

**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.

ADVANTAGES

- One relay can simultaneously monitor three phases plus neutral currents.
- 16 field selectable characteristic curves, including inverse, definite, I²t, and BS 142 functions.
- Wide range sensing inputs with continuously adjustable pickup.
- Up to two instantaneous elements available.
- BIT (built-in test) provides an operational check to confirm the integrity of outputs, LEDs and targets, and simplifies calibration.
- Large array of options, including voltage control and voltage restraint.
- Pickup repeatability $\pm 2\%$.
- Timing repeatability $\pm 5\%$.
- UL Recognized under Standard 508, UL File #E97033.

ADDITIONAL INFORMATION

INSTRUCTION MANUALS

Request Publications: 9-1372-00-997 for BE1-51
 9-1372-00-998 for BE1-51/27C
 9-1372-00-999 for BE1-51/27R

SERVICE MANUAL

Request Publication 9-1372-00-620

STANDARDS, DIMENSIONS & ACCESSORIES

Request Bulletin SDA

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ORDERING INFORMATION Pages 11 & 12

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 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.

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.

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 B6, E6 B7, E7	Inverse Very Inverse Extremely 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.
B8	I ² T	Motors	Prevents tripping from motor starting currents. Provides protection against light, medium and heavy overloads.
C1-C8	I ² 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 (page 4) 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, as well as all units with current operated (type M) power supplies, include single input ranges. The current sensing characteristics at 100/120 Vac, 50/60 Hz, are shown in Table 2.

Units with Power Supply Type ^a O, P, R, S, & T			Units with Type M Power Supply †			
SENSING INPUT TYPE	MAXIMUM CONTINUOUS CURRENT*	Burden at Maximum TAP Value	TAP Value	MAXIMUM CONTINUOUS CURRENT*	Burden at TAP Value	Burden at 2X TAP
Single-Phase	20A	Less than 0.1 ohm per phase or neutral	1	2x tap or 15A (whichever is less)	8 VA	14 VA
Two-Phase and Neutral	20A		2		8 VA	14 VA
Three-Phase	20A		4		8 VA	13 VA
			6		8 VA	15 VA
and neutral	20A		8		8 VA	17 VA
			12		8 VA	20 VA

(f) Type M power supply available in three-phase or three-phase-and-neutral sensing units only.

(*) 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 BE1-27R)

The voltage input (when specified) imposes a maximum of 1VA nominal burden on the sensing transformers. The input is compatible with 100/120 Vac circuits, and is rated for 160 volts continuously at 50/60 ± 10 Hz.

Power Supply Inputs

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

Type	O	P	R	S*	T	M
Nominal Voltage	48 Vdc	125 Vdc 120 Vac	24 Vdc	48 Vdc 125 Vdc	250 Vdc 230 Vac	Current operated
Burden	6.6 W	6.7W 12.8 VA	7.2 W	5.0 W 5.3 W	7.8 W 19.8 VA	See Table 2.

All ac references are at 50/60 Hz.

*The type S power supply is field selectable for use with either 48 or 125 Vdc.

Selection must be accomplished at the time of installation and prior to application of power.

TABLE 3. POWER SUPPLY OPTIONS

Only three-phase or three-phase-and-neutral sensing units are available with a Type M (current operated) power supply. The Type M power supply does not require an external power source. The relay derives its operating power from the power system current transformer. Due to the additional magnetics involved, the time overcurrent relays with type M power supplies require an M1 size case (See Bulletin SDA for dimension details).

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 - break 0.1 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). When type M power supply is specified, input sensing range selection is accomplished by placing a tap screw in the TAP block rather than turning the TAP Selector to the desired position.

SPECIFICATIONS

(continued)

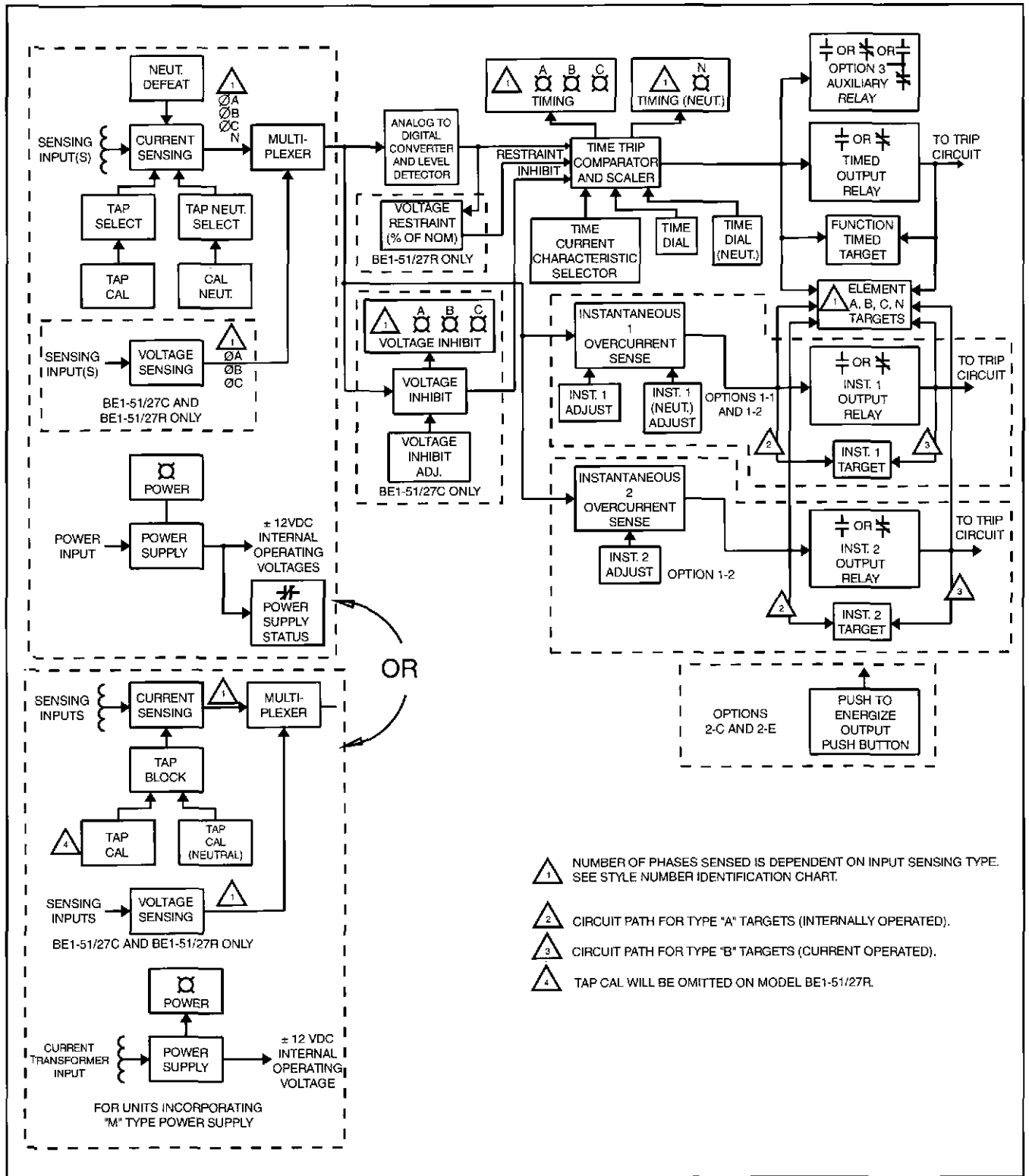


FIGURE 1. FUNCTIONAL BLOCK DIAGRAM

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.

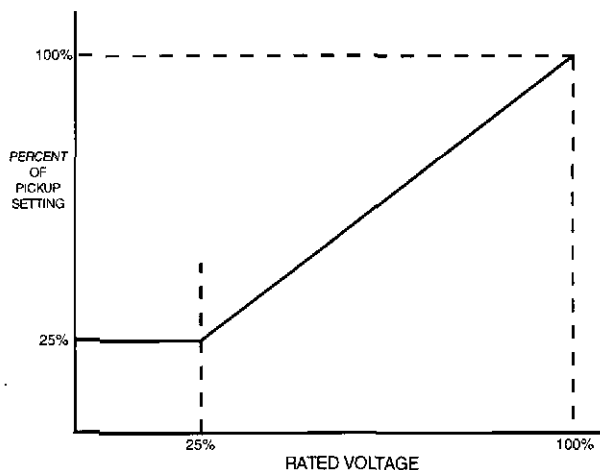


Figure 2. Voltage Restraint Characteristic

SURGE WITHSTAND CAPABILITY

Qualified to ANSI/IEEE C37.90a-1989 Surge Withstand Capability Test and IEC 255 Impulse test and Dielectric test.

MECHANICAL

Operating Temperature

-40°C (-40°F) to +70°C (+158°F).

Storage Temperature

-65°C (-85°F) to +100°C (+212°F)

Shock

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

Vibration

In standard tests, the relay has withstood 2g 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, without structural damage or degradation of performance.

Weight

For relays without type M power supply:

Single-phase	13.0 lb max net
Three-phase	14.0 lb max net
Two-phase-and-neutral	14.0 lb max net
Three-phase-and-neutral	14.4 lb max net

For relays with type M (current operated) power supply:

Three-phase	30.6 lb max net
Three-phase-and-neutral	31.0 lb max net

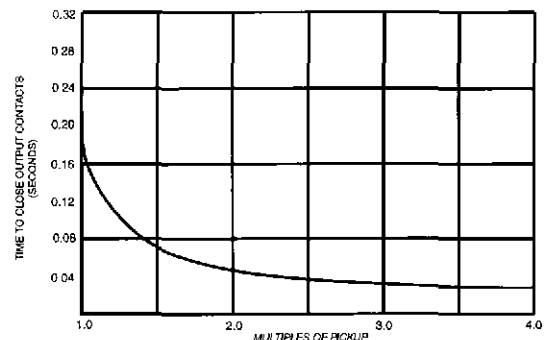


Figure 3. Typical Instantaneous Function Response Time

SPECIFICATIONS

(continued)

TIME OVERCURRENT CHARACTERISTIC CURVES

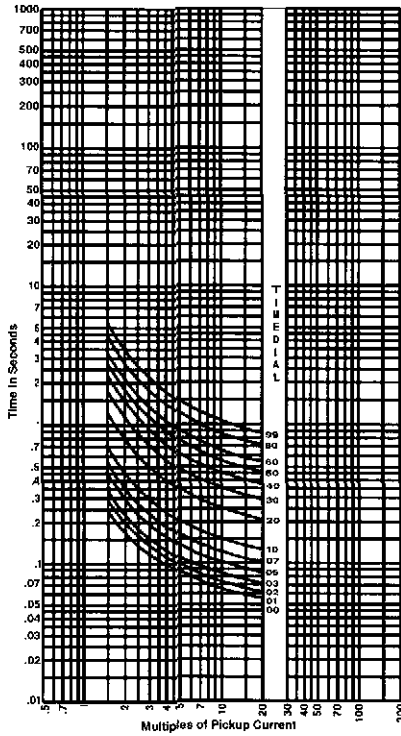


FIGURE 4. B1 - SHORT INVERSE

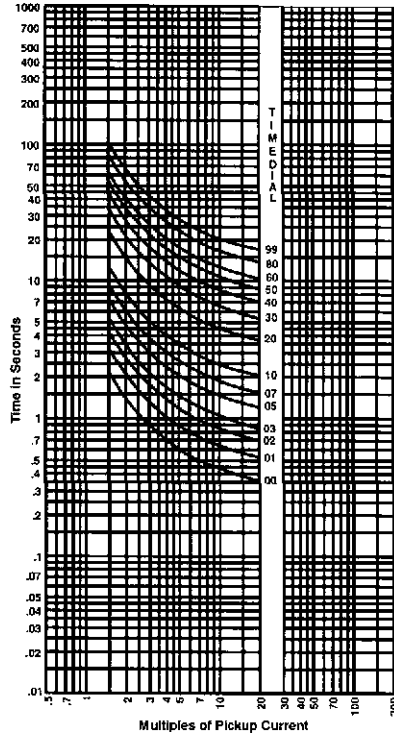


FIGURE 5. B2 - LONG INVERSE

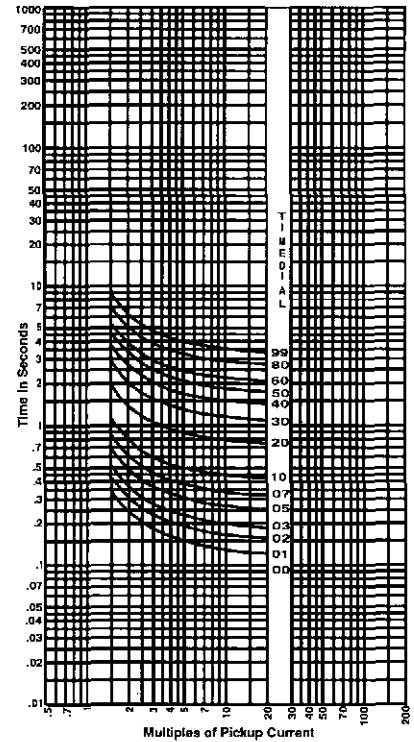


FIGURE 6. B3 - DEFINITE TIME

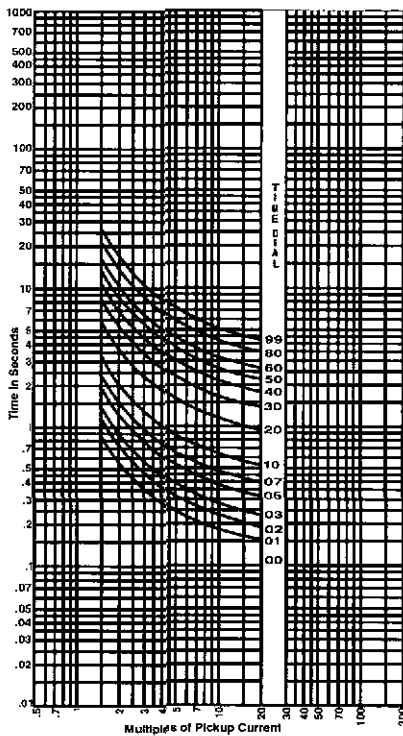


FIGURE 7. B4 - MODERATELY INVERSE

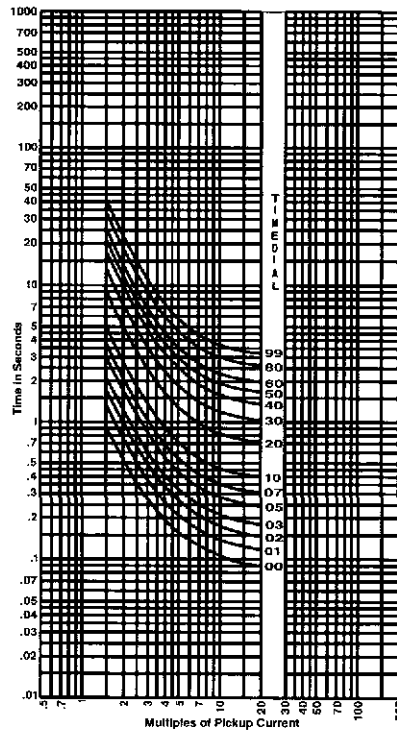


FIGURE 8. B5 - INVERSE

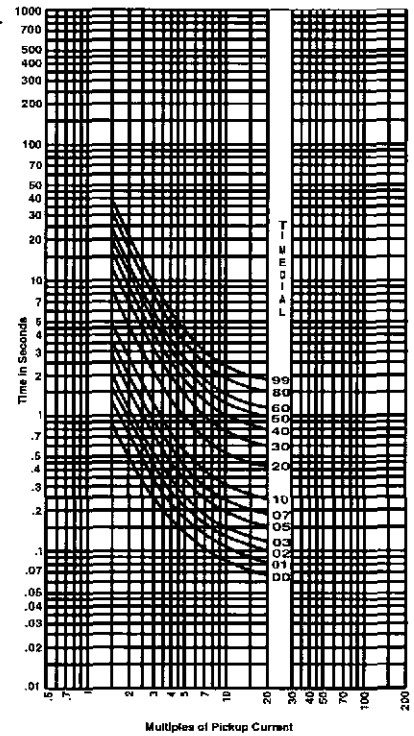


FIGURE 9. B6 - VERY INVERSE

SPECIFICATIONS

(continued)

TIME OVERCURRENT CHARACTERISTIC CURVES (continued)

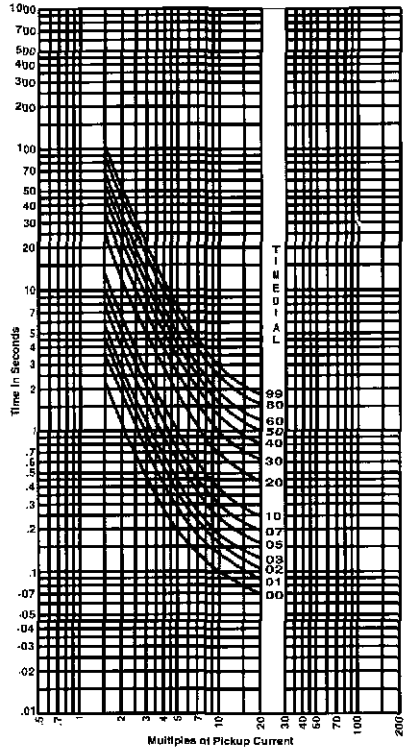


FIGURE 10. B7 - EXTREMELY INVERSE

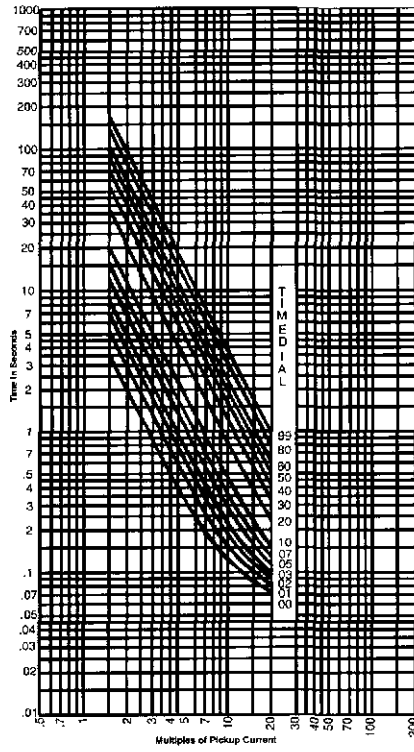


FIGURE 11. B8 - I²T

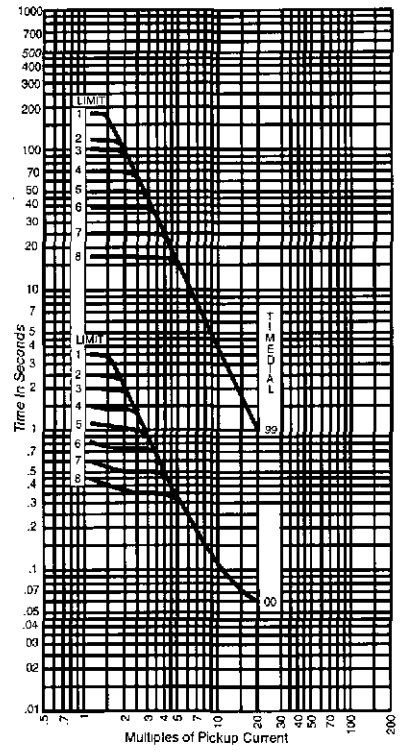


FIGURE 12. TIMING TYPES C1 THROUGH C8 I²T WITH LIMITS #1 THROUGH #8

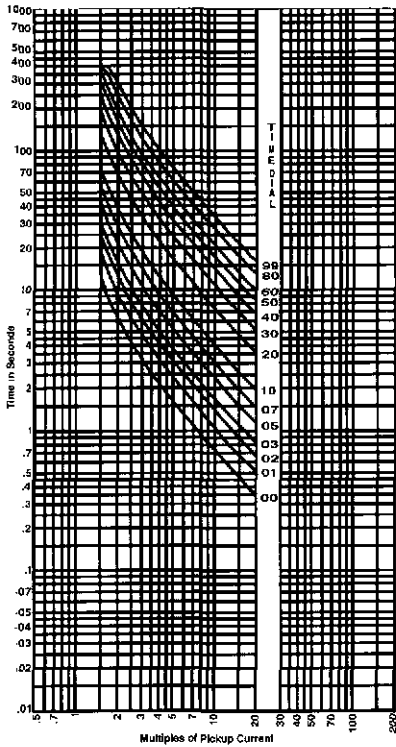


FIGURE 13. E2 - LONG INVERSE
BRITISH STANDARD 142 CURVE

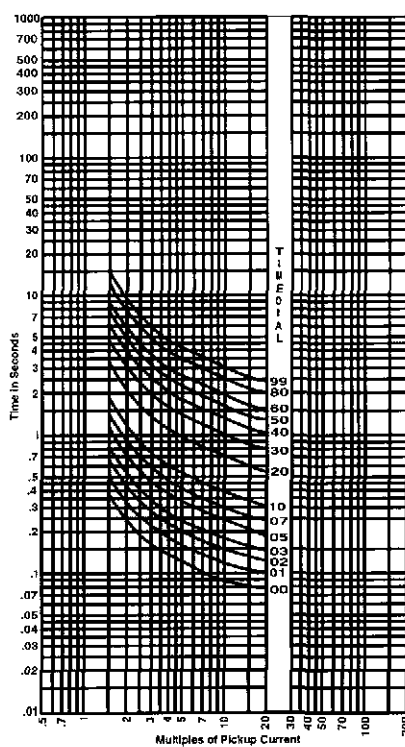


FIGURE 14. E4 - INVERSE (1.3)
BRITISH STANDARD 142 CURVE

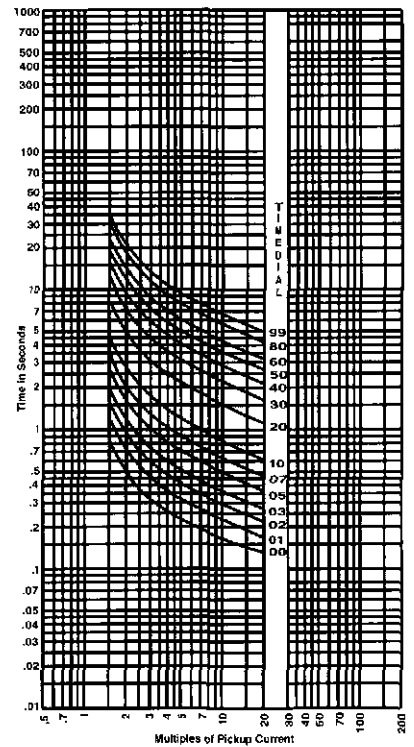


FIGURE 15. E5 - INVERSE (2.9)
BRITISH STANDARD 142 CURVE

SPECIFICATIONS

(continued)

TIME OVERCURRENT CHARACTERISTIC CURVES (continued)

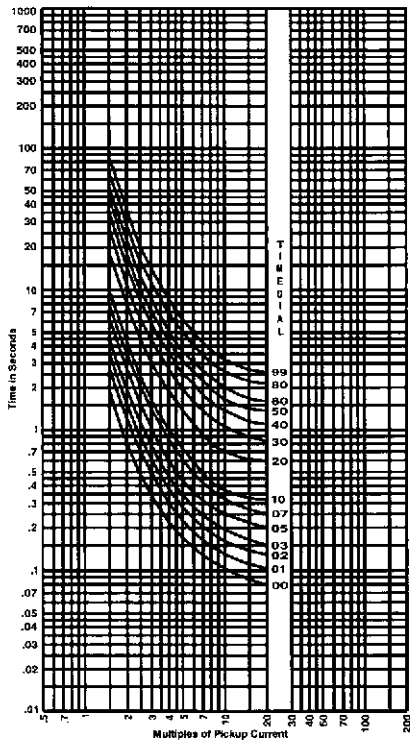


FIGURE 16. E6 - VERY INVERSE BRITISH STANDARD 142 CURVE

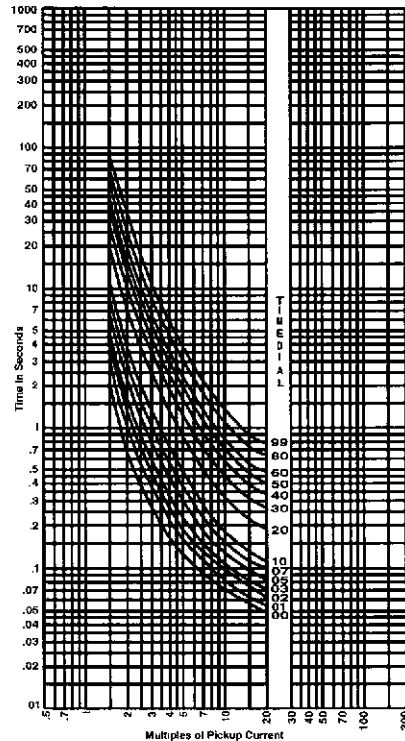


FIGURE 17. E7 - EXTREMELY INVERSE BRITISH STANDARD 142 CURVE

CONNECTIONS

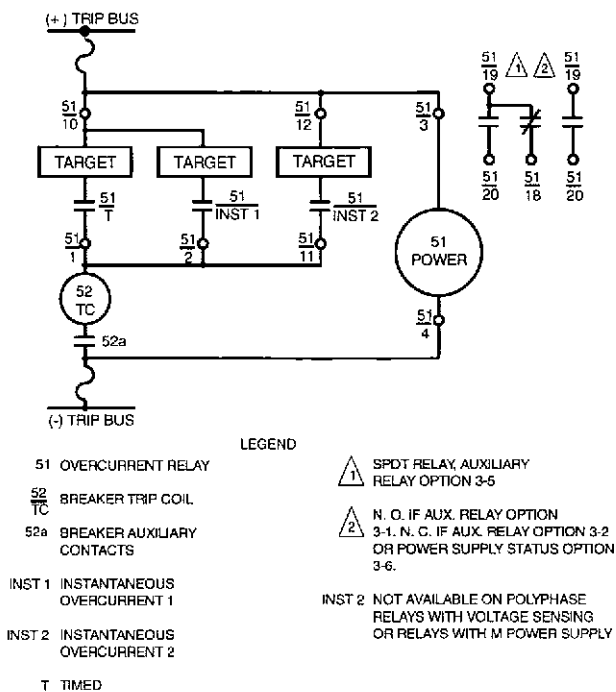


FIGURE 18. CONTROL CIRCUITS

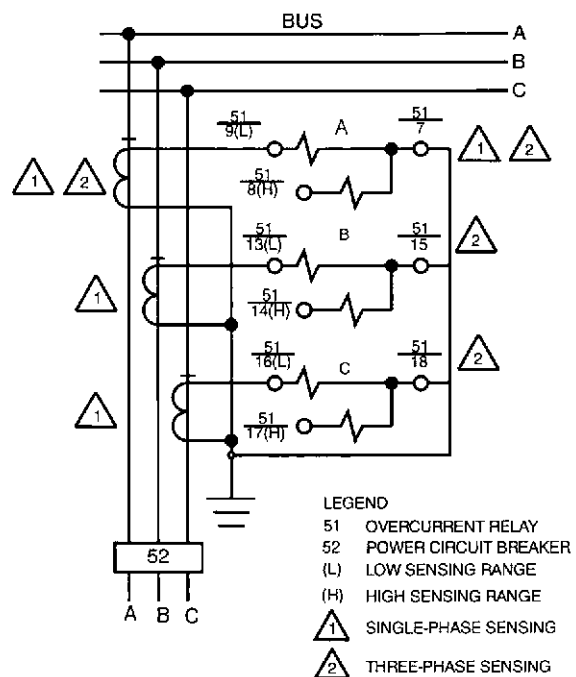


FIGURE 19. SINGLE-PHASE AND THREE-PHASE CURRENT SENSING

CONNECTIONS (continued)

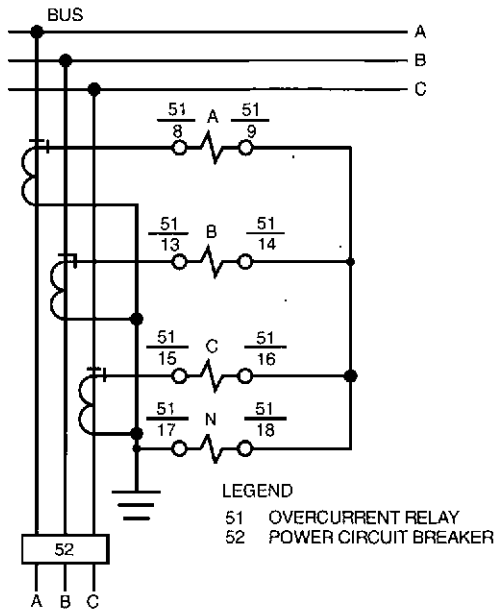


FIGURE 20. THREE-PHASE-WITH-NEUTRAL CURRENT SENSING

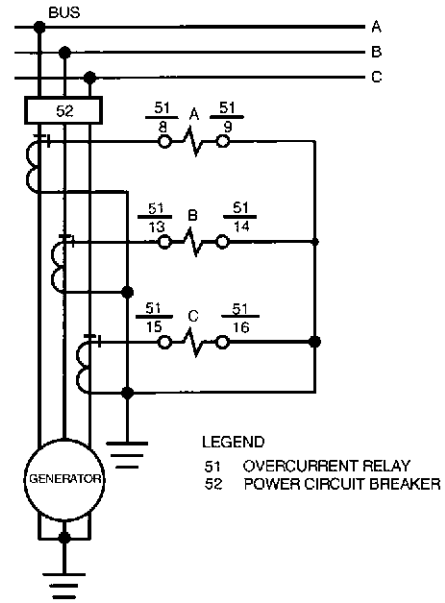


FIGURE 21. CURRENT SENSING WITH M-TYPE POWER SUPPLY INSTALLED

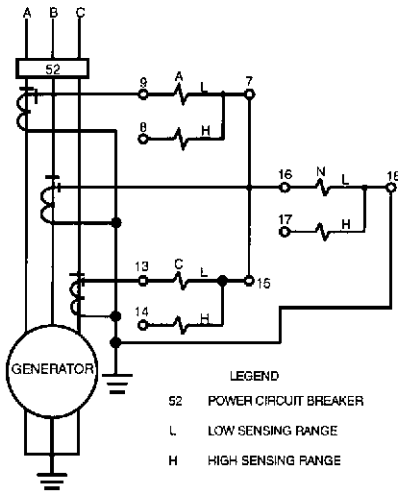


FIGURE 22. TWO-PHASE-AND-NEUTRAL CURRENT SENSING

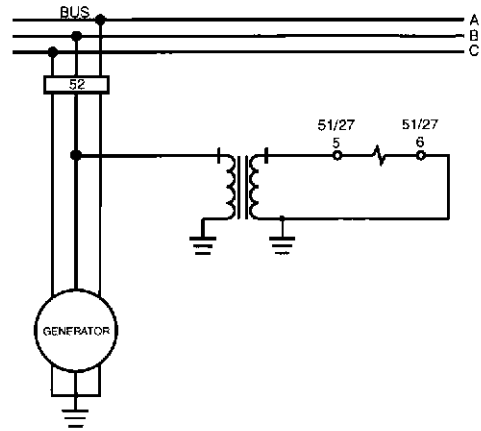


FIGURE 23. SINGLE PHASE VOLTAGE SENSING

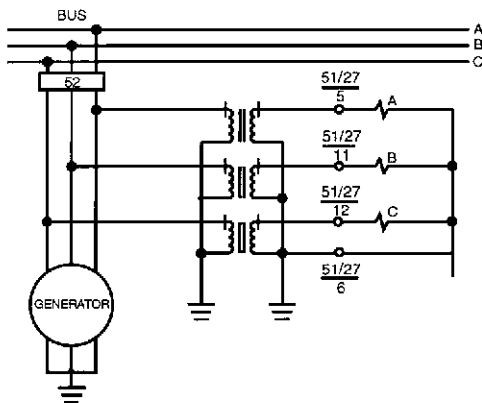


FIGURE 24. 3-PHASE 4-WIRE VOLTAGE SENSING

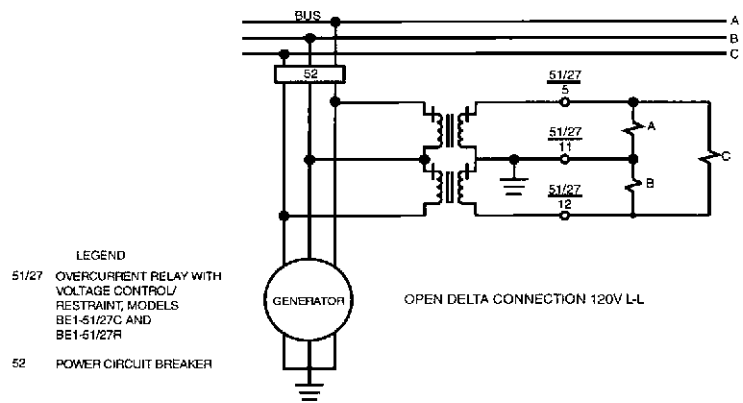


FIGURE 25. 3-PHASE 3-WIRE VOLTAGE SENSING

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 Chart (page 12) defines each of the options and characteristics available for this device.

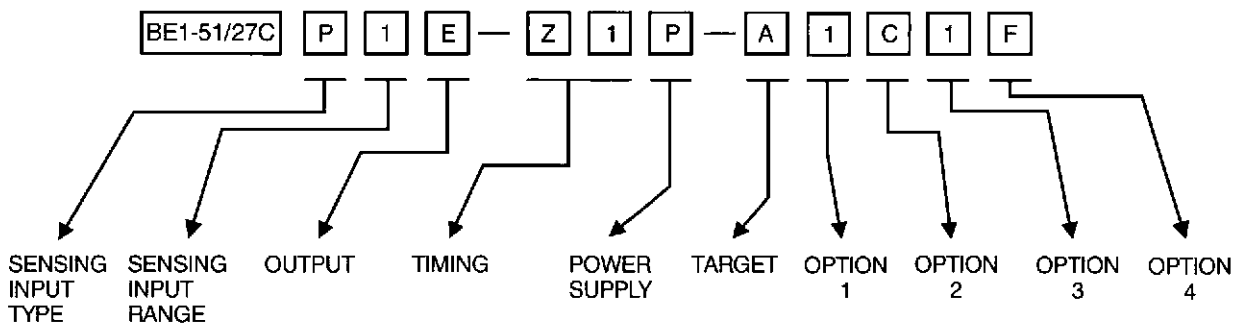
SAMPLE STYLE NUMBER: P1E Z1P A1C1F

The style number above describes a BE1-51/27C Time Overcurrent with Voltage Control Relay having the following features.

- (P) 3-phase current and 3-phase, 4-wire voltage sensing.
- (1) 0.5 to 12 ampere time overcurrent pickup range.

- (E) All output contacts are normally open.
- (Z1) B and C type time curves.
- (P) Internal operating power is obtained from an external 125 Vdc or 100/120 Vac source.
- (A) All targets are internally operated.
- (1) One Instantaneous Overcurrent element for each phase.
- (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).

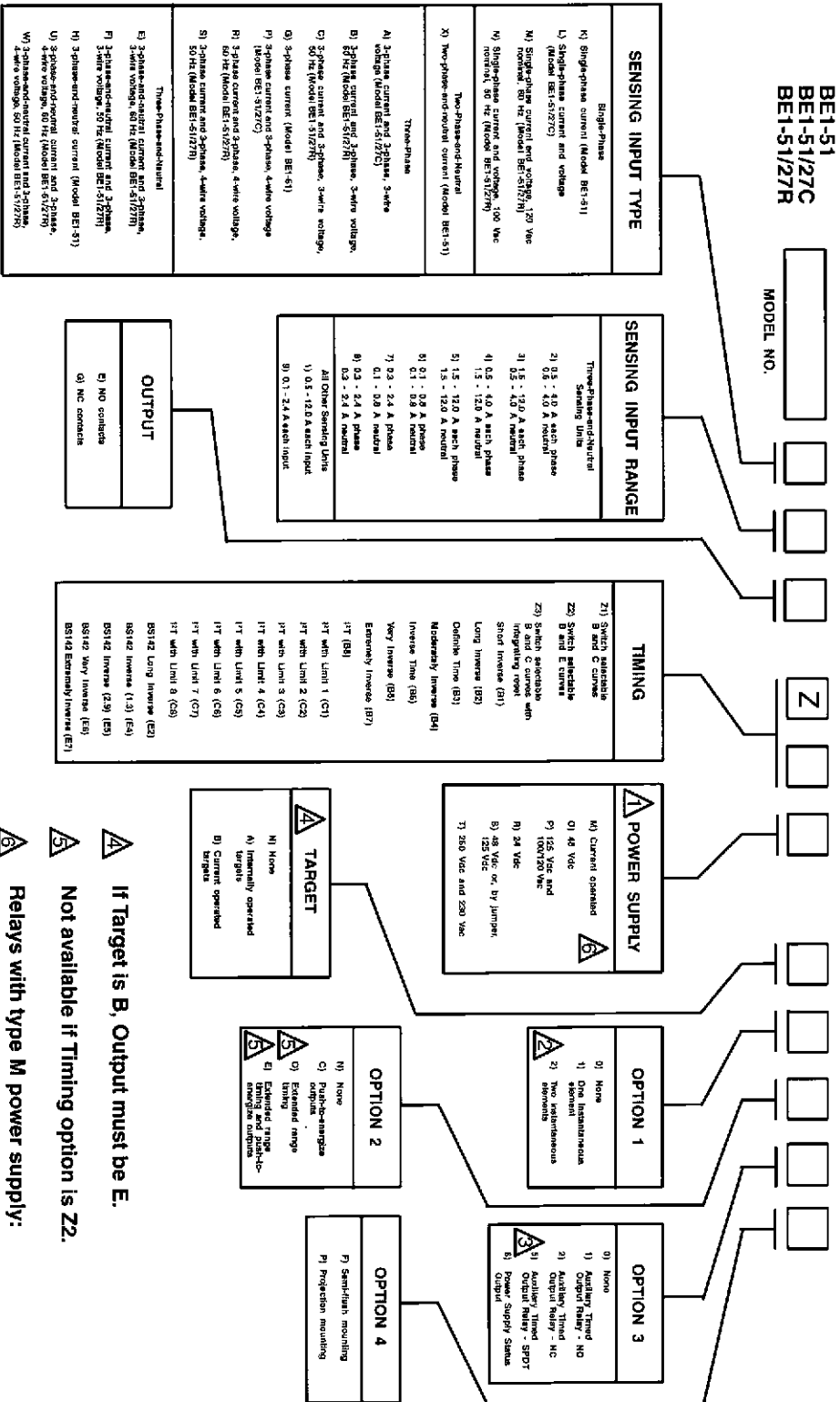
Extender Board

The Extender Board will permit troubleshooting of the P. C. boards outside the relay cradle. Order Basler part number 9 1655 00 100.

STYLE NUMBER IDENTIFICATION CHART

BE1-51
BE1-51/27C
BE1-51/27R

MODEL NO.



- ⚠ Relays with type O, P, R, S, or T power supply are supplied in an S1 case.
- ⚠ Option 1-2 is available for all BE1-51 Relays NOT using type M power supply; also on all single-phase BE1-51/27C and BE1-51/27R units.
- ⚠ Option 3-5 is only available on single-phase units.

- ⚠ If Target is B, Output must be E.
- ⚠ Not available if Timing option is Z2.
- ⚠ Relays with type M power supply:
 - a. If Power Supply is M, Sensing Input Range must be 1.
 - b. Sensing Input Type must be three-phase or three-phase-and-neutral.
 - c. Requires M1 case.
 - d. Option 1-2 not available.
 - e. Option 3-6 not available.