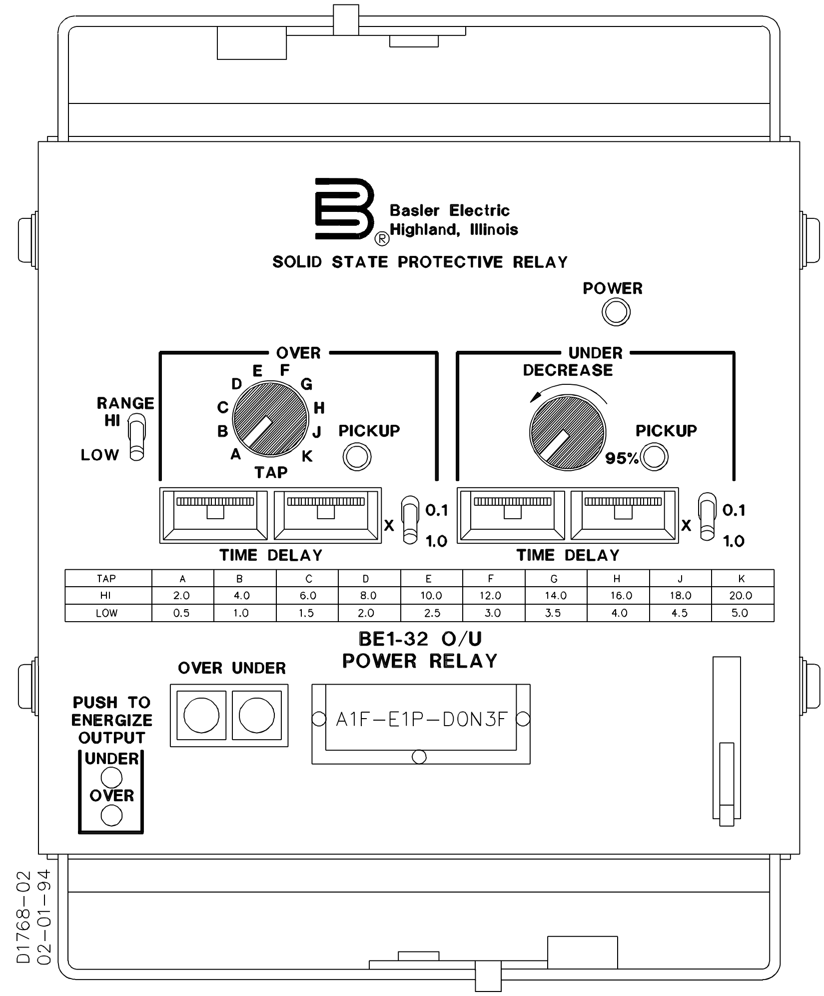
INSTRUCTION MANUAL

FOR
DIRECTIONAL POWER RELAYS
BE1-32R AND BE1-32 O/U



Basler Electric

Publication Number: 9 1711 00 990
Revision: K 08/2001

INTRODUCTION

This Instruction Manual provides information concerning the operation and installation of BE1-32R, O/U Directional Power Relays. To accomplish this, the following is provided.

- Specifications
- Functional characteristics
- Installation
- Operational Tests
- Mounting Information

WARNING
To avoid personal injury or equipment damage, only qualified personnel should perform the procedures presented in this manual.

First Printing: September 1986

Printed in USA

August 2001

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

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SECTION 1 • GENERAL INFORMATION

PURPOSE

BE1-32R, Directional Overpower and BE1-32 O/U, Directional Over/Underpower Relays sense real power (IE times cos θ). These relays are solid state devices that are designed for use in single-phase or three-phase systems to provide equipment protection for overpower and/or underpower, or for use in the supervisory control of circuits.

APPLICATION

Directional Power Relays are typically used in applications where excessive power flow in the tripping direction is bad. Some examples in which over and/or underpower protection is desirable are as follows.

Example:

1. Where power flows into a generator, indicating loss of prime mover torque (motoring).
2. Where power flows into the secondary of a station distribution transformer, indicating an industrial or private customer is supplying power into the utility system.
3. Where excessive load has been connected to a system.
4. Where overload has been placed on a distribution system.
5. Where overspeeding is a prime concern.
6. Where an open breaker creates an overload on a local generation facility.
7. Where loss of excitation can be determined by VAR sensing.

Example 1, Anti-Motoring

When a synchronous generator, operating in parallel with a power system, loses prime mover torque, it remains in synchronism with the system and continues to run as a synchronous motor. Motoring draws power from the system to drive the prime mover and can cause severe damage to the prime mover. Steam turbines require a constant flow of steam to remove the heat caused by turbulence or cavitation on or about the blades. Without this flow of steam, heat builds up and may cause softening or distortion of the turbine blades. Diesel engines and gas turbines are less susceptible to immediate damage, but unburned fuel may present a fire or explosion hazard.

BE1-32 Directional Power Relays can detect power flow into the generator and disconnect the generator before the prime mover sustains inevitable damage. Unlike the conditions arising from faults, the electrical conditions involved in anti-motoring protection are balanced. Therefore, single-phase relay protection is adequate. Figure 1-1 shows connections for single-phase relay (type B or V sensing). This connection measures real power if the system voltages are balanced.

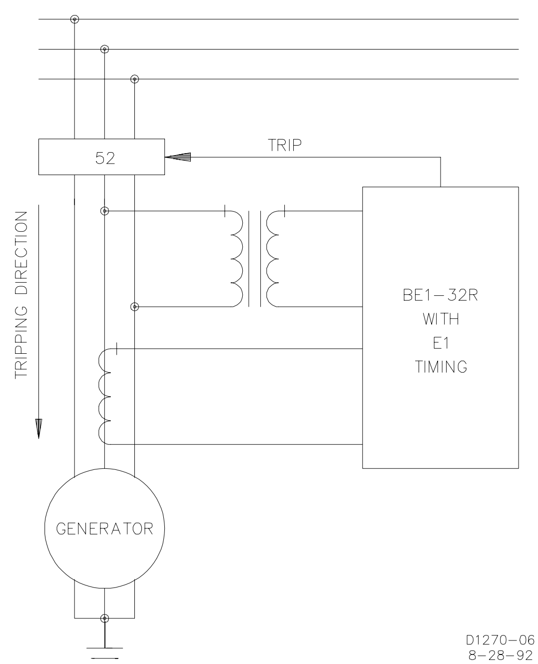


Figure 1-1. Single-Phase Motoring Protection

The BE1-32R, Reverse Power Relay must be sensitive enough to detect power levels lower than those required to motor the generator. Sensitivity is much more important on steam and hydro turbines than on reciprocating engines and gas turbines.

Table 1-1 represents the reverse power requirements to motor a generator when the prime mover is rotating at synchronous speed with no input power supplied by the prime mover.

Table 1-1. Motoring Reverse Power Requirements

Prime Mover Type	Percent Of Rated kW
Hydro turbines	0.2 to 2.0
Steam turbines (condensing/non-condensing)	3.0 / ≥ 3.0
Diesel engine (No cylinders firing)	25
Gas turbines	50 (due to compressor load)

The Reverse Power Relay is generally set for levels as low as possible with steam turbines typically being set not higher than three percent and diesels and gas turbines slightly below ten percent.

Time delays are usually employed to avoid nuisance tripping caused by reverse power transient surges that may result from synchronizing or other system disturbances. These time delays are typically set from 2 to 10 seconds, but may be set as high as 30 seconds or more.

Example 2, Co-Generator Control

In example 2, co-generation concepts are addressed. To illustrate, assume that the co-generation system has automatic engine controls, an auto synchronizer, automatic kW, and kVAR controls. The system operates virtually by itself. The only lacking function is the start/stop signals to the generators. Two system configurations may be implemented to generate contact closures for start/stop signals.

The first configuration (Figure 1-2) shows a directional power relay connected to the utility to sense kW. The pickup point of the relay is set at the maximum desired utility power level. When the utility power level exceeds the relay pickup point, the output relay contact closes and the generator is automatically started and paralleled with the utility. A time delay is generally included in the start circuit of about 15 or more seconds to ignore transient overload conditions.

When the generator is paralleled and loaded, the kW signal of the utility decreases by the amount of load the generator has accepted. An underpower relay can measure utility power and generate a stop signal when the utility power decreases below a selected level. A time delay is typically provided for the stop signal of one minute or more (however, time delays are totally user controlled). The Basler Electric Model BE1-32 O/U Power Relay incorporates both overpower and underpower sensing in a single relay unit and is ideal for this type of application.

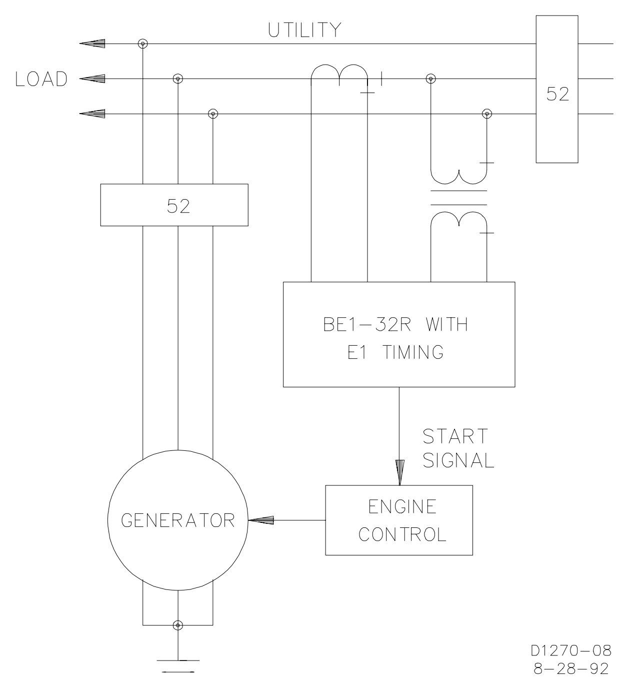


Figure 1-2. Power Relay Start Control

In the second configuration the start signal is generated in the same manner as that of Figure 1-2. The start signal setpoint may be set above the import power setting. The stop signal will require an underpower relay on the generator output. This system is illustrated in Figure 1-3.

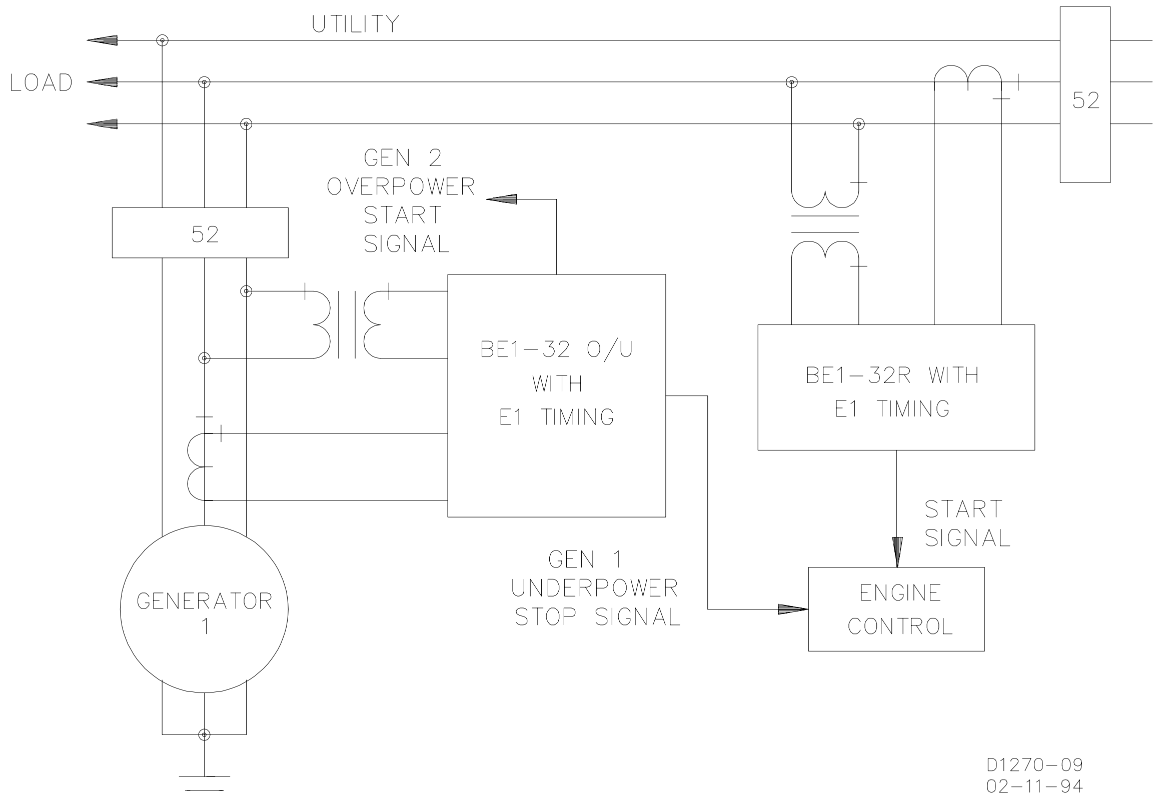


Figure 1-3. Power Relay Start/Stop Control

Example 3, Generator Overload

When excessive load has been connected to a generating system, the directional power relay can initiate corrective action. Corrective action could be energizing an alarm to alert the station operator. For automated systems, corrective action could be initiating the sequence to either shed noncritical load or to start and parallel an in-house generator to assume the excess load.

Example 4, Intertie

Another typical use of the directional power relay, addressing excessive load, concerns distribution protection, see Figure 1-4. A high voltage bus supplies two transformers (T1 and T2). Both transformers (T1 and T2) can supply all connected load, however, neither T1 nor T2 alone can supply the total load. The BE1-32 O/U, over/underpower directional relays can protect this distribution system by providing overload protection for each transformer (overpower function) or by sensing power flow through the transformers (reverse power function) in an undesired direction.

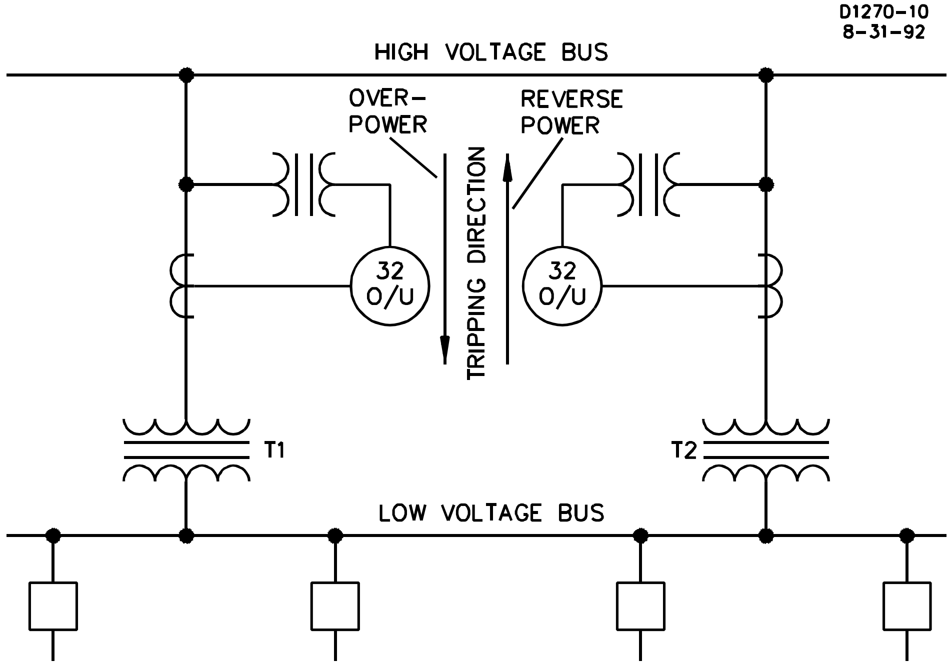


Figure 1-4. Power Relay Distribution Protection

Example 5, Delayed Electrical Trip

On large steam units, where overspeeding is a prime concern, a reverse power relay can be used to supervise electrical tripping (field and main ac breakers) for selected relay operations (e.g. non-electrical trips, loss of field relay), as shown in Figure 1-5. The reverse power relay delays breaker tripping until trapped steam has been removed from the piping. In this case, as separate direct-tripping anti-motoring relay can be used to protect for situations not related to an automatic shutdown of the unit.

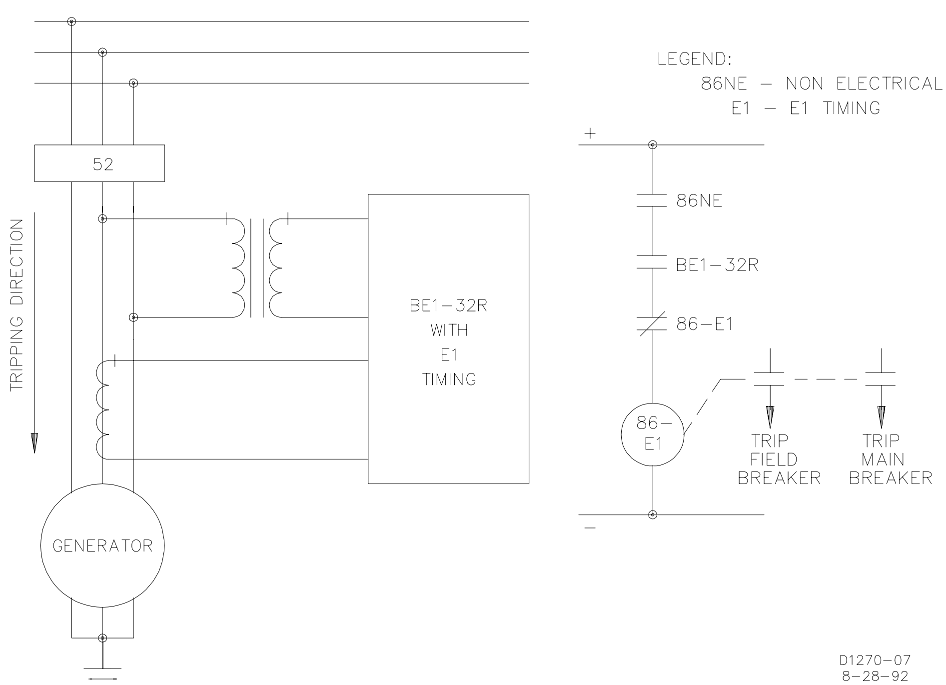


Figure 1-5. Single-Phase, Non-Electrical Trip Supervision

Example 6, Breaker Opening Detection

Figure 1-6 shows a reverse power relay used to detect the opening of a source at an industrial (or other independent generation) location. A location with no generation but multiple ties from a common source is a good candidate for this relay application. With local generation, the relay is applicable if the local generation is not to deliver real power to the utility.

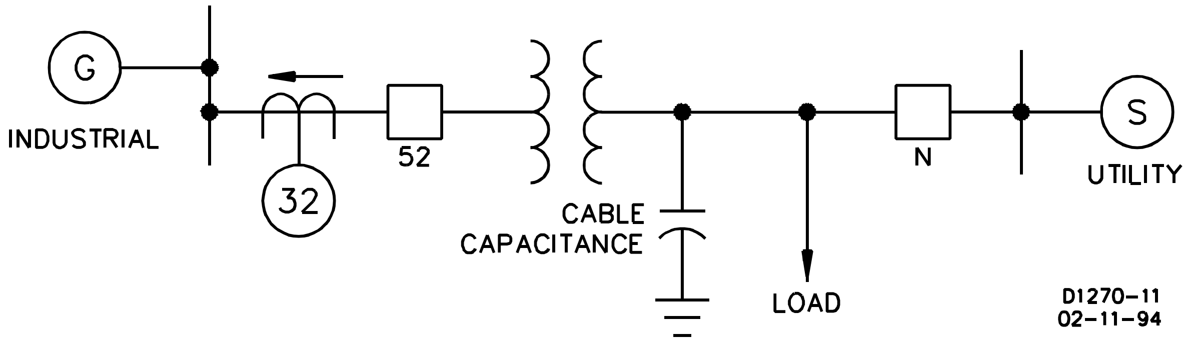


Figure 1-6. Breaker Opening Detection

Under near floating conditions (minimal flow of real power from the utility), the relay can encounter a wide range of power factor angles in the first and second quadrants, reference Figure 1-7. If the local generation is underexcited, reactive power is supplied by the utility and operation is in the first quadrant. Figure 1-7 shows the range of power factor angles (also in the first two quadrants) under heavy line loading. Because of these power factors, the relay must not operate for any angle in the first and second quadrants.

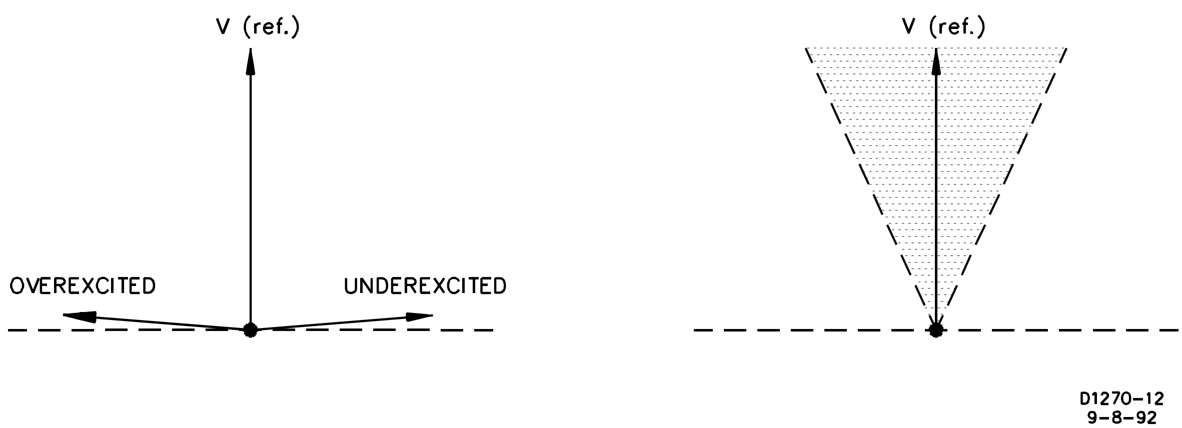


Figure 1-7. Power Factor, First And Second Quadrants

When breaker N opens, operation transfers to the third or fourth quadrants, reference Figure 1-8. If transformer exciting current predominates, operation falls in the third quadrant. If cable charging current predominates, operation falls in the fourth quadrant. In either case, the transformer losses must be supplied. In Figure 1-8, a real current component of four milliamperes is shown and represents core losses of the transformer (about 0.1% of rated).

When breaker N opens, real power reverses from normal and flows toward the utility. This power may be flowing to the tapped load. At this time, the relay operates and causes the 52 breaker to open.

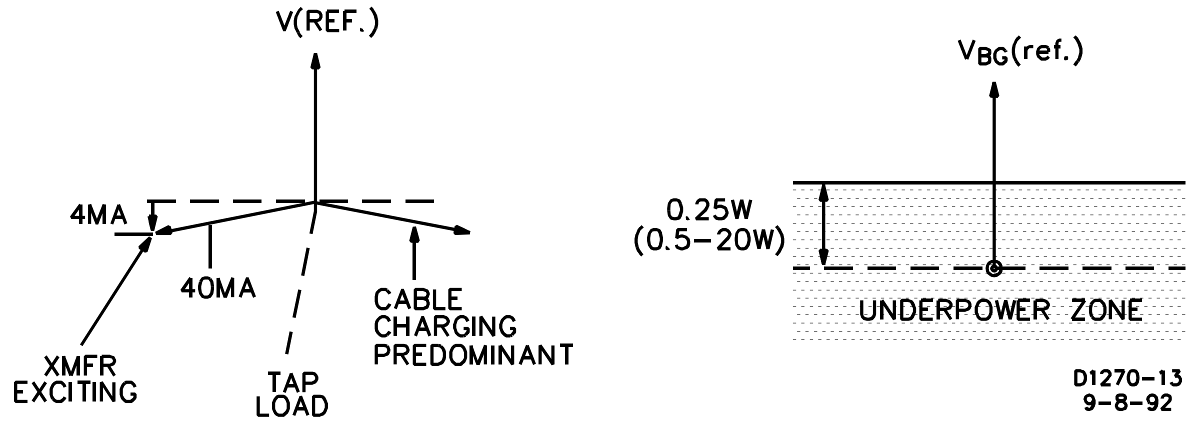


Figure 1-8. Power Factor, Third And Fourth Quadrants

Figure 1-9 (a) shows an underpower tripping application based on the BE1-32 O/U, model A1F with an overpower setting of 0.5 watts and an underpower setting of 50%. The control circuit for this application is shown in Figure 1-9 (b). Figure 1-8 (b) shows the operating characteristic in the first and second quadrant. The relay UNDER contact closes to trip the breaker when the real power flow from the utility drops below 0.25 watts. Because this contact is preclosed at the instant of breaker closing, the trip circuit must be disabled by a timing relay (62) until after the breaker has closed.

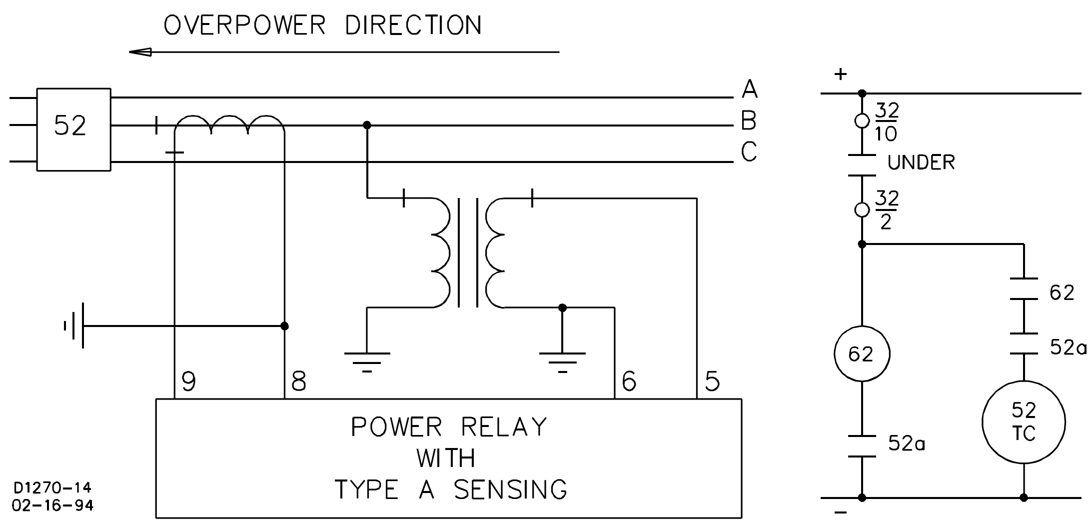


Figure 1-9. Underpower Tripping

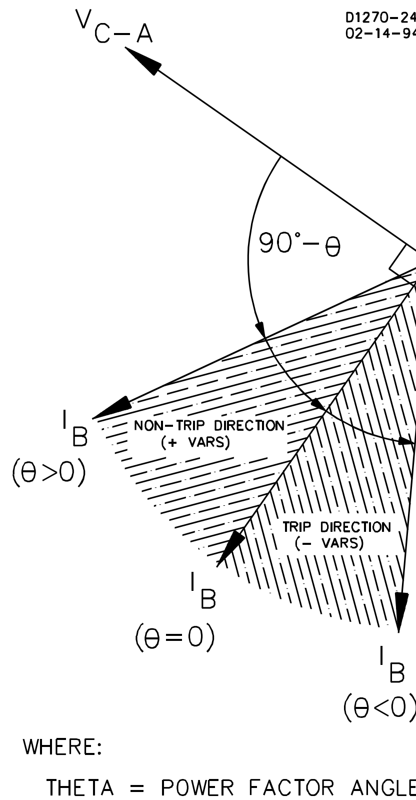
Example 7, Reactive Power (VARS) Detection

This example illustrates a directional power relay configured to distinguish between real and reactive power. Real power (watts) is supplied to the synchronous generator by the prime mover, and reactive power (VARS) is supplied to the field by the exciter. When field excitation is significantly reduced and the connected system can provide sufficient reactive power to maintain the generator's terminal voltage, reactive power flows into the machine and causes it to operate as an induction generator with essentially the same kW output. This situation causes two major problems. First, the additional reactive loading of the faulty generator must be redistributed to other synchronous generators on the system. Secondly, a synchronous generator is not designed to operate as an induction generator. Excessive heating results in the damper (amortissuer) windings, slot wedges, and in the surface iron of the rotor due to the slip frequency current flow when a synchronous generator is operated as an induction generator.

BE1-32R and BE1-32 O/U Directional Power Relays are designed to respond to true power (P) as defined by the equation:

$$P = EI(\cos \Theta)$$

where, P = real power (watts)
I = effective current
E = effective emf or system voltage
Θ = the power factor angle



However, reactive power (Q) is defined by the equation:

$$Q = EI(\sin \Theta).$$

Using the trigonometric identity $\sin \Theta = \cos(\Theta - 90°)$

then: $Q = EI(\cos(\Theta - 90°))$

If the phase of the sensed voltage is shifted +90°, the true power relay can be used to monitor reactive power. In practice, this can be accomplished by applying the appropriate line-to-line voltage to a true power measuring relay designed for line-to-neutral sensing. Figure 1-10 illustrates how a single-phase BE1-32R or BE1-32 O/U can be connected to measure either real power (watts) or reactive power (vars) flow in a three-phase system. Notice the difference of phase relationship between the alternate connections in Figure 1-10.

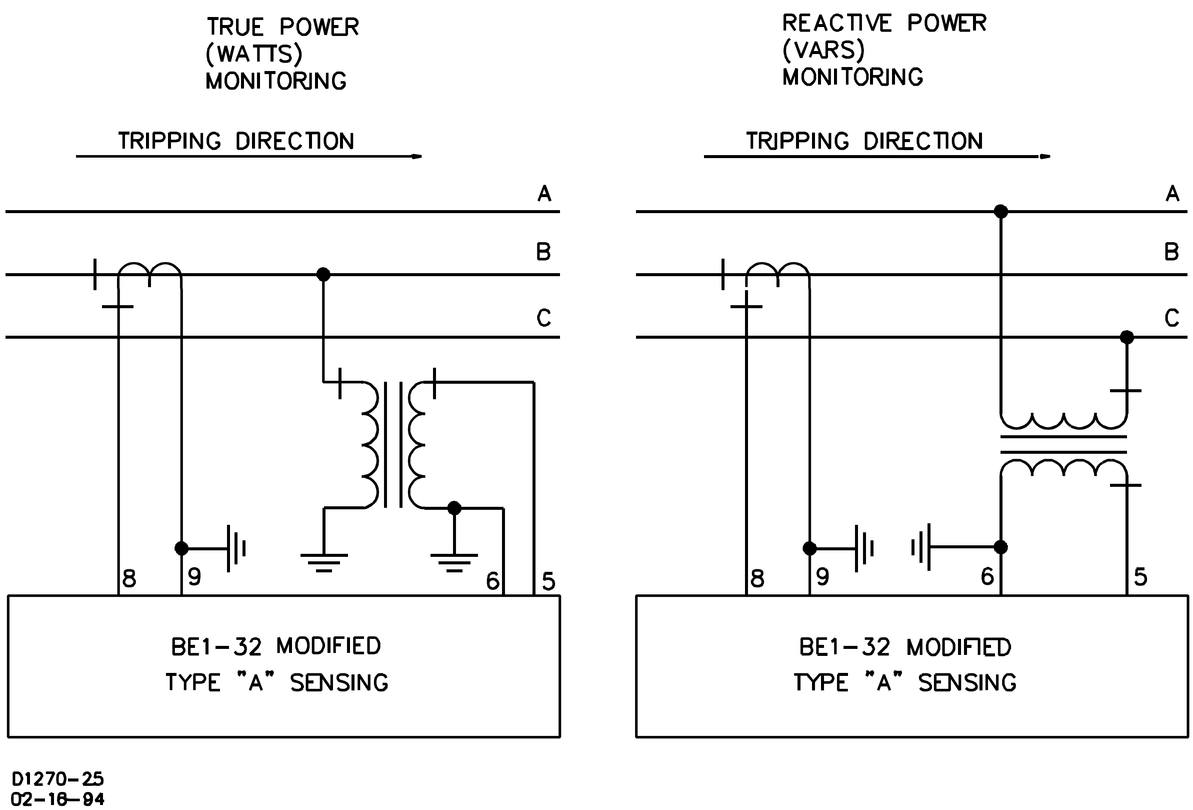


Figure 1-10. Modified Type A Sensing

MODEL AND STYLE NUMBER DESCRIPTION

BE1-32R and -32 O/U Directional Power Relays electrical characteristics and operational features are defined by a combination of letters and numbers that make up the style number. Model numbers BE1-32R or BE1-32 O/U designate the relay as a Basler Electric, Class 100, Directional Power Relay. The model number, together with the style number, describe the options included in a specific device, and appear on the front panel, drawout cradle, and inside the case assembly. Upon receipt of a relay, be sure to check the style number against the requisition and the packing list to ensure that they agree.

SAMPLE STYLE NUMBER

Style number identification chart (Figure 1-11) defines the electrical characteristics and operational features included in BE1-32R, -32 O/U relays. For example, if the model number of the relay was BE1-32R, and the style number was **A1G-A1P-A0N1F**, the device would have the following features:

A - Single-phase current sensing, L-N voltage sensing
1 - 120 Vac, 4 to 200 W
G - One output relay with normally closed contacts
A1 - Instantaneous timing characteristics with one setpoint
P - 125 Vdc power supply
A - One internally operated target
O - None
N - None
1 - One auxiliary output relay, normally open
F - Semi-flush mounting case

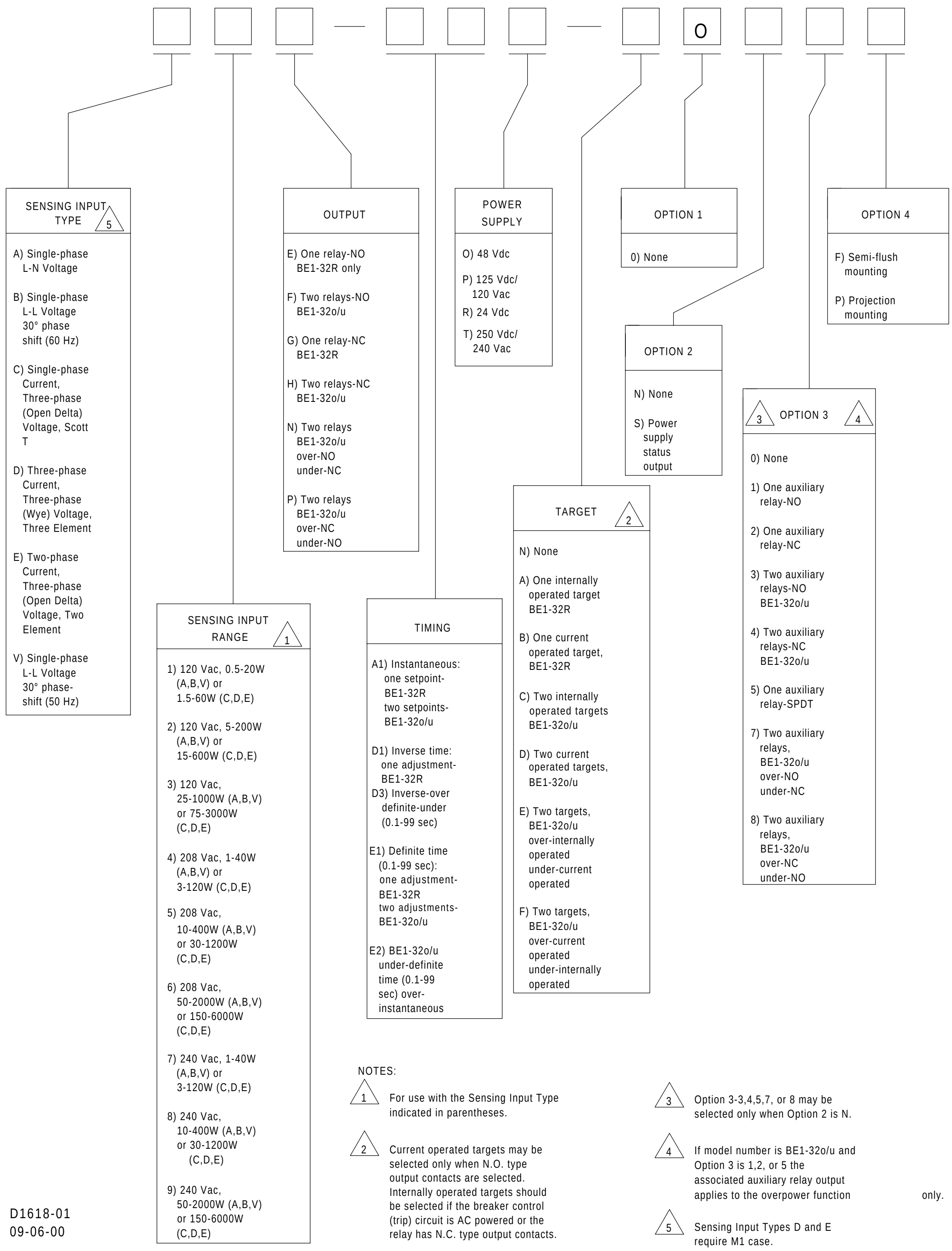


Figure 1-11. Style Number Identification Chart

SPECIFICATIONS

Current Sensing

BE1-32R and -32 O/U Directional Power Relays are designed for use with five amperes nominal (50/60 HZ) system current transformer secondaries. The input sensing current transformers within the relay are rated as follows:

1.) If sensing input range 1, 4, or 7 is selected, input current transformers are capable of 7 amperes continuous current, 10 amperes for 1 minute and 140 amperes for 1 second.

2.) If sensing input range 2, 3, 5, 6, 8, or 9 is selected, input current transformers are capable of 10 amperes continuous current, 15 amperes for 1 minute and 200 amperes for 1 second.

Refer to Table 1-2 for current sensing burden.

Table 1-2. Current Sensing Burden In Ohms

	Sensing Input Range					
	1, 4, 7		2, 5, 8		3, 6, 9	
Range	Low	High	Low	High	Low	High
Tap A	4.811	0.400	0.096	0.022	0.013	0.010
Tap B	2.466	0.240	0.058	0.019	0.012	0.010
Tap C	1.677	0.190	0.045	0.018	0.011	0.010
Tap D	1.277	0.165	0.039	0.018	0.011	0.010
Tap E	1.036	0.151	0.034	0.017	0.011	0.010
Tap F	0.874	0.142	0.032	0.017	0.011	0.010
Tap G	0.760	0.134	0.030	0.017	0.011	0.010
Tap H	0.674	0.129	0.029	0.017	0.011	0.010
Tap J	0.611	0.126	0.028	0.017	0.010	0.010
Tap K	0.556	0.123	0.027	0.017	0.010	0.010

Voltage Sensing

Voltage signals are provided by the secondaries of standard potential transformers (100/200, 50 Hz or 120/240, 60 Hz) with less than 1 VA burden per phase at nominal. Continuous voltage rating is limited to 150% of nominal.

Targets

Magnetically latching, manually reset target indicators are optionally available to indicate that a trip output contact has been energized. Either internally operated or current operated targets may be selected. Current operated targets require a minimum of 0.2 ampere flowing through the output trip circuit, and are rated at 30 amperes for 1 second, 7 amperes for 2 minutes, and 3 amperes continuously. Internally operated targets should be selected if the relay has normally closed output contacts.

Output Circuits Output contacts are rated as follows:

Resistive:

120/240 Vac	Make 30 A for 0.2 seconds, carry 7 A continuously, and break 7 A.
250 Vdc	Make 30 A for 0.2 seconds, carry 7 A continuously, and break 0.3 A.

Inductive:

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

Power Supply

Table 1-2. Power Supply Specifications

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
O (Mid Range)	48 Vdc	24 to 150 Vdc	5.0 W
P (Mid Range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	5.2 W 15.1 VA
†R (Low Range)	24 Vdc	12 to 32 Vdc	5.1 W
T (High Range)	250 Vdc 240 Vac	62 to 280 Vdc 90 to 270 Vac	5.2 W 14.0 VA

NOTES: All references are at 50/60 Hz.

† Type R Power Supply may require 14 Vdc to begin operation. Once operating, the voltage may be reduced to 12 Vdc.

Pickup Accuracy

Single Phase

PF = 1	±2 percent of front panel setting or 0.05 watts (whichever is greater).
.5<PF<1	±5 percent of front panel setting or 0.05 watts (whichever is greater).

Three Phase

PF =1	±2 percent of front panel setting or 0.15 watts (whichever is greater).
.5<PF<1	±5 percent of front panel setting or 0.15 watts (whichever is greater).

Pickup Dropout Accuracy 95 percent of actual pickup.

Timing Adjustment Range

Instantaneous

Overpower The overpower instantaneous response time is less than 80 ms, 60 Hz or less than 100 ms, 50 Hz for real power magnitude of 2 times the setting and greater. The response time is characterized by the graph in Figure 1-12.

Underpower The underpower instantaneous response time is less than 50 ms, 60 Hz or less than 65 ms, 50 Hz for real power magnitude of .8 times the setting and less. The response time is characterized by the graph in Figure 1-13.

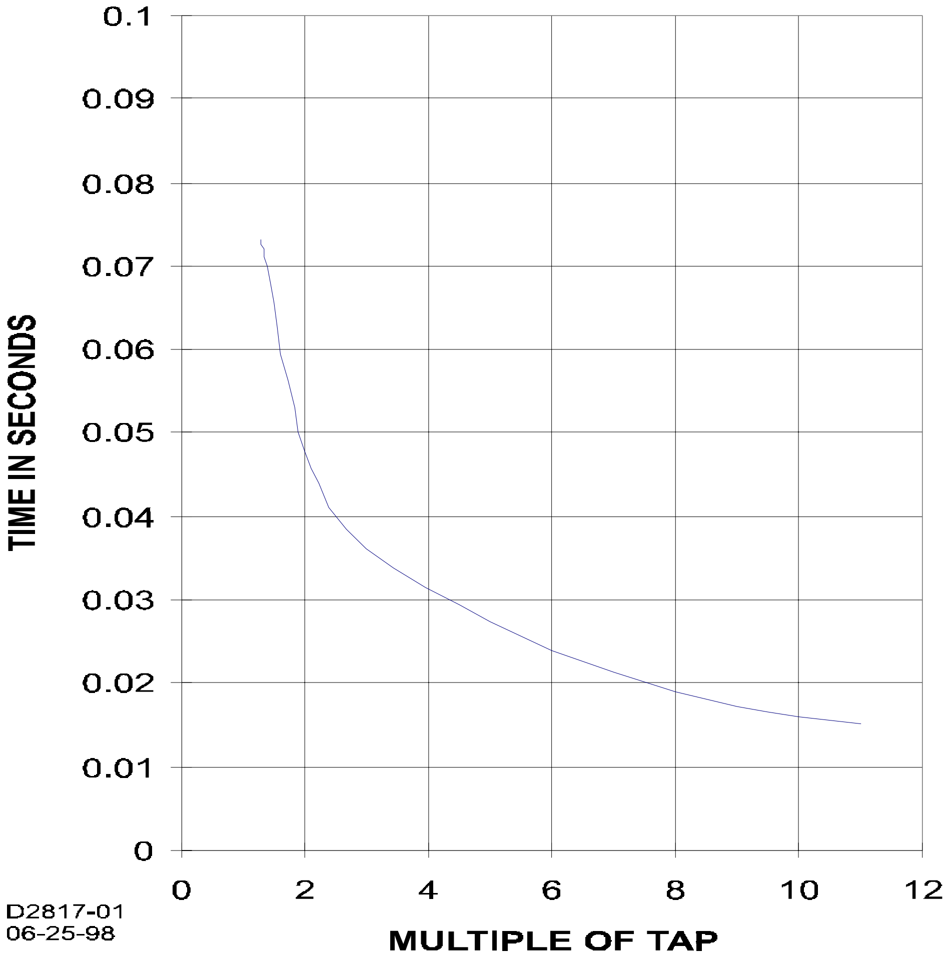


Figure 1-12. Overpower Instantaneous Response Time

Timing Adjustment Range	-Continued
Definite Time	Thumbwheel adjustable over the range of 0.1 to 9.9 seconds in increments of 0.1 seconds or by use of a multiplier switch, 01 to 99 seconds in increments of 01 seconds. A setting of 00 enables instantaneous timing.
Inverse Time	Available for the overpower function only. Adjustment of the Time Dial thumbwheel selects curves from 01 to 99 in increments of 01. A setting of 00 enables instantaneous timing. Refer to Figure 1-14 for examples of the overpower inverse time characteristic curves.
Timing Accuracies	
Instantaneous	< 80 ms, 60 Hz or <100 ms, 50 Hz up to a real power magnitude of 2 times the setting.
Definite Time	±5 percent or 50 ms (whichever is greater) of the front panel time delay setting.
Inverse Time	+5 percent or 50 ms (whichever is greater) of the indicated time for any time dial setting. NOTE: Operating time is repeatable within 2 percent or 50 ms (whichever is greater) for any combination of time dial and power settings within the specified operating temperature range.

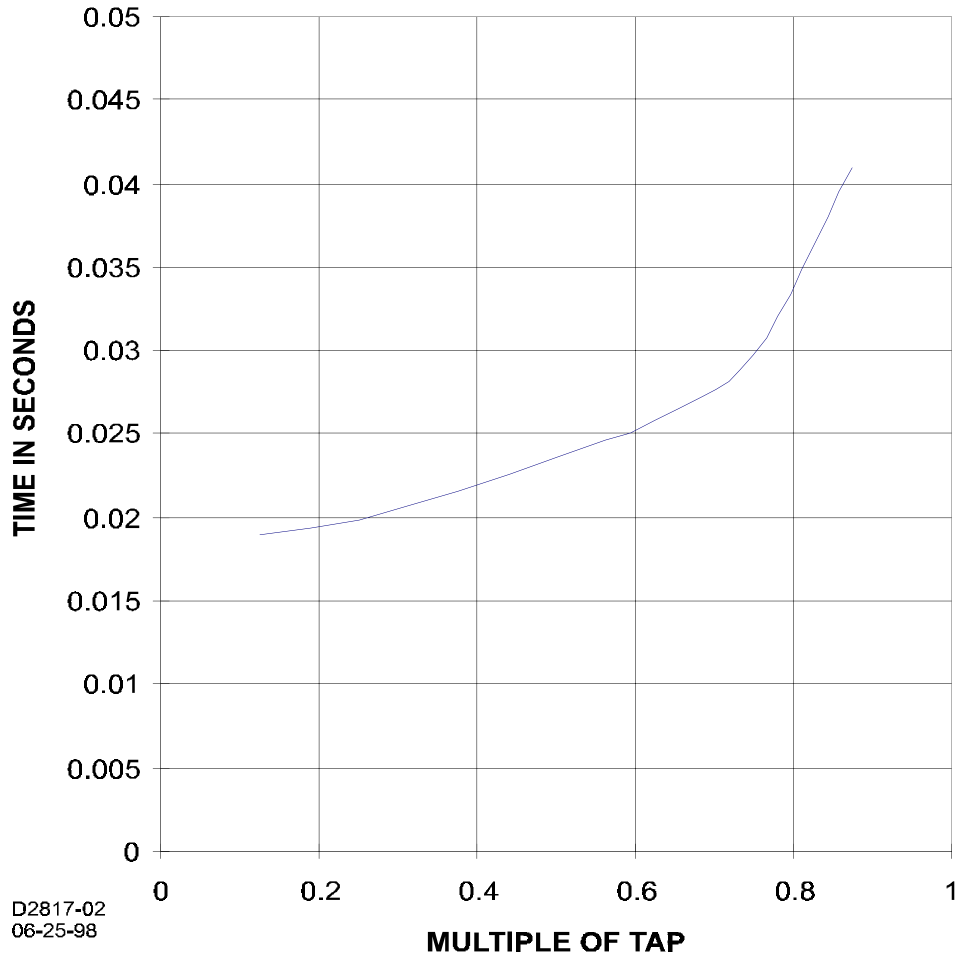


Figure 1-13. Underpower Instantaneous Response Time

Power Range (Pickup)	Adjustable over the ranges listed in Table 1-3.
Isolation	In accordance with IEC 255-5 and ANSI/IEEE C37.90, one minute dielectric (high potential) tests as follows: All circuits to ground: 2121 Vdc Input to output circuits: 1500 Vac or 2121 Vdc
Radio Frequency Interference (RFI)	Maintains proper operation when tested for interference in accordance with IECC C37.90-1989, Trial-Use Standard Withstand Capability of Relay systems to Radiated electromagnetic Interference from Transceivers.
UL Recognized	UL Recognized per Standard 508, UL File No. E97033. Note: Output contacts are not UL Recognized for voltages greater than 250 volts.

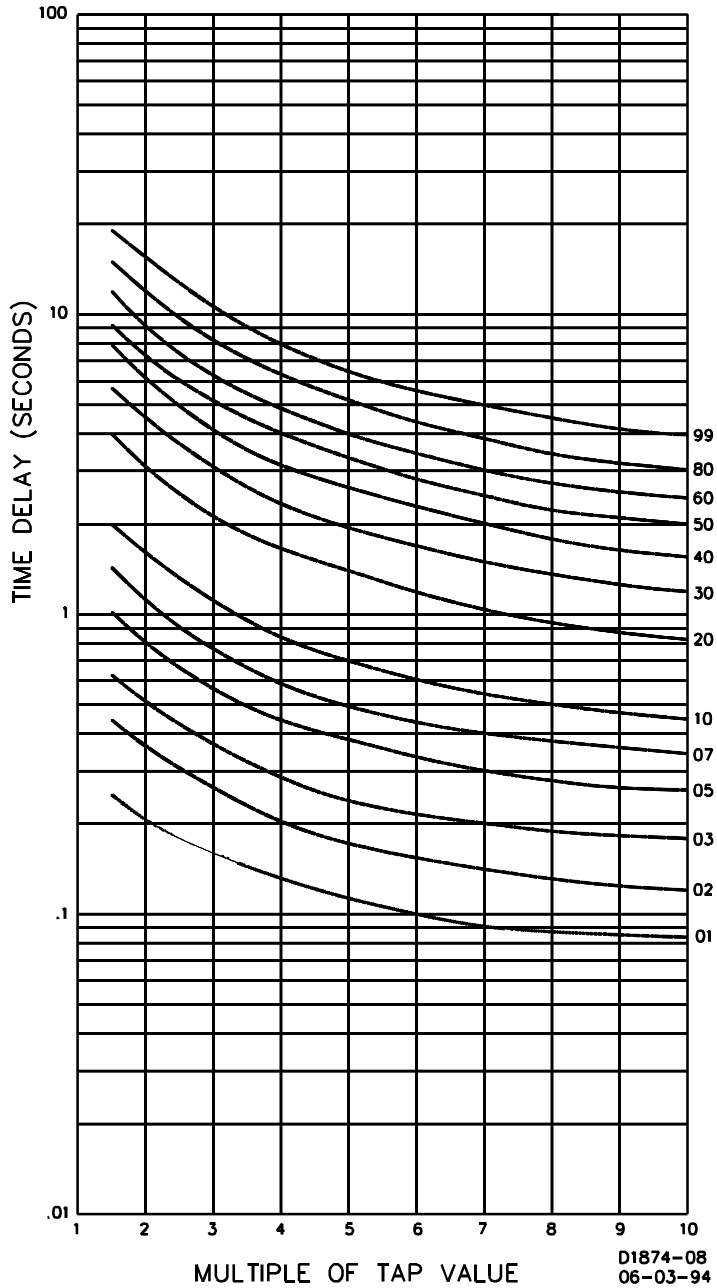


Figure 1-14. Overpower Inverse Time Characteristic Curves

Table 1-3. Pickup Power Range

Sensing Input Type	Nominal Volts	Range		A	B	C	D	E	F	G	H	J	K
				Switch Positions (In Watts)									
A, B, or V 1ϕ	120	1	Hi	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
			Lo	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
		2	Hi	20	40	60	80	100	120	140	160	180	200
			Lo	5	10	15	20	25	30	35	40	45	50
		3	Hi	100	200	300	400	500	600	700	800	900	1000
			Lo	25	50	75	100	125	150	175	200	225	250
C, D, or E 3ϕ	120	1	Hi	6.0	12.0	18.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0
			Lo	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
		2	Hi	60	120	180	240	300	360	420	480	540	600
			Lo	15	30	45	60	75	90	105	120	135	150
		3	Hi	300	600	900	1200	1500	1800	2100	2400	2700	3000
			Lo	75	150	225	300	375	450	525	600	675	750
A, B, or V 1ϕ	208 or 240	4, 7	Hi	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40.0
			Lo	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
		5, 8	Hi	40	80	120	160	200	240	280	320	360	400
			Lo	10	20	30	40	50	60	70	80	90	100
		6, 9	Hi	200	400	600	800	1000	1200	1400	1600	1800	2000
			Lo	50	100	150	200	250	300	350	400	450	500
C, D, or E 3ϕ	208 or 240	4, 7	Hi	12.0	24.0	36.0	48.0	60.0	72.0	84.0	96.0	108.0	120.0
			Lo	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
		5, 8	Hi	120	240	360	480	600	720	840	960	1080	1200
			Lo	30	60	90	120	150	180	210	240	270	300
		6, 9	Hi	600	1200	1800	2400	3000	3600	4200	4800	5400	6000
			Lo	150	300	450	600	750	900	1050	1200	1350	1500

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

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 a total of six sweeps, 15 minutes each sweep, without structural damage or degradation of performance.

Weight S1 - 13.5 pounds maximum
M1 - 18.5 pounds maximum

SECTION 2 • HUMAN-MACHINE INTERFACE (Controls and Indicators)

Table 2-1. BE1-32R -32 O/U Controls and Indicators (Refer to Figure 2-1)

Locator	Control or Indicator	Function
A	**OVERpower** Tap Selector	A 10-position rotary switch provides selection of the overpower pickup point when used in conjunction with the range switch (O). Over power pickup levels are labeled on the tap select range chart.
B	**OVERpower PICKUP** LED	LED is ON when the OVERpower pickup level has been exceeded.
C	Multiplier Switch	Provides selection of the TIME DELAY multiplier factor (0.1 or 1.0 times the indicated TIME DELAY setting, definite time only).
D	**UNDERpower** Percent of Tap Selector	A continuously adjustable potentiometer provides selection of the percent of tap underpower pickup point.
E	**POWER** LED	LED is ON when proper operating power is supplied to the relay internal circuitry.
F	**UNDERpower PICKUP** LED	LED is ON when the underpower pickup level has been surpassed.
G	**UNDERpower TIME DELAY** Control	Front panel thumbwheel switches provide selection of the UNDERpower trip time delay when used in conjunction with the multiplier switch (H). A TIME DELAY setting of 00 indicates instantaneous time.
H	**UNDERpower TIME DELAY** Multiplier Switch	Provides selection of the TIME DELAY multiplier factor (0.1 or 1.0 times the indicated TIME DELAY setting, definite time only.
I	Target Reset Lever	Provides manual reset of magnetic target indicators.
J	**UNDERpower** Target Indicator	Provides visual indicator that the UNDERpower output relay has energized. Must be manually reset.
K	**OVERpower** Target Indicator	Provides visual indicator that the OVERpower output relay has energized. Must be manually reset.
L	**PUSH-TO-ENERGIZE OUTPUT** Pushbuttons	Provides manual actuation of the output relays by inserting a 1/8 inch thick, non-conduction rod through the front-panel access hole.
M	**TAP** Select Range Chart	Provides an index of power levels that correspond to OVERpower TAP select switch positions.
N	**OVERpower TIME DELAY** Control	Front panel thumbwheel switches provide selection of the OVERpower trip time delay when used in conjunction with the multiplier switch (C). A TIME DELAY setting of 00 indicates instantaneous time.
O	**RANGE** Select Switch	Provides HI/LOW power range selection for system protection.

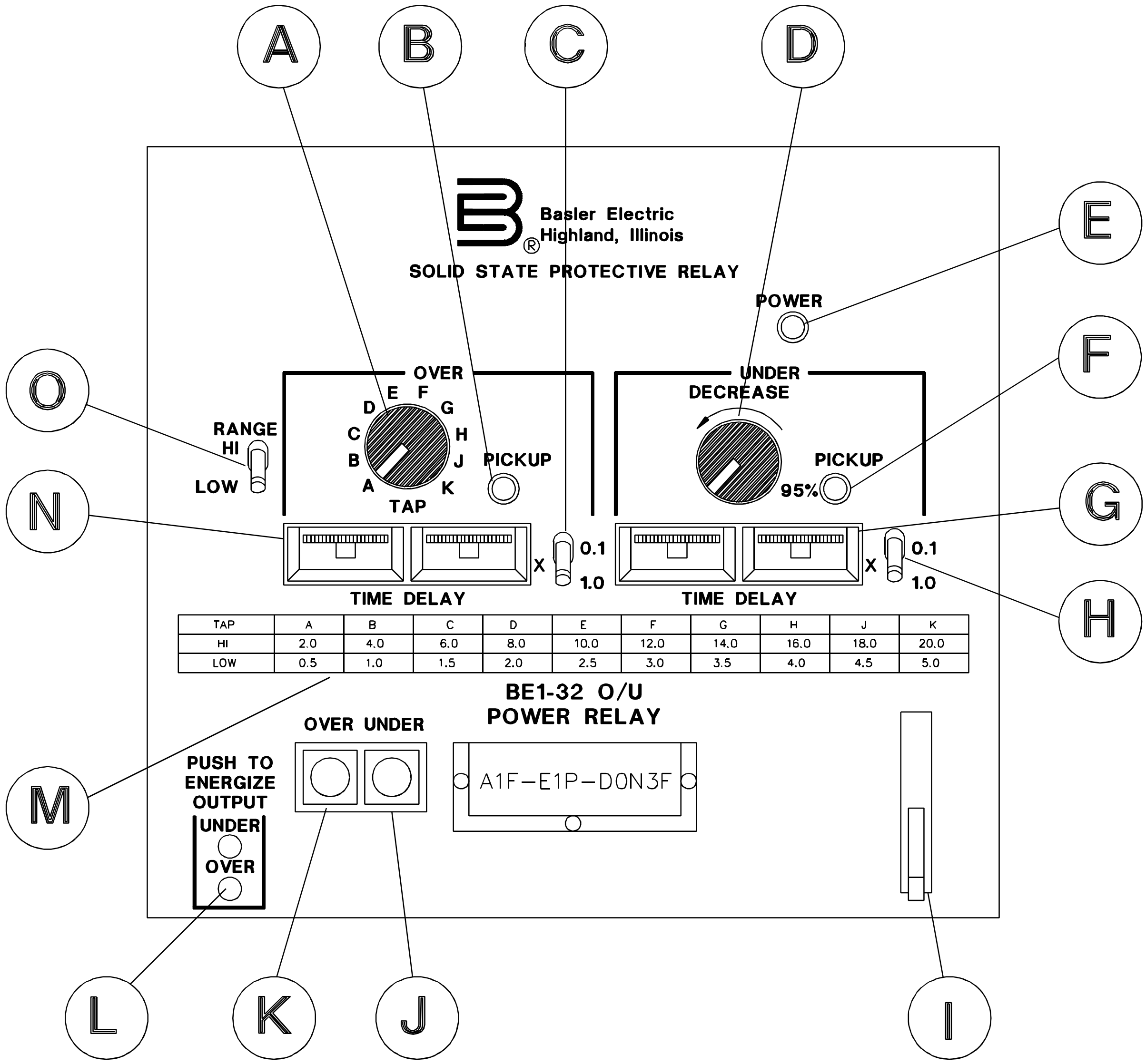


Figure 2-1. Location of Controls and Indicators

SECTION 3 • FUNCTIONAL DESCRIPTION

FUNCTIONAL DESCRIPTION

BE1-32R, -32 O/U Directional Power Relays are solid state devices that provide equipment protection for system overpower, and/or underpower, or circuit supervisory control. A relay functional description is provided in the following paragraphs. Refer to Figure 3-1 to follow the functional description.

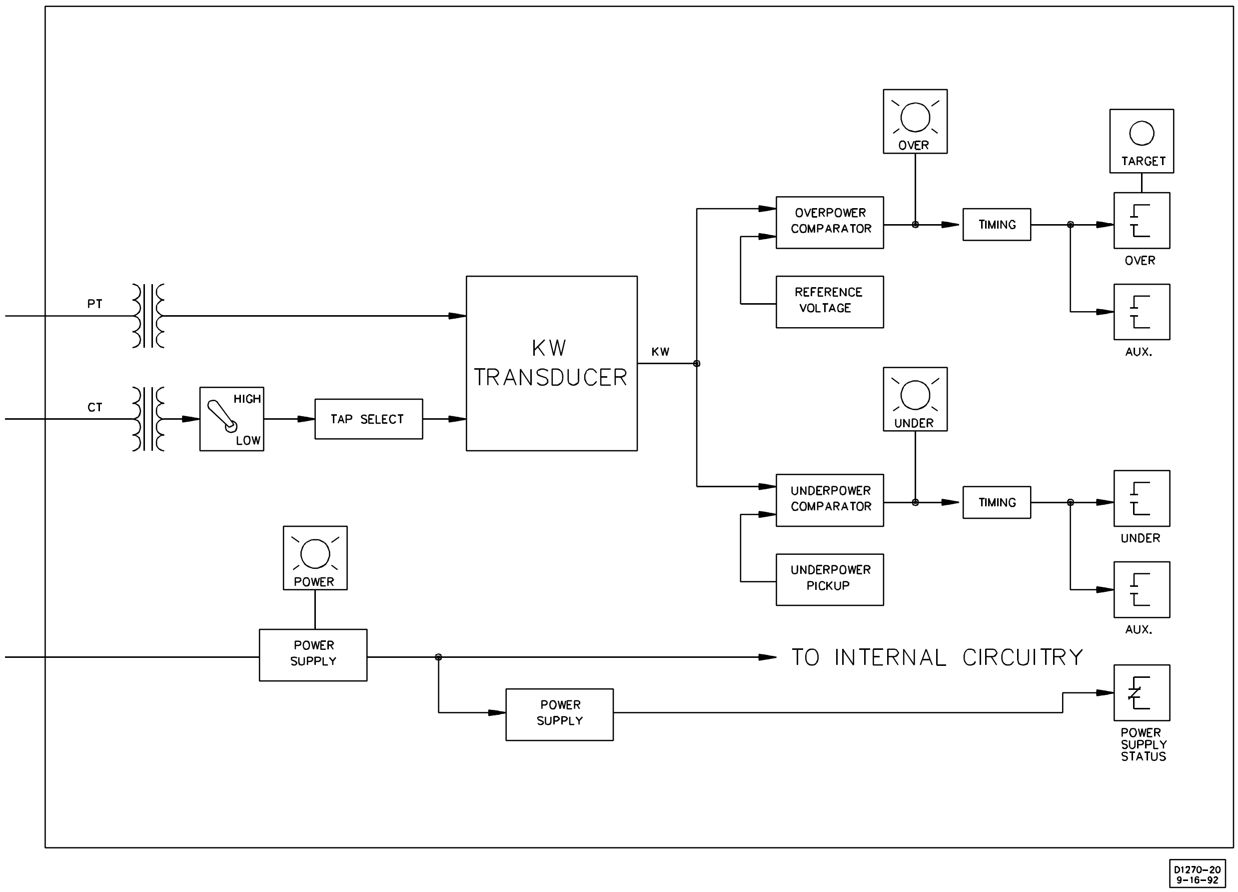


Figure 3-1. Functional Block Diagram

Current Sensing

System current transformers (CTs) with nominal five ampere secondaries supply the directional power relay input transformers with one or three-phase currents. If sensing input range 1, 4, or 7 is selected, the input transformers are capable of 7 amperes continuous current, 10 amperes for one minute, and 140 amperes for one second. If sensing input range 2, 3, 5, 6, 8, or 9 is selected, the input transformers are capable of 10 amperes continuous current, 15 amperes for 1 minute, and 200 amperes for one second. Refer to Table 3-1 for current sensing burden.

Voltage Sensing

System potential transformers (PTs) with 120/240 volt secondaries supply the directional power relay input transformers with single or three-phase voltage. Voltage sensing inputs are nominally rated at 100/220 V (50 Hz) or 120/240 (60 Hz) with a maximum burden of one VA per input (2 terminals) over the frequency range of 45 to 65 Hz.

Table 3-1. Current Sensing Burden In Ohms

	Sensing Input Range					
	1, 4, 7		2, 5, 8		3, 6, 9	
Range	Low	High	Low	High	Low	High
Tap A	4.811	0.400	0.096	0.022	0.013	0.010
Tap B	2.466	0.240	0.058	0.019	0.012	0.010
Tap C	1.677	0.190	0.045	0.018	0.011	0.010
Tap D	1.277	0.165	0.039	0.018	0.011	0.010
Tap E	1.036	0.151	0.034	0.017	0.011	0.010
Tap F	0.874	0.142	0.032	0.017	0.011	0.010
Tap G	0.760	0.134	0.030	0.017	0.011	0.010
Tap H	0.674	0.129	0.029	0.017	0.011	0.010
Tap J	0.611	0.126	0.028	0.017	0.010	0.010
Tap K	0.556	0.123	0.027	0.017	0.010	0.010

Phase Rotation Sensitivity

Relays that operate using phase current and phase-to-phase voltages to determine direction are sensitive to phase rotation. BE1-32 Directional Power Relays with type B, E, or V sensing are phase rotation sensitive. Unless otherwise noted, all connections shown in this manual assume ABC rotation.

Type E Sensing

Type E sensing relays (two elements) monitor two phase-to-phase voltages (the third phase is used as a reference) and two phase currents to determine directional power flow. This is sometimes referred to as the two wattmeter method for power flow measurement. Figure 3-2 shows the phasor representations for ABC rotation. Figure 3-3 shows the phasor representations for ACB rotation.

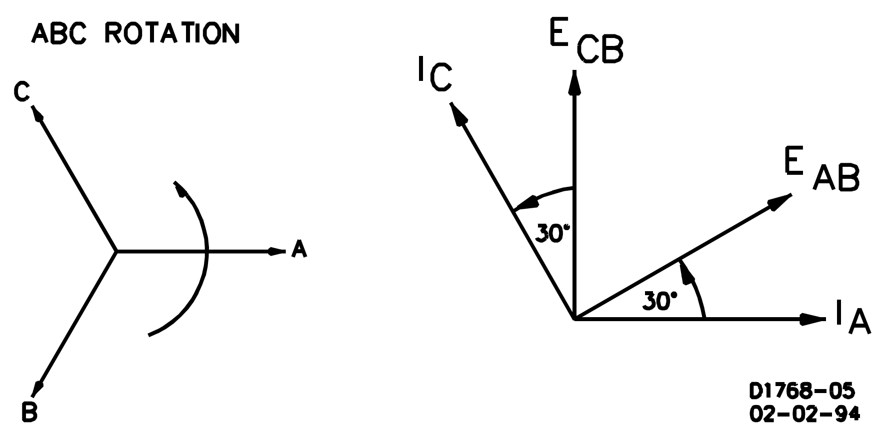


Figure 3-2. Type E Sensing With ABC Rotation

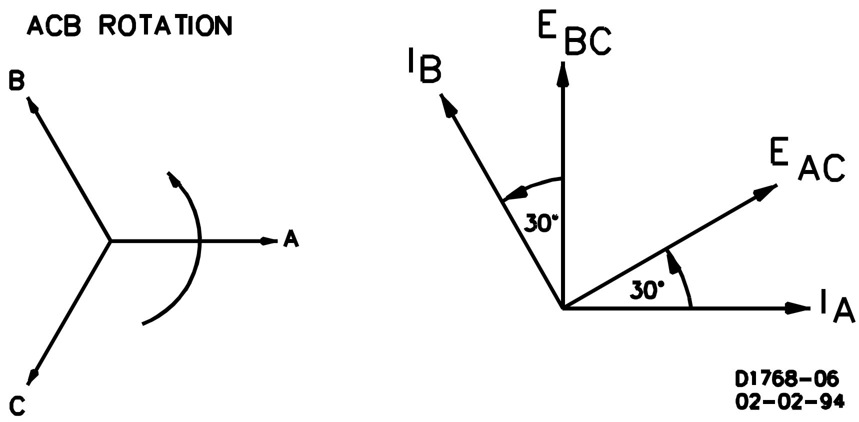


Figure 3-3. Type E Sensing With ACB Rotation

<u>*Type B Or V Sensing*</u>

Type B (60 hertz) and Type V (50 hertz) sensing relays monitor a single phase-to-phase voltage and one phase current to determine directional power flow. An internal 30° phase delay network (frequency dependent) aligns the voltage signal with the current signal. Figure 3-4. shows the phasor representation monitoring phase A current and phase A to B voltage with ABC rotation. Figure 3-5. shows the phasor representation monitoring phase A to C voltage with ACB rotation.

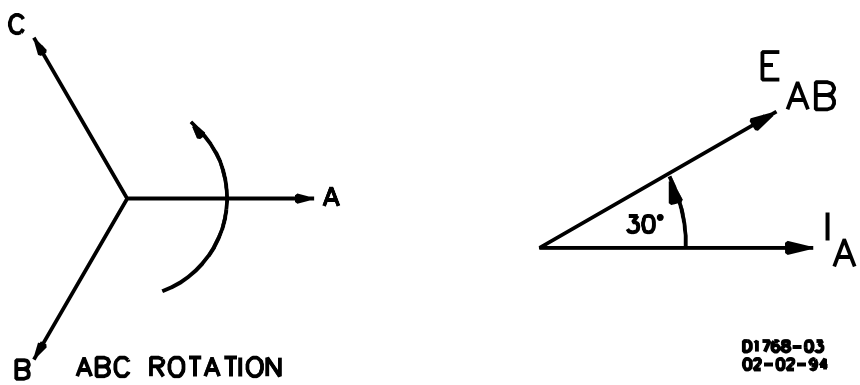


Figure 3-4. Type B or V Sensing With ABC Rotation

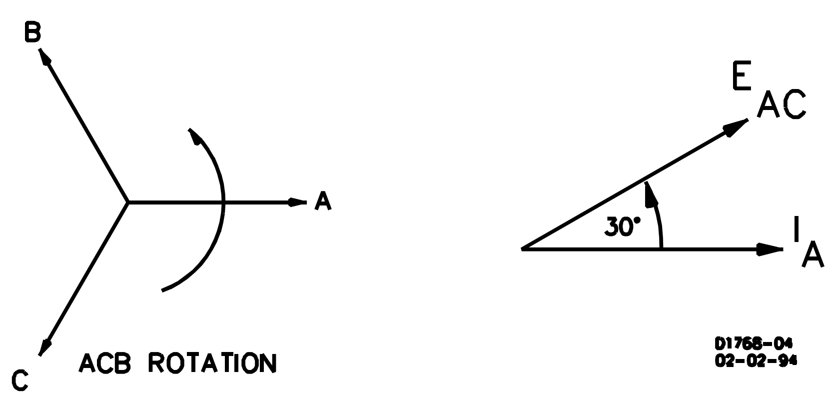


Figure 3-5. Type B or V Sensing With ACB Rotation

Sensing Input Types

Type A, Single-Phase Sensing

Refer to Figure 3-6. Type A sensing configurations monitor line-to-neutral voltage and a single-phase current of a three-phase, four-wire circuit, and calculate the power flowing in the tripping direction. These relays can also be applied in a three-phase, three-wire system using phase-to-ground voltages. Type A sensing configurations are not phase rotation sensitive. The range switch for this type sensing is calibrated in single-phase watts.

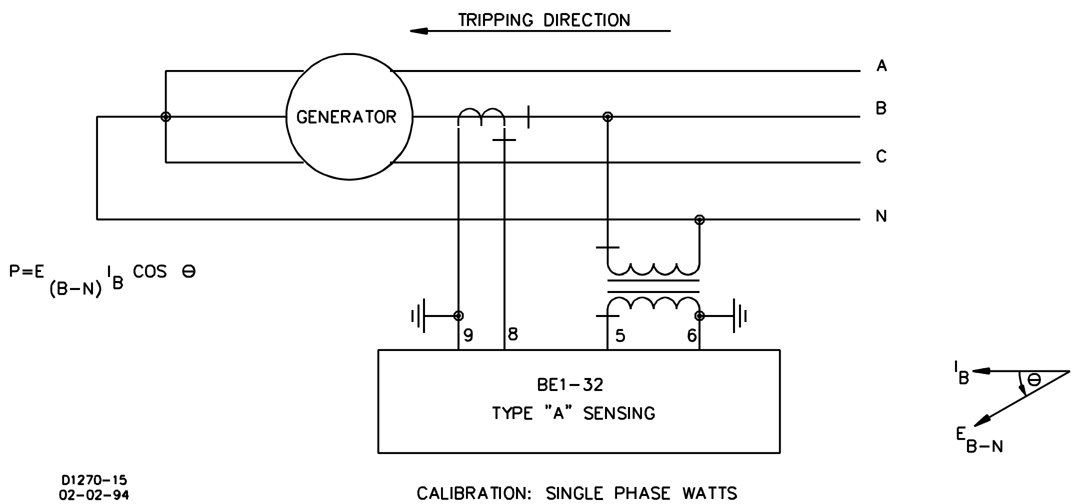


Figure 3-6. Type A Sensing

Type B or V, Single-Phase Sensing

Refer to Figure 3-7. Type B or V sensing configurations monitor line-to-line voltage and a single-phase current of a three-phase, three-wire circuit and calculate the power flowing in the tripping direction. The power equation assumes balanced conditions. Because the input voltage leads the input current by 30° (assuming unity power factor), a 30° lagging phase shift network is designed into the voltage input circuit. Type B or V configurations are phase rotation sensitive. The range switch of this type sensing is also calibrated in single-phase watts.

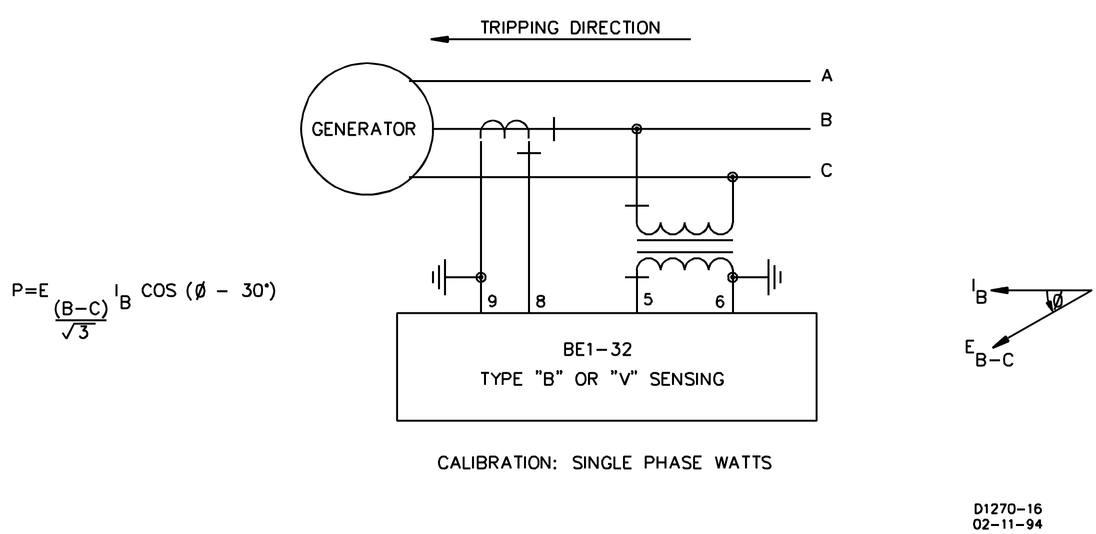


Figure 3-7. Type B or V Sensing

Type C, Three-Phase Sensing

Refer to Figure 3-8. Type C sensing configurations monitor three line-to-line voltages and a single-phase current of a three-phase, three-wire circuit and calculate the power flowing in the tripping direction. The relay measures actual power even if the system voltages are not balanced. Therefore, the power equation using E_{AVE} is approximate. Type C sensing configurations are not phase rotation sensitive. The range switch of this type sensing is also calibrated in three-phase watts.

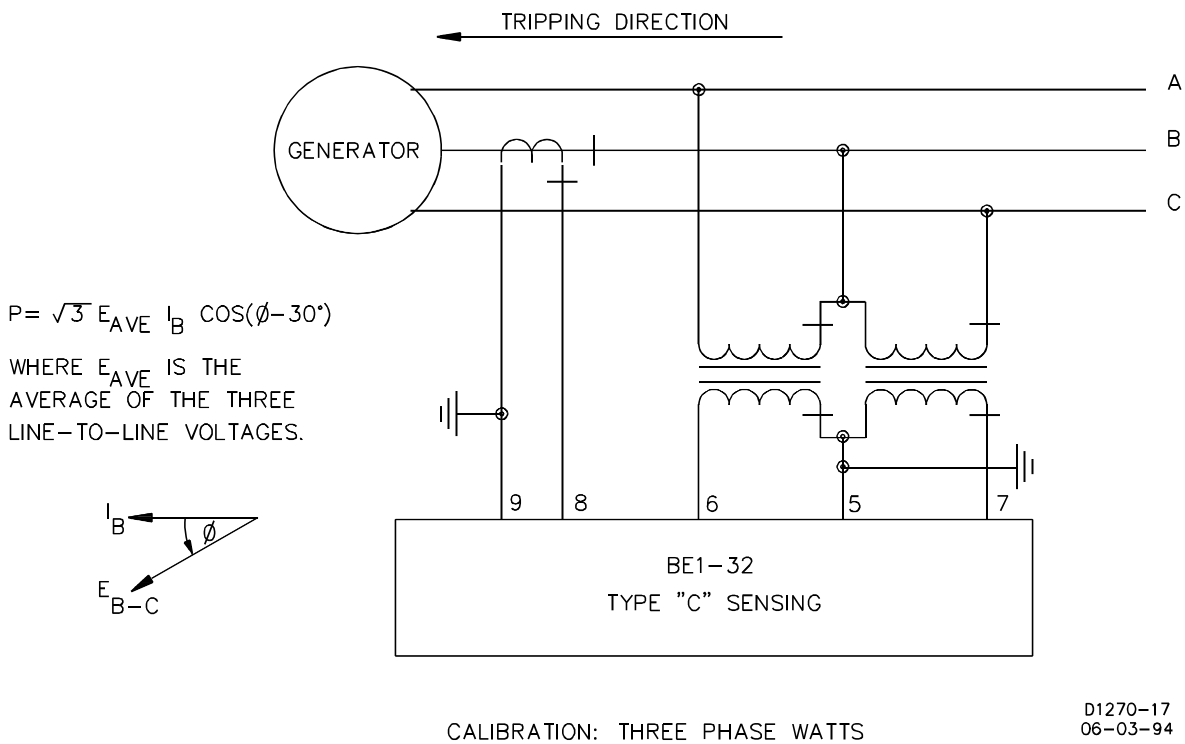


Figure 3-8. Type C Sensing

Type D, Three-Phase Sensing

Refer to Figure 3-9. Type D sensing configurations monitor three line-to-neutral voltages and three-phase currents of three-phase, four-wire circuits, and calculate the power flowing in the tripping direction. This relay can also be applied on a three-phase, three-wire system using phase-to-ground voltages. Type D sensing configurations are not phase rotation sensitive. The range switch of this type sensing is calibrated in three-phase watts.

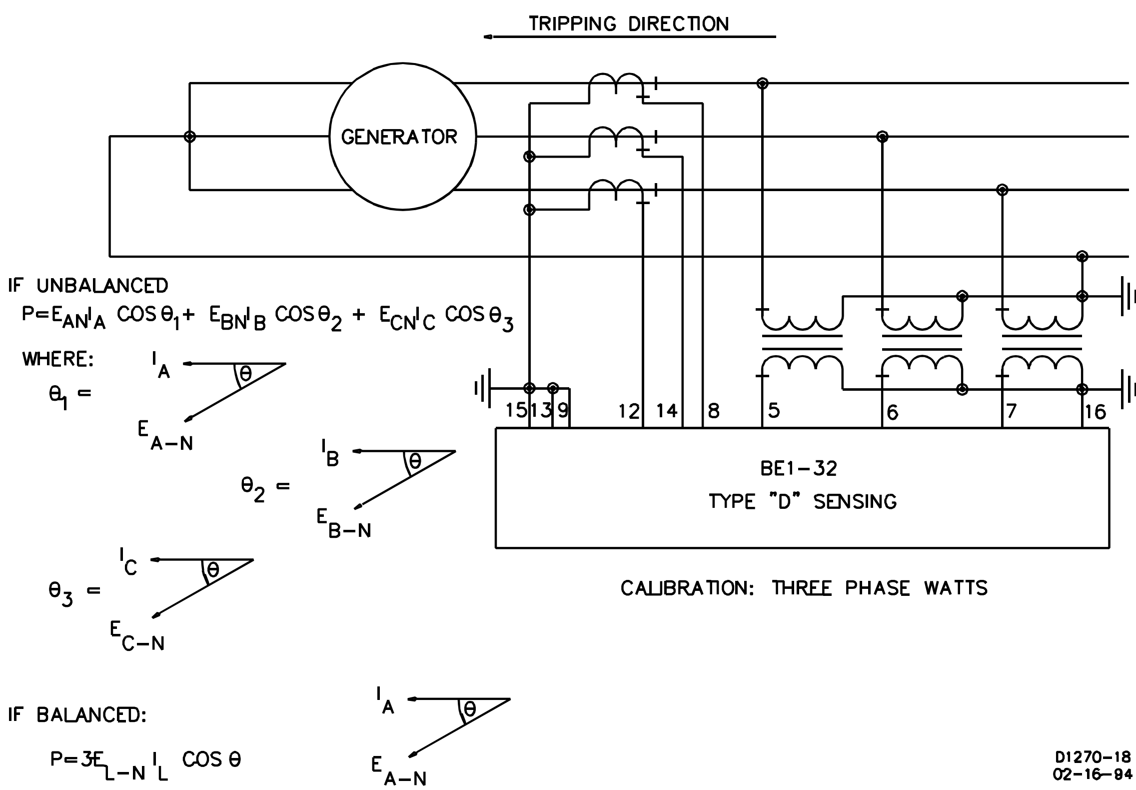
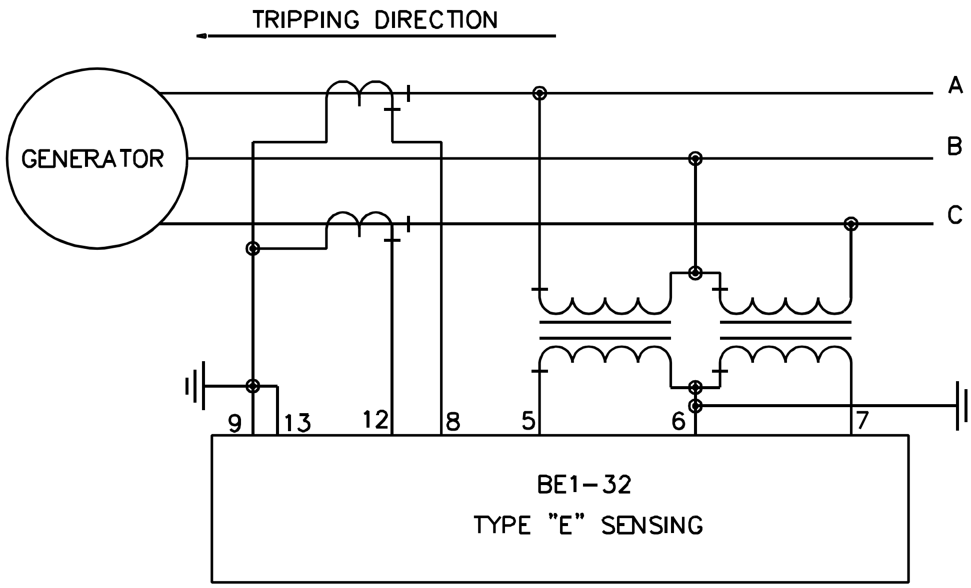


Figure 3-9. Type D Sensing

Type E, Three-Phase Sensing

Refer to Figure 3-10. Type E sensing configurations monitor three line-to-line voltages and two of the phase currents of a three-phase, three-wire circuit and calculate the power flowing in the tripping direction. The relay measures actual power under balanced or unbalanced conditions. The power equation assumes that conditions are balanced. Type E sensing configurations are phase rotation sensitive. The range switch for this type sensing is calibrated in three-phase watts.

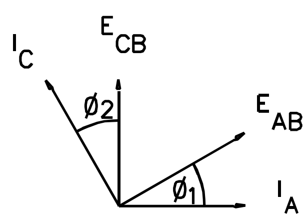


CALIBRATION: THREE PHASE WATTS

IF UNBALANCED

$$P3 = E_{AB} I_A \cos \phi_1 + E_{CB} I_C \cos \phi_2$$

WHERE:



IF BALANCED

$$P = \sqrt{3}\, E_{L-L}\, I_A \cos\theta$$

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Figure 3-10. Type E Sensing

KW Transducer

Single-phase or three-phase current and voltage signals (determined by the sensing input circuitry type) are applied to the KW transducer. The signals are applied to a multiplexor that selectively combines the input conditions and feeds them to a multiplier circuit. The output of the multiplier is true power (watts) that is then integrated to produce a dc voltage proportional to the monitored power flow. The conditioned proportional signal is then applied to the comparator circuits.

Comparator Circuits

The dc signal representative of the monitored power level is applied to the comparator circuit or circuits (as applicable) to be compared with the front panel underpower and/or overpower settings. When the reference level of the comparators is surpassed, the output is energized (if instantaneous timing has been selected) or timing is initiated.

Pickup

Overpower pickup point is selected with the associated front panel mounted rotary switch in conjunction with the HIGH/LOW range switch. Table 3-2 shows the overpower pickup range for each relay configuration.

Underpower pickup point is selected with the associated front panel mounted rotary switch. Underpower pickup can be set from10% to 95% of the associated overpower pickup.

Pickup accuracy is ± 2% of the front panel setting at unity power factor, and ± 5% for power factors above 0.5. Specified accuracy is for currents below ten times the current required to pick up at nominal volts and unity power factor. That is, maximum current to maintain specified accuracy is equal to watts (setting) divided by the nominal volts times ten**.** (See the following equation.)

$$\frac{Watts\ \ (Setting)}{Nominal\ \ Volts} \times 10$$

Timing

Directional Power Relays (BE1-32R or BE1-32 O/U) are capable of instantaneous trip, definite time delayed trip, or an inverse time delayed trip and is defined by the style number.

Instantaneous timing responds to a trip condition with no intentional time delay. Overall response time of the relay is less than 80 milliseconds, 60 hertz or 100 milliseconds, 50 hertz for a real power magnitude of 2 times the pickup setting. The response time decreases as the magnitude of the input signal increases. Typical response curves are provided in Section 1.

NOTE

On units with the definite time delay option, a setting of 00 enables instantaneous time operation.

Definite time delayed response is initiated when the overpower or underpower condition surpasses the pre-selected pickup setting. Definite time is adjustable by a front panel thumbwheel switch over the ranges of 0.1 to 9.9 seconds and 01 to 99 seconds. Selection of the definite timing ranges is accomplished by the front panel multiplier toggle switch that selects either 0.1 or 1.0 as a multiplier of the front panel TIME DIAL setting.

Inverse time delayed response is only available for the overpower function. Inverse time delayed response is initiated when the overpower condition exceeds the pre-selected pickup power setting. Inverse time curve selection is facilitated by the front panel TIME DIAL thumbwheel switch which may be incremented from 01 to 99 to select the most desirable inverse time response for the application. Refer to Section 1 for a drawing of the available inverse time characteristic curves.

Table 3-2. Pickup Power Range

Sensing Input Type	Nominal Volts	Range		Switch Positions (In Watts)									
				A	B	C	D	E	F	G	H	J	K
A, B, or V 1ϕ	120	1	Hi	2.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0	18.0	20.0
			Lo	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
		2	Hi	20	40	60	80	100	120	140	160	180	200
			Lo	5	10	15	20	25	30	35	40	45	50
		3	Hi	100	200	300	400	500	600	700	800	900	1000
			Lo	25	50	75	100	125	150	175	200	225	250
C, D, or E 3ϕ	120	1	Hi	6.0	12.0	18.0	24.0	30.0	36.0	42.0	48.0	54.0	60.0
			Lo	1.5	3.0	4.5	6.0	7.5	9.0	10.5	12.0	13.5	15.0
		2	Hi	60	120	180	240	300	360	420	480	540	600
			Lo	15	30	45	60	75	90	105	120	135	150
		3	Hi	300	600	900	1200	1500	1800	2100	2400	2700	3000
			Lo	75	150	225	300	375	450	525	600	675	750
A, B, or V 1ϕ	208 or 240	4, 7	Hi	4.0	8.0	12.0	16.0	20.0	24.0	28.0	32.0	36.0	40.0
			Lo	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
		5, 8	Hi	40	80	120	160	200	240	280	320	360	400
			Lo	10	20	30	40	50	60	70	80	90	100
		6, 9	Hi	200	400	600	800	1000	1200	1400	1600	1800	2000
			Lo	50	100	150	200	250	300	350	400	450	500
C, D, or E 3ϕ	208 or 240	4, 7	Hi	12.0	24.0	36.0	48.0	60.0	72.0	84.0	96.0	108.0	120.0
			Lo	3.0	6.0	9.0	12.0	15.0	18.0	21.0	24.0	27.0	30.0
		5, 8	Hi	120	240	360	480	600	720	840	960	1080	1200
			Lo	30	60	90	120	150	180	210	240	270	300
		6, 9	Hi	600	1200	1800	2400	3000	3600	4200	4800	5400	6000
			Lo	150	300	450	600	750	900	1050	1200	1350	1500

Outputs

Each model of the directional power relay family (BE1-32R or BE1-32 O/U) has a dedicated output relay for each indicated function. The BE1-32R output relay contacts, dedicated for directional overpower trip, may have either a normally open (NO) or a normally closed (NC) configuration for use in the customers circuitry. The BE1-32 O/U has dedicated output relay contacts for an overpower trip function and an underpower trip function. These output contacts may be any combination of NO or NC output configurations.

In addition, auxiliary output contacts are provided for all models when specified by style number. Auxiliary relays are provided for both over and underpower trip functions. The auxiliary output contacts may be NO, NC or SPDT as specified by the Style Chart.

Power Supply Status Output

Power supply status output relays have a set of normally closed contacts that are energized open during power-up. If either or both power supply output legs (+12 Vdc or -12 Vdc) fails, the power supply status output relay is de-energized and the output contacts close. Shorting bars across the output contacts are held open by the installed connection plug. When the relay is removed from service by removing the connection plug, the shorting bars are closed.

Targets

Magnetically latched, manually reset target indicators are optionally available to indicate that the trip output relay has energized. Either internally operated or current operated targets may be selected. A current operated target requires a minimum of 0.2 ampere flowing through the output trip circuit, and is rated at 30 amperes for 1 second, 7 amperes for two minutes, and for 3 amperes continuously. The internally operated target should be selected if the relay has normally closed output contacts.

PUSH-TO-ENERGIZE OUTPUT Pushbutton

A small pushbutton switch is provided to allow testing the primary output contact and (if present) the auxiliary output contact. To prevent accidental operation, the pushbutton is recessed behind the front panel and is depressed by inserting a thin, non-conducting rod through an access hole in the front panel.

Power Supply

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

Table 3-3. Wide Range Power Supply Voltage Ranges

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

† 14 Vdc is required to start the power supply.

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

SECTION 4 • INSTALLATION

GENERAL

When not shipped as part of a control or switchgear panel, relays are shipped in sturdy cartons to prevent damage during transit. Immediately upon receipt of a relay, check the model and style number against the requisition and packing list to see that they agree. Visually inspect the relay for damage that may have occurred during shipment. If there is evidence of damage, immediately file a claim with the carrier and notify the Regional Sales Office, or contact the Sales Representative at Basler Electric, Highland, Illinois.

In the event the relay is not to be installed immediately, store the relay in its original shipping carton in a moisture and dust free environment. When the relay is to be placed in service, it is recommended that the operational test procedure (Section 5) be performed prior to installation.

RELAY OPERATING PRECAUTIONS

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

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

DIELECTRIC TEST

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

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

RELAY MOUNTING

Because the relay is of solid state design, it does not have to be mounted vertically. Any convenient mounting angle may be chosen. Figures 4-1 through 4-16 provide relay outline dimensions and panel drilling diagrams.

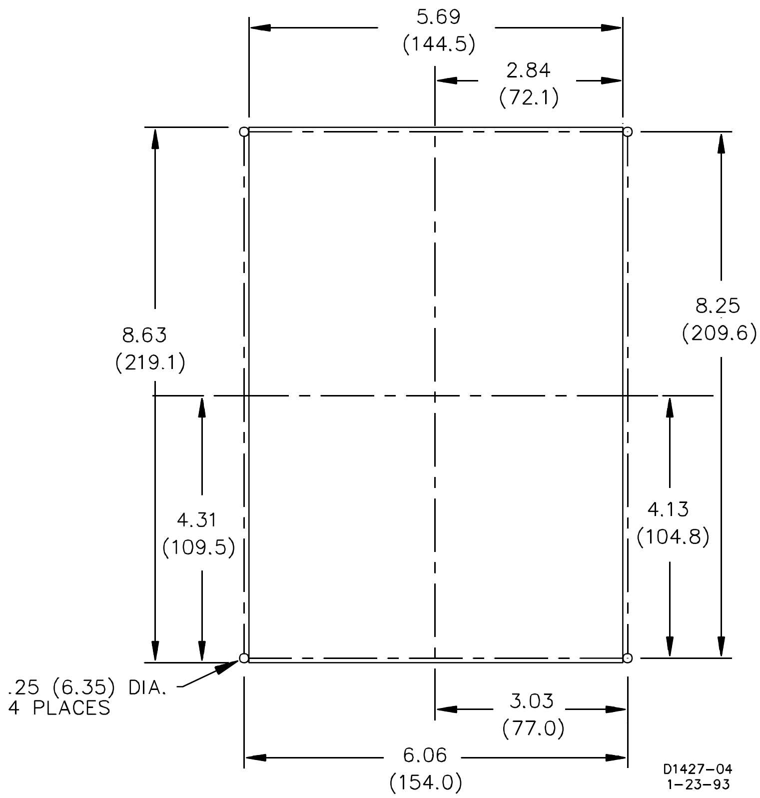


Figure 4-1. S1 Case, Panel Drilling Diagram, Semi-Flush Mounting

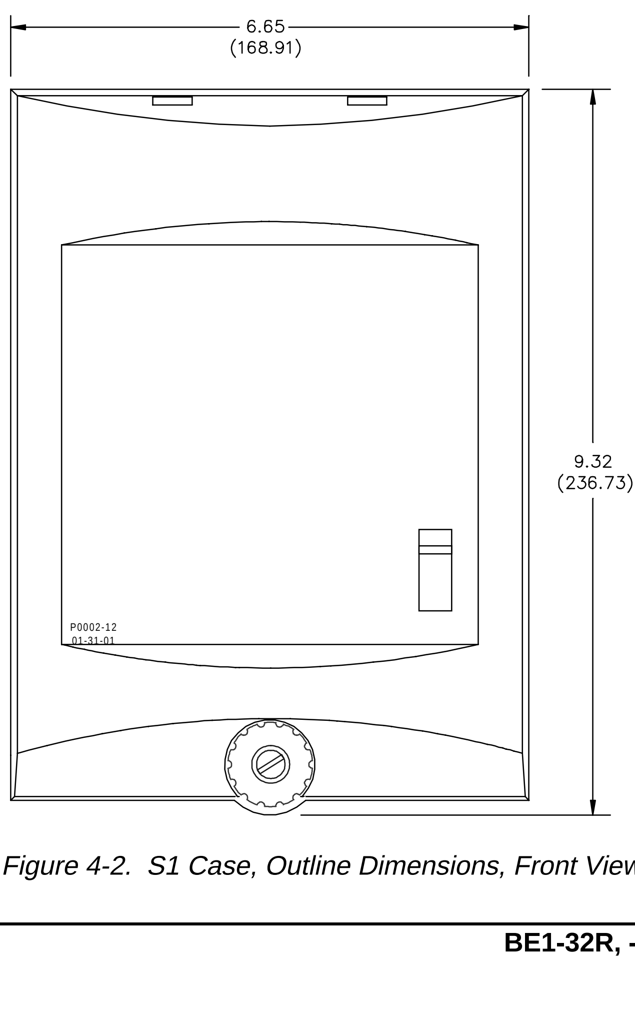


Figure 4-2. S1 Case, Outline Dimensions, Front View

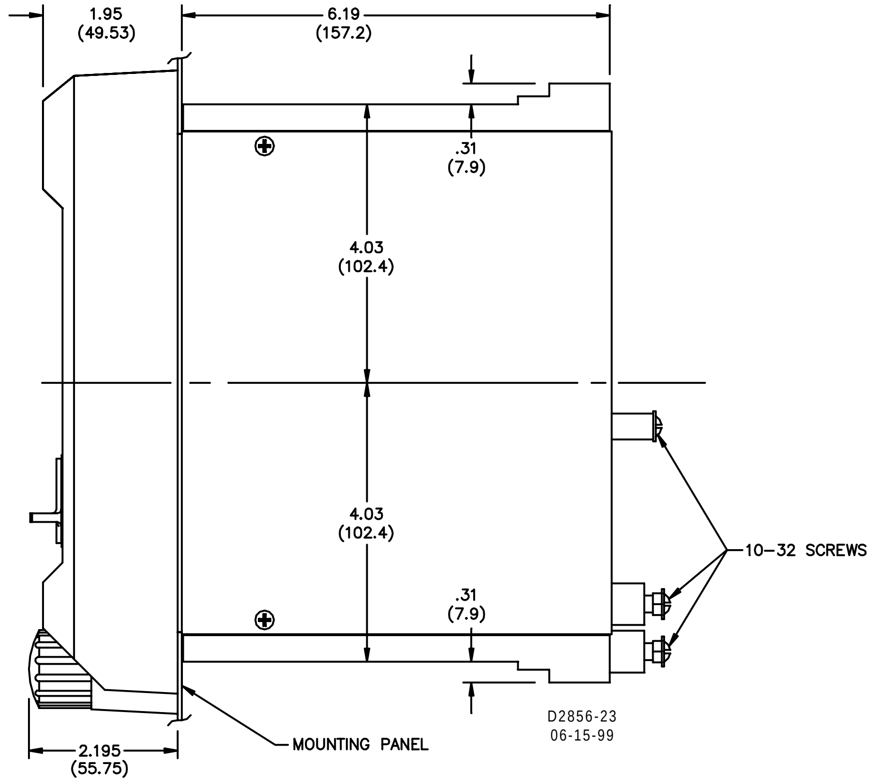


Figure 4-3. S1 Case, Single-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

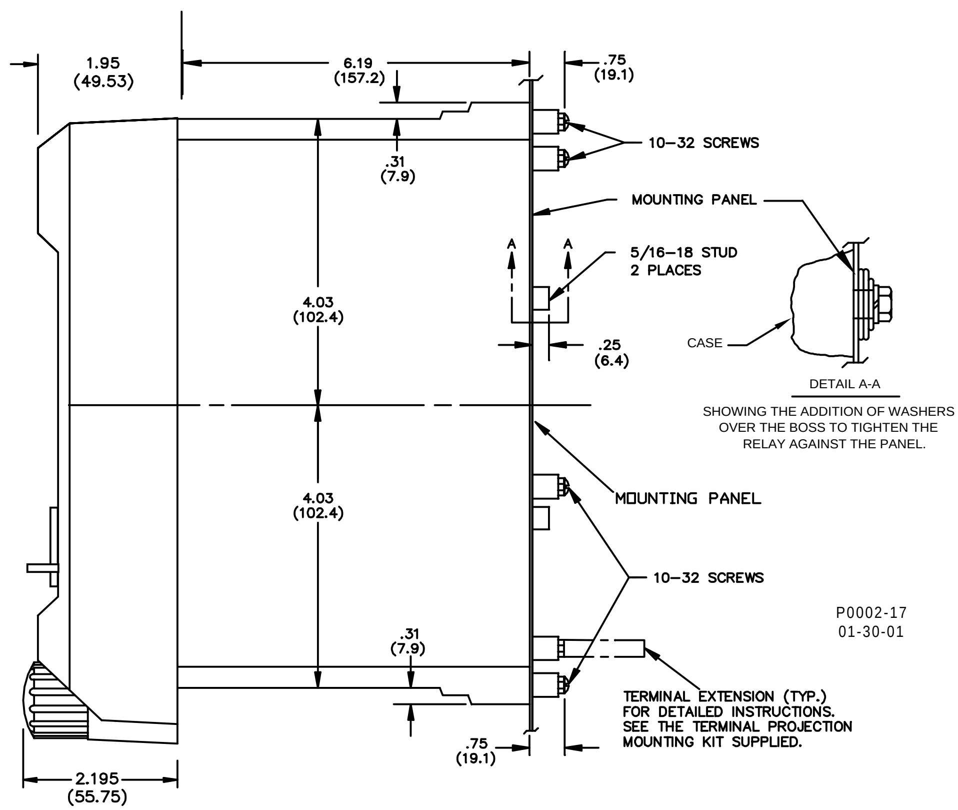


Figure 4-4. S1 Case, Single-Ended, Projection Mounting, Outline Dimensions, Side View

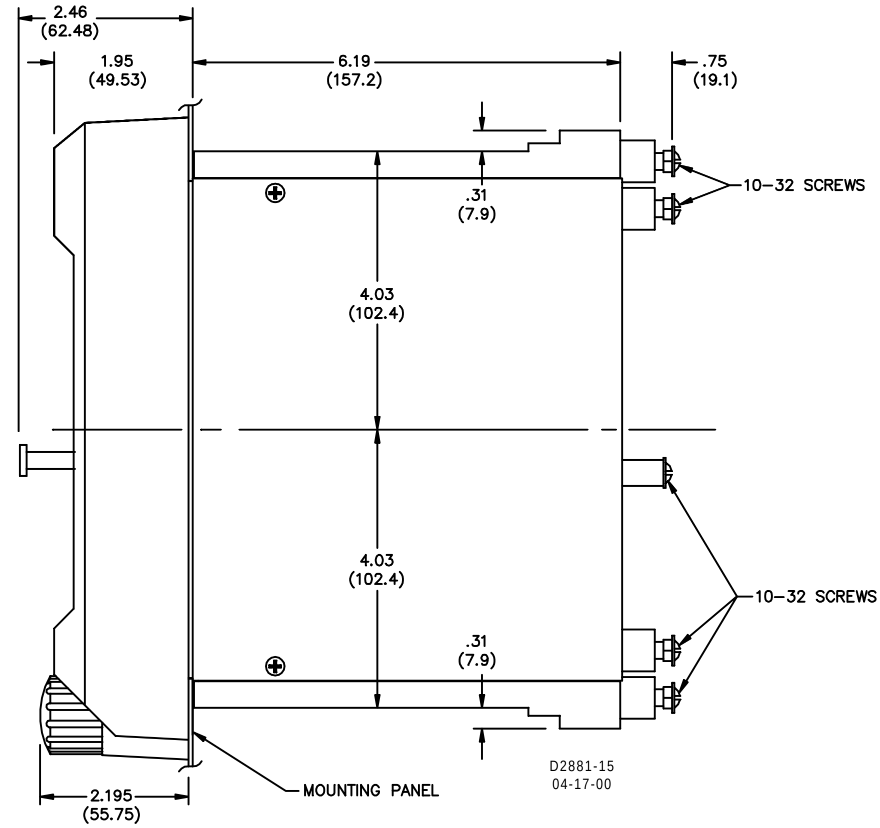


Figure 4-5. S1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

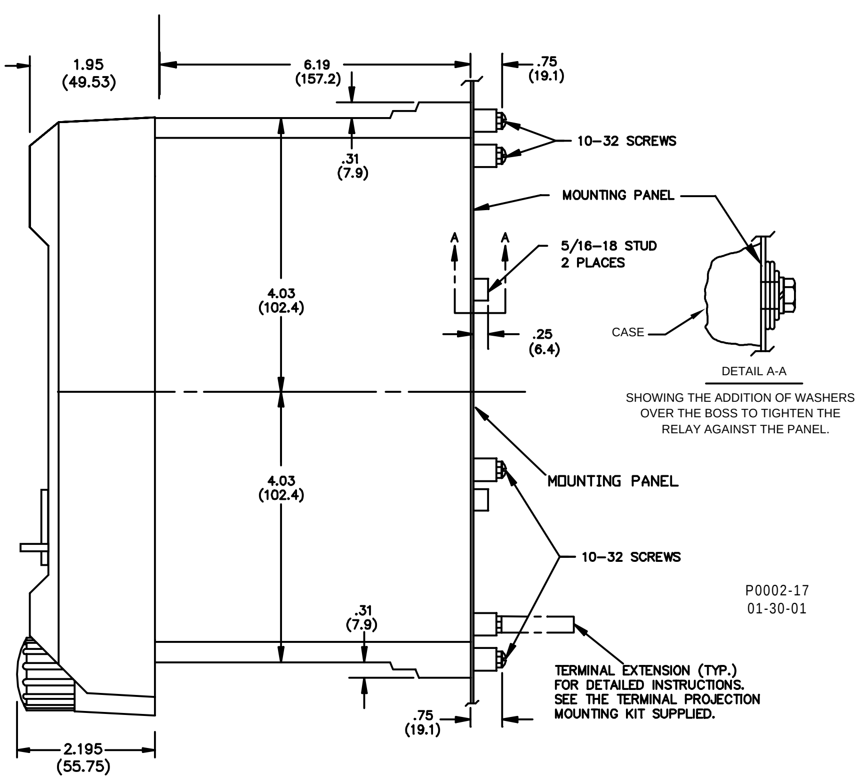


Figure 4-6. S1 Case, Double-Ended, Projection Mounting, Outline Dimensions, Side View

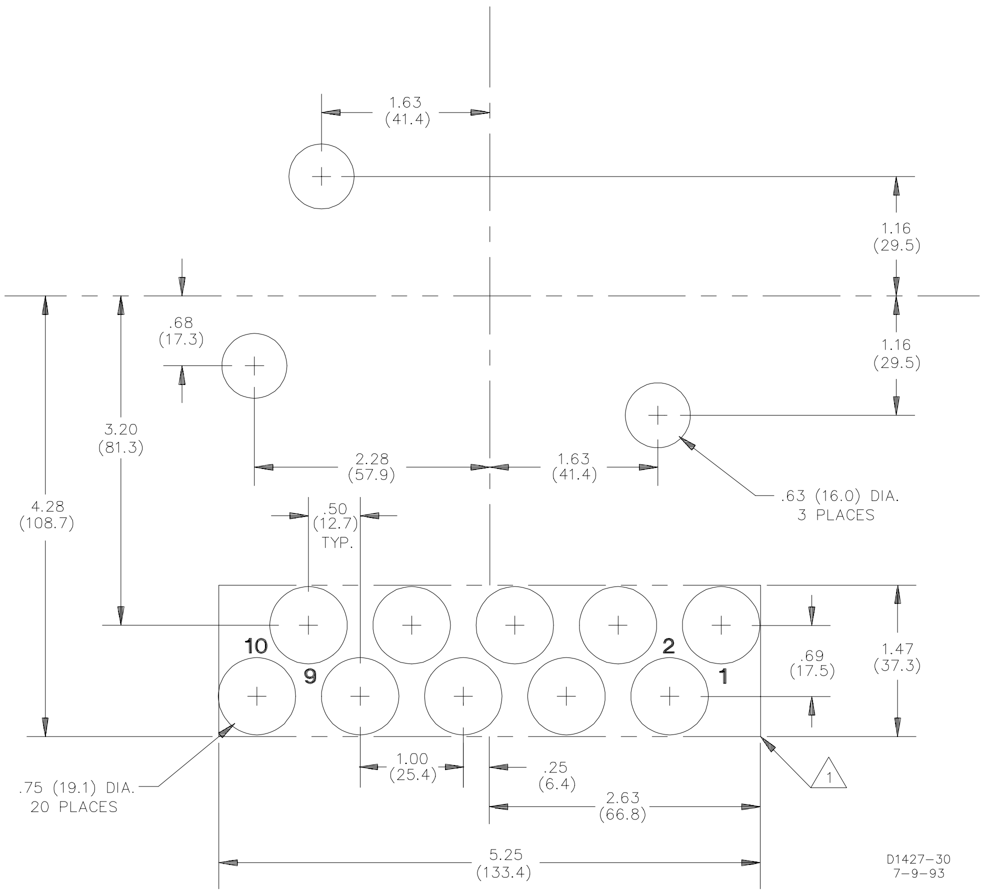
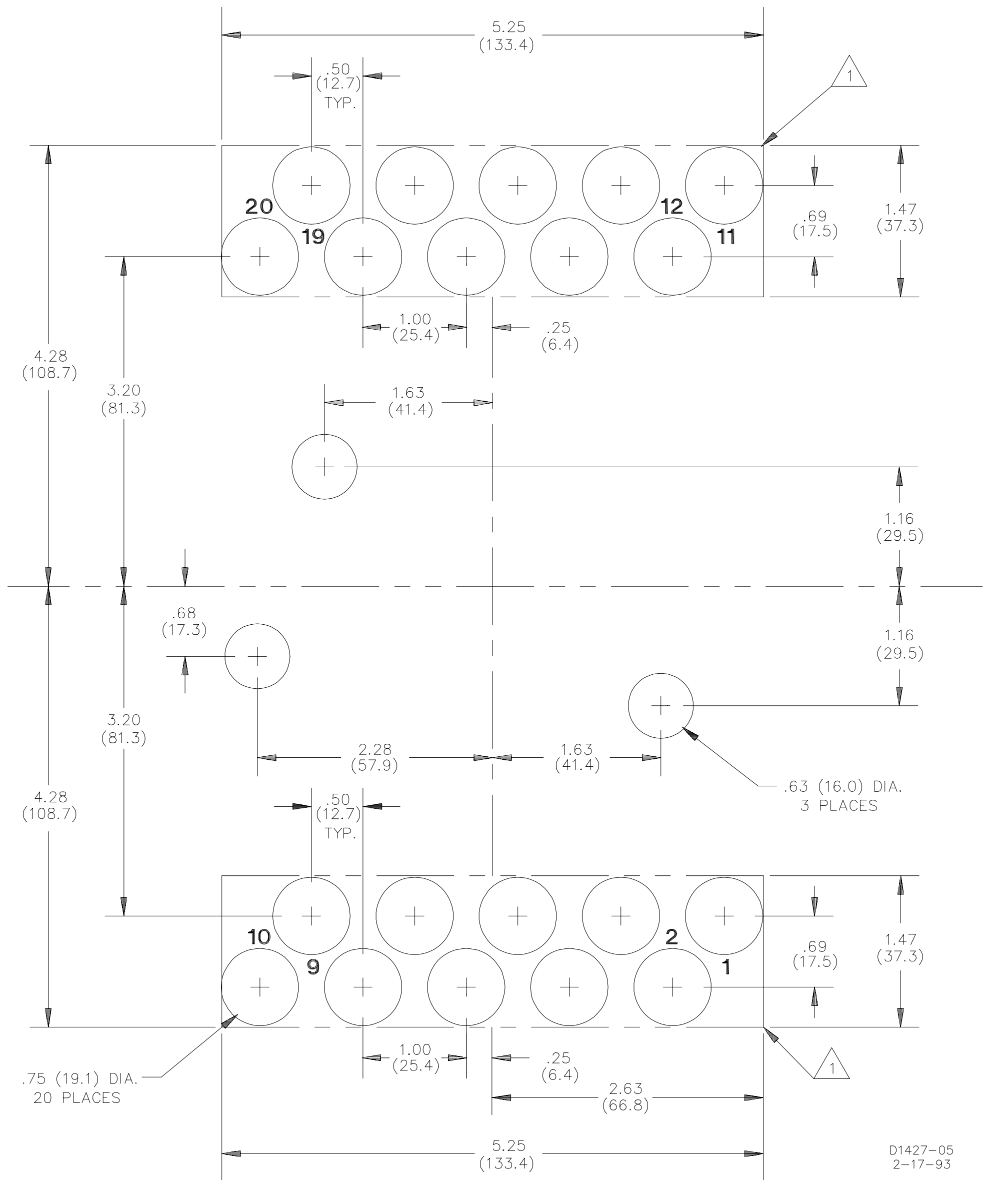


Figure 4-7. S1 Case, Single-Ended, Panel Drilling Diagram, Rear View



5.25
(133.4)
.50
(12.7)
TYP.
1
20
19
12
11
.69
(17.5)
1.47
(37.3)
1.00
(25.4)
.25
(6.4)
4.28
(108.7)
3.20
(81.3)
1.63
(41.4)
1.16
(29.5)
.68
(17.3)
1.16
(29.5)
3.20
(81.3)
2.28
(57.9)
1.63
(41.4)
.63 (16.0) DIA.
3 PLACES
4.28
(108.7)
.50
(12.7)
TYP.
10
9
2
1
.69
(17.5)
1.47
(37.3)
.75 (19.1) DIA.
20 PLACES
1.00
(25.4)
.25
(6.4)
2.63
(66.8)
1
5.25
(133.4)
D1427-05
2-17-93

Figure 4-8. S1 Case, Double-Ended, Panel Drilling Diagram, Rear View

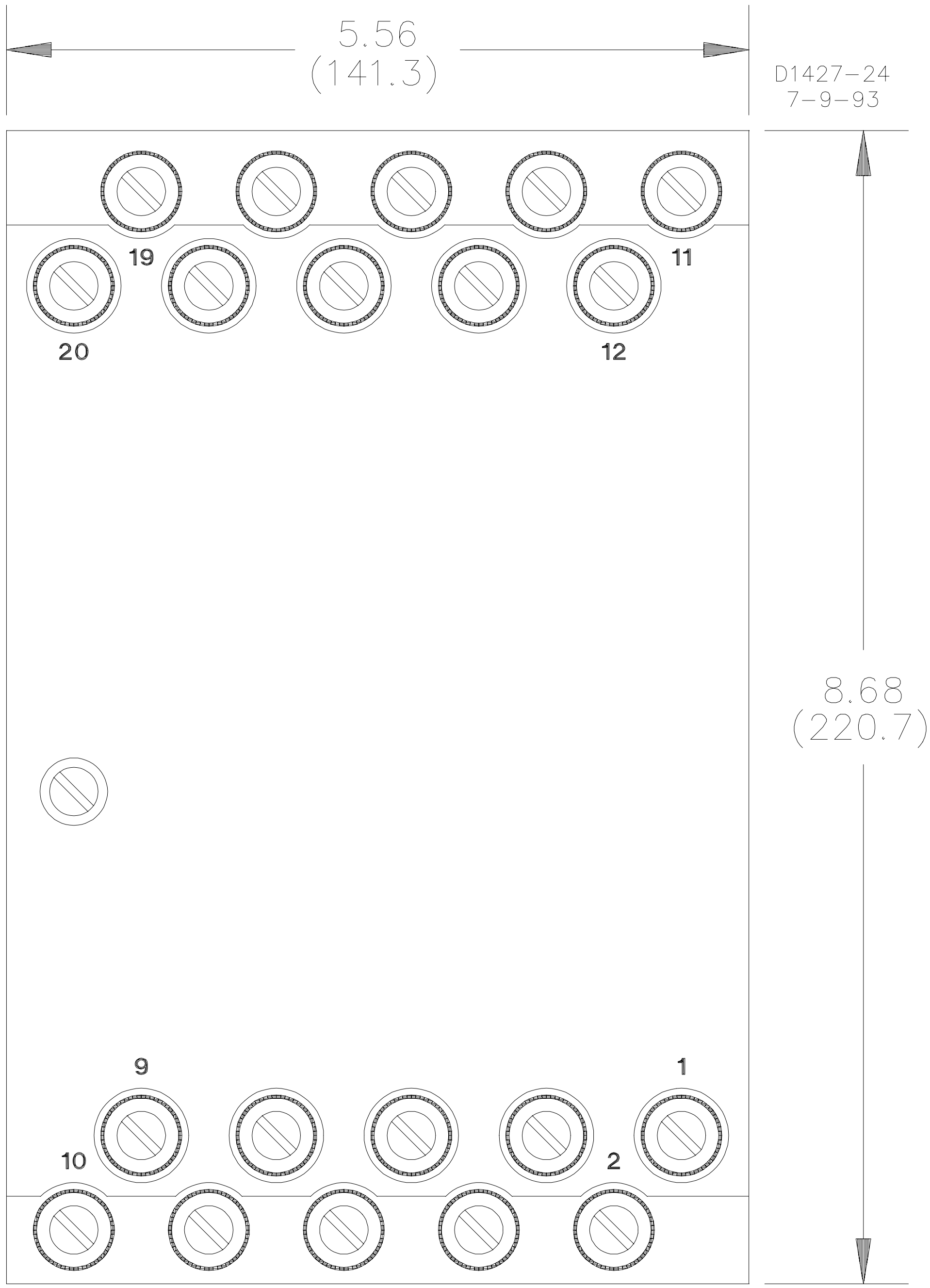


Figure 4-9. Semi-Flush Mounting, Outline Dimensions, Rear View

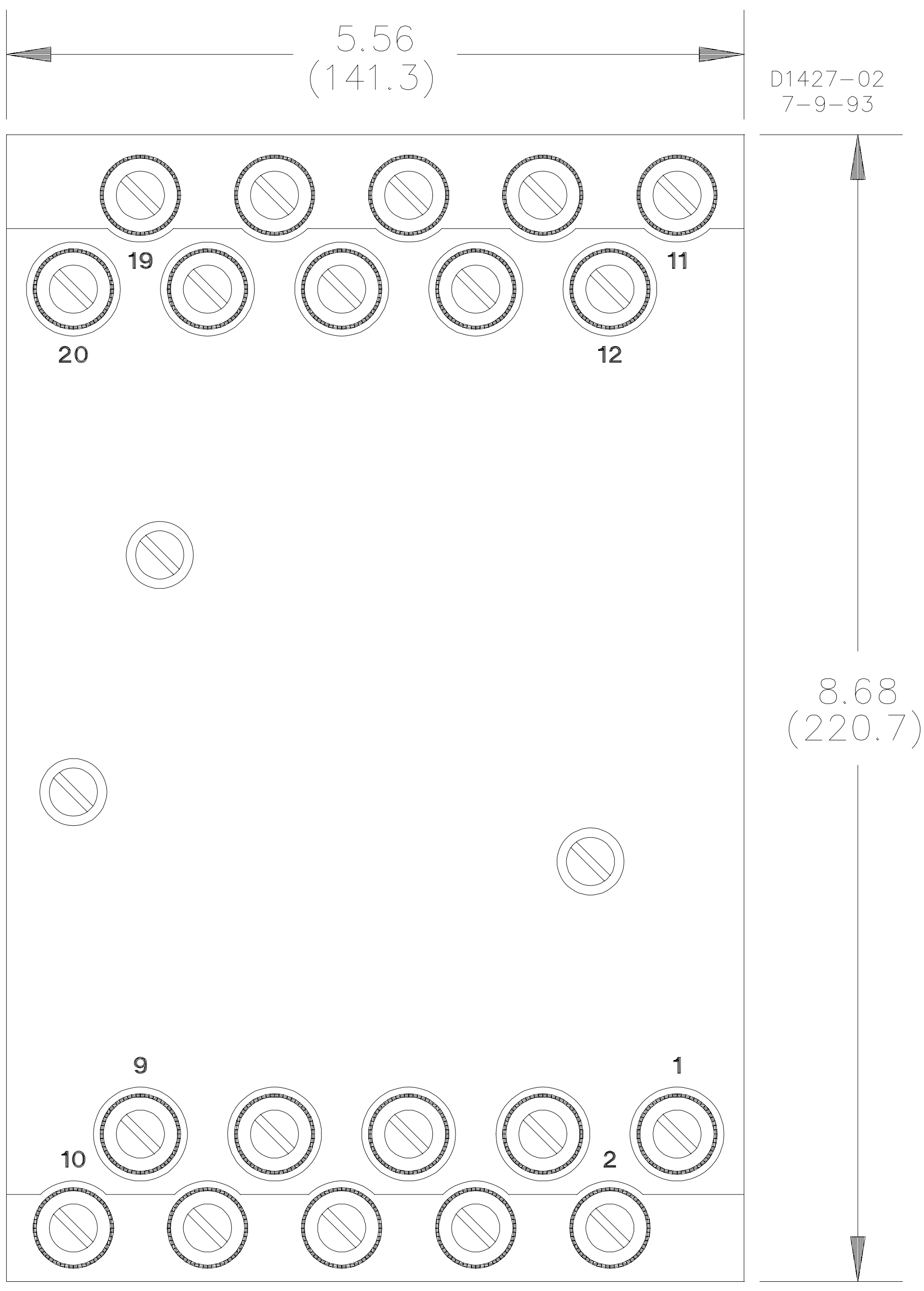


Figure 4-10. S1 Case, Projection Mounting, Outline Dimensions, Rear View

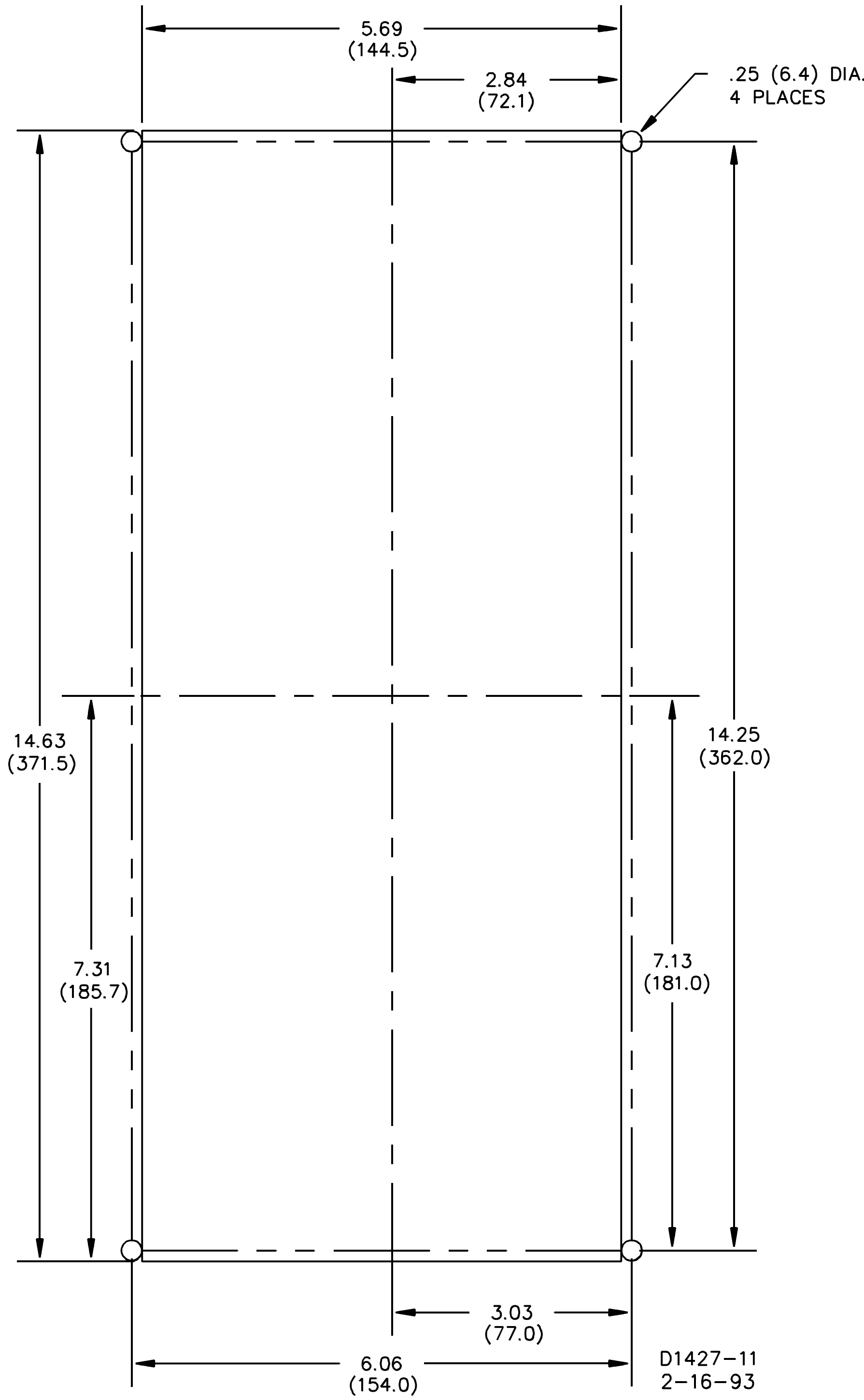


Figure 4-11. M1 Case, Semi-Flush Mounting, Panel Drilling Diagram

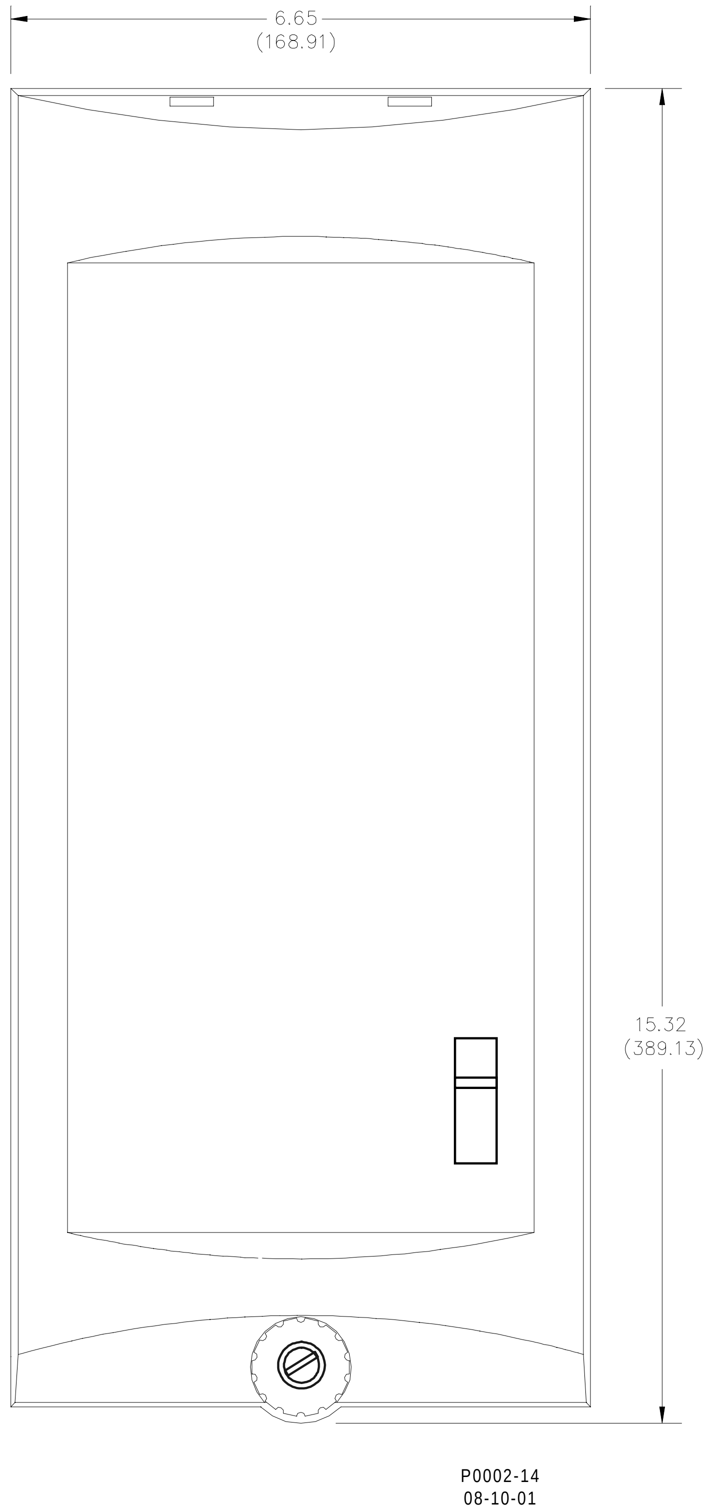


Figure 4-12. M1 Case, Outline Dimensions, Front View

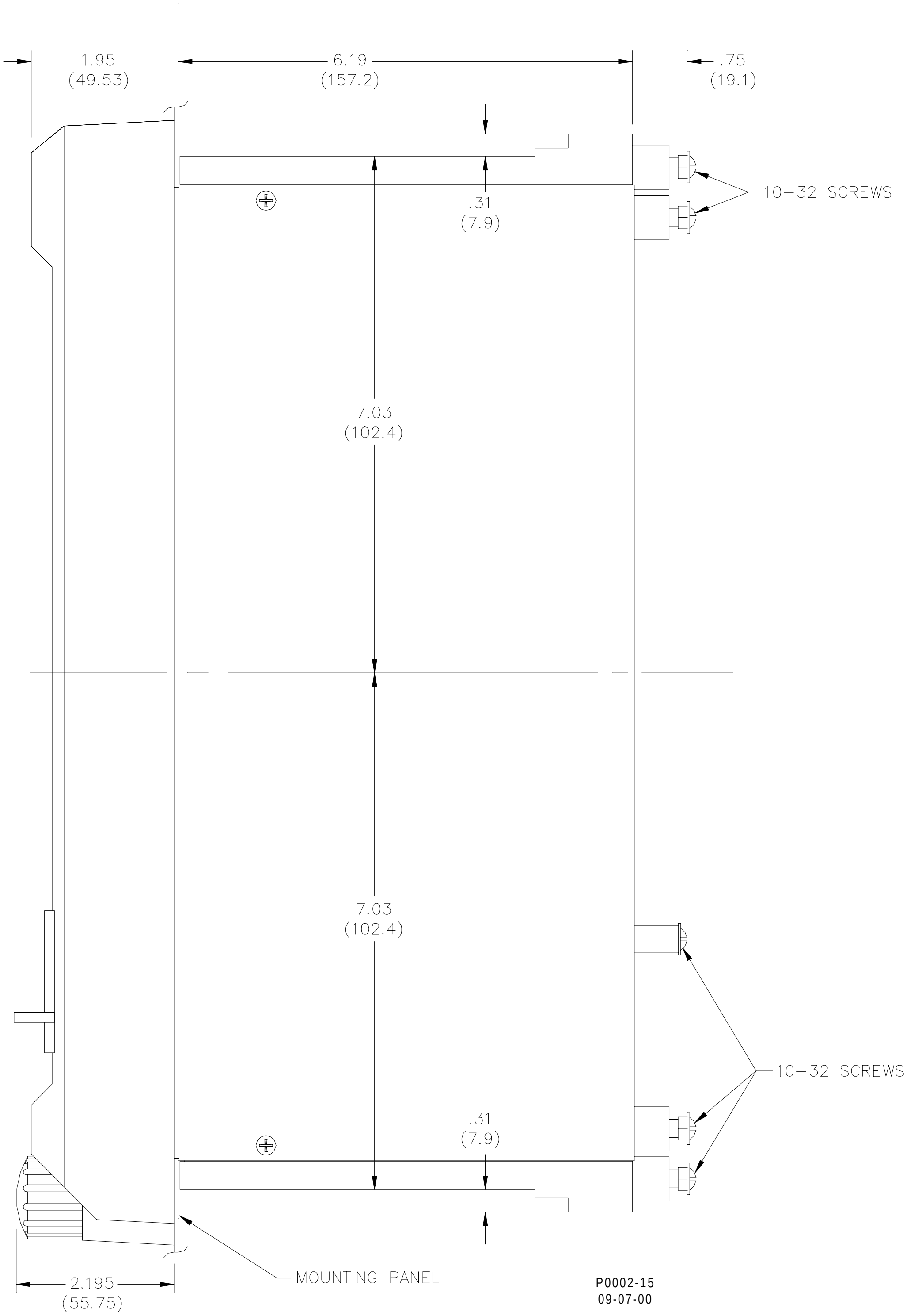


Figure 4-13. M1 Case, Double-Ended, Semi-Flush Mounting, Side View

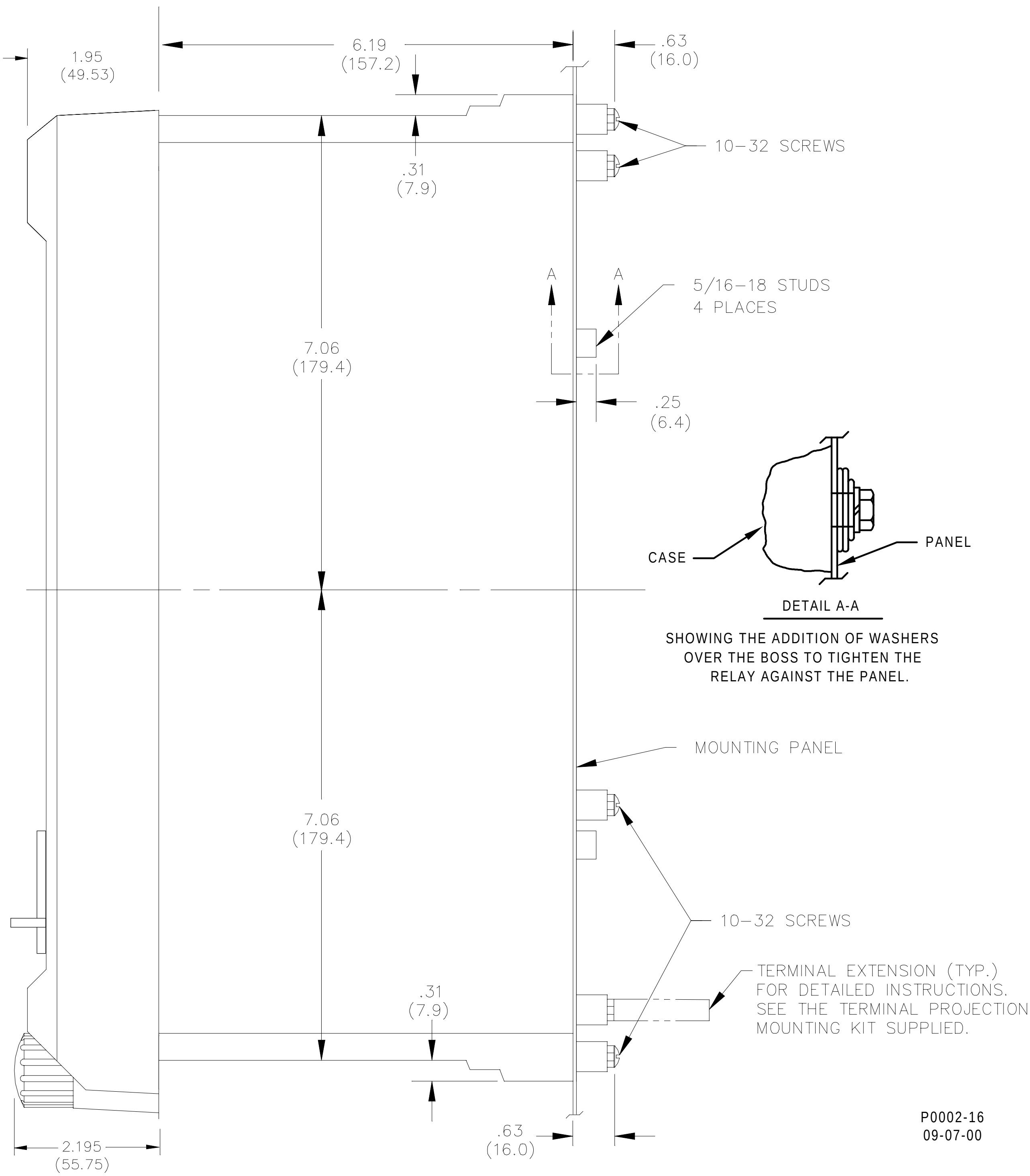


Figure 4-14. M1 Case, Double-Ended, Projection Mounting, Side View

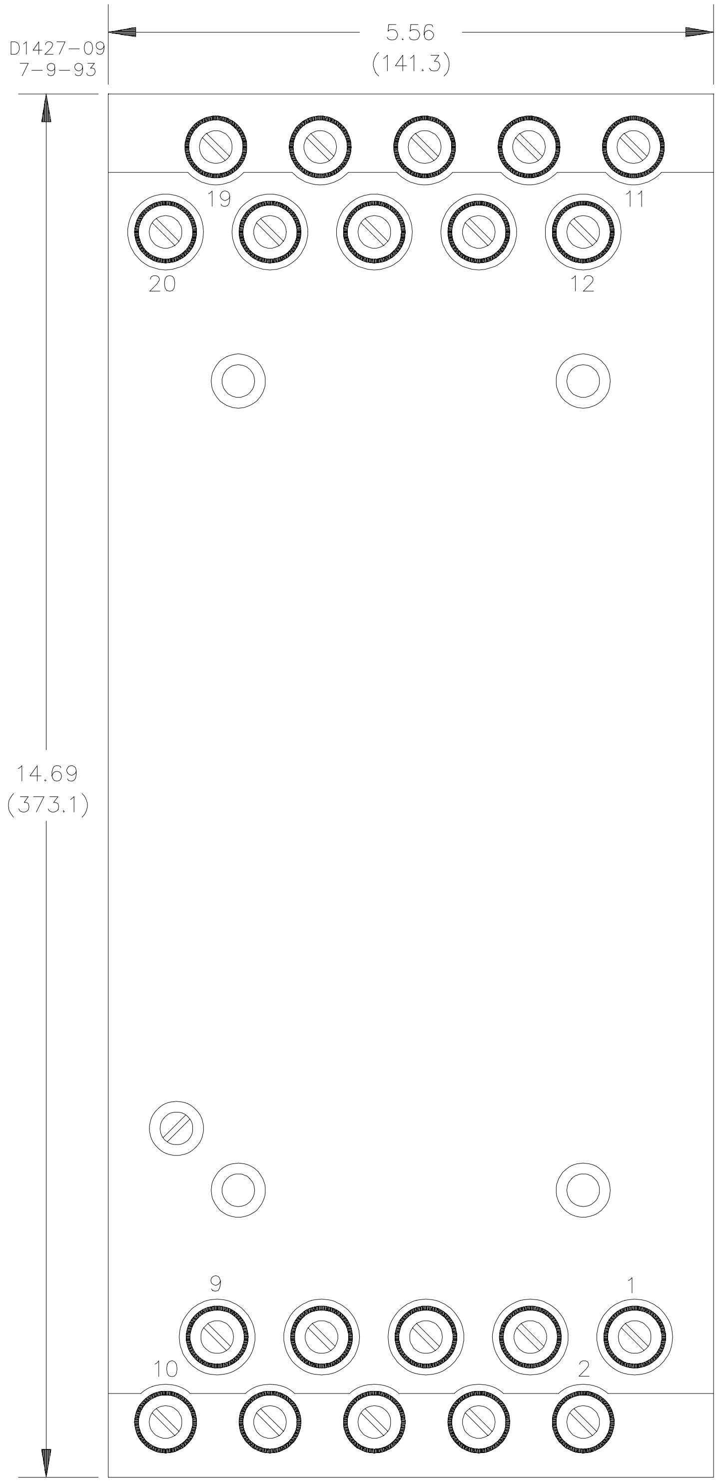


Figure 4-15. M1 Case, Double-Ended, Projection Mounting, Panel Drilling Diagram, Rear View

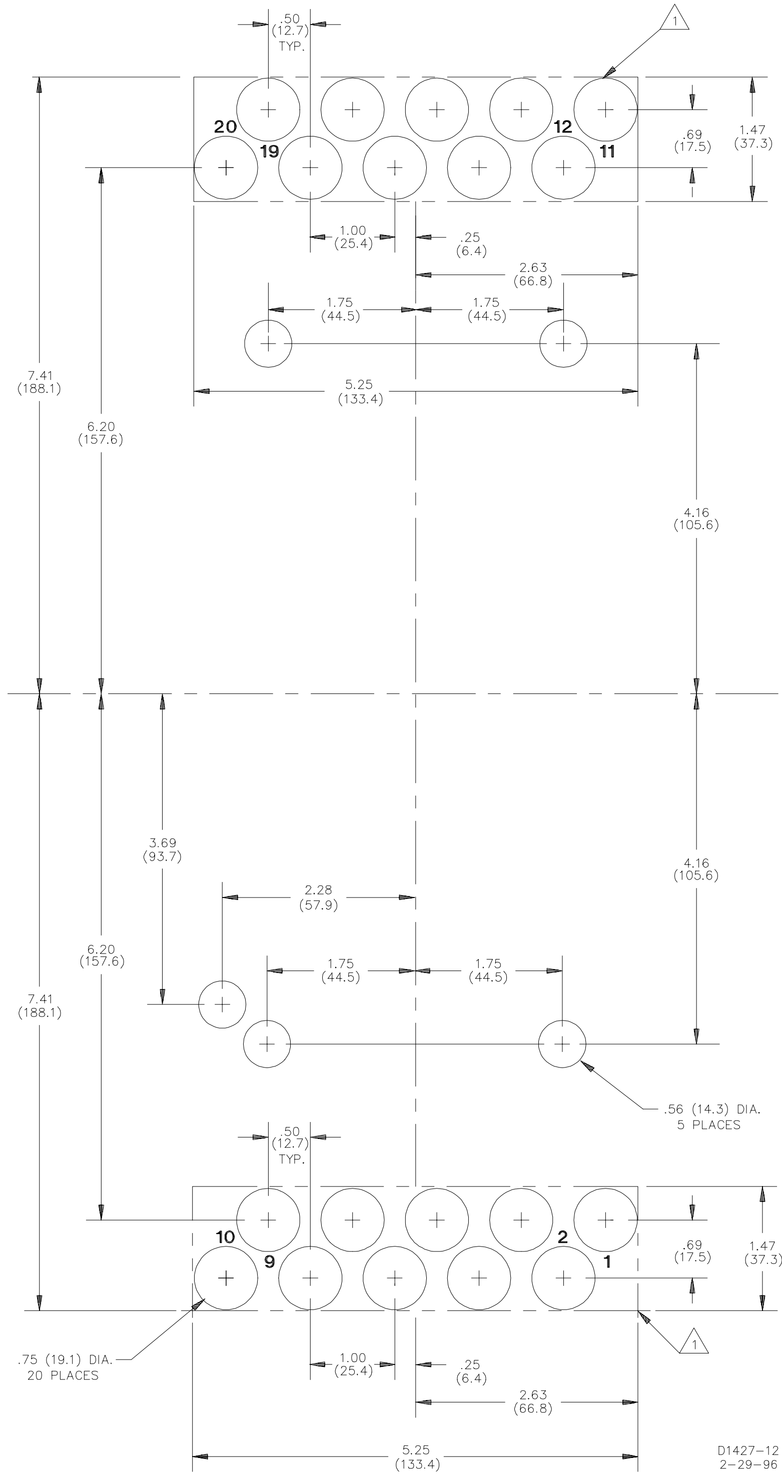


Figure 4-16. M1 Case, Double-Ended, Projection Mount, Outline Dimensions, Rear View

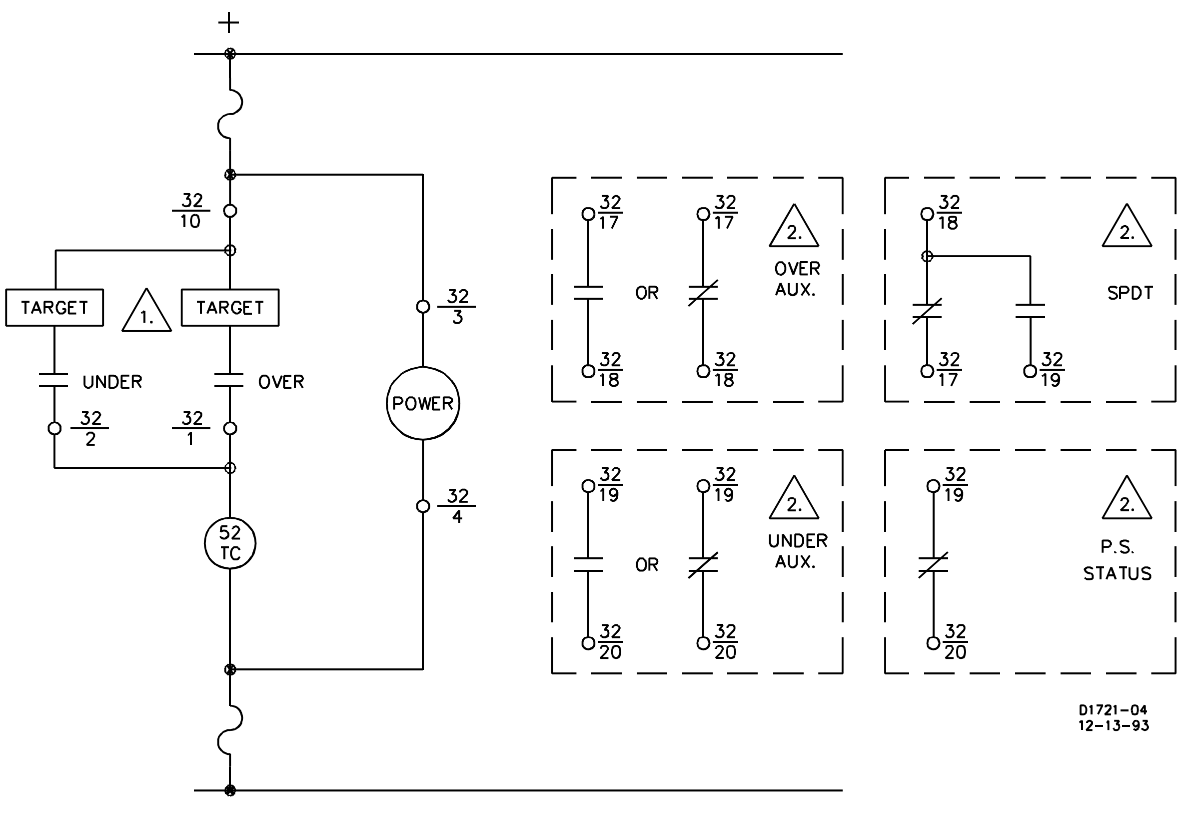
CONNECTIONS

Incorrect wiring may result in damage to the relay. Be sure to check model and style number before connecting and energizing the particular relay.

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

Except as noted above, connections should be made with minimum wire size of 14 AWG. The following illustrations provide information on relay connections.

- Control circuit connections are shown in Figure 4-17.
- Internal connections are shown in Figures 4-18 through 4-21.
- Typical external connections are shown in Figures 4-22 and 4-23.
- Sensing input connections are shown in Figures 4-24 through 4-29.



NOTES:

1. Overpower, underpower, and power supply status output contacts are optionally normally open or normally closed.
2. Auxiliary output contacts are optionally normally open, normally closed, or SPDT. if SPDT, power supply status is not available.

Figure 4-17. Control Circuit Diagram

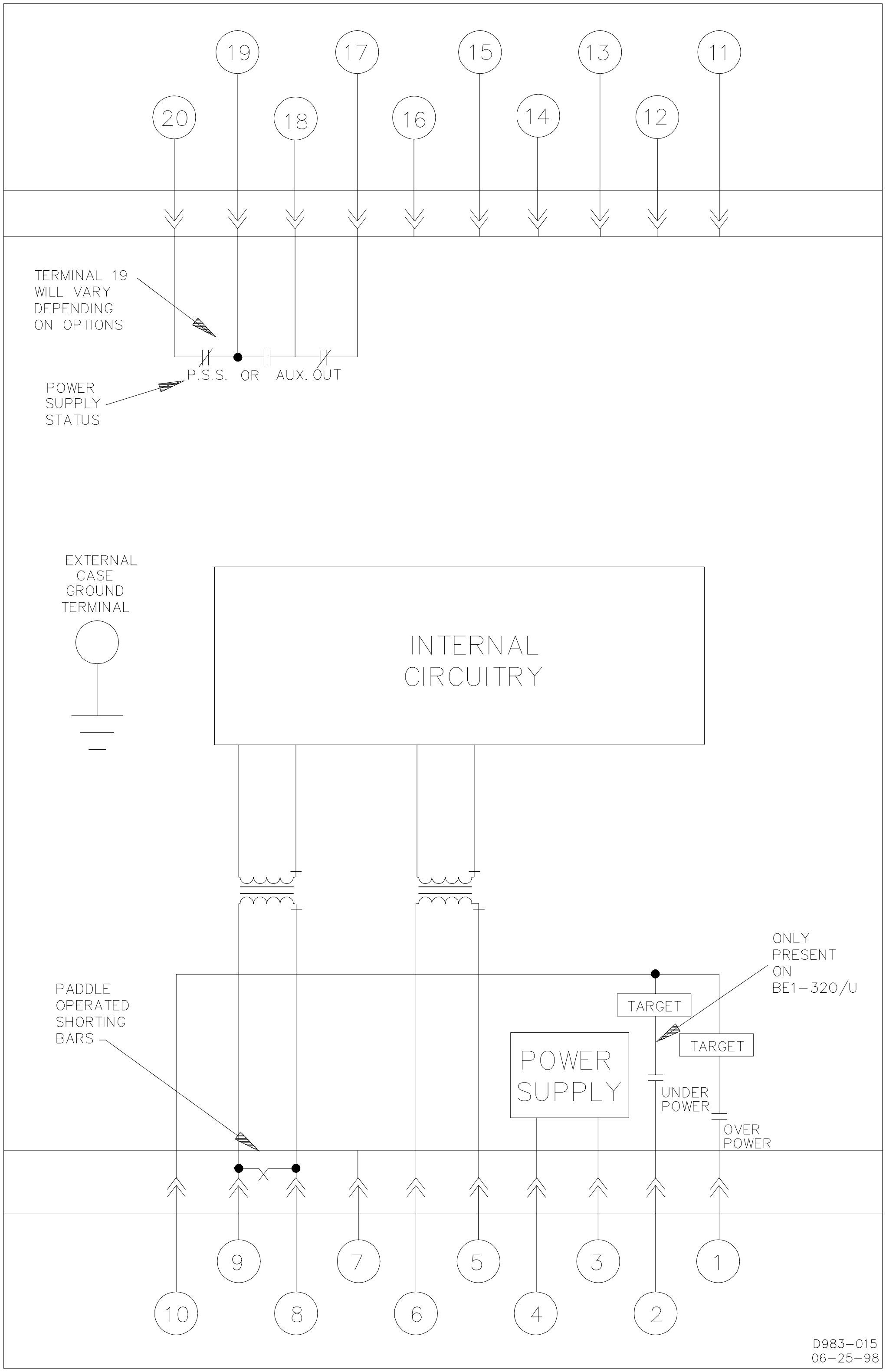


Figure 4-18. Internal Connections Sensing Type A, B, or V

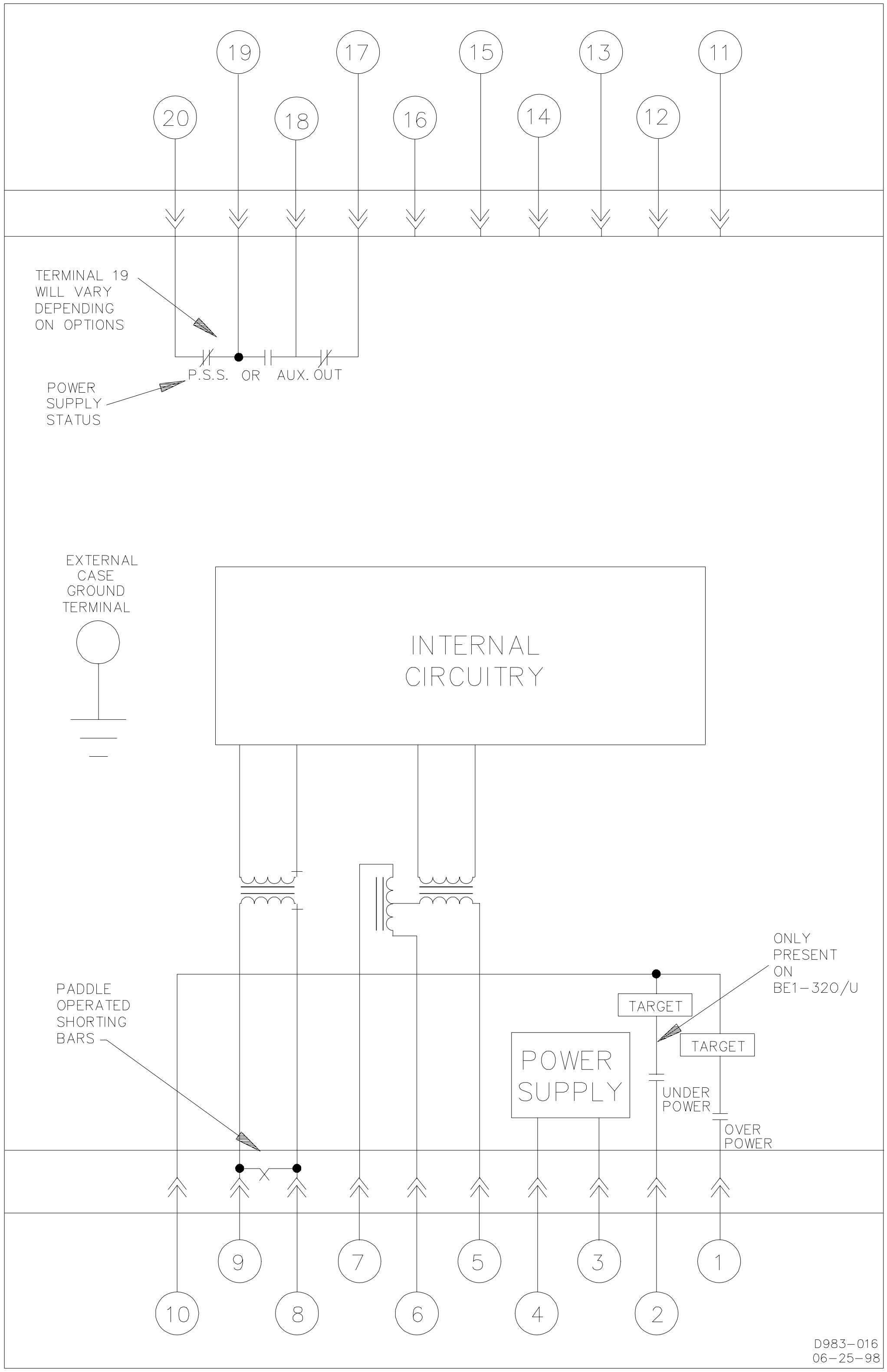


Figure 4-19. Internal Connections Sensing Type C

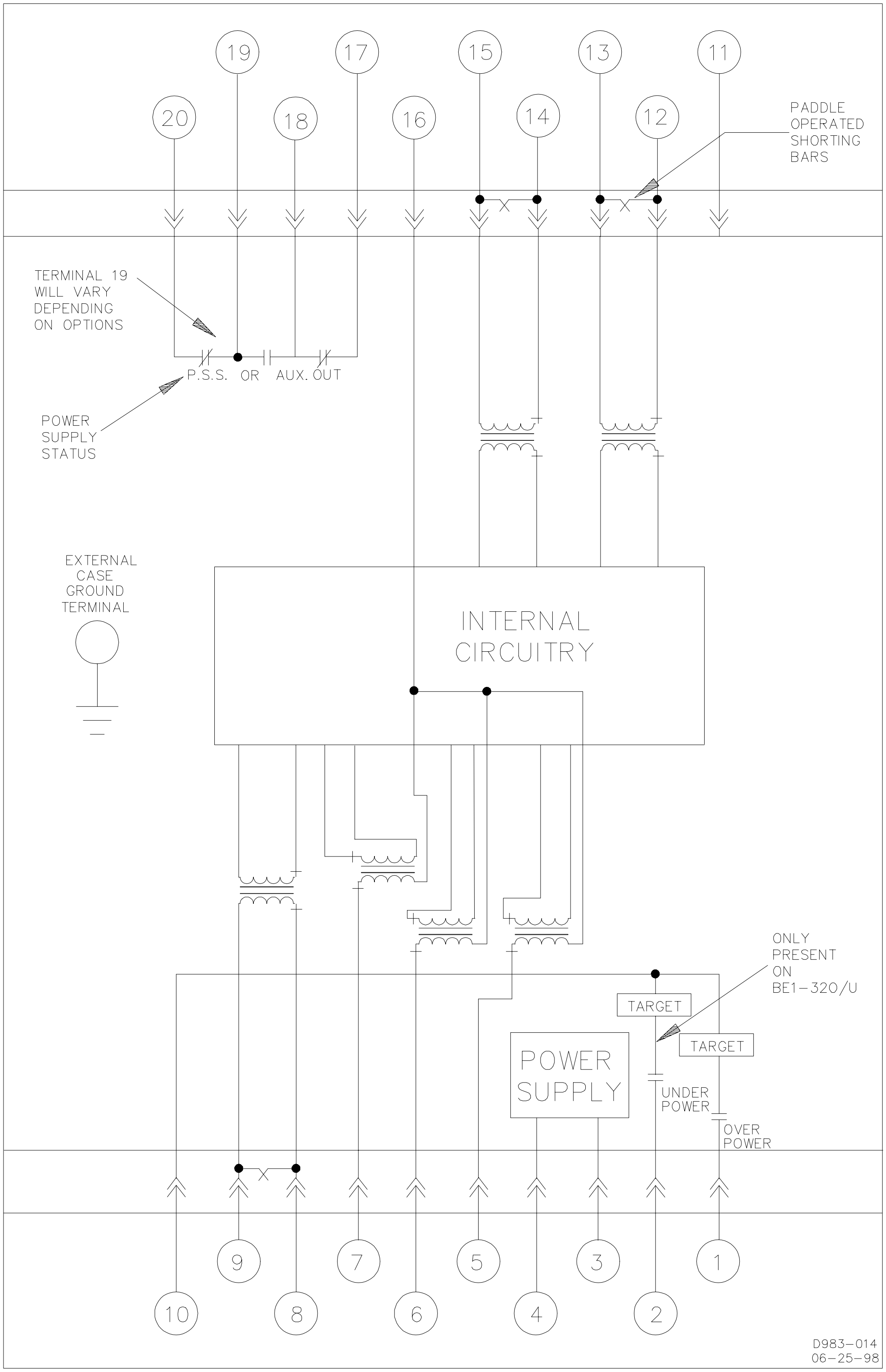


Figure 4-20. Internal Connections Sensing Type D

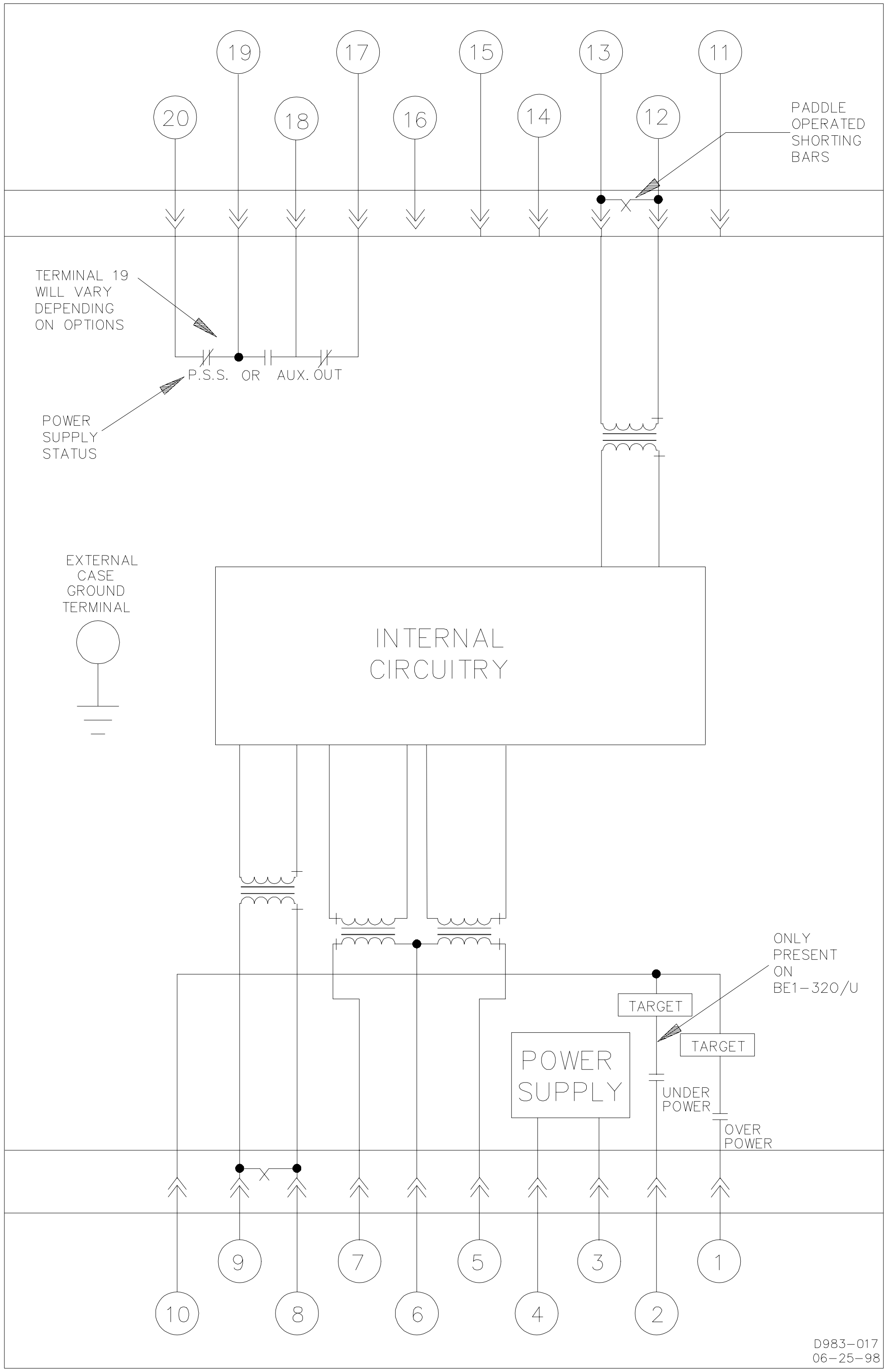


Figure 4-21. Internal Connections Sensing Type E

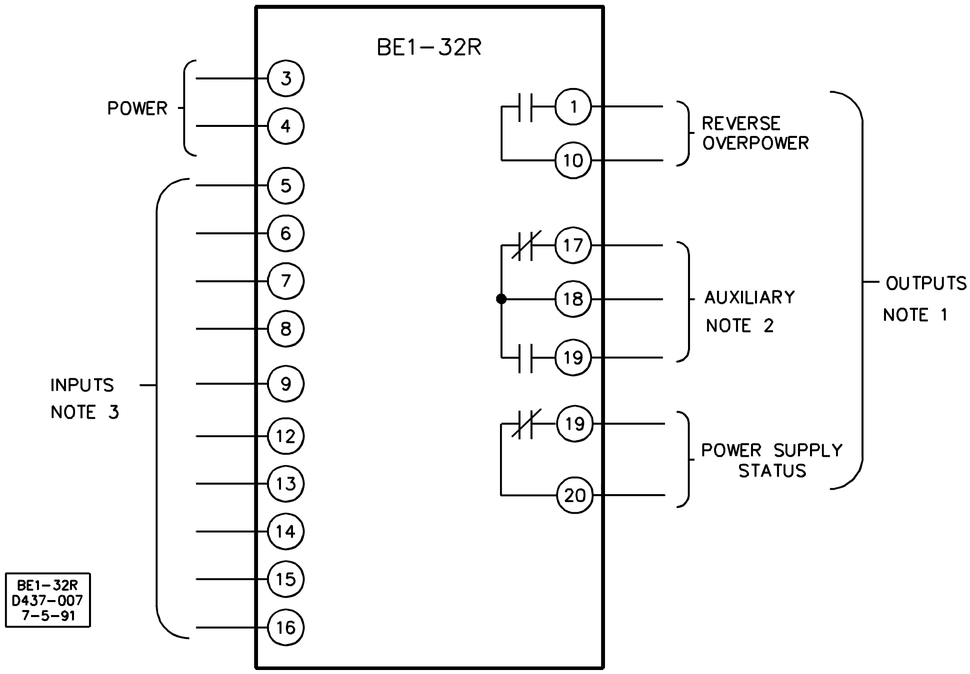


Figure 4-22. BE1-32R Typical External Connections

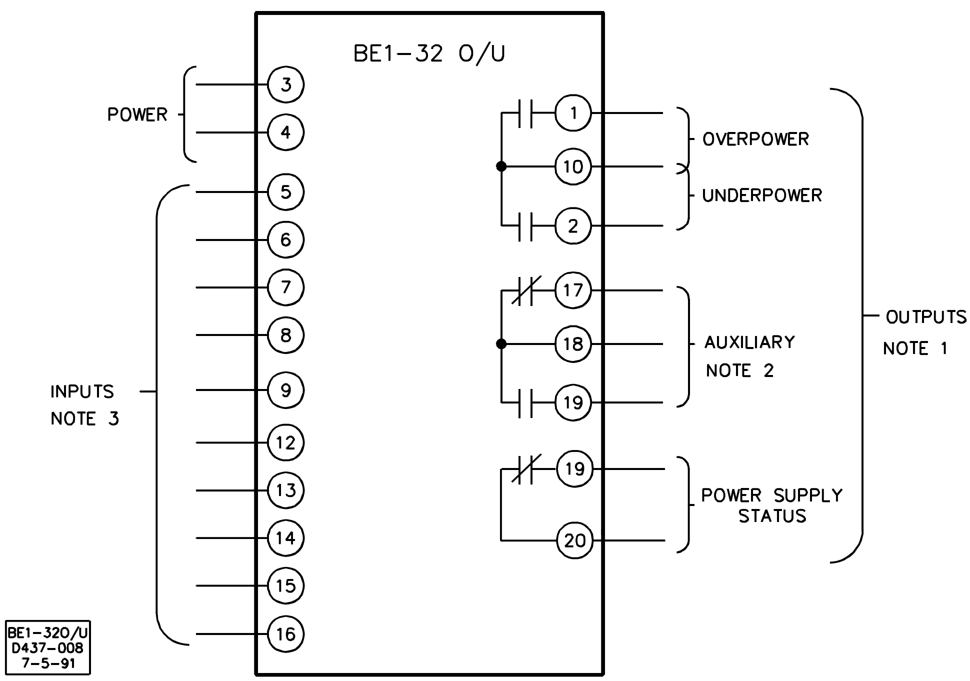


Figure 4-23. BE1-32 O/U Typical External Connections

NOTES:

1. Overpower, underpower, and power supply status output contacts are optionally normally open or normally closed.
2. Auxiliary output contacts are optionally normally open, normally closed, or SPDT. If SPDT, power supply status is not available.
3. Sensing input type determines sensing inputs.

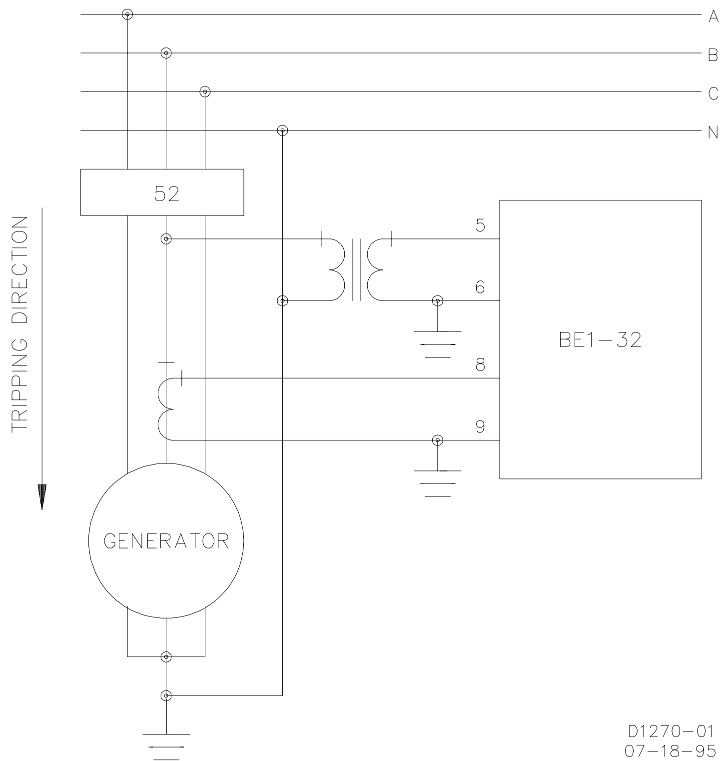


Figure 4-24. Type A Sensing

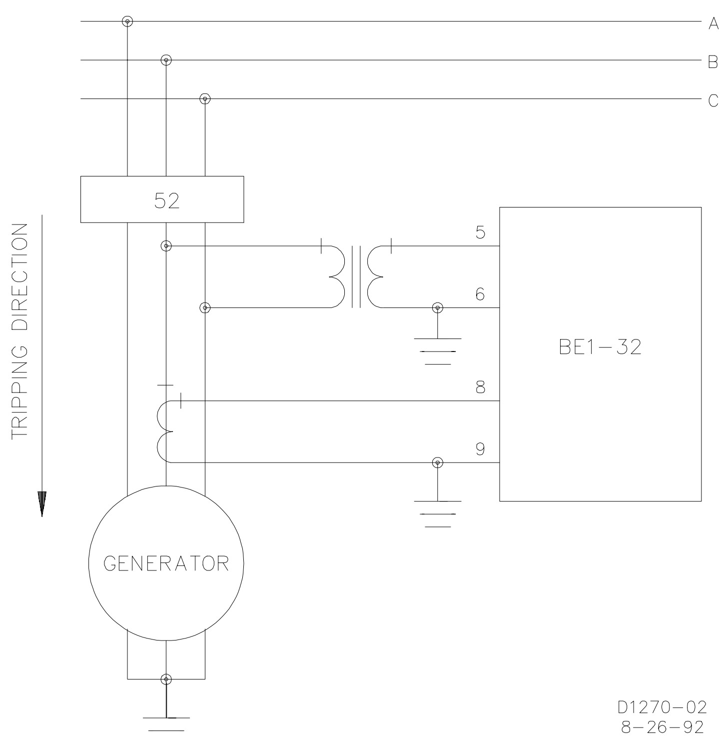


Figure 4-25. Type B or V Sensing With ABC Rotation

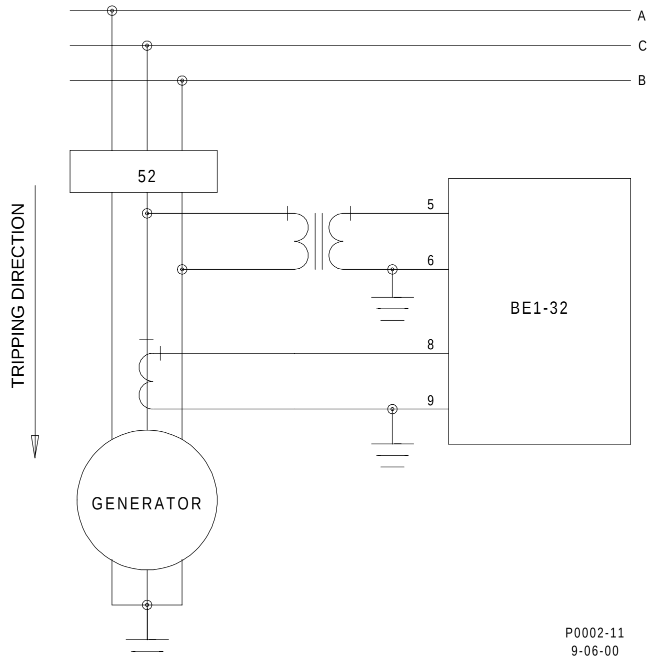


Figure 4-26. Type B or V Sensing with ACB Rotation

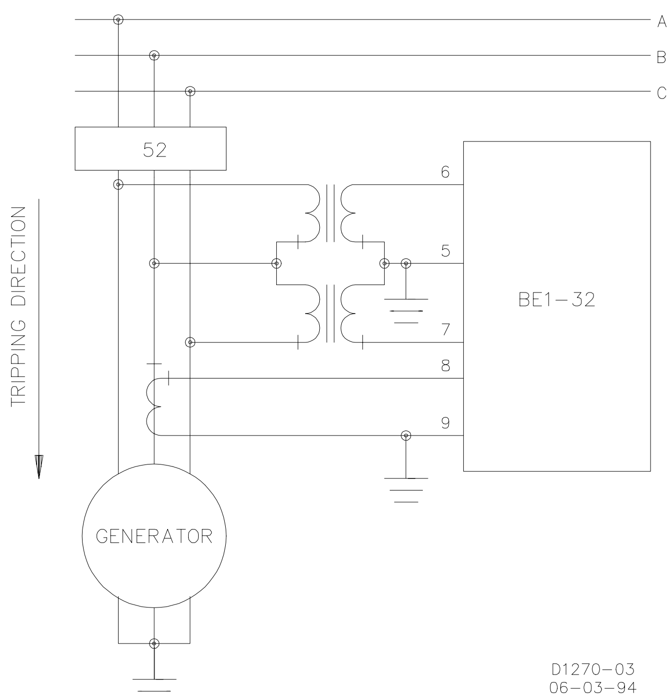


Figure 4-27. Type C Sensing

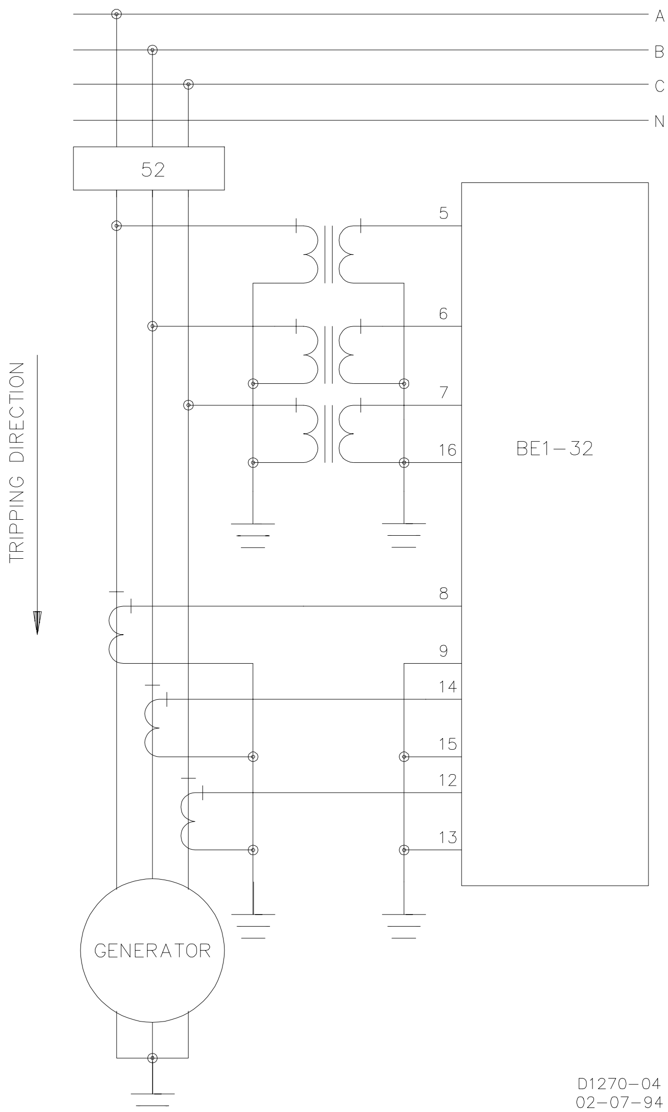


Figure 4-28. Type D Sensing

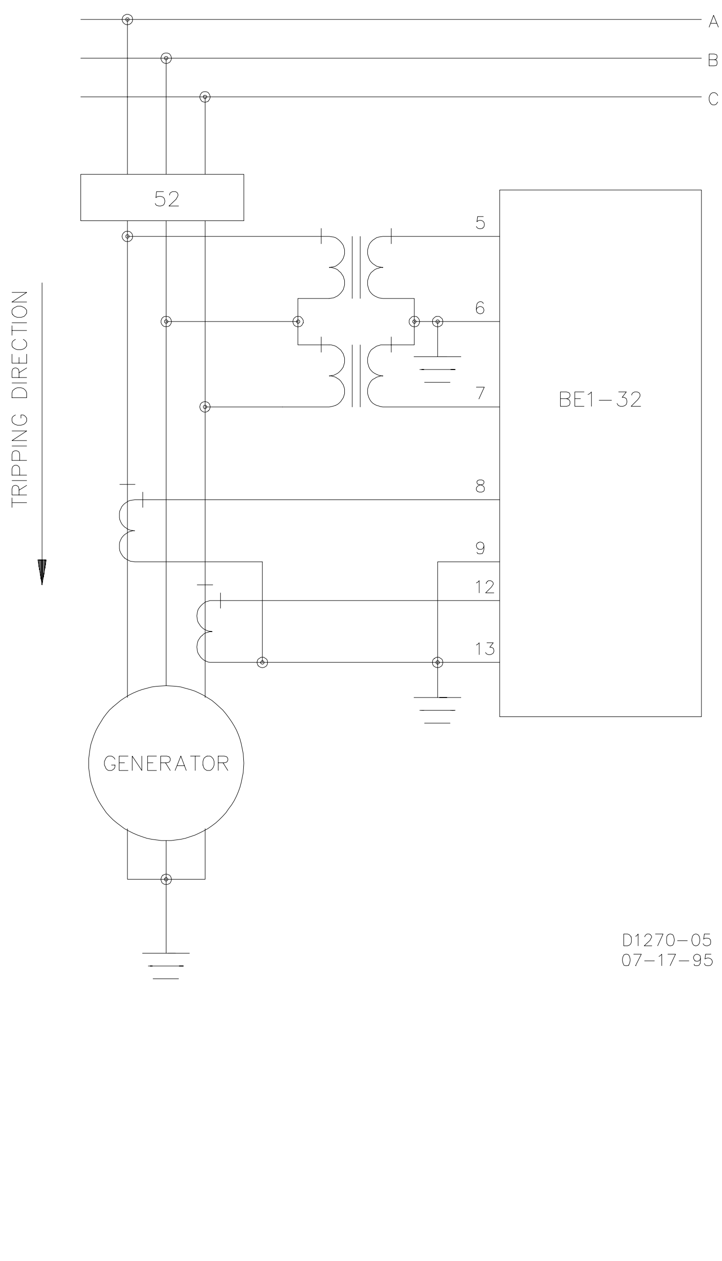


Figure 4-29. Type E Sensing With ABC Rotation

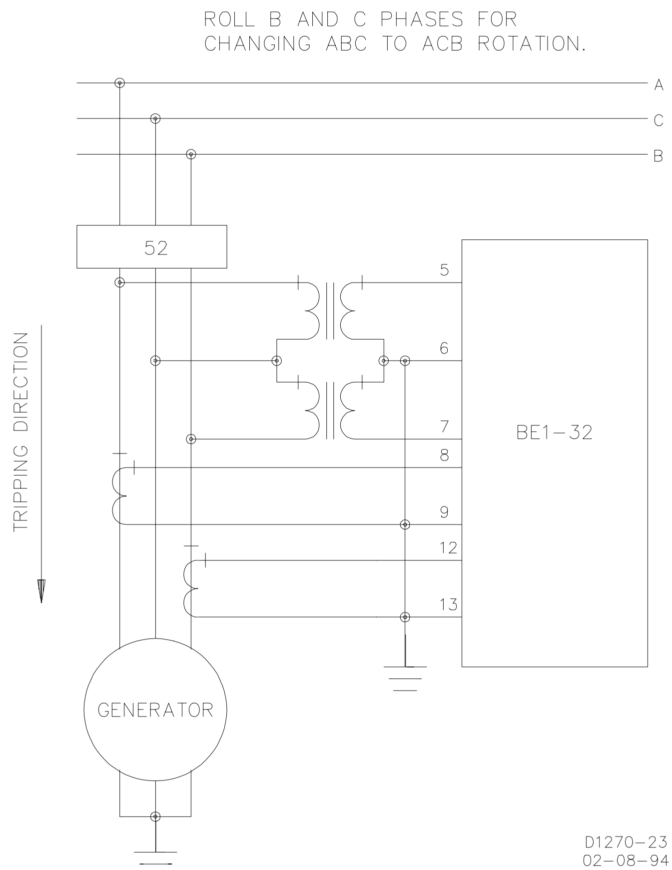


Figure 4-30. Type E Sensing With ACB Rotation

SECTION 5 • TESTING

GENERAL

The following procedures verify operation and calibration of the relay.

Results obtained from these procedures may not fall within specified tolerances. When evaluating results, consideration must be given to three prominent factors.

- The inherent error of the test equipment used.
- The inconsistent method of testing (i.e. Timing start signal).
- The tolerance level of external components used in the test setup.

OPERATIONAL TEST PROCEDURES

Overpower Pickup and Dropout (Unity Power Factor)

Step 1. Connect the relay for the appropriate sensing input type, reference Figures 5-1 through 5-5.

Step 2. Make the following relay front panel adjustments:

> **NOTE**
> Units with inverse or instantaneous timing options will not have a multiplier switch.

RANGE switch - LOW
OVER TAP pickup selector B
OVER TIME DELAY setting - 00 (instantaneous)
OVER multiplier switch (X) - 0.1
UNDER pickup control fully CCW

Step 3. Apply operating power to the relay (case terminals 3 and 4). Apply nominal input voltage according to sensing input type and range. (A single voltage source may be paralleled to the relays inputs to simulate a three-phase source.)

Step 4. Apply a current source to the relay current sensing inputs and increase the source to a point where the OVER PICKUP LED is illuminated.

> **NOTE**
> Main relay contacts, auxiliary output contacts, and targets (if present) should actuate.

Verify wattmeter reads within ±2 % of the front panel selected setting (LOW range, TAP B).

Step 5. Slowly decrease the current source to a point where the OVER PICKUP LED just extinguishes. Verify the wattmeter reading is within 98% of the pickup value established in Step 4.

Step 6. Reset targets if present.

Step 7. Repeat Steps 1 through 6 for OVER pickup TAP settings of E and K.

Underpower Pickup and Dropout (Unity Power Factor)

Step 1. Make the following relay front panel adjustments:

> **NOTE**
> Units with inverse or instantaneous timing options will not have a multiplier switch.

RANGE switch - LOW
UNDER pickup control - fully CW (95 %)
UNDER TIME DELAY - 00 (instantaneous)

OVER and UNDER multiplier switches (X) - 0.1
OVER TAP pickup selector B

Step 2. With the relay powered up, apply nominal input voltage according to sensing input type and range.

Step 3. Apply a current source to the relay current sensing inputs and increase the source until it is greater than the underpower pickup point.

Step 4. Slowly decrease the current source to a point where the UNDER PICKUP LED Illuminates.

> **NOTE**
> Main relay contacts, auxiliary output contacts, and targets (if present) should actuate.

Verify wattmeter reads within ±2 % or 0.1 watt, whichever is greater of 95% of the front panel selected setting (LOW range, TAP B).

Step 5. Slowly increase the current source to a point when the UNDER PICKUP LED just extinguishes. Verify wattmeter reading is within 105 % of the underpower pickup value established in Step 4.

Instantaneous Time (Overpower)

Step 1. Connect the timer/counter so that timing begins when sensing current is applied and ends when the trip output circuit is energized.

Step 2. Select a mid-range pickup point and apply input voltage according to sensing input type and range.

Step 3. Apply (step) current to obtain two times the selected watts setting at unity power factor and measure the interval from initiation to contact closure.

RESULT: Measured time should be less than 80 ms (60 Hz) or less than 100 ms (50 Hz).

Definite Time (Overpower)

Step 1. Connect the timer/counter so that timing begins when sensing current is applied and stops when the trip output circuit is energized.

Step 2. Make the following relay front panel adjustments:

RANGE switch - LOW
OVER TAP pickup selector - B
OVER TIME DELAY - 01
OVER multiplier switch (X) - 0.1
UNDER pickup control - fully CCW

Step 3. Apply nominal input sensing voltage and operating power.

Step 4. Adjust (but do not apply) the current source to two times the tap value. Apply the current and measure the interval from initiation to output actuation.

RESULT: The measured interval should be 0.1 ±0.050 seconds.

Step 5. Repeat Steps 1 through 4 for TIME DELAY settings of 05 and 99.

RESULT:

Setting	Expected Time
50	5.0 ±0.25 seconds
99	9.9 ±0.50 seconds

Definite Time (Underpower)

Step 1. Make the following relay front panel adjustments:

NOTE
Units with inverse or instantaneous timing options will not have a multiplier switch.

RANGE switch - LOW
UNDER pickup control - fully CW (95 %)
UNDER TIME DELAY - 01
OVER and UNDER multiplier switches (X) - 0.1
OVER TAP pickup selector B

Step 2. With the relay powered up, apply nominal input voltage according to sensing input type and range.

Step 3. Apply a current source to the relay current sensing inputs and increase the source until it is greater than the underpower pickup point.

Step 4. Remove the current source so that the UNDER PICKUP LED Illuminates and record the interval from underpower pickup to output contact actuation.

RESULT:	Setting	Multiplier Switch	Expected Time
	01	0.1	0.1 ±0.05 seconds

Step 5. Repeat Steps 3 and 4 with UNDER TIME DELAY and multiplier switch (X) settings as shown in the RESULTS below. Record the interval from underpower pickup to output contact actuation.

RESULTS:	Setting	Multiplier Switch	Expected Time
	05	0.1	0.5 ±0.05 seconds
	50	1.0	50.0 ±2.50 seconds

Inverse Time (Overpower)

Step 1. Connect timer/counter so that timing begins when sensing input current is applied and stops when the trip output circuit is energized.

Step 2. Make the following relay front panel adjustments:

RANGE switch - LOW
OVER TAP pickup selector - B
OVER TIME DELAY - 05
OVER multiplier switch (X) - 0.1
UNDER pickup control - fully CCW

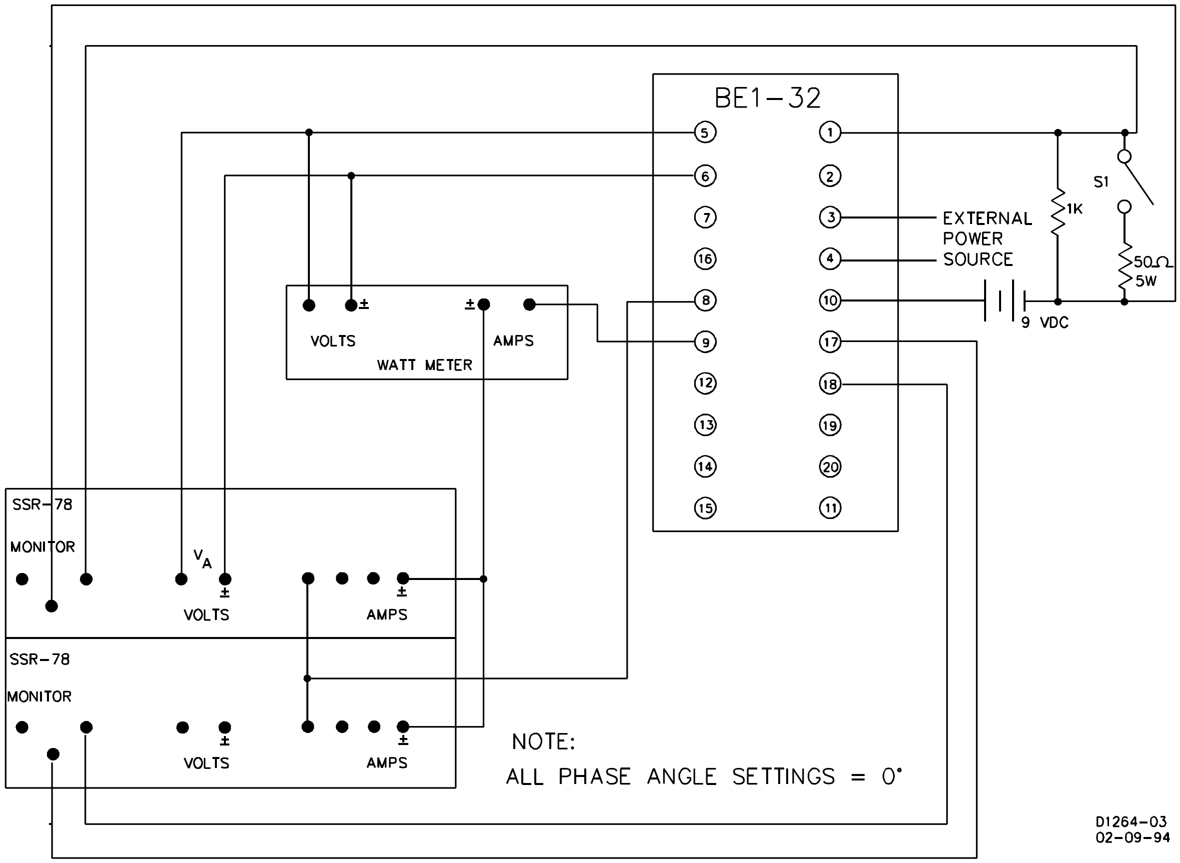
Step 3. Adjust (but do not apply) the current source to a level four times the pickup point (TAP B) setting. Apply the current and measure the interval from initiation to output actuation.

RESULT: The measured interval should be 0.460 ±0.050 seconds.

Step 4. Repeat Steps 1 through 3 for sensing input power magnitudes of 1.5 times and 8 times the TAP B watts setting.

RESULTS:	Setting	Actual Time
	1.5 X	1.048 ± 0.053 seconds
	8.0 X	0.282 ± 0.050 seconds

This concludes the operational test.



NOTES:

1. Type A sensing is calibrated in single-phase watts. If a wattmeter is not available, use the following equation to determine the pickup current corresponding to the desired overpower or underpower pickup in watts. Adjust the relay test set to produce this current value.

$$W = V_A \times I$$

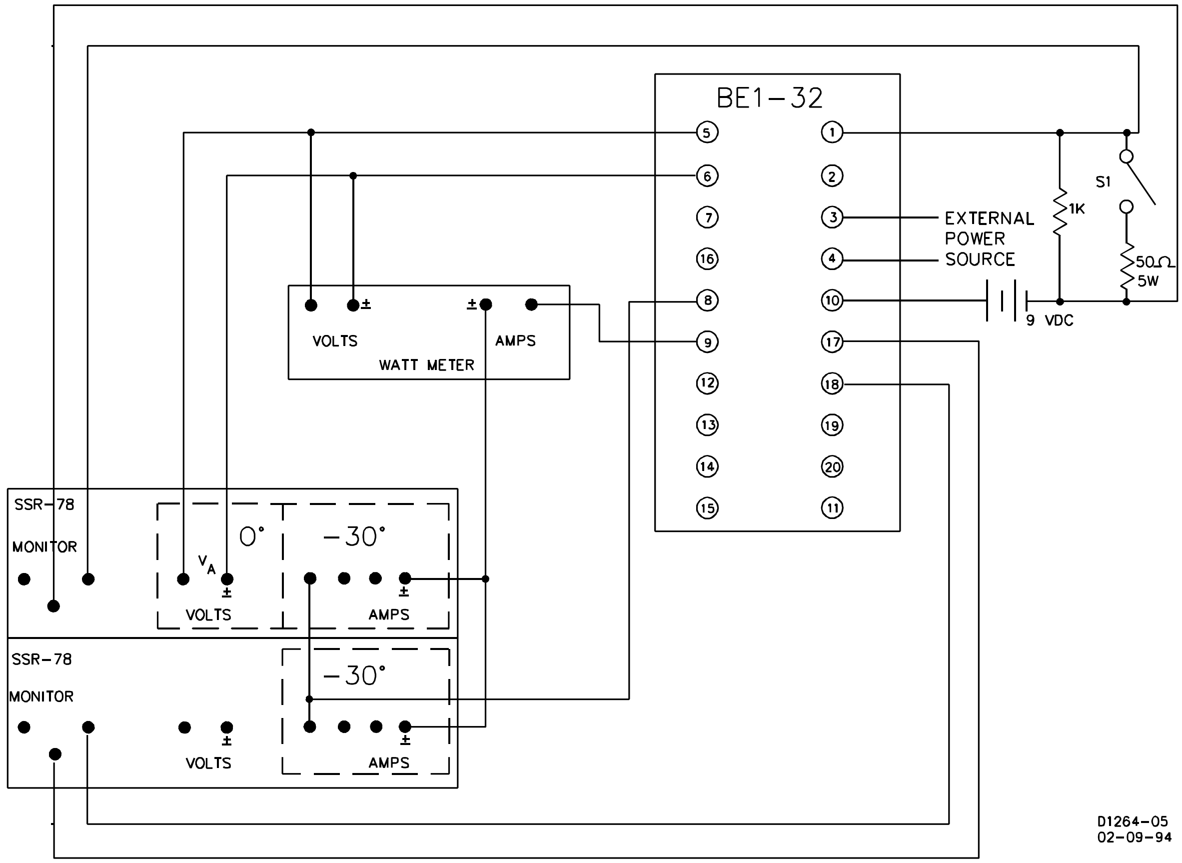
Where:W = Desired pickup in watts (front panel setting)
V = Applied voltage
I = Applied current

With a wattmeter: $W = Wattmeter\ Reading$

2. Terminals 1 and 10 are the overpower trip output device connections for both BE1-32R and BE1-32 0/U. Terminals 2 and 10 are the underpower output connections for the BE1-32 0/U.

3. Terminals 17 thru 20 are auxiliary relay output contacts. Determine the auxiliary output contact configuration by referring to the relay style number.

Figure 5-1. Type A Sensing Test Setup Diagram



NOTES:

1. Types B and V (30° phase shift) sensing are calibrated in single-phase watts. If a watt meter is not available, use the following equation to determine the pickup current corresponding to the desired overpower or underpower pickup in watts. Adjust the relay test set to produce this current value.

$$W = \frac{V_A \times I}{\sqrt{3}}$$

Where: W = Desired pickup in watts
V = Applied voltage
I = Applied current

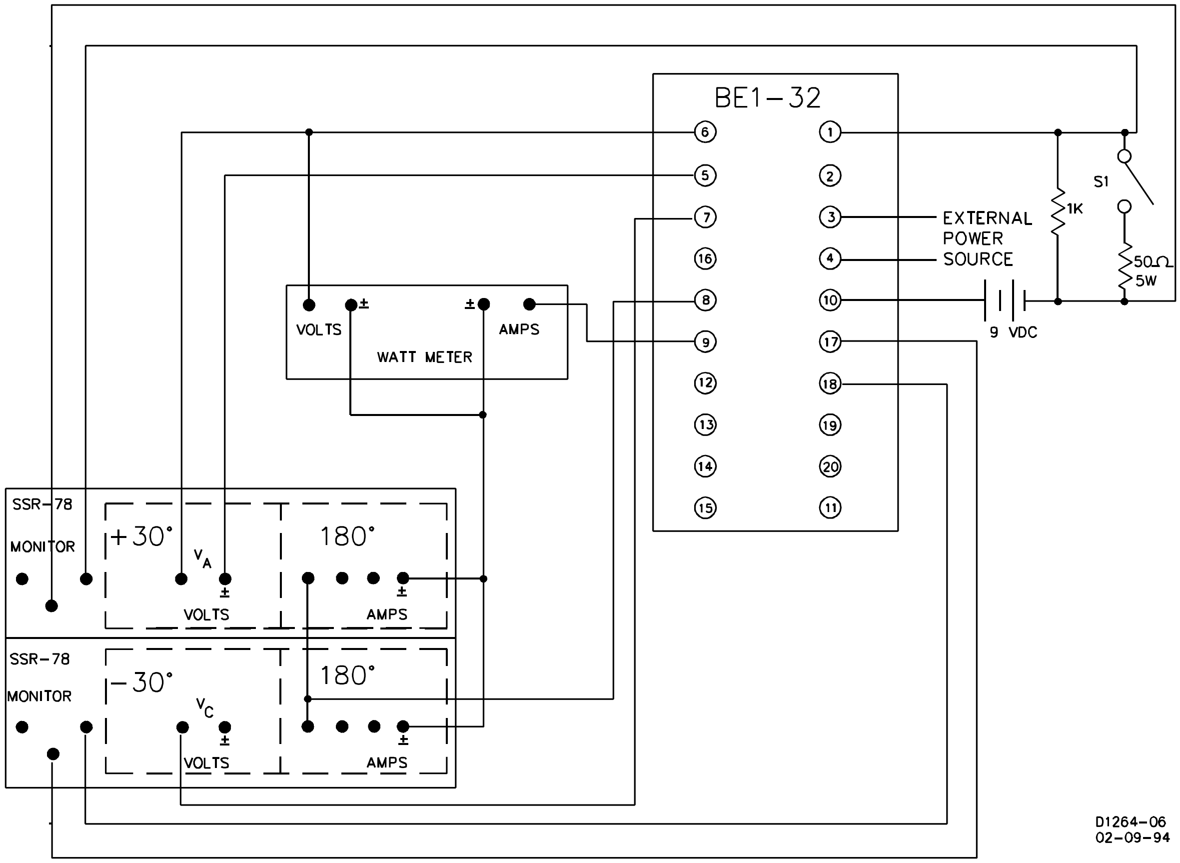
With a wattmeter:

$$W = \frac{Wattmeter\ \ Reading}{1.5}$$

2. Terminals 1 and 10 are the overpower trip output device connections for both BE1-32R and BE1-32 0/U. Terminals 2 and 10 are the underpower output connections for the BE1-32 0/U.

3. Terminals 17 thru 20 are auxiliary relay output contacts. Determine the auxiliary output contact configuration by referring to the relay style number.

Figure 5-2. Type B or V Sensing



NOTES:

1. Type C (Scott-T) sensing is calibrated in three-phase watts. If a wattmeter is not available, use the following equation to determine the pickup current corresponding to the desired overpower or underpower pickup in watts. Adjust the relay test set to produce this current value.

$$W = \sqrt{3} \times V_A \times I$$

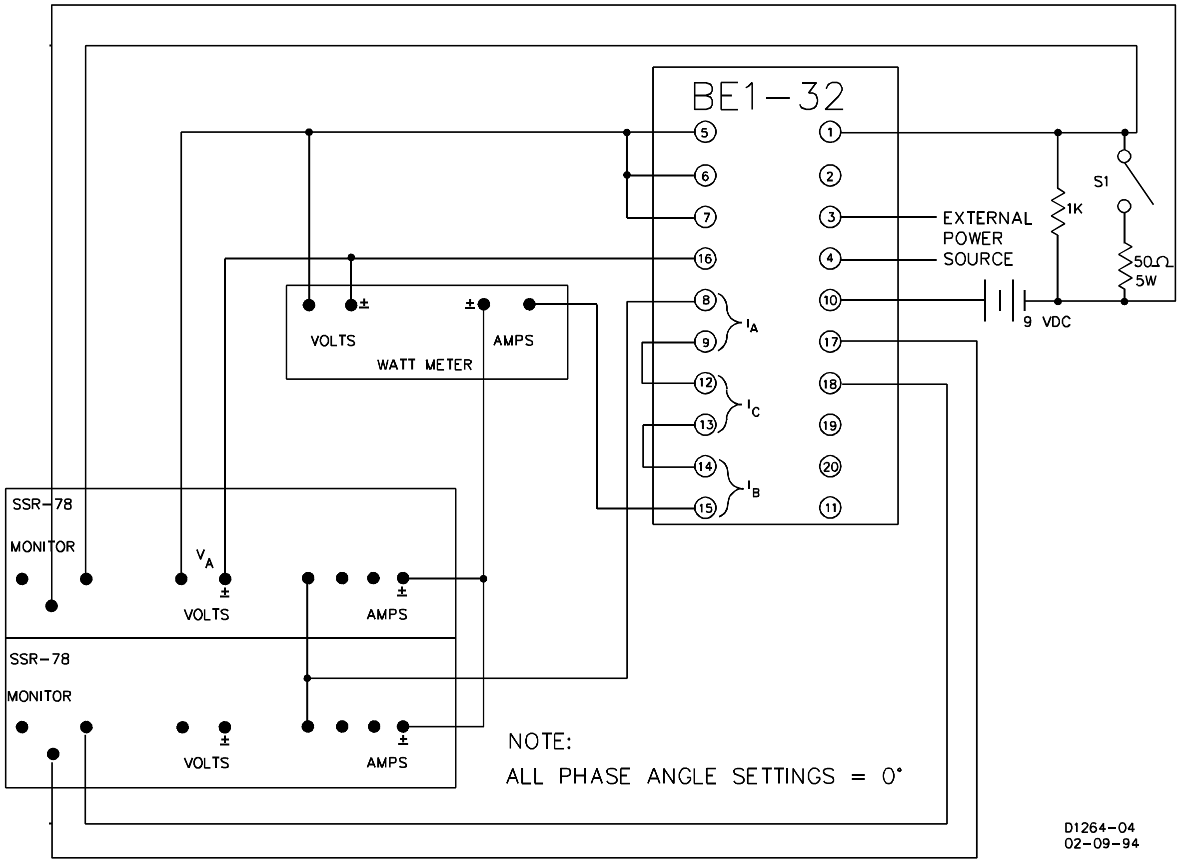
Where: W = Desired pickup in watts
V = Applied voltage
I = Applied current

With a wattmeter: $W = 2 \times Wattmeter\ \ Reading$

2. Terminals 1 and 10 are the overpower trip output device connections for both BE1-32R and BE1-32 0/U. Terminals 2 and 10 are the underpower output connections for the BE1-32 0/U.

3. Terminals 17 thru 20 are auxiliary relay output contacts. Determine the auxiliary output contact configuration by referring to the relay style number.

Figure 5-3. Type C Sensing Test Setup Diagram



NOTES:

1. Type D sensing is calibrated in three-phase watts using single-phase sensing inputs. Using the test setup shown, the relay may be calibrated in true three-phase power using one-third of the pickup current corresponding to the desired overpower or underpower pickup in watts. Adjust the relay test set to produce this current value from the following equation.

   $$W = 3 \times V_A \times I$$

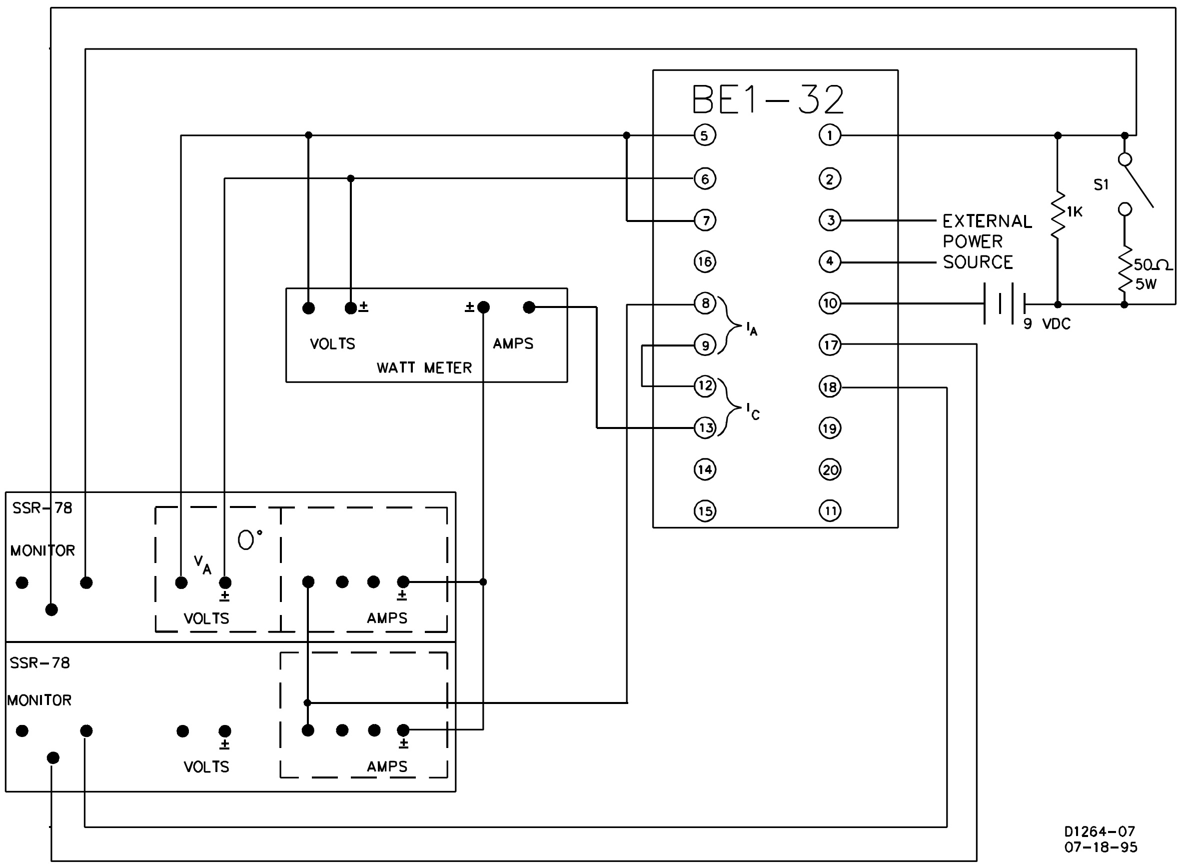
   Where:W = Desired pickup in watts
   V = Applied voltage
   I = Applied current

   With a wattmeter: $$W = 3 \times Wattmeter\ \ Reading$$

2. Terminals 1 and 10 are the overpower trip output device connections for both BE1-32R and BE1-32 0/U. Terminals 2 and 10 are the underpower output connections for the BE1-32 0/U.

3. Terminals 17 thru 20 are auxiliary relay output contacts. Determine the auxiliary output contact configuration by referring to the relay style number.

Figure 5-4. Type D Sensing Test Setup Diagram



NOTES:

1. Type E sensing is calibrated in three-phase watts using single-phase sensing inputs. Using the test setup shown, the relay may be calibrated in true three-phase power using one-half the pickup current corresponding to the desired overpower or underpower pickup in watts. Adjust the relay test set to produce this current value from the following equation.

$$I = 0.5 \times \frac{W}{V}$$

Where: W = Desired pickup in watts
V = Applied voltage
I = Applied current

With a wattmeter:

$$W = 2 \times Wattmeter\ Reading$$

2. Terminals 1 and 10 are the overpower trip output device connections for both BE1-32R and BE1-32 0/U. Terminals 2 and 10 are the underpower output connections for the BE1-32 0/U.

3. Terminals 17 thru 20 are auxiliary relay output contacts. Determine the auxiliary output contact configuration by referring to the relay style number.

Figure 5-5. Type E Sensing Test Setup Diagram

SECTION 6 • MAINTENANCE

GENERAL

BE1-32R, -32 O/U Directional Power Relays require no preventive maintenance other than a periodic operational test (refer to Section 5 for test procedures). If the relay fails to function properly, contact the Customer Service Department of the Power Systems Group, Basler Electric, for a return authorization number prior to shipping.

IN-HOUSE REPAIR

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

> **CAUTION**
> Substitution of printed circuit boards or individual components does not necessarily mean the relay will operate properly. Always test the relay before placing it in operation.

If in-house repair is to be attempted, component values may be obtained from the schematics or the parts list of the Service Manual. Replacement parts may be purchased locally. The quality of replacement parts must be at least equal to that of the original components.

Where special components are involved, Basler Electric part numbers may be obtained from the number stamped on the component or assembly, the schematic, or parts list. These parts may be ordered directly from Basler Electric. When complete boards or assemblies are needed, the following information is required.

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

STORAGE

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

TEST PLUG

Test plugs (Basler part number 10095 or G.E. part number XLA12A1) provide a quick, easy method of testing relays without removing them from their case. Test plugs are simply substituted for the connection plugs. This provides access to the external stud connections as well as to the internal circuitry.

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

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

SECTION 7 • MANUAL CHANGE INFORMATION

SUMMARY AND CROSS REFERENCE GUIDE

This section contains information concerning the previous editions of the manual. The substantive changes to date are summarized in the Table 7-1.

Table 7-1. Changes

Revision	Change	Date/ECA
E	Revised the entire manual to the current instruction manual format. Added internal connection diagrams, typical connection diagrams, and in Section 1, phase rotation sensitivity.	02-16-94/13989
F	Added 120 Vac to Figure 1-11, power supply type P. Changed reference for Figure 1-12 from *Specifications*, *Timing Accuracies*, to *Timing Adjustment Range*. Added Figure 1-13, Overpower Inverse Time Characteristic Curves. Corrected Figure 3-8, input sensing terminal numbers. Deleted reference to Figure 3-8 on page 3-9 (Figure 3-8 was replaced by Figure 1-13). Corrected Figure 4-23, input sensing terminal numbers.	06-03-94/14255
G	Changed *Section 1, Specifications, Pickup Accuracy* from ±2 percent to ±2 percent or 0.05 watts per phase. Corrected *Section 1, Specifications, Isolation* and *Section 4, Dielectric Test*. Corrected Figure 4-20 by adding NOTE 3. Corrected Figure 4-21 by moving the CT sensing to phase B. Changed Figure 4-25 (moved polarity indicators to opposite PT connections). Corrected Figure 5-5 (deleted ±30° in illustration and changed formula). Changed Table 7-1 to show ECA dates and numbers.	07-18-95/15172
H	Deleted reference to Service Manual 9 1711 00 620. Changed Input Voltage Range and Burden Data in Power supply table in *Specifications*, Section 1. Added information to Instantaneous Response Time also in *Specifications*. This included adding a Figure 1-13 for the underpower element and accompanying statements to describe it. Corrected Style Chart by adding 120 Vac to power supply type P and changed power supply type T from “250/230 Vac” to “250/240 Vac”. Added information to Pickup Accuracy in Specifications which separated Single and Three-phase. Added new power supply information to Section 3 in *Power Supply* paragraph starting with “Basler Electric enhanced the power supply design...”. Added new dimension figures to include all options available (S1 Single-Ended and Double-Ended, M1 Double-Ended, and both mounting positions). Changed the symbol for case ground in *Internal Connection* Figures. Changed the format of the manual.	06-30-98/16839

Table 7-1. Changes

Revision	Change	Date/ECA
J	Updated the case drawings in Section 4 to the new style S1 and M1 cases. Removed selectable power supply option from the style chart.	09-06-00/10628
K	Revised page 3-8 to better describe Pickup. Changed Figure 4-2 and Figure 4-12 to show the slotted knob on the front panel. Changed Figure 4-4. Changed the drawing number for Figure 4-6.	08-10-01/14405