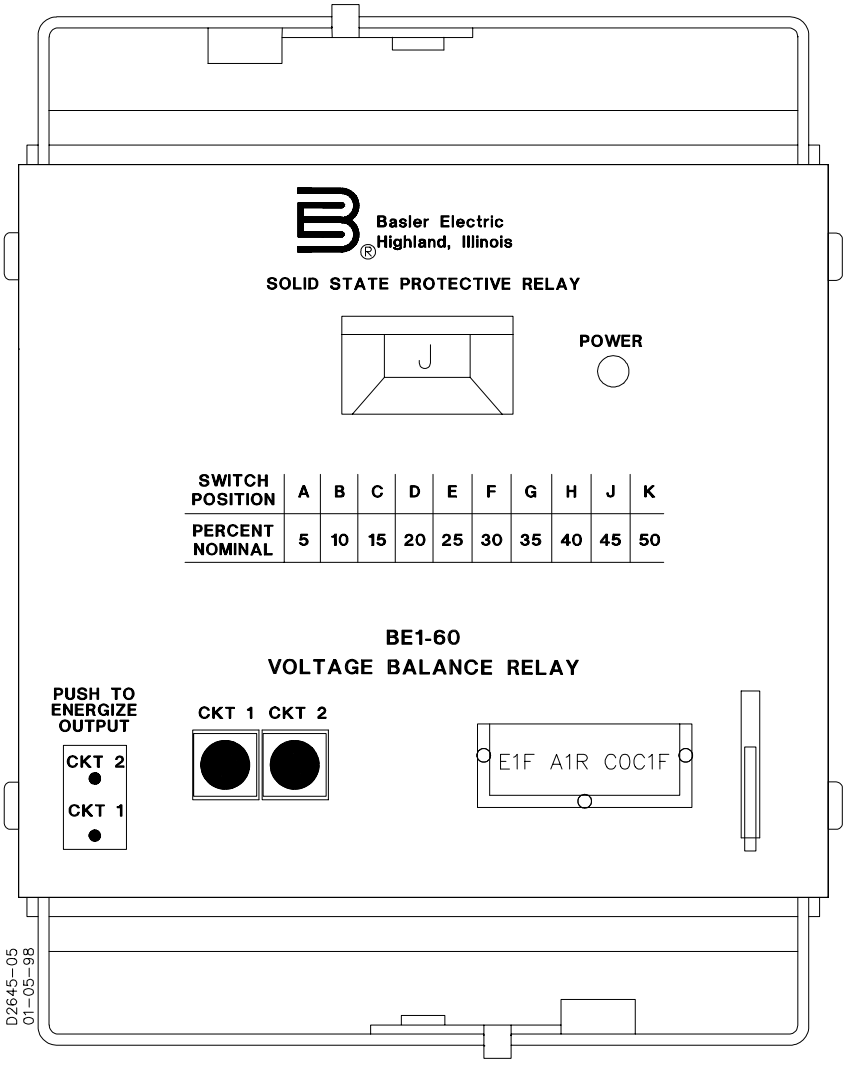
CONTENTS

INSTRUCTION MANUAL

FOR

VOLTAGE BALANCE RELAY
BE1-60



Basler Electric

Publication Number: 9 1707 00 990
Revision: B 07/98

INTRODUCTION

This Instruction Manual provides information concerning the operation and installation of BE1-60 Voltage Balance Relay. 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: May 1985

Printed in USA

July 1998

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.

BASLER ELECTRIC
ROUTE 143, BOX 269
HIGHLAND, IL 62249 USA
http://www.basler.com, info@basler.com
PHONE 618-654-2341 **FAX 618-654-2351**

INTRODUCTION

This Instruction Manual provides information concerning the operation and installation of BE1-60 Voltage Balance Relay. 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: May 1985

Printed in USA

July 1998

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.

BASLER ELECTRIC
ROUTE 143, BOX 269
HIGHLAND, IL 62249 USA
http://www.basler.com, info@basler.com
PHONE 618-654-2341 **FAX 618-654-2351**

CONTENTS

SECTION 1 • GENERAL INFORMATION

GENERAL

BE1-60 Voltage Balance Relays are intended to provide high speed protection for power systems equipment and protective systems from misoperation or false tripping in the event of a sudden loss of sensing potential resulting from a blown fuse. The relays are applied to detect this condition and initiate the required corrective/preventative action as well as indicate the problem and location.

Devices that may require this form of protection include voltage control or restraint types of overcurrent relays, impedance measuring relays, synchronizing relays, voltage regulators and static excitation systems.

APPLICATION

In the system shown in Figure 1-1, the generator is equipped with a static exciter and includes voltage controlled or restrained time overcurrent relays in the protection package (as well as other devices).

If one of the fuses in the power potential transformer blows, the resulting unbalanced voltage condition may cause excessive heating in the power stage of the static exciter. For this condition it is desirable to alarm the condition and initiate an orderly shutdown of the unit. Output #1 would accomplish this task.

If one of the fuses in the sensing potential transformer were to open up, the static exciter (with 3-phase sensing) would increase the output to maximum in an attempt to restore the sensed voltage to the proper level. For this condition, the BE1-60 Voltage Balance Relay would initiate an emergency shutdown of the unit and alarm the condition. Output #2 would accomplish this task.

Also in this case, since the same potential source provides the restraint or control input to the time overcurrent relays, false tripping of the unit may result by operation of the overcurrent function. This is not desirable as the overcurrent relay's target would give a false indication of the reason for tripping. Output #2 would be required to block operation of the overcurrent devices. This would be accomplished by opening a normally closed contact from the BE1-60 which is in series with the tripping outputs from the overcurrent functions.

Note: 1) If the overcurrent functions were voltage controlled and the output current was in excess of the pickup setting of the relay, a loss of control potential would allow this overcurrent function to pickup and start timing. Without the inhibit from the BE1-60, tripping would result.

2) If the overcurrent functions were voltage restrained, the loss of a restraint potential would result in the sensitivity of the relay being increased (0.25 times setting), the relay would pickup and start timing. Again, without the inhibit from the BE1-60, tripping would result.

Targets on the BE1-60 would indicate that CKT #1 (Power Potential Transformer Fuse) or CKT #2 (Sensing Potential Transformer Fuse) had caused the correct shutdown sequence.

SETTING THE RELAY

When setting the relay's % difference pickup, consideration should be given to the maximum voltage excursions permitted for normal operating conditions. For instance, if the output voltage of the power potential transformer varies 5 percent from machine no load to machine full load then the setting must permit this fluctuation.

It should also be noted that since both of the inputs to the BE1-60 are monitoring essentially the same voltage, tripping of the BE1-60 will not occur for system faults.

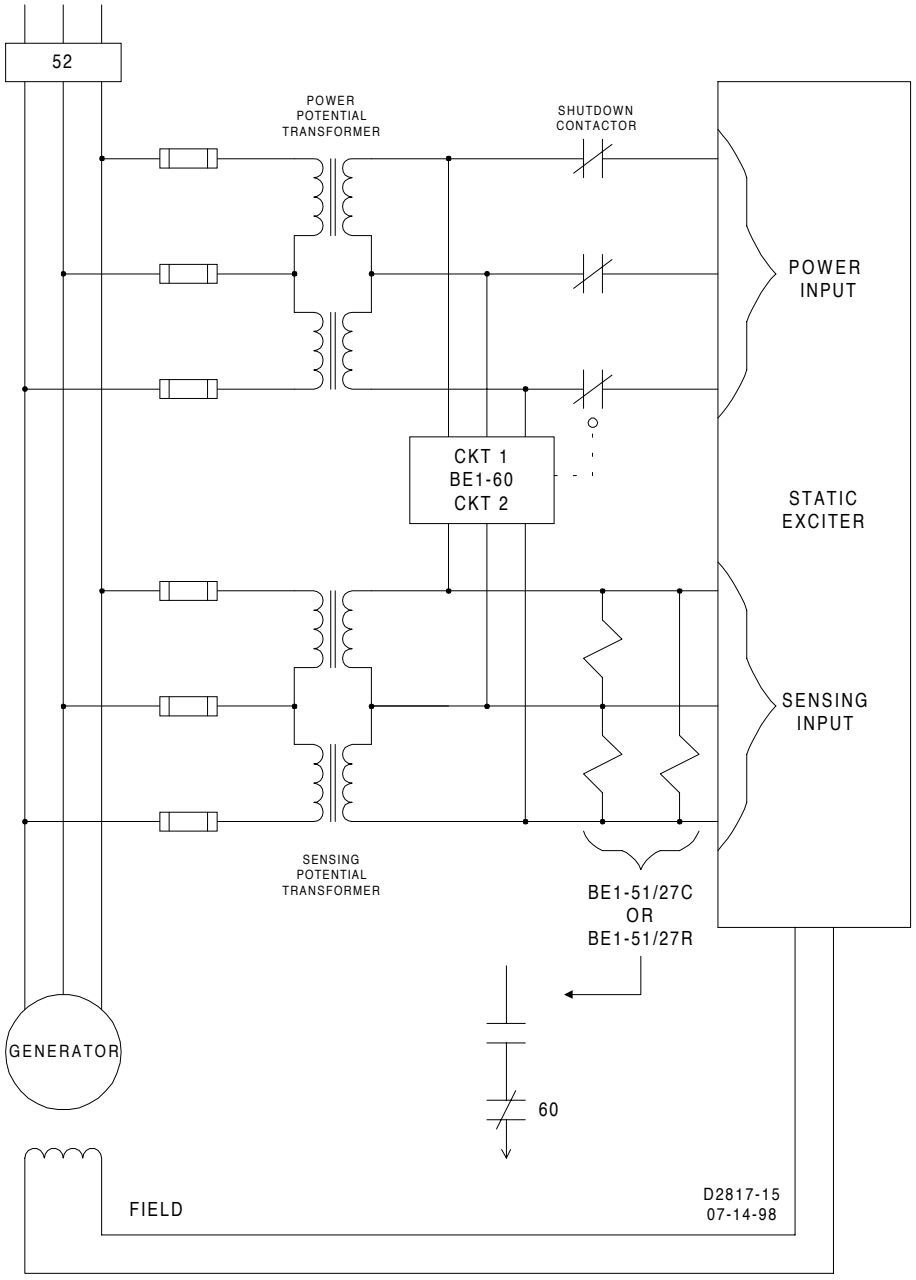
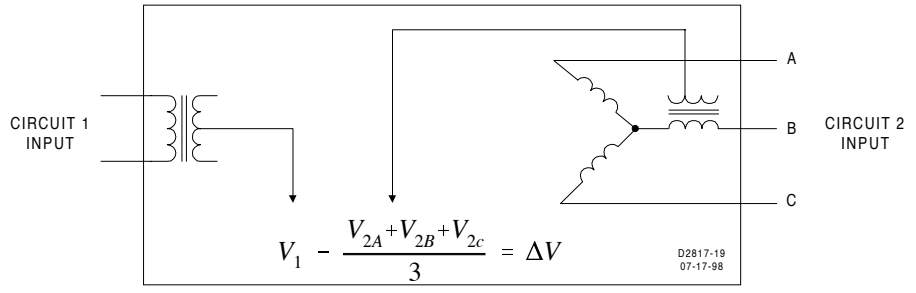


Figure 1-1. Typical Application

Relay styles with Sensing Input Type E (single-phase to three-phase wye) or Sensing Input Type F (single-phase to three-phase delta) apply the three-phase input to a Scott-T transformer. The transformer outputs a single-phase voltage proportional to the average of the three-phase voltages as shown at left. This decreases the relay's sensitivity as illustrated by the following example.



With all voltages at nominal Circuit 2 senses a blown fuse in Phase C. This produces an apparent voltage difference of 40 volts within the relay.

$$(120) - \left(\frac{120 + 120 + 0}{3}\right) = |40|$$

Since Circuit 1 is nominally rated at 120 Vac, the three-phase voltages of Circuit 2 are defined as line-to-neutral for Type E wye input or line-to-line for Type F delta input. This apparent voltage difference is not sufficient to produce a response if the pickup setting is G, H, J or K since these settings represent required voltage differences of 42, 48, 54, and 60 volts respectively. Therefore, it is recommended that the lower pickup settings be used for relay styles with Sensing Input Types E or F.

OPERATIVE EXAMPLE

The following example details the effect the BE1-60 Voltage Balance Relay would have on the system shown in Figure 1-1.

Given:

Potential transformer secondary voltages at 120 Vac
BE1-51/27R pickup setting of 4.5 A
BE1-60 pickup setting of 10%

Assume a fault develops causing the sensing potential transformer secondary voltage to dip 9% to 109.2 Vac. Characteristically, the BE1-51/27R will now pickup and start timing when line current reaches 4.095 A (instead of 4.5 A) as determined below.

4.5 A (100% - 9%) = 4.5 A (91%) = 4.095 A

This will result in the BE1-51/27R producing an undesired trip. The trip is undesired because the current pickup level has been inadvertently lowered by the voltage dip seen on the secondary of the sensing transformer, even though line voltage has not changed.

Now assume that the fault causes the sensing potential transformer secondary voltage to dip 10% to 108 Vac. This will cause the BE1-51/27R to pickup and start timing at 4.05 A as shown below.

4.5 A (100% - 10%) = 4.5 A (90%) = 4.05 A

However, since the voltage dip seen on the secondary of the sensing potential transformer meets the 10% pickup setting of the BE1-60 and the secondary voltage of the power potential transformer has not changed, any undesired trip signal from the BE1-51/27R will be blocked by the Circuit 2 output contacts of the BE1-60 Voltage Balance Relay.

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 BE1-60 designates the relay as a Basler Electric Class 100 Voltage Balance Relay.

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 style number were D1H A1R C0C2F the device would have the following features:

D) three-phase wye to three-phase delta sensing input
1) sensing range of 60 to 125% of nominal
H) two normally closed output relays (one per monitored circuit)
A1) instantaneous timing
R) operating power derived from 24 Vdc source
C) two internally operated targets (one per circuit)
0) no option 1 available
C) push-to-energize outputs (pushbuttons)
2) normally closed auxiliary output contacts (one per circuit)
F) semi-flush mounting

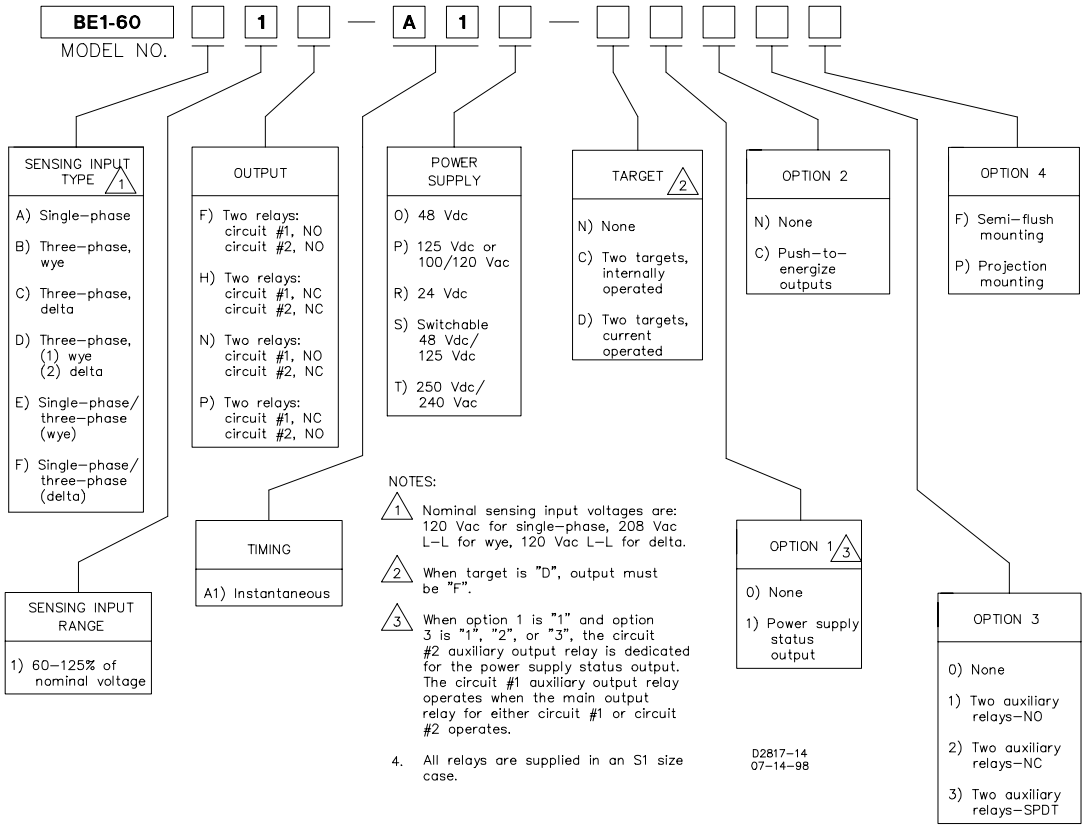


Figure 1-2. Style Identification Chart

SPECIFICATIONS

Sensing

Nominally rated at 60 Hz with a range of 45 to 65 Hz at a maximum burden of 1 VA per phase. Wye nominal voltage rating of 208 Vac L-L. Delta nominal voltage rating of 120 Vac L-L. Single-phase nominal voltage rating of 120 Vac (L-L or L-N). Sensing range of 60% to 125% of nominal voltage. Maximum continuous voltage rating is 160% of nominal.

Pickup

Adjustable from 5% to 50% of nominal. Accuracy of 1 volt or 5% of differential limit setting, whichever is greater.

Dropout

90% of pickup or greater.

Timing

150 milliseconds or less for voltage differences greater than three times the setting.

Power Supply

One of the five types of power supplies listed in the following table may be selected to provide internal relay operating power.

Table 1-1. Power Supply Types And Specifications

Type	Nominal Input Voltage	Input Voltage Range	Burden at Nominal
O (Mid Range)	48 Vdc	24 to 150 Vdc	3.5 W
P (Mid Range)	125 Vdc 120 Vac	24 to 150 Vdc 90 to 132 Vac	4.4 W 10.0 VA
R (Low Range)	24 Vdc	12 † to 32 Vdc	4.0 W
S (Mid Range)	48 Vdc 125 Vdc	24 to 150 Vdc 24 to 150 Vdc	4.4 W 10.0 VA
T (High Range)	250 Vdc 240 Vac	62 to 280 Vdc 90 to 270 Vac	6.5 W 14.5 W

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

Targets

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 A in 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 relay has normally closed output contacts.

Outputs	Output contacts are rated as follows:
Resistive	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.
Inductive	120 Vac, 125 Vdc, 250 Vdc - break 0.1 A (L/R = 0.04).
Shock	15g in each of three mutually perpendicular axes.
Vibration	29 in each of three mutually perpendicular axes swept over the range of 10 to 500 Hz for a total of six sweeps, 15 minutes each sweep.
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.
Surge Withstand Capability	Qualified to ANSI/IEEE C37.90.1989 (Transient Immunity and Radiated Susceptibility). Qualified to IEC-255-5 (Impulse Requirements) and IEC-255-5/6 (Surge requirements).
Radio Frequency Interference (RFI)	Type tested using a five watt, hand-held transceiver in the ranges of 144 and 440 MHZ with the antenna placed within six inches of the relay.
U.L Recognition	U.L. recognized per Standard 508, U.L. File Number E97033. Note: Output contacts are not U.L. recognized for voltages greater than 250 V.
Fast Transient	Qualified to ANSI/IEEE C37.90.1-198X
Impulse Test	Qualified to IEC 255-5
Temperature	
Operating	-40°C (-40°F) to 70°C (158°F)
Storage	-65°C (-85°F) to 100°C (212°F)
Weight	14.25 pounds maximum
Case Size	All relays supplied in S1 size case

SECTION 2 • HUMAN-MACHINE INTERFACE (CONTROLS AND INDICATORS)

The following table is referenced to Figure 2-1.

LOCATOR	CONTROL OR INDICATOR	FUNCTION
A	Differential Limit Switch	Ten-position thumbwheel switch that establishes the maximum allowable voltage difference between the two monitored circuits. The letters on the switch (A through K, excluding I) correspond to percent of nominal voltage as indicated on the front panel. Adjustable in 5% increments from 5% to 50% of nominal.
B	Power Indicator	LED which illuminates to indicate that power supply is operating.
C	Target Reset Lever (Optional)	Linkage extending through bottom of front cover used to reset magnetically latching target indicators.
D	Target Indicators (Optional)	Magnetically latching indicators that indicate the associated output relay has been energized.
E	Push-to-Energize (Optional)	Momentary pushbutton accessible through front panel used to test output relays and system wiring.

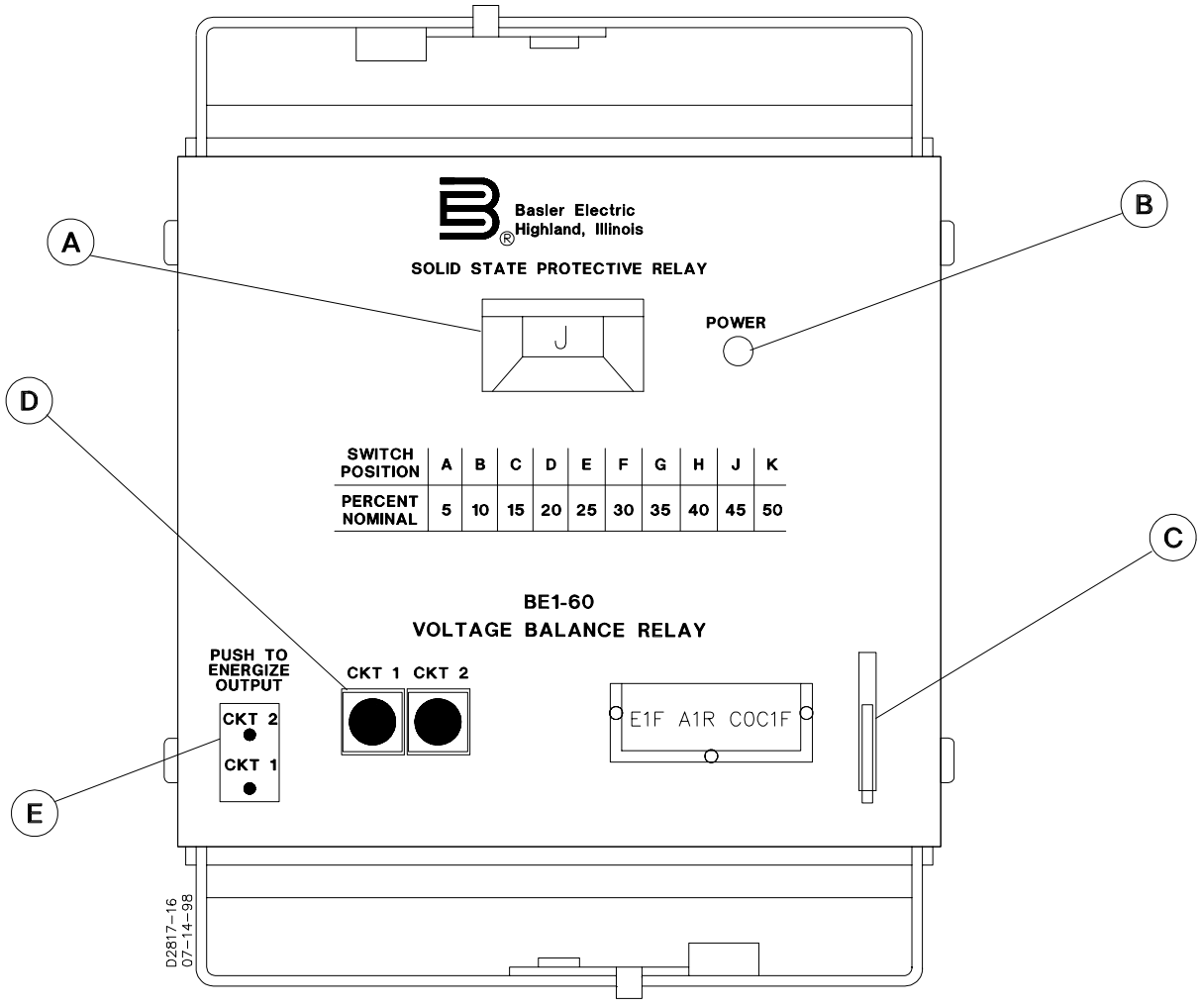


Figure 2-1. Location of Controls and Indicators

SECTION 3 · FUNCTIONAL DESCRIPTION

GENERAL

BE1-60 Voltage Balance Relays are static devices that respond to the magnitude of the difference between two circuits. Figure 3-1 is a functional block diagram of the Voltage Balance Relay.

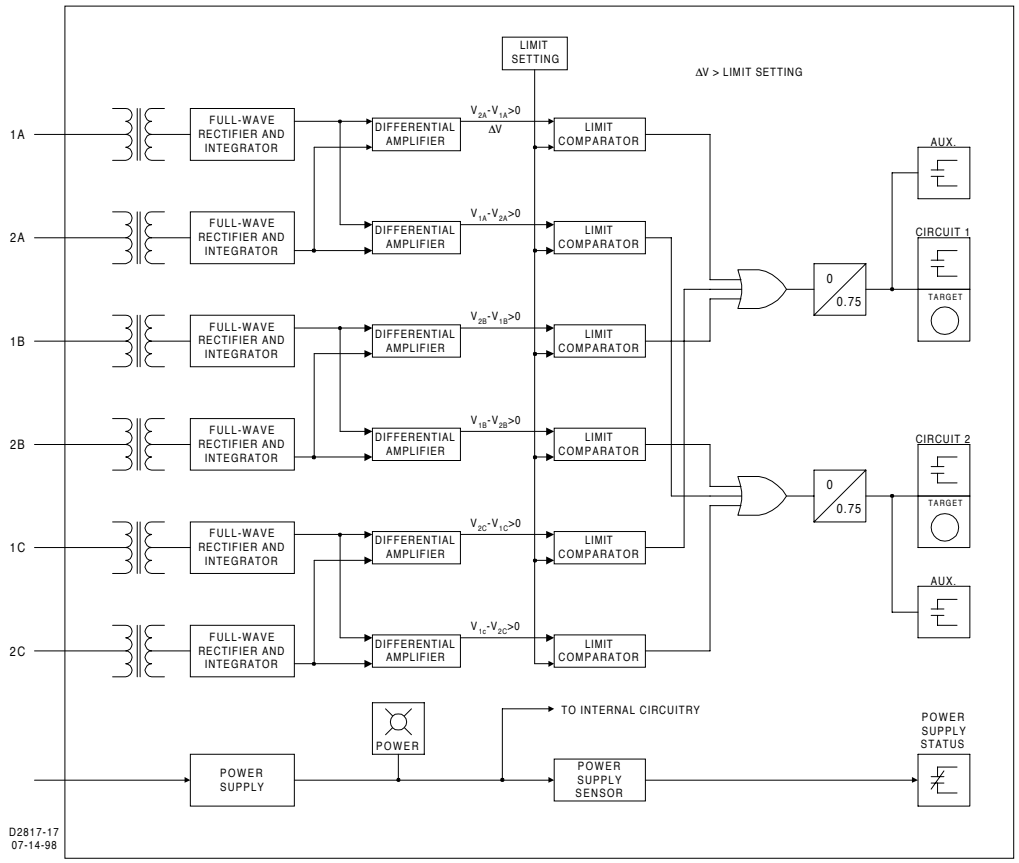


Figure 3-1. Functional Block Diagram

STEP-DOWN TRANSFORMERS

Through the systems standard potential transformers, system voltage is applied to the primaries of internal potential transformers and stepped down to internal circuit levels. The transformers provide a high degree of isolation.

FULL-WAVE RECTIFIERS AND INTEGRATORS

Outputs from the step-down transformers are full-wave rectified and then integrated. The integrator circuits establish a dc voltage which is representative of the magnitude of the associated sensing input.

DIFFERENTIAL AMPLIFIERS

The representative dc voltage from each integrator is applied to a pair of differential amplifiers. Each differential amplifier pair is dedicated to a particular phase of the monitored system. The pair determines which monitored circuit has the lower voltage (for that phase) and the magnitudinal difference. For example, if phase A of circuit 1 is lower than phase A of circuit 2, then V_{2A} -V_{1A}= V .

LIMIT SETTING

Controlled by a front panel ten-position thumbwheel switch, the limit setting circuit establishes a reference voltage that represents the maximum allowable voltage difference.

LIMIT COMPARATORS

Reference voltage established by the limit setting circuit is compared to the output of each differential amplifier. When the limit is exceeded by the voltage difference, a limit comparator generates a trip command signal. (V > Limit setting)

OUTPUTS

Outputs of the limit comparators are ORed so that the coil of the output relay associated with the monitored circuit having the lower voltage level is energized. When the voltage difference falls below the limit setting, the coil is de-energized after a delay of 0.75 seconds.

TARGETS (Optional)

Depending on the style number, a unit may contain either internally operated or current operated targets. Internally operated targets are actuated in conjunction with the output relays. Current operated targets require a minimum of 0.2 A in the output circuit for actuation. Both types are magnetically latching devices and must be manually reset by use of the reset lever.

PUSH-TO-ENERGIZE (Optional)

Depending on the style number, the unit may include two momentary pushbuttons accessible through the front panel. When pushed, these operate the output relays.

AUXILIARY OUTPUTS

When specified, the relay is equipped with auxiliary output relays that operate when the main output relays operate, one for each circuit (#1 and #2). However, when the power supply status output has been selected, the circuit #2 auxiliary is dedicated for that function. The circuit #1 auxiliary output relay will then operate when either circuit #1 or circuit #2 main output relay operates.

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 Table 3-1.

Table 3-1. 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, S	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.

POWER SUPPLY STATUS OUTPUT (Option 1-1)

The power supply status output relay has normally closed (NC) output contacts. The 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.

It should be noted that if two auxiliary outputs have been selected (Option 3-1, 2 or 3) and the power supply status output has also been selected (Option 1-1) then circuit #2 auxiliary output relay will be dedicated for the power supply status output. Circuit #1 auxiliary output relay will then operate when either circuit #1 or circuit #2 main output relay operates.

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 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 following 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 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 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.

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

OPERATIONAL TEST PROCEDURE

The following procedure verifies operation of the relay. Stated voltages refer to line-to-neutral for single-phase and wye inputs, and line-to-line for delta inputs. Terminal numbers may be found in the connection diagrams in Figures 4-7 and 4-8. Target indicators, if present, should operate in conjunction with their corresponding output.

STEP 1. Set the differential limit control to the "A" position.

STEP 2. Apply 120 Vac +0.1% to Circuit 1 and Circuit 2 inputs. After allowing conditions to stabilize, both outputs should be in their normal states. If present, reset the target indicators.

STEP 3. Slowly increase the Circuit 1A input until the Circuit 2 output changes states. Circuit 1A input should be between 125 and 127 Vac.

STEP 4. Decrease the Circuit 1A input to 120 Vac. Circuit 2 output should return to its normal state in approximately 0.75 seconds. Reset the target indicator.

STEP 5. Set the differential limit control to the "K" position.

STEP 6. Slowly decrease the Circuit 1A input until the Circuit 1 output changes states. Circuit 1A input

should be between 57 and 63 Vac.

STEP 7. Increase the Circuit 1A input to 120 Vac. Circuit 1 output should return to its normal state in approximately 0.75 seconds. Reset the target indicator.

STEP 8. For units with Sensing Input Types B, C, or D, repeat STEPS 3 through 7 accordingly for phase B and C inputs.

STEP 9. For units with Push-to-Energize outputs, actuate pushbuttons. Observe output contacts.

MOUNTING

Because the relay is of solid-state design, it may be mounted at any convenient angle. Relay outline dimensions and panel drilling diagrams are supplied in Figures 4-1 through 4-6 .

CONNECTIONS

External connections are made at the rear of the relay case. Typical external connections are shown in Figures 4-7 and 4-8. Connections should be made with a minimum 14 AWG stranded wire.

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 ground bus from each relay.

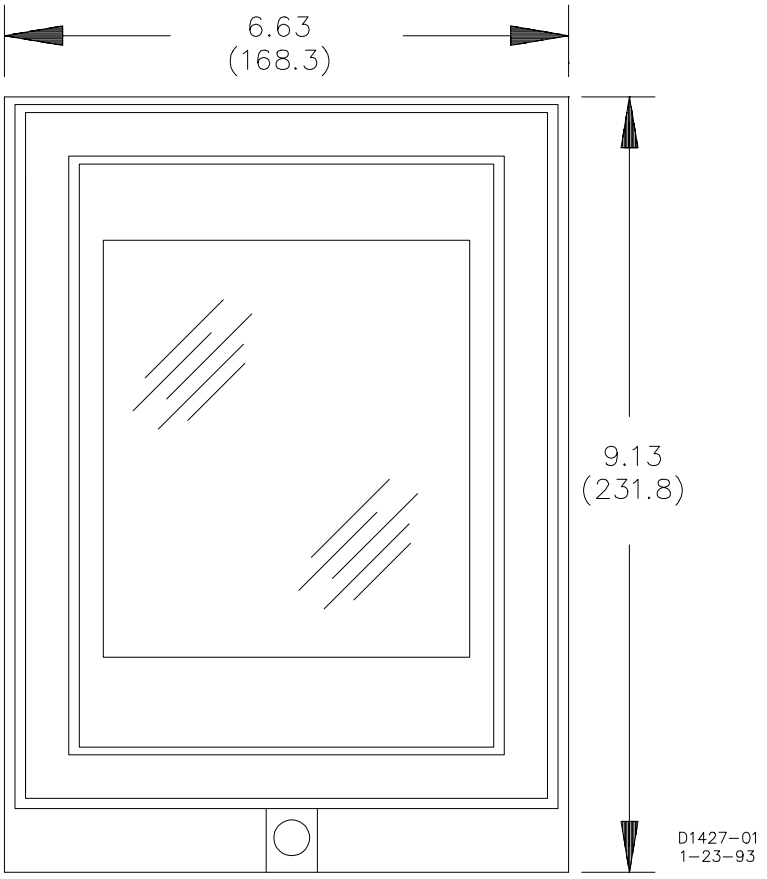


Figure 4-1. S1 Case, Outline Dimensions, Front View

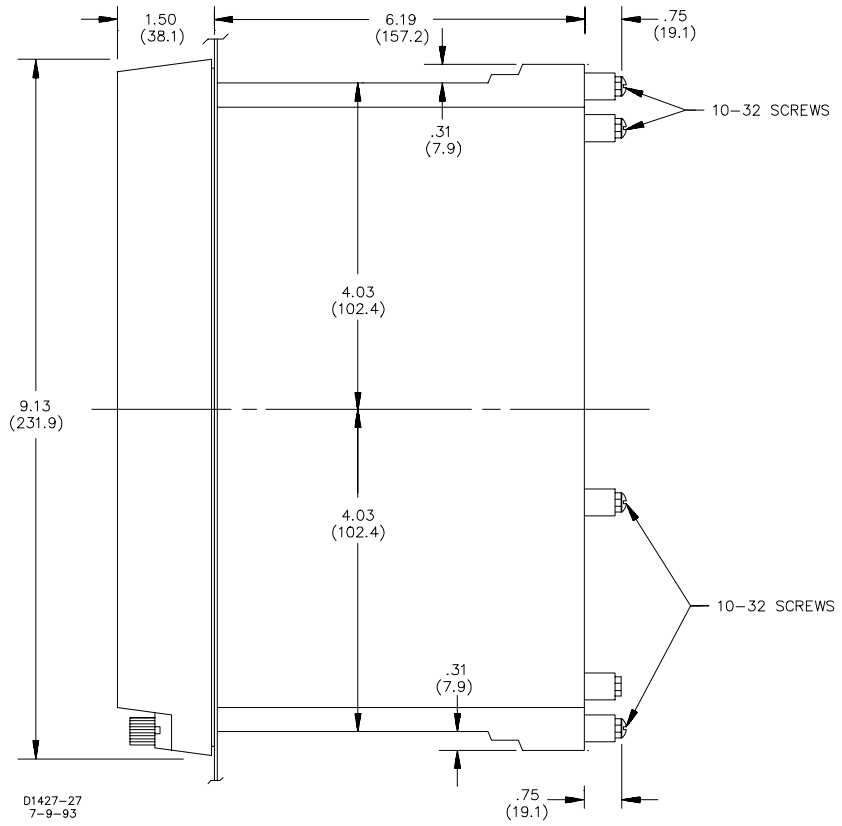


Figure 4-2. S1 Case, Double-Ended, Semi-Flush Mounting, Outline Dimensions, Side View

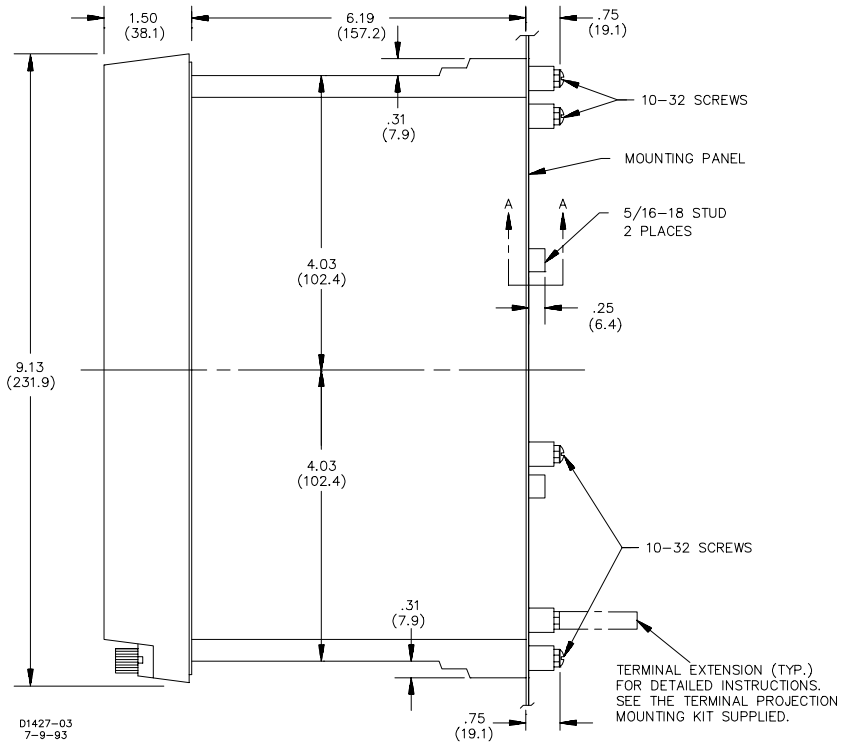


Figure 4-3. S1 Case, Double-Ended, Projection Mounting, Outline Dimensions, Side View

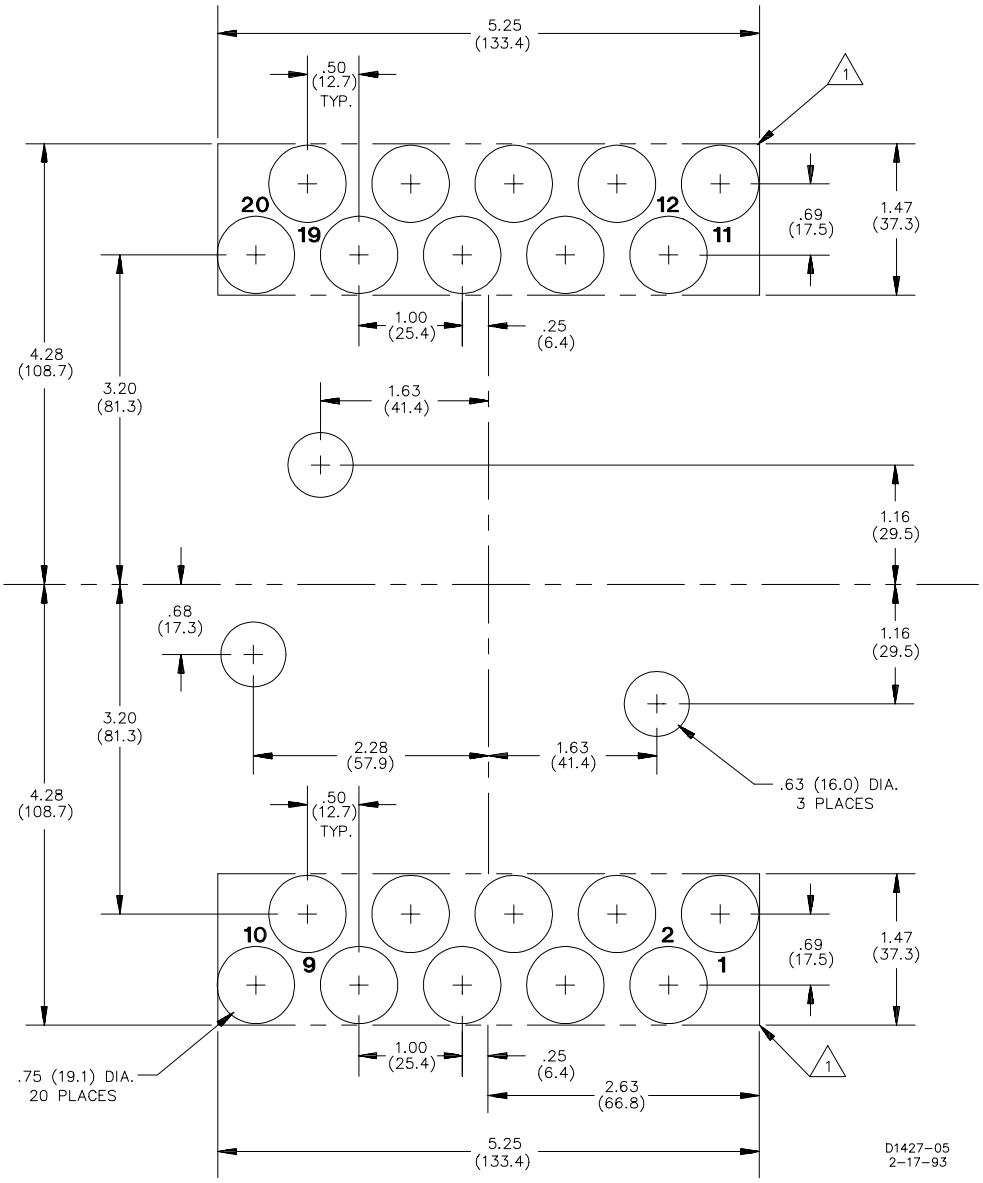


Figure 4-4. S1 Case, Double-Ended, Panel Drilling Diagram, Rear View

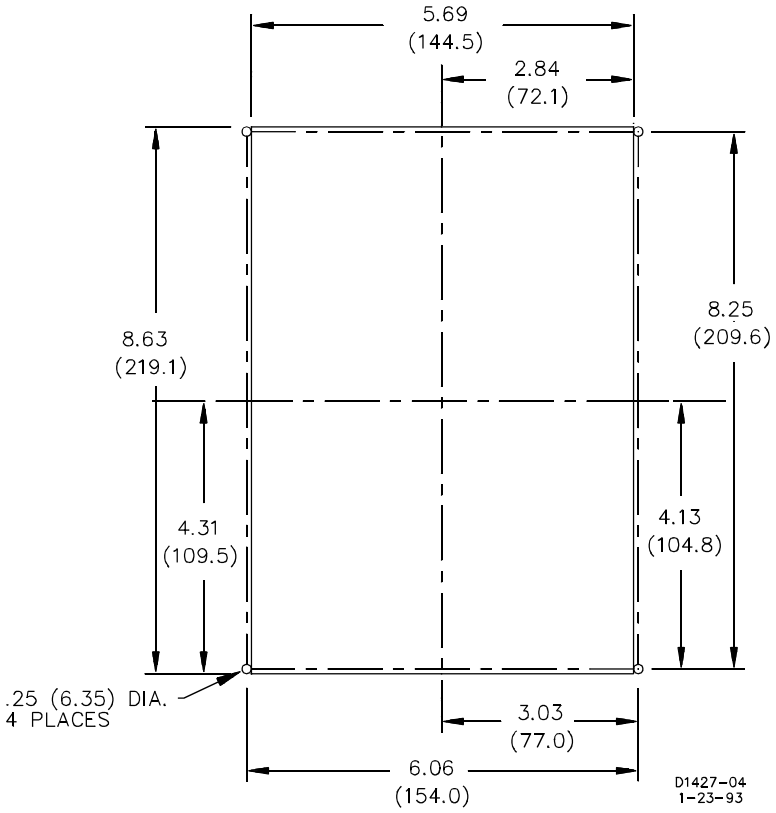


Figure 4-5. S1 Case, Panel Drilling Diagram, Semi-Flush Mounting

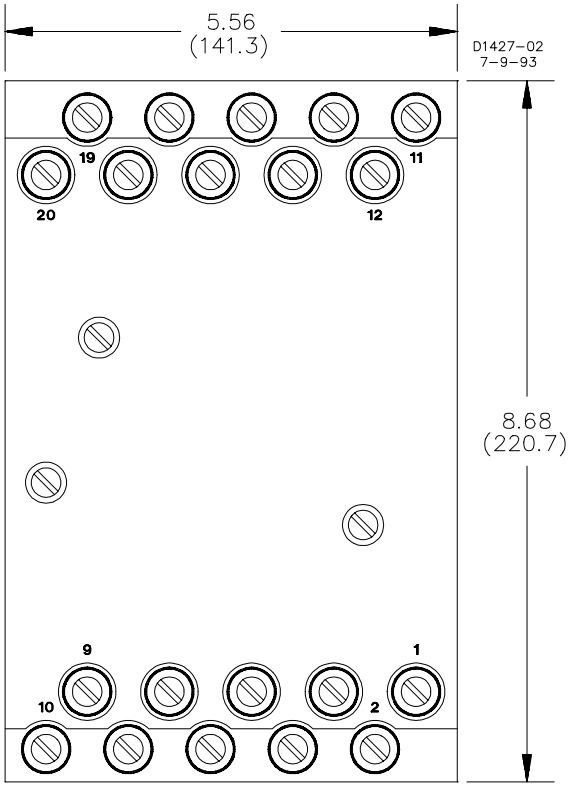


Figure 4-6. S1 Case, Projection Mounting, Outline Dimensions, Rear View

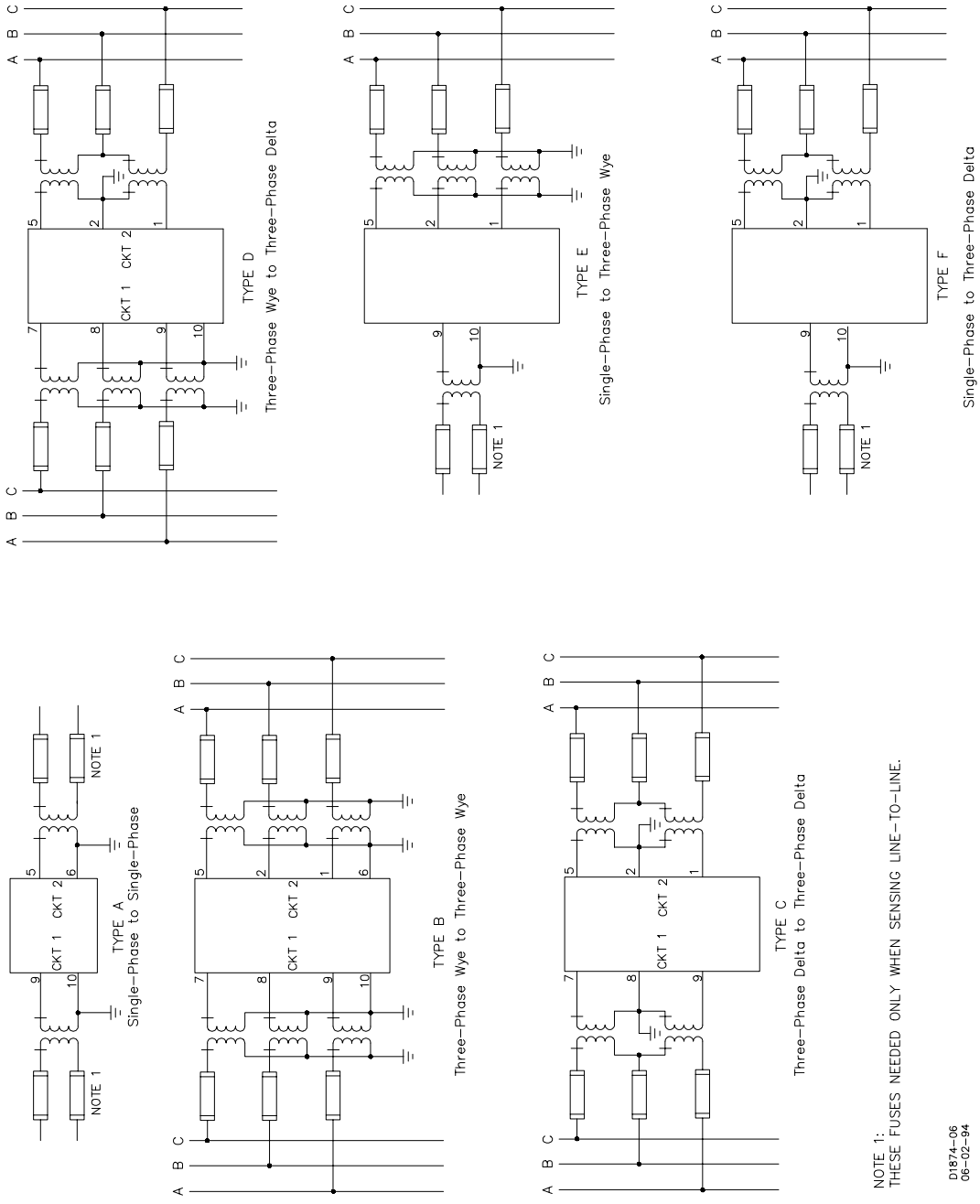


Figure 4-7. Sensing Input Connections

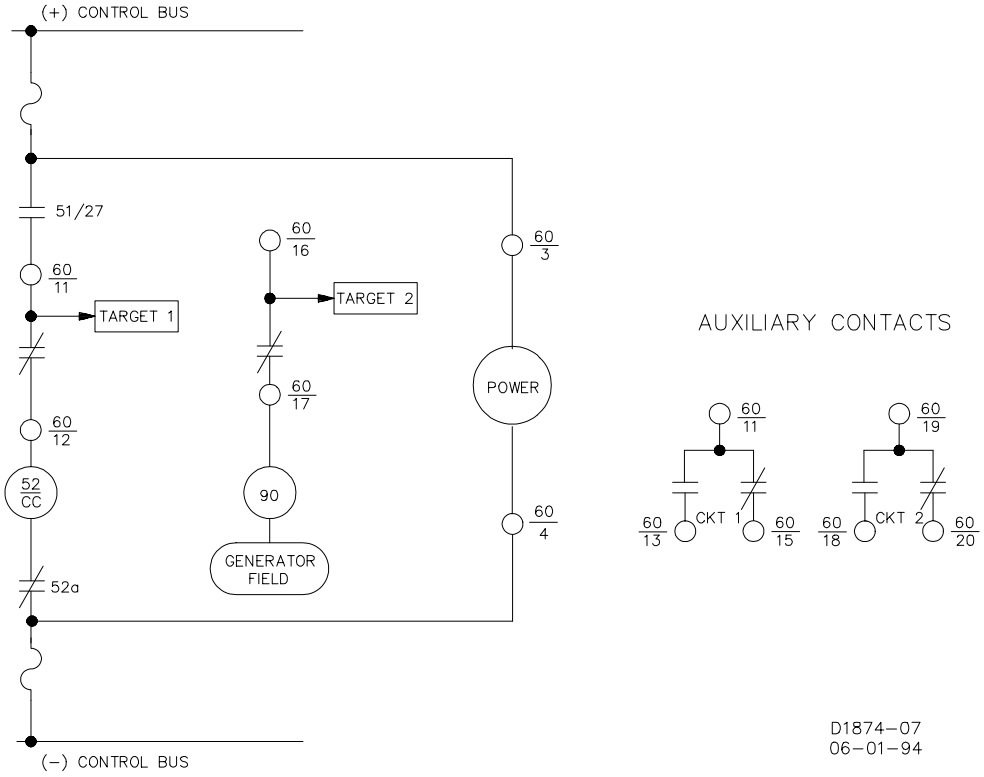


Figure 4-8. Typical Output Connections

SECTION 5 • MAINTENANCE

GENERAL

Basler relays are static devices which require no preventive maintenance other than a periodic operational check. The operational test procedure of Section 4 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 and recalibration. When returning the relay to the factory ship the entire relay cradle assembly, preferably in its case.

IN-HOUSE REPAIR

The quality of replacement parts must be at least equal to that of the original components.

CAUTION

When the printed circuit boards are conformally coated special soldering equipment must be used to prevent thermal damage to the delicate components. Care must also be taken not to bridge over the printed circuit board traces. The repaired area must be re-covered with a suitable plastic coating (acrylic) to avoid breakdown of traces due to moisture or dust.

Where special components are involved, Basler Electric part numbers may be obtained from the number stamped on the component or assembly, the schematic, or the parts list. 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

Removal and direct substitution of printed circuit boards or individual components does not necessarily mean the relay will operate properly without calibration. Always check/calibrate relay prior to placing into an operating system.

SECTION 6 • MANUAL CHANGE INFORMATION

CHANGES

This section contains information concerning the previous editions of the manual. The substantive changes to date are summarized in Table 6-1.

Table 6-1. Changes

Revision	Change	ECA/Date
B	Deleted reference to Service Manual 9 1707 00 620. Updated the Dielectric Test information. Corrected Timing from “100 milliseconds” to “150 milliseconds.” Changed Input Voltage Range and Burden Data in Power supply table in *Specifications*, Section 1. Corrected Style Chart by changing power supply type T from “230 Vac” to “240 Vac”. Added new power supply information to Section 3 in *Power Supply* paragraph starting with “Basler Electric enhanced the power supply design...”. Changed the format of the manual.	16888/07-98