



**BE1-51  
BE1-51/27C  
BE1-51/27R  
TIME OVERCURRENT  
RELAY**

The BE1-51 Series of Time Overcurrent Relays is microprocessor-based to provide versatile overload and fault protection on 50Hz or 60Hz systems.

## ADVANTAGES

- One relay can simultaneously monitor three phases plus neutral currents.
- 16 field selectable characteristic curves, including inverse, definite, I<sup>2</sup>t, and BS 142 functions.
- Wide range sensing inputs with continuously adjustable pickup.
- Up to two instantaneous elements available.
- Large array of options, including voltage control and voltage restraint.
- Five year warranty.

## ADDITIONAL INFORMATION

### INSTRUCTION MANUALS

Request publication: BE1-51: 9137200997  
BE1-51/27C: 9137200998  
BE1-51/27R: 9137200999

### TIMING CURVES

Request publication 9137200897

### STANDARDS, DIMENSIONS & ACCESSORIES

Request Bulletin SDA

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## APPLICATION

### THE BE1-51 SERIES

Time overcurrent relays provide phase and ground fault protection for distribution circuits, generators, transformers and other major components of the power system. The relays need to be capable of a wide range of pickup settings and characteristics in order to coordinate properly with other protective devices in the power system.

The BE1-51 family of time overcurrent relays provides single or multiple phase current sensing within a single unit. These relays feature a pickup setting range of 0.5 to 12 amperes and a variety of timing characteristics for proper coordination.

The overcurrent timing functions provide a means to coordinate with other protective devices and to discriminate between fault currents and transitory overloads. Table 1 illustrates typical applications. An extended range timing option is available which delays the standard functions by a timing factor of approximately 5.7. This further enhances flexibility in meeting application objectives.

The optional neutral defeat function allows neutral current sensing to be disabled. This allows the user to energize desired circuits and block tripping due to unbalanced currents reflected in the neutral circuit. After the circuits are balanced, the neutral defeat function would be switched off and neutral protection would be enabled. The built-in test (BIT) provides an operational check to

confirm the integrity of outputs, LEDs and targets, and simplifies calibration.

### INSTANTANEOUS OVERCURRENT MONITORING

One or two instantaneous outputs, individually adjustable for current level, may be specified as an aid in coordinating a relay scheme.

### VOLTAGE CONTROL

The BE1-51/27C Time Overcurrent Relay provides voltage controlled backup phase fault protection for a generator and power system when protective devices located downstream from the generator fail to operate. The time overcurrent response is inhibited when the monitored system voltage is above the voltage control setting, allowing setting below load current levels. Instantaneous overcurrent response (if included) is not affected.

### VOLTAGE RESTRAINT

Under fault conditions, system voltage may collapse to a low value compared to the relatively small voltage drop associated with overloads. The BE1-51/27R Time Overcurrent Relay with voltage restraint decreases the current pickup proportionally to this voltage reduction to increase overcurrent sensitivity of the relay during fault conditions. Neutral time overcurrent response and instantaneous overcurrent response (if included) are not affected.

**Table 1 - Applications Summary**

| Function                   |                              | Typical Protective Application                                                     | Special Characteristics                                                                                                                                      |
|----------------------------|------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number                     | Name                         |                                                                                    |                                                                                                                                                              |
| B1                         | Short Inverse                | Generator, busses                                                                  | Relatively short time, desirable where preserving system stability is a critical factor.                                                                     |
| B2, E2                     | Long Inverse                 | Motors                                                                             | Provides protection for starting surges and overloads of short duration.                                                                                     |
| B3                         | Definite Time                | General use                                                                        | Timing relatively independent of current. Useful in sequential tripping schemes.                                                                             |
| B4                         | Moderately Inverse           | Transmission and feeder lines. Useful in both phase and ground fault applications. | Accommodates moderate load changes, as may occur on parallel lines where one line may occasionally have to carry both loads.                                 |
| B5, E4, E5                 | Inverse                      | Feeder lines, or backup protection for other types of relays                       | Provides additional variations of the inverse characteristic, thereby allowing flexibility in meeting load variations, or in coordinating with other relays. |
| B6, E6                     | Very Inverse                 |                                                                                    |                                                                                                                                                              |
| B7, E7                     | Extremely Inverse            |                                                                                    |                                                                                                                                                              |
| B8                         | I <sup>2</sup> T             | Motors                                                                             | Prevents tripping from motor starting currents. Provides protection against light, medium and heavy overloads.                                               |
| C1-C8                      | I <sup>2</sup> T with Limits |                                                                                    |                                                                                                                                                              |
| All of the above, Extended | Extended Timing Range        | See B1 through C8 above                                                            | Provides a second set of the above listed curves with longer timing for increased flexibility.                                                               |

## SPECIFICATIONS

### FUNCTIONAL DESCRIPTION

The specifications on these pages define the many features and options that can be combined to exactly satisfy an application requirement. A block diagram (Figure 1) is included to show how various standard features, as well as the options, relate to each other.

### INPUTS

#### Current Sensing

In most models, two ranges are included (HIGH/LOW), each with its own pair of input terminals. Note: Units with three-phase-and-neutral sensing have single input ranges only. The current sensing characteristics at 100/120 Vac, 50/60 Hz, are shown in Table 2.

| SENSING INPUT TYPE      | MAXIMUM CONTINUOUS CURRENT* | BURDEN AT MAX. TAP VALUE               |
|-------------------------|-----------------------------|----------------------------------------|
| Single-Phase            | 20A                         | Less than 0.1 ohm per phase or neutral |
| Two-Phase and Neutral   | 20A                         |                                        |
| Three-Phase             | 20A                         |                                        |
| Three-Phase and Neutral | 20A                         |                                        |

(\*) The maximum 1 second current rating is 50 x the maximum tap current selected, or 500A, whichever is less. For ratings other than those specified by time curves, rating is calculated as follows:

$$I = \frac{(50 \times \text{tap value or } 500 \text{ A, whichever is less})}{\sqrt{T}}$$

where,  $I$  = maximum current  
 $T$  = Time of current flow in seconds

**Table 2 - Sensing Burdens**

#### Voltage Sensing (BE1-51/27C and BE1-51/27R)

The voltage input (when specified) imposes a less than nominal burden on the sensing transformers. The input is compatible with 100/120 Vac circuits, and is rated for 160 volts continuously at 50/60Hz  $\pm$  10 Hz.

#### Power Supply Inputs

One of five power supply types may be selected to provide internal operating power. These are described in Table 3.

| Type            | O     | P                  | R      | S                 | T                  |
|-----------------|-------|--------------------|--------|-------------------|--------------------|
| Nominal Voltage | 48Vdc | 125 Vdc<br>120 Vac | 24 Vdc | 48 Vdc<br>125 Vdc | 250 Vdc<br>230 Vac |
| Burden          | 6.6 W | 6.7 W<br>12.8 VA   | 7.2 W  | 5.0 W<br>5.3 W    | 7.8 W<br>19.8 VA   |

All ac references are at 50/60 Hz.

**Table 3 - Power Supply Options**

### OUTPUTS

All output contacts are rated as follows:

#### Resistive

|             |                                                                           |
|-------------|---------------------------------------------------------------------------|
| 120/240 Vac | Make 30 A for 0.2 seconds, carry 7 A continuously, break 7 A.             |
| 250 Vdc     | Make and carry 30 A for 0.2 seconds, carry 7 A continuously, break 0.3 A. |
| 500 Vdc     | Make and carry 15 A for 0.2 seconds, carry 7 A continuously, break 0.1 A. |

#### Inductive

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

### PANEL CONTROLS AND INDICATORS

**TAP SELECTOR:** The time overcurrent pickup point is selected using a 10-position TAP SWITCH. Along with the TAP CAL control (described below), this allows simultaneous precise settings for all phase elements. A similar set of controls independently adjusts neutral pickup (if specified).

## SPECIFICATIONS, continued

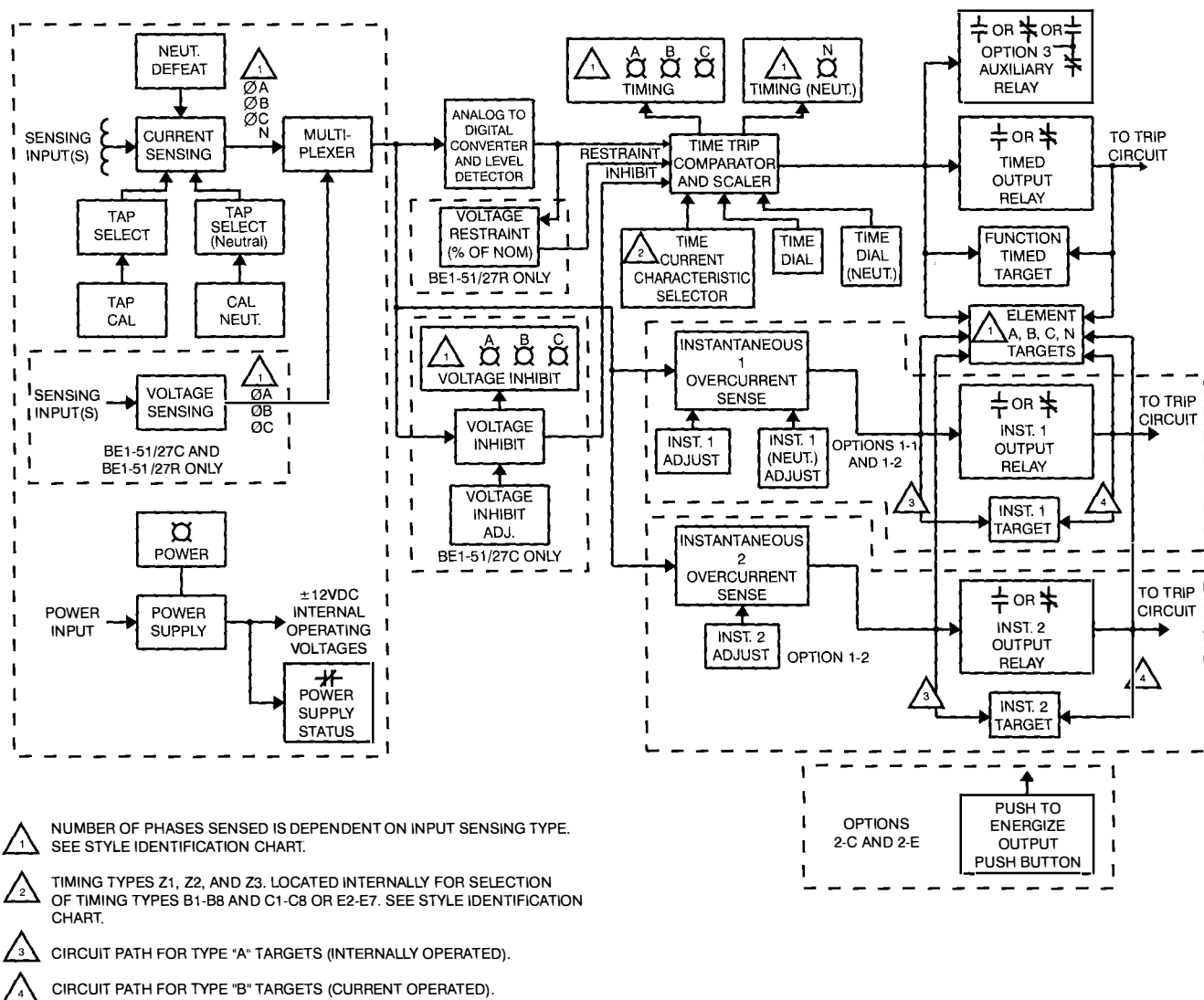


Figure 1 - Functional Block Diagram

## SPECIFICATIONS, continued

**TAP CAL CONTROL:** This control provides fine adjustment of the overcurrent pickup point between TAP selector settings. When the TAP CAL control is fully clockwise, the actual pickup will be within  $\pm 5\%$  of the indicated TAP selector setting.

|                                               |                             |
|-----------------------------------------------|-----------------------------|
| Time Overcurrent Pickup<br>Measuring Accuracy | $\pm 2\%$ of pickup setting |
|-----------------------------------------------|-----------------------------|

|                                          |                                    |
|------------------------------------------|------------------------------------|
| Time Overcurrent Pickup<br>Dropout Ratio | Better than 92% of<br>pickup level |
|------------------------------------------|------------------------------------|

**TIME DIAL:** This pair of thumbwheel selectors determines the time delay between the sensing of a phase overcurrent condition and a relay trip. The time delay is selected over the range of 00 to 99. For relays with extended timing range (Option 2-D or 2-E), the actual time delay will be approximately 5.7 times the value shown in the curves.

|                     |                                                                                   |
|---------------------|-----------------------------------------------------------------------------------|
| Time Delay Accuracy | $\pm 5\%$ of the characteristic<br>curve value with repeatability<br>of $\pm 2\%$ |
|---------------------|-----------------------------------------------------------------------------------|

All phases of multiphase styles are set simultaneously and will exhibit the same time-current characteristic. The neutral element TIME DIAL is independently set.

**TIMING INDICATOR:** For each phase (or neutral) specified, there is an LED to indicate when the sensed current exceeds the time overcurrent pickup setting - unless the voltage control (if present) is above the preselected inhibit level.

**POWER INDICATOR:** A front panel LED illuminates to indicate the power supply is providing the internal operating voltages.

**TARGET INDICATORS:** Targets may be specified to indicate which phase (or neutral) element initiated the overcurrent condition, and which protective function caused an output (TIME, INST 1, or INST 2).

Element phase targets are always internally operated. Function targets may be either internally operated or current operated by a minimum of 0.2A through the output trip circuit. When current operated, the output circuit must be limited to 30A for 0.2 seconds, 7A for 2 minutes, and 3A continuously.

### TIME CURRENT CHARACTERISTIC CURVE SELECTOR

The BE1-51 relays include up to 16 individual time curve types selected by means of a switch directly behind the front panel. The time curve groupings are identified as Z1, Z2 and Z3 in the style chart.

Option Z1 includes seven inverse time curve types and nine  $I^2t$  time curve types. Option Z2 includes seven inverse time curve types, one  $I^2t$  time curve and five British Standard inverse curves. Option Z3 includes the same curve types as Z1 but includes integrating timing to more closely simulate the operating characteristic of electromechanical relays. Extended timing can be included with Z1 and Z3 type timing to delay the relay operation.

### OPTIONS

In addition to the range of choices indicated above, the following optional functions may be specified.

#### Volts Inhibit Adj (BE1-51/27C Models)

A front panel control provides continuous adjustment of the sensed voltage inhibit level over a range of 40-120 Vac. When the level is exceeded, operation of the time overcurrent circuitry is inhibited. The optional instantaneous overcurrent element is not affected by the voltage inhibit circuitry.

For each phase there is an LED to indicate that voltage has exceeded the inhibit level setting.

#### Voltage Restraint (BE1-51/27R Models)

The voltage restraint option compares the sensed voltage with the nominal voltage level. A decrease of the sensed voltage (between 100% and 25% of nominal) results in a proportional decrease of the time overcurrent pickup point as defined by the TAP selector/TAP CAL control (Figure 2). When the sensed voltage falls below 25% of nominal, the time overcurrent pickup point will be 25% of the TAP selector/TAP CAL control setting. The pickup point of the neutral time overcurrent and optional instantaneous overcurrent element(s) are not affected by voltage restraint.

#### Instantaneous Overcurrent

A front panel control provides the instantaneous overcurrent element with adjustment over the range of 1 to 40 times the phase overcurrent pickup point selected by the TAP selector/TAP CAL control. When the setting is exceeded, the inst. 1 output relay energizes (Figure 3). This element is not affected by the voltage control circuit of the BE1-51/27C or the voltage restraint circuit of the BE1-51/27R.

## SPECIFICATIONS, continued

An additional independent control (Option 1-2) provides pickup point adjustment for a second instantaneous function. (This option is available on all BE1-51 relays and single-phase BE1-51/27C and BE1-51/27R units.)

For relays including neutral sensing, an independent control adjusts the neutral instantaneous overcurrent pickup point.

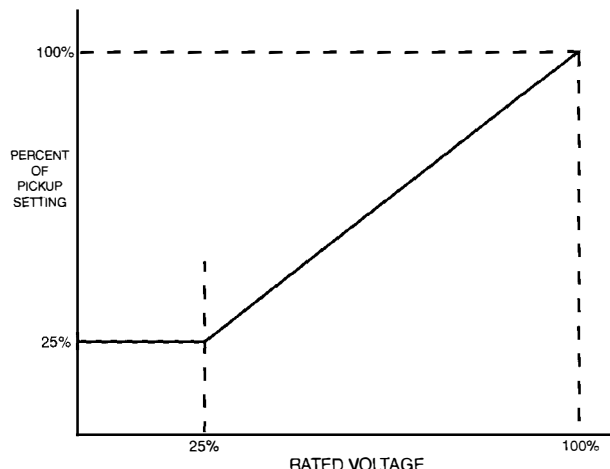
|                                                                     |                                                                        |
|---------------------------------------------------------------------|------------------------------------------------------------------------|
| Instantaneous Overcurrent Pickup Measuring Accuracy                 | ±2% of pickup setting                                                  |
| Instantaneous Overcurrent Dropout Ratio                             | Better than 98% of pickup level                                        |
| Voltage Sensing Measuring Accuracy (BE1-51/27C and BE1-51/27R Only) | ±2% of pickup setting (BE1-51/27C); ±2% of sensed voltage (BE1-51/27R) |

### Push-to-Energize-Output Pushbutton (Option 2-C or 2-E)

Applying a thin non-conducting rod through a hole in the front panel energizes trip relays for testing the external trip circuits.

### Power Supply Status Output (Option 3-6)

The power supply status output relay is energized and its NC output contact is opened when power is applied to the relay. Normal internal relay operating voltage maintains the power supply status output relay continuously energized with its output contact open. If the power supply output voltage falls below the requirements of proper operation, the power supply output relay is de-energized, closing the NC output contact.



**Figure 2 - Voltage Restraint Characteristic (BE1-51/27R)**

### SURGE WITHSTAND

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

### ENVIRONMENT

Operating temperature range: -40°C to +70°C  
(-40°F to +158°F)

Storage temperature range: -65°C to +100°C  
(-85°F to +212°F)

### VIBRATION

In standard tests, the relay has withstood 2g 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.

### SHOCK

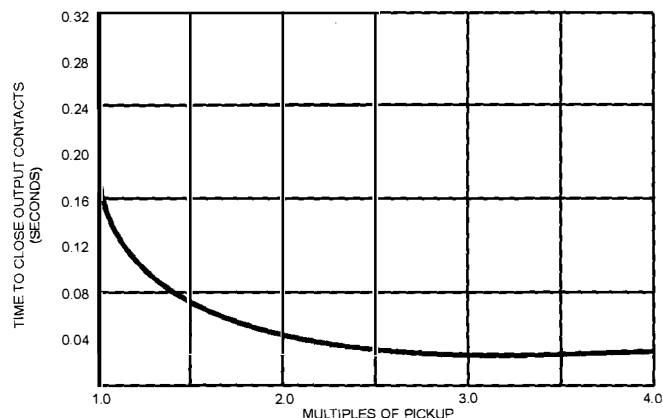
In standard tests, the relay has withstood 15g in each of three mutually perpendicular axes without structural damage or degradation of performance.

### WEIGHT

|                         |                      |
|-------------------------|----------------------|
| Single-phase            | 13.0 lb max (5.9 kg) |
| Three-phase             | 14.0 lb max (6.4 kg) |
| Two-phase-and-neutral   | 14.0 lb max (6.4 kg) |
| Three-phase-and-neutral | 14.4 lb max (7.2 kg) |

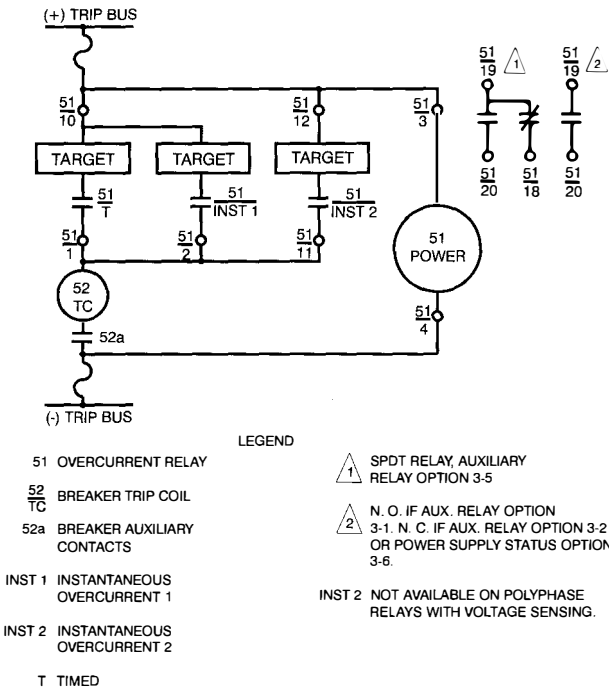
### AGENCY RATINGS

UL recognized per Standard 508, UL File number E97033.

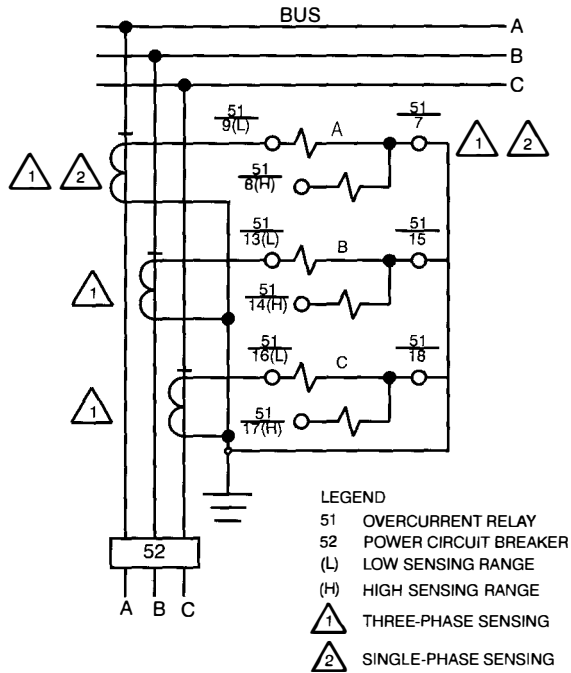


**Figure 3 - Typical Instantaneous Function Response Time**

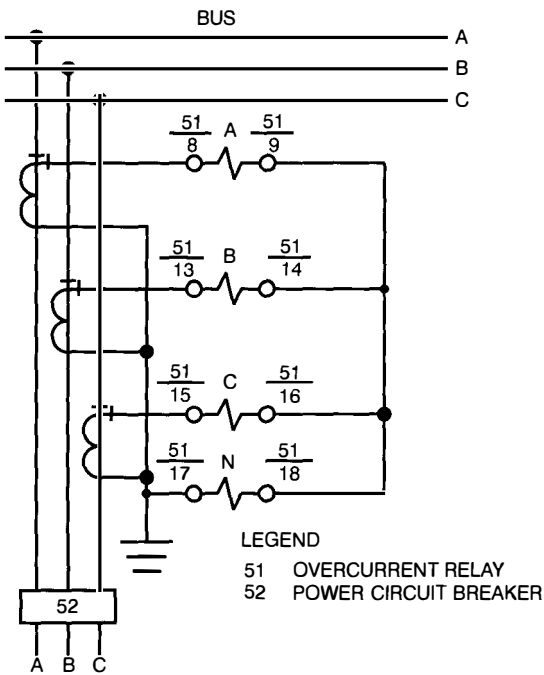
# CONNECTIONS



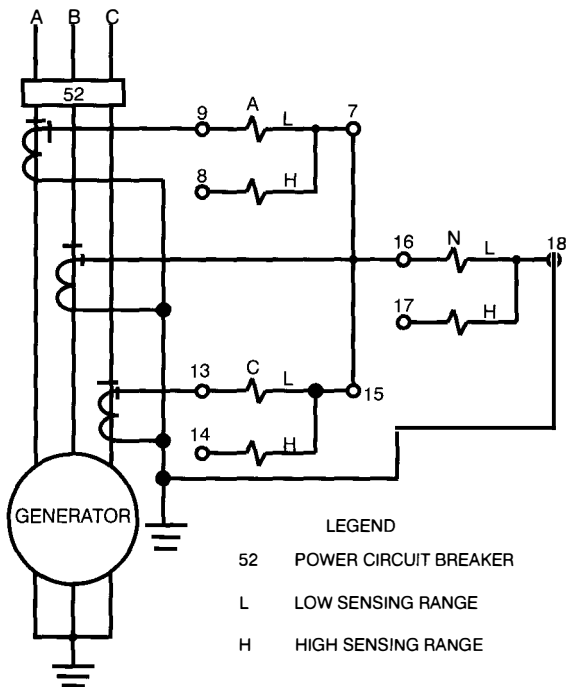
### Figure 4 - Control Circuits



### Figure 5 - Single-Phase and Three-Phase Current Sensing



### Figure 6 - Three-Phase-with-Neutral Current Sensing



### Figure 7 - Two-Phase-and-Neutral Current Sensing

CONNECTIONS, continued

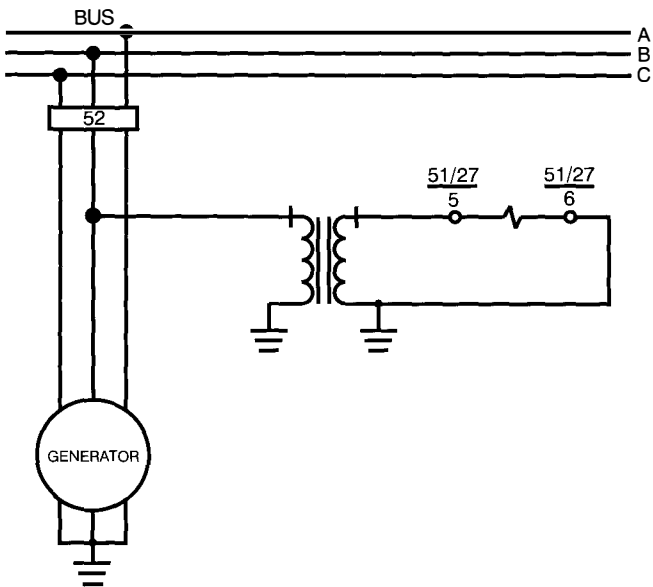


Figure 8 - Single-Phase Voltage Sensing  
(BE1-51/27C and BE1-51/27R)

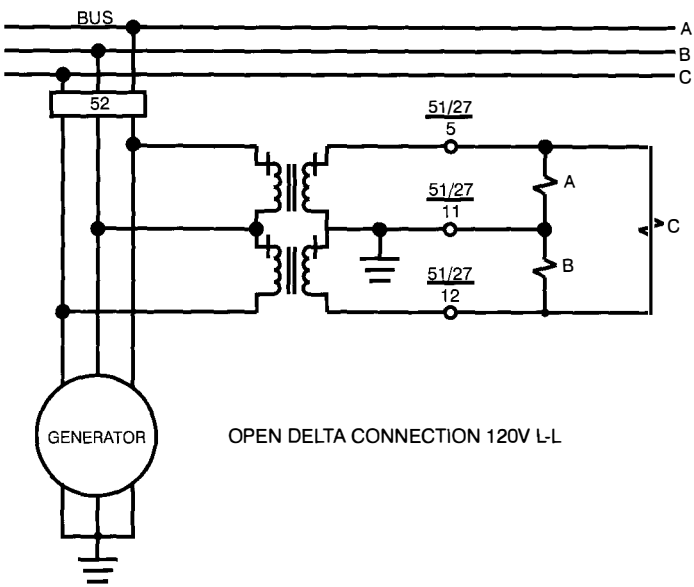
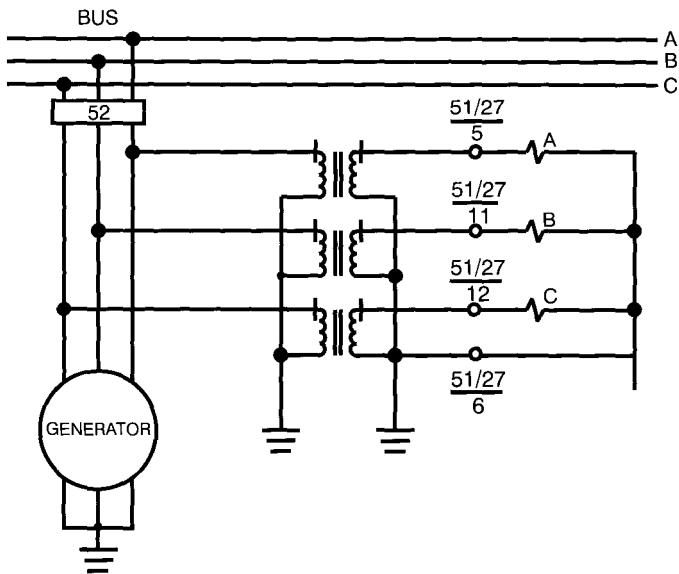


Figure 9 - 3-Phase 3-Wire Voltage Sensing  
(BE1-51/27C and BE1-51/27R)



- LEGEND
- 51/27 OVERCURRENT RELAY WITH VOLTAGE CONTROL/RESTRAINT, MODELS BE1-51/27C AND BE1-51/27R
  - 52 POWER CIRCUIT BREAKER

Figure 10 - 3-Phase 4-Wire Voltage Sensing  
(BE1-51/27C and BE1-51/27R)

## ORDERING

### MODEL NUMBER

BE1-51, BE1-51/27C, and BE1-51/27R  
Time Overcurrent Relays

### STYLE NUMBER

The style number appears on the front panel, drawout cradle, and inside the case assembly. This style number is an alphanumeric combination of characters identifying the features included in a particular unit. The sample style number below illustrates the manner in which the various features are designated. The Style Number Identification Charts located at the end of this publication define each of the options and characteristics available for this device.

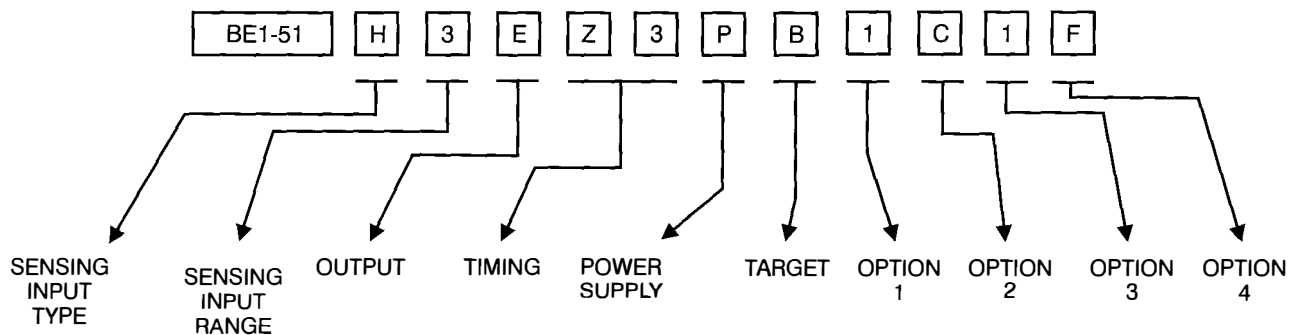
### SAMPLE STYLE NUMBER: H3E Z3P B1C1F

The style number above describes a BE1-51 Time Overcurrent with Voltage Control Relay having the following features.

- (H) 3-phase and neutral current
- (3) 1.5 to 12 ampere time overcurrent pickup range
- (E) All output contacts are normally open.

- (Z3) B and C type time curves, integrated timing.
- (P) Internal operating power is obtained from an external 125 Vdc or 100/120 Vac source.
- (B) All targets are current operated.
- (1) One Instantaneous Overcurrent element for each sensing input.
- (C) Push-to-energize switches are included to verify external output connections.
- (1) Normally open auxiliary output contacts operate concurrently with the time overcurrent output relay.
- (F) The relay case is configured for flush mounting.

NOTE: Description of a relay must include both the model number and the complete style number as shown below.



### HOW TO ORDER

Designate the model number followed by the complete style number.

BE1-51, Style No.      
 BE1-51/27C, Style No.      
 BE1-51/27R, Style No.   

Complete the style number by selecting one feature from each column of the Style Number Identification Chart and entering its designation letter or number into the appropriate square. (Two squares are used to indicate time delay characteristics.) All squares must be completed.

### STANDARD ACCESSORIES

The following standard accessories are available for the BE1-51, BE1-51/27C, and BE1-51/27R Time Overcurrent Relays.

#### Test Plug

Order Test Plug, Basler Electric part number 10095. (Two plugs may be required for complete testing capabilities).

#### Extender Board

The Extender Board will permit troubleshooting of the P. C. boards outside the relay cradle. Order Basler part number 9165500100.

ORDERING, continued

STYLE NUMBER IDENTIFICATION CHART

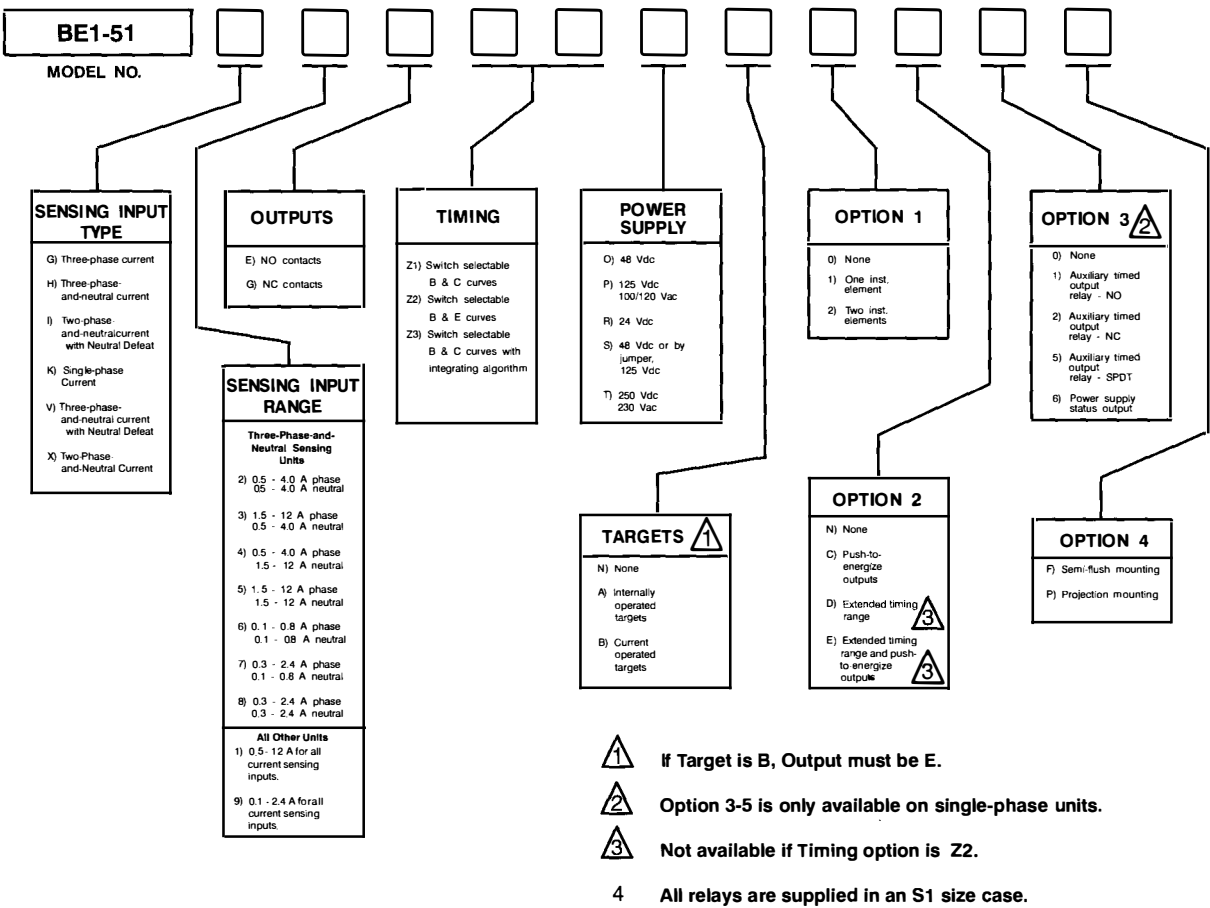
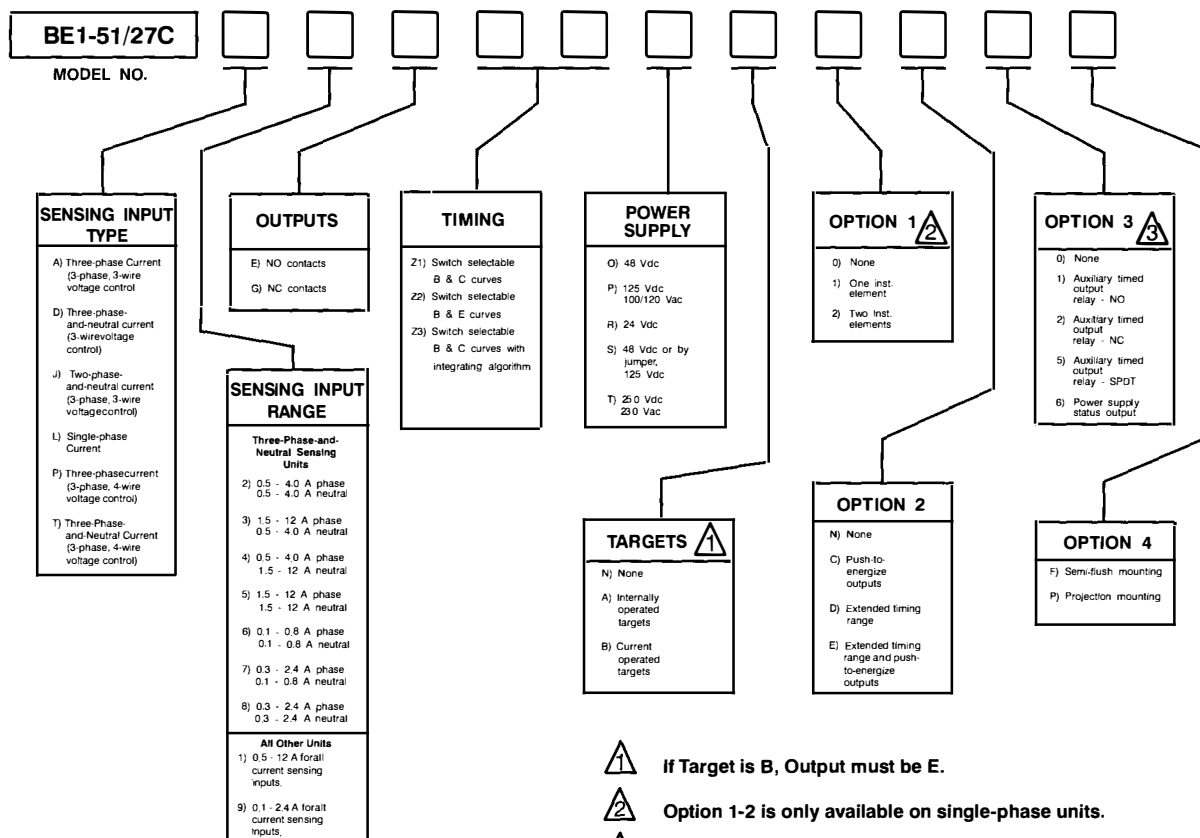


Table 2 - Timing Choices with Available Curves

| Timing Choices   | Z1                            | Z2                      | Z3 (Integrating)              |
|------------------|-------------------------------|-------------------------|-------------------------------|
| Available Curves | Short Inverse                 | Short Inverse           | Short Inverse                 |
|                  | Long Inverse                  | Long Inverse            | Long Inverse                  |
|                  | Definite Time                 | Definite Time           | Definite Time                 |
|                  | Moderately Inverse            | Moderately Inverse      | Moderately Inverse            |
|                  | Inverse Time                  | Inverse Time            | Inverse Time                  |
|                  | Very Inverse                  | Very Inverse            | Very Inverse                  |
|                  | Extremely Inverse             | Extremely Inverse       | Extremely Inverse             |
|                  | I <sup>2</sup> t              | BS142 Long Inverse      | I <sup>2</sup> t              |
|                  | I <sup>2</sup> t with Limit 1 | BS142 Inverse (1.3 sec) | I <sup>2</sup> t with Limit 1 |
|                  | I <sup>2</sup> t with Limit 2 | BS142 Inverse (2.9 sec) | I <sup>2</sup> t with Limit 2 |
|                  | I <sup>2</sup> t with Limit 3 | BS142 Very Inverse      | I <sup>2</sup> t with Limit 3 |
|                  | I <sup>2</sup> t with Limit 4 | BS142 Extremely Inverse | I <sup>2</sup> t with Limit 4 |
|                  | I <sup>2</sup> t with Limit 5 |                         | I <sup>2</sup> t with Limit 5 |
|                  | I <sup>2</sup> t with Limit 6 |                         | I <sup>2</sup> t with Limit 6 |
|                  | I <sup>2</sup> t with Limit 7 |                         | I <sup>2</sup> t with Limit 7 |
|                  | I <sup>2</sup> t with Limit 8 |                         | I <sup>2</sup> t with Limit 8 |

## ORDERING, continued

## STYLE NUMBER IDENTIFICATION CHART



If Target is B, Output must be E.



Option 1-2 is only available on single-phase units.



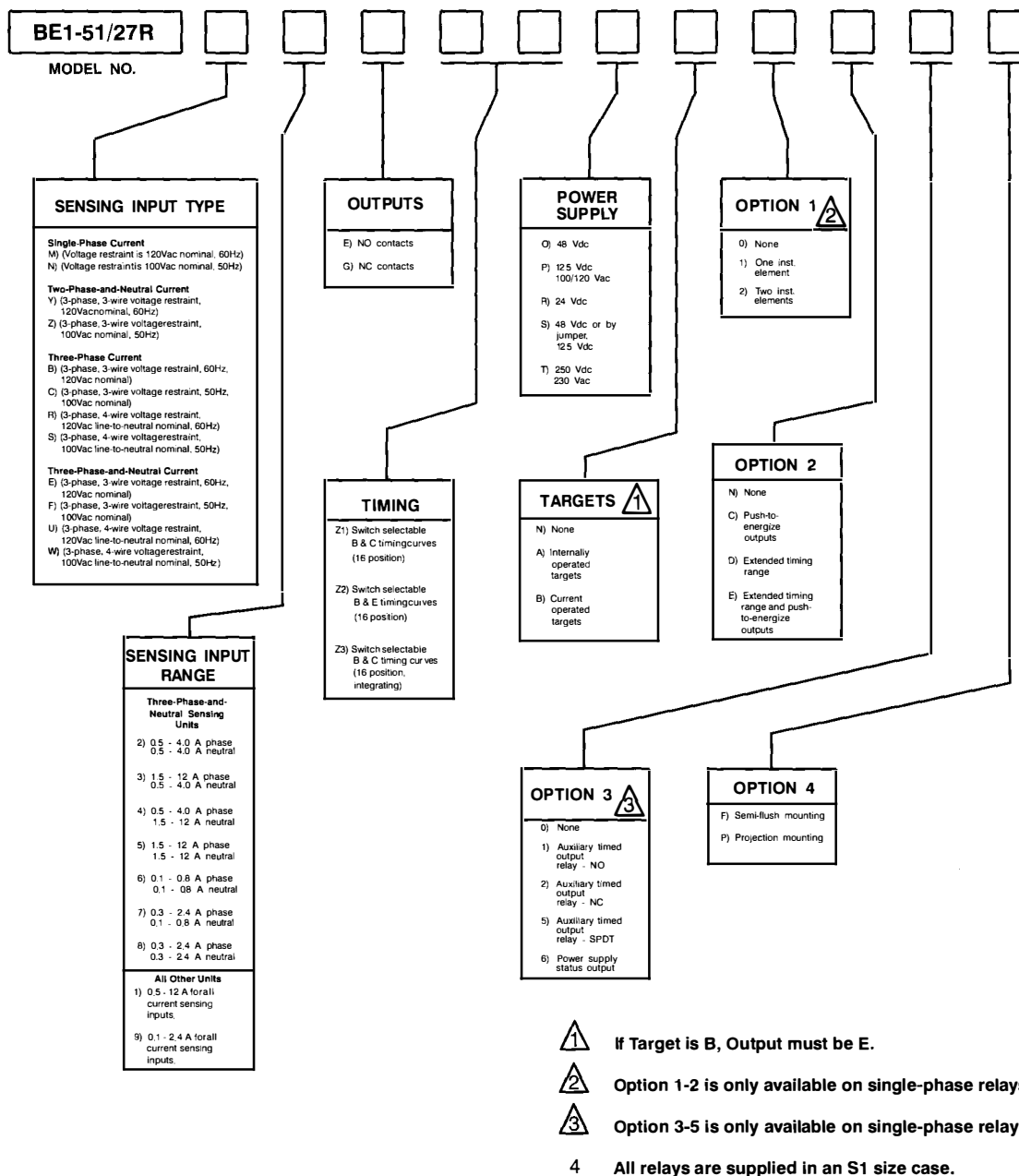
Option 3-5 is only available on single-phase units.

4

All relays are supplied in an S1 size case.

## ORDERING, continued

## STYLE NUMBER IDENTIFICATION CHART



# Basler Electric



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