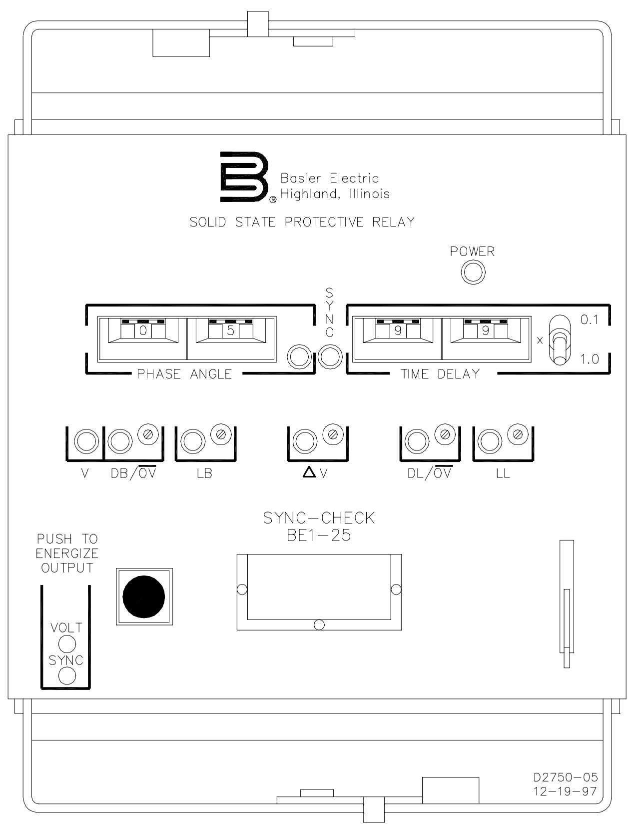
INSTRUCTION MANUAL

for

SYNC-CHECK RELAY

BE1-25



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INTRODUCTION

This manual provides information concerning the operation and installation of BE1-25 Sync-Check Relays. To accomplish this, the following is provided.

- Specifications
- Functional Description
- Mounting Information
- Testing Procedures

WARNING!

TO AVOID PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED PERSONNEL SHOULD PERFORM THE PROCEDURES PRESENTED IN THIS MANUAL.

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SECTION 1 • GENERAL INFORMATION

INTRODUCTION

These instructions provide information concerning the operation and installation of BE1-25 Sync-Check Relays. To accomplish this, the following is provided:

- Specifications
- Functional characteristics
- Mounting information
- Setting procedures and examples

Relays with a Type T power supply require a Contact Sensing Module, which comes supplied with its own instructions, publication 9 1702 06 990.

WARNING!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures presented in these instructions.

These instructions may be used in place of all earlier editions. For change information, see Section 7.

It is not the intention of these instructions 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 Customer Service, Basler Electric Company, Highland, IL.

DESCRIPTION

BE1-25 Sync-Check Relays are solid-state synchronism check relays designed to permit breaker closure when the desired maximum phase angle conditions have held for a specified minimum time. The maximum allowable phase angle and time delay requirements can be set on front panel thumbwheel switches. Five voltage measuring options are available that identify significant line and bus voltage conditions, and this information is used to influence the relay output.

APPLICATION

BE1-25 Sync-Check Relays are recommended for situations that require verification of synchronism prior to closing a circuit breaker. Typical applications are:

- Paralleling a generator to a system.
- Reestablishing a connection between two parts of a power system.
- Supervising fast transfer schemes, where fast pickup and dropout of the phase measuring circuit are required.

If optional voltage measuring circuits are incorporated, the BE1-25 can determine whether an input is live, dead, or in an overvoltage state.

SYNC-CHECK FUNCTION

NOTE

Voltage sensing circuits are guaranteed to operate at a minimum voltage of 60 volts. They are guaranteed not to operate at voltages less than 20 volts. Some units may operate at voltages in between these two levels because of the individual characteristics of specific components. Minimum voltage detection is usually in the range of 45 to 55 volts.

BE1-25 Sync-Check function measures the phase angle between single-phase voltages of line and bus. Then sync-check verifies that this angle is less than the front panel PHASE ANGLE selector setting. If the measured angle has met this criteria for the time period defined by the front panel TIME DELAY setting, the SYNC output contact closes.

The allowable phase angle is adjustable over the range of 1 to 99 degrees. The time delay is adjustable over either of two ranges: 1 to 99 cycles, 50/60 hertz (using the bus frequency as the reference), or 0.1 to 99 seconds (using the internal crystal controlled oscillator as the reference).

An optional target may be specified to indicate operation of the Sync-Check function.

CONTACT SENSING

To control operation of the relay, an input from the breaker auxiliary 52b contact is required to signal the breaker status. If the breaker is open, the relay is enabled to perform its function. When the breaker closes, the 52b input changes state and causes the relay to terminate its close signal.

Two configurations of the 52b contact sensing input are available to provide additional flexibility for the protection circuit designer:

- Isolated contact sensing monitors a current supplied by the relay through an isolated contact.
- Non-isolated contact sensing monitors the presence of voltage at its input due to the closure of a contact.

See Figure 4-10 for typical control circuit connections for each configuration. Also see Figure 4-11 if a Type T power supply has been selected.

VOLTAGE MONITOR OPTIONS

Mode Switches

Two Mode switches are located on the Voltage Monitor card. Mode Switch No. 1 serves the bus Voltage Monitor function. Mode Switch No. 2 serves the line Voltage Monitor function. Mode switch positions are as follows:

NORMAL Mode (Up) - allows measuring elements to establish live and dead reference levels for the input level.

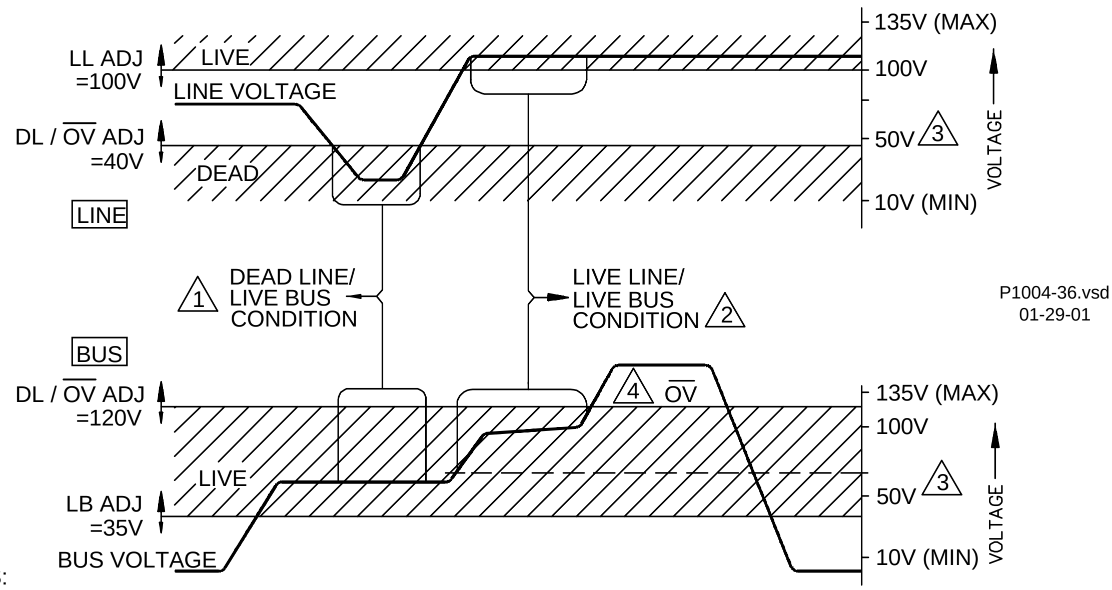
NOT-OV Mode (Down) - allows measuring elements to establish live and Not-Overvoltage reference levels for the input level.

When a Mode Switch is in the NORMAL Mode position (Up), a dead level is defined as a monitored voltage level below the DEAD reference setting. See Figure 1-1 for voltage monitor acceptance zones. A live level is defined as a monitored voltage above the LIVE reference setting.

When a Mode Switch is in the NOT-OV Mode position (Down), a dead level is defined as a monitored voltage less than the LIVE reference setting, and a live level is defined as a monitored voltage greater than the LIVE reference setting, but less than the NOT-OV setting. (An input is considered to be over-voltage when it exceeds the NOT-OV reference setting.)

It is permissible to operate the line input in either the same mode or a different mode than the bus input. This flexibility allows the BE1-25 to be used, for example, to close a generator breaker onto a dead bus, or to prevent closure if the generator and/or bus voltage is too high.

See Table 2-1, callout R, for a complete description and precautions on setting the Mode Switches. The location of the switches is shown in Figure 2-2. Also see *Condition and Mode Switches* in Section 5.



NOTES:

1. SYNC RELAY CONTACTS CLOSED BY VOLTAGE MONITOR LOGIC
2. SYNC-CHECK LOGIC ENABLED
3. 60V FIXED MINIMUM VOLTAGE LIMIT (LIVE LINE/LIVE BUS CONDITION SYNC-CHECK FUNCTION ONLY)
4. OV EXCEEDED, SYNC-CHECK LOGIC NOT ENABLED (SETTING MODE SWITCH NO. 1 TO ON AND CONDITION SWITCH NO. 1 TO ON PERMITS OV)

Figure 1-1. Voltage Monitor Acceptance Zones

Condition Switches

Five Condition Switches are located on the Voltage Monitor Card, each with two positions to select ON (Down) and OFF (Up). When ON, Condition Switch No. 1 programs the relay to require recognition that the line and bus are not in an overvoltage condition (NOT OV) before the SYNC output is allowed. Condition Switches No. 2 through No. 5 modify the voltage monitor response according to a programmed set of external conditions. The possible external conditions for each of these four switches are:

Switch 2. Live Line/Live Bus (LL-LB)

Switch 3. Dead Line/Live Bus (DL-LB)

Switch 4. Live Line/Dead Bus (LL-DB)

Switch 5. Dead Line/Dead Bus (DL-DB)

When a selected condition has been recognized, the voltage monitor circuit may be instructed to immediately energize the Sync-Check output relay, or (if provided) the Voltage Monitor output relay. (See Figure 1-1, Note 1.)

See Table 2-1, callout S, for a complete description and precautions on setting the Conditions Switches. The location of the switches is shown in Figure 2-2.

Voltage Difference

A voltage monitor is available that checks the phasor or average voltage difference between the two inputs. This can be used to prevent the closure of a generator breaker if the voltage difference is too great (even if the phase angle and voltage level monitoring circuits indicate that proper closing conditions are otherwise present).

The voltage difference option (included with option 2-A, 2-B, 2-C, 2-R, 2-T or 2-U) is typically used to reduce the amount of possible system shock or transients when closing a breaker. This option compares the voltage between line and bus against a selected limit, and initiates either an enable or an inhibit signal for the sync-check logic, thereby narrowing the voltage across the breaker contacts (as compared to a simple sync-check acting alone). Figure 1-2 shows closing zones obtained by combining phasor voltage difference, phase angle limit, and line and bus live/dead voltage limits. Figure 1-3 shows closing zones obtained by combining average voltage difference, phase angle limit, and line and bus live/dead voltage limits. If a separate Voltage Monitor relay is supplied (Output option G or H), the NO contact must be in series with the SYNC relay contact to perform the LL/LB and line not-overvoltage/bus not-overvoltage enabling functions in Figure 1-2.

Option 2-R, 2-T, or 2-U (Phasor Voltage Difference)

Figure 1-4 may be used as an aid in formulating the voltage difference control settings. Note that the center reference phasor (V_B) represents the monitored bus voltage, while the adjacent phasor (V_L) represents the monitored line voltage. The voltage difference control (ΔV) forms an area of acceptance limit when rotated through 360 degrees. This allows either the voltage difference or the phase angle to be selected, and the remaining value to be calculated.

Calculate the voltage difference (ΔV) using the law of cosines. The equation is:

$$\Delta V = (V_L^2 + V_B^2 - 2 \cdot V_L \cdot V_B \cdot \cos\theta)^{\frac{1}{2}} \qquad (1)$$

When V_L is tangent to the voltage difference circle, the ΔV phasor is perpendicular to V_L at the phase angle limit. Accordingly, the voltage difference or the phase angle can be calculated by equations 2 and 3, respectively.

$$\Delta V = V_B \sin\theta \qquad (2)$$

$$\theta = \sin^{-1} \frac{\Delta V}{V_B} \qquad (3)$$

where:

ΔV = Voltage Difference

V_L = Line Voltage

V_B = Bus Voltage

θ = Phase Angle

Note that the point where V_L is tangent to the voltage difference circle represents the most extreme condition of θ for a closure. Assuming that a constant voltage difference exists, the following condition is valid: If the magnitude of the line voltage decreases, the phase angle must also decrease to allow sync-acceptance. Therefore, the minimum line voltage possible for sync-acceptance occurs at zero phase angle.

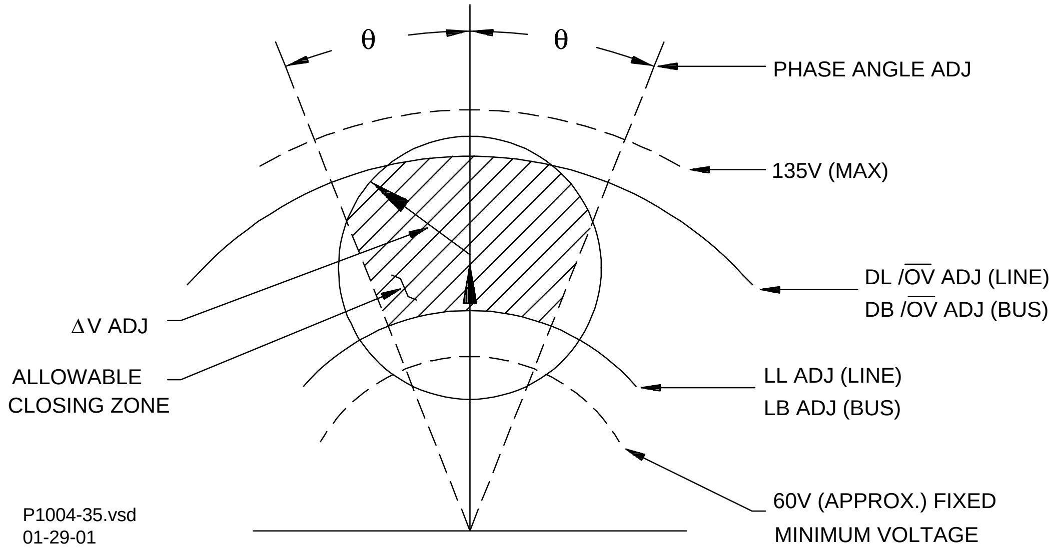


Figure 1-2. Closing Zone (Phasor Sensing)

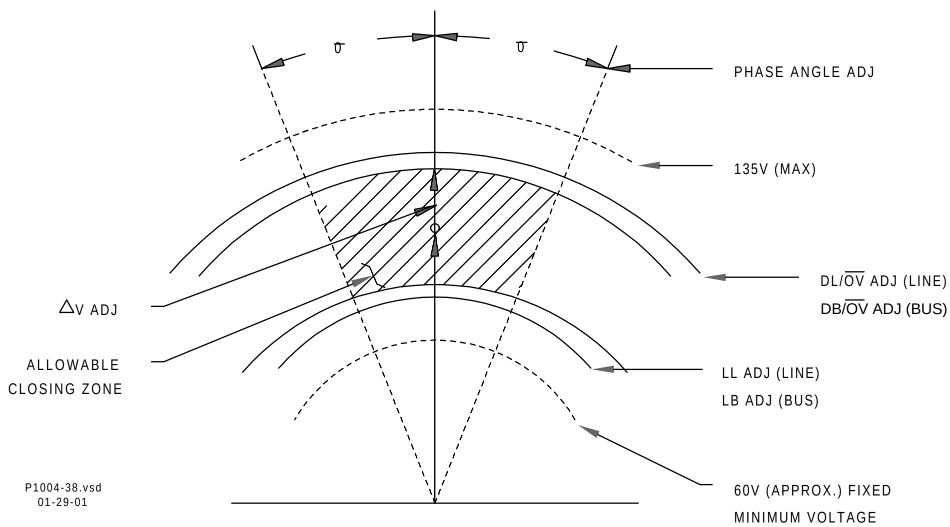


Figure 1-3. Closing Zone (Average Sensing)

Option 2-A, 2-B, or 2-C (Average Voltage Difference)

This option is similar to option 2-T, 2-R, or 2-U except for the sensing method. This option provides average voltage sensing instead of phasor voltage sensing. This provides a constant ΔV setting independent of the phase relationship between the line and bus voltages.

Figure 1-5 may be used as an aid in formulating the voltage difference control settings. Note that the center reference phasor (V_B) represents the monitored bus voltage, while the adjacent phasor (V_L) represents the monitored line voltage. The voltage difference control (ΔV) forms an area of acceptance limit.

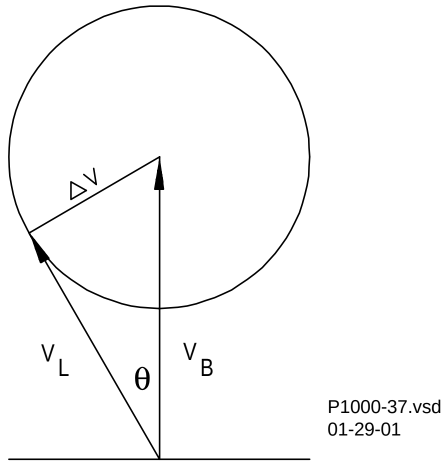


Figure 1-4. Closing Zone Calculation Diagram (Phasor Sensing)

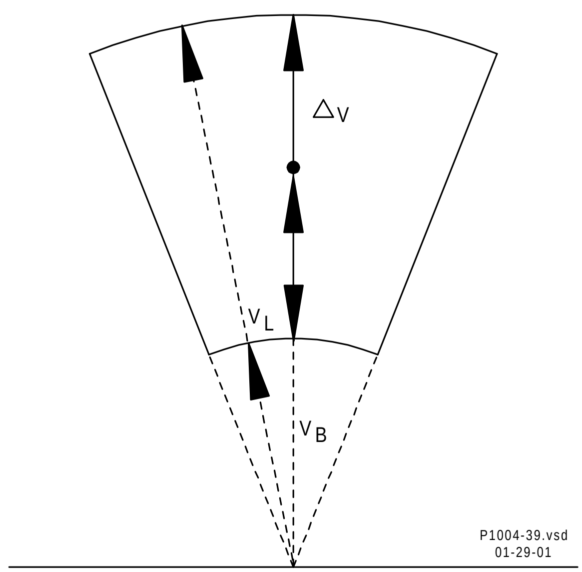


Figure 1-5. Closing Zone Diagram (Average Sensing)

Output Relay

The Voltage Monitor output relay option G or H provides additional supervision of the breaker closing circuit, or provides an indication of the existing voltage conditions for the supervisory control system. When a Voltage Monitor output relay is installed, the SYNC relay is no longer directly operable by voltage monitor logic. However, the live line/live bus condition may be utilized to enable the Sync-Check function.

Detailed instructions and precautions for setting the Mode switches and Condition switches are provided in Table 2-1, callouts R and S. The location of the switches is shown in Figure 2-2.

Voltage sensing connections are shown in Figure 4-8.

OTHER OPTIONS

Expandable Window

An expandable window (option 9 in the second position of the Style Number) is available to enable a local operator (through a switch) or a remote dispatcher (through the supervisory control system) to expand the preset phase angle window by a programmed ratio.

Under normal conditions, the phase angle setting is determined by the maximum angular difference that has been calculated as suitable to meet the expected load flow of the total system. But under emergency conditions, the load flow throughout the system may result in excessive phase angle separation across the opened breaker.

In order to reestablish load on a previously faulted line quickly, it may be necessary to expand the allowable phase window. With this option, closing a contact input to the relay expands the preset phase setting by a programmed multiple of 2 or 3 (according to the position of a jumper on the circuit card).

This option is not suggested for use in generator applications for the following reason: The phase angle setting for a generator breaker is determined by the maximum phase difference that can be tolerated by the generator when connected to the system. An excessive angle can result in excessive mechanical forces in the generator and associated mountings.

Internal connections for the expandable window are shown in Figure 4-7; control circuit connections are in Figures 4-10 and 4-11.

External Condition Switches

If a line and bus Voltage Monitor output is incorporated in the relay, the internal Condition Switches may be functionally operated by remotely located external contacts. This capability is provided by Voltage Monitor option 2-C, 2-U, or 2-V, but requires a voltage dropping Resistor Module to be mounted on the relay back panel (see Figure 4-9).

Push-to-Energize Output Pushbuttons

Two PUSH-TO-ENERGIZE OUTPUT switches are available to provide a means of verifying external output wiring without the inconvenience of having to test the entire relay. These optional switches are provided for each isolated output function (Sync-Check, Auxiliary Sync-Check and Voltage Monitor), and may be actuated by inserting a thin, non-conducting rod through access holes in the front panel. See Figure 2-1 for location.

MODEL AND STYLE NUMBER

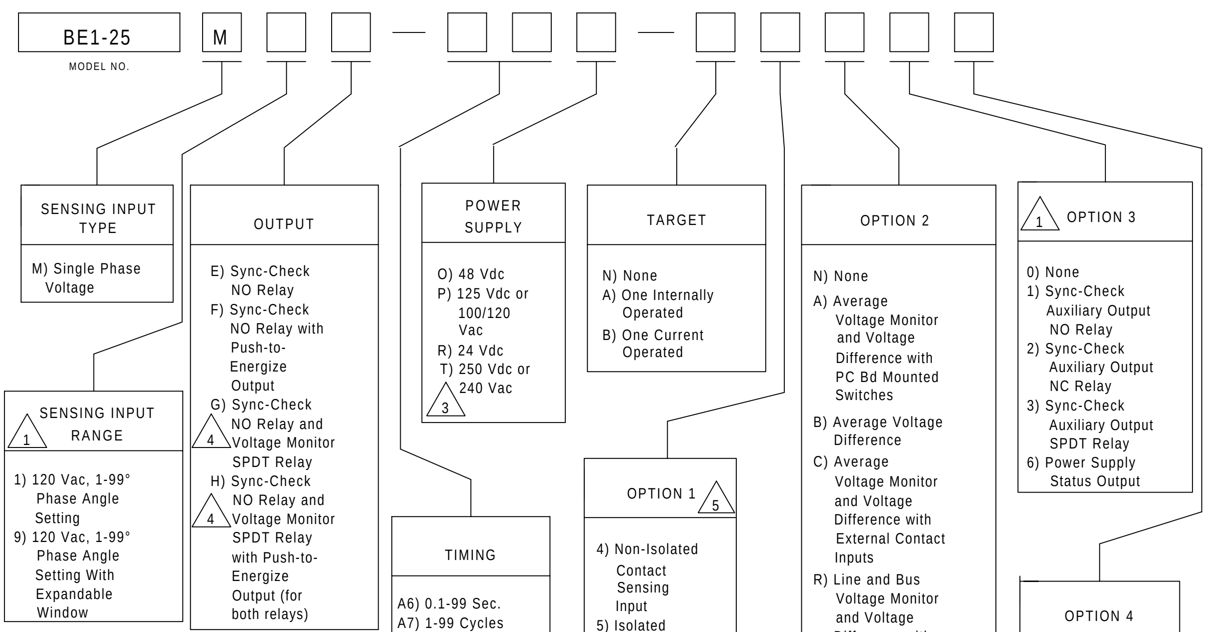
The electrical characteristics and operational features of the BE1-25 Sync-Check Relays are defined by a combination of letters and numbers that make up its Style Number. The model number, together with the Style Number, describe the options included in a specific device, and appear on the front panel, drawout cradle, and inside the case assembly.

Upon receipt of a relay, be sure to check the Style Number against the requisition and the packing list to ensure that they agree.

Style Number Example

The Style Number identification chart (Figure 1-6) defines the electrical characteristics and operational features included in BE1-25 relays. For example, if the Style Number were **M9H A6P N4R0F**, the device would have the following:

BE1-25 Model Number (designates the relay as a Basler Electric, Class 100, Sync-Check Relay)
M Single-phase sensing
9 Expandable phase angle window
H Voltage Monitor relay and Push-to-Energize outputs
A6 0.1 to 99 seconds timing range
P Operating power derived from 125 Vdc or 100/120 Vac
N No target
4 Non-isolated contact sensing input
R Line and Bus Voltage Monitor; also a Voltage Difference Monitor with Condition Switches internal to the relay.
0 No auxiliary output
F Semi-flush mounting



CONTACT SENSING MODULES
(Required when Type T Power Supply is specified)

Relay Options	Number of Contacts Sensed	Module Ordering Number: Isolated Contact Sensing	Module Ordering Number: Non-Isolated Contact Sensing
Voltage Monitor with External Contact Inputs plus Expandable Phase Window	6	9 1702 06 100	9 1702 06 106
Voltage Monitor with External Contact Inputs	5	9 1702 06 101	9 1702 06 107
Expandable Phase Window	2	9 1702 06 104	9 1702 06 110
None of the above	1	9 1702 06 105	9 1702 06 111

NOTES:

1. When Sensing Input Range 9 is Selected from the Style Chart, Option 3 must be 0.
2. All relays are supplied in an S1 size case.
3. Requires Contact Sensing Module. See Table in this chart.
4. Not available if Option 2 is B, N, or T.
5. For more information on contact sensing see *Specifications*.

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01-30-01

Figure 1-6. Style Number Identification Chart

SPECIFICATIONS

Voltage and Phase Sensing

Nominally rated at 60 hertz with a range of 45 to 65 hertz at a maximum burden of 1 VA per phase to 125% of nominal voltage. Maximum continuous voltage rating is 160% of nominal.

Contact Sensing

User-supplied contacts with a minimum rating of 0.05 ampere at 250 Vdc are required at all contact sensing inputs. (Specifically the 52b input, the optional expandable phase angle window, and the optional external voltage condition switches.)

Sensing circuit current is supplied by the relay when isolated sensing is selected. Non-isolated sensing requires an externally applied dc sensing voltage equal to the nominal voltage of the relay power supply input.

Contact Sensing Burden

For Power Supply Option O ....2.4 VA
For Power Supply Option P........6.25 VA
For Power Supply Option R........1.2 VA
For Power Supply Option T........12.5 VA

Burden	**Operating Power**	**Burden**
Without Voltage Monitor	50 Hz 100 Vac	12 VA
	60 Hz 120 Vac	18 VA
	125 Vdc	9 W
	48 Vdc	9 W
	24 Vdc	9 W
	250 Vdc	12 W
	60 Hz 230 Vac	28 VA
With Voltage Monitor	50 Hz 100 Vac	20 VA
	60 Hz 120 Vac	26 VA
	125 Vdc	15 W
	48 Vdc	15 W
	24 Vdc	15 W
	250 Vdc	21 W
	60 Hz 230 Vac	41 VA

Power Supply

One of the four types of power supplies listed in Table 1-1 may be selected to provide internal relay operating power.

Table 1-1. Power Supply

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
O (Mid Range)	48 Vdc	24 to 150 Vdc	4.0 W
P (Mid Range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	4.0 W 10.0 VA
R (Low Range)	24 Vdc	12† to 32 Vdc	4.0 W
T (High Range)	250 Vdc 240 Vac	62 to 280 Vdc 90 to 270 Vac	5.0 W 12.0 VA

† Type R power supply initially requires 14 Vdc to begin operating. Once operating, the voltage may be reduced to 12 Vdc and operation will continue.

Output Contacts	**Output contacts are rated as follows:**
<u>Resistive</u> 120/240 Vac	Make 30 A for 0.2 seconds, carry 7 A continuously, and break 7 A.
125/250 Vdc	Make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.3 A.
<u>Inductive</u> 120/240 Vac, 125/250 Vdc	Break 0.3 A, (L/R = 0.04).
Target Indicator	Target indicators may be either internally operated or current operated (operated by a minimum of 0.2 A through the output trip circuit). When the target is current operated, the sync output circuit must be limited to 30 A for 1 second, 7 A for 2 minutes, and 3 A continuously.
Phase Angle	
Selection Accuracy	± 0.5° or ± 5.0% of the front panel setting for degrees, whichever is greater, for a nominal input frequency of 50/60 hertz, a sensing input range of 80 to 135 volts, and at 25°C.
Setpoint Accuracy	±0.5° or ±5%, whichever is greater, from a reference measurement at 25°C, at nominal input frequency and levels, over the specified operating range of temperature and input voltages.
Timing Accuracy at 25°C	Maximum of 25 milliseconds or 5% of the front panel setting for time whichever is greater, for a nominal input frequency of 50/60 hertz at 25°C.
TIME Delay Accuracy (Overall)	±10 milliseconds or ±2%, whichever is greater, of the time delay at 25°C, over the full temperature, voltage and frequency ranges.
Minimum Voltage Requirement	Minimum voltage detection circuitry enables the sync-check circuitry when both line and bus are within operating range of the relay. Voltage sensing circuits are guaranteed to operate at a minimum voltage of 60 volts. They are guaranteed not to operate at voltages less than 20 volts. Some units may operate at voltages in between these two levels because of the individual characteristics of specific components. Minimum voltage detection is usually in the range of 45 to 55 volts.
Voltage Difference Option	
Range	Continuously adjustable over the range of 1 to 135 Vac.
Accuracy	Voltage difference setpoint does not vary more than 0.5 V or 5%, whichever is greater, from a reference measurement at 25°C, with nominal input frequency, and variation of temperature or voltage inputs over their specified operating range. This setpoint does not vary more than 3% from a reading at 25°C over the limited range of +15 to +40°C.

Line and Bus Voltage Monitor Option

Range	Continuously adjustable over the range of 10 to 135 Vac.
Accuracy	The line and bus voltage setpoints do not vary more than 3% from a reference measurement at 25°C, with nominal input frequency, and with temperature and voltage inputs within specified operating range. Setpoints do not vary more than 1% from a reading at 25°C over the limited temperature range of +15 to +40°C.

Isolation

In accordance with IEC 255-5 and IEEE C37.90, one minute dielectric (high potential) tests as follows:

All circuits to ground:	2121 Vdc
Input to output circuits:	1500 Vac or 2121 Vdc

Surge Withstand Capability

Oscillatory	Qualified to IEEE C37.90.1-1989 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.*
Fast Transient	Qualified to IEEE C37.90.1-1989 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.*

Radio Frequency Interference (RFI)
Maintains proper operation when tested in accordance with IEEE C37.90-1989, *Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.*

UL Recognition
UL recognized per Standard 508, UL File No. E97033. Note: Output contacts are not UL recognized for voltages greater than 250 V.

Shock
In standard tests, the relay has withstood 15g in each of three perpendicular planes without structural damage or degradation of performance.

Vibration
In standard tests, the relay has withstood 2g in each of three mutually perpendicular axes swept over the range of 10 to 500 hertz for a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance.

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

Storage Temperature
-65°C (-85°F) to 100°C (212°F).

Weight
13.7 pounds maximum.

Case Size
S1

SECTION 2 • HUMAN-MACHINE INTERFACE

CONTROLS AND INDICATORS

Table 2-1 lists and briefly describes the operator controls and indicators of the BE1-25 Sync-Check Relay. Reference the callouts A through P to Figure 2-1 and Q through S to Figure 2-2.

Table 2-1. Location of Controls and Indicators

Callout	Control or Indicator	Function
A	**SYNC Indicator**	Red LED lights when an in-sync condition has been of sufficient duration to match the TIME DELAY setting. Lighting of the LED coincides with closure of the Sync Output contacts. The LED extinguishes when 52b opens or the in-sync condition ceases.
B	**TIME DELAY Selector**	Thumbwheel switches establish the time delay between sensing the desired in-sync condition and closing the Sync Output contact. Time delay is in units of seconds or of cycles, according to the option selected. Option A6: Adjustable in 1-second increments over a range of 01 to 99 seconds when multiplier switch (callout D) is in the X 1.0 position. Alternatively, the range is 0.1 to 9.9 seconds with the multiplier switch in the X 0.1 position. Option A7: Adjustable in 1-cycle increments from 1 to 99 cycles. The multiplier switch (callout D) is omitted. **NOTE** A setting of 00 will inhibit closing of the SYNC output.
C	**POWER Indicator**	LED lights to indicate that the relay power supply is functioning properly.
D	**TIME DELAY Multiplier Switch**	Explained above; see callout B.
E	**ΔV Indicator**	Red LED lights when the difference between the bus and line voltage is less than the ΔV setting.
	ΔV Adjustment	Continuously adjustable from 1 to 135 Vac. Adjustment is by small screwdriver through an access hole in the front panel. CW rotation increases the voltage difference setting.

Callout	Control or Indicator	Function
F	**LL Indicator**	Red LED lights when the line voltage exceeds the reference voltage established by the LL setting.
	LL Adjustment	Continuously adjustable from 10 to 135 Vac. Adjustment is by small screwdriver through an access hole in the front panel. CW rotation increases the voltage setting.
G	**DL/NOT OV Indicator**	When in the NORMAL Mode: Red LED lights when the line voltage is less than the reference voltage established by the DL/NOT OV setting that defines a dead line. When in the NOT OV Mode: Red LED lights when the line voltage does not exceed the reference voltage established by the DL/NOT OV setting that defines an overvoltage condition.
	DL/NOT OV Adjustment	Continuously adjustable over the range of 10 to 135 Vac. Adjustment is by small screwdriver through an access hole in the front panel. CW rotation increases voltage setting.
H	**Target Reset Lever**	Allows manual reset of the target.
I and J	**PUSH-TO-ENERGIZE OUTPUT Switches**	Momentary pushbuttons are accessible by inserting a 1/8 inch diameter non-conducting rod through access holes in the front panel. Switch I, when actuated, closes the Sync Output contacts and (if specified) the Auxiliary Sync Output contacts; Switch J closes the (optional) Voltage Monitor Output contacts.
K	**Target Indicator (Optional)**	Magnetically latching indicator which indicates that the Sync Output relay is or was energized.
L	**LB Indicator**	Red LED lights when bus voltage exceeds the reference voltage established by the LB setting that defines a live bus condition.
	LB Adjustment	Continuously adjustable over a range of 10 to 135 Vac. Adjustment is by small screwdriver through an access hole in the front panel. CW rotation increases voltage setting.
M	**V Indicator**	Red LED lights whenever the (optional) Voltage Monitor Output relay is energized.

Callout	Control or Indicator	Function
N	**DB/NOT OV Indicator**	When in the NORMAL Mode: Red LED lights when the bus voltage is less than the reference voltage established by the DB/NOT OV setting that defines a dead bus condition. When in the NOT OV Mode: Red LED lights when the bus voltage does not exceed the reference voltage established by the DB/NOT OV setting that defines an overvoltage condition.
	DB/NOT OV Adjustment	Continuously adjustable over the range of 10 to 135 Vac. Adjustment is by small screwdriver through an access hole in the front panel. CW rotation increases the voltage setting.
O	**PHASE ANGLE Selector**	**NOTE** A PHASE ANGLE setting of 00 inhibits operation of the relay. Thumbwheel switches set the acceptable maximum phase difference between the line and bus voltages. This phase difference window is adjustable in 1° increments over a range of 01° to 99°.
P	**PHASE ANGLE Indicator**	Red LED lights when the phase angle is within the limits established by the adjacent PHASE ANGLE Selector.
Q	**Switchable jumper for EXPAND option**	Position of jumper in Figure 2-2 controls the width of the expanded phase angle window as a multiple of the PHASE ANGLE setting. The two positions are X2 and X3.
R	**MODE Switch No. 1 (Bus)** **MODE Switch No. 2 (Line)**	For Both Mode Switches: Up = NORMAL Mode; Down = NOT OV Mode. When in the NORMAL Mode: (1) A high voltage threshold is established by front panel controls, above which the bus (or line, as the case may be) is considered live; (2) A low voltage threshold is established by front panel controls, below which the bus (or line) is considered dead.

Callout	Control or Indicator	Function
R **(Cont'd)**		When in the NOT OV Mode: (1) A voltage above the high voltage setpoint setting is considered overvoltage. (2) A voltage below the low voltage setpoint setting is defined as dead. (3) A voltage between the two setpoints is defined as live. This condition is indicated by the illumination of two LEDs: either LL or LB and the corresponding NOT OV.
S	**CONDITION Switches** **No. 1 (Not-Overvoltage Enable to the sync logic circuitry)**	Up = OFF: Disables the NOT OV Mode of operation during a live line/live bus condition. Down = ON: Allows the NOT OV Mode of operation to add a further constraint to the live line/live bus condition (assuming that the NOT OV Mode has been previously selected on Mode Switch No. 1 or No. 2). The additional constraint is that the line and/or bus must not be in the overvoltage region. (This switch does not affect the Voltage Monitor Output relay.)
	No. 2 (Live Line/Live Bus)	Up = OFF Down = ON When ON (Down), the Voltage Monitor Output relay is actuated when a live line/live bus condition is recognized. **WARNING!** **If relay has Output Option E or F:** Condition Switch No. 2 (LL-LB) must be Up (OFF) when output option E or F is selected. Otherwise, sync outputs will occur under live line/live bus conditions without benefit of the Sync-Check function. No switch or contact should be connected to the LL-LB input terminal in this case.

Callout	Control or Indicator	Function
S (Cont'd)		**WARNING!** **If relay has Output Option G or H:** Condition Switch No. 2 (LL-LB) may be Down (ON) only when output option G or H has been selected and the Voltage Monitor Output contacts do not by-pass the Sync-Check contact. Use of the external LL-LB switch (if installed) is similarly limited..
	No. 3 (Dead Line/Live Bus)	Up = OFF <u>If relay has Output Option E or F:</u> The ON (Down) position causes immediate closure of the Sync Output contact, if a dead line/live bus condition is detected with the breaker open. <u>If relay has Output Option G or H:</u> The ON (Down) position causes immediate actuation of the Voltage Monitor relay, if a dead line/live bus condition is detected with the breaker open.
	No. 4 (Live Line/Dead Bus)	Up = OFF <u>If relay has Output Option E or F:</u> The ON (Down) position causes immediate closure of the Sync Output contact, if a live line/dead bus condition is detected with the breaker open. <u>If relay has Output Option G or H:</u> The ON (Down) position causes immediate actuation of the Voltage Monitor relay, if a live line/dead bus condition is detected with the breaker open.

Callout	Control or Indicator	Function
S (Cont'd)	**No. 5 (Dead Line/Dead Bus)**	Up = OFF <u>If relay has Output Option E or F:</u> The ON (Down) position causes immediate closure of the Sync Output contact if a dead line/dead bus condition is detected with the breaker open. <u>If relay has Output Option G or H:</u> The ON (Down) position causes immediate actuation of the Voltage Monitor relay if a dead line/dead bus condition is detected with the breaker open.

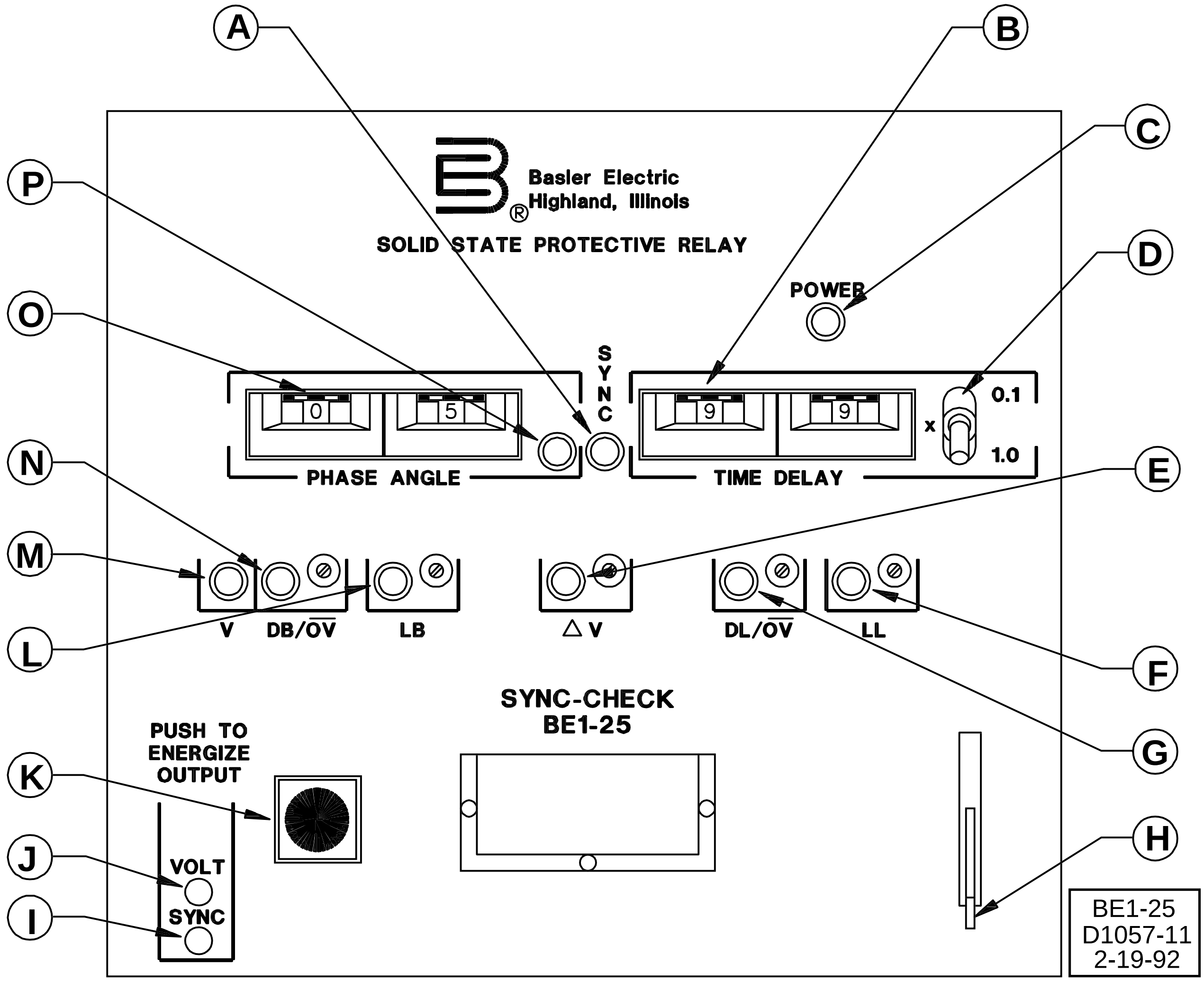


Figure 2-1. Location of Controls and Indicators (Front Panel View)

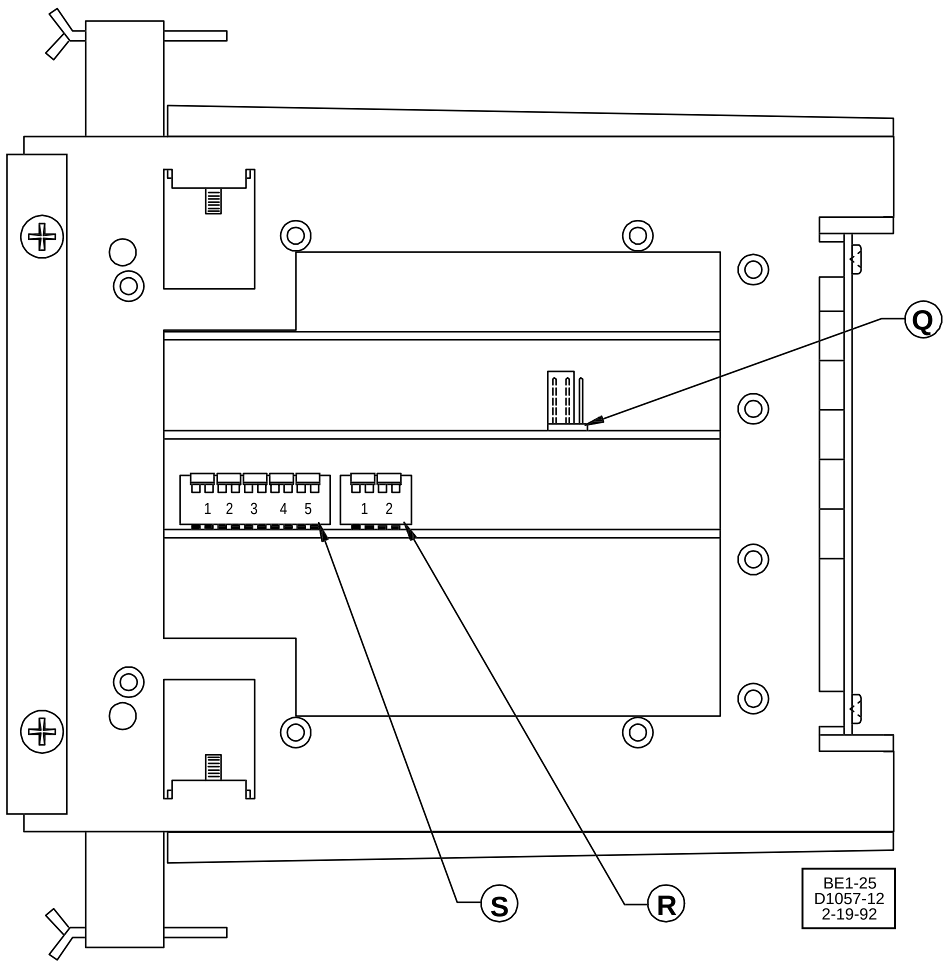


Figure 2-2. Location of Controls and Indicators (Interior View)

SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

BE1-25 Sync-Check Relays are static devices that use digital circuitry to provide a breaker closure signal when the phase and voltage difference between two voltage inputs, typically line and bus, are within preset limits. The functional block diagram in Figure 3-1 illustrates the overall operation of the BE1-25 Sync-Check Relay.

FUNCTIONAL DESCRIPTION

Figure 3-1 is a block diagram that illustrates the BE1-25 Sync-Check Relay circuit functions described in the following paragraphs.

Step-Down Transformers

Standard system transformers with a 120 volt secondary provide line and bus voltages to the sensing transformer of the BE1-25 Sync-Check Relay. Internal sensing transformers isolate the relay from the system and step down the voltage to internal circuit levels.

Zero-Cross and Phase Difference Measurement

Zero-cross detection circuits digitize the output voltages from the sensing transformers. Time delays between the zero crosses are measured in the phase difference measurement circuitry to provide a binary output.

Comparator

The binary number representing phase difference is compared with the setting of the PHASE ANGLE thumbwheel switches. If the detected phase difference is less than the setting of the switches, the time delay is started and the PHASE ANGLE LED is illuminated.

Timer

The time delay timer clock is controlled by the TIME DELAY multiplier switch on the front panel.

The timer is enabled when:

1. Phase angle is less than the set limit.
2. Minimum line and bus voltages are present.
3. 52b contact is closed.
4. Voltage difference (ΔV) is within set limits (if option is selected).
5. A live-line and live-bus condition is present (if the Voltage Monitor option is selected).

When the time delay reaches the count entered by the TIME DELAY select switches, the SYNC output is energized, the SYNC LED is turned ON, and the target (if selected) turns red. The SYNC LED is turned OFF as soon as any of the five above listed enables are removed. Generally this occurs when the circuit breaker closes.

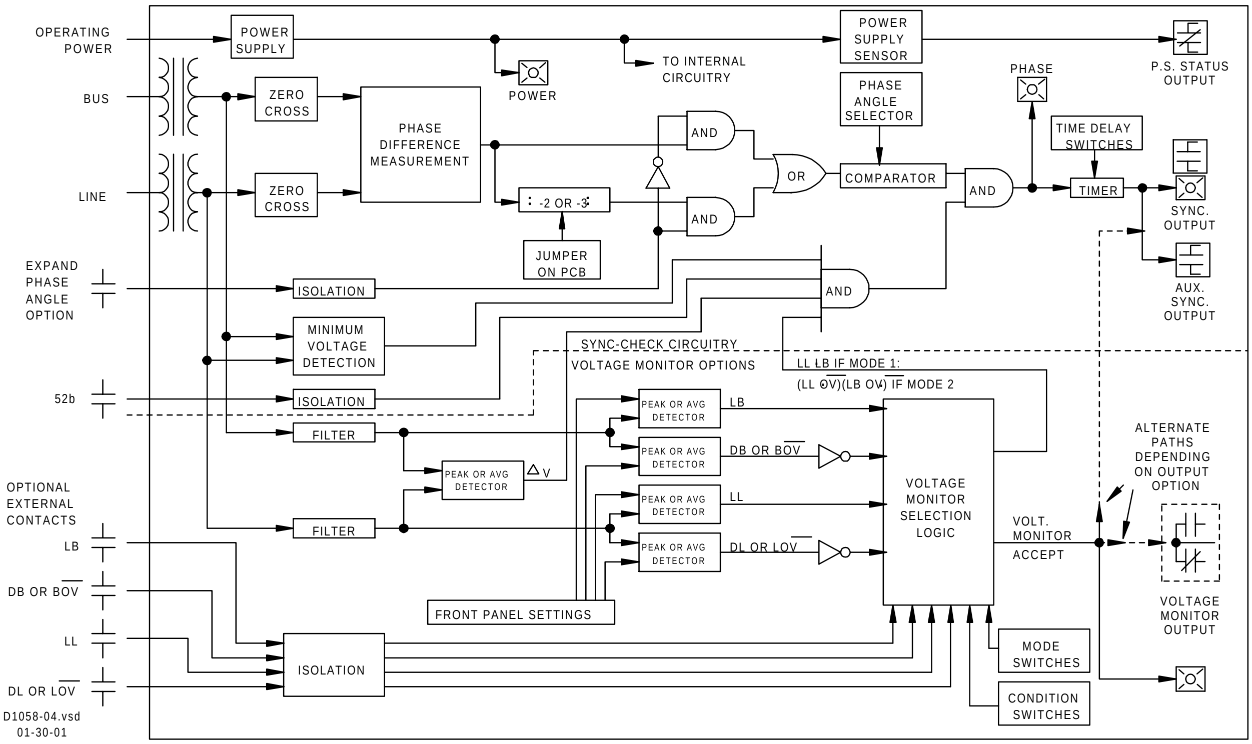


Figure 3-1. Functional Block Diagram

Minimum Voltage Detection

Minimum voltage detection circuitry enables the TIME DELAY timer when both line and bus are within operating range of the relay. Voltage sensing circuits are guaranteed to operate at a minimum voltage of 60 volts. They are guaranteed not to operate at voltages less than 20 volts. Some units may operate at voltages in between these two levels because of the individual characteristics of specific components. Minimum voltage detection is usually in the range of 45 to 55 volts.

Contact Sensing Options

Before any relay output can occur, there must be an initiating signal from external contacts. Contact sensing circuitry allows the relay to monitor circuit breaker status (52b) and various conditions selected by the user. (Contact requirements are provided in the Specifications.)

In any sync-check relay, all of the contact sensing inputs supplied must use one of two methods.

1. Isolated sensing (Option 1-5), uses current supplied by the relay to monitor the isolated contacts.
2. Non-isolated sensing (Option 1-4), monitors an external dc source whose nominal voltage is equal to the input to the BE1-25 power supply.

Power Supply

Basler Electric enhanced the power supply design for unit case relays. This new design created three, wide range power supplies that replace the four previous power supplies. Style number identifiers for these power supplies have not been changed so that customers may order the same style numbers that they ordered previously. The first newly designed power supplies were installed in unit case relays with EIA date codes 9638 (third week of September 1996). Relays with a serial number that consists of one alpha character followed by eight numerical characters also have the new wide range power supplies. A benefit of this new design increases the power supply operating ranges such that the 48/125 volt selector is no longer necessary. Specific voltage ranges for the three new power supplies and a cross reference to the style number identifiers are shown in Table 3-1.

Table 3-1. Wide Range Power Supply Voltage Ranges

Power Supply	Style Chart Identifier	Nominal Voltage	Voltage Range
Low Range	R	24 Vdc	12† to 32 Vdc
Mid Range	O, P	48, 125 Vdc, 120 Vac	24 to 150 Vdc, 90 to 132 Vac
High Range	T	125, 250 Vdc, 120, 240 Vac	62 to 280 Vdc, 90 to 270 Vac

† 14 Vdc required to start the power supply.

Relay operating power is developed by the wide range, isolated, low burden, flyback switching, solid state power supply. Nominal ±12 Vdc is delivered to the relay internal circuitry. Input (source voltage) for the power supply is not polarity sensitive. A red LED turn ON to indicate that the power supply is functioning properly.

Power Supply Status Output Option

The power supply status output relay (Option 3-6) has normally closed (NC) output contacts. The relay is energized upon power-up, thus opening its contacts. The contacts will remain open as long as normal relay operating voltage is maintained. However, if the power supply voltage falls below the requirements for proper operation, the power supply status output relay de-energizes, thus closing the NC output contacts.

Voltage Monitor Options

Voltage monitor options are shown in the lower portion of Figure 3-1, and described in the following paragraphs.

Filters

Input voltages from bus and line are filtered and applied to the peak detectors or average detector circuitry.

Peak Detectors (Option 2-R, 2-T, or 2-U)

Voltage difference (ΔV) peak detectors measure the phasor voltage difference between line and bus, and compare this difference against the setting of the front panel ΔV control. If the detected difference is less than the limit, the sync-check timer is enabled, and the front panel ΔV LED is lighted.

Four additional peak detectors compare the sensed line and bus voltages with reference voltages established by the front panel control settings. To illustrate operation, let us first consider the two upper peak detectors, noting that they monitor the bus, and that one of them has its output inverted.

When the live bus (LB) peak detector determines the sensed bus voltage is above the threshold voltage, it outputs a logic-high signal to the selection logic. But the DB/Not Overvoltage peak detector, because of inversion, only provides a logic-high signal when sensed voltage is below the threshold, thereby identifying either a dead bus (i.e., Mode Switch No. 1 is Up to select the NORMAL Mode), or a Not Overvoltage condition (Mode Switch No. 1 is Down to select the NOT OV Mode).

The lower pair of peak detectors work in similar fashion to define line conditions, as determined by the position of Mode Switch No. 2.

Average Detectors (Option 2-A, 2-,B or 2-C)

Voltage difference average detectors provide the same functionality as the peak detector inputs except they measure the average voltage difference instead of phasor voltage difference.

Selection Logic

Voltage monitor selection logic is controlled by Mode and Condition switches or External Condition Switches to produce the Voltage Monitor output.

Another output from the voltage monitor selection logic serves as an additional qualifier for the timer in the sync output circuit. The specific conditions being monitored depend upon whether NORMAL or NOT OV operation is used. Live line and live bus is monitored if NORMAL Mode is selected. Live line, live bus, and Not Overvoltage is monitored if NOT OV Mode is selected.

Detailed instructions and precautions for programming the Mode and Condition switches are provided in Table 2-1, callouts R and S. The location of the switches is shown in Figure 2-2.

Target Indicator Option

Each target indicator is visible on the front panel of the relay with the cover in place. When tripped, the disc in the target changes from black to red and is magnetically latched in this position. To reset the target after an abnormal system condition has been cleared, manually raise the target reset lever on the front of the relay (or its extension which protrudes through the bottom of the front cover).

When a Target option is specified as either A or B as described in the following paragraphs and shown in Figure 1-6, a magnetically latched indicator is incorporated in the front panel. When a target is tripped, a SYNC output occurs. The target may be actuated by either of two methods:

Type A

Type A target (referred to as internally operated) is actuated by an integral driver circuit that responds directly to the relay internal logic. This type of target is tripped regardless of the amount of current flowing through the output contact.

Type B

Type B target (referred to as current operated) is actuated when a minimum of 0.2 ampere flows through the SYNC output contact. To accomplish this, a special reed relay is placed in series with the contact to signal the target indicator. (The series impedance of the reed relay is less than 0.1 ohm.) Current in the output circuit must be limited to 30 amperes for 0.2 seconds, 7 amperes for 2 minutes, and 3 amperes continuously.

SECTION 4 • INSTALLATION

GENERAL

When not shipped as part of a control or switchgear panel, the relays are shipped in sturdy cartons to prevent damage during transit. Immediately upon receipt of a relay, check the model and Style Number against the requisition and packing list to see that they agree. Visually inspect the relay 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 relay is not to be installed immediately, store the relay in its original shipping carton in a moisture and dust free environment. For more information, see Section 6, Maintenance. When the BE1-25 is to be placed in service, it is recommended that the Operational Test Procedure be performed prior to installation.

RELAY OPERATING PRECAUTIONS

Before installation or operation of the relay, note the following precautions:

1. A minimum of 0.2 A in the output circuit is required to ensure operation of current operated targets.
2. The relay is a solid-state device. If a wiring insulation test is required, remove the connection plugs and withdraw the cradle from its case.
3. When the connection plugs are removed the relay is disconnected from the operating circuit and will not provide system protection. Always be sure that external operating (monitored) conditions are stable before removing a relay for inspection, test, or service.
4. Be sure the relay case is hard wired to earth ground using the ground terminal on the rear of the unit. It is recommended to use a separate ground lead to the ground bus for each relay.

DIELECTRIC TEST

In accordance with IEC 255-5 and IEEE C37.90, one minute dielectric (high potential) tests as follows:

All circuits to ground:	2121 Vdc
Input to output circuits:	1500 Vac or 2121 Vdc

MOUNTING

Relay

Because the relay is of solid-state design, it does not have to be mounted vertically. Any convenient mounting angle may be chosen. Relay outline dimensions and panel drilling diagrams are supplied at the end of this section.

Resistor Module

When the condition and mode switching of the Voltage Monitor option is controlled by external contacts (option 2-C, 2-U, or 2-V), a voltage dropping Resistor Module is bolted to the rear of the relay (Figure 4-9). If the relay is to be projection mounted (Figure 4-3), it will be necessary to first remove the module when mounting the relay, then reattach it so that the mounting panel lies between the relay and module.

In planning the installation, reserve a clear space directly behind the relay, or behind the mounting panel if projection mounted, since the Resistor Module will give off some heat during use.

Contact Sensing Module

If a type T power supply (250 Vdc or 240 Vac) is used, an external Contact Sensing Module is required. (See Figure 4-11.) If external control of condition and mode switching is also specified, the Resistor Module must also be used in addition to the Contact Sensing Module.

The ideal mounting position for the contact sensing module is with the fins vertical (to facilitate upward air movement). This module is best mounted as close to the relay as is conveniently possible in order to take full advantage of transient suppressors within the module.

Further installation information for the contact sensing module is contained in Publication 9 1702 06 990, which is packed with the module.

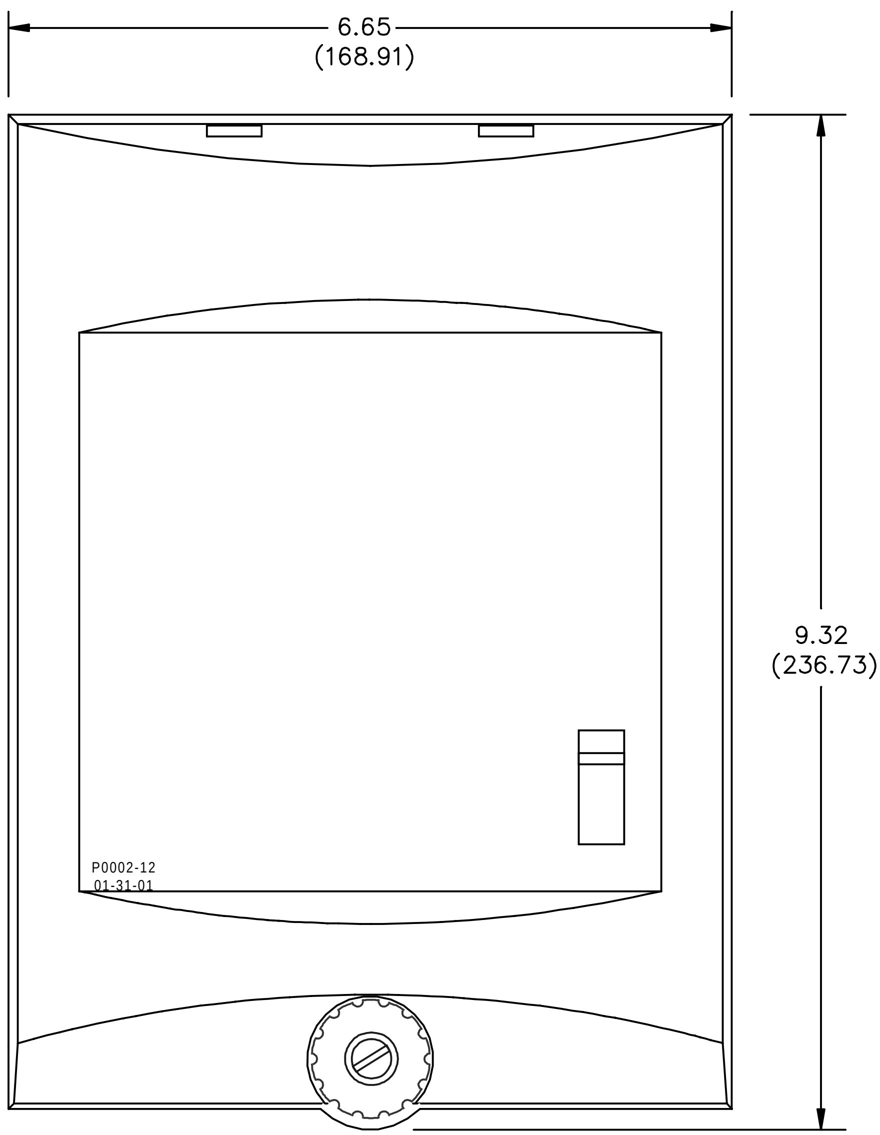


Figure 4-1. S1 Case, Outline Dimensions Front View

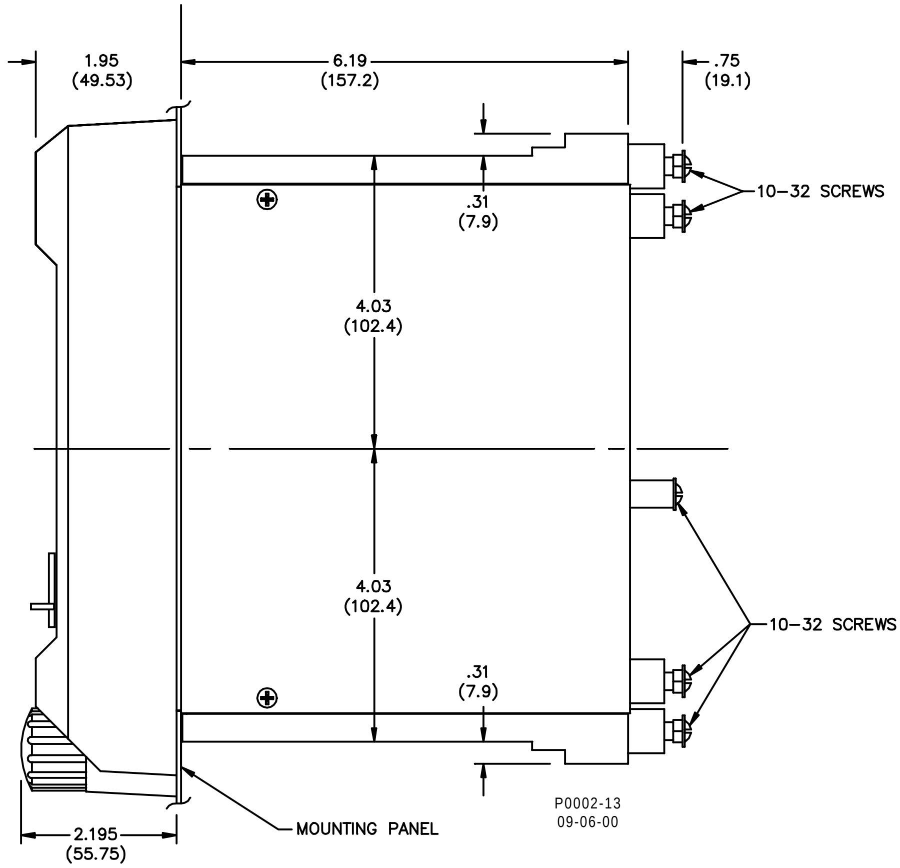


Figure 4-2. S1, Double-Ended, Semi-Flush Mounting, Side View

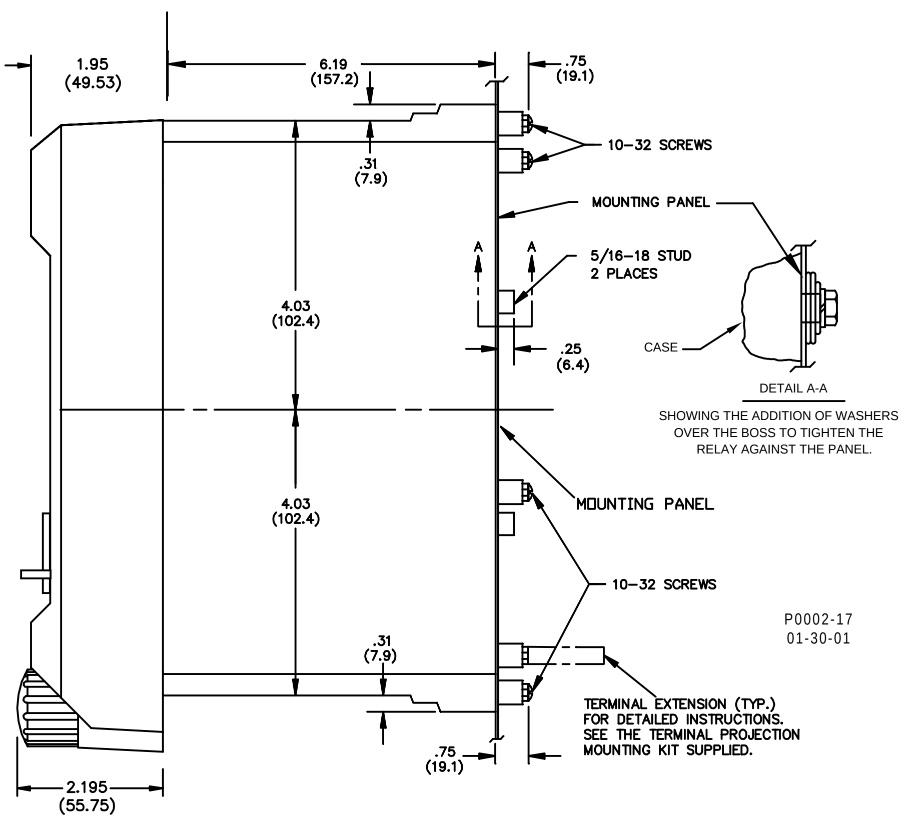


Figure 4-3. S1 Case, Double-Ended, Projection Mounting, Side View

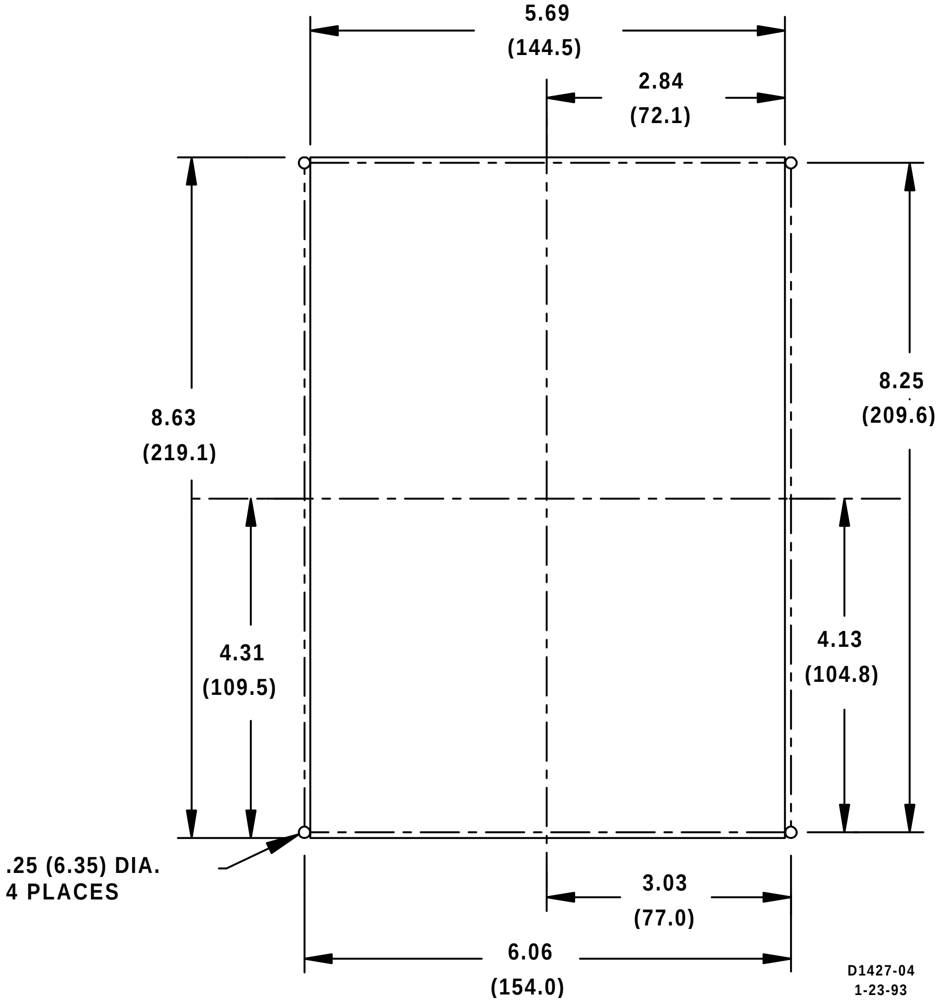
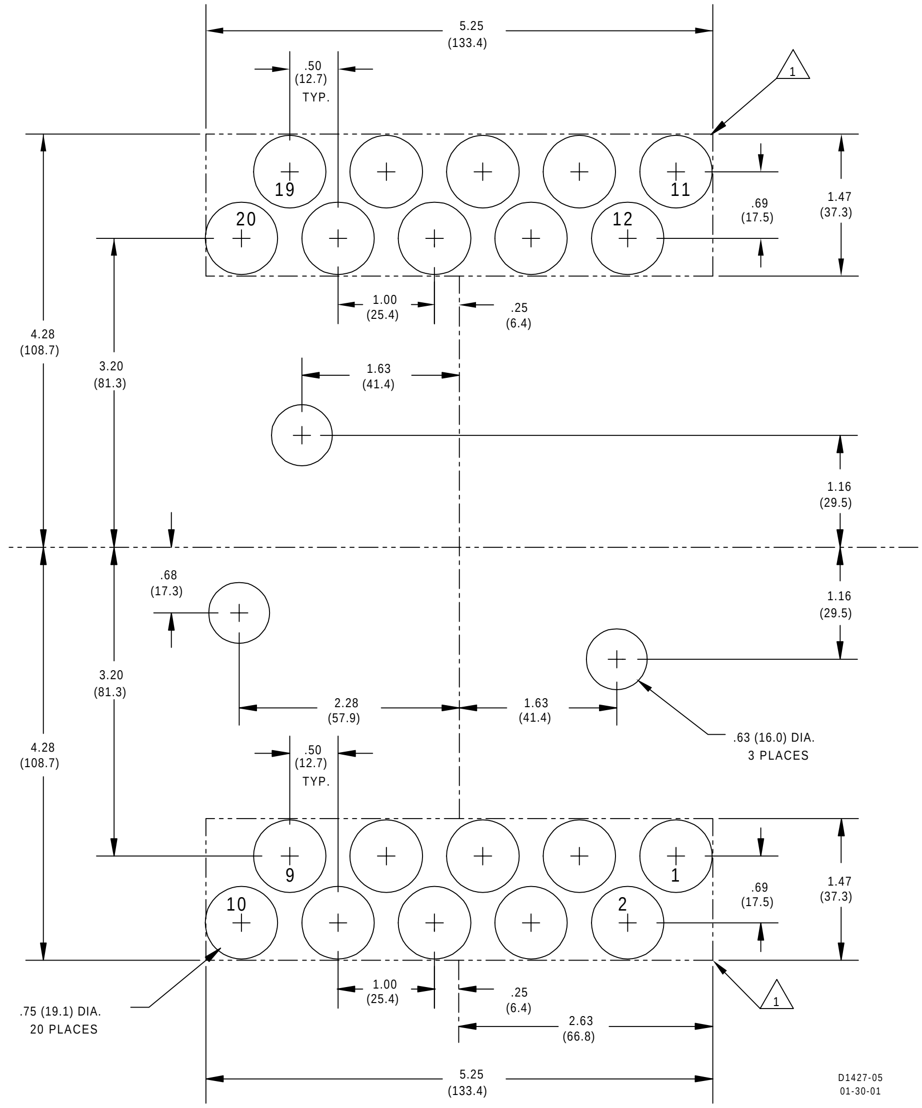


Figure 4-4. S1 Case, Panel Drilling Diagram Semi-Flush Mounting



Notes:

1. Optional rectangular cutout may replace the ten drilled holes.

2. Terminal numbers shown are as viewed from rear of relay.

Figure 4-5. Panel Drilling Diagram (Projection Mounting)

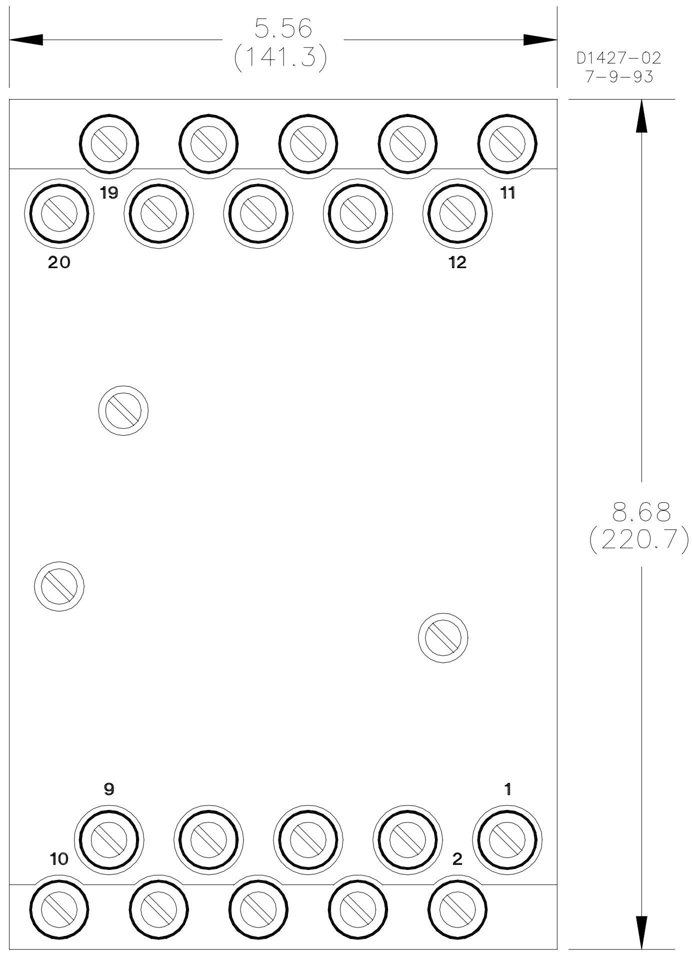


Figure 4-6. S1 Case, Double-Ended, Projection Mounting, Outline Dimensions, Rear View

CONNECTIONS

Incorrect wiring may result in damage to the relay. Be sure to check the model and Style Number against the options listed in the Style Number identification chart, Figure 1-6, before connecting and energizing a particular relay.

NOTE
Be sure the relay case is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the relay case. When the relay is configured in a system with other protective devices, it is recommended to use a separate lead to the ground bus from each relay.

Except as noted above, connections should be made with minimum wire size of 14 AWG. Typical internal connections are shown in Figure 4-7. Typical external connections are shown in Figures 4-8 through 4-11. Be sure to use the correct input power for the power supply specified.

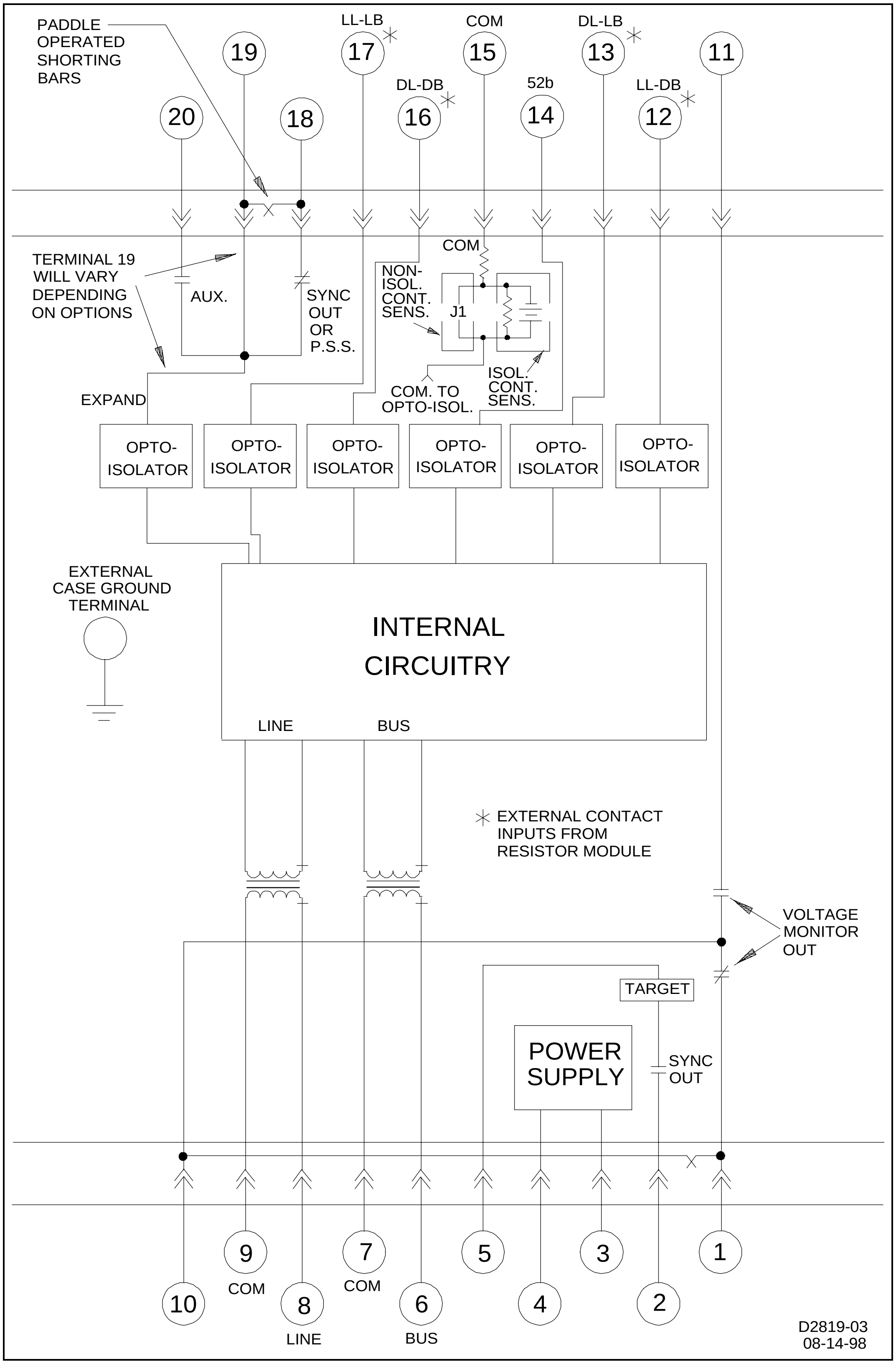


Figure 4-7. Internal Diagram

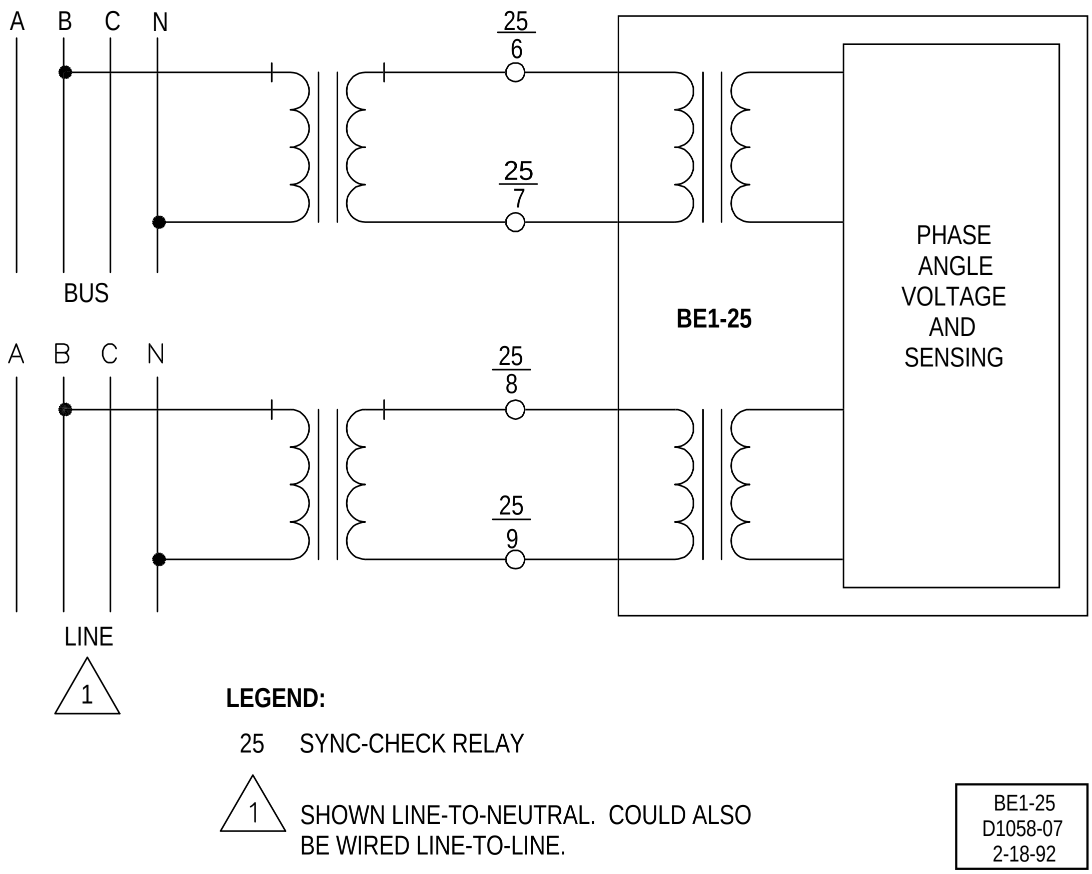


Figure 4-8. Voltage Sensing Connections

NOTE

The Resistor Module shown in Figure 4-8 is required for BE1-25 Sync-Check relays, Voltage Monitor option 2-C, 2-U, or 2-V.

When the relay is to be projection mounted (see Figure 4-3), the Resistor Module must be removed prior to installation. Once the relay is installed, the Module is then attached to the rear of the mounting panel. The external contact inputs are then wired to the Resistor Module at TB2.

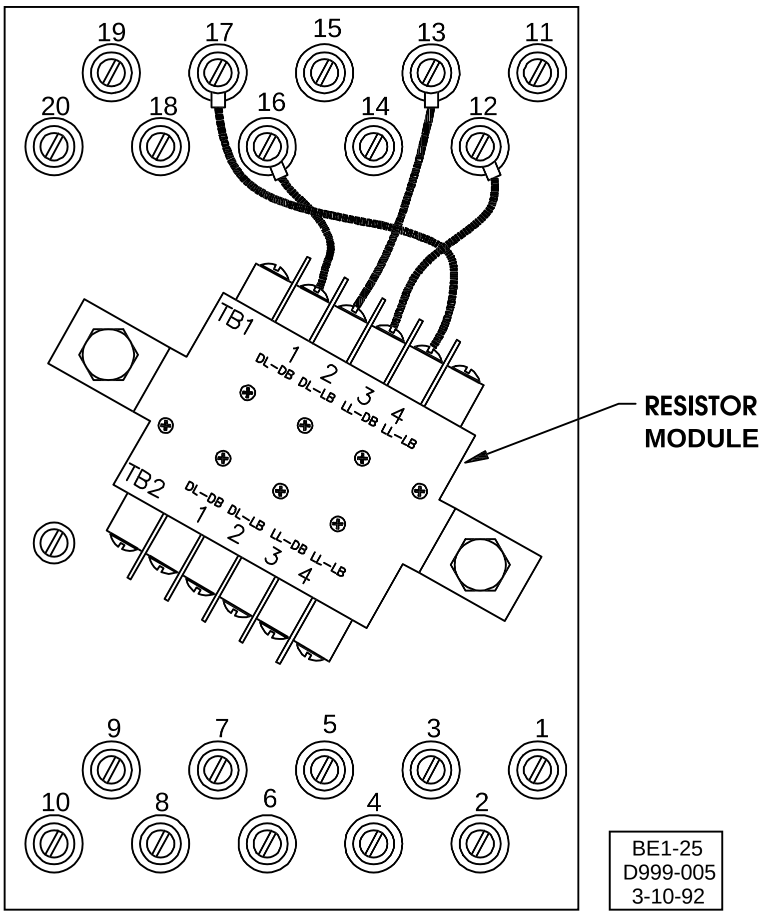


Figure 4-9. Resistor Module Connections

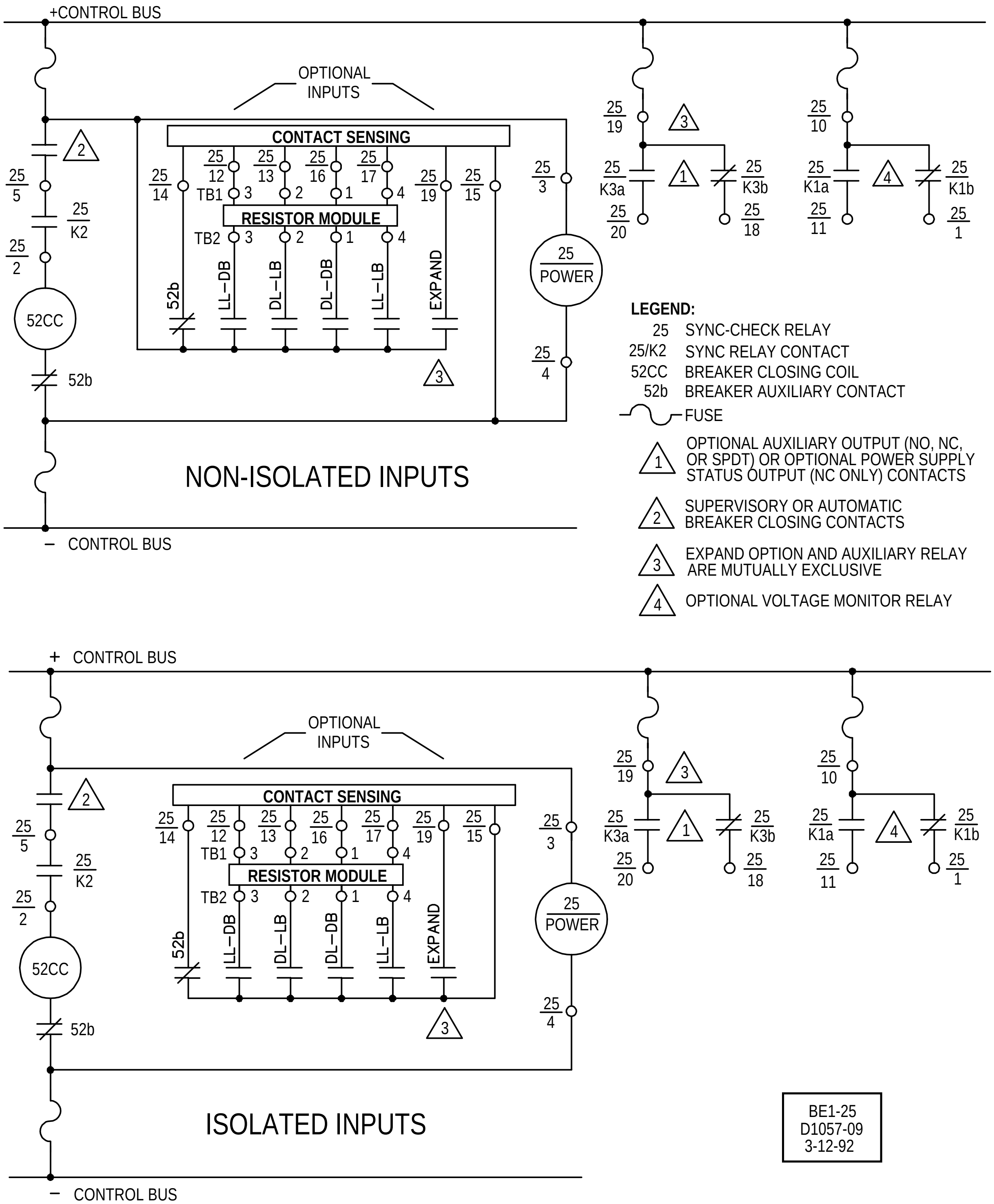


Figure 4-10. Control Circuit Connections (Typical)

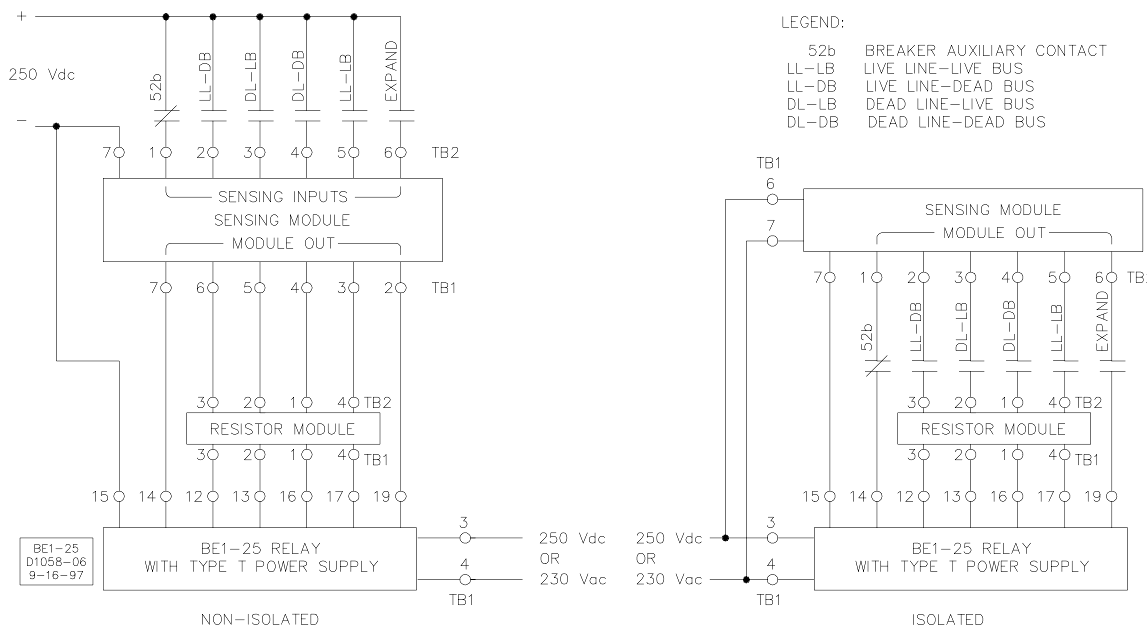


Figure 4-11. Contact Sensing and Resistor Modules For Type T Power Supply Only

SECTION 5 • TESTING

GENERAL

In the event the relay is not to be installed immediately, store the relay in its original shipping carton. When the relay is to be place in service, it is recommended that the operational test procedure in this section be performed prior to installation.

RELAY OPERATING PRECAUTIONS

Before installation or operation of the relay, note the following precautions:

1. A minimum of 0.2 ampere in the output circuit is required to ensure operation of current operated targets.
2. The relay is a solid-state device. If a wiring insulation test is required, remove the connection plugs and withdraw the cradle from its case.
3. When the connection plugs are removed the relay is disconnected from the operating circuit and will not provide system protection. Always be sure that external operating (monitored) conditions are stable before removing a relay for inspection, test, or service.
4. Be sure the relay case is hard wired to earth ground using the ground terminal on the rear of the unit. It is recommended to use a separate ground lead to the ground bus for each relay.

SWITCH SETTINGS

Setting Time Delay or Phase Angle

Figure 5-1 graphically relates time delay settings to phase angle settings in terms of slip frequency.

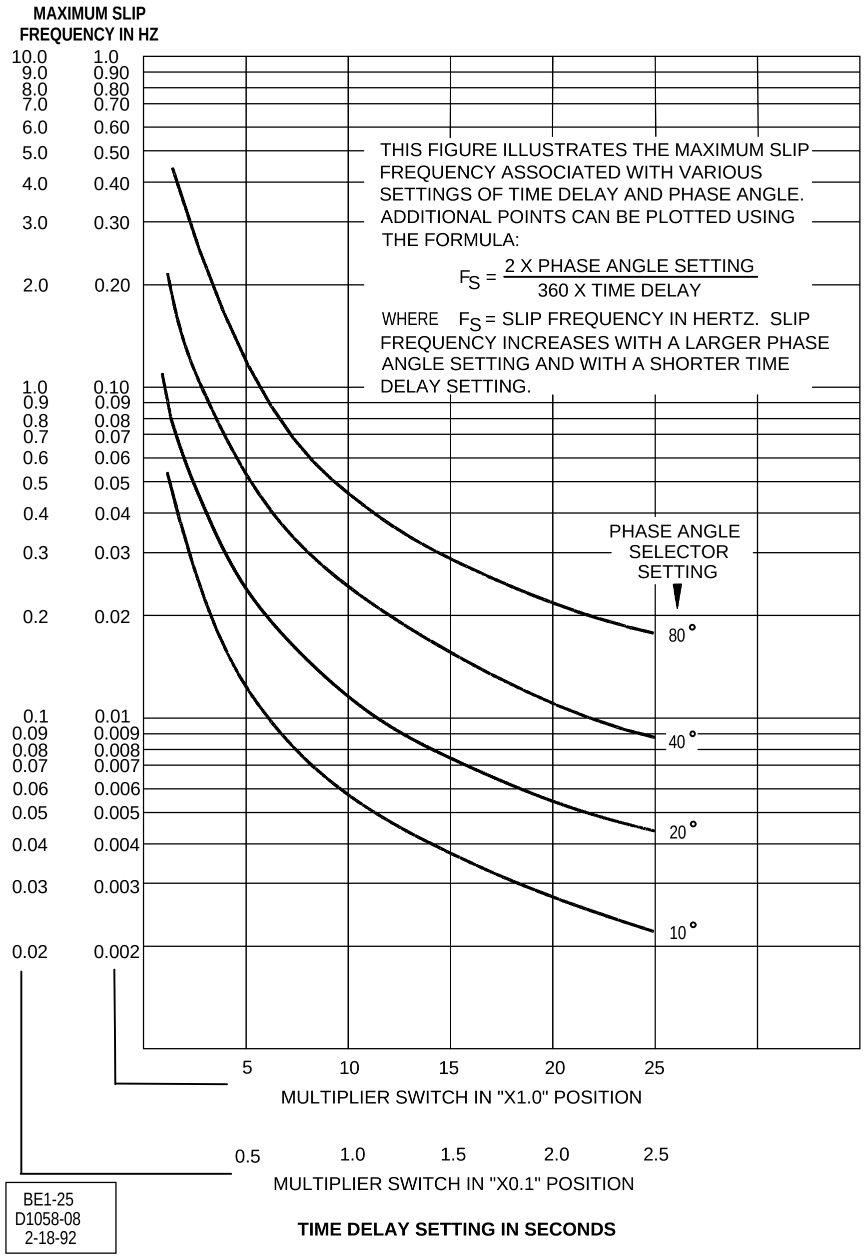


Figure 5-1. Maximum Slip Frequency Versus Time Delay and Phase Angle Settings

Condition and Mode Switches

Detailed instructions and precautions for programming the Mode switches and Condition switches are provided in Table 2-1, callouts R and S. The location of the switches is shown in Figure 2-2.

When output contacts of both Sync and Voltage Monitor functions are wired in parallel, the live line/live bus Condition Switch No. 2 must be in OFF position. Otherwise the Sync function will be overruled. If the condition switches are external (option 2-C, 2-U, or 2-V), the external LL-LB switch should be omitted when Sync and Voltage Monitor contacts are in parallel.

OPERATIONAL TEST PROCEDURE

The following procedure verifies operation of the relay. The test setup of Figure 5-2 is intended primarily as an illustration of the principles involved. Other test setups known to be capable of testing within the stated and implied tolerances (including equipment specifically designed for testing relays) may be used.

Preliminary Settings

(a) All contact sensing inputs are open circuited.

(b) All Condition Switches and Mode Switches are UP.

(c) Some styles of relay are equipped with multiturn pots accessible through holes in the front panel. All such controls should be turned fully CCW (to their minimum settings) except the ΔV control, which is turned fully CW.

(d) Adjust bus and line sensing input voltages to 95 Vac with zero phase difference.

(e) Apply power to the relay.

(f) If equipped with power supply status output (option 3-6): verify that the power supply status output contacts are open.

(g) Remove input power and verify that the status contacts close.

(h) Apply power to the relay.

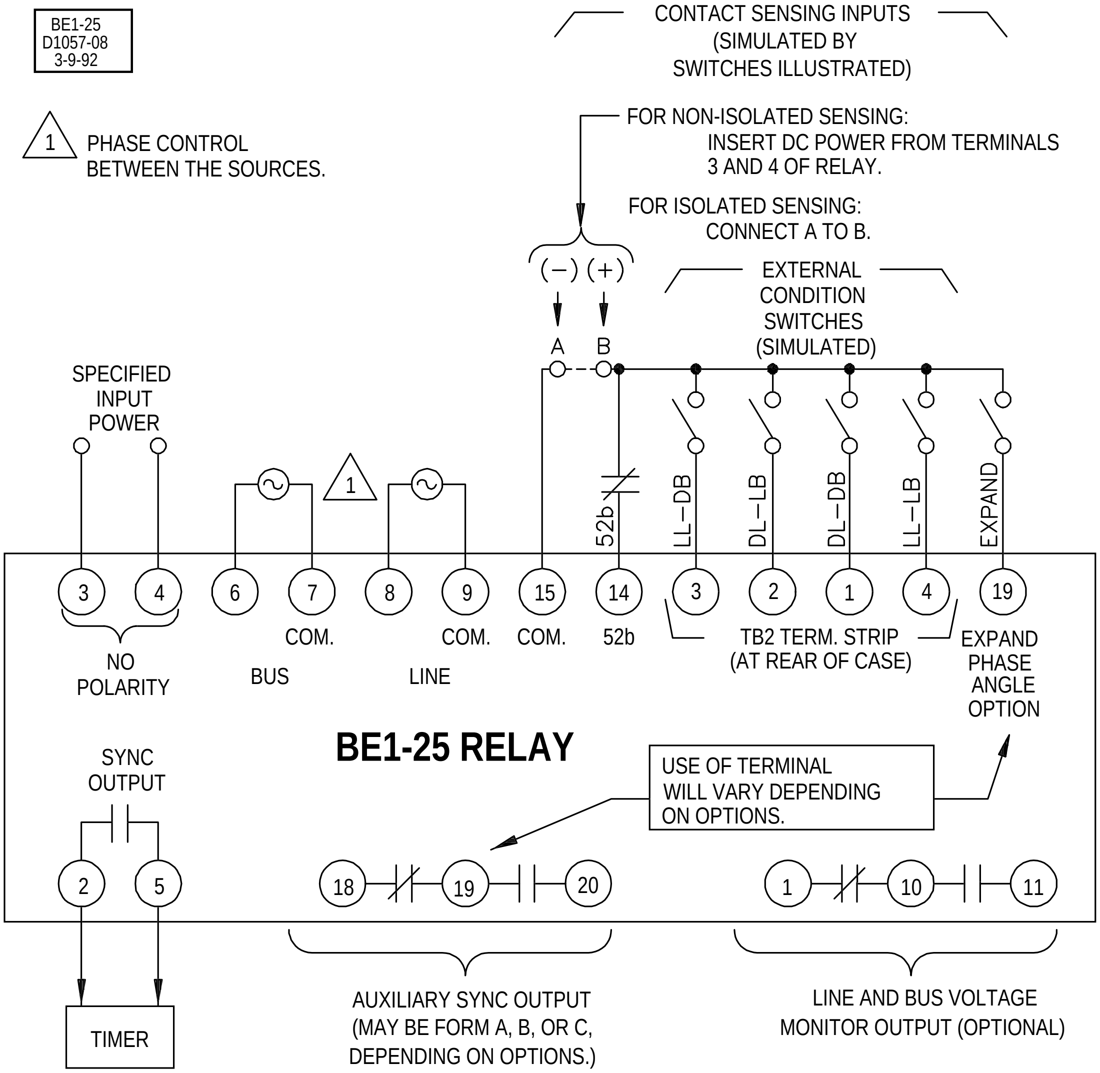


Figure 5-2. Test Setup (Typical)

Test Procedure

> **NOTE**
>
> A 00 setting of either control must inhibit the Sync-Check function.
>
> If target option B (current operated target) is present, check that targets operate at closure of the sync contacts. (Requires a minimum of 0.2 A in the output circuit.)

Step 1. Confirm proper sync-check operation at selected PHASE ANGLE settings with TIME DELAY set at minimum (for convenience). Check that go/no-go operation is within specs.

> **NOTE**
>
> When making this test, observe that the PHASE ANGLE LED is turned ON during the delay period, and that the SYNC LED flashes when the output contacts close. (Both LEDs go out as soon as the 52b input is open.)

If auxiliary contacts are supplied, check for proper switching action as relay cycles.

Step 2. With line and bus inputs in phase, check for proper operation of timer, using a time delay of 9.9 seconds, and again at 99 seconds (multiplier switch at 0.1 and at 1.0 respectively). (Close and open the 52b input to begin and terminate the timing cycle.) Check that accuracy of timing cycle is within specs.

Step 3. Check that operation of the sync function is inhibited during low voltage conditions of line or bus.

(a) Lower line and bus sensing input to 60 Vac and repeat Step 1. SYNC output should not be inhibited.

(b) Lower the line sensing inputs to 20 Vac. Attempt Step 1. SYNC function is inhibited and PHASE ANGLE LED should not turn ON.

(c) Return the line input to 60 Vac and lower the bus input to 20 Vac. Attempt Step 1. Sync function is inhibited and PHASE ANGLE LED should not turn ON.

It is not necessary to determine the exact voltage threshold at which inhibition occurs in order to confirm proper operation of this circuit.

NOTE

Steps 4 through 8 check for proper operation of line and bus Voltage Monitor (options 2-A, 2-C, 2-R, 2-S, 2-U, or 2-V). If these options are not present, proceed to step 7.

Step 4. Verify that the voltage monitor controls operate over the specified range as follows.

(a) Rotate the LL and LB controls (front panel) fully CW; rotate the DL/NOT overvoltage and DB/NOT overvoltage controls fully CCW.

(b) Adjust line and bus sensing inputs to 135 Vac.

(c) Slowly rotate the LL and LB controls CCW until LEDs turn ON. This should occur only a few turns from the maximum (fully CW) position.

(d) Adjust line and bus sensing inputs to 10 Vac.

(e) Rotate the LL and LB controls CCW until their indicators LEDs turn ON. This should occur only a few turns from the minimum (fully CCW) position.

(f) With input voltages remaining at 10 Vac, rotate the DL/NOT overvoltage and DB/NOT overvoltage controls CW until their LEDs just light. Both adjustments should require only a few turns from the minimum (fully CCW) position.

(g) Return line and bus sensing inputs to 135 Vac. (Both LEDs of step (f) must now be OFF.)

(h) Again rotate the DL/NOT overvoltage and DB/NOT overvoltage controls CW until the LEDs just light. Both adjustments should be near their maximum (fully CW) limits.

NORMAL Mode Testing

Step 5. Test NORMAL Mode operation of the line and bus voltage monitor as follows. (Proceed to step 6 if the NORMAL Mode is not used.)

(a) Adjust the following front panel controls by applying the voltages listed below, adjusting each control to the threshold where its LED just lights. (Reference callouts L, N, F, and G of Figure 2-1.)

LB:	Adjust to 80 Vac.
DB/NOT OV:	Adjust to 30 Vac.
LL:	Adjust to 80 Vac.
DL/NOT OV:	Adjust to 30 Vac.

(b) If the relay is not equipped with a separate relay for Voltage Monitor (output options G and H), set TIME DELAY to 99 seconds. This allows the convenience of using in-phase voltages for testing non-synchronous functions (without unwanted SYNC contact closures).

(c) Apply simulated line and bus voltages, adjusted to check the bus and line voltage criteria given in Table 5-1. To be valid, an output must occur immediately after line and bus voltages are applied.

NOTE

In some units, both the internal Condition Switches and the external condition sensing inputs are present and in parallel. Take care that only one input method is utilized when testing the relay, and (most importantly) after the relay is installed.

Table 5-1. NORMAL Mode Testing

No output* throughout voltage range.

Condition Switch

1	Up
2	Up
3	Up
4	Up
5	Up

Mode Switch

1	Up
2	Up

Output* only when bus input voltage is greater than 80 volts and line is less than 30 volts.

Condition Switch

1	Up
2	Up
3	Down
4	Up
5	Up

Mode Switch

1	Up
2	Up

Output* only when bus input voltage is less than 30 volts and line is greater than 80 volts.

Condition Switch

1	Up
2	Up
3	Up
4	Down
5	Up

Mode Switch

1	Up
2	Up

Output* only when bus and line input voltages are less than 30 volts.

Condition Switch

1	Up
2	Up
3	Up
4	Up
5	Down

Mode Switch

1	Up
2	Up

Output* only when bus and line input voltages are greater than 80 volts.

Condition Switch

1	Up
2	Down§
3	Up
4	Up
5	Up

Mode Switch

1	Up
2	Up

* Contact is SYNC output for output option E or F; Voltage Monitor output for output option G or H.

§ The only valid use for the LB-LL Condition Switch No. 2 Down is when there is an independent output relay for the Voltage Monitor output options G and H.

If the delta voltage option is present, it is factory set to 20 volts. (The timed SYNC output is inhibited if the voltage difference between the line and the bus is greater than 20 volts.)

WARNING!

Condition Switch No. 2, shown in Figure 2-2, must be OFF (Up) when output option E or F is selected. Otherwise, SYNC outputs will occur under live line/live bus conditions without benefit of the Sync-Check function.

NOT OV Testing

Step 6. Test the NOT OV Mode of the Voltage Monitor as follows. (Proceed to step 7 if this mode is not used.)

(a) Adjust the following front panel controls by applying the voltages stated below, adjusting each control to the threshold where its LED indicator just turns ON. (Reference callouts L, N, F, and G of Figure 2-1).

LB:	Adjust to 80 Vac.
DB/NOT OV:	Adjust to 120 Vac.
LL:	Adjust to 80 Vac.
DL/NOT OV:	Adjust to 120 Vac.

(b) Set TIME DELAY to 99 seconds. This allows the convenience of using in-phase voltages for testing non-synchronous functions (without unwanted SYNC outputs).

(c) Apply simulated line and bus voltages adjusted to check the bus and line voltage criteria given in Table 5-2. To be valid, an output must occur immediately after line and bus voltages are applied.

Step 7. If the voltage difference option is furnished, check for proper enabling of the Sync-Check output contacts when the voltage differential between line and bus is within selected ΔV settings.

Step 8. If the expand phase angle option is furnished, check that the phase window widens by a factor of 2 or 3 (according to the position of the jumper on the Sync-Check PC board) when the expand phase input terminal is closed.

Table 5-2. NOT OVERVOLTAGE Mode Testing

No output* throughout voltage range. (Normal SYNC output function still operates. SYNC output occurs after 99 seconds time delay if the line and bus voltages are greater than 60 Vac. This 60 Vac corresponds to the minimum voltage requirement for the sync-check function, not the LL and LB settings. For the following tests, if your unit has a minimum voltage requirement of less than 60 Vac, use a voltage that is appropriate for your unit.

Condition Switch

1	Up
2	Up
3	Up
4	Up
5	Up

Mode Switch†

1	Down
2	Down

Output* only when bus input voltage is greater than 60 volts but less than 120 volts, and line is less than 60 volts.

Condition Switch

1	Up
2	Up
3	Down
4	Up
5	Up

Mode Switch†

1	Down
2	Down

Output* only when bus input voltage is less than 60 volts and line is greater than 60 volts but less than 120 volts.

Condition Switch

1	Up
2	Up
3	Up
4	Down
5	Up

Mode Switch†

1	Down
2	Down

Output* only when bus and line input voltages are less than 60 volts.

Condition Switch

1	Up
2	Up
3	Up
4	Up
5	Down

Mode Switch†

1	Down
2	Down

Output* only when bus and line input voltages are greater than 60 volts but less than 120 volts.

Condition Switch

1	Up
2	Down§
3	Up
4	Up
5	Up

Mode Switch†

1	Down
2	Down

No output throughout voltage range. (Normal SYNC function still operates with the additional NOT overvoltage constraint. Output occurs after 99 seconds time delay if the line and bus voltages are greater than 60 Vac and less than the NOT overvoltage setting of 120 Vac.)

Condition Switch

1	Down
2	Up
3	Up
4	Up
5	Up

Mode Switch†

1	Down
2	Down

Notes for Table 5-2:

- Contact is SYNC output for output option E or F; Voltage Monitor output for output option G or H.

† Placing both bus and line NOT OV Mode Switches Down, does NOT imply that line and bus must operate in the same mode. Any combination is permissible.

§ The only valid use for the LB-LL Condition Switch No. 2 Down is when there is an independent output relay for the Voltage Monitor output options G and H.

If the delta voltage option is present, it is factory set to 20 volts. (The timed SYNC output is inhibited if the voltage difference between the line and the bus is greater than 20 volts.)

SECTION 6 • MAINTENANCE

GENERAL

BE1-25 Sync-Check Relay requires no preventive maintenance other than a periodic operational test (see Section 5, Operational Test Procedure). If factory repair is desired, contact the Customer Service Department of the Power Systems Group, Basler Electric, for a return authorization number prior to shipping.

IN-HOUSE REPAIR

In-house replacement of individual components may be difficult and should not be attempted unless appropriate equipment and qualified personnel are available.

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.

Replacement parts may be purchased locally. The quality of replacement parts must be at least equal to that of the original components. When complete boards or assemblies are needed, the following information is required.

1. Relay model and Style Number
2. Relay serial number
3. Board or assembly
   a) Part number
   b) Serial number
   c) Revision letter
4. The name of the board or assembly.

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.

TEST PLUG

CAUTION

When the Voltage Monitor option is controlled by external contacts (option 2-C, 2-U, or 2-V), do not replace the upper connection plug with a test plug unless the test plug is equipped with proper adapter (see Figure 5-1). If the correct Test Plug Adapter is not readily available, an alternative procedure is described at the end of this section.

Test plugs (Basler P/N 10095 or GE model XLA12A) provide a quick, easy method of testing relays without removing them from their case. Test plugs are simply substituted for the connection plugs. This provides access to the external stud connections as well as to the internal circuitry.

Test plugs consist of a black and red phenolic molding with twenty electrically separated contact fingers connected to ten coaxial binding posts. The ten fingers on the black side are connected to the inner binding posts (black thumb nuts) and tap into the relay internal circuitry. The ten fingers on the red side of the test plug are connected to the outer binding posts (red thumb nuts) and also connect to the relay case terminals.

When testing circuits connected to the bottom set of case terminals, the test plug is inserted with the numbers 1 through 10 facing up. Similarly, when using the test plug in the upper part of the relay, the numbers 11 through 20 are face up. It is impossible, due to the construction of the test plug, to insert it with the wrong orientation.

TEST PLUG ADAPTER

General

BE1-25 relays equipped with external contacts to control the Condition Switches (option 2-C, 2-U, or 2-V) have a voltage-dropping Resistor Module mounted externally on the back side of the case. (Refer to Figures 4-7 and 4-9). Functionally, this module is part of the internal circuitry despite its external location.

When using the test plug on these relays, compensating resistors must be added. The most convenient method is to use the Test Plug Adapter shown in Figure 6-1. This adapter is attached to the test plug before inserting the test plug into the relay upper jack. See Table 6-1 for the correct adapter.

CAUTION

Do not attempt to use an adapter for an application not specified in Table 6-1.

The surface of 230 V adapter units may become hot.

If the correct Test Plug Adapter is not readily available, an alternative procedure is described at the end of this section.

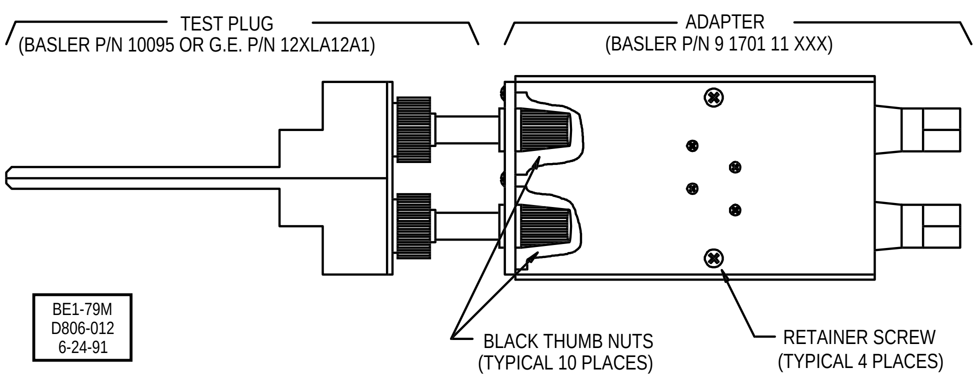


Figure 6-1. Adapter and Test Plug

Table 6-1. Test Plug Adapter Requirements

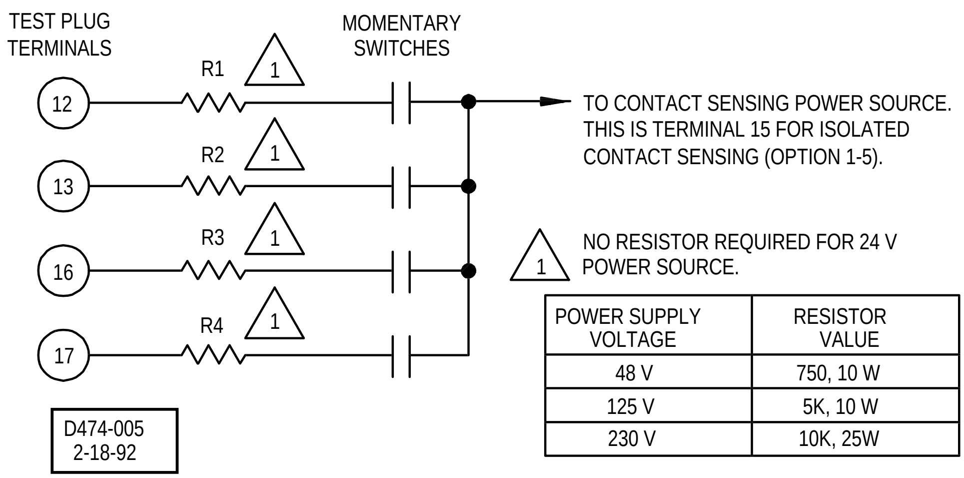
Nominal Power Supply Type	Test Plug Adapter Part Number
24V	None Required
48V	9 1701 11 101
125V	9 1701 11 103
230V	9 1701 11 105

Assembling Adapter to Test Plug

1. Remove top and bottom covers of Test Plug Adapter by removing the four retaining screws.
2. Remove the 10 black thumb nuts from test plug.
3. Note that the studs of the test plug may be entered into the 10 matching holes of the adapter. Before assembling the test plug to the adapter, it is necessary to correctly orient the two units to each other by holding the black side of the test plug UP as it engages the adapter. (The adapter itself is held top-side UP; i.e., the front panel letters are upright.)
4. Replace the 10 black thumb nuts. Firmly hand-tighten each thumb nut.
5. Replace top and bottom covers; replace the four retaining screws.

If Test Plug Adapter is Unavailable

In the event that the proper adapter is not on hand, a test setup may be improvised by inserting the proper resistors in series with terminals 12, 13, 16 and 17 as indicated in Figure 6-2.



POWER SUPPLY VOLTAGE	RESISTOR VALUE
48 V	750, 10 W
125 V	5K, 10 W
230 V	10K, 25W

Figure 6-2. Improvised Test Setup

SECTION 7 • Manual Change Information

CHANGES

Substantive changes in this manual to date are summarized in Table 7-1.

Table 7-1. Changes

Revision	Summary of Changes	ECA/ECO	Date
A	Added information to Figures 4-4, 4-9, and 4-10. Added storage recommendation paragraph.	7274	11-85
B	Added note to style Chart. Added footnote † to power supply table and deleted the words make and from inductive contact specification. Corrected and clarified phase angle specifications. Corrected typographical errors on Slip Frequency graph.	8381	12-86
C	Revised manual to reflect introduction of power supply status option.	8459	06-87
D	Added test plug/adapter information. Added TB2 terminal strip to connection diagrams.	9728	07-88
E	Edited General Information Section and Controls and Indicators Section for clarification. Revised Figure 4-12 and edited Operational Test Procedure.	11378	05-90
F	Added new Figure 4-7, Internal Diagram and incorporated new instruction manual format.	12467	03-92
G	Reformatted instruction manual as Windows Help file for electronic documentation.	14566	01-95
H	Corrected power supply type P, voltage input and range from Vdc to Vac. Minor page layout changes developed from using a word processor application upgrade.	15469	01-96
J	Added three new types (A, B, & C) to Option 2. This included new paragraphs describing Average Detectors.	16347	10-97
K	Deleted the reference to Service Manual 9 1702 00 620 on page 1-1. Corrected an error found on page 1-11 in Minimum Voltage Requirement from '45 ±2 Vac' to '80 Vac.' Updated front cover and Manual Change Information.	16493	12-97
L	Added Power Supply information to Section 3 and added new wide range power supply information to Section 1. Corrected Style Chart by changing Power Supply Type T from 230 Vac to 240 Vac. Moved Testing information from Section 4 to new Section 5 Testing. Added new outline dimensions to include all options (S1 Case, Double-Ended, Semi-flush and Projection Mounting). Corrected ground symbol in Figure 4-7, Internal Diagram. Updated front cover and Manual Change Information.	16959	08-98

Revision	Summary of Changes	ECA/ECO	Date
M	Changed the Specifications, illustrations, and the descriptions throughout the manual for the minimum voltage required to operate the sync-check function. Corrected Figure 1-6, Style Chart. Added contact sensing burden and enhanced Surge Withstand Capability description. Added new covers information. Changed Section 5, *Testing*, to reflect the minimum voltage requirements for sync-check function.	12147	02-01

DOCUMENTATION SURVEY

COMMENTS AND ERRORS

Thank you for using Basler Electric products. We want you to be satisfied, and ask that you provide us with some feedback. Please answer the questions in the following form, and mail it to:

Basler Electric
Power System Group
Corporate Communications, Attn: Dave Kassing
Box 269, Route 143
Highland, IL 62249

1. Does the manual provide all the information you need?

   If not, what subject is missing?

2. Were you able to install and set up the equipment using the documentation?

   If a problem occurred that was due to an error in the documentation, please note the page number and describe the error.

   If a problem occurred that was due to a lack of information in the documentation, please note the page number and describe what additional information is needed.

3. Have you noticed other errors or subjects that need clarification?

   If you have, please note the page number and describe the confusion.

4. Additional comments:

5. May we contact you regarding your comments?

   Name:

   Company:

   Phone Number:

GLOSSARY OF TERMS

Allowable phase angle

Angular difference between two ac voltages that is within preset limits for paralleling.

IEEE C37.90-1989

American National Standards Institute/Institute of Electrical and Electronics Engineers standard incorporating dielectric tests for relays and relay systems.

Auxiliary 52b

An auxiliary contact to an ac circuit breaker that is open when the breaker is closed and closed when the breaker is open.

Auxiliary output

The tenth position of the Style Number defines the Auxiliary or Status Outputs Option 3. The following numbers designate the output type:

1) Sync-Check Auxiliary Output NO Relay

2) Sync-Check Auxiliary Output NC Relay

3) Sync-Check Auxiliary Output SPDT Relay

Note that if the Expandable Window is selected (second position of the Style Number is 9), an Auxiliary or Status Output is not available (a zero must be in the tenth position of the Style Number).

Case size

Basler Electric relays are housed in a fabricated steel and phenolic enclosure (case) designed for the specific relay requirements. Case sizes are referenced to an alpha-numeric code for ease of identification.

Class 100

Basler Electric Class 100 Equipment is primarily designed for high performance and high reliability requirements.

Comparator

A circuit with two logic output states that compares the relative amplitudes of two variables or a variable and a constant, such that the logic signal output determines which amplitude is greater at all times.

Condition switches

Five condition switches are located on the Voltage Monitor Card, each with two positions to select ON (Down) and OFF (Up). When ON, Condition Switch No. 1 programs the relay to require recognition that the line and bus are not in an overvoltage condition (NOT OV) before the SYNC output is allowed. Condition Switches No. 2 through No. 5 modify the voltage monitor response according to a programmed set of external conditions.

Continuously adjustable

Adjustment varies linearly (not in steps) as the control is moved through the entire range.

Current operated

Current operated targets confirm that signal current (minimum 0.2 amperes) occurred in the output circuit. This target type requires the output relay contacts to be normally open contacts. The seventh position of the Style Number defines the target type; Type B is current operated.

Dead line/Dead bus

Preset voltage reference levels determine when the bus and line are considered dead.

Dead line/Live bus

Preset voltage reference levels determine when the line is considered dead and the bus live.

Expandable Window

The second position of the Style Number selects the Sensing Input Range. A relay with option 9 in this position includes a switchable jumper to control the width of the phase angle window as a multiple of the PHASE ANGLE setting. This feature enables a local operator (through a switch) or a remote dispatcher (through supervisory control) to expand the preset phase angle window by a ratio of X2 or X3, depending on the position of the jumper.

Note that when option 9 is selected, the Auxiliary or Status Outputs Option 3 are not available (a zero must be in the tenth position of the Style Number).

IEC 255-5

International Electrotechnical Commission standard incorporating dielectric and surge withstand capability tests for relays and relay systems.

Internally operated

Internally operated targets are operated by an electronic signal and provide an indication that the associated contact attempted an output. There is no assurance that a signal actually occurred. This target type may be used with either normally open or normally closed output relay contacts. The seventh position of the Style Number defines the target type; Type A is internally operated.

Isolated contact sensing

With this configuration of the 52b input, the BE1-25 monitors a current supplied by the relay through an isolated contact. The eighth position of the Style Number selects the contact sensing; option 1-5 is isolated contact sensing.

Line Not-Overvoltage/bus Not-Overvoltage

Line and bus voltages are considered to be not over setpoint (reference) levels.

Live bus setpoint

Live bus setpoint is the preset voltage reference level that determines when the bus is considered to be live.

Live line setpoint

Live line setpoint is the preset voltage reference level that determines when the line is considered to be live.

Live Line/Dead Bus

Preset voltage reference levels determine when the line is considered live and the bus dead.

Live Line/Live Bus

Preset voltage reference levels determine when the bus and line are considered live.

Magnetically latched indicator

When a target is operated, the display is held in place by a magnet until the target reset lever is actuated.

Mode switches

Two switches are located on the Voltage Monitor Card, with two positions for selecting Live/Dead (NORMAL Mode) or Live/Not-Overvoltage (NOT OV Mode) references for bus and line. Mode Switch No. 1 refers to bus voltage reference levels, and Mode Switch No. 2 refers to line voltage reference levels.

Non-isolated contact sensing

With this configuration of the 52b input, the BE1-25 monitors the presence of dc voltage at the input due to the closure of a contact. The eighth position of the Style Number selects the contact sensing; option 1-4 is non-isolated contact sensing.

Option 1

Relay option 1 provides either a non-isolated contact sensing input (1-4) or isolated contact sensing input (1-5). The eighth position of the Style Number defines the input type.

Option 2

Relay option 2 provides sync-check variations for line and bus voltage monitoring and/or voltage difference monitor selections to meet customer needs for a particular system scheme. The ninth position of the Style Number defines the voltage monitor type.

Option 3

Relay option 3 provides for various auxiliary outputs or for a status output. The tenth position of the Style Number defines the output type:

0) None

1) Sync-Check Auxiliary Output NO Relay

2) Sync-Check Auxiliary Output NC Relay

3) Sync-Check Auxiliary Output SPDT Relay

6) Power Supply Status Output

Note that if the Expandable Window is selected (second position of the Style Number is 9), an Auxiliary or Status Output is not available (a zero must be in the tenth position of the Style Number).

Option E or F

An E in the third position of the Style Number designates a Sync-Check NO output relay; an F designates a Sync-Check NO output relay with Push-to-Energize Output.

Option G or H

A G in the third position of the Style Number designates a Sync-Check NO output relay and Voltage Monitor SPDT output relay; an H designates a Sync-Check NO relay and Voltage Monitor SPDT output relay with Push-to-Energize Output for both relays. These options are not available if Voltage Monitor Option 2 is N or T.

Output option

The third position of the Style Number defines the Output Relay options:

E) Sync-Check NO Relay

F) Sync-Check NO Relay with Push-to-Energize Output

G) Sync-Check NO Relay and Voltage Monitor SPDT Relay. Not available if Voltage Monitor Option 2 is N or T.

H) Sync-Check NO Relay and Voltage Monitor SPDT Relay with Push-to-Energize Output for both relays. Not available if Voltage Monitor Option 2 is N or T.

Power supply

Projection mount

The eleventh position of the Style Chart selects the mounting option; Option 4-P is a projection mounted relay

Qualified to IEEE C37.90.1-1989

Designed to meet or exceed industry standards for the specified American National Standards Institute/Institute of Electrical and Electronics Engineers standard incorporating surge withstand capability tests for relays and relay systems.

Semi-flush mount

The eleventh position of the Style Chart selects the mounting option; Option 4-F is a semi-flush mounted relay

Sensing input range

The second position of the Style Number selects the Sensing Input Range:

1) 120 Vac, 1 - 99° Phase Angle Setting

9) 120 Vac, 1 - 99° Phase Angle Setting with Expandable Window

Note that when option 9 is selected, an Auxiliary or Status Output Option 3 is not available (a zero must be in the tenth position of the Style Number).

Status output

The tenth position of the Style Number defines the Auxiliary or Status Outputs Option 3. A 6 in this position designates a Power Supply Status Output.

Note that if the Expandable Window is selected (second position of the Style Number is 9), an Auxiliary or Status Output is not available (a zero must be in the tenth position of the Style Number).

Synchronism-check

Synchronizing or synchronism-check devices operate when two ac circuits are within the desired limits of frequency, phase angle, or voltage to permit or to cause the paralleling of these two circuits.

Time delay

Two thumbwheel switches on the front panel adjust the time delay. The fourth and fifth positions of the Style Number define the option selected:

A6) 0.1 - 99 sec., adjustable from 1 to 99 sec when multiplier switch is in X1 position; 0.1 to 9.9 when in X1.0 position

A7) 1 - 99 cycles, adjustable in 1-cycle increments. Multiplier switch is omitted with this option.

Type A target

The seventh character of the relay Style Number designates the target type. Type A is an internally operated target.

Type B target

The seventh character of the relay Style Number designates the target type. Type B is a current operated target.

Voltage difference (Peak Detector)

Voltage difference is equal to the monitored bus voltage times the sine of theta when theta is equal to the phase angle formed by the bus voltage and line voltage phasors. Available with the Voltage Monitor Option 2-R, 2-T and 2-U.

Voltage difference (Average Detector)

Voltage difference is equal to the monitored bus voltage minus the monitored line voltage. Available with the Voltage Monitor Option 2-A, 2-B and 2-C.

Voltage monitor

The ninth position of the Style Number defines the Voltage Monitor Option 2:

N) None. With this selection, the third position of the Style Number (Output options) must be either E or F.

A) Average Voltage Monitor and Voltage Difference with PCB mounted switches

B) Average Voltage Difference.

C) Average Voltage Monitor and Voltage Difference with External Contact Inputs to control the Condition Switches. This option requires the voltage dropping Resistor Module.

R) Line and Bus Voltage Monitor and Voltage Difference with PCB mounted switches

S) Line and Bus Voltage Monitor with PCB mounted switches

T) Voltage Difference. With this selection, the third position of the Style Number (Output options) must be either E or F.

U) Line and Bus Voltage Monitor and Voltage Difference with External Contact Inputs to control the Condition Switches. This option requires the voltage dropping Resistor Module.

V) Line and Bus Voltage Monitor and External Contact Inputs to control the Condition Switches This option requires the voltage dropping Resistor Module.

Zero cross detection circuits

Each time that the input ac signal crosses through the zero reference voltage as it is going from negative to positive, a pulse is generated that marks the start of the ac signal.

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