

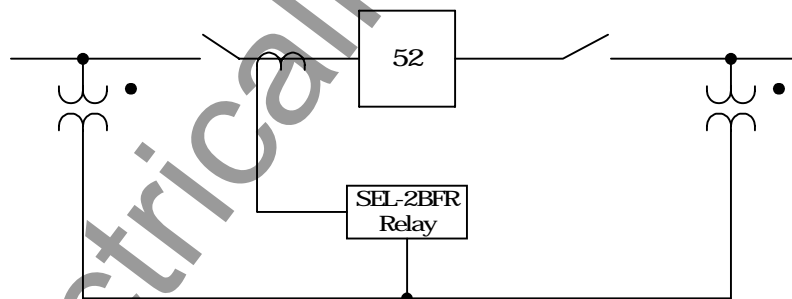


SEL-2BFR Breaker Failure Relay and Monitor



Data Sheet

- Detects failure to interrupt fault, load, or line-charging currents
- Apply to single-breaker, ring-bus, and breaker-and-a-half installations
- Operates in single- or three-pole trip schemes
- Thermal models protect trip and close resistors
- Detects current unbalance when one or two poles fail to close
- Detects current through an open breaker (flashover)
- Provides detailed breaker operation data with 15-cycle event reports
- Stores 100 breaker operation summaries
- Programmable mask logic for flexible application and testing
- Serial communication ports allow local or remote interaction with the relay



Optional PT Connections Provide
Thermal and Flashover Protection

DWG: DS2BFR001

Figure 1: Basic AC Connections of the SEL-2BFR Relay

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GENERAL DESCRIPTION

The SEL-2BFR Relay is a single- or three-pole breaker failure protection and monitoring package. The relay provides classical overcurrent-based breaker failure protection for a wide variety of breaker arrangements. Additional features include metering, breaker operating time monitors, energy interruption monitors, flashover protection, phase-discordance protection, and breaker resistor thermal protection. These features combine with event reporting and remote setting capabilities to make the SEL-2BFR Relay an excellent choice for circuit breaker protection.

Figure 1 shows a one-line diagram of the ac connections. Only three connections are required for most relay functions.

CIRCUIT BREAKER PROTECTION LOGIC

The SEL-2BFR Relay has six current-driven breaker protection schemes, including one specially designed for ring-bus or breaker-and-a-half applications. Tailor the relay to your circuit breaker protection requirements by selecting the most appropriate scheme.

The relay detects failures to interrupt fault, load, or line-charging current. It also detects failures of breaker poles to complete a close sequence. When potential transformers are used, the relay can detect open breaker pole flashover failures.

Independent phase current detectors, protection logic, and timers make the relay easy to apply on both simple systems and more complicated breaker arrangements such as single-pole trip installations.

When you use a motor-operated disconnect switch (MOD) with the protected breaker, the SEL-2BFR Relay can trip the MOD to isolate the failed breaker when phase current drops below a settable value. This logic replaces an overstress scheme on the MOD. When an MOD is not installed, the MOD logic may be used to indicate a “Safe to Disconnect” condition to personnel.

THERMAL MODELS

A breaker can occasionally operate incompletely, leaving trip or close resistors in service. The energy dissipated in a breaker resistor due to current flow can exceed the resistor thermal rating within seconds, resulting in dangerous and expensive resistor failure.

When potential transformer inputs are used, the SEL-2BFR Relay monitors energy dissipated in breaker trip and close resistors using six thermal models. When a resistor temperature estimate reaches preset limits, the SEL-2BFR Relay can alarm, generate an event report, or trip the lockout relay. Resistor thermal models have pending failure and failure temperature levels.

The thermal protection function does not require an initiating input; it monitors the breaker continuously. Thermal protection can be disabled when trip and close resistors are not used.

EVENT REPORTING AND BREAKER MONITORING

The SEL-2BFR Relay stores the nine latest event reports. These 15-cycle reports contain current, voltage, input, output, and relay element data presented on a quarter-cycle basis.

This information simplifies event analysis and improves understanding of the protective scheme operation. An operator can retrieve the event reports locally or remotely to determine the causes of relay and breaker operations.

The SEL-2BFR Relay stores summaries of the 100 latest events in nonvolatile memory. Event type, mechanical and electrical operating times, and breaker energy are stored along with the date and time of operation. Using this breaker history, operators can monitor breaker wear and effectively schedule routine breaker maintenance.

PROGRAMMABLE MASK LOGIC

Programmable mask logic is another feature included in the SEL-2BFR Relay. Programmable mask logic allows you to configure the 86BF TRIP and 5 auxiliary outputs to operate when any of 40 protective elements or logic outputs pick up. You can implement complete application-specific protective schemes with a minimum of wiring and panel space. Programmable mask logic also simplifies relay testing.

SERIAL COMMUNICATION PORTS

The relay has two serial communication ports that provide local or remote access to setting, metering, and event reporting capabilities.

A two-level password security scheme prevents unauthorized access to the relay. The user examines settings and data in the first level. Setting and logic changes can be made from the second level only.

The relay requires no special communication software. Access the relay with a dumb terminal, printing terminal, or computer with serial port and terminal emulation software.

CIRCUIT BREAKER PROTECTION LOGIC

PROTECTION OVERVIEW

The SEL-2BFR Relay performs many circuit breaker protective relaying, diagnostic, and data recording functions. The relay detects the following circuit breaker failure modes:

- Failure to clear a fault (six available schemes)
- Failure to trip under load
- Failure of the breaker auxiliary contact to indicate that the breaker tripped
- Failure to complete trip sequence due to trip resistor(s) remaining inserted
- Failure to complete close sequence due to close resistor(s) remaining inserted
- Failure to close
- Failure while open: breaker pole flashover detected

The SEL-2BFR Relay provides reset logic for applications with and without motor-operated disconnects. The relay also provides instantaneous or time-delayed retripping. The following sections describe the logic for each of these protection schemes.

PROTECTION WHILE TRIPPING FAULT CURRENT

The SEL-2BFR Relay provides six different protection schemes to safeguard the circuit breaker under fault current conditions. While the schemes share elements and timers, each is independent. You may enable only one protection scheme at a time. The SEL-2BFR Relay applies the single chosen scheme to all three breaker poles.

In ring-bus and breaker-and-a-half installations, two circuit breakers must operate to interrupt line current. Current distribution between the two breakers is unknown until the first breaker opens. This causes an uncertainty with respect to the timing of 50FT overcurrent element assertion. This uncertainty is not present in a single breaker arrangement.

Timing uncertainty is accounted for in the SEL-2BFR Relay breaker protection schemes intended for these complex bus/breaker arrangements. The SEL-2BFR Relay is intended to protect a single breaker, regardless of the bus/breaker arrangement. In breaker-and-a-half and ring-bus arrangements, you must use an independent breaker failure relay for each breaker.

PROTECTION WHILE TRIPPING LOAD OR LINE-CHARGING CURRENT

The 50LD overcurrent element is used in the failure to trip load current breaker protection scheme. The 50LD element should pick up when the protected breaker is closed. This scheme detects failures of the breaker to open when breaker current is lower than the 50FT setting, such as end-of-section faults and load breaking operations.

When the protected breaker is part of a ring-bus or breaker-and-a-half installation, load current may be very low due to unequal current distribution between the two breakers. Failure to trip load current logic may still be used to protect the breaker.

THERMAL PROTECTION OF CLOSE AND TRIP RESISTORS

If the protected breaker is equipped with trip and close resistors and three-phase potentials are available on both sides of the breaker, you can use the SEL-2BFR Relay thermal protective elements to protect breaker resistors. Occasionally, a trip or close resistor can be left in service following a breaker operation. The SEL-2BFR Relay can detect that condition, model the energy accumulated in the resistor, and trip the protected breaker or 86 lockout relay when resistor energy reaches a preset level.

The Relay Word bits CTF (Close resistor Thermal Failure) and TTF (Trip resistor Thermal Failure) assert when any Close or Trip resistor thermal model has reached the failure energy level and current is flowing in the hot resistor phase. If you set the CTF and TTF bits in the M86T logic mask, the relay asserts the 86BF TRIP outputs when a resistor thermal failure occurs.

The relay models cooling of the breaker resistors using settable time constants. The thermal elements do not drop out until the resistor thermal models have cooled below the element thresholds. This function helps prevent hot resistors from being returned to service.

PROTECTION FOR CURRENT THROUGH AN OPEN BREAKER (FLASHOVER)

The relay contains logic to detect breaker pole flashover failure. If a flashover is detected and continues until the 62FP and 62FF timers expire, the FOPF (Flashover Pending Failure) bit then the FOBF (Flashover Breaker Failure) bit assert in the Relay Word.

PROTECTION FOR FAILURE TO CLOSE

The SEL-2BFR Relay includes logic that detects a failure of one or two breaker poles to close. Because the logic operates based on current flowing in the breaker poles, protection is not dependent upon the operation of auxiliary contacts. Thus, this logic is not subject to misoperation due to mechanical failures in the breaker or contacts.

MOD TRIP LOGIC

You can set the SEL-2BFR Relay to operate a motor-operated disconnect switch following a breaker failure. The protection scheme must meet two requirements:

- The relay must be able to measure all current flowing in the MOD.
- The MOD must have an "a" configuration auxiliary contact to indicate status.

If you do not use an MOD on the protected breaker, consider using this logic to indicate a "Safe to Disconnect" condition for station personnel.

52BV LOGIC

The 52BV Relay Word bit asserts if the 52A input is deasserted while no phase current is above the 50LD setting. The 52BV bit deasserts when the 52A input asserts or when any phase current exceeds the 50LD setting.

ALARM LOGIC

In addition to the relay ALARM output, the ALRM bit is available in the Relay Word. The ALRM bit indicates dangerous or abnormal conditions related to operation of the protected circuit breaker.

The relay sets the ALRM bit for one second and stores a message in the alarm message buffer when any of the following conditions are detected:

| | |
|---|--|
| Failed CB trip resistors put in service | Failed CB close resistors put in service |
| 52A contradicts voltage | Current while open |
| Trip while open | CB did not close |
| Blown pot fuse | Current after MOD Trip |
| MOD contradicts current | Volts across closed CB |
| Slow trip | Slow close |

LOGIC

OPTOISOLATED INPUTS

Six optoisolated input circuits are provided: TRIP A, TRIP B, TRIP C, 52A STATUS, MOD STATUS, CLOSE. Assert an input by applying nominal control voltage to the appropriate terminal pair. These inputs are included in the Relay Word as bits in Row 7. Table 1 provides an overview and Table 2 provides a description of the Relay Word bits.

RELAY WORD

The Relay Word consists of seven eight-bit rows containing relay elements, timer outputs, and logic outputs. Each bit in the Relay Word is either a logical 1 or logical 0:

- 1 indicates that the element is picked up or logic condition is true
- 0 indicates that the element is dropped out or logic condition is false

The logic description defines the logic conditions in the Relay Word. The relay updates the Relay Word each quarter cycle.

Table 1: SEL-2BFR Relay Word

| Row | Relay Word Bits | | | | | | | |
|-----|-----------------|------|------|------|------|------|------|-------|
| 0 | EN | AL | PF | A | B | C | 52A | MOD |
| 1 | FBF | LBF | LPF | 50FT | 50LD | 50MD | 52BV | TTF |
| 2 | FOBF | FOPF | 59FO | 59H | ALRM | TC | TB | TA |
| 3 | PDBF | PDPF | 87UA | 87UB | 87UC | 86RS | MDT | CTF |
| 4 | CRFA | CRPA | TRFA | TRPA | CRFB | CRPB | TRFB | TRPB |
| 5 | CRFC | CRPC | TRFC | TRPC | DOPA | DOPB | DOPC | 47Q |
| 6 | * | 86BF | A1 | A2 | A3 | A4 | A5 | ALARM |
| 7 | * | * | CLOS | MOD | 52A | TPC | TPB | TPA |

PROGRAMMABLE OUTPUT LOGIC

The relay uses programmable logic masks to control the 86BF TRIP and programmable output relays. Logic masks are saved in nonvolatile memory with the other settings. They are set with the LOGIC command and retained through losses of control power.

Select Relay Word elements to program each logic mask. If any Relay Word element selected in a logic mask asserts, the output contact associated with the logic mask operates.

Table 2: Relay Word Bit Summary Table

| Row | Bit | Description |
|-----|------|-----------------------------------|
| 0 | EN | Normal Operation |
| | AL | ALARM Condition |
| | PF | Pending Failure Condition |
| | A | Phase A Breaker Failure |
| | B | Phase B Breaker Failure |
| | C | Phase C Breaker Failure |
| | 52A | 52A STATUS Input Assertion |
| | MOD | MOD STATUS Input Assertion |
| | | |
| | | |
| 1 | FBF | Fault Current Breaker Failure |
| | LBF | Load Current Breaker Failure |
| | LPF | Load Current Pending Failure |
| | 50FT | Fault Current Overcurrent Element |
| | 50LD | Load Current Overcurrent Element |
| | 50MD | MOD Overcurrent Element |
| | 52BV | Current-Verified 52B |
| | TTF | Trip Resistor Thermal Failure |
| | | |
| | | |
| 2 | FOBF | Flashover Breaker Failure |
| | FOPF | Flashover Pending Failure |
| | 59FO | Overvoltage Element |
| | 59H | Flashover Overvoltage Element |
| | ALRM | Breaker Operation Alarms |
| | TC | C-Phase Retrip Output |
| | TB | B-Phase Retrip Output |
| | TA | A-Phase Retrip Output |
| 3 | PDBF | Phase Discordance Breaker Failure |
| | PDPF | Phase Discordance Pending Failure |
| | 87UA | A-Phase Discordance |
| | 87UB | B-Phase Discordance |
| | 87UC | C-Phase Discordance |
| | 86RS | 86BF Reset |
| | MDT | MOD Trip |
| | CTF | Close Resistor Thermal Failure |

| Row | Bit | Description |
|-----|-------|--|
| 4 | CRFA | A-Phase Close Resistor Failure |
| | CRPA | A-Phase Close Resistor Pending Failure |
| | TRFA | A-Phase Trip Resistor Failure |
| | TRPA | A-Phase Trip Resistor Pending Failure |
| | CRFB | B-Phase Close Resistor Failure |
| | CRPB | B-Phase Close Resistor Pending Failure |
| | TRFB | B-Phase Trip Resistor Failure |
| | TRPB | B-Phase Trip Resistor Pending Failure |
| 5 | CRFC | C-Phase Close Resistor Failure |
| | CRPC | C-Phase Close Resistor Pending Failure |
| | TRFC | C-Phase Trip Resistor Failure |
| | TRPC | C-Phase Trip Resistor Pending Failure |
| | DOPA | A-Phase Delayed Overpower |
| | DOPB | B-Phase Delayed Overpower |
| | DOPC | C-Phase Delayed Overpower |
| | 47Q | Negative-Sequence Overvoltage Element |
| 6 | * | Reserved for Future Use |
| | 86BF | 86BF Trip Contact Output |
| | A1 | A1 Trip |
| | A2 | A2 Trip |
| | A3 | A3 Trip |
| | A4 | A4 Trip |
| | A5 | A5 Trip |
| | ALARM | ALARM Trip |
| 7 | * | Reserved for Future Use |
| | * | Reserved for Future Use |
| | CLOS | CLOSE Optoisolated Input |
| | MOD | MOD STATUS Optoisolated Input |
| | 52A | 52A STATUS Optoisolated Input |
| | TPC | TRIP C Optoisolated Input |
| | TPB | TRIP B Optoisolated Input |
| | TPA | TRIP A Optoisolated Input |

CONTACT OUTPUTS

The SEL-2BFR Relay has seven contact outputs. All output contacts are rated for circuit breaker tripping duty. These outputs are included in the Relay Word as Row 6. Table 2 lists these Relay Word bits and their descriptions.

PROGRAMMABLE OUTPUT APPLICATIONS

The versatility of programmable output contacts allows you to perform many tasks. The following examples describe programmable output contact applications using the SEL-2BFR Relay.

Breaker Operation Alarm

You can set a programmable output contact to close and indicate when the relay detects a breaker operation alarm condition.

Three-Pole Instantaneous Retrip

You may use an SEL-2BFR Relay programmable output contact to perform instantaneous retrip of the protected circuit breaker. Set a single programmable logic mask with TA, TB, and TC equal to one. Connect the contact in series with a breaker 52A contact and Breaker Trip coil #2. Each time any SEL-2BFR Relay trip input is asserted, the relay asserts the A1 contact, energizing the second breaker trip coil.

Single-Pole Instantaneous Retrip

You may use three programmable output contacts to perform single-pole instantaneous retrip of the protected circuit breaker. In this application, set three individual programmable output contacts to close when a single breaker trip input is asserted. For instance, MA1 could contain the TA bit, MA2 the TB bit, and MA3 the TC bit. Connect each contact in series with the appropriate 52A contact and single-pole trip coil. Each time a single-phase trip input to the SEL-2BFR Relay asserts, the relay asserts the corresponding programmable output contact, energizing the second breaker trip coil and retripping the protected breaker pole.

Loss-of-Potential Indication

In three-pole trip installations, the relay 47Q element asserts to indicate that a potential fuse has blown. Set 47Q in a programmable output contact logic mask and monitor that contact externally using an annunciator, indicator lamp, or sequential events recorder input. When 47Q asserts, the programmable output contact closes, indicating a blown potential fuse.

In single-pole trip installations, you may use the 47Q element in the same manner. However, because the element may assert during single-pole-open intervals, you may want to use a time delayed pickup timer between the relay output contact and the annunciator input or indicator lamp. The time delay should be set longer than the maximum single-pole-open interval. Thus, only permanent output contact closures activate the annunciator.

Hot Resistor Indication

When you use the SEL-2BFR Relay breaker resistor thermal protection elements, you can set a programmable output contact to close, indicating when one or more breaker resistor thermal models contain energy above the pending failure or failure level. You can monitor the contact using an annunciator input, indicator lamp, or sequential events recorder input.

DATA RECORDING

EVENT REPORTING

The relay retains a 15-cycle data record for each of the last 9 events. The record includes input currents and voltages, Relay Word elements, input contacts, and output contacts. The relay saves a report when any of the following occur:

- The relay trips
- User selected Relay Word bits, inputs, or outputs assert
- User executes the TRIGGER command

The relay stores the last nine event reports in a buffer. You can examine any full-length report stored in the relay using the EVENT command. The relay clears the event buffer when relay power is interrupted or when you make a setting or logic change.

The relay stores 100 event summaries in nonvolatile memory. The event summaries are retained through setting changes and losses of control power. Summaries contain breaker operation data such as event type, mechanical and electrical breaker operating times, and the event date and time. You can use this data to monitor breaker wear and more effectively schedule routine breaker maintenance.

METERING

The meter function shows the values of ac current through the breaker, voltage across it, and real and reactive power dissipated in it.

ADDITIONAL FEATURES

SERIAL INTERFACES

The SEL-2BFR Relay is equipped with two serial ports. Generally, one port is used for remote communications via a modem, while the other port is used for local communications.

The baud rate for each port is set by jumpers near the front of the main board. Available baud rates are 300, 600, 1200, 2400, 4800, and 9600. The serial data format is: eight data bits, two stop bits, no parity.

TARGETING

The relay normally displays the targets identified on the front panel. Under normal operating conditions, the Enable (EN) target lamp is lit. The AL, PF, A, B, and C target LEDs latch. These front-panel targets are included in the Relay Word as bits in Row 0. Table 2 lists these Relay Word bits and their descriptions.

The Enable (EN) LED indicates that the relay is energized and operating.

The Alarm (AL) LED asserts for Level 1 access failures, Level 2 access attempts, and self-test warnings or failures. When the ALRM bit asserts, the AL LED does not assert, but the AL LED latches.

The PF LED illuminates if any pending failure bits routed to an output contact assert.

If the relay asserts the 86BF TRIP output, the A, B, or C targets latch to indicate the failed breaker pole.

The 52A and MOD LEDs illuminate if the associated rear-panel input is asserted.

Target LEDs illuminated during the last trip output stay lit until one of the following occurs:

- Operator presses front-panel TARGET RESET button
- Operator executes TARGET R command

The relay does not clear the targets when additional trip outputs occur. New and old tripping targets are displayed in a cumulative fashion until an operator clears them as described above.

TIME CLOCK SYNCHRONIZATION (IRIG-B)

The SEL-2BFR Relay accepts a demodulated IRIG-B format signal of synchronizing its internal clock to an external source.

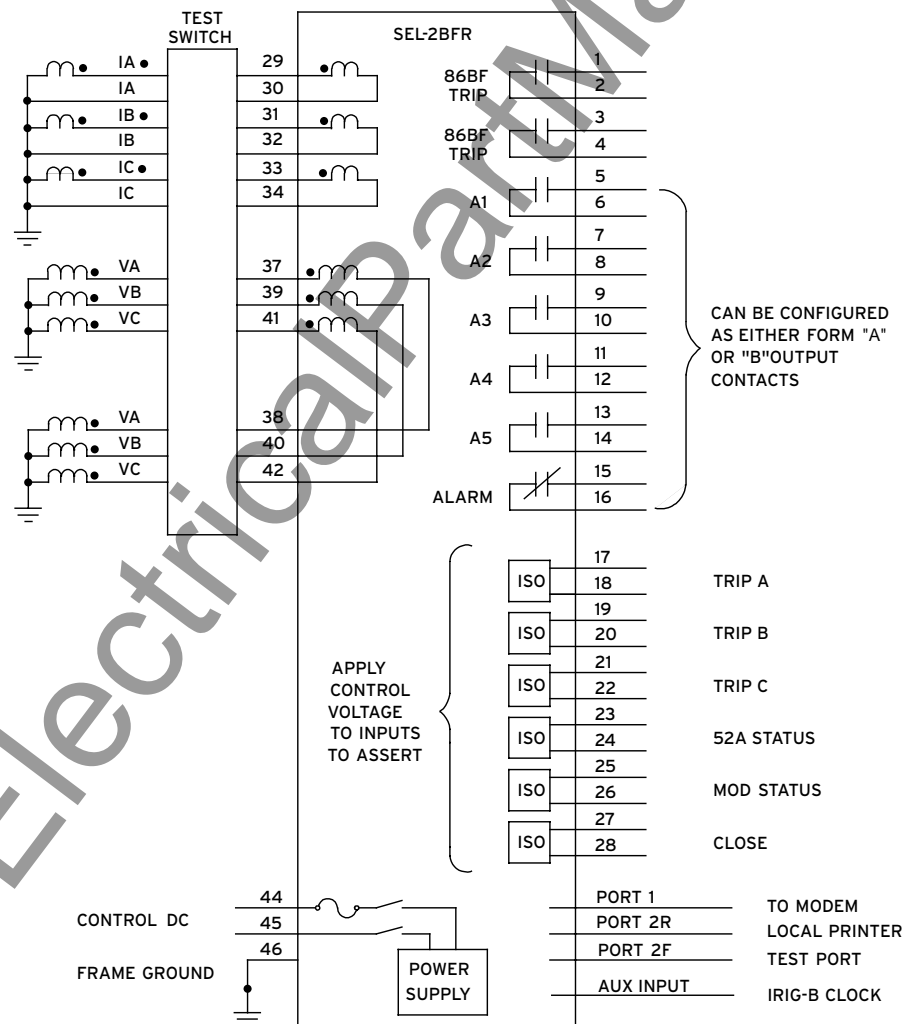
INSTALLATION

AC CONNECTIONS

To effectively protect a power circuit breaker that includes tripping or closing resistors, the SEL-2BFR Relay must measure current flowing through each breaker pole and voltage drop across it. Figure 2 shows ac current and voltage inputs to the relay.

Apply current to the relay from current transformers on each phase of the protected breaker. The relay calculates voltage drop across each phase breaker by measuring the difference voltage between the secondaries of potential transformers connected on both sides of the protected breaker.

If you do not wish to use voltage-based breaker protection features such as resistor thermal protection, flashover protection, and breaker voltage warning, you need not connect the voltage inputs.



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Figure 2: Example AC Input Connections

DC CONNECTIONS

Figure 3 and Figure 4 show dc connections to the relay for an example protection scheme. When you use the relay in a single-pole tripping scheme, consider wiring single-pole breaker auxiliary contacts in series for connection to the SEL-2BFR Relay 52A input.

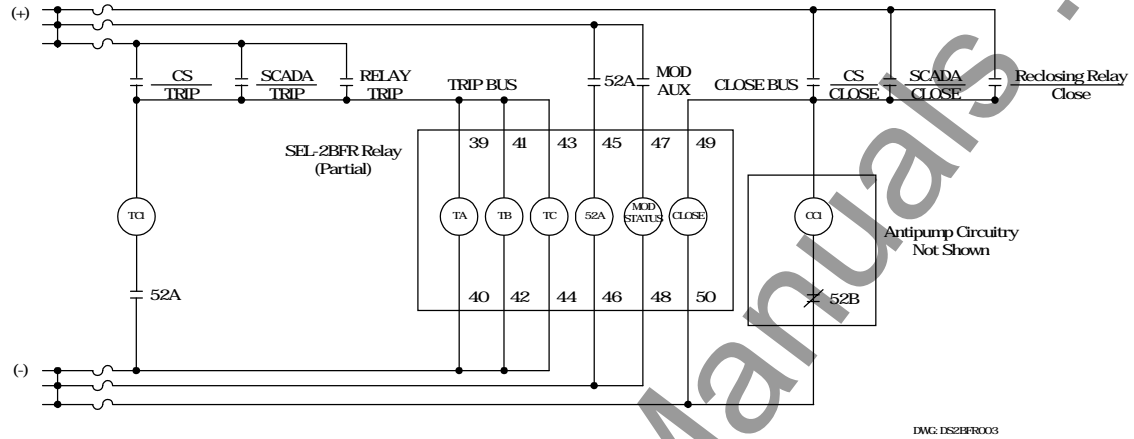


Figure 3: Example DC Input Connections

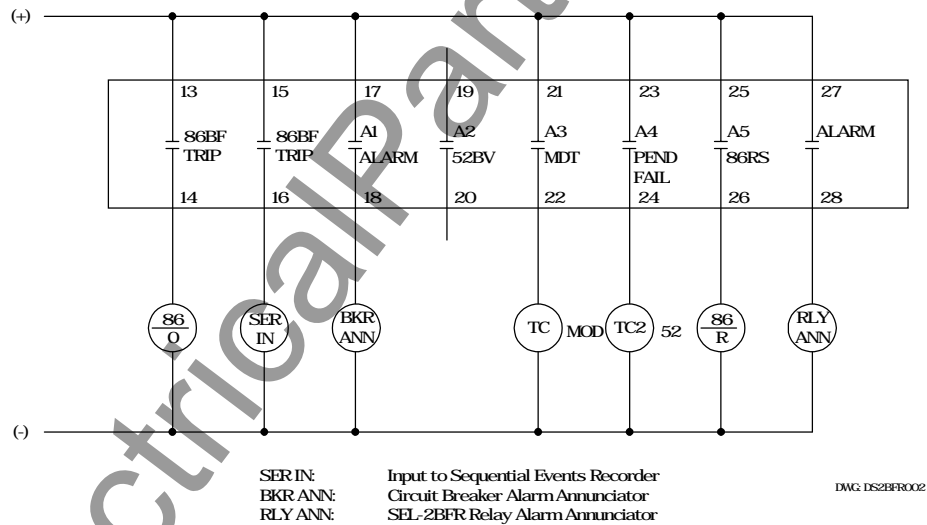
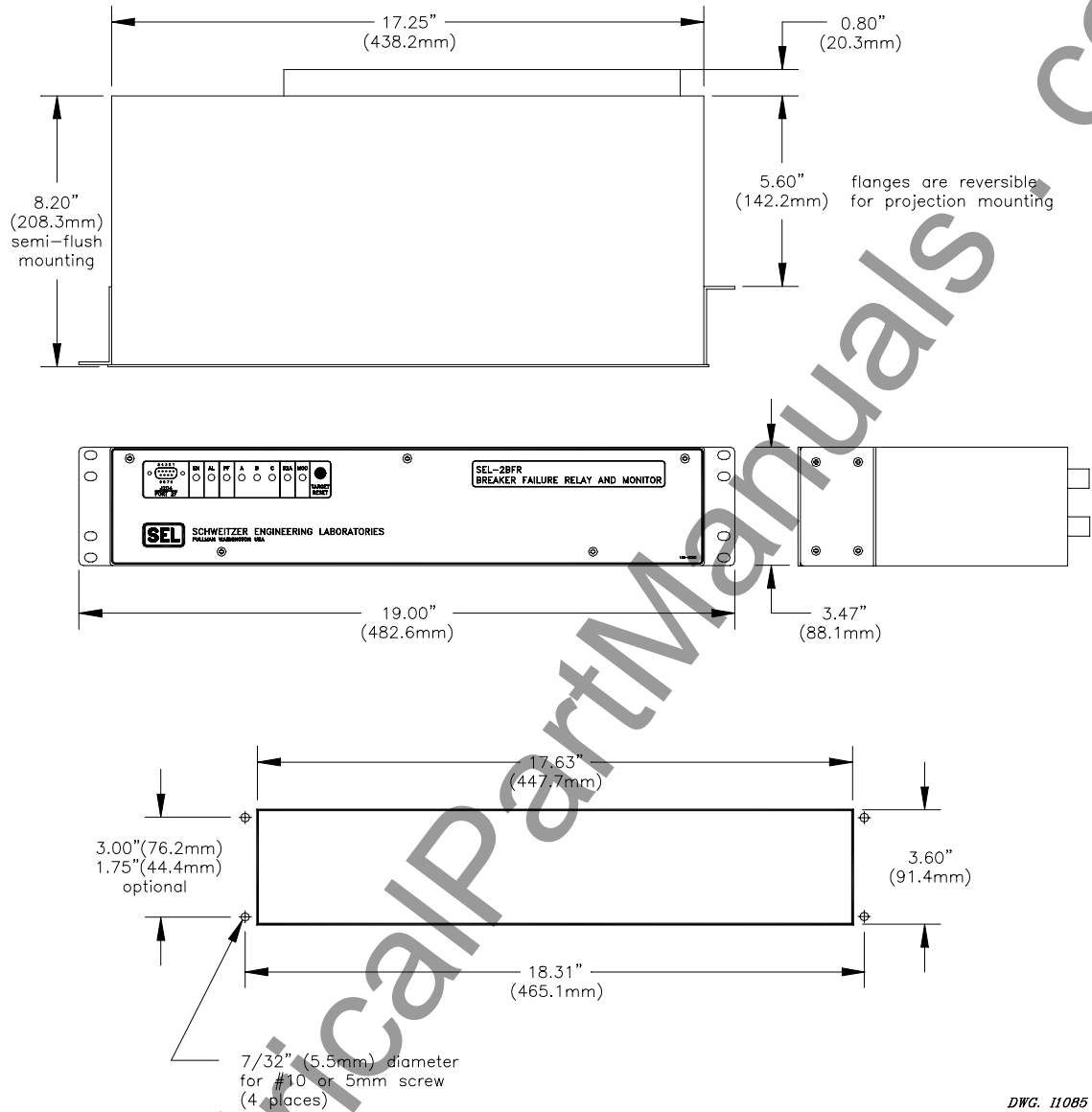


Figure 4: Example Contact Output Connections



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Figure 6: Relay Dimensions, Panel Cutout, and Drill Plan

GENERAL SPECIFICATIONS

| | | | |
|--|---|------------------------------|------------------------------|
| <u>AC Voltage Inputs</u> | 0 – 150 Vac line-to-neutral | | |
| <u>AC Current Inputs</u> | <u>5 A Version</u> | <u>1 A Version</u> | |
| | 15 A per phase continuous | 3 A per phase continuous | |
| | 500 A for 1 s thermal rating | 100 A for 1 s thermal rating | |
| <u>Rated Burden</u> | Current Inputs | Current Inputs | |
| | <u>5 A Version</u> | <u>1 A Version</u> | <u>Voltage Inputs</u> |
| | 0.27 VA @ 5 A | 0.06 VA @ 1 A | 0.13 VA @ 67 V |
| | 2.51 VA @ 15 A | 0.50 VA @ 3 A | 0.45 VA @ 120 V |
| <u>Optoisolated Input Ratings</u> | 24 Vdc: 15 – 30 Vdc 48 Vdc: 30 – 60 Vdc 125 Vdc: 80 – 150 Vdc 250 Vdc: 150 – 300 Vdc Current = 4 mA at nominal voltage | | |
| <u>Contact Outputs</u> | 30 A make per IEEE C37.90 para 6.6.2 6 A carry continuously; MOV protection provided | | |
| <u>Power Supply</u> | 24/48 Volt: 20 – 60 Vdc; 125/250 Volt: 85 – 350 Vdc or 85 – 264 Vac 12 W | | |
| <u>Communications</u> | Two EIA-232 serial communications ports; Port 2 of the SEL-2BFR Relay has front- and rear-panel connectors | | |
| <u>Time Code Input</u> | Relay accepts demodulated IRIG-B time code | | |
| <u>Dimensions</u> | 3.47" x 19.00" x 9.00" (8.81 cm x 48.26 cm x 22.86 cm) (H x W x D) Depth (D) is to end of the rear-panel terminal blocks | | |
| <u>Mounting</u> | Available in horizontal or vertical mounting configurations | | |
| <u>Dielectric Strength</u> | V, Linings: 2500 Vac for 10 s Other: 3000 Vdc for 10 s (excludes EIA-232) Routine tested | | |
| <u>Operating Temp.</u> | -40° to +158°F (-40° to +70°C) | | |
| <u>Environment</u> | IEC 68-2-30 Temperature/Humidity Cycle Test – six day (type tested) | | |
| <u>Interference Tests</u> | IEEE C37.90 SWC Test (type tested) IEC 255-6 Interference Test (type tested) IEC 801-4 Electrical Fast Transient/Burst Test (type tested) | | |
| <u>Impulse Tests</u> | IEC 255-5 0.5 J, 5000 V Test (type tested) | | |
| <u>RFI Tests</u> | IEEE C37.90.2-199X (draft) Withstand Capability of Relay Systems to Radiated Electromagnetic Interface from Transceivers | | |
| <u>Vibration and Shock Tests</u> | IEC 255-21-1 and –2, Class 1 Test (type tested) | | |
| <u>ESD Test</u> | IEC 801-2 Electrostatic Discharge Test (type tested) | | |
| <u>Unit Weight</u> | 12 lb (5.5 kg); shipping weight 17 lb (7.7 kg), including one instruction manual | | |

FUNCTIONAL SPECIFICATIONS

Overcurrent Elements

| | |
|------|---|
| 50FT | Fault Current Element |
| | setting range 0.50 – 45.00 A secondary (5 A relay) |
| | 0.10 – 9.00 A secondary (1 A relay) |
| | pickup time less than 0.84 cycle at 2 multiples of pickup |
| | dropout time less than 1.10 cycle |
| | pickup and dropout ± 0.025 A secondary $\pm 5\%$ of setting |
| | transient overreach (Scheme 6) 12% of setting |
| 50MD | MOD Current Element |
| | setting range 0.10 – 45.00 A secondary (5 A relay) |
| | 0.02 – 9.00 A secondary (1 A relay) |
| | pickup time less than 1.10 cycle at 2 multiples of pickup |
| | dropout time less than 1.55 cycle |
| | pickup and dropout ± 0.025 A secondary $\pm 5\%$ of setting |
| 50LD | Load/Line-Charging Current Element |
| | setting range 0.10 – 45.00 A secondary (5 A relay) |
| | 0.02 – 9.00 A secondary (1 A relay) |
| | pickup time less than 1.10 cycle at 2 multiples of pickup |
| | dropout time less than 1.55 cycle |
| | pickup and dropout ± 0.025 A secondary $\pm 5\%$ of setting |

Overvoltage Elements

| | |
|-------|---|
| 59FO | Flashover Voltage Element |
| | setting range 1.0 – 67.0 V secondary |
| | pickup time less than 1.35 cycle |
| | dropout time less than 1.55 cycle |
| | pickup and dropout ± 0.09 V secondary $\pm 5\%$ of setting |
| 47Q | Negative-Sequence Overvoltage Element |
| | setting range 2.0 – 170.0 V secondary |
| | pickup time less than 1.35 cycle |
| | dropout time less than 1.55 cycle |
| | pickup and dropout ± 0.27 V secondary $\pm 15\%$ of setting |
| 59H | Flashover Voltage Element |
| | fixed setting 67.0 V secondary |
| | pickup time less than 1.35 cycle |
| | dropout time less than 1.55 cycle |
| | pickup and dropout ± 3.5 V secondary |
| Vwarn | Voltage Across Closed Breaker Element |
| | setting range 0.5 – 7.5 V secondary |
| | pickup time less than 3 seconds |
| | pickup and dropout ± 0.09 V secondary $\pm 5\%$ of setting |

Current Unbalance Element

| | |
|------|---|
| 87UB | Phase Current Unbalance Element |
| | 87 UB detects phase discordance when the protected breaker closes. For example, A-phase is unbalanced if phase current is above the 50LD setting in one or more phases and: |
| | $ I_A < (I_A + I_B + I_C) / 87UB \text{ setting}$ |
| | where 87UB setting = 8, 16, 32, or 64. |
| | Stabilization time..... less than 1.35 cycle |

Overpower Elements

| | |
|------|--|
| 37OP | Breaker Overpower Element |
| | setting range 0.10 – 3400.00 W secondary (5 A relay) |
| | 0.02 – 680.00 W secondary (1 A relay) |
| | pickup time less than 2.10 cycles |
| | dropout time less than 3.00 cycles |
| | maximum element error, secondary units: |
| | ±2.25 mW ±10.25% (measured input power) |
| | ±2.63% (measured voltage) ±9.45% (measured current) |

Breaker Resistor Thermal Elements

| | |
|------|--|
| 26CF | Close Resistor Failure Element |
| 26CP | Close Resistor Pending Failure Element |
| 26TF | Trip Resistor Failure Element |
| 26TP | Trip Resistor Pending Failure Element |
| | setting range 0.01 – 1000.00 J secondary (5 A relay) |
| | 0.002 – 200.000 J secondary (1 A relay) |

Settable Timers

| | |
|-------------------------------------|---|
| Failure to Trip | |
| Flashover | |
| Phase Discordance Close Input | |
| Trip and Close Resistor Heating | |
| Retrip, etc. Timers | |
| | setting ranges.....0.25 – 63.75 cycles in quarter-cycle steps |
| Phase Discordance Failure | |
| Bus Clearing and MOD Operate Timers | |
| | setting range0.25 – 16,383.75 cycles in quarter-cycle steps |

Fixed Timers

| | |
|------|--|
| 62F1 | Flashover Voltage Time Delayed Dropout Timer.....5 cycles |
| 62F2 | Load Current Pickup Timer (Flashover Logic).....5 cycles |
| 62F3 | Trip or Close Dropout Timer (Flashover Logic).....6 cycles |
| 62M3 | 86BF Reset Signal Duration Timer60 cycles |
| 62M4 | 86BF Reset Time Delay, MOD Logic Enabled.....300 cycles |

Note: All timers are crystal controlled. Any significant ambiguities in timing are due to pickup/dropout times of measuring elements, inputs, and outputs. However, the 62OP timer has an accuracy of plus or minus one-half cycle.

FACTORY ASSISTANCE

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SEL-2BFR Breaker Failure Relay and Monitor

Date Code 20000302



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