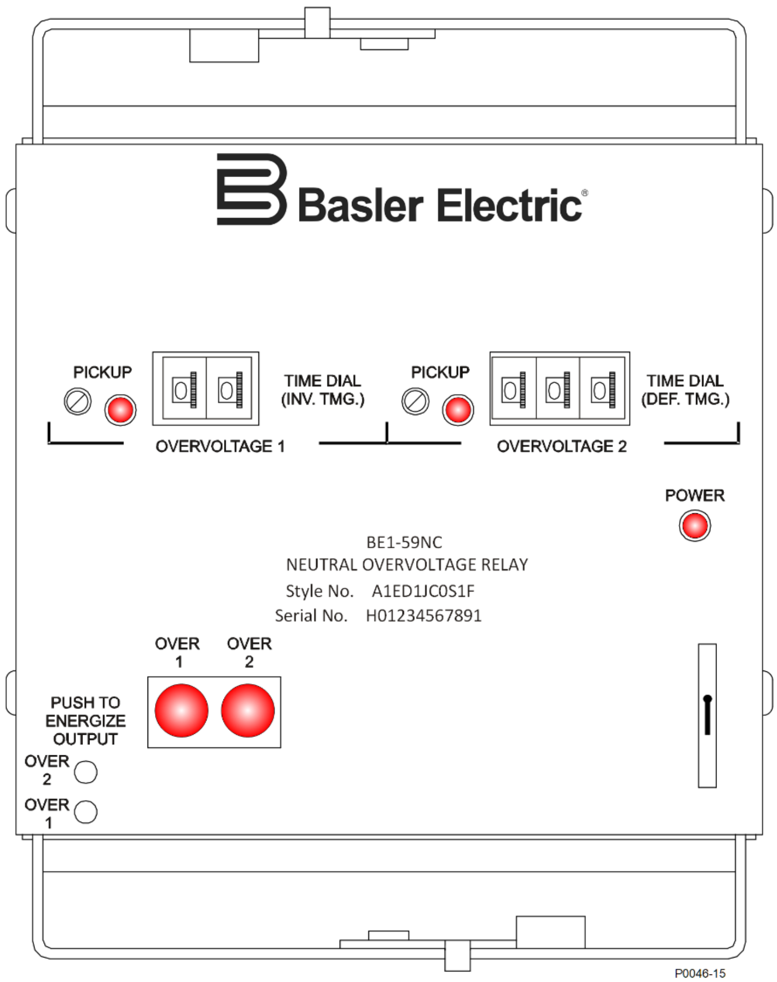
BE1-59NC
Neutral Overvoltage Relay

Instruction Manual



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Preface

This instruction manual provides information about the installation and operation of the BE1-59NC relay. To accomplish this, the following information is provided:

- General information and specifications
- Controls and indicators
- Functional description
- Installation
- Setting and testing

Conventions Used in this Manual

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

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

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

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

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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.

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
G, Jul 2022	• Added a note about EMI suppression in the Installation section.
F, Dec-2021	• Adjusted style chart to reflect obsolescence of current-operated targets. • Updated manual to new style.
E2, Apr-2019	• Replaced Prop 65 warning with generic version.
E1, Jan-2019	• Added Prop 65 warning on back of cover page.
E, Jun-2015	• Updated manual to latest style • Minor text edits throughout manual
D, Mar-2014	• Corrected inverse and definite timing accuracies in Section 1
C, Jan-2013	• Updated case and cover drawings in Section 4
B, Sep-2007	• Updated *Output Contacts* ratings in Section 1 • Moved content of Section 6, *Maintenance* to Section 4 • Updated front panel illustrations to show laser graphics • Moved content of Section 7, *Manual Change Information* to manual introduction • Added manual part number and revision to all footers • Updated cover drawing • Updated power supply burden data in Section 1 • Updated *Target Indicator* description in Section 3
A, Sep-1994	• Corrected voltage sensing input range in *Specifications* and throughout the manual • Changed Figure 1-3, *Overvoltage Inverse Time Curves* to divide the curves for low ranges (sensing input ranges 1, 3, 5, and 7) and high ranges (sensing input ranges 2, 4, 6, and 8) • Corrected typographical error in Figure 4-9 • Changed *Testing Procedures*, D1 and D2 Timing Options TIME DIAL settings • Added Section 7
—, Apr 1994	• Initial release

Contents

1 • General Information

BE1-59NC Neutral Overvoltage Relays provide sensitive protection for capacitor banks. There are three common types of capacitor bank failures that BE1-59NC relays recognize. They are:

- Unit dielectric failure
- Capacitor bank insulator failure
- Blown fuses

BE1-59NC relays protect for overvoltage due to internal voltage shifts that occur as a result of these types of failures.

Application

Capacitor banks are widely used by utilities to maintain specified system voltage. Addition of capacitive loads at appropriate points on the system compensate for heavy inductive loading that normally tends to reduce voltage. This adding of leading megavars to compensate for the lagging megavar component of electric loads is frequently referred to as power factor correction. Capacitor banks must be switched in response to actual load conditions in order to obtain maximum power factor correction benefits.

Capacitor Bank Switching

One of the common methods of maximizing capacitor bank benefits is by evaluating the bus voltage. A bandwidth surrounding the desired bus voltage level is established. When the bus voltage falls below the bandwidth level, the capacitor bank is switched into the circuit. When the bus voltage rises above the bandwidth level, the capacitor bank is switched out.

Protection

Protection of capacitor banks has always been difficult. It is especially difficult to sense failures inside the capacitor banks because of the configuration. Experience indicates that most capacitor bank faults involve one or more insulator failures with arcing across groups and/or phase-to-phase inside the bank. In most cases, these types of faults are not seen by the bus differential or other protection unless the arcing spills over to the area between the fuses and the circuit switcher. A fault across an insulator usually means that one or more groups of parallel units are shorted. This will cause a neutral shift and unbalanced phase currents. Unbalanced phase current magnitudes are determined by the number of series connected groups. For full phase-to-neutral flashover, the maximum phase current is three times normal capacitor bank load in the faulted phase.

One main protection concern is overvoltage cascading. A capacitor bank is unique in that cascading of units may take place after a predetermined number of unit fuses have operated. Normally after a fuse has blown in any other type of equipment, the faulted apparatus is disconnected and usually does not affect any remaining equipment that is in service. That is not so with a capacitor bank. Each fuse that blows to isolate the faulted unit sets up an increased voltage stress on the remaining units (Figure 1-1). Sometime later, the next weakest unit in that group fails. As each successive fuse blows, the voltage increases another step and rapidly causes the next unit to fail. Cascading takes place and results in serious damage to the capacitor bank and possible hazards to personnel. While the capacitor bank is failing, the station in minimally affected. The voltage is nearly normal, the current flow is almost unaffected, and station relay protection is not taking any action until the failure has developed into a phase-to-phase or phase-to-ground fault.

A solution was to develop a protective scheme for the capacitor bank with the main emphasis on preventing overvoltage cascading. To do this, a ground fault relay or neutral shift device had to be developed that was sensitive enough to detect blown fuses for both alarming and tripping purposes. The best place to obtain the sensing information is between the neutral of the capacitor bank and ground. Voltage differentials between the normal capacitor bank status and that of one blown fuse are very small. However, BE1-59NC relays are sensitive enough to differentiate between these conditions and act decisively.

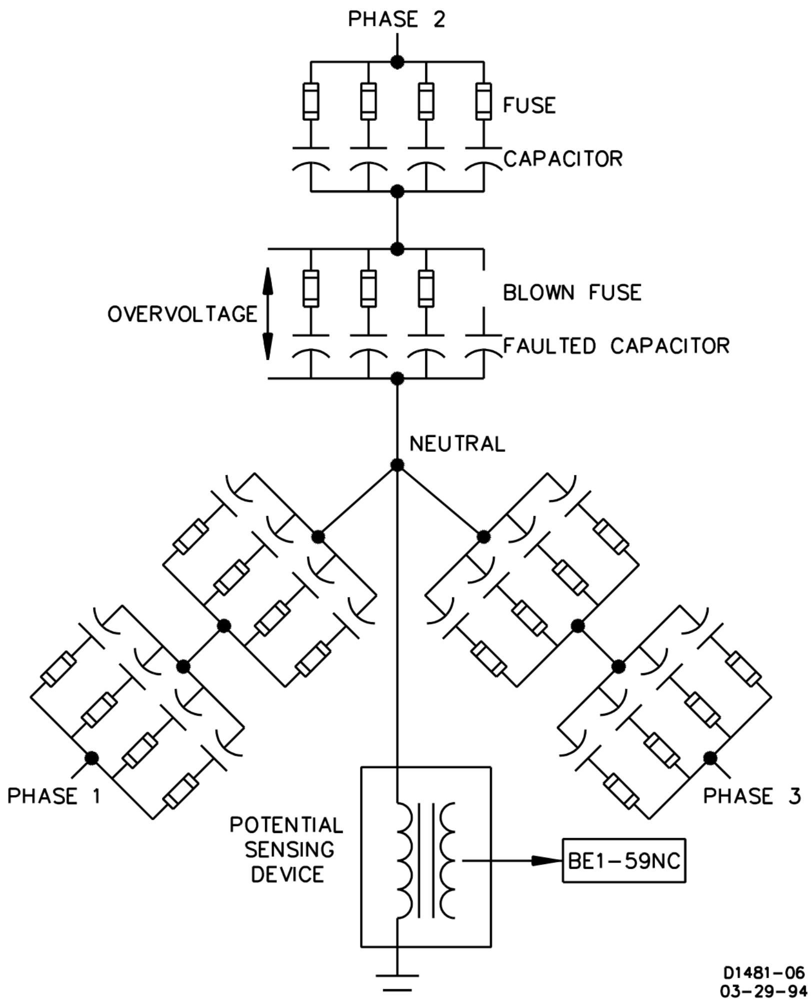


Figure 1-1. Ungrounded 3-Phase, 3-Wire System

Input Sensing

BE1-59NC relays receive the input signal from voltage sensing devices connected between the capacitor bank neutral and ground. These voltage sensing devices can be potential transformers or resistor potential devices. Ideally, the voltage across each leg of a capacitor bank is balanced, and the voltage from neutral to ground is zero. If a single capacitor fails and blows the protecting fuse, an unbalanced condition occurs that shifts the neutral and creates a small but measurable voltage. Through the potential sensing devices, the neutral relay senses this voltage unbalance and reacts to give the appropriate signal (usually an alarm or trip depending on the voltage level).

Further loss of more capacitors increases the neutral voltage. The relay senses this voltage increase, and reacts to give the appropriate signal. This signal is usually a trip depending on the voltage levels and how the protection scheme is designed.

Alarms and Outputs

Sensitive settings on the relay are used as an alarm to alert that a fuse has blown and maintenance is required. They would be typically set at a level corresponding to the voltage rise caused by one blown fuse. The second output would have a setting that would be set to trip the capacitor bank off the bus or line when the voltage exceeds 110% of the nominal capacitor bank voltage. This setting depends on the capacitor bank size and configuration.

Model and Style Number

Electrical characteristics and operational features included in a specific relay are defined by a combination of letters and numbers that make up the style number. Model number BE1-59NC designates the relay as a Basler Electric Neutral Overvoltage Relay. The model number, together with the style number, describes the options included in a specific device and appears on the front panel, draw-out cradle, and inside the case assembly.

The style number identification chart for the BE1-59NC relay is illustrated in Figure 1-2.

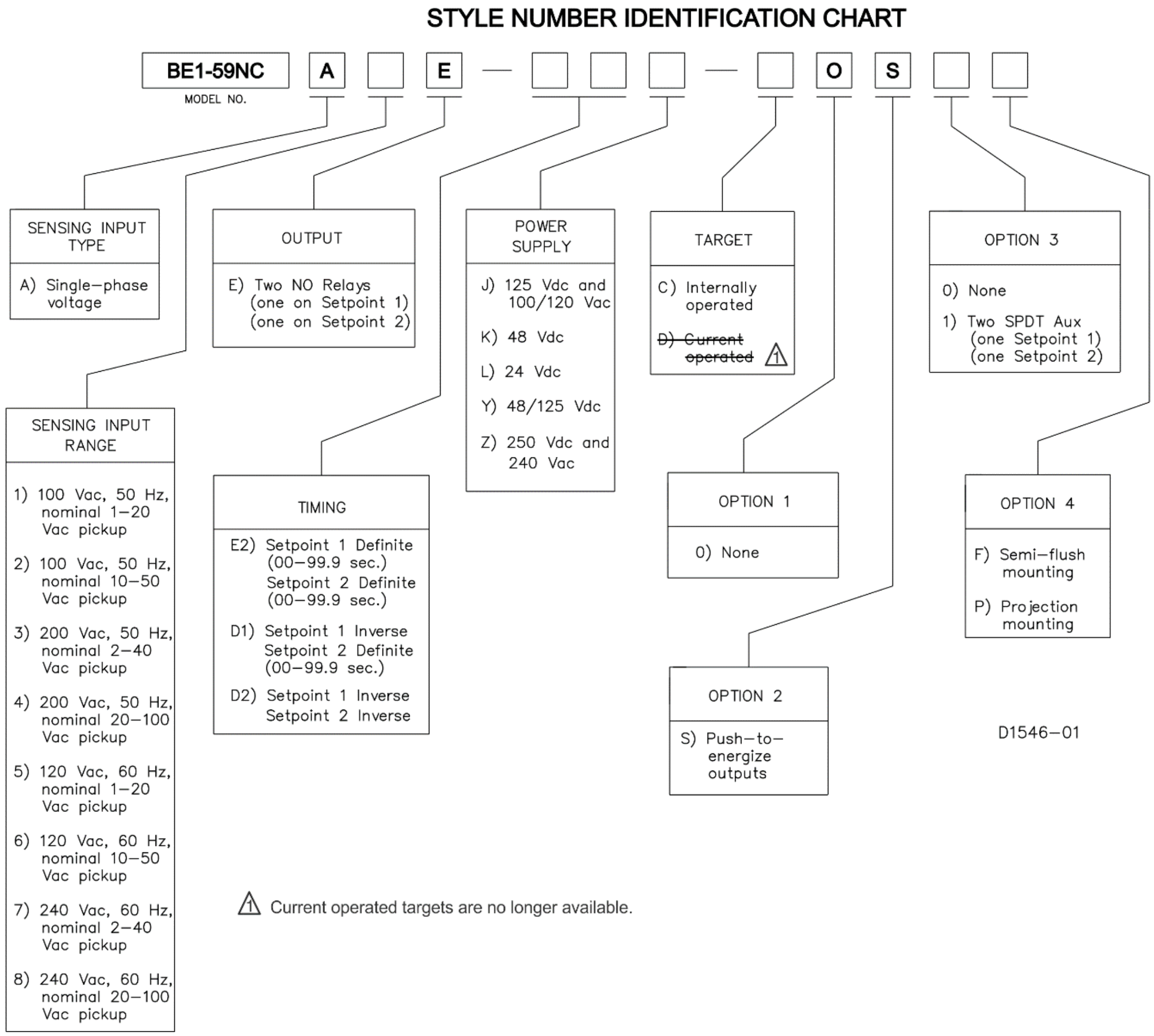


Figure 1-2. Style Number Identification Chart

Style Number Example

If a BE1-59NC relay has a style number of **A5E–E2J–C0S1F**, the relay has the following features:

A Single-phase voltage sensing
5 120 Vac, 60 Hz, nominal 1 to 20 Vac pickup
E Two output relays with normally open contacts
E2 Setpoint 1 Definite (0.1 to 99.9 sec.), Setpoint 2 Definite (0.1 to 99.9 sec.)
J 125 Vdc or 100/120 Vac power supply
C Internally operated targets
0 None
S Push-to-energize outputs
1 Two SPDT auxiliary output relays, one for setpoint 1 and one for setpoint 2
F Semi-flush mounting case

Specifications

BE1-59NC Neutral Overvoltage Relays electrical and physical specifications are described below.

Voltage Sensing

Maximum Continuous Rating.....360 Vac for 100/120 Vac input, 480 Vac for 200/240 Vac input
Maximum Burden.......................2 VA

Sensing Input Ranges

Ranges 1 and 5..........................1 to 20 Vac pickup
Ranges 2 and 6..........................10 to 50 Vac pickup
Ranges 3 and 7..........................2 to 40 Vac pickup
Ranges 4 and 8..........................20 to 100 Vac pickup

Pickup Accuracy

Ranges 1, 3, 5, or 7....................±2% or 100 millivolts, whichever is greater
Ranges 2, 4, 6, or 8....................±2% or 200 millivolts, whichever is greater

Dropout

98% of pickup within 7 cycles

Timing Characteristics

Inverse

Response time decreases as the difference between the monitored voltage and the setpoint increases. The inverse time characteristics switch is adjustable from 01 to 99 in 01 increments. Each position corresponds to a specific curve except 00, which is instantaneous. Accuracy is within ±5% or 25 milliseconds, whichever is greater.

Definite

Adjustable from 00.1 to 99.9 seconds, in steps of 0.1 seconds. (A setting of 00.0 provides instantaneous timing.) Accuracy is within ±2% or 100 milliseconds, whichever is greater.

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 1-1.

Table 1-1. Power Supply Specifications

Type	Input Voltage		Burden at Nominal
	Nominal	Range	
K (mid-range)	48 Vdc	24 to 150 Vdc	2.5 W
J (mid-range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	2.8 W 12.4 VA
L (low-range)	24 Vdc	12 to 32 Vdc *	2.7 W
Y (mid-range)	48 Vdc 125 Vdc	24 to 150 Vdc 24 to 150 Vdc	2.5 W 2.8 W
Z (high-range)	250 Vdc 240 Vac	68 to 280 Vdc 90 to 270 Vac	3.0 W 19.7 VA

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

Target Indicators

Electronically latched, manually reset target indicators indicate closure of the trip output contacts. Either internally operated or current operated targets may be specified.

Current Operated Targets
Minimum Rating ....200 mA flowing through the trip circuit
Continuous Rating......................3 A
1 Second Rating.........................30 A
2 Minute Rating ....7 A

Isolation

1,500 Vac at 60 Hz for one minute in accordance with IEC 255-5 and ANSI/IEEE C37.90-1989 (Dielectric Test).

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)

Field tested using a five-watt, hand-held transceiver operating at random frequencies centered around 144 megahertz and 440 megahertz, with the antenna located six inches from the relay in both horizontal and vertical planes.

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

13.5 lb (6.1 kg), maximum.

Case Size

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

Characteristic Curves

BE1-59NC overvoltage inverse time curves are illustrated in Figures 1-3 and 1-4.

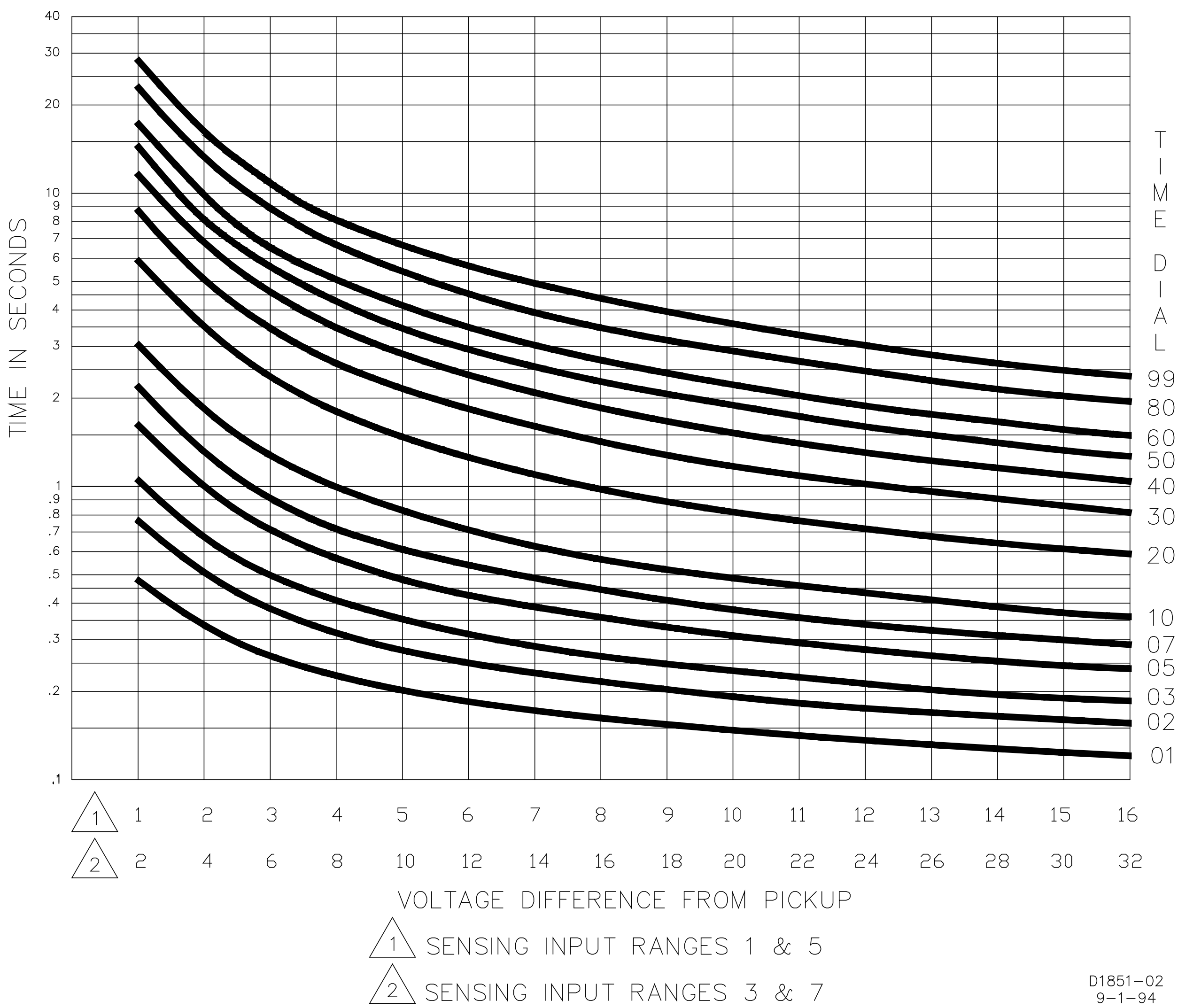


Figure 1-3. Overvoltage Inverse Time Curves, Low Ranges

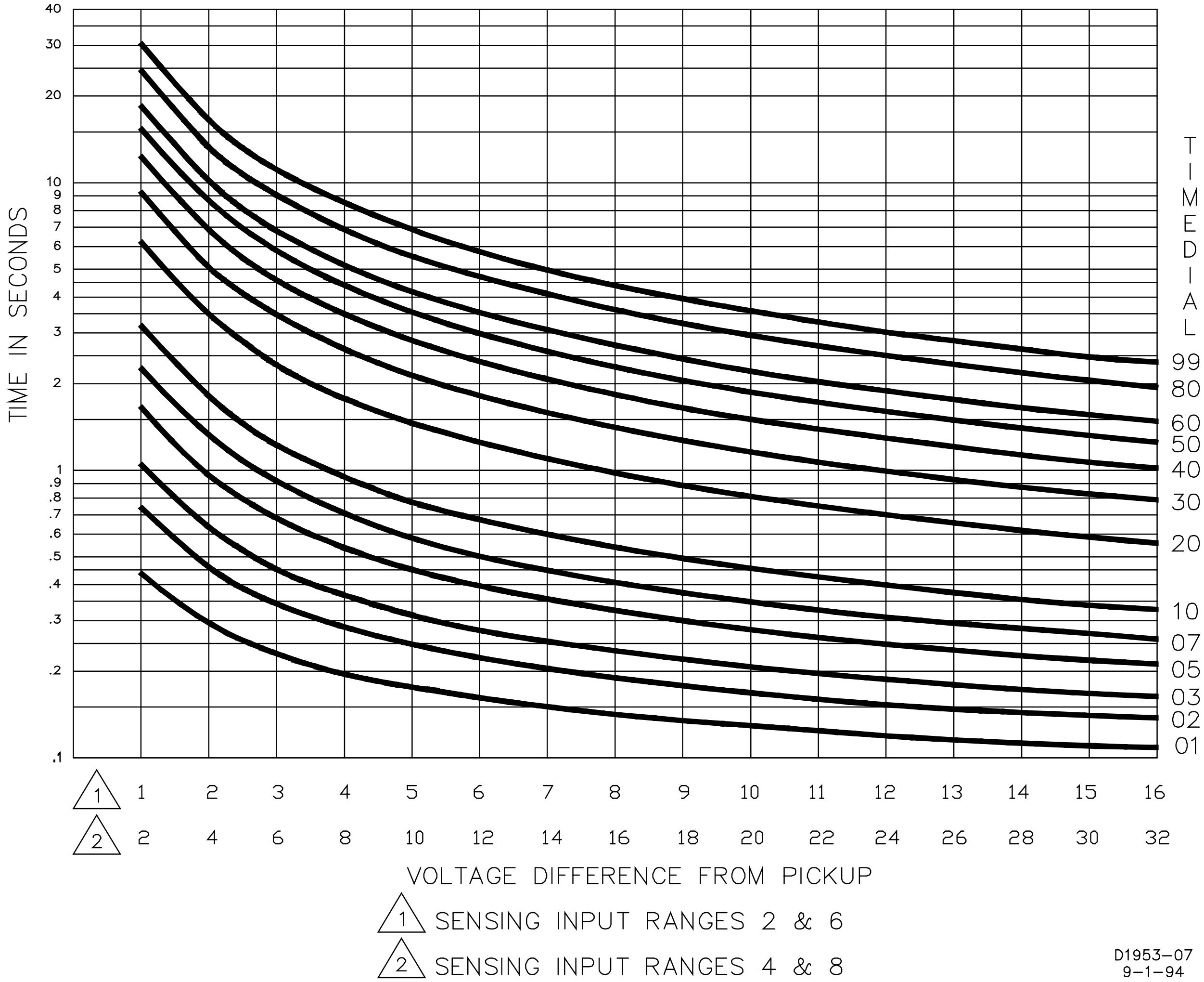


Figure 1-4. Overvoltage Inverse Time Curves, High Ranges

2 • Controls and Indicators

BE1-59NC controls and indicators are located on the front panel. The controls and indicators are shown in Figure 2-1 and described in Table 2-1. Your relay may not have all of the controls and indicators shown and described here.

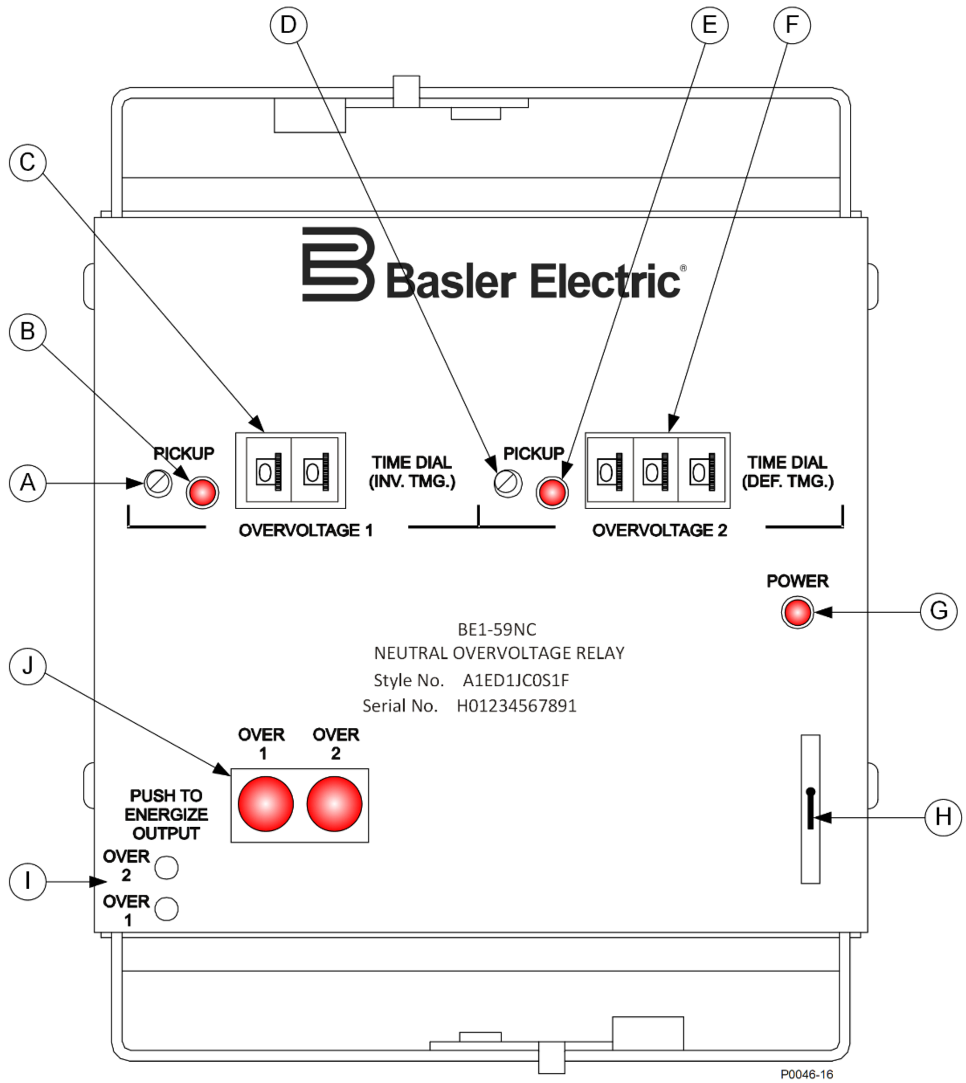


Figure 2-1. Location of Controls and Indicators

Table 2-1. Control and Indicator Descriptions

Locator	Description
A	***OVERVOLTAGE 1 PICKUP*** *Adjustment.* A multiturn potentiometer that sets the overvoltage comparator threshold voltage. Continuously adjustable for the sensing input voltage range.
B	***OVERVOLTAGE 1 PICKUP*** *LED.* A red LED that illuminates when overvoltage exceeds the pickup setting.
C	***OVERVOLTAGE 1 TIME DIAL***. Thumbwheel switch that selects the desired overvoltage output delay (definite timing characteristic adjustable from 00.1 to 99.9 seconds, in 0.1 second increments). A setting of 00 is instantaneous.

Locator	Description
D	***OVERVOLTAGE 2 PICKUP*** *Adjustment.* A multiturn potentiometer that sets the overvoltage comparator threshold voltage. Continuously adjustable for the sensing input voltage range.
E	***OVERVOLTAGE 2 PICKUP*** *LED.* A red LED that illuminates when overvoltage exceeds the pickup setting.
F	***OVERVOLTAGE 2 TIME DIAL****.* Thumbwheel switch that selects the desired overvoltage output delay (definite timing characteristic adjustable from 00.1 to 99.9 seconds, in 0.1 second increments). A setting of 00 is instantaneous.
G	***POWER*** *LED.* LED illuminates when proper operating power is applied to the relay internal circuitry.
H	*Target Reset Switch.* Provides manual reset of the target indicators (locator J).
I	***PUSH TO ENERGIZE OUTPUTS****.* These pushbuttons allow manual actuation of the output relays. Output relay actuation is achieved by inserting a nonconductive rod through the front panel access holes.
J	*Target Indicators.* These electronically latched red target indicators illuminate when the trip output relays energize. To ensure proper operation of a current-operated target, the current flowing through the trip circuit must be 200 mA or higher. The target indicators are reset by operating the target reset switch (locator H).

3 • Functional Description

BE1-59NC relay functions are illustrated in Figure 3-1 and described in the following paragraphs.

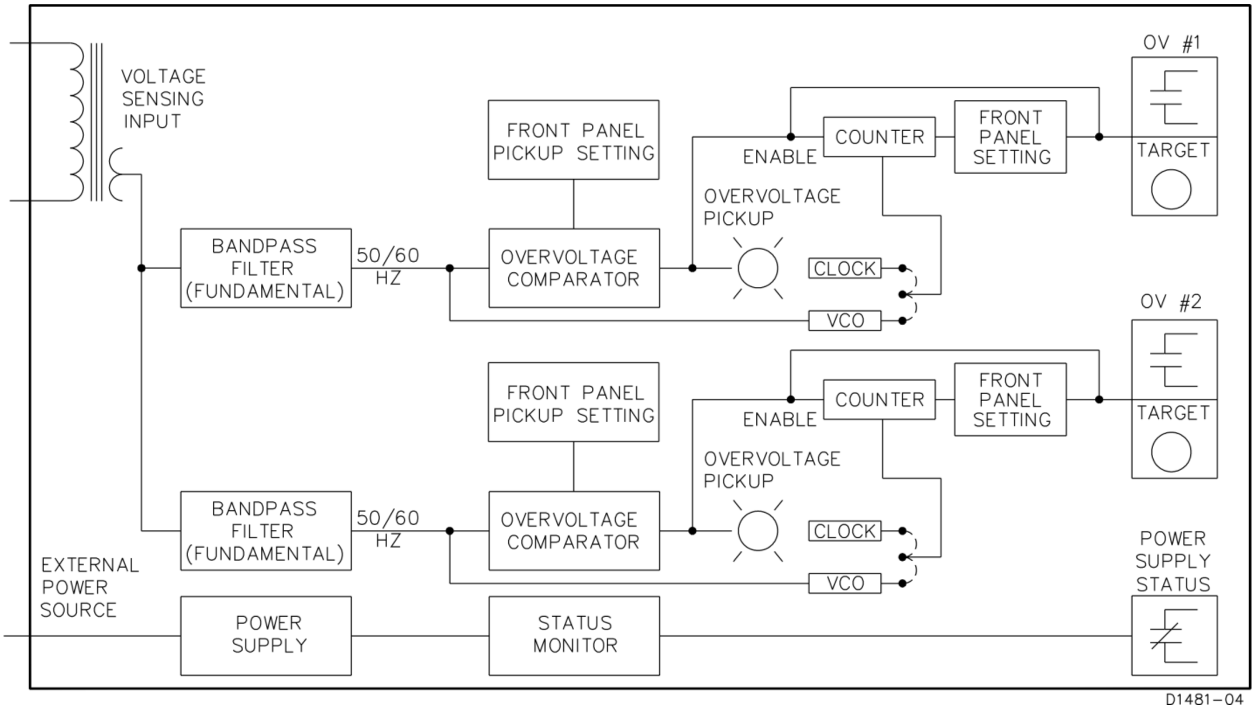


Figure 3-1. Function Block Diagram

Functional Description

Inputs

Sensed voltage developed across the input sensing device connected in the neutral-grounding current transformer secondary is applied to the BE1-59NC Neutral Overvoltage Relay. Internal transformers provide further isolation and step down for the relay logic circuits. BE1-59NC relays may also be used in ungrounded systems with voltage transformers connected in wye/broken delta configurations. Typical connection methods are shown in the *Installation* chapter. Overvoltage #1 and Overvoltage #2 circuits are functionally the same except for timing characteristics.

Filters

Bandpass filters provide peak sensitivity at 50 or 60 hertz for the overvoltage #1 and overvoltage #2 inputs. Third harmonic rejection is 40 dB minimum.

Overvoltage Comparator

Each overvoltage comparator circuit receives a sensing voltage from the bandpass filter and a reference voltage from the front panel setting. When the input exceeds the setting reference, the comparator output enables the timing circuit and the OVERVOLTAGE PICKUP LED turns ON.

Definite Time Delay

An output signal from the comparator circuit enables a counting circuit to be incremented by an internal clock. When the counting circuit reaches the count that matches the number entered on the TIME DIAL, the output relay and auxiliary relay are energized. However, if the sensed input voltage falls below the pickup setting before the timer completes its cycle, the timer resets within 2.0 cycles.

The definite time delay is adjustable from 00.1 to 99.9 seconds in 0.1 second increments. Front panel mounted switches determine the delay. Position 00.0 is instantaneous.

Inverse Time Delay

Inverse time delay circuits are identical to definite time delay circuits except that a voltage controlled oscillator (VCO) is substituted for the clock signal. The VCO is controlled by a voltage derived from the sensed input. Because the frequency of the oscillator is kept proportional to the sensed input voltage, the desired inverse time delay is produced.

Inverse time characteristic curve thumbwheel switches are settable from 01 to 99 in 01 increments. Each position corresponds to a specific curve setting except 00, which is instantaneous. Refer to the *Introduction* chapter to see the inverse time characteristic curves.

Reference Voltage Circuit

A constant voltage source provides a reference voltage to the potentiometers on the front panel. The potentiometers, in turn, provide reference voltages to all the comparator circuits and establish the threshold for each circuit.

Power Supply Status Output

The power supply status relay has a set of normally closed contacts and energizes when operating power is applied to the relay. If relay operating power is lost or either side of the power supply output (+12 Vdc or –12 Vdc) fails, the power supply status relay de-energizes and closes the power supply status output contacts.

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.

Target Indicators

Target indicators are optional components selected when a relay is ordered. The electronically latched and reset targets consist of red LED indicators located on the relay front panel. Latched targets are reset by operating the target reset switch on the front panel. If relay operating power is lost, any illuminated (latched) targets are extinguished. When relay operating power is restored, the previously latched targets are restored to their latched state.

A relay can be equipped with either internally operated targets or current operated targets.

Internally Operated Targets

The relay trip outputs are directly applied to drive the target indicators. The indicators are illuminated regardless of the current level in the trip circuits.

Current Operated Targets

Current operated targets are triggered by closure of the corresponding output contact and the presence of at least 200 milliamperes of current flowing in the trip circuit.

Note
Prior to September 2007, the BE1-59NC target indicators consisted of magnetically latched, disc indicators. These mechanically latched target indicators have been replaced by the electronically latched LED targets in use today.

4 • Installation

BE1-59NC 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.

Note

Be sure that the BE1-59NC 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 BE1-59NC 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.

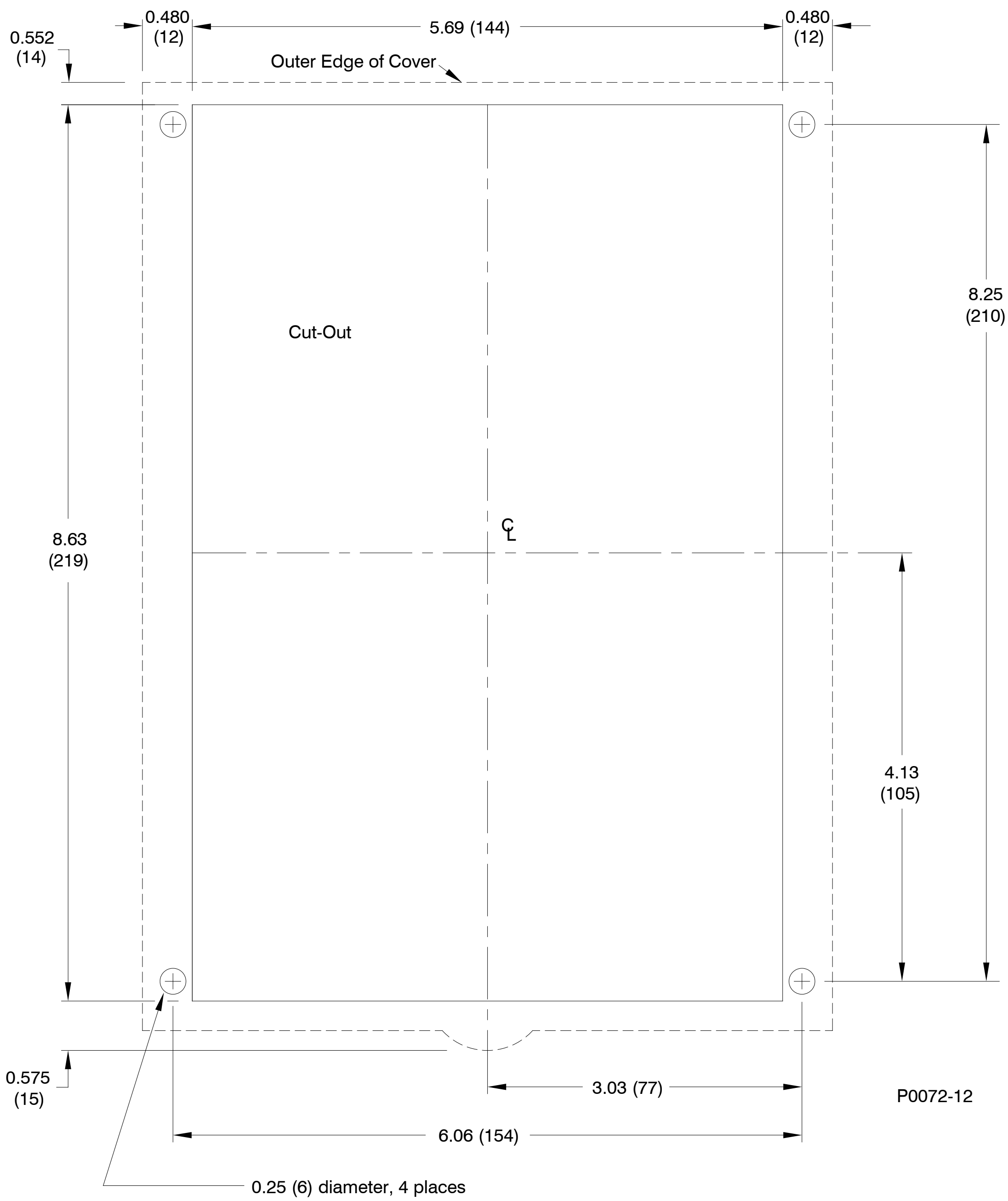


Figure 4-1. Panel Cutting/Drilling, Semi-Flush, S1 Case

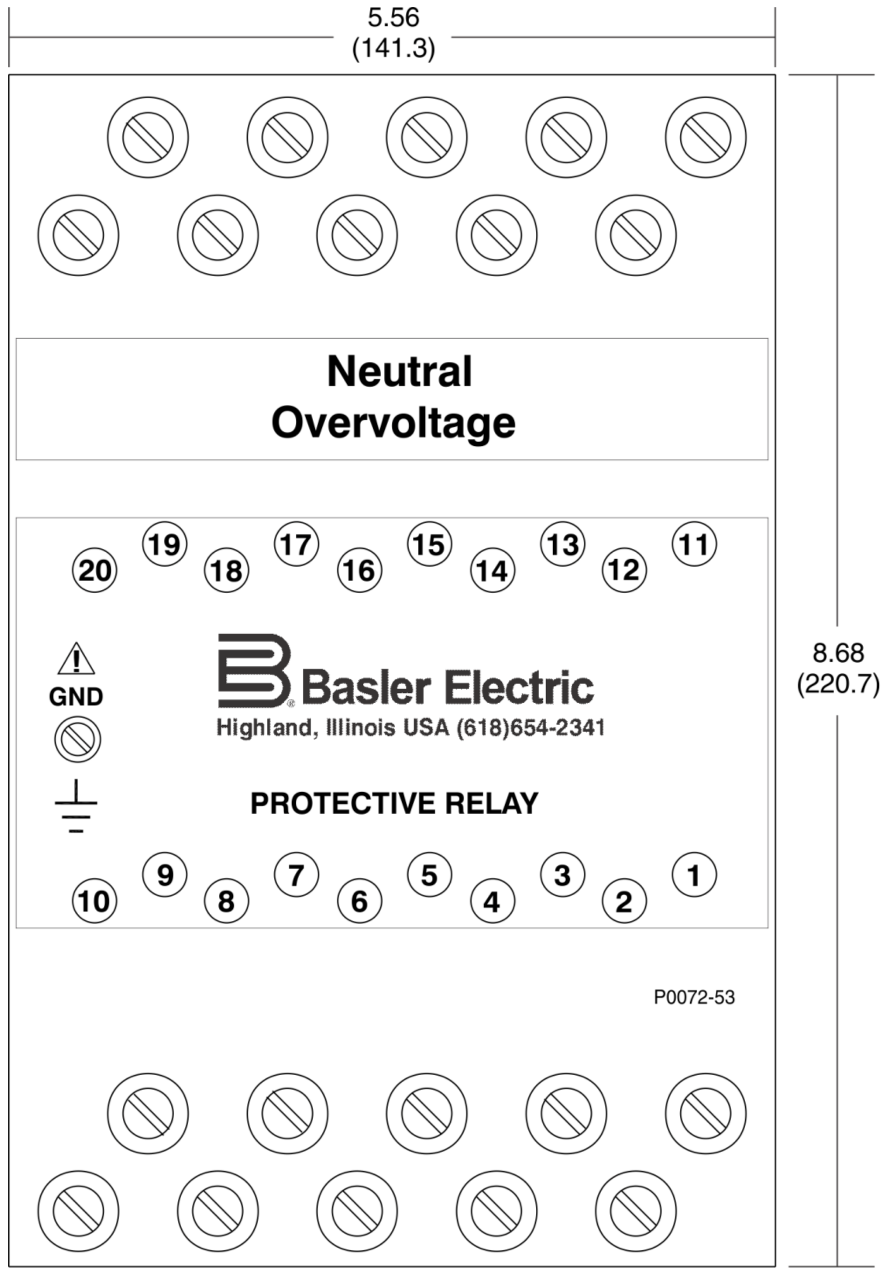


Figure 4-2. S1 Case Dimensions, Rear View, Double Ended, Semi-Flush Mount

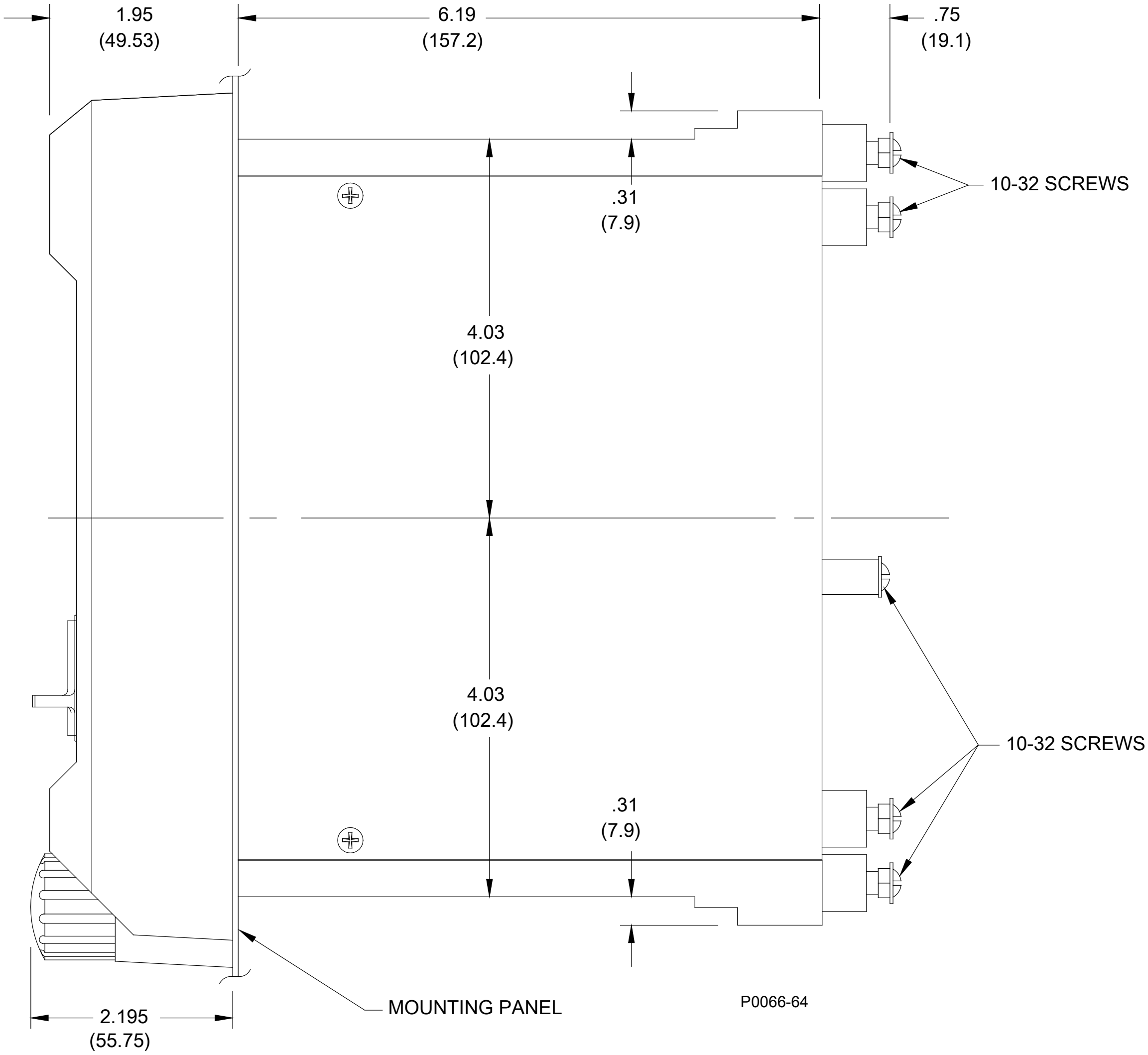


Figure 4-3. S1 Case Dimensions, Side View, Double Ended, Semi-Flush Mount

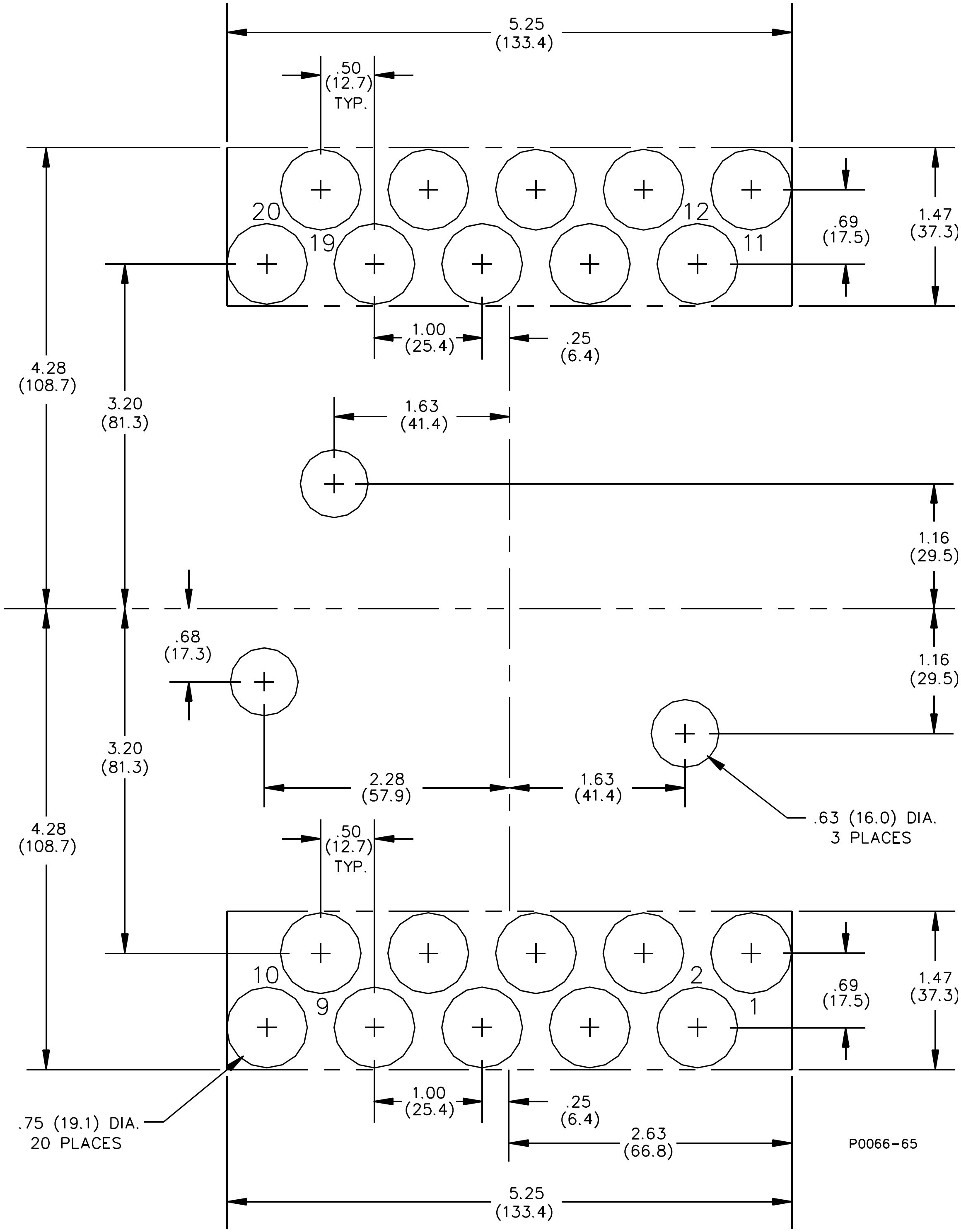


Figure 4-4. Panel Cutting/Drilling, Double Ended, Projection Mount, S1 Case

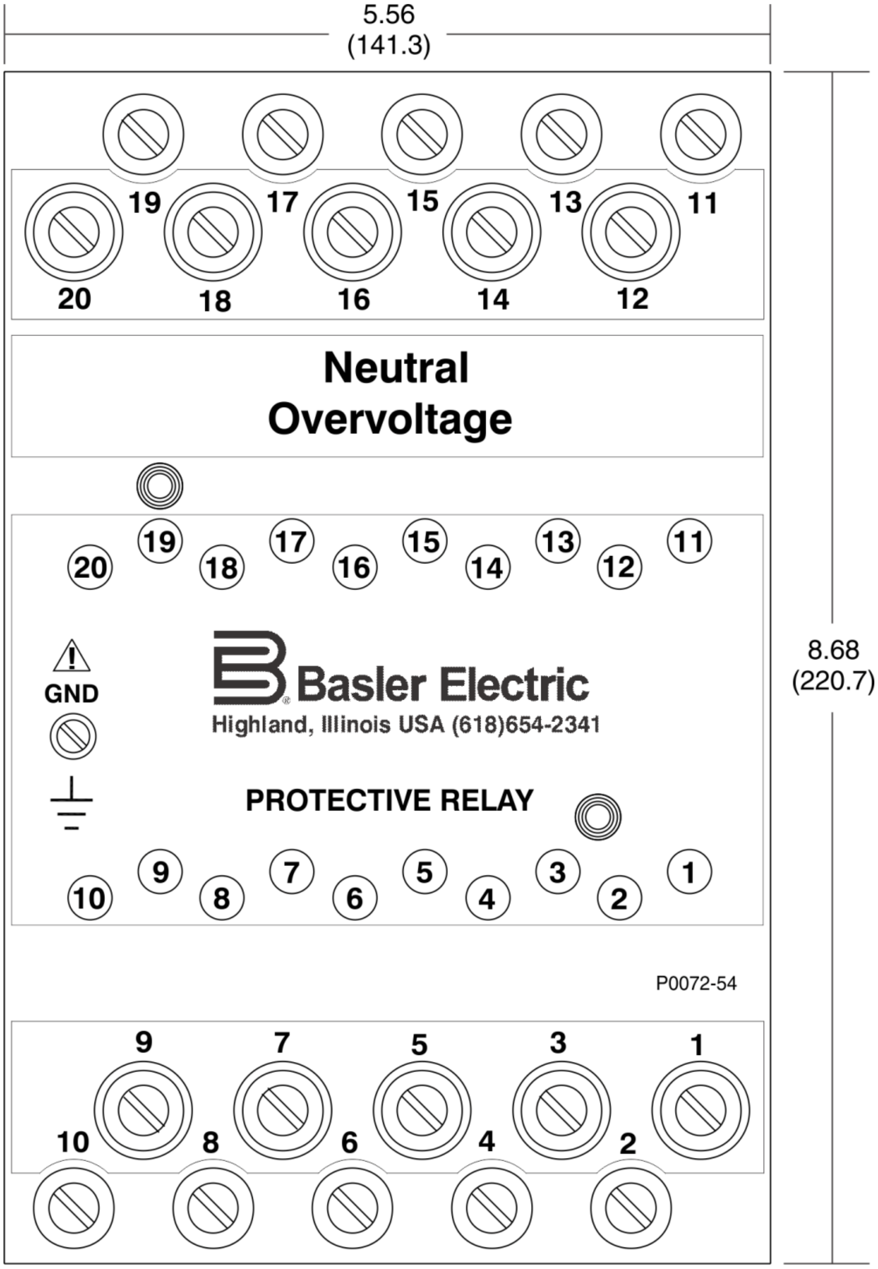


Figure 4-5. S1 Case Dimensions, Rear View, Double Ended, Projection Mount

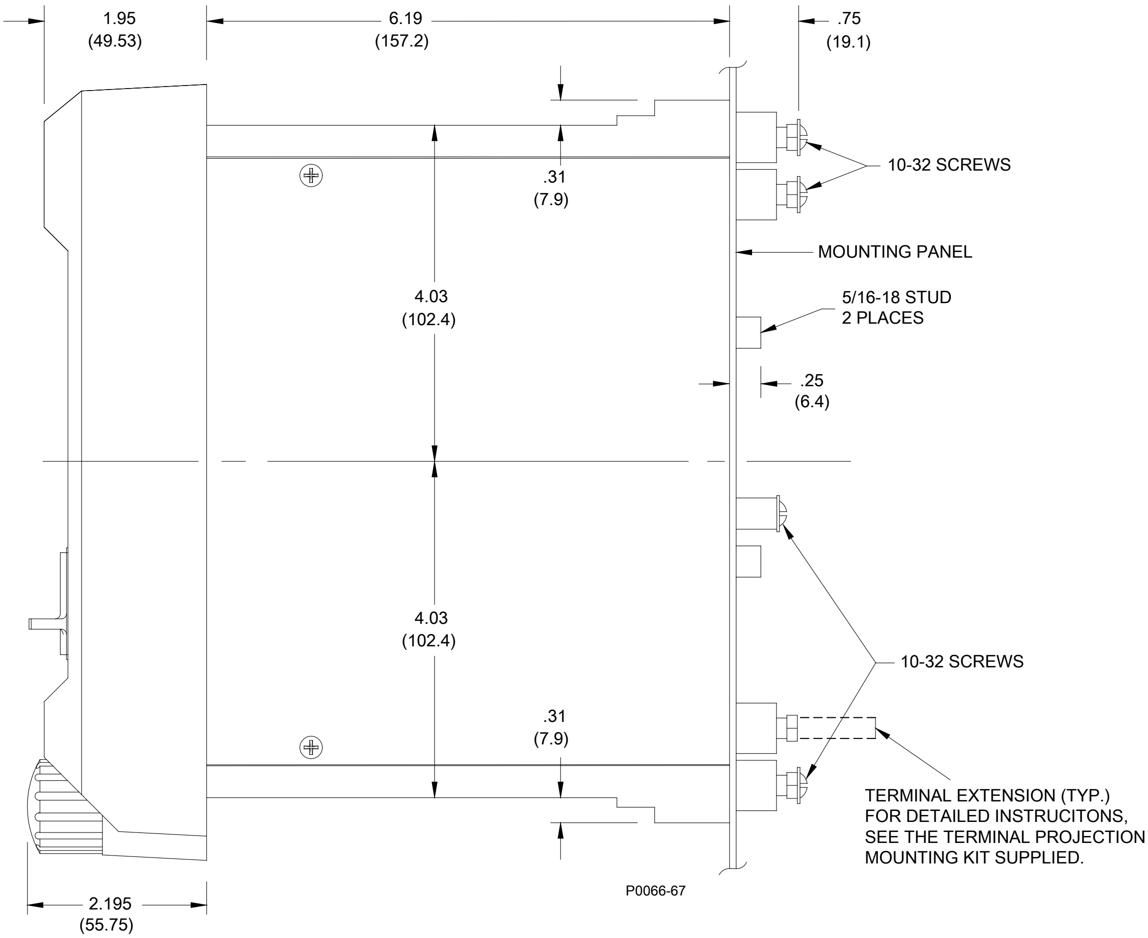


Figure 4-6. S1 Case Dimensions, Side View, Double Ended, Projection Mount

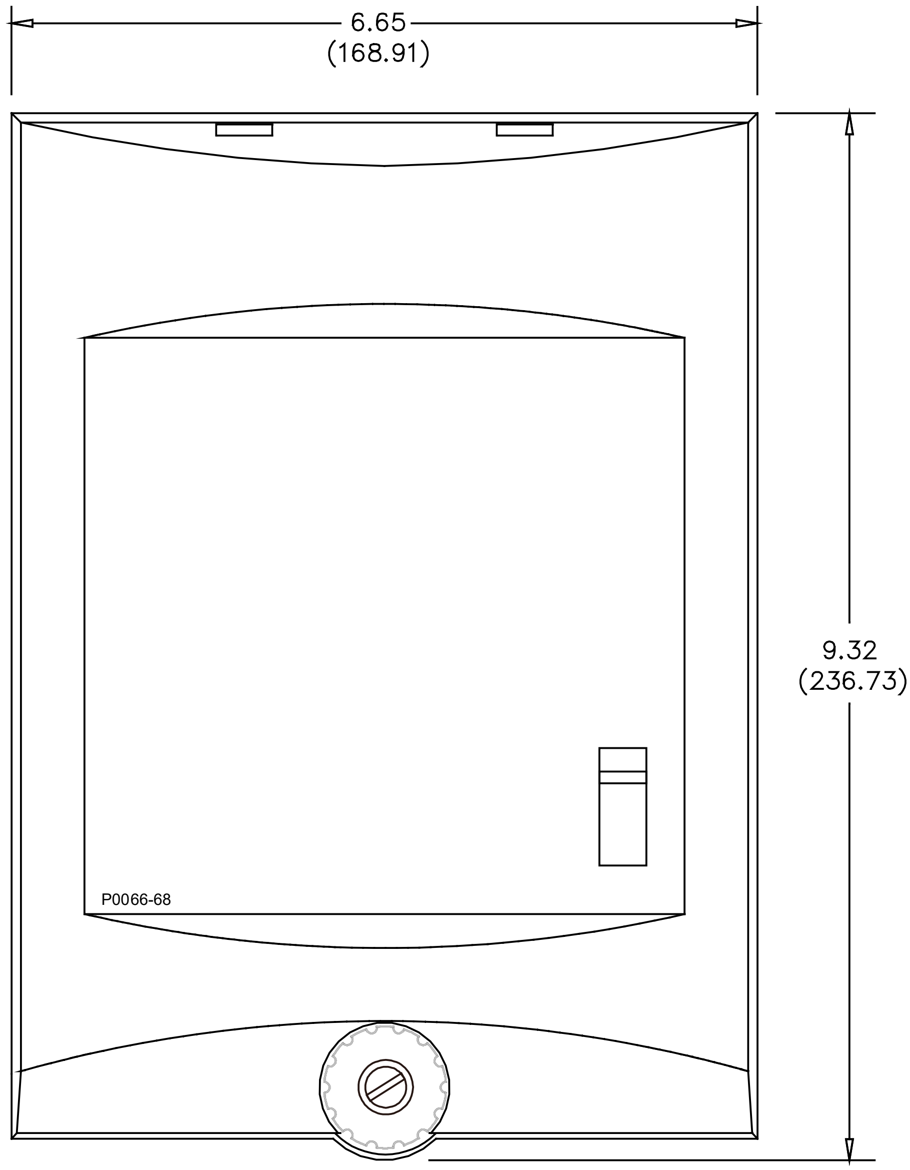


Figure 4-7. S1 Case Cover Dimensions, Front View

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.

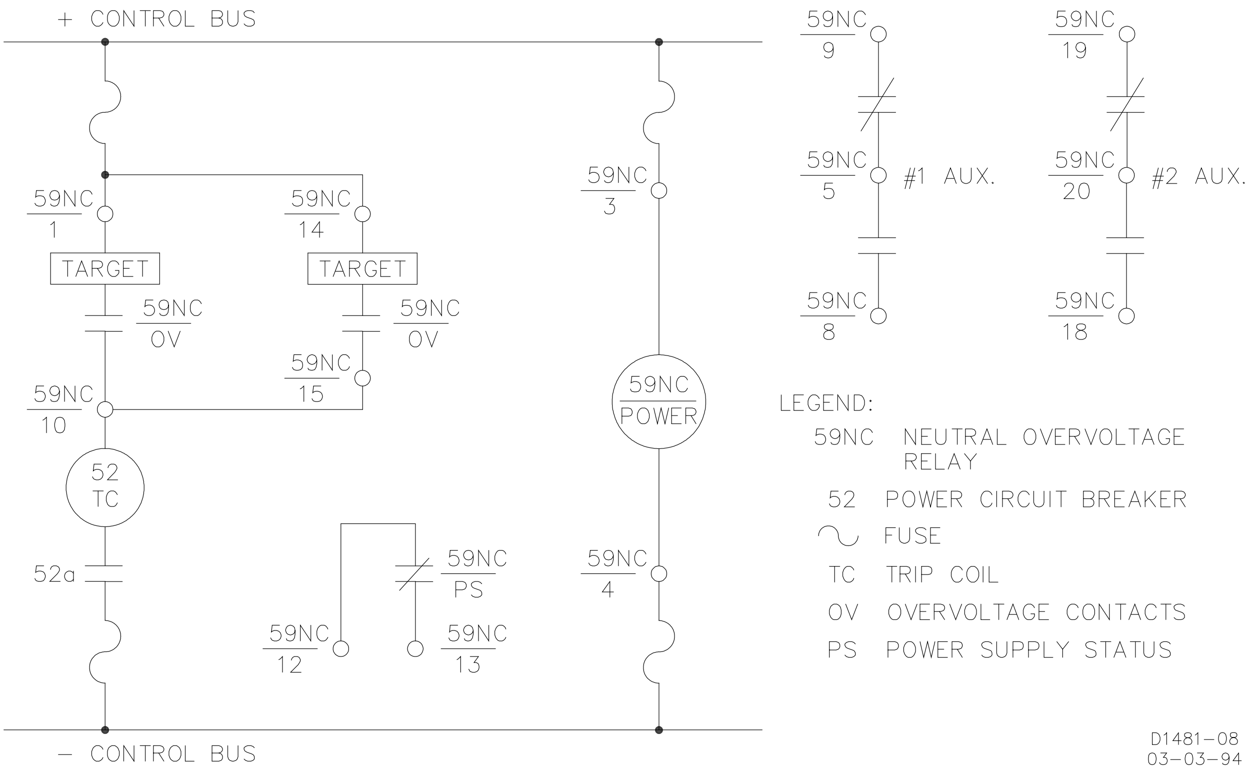


Figure 4-8. Typical Control Circuit Connections

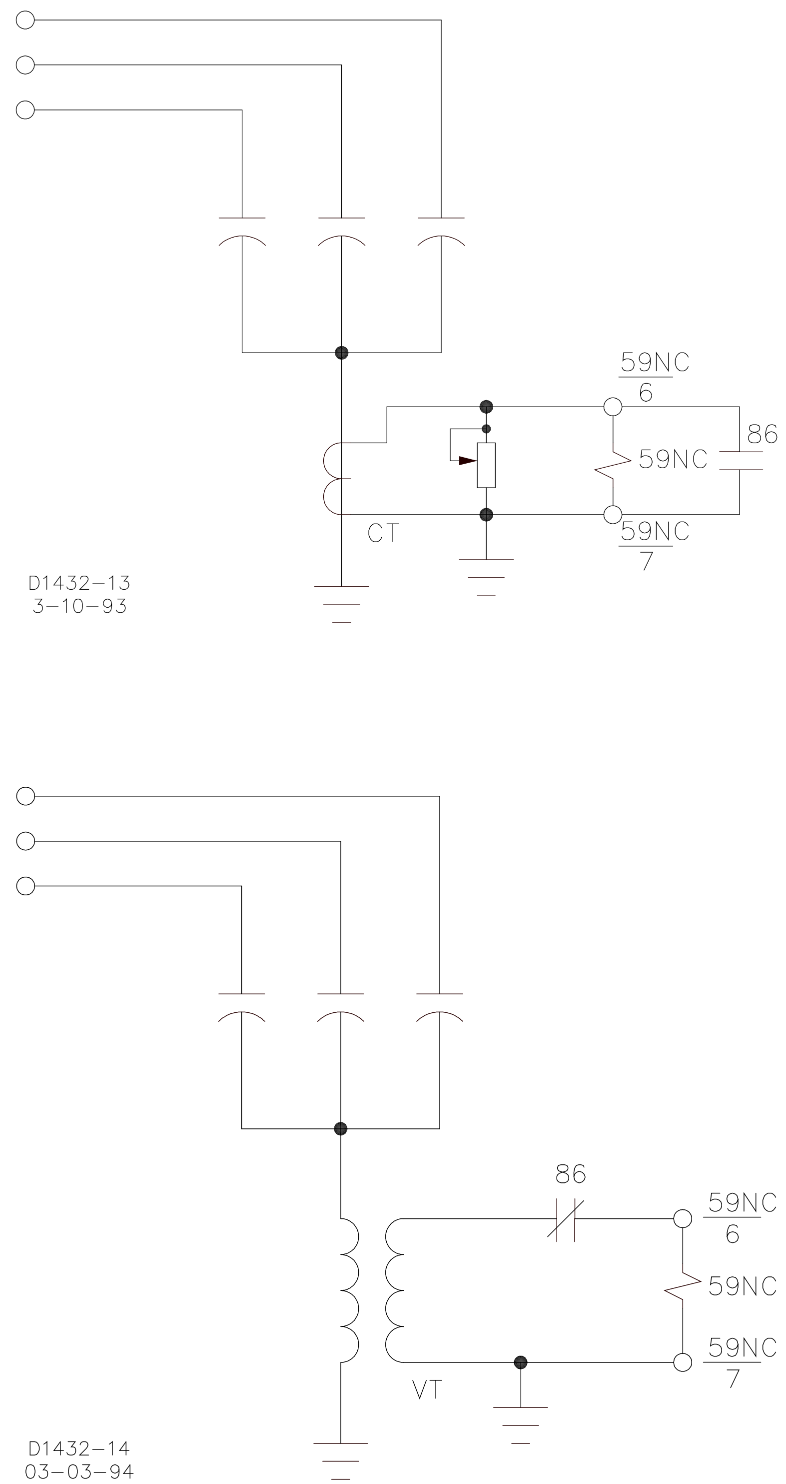


Figure 4-9. Typical Protection Methods

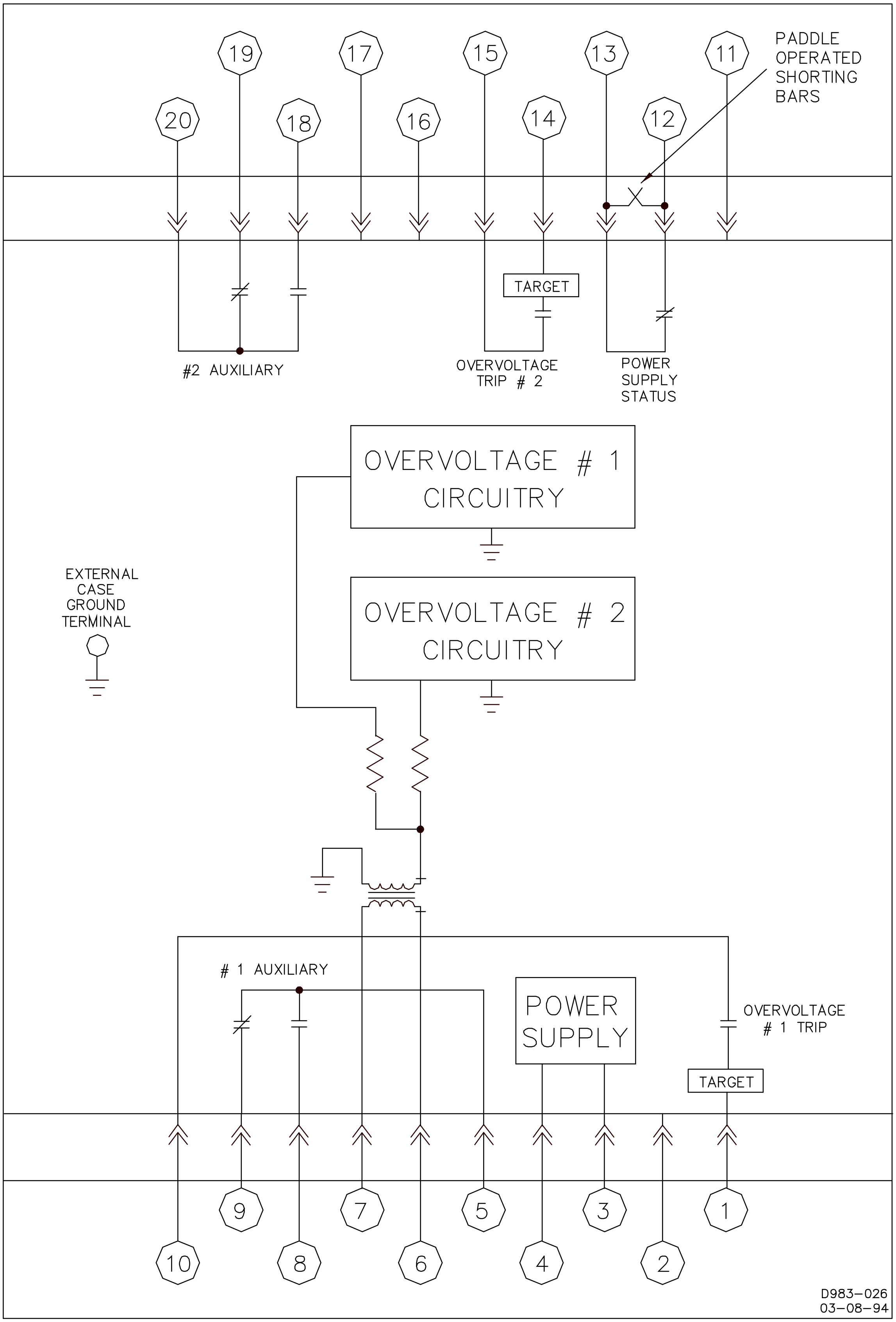


Figure 4-10. Typical Internal Connections

Maintenance

BE1-59NC 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

The following procedures verify proper relay operation and calibration.

Results obtained from these procedures may no fall within specified tolerances. When evaluating results, consider three prominent factors:

- Test equipment accuracy
- Testing method
- External test set components tolerance level

Required Test Equipment

Minimum test equipment required for relay testing and adjustment is listed below.

- Two ac voltage sources and a counter/timer accurate to at least 1.0%.
- Digital voltmeter accurate to within 1% or better.
- Variable AC/DC (0-250V) power supply (for power input).
- DC power supply (for current operated targets).

Operational Test

Step 1. Perform the appropriate test setup for your relay. Use Figure 5-1 for timing option E2 and Figure 5-2 for timing options D1 or D2. On D1, setpoint one is inverse time and setpoint two is definite time.

Step 2. Apply operating power to the relay, verify that the POWER LED is ON, and verify that the power supply status contact is open.

Step 3. Perform the following timing tests as appropriate for your relay.

E2 Timing Option

Step 1. Reference to Figure 5-1, connect an ac voltage source (50 or 60 Hz, depending upon input option) to case terminals 6 and 7. Adjust this voltage to equal the desired overvoltage pickup level for OVERVOLTAGE 1.

Step 2. Starting at maximum CW, slowly turn OVERVOLTAGE 1 PICKUP adjust potentiometer R63 CCW until OVERVOLTAGE 1 PICKUP LED just illuminates.

Step 3. Set OVERVOLTAGE 1 TIME DIAL to 001 and apply to case terminals 6 and 7, a voltage that is 10% greater than the value applied in Step 1.

Step 4. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 5. Set OVERVOLTAGE 1 TIME DIAL to 010. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 6. Set OVERVOLTAGE 1 TIME DIAL to 100. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 7. Set OVERVOLTAGE 1 TIME DIAL to 999. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 8. Adjust the voltage source equal the desired overvoltage pickup level for OVERVOLTAGE 2.

Step 9. Starting at maximum CW, slowly turn OVERVOLTAGE 2 PICKUP adjust potentiometer R43 CCW until OVERVOLTAGE 2 PICKUP LED just illuminates.

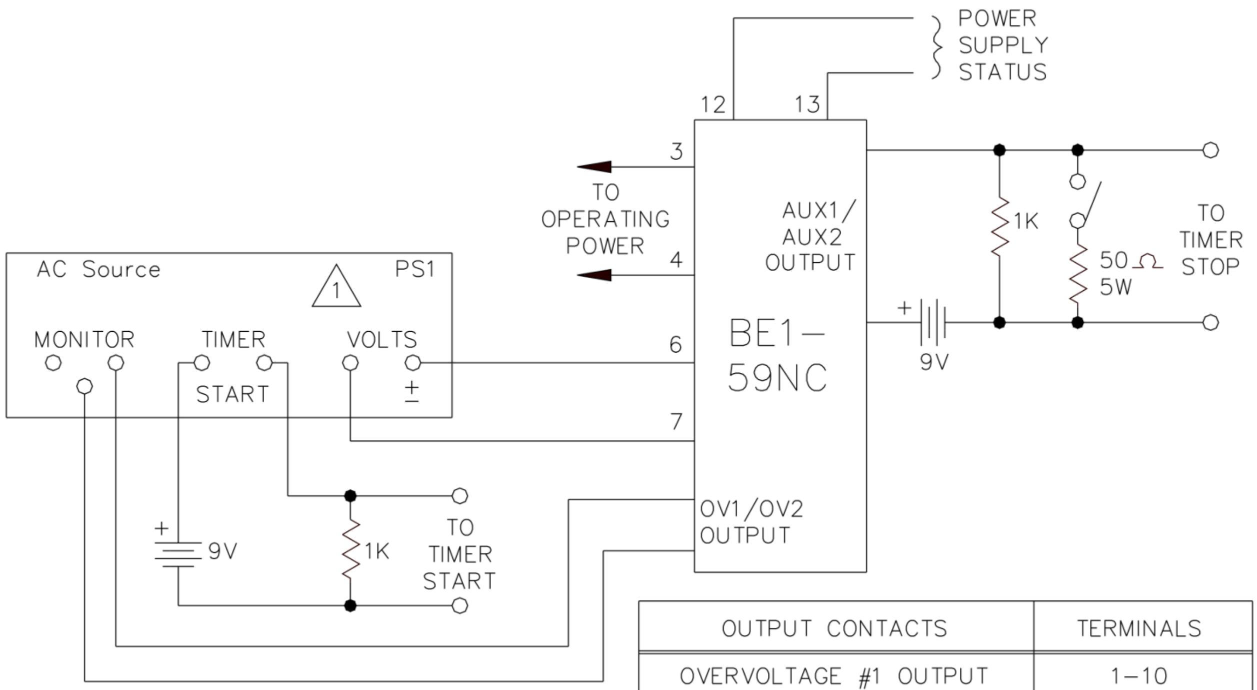
Step 10. Set OVERVOLTAGE 2 TIME DIAL to 001 and apply to case terminals 6 and 7, a voltage that is 10% greater than the value applied in Step 1.

Step 11. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 12. Set OVERVOLTAGE 2 TIME DIAL to 010. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 13. Set OVERVOLTAGE 2 TIME DIAL to 100. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 14. Set OVERVOLTAGE 2 TIME DIAL to 999. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.



OUTPUT CONTACTS	TERMINALS		
OVERVOLTAGE #1 OUTPUT	1–10		
OVERVOLTAGE #2 OUTPUT	14–15		
	NO	COM	NC
OVERVOLTAGE #1 AUXILIARY	8	5	9
OVERVOLTAGE #2 AUXILIARY	18	20	19

Figure 5-1. Typical Test Setup Timing Option E2

D1 Timing Option

Note
In the following inverse time tests, voltage is stepped from one-half of pickup to a voltage that is higher (by value in column for Volts Over Pickup, Table 5-1) than the pickup.

Step 1. With reference to Figure 5-2, set PS1 for the value shown in Table 5-1, input option (column 1) and for the specific pickup voltage (column 2, **Volts Pickup 50/60 Hz**). **Example:** input option 1, PS1 set to 10 volts, at 0°.

Table 5-1. Inverse Time Overvoltage Levels and Delays for Input Options

Input Option (Style NO. 2nd Digit)	Volts Pickup 50/60 Hz	PS1 50/60 Hz Volts @ °	PS2 50/60 Hz Volts @ °	Volts Over Pickup	TIME DIAL			
					11 (Sec.)	33 (Sec.)	55 (Sec.)	88 (Sec.)
1	10	5 @ 0°	13 @ 0°	8	0.612	1.545	2.478	3.876
2	30	15 @ 0°	23 @ 0°	8	0.582	1.534	2.487	3.916
3	21	10.5 @ 0°	26.5 @ 0°	16	0.612	1.545	2.478	3.876
4	60	30 @ 0°	46 @ 0°	16	0.582	1.534	2.487	3.916
5	10	5 @ 0°	13 @ 0°	8	0.612	1.545	2.478	3.876
6	30	15 @ 0°	23 @ 0°	8	0.582	1.534	2.487	3.916
7	21	10.5 @ 0°	26.5 @ 0°	16	0.612	1.545	2.478	3.876
8	60	30 @ 0°	46 @ 0°	16	0.582	1.534	2.487	3.916

Step 2. Adjust the OVERVOLTAGE 1 PICKUP adjust potentiometer R63 so the OVERVOLTAGE 1 PICKUP LED just illuminates.

Step 3. Adjust PS1 and PS2 for the voltage levels and phase angles based on input options as shown in Table 5-1 (columns 3 and 4).

Step 4. Set the OVERVOLTAGE 1 TIME DIAL to 11.

Step 5. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 6. Remove PS1 and PS2 voltage.

Step 7. Set the OVERVOLTAGE 1 TIME DIAL to 33.

Step 8. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 9. Remove PS1 and PS2 voltage.

Step 10. Set the OVERVOLTAGE 1 TIME DIAL to 88.

Step 11. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-1 for OVERVOLTAGE 1, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 12. Remove PS1 and PS2 voltage.

Step 13. Adjust the voltage source to equal the desired overvoltage pickup level for OVERVOLTAGE 2.

Step 14. Starting at maximum CW, slowly turn OVERVOLTAGE 2 PICKUP adjust potentiometer R43 CCW until OVERVOLTAGE 2 PICKUP LED just illuminates.

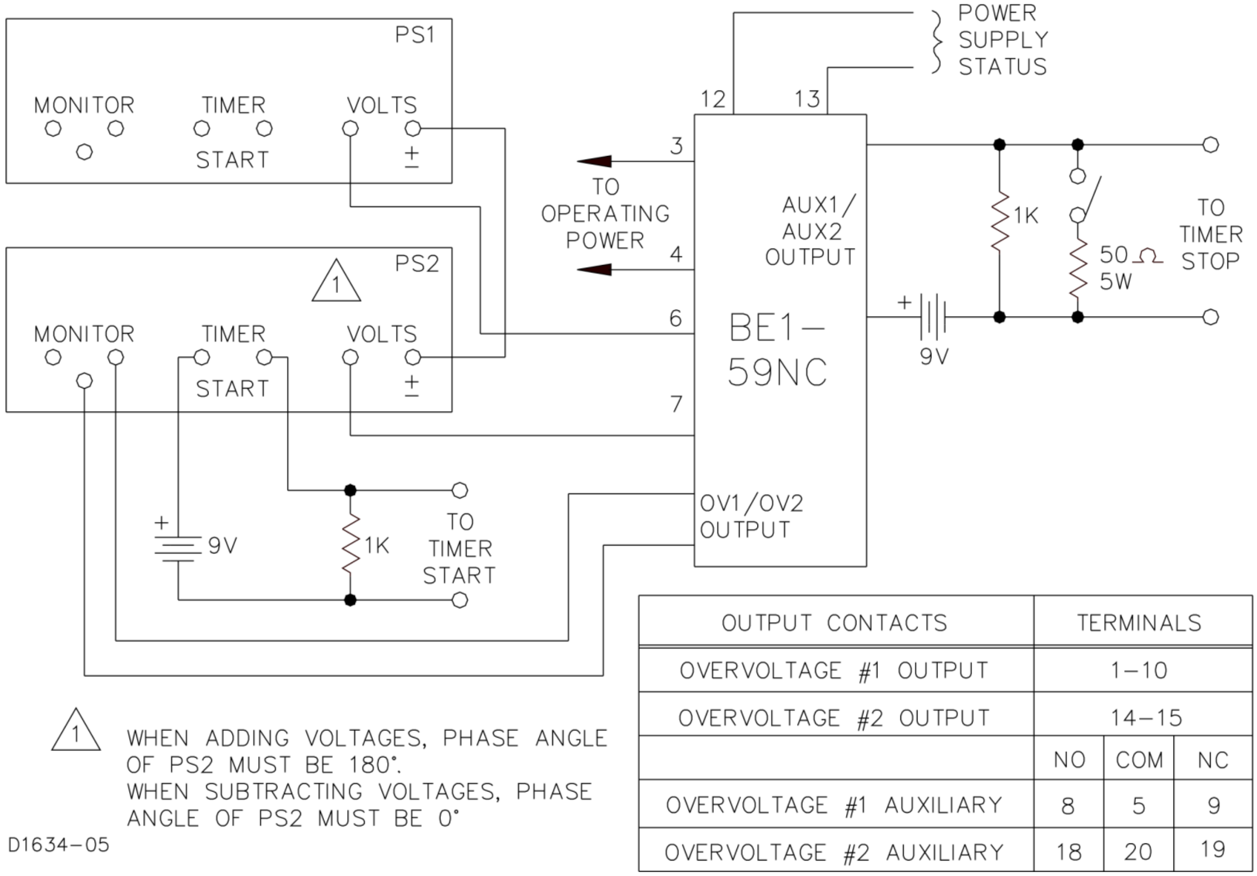
Step 15. Set OVERVOLTAGE 2 TIME DIAL to 001 and apply to case terminals 6 and 7, a voltage that is 10% greater than the value applied in Step 13.

Step 16. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 17. Set OVERVOLTAGE 2 TIME DIAL to 010. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 18. Set OVERVOLTAGE 2 TIME DIAL to 100. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.

Step 19. Set OVERVOLTAGE 2 TIME DIAL to 999. Monitor the output terminals indicated in Figure 5-1 for OVERVOLTAGE 2. Remove, and then reapply the overvoltage at case terminals 6 and 7. Observe the time registered by the counter. Time must equal the setting ±100 milliseconds or 2%, whichever is greater.



OUTPUT CONTACTS	TERMINALS		
OVERVOLTAGE #1 OUTPUT	1–10		
OVERVOLTAGE #2 OUTPUT	14–15		
	NO	COM	NC
OVERVOLTAGE #1 AUXILIARY	8	5	9
OVERVOLTAGE #2 AUXILIARY	18	20	19

Figure 5-2. Typical Test Setup Timing Options D1 or D2

Note
In the following inverse time tests, voltage is stepped from one-half of pickup to a voltage that is higher (by value in column for Volts Over Pickup, Table 5-1) than the pickup.

D2 Timing Option

Step 1. With reference to Figure 5-2, set PS1 for the value shown in Table 5-1, input option (column 1) and for the specific pickup voltage (column 2, **Volts Pickup 50/60 Hz**). **Example:** input option 1, PS1 set to 10 volts, at 0°.

Step 2. Adjust the OVERVOLTAGE 1 PICKUP adjust potentiometer R63 so the OVERVOLTAGE 1 PICKUP LED just illuminates.

Step 3. Adjust PS1 and PS2 for the voltage levels and phase angles based on input options as shown in Table 5-1 (columns 3 and 4).

Step 4. Set the OVERVOLTAGE 1 TIME DIAL to 11.

Step 5. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-2 for OVERVOLTAGE 1, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 6. Remove PS1 and PS2 voltage.

Step 7. Set the OVERVOLTAGE 1 TIME DIAL to 33.

Step 8. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-2 for OVERVOLTAGE 1, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 9. Remove PS1 and PS2 voltage.

Step 10. Set the OVERVOLTAGE 1 TIME DIAL to 88.

Step 11. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-2 for OVERVOLTAGE 1, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 12. Remove PS1 and PS2 voltage.

Step 13. With reference to Figure 5-2, set PS1 for the value shown in Table 5-1 and for the specific input option.

Step 14. Adjust the OVERVOLTAGE 2 PICKUP adjust potentiometer R43 so the OVERVOLTAGE 2 PICKUP LED just illuminates.

Step 15. Adjust PS1 and PS2 for the voltage levels and phase angles based on input options as shown in Table 5-1.

Step 16. Set the OVERVOLTAGE 2 TIME DIAL to 11.

Step 17. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-2 for OVERVOLTAGE 2, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 18. Remove PS1 and PS2 voltage.

Step 19. Set the OVERVOLTAGE 2 TIME DIAL to 33.

Step 20. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-2 for OVERVOLTAGE 2, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 21. Remove PS1 and PS2 voltage.

Step 22. Set the OVERVOLTAGE 2 TIME DIAL to 88.

Step 23. Reset the timer. Turn on PS1. While monitoring the output terminals indicated in Figure 5-2 for OVERVOLTAGE 2, initiate PS2 and record the time delay. Verify that the time is within 5.0% or 25 milliseconds (whichever is greater) of the time shown in Table 5-1.

Step 24. Remove PS1 and PS2 voltage.

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