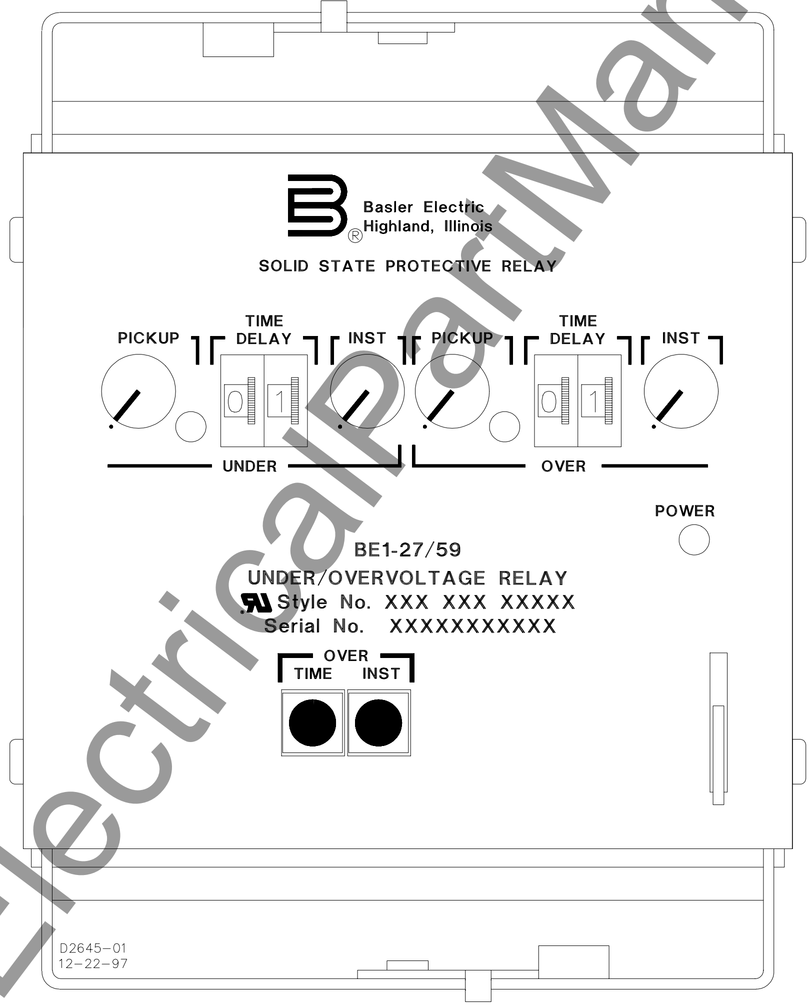
INSTRUCTION MANUAL

FOR

UNDERVOLTAGE, OVERVOLTAGE, AND UNDER/OVERVOLTAGE RELAYS BE1-27, BE1-59, AND BE1-27/59



Basler Electric

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INTRODUCTION

The purpose of this Instruction Manual is to furnish information concerning the operation and installation of this device. To accomplish this, the following is provided.

- Specifications
- Functional Characteristics
- Operational Tests
- Mounting Information

WARNING!

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

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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, call Basler Electric Company, Highland, Illinois.

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SECTION 1 • GENERAL INFORMATION

PURPOSE

The BE1-27 Undervoltage, BE1-59 Overvoltage and the BE1-27/59 Under/Overvoltage Relays are solid-state devices which provide reliable protection for generators, motors and transformers against adverse system voltage conditions.

Application

Electric power systems are designed for constant voltage operation. Loads utilizing commercial electric power are designed to operate at a constant input voltage level with some tolerance. Radical voltage variations on a power system are indicative of a system malfunction. Protective relays which monitor system voltage and provide an output signal when the voltage goes outside predetermined limits, find a variety of applications. Some of these applications include motor, and transformer protection, interface protection for cogeneration systems, and supervision of automatic transfer switching schemes.

Motor Protection

When selecting the type of protection for motor applications, the motor type, voltage rating, horsepower, thermal capability during start-up, and exposure to automatic transfer restarting following a voltage interruption need to be considered. During motor start-up, a low terminal voltage condition will inhibit the motor from reaching rated speed. The BE1-27 undervoltage relay will detect this low voltage condition and trip. Critical applications requiring continuous motor operation and applications where overloads during start-up may be maintained for a given time period, usually have a definite time or inverse time delay characteristic incorporated to avoid unnecessary tripping during low voltage dips. If the undervoltage condition persists for the established time delay, the relay output contacts are connected to the station alarm annunciator panel, allowing the station operator to take corrective action. The BE1-59 Overvoltage relay is applied to insure the voltage does not exceed the limits established by the machine manufacturer for proper operation. Overvoltage conditions stress the insulation level of the equipment and may cause a dielectric breakdown resulting in a flashover to ground.

Automatic Transfer Switching

Distribution substations are sometimes designed with duplicate supply circuits and transformers to eliminate service interruptions due to faults located on the primary feeder. In order to restore service within a given acceptable time period, automatic transfer switching can be applied to initiate the throwover from primary power to the alternate power source. The BE1-27 Undervoltage Relay can initiate switching after a given time delay to void transfer switching during temporary low voltage conditions. To return the substation to normal service upon the restoration of primary voltage, the BE1-59 overvoltage relay supervises the transition to its normal operating condition.

Cogeneration

Utilities employ the use of a voltage check scheme to supervise reclosing at the substation when cogenerators are connected to a radial distribution feeder and the cogenerator is capable of supplying the entire load when the utility circuit breaker is open. During a faulted condition, the utility requires the cogenerator to be disconnected from the system before reclosing the utility breaker. If the cogenerator is connected to the system, the utility will reclose to an energized line.

This could result in reconnecting two systems out of synchronism with each other. A BE1-27 undervoltage relay monitoring the line voltage will inhibit reclosing of the utility circuit breaker if the line is energized by the cogenerator.

At the interface between the utility and the cogenerator, overvoltage and undervoltage relays are installed as minimum protection to provide an operating voltage window for the cogenerator. During faulted conditions, when the cogenerator may become overloaded, the BE1-27 Undervoltage Relay will detect the decline in voltage and remove the cogenerator from the system. The BE1-59 Overvoltage Relay will protect the system from overvoltage conditions that occur when power factor correction capacitors are located on the feeder.

Transformer Protection

Voltage relays can be applied to protect large transformers from damage as a result of overexcitation. The concern for transformer overvoltage may be minimized in many power system applications where proper voltage control of the generating unit is provided. However, where a tap changing regulating transformer is located between the generating source and the load, some form of voltage protection may be required to supplement the tap changing control and to prevent equipment damage due to over, as well as undervoltages resulting from a failure of the tap changing control. The BE1-27/59 Under/Overvoltage Relay is well suited for these applications.

Ground Fault Detection

In a three-phase, three-wire system, a single conductor may break or the insulation may deteriorate resulting in a high resistance ground fault which may not be detected by the overcurrent relays. This condition, however, may be sensed by an overvoltage relay connected to a grounded wye, broken delta set of potential transformers (PT's) as illustrated in Figure 1 -1 with this connection, and a sensitive relay setting, an unbalanced voltage condition, such as described above, can be quickly detected and isolated.

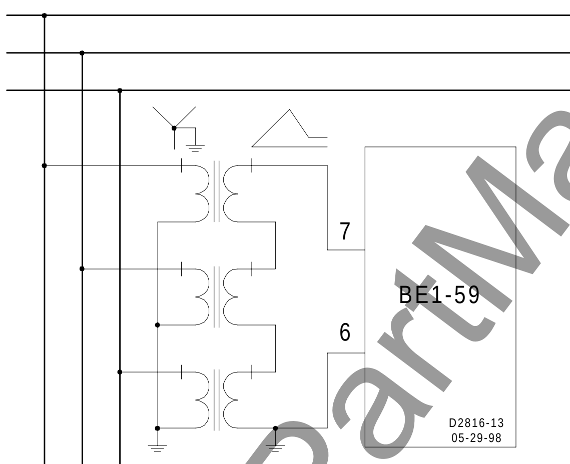

Figure 1-1. Ground Fault Detection

MODEL AND STYLE NUMBER

The electrical characteristics and operational features included in a specific relay are defined by a combination of letters and numbers which constitutes the device's style number. The style number together with the model number describe the features and options in a particular device and appear on the front panel, drawout cradle, and inside the case assembly. The model number BE1-27/59 designates the relay as a Basler Electric Class 100 Under/Overvoltage Relay.

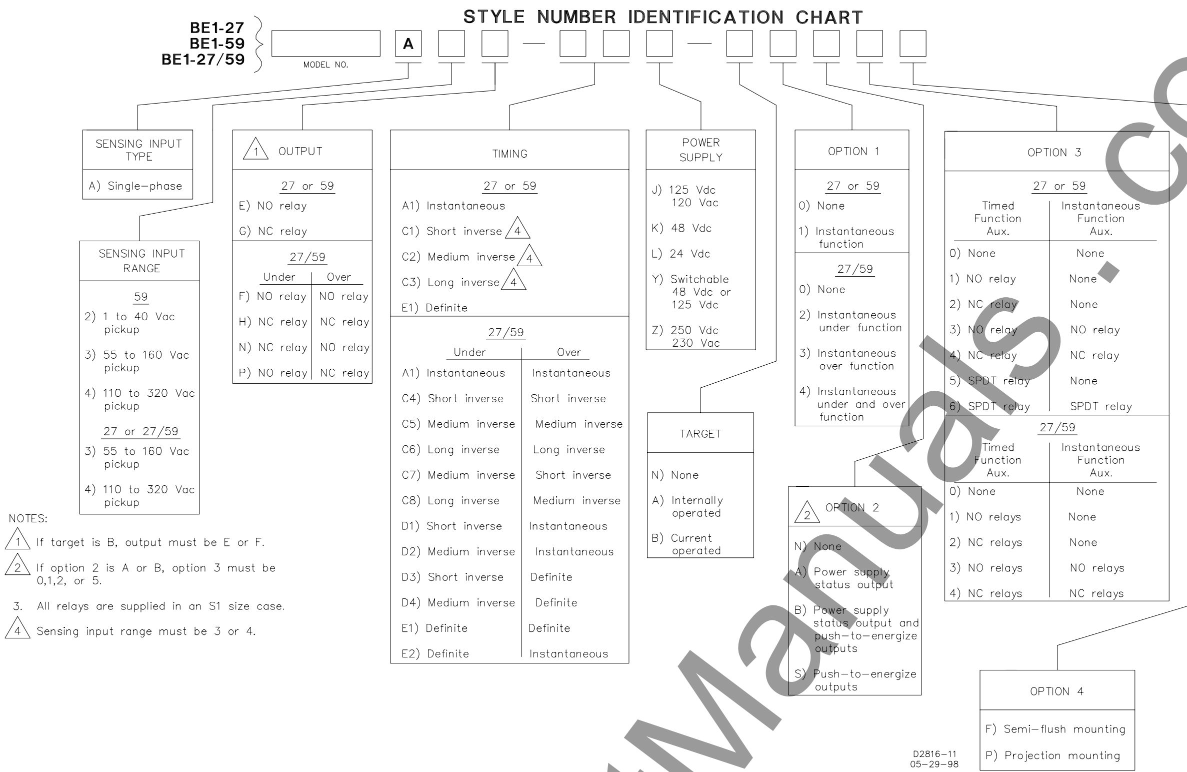

Figure 1-2. Style Number Identification Chart

SAMPLE STYLE NUMBER

The style number identification chart above illustrates the manner in which a relay's style number is determined. For example, if the model number is BE1-27/59 and the style number is A3F E1J AOS1F the device has the following features:

A) Single-phase voltage sensing

3) Sensing input compatible with a pickup adjustment range of 55 to 160 Vac

F) Two normally open output relays (one per function)

E1) Definite timing for each function

J) Operating power derived from a 125 Vdc or 100/120 Vac source

A) Two internally operated target indicators (one per function)

O) No instantaneous functions

S) Push-to-energize outputs (pushbuttons)

1) Two normally open auxiliary output relays (one per function)

F) Semi-flush mounting

SPECIFICATIONS

Voltage Sensing — Nominally rated at 50/60 Hz, (120/240 V or 100/200 V) with a maximum continuous voltage rating of 360 V (120 V nominal) or 480 V (240 V nominal) at a burden less than 1 VA per phase. Frequency range is from 40 to 70 Hz.

Power Supply

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
K (Mid Range)	48 Vdc	24 to 150 Vdc	4.4 W
J (Mid Range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	4.4 W 10.1 VA
†L (Low Range)	24 Vdc	12 to 32 Vdc	4.5 W
Y (Mid Range)	48 Vdc 125 Vdc	24 to 150 Vdc 24 to 150 Vdc	4.4 W 4.4 W
Z (High Range)	250 Vdc 230 Vac	68 to 280 Vdc 90 to 270 Vac	5.5 W 14.0 VA

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

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

Output Contacts: — Output contacts are rated as follows:

<u>Resistive</u>
120 Vac - make, break, and carry 7 A continuously.
250 Vdc - make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.1 A.
500 Vdc - make and carry 15 A for 0.2 seconds, carry 7 A continuously, break 0.1 A.

<u>Inductive</u>
120 Vac, 125 Vdc, 250 Vdc - break 0.1 A (L/R = 0. 04) .

Undervoltage and Overvoltage Pickup Range — Continuously adjustable over the range of 1 to 40, 55 to 160, or 110 to 320 Vac as defined by the Style Chart. See Section 3, System Voltages for explanation of pickup ranges.

Undervoltage and Overvoltage Pickup Accuracy — ± 2% or ± 0.5 volts of the pickup setting, whichever is greater.

Dropout Accuracy — ± 2% of pickup.

Instantaneous Time Accuracy — Less than 50 ms for a voltage level that exceeds the pickup setting by 5% or 1 volt, whichever is greater.

Definite Time Range — Adjustable over the range of 0.1 to 9.9 seconds in increments of 0.1 seconds. A setting of 00 designates instantaneous timing.

Definite Time Accuracy	Within ± one half of the least significant digit time plus 50 ms.
Inverse Time	Inverse curve types are defined by the Style Chart and are represented by the curves shown in Section 3. Inverse time is adjustable from 01 to 99 in increments of 01. Incrementing the time dial varies the inverse curve along the Y axis. A setting of 00 designates instantaneous timing.
Inverse Time Accuracy	Within ± 5% or 50 ms (whichever is greater) of the indicated time for any combination of time dial setting and pickup setting and is repeatable within ± 2% or 50 ms (whichever is greater) for any combination of time dial and tap setting. Curves were generated with prefault voltages at 10% greater than pickup for the 27 curves and 10% less than pickup for the 59 curves. For prefault voltages that are greater in difference from the pickup setting, the timing accuracy is ±10% or 100 ms (whichever is greater).
UL Recognition	UL Recognized per Standard 508, UL File No. E97033. Note: Output contacts are not UL Recognized for voltages greater than 250 V.
Isolation	Meets IEC 255-5 and exceeds ANSI/IEEE C37.90 one minute dielectric test as follows. All Circuits to Ground: 2,828 Vdc (excludes communication ports). Communication Ports to Ground: 500 Vdc. Input Circuits to Output Circuits: 2,000 Vac or 2,828 Vdc.
Surge Withstand Capability:	
Oscillatory	Qualified to IEEE C37.90.1-1989 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems. (Excluding communication ports)*.
Fast Transient	Qualified to IEEE C37.90.1-1989 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems. (Excluding communication ports)*.
Electrostatic Discharge (ESD) CE Certified	4 kilovolts contact discharges and 8 kilovolts air discharges applied in accordance with Qualification EN61000-4-2.
Radio Frequency Interference	Qualified to IEEE C37.90.2-1995 *Standard For Withstand Capability Of Relay Systems To Radiated Electromagnetic Interference From Transceivers.*
Impulse Test	Qualified to IEC 255-5.
Shock	15 Gs in each of three mutually perpendicular axes.
Vibration	2 Gs in each of three mutually perpendicular axes swept over the range of 10 to 500 Hz for a total of si x sweeps, 15 minutes each sweep.
Temperature:	
Operating	-40°C (-40°F) to +70°C (+158°F)
Storage	-65°C (-85°F) to +100°C (+212°F)
Weight	14 pounds maximum.
Case Size	All units supplied in an SI size case.

SECTION 2 • HUMAN-MACHINE INTERFACE CONTROLS AND INDICATORS

The following table is referenced to Figure 2-1.

Table 2-1. Controls And Indicators

Locator	Control or Indicator	Function
A	UNDER PICKUP Control	Establishes setpoint for the timed undervoltage function. Continuously adjustable over the range defined by the style number.
B	UNDER TIME DELAY Control (Optional)	Establishes the interval between under-voltage pickup and the time-delayed output. Defined by the style number, this delay is either a user-adjustable definite time, or inversely proportional to the magnitude of the undervoltage condition. A setting of 0.0 provides an instantaneous response. Definite - adjustable from 0.0 to 9.9 seconds in 0.1 second increments. Inverse - adjusts inverse timing characteristic curve relative to the time axis. (See the characteristic curves in Section 3.)
C	UNDER INST Control (Optional)	Establishes setpoint for the instantaneous undervoltage function. Continuously adjustable over the range defined by the style number.
D	OVER PICKUP Control	Establishes setpoint for the timed over-voltage function. Continuously adjustable over the range defined by the style number.
E	OVER TIME DELAY Control (Optional)	Establishes the interval between over-voltage pickup and the time-delayed output. Defined by the style number, this delay is either a user-adjustable definite time, or inversely proportional to the magnitude of the overvoltage condition. A setting of 0.0 provides an instantaneous response. Definite - adjustable from 0.0 to 9.9 seconds in 0.1 second increments. Inverse - adjusts inverse timing characteristic curve relative to the time axis (See the characteristic curves in Section 3.)
F	OVER INST Control (Optional)	Establishes setpoint for the instantaneous overvoltage function. Continuously adjustable over the range defined by the style number.
G	POWER Indicator	Illuminated to indicate that the power supply is operating.

H	Target Reset Lever (Optional)	Linkage extending through bottom of front cover pushed to reset the magnetically latching target indicators.
I	OVER PICKUP Indicator	Illuminated to indicate that the timed overvoltage pickup setting is exceeded.
J	Target Indicators (Optional)	Magnetically latching indicators are tripped to red to indicate that an undervoltage or overvoltage output relay has been energized.
K	Push-to-Energize (Optional)	Momentary pushbuttons accessible through the front panel used to test output relays and system wiring.
L	UNDER PICKUP Indicator	Illuminated to indicate that the timed pickup setting is exceeded.

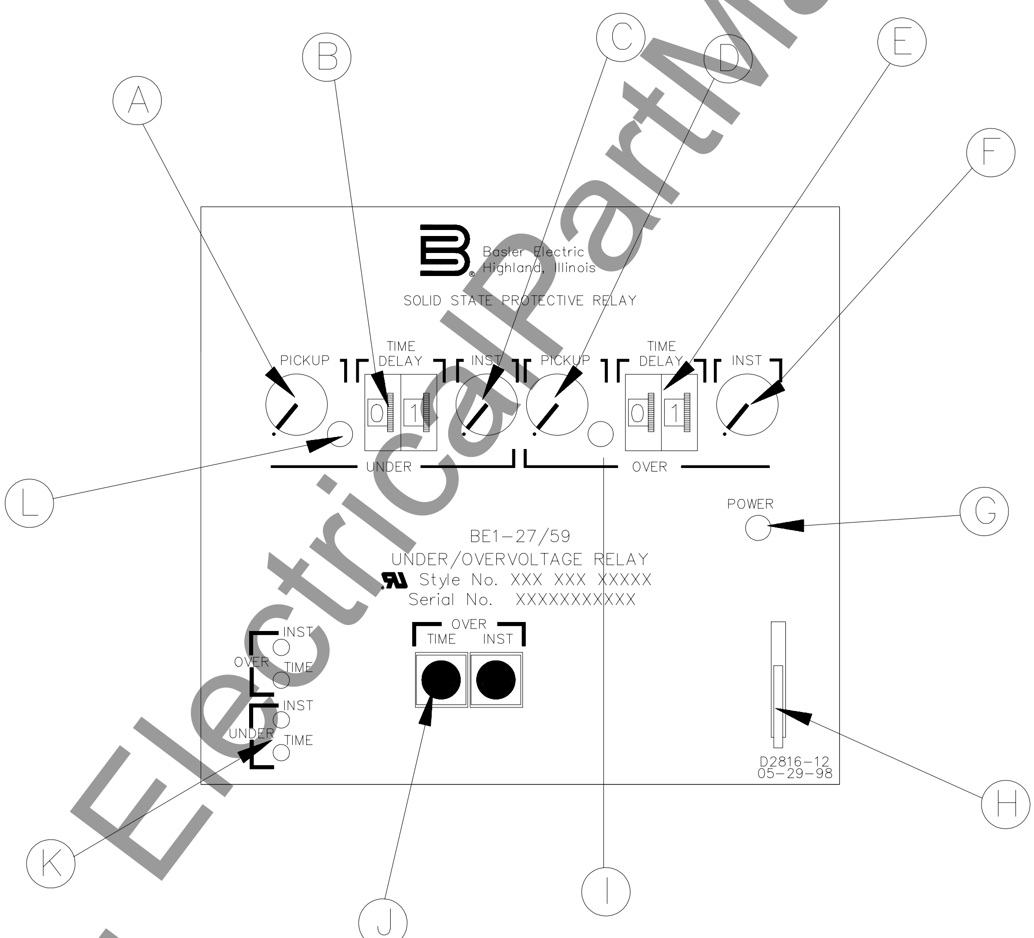

Figure 2-1. Location of Controls and Indicators

SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

The BE1-27 Undervoltage, BE1-59 Overvoltage, and BE1-27/59 Under/Overvoltage Relays are static devices which respond to the voltage magnitude of the monitored circuit. Figure 3-1 is a functional block diagram of the BE1-27/59 Under/Overvoltage Relay.

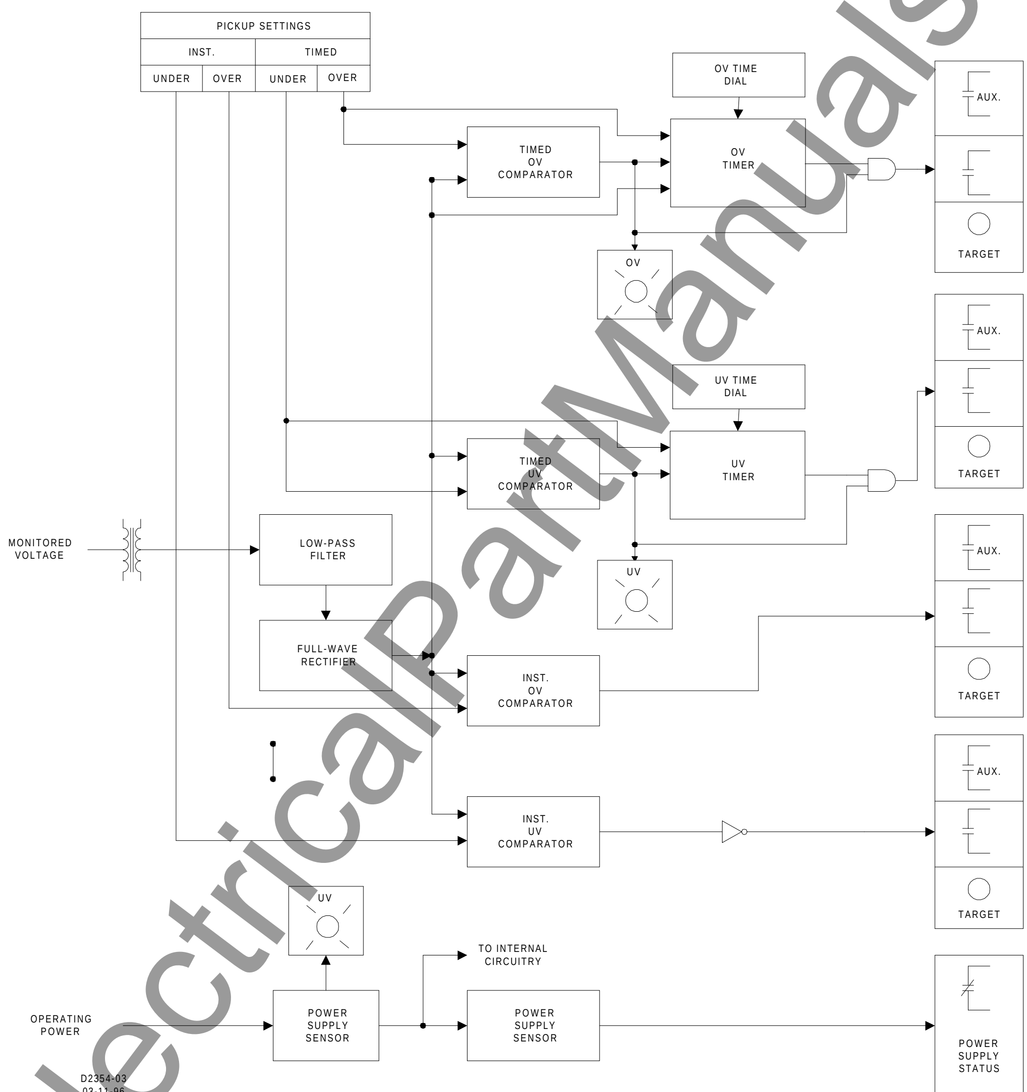

Figure 3-1. Functional Block Diagram

SYSTEM VOLTAGES

The BE1-27, BE1-59, and BE1-27/59 relays are available with three sensing input ranges. The 55 to 160V range is intended for use with nominal system voltages of 120V or 69V (120/ 3). The 110 to 320 volt range is intended for use with nominal system voltages of 240V, 208V (120 X 3), or 277V (480/ 3). The 1 to 40V range is intended for use with a wye/broken delta PT configuration with 120V or 69V (120/ 3) line-to-ground secondary voltages. The wye/broken delta PT configuration is a zero sequence filter capable of producing three times the line-to-ground voltage (3Vo).

STEP-DOWN TRANSFORMER

The monitored system voltage is applied to the primary of an internal potential transformer and stepped down to internal circuit levels. The transformer provides a high degree of isolation.

LOW-PASS FILTER AND FULL WAVE RECTIFIER

The output of the step-down transformer is low-pass filtered to prevent undesired response to high-frequency noise. Frequencies above 226 Hz are attenuated. The ac signal is then full-wave rectified to produce positive-going half-cycles which represent the magnitude of the monitored system voltage.

PICKUP SETTINGS

Controlled by front panel single-turn potentiometers, the pickup settings establish reference voltages representative of the system voltage which will cause the relay to respond. Pickup settings are individually adjustable for timed under/overvoltage functions and instantaneous under/overvoltage functions. On BE1-27/59, under/overvoltage units, the undervoltage function takes precedence over the overvoltage function.

PICKUP COMPARATORS

The output of the rectifier circuit is compared to each pickup setting. When the monitored system voltage is greater than any pickup setting, the effected comparator's output goes high. When the monitored system voltage is less than any pickup setting, the effected comparator's output goes low. The effects of these outputs are shown below.

Comparator	Relevant Pickup Setting			
	Timed		Instantaneous	
	Undervoltage	Overvoltage	Undervoltage	Overvoltage
High	No effect	Illuminates OV pickup indicator; initiates timer	No effect	Energizes output relay
Low	Illuminates UV pickup indicator; initiates timer	No effect	Energizes output relay	No effect

TIMER CIRCUIT

Once initiated, the timer circuit measures the interval from pickup. If the adverse condition continues through the programmed delay, the timer circuit energizes the appropriate output relay. In relay styles with inverse timing, the extent to which the monitored system voltage exceeds the pickup setting influences the actual time delay such that a greater voltage difference from pickup produces a more rapid response. This response is illustrated in the characteristic curves as shown in Figures 3-2 through 3-7.

OUTPUTS

Defined by the model and style numbers, output relays may be provided for each of the following functions: timed undervoltage, timed overvoltage, instantaneous undervoltage, and instantaneous overvoltage. Auxiliary output relays may be provided for each of these functions as well. Once energized, output relays will remain energized until the adverse condition stops.

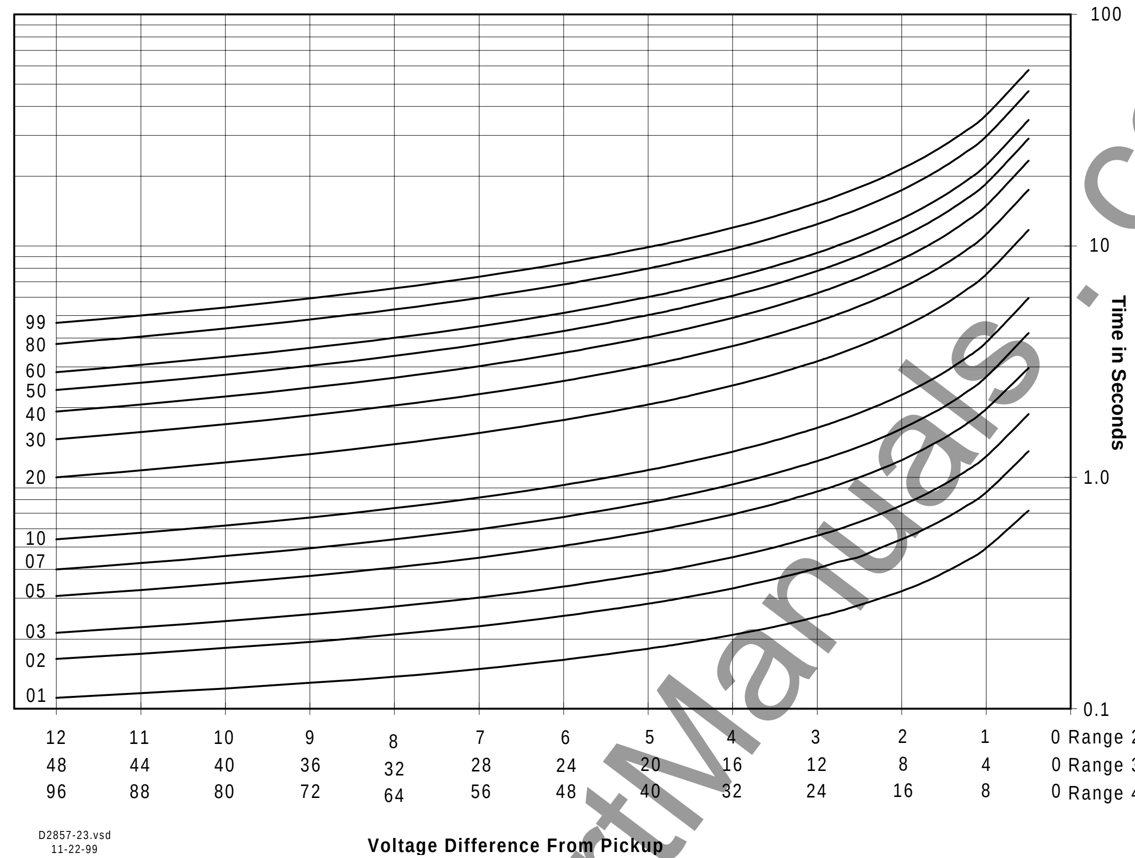

Figure 3-2. Undervoltage, Short Inverse Timing Characteristic Curve

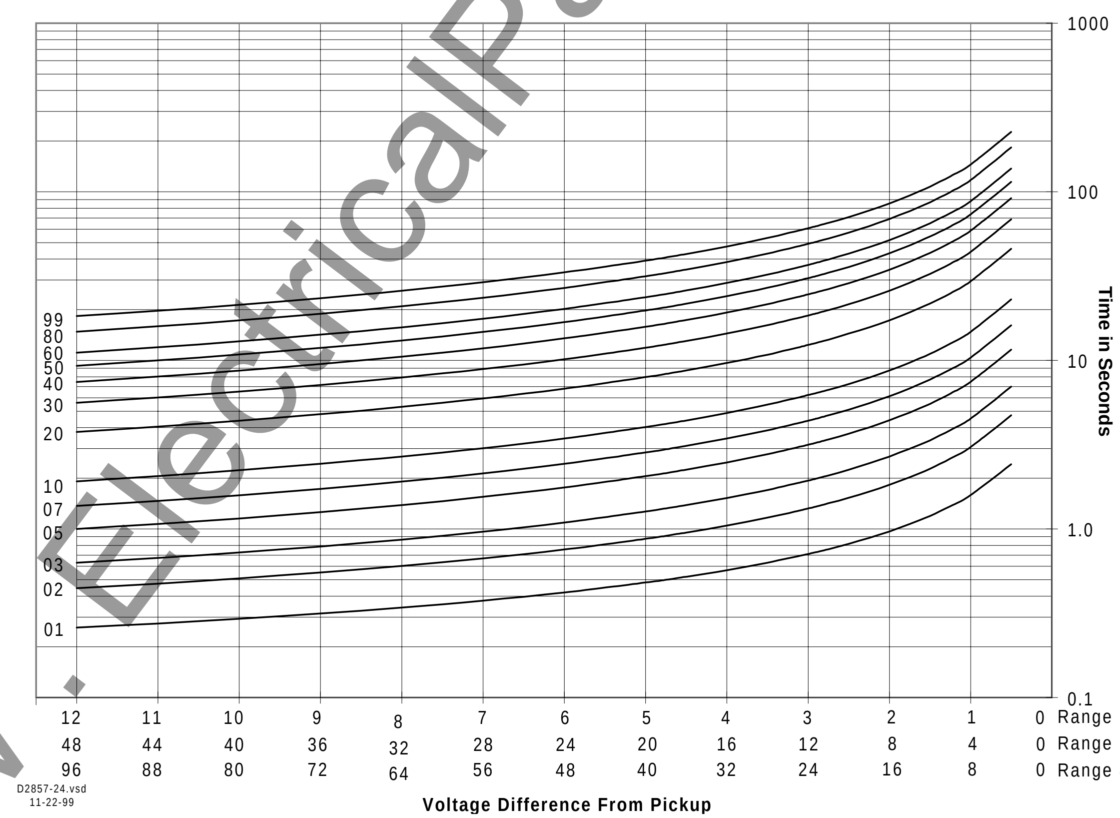

Figure 3-3. Undervoltage, Medium Inverse Timing Characteristic Curve

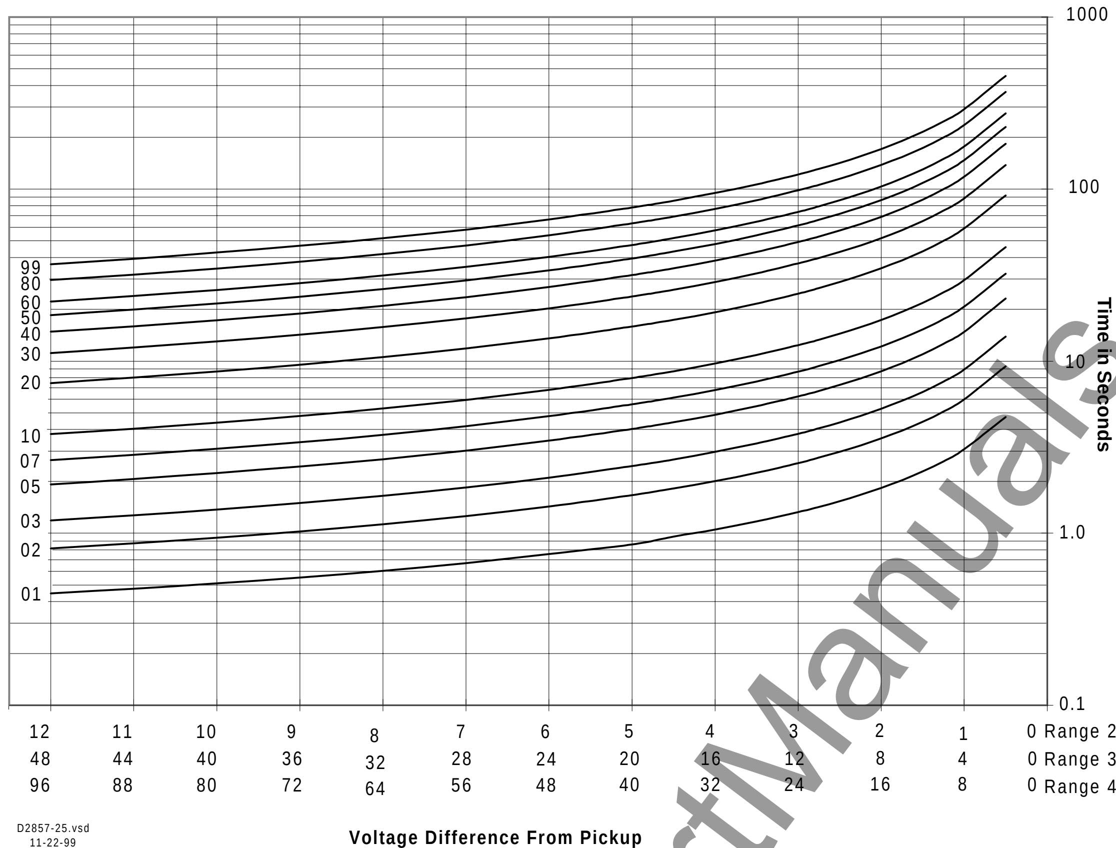

Figure 3-4. Undervoltage, Long Inverse Timing Characteristic Curve

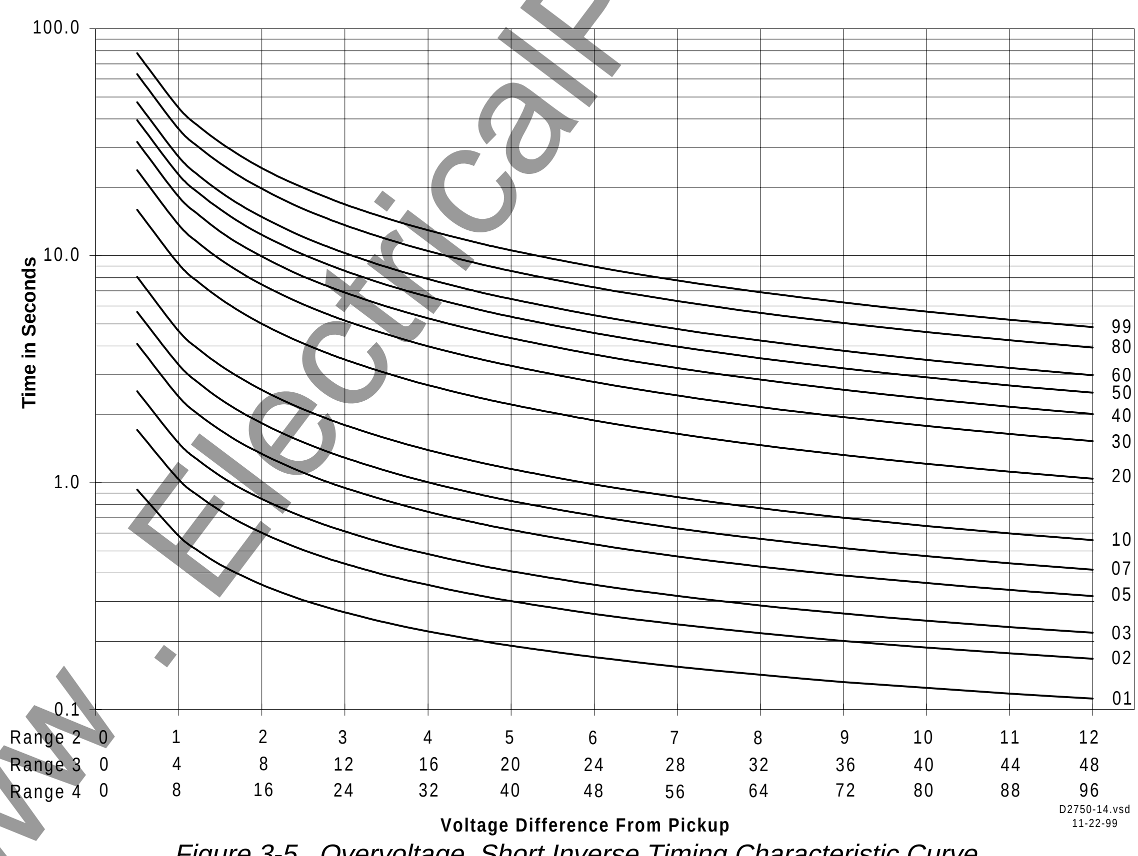

Figure 3-5. Overvoltage, Short Inverse Timing Characteristic Curve

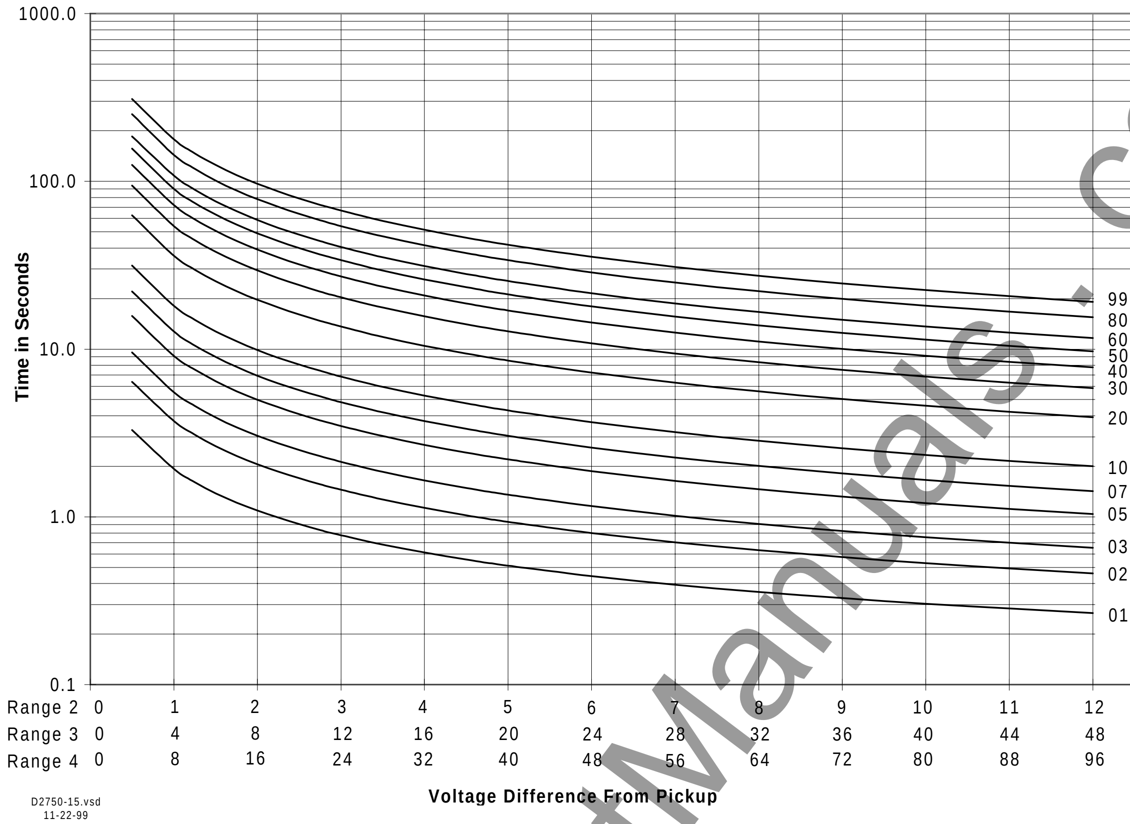

Figure 3-6. Overvoltage, Medium Inverse Timing Characteristic Curve

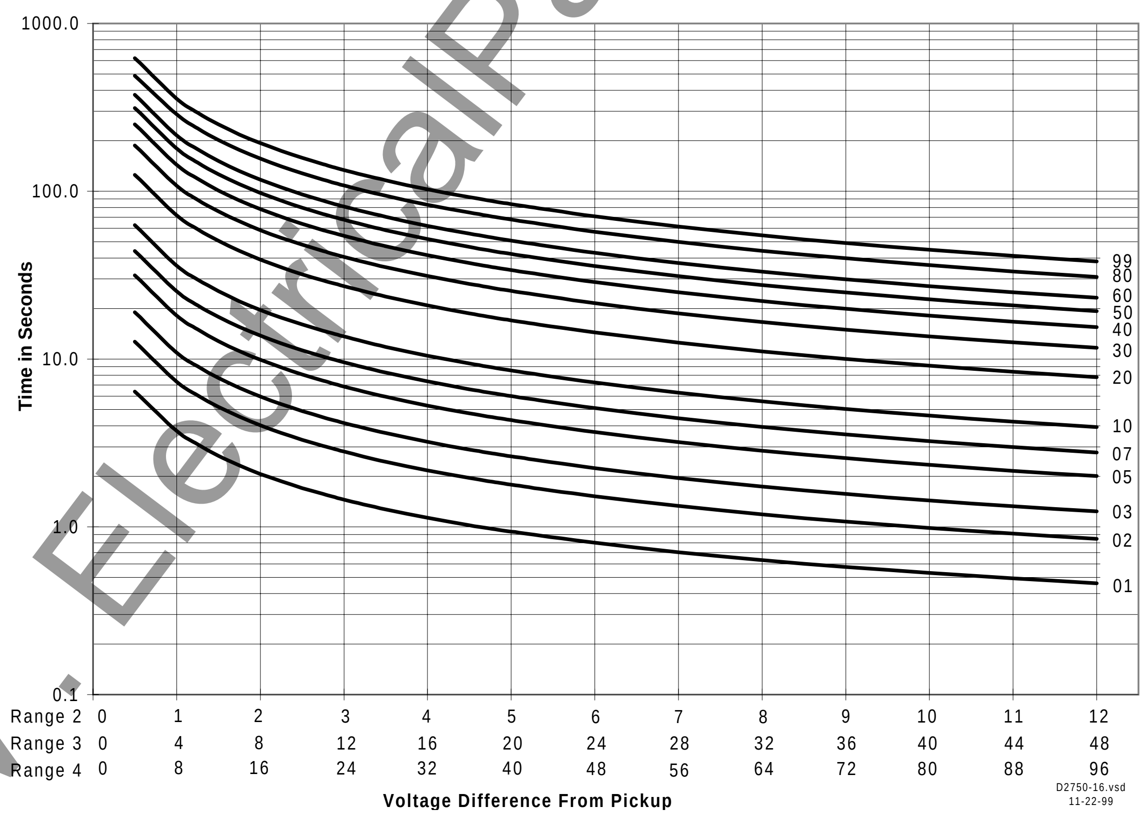

Figure 3-7. Overvoltage, Long Inverse Timing Characteristic Curve

TARGETS

Defined by the model and style numbers, magnetically latching target indicators may be provided for each timed and instantaneous function. These targets are actuated in conjunction with their corresponding output relays (internally operated), or by a minimum of 0.2 Adc flowing through the output relay's trip circuit (current operated). Target indicators must be manually reset.

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 3-1. Wide Range Power Supply Voltage Ranges

Power Supply	Style Chart Identifier	Nominal Voltage	Voltage Range
Low Range	L	24 Vdc	12† to 32 Vdc
Mid Range	J, K, Y	48, 125 Vdc, 125 Vac	24 to 150 Vdc 90 to 132 Vac
High Range	Z	125, 250 Vdc, 120, 240 Vac	62 to 280 Vdc 90 to 270 Vac

† 14 Vdc required to start the power supply.

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

POWER SUPPLY STATUS OUTPUT (Option 2-A, B)

The power supply status output relay has normally closed (NC) output contacts. This relay is energized upon power-up thus opening its contacts. Normal relay operating voltage maintains the power supply status output relay continually energized and its output contacts open. However, if the power supply output voltage falls below the requirements for proper operation, the power supply status output relay de-energizes, thus closing the NC output contacts.

SECTION 4 • INSTALLATION

GENERAL

When not shipped as part of a control or switchgear panel, the relays are shipped in sturdy cartons to prevent damage during transit. Immediately upon receipt of a relay, check the model and style number against the requisition and packing list to see that they agree. Visually inspect the relay for damage that may have occurred during shipment. If there is evident damage, immediately file a claim with the carrier and contact the Basler Electric Regional Sales Office, your Sales Representative, or 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 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 Adc 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 connecting plugs and withdraw the cradle from its case.
3. When the connecting 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. Also, be sure that connecting plugs are in place before replacing the front cover.
4. Be sure the relay case is hard wired to earth ground using the ground terminal on the rear of the unit. Use a separate ground lead to the ground bus for each relay.
5. An undervoltage target indication may occur when the lower connecting paddle is removed if:

   a) the instantaneous time function is selected, or

   b) a time delay (definite or inverse) below 0.3 seconds is selected.

   No actual trip output occurs if the upper paddle is removed first.

DIELECTRIC TEST

In accordance with IEC 255-5 and IEEE C37.90-1978, one-minute dielectric (high potential) tests may be performed up to 2000 Vac (45-65 Hz). Note that this device employs decoupling capacitors to ground from terminals 3 and 4. Accordingly, a leakage current is to be expected at these terminals.

MOUNTING

Outline dimensions and drilling diagrams are supplied in Figures 4-1 through 4-12.

CONNECTIONS

Incorrect wiring may result in damage to the relay. Typical internal connections are shown in Figures 4-13 through 4-15. Typical ac connections are shown in Figure 4-16. Typical dc connections are shown in Figure 4-17. Be sure to check model and style number against the options listed in the Style Number Identification Chart before connecting and energizing a particular relay. Connections should be made with 14 AWG stranded wire or better.

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, always use a separate lead to the groung bus from each relay.

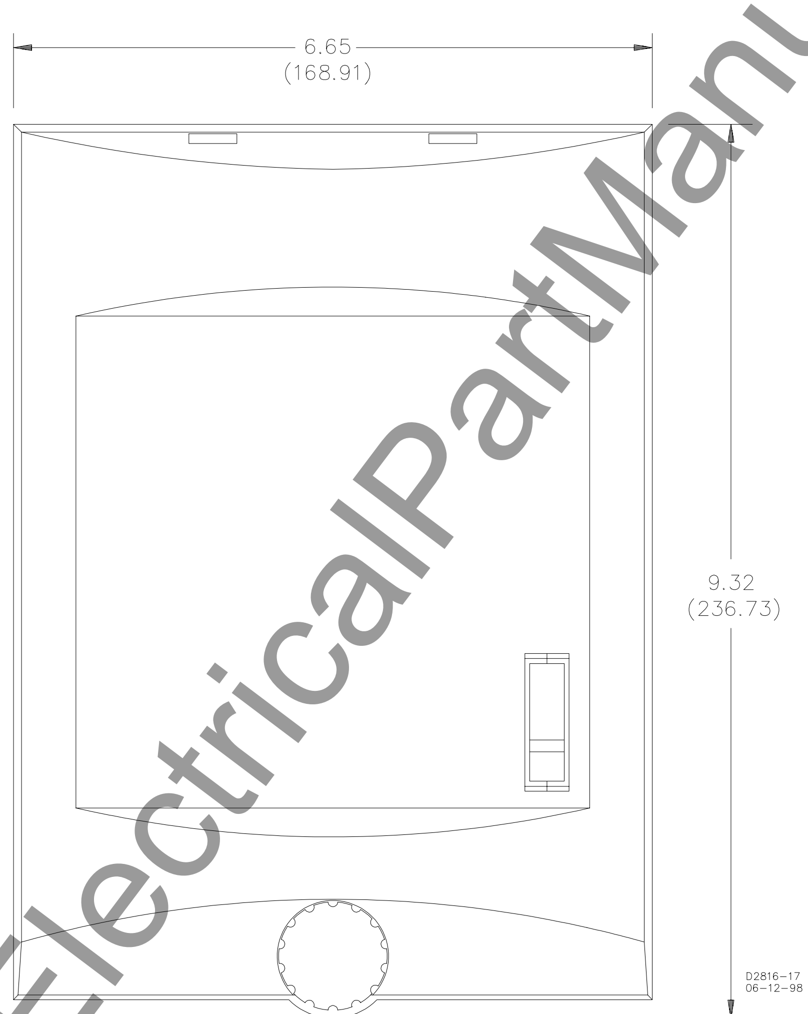

Figure 4-1 . S1 Case, Outline Dimensions, Front View

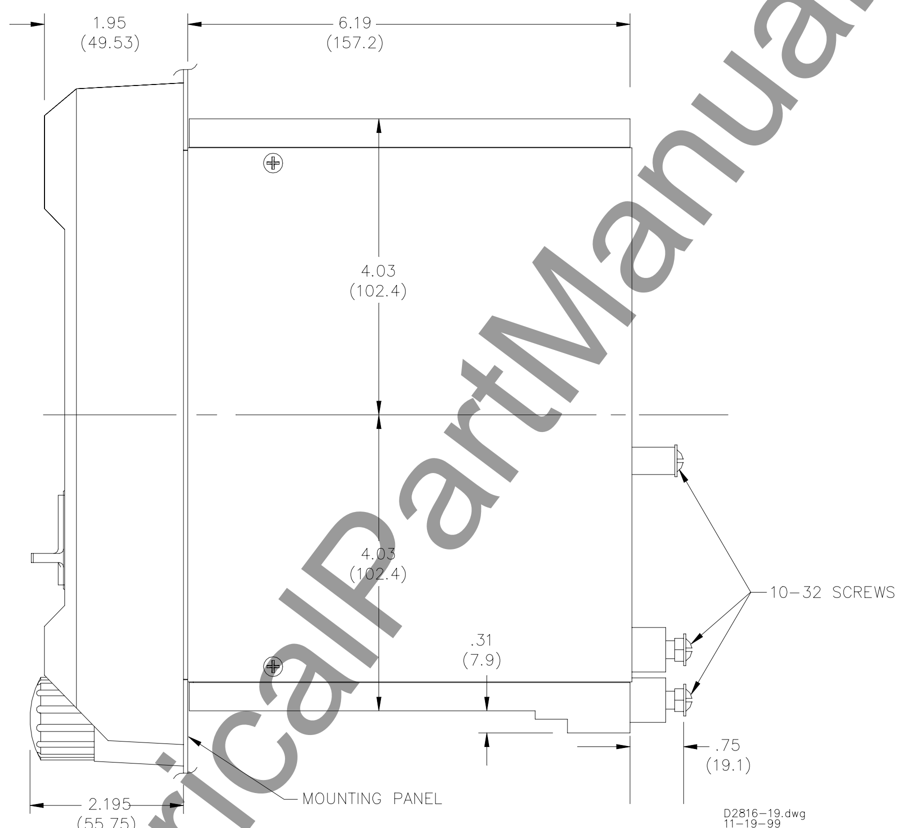

Figure 4-2 . S1 Case, Single-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

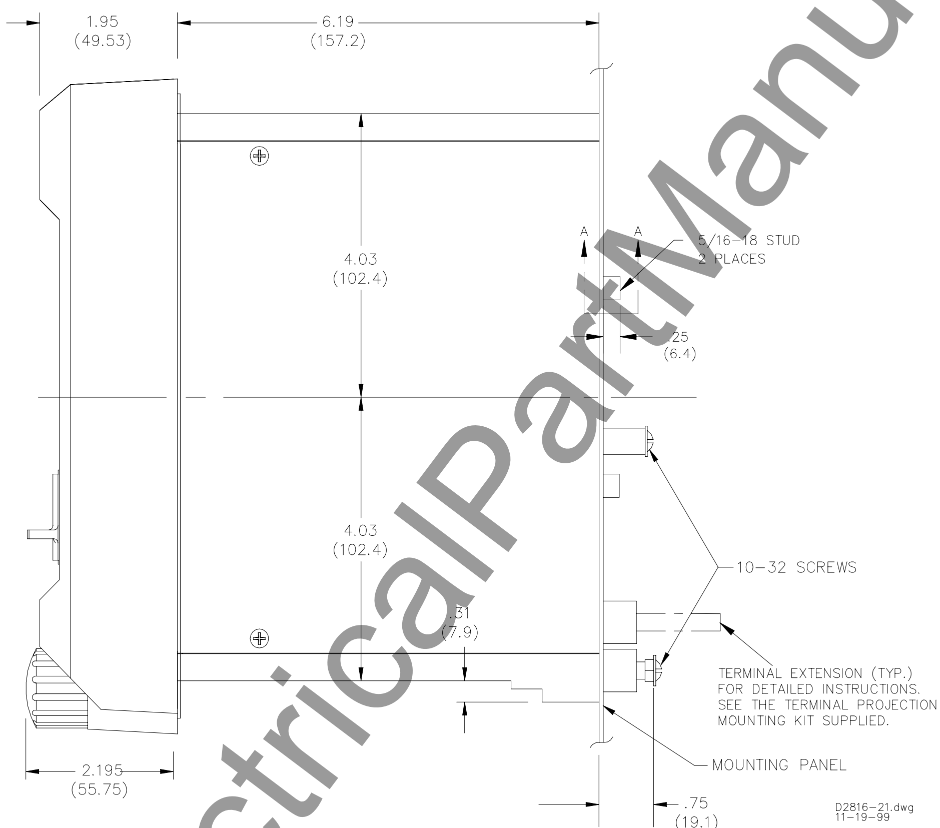

Figure 4-3 . S1 Case, Single-Ended, Projection Mount, Outline Dimensions, Side View

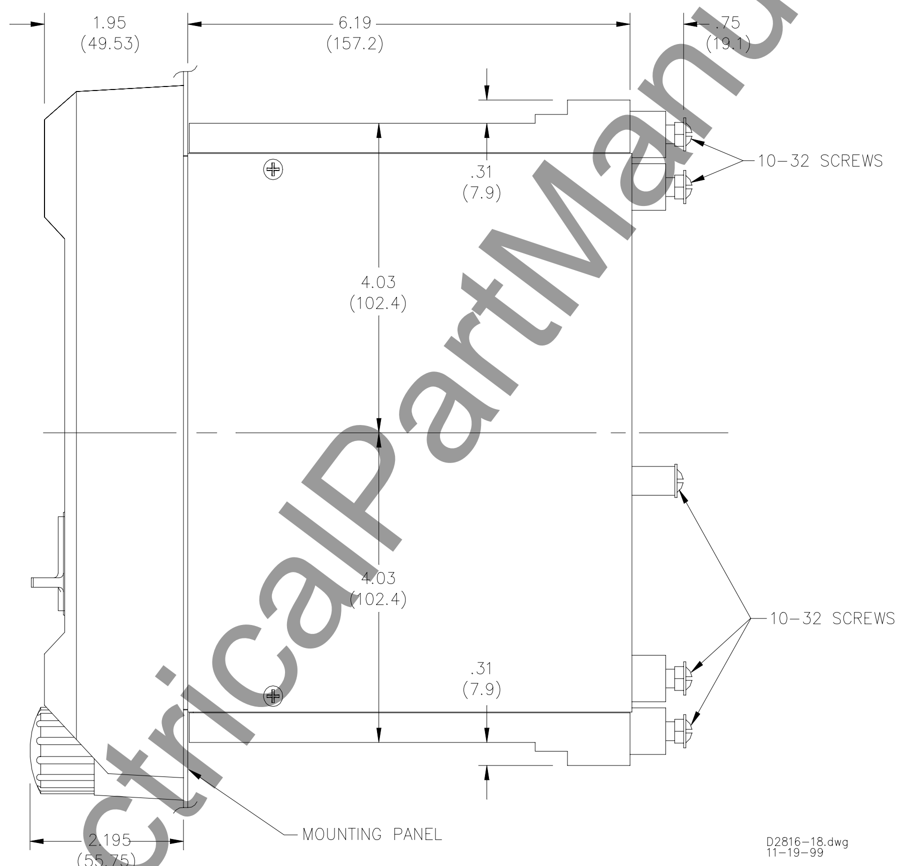

Figure 4-4 . S1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

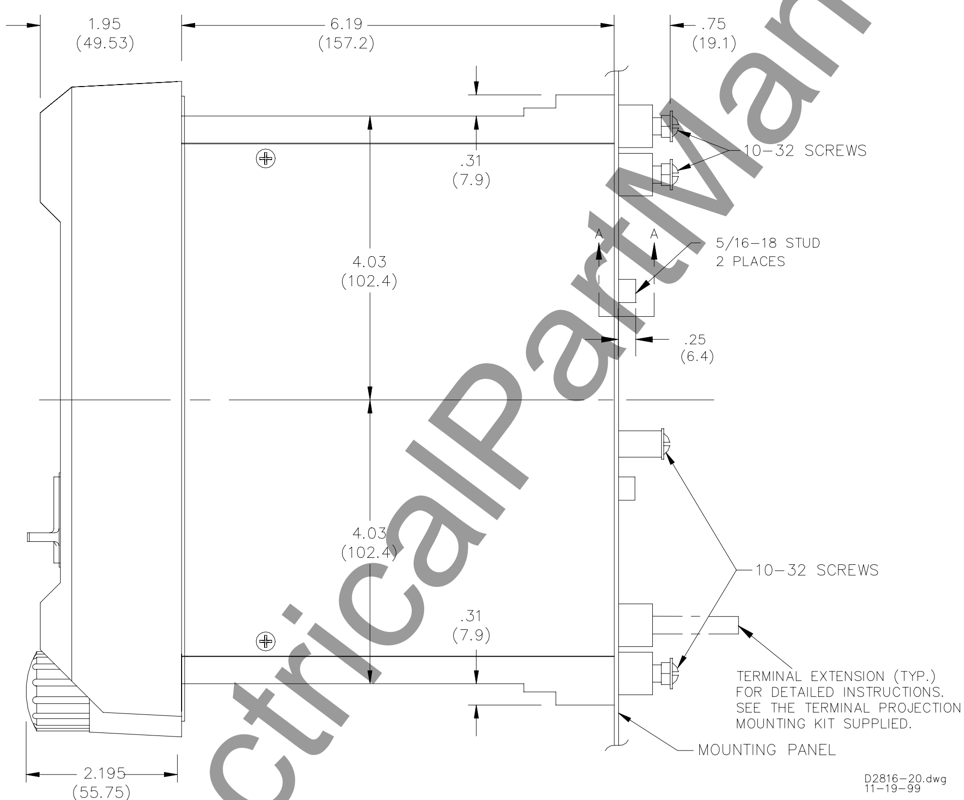

Figure 4-5 . S1 Case, Double-Ended, Projection Mount, Outline Dimensions, Side View

Figure 4-6 . S1 Case, Single-Ended, Semi-Flush Mounting, Outline Dimensions, Rear View

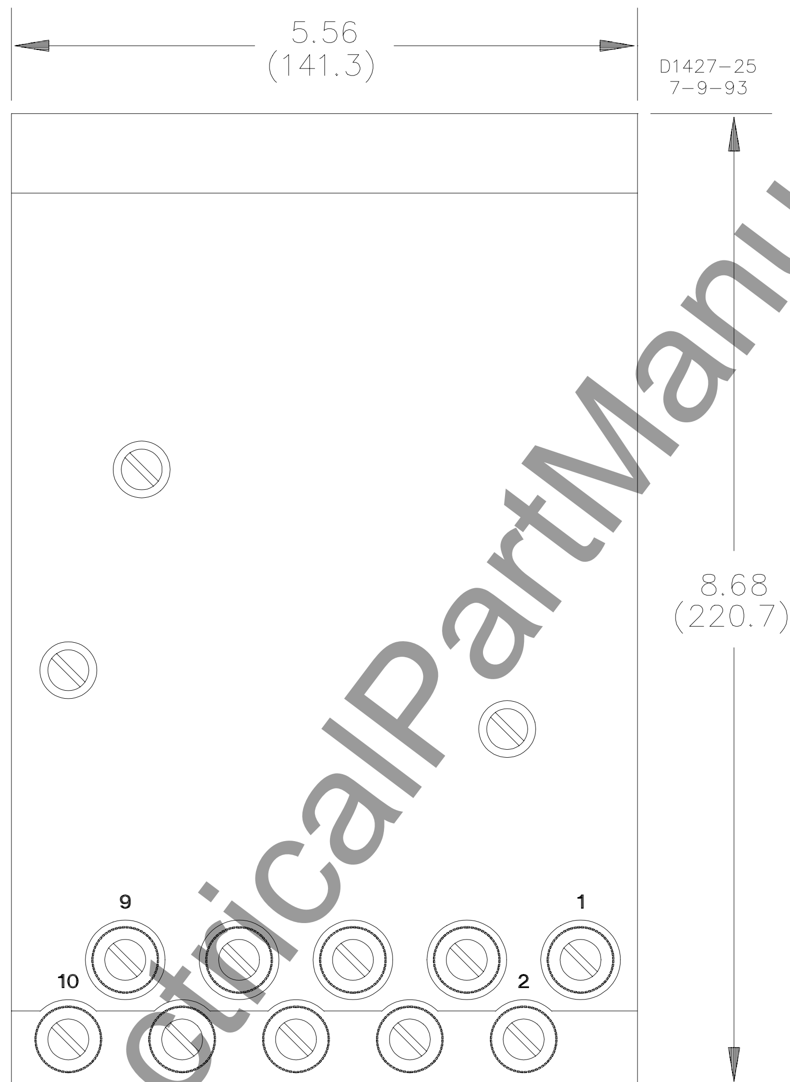

Figure 4-7. S1 Case, Single-Ended, Projection Mount, Outline Dimensions, Rear View

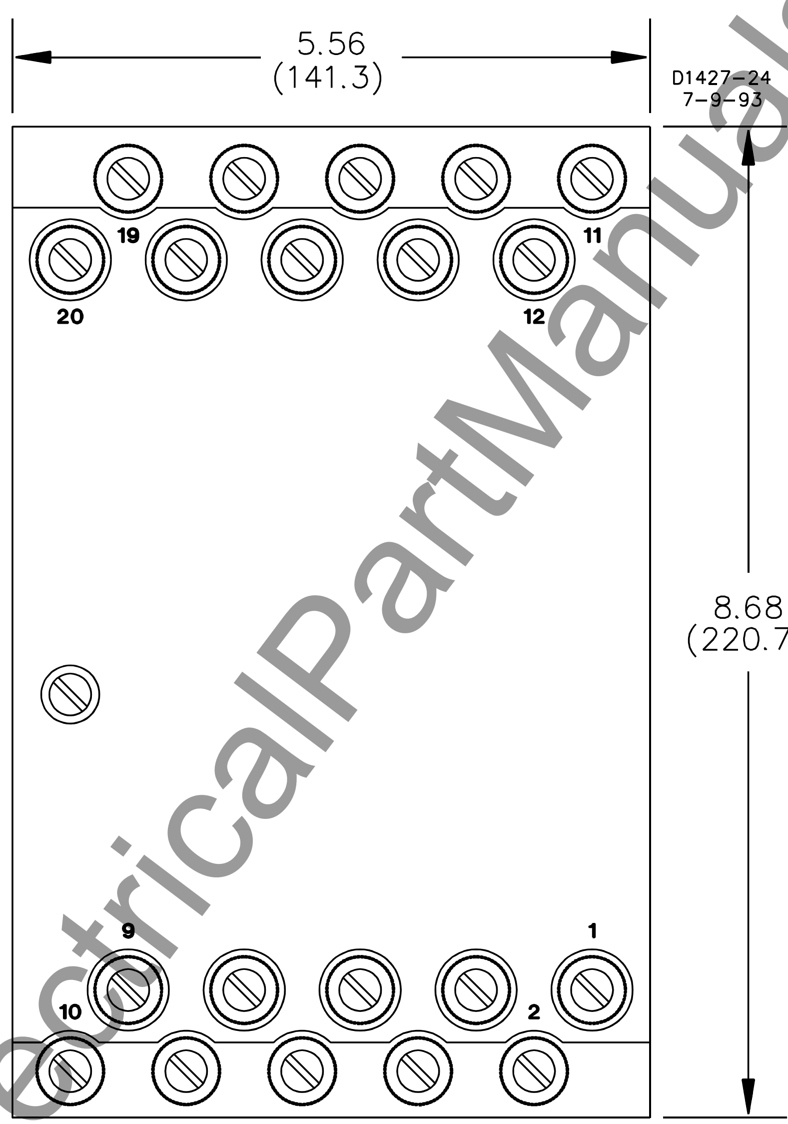

Figure 4-8 . S1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Rear View

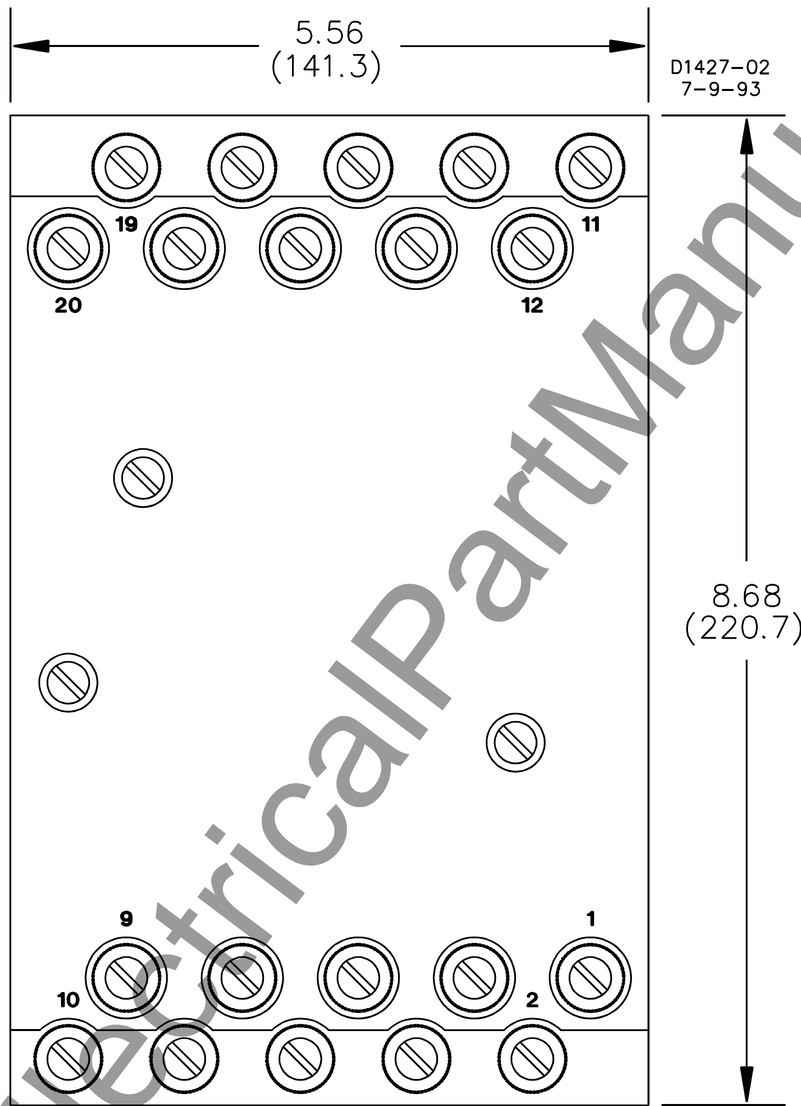

Figure 4-9 . S1 Case, Double-Ended, Projection Mount, Outline Dimensions, Rear View

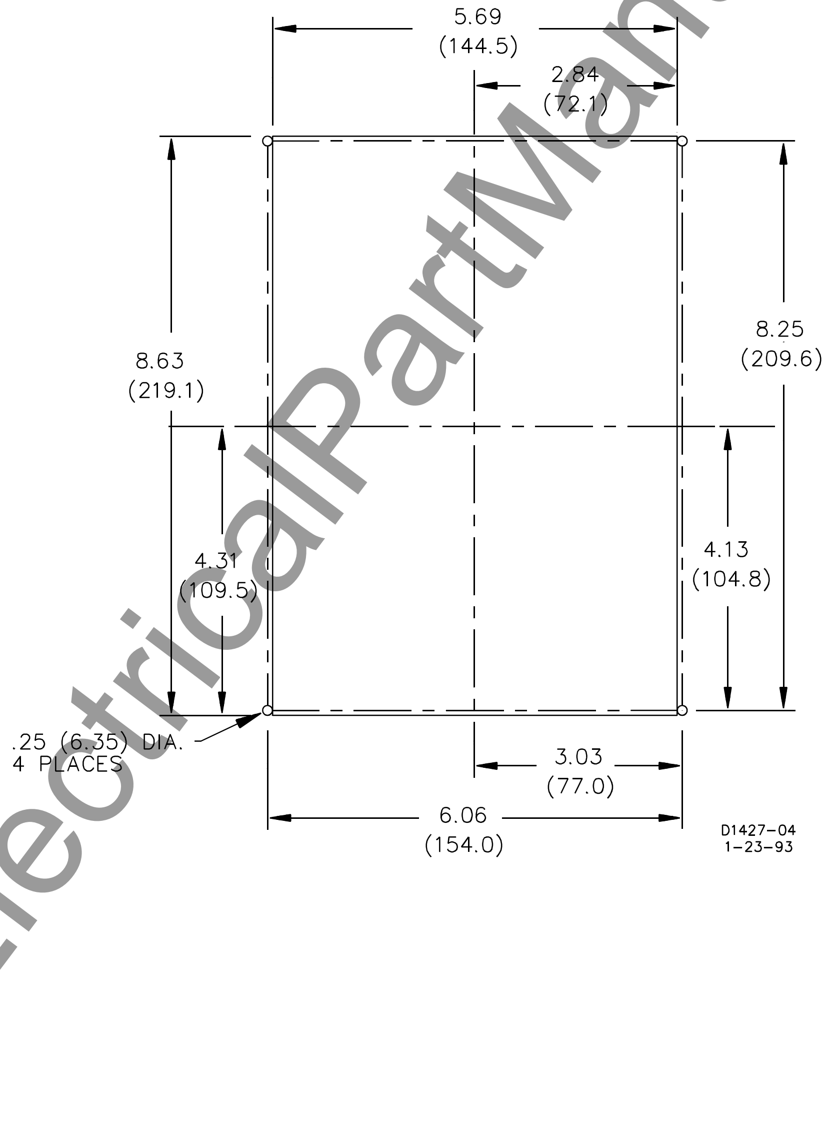

Figure 4-10 . S1 Case, Panel Drilling Diagram, Semi-Flush Mounting

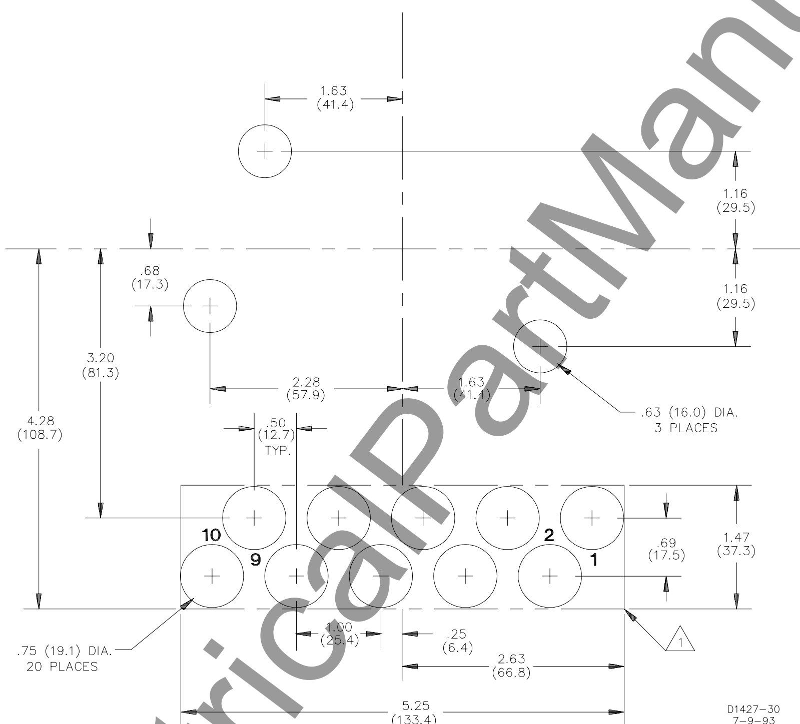

Figure 4-11 . S1 Case, Single-Ended, Projection Mount, Panel Drilling Diagram, Rear View

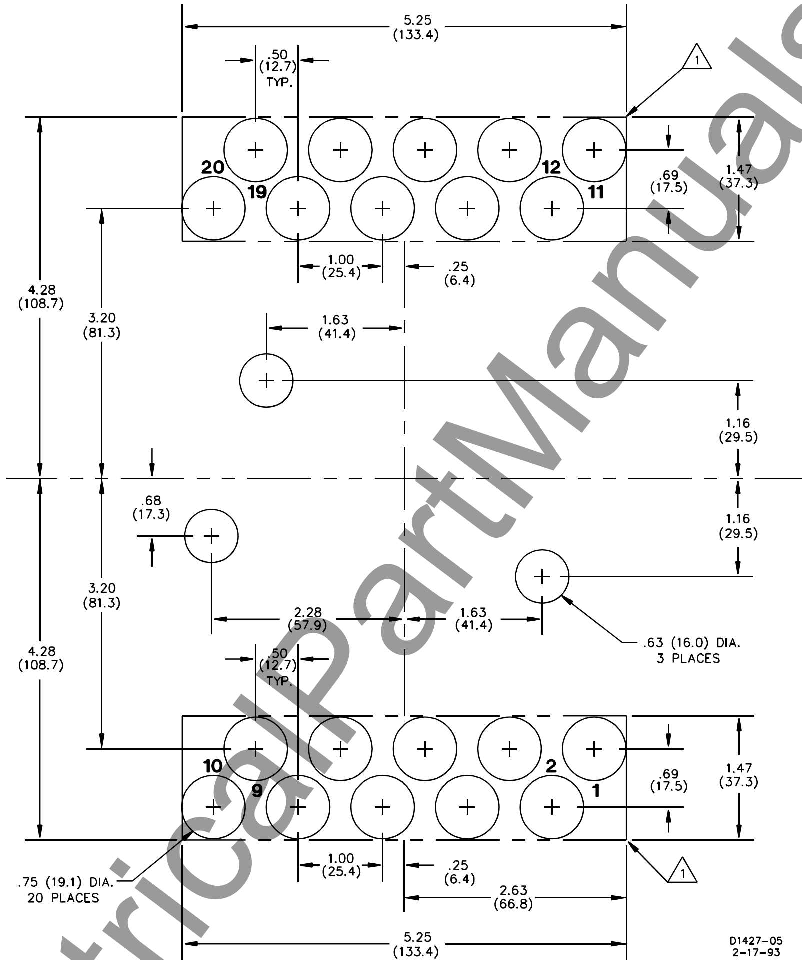

Figure 4-12 . S1 Case, Double-Ended, Projection Mounting, Panel Drilling Diagram, Rear View

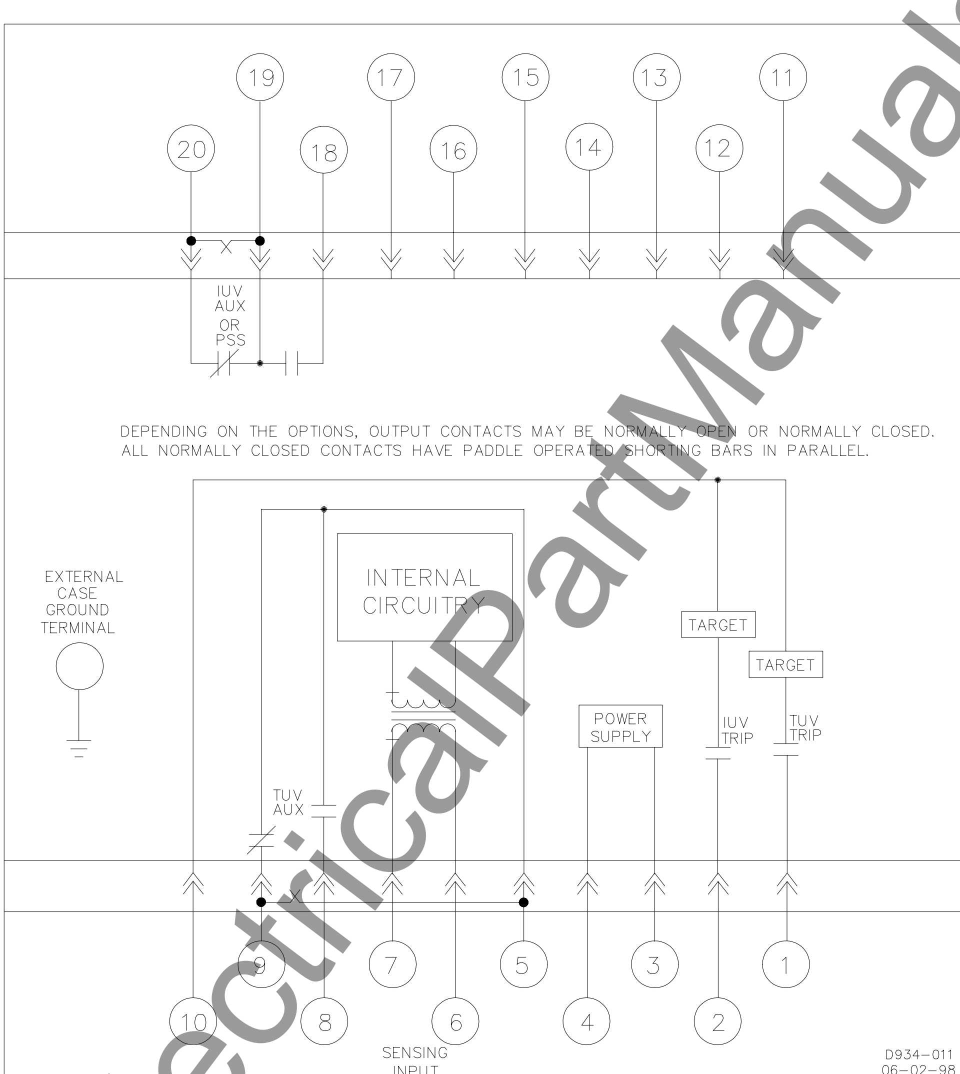

Figure 4-13. BE1-27 Internal Connections

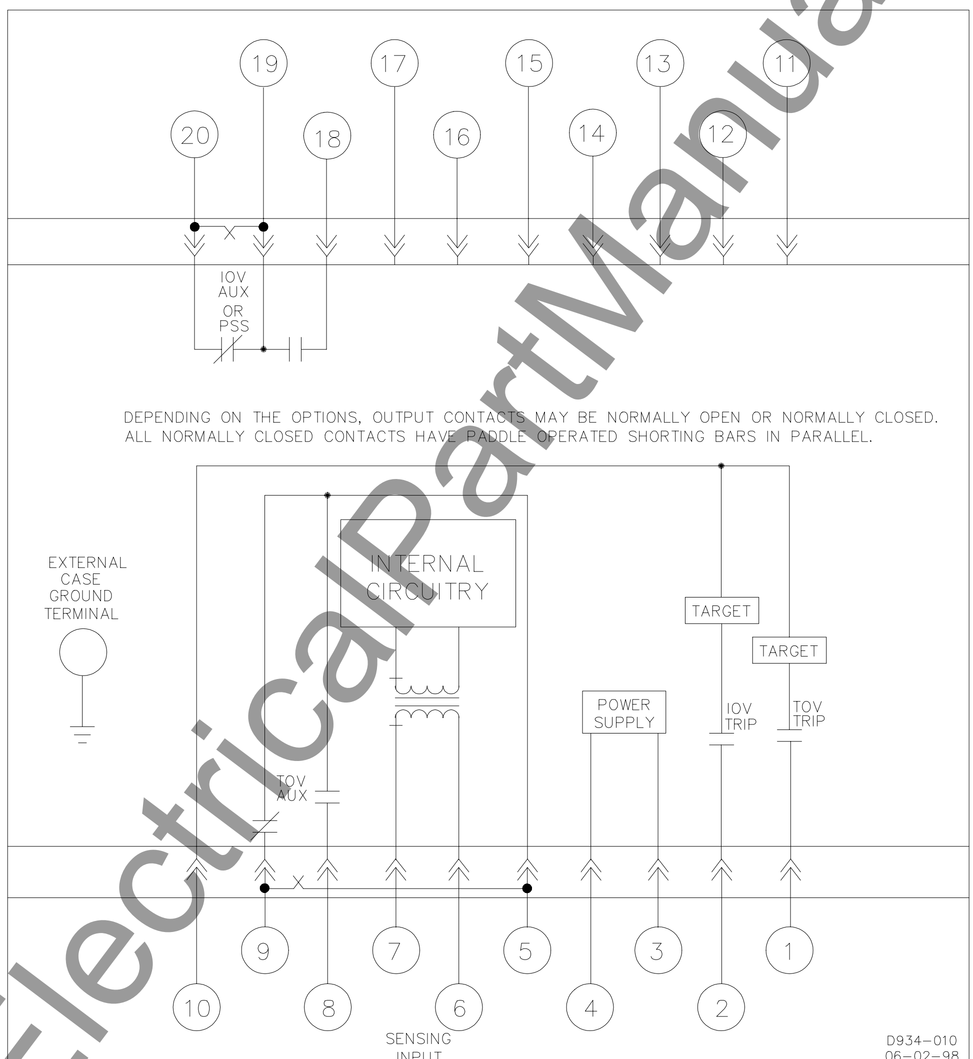

Figure 4-14 . BE1-59 Internal Connections

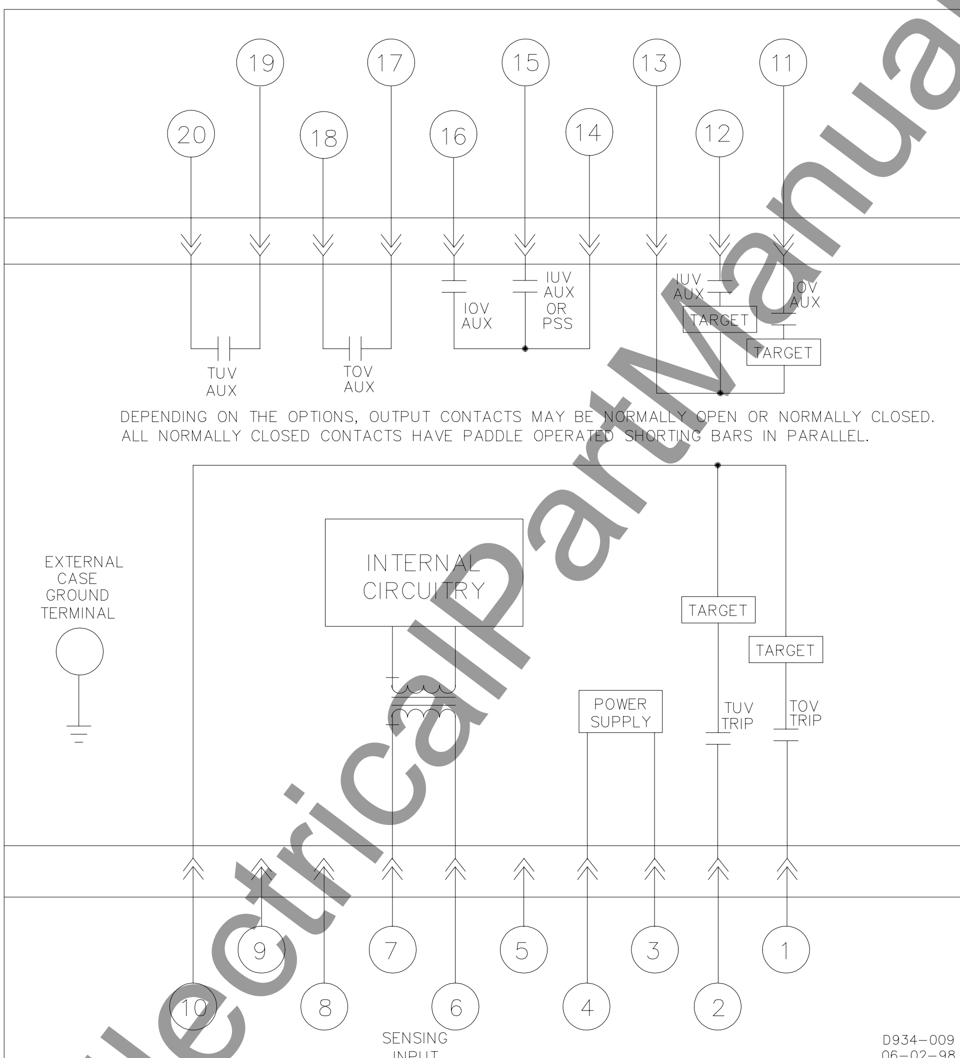

Figure 4-15 . BE1-27/59 Internal Connections

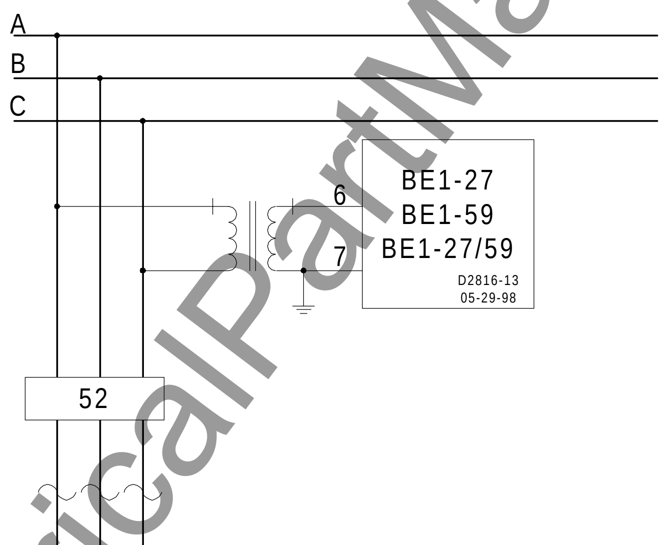

Figure 4-16 . Typical AC Connections

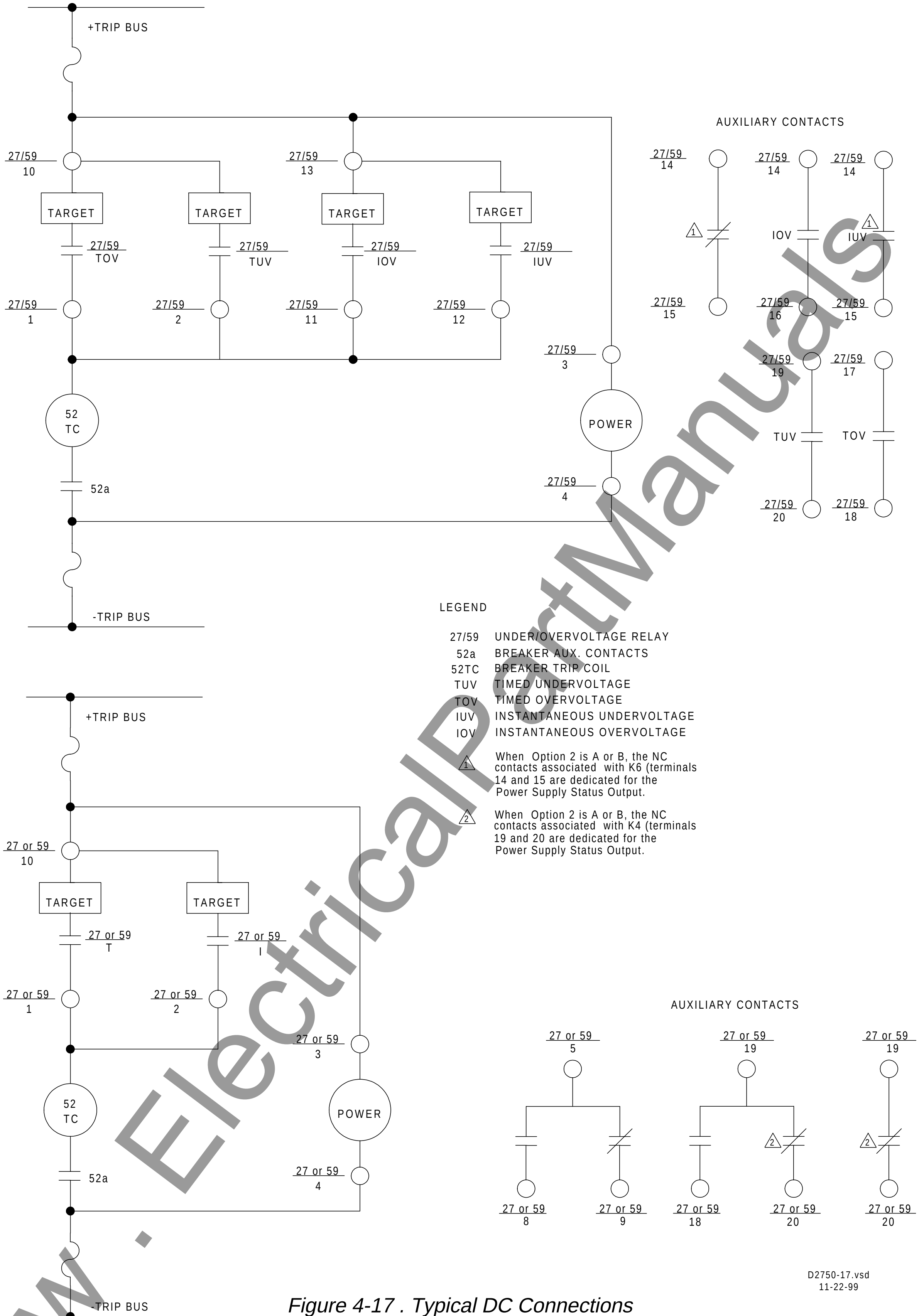

Figure 4-17 . Typical DC Connections

SECTION 5 • TESTS AND ADJUSTMENTS

GENERAL

Procedures in this section are for use in testing and adjusting a relay for the desired operation in a protective scheme. If a relay fails an operational test, or is an adjustment discloses a faulty relay, refer to Section 6.

REQUIRED TEST EQUIPMENT

Minimum test equipment required for relay testing and adjustment is listed below. Refer to Figure 5-1 for the test setup.

> **NOTE**
>
> Commercially available frequency relay test sets with frequency and time generating accuracies exceeding those of the relay, and including electronic switching, may be used.

a. Appropriate ac or dc power source for relay operation.

b. Appropriate ac source for frequency sensing. (A source with frequency stability of 0.00002 Hz must exhibit phase noise of less than 90 db for accurate measurement. The accuracy and stability of this source is necessary as the relay precisely measures the period between positive going zero-crossings of the applied waveform and responds instantaneously to the sensed condition.)

c. Hardware (battery and lamp, multimeter, etc.) or method of determining that the output contacts close.

OPERATIONAL TEST PROCEDURE

The following procedure verifies operation and calibration of the relay. It should be noted that the results obtained from this procedure may not fall strictly within specified tolerances. When evaluating results, consideration must be given to three prominent factors:

1. The inherent error of test equipment. Test equipment should be accurate within 1% or better.
2. The inconsistent method of testing. (Example: The timer will start before the K1a contacts close.)
3. The tolerance level of components used in the test setup.

Power Supply Status Output (Option 2-A or B)

Step 1. With the unit in a powered-up condition, verify that the power supply status output contacts are energized open.

Step 2. Remove input power and verify that the status output contacts close.

Pickup

Step 1. Connect the test circuit shown in Figure 5-1 as necessary for the functions included in your relay model. (See Table 5-1.) Turn all undervoltage pickup controls fully CCW and all overvoltage pickup functions fully CW. Set all time delay controls to 00. Adjust T1 to nominal voltage for your Sensing Input Range as indicated below.

Sensing Input Range		
2	3	4
120 Vac	120 Vac	240 Vac

NOTE

Results assume normally open output contacts. Test indicator states will be opposite for normally closed output contacts.

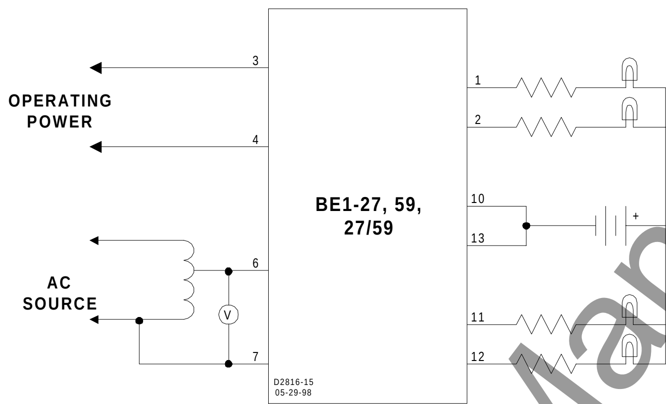

Figure 5-1. Pickup and Dropout Test Circuit Diagram

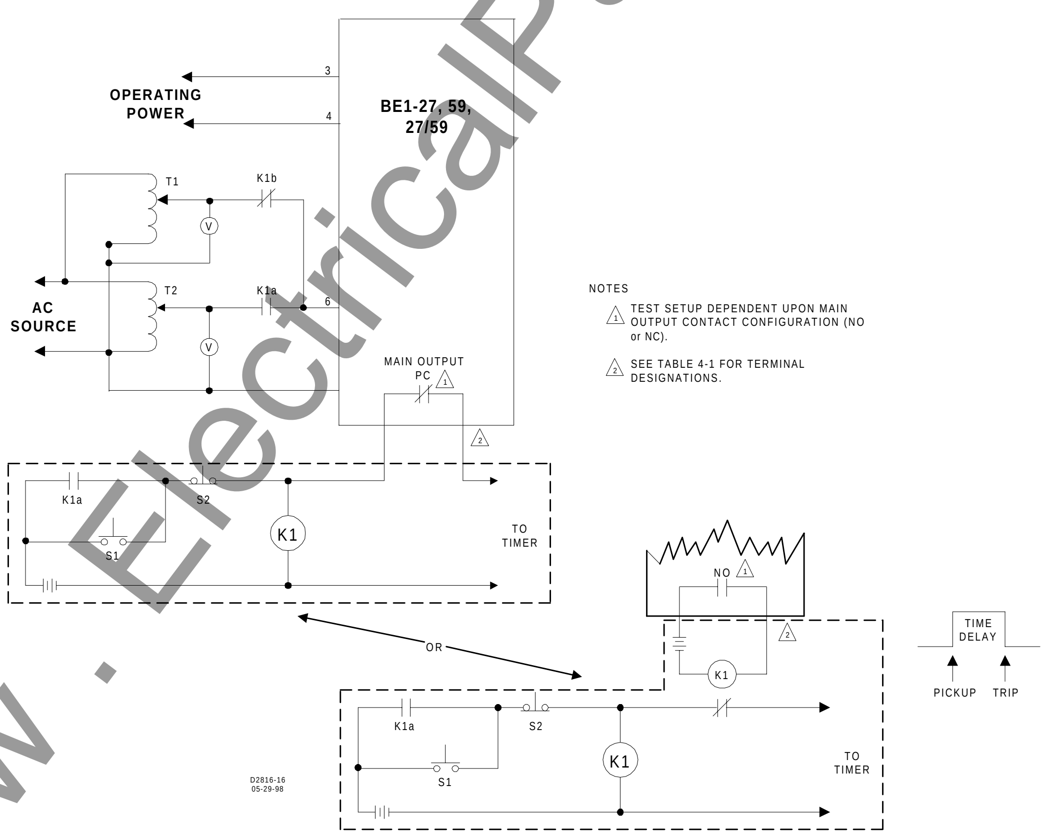

Figure 5-2. Timing Test Circuit Diagram

RESULTS: In units with Sensing Input Range 2 the OVER PICKUP indicator is illuminated as well as the timed and instantaneous overvoltage test indicators. In units with Sensing Input Range 3 or 4, all pickup and test indicators will be extinguished.

Table 5-1. Output Terminals

Pickup Function	Relay Model		
	27	**59**	**27/59**
Timed Undervoltage	1-10	-	2-10
Instantaneous Undervoltage	2-10	-	12-13
Timed Overvoltage	-	1-10	1-10
Instantaneous Overvoltage	-	2-10	11-13

NOTE

Steps 2 through 4 apply only to units with Sensing Input Range 2.

Step 2. Slowly decrease the T1 voltage until the OVER PICKUP indicator and the timed and instantaneous overvoltage test indicators extinguish. Slowly increase the T1 voltage until the OVERVOLTAGE PICKUP indicator and the timed and instantaneous overvoltage test indicators illuminate. Record the voltage.

RESULT: This voltage is between 39.2 and 40.8 Vac.

Step 3. Turn the timed and instantaneous OVERVOLTAGE PICKUP controls fully CCW. Slowly decrease the T1 voltage until the OVERVOLTAGE PICKUP indicator and the timed and instantaneous test indicators extinguish.

Step 4. Slowly increase the voltage at T1 until the OVERVOLTAGE PICKUP indicator and the timed and instantaneous overvoltage test indicators illuminate. Measure and record the voltage.

RESULT: This voltage is between 0.5 and 1.5 Vac.

This concludes the pickup test for units with Sensing Input Range 2.

NOTE

Steps 5 and 6 apply only to undervoltage functions.

Step 5. Slowly decrease the voltage at T1 until the UNDER PICKUP indicator and the timed and instantaneous test indicators illuminate. Measure and record the voltage.

RESULT: The voltage is between 53.9 and 56.1 Vac for Sensing Input Range 3 or between 107.8 and 112.2 Vac for Sensing Input Range 4.

Step 6. Increase T1 voltage to 170 Vac for Sensing Input Range 3 or 330 Vac for Sensing Input Range 4. Turn all undervoltage pickup controls fully CW. Slowly decrease T1 voltage until the UNDER PICKUP indicator and timed and instantaneous undervoltage test indicators illuminate. Measure and record the voltage.

RESULT: This voltage is between 156.8 and 163.2 Vac for Sensing Input Range 3 or between 313.6 and

326.4 for Sensing Input Range 4.

This concludes the pickup test for Relay Model BE1-27.

> **NOTE**
> Steps 7 and 8 apply only to overvoltage functions.

Step 7. Slowly increase the T1 voltage until the OVER PICKUP indicator and the timed and instantaneous overvoltage test indicators illuminate. Measure and record the voltage.

RESULT: This voltage is between 156.8 and 163.2 Vac for Sensing Input Range 3 or between 313.6 and 326.4 Vac for Sensing Input Range 4.

> **NOTE**
> Step 8 applies only to Relay Model BE1-59 with Sensing Input Range 3 or 4.

Step 8. Decrease the T1 voltage to 50 Vac . Turn all overvoltage pickup controls fully CCW. Slowly increase the T1 voltage until the OVER PICKUP indicator and the timed and instantaneous overvoltage test indicators illuminate. Measure and record the voltage.

RESULT: The voltage is between 53.9 and 56.1 Vac for Sensing Input Range 3 or between 107.8 and 112.2 Vac for Sensing Input Range 4.

This concludes the pickup test.

Timing

The following procedure verifies timing characteristics.

Step 1. Connect the test circuit shown in Figure 5-2. Output terminal connections are dependent on the function to be tested. (See Table 5-1.)

Step 2. Adjust the under or overvoltage pickup settings and the T1 and T2 tap voltage levels as indicated below for the function being tested.

Sensing Range	Over Pickup	Under Pickup	T1 Voltage	T2	
				Over	Under
2	30	—	20	40	—
3	120	100	110	152	68
4	240	200	220	304	136

Step 3. Set the time delay control for the function being tested to 0.1. Press and release S2 to assure that K1 is de-energized. Reset the timer. Press and release S1.

RESULT: The timer displays a response time, dependent on timing type, as indicated in Column 1 of Table 5-2.

Step 4. Press and release S2. Set the time delay control for the function being tested to 99. Reset the timer. Press and release S1.

RESULT: The timer displays a response time, dependent on timing type, as indicated in Column 2 of Table 5-2.

Step 5. Repeat Steps 9 through 13 as necessary for each function's time delay control.

This concludes the operational test procedure.

Table 5-2. Timing Test Results

Timing Type	Column 1		Column 2	
Instantaneous	50 ms or less		50 ms or less	
Definite	Less than 0.2 sec		9.8 - 10.0 sec	
	Under	**Over**	**Under**	**Over**
Short Inverse	0.087 to 0.187 sec	0.092 to 0.192 sec	6.231 to 6.687 sec	6.557 to 7.247 sec
Medium Inverse	0.292 to 0.392 sec	0.307 to 0.407 sec	24.626 to 27.218 sec	25.991 to 28.727 sec
Long Inverse	0.553 to 0.653 sec	0.583 to 0.683 sec	49.185 to 54.363 sec	51.895 to 57.358 sec

SECTION 6 • MAINTENANCE

GENERAL

Basler relays are static devices which require no preventive maintenance other than a periodic operational check. The operational test procedure of Section 5 provides an adequate check to verify proper operation of the relay.

Most components are on conformally coated PC boards. In-house replacement of individual components may be difficult and should not be attempted unless appropriate equipment and qualified personnel are available. The relay may be returned to the factory for repair. When returning the relay to the factory ship the entire relay cradle assembly, preferably in its case.

IN-HOUSE REPAIR

If in-house repair is to be attempted, 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. These parts may be ordered directly from Basler Electric. Complete boards or assemblies may be ordered by supplying the following information.

1. 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

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.

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 1 year intervals, power is applied to the relay for a period of thirty minutes.

SECTION 7 • MANUAL CHANGE INFORMATION

CHANGES

This section contains information concerning the previous editions of the manual. The substantive changes to date are summarized below.

Table 7-1. Summary of Changes

Revision	Summary of Changes	ECA/ECO/Date
A and B	Information on these revisions is not available at this time.	8401 & 8449
C	Revised the manual to the current standard format. Changed the characteristic curves Figures in Section 3 to improve the accuracy. Added ground terminals to new Figures 1-1 and 4-16. Added interconnection diagrams 4-13, 4-14, and 4-15. Added Section 7, *Manual Change Information*.	5484/11-22-99