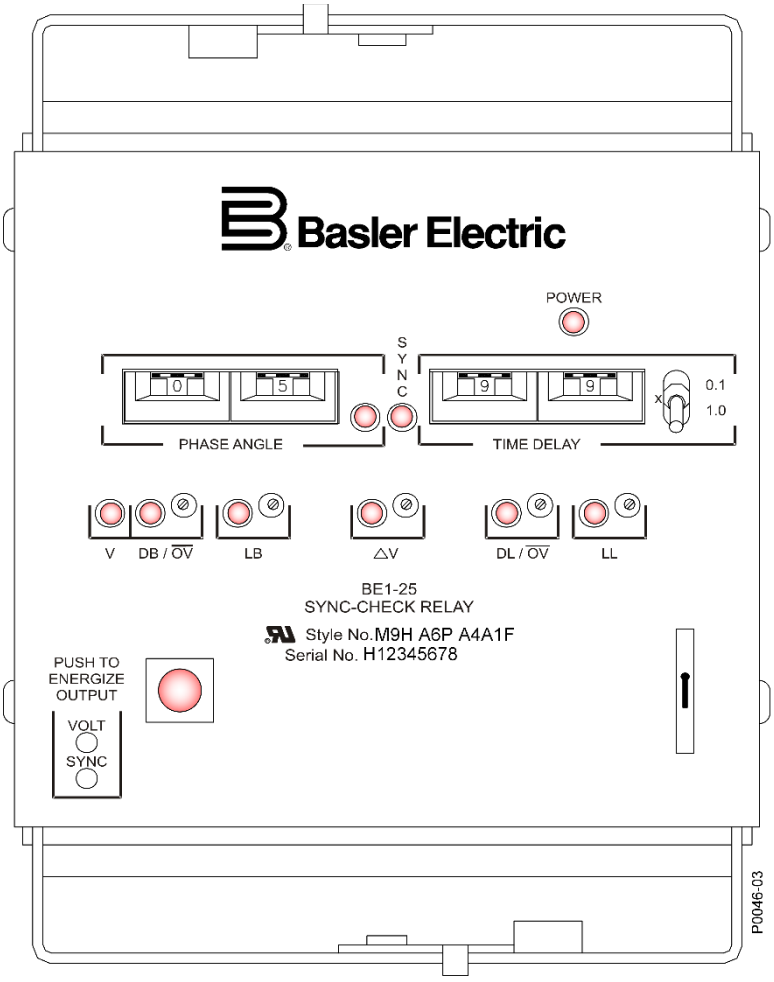
BE1-25
Sync-Check Relay

Instruction Manual



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Preface

This instruction manual provides information about the installation and operation of the BE1-25. To accomplish this, the following information is provided:

- General information and specifications
- Controls and indicators
- Functional description
- Installation
- Testing

Conventions Used in this Manual

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

Warning!

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

Caution

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

Note

Note boxes emphasize important information pertaining to installation or operation.

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Warning!

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

Basler Electric does not assume any responsibility to compliance or noncompliance with national code, local code, or any other applicable code. This manual serves as reference material that must be well understood prior to installation, operation, or maintenance.

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This publication contains confidential information of Basler Electric Company, an Illinois corporation. It is loaned for confidential use, subject to return on request, and with the mutual understanding that it will not be used in any manner detrimental to the interests of Basler Electric Company and used strictly for the purpose intended.

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Over time, improvements and revisions may be made to this publication. Before performing any of the following procedures, contact Basler Electric for the latest revision of this manual.

The English-language version of this manual serves as the only approved manual version.

Revision History

A historical summary of the changes made to this instruction manual is provided below. Revisions are listed in reverse chronological order.

Instruction Manual Revision History

Manual Revision and Date	Change
AA, May 2022	• Added a note about EMI suppression in the *Installation* chapter
Z, Dec 2021	• Updated style chart to reflect obsolescence of current-operated target • Reformatted style chart for improved readability • Correct equation references in the *Introduction* chapter
Y, Jun 2019	• Clarified Test Procedure, Step 1.
X, Apr 2019	• Changed minimum voltage requirements for sync-check function from 60V to 80V throughout manual • Minor text edits throughout manual
W, Oct 2018	• Minor clarifications to style chart, S1 case cutout, and power supply burden
V, Jun 2015	• Updated manual to latest style • Minor text edits throughout manual
U, Jul 2013	• Added Caution for contact sensing in Specifications • Minor text and formatting edits
T, Oct 2012	• Standardized case and cover drawings in Section 4
S, Mar 2011	• Updated power supply burden data in Section 1 • Updated GOST-R statement in Section 1 • Updated Storage Statement in Section 4
R, Sep 2007	• Moved content of Section 6, Maintenance to Section 4 • Added manual part number and revision to all footers • Updated power supply burden data in Section 1 • Updated Target Indicator description in Section 3
Q	• This revision letter not used
P, Nov 2006	• Updated Output Specs in Section 1 • Added footnote to Figures 1-2 and 1-3 • Updated drawings of case cover in Section 4, *Installation* • Updated front panel drawing in Section 2, *Controls and Indicators* • Moved manual Revision History to the front of the manual • Updated drawing on front cover
O	• This revision letter not used
N, Aug 2002	• Updated drawings in the manual to label terminal 15 (COM) as Vctrl • Corrected various minor errors throughout the manual
M, Feb 2001	• 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

Manual Revision and Date	Change
	• Changed Section 5, Testing to reflect the minimum voltage requirements for sync-check function
L, Aug 1998	• 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
K, Dec 1997	• Deleted the reference to Service Manual 9170200620 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
J, Oct 1997	• Added three new types (A, B, & C) to Option 2. This included new paragraphs describing Average Detectors
I	• This revision letter not used
H, Jan 1996	• 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
G, Jan 1995	• Reformatted instruction manual as Windows Help file for electronic documentation
F, Mar 1992	• Added new Figure 4-7, *Internal Diagram* and incorporated new instruction manual format
E, May-90	• Edited *General Information* section and *Controls and Indicators* section for clarification • Revised Figure 4-12 and edited Operational Test Procedure
D, Jul 1988	• Added test plug/adapter information • Added TB2 terminal strip to connection diagrams
C, Jun 1987	• Revised manual to reflect introduction of power supply status option
B, Dec 1986	• 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
A, Nov 1985	• Added information to Figures 4-4, 4-9, and 4-10 • Added storage recommendation paragraph

Contents

1 • Introduction

The BE1-25 is a solid-state synchronism check relay 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 (Option 2), the BE1-25 can determine whether an input is live, dead, or in an overvoltage state.

Sync-Check Function

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 these criteria for the time period defined by the front panel TIME DELAY setting, the SYNC output contact closes.

Note

Sync-Check Voltage sensing circuits are guaranteed to operate at a minimum voltage of 80 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.

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 the *Installation* chapter for typical control circuit connections for each configuration.

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 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 the *Controls and Indicators* chapter for a complete description and precautions on setting the Mode Switches. The location of the switches is shown. Also, see *Switch Settings, Condition and Mode Switches* in the *Testing* chapter.

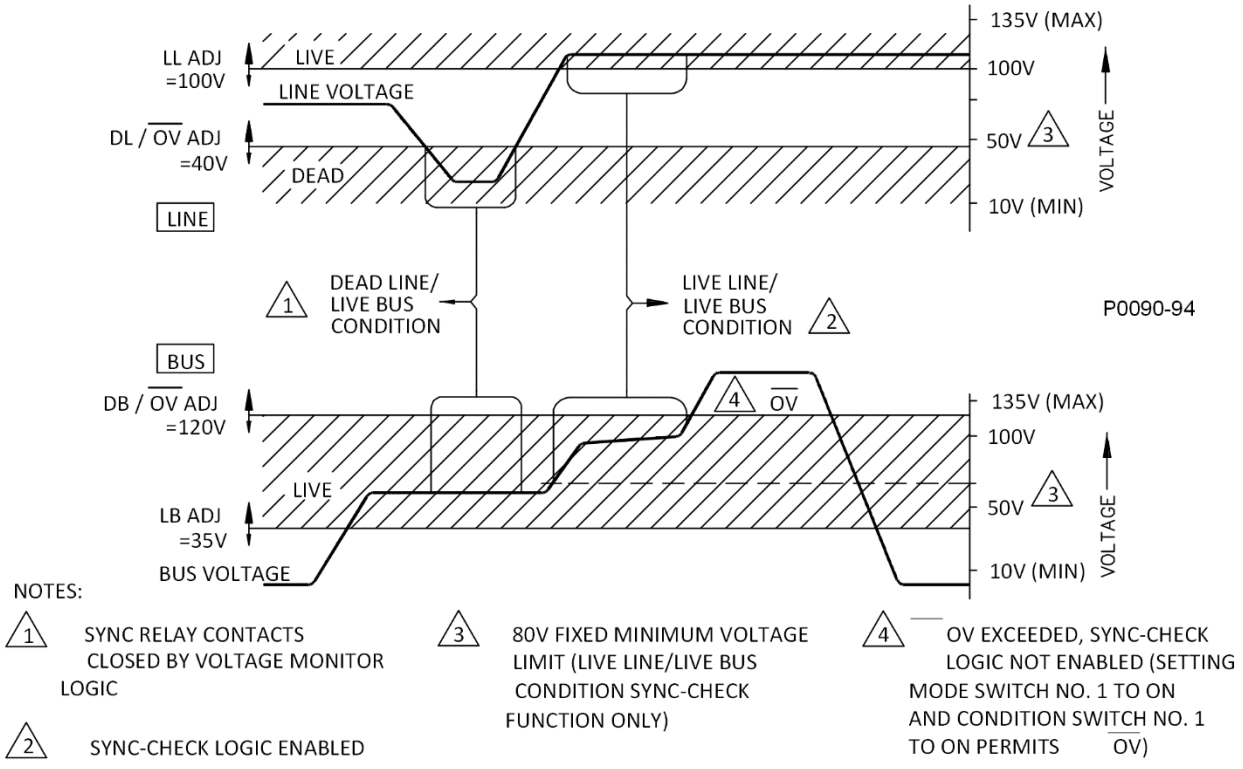


Figure 1-1. Voltage Monitor Acceptance Zones

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 the *Controls and Indicators* chapter for a complete description and precautions on setting the Conditions Switches. The location of the switches is shown.

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.

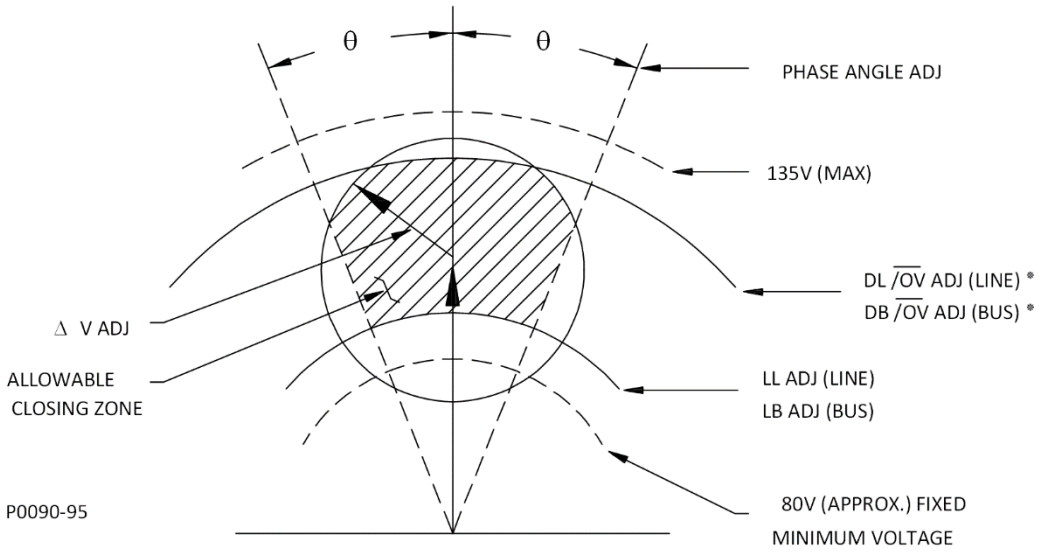


Figure 1-2. Closing Zone (Phasor Sensing)

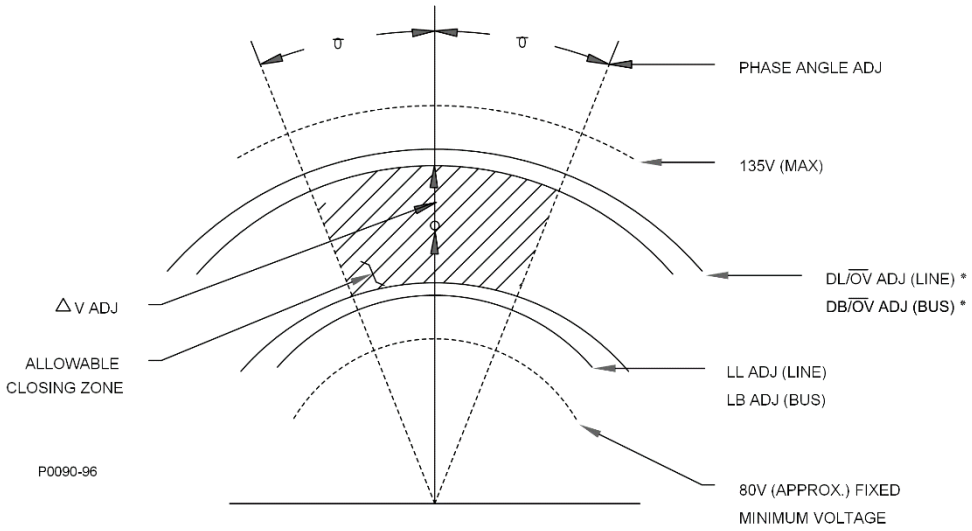


Figure 1-3. Closing Zone (Average Sensing)

∗ Lines apply only if using the NOT-OV mode setting. When operating in NORMAL mode, the 135V (MAX) line applies as an upper limit.

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 as shown in Equation 1-1.

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

Equation 1-1

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 1-2 and 1-3, respectively.

$$\Delta V = V_B \sin\theta$$

Equation 1-2

$$\theta = \sin^{-1}\frac{\Delta V}{V_B}$$

Equation 1-3

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.

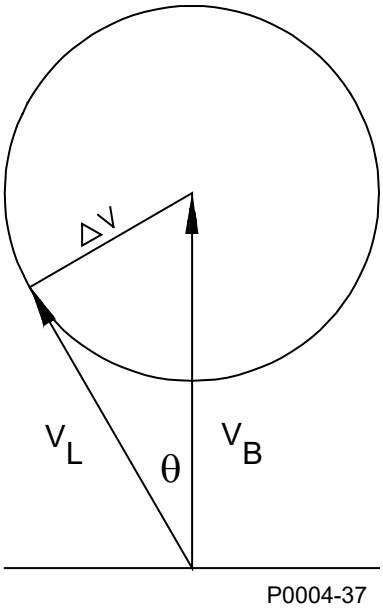


Figure 1-4. Closing Zone Calculation Diagram (Phasor Sensing)

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.

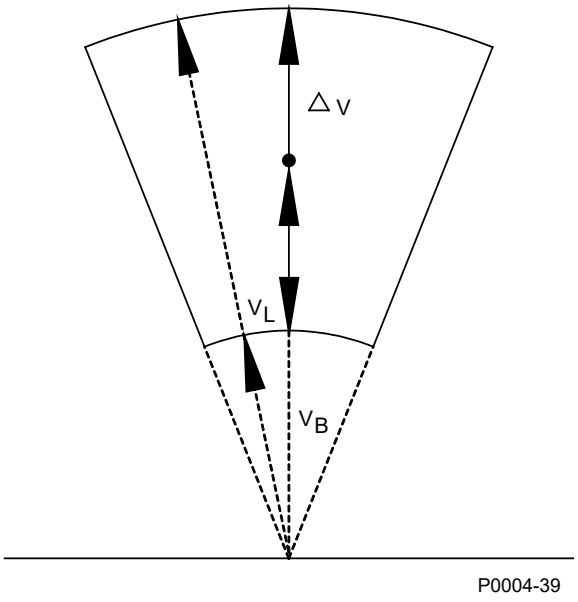


Figure 1-5. Closing Zone Diagram (Average Sensing)

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 the *Controls and Indicators* chapter. The location of the switches is shown.

Voltage sensing connections are shown in the *Installation* chapter.

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. However, 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 along with control circuit connections are shown in the *Installation* chapter.

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 the *Installation* chapter).

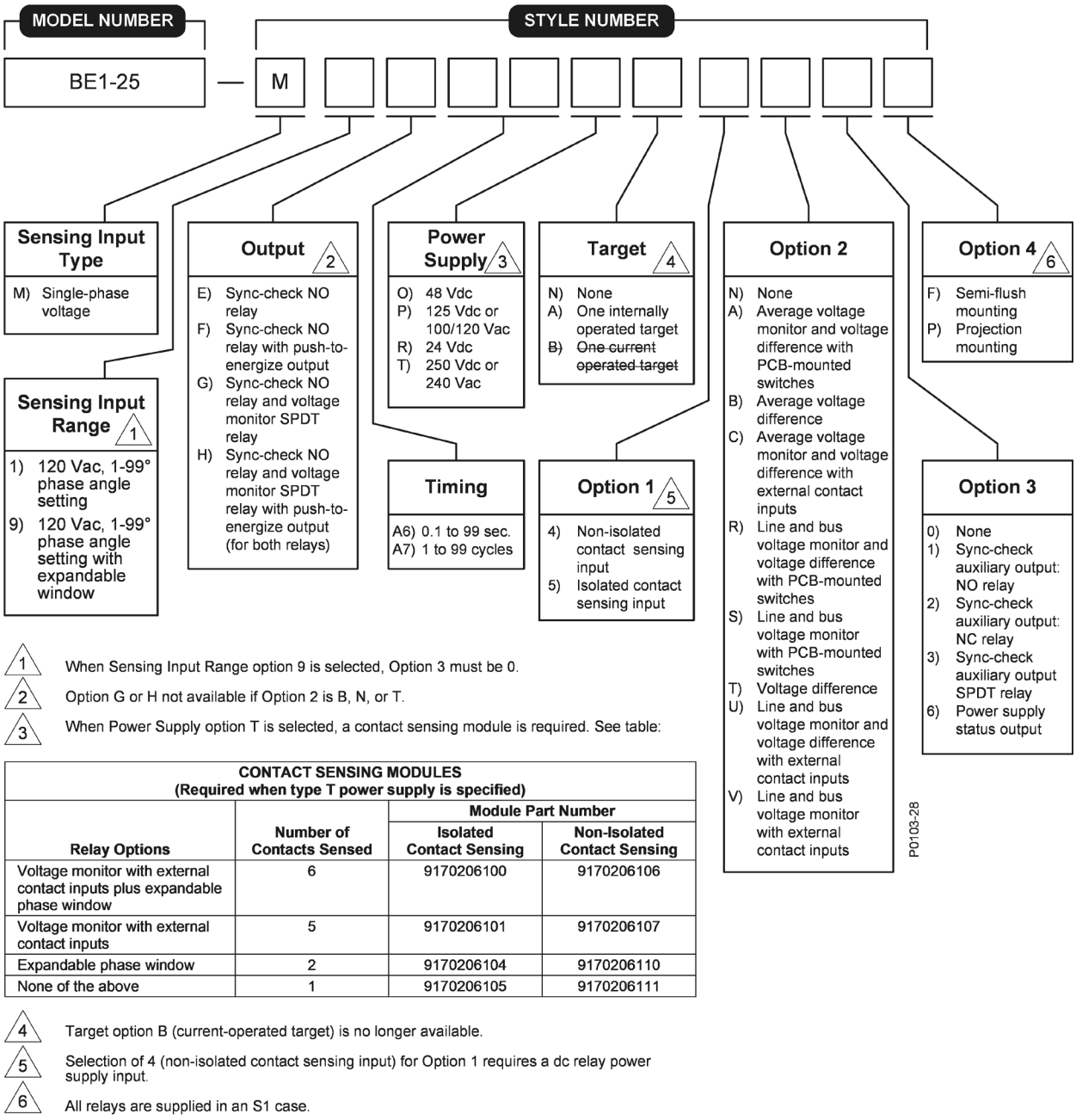
Push-to-Energize Output Pushbuttons

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 the *Controls and Indicators* chapter for location.

Model and Style Number

The electrical characteristics and operational features of a BE1-25 Sync-Check Relay are defined by a combination of letters and numbers that make up its style number. The model number and style number appear on the front panel, drawout cradle, and inside the case. The style chart for the BE1-25 is shown in Figure 1-6.

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



1 When Sensing Input Range option 9 is selected, Option 3 must be 0.

2 Option G or H not available if Option 2 is B, N, or T.

3 When Power Supply option T is selected, a contact sensing module is required. See table:

CONTACT SENSING MODULES (Required when type T power supply is specified)

Relay Options	Number of Contacts Sensed	Module Part Number	
		Isolated Contact Sensing	Non-Isolated Contact Sensing
Voltage monitor with external contact inputs plus expandable phase window	6	9170206100	9170206106
Voltage monitor with external contact inputs	5	9170206101	9170206107
Expandable phase window	2	9170206104	9170206110
None of the above	1	9170206105	9170206111

4 Target option B (current-operated target) is no longer available.

5 Selection of 4 (non-isolated contact sensing input) for Option 1 requires a dc relay power supply input.

6 All relays are supplied in an S1 case.

Figure 1-6. BE1-25 Style Number Identification Chart

Style Number Example

If a BE1-25 relay has a style number of **M9HA6PN4R0F**, the device would have the following features and characteristics.

BE1-25 ---- Model Number: Basler Sync-Check Relay
M ----- Sensing Input Type: single-phase voltage sensing
9------ Sensing Input Range: expandable phase angle window
H ----- Output: voltage monitor relay and push-to-energize outputs
A6---- Timing: 0.1 to 99 seconds timing range
P ----- Power Supply: operating power derived from 125 Vdc or 120 Vac
N ----- Target: no target
4------ Option 1: non-isolated contact sensing input
R ----- Option 2: line and bus voltage monitor plus a voltage difference monitor with condition switches internal to the relay.

0------ Option 3: no auxiliary output
F------ Option 4: semi-flush mounting

2 • Controls and Indicators

BE1-25 controls and indicators are located on the front panel and right-side interior. The controls and indicators are shown in Figure 2-1 and Figure 2-2, and described in Table 2-1. Your relay may not have all of the controls and indicators shown and described here.

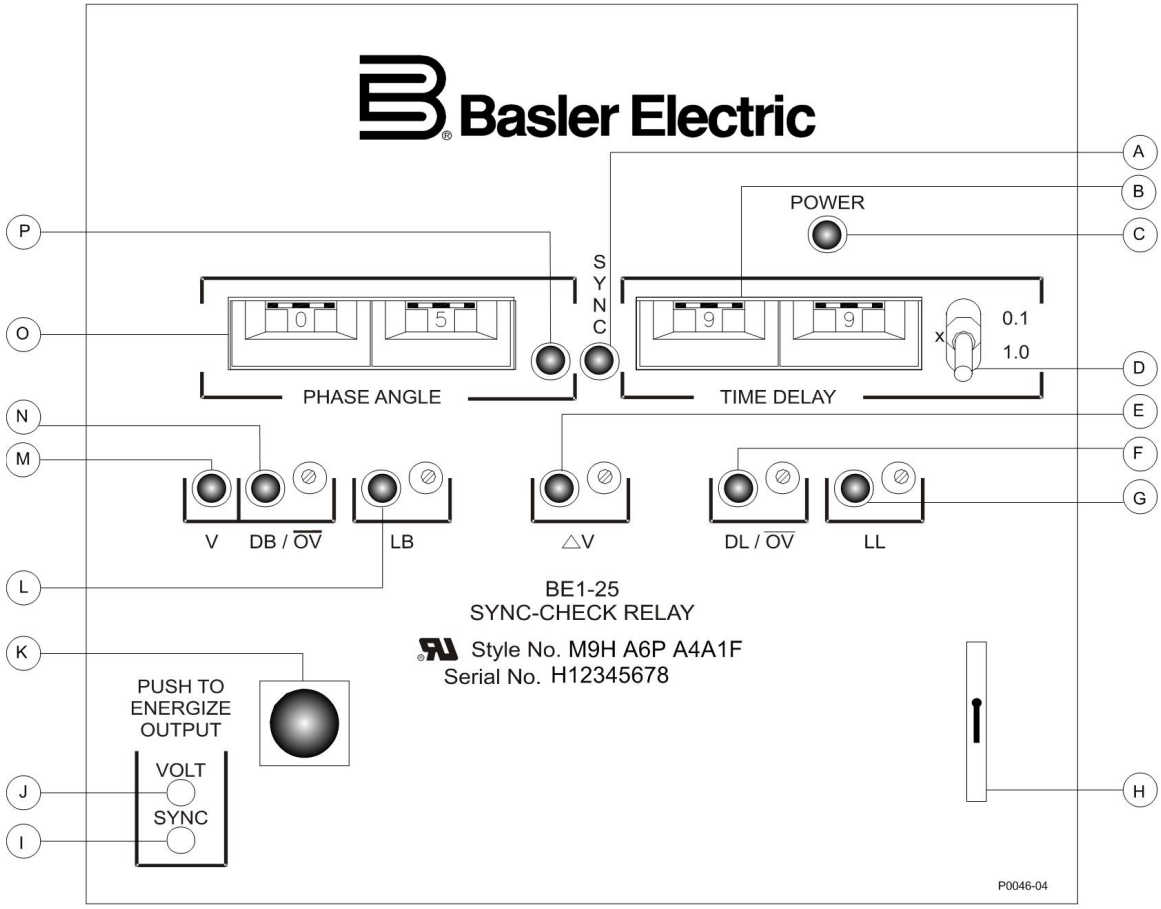


Figure 2-1. Location of Controls and Indicators (Front Panel View)

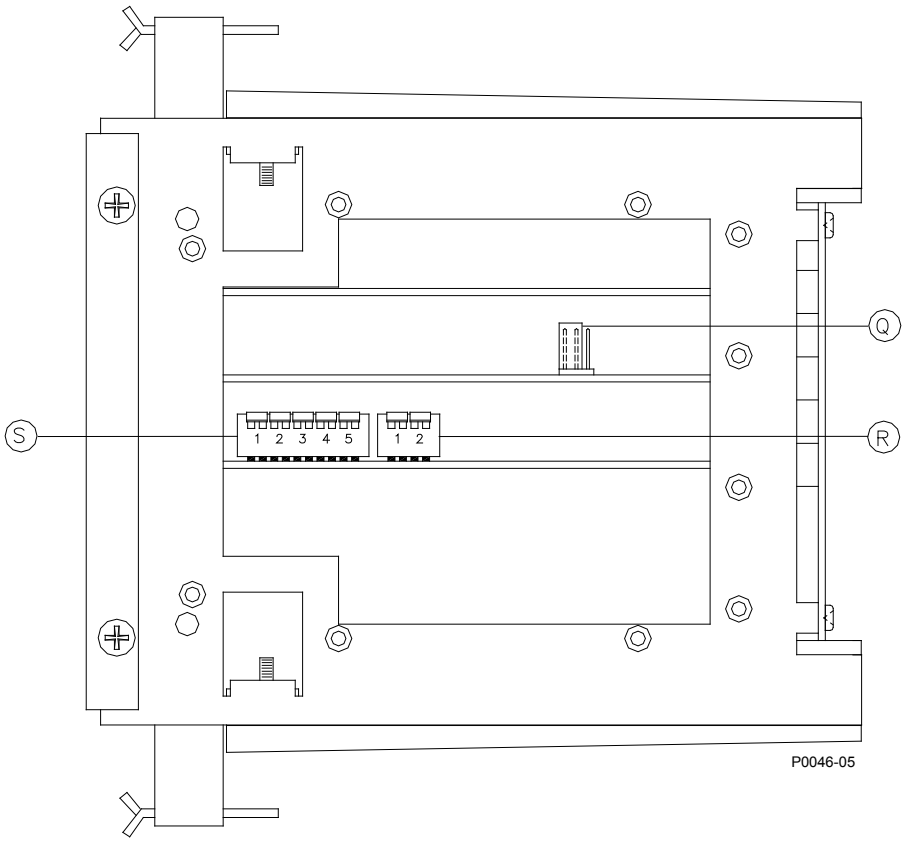


Figure 2-2. Location of Controls and Indicators (Interior View)

Table 2-1. 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 in B, TIME DELAY Selector.

Callout	Control or Indicator	Function
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.
F	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.
G	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.
H	Target Reset Switch	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)	Electronically latching red indicator lights when 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.
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

Callout	Control or Indicator	Function
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 degree increments over a range of 1 to 99 degrees.
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) and MODE Switch No. 2 (Line)	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. *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 Switch 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.)

<table>
<tr><th>Callout</th><th>Control or Indicator</th><th>Function</th></tr>
<tr><td rowspan="3">S</td><td>CONDITION Switch No. 2 (Live Line/Live Bus)</td><td>Up = OFF
Down = ON

When ON (Down), the Voltage Monitor Output relay is actuated when a live line/live bus condition is recognized.

Caution

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/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.

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 bypass the Sync-Check contact. Use of the external LL-LB switch (if installed) is similarly limited.</td></tr>
<tr><td>CONDITION Switch No. 3 (Dead Line/Live Bus)</td><td>Up = OFF

If relay has Output Option E or F:

The Down (ON) position causes immediate closure of the Sync Output contact, if a dead line/live bus condition is detected with the breaker open.

If the relay has Output Option G or H:

The Down (ON) position causes immediate actuation of the Voltage Monitor relay, if a dead line/live bus condition is detected with the breaker open.</td></tr>
<tr><td>CONDITION Switch No. 4 (Live Line/Dead Bus)</td><td>Up = OFF

If relay has Output Option E or F:

The Down (ON) position causes immediate closure of the Sync Output contact, if a live line/dead bus condition is detected with the breaker open.

If the relay has Output Option G or H:

The Down (ON) position causes immediate actuation of the Voltage Monitor relay, if a live line/dead bus condition is detected with the breaker open.</td></tr>
</table>

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

3 • Functional Description

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.

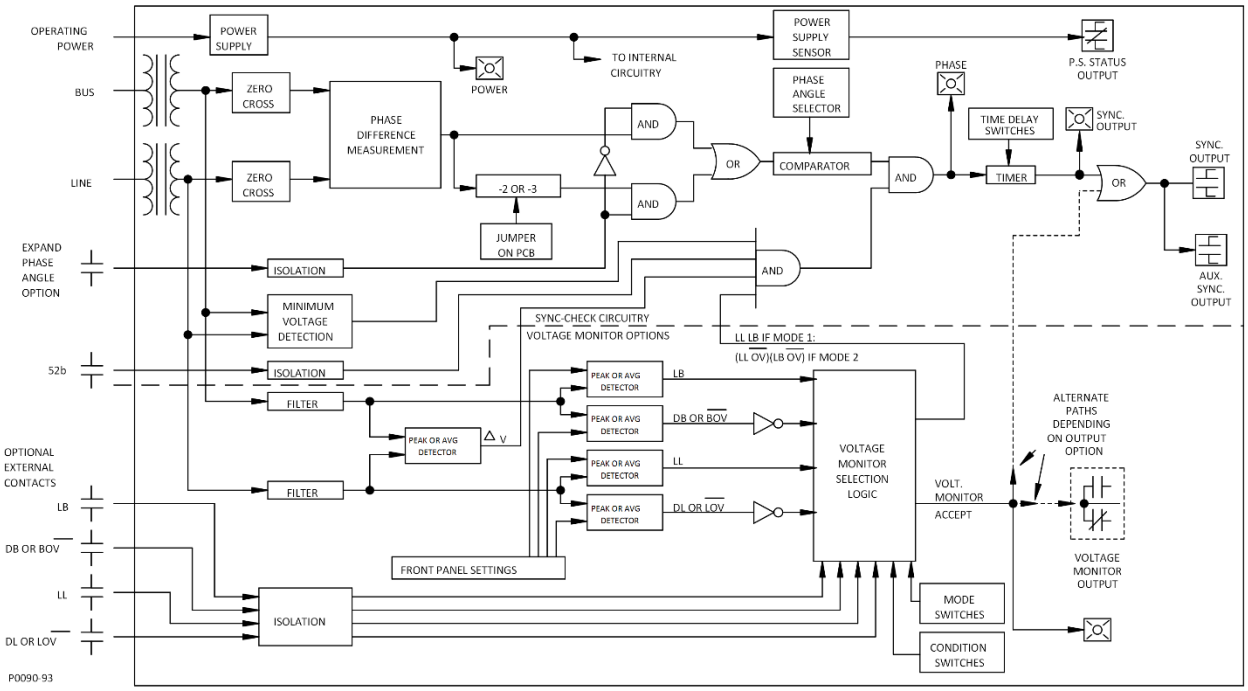


Figure 3-1. Functional Block Diagram

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 80 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

Operating power for the relay circuitry is supplied by a wide range, electrically isolated, low-burden power supply. Power supply operating power is not polarity sensitive. The front panel power LED and power supply status output indicate when the power supply is operating. Power supply specifications are listed in the *Specifications* chapter.

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 *Introduction* chapter, 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 works 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 the *Controls and Indicators* chapter. The location of the switches is shown.

Target Indicator

A target indicator is an optional component selected when a relay is ordered. The electronically latched and reset target consists of a red LED indicator located on the relay front panel. A latched target is reset by operating the target reset switch on the front panel. If relay operating power is lost, an illuminated (latched) target is extinguished. When relay operating power is restored, the previously latched target is restored to its latched state.

A relay can be equipped with either an internally operated target or a current operated target.

Internally Operated Target

The relay SYNC output is directly applied to drive the target indicator. The indicator is illuminated regardless of the amount of current flowing through the output contact.

Current Operated Target

A current operated target is triggered when at least 200 milliamperes of current flows through the SYNC output contact.

Note

Prior to September 2007, BE1-25 the target indicator consisted of a magnetically latched, disc indicator. This mechanically latched target indicator has been replaced by the electronically latched LED target in use today.

4 • Installation

BE1-25 relays are shipped in sturdy cartons to prevent damage during transit. Upon receipt of a relay, check the model and style number against the requisition and packing list to see that they agree. Inspect the relay for shipping damage. If there is evidence of damage, file a claim with the carrier, and notify your sales representative or Basler Electric.

If the relay will not be installed immediately, store it in its original shipping carton in a moisture- and dust-free environment. Before placing the relay in service, it is recommended that the test procedures of the *Testing* chapter be performed.

Relay Operating Guidelines and Precautions

Before installing or operating the relay, note the following guidelines and precautions:

- For proper current operated target operation, a minimum current of 200 milliamperes must flow through the output trip circuit.
- If a wiring insulation test is required, remove the connection plugs and withdraw the relay from its case.

Caution

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.

Notes

Be sure that the BE1-25 is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the case. When the BE1-25 is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each device.

It is recommended in all applications where contact outputs drive relay coils that a reverse biased diode be implemented in parallel with the relay coil for EMI suppression.

Mounting

Because the relay is of solid-state design, it does not have to be mounted vertically. Any convenient mounting angle may be chosen. Refer to the following figures for relay outline dimensions and panel drilling diagrams.

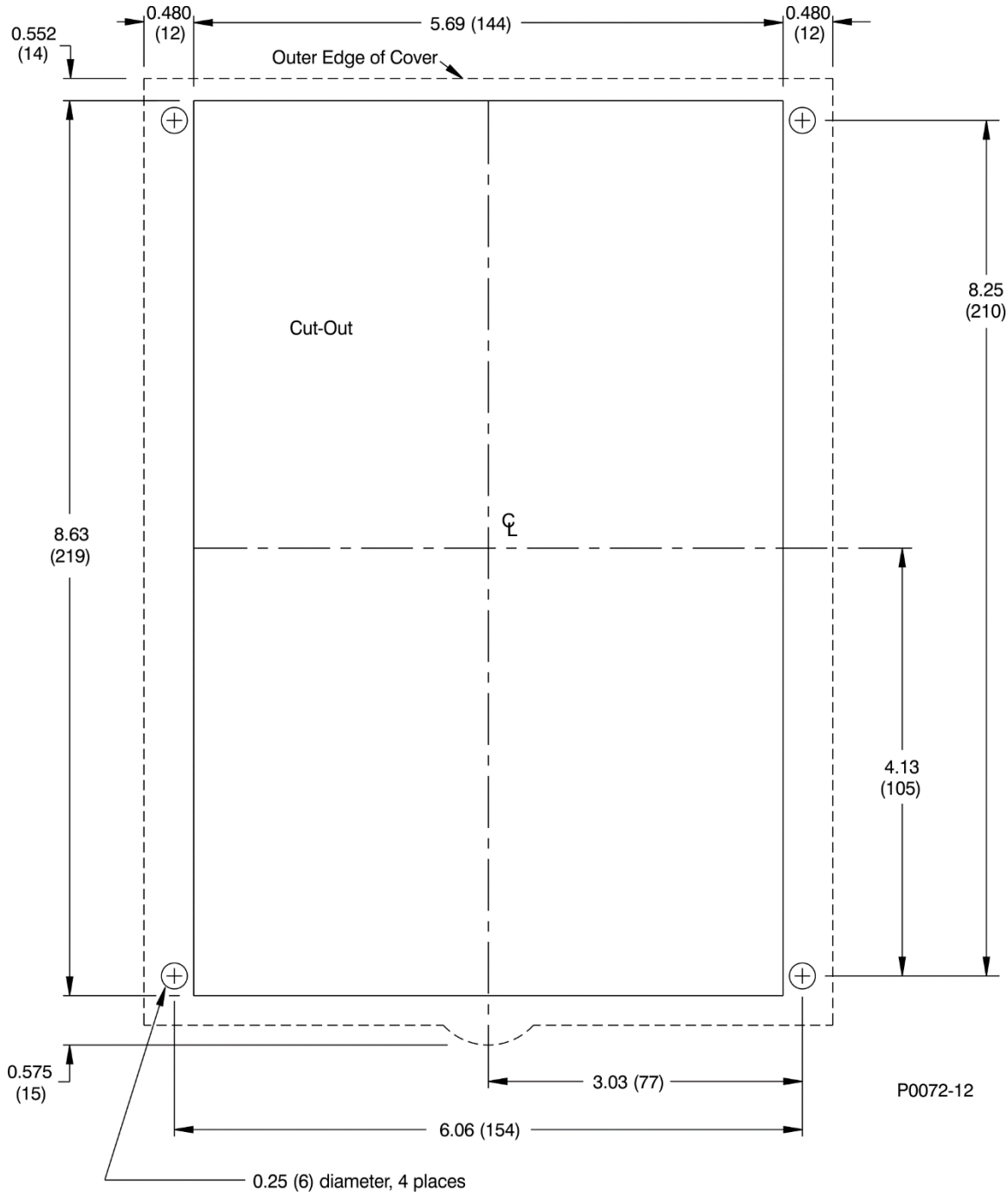


Figure 4-1. Panel Cutting/Drilling, Semi-Flush, S1 Case

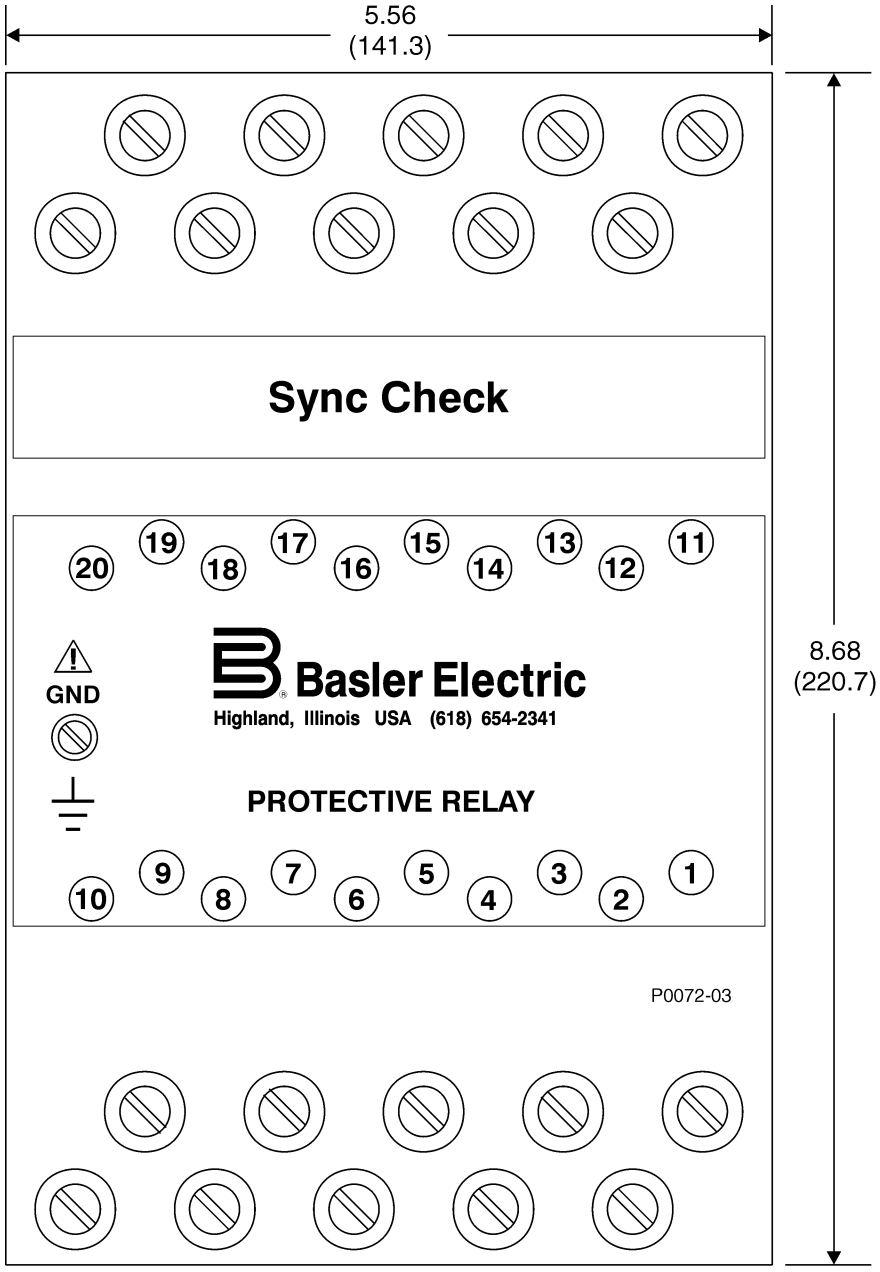


Figure 4-2. S1 Case Dimensions, Rear View, Double Ended, Semi-Flush Mount

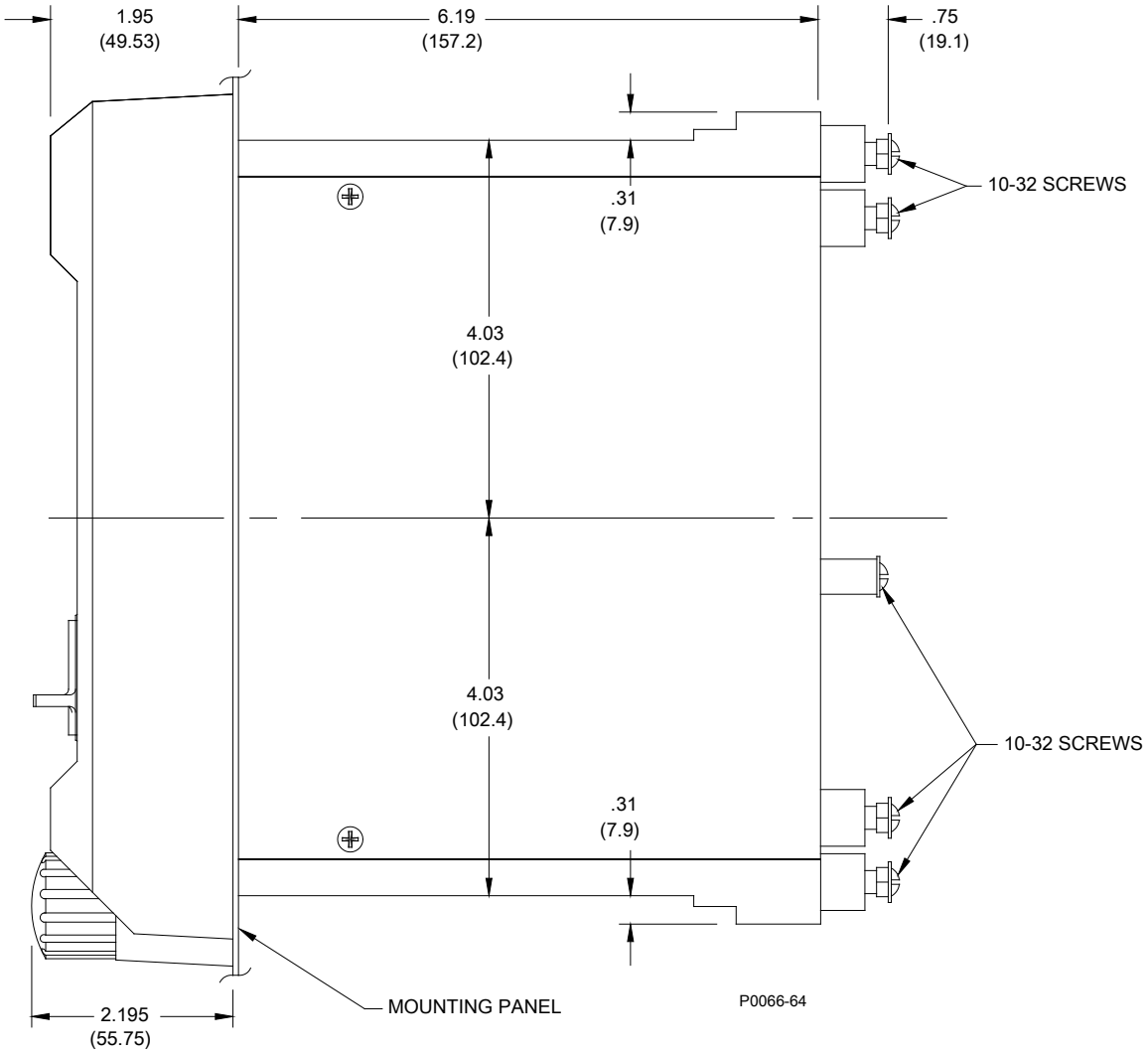


Figure 4-3. S1 Case Dimensions, Side View, Double Ended, Semi-Flush Mount

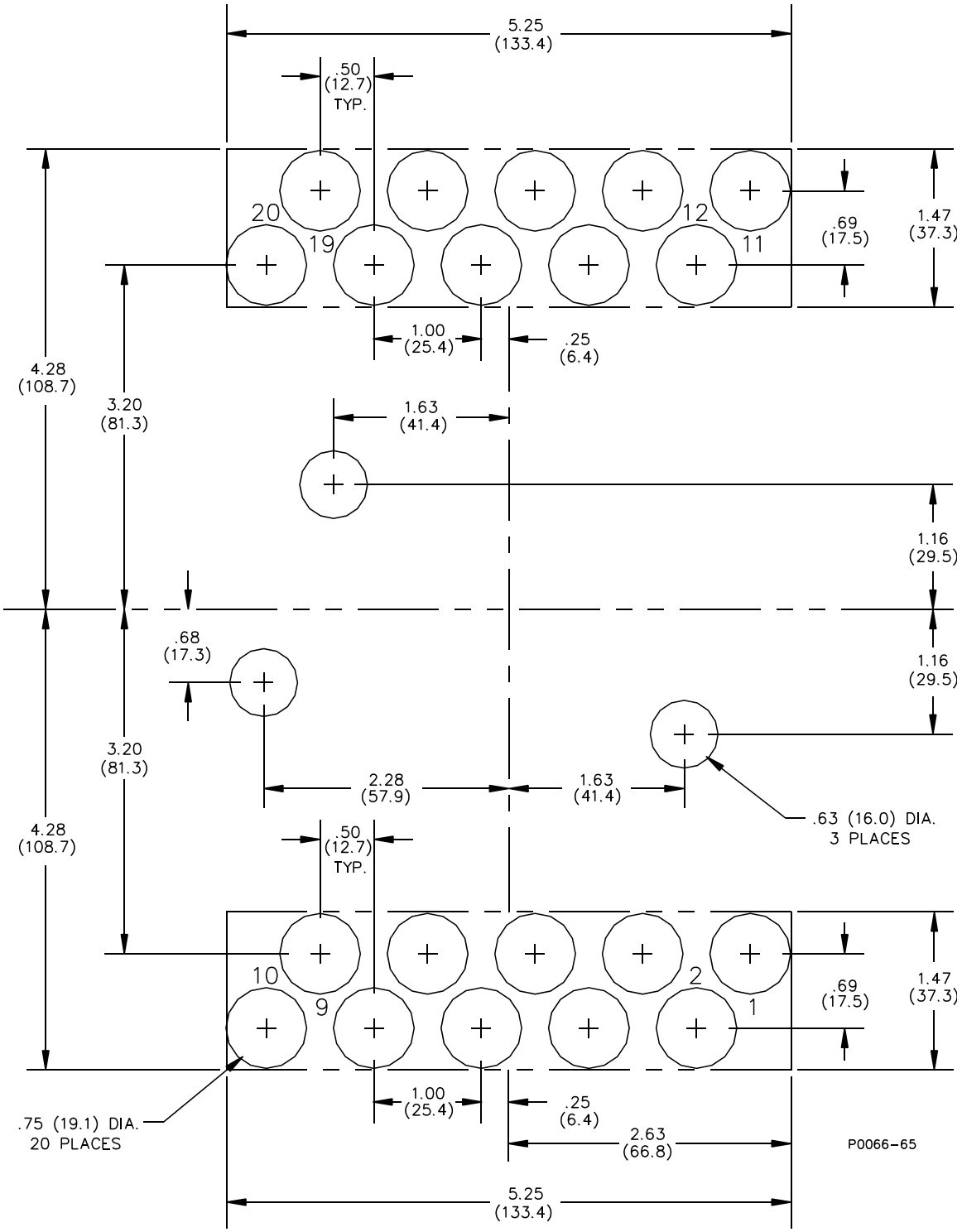


Figure 4-4. Panel Cutting/Drilling, Double Ended, Projection Mount, S1 Case

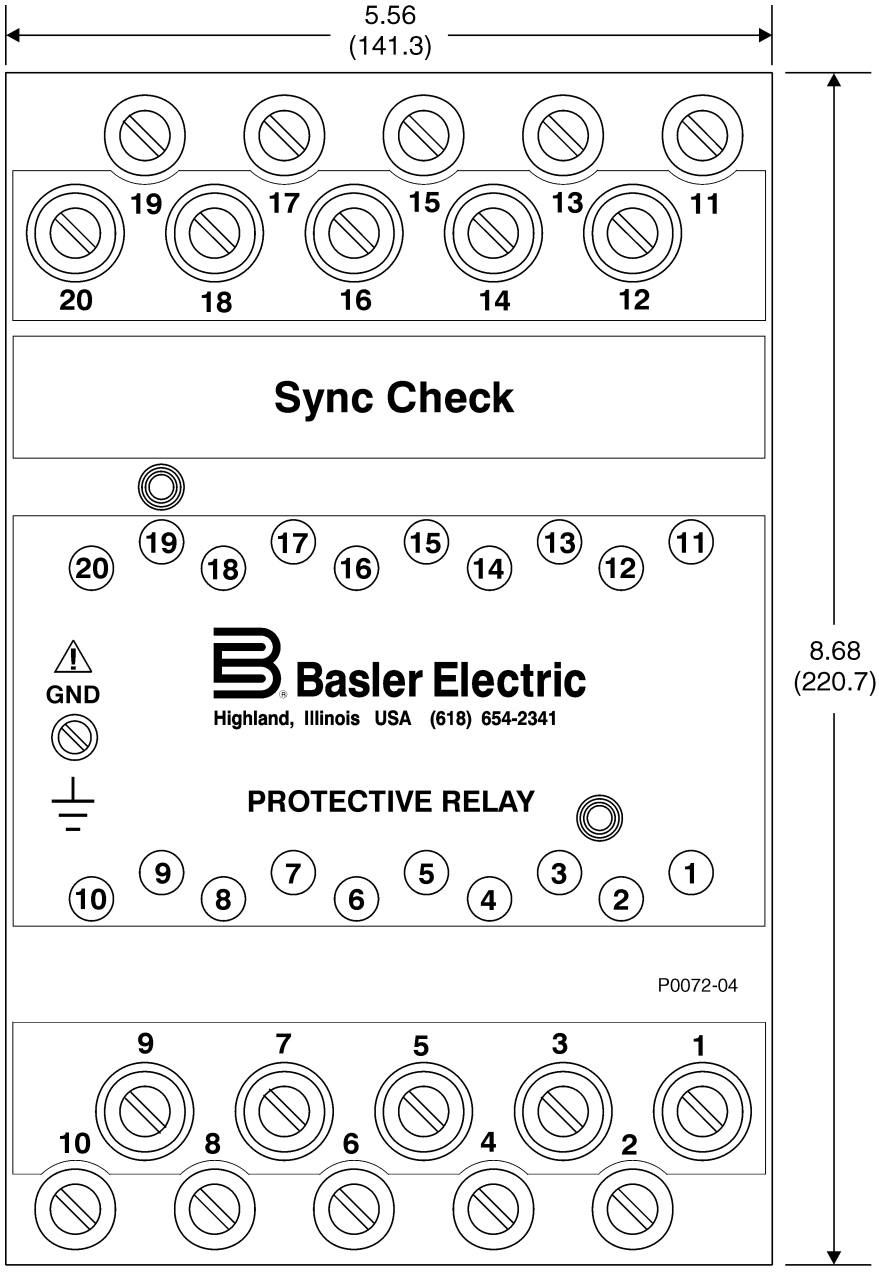


Figure 4-5. S1 Case Dimensions, Rear View, Double Ended, Projection Mount

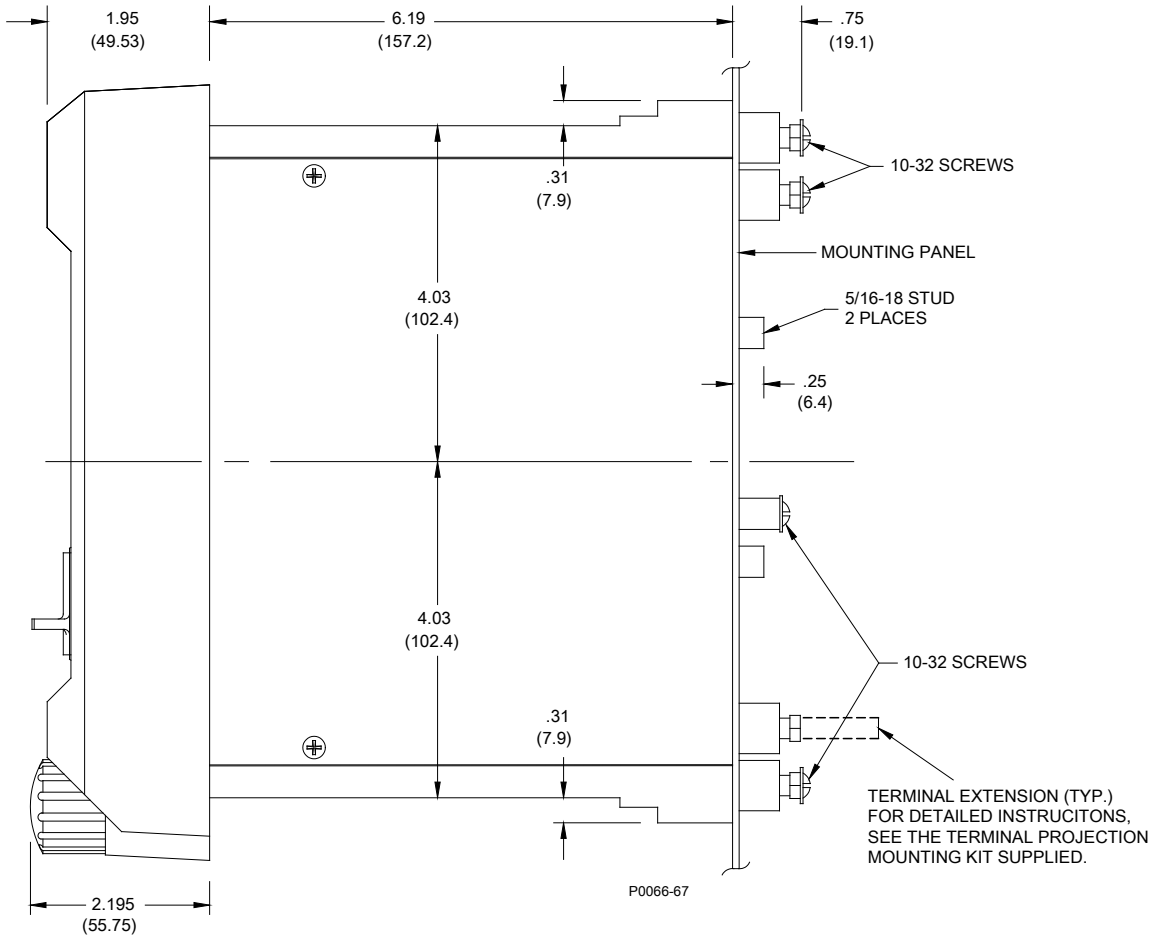


Figure 4-6. S1 Case Dimensions, Side View, Double Ended, Projection Mount

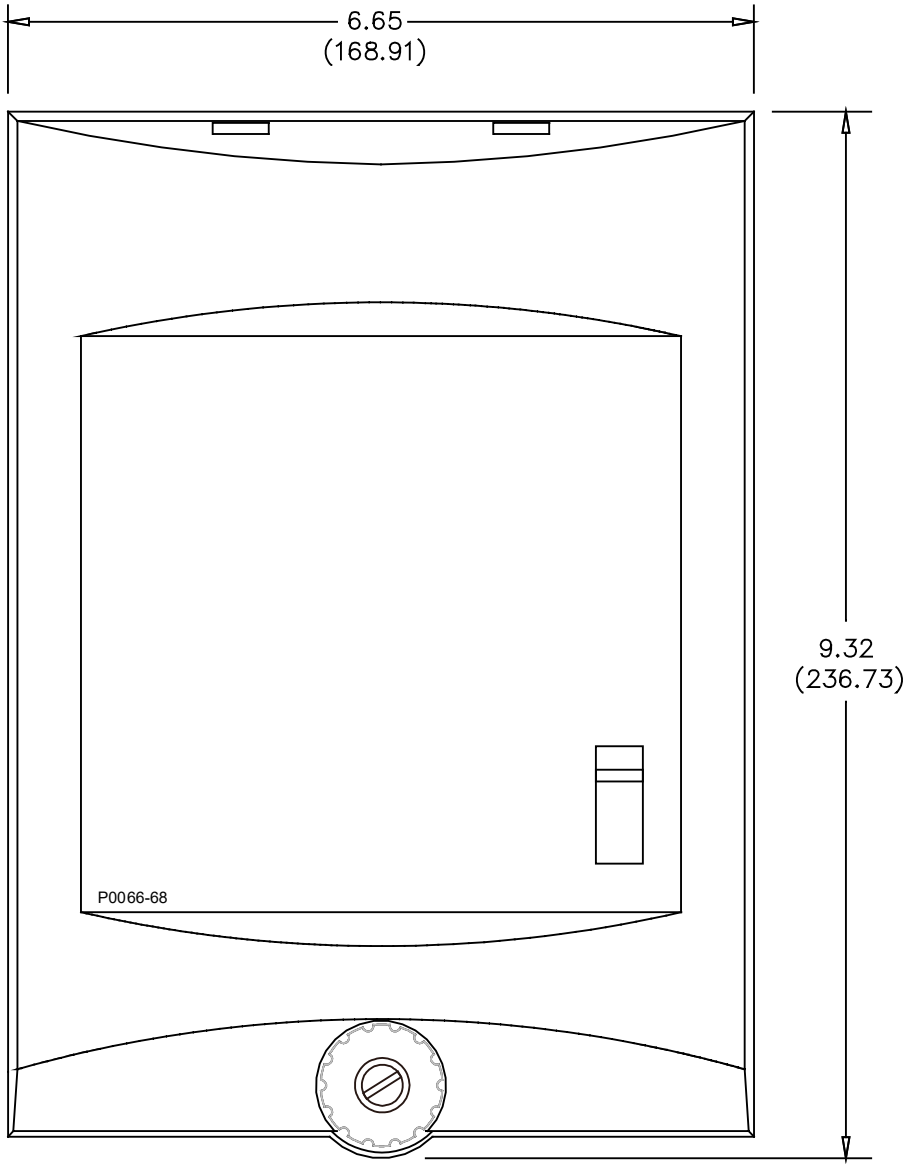


Figure 4-7. S1 Case Cover Dimensions, Front View

Connections

Be sure to check the model and style number of a relay before connecting and energizing the relay. Incorrect wiring may result in damage to the relay. Except where noted, connections should be made with wire no smaller than 14 AWG.

Typical external and internal connections are shown in the following figures.

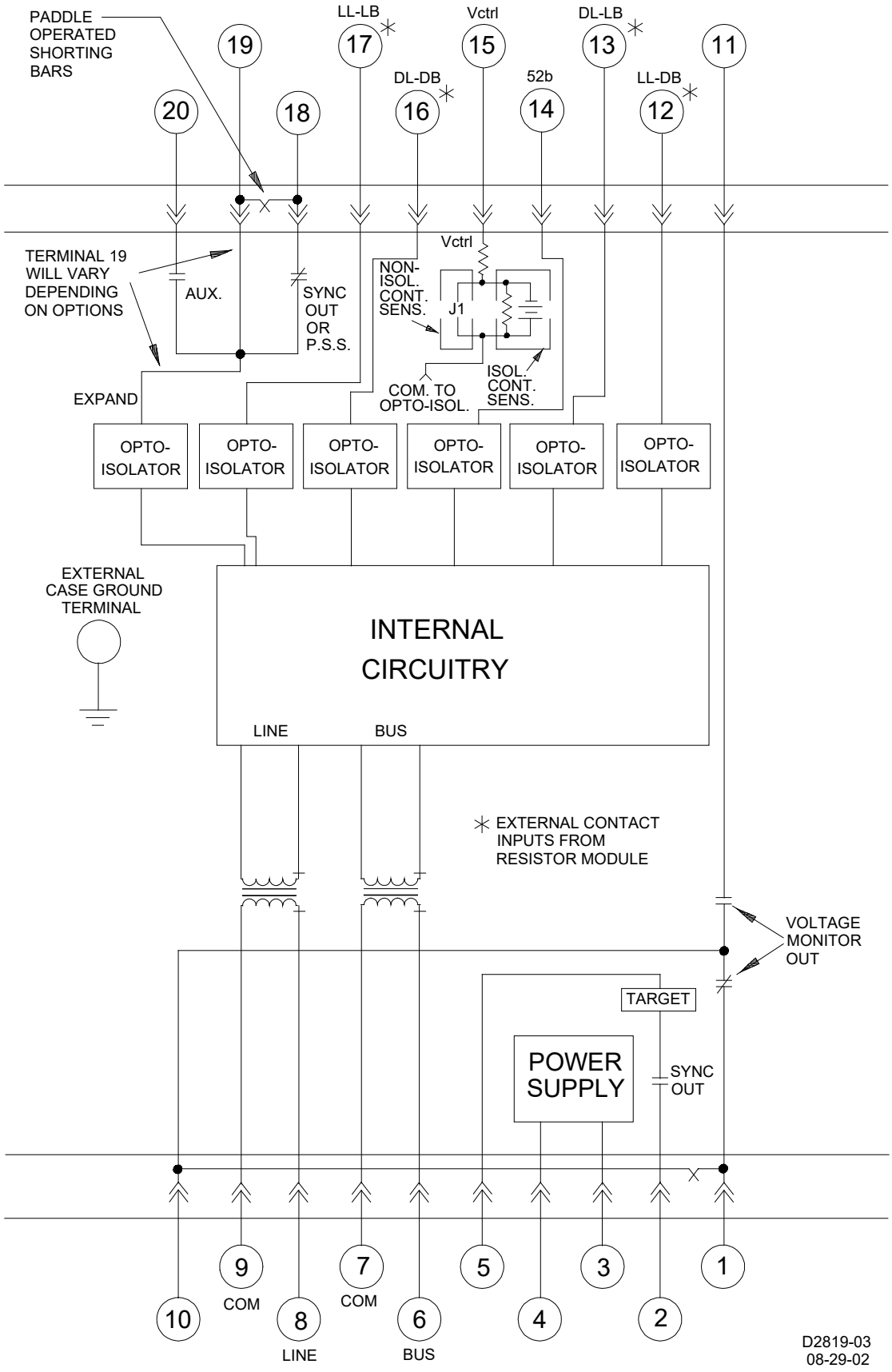


Figure 4-8. Internal Diagram

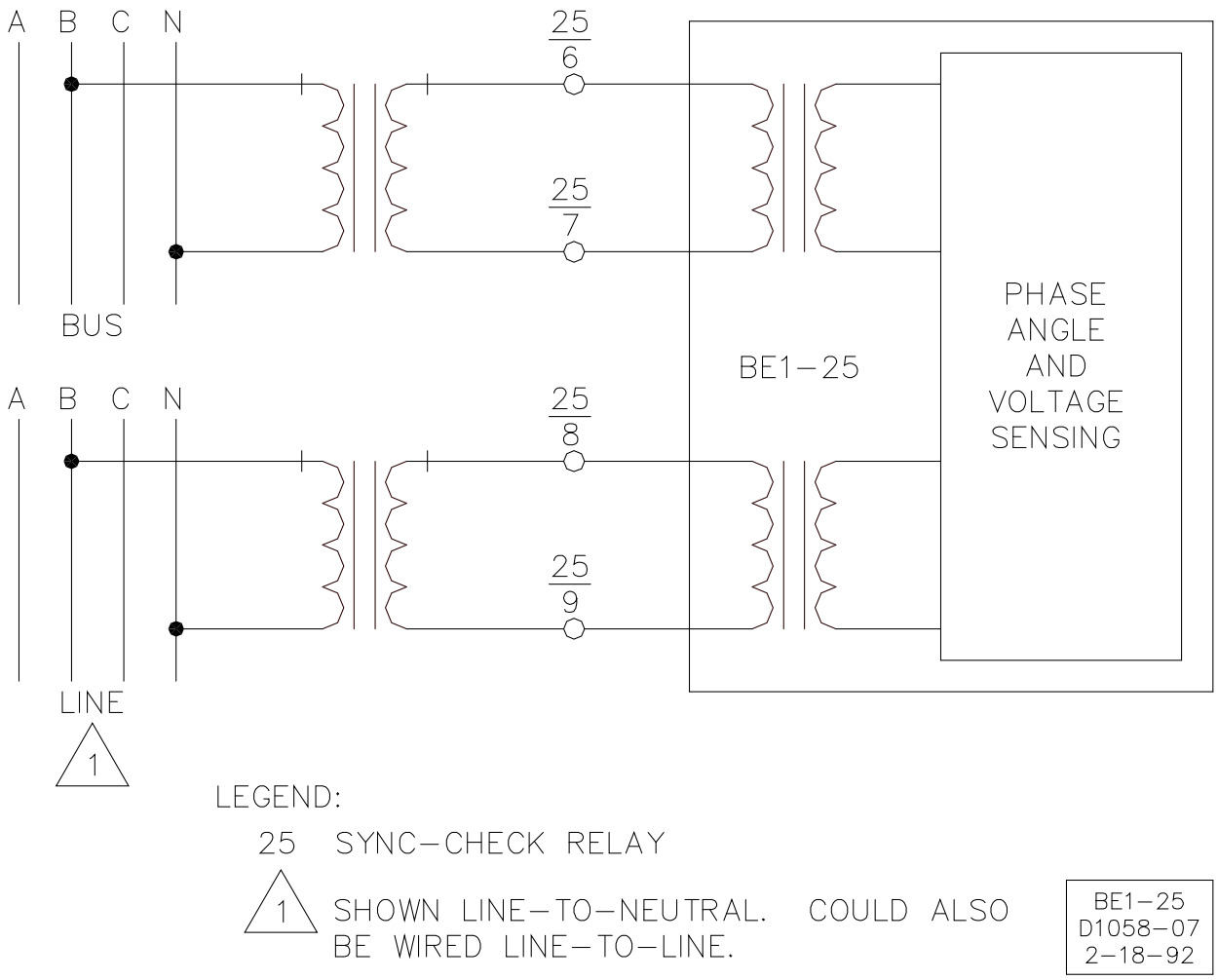


Figure 4-9. Voltage Sensing Connections

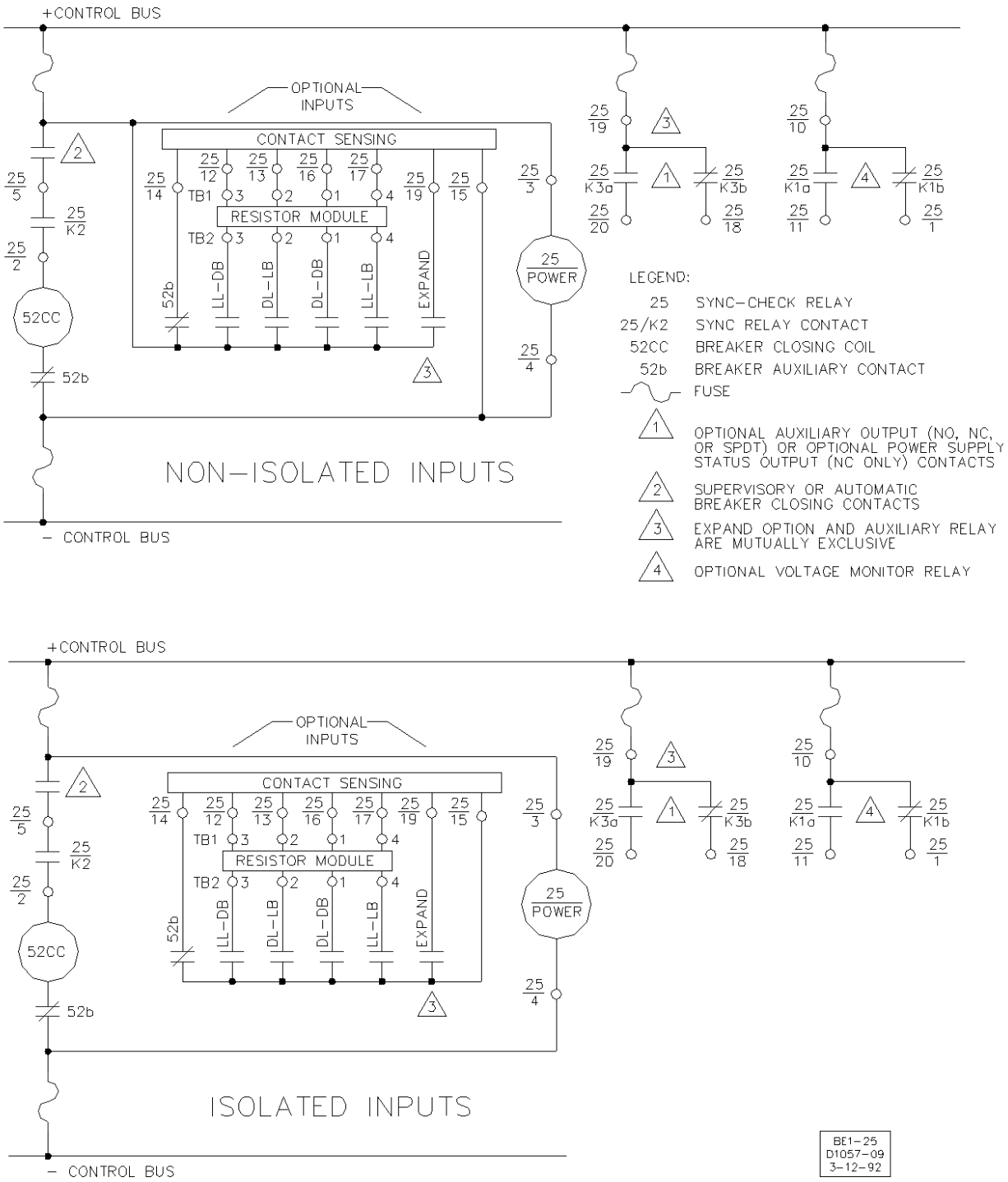


Figure 4-10. Control Circuit Connections (Typical)

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 4-11). If the relay is to be projection mounted (Figure 4-6), 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.

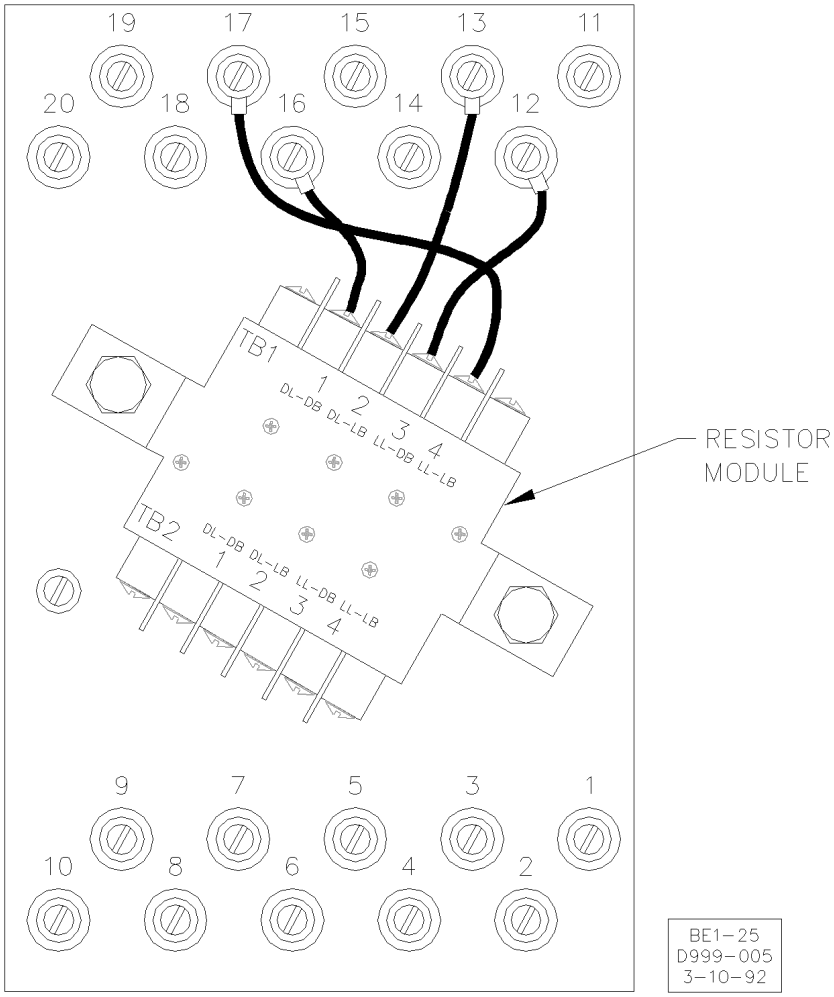


Figure 4-11. Resistor Module Connections

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 4-12.) 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 9170206990, which is packed with the module.

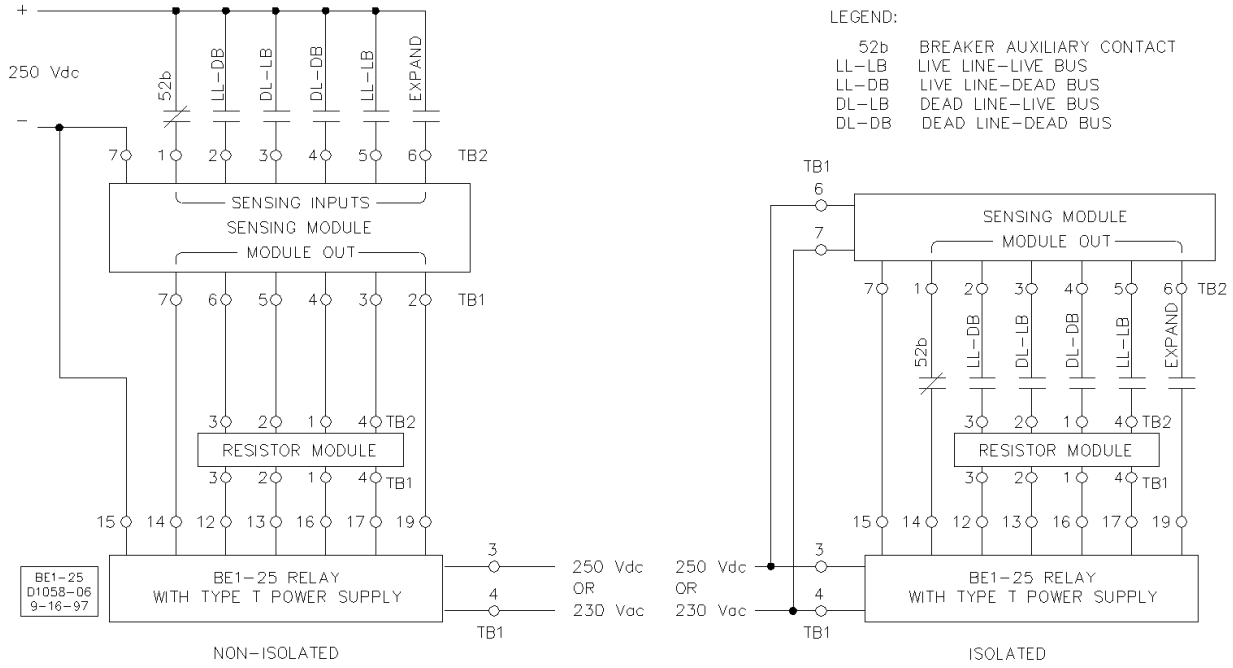


Figure 4-12. Contact Sensing and Resistor Modules for Type T Power Supply Only

Maintenance

BE1-25 relays require no preventative maintenance other than a periodic operational check. If the relay fails to function properly, contact Technical Sales Support at Basler Electric to coordinate repairs.

Storage

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

5 • Testing

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 placed into 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.

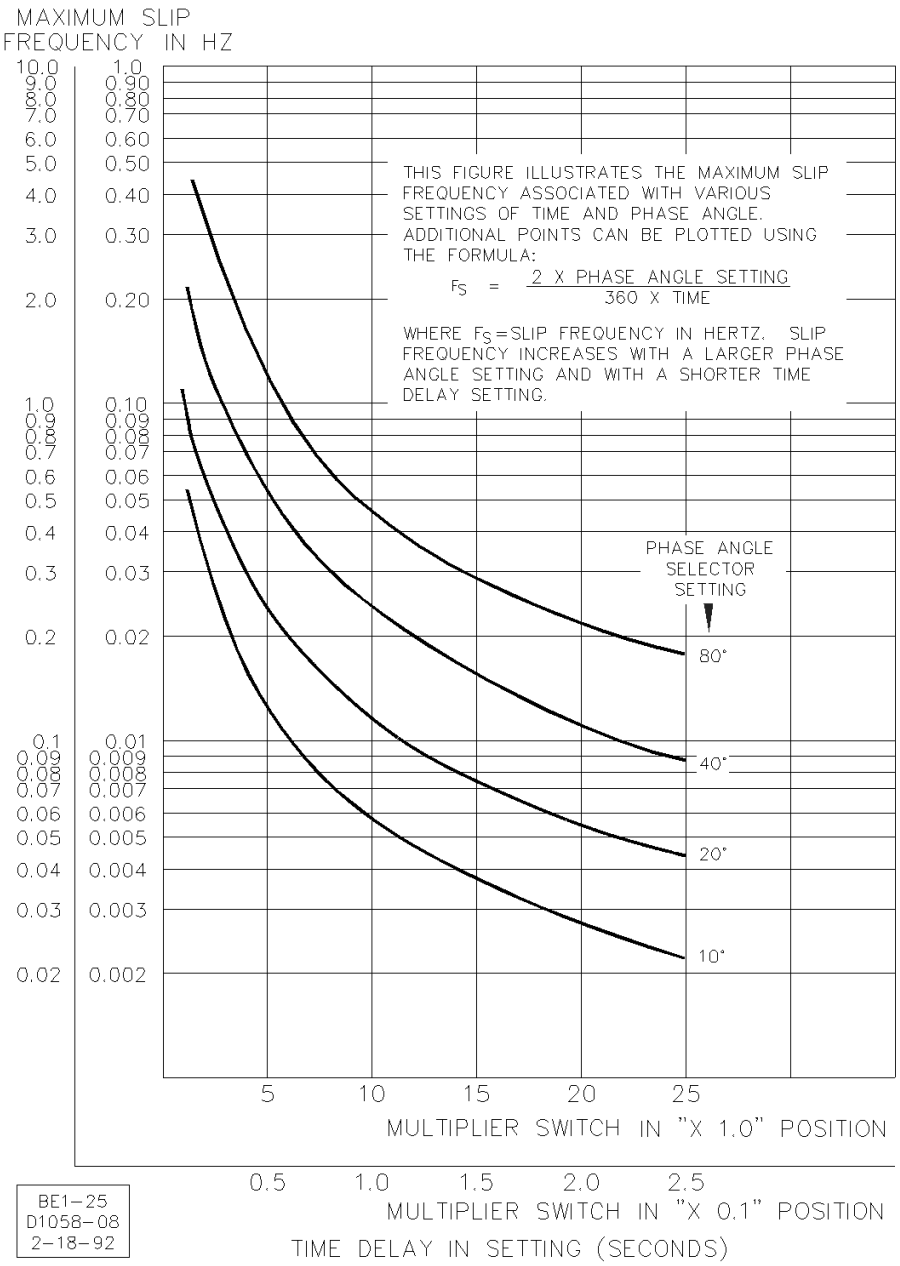


Figure 5-1. Maximum Slip Frequency versus Time Delay and Phase Angle Settings

Condition and Mode Switches

Detailed instructions and precautions for programming the Mode switches and Condition switches are provided in the *Controls and Indicators* chapter. The location of the switches is shown.

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.

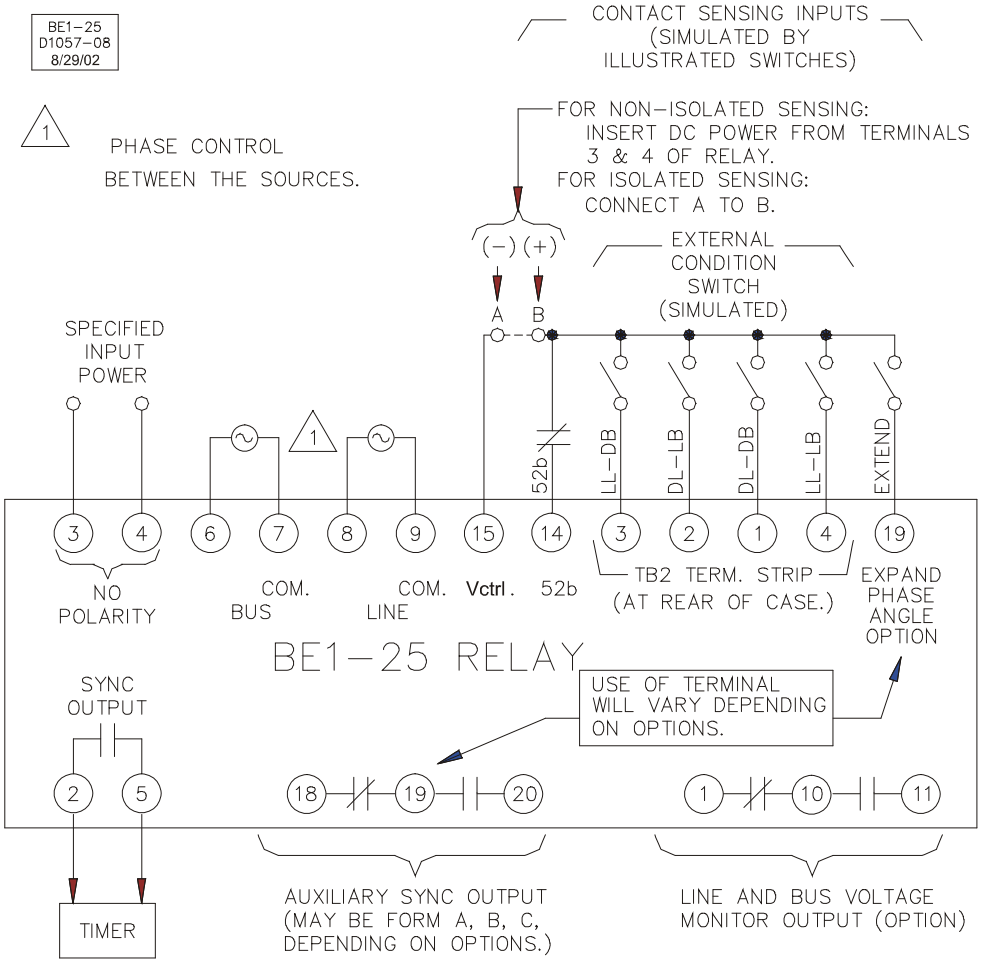


Figure 5-2. Test Setup (Typical)

Test Procedure

Notes
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. Set PHASE ANGLE to a value appropriate for the intended application and set TIME DELAY to minimum (for convenience). Confirm proper sync-check operation. 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 80 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 80 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 the *Controls and Indicators* chapter.)

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 2. 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 2. 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.)

Caution

Condition Switch No. 2, shown in the *Controls and Indicators* chapter, 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 the *Controls and Indicators* chapter).

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 3. 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 3. 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 80 Vac. This 80 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 80 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 80 volts but less than 120 volts, and line is less than 80 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 80 volts and line is greater than 80 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 80 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 80 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 80 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 3:

* 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.)

6 • Specifications

BE1-25 Sync-Check Relays electrical and physical specifications are described below.

Operational Specifications

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 80 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 line and bus input voltages over the specified operating range of 10 to 135 Vac. 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 1 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.

General 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 applied by the relay when isolated sensing is selected. Non-isolated sensing requires an externally applied dc sensing voltage within the range of the power supply as listed in Table 6-1.

Caution

If contact sensing is isolated (style number Mxxxxxx5xxx), external voltage should not be applied to the contact sensing inputs. Applying voltage to the contact sensing inputs will result in damage to the relay.

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

Output Contacts

Resistive Ratings

120 Vac .....Make, break, and carry 7 Aac continuously
250 Vdc .....Make and carry 30 Adc for 0.2 s, carry 7 Adc continuously, and break 0.3 Adc
500 Vdc .....Make and carry 15 Adc for 0.2 s, carry 7 Adc continuously, and break 0.3 Adc

Inductive Ratings

120 Vac, 125 Vdc, 250 Vdc.....Break 0.3 A (L/R = 0.04)

Power Supply

Power for the internal circuitry may be derived from a variety of ac or dc external power sources as indicated in Table 6-1.

Table 6-1. Power Supply Specifications

Type	Input Voltage		Burden at Nominal †
	Nominal	Range	
O (mid-range)	48 Vdc	24 to 150 Vdc	1.5 W
P (mid-range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	1.8 W 10.5 VA
R (low-range)	24 Vdc	12 to 32 Vdc *	1.6 W
T (high-range)	250 Vdc 240 Vac	68 to 280 Vdc 90 to 270 Vac	2.1 W 17.4 VA

* Type R power supply may require 14 Vdc to begin operation. Once operating, the voltage may be reduced to 12 Vdc.

† Value represents highest-burden style options.

Target Indicator

The target indicator 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.

Isolation

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

All circuits to ground ..... 2,121 Vdc
Input to output circuits ..... 1,500 Vac or 2,121 Vdc

Surge Withstand Capability

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

Radio Frequency Interference (RFI)

Qualified to IEEE C37.90.2-1987, *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 volts.

Operating Temperature

–40°C (–40°F) to +70°C (+158°F).

Storage Temperature

–65°C (–85°F) to +100°C (+212°F).

Shock

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

Vibration

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

Weight

13.7 lb (6.2 kg), maximum.

Case Size

S1 (Refer to the *Installation* chapter for case dimensions.)