifications.

Table 1-3. Input Contact Sensing Burden

Power Supply	Burden
48/125 V ac/dc	30 kΩ
125/250 V ac/dc	100 kΩ

IRIG-B Input Burden

IRIG-B burden is non-linear and fully isolated using optical couplers. With a typical 5.0 volt input signal, burden is 4 kΩ. Maximum input signal level is 25 volts. Minimum input signal level is 4.5 volts.

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 cycles in 1 cycle increments.

Timer 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 Setability

±1 second

Real Time Clock Resolution ±1 second

Real Time Clock Stability ±30 ppm typical

Real Time Clock Accuracy Relays with IRIG-B, ±1 millisecond. If IRIG-B 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 preset output
  contact configuration:
    ALARM Output: Output contacts close when ALARM logic (LOA) is true or power is lost.
    Output 1 - 5: Output contacts close when the corresponding logic equation (LO1 - LO5) is true.

Output Relay Pickup Time
  ALARM: 8 milliseconds typical, 10 milliseconds maximum.
  Output 1: ¼ cycle (4.2 milliseconds) maximum.
  Output 2, 3, 4, 5: 8 milliseconds typical, 10 milliseconds maximum.

Output Contact Rating Output contacts are rated as follows:
Resistive:
  120/240 Vac Make and carry 30 amperes for 0.2 second, carry 7 amperes continuously, and break 7 amperes.
  250 Vdc Make and carry 30 amperes for 0.2 seconds, carry 7 amperes continuously, and break 0.3 amperes.

Inductive:
  120/240 Vac Make and carry 30 amperes for 0.2 seconds, carry 7 amperes continuously,
  125/250 Vdc and break 0.3 amperes. (L/R=0.04).

Display Two lines by 16 character LCD alphanumeric display with LED backlight.

Targets/Indicators Five diagnostic LEDs 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.
  Connectors: Front panel - RS-232, 9 pin, female, D-sub DCE
    Rear panel - RS-232, 9 pin, female, D-sub DCE; RS-485, 3 position terminal block
  Baud Rate: 300, 600, 1200, 2400, 4800, 9600, and 19.2 k (19,200)
  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 and is provided in Table 1-4.

Table 1-4. 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 groupt 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 five watt, hand held transceiver operating at random frequencies centered around 144 megahertz and 440 megahertz, with the antenna allocated six inches from the relay in both horizontal and vertical planes.

Operating Temperature   -40° C (-40° F) to +70° C (+158° F)

Storage Temperature   -40° C (-40° F) to +70° C (+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 pounds maximum

SECTION 2 • APPLICATION

GENERAL

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 convertor 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 non-volatile memory. These schemes take full advantage of the special features available in this relay without requiring the user to do any programming. 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

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 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 2-1 shows maximum pickup timing versus current input levels.
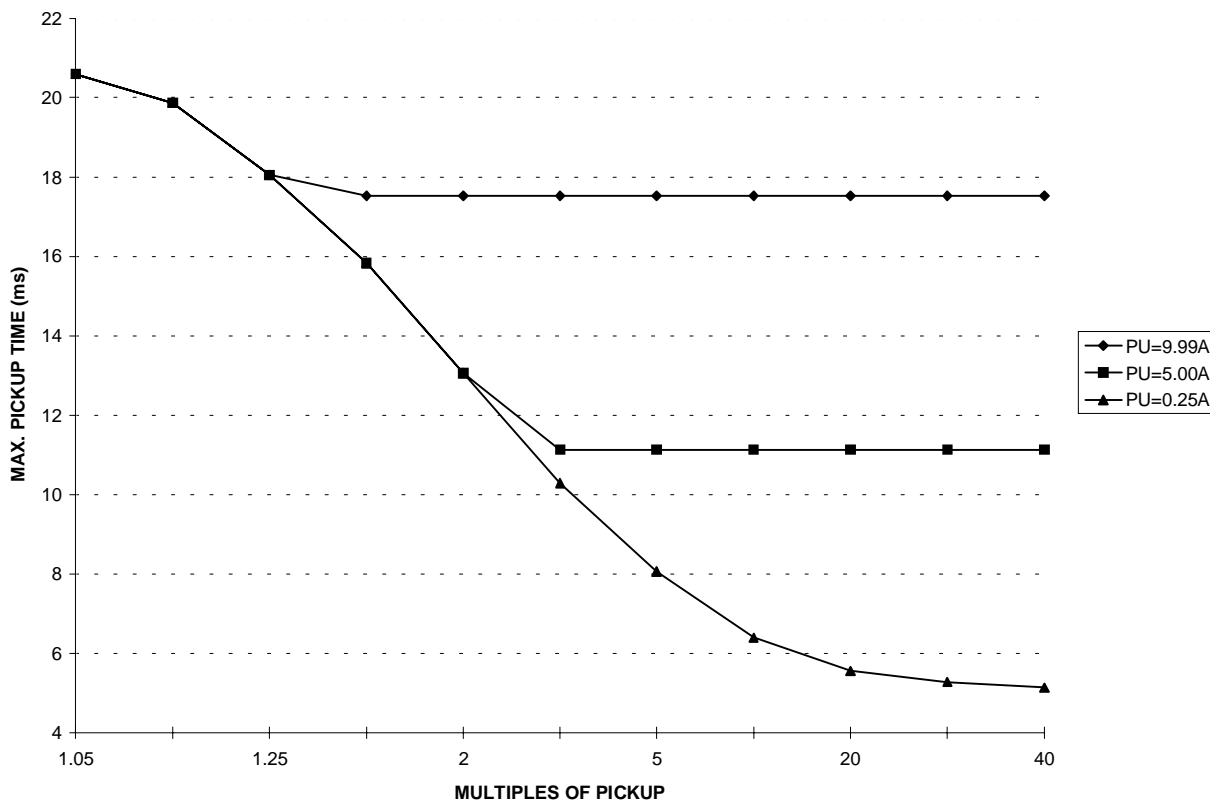
Figure 2-1. Maximum Pickup Timing

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 2-2 shows maximum dropout timing versus current input levels.
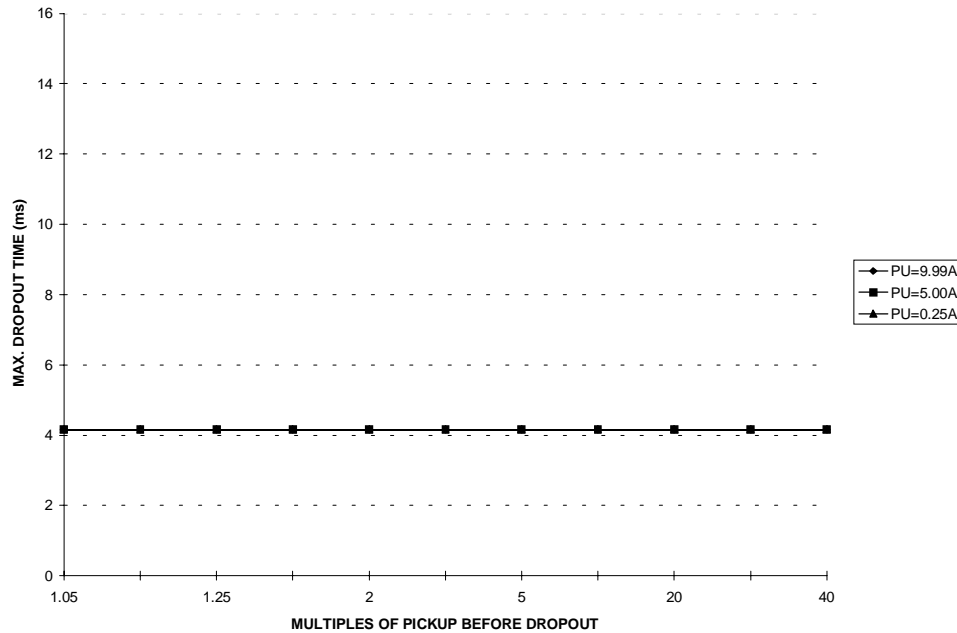
Figure 2-2. Maximum Dropout Timing

<u>Moving Average Filter Fault Detector Type 2</u>

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 2-3 shows maximum pickup timing versus current input levels for a 10 cycle MAF fault detector.
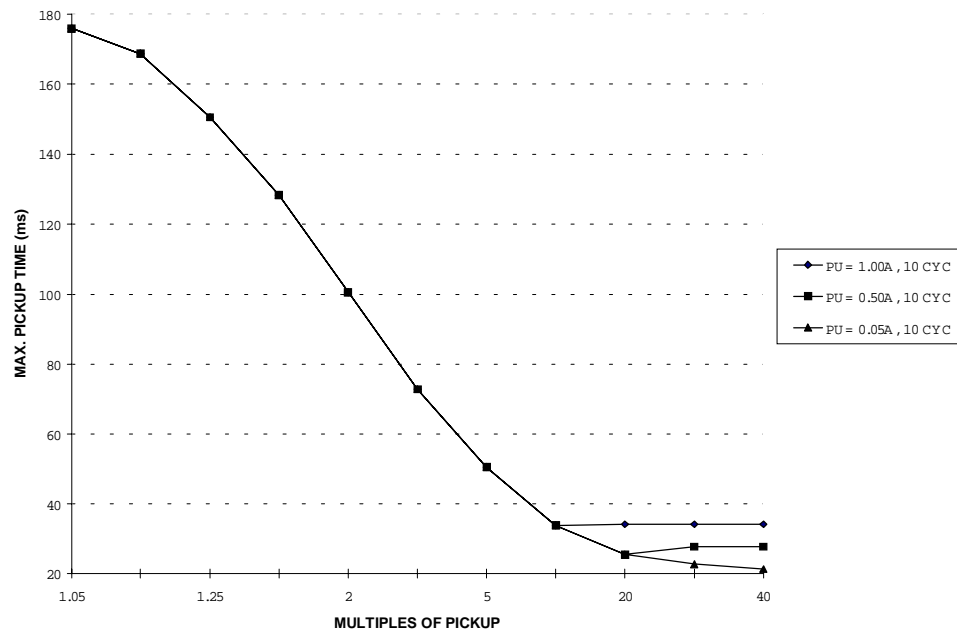
Figure 2-3. Maximum Pickup Timing With 10 Cycle MAF FD

This MAF fault detector is programmed by setting the fault detector digital filter selection to 2 (DFLTR2). For the MAF fault detector to pickup (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.

BE1-BPR Application 2-3

Figure 2-4 shows maximum dropout timing versus current input levels for a 10 cycle MAF fault detector.
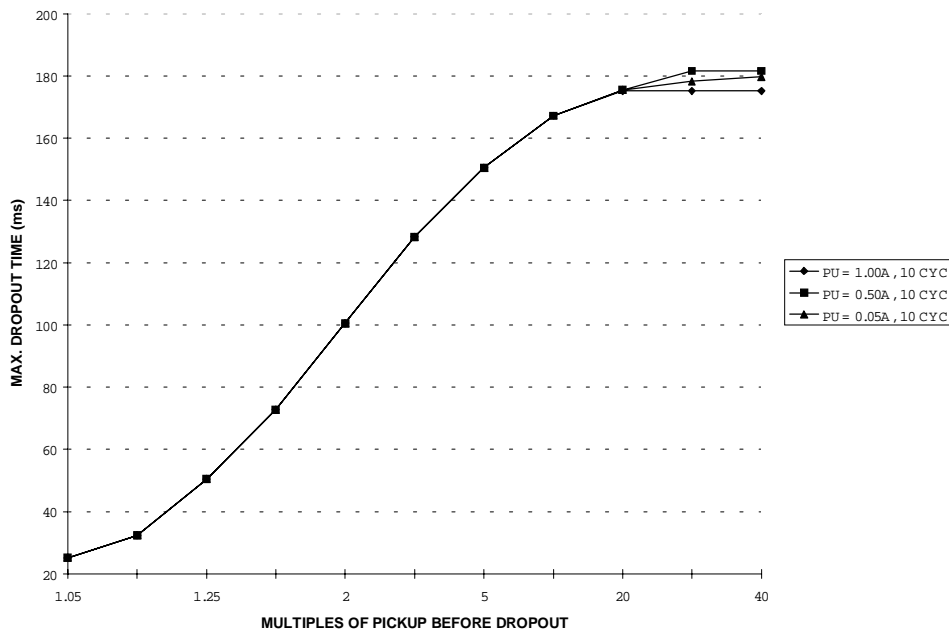
Figure 2-4. Maximum Dropout Timing With 10 Cycle MAF Fault Detector

<u>*Three-Phase Fault Instantaneous (50) Fault Detector Type 3*</u>

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 pickup. 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 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.

<u>*Application of Fault Detectors*</u>

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 pickup 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 more rare 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 a 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 2-5, 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 is 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.
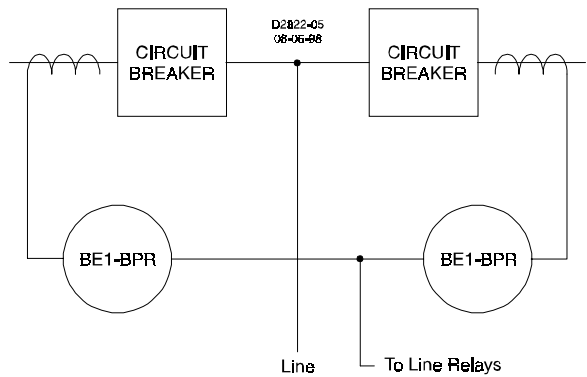
Figure 2-5. Multiple Breaker Arrangement

General Purpose Timers

Each 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 2-6.
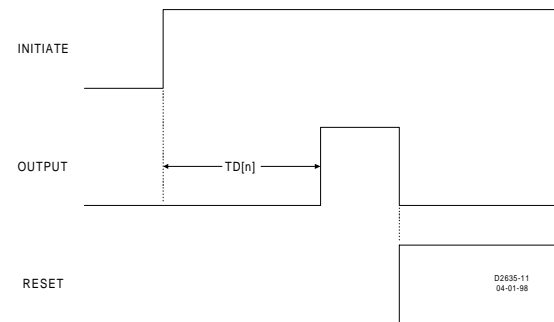
Figure 2-6. Delay Timer Operation

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 2-7.
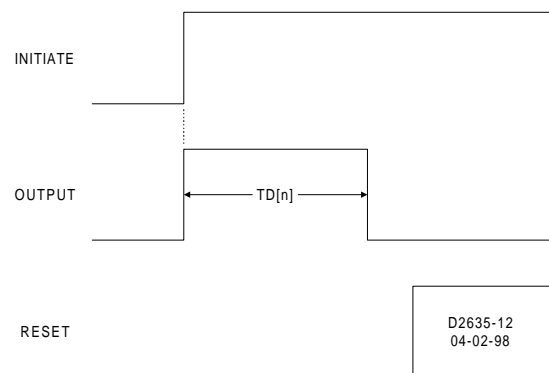
Figure 2-7. Control Timer Operation

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 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 *Section 1, General Information, Timing Diagnostics* 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 timer 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. *Section 4, Functional Description* 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 deenergizes 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 2-8 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 2-9 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.
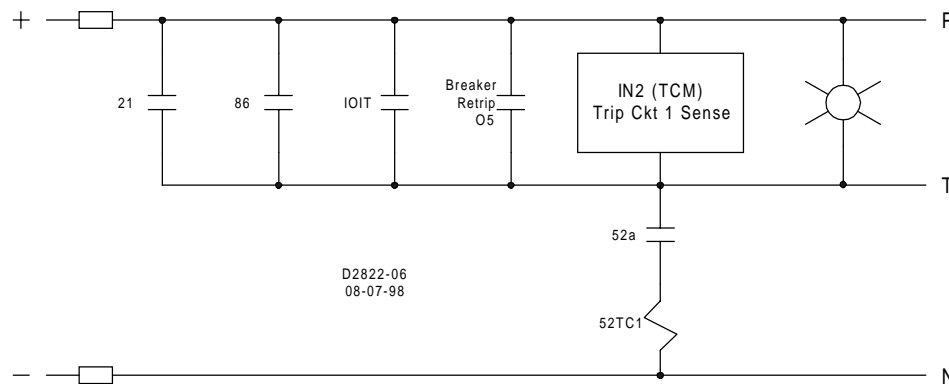
Figure 2-8. Trip Circuit Monitor Schematic Diagram
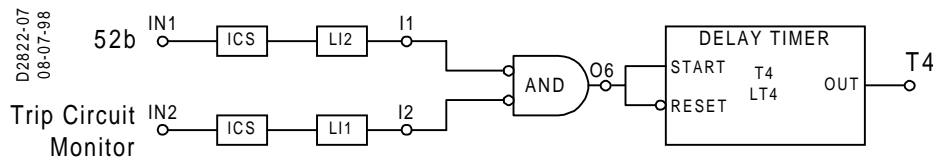
Figure 2-9. Trip Circuit Monitor Logic Diagram

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 a logic 1. Figure 2-10 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 a 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 is open. The timer is used to prevent an alarm output during the transition between the closed and open states.

LEGEND

A	Fault occurs, TCM shorted by Line relay	21	Protective Relays
B	Breaker opens, trip circuit opened	TCM	Trip Circuit Monitor
C	Relay drops out, trip bus floating	O6	TCM Timer Start
D	Breaker closed	T4	TCM Timer
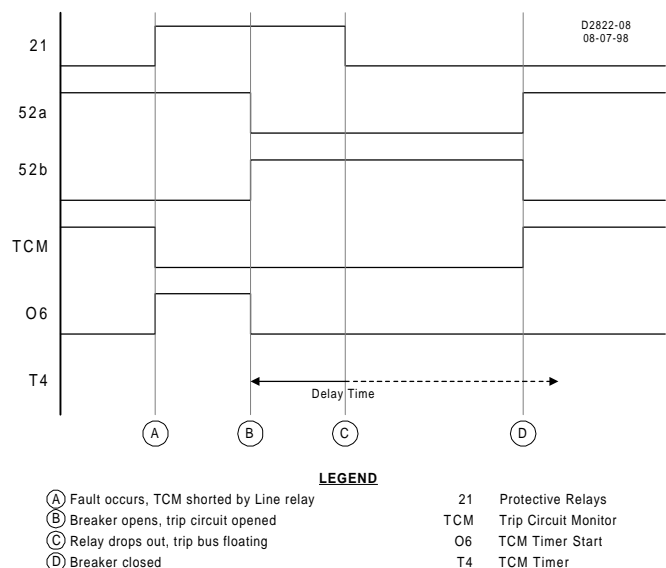
Figure 2-10. Trip Circuit Monitor Timing Diagram

Figure 2-11 illustrates a problem that can occur when using the trip circuit monitor feature. If the breaker failure initiate (BFI) sensing is connected directly to the breaker trip bus as shown in Figure 2-11a, the equivalent circuit shown in Figure 2-11b 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.
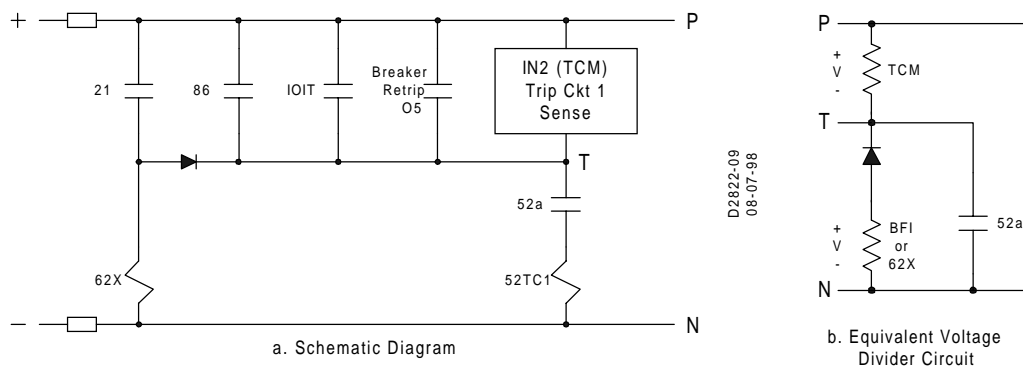
Figure 2-11. Trip Circuit Monitor With BFI Sensing

In Figure 2-11a, 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 airblast 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 2-12 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 pickup 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.
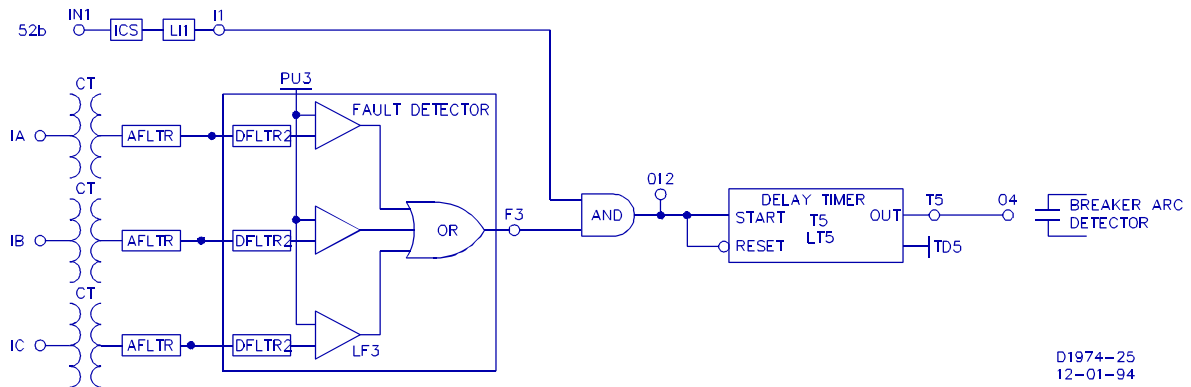
Figure 2-12. Breaker Arc Detector Circuits

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 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 2-9) 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 section for additional information if your requirements call for a NC contact for this purpose. Also see *Section 4, Functional Description*, for a detailed functional description on how to program the resistor protection function module.
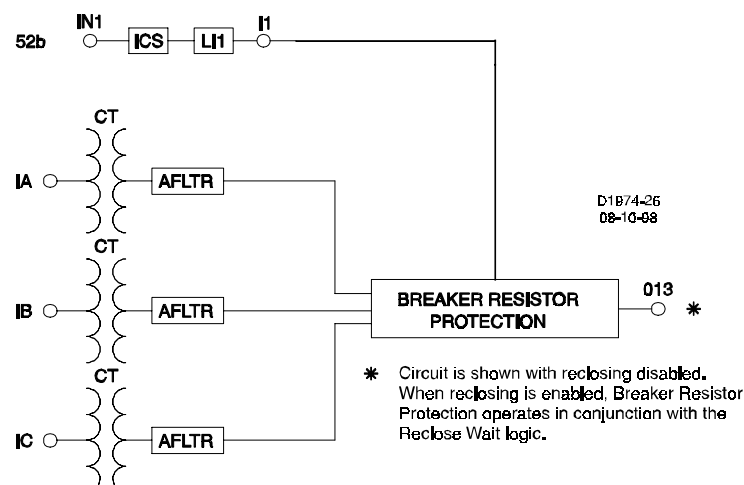
Figure 2-13. Breaker Resistor Protection Circuits

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 pickup 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, Section 5, Programmable Logic,* 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 an $\sum I^2t$ 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 2-14 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 *Section 4, Functional Description*, for a detailed functional description on how to program the duty log diagnostic feature.
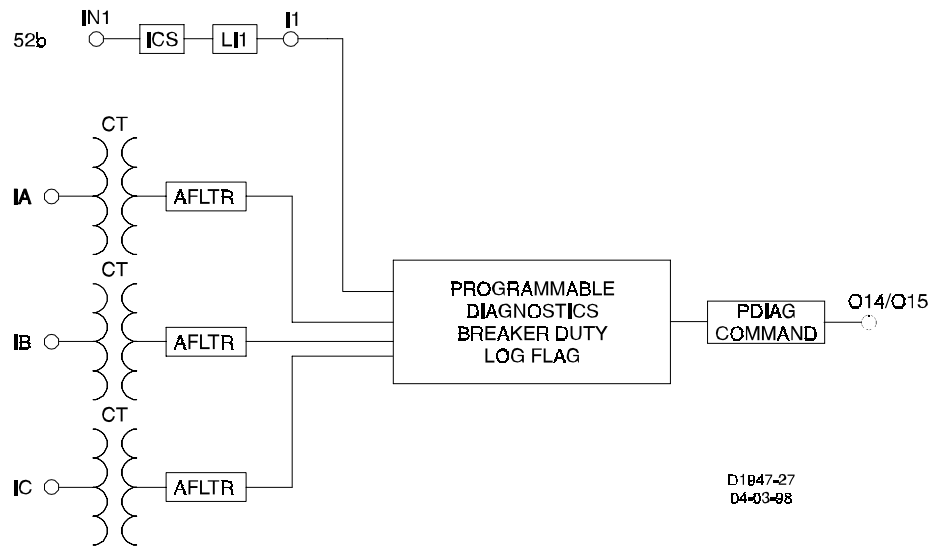
Figure 2-14. Breaker Contact Duty Log Circuits

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 2-15.
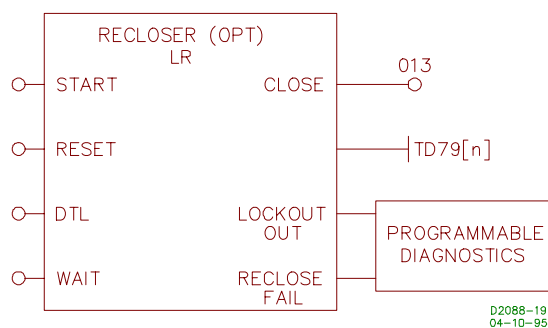
Figure 2-15. Reclosing Logic Circuit

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 *Section 5, Programmable Logic*, 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)
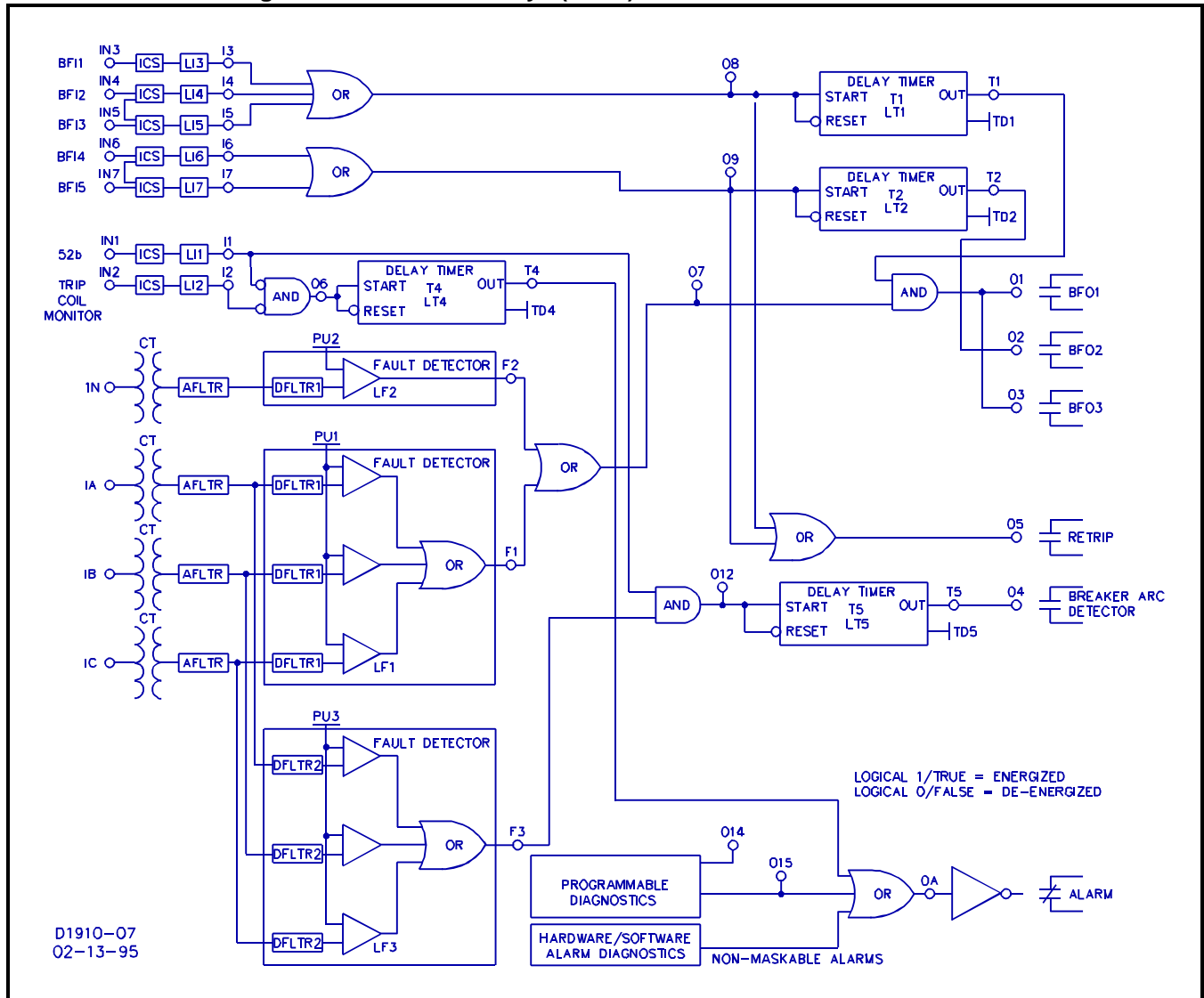
BFL1 logic provides the following application features:

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 section 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 section 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.

Breaker Failure Logic 2 For Standard Relays (BFL2)

BFL2 logic 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 Section 1 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 Section 1 for information on setting the delay and control timers.

   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.

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 section information 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 section 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.

Breaker Failure Logic 3 For Standard Relays (BFL3)


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BFL3 logic 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 Section 1 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 Section 1 for information on setting the delay and control timers.

    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.

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 section information 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 section 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.

Breaker Failure Logic 1 For Enhanced Relays (BFL1E)
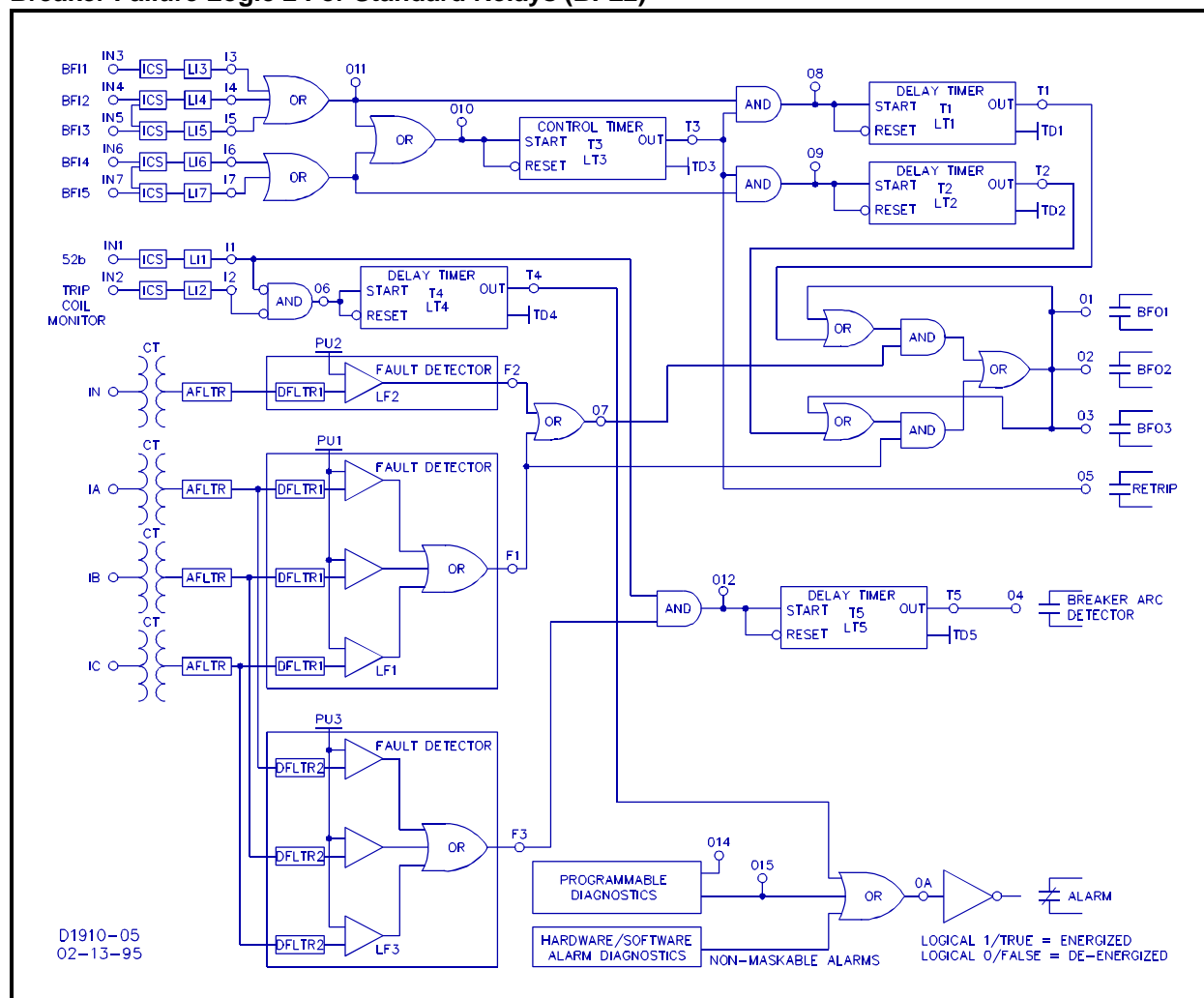

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BFL1E logic provides the following application features:

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 Section 1 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 Section 1 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 section 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 section 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 section 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.

Breaker Failure Logic 2 For Enhanced Relays (BFL2E)
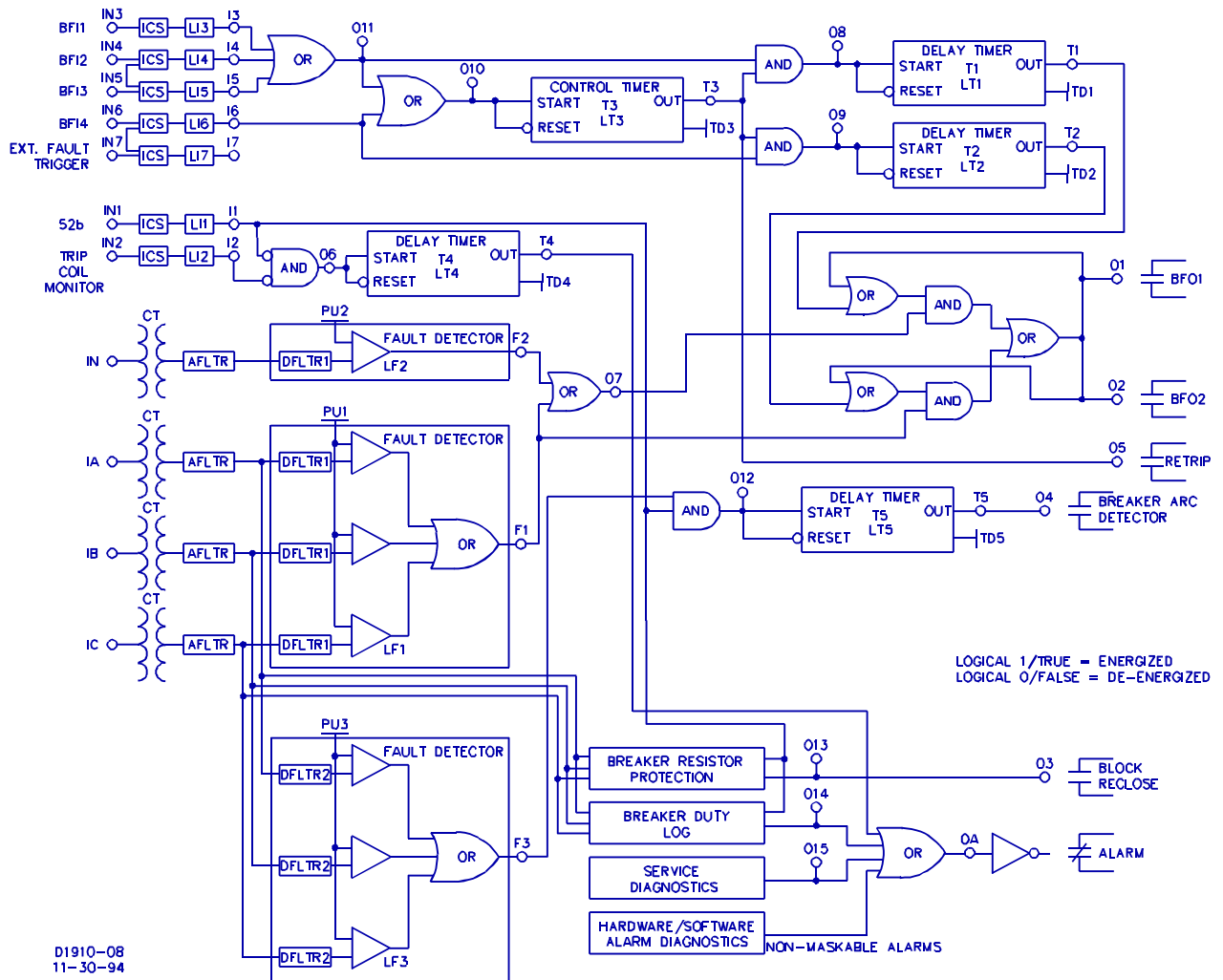
BFL2E logic provides the following application features:

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 Section 1 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 Section 1 for information on setting the delay and control timers.
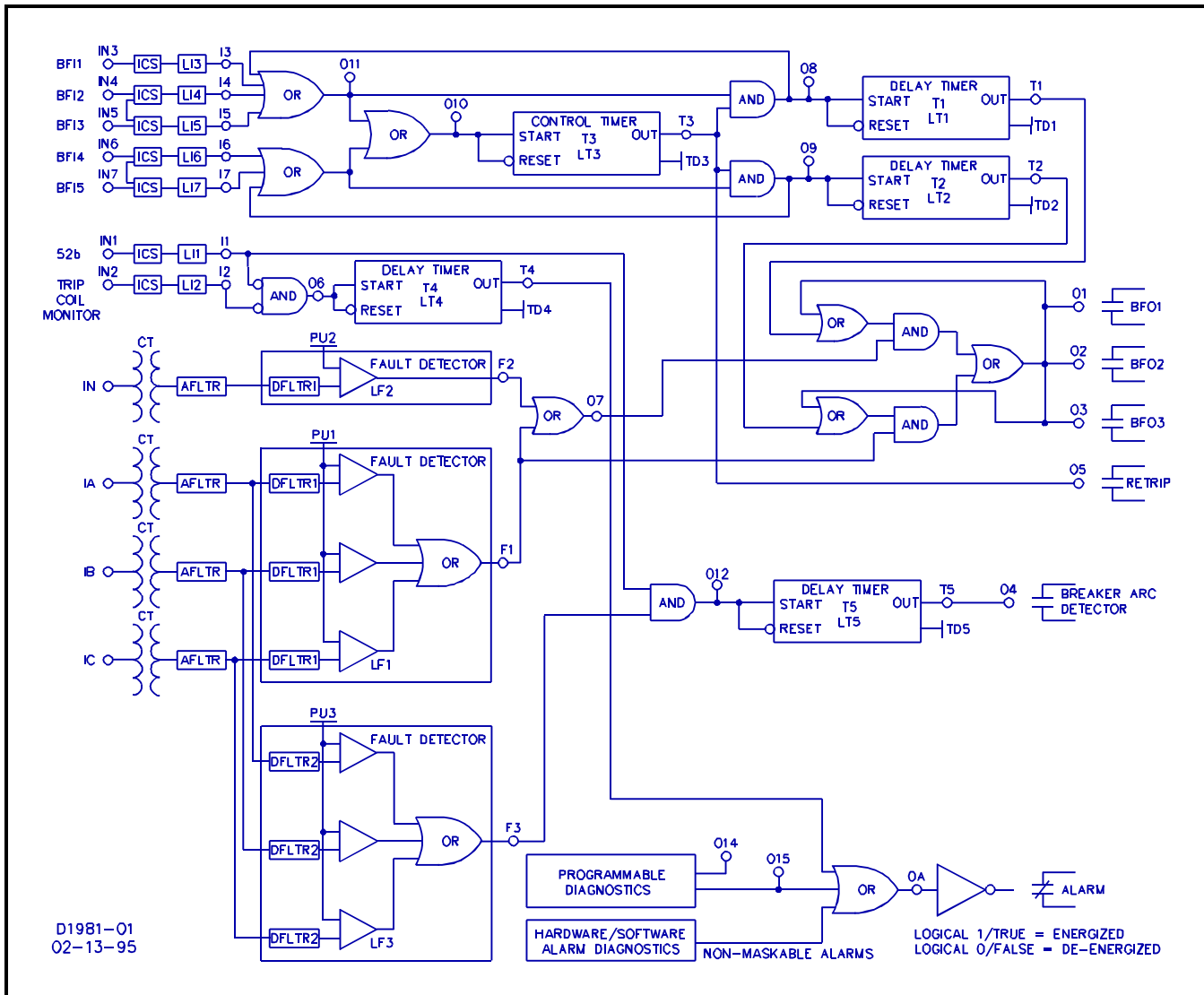
   Neutral fault detector F2 is not used to supervise the single-pole BF logic because F2 is still picked up by the phase imbalance after the fault clears. Three-phase BF logic is inhibited during this period because there is no 3-phase BFI input active. For single-pole tripping, the phase pickup (PU1) must be set above maximum load levels.

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 section for further details on the circuit operation.

BE1-BPR Application 2-21

4. 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 section 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 section 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 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.

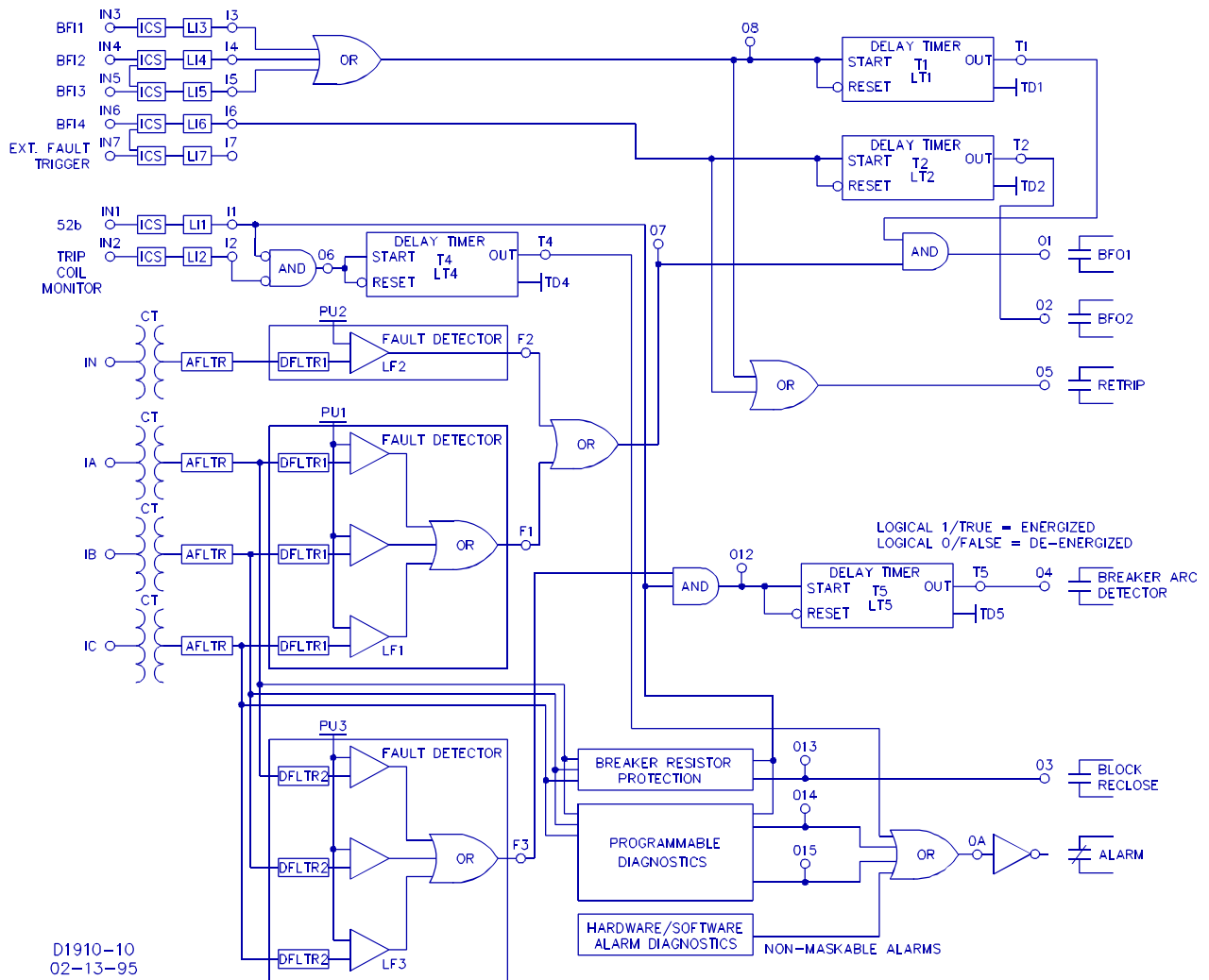## Breaker Failure Logic 3 For Enhanced Relays (BFL3E)

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BFL3E logic 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 Section 1 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 Section 1 for information on setting the delay and control timers.

    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.

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 section for further details on the circuit operation.

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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 section 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 section 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 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.

SECTION 3 • HUMAN-MACHINE INTERFACE

Figures 3-1 and 3-2 show front panel sections for the human-machine interface (HMI). Figures 3-3 through 3-5 show BE1-BPR front and rear views.

Table 3-1. Relay Indicators (Illustrated in Figure 3-1)

Indicator	Function
POWER	GREEN LED that turns ON to indicate power supply is operational.
CLOCK	RED LED that turns ON to indicate that the real-time-clock (RTC) has not been set.
50PU	RED LED that turns ON to indicate that one or more of the instantaneous overcurrent pickup settings has been exceeded.
ALARM	RED LED that turns ON to indicate a diagnostic problem with the relay.
TARGET	RED LED that turns ON when one or more of the output relays is energized and target information has been saved to non-volatile memory. (Detailed target information is available from the display TARGET MENU.)

Figure 3-1. BE1-BPR Displays and Indicators
(Vertical Mount Not Shown)

Table 3-2. Front Panel Switch Operation (Refer to Figure 3-2)

Switch	Function
RESET	Returns the cursor to the top of the current menu. If the current screen is the target screen or a diagnostic screen, this switch resets (clears) the target or diagnostic information. When held for 2 seconds in the PROGRAM mode, exits the PROGRAM mode without saving changes.
PROG	When first pressed, enables the PROGRAM mode which allows settings changes. A password may have to be entered before PROGRAM mode is entered. If PROG key and then EDIT +/- key are pressed, the direction of the change is reversed until a new key other than EDIT +/- is pressed. When held for 2 seconds in PROGRAM mode, brings up the SAVE screen, which allows the operator to save changes made to non-volatile memory or exit without saving changes.
VIEW / SELECT ➤	Selects the next menu to view. After the last menu, the display returns to the first menu. In PROGRAM mode, selects the next number or string to change. **NOTE** PROGRAM mode must be enabled in order for the EDIT +/- key to operate.
VIEW / SELECT ▼	Selects different menu screens to view. After the last menu screen, the display returns to the top of the menu. In PROGRAM mode, selects a different screen for programming changes (settings).
EDIT +/−	Changes the ITEM selected, usually a character or a string, to the next possible value. If PROG key and then EDIT +/- key are pressed, the direction of the change is reversed until a new key other than +/- is pressed.
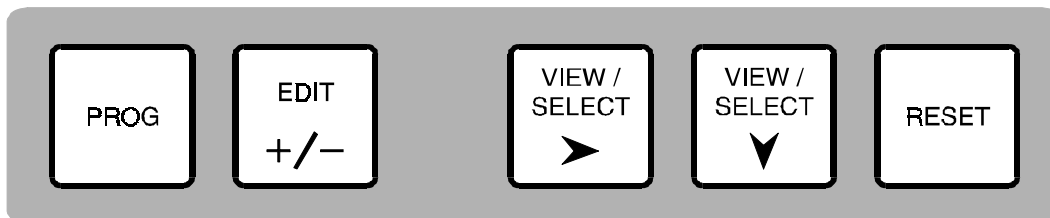
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Figure 3-2. BE1-BPR Controls (Switches)
(Vertical Mount Not Shown)
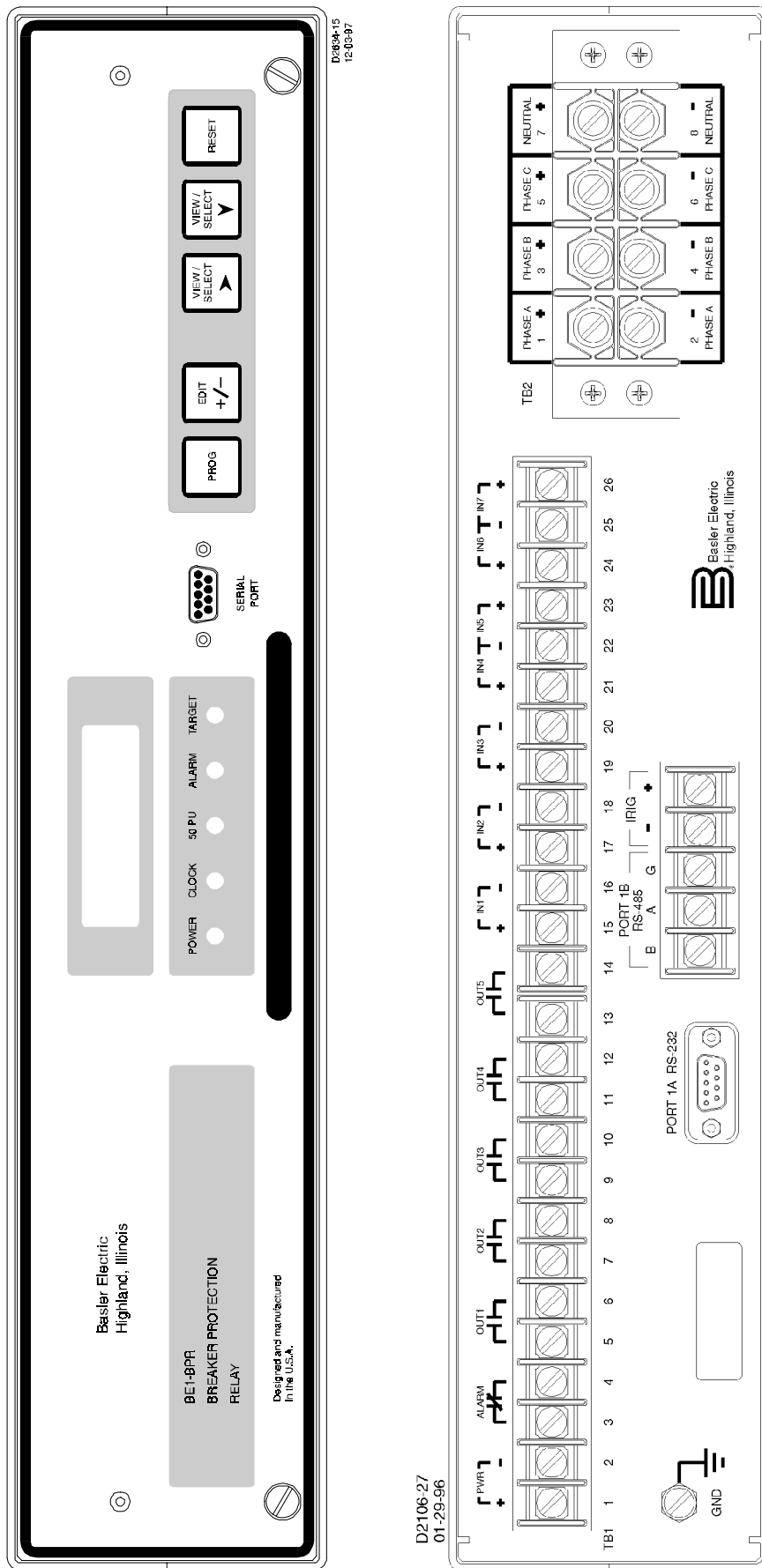
Figure 3-3. BE1-BPR Relay, Horizontal Mount Front And Rear Views
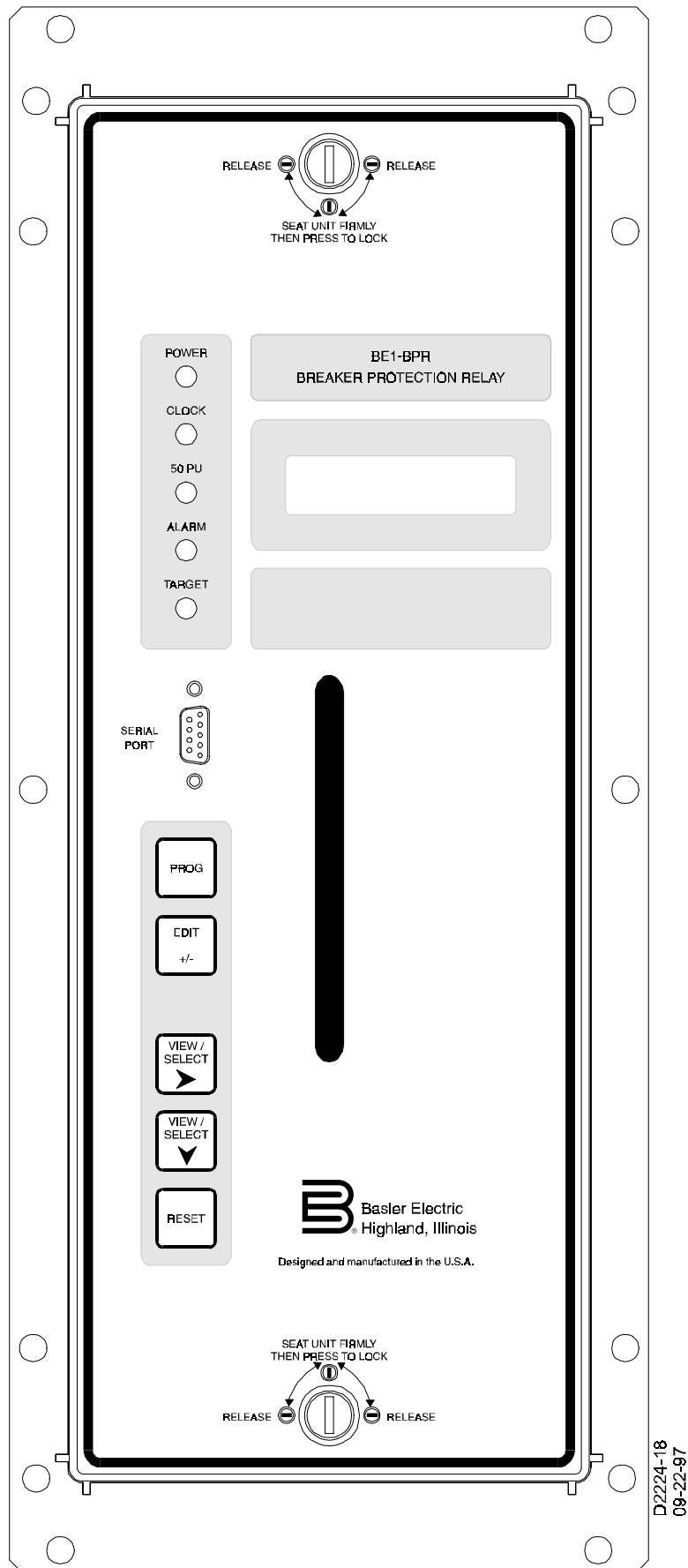
Figure 3-4. BE1-BPR Relay, Vertical Mount Front View
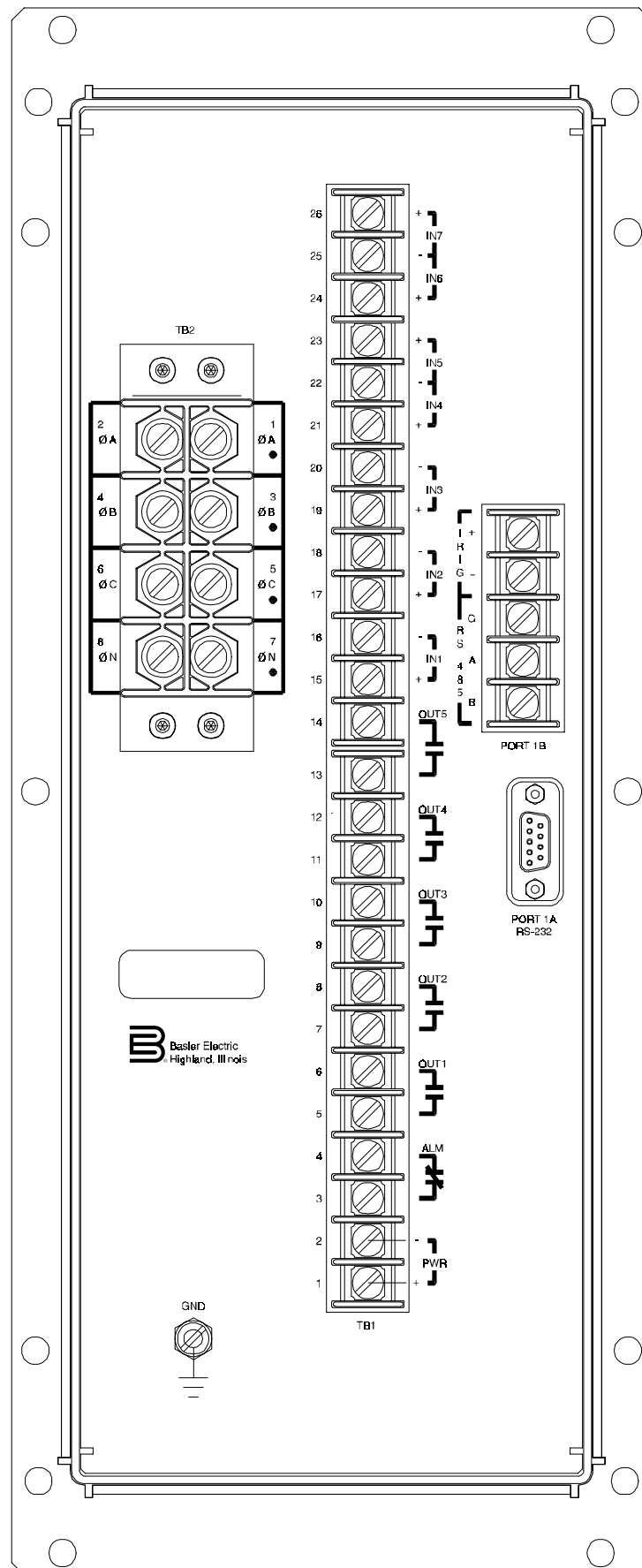
Figure 3-5. BE1-BPR Relay, Vertical Mount Rear View

SECTION 4 • FUNCTIONAL DESCRIPTION

GENERAL

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 section describes the hardware and software functional descriptions.

HARDWARE FUNCTIONAL DESCRIPTION

BPRs are available as either 19 inch rack mount units or vertical panel mount units. The rack mount is approximately 3.48 inches high and the vertical panel mount is about 5.38 inches wide and 14.32 inches high. The vertical panel mount unit assemblies are arranged differently to fit the 14.32 inch casing. A transparent front cover protects the unit but allows access to some front panel controls. A spring loaded handle under the front cover retracts when released and provides drawout capability of the BPR relay (chassis assembly) from the rack assembly. It is not necessary to disturb system wiring when removing a BPR relay from the case.

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

Inputs

There are five types of inputs to the 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 isolated internal switching power supply. Required operating power is either 48/125 VDC or 125/250 VDC and is determined by the relay part number shown in Section 1, *General Information, Specifications.*

Contact Sensing

Seven external contact sensing inputs provide external stimulus to initiate BPR relay actions. Nominal voltage(s) of the external dc source(s) 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 transformer primaries and stepped down to internal circuit levels. The internal current transformers provide isolation from the monitored line currents.

Keyboard

A five key keyboard (illustrated in Section 3) provides limited local programming capability and the ability to select a number of status and diagnostic menu screens.

Serial communication ports at the front and rear of the BPR relay provide total programming capability and remote access for diagnostic, relay setup, and 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 BPR Relay off-line and activates the alarm output. Relay circuit functions illustrated in Figure 4-1 are described in the following paragraphs.
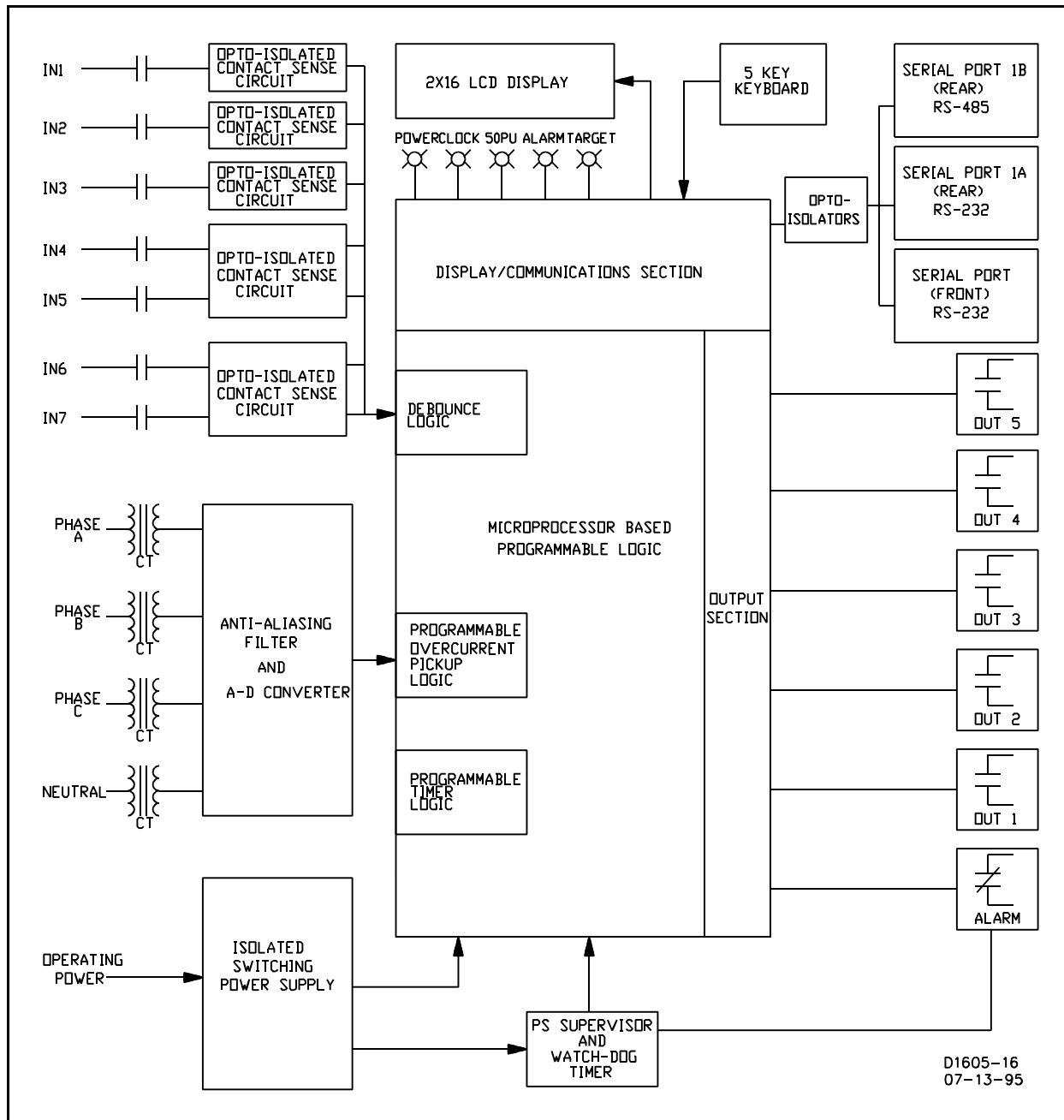
Figure 4-1. Functional Block Diagram

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 will be reset by the power supply supervisory circuit. This reset takes the relay off-line and lights the ALARM LED.

Watchdog Timer

If the microprocessor fails for any reason, output pulses to the watch-dog timer stop. After a short duration of time, the watch-dog timer will take the relay off-line and turn on 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 A/D Converter

Stepped down inputs from each current transformer 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 and digitally filtered and the 50/60 HZ 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 Section 5, *BESTlogic Programmable Logic*.

Outputs

There are five types of outputs from the BPR relay. They are:

- ALARM Relay
- Output Relays
- Targets
- LCD Display
- Serial Ports RS-232/RS-485

BE1-BPR Functional Description **4-3**

Either normally open or normally closed contacts are available for the ALARM relay. Normally closed is the usual configuration for fail safe operation. However, you may configure the ALARM output to fit your system requirements by placing a jumper in the appropriate position. The output is normally energized and if the power supply output falls below a predetermined voltage or the microprocessor watchdog timer times out, the alarm output is de-energized. The software ALARM output (OA) is logically ORed with the hardware logic power sensor and watchdog timer. Either input may 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 by the programmable logic section when the associated logic equation(s) (LO1 through LO5) are TRUE. Output relay O1 is a high speed output with a maximum operate time of 4.2 milliseconds.

Targets

Detailed target information about the inputs and outputs is displayed by the TARGETS menu screen. Whenever any of the target output relays are energized, the front panel TARGET LED turns on. The TARGET information is latched in non-volatile memory by software if the output is programmed as latching. To reset the TARGET LED, operate the manual RESET key on the front panel keyboard or enter the RESET command through the serial communication port. The PTARGET command programs output relays as target relays.

LCD Display

A 2 line by 16 character, LCD display shows targets, setup, status, and diagnostic information and allows local programming capability. LED backlighting is used to provide illumination for the LCD display.

Serial Ports RS-232/RS-485

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

SOFTWARE FUNCTIONAL DESCRIPTION

A majority of the relay settings may be made using the front panel keyboard and display. However, to program the relay logic, change breaker configuration data, change time and date format, change CT data, and request reports, the operator must use the front or rear communications port. In general, tasks that are not easily done 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 4-2 shows the menu progression from start-up to maintenance for an enhanced BE1-BPR. Figure 4-3 shows the menu progression for a standard BE1-BPR. The operator uses the right arrow key to scroll through the available menu screens and the down arrow key to access menu sub-screens. When using a communication port, the relay is programmed using ASCII software commands. Helpful 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 start-up 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. Timer 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 screen.

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 (e.g. — 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.

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.

Figure 4-2. Enhanced BE1-BPR Menu Display Screens

MENU BRANCH 0

| TARGETS |
| NONE |

MENU BRANCH 1

| RELAY SETUP |
| LOGIC=BFL1E |

| PU1 PU2 PU3 |
| 8.00 2.00 0.50 |

| TD1 TD2 TD3 |
| 200m 200m 0m |

| TD4 TD5 TD6 |
| 500M 30S 0m |

| TD791 792 793 |
| 3s 10s 10s |

| TD79R 79F 79M |
| 5.0s 0m 0m |

MENU BRANCH 2

| RELAY STATUS |
| CHECK DIAG LOG |

| I1234567 0A12345 000000 |
| 0000000 000000 |

| IA=0.00 IB=0.00 |
| IC=0.00 IN=0.00 |

| Ia=0.00 Ib=0.00 |
| Ic=0.00 In=0.00 |

| RECLOSER |
| RESET |

| CLOCK NOT SET |
| DIAG: 1 OF 1 |

MENU BRANCH 3

| BREAKER STATUS |
| OPERATIONS=00036 |

| BREAKER |
| CLOSED |

| DLOG A B C |
| 035 049 028 |

| BKROPS RESOPS |
| 00036 0 OF 0 |

MENU BRANCH 4

| TIMER LOG (TLOG) |

| TLOG2=   0m |
| 12:24:126 2/21/95 |

| TLOG2=   87m |
| 15:19:269 1/14/95 |

| --ETC-- |

MENU BRANCH 5

| FAULT LOG |

| 005 12:24 2/21 |
| 50 TARGETS=A,N |

| 004 15:19 1/14 |
| 50 TARGETS C,N |

| --ETC-- |

MENU BRANCH 6

| MAINTENANCE |

| TIME   DATE |
| 18:55:26 3/1/95 |

| COM0(F)   COM1(R) |
| 9600N81   2400N81 |

| PASSWORD ENTRY |
| PW1=********,B |

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

| LCD CONTRAST |
| 10 |

| MODEL :BE1-BPR |
| PROGRAM:VER2.24E |

| RELAY ID |
| 0 |

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Figure 4-3. Standard BE1-BPR Menu Display Screens

MENU BRANCH 0
```
TARGETS
NONE
```

MENU BRANCH 1
```
RELAY SETUP
LOGIC=BFL1E

PU1 PU2 PU3
8.00 2.00 0.50

TD1 TD2 TD3
200m 200m 0m

TD4 TD5 TD6
500M 30S 0m

TD791 792 793
3s  10s  10s

TD79R 79F  79M
5.0s  0m   0m
```

MENU BRANCH 2
```
RELAY STATUS
CHECK DIAG LOG

I1234567 0A12345
0000000  000000

IA=0.00 IB=0.00
IC=0.00 IN=0.00

Ia=0.00 Ib=0.00
Ic=0.00 In=0.00

RECLOSER
RESET

CLOCK NOT SET
DIAG: 1 OF 1
```

MENU BRANCH 3
```
BREAKER STATUS
OPERATIONS=00036

BREAKER
CLOSED

BKROPS  RESOPS
00036   0 OF 0
```

MENU BRANCH 4
```
TIMER LOG (TLOG)

TLOG2=    0m
12:24:126 2/21/95

TLOG2=    87m
15:19:269 1/14/95

--ETC--
```

MENU BRANCH 5
```
MAINTENANCE

TIME    DATE
18:55:26  3/1/95

COM0(F)  COM1(R)
9600N81  2400N81

PASSWORD ENTRY
PW1=********,B

CAL        FREQ
RANGE-1L/2H  60

LCD CONTRAST
10

MODEL   :BE1-BPR
PROGRAM:VER2.24S

RELAY ID
0
```

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06-09-98

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 4-4 illustrates entering the PROGRAM mode.

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 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 BPR relay remains on-line and the changes do not take effect until the PROGRAM mode is exited and the changes 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 4-5). Press the EDIT +/- key to select Y for yes. Press PROG key and the relay will go off-line for 1-2 seconds while the new settings are saved and the BPR relay re-initializes itself.
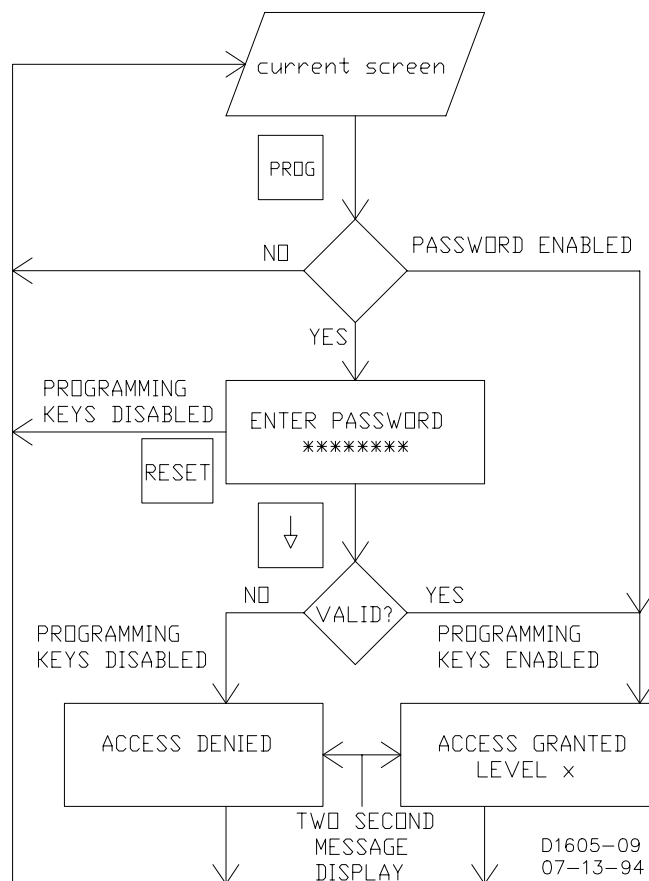
Figure 4-4. Accessing PROGRAM Mode from HMI

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	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 available are:		

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.

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

After the change(s) are made, the new data must be saved using 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) ? Y<CR>	Relay verification. Enter Y to save the data.
RELAY OFF_LINE	
CHANGES SAVED	The new pickup setting for PU2 is now 6.3 A.
RELAY ON_LINE	
>	

The <CR> character at the end of typed lines stands for carriage return or ENTER key. For simplicity it will no longer be shown in the examples, but each line <u>must</u> 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 <u>all</u> changes to relay parameters before executing the SAVE command. Doing this prevents a partial or incomplete protection scheme from being implemented.
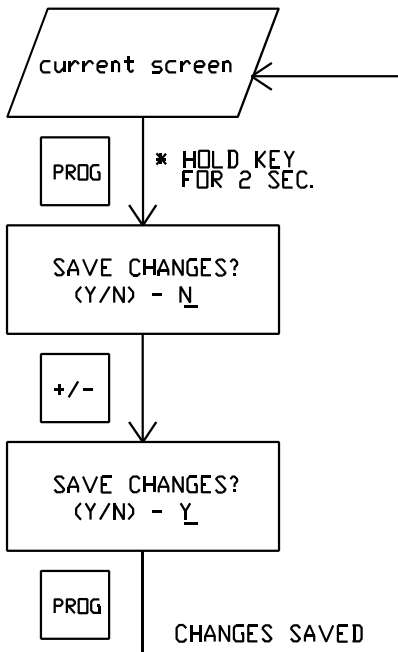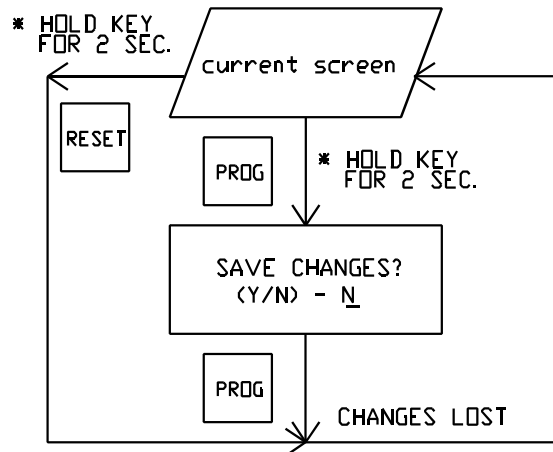
Figure 4-5. Exiting PROGRAM Mode From HMI

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 to 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 One allows write access to all setting and operating registers with no restrictions. The Access Area Two password permits changes to be made to relay protection settings. The password for Access Area Three allows breaker related settings changes to be made. The Access Area Four password allows control of relay outputs for testing purposes. General access settings can be accessed by using passwords for areas one, two, or three. Table 4-1 provides a summary of the write commands associated with each access area. Table 4-1 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.

A second dimension of security is provided. Passwords may be configured to operate from different access ports. An access port designation of F allows access only from the Front panel (COM 0 serial port and the front panel display/keyboard). An access port designation of R allows access only from the Rear panel (COM 1 serial port). An access port designation of B allows access from 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 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.

Table 4-1. Password Write Access Areas

Access Area	Command	Function	Standard Models	Enhanced Models
NA = Not applicable ★ = Enhanced units only			HMI Menu Branch	
0	DATE	Set clock date	5	6
0	DIAG	Reset alarms	2	2
0	FLOG	Reset fault log ★	NA	5
0	RESET	Reset targets or reset other logs if specified	0	0
0	TIME	Set time clock	5	6
0	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, 2, 3	CT	Set CT ratios	NA	NA
1, 2, 3	PCLK	Set clock display format	NA	NA
1, 2, 3	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	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

Password Protection Example

If the following password protection is desired:

- Area One changes to only be performed from the front panel by personnel with the password OPENUP.
- Area Two changes to be performed with no password required but only from the front panel.
- Area Three changes to be performed from either the front or rear panels by personnel with the password BKRGRP.
- Area Four 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 One
>PW2=0,F                               Password for Area Two
>PW3=BKRGRP,B                          Password for Area Three
>PW4=TEST,F                            Password for Area Four
SAVE
ARE YOU SURE (Y/N) ? Y                 Relay verification. 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.

<u>Entering An Access Password At The Front Panel</u>

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

```
  ┌─────────────────────┐
  │   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 the password is rejected   If programming conflict

```
┌─────────────────────┐              ┌─────────────────────┐              ┌─────────────────────┐
│   ACCESS GRANTED    │   or         │    ACCESS DENIED    │   or         │    ACCESS DENIED    │
│     LEVEL _         │              │                     │              │   ACCESS CONFLICT   │
└─────────────────────┘              └─────────────────────┘              └─────────────────────┘
```

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

<u>Entering An Access Password Through Communication Ports</u>

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

BE1-BPR Functional Description   **4-13**

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 non-volatile memory if power is lost and the target data is restored when power is restored.

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	targets (default) 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 target data.
Syntax: RESET
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 Selection**	**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 will not latch unless the related output target is 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: PARGET[=<iiiiiii>,<ooooo>]
Comments: Access area one or two password is required to change settings.

PTARGET Command Example

Program outputs 1, 2, and 3 to target.
       PTARGET=0000000,11100

Relay Setup

BPR relay 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 non-volatile 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. 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 current transformer 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 one, two, or three 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. A CTI value is reported when the ct information is read. A value of 5 is reported for units with 5 ampere CTs and a value of 1 is reported for units with 1 ampere CTs. This setting is factory programmed and is not user adjustable.

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 pre-programmed 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 ampere 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 get 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 (1 cycle 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 - 9.99	0.01	PU1=8.00
				PU2=2.00
				PU3=0.50,10

level
    5 A CT
  LFx=type,**2**
	amperes	0.05 - 1.00	0.01	

level
    1 A CT
  LFx=type,**1** or **3**
	amperes	0.05 - 2.00	0.01	PU1=2.00
				PU2=2.00
				PU3=0.20,10

level
    1 A CT
  LFx=type,**2**
	amperes	0.01 - 0.10	0.01	

cycles	cycles	1 - 100	1	N/A

NOTE: 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 one or two 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

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 4-6 illustrates the timer circuit components.
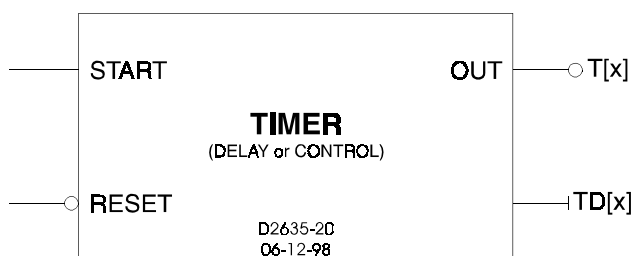
Figure 4-6. Timer Circuit

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)	LT1=D,O8,/O8 LT2=D,O9,/O9
start	any logic variable	LT3=0,0,0 LT4=D,O6,/O6
reset	any logic variable	LT5=D,O12,/O12 LT6=0,0,0

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 one 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	Timer delays		HMI Menu Branch: 1	
Parameter	**Unit of Measure**	**Range**	**Increment**	**Default**
delay	cycles (c) milliseconds (m) seconds (s)	1 - 3600 cycles 10 - 999 ms 1 - 60 seconds	1 cycle 1 ms 0.1 s	TD1=150m TD2=200m TD3=1.0s TD4=500m TD5=30.0s TD6=0m

TD HMI Screen Example

```
┌─────────────────────────────────┐
│  TD1          TD2          TD3   │
│  150m         200m         1.0s  │
└─────────────────────────────────┘
```

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, milliseconds, or seconds
               A setting of zero disables a timer. An access area one or two password is required to change
               settings.

TD Command Examples
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 pre-programmed 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 pre-programmed 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

A Reclosing Function is provided 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, 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 4-8 illustrates how the recloser and breaker resistor protection function 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 from the front panel recloser status screen in the relay status menu
or by using the STATUS command.

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

TD79 HMI Screen Examples

```
┌─────────────────────────────┐     ┌─────────────────────────────┐
│  TD791      792       793   │     │  TD79R      79F       79M   │
│   50m       1.0s      5.0s  │     │   120S       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 one or two 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 4-7.

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.
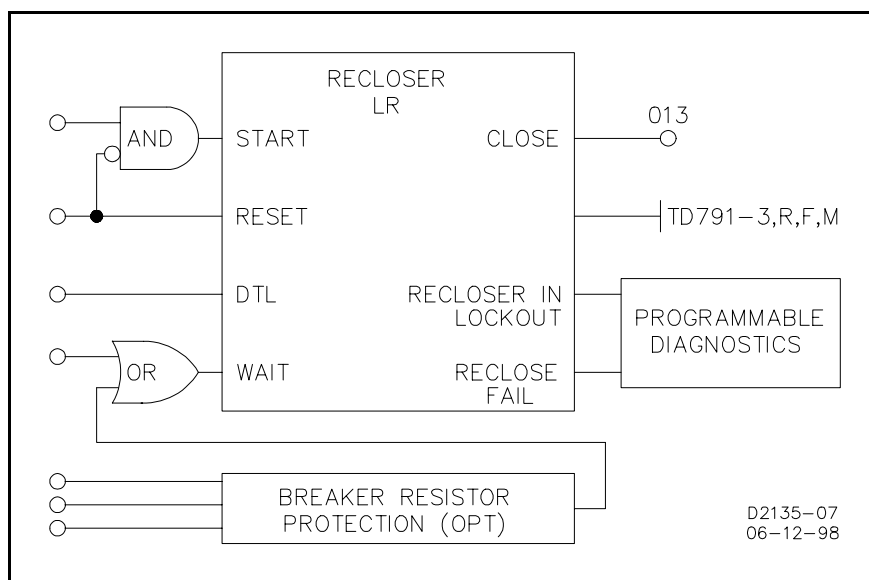
Figure 4-7. Reclosing Logic Circuit

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**	**Comments**
type	0 (disabled) 1 (standard recloser) 2 (power-up to 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 one 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

Recloser 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 power-up. 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 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**	**Comments**
#####	0 (no minimum hold time) 1 (200 millisecond. 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 one, two, or three 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**	`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 OF 1 TIMER ALARM`

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**	

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 OF 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

```
IA=1.28K   IB=1.28K
IC=1.28K   IN=0.00K
```
Primary Current

```
Ia=2.13   Ib=2.13
Ic=2.13   In=0.00
```
Secondary Current

I Command
Purpose: Reads the primary current value of all or individual phases.
Syntsx: 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: ROM ERROR: uP ERROR: EEPROM ERROR: EEDATA ERROR: ADC ERR: CALIBRATION ERR: POWER SUPPLY ERR:	Static RAM read/write error EPROM program memory checksum error uP self test error EEPROM read/write error EEPROM data checksum error Analog to digital converter error Relay not calibrated or calibration checksum error Power supply out of tolerance
Maskable Alarms	ALARM LOGIC (OA): TIMER ALARM (TL): CONTACT DUTY ALM (DL): BKROP >1 SEC (BKR): POWER RESET (RST): CLOCK NOT SET (CLK): RECLOSE FAIL (RF):	Alarm logic (OA equation) was TRUE Timer alarm setting exceeded (refer toPTLOG Command) Contact duty maximum (DMAX) exceeded (refer to BKRCON Command) Breaker operation (clearing) time was greater than 1 second Power supply to microprocessor has been reset Real time clock has not been set 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 one, two, or three 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.

PDIAG	Programmable diagnostic alarms		HMI Menu Branch: N/A
Parameter	**Range**	**Parameter Selections**	
DIAG1 mask	0 or 1	<(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 using the DIAG=0 command. 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 $\geq$ 100% of DMAX. Flag is reset when the DLOG value is reset and the diagnostic alarms are cleared using the DIAG=0 command.
DIAG2 mask	0 or 1	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 clock has not been set. Flag is reset when the clock is set and the diagnostic alarm is cleared using the DIAG=0 command.
		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.

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.

TEST	Diagnostic data	HMI Menu Branch: N/A
Comments		
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.		

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 logs for diagnostic purposes. 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 - 99,999	1	00,000
52b 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>,<52a/b contact logic>]
Comments: An access area one or three password is required to change settings. 52a/b contact logic can be defined using any contact sensing input. The logic defines when the breaker is open.

BKROPS Command Example

Set the breaker operations counter at zero and use contact input 2 to sense when the breaker opens (52a contact finger).

    BKROPS=0,/I2

Breaker Contact Duty Diagnostics (Enhanced Relays Only)

Breaker contact duty log, DLOG, is stored in non-volatile 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 to work 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 initialized to 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 second (A^2-S) in exponential notation, (i.e. - 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.

A breaker contact is typically rated in terms of the number of interruptions allowed as a percent of rated short circuit current (Isc). A first approximation for DMAX in A^2-S can be calculated as:

$$DMAX = Isc^2 \bullet (Tbo) \bullet (\text{\# Interruptions @ Isc})$$

where:
Tbo = Breaker operate time is the average time from when the breaker contacts start to part to when the arc across the contacts is extinguished. (Tbo $\approx$ T-Tc).

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

$$D[p] = \sum_{n=1}^{\infty}(CTP \bullet I[p][n])^2(Tbo)$$

where:
D[p] = breaker duty for pole p
p = phase identification number where 1/2/3=a/b/c
CTP = Phase current transformer stepdown ratio
n = accumulated number of breaker operations
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 below.
Tbo = Breaker operate time calculate as Tbo $\approx$ T-Tc.
T = time in msec measured by the relay from when the 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 one or three
                 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 port 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 - 6.8E38	0.001	0.000E00
Tc	milliseconds	0 - ±50	1	0
Ti	milliseconds	0 - ±50	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.

                 This function is available on enhanced BE1-BPR relays only. An access area one or three
                 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 three milliseconds after the main contacts part.   Set Ti for 5 milliseconds. The timing diagram is shown in Figure 4-7.
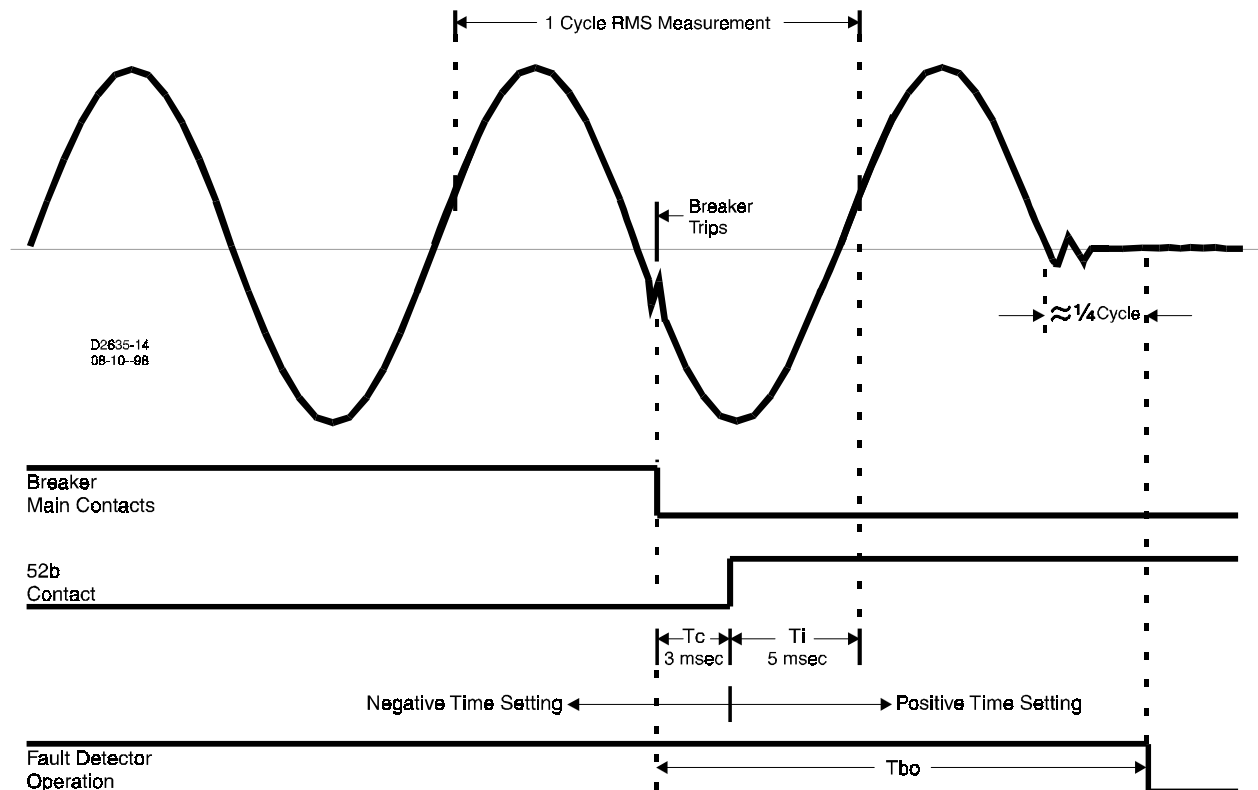

Figure 4-7. Tc and Ti Timing Diagram

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 when the breaker is open. 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 4-8 illustrates the logic that controls virtual output 13 (O13) when breaker resistor protection and/or reclosing is enabled.
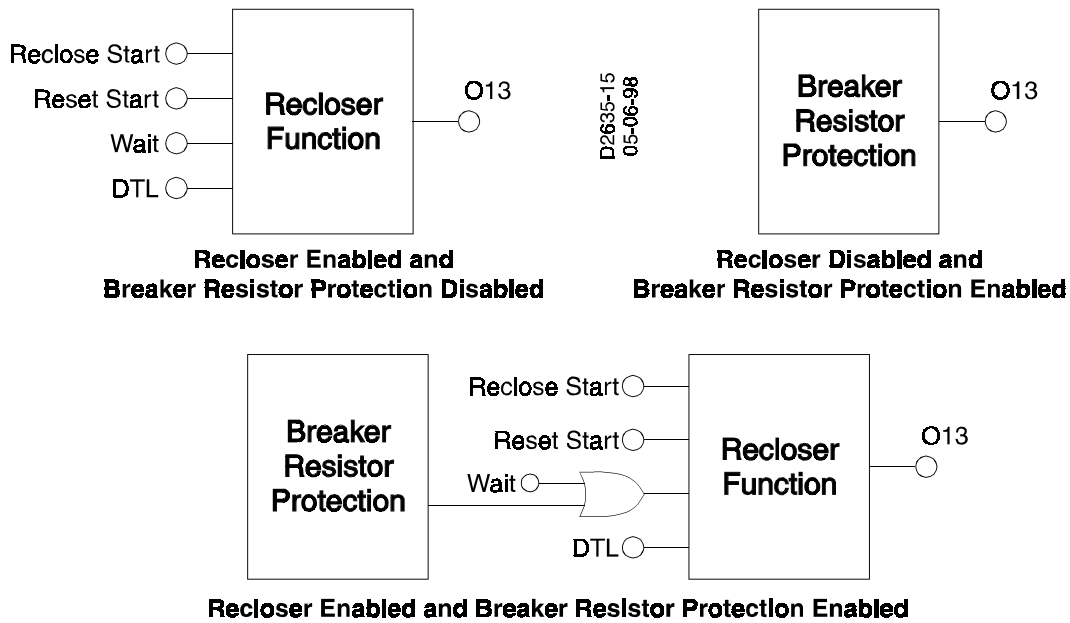
Figure 4-8. Output 13 Logic

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.

Breaker information used in the breaker resistor diagnostics are 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 - 10	1	00,000
reset	minutes	0 - 255	1	0
Ires	primary amperes	0.000 - 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 one or three 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. A log for the last 40 events is stored in volatile memory. The 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 Section 1 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 will be 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 time order (last in - first out) 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 8/08/97** **TLOG2=92m**
Sub-screen 2	**5:51:09 8/07/97** **TLOG2=0m***
Sub-screen 40	**15:22:54 5/20/97** **TLOG2=105m**

```
TLOG2= 92m 10:31:31.091 08/08/97
TLOG2= 0m* 05:51:09.254 08/07/97
TLOG2= 96m 03:33:11.669 08/07/97
TLOG2= 8m* 12:45:26.405 08/06/97
TLOG2= 47m 20:08:58.883 08/01/97
TLOG2= 8m* 17:10:07.259 08/01/97
TLOG2= 88m 16:44:12.855 08/01/97
TLOG2= 85m 17:01:23.307 07/25/97
TLOG2= 77m 18:29:55.697 07/17/97
TLOG2= 6m* 15:15:20.101 07/03/97
TLOG2= 55m 14:57:10.550 07/03/97
TLOG2= 94m 19:07:32.667 06/24/97
TLOG2= 70m 12:59:02.029 06/15/97
```

Example.   A margin log is created using the following settings. A logic diagram (using pre-programmed logic BFL1) for the margin log is shown in Figure 4-9. The timing sequence and timer log is illustrated in Figure 4-10.

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.
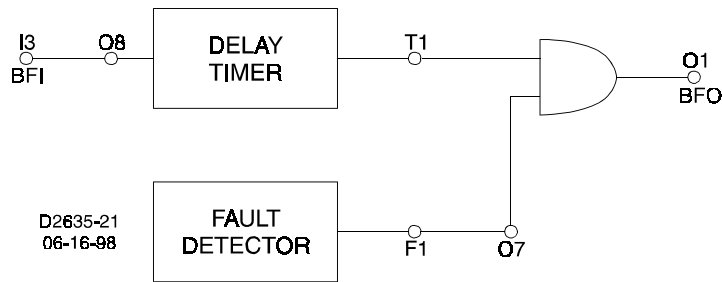
Figure 4-9. Margin Log Logic

ASCII TIMER LOG
TLOG1= 8m* 19:00:00.000 05/01/98
TLOG1= 13m 18:00:00.000 05/01/98
TLOG1= 25m 17:00:00.000 05/01/98

D2635-13
05-05-98
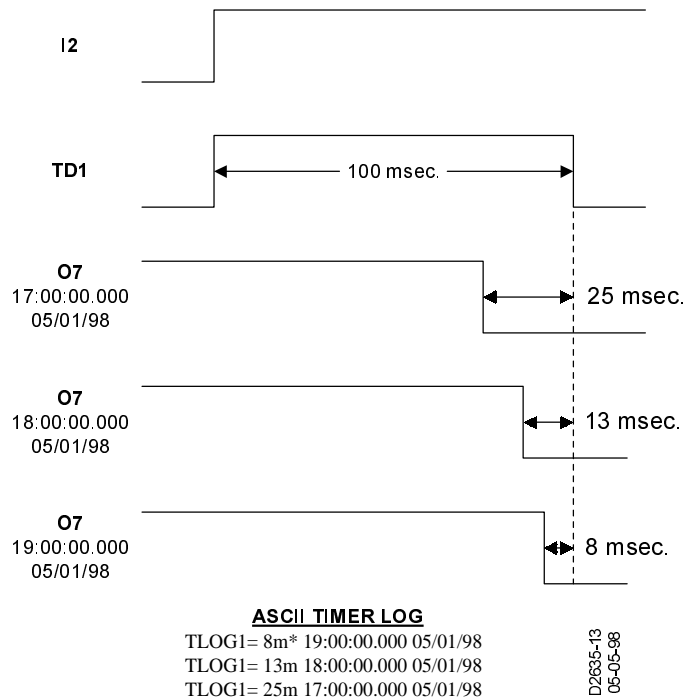
Figure 4-10. Margin Log Timing Sequence

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 4-11 illustrates an example of an H alarm and L alarm condition.
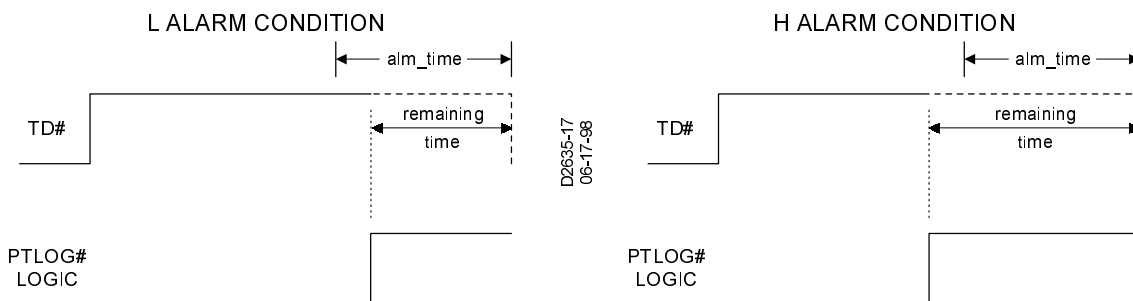
Figure 4-11. H, L Alarm Conditions

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 one, two, or three 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. TLOG lists all entries for all timers. TLOG# lists the entries for Timer# (T#). Each entry gives the time remaining on the timer and the time and date it was logged. Entering TLOG=0 resets all timer logs. A maximum of 40 logs can reside in memory. If more than 40 logs are generated, then the oldest log is overwritten. If a logged time has triggered a timer log alarm, then that timer is marked with an asterisk in the timer log.	

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 timer 1.

       TLOG1
```
TLOG1=40m 11:45:12.008 07/17/93
TLOG1=38m 11:31:44.633 07/17/93
TLOG1=14m* 07:28:13.812 07/06/93
TLOG1=55m 16:15:16.589 07/05/93
```

Fault Log (Enhanced Relays Only)

The fault log provides information about the last twelve events that caused an oscillographic data record to be generated. A record is generated when the TRIGGER command logic expression becomes TRUE. Events are accessed in reverse time order (last in - first out). The fault records are numbered from 1 to 255. The number of the oscillographic record corresponds to the number of the fault log. After fault log number 255, the fault log number automatically returns to 1 and starts again. If the fault memory is full, the oldest record is replaced by the latest one acquired. The fault log data records are reset to zero at power-up or when the FLOG=0 command is given.

Fault Log Listing

A listing 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 are shown below.

FAULT LOG
menu screen

FAULT LOG (FLOG)

Sub-screen 1

129 8:33 2/22
50 TARGETS: AN

Sub-screen 2

128 8:33 2/22
50 TARGETS: AN

Sub-screen 10

120 23:55 7/22
50 TARGETS: AN

129 08:33:22.751 02/22/94, 50 TARGETS=A,N
128 08:33:09.796 02/22/94, 50 TARGETS=A,N
127 19:34:48.467 01/30/94, 50 TARGETS=A,N
126 14:25:09.663 12/20/93, 50 TARGETS=A,N
125 12:26:41.653 11/25/93, 50 TARGETS=B,N
124 11:19:19.684 11/01/93, 50 TARGETS=A,N
123 11:19:15.176 11/01/93, 50 TARGETS=A,N
122 12:08:23.488 10/09/93, 50 TARGETS=B,N
121 00:00:22.758 09/18/93, 50 TARGETS=A,N
120 23:55:09.896 07/22/93, 50 TARGETS=A,N
119 18:34:58.367 07/03/93, 50 TARGETS=A,N
118 13:25:06.613 05/20/93, 50 TARGETS=A,N

FLOG	Fault log information	HMI Menu Branch: 5
Parameter	**Parameter Selections**	**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 is required to read or reset fault log data.

FLOG Command Example

Read fault log 125.

```
FLOG125
FAULT LOG #125
DATE = 11/25/93
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 communications ports 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  =11/25/93
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 re-armed after the TRIGGER definition becomes FALSE.

The fault data recorded is as follows:

- Fault log number (1-255).
- 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 hertz 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	Oscillograph 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> can contain numbers but may not begin with a number.

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. 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 with: 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 with: 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.

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. A listing of these features is provided below. The corresponding commands are listed 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 8/22/93

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	00:00:00
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)	01/01/84
md	month or day (based on PCLK 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
    01/01/84
2. Enter a date of June 1, 1998.
    DATE=06/01/98

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 displayed in a 12 hour format or a 24 hour format.

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
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 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.

Communications 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 ports 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 96008N1 for both ports.

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 8 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 are 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 HMI Screen Example

```
 _____
/                                \
|  COM0(F)          COM1(R)       |
|  19K 8N1          96008N1       |
_____/
```

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 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,C0,E0,H1,P24,X1`

3. Read the settings for all communications ports.
    COM
    `COM0=19.2K8N1,A1,C0,E0,H1,P24,X1`
    `COM1=96008N1,A1,C0,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	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
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 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 communications 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	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
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 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,      FPW3=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 section, 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.

Section 8, *Calibration and Testing* 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

BE1-BPR Functional Description   **4-45**

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 1-20 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 4-2 (Enhanced Relays) or Figure 4-3 (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. Menus 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 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

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 on for 200 to 250 milliseconds. 0 pulses OUTx off for 200 to 250 milliseconds. 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.

    OUT=ENABLE

2. Test output 1 by momentarily closing it.

    OUT1=1

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 2.23E
PN       : 9 2720 00 101
SN       : UHG9827-001
```

SECTION 5 • BESTlogic PROGRAMMABLE LOGIC

GENERAL

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 a totally 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 don't 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 A/D converter (ADC) rate of twelve 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 pre-programmed logic schemes in memory to configure the relay for common breaker failure applications. Enhanced BE1-BPR relays have six pre-programmed logic schemes. Not all features of these pre-programmed 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 non-volatile EEPROM. This custom scheme may be revised or changed completely many times, but only one custom scheme may be stored at one time.

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.

LINFO	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.

   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 5-1 lists the variable names and what they represent. Figure 5-1 illustrates the logic variables in the form of function modules.

Table 5-1. 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
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

Variable Name	Description	Terminal Name	Terminals
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	N/A	N/A
O7	Virtual Output 7	N/A	N/A
O8	Virtual Output 8	N/A	N/A
O9	Virtual Output 9	N/A	N/A
O10	Virtual Output 10	N/A	N/A
O11	Virtual Output 11	N/A	N/A
O12	Virtual Output 12	N/A	N/A
O13	Virtual Output 13	N/A	N/A
O14	Virtual Output 14	N/A	N/A
O15	Virtual Output 15	N/A	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).
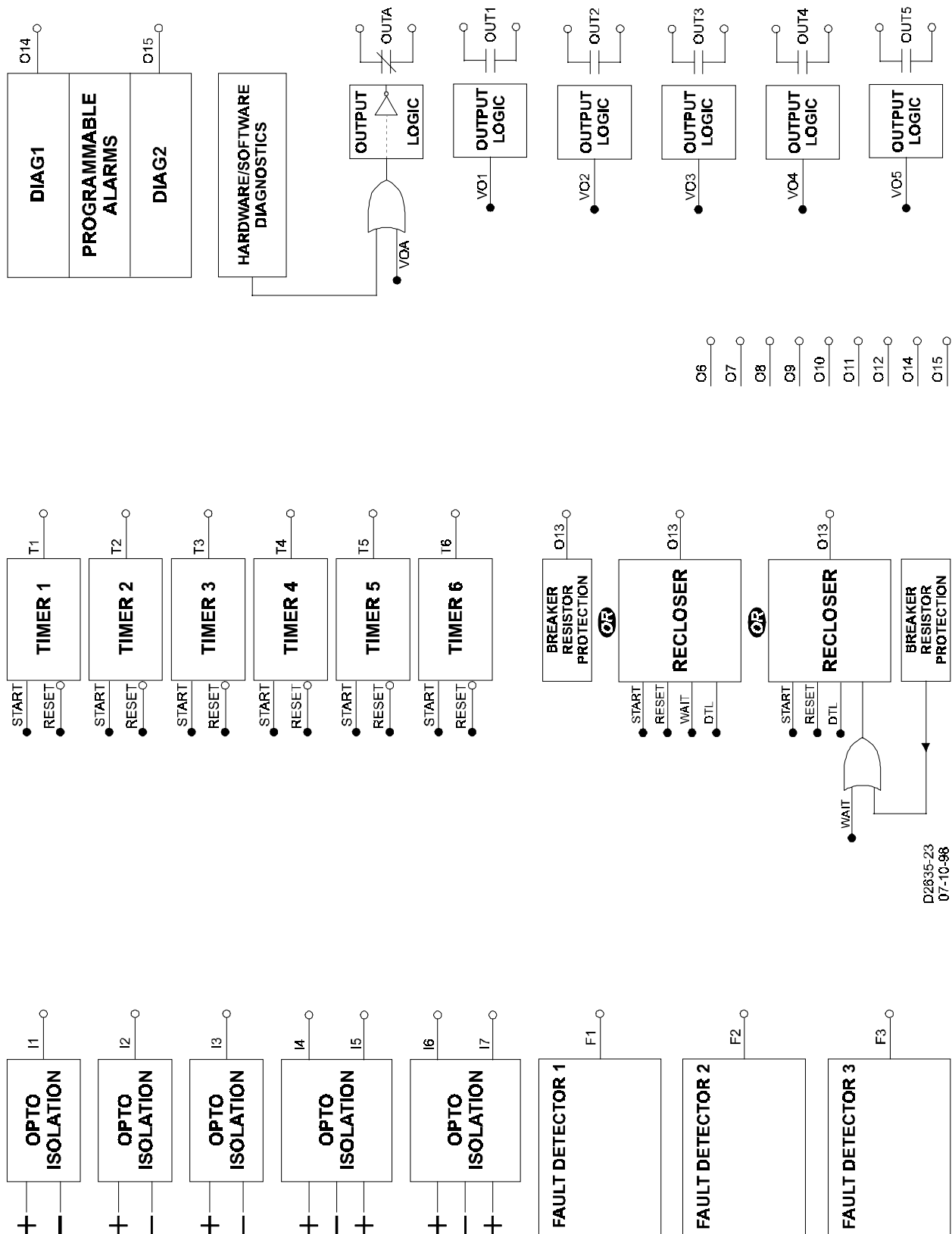
Figure 5-1. BESTlogic Function Blocks

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 can not 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 Table 5-1. 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 isn't 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.

Section 2, *Applications* provides more information about the application of these functions. Section 4, *Functional Description* 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 doesn't 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. Section 4, *Functional Description* 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) 1-15 (OUT1-OUT15)	

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 and 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: LO1=F1T1I1+F1T1I2+F2T1I1+F2T1I2

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 2 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   LO11=I1+I2+I3

INPUT CONTACT LOGIC

Definition of Input Contact Operation

On power-up, variable I[n] = 0. If the physical input contact changes for the defined LI[n] recognition time (r), then logic variable I[n] changes to the new state, where 0=open and 1=closed. After being recognized, (i.e. - changing state) the input contact must stay in a stable state for the defined LI[n] de-bounce time (db) before a new state can be recognized.

Each contact input has a logical mode of operation (LI[n]) that defines the contact input operating characteristics.

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.

    LI=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:

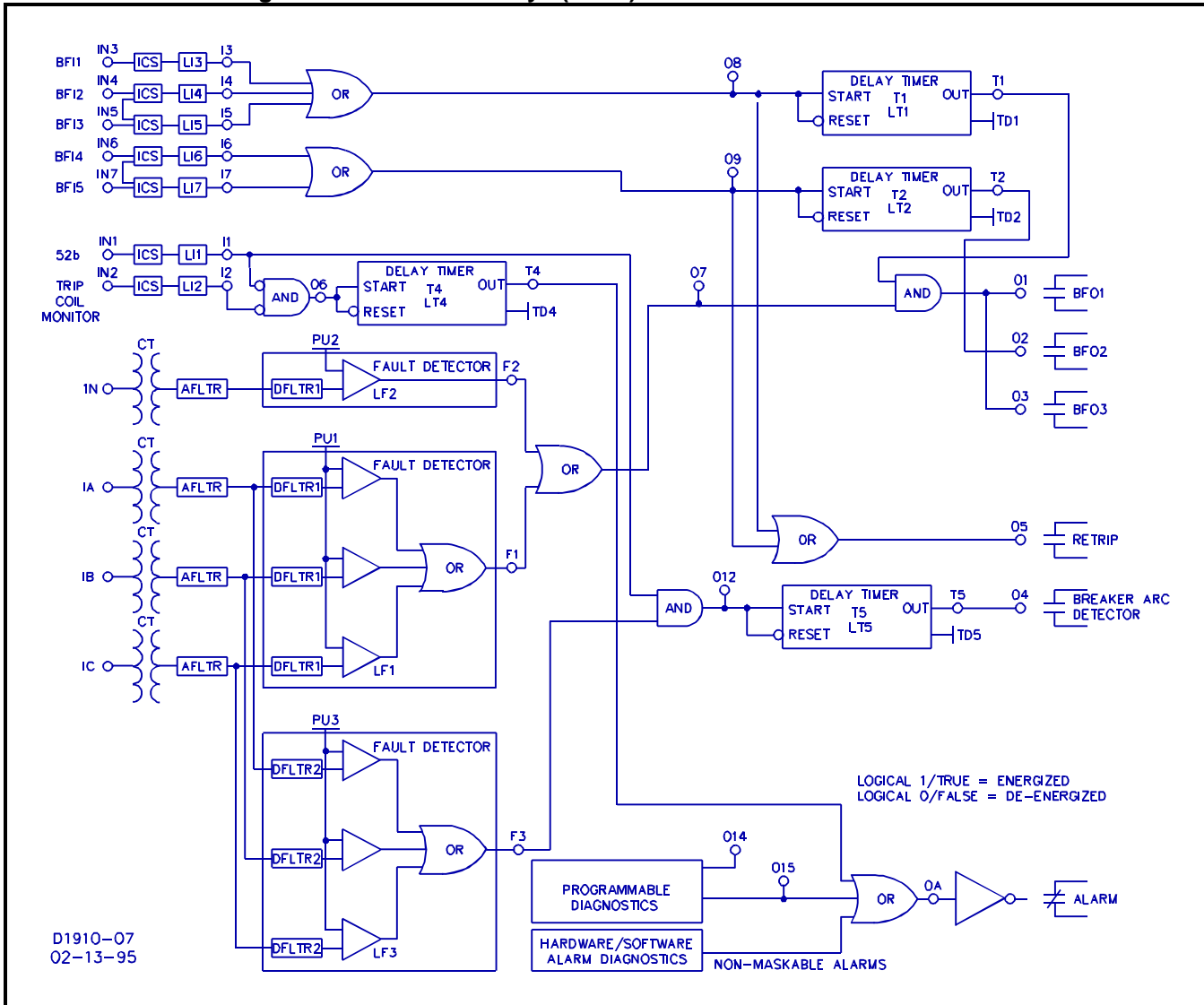|	
IN1 (I1)	= Breaker status contact (isolated input)
IN3 (I3)	= Primary BFI (isolated input)
IN7 (I7)	= External fault trigger to record fault records on enhanced relays
F1	= Always associated with phase fault detector
F2	= Always associated with neutral fault detector
ALM (OA)	= Alarm output
OUT1 (O1)	= Primary BFO - high speed (1/4 cycle pickup)
OUT2 (O2)	= Secondary BFO
OUT5 (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. Section 2, *Application* 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)

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 are always ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 2 For Standard Relays (BFL2)


```
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```

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	L LO4=T5	
LI2=4,12	T3=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 are always ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 3 For Standard Relays (BFL3)

LN=BFL3	LI6=4,12	✱ LOA=T4+O15	LO9=T3I6+T3I7+T3O9
LF1=PI,1	LI7=4,12	LO1=O3	O10=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=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 are always ORed with the programmable diagnostics to provide an alarm output.

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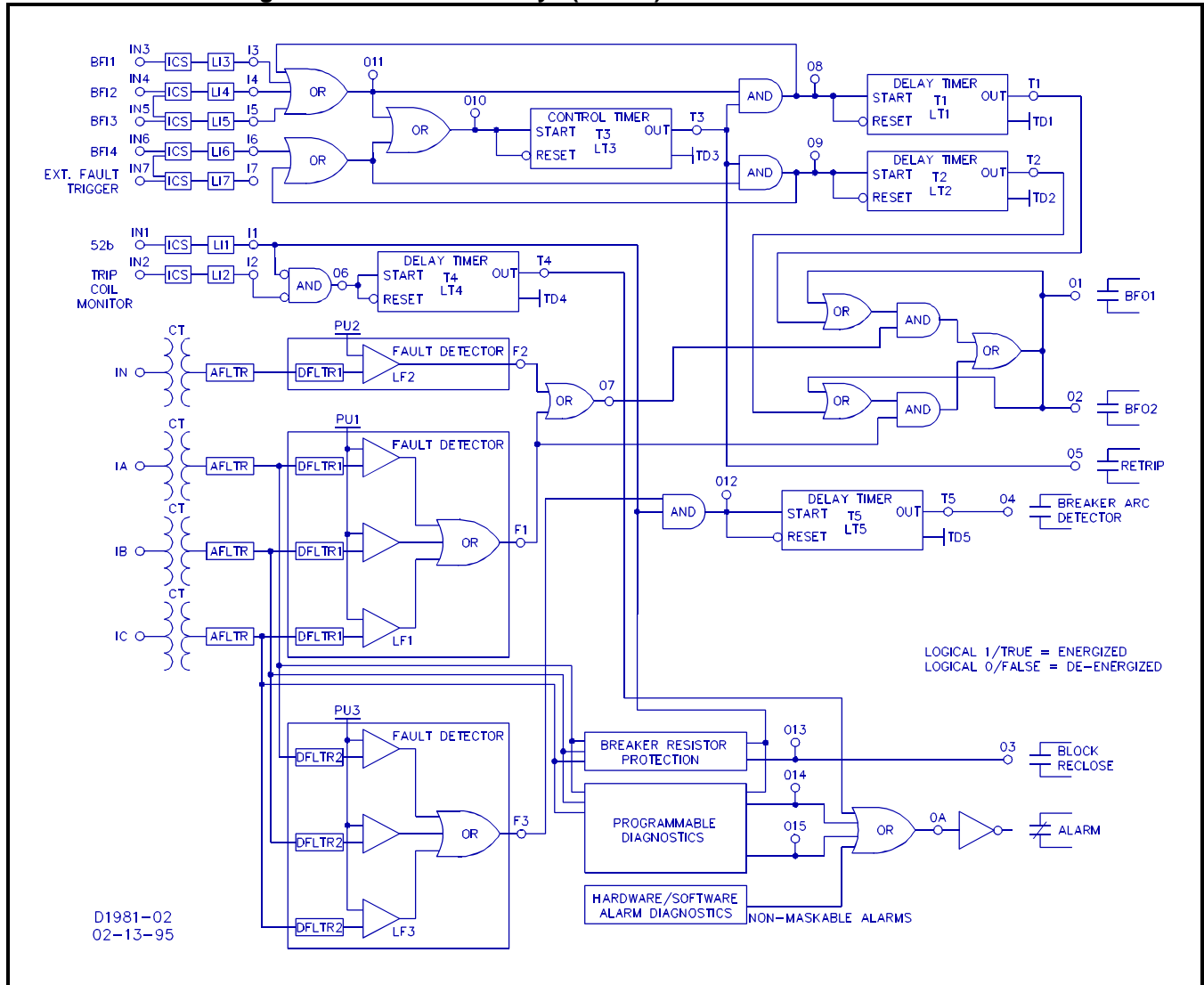|			
LN=BFL1E	LI6=1,12	✱ LOA=T4+O14+O15	LO9=0
LF1=PI,1	LI7=1,12	LO1=T1O7	LO11=0
LF2=NI,1	LR=0,0,0,0,0	LO2=T2	LO12=F3I1
LF3=PI,2	LT1=D,O8,/O8	LO3=O13	
LI1=1,12	LT2=D,I6,/I6	LO4=T5	
LI2=1,12	LT3=0,0,0	LO5=O8+I6	
LI3=1,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=1,12	LT5=D,O12,/O12	LO7=F1+F2	
LI5=1,12	LT6=0,0,0	LO8=I3+I4+I5	

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

Breaker Failure Logic 2 For Enhanced Relays (BFL2E)

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 are always ORed with the programmable diagnostics to provide an alarm output.

Breaker Failure Logic 3 For Enhanced Relays (BFL3E)

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LOGICAL 1/TRUE = ENERGIZED
LOGICAL 0/FALSE = DE-ENERGIZED

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=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 are always 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 Section 4, *Functional Description*.

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 LINF0 <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.

   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.
   LN=BFL1
   LN=BFL1-52A
   LO6=I1/I2
   LO12=F3/I1
   LOGIC=BFL1-52A
   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.

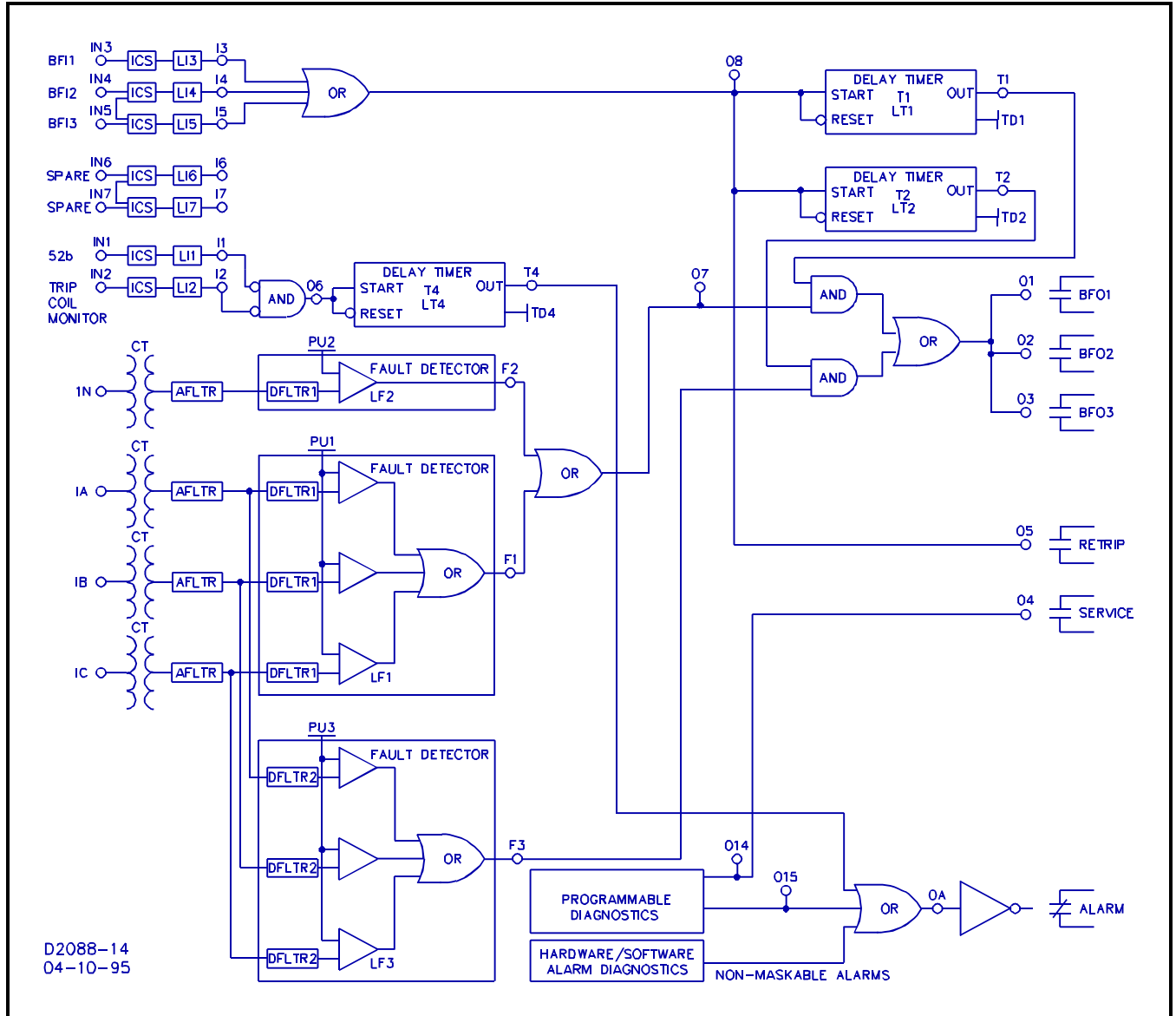   Example 1: LI=8,12 changes all input logic to 8,12.

   Example 2: LO=0 clears all output equations before writing new ones.

3. Change the logic equations as needed using the LF, LI, LT, and LO commands.

4. Review the changes using LINF0 <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. 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 Section 2, *Breaker Failure Protection With Pre-Insertion Resistors*.

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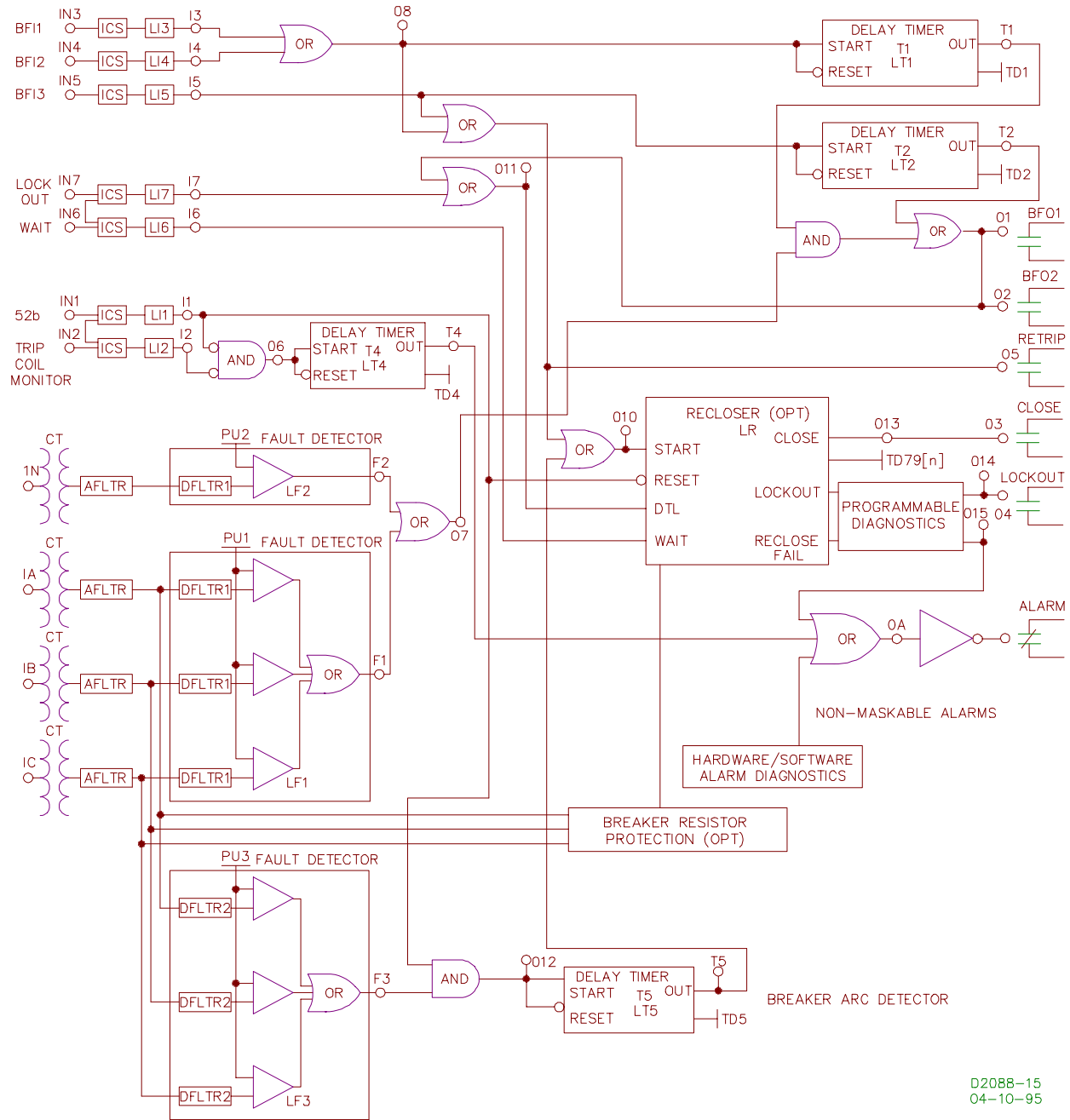|			
LN=BFRES	LI6=4,12	LOA=T4+O15	LO9=0
LF1=PI,1	LI7=4,12	LO1=T1O7+T2F3	LO10=0
LF2=NI,1	LR=0,0,0,0,0	LO2=T1O7+T2F3	LO11=0
LF3=PI,2	LT1=D,O8,/O8	LO3=T1O7+T2F3	LO12=F3I1
LI1=4,12	LT2=D,O8,/O8	LO4=O14	
LI2=4,12	LT3=0,0,0	LO5=O8	
LI3=4,12	LT4=D,O6,/O6	LO6=/I1/I2	
LI4=4,12	LT5=0,0,0	LO7=F1+F2	
LI5=4,12	LT6=0,0,0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

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

Breaker Failure Logic With Reclosing (BF+79)


```
LN=BF+79          LI6=4,12                 LOA=T4+O15           LO9=0
LF1=PI,1          LI7=4,12                 LO1=T1O7+T2          LO10=O5+T5
LF2=NI,1          LR=1,O10,/I1,I6,O11      LO2=T2+T2            LO11=I7+O1
LF3=PI,2          LT1=D,O8,/O8             LO3=O13              LO12=F3I1
LI1=4,12          LT2=D,I5,/I5             LO4=O14
LI2=4,12          LT3=0,0,0                LO5=O8+I5
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
```

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

Note: Breaker resistor protection is included in the logic scheme only if the BKRRES command is entered.

SECTION 6 • COMMUNICATIONS

GENERAL

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 oscillographic 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 oscillographic 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. For a free copy of BESTview for Windows™, contact the Customer Service Department of the Basler Electric Power Systems Group at 618-654-2341.

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 <u>must be disabled</u> on COM1 (i.e. COM1=,H0,E0, XO).

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 setup another relay with the same protection scheme by sending the data to the other relay.		

SHOWSET Command
Purpose: Returns a report of relay settings and logic equations.
Syntax: SHOWSET
Comments: No access area password is required for reporting functions.

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;          CTI=5
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. Instructions for configuring Windows 95® HyperTerminal and Windows® Terminal are provided in Appendix A, *Terminal Emulation*.

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 of your terminal emulation software to "0".

```
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
PRESS ANY KEY TO CONTINUE ...
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;          CTI=5
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.

COMMANDS

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

ACCESS Command

Purpose: Reads or changes access area so that programming or settings changes can be made.
Syntax: ACCESS[=<password>]
Reference: Section 4, *Functional Description, Software Functional Description, Changing Parameters Using Communication Ports*

BKRCON Command   (Enhanced Relays Only)

Purpose: Reads or changes data on the breaker contacts used by breaker diagnostic routines.
Syntax: BKRCON[=<DMAX>,<Tc>,<Ti>]
Reference: Section 4, *Functional Description, Software Functional Description, Breaker Status, Breaker Contact Duty Diagnostics (Enhanced Relays Only)*

BKROPS Command

Purpose: Reads or changes breaker operations data.
Syntax: BKROPS[=<#operations>,<52a/b contact logic>]
Reference: Section 4, *Functional Description, Software Functional Description, Breaker Status, Breaker Status Screens*

BKRRES Command

Purpose: Reads or changes data on the breaker resistor used by breaker diagnostic routines.
Syntax: BKRRES[=<MAXOPS>,<reset>,<Ires>]
Reference: Section 4, *Functional Description, Software Functional Description, Breaker Status, Breaker Resistor Diagnostics*

CAL Command

Purpose: Read or change calibration values.
Syntax: CAL[x][=<amps>]
Reference: Section 4, *Functional Description, Software Functional Description, Maintenance, Calibrating the Analog Channels*

COM Command

Purpose: Reads or changes the communications protocol
Syntax: COM[x][=<ratedps>][,Ay][,Ey][,Hy][,Pyy][Xy]
Reference: Section 4, *Functional Description, Software Functional Description, Maintenance, Communication Settings*

CT Command

Purpose: Reads or changes the current transformer ration settings.
Syntax: CT[t][=<ratio>]
Reference: Section 4, *Functional Description, Relay Setup, Transformer Ratios*

DATE Command

Purpose: Reads or changes the date setting.
Syntax: DATE[=<dm>/<md>/<yr>]
Reference: Section 4, *Functional Description, Maintenance, Time and Date*

DIAG Command

Purpose: Reads or resets diagnostic information.
Syntax: DIAG[=0]
Reference: Section 4, *Functional Description, Relay Status*

DLOG Command   (Enhanced Relays Only)

Purpose: Reads or changes breaker contact duty log data.
Syntax: DLOG[P][=<YY>]
Reference: Section 4, *Functional Description, Breaker Status, Breaker Contact Duty Diagnostics (Enhanced Relays Only)*

FLOG Command   (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:	Section 4, *Functional Description, Fault Log (Enhanced Relays Only), Fault Log Listing*

FLT Command   (Enhanced Relays Only)

Purpose:	Obtains a COMTRADE report.
Syntax:	FLT<#><type>
Reference:	Section 4, *Functional Description, Fault Log , Oscillographic Data Acquisition*

FREQ Command

Purpose:	Reads or changes the nominal power system frequency information used by the relay.
Syntax:	FREQ[=<freq(hz)>]
Reference:	Section 4, *Functional Description, Maintenance, Calibrating the Analog Channels*

HELP Command

Purpose:	Obtains helpful information about communication port commands.
Syntax:	HELP[x/<cmd>]
Reference:	Section 4, *Functional Description, Software Functional Description, Introduction*

I Command

Purpose:	Reads the primary current value of all or individual phases.
Syntax:	I[<phase>]
Reference:	Section 4, *Functional Description, Software Functional Description, Relay Status*

ID Command

Purpose:	Reads or programs a relay ID number for polled communication.
Syntax:	ID [=<id(0-255)>]
Reference:	Section 4, *Functional Description, Software Functional Description, Maintenance, Communication Settings*

LF Command

Purpose:	Reads or changes the fault detector logic of the active logic scheme.
Syntax:	LF[x][=<type>,<filter>]
Reference:	Section 4, *Functional Description, Software Functional Description, Relay Setup, Fault Detectors*

LI Command

Purpose:	Reads or programs contact input logic.
Syntax:	LI [#[=<r>,<db>]]
Reference:	Section 5, *BESTlogic Programmable Logic, Input Contact Logic, Definition of Input Contact Operation*

LINFO Command

Purpose:	Reads the names of all logic schemes in memory or the equations associated with the named logic scheme.
Syntax:	LINFO[<name>]
Reference:	Section 5, *BESTlogic Programmable Logic, General*

LN Command

Purpose:	Reads the name of the active logic or program a new set of logic equations called <name>.
Syntax:	LN[=<name>]
Reference:	Section 5, *BESTlogic Programmable Logic, Logic Names*

LO Command

Purpose:	Reads or programs output logic.
Syntax:	LO [#[=<Boolean equation>]]
Reference:	Section 5, *BESTlogic Programmable Logic, Programming Output Operational Characteristics*

LOGIC Command

Purpose:	Reads or changes the active logic of the relay.
Syntax:	LOGIC[=<existing name>]
Reference:	Section 5, *BESTlogic Programmable Logic, General*

LR Command

Purpose:	Reads or programs the recloser input logic.
Syntax:	LR [=<type>,<start>,<reset>,<wait>,<lockout>]
Reference:	Section 5, *BESTlogic, Recloser Logic, Programming Definition Characteristics*

LT Command

Purpose:	Reads or changes timer logic.
Syntax:	LT[x][=<type>,<start>,<reset>]
Reference:	Section 4, *Functional Description, Relay Setup, Timers*

OUT Command

Purpose:	Pulses outputs on or off for testing purposes.
Syntax:	LT[x][=<type>,<start>,<reset>]
Reference:	Section 4, *Functional Description, Maintenance, Output Contact Testing*

PCLK Command

Purpose:	Reads or changes the time clock time/date format.
Syntax:	PCLK[=<date_format(M/D)>,<time_format(12/24)>]
Reference:	Section 4, *Functional Description, Software Functional Description, Maintenance, Time And Date*

PDIAG Command

Purpose:	Reads or programs service diagnostic alarms.
Syntax:	PDIAG[=<DIAG1 mask>,<DIAG2 mask>]
Reference:	Section 4, *Functional Description, Software Functional Description, Relay Status*

PDISPLAY Command

Purpose:	Reads or programs the default HMI display screen.
Syntax:	PDISPLAY[=<default_menu>,<default_screen>]
Reference:	Section 4, *Functional Description, Software Functional Description, Maintenance, Default HMI Display Screen*

PHOLD Command

Purpose:	Reads or programs the output hold timer mask.
Syntax:	PHOLD[=<#####>]
Reference:	Section 4, *Functional Description, Software Functional Description, Relay Setup, Reclosing*

PTARGET Command

Purpose: Reads or programs the target operation and display.
Syntax: PARGET[=<iiiiiii>,<ooooo>]
Reference: Section 4, *Functional Description, Software Functional Description, Target Data, TARGETS Screen*

PTLOG Command

Purpose: Reads or changes timer log and alarm logic.
Syntax: PTLOG [#[=<logic term>,<alm_type>,<alm_time>]]
Reference: Section 4, *Functional Description, Software Functional Description, Timer Log*

PU Command

Purpose: Reads or changes the fault detector pickup levels
Syntax: PU[x] [=<level>[,<cycles>]]
Reference: Section 4, *Functional Description, Software Functional Description, Relay Setup, Fault Detector*

PW Command

Purpose: Reads or changes password settings.
Syntax: PW [<#>[=<password>,<access(F/R/B)>]]
Reference: Section 4, *Functional Description, Software Functional Description, Maintenance, Programming A New Password*

QUIT Command

Purpose: Exits the programming mode and returns the relay to on-line without saving any changes.
Syntax: QUIT
Reference: Section 4, *Functional Description, Software Functional Description, Changing Parameters Using Communication Ports*

RESET Command

Purpose: Clears latched target data.
Syntax: RESET
Reference: Section 4, *Functional Description, Software Functional Description, Target Data, TARGETS Screen*

SAVE Command

Purpose: Saves programming or settings changes, exits the programming mode, and returns the relay to an on-line condition.
Syntax: SAVE
Reference: Section 4, *Functional Description, Software Functional Description, Changing Parameters Using Communication Ports*

SHOWSET Command

Purpose: Returns a report of relay settings and logic equations.
Syntax: SHOWSET
Reference: Section 5, *BESTlogic Programmable Logic, Miscellaneous Commands*

SNAME Command   (Enhanced Relays Only)

Purpose: Reads or changes the station name and number for COMTRADE reports.
Syntax: SNAME [=<#>,<name>]
Reference: Section 4, *Functional Description, Software Functional Description, Fault Log (Enhanced Relays Only), Data Acquisition*

STATUS Command

Purpose: Returns a report of inputs, outputs, and internal relay status.
Syntax: STATUS
Reference: Section 4, *Functional Description, Software Functional Description, Relay Status*

TARGET Command

Purpose: Reads input and output target information
Syntax: TARGET
Reference: Section 4, *Functional Description, Software Functional Description, Target Data, TARGETS Screen*

TD Command

Purpose: Reads or changes timer delay settings.
Syntax: TD[x][=<delay>]]
Reference: Section 4, *Functional Description, Software Functional Description, Relay Setup, Timers*

TD79 Command

Purpose: Reads or changes recloser (79) time delay changes.
Syntax: TD[x][=<delay>]]
Reference: Section 4, *Functional Description, Software Functional Description, Relay Setup, Reclosing*

TEST Command

Purpose: Reads diagnostic data.
Syntax: TEST
Reference: Section 4, *Functional Description, Relay Status*

TIME Command

Purpose: Reads or changes the time clock.
Syntax: TIME [=<hr>:<mn><f><sc>.<msc>]
Reference: Section 4, *Functional Description, Software Functional Description, Maintenance, Time And Date*

TLOG Command

Purpose: Reads or reset the timer logs.
Syntax: TLOG[#]
Reference: Section 4, *Functional Description, Software Functional Description, Timer Log*

TRIGGER Command   (Enhanced Relays Only)

Purpose: Reads or changes the trigger logic or triggers a fault record.
Syntax: TRIGGER[=<logic term>/Y]
Reference: Section 4, *Functional Description, Software Functional Description, Fault Log (Enhanced Relays Only), Oscillographic Data Acquisition*

VER Command

Purpose: Returns information about relay hardware and software.
Syntax: VER
Reference: Section 4, *Functional Description, Software Functional Description, Maintenance, Software Version Display*

SECTION 7 • INSTALLATION

GENERAL

When not shipped as part of a control or switchgear panel, BE1-BPR Breaker Protection Relays (BPR) 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 the Regional Sales Office, or contact the Sales Representative at Basler Electric, Highland, Illinois.

In the event the unit is not to 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 Section 8) 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 switchgear 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 eight milliamperes 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 7-1. The rack unit may be panel mounted at any convenient angle, using the cutout dimensions of Figure 7-2 as a guide. Figures 7-3 and 7-4 show the dimensions for the vertical panel mount. The cutout dimensions for the vertical panel mount are shown in Figure 7-5. When panel mounting the rack unit, an optional escutcheon plate can be installed to cover variations in panel cutouts. Figure 7-6 shows the mounting flanges removed and the escutcheon plate installed. Figure 7-7 shows the mounting flange and alternate location that requires less mounting depth.
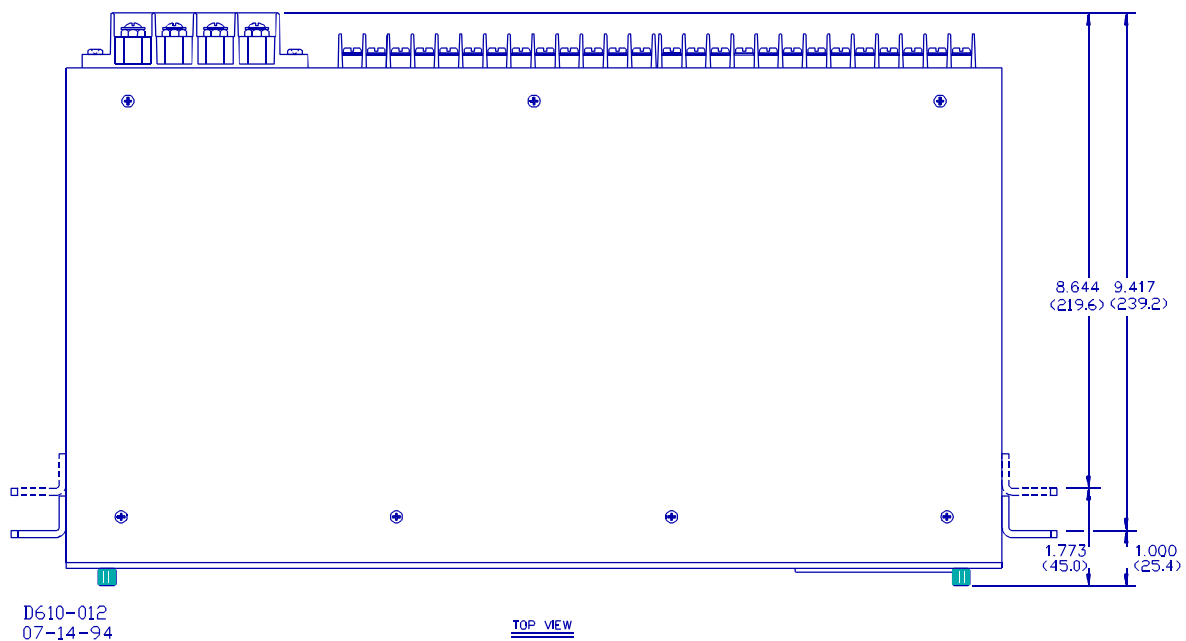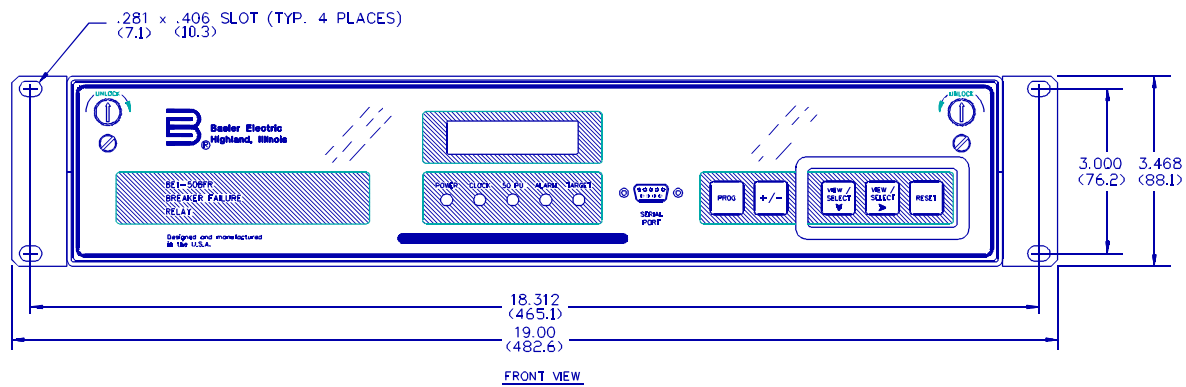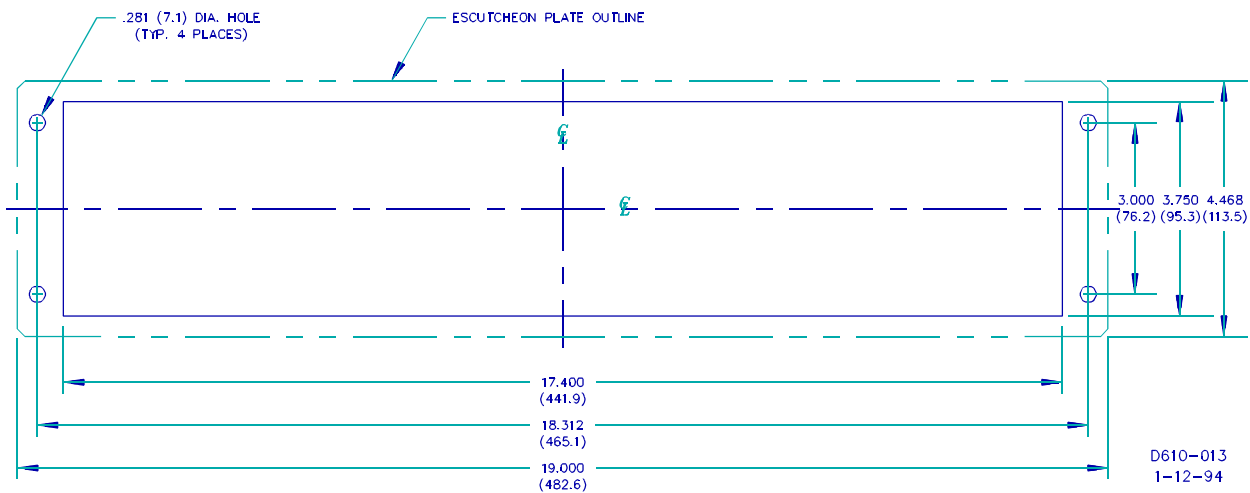
Figure 7-1 Overall Dimensions
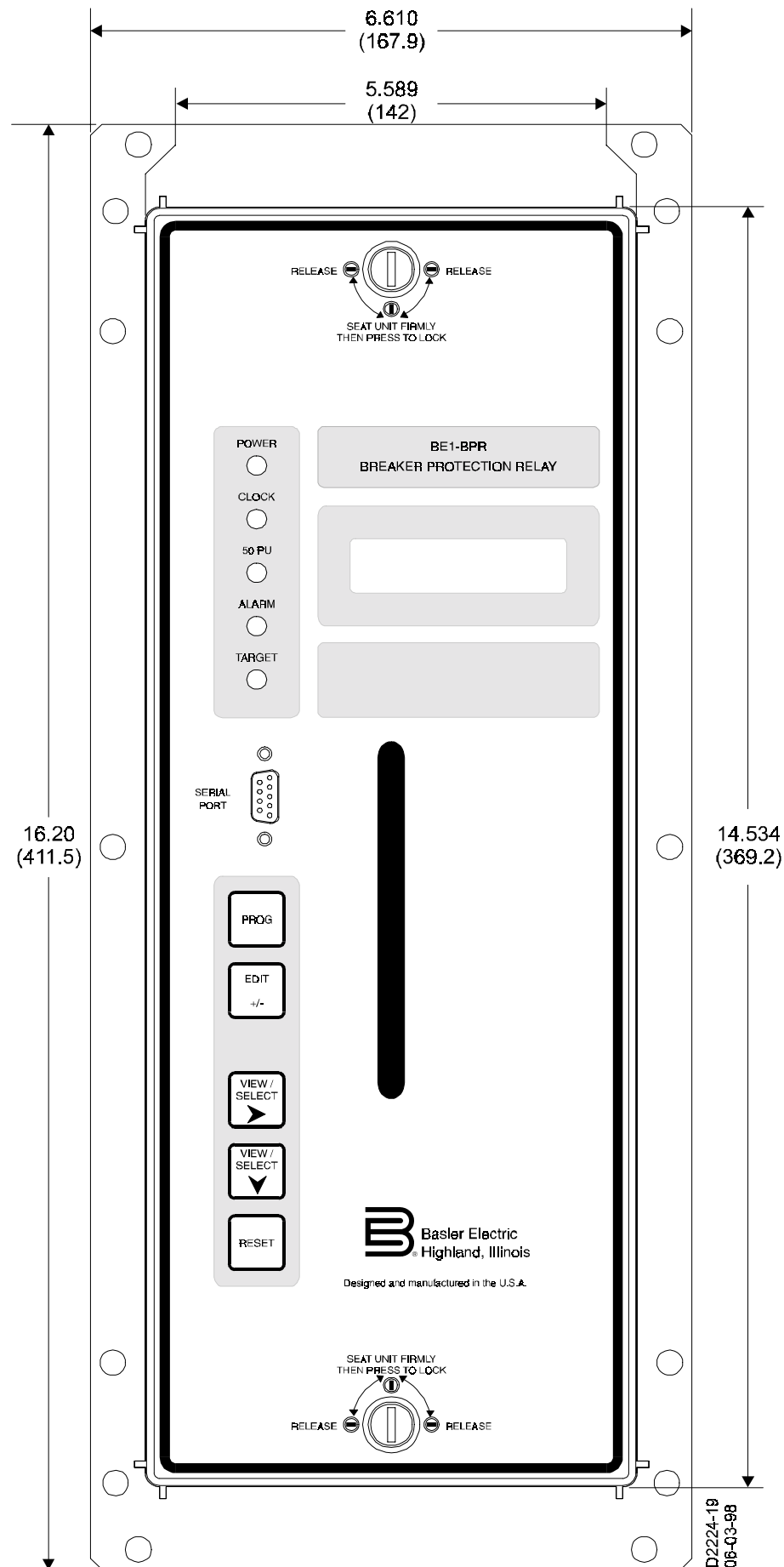

Figure 7-2. Cutout Dimensions (Panel Mount)
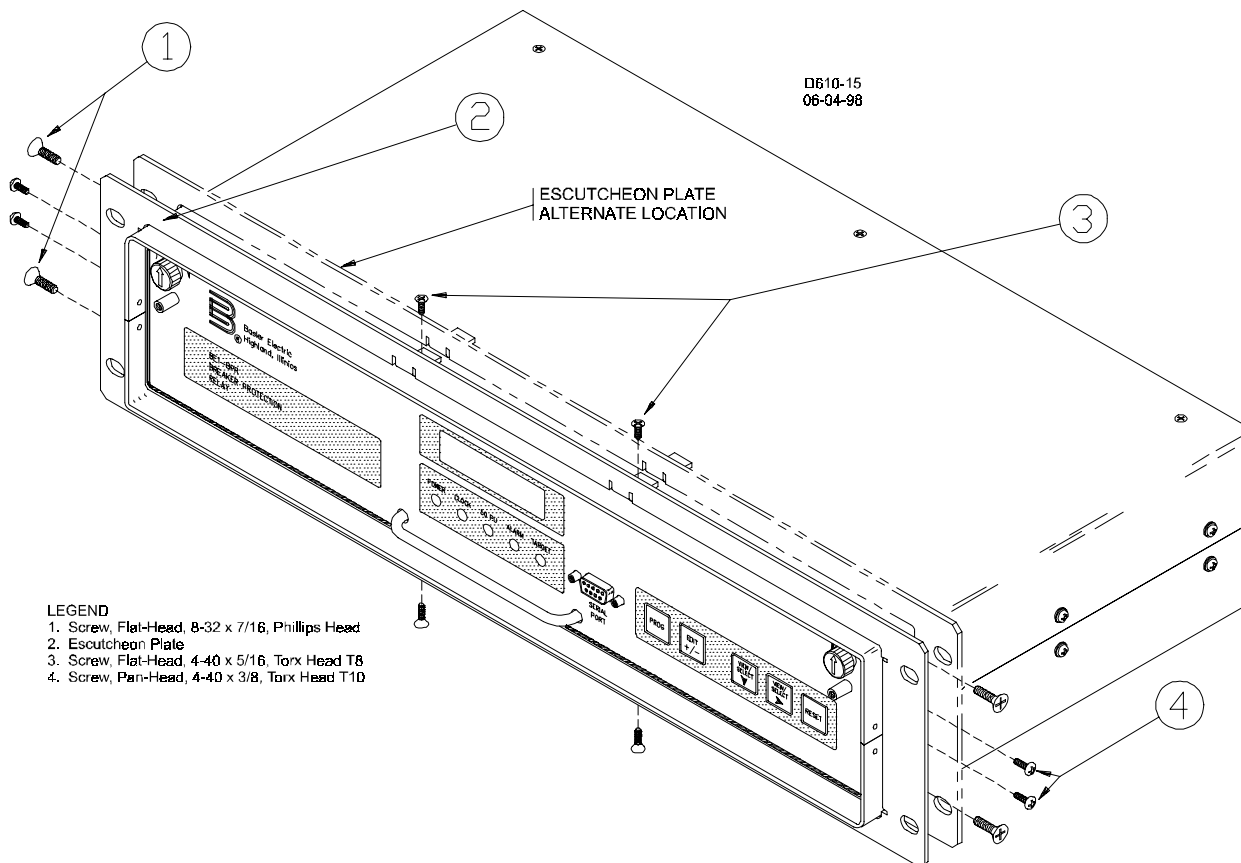
Figure 7-3. Overall Dimensions (Vertical Mount)

.107
(2.72)

14.320
(363.7)

D2224-20
06-03-98

ALTERNATE MOUNTING LOCATION

.545
(13.8)

9.452
240.1

1.315
(33.4)

8.682
(220.5)

Figure 7-4. Overall Dimensions, Side View (Vertical Mount)

Figure 7-5. Panel Drilling Diagram (Vertical Mount)

Figure 7-6. Escutcheon Plate Mounting (Vertical Mount Not Shown)

Installing Escutcheon Plates

Horizontal Mount

To install the escutcheon plate kit (Basler part number, 9 2720 13 100) you must first remove the mounting flanges by removing the four screws (1) from the relay (two from each side). To allow the escutcheon plate to slide onto the relay, remove the four screws (4) from the relay (two from each side).

To install the escutcheon plate in the standard location, it is also necessary to remove four screws (3), 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 (3) that are provided with the optional escutcheon plate kit. Refer to Figure 7-7 for the alternate location side view. Reinstall four screws (4). Reinstall the four screws (1) 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
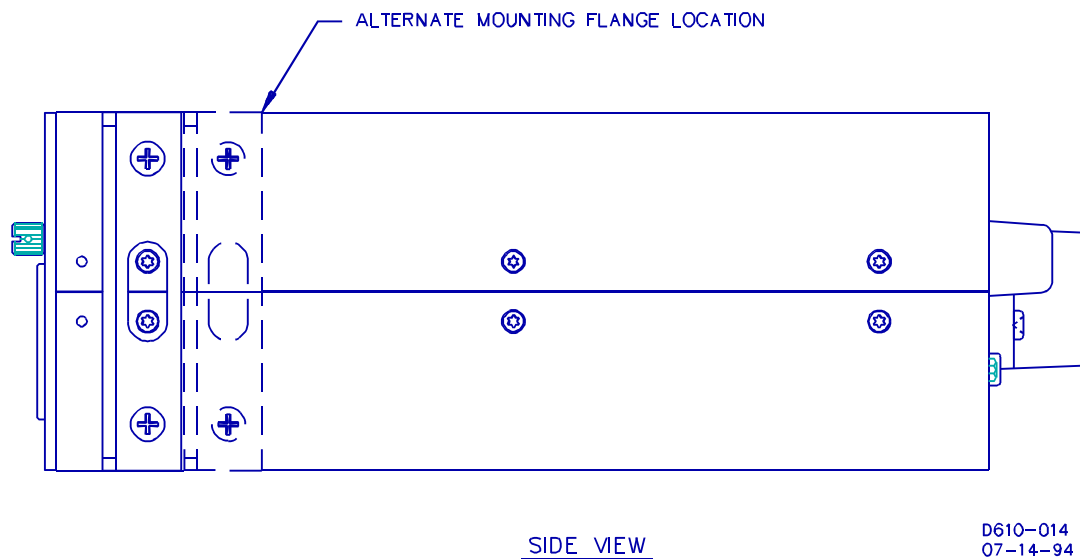
Figure 7-7. BE1-BPR Alternate Mounting Location (Vertical Mount Not Shown)

- Westinghouse FT31 and FT32 cases

CONNECTIONS

Incorrect wiring may result in damage to the unit. Typical external sensing connections are shown in Figure 7-8. Connections for BE1-BPR relay terminals are identified in Figure 7-9. Terminals are suitable for use with wire sizes 12 AWG or larger.
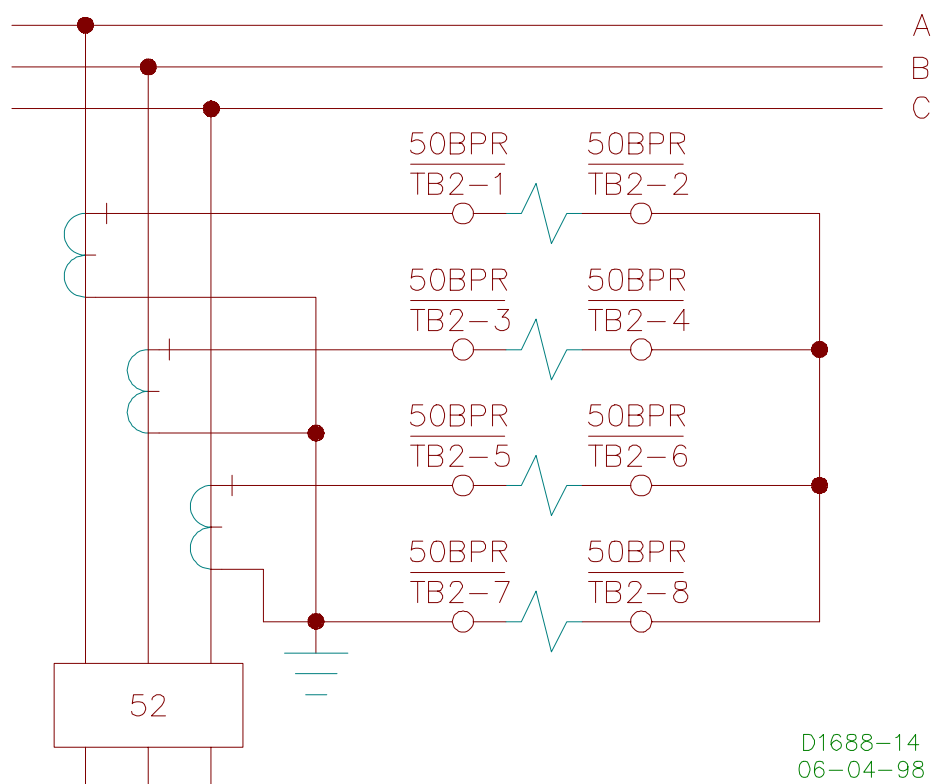

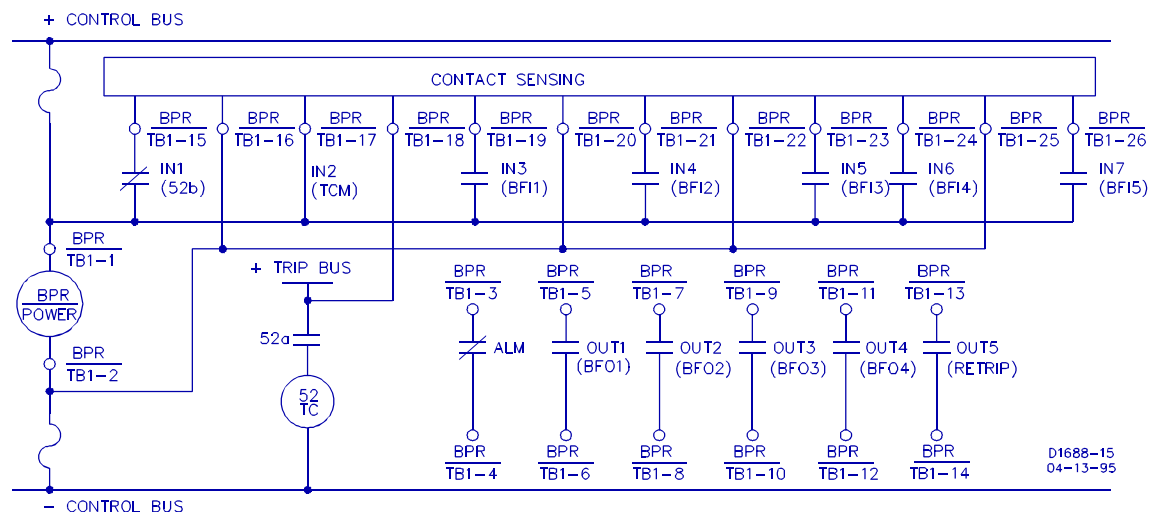Figure 7-8. Typical External Sensing Connections

Figure 7-9. Typical External Connections

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 7-1. Figures 7-10 through 7-13 provide RS-232 cable connection diagrams.

Table 7-1. 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	(RQS)	FROM RELAY
9	N/C	----	N/A
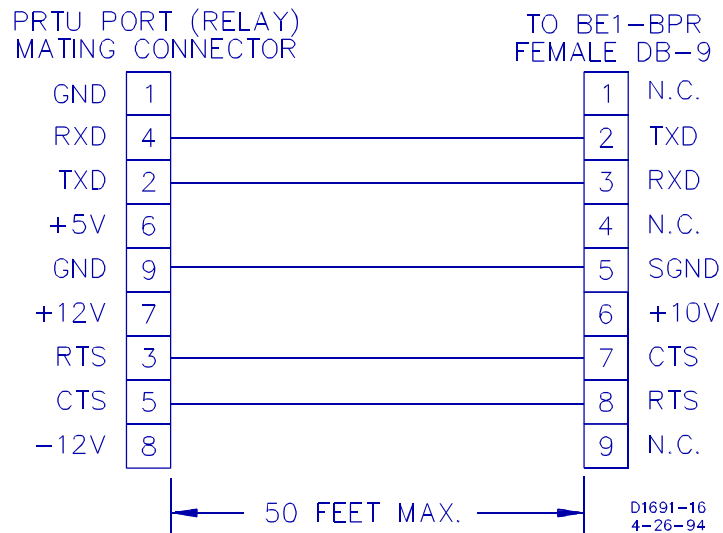
Figure 7-10. Protective Relay Terminal (PRTU) to BE1-BPR
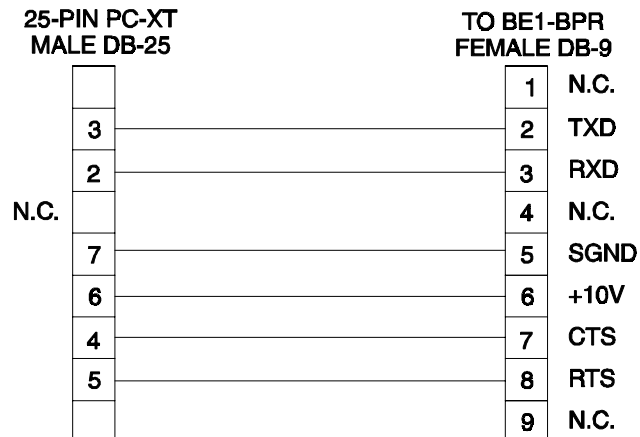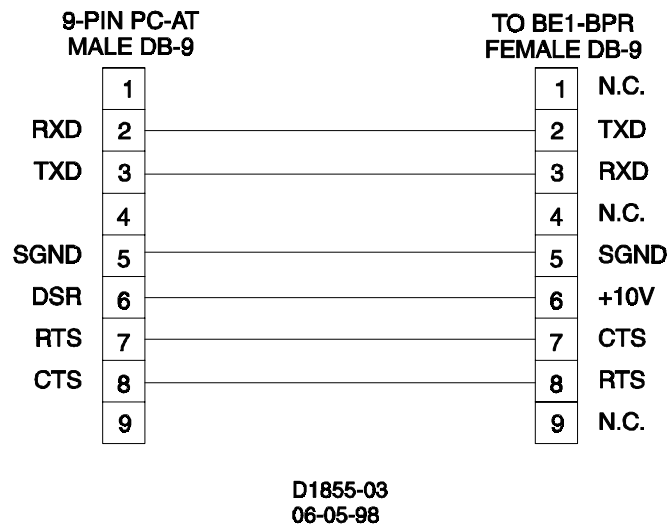
Figure 7-11. Personal Computer to BE1-BPR Cable
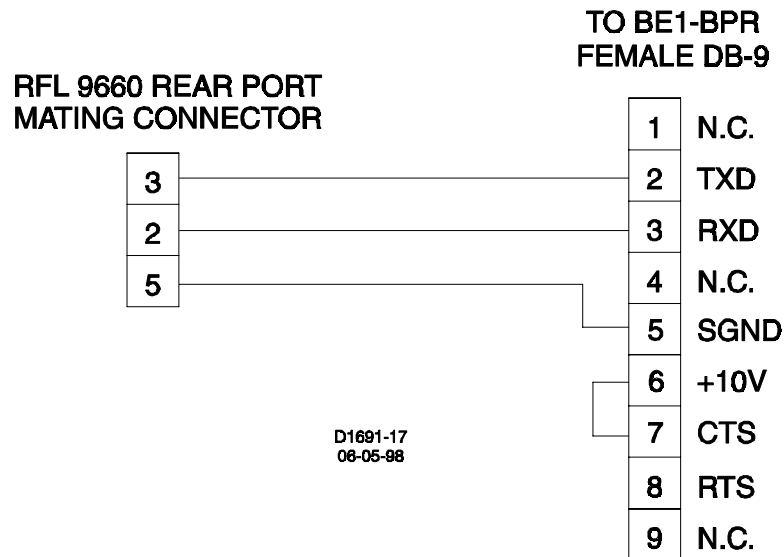
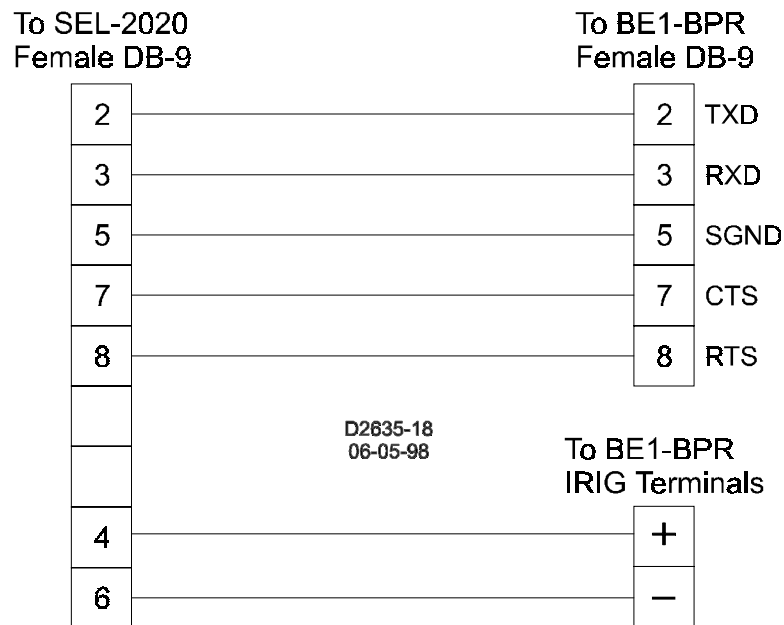*Figure 7-12. RFL 9660 Protective Relay Switch to BE1-BPR Cable*

Figure 7-13. SEL-2020 Communications Processor to BE1-BPR 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 7-2. A cable connection diagram is provided in Figure 7-14.

Table 7-2. 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.
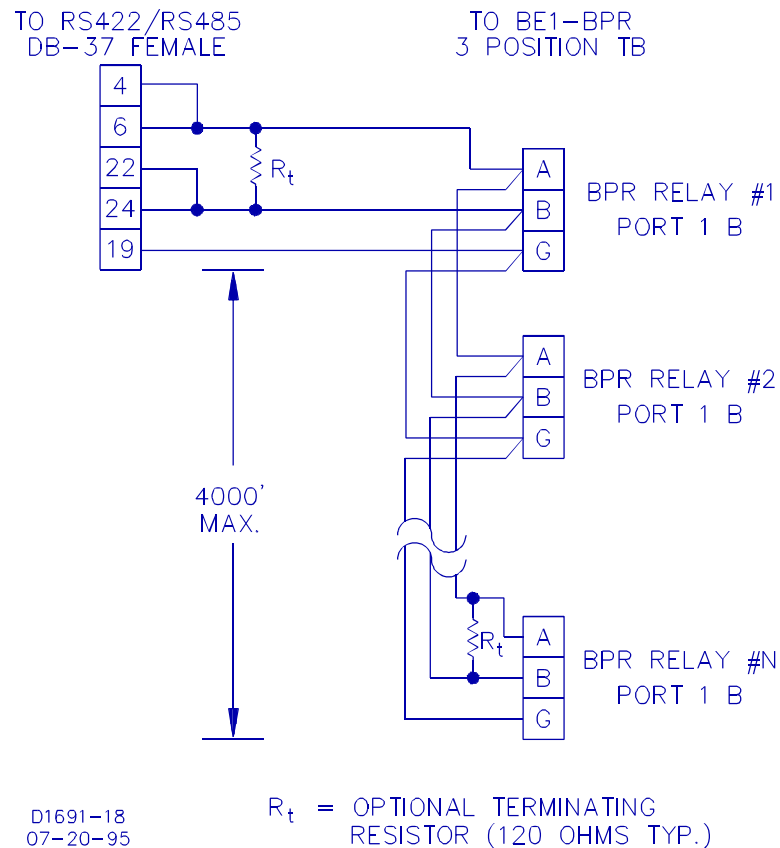

Figure 7-14. RS-422/RS-485 DB-37 to BE1-BPR Cable Connection

BE1-BPR Installation   **7-11**

IRIG-B Connections

The IRIG-B connections are located on a terminal block shared with the RS-485 terminals. Terminal designations and functions are shown in Table 7-3.

Table 7-3. IRIG-B Pinouts

Terminal	Function
–	REFERENCE
+	SIGNAL

SECTION 8 • CALIBRATION AND TESTING

CALIBRATION

To calibrate the relay, perform the following steps.

Test Equipment Required: Doble Model F2500 ac current source or equivalent

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 factory default protocol is 96008N1.)

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 8-1 as a guide, apply the appropriate value of current and enter the corresponding calibration command.

Table 8-1. 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 OK.

Step 5. This step step applies only to enhanced model relays (high range capability). Using Table 8-2 as a guide, apply the appropriate value of current and enter the corresponding calibration command.

Table 8-2. High 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 OK.

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

Calibration Using The Front Panel Display and Keyboard

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 hertz.

```
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   │          │CAL           FREQ   │
│1      10.00    50   │          │1      10.00    60   │
└─────────────────────┘          └─────────────────────┘
```
         50 Hertz Calibration   *60 Hertz Calibration*

Step 4.   Using Table 8-1 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 8-2 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   │          │CAL           FREQ   │
│1      40.00    50   │          │1      40.00    60   │
└─────────────────────┘          └─────────────────────┘
```
         50 Hertz Calibration   *60 Hertz Calibration*

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, LC, 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, LC, 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: LC=2,12 changes all input logic to 2,12.
        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.

Step 2.   Calibrate the A/D section of the relay using the A/D calibration procedure described above.

Note
Steps 3 through 16 of this procedure can be automated by using any word processor to type all the required commands into an ASCII file. This file would then be downloaded 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 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, entered 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.

SECTION 9 • MAINTENANCE

GENERAL

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

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 necessarily mean the relay will operate properly. Always test the relay before placing it in operation.

STORAGE

This protective relay contains aluminum electrolytic capacitors which generally have a life expectancy in excess of 10 years at storage temperatures less than $40°$C. Typically, the life expectancy of the capacitor is cut in half for every $10°$C rise in temperature. Storage life can be extended if, at one-year intervals, power is applied to the relay for a period of thirty minutes.

SECTION 10 • MANUAL CHANGE INFORMATION

SUMMARY AND CROSS REFERENCE GUIDE

This section summarizes the changes made to the current edition and previous editions of the manual. Manual revisions to date are summarized in Table 10-1.

Table 10-1. Instruction Manual Changes

Revision	Change	ECA/ECO	Date
A	Revised the entire manual to reflect changes in the relay that added reclosing functions.	15067	04-18-95
B	Made revisions throughout manual to reflect the vertical mounting option. Added Figures 3-4, 7-3, 7-4, and 7-5 to show vertical mount. Minor corrections made in *Reclosing Mode* and *FLOG Command*. Corrected figure 4-2.	15159	07-20-95
C	Revised manual to include changes resulting from adding IRIG-B functions (ECA 15457).	15494	01-29-96
D	Manual was revised to reflect changes made in firmware version 3.26. The "r" parameter range of the LI command was changed from 1-255 to 4-255. Password access areas were expanded to four areas; area 4 enables output contacts to be pulsed for testing. The CTI, DLOG, LO13, LO14, and LO15 settings were removed from all SHOWSET settings report examples. COMMAND information was summarized in tables. Missing command setting range information was added. Various inaccuracies were corrected. Figure 7-5, *Panel Drilling Diagram (Vertical Mount)* was updated. Setup instructions for using Windows® Terminal and HyperTerminal® were added. Added Figure 7-13 to show how connections are made to SEL-2020. Updated/clarified calibration and testing procedures of Section 8. Updated the manual style and added an index.	267	09-14-98
E	Revised the manual to change pg. 1-7 *Output Relay Pickup Time*, Output 1 from "1/4 cycle (4.2 milliseconds) maximum" to "4 milliseconds typical, 5 milliseconds maximum."	1046	12-10-98

APPENDIX A • TERMINAL EMULATION

This appendix provides instructions for configuring Windows 95® HyperTerminal and Windows® Terminal to communicate with your BE1-BPR relay.

WINDOWS 95® HYPERTERMINAL

Step 1.   Click Start: Highlight Programs, Accessories, HyperTerminal.

Step 2.   Click HyperTerminal to open the folder.

Step 3.   Select the file or icon labeled *Hypertrm* or *Hypertrm.exe*. Once the program has started, you will be presented with a series of dialog boxes.

Step 4.   Dialog Box: CONNECTION DESCRIPTION See Figure A-1.

    a. Type the desired file name,

       e.g., BE1-BPR

    b. Click "OK"

Step 5.   Dialog Box: PHONE NUMBER

    a. Click drop-down menu:

       CONNECT USING

       Select *Direct To ComX,* where *X* is the port you are using on your computer.

    b. Click "OK"

Figure A-1. Connection Description Dialog Box

Step 6.   Dialog Box: COM*X* Properties

    a. Make the following selections using Figure A-2 as a guide.

       Set the bits per second setting so that it matches the setting of the relay. The default baud rate of the relay is 9600.

       Set the data bits at *8*.

       Set the stop bits at *1*.

       Set flow control to *Xon/Xoff*.

    b. Click "OK". This creates an icon with the file name entered in Step 4 and places it in the HyperTerminal folder. Future communication sessions can then be started by clicking the appropriate icon.

Step 7.   Click File/Properties on the menu bar. Click the Settings tab.

    a. Make the following selections:

       Check the *Terminal Keys* radio button.

       Select *VT-100* emulation.

       Set the Backscroll Buffer to the maximum setting of 500.

Figure A-2. COM Properties Dialog Box

b. Click the ASCII Setup button. Make the following selections using Figure A-3 as a guide.

<u>ASCII Sending</u>

Place a check at Send line ends...

Place a check at Echo typed...

Select a line delay setting of 100 to 200 milliseconds.

Select the Character delay at 0.

<u>ASCII Receiving</u>

Disable Append line feeds... by leaving unchecked.

Disable Force incoming... by leaving unchecked.
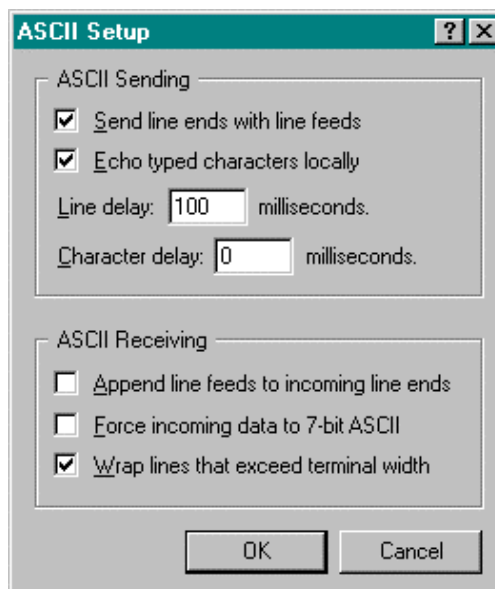
Place a check at Wrap lines...

c. Click "OK".

d. Click "OK".

Figure A-3. ASCII Setup Dialog Box

Step 8. Click File and click Save.

<table>
<tr><td align="center">NOTE</td></tr>
<tr><td align="center">Settings changes do not become active until the settings are saved.</td></tr>
</table>

Step 9. HyperTerminal is now ready to communicate with the relay. Table A-1 describes the required connection for each RS-232 port.

Table A-1. RS-232 Communication Ports

Connection	Type
Front Port	9 pin, female DCE
PC to Front RS232 port cable	Straight
Rear port	9 pin, female DCE
Modem to Rear RS-232 port cable	Null modem
PC to Rear RS-232 port cable	Straight

WINDOWS® TERMINAL

Step 1. In Program Manager, open the Accessories program group and double click the Terminal icon to start the program.

Step 2. On the menu bar, select Settings/Terminal Emulation.

a. In the dialog box, click *DEC VT-100 (ANSI).*

b. Click "OK".

Step 3. Select Settings/Terminal Preferences.

    a. Using Figure A-4 as a guide, make the following selections in the dialog box:

       Check the *Line Wrap* and *Local Echo* boxes to enable these functions.

       Disable the *CR->CR/LF Inbound* function.

       Enable the *CR->CR/LF Outbound* function.
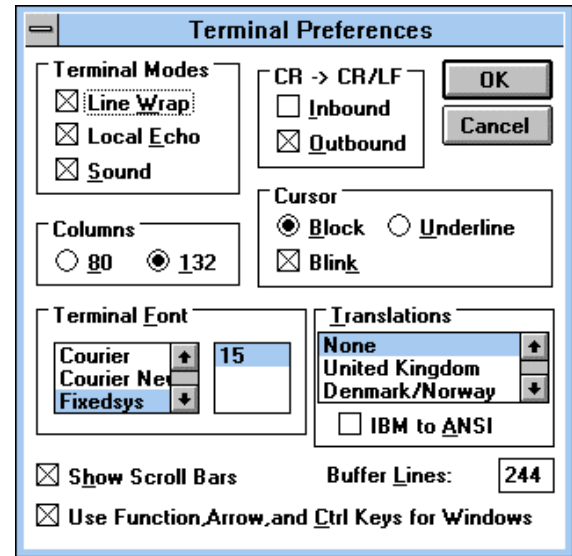
    b. Set the *Buffer Lines at 244.*

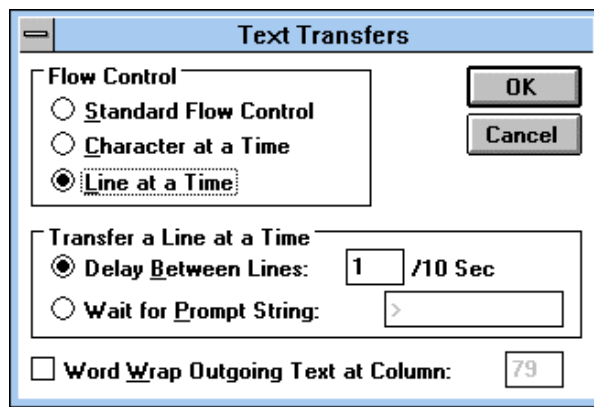   c. Click "OK".

Figure A-4. Terminal Preferences Dialog Box

Figure A-5. Text Transfers Dialog Box

Step 4. Select Settings/Text Transfers

    a. Make the following selections using Figure A-5 as a guide.

       Set Flow Control at *Line at a Time.*

       Enable *Delay Between Lines* and set the delay at 1 or 2/10 Sec.

       Disable *Word Wrap...*

    b. Click "OK".

Step 5. Select Settings/Communications

    a. Make the following selections:

       Under *Connector,* select the appropriate communiation port for your computer.

       Adjust the Baud Rate setting so that it matches the setting of the relay. The default baud rate of the BE1-BPR is 9600.

       Set the Data Bits at *8*.

       Disable *Parity Check.*

       Set the Stop Bits at *1*.

       Set Flow Control to *Xon/Xoff.*

    b. Click "OK".
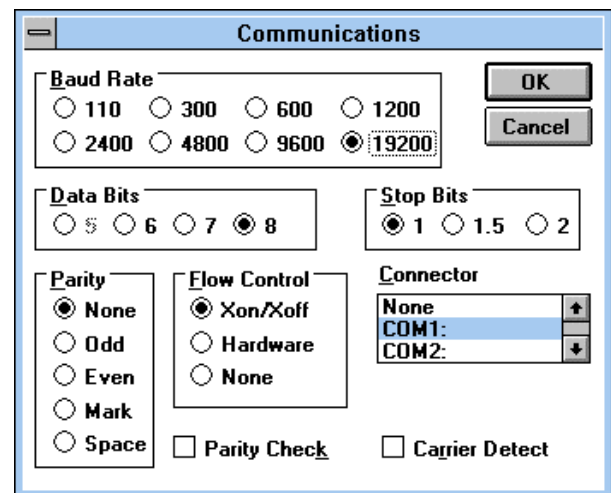
Figure A-6. Communications Dialog Box

Step 6. Click File/Save. Enter a desired file name, e.g., BE1-BPR.trm. For future communication sessions, click File and open this file. Terminal will automatically be set up properly to communicate with the BE1-BPR relay.

Step 7. Terminal is now ready to communicate with the relay. Table A-1 describes the required connection for each RS-232 port.

APPENDIX B • COMMANDS SUMMARY

INTRODUCTION

Table B-1 provides an alphabetical list of communication commands accompanied by the following information.

- Syntax
- Brief description
- Corresponding menu branch
- Password area for each write command

Refer to Figures 4-2 and 4-3 of Section 4, *Functional Description* for HMI menu branch numbering and screen locations.

Table B-1. Communication Commands

★ = Enhanced Relays Only NA = Not Applicable			HMI Menu Branch	
Command		**Function**	**Standard Models**	**Enhanced Models**
ACCESS[=<password>]		Read/Change access area in order to change settings	NA	NA
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>, <Ires>]		Read/Change breaker resistor data.	NA	NA
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	NA	NA
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	NA	3
FLOG[x][=0]	★	Read fault log or Clear FLOG and FAULT data	NA	5
FLT<#><type>	★	Read COMTRADE report for fault <xxx>	NA	NA
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	NA	NA
I[<phase>]		Read phase current in primary units	2	2
ID[=<id>]		Read/Change relay ID number for polled communications	NA	NA
LF[x] [=<type>,<dflt>]		Read/Change Logic for Fault detector operation	NA	NA
LI[x] [=<r>,<db>]		Read/Change Logic for Contact input	NA	NA
LINFO[<name>]		Read logics available or <name> logic equations	NA	NA
LN[= <name>]		Read/Change custom logic name	1	1
LO[#[=<Boolean equation>]]		Read/Change Program operation for an output	NA	NA
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	NA	NA
LT[x[=<Type>,<start>,<reset>]]		Read/Change Logic for Timer/Counter operation	NA	NA
OUT[x][=<1/0>/DISABLE]		Pulse Output ON(1) or OFF(0) for test	NA	NA
PCLK[=[<date_format>, <time_format>]		Read/Program date/time format	NA	NA
PDIAG[=<DIAG1 mask>, <DIAG2 mask>]		Read/Program diagnostic alarms as ON(1) or OFF(0)	NA	NA
PDISPLAY[=<default_menu>,<default_screen>]		Read/Program the default display screen	NA	NA
PHOLD [= <#####>]		Read/program the 200 msec output hold mask	NA	NA
PTARGET[= <iiiiiii>, <ooooo>]		Read/Program the target data format	NA	NA

Command	★	Function	HMI Menu Branch	
★ = Enhanced Relays Only NA = Not Applicable			Standard Models	Enhanced Models
PTLOG[x [=<logic>[<alarm_type>, <alarm_time]]]		Read/Program Timer log logic, alarm type and alarm time	NA	NA
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	NA	NA
RESET		Reset latched target data	0	0
SAVE		Exit programming mode and save changes	NA	NA
SHOWSET		Read relay setup parameters	NA	NA
SNAME [= <#>,<name>]	★	Read/Change station name for the COMTRADE report	NA	NA
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	NA	NA
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.	NA	NA
VER		Read Model, SN, PN and Program data	5	6

APPENDIX C • RELAY SETTINGS RECORD

INTRODUCTION

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,1-254

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   = [   ]

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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, H0,1

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, H0,1

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)
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, msec	,	Delta t, Current, msec
BKRCON	=		,		,	

Breaker Status & Op Counter	=		,	Breaker Open Logic
BKROPS	=		,	

Breaker Pre-insertion Resister	=	Reset Time, Min	,	Max Ops to Blk Reclose	,	Res Current V_{PN}/R
BKRRES	=		,		,	

SAVE SETTINGS; YES

SAVE; Y

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