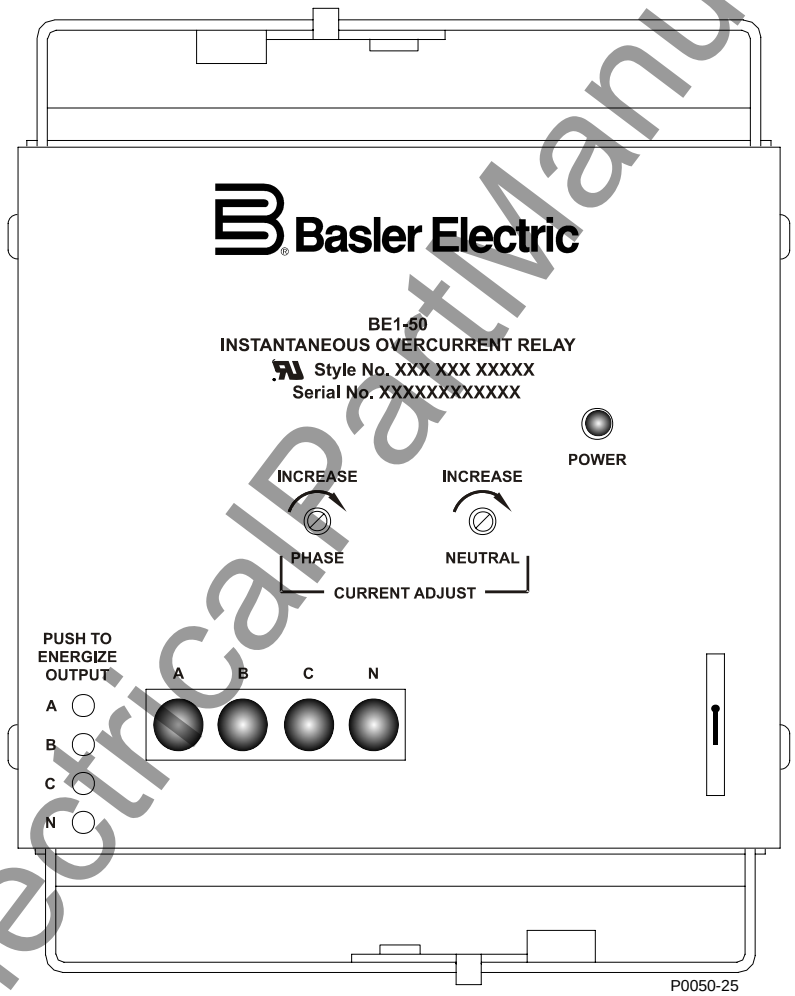
INSTRUCTION MANUAL

FOR

INSTANTANEOUS OVERCURRENT RELAY

BE1-50



Basler Electric

Publication: 9171000990
Revision: E 09/07

INTRODUCTION

This instruction manual provides information about the operation and installation of the BE1-50 Instantaneous Overcurrent Relay. To accomplish this, the following information is provided:

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Installation
- Testing

WARNING!

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

NOTE

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

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September 2007

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.

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REVISION HISTORY

The following information provides a historical summary of the changes made to the BE1-50 instruction manual (9171000990). Revisions are listed in reverse chronological order.

Manual Revision and Date	Change
E, 09/07	• Added manual part number and revision to footers. • Updated Output Contact ratings in Section 1. • Updated Power Supply Burden data in Section 1. • Updated front panel illustrations to show laser graphics. • Updated Target Indicator description in Section 3. • Added GOST-R to Section 1, *General Information.* • Moved content of Section 7, *Manual Change Information* to Manual Introduction. • Moved content of Section 6, *Maintenance* to Section 4, *Installation*.
D, 12/01	• Updated cover drawings in Section 4 to reflect new drawings.
C, 11/98	• Deleted all references to Service Manual. • Updated Style Chart by adding Option 3-6 Power Supply Status Output, changing Power Supply Type T from “230 Vac” to “240 Vac”, deleted “Selectable” from Type S, and added Note 6. • Deleted 500 Vdc from Output Circuits in *Specifications*. • Added Note to Table 1-1. • Added new power supply information and Fast Transient to *Specifications*. • Corrected Figure 2-1 from “Instantaneous Undercurrent Relay” to Instantaneous Overcurrent Relay”. • Added new power supply information to Section 3 starting with “Basler Electric enhanced the power supply design…” • Divided Section 4, *Installation* into two sections Section 4, *Installation* and Section 5, *Testing*. • Added new dimension figures to include all options available (S1 single-ended and double-ended, and both mounting positions) to Section 4. • Changed Output Connection diagrams to include Sensing Type E or G and Output F or H, Sensing Type J and Output J or K, and Sensing Type F and output E or G. • Corrected minor errors and changed the format of the manual.
B, 06/93	• Added UL Recognition statement, page 1-5. • Added new Figures 4-6 through 4-9.
—, 01/86	• Initial release

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CONTENTS

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SECTION 1 • GENERAL INFORMATION

PURPOSE

Instantaneous overcurrent relays provide phase and ground fault protection for distribution circuits, generators, motors, transformers, and other major components of power systems. BE1-50 Instantaneous Overcurrent relays have a wide range of pickup settings and input configurations to accommodate protection requirements for power systems. BE1-50 relays are available in single or multi-phase for power units.

APPLICATION

Some applications are illustrated in Figure 1-1.

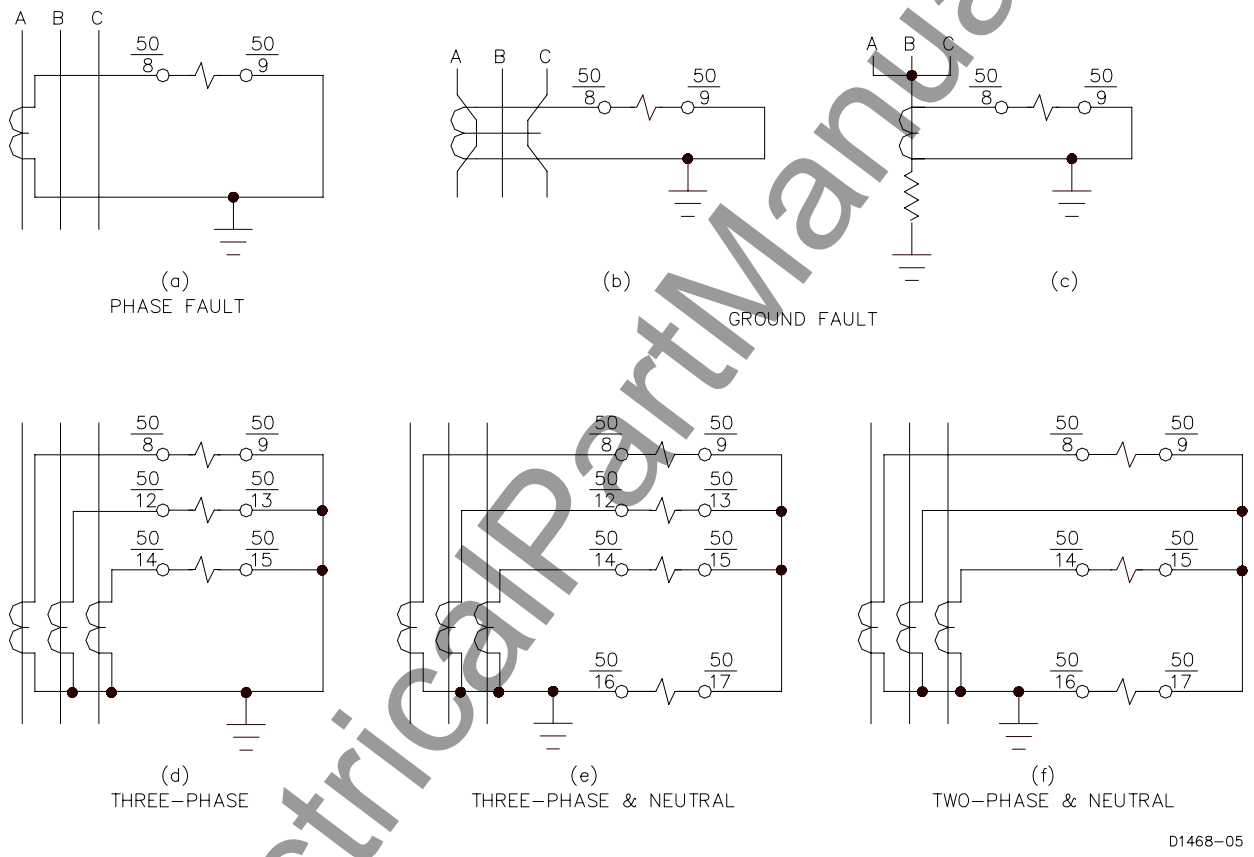

Figure 1-1. Typical BE1-50 Applications

Ground Fault Detection

BE1-50 relays can be applied to monitor zero sequence currents that are indicative of ground faults. The most sensitive method of ground fault protection utilizes a single current transformer through which all the conductors are passed (Figure 1-1b). Another method uses the residual connection of the three-phase CTs (Figure 1-1d) with the relay set higher than the normal system unbalance. The most direct method is to place a CT in the neutral of a grounded wye connection for equipment such as power transformers or generators (Figure 1-1c).

Phase Fault Detection

BE1-50 relays can be used in two ways to detect phase faults. The first method is to place an instantaneous overcurrent element in each phase with the setting higher than expected load current for any power system element (Figure 1-1a, d, e, f). The second method is called self-balancing differential protection (Figure 1-2).

In this application, the two leads of each phase of the protected motor or generator are passed through the window of the same associated phase current transformer so that the resulting secondary current is zero under normal operating conditions.

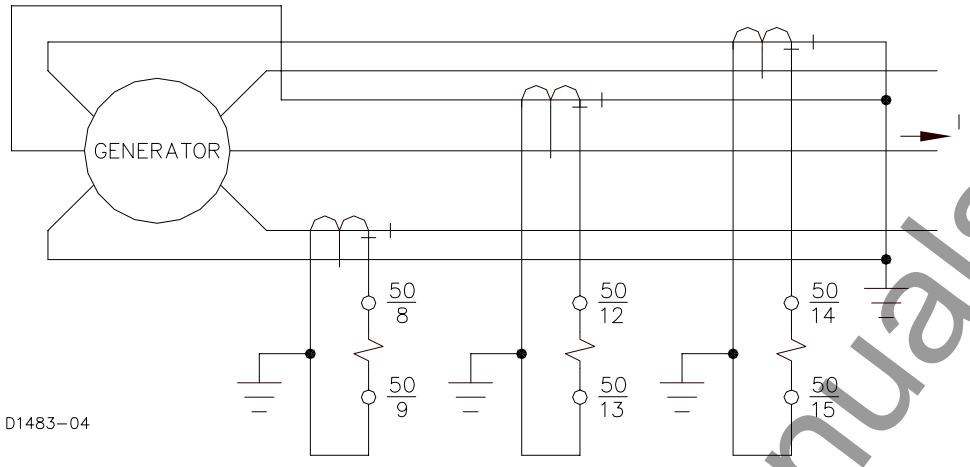

Figure 1-2. Self-Balancing Differential Protection

Combination with Other Protective Devices

Because BE1-50 relays can provide complete phase and ground fault protection in one unit (and with independent settings for phase and ground), they are often used to supervise other relay functions. In distance protection, BE1-50 relays can be used to prevent misoperation for light loading conditions by requiring a minimum current level before enabling the distance relay. As a fault detector, they are particularly effective because of their sensitivity, speed, and dropout ratio.

MODEL AND STYLE NUMBER

BE1-50 electrical characteristics and operational features are defined by a combination of letters and numbers that make up the style number. Model number BE1-50 designates the relay as a Basler Electric Instantaneous Overcurrent 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 BE1-50 relay is illustrated in Figure 1-3.

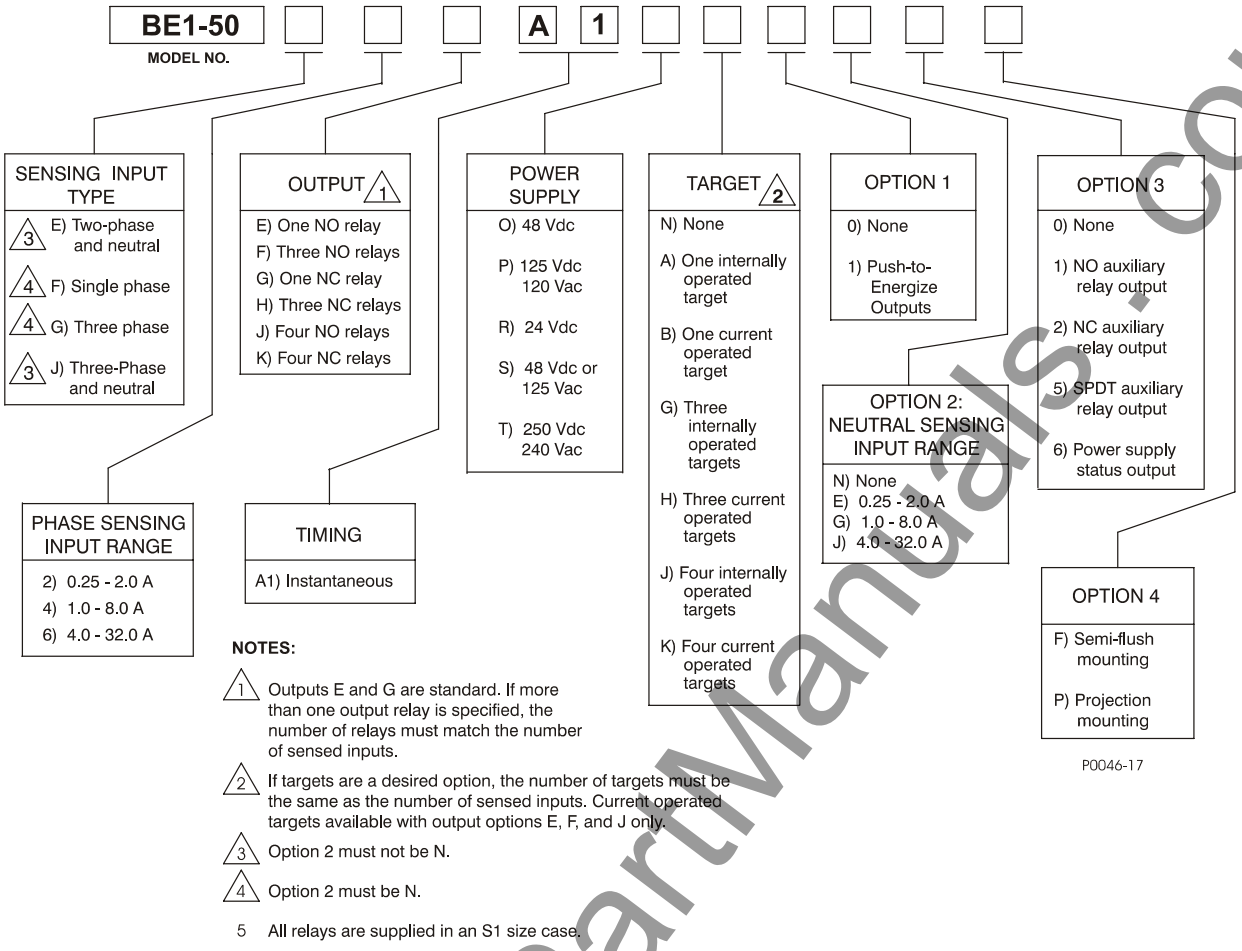

Figure 1-3. BE1-50 Style Identification Chart

Style Number Example

If a BE1-50 relay has a style number of **J6J–A1P–J1E1F**, the relay has the following features:

J -------- Three-phase-and-neutral current sensing
6 -------- 8.0 to 16.0 A phase sensing input range
J -------- Four output relays with normally open contacts
A1 ------ Instantaneous timing
P -------- Operating power derived from 125 Vdc or 120 Vac
J -------- Four internally operated targets
1 -------- Push-to-energize outputs
E -------- 0.5 to 1.0 A neutral sensing input range
1 -------- One auxiliary output relay with normally open contacts
F -------- Semi-flush mounting case

SPECIFICATIONS

BE1-50 electrical and physical specifications are listed in the following paragraphs.

Current Sensing

Sensing inputs are nominally rated at 50/60 Hz and have a frequency range of 40 to 70 Hz. Current ratings and sensing burdens depend on the sensing range and power supply type (defined by the style number), and are shown in Table 1-1.

Table 1-1. Current Ratings and Sensing Burdens

Power Supply	Sensing Range Designation		Actual Sensing Range	Maximum Rating 50 or 60 Hz			
	For Phase	For Neutral		Current			Burden Per Input
				K *	1 Second	Continuous	
F, G, or H †	1	D	0.25 - 0.5 A	144	12.0 A	0.75 A	8.5 VA
	2	E	0.5 - 1.0 A	144	12.0 A	1.5 A	8.5 VA
	3	F	1.0 - 2.0 A	625	25.0 A	3 A	8.5 VA
	4	G	2.0 to 4.0 A	2500	50.0 A	6 A	8.5 VA
	5	H	4.0 to 8.0 A	10000	100 A	12 A	8.5 VA
	6	J	8.0 - 16.0 A	40000	200 A	20 A	9.5 VA
	7	K	16.0 - 32.0 A	90000	300 A	20 A	14.0 VA
O, P, R, S, or T	2	E	0.25 - 2.0 A	10000	100 A	5 A	0.2 VA
	4	G	1.0 - 8.0 A	90000	300 A	10 A	0.6 VA
	6	J	4.0 - 32.0 A	90000	300 A	20 A	4.8 VA

* Ratings other than continuous may be calculated using the equation:

$$I = \sqrt{\frac{K}{t}}$$

where:

K = the indicated value
T = the time in seconds
I = maximum current

† Power Supply types F, G, and H are no longer available.

Pickup Range

Continuously adjustable over the range defined by the style number with independent ranges and adjustments for each phase and neutral pickup.

Pickup Accuracy

±2% or ±40 mA of pickup setting, whichever is greater.

Dropout

Within 2% of pickup.

Timing

1.5 cycles or less from onset of overcurrent condition. (30 milliseconds at 50 Hz, 25 milliseconds at 60 Hz.)

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, break 0.3 Adc
500 Vdc:	Make and carry 15 Adc for 0.2 s, carry 7 Adc continuously, break 0.3 Adc

Inductive Ratings

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

Power Supply

Externally powered power supply types are listed in Table 1-2.

Table 1-2. Power Supply Ratings

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
O (midrange)	48 Vdc	24 to 150 Vdc	1.2 W
P (midrange)	125 Vdc	24 to 150 Vdc	1.5 W
	120 Vac	90 to 132 Vac	19.3 VA
R (low range)	24 Vdc	12 to 32 Vdc ∗	1.3 W
S (midrange)	48 Vdc	24 to 150 Vdc	1.2 W
	125 Vdc	24 to 150 Vdc	1.5 W
T (high range)	250 Vdc	68 to 280 Vdc	1.7 W
	240 Vac	90 to 270 Vac	31.6 VA

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

Target Indicators

Electronically latched, manually reset target indicators are optionally available to indicate closure of the trip output contacts. Either internally operated or current operated targets may be specified. Internally operated targets should be selected when normally closed (NC) output contacts are 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

Type Tests

Shock:	Withstands 15 G in each of three mutually perpendicular planes without structural damage or performance degradation.
Vibration:	Withstands 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.
Dielectric Strength:	Tested in accordance with IEC 255-5 and IEEE C37.90. All circuits to ground: 2,121 Vdc. Input to Output circuits: 1,500 Vac/2,121 Vdc.
Radio Frequency Interference:	Maintains proper operation when tested for interference in accordance with IEEE C37.90.2-1987, *Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.*
Surge Withstand Capability:	Qualified to IEEE C37.90.1-1989, *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems*.

Physical

Temperature

Operating Range:	–40 to 70°C (–40 to 158°F)
Storage Range:	–65 to 100°C (–85 to 212°F)
Weight:	17.5 lb (7.76 kg)
Case Size:	S1 (Refer to Section 4 for case dimensions.)

Agency Recognition/Certification

UL Recognition:	UL recognized per Standard 508, File E97033 NOTE: Output contacts are not UL recognized for voltages greater than 250 volts.
Gost-R Certification:	Gost-R certified, No. POCC US.ME05.B03391; complies with the relevant standards of Gosstandart of Russia. Issued by accredited certification body POCC RU.0001.11ME05.

SECTION 2 • CONTROLS AND INDICATORS

INTRODUCTION

All BE1-50 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. Figure 2-1 illustrates a relay with the maximum number of controls and indicators. Your relay may not have all of the controls and indicators shown and described here.

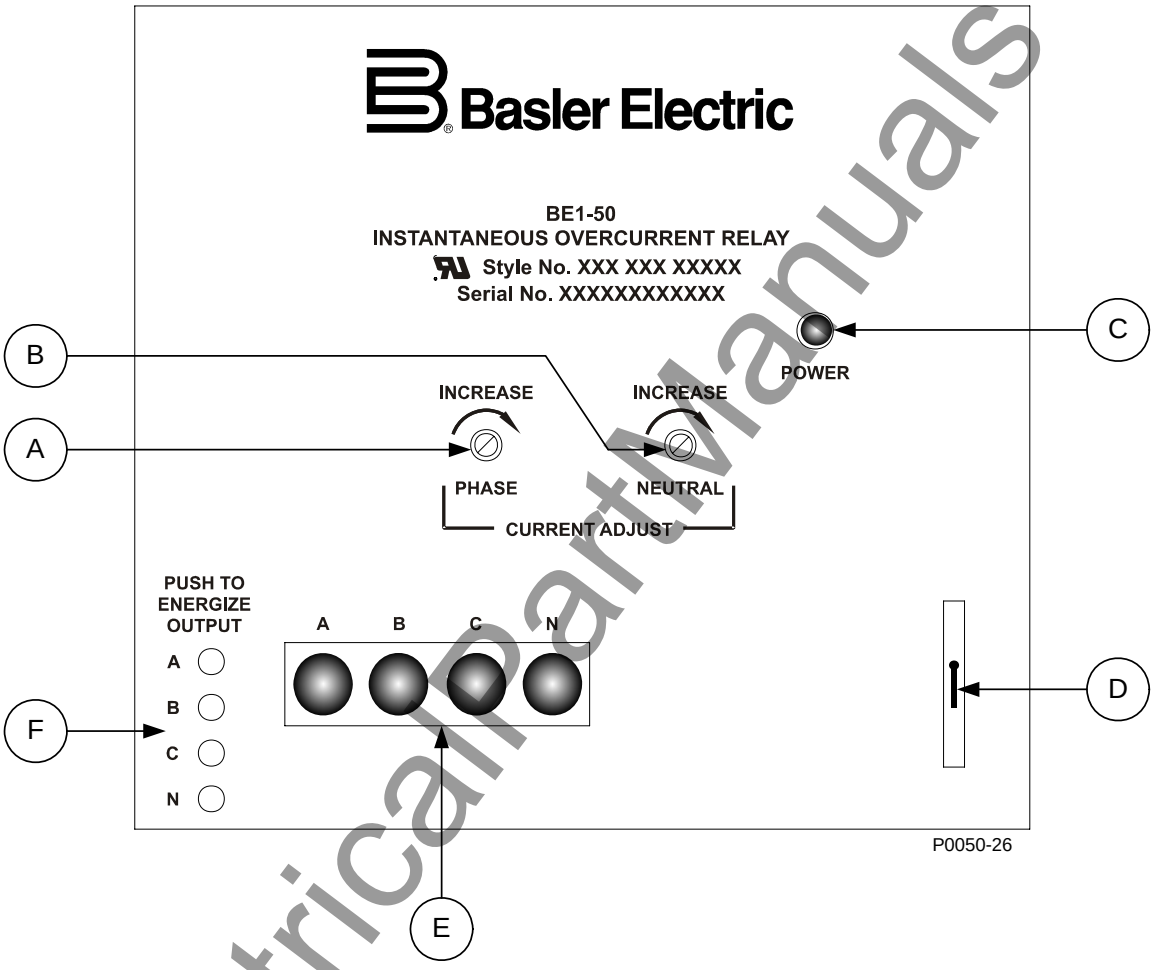

Figure 2-1. BE1-50 Controls and Indicators

Table 2-1. Control and Indicator Descriptions

Locator	Description
A	*Phase Current Adjust.* This multi-turn potentiometer sets the pickup point for all phase overcurrent elements within the relay. Continuously adjustable over the range defined by the style number.
B	*Neutral Current Adjust.* This multi-turn potentiometer sets the pickup point for the neutral overcurrent element within the relay. Continuously adjustable over the range defined by the style number.
C	*Power Indicator.* This red LED lights when operating power is applied to the relay.
D	*Target Reset Switch.* This switch is operated to reset the target indicators.

Locator	Description
E	*Target Indicators.* These electronically latched red target indicators illuminate when the corresponding output relay energizes. To ensure proper operation of the current-operated targets, 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 D).
F	*Output Test Pushbuttons.* These pushbuttons allow manual actuation of the output relays. Output relay actuation is achieved by inserting a nonconductive rod through the front panel access hole.

SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

BE1-50 Instantaneous Overcurrent relays are static devices that respond to the current magnitude of the monitored circuit. BE1-50 relay functions are illustrated in Figure 3-1 and described in the following paragraphs.

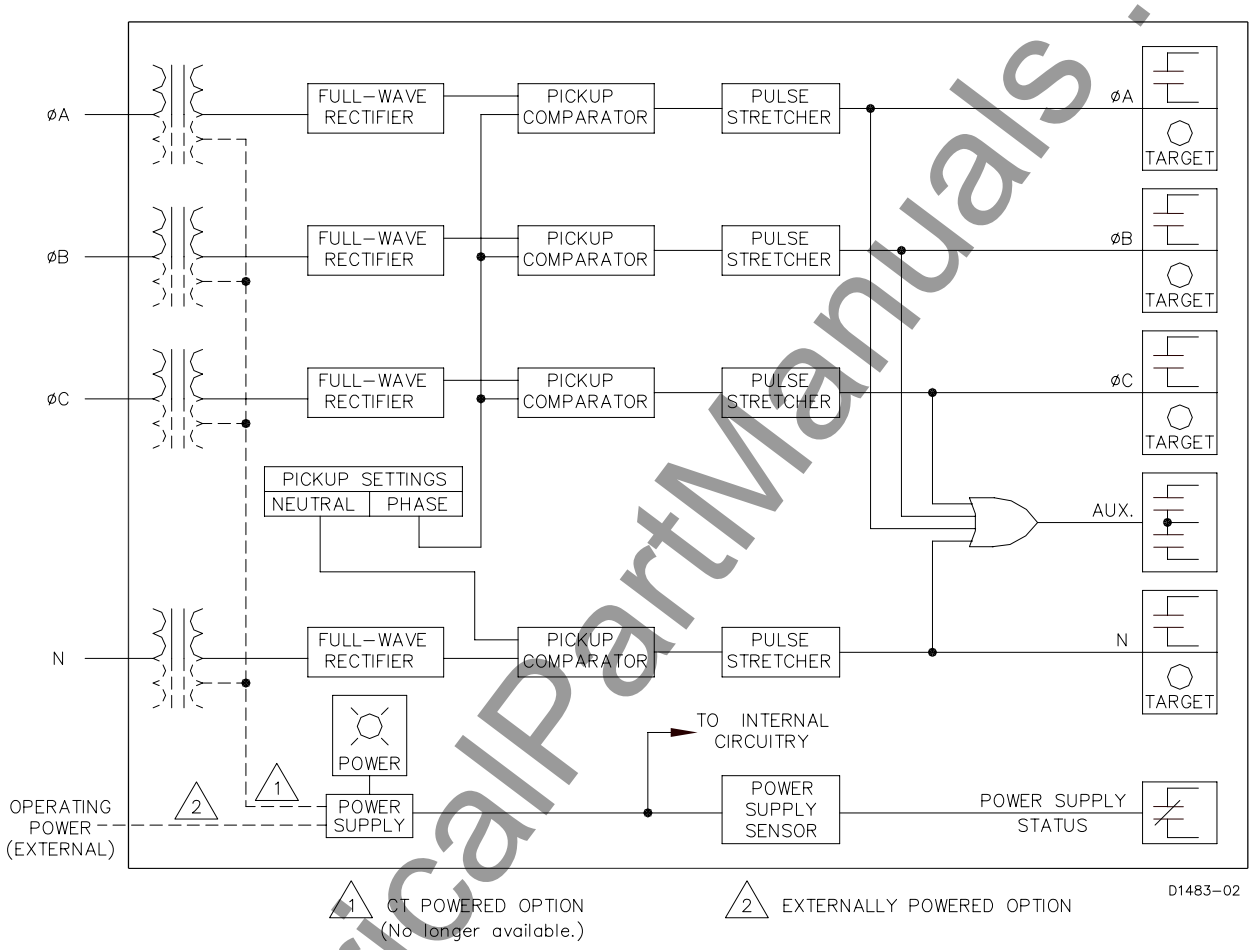

Figure 3-1. Function Block Diagram

STEP-DOWN TRANSFORMER

Monitored system currents are applied to the primaries of internal current transformers and stepped down to internal circuit levels. The internal current transformers provide 1,500 V of isolation for the twelve-volt logic circuits of the relay.

FULL-WAVE RECTIFIERS

Outputs from each step-down transformer are full-wave rectified and applied to resistor networks to develop voltages that represent the magnitude of the monitored system currents.

RESPONSE CHARACTERISTICS

Input current signals are rectified and passed through a low pass filter. Filtering smoothes out current spikes and provides a degree of security against operation on short-term transients.

Filtering also smoothes out the harmonic component effects on current signals. Harmonic component effects are reduced approximately by 1/n where n is the order of the harmonic. For example, the third harmonic effect is reduced by filtering to 1/3 of what is would be without filtering. With filtering, the response characteristics are similar to those of electromechanical relays.

PICKUP SETTINGS

A front panel multiple-turn potentiometer controls the pickup setting for all phases. The potentiometer establishes the reference voltage representative of the system current, which will cause the relay to respond. On relay styles monitoring neutral current, an independent potentiometer is provided to establish the pickup level for neutral.

PICKUP COMPARATORS

The magnitude of each monitored current is compared with the appropriate pickup setting. When a pickup setting is exceeded, a pulse stretcher for that phase (or neutral) is activated.

PULSE STRETCHERS

Because the sensed currents are full-wave rectified and minimally filtered to retain high-speed operation, the pulse output from the comparators must be extended.

OUTPUTS

Defined by the style number, individual output relays may be provided for each monitored phase (and neutral). One output relay may serve for all monitored phases (and neutral). In addition, one auxiliary output relay may be provided that serves for all monitored phases (and neutral).

PUSH-TO-ENERGIZE OUTPUT PUSHBUTTONS

Small pushbutton switches may be provided as an option to allow testing the primary output contacts and (if present) the auxiliary output contact. To prevent accidental operation, the pushbuttons are recessed behind the front panel and are depressed by inserting a thin, non-conducting rod through an access hole in the front panel.

POWER SUPPLY STATUS OUTPUT

The optional power supply status relay has a set of normally closed contacts and energizes when operating power is applied to the BE1-50. If relay operating power is lost or one side of the power supply output (+12 Vdc or –12 Vdc) fails, the power supply status relay de-energizes and opens the power supply status output contacts. If the power supply status output is provided, then the auxiliary contact is not available.

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 Table 1-2.

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. A latched target is reset by operating the target reset switch on the front panel. If relay operating power is lost, 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 circuit.

Current Operated Targets

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

NOTE

Prior to September 2007, BE1-50 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.

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SECTION 4 • INSTALLATION

INTRODUCTION

BE1-50 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 Section 5, *Testing* be performed.

RELAY OPERATING GUIDELINES AND PRECAUTIONS

Before installing or operating the relay, not 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 relay 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 relay is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each device.

MOUNTING

Because the relay is of solid-state design, it does not have to be mounted vertically. Any convenient mounting angle may be chosen.

Panel cutting and drilling dimensions are shown in Figures 4-1 through 4-3. Case dimensions are illustrated in Figures 4-4 through 4-9. Case cover dimensions are shown in Figure 4-10.

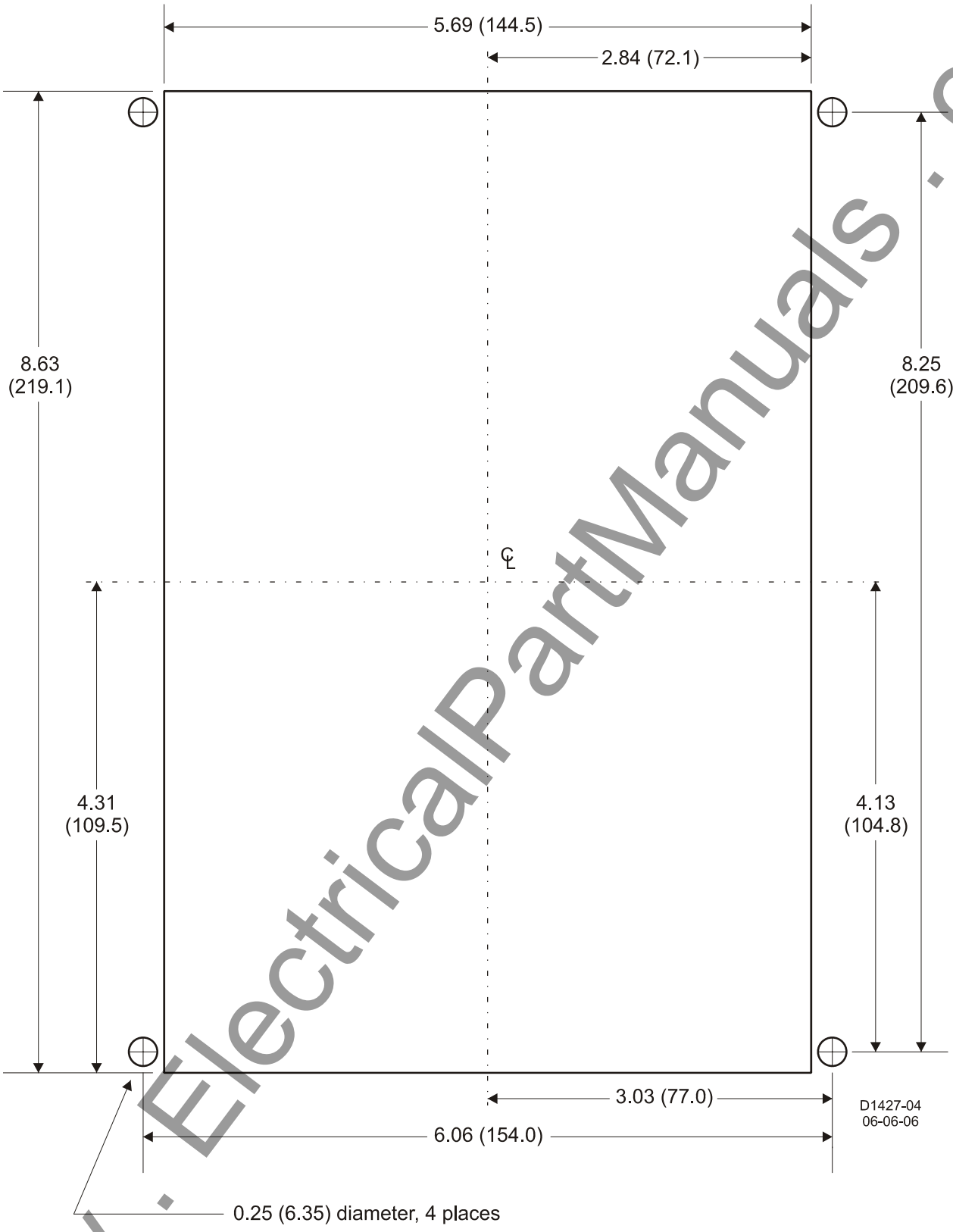

Figure 4-1. Panel Cutting/Drilling, Semi-Flush Case

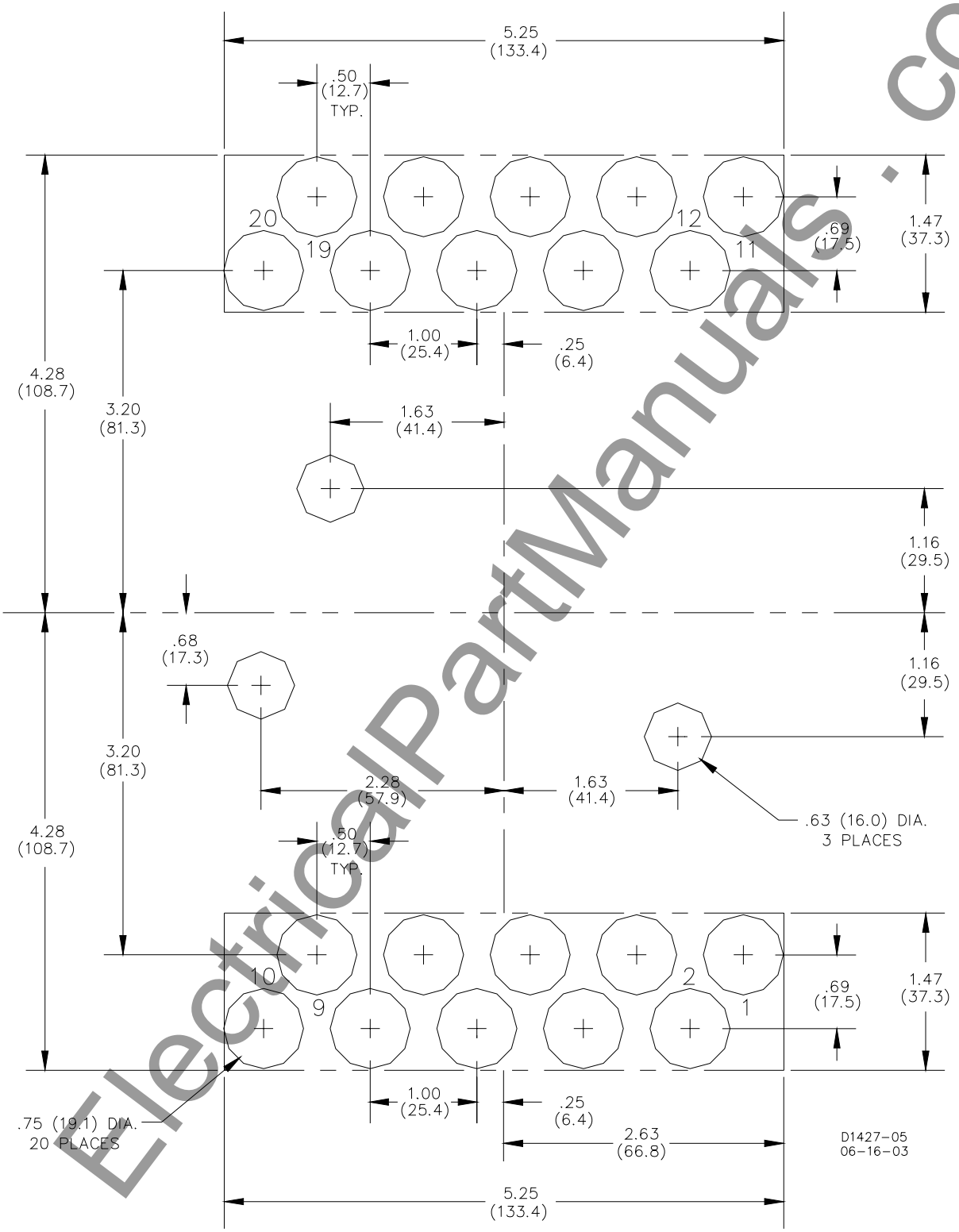

Figure 4-2. Panel Cutting/Drilling, Double-Ended Projection-Mount Case

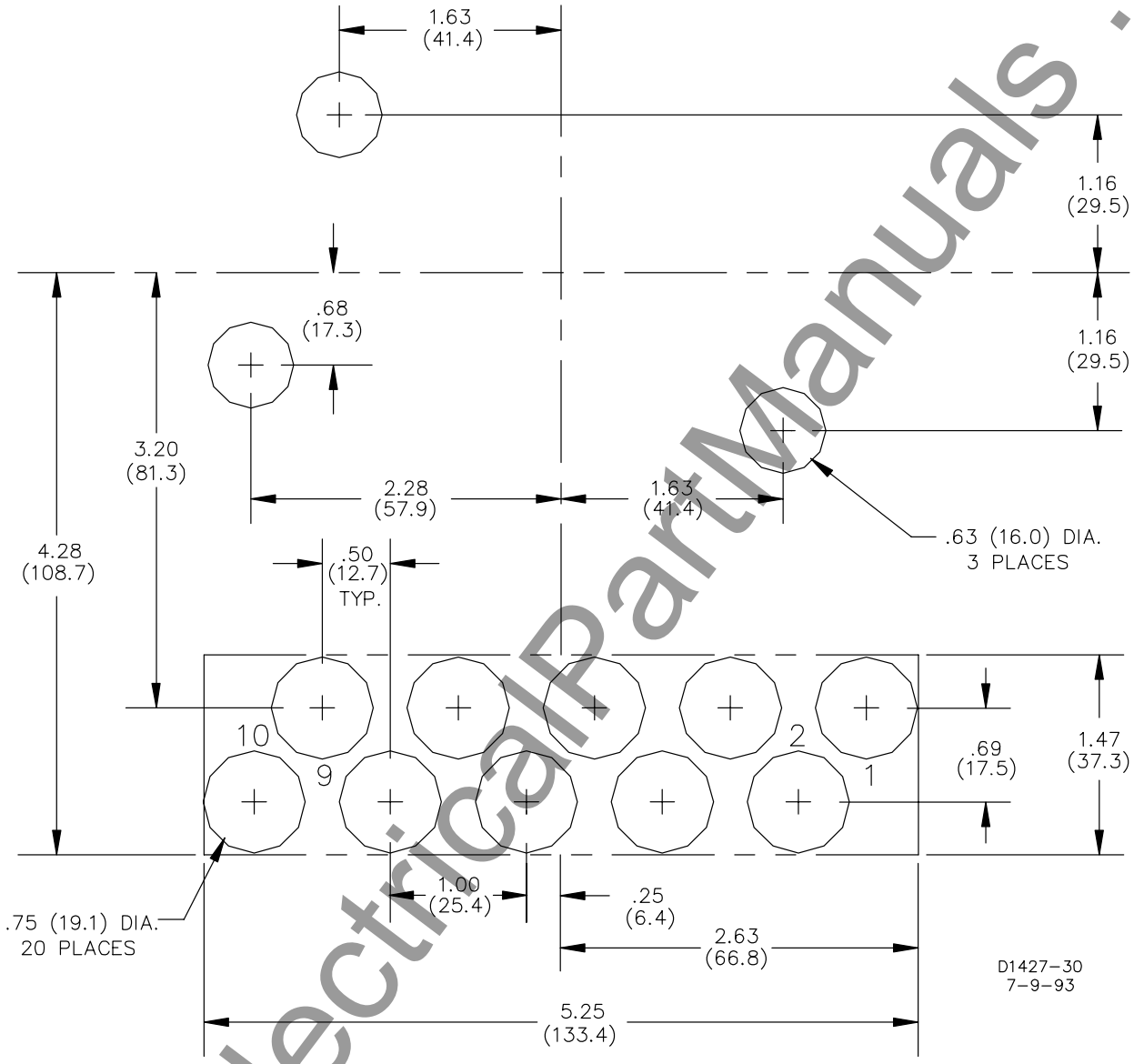

Figure 4-3. Panel Cutting/Drilling, Single-Ended Projection-Mount Case

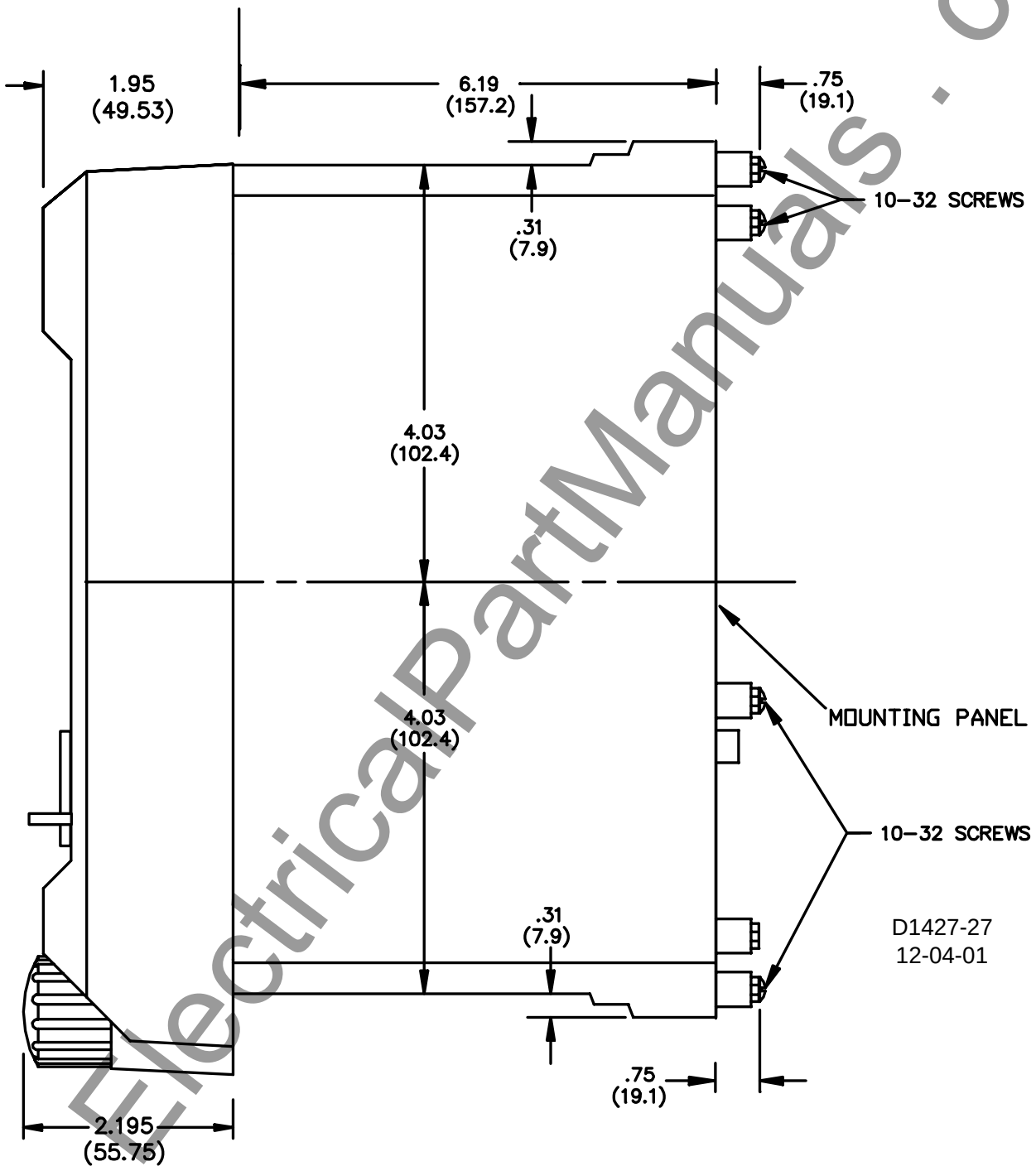

Figure 4-4. Case Dimensions, Side View, Double-Ended Semi-Flush Case

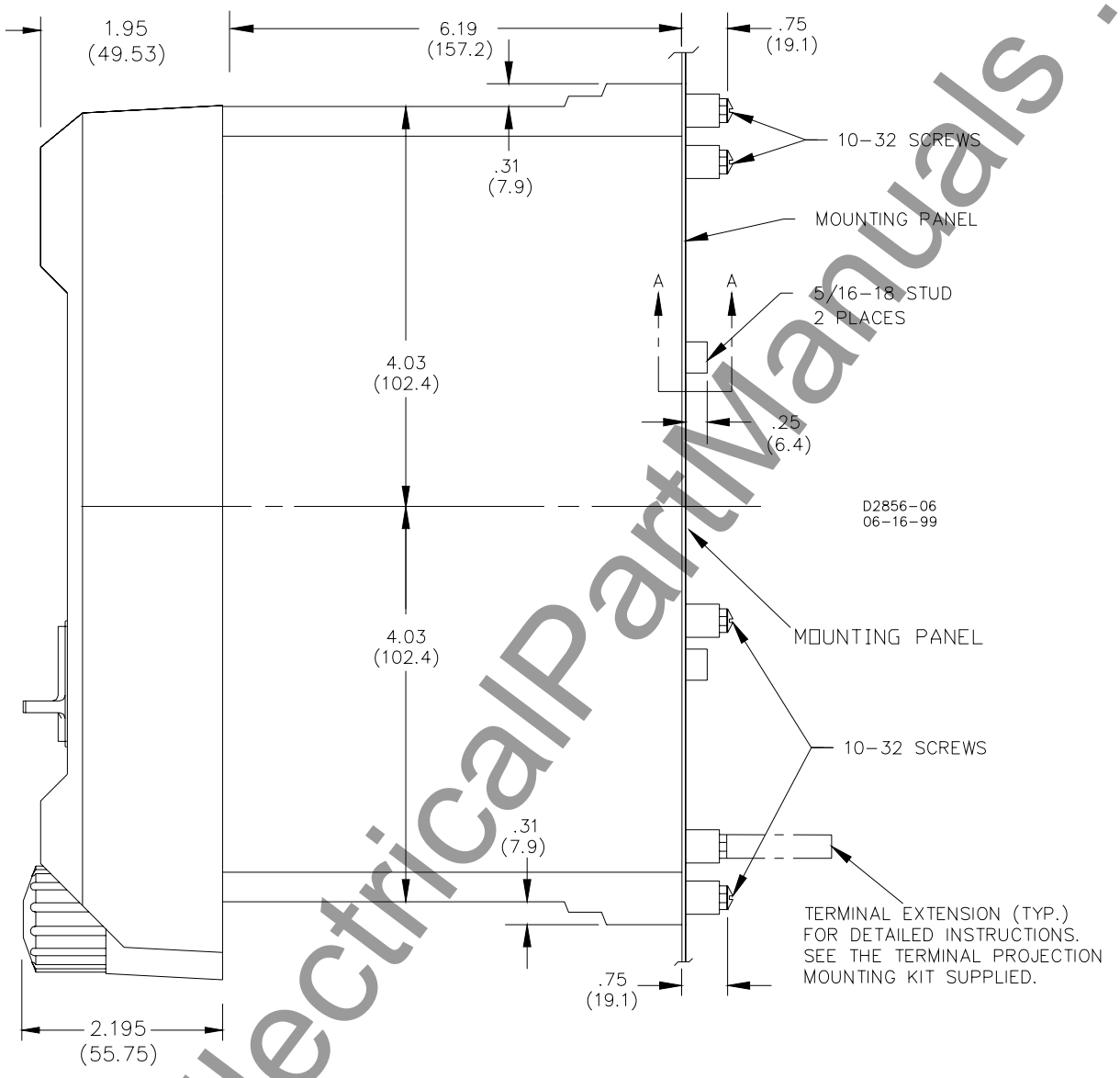

Figure 4-5. Case Dimensions, Side View, Double-Ended Projection-Mount Case

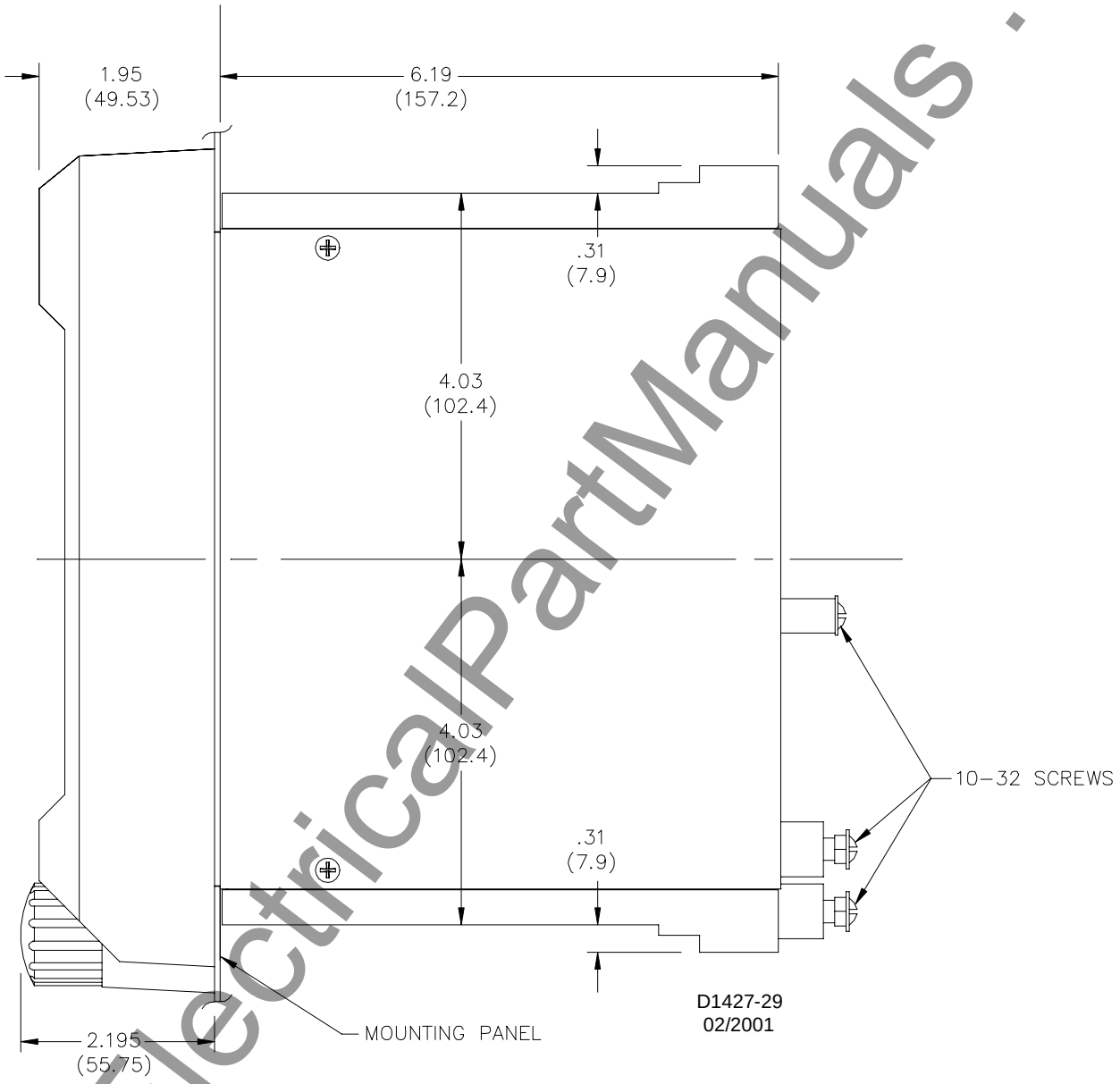

Figure 4-6. Case Dimensions, Side View, Single-Ended Semi-Flush Case

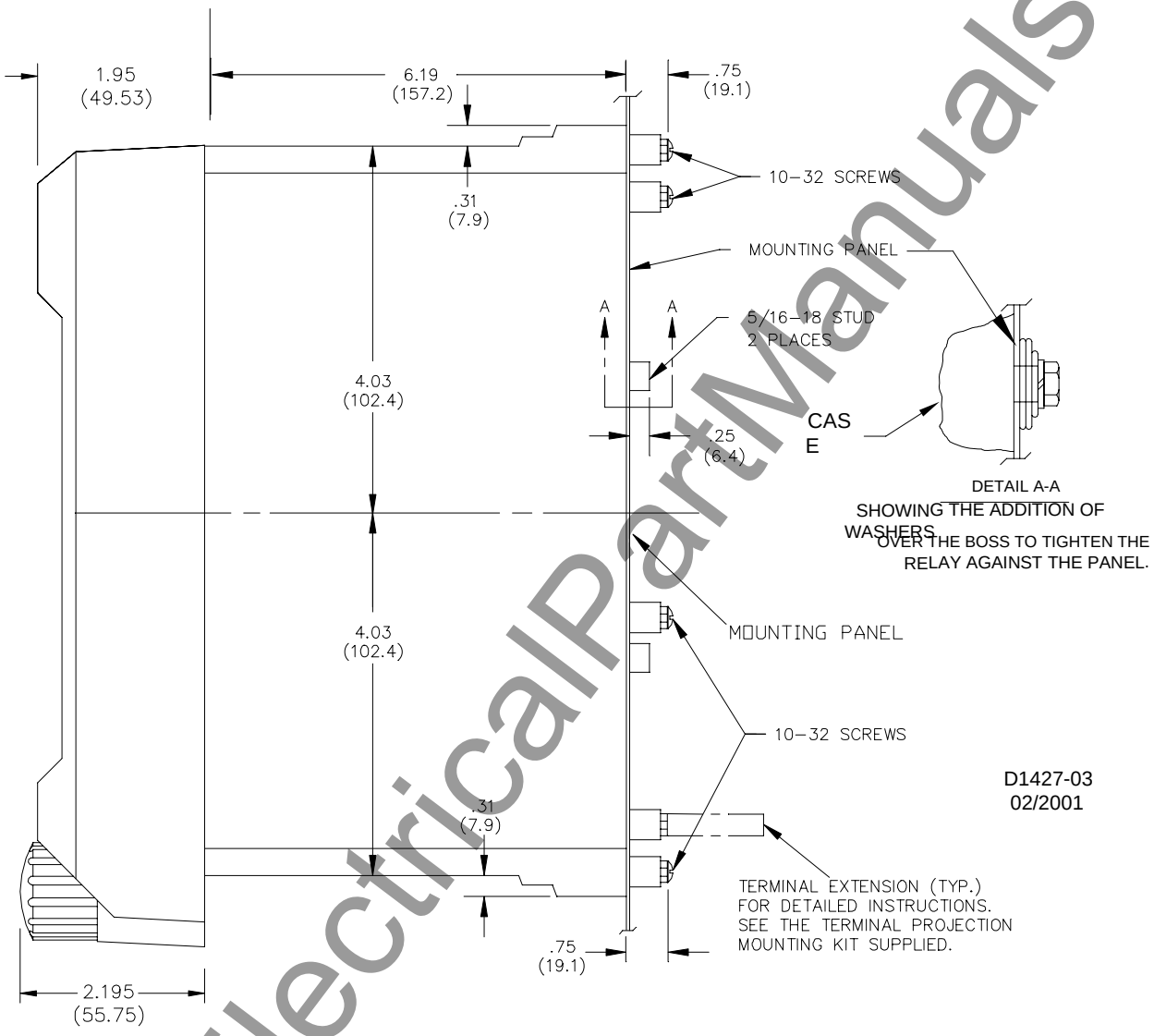

Figure 4-7. Case Dimensions, Side View, Single-Ended Projection-Mount Case

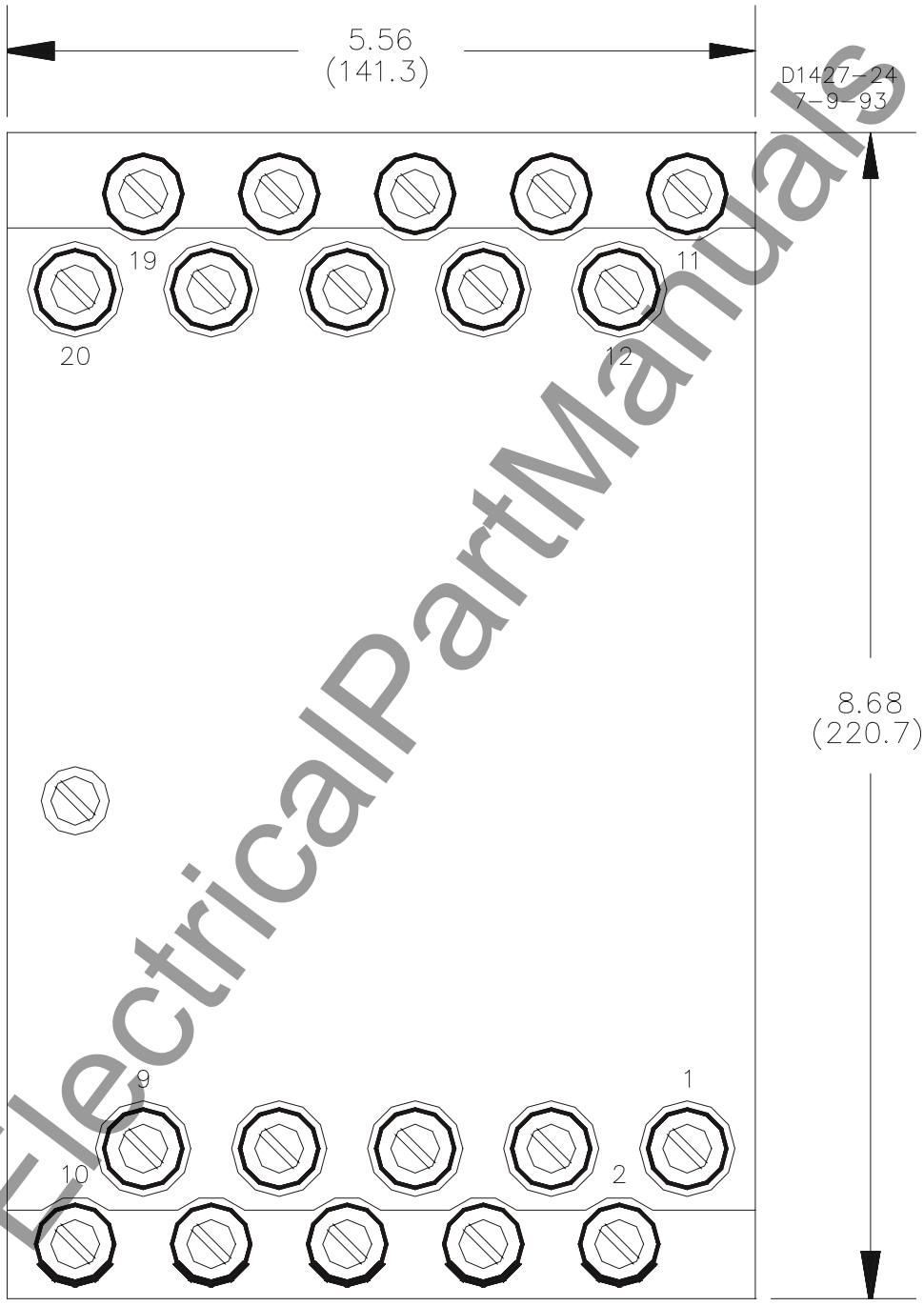

Figure 4-8. Case Dimensions, Rear View, Semi-Flush Case

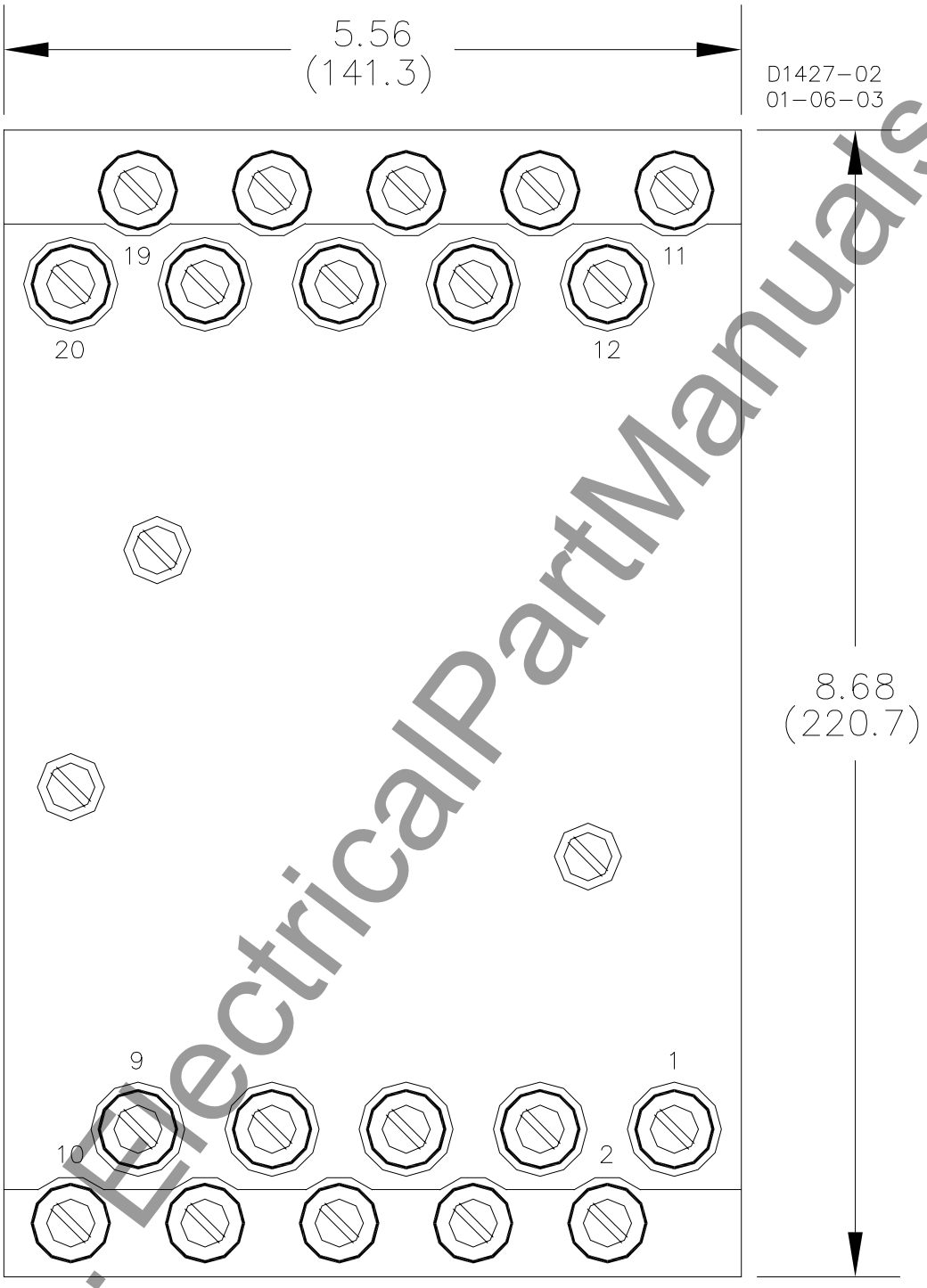

Figure 4-9. Case Dimensions, Rear View, Projection-Mount Case

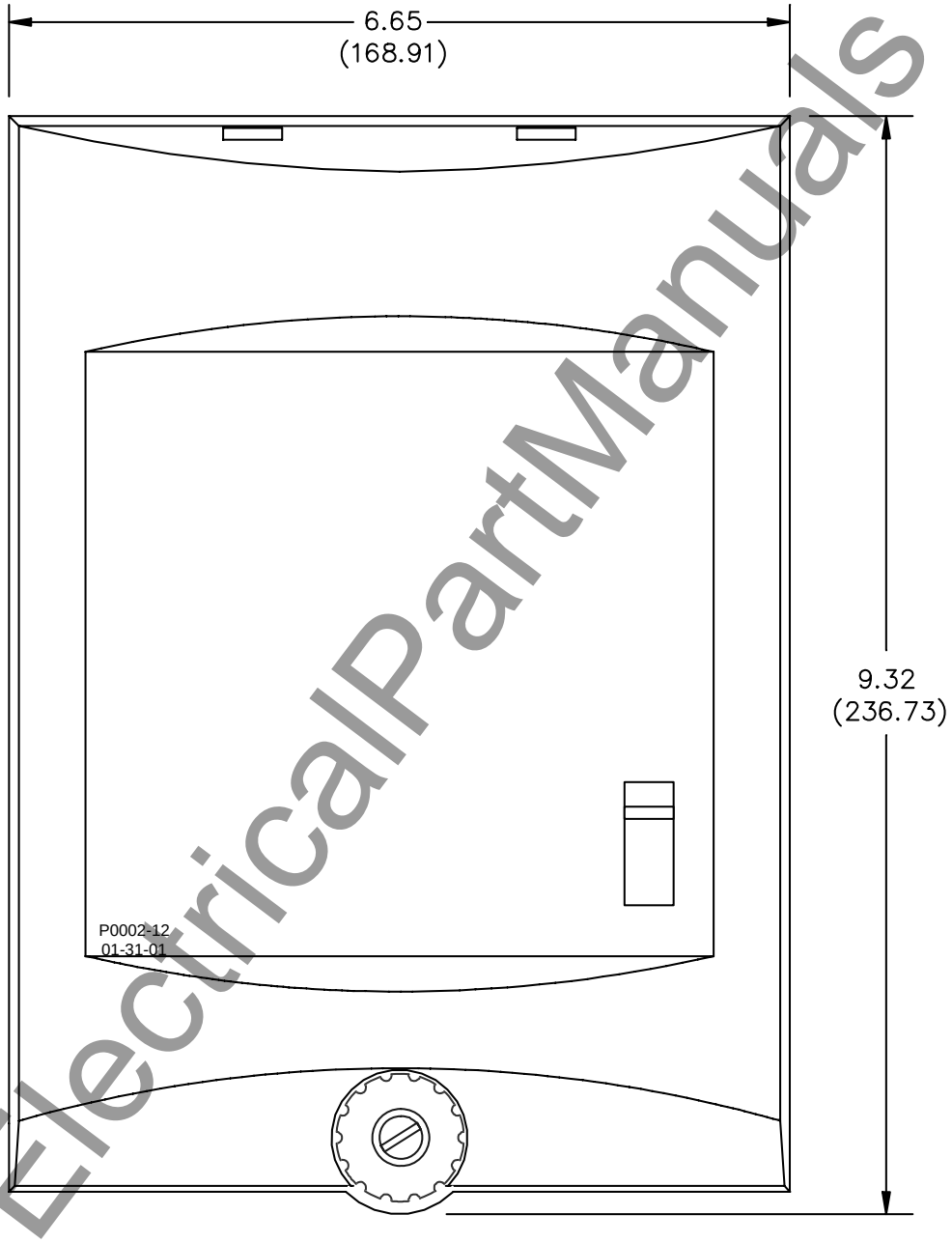

Figure 4-10. Case Cover Dimensions, Front View

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 sensing input connections are shown in Figures 4-11 through 4-14. Typical output connections are shown in Figures 4-15 and 4-16. Internal wiring diagrams are shown in Figures 4-17 through 4-19.

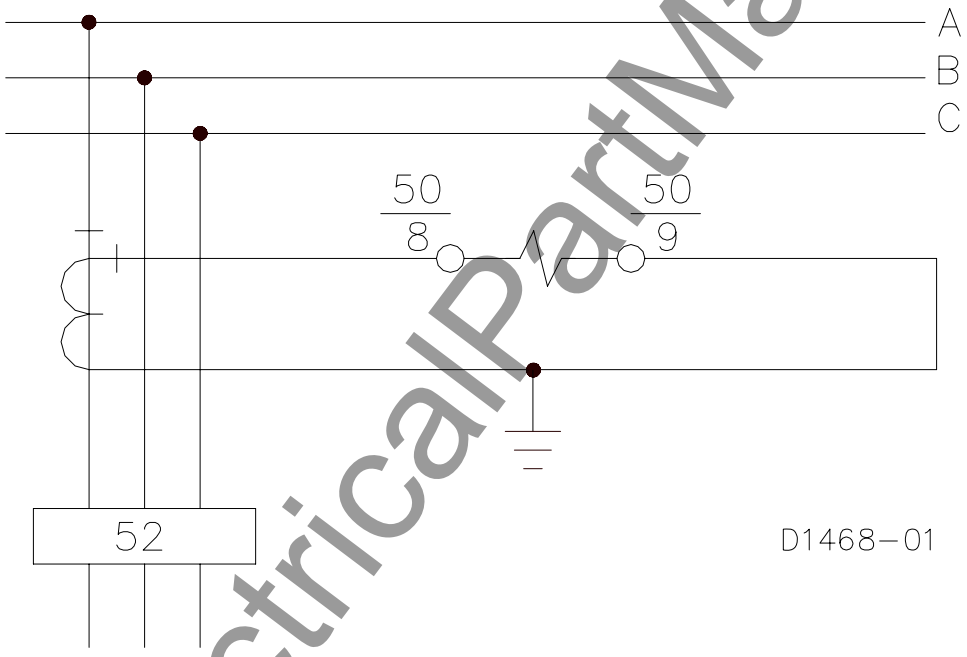

Figure 4-11. Single-Phase Sensing Input Connections

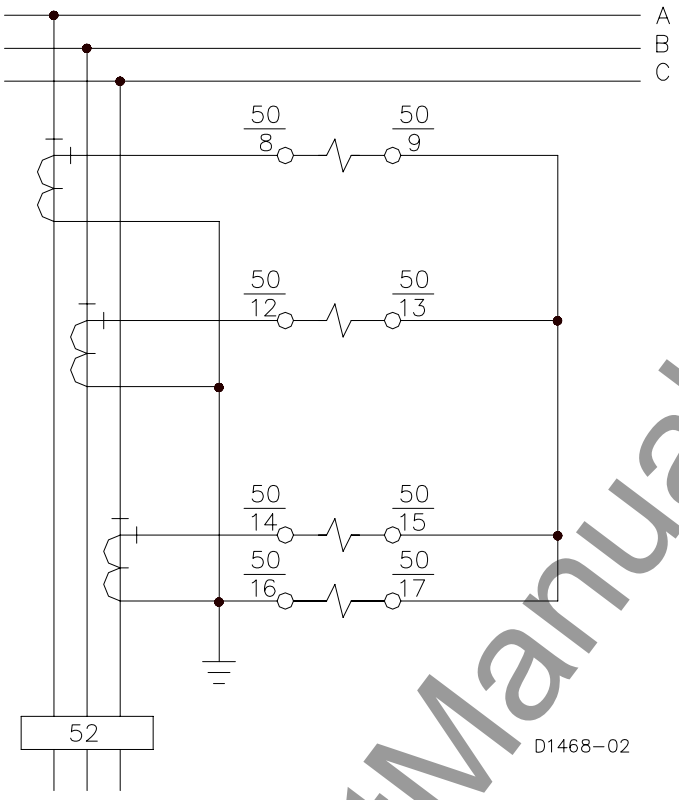

Figure 4-12. Three-Phase-and-Neutral Sensing Input Connections

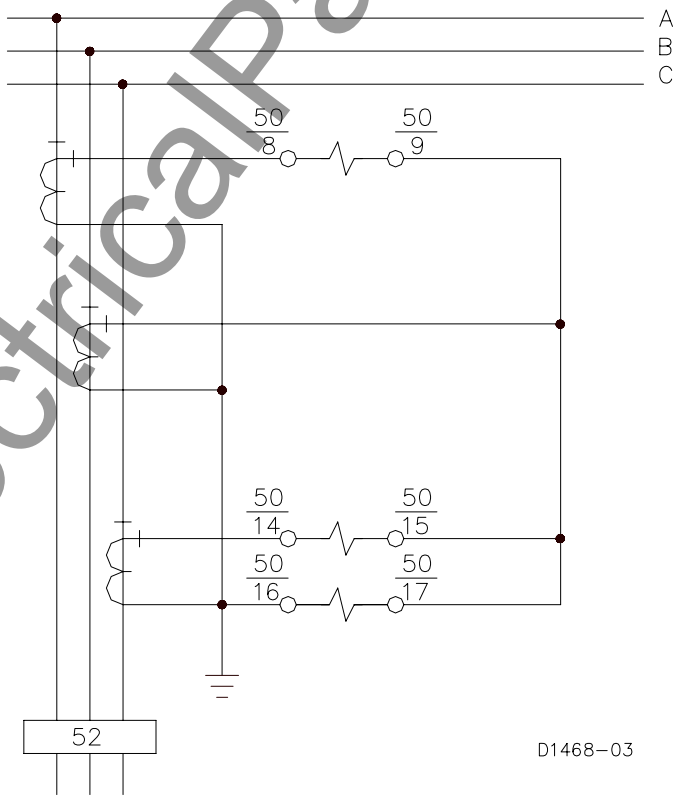

Figure 4-13. Two-Phase-and-Neutral Sensing Input Connections

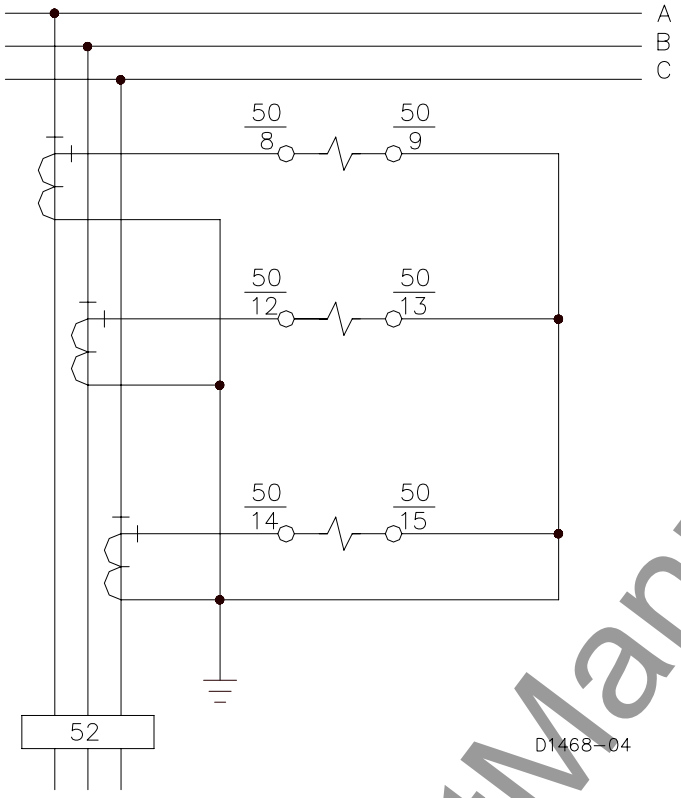

Figure 4-14. Three-Phase Sensing Input Connections

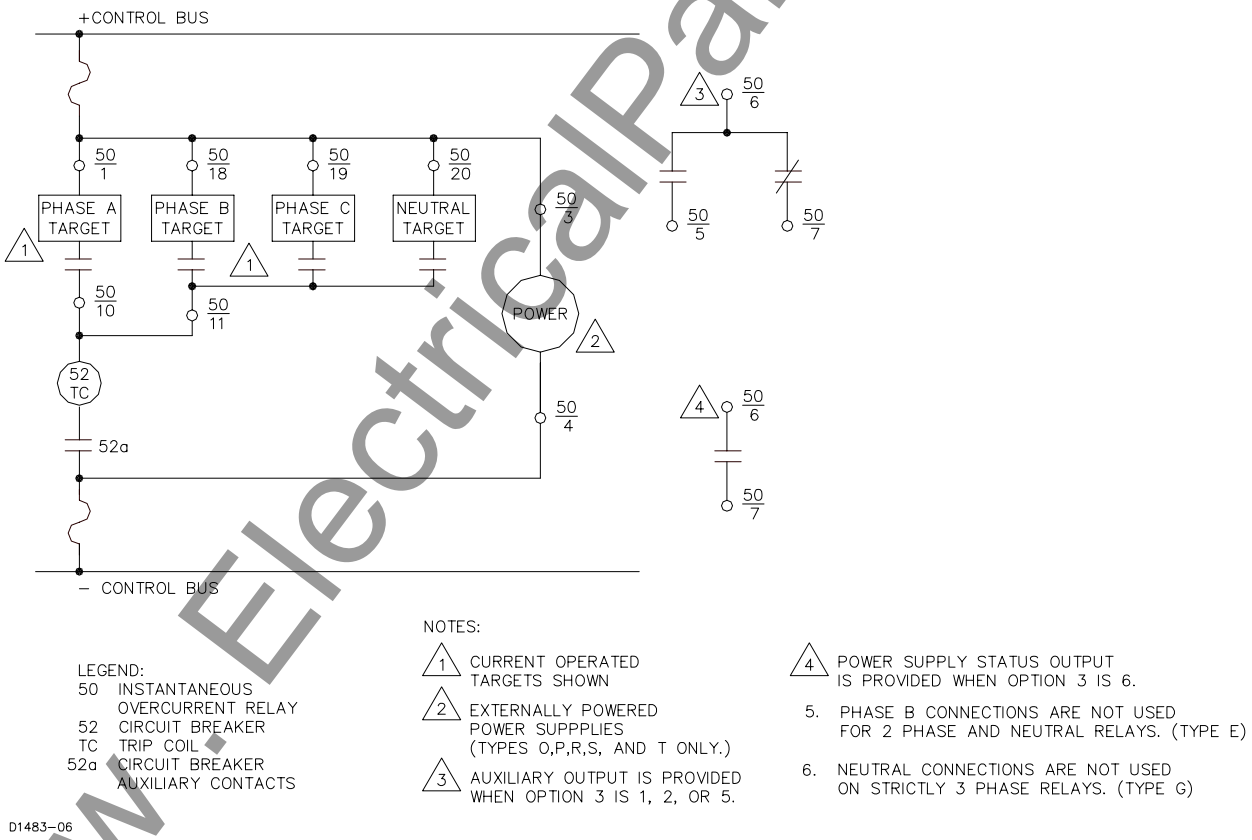

Figure 4-15. Typical Output Connections (Sensing Input Type E or G and Output F or H) or (Sensing Input Type J and Output J or K)

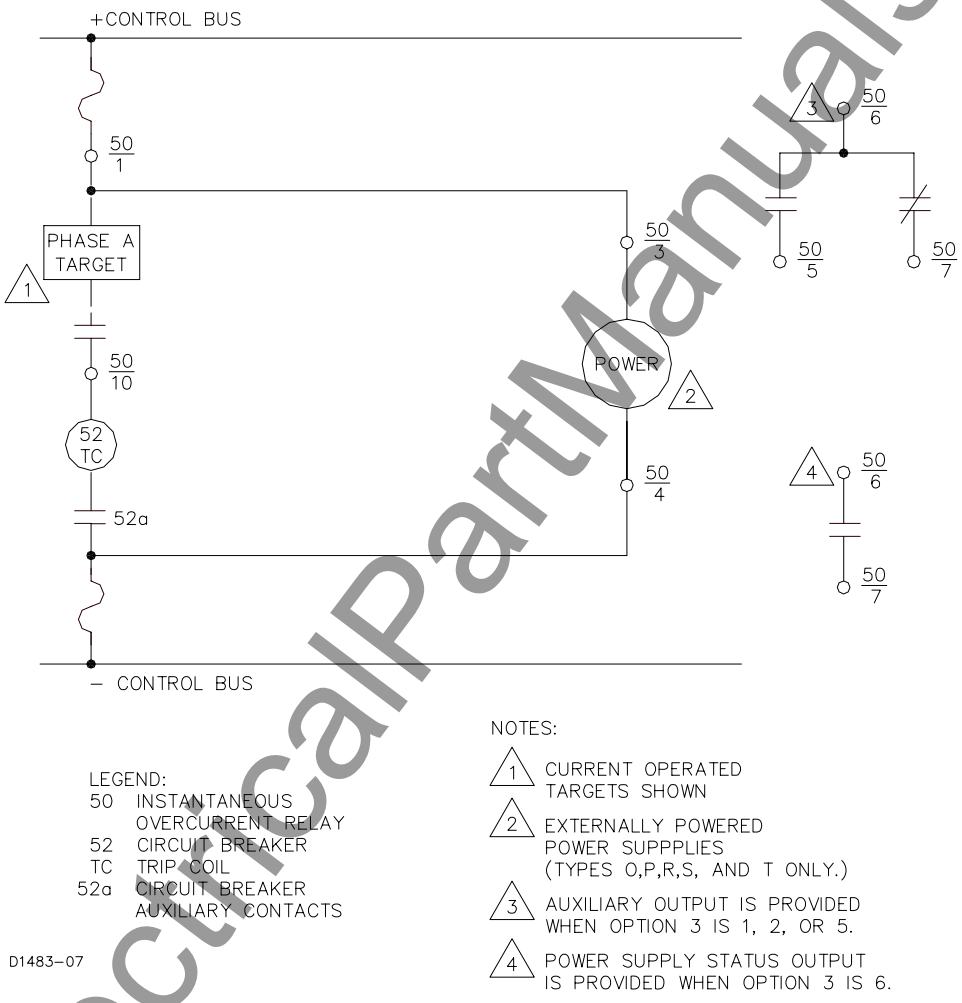

Figure 4-16. Typical Output Connections (Sensing Input Type F and Output E or G)

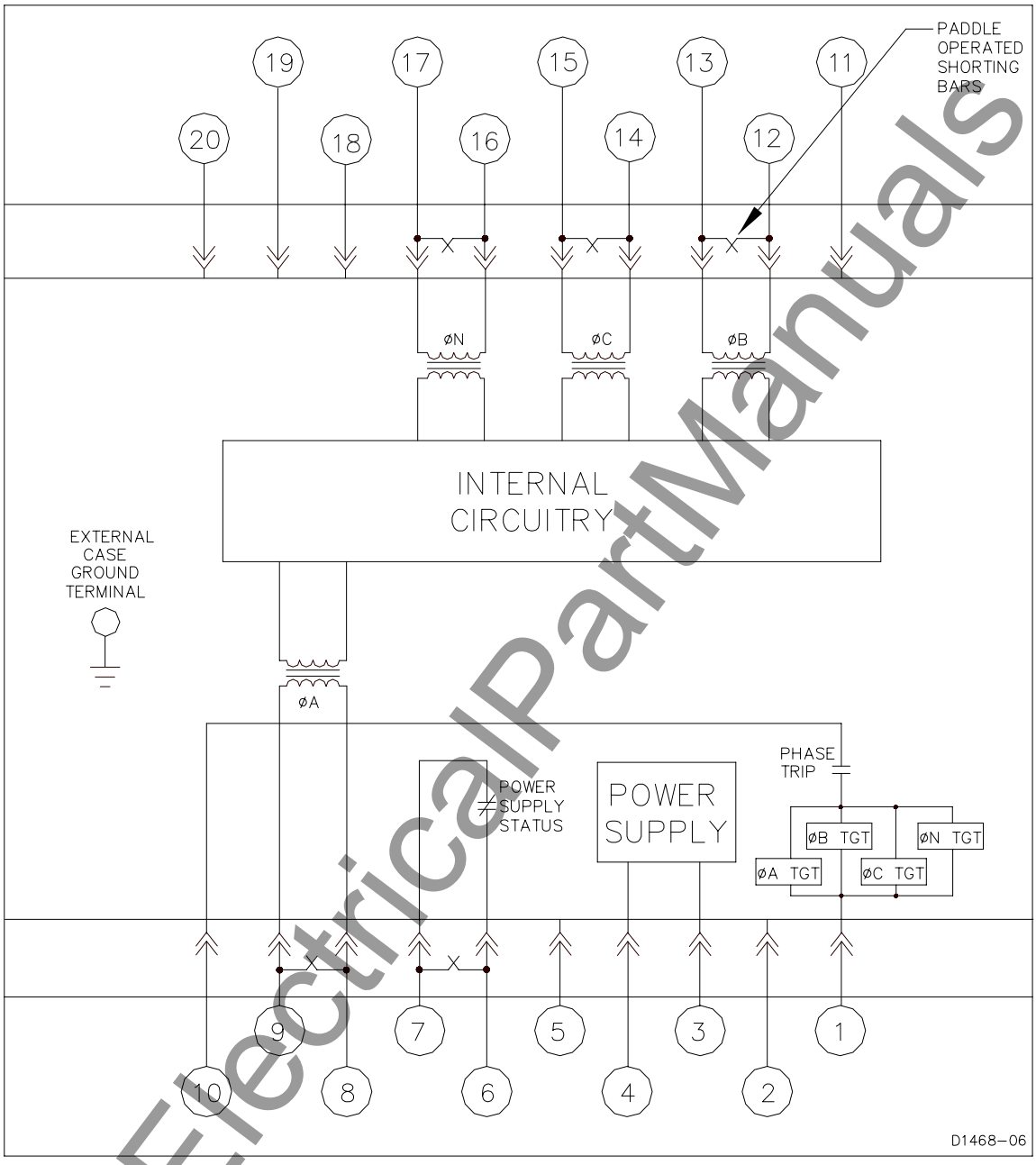

Figure 4-17. Typical Internal Connections, Three-Phase-and-Neutral Sensing, Output Type E

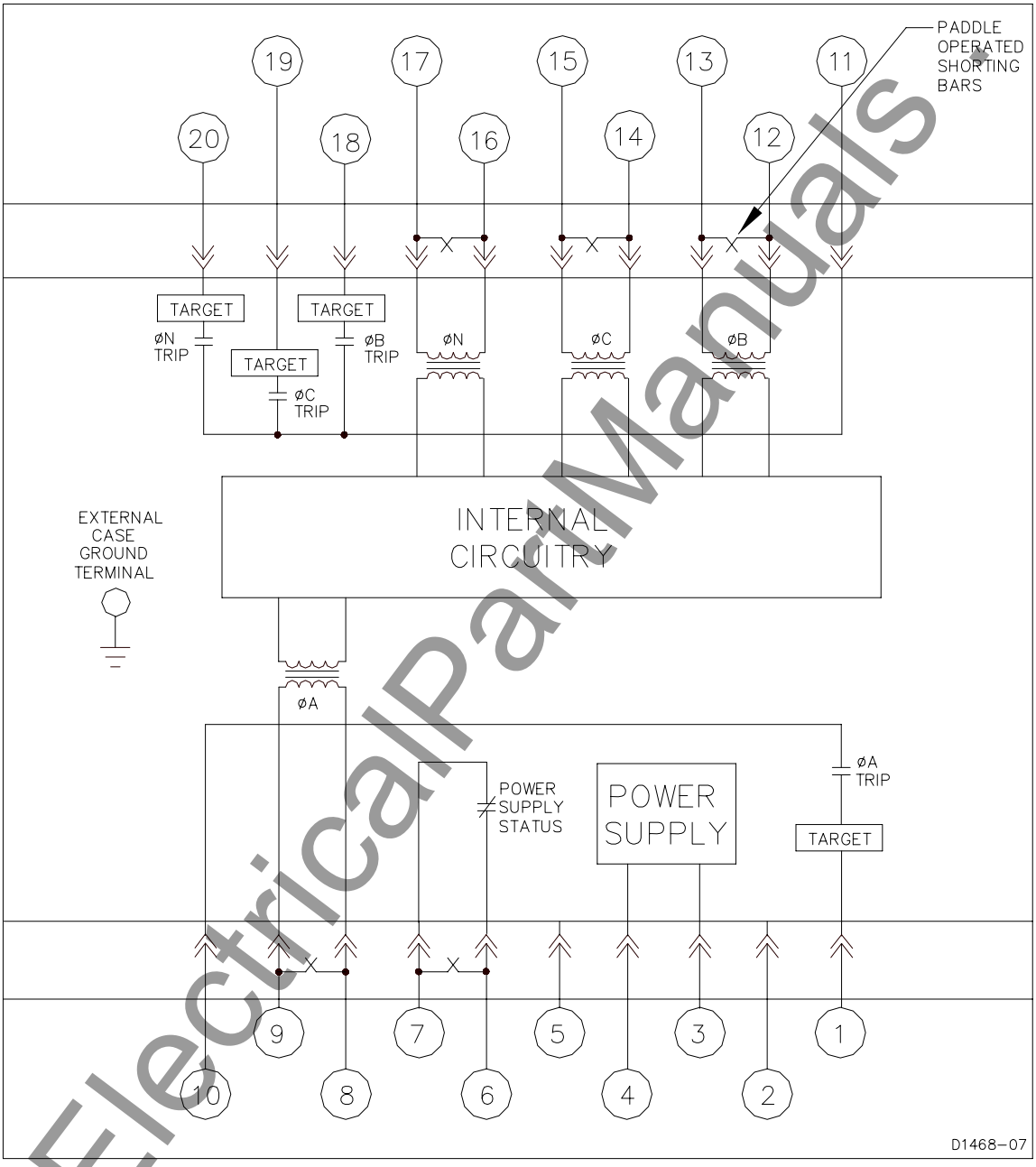

Figure 4-18. Typical Internal Connections, Three-Phase-and-Neutral Sensing, Multiple Output Relays

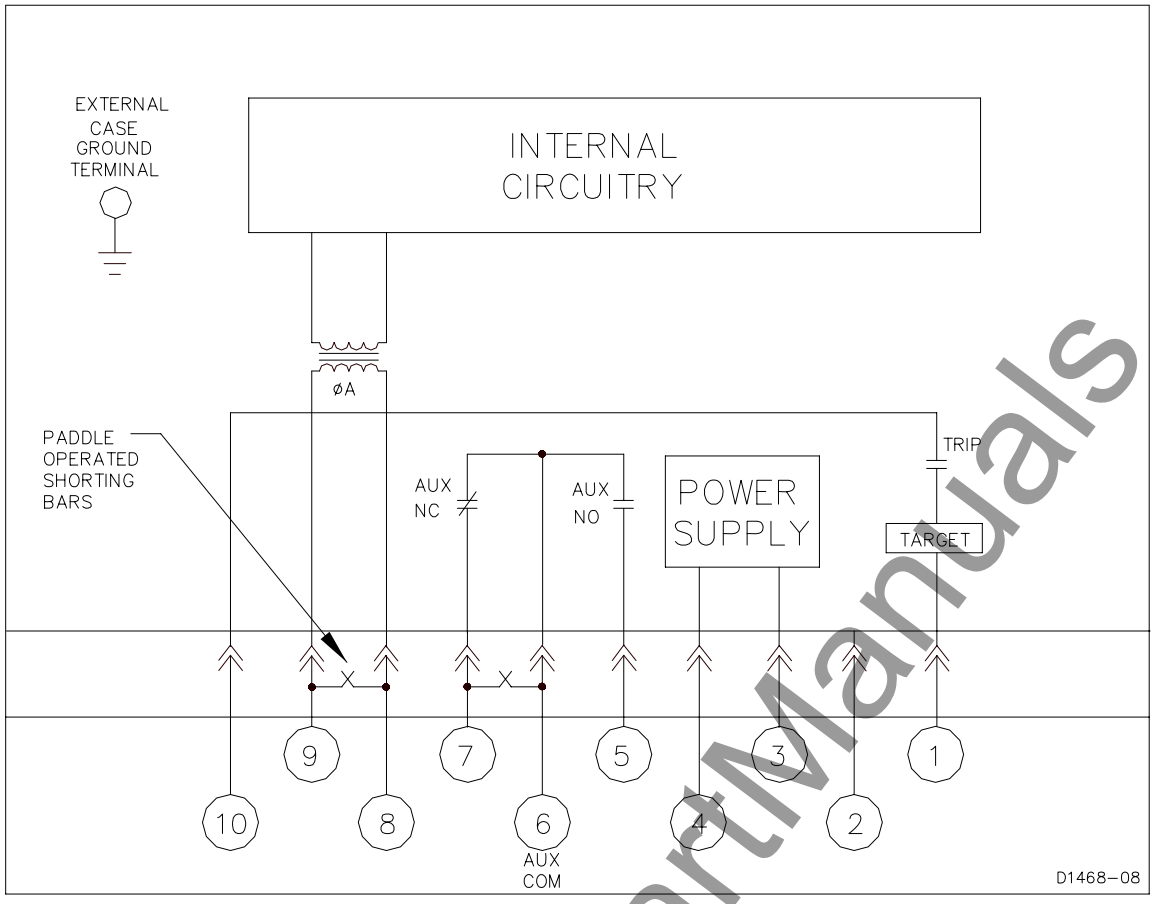

Figure 4-19. Typical Internal Connections, Single-Phase, Output E

MAINTENANCE

BE1-50 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 protective relay contains aluminum electrolytic capacitors which generally have a life expectancy in excess of 10 years at storage temperatures less than 40°C (104°F). Typically, the life expectancy of a 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 30 minutes.

SECTION 5 • TESTING

INTRODUCTION

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

CAUTION

When adjusting for currents higher than 20 amperes AC, do NOT allow sustained current flow longer than thirty seconds. Allow a minimum one minute cooling time between applications.

OPERATIONAL TEST

Step 1. Connect the test circuit shown in Figure 5-1. For relay styles with power supply types O, P, R, S, or T, apply appropriate operating power to terminals 3 and 4. If equipped with power supply status contacts (option 3-6), verify that these contacts when external power is applied. Remove input power and verify that the status contacts close. (For relay styles with power supply types F, G, and H, the relay is powered from the current sensing inputs.)

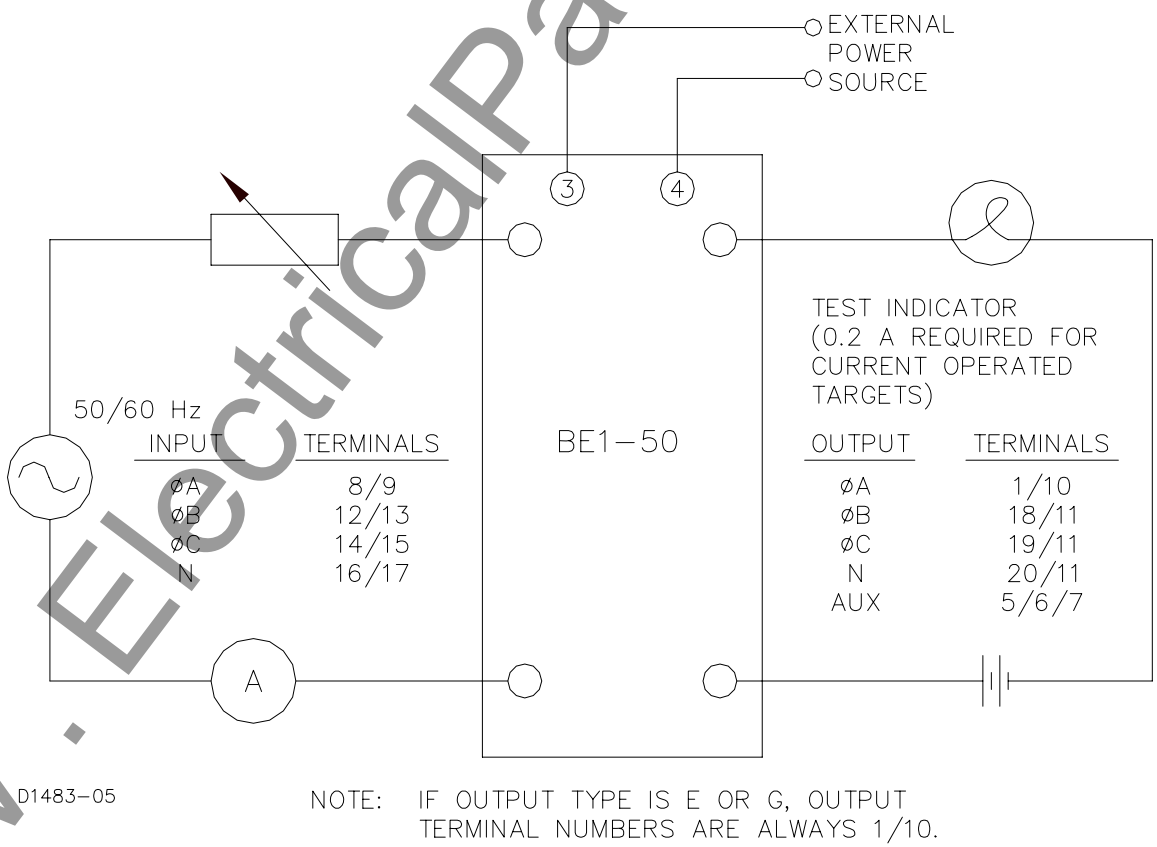

Figure 5-1. Test Circuit Connection

Step 2. Turn the phase pickup adjustment fully CCW. For relay styles with target indicators, operate the manual reset switch to ensure that the targets are reset.

Step 3. Apply sensing current (near zero) and slowly increase the sensed current until the test indicator changes state.

Result: Current indicated by the ammeter is within two percent of the low end of the sensing range. If present, the target indicator for the tested phase (or neutral) should be actuated.

Step 4. Turn the pickup adjustment fully CW. Reset target indicators if present.

Step 5. Apply sensing current (near zero) and slowly increase the sensed current until the test indicator changes state.

Result: Current indicated by the ammeter is within two percent of the high end of the sensing range. If present, the target indicator for the tested phase (or neutral) should be actuated.

Step 6. Repeat Steps 2 through 5 for each phase and neutral as necessary for your style relay. (Neutral sensing ranges may be different from the phase sensing range.)

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