



BE1-50/51M TIME OVERCURRENT RELAY

The BE1-50/51M Time Overcurrent Relay provides economical overload and fault protection for generators, transformers, lines and motors.

ADVANTAGES

- Self powered from 50/60Hz systems, available for 5 or 1 amp CT secondaries.
- Models available to replicate decaying reset of electromechanical relay disks when current goes to zero.
- 10 Field selectable curves.
- Independent instantaneous overcurrent function.
- Drawout construction.
- Qualified to the requirements of:
 - IEEE C37.90-1989, C37.90.1-1989, C37.90.2-1989, UL508
- Five year warranty.

ADDITIONAL INFORMATION

INSTRUCTION MANUAL

Request Publication 9252000990

TIMING CURVES

Request Publication 9252000999

STANDARDS, DIMENSIONS and ACCESSORIES

Request Publication SDA

**FEATURES and
APPLICATIONS**
Page 2

**FUNCTIONAL
DESCRIPTION**
Page 3 - 6

SPECIFICATIONS
Page 7

**ORDERING
INFORMATION**
Page 8



FEATURES

- Ten field selectable, inverse, fixed time and British Standard (BS142) time overcurrent curves.
- Instantaneous overcurrent function.
- Wide setting ranges:
 - Time Overcurrent: 0.5 to 15.9 (5 Amp Unit)
 - 0.1 to 3.18 (1 Amp Unit)
- Inst. Overcurrent: 1 to 99 (5 Amp Unit)
- 0.2 to 19.8 (1 Amp Unit)
- Current pickup accuracy $\pm 2\%$.
- Timing accuracy $\pm 2\%$.
- Less than 10% transient overreach.
- Zero Pickup setting for safety during installation.
- Timed Overcurrent Reset - Selectable Instantaneous or Decay Characteristic.
- 5VA burden (at nominal) self powered from 50/60 Hz systems, utilizes standard 5 or 1 Amp CT secondaries.
- Drawout construction.
- Manual method for trip circuit testing.
- Standard magnetically latched targets for TOC and IOC.
- Direct reading front panel controls.
- UL recognized under standard 508.
- Qualified to the requirements of:
 - IEEE C37.90.1-1989 for SWC.
 - IEEE C37.90.2-1989 for RFI.
 - IEC 255-5 for impulse.
- Continuous automatic calibration.
- Time characteristics extend to 40 X Pickup.
- Positive visual indication that microprocessor is executing code.

APPLICATION

The BE1-50/51M is a single phase self powered, micro-processor based time overcurrent relay. The relay is designed for use in applications requiring time delayed coordination for phase or ground overcurrent conditions.

The relay can be used to provide coordinated protection for overhead and underground distribution circuits. Other applications include overcurrent backup protection for transformers and generators, and the protection of neutral grounding resistors and reactors.

Since all of the time-current characteristics are included within the relay, a standard relay may be ordered before the coordination study is completed, thereby allowing the physical construction to proceed. This is also an advantage as changes in the system configuration or coordination may be accomplished without a hardware change. Table 1 lists typical applications for each of the time-current characteristic curves.

Models are included (200 series) which have memory to replicate the decaying reset of electromechanical relays even when power to the relay is lost. Use the 200 series for applications that require coordination with the resetting of nearby electromechanical relays.

The instantaneous overcurrent element is standard in the relay. This element is designed to minimize transient overreach. The instantaneous element includes selectable delay characteristics for improved coordination with downstream devices and customer requirements.

Table 1 - Time-Current Characteristics

CHARACTERISTIC CURVE		TYPICAL PROTECTIVE APPLICATION	APPLICATION COMMENTS
SWITCH DESIGNATION	NAME		
S	Short Inverse	Generator or Bus	Relatively short time, desirable where preserving system stability is a critical factor.
L	Long Inverse	Motors	Provides protection for starting surges and short duration overloads.
D	Definite Time	General Use	Timing relatively independent of current. Useful in sequential tripping schemes.
M	Moderately Inverse	Transmission and feeder lines. Useful for both phase and ground application. Feeder lines or back-up protection for other types of relays.	Accommodates moderate load changes, as may occur on parallel lines where one line may occasionally have to carry both loads.
I	Inverse		Provides additional variations of the inverse characteristic, thereby allowing flexibility in meeting load variations, or in coordinating with other relays.
V	Very Inverse		
E	Extremely Inverse		
B	BS142 Very Inverse		
C	BS142 Extremely Inverse		
F	Fixed Time	General Use	Fixed time delay defined by dial setting. Useful in sequential tripping schemes.

FUNCTIONAL DESCRIPTION

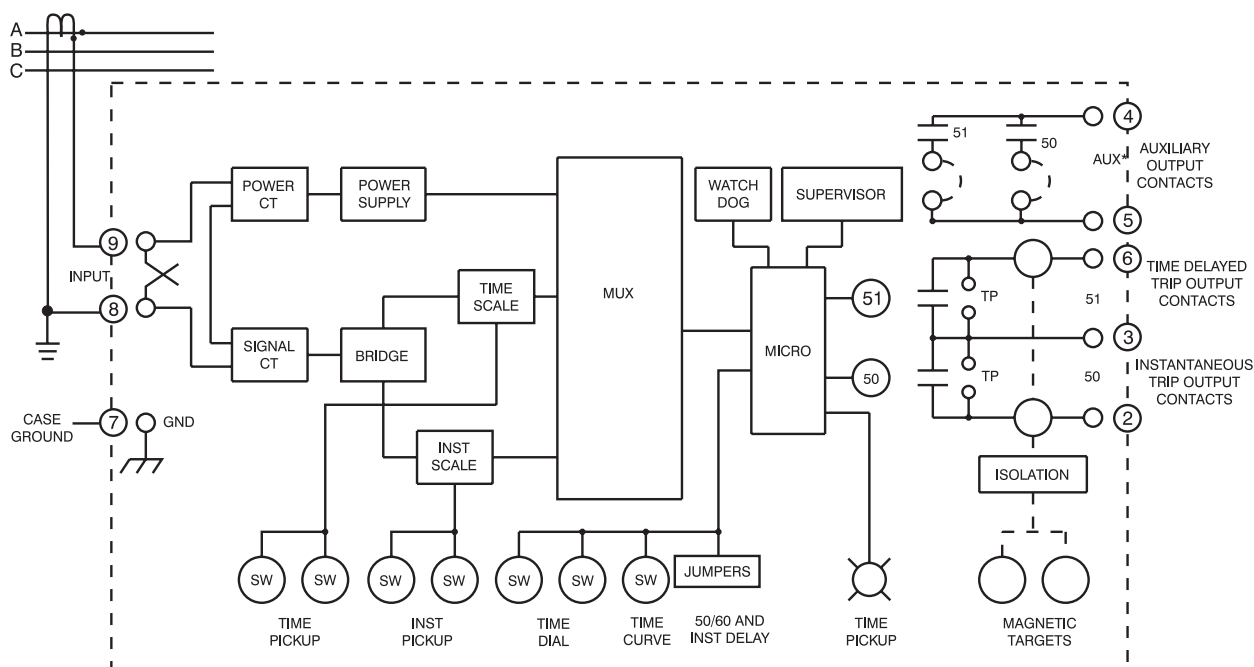


Figure 1 - Functional Block Diagram

CURRENT INPUT

A single phase of ac current from a 5 Amp or 1 Amp 50/60 Hz, system current transformer (CT) is applied to the BE1-50/51M. This input current provides both the power and sensing quantity for the relay.

The current applied to the relay provides the energy for the internal power supply. When sufficient current is available, the Active/Pickup LED will turn green. In applications where circuit loading conditions are less than that required to illuminate the LED, the relay remains operable and will provide overcurrent protection.

The sensing input transformer provides the quantity to be scaled and measured by the Time and Instantaneous functions. Ranges, ratings, and accuracies apply as described in Table 2.

Scaling of the input signal is accomplished by separate networks for the time and instantaneous functions. The scale factors are established by the front panel pickup settings. Pickup settings of 00 provide maximum sensitivity as a safety precaution for the installation process. Pickup will occur when the input current level is adequate to power the unit.

MICROPROCESSOR

The settings of the TIME DIAL, TIME CURVE selector switch, and circuit board jumpers provide the microprocessor with ten operating parameters for the desired response by the relay. The microprocessor performs the program operations based on the input current level and internal software program. When the Active/Pickup LED is green, the microprocessor is active and executing code.

Operating power from the power supply is applied to the microprocessor supervisor circuit. When the input current falls below an acceptable level, the supervisor circuit interrupts the microprocessor and halts further operation.

The watchdog timer monitors the microprocessor for specific pulses indicating proper program operation. If something occurs to disrupt the microprocessor, these pulses stop, the watchdog timer times out and sends a reset pulse to the microprocessor. The microprocessor resets and resumes normal operation.

Table 2 - Current Sensing Capabilities

50/60 Hz System CT Secondary	Time Element Pickup Range	Time Element Max. Continuous Current	Time Element Max. Current For 1 Second	Instantaneous Pickup Range	Time Element Pickup Accuracy	Instantaneous Pickup Accuracy
5 AMP	0.5 to 15.9 Amps in 0.1 Amp Steps	14 Amps	400 Amps	1 to 99 Amps in 1 Amp Steps	2% from 0.5 to 15.9 Amps	2% from 1 to 99 Amps
1 Amp	0.1 to 3.18 Amps in .02 Amp Steps	2.8 Amps	80 Amps	0.2 to 19.8 Amps in 0.2 Amp Steps	2% from 0.1 to 3.18 Amps	2% from 0.2 to 19.8 Amps

FUNCTIONAL DESCRIPTION, continued

OUTPUTS

The TIME contacts (51 and 51AUX) are closed in accordance with conditions defined by the selected time characteristic equation and the sensed current magnitude. If the sensed current exceeds the INST PICKUP setting, the INST contacts (50) are closed.

Breakers controlled by the output contacts can be manually trip tested by inserting a jumper between the TIME and INST MANUAL TRIP test points on the front panel.

TIME ELEMENT
CHARACTERISTIC SHAPES

All time characteristic curves follow the relation:

T_T = (AD / M^{N-C}) + BD + K = Time to trip

T_R = RD / (M²-1) = Time for decaying reset

Table 3.

Curve Type	Constants					
	A	B	C	N	K	R
S	0.2663	0.03393	1.000	1.2969	0.028	0.500
L	5.6143	2.18592	1.000	1.0000	0.028	15.750
D	0.4797	0.21359	1.000	1.5625	0.028	0.875
M	0.3022	0.12840	1.000	0.5000	0.028	1.750
I	8.9341	0.17966	1.000	2.0938	0.028	9.000
V	5.4678	0.10814	1.000	2.0469	0.028	5.500
E	7.7624	0.02758	1.000	2.0938	0.028	7.750
B	1.4636	0.00000	1.000	1.0469	0.028	3.250
C	8.2506	0.00000	1.000	2.0469	0.028	8.000
F	0.0000	1.00000	0.000	0.0000	0.000	1.000

S=Short Inverse M=Moderately Inverse B=BS142 Very Inverse
L=Long Inverse I=Inverse C=BS142 Extremely Inverse
D=Definite Time V=Very Inverse F=Fixed Time
E=Extremely Inverse

Where **D** is the time dial setting (0.0 to 9.9) and **M** is the multiple of pickup. **A, B, C, N, K and R** are constants defining with the shape of the curve. The constants have been selected to provide a very close match to the characteristics of electromechanical relays. The constants are provided in Table 3 for each characteristic curve shape. Figure 2 illustrates the characteristic shapes.

The Active/Pickup LED on the front panel will turn red when the applied current just exceeds the PICKUP setting (See Figure 4).

RESET

Reset occurs when the current level is less than pickup. Jumper selection provides selection of either an Instantaneous or a decaying reset characteristic.

The instantaneous reset characteristic forces the timer to zero when the input current falls below 95% of setting. This fast reset characteristic prevents the ratcheting effect on electromechanical relay disks that occurs for repeated faults.

The decaying reset characteristic replicates the decaying reset of electromechanical relay disks. Models with dash numbers in the 200 series continue the decaying process even when the input current goes to zero. Models with dash numbers in the 100 series reset immediately when the input current drops below the minimum required to power-up the relay (.5A for 5A models and 0.1A for 1A models).

TIME DIAL RANGE AND ACCURACY

The TIME DIAL range is 0.0 to 9.9 in 0.1 steps. A setting of 0.0 results in instantaneous operation without intentional time delay.

INSTANTANEOUS ELEMENT CHARACTERISTICS

The characteristic for phase faults is faster because the relay will be powered up. However, the tripping characteristic for ground applications is slightly longer to allow time to power up the relay. This longer trip time for ground applications is beneficial because it helps avoid nuisance trips. These timing characteristics are shown in Figure 3.

Additional definite time delays of 0.1, 0.2, or 0.3 seconds may be added to the instantaneous element. The definite delay is determined by switches on the circuit card.

OUTPUTS

Separate output contacts are provided for the TIME (51) and INST (50) trip functions. An additional auxiliary output relay (51 AUX) is included. This output operates simultaneously with the TIME output relay. All output contacts are configured normally open (NO).

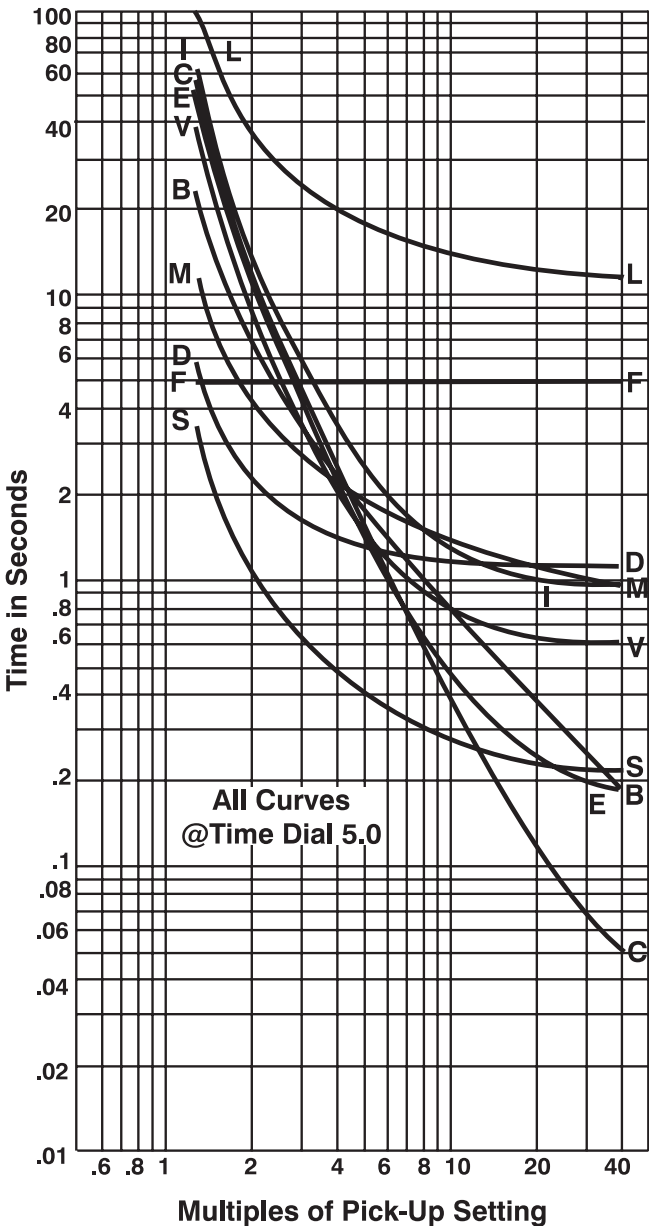
MANUAL TRIP TESTING

The relay is provided with front panel test points to allow shorting the output terminals to verify external control circuit wiring.

TARGETS

Two target indicators are provided as a standard feature of the BE1-50/51M. These magnetically latched, current operated targets provide visual indication of trip by the TIME or INST output contact. These targets must be manually reset after the abnormal condition has been removed or corrected.

FUNCTIONAL DESCRIPTION, continued



S=Short Inverse **M**=Moderately Inverse **B**=BS142 Very Inverse
L=Long Inverse **I**=Inverse **C**=BS142 Extremely Inverse
D=Definite Time **V**=Very Inverse **F**=Fixed Time
E=Extremely Inverse

Figure 2 - Time-Current Characteristics

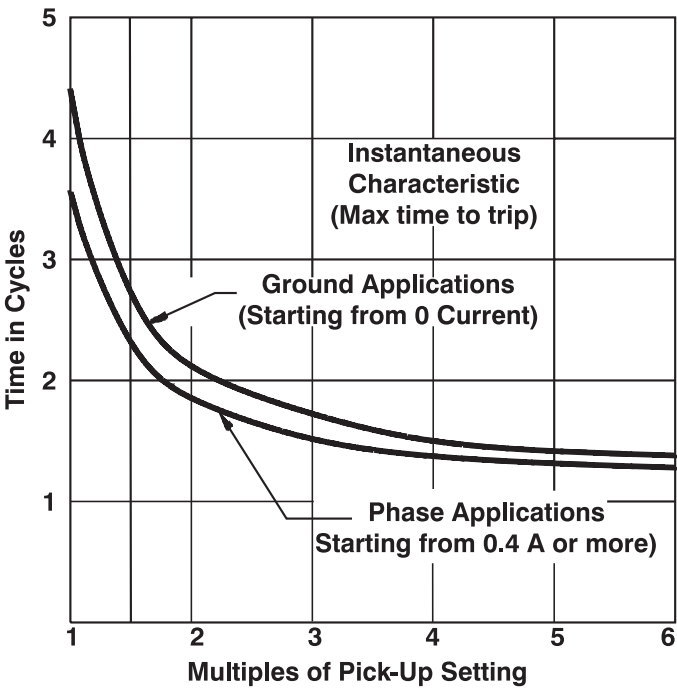


Figure 3 - Instantaneous Characteristics

FUNCTIONAL DESCRIPTION, continued

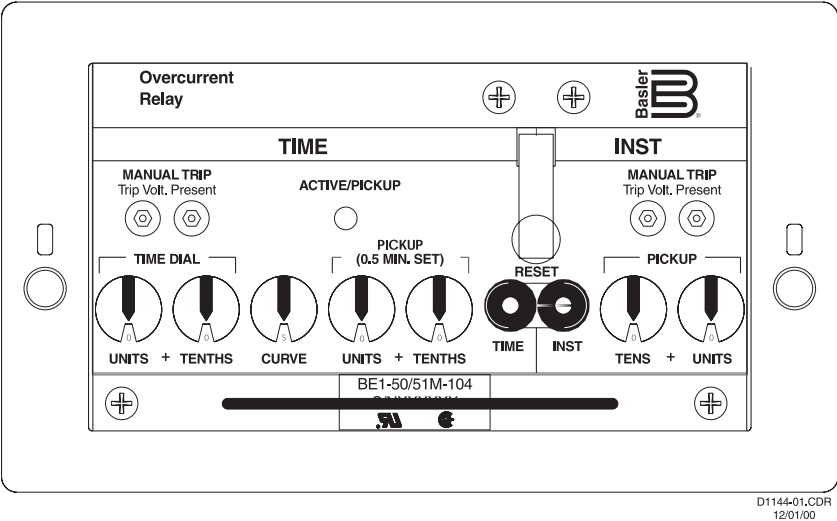


Figure 4 - Front Panel, Horizontal Mounting

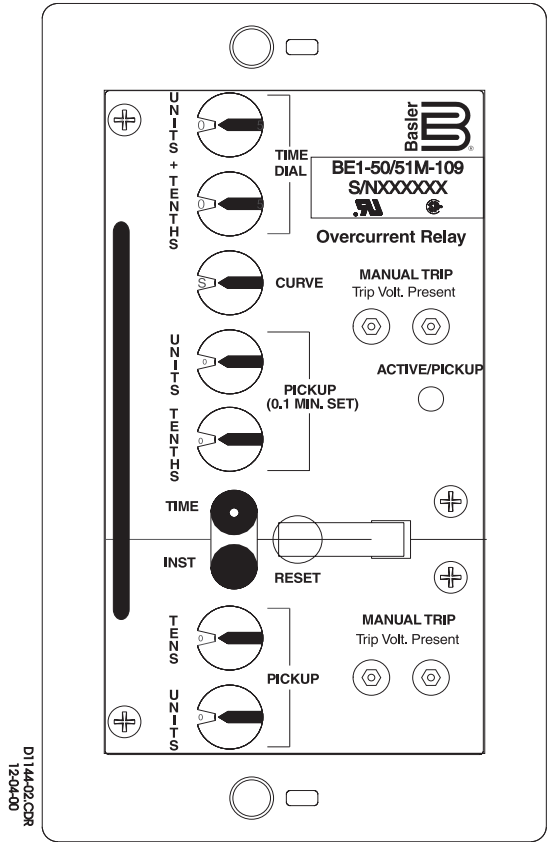


Figure 5 - Front Panel, Vertical Mounting

SPECIFICATIONS

CURRENT SENSING INPUT:	Continuous Current	One Second Current
5 Amp Unit	10.0 Amps	400 Amps
1 Amp Unit	2.0 Amps	80 Amps

TIME PICKUP RANGE:

5 Amp Unit: 0.5 to 15.9 Amps in 0.1 Amp steps

1 Amp Unit: 0.1 to 3.18 Amps in 0.02 Amp steps

TIME DROPOUT:

Not less than 95% of pickup value.

TIME PICKUP ACCURACY:

± 2% of setting

TIME DIAL RANGE:

0.0 to 9.9 in 0.1 steps

TIME CHARACTERISTICS:

Nine inverse time and 1 fixed time function can be selected by a front panel switch. Characteristic curves are defined by the time characteristic equation. The fixed time characteristic provides delays of 0.0 to 9.9 seconds corresponding to the dial setting.

INVERSE TIMING ACCURACY:

± 2%, ±1 cycle for multiples of pickup from 2 to 40. Below multiples of 2, errors may increase directly proportional to the value of $\frac{1}{(M^N-1)}$.

FIXED TIME ACCURACY:

±2% or 30 milliseconds, whichever is greater.

TIME RESET:

Instantaneous or decay as selected by jumper.

INST PICKUP RANGE:

5 Amp Unit: 1 to 99 Amps in 1 Amp steps

1 Amp Unit: 0.2 to 19.8 Amps in 0.2 Amp steps

INST DROPOUT:

95% of pickup

INST PICKUP ACCURACY:

± 2% of setting

INST CHARACTERISTIC:

Industry accepted shape. Longer time for ground applications. Additional definite delays of 0.1, 0.2 and 0.3 seconds are user selectable by jumpers.

INST TRANSIENT RESPONSE:

Less than 10% overreach with system time constants up to 40 milliseconds.

BURDEN: Burden is non-linear and resistive.

5 Amp Unit: 4.8 Ohms @ 0.5A & 0.2 Ohms @ 5A

1 Amp Unit: 120 Ohms @ 0.1A & 5 Ohms @ 1A

TARGETS:

Magnetically latched, manually reset for TIME and INST output functions.

Operate Current: 0.2 Amp minimum

Coil Resistance: 0.1 Ohm

Operate Time: < 1 millisecond

OUTPUTS: (50, 51 and 51 Aux)

Resistive:

250 Vdc-Make and carry 30 Amps for 0.2 seconds, 7 Amps for 2 minutes and 3 Amps continuously, break 0.3 Amp.

Inductive:

250 Vdc- Break 0.3 Amp (L/R = 0.04)

ISOLATION:

2000 Vac at 50/60 Hz for one minute (1500 Vac for one minute across open contacts) in accordance with IEC 255-5 and IEEE C37.90-1-1989 (Dielectric Test).

SURGE WITHSTAND CAPABILITY:

Qualified to IEEE C37.90.1-1989

Standard Surge Withstand Capability (SWC)

Tests for Protective Relays and Relay Systems.

FAST TRANSIENT:

Qualified to IEEE C37.90.1-1989

IMPULSE TEST:

Qualified to IEC 255-5

RADIO FREQUENCY INTERFERENCE (RFI):

Qualified to IEEE C37.90.2-1989. Field tested using five watt transceiver operating at random frequencies centered around 144 MHZ and 440 MHZ.

TEMPERATURE:

Operating Range -40° C (-40° F) to 70° C (158° F).

Recommended Storage Range -50° C (-58° F) to 50° C (122° F).

SHOCK:

15g in each of three mutually perpendicular planes.

VIBRATION:

2g in each of three mutually perpendicular planes swept over the range of 10 to 500 Hz for a total of 6 sweeps, 15 minutes per sweep.

CASE SIZE:

C1 - 6.88" x 4.00"

7.00" Depth from mounting surface.

NET WEIGHT:

5.2 pounds

ORDERING

MODEL NUMBER

BE1-50/51M Time Overcurrent Relay

HOW TO ORDER:

Designate the Model Number and the 3 digit dash number from TABLE 4 to define the configuration desired.

Table 4.

DESCRIPTION	MODEL NUMBER (See Note)
For 5 Amp System CT Secondaries Semi-Flush Horizontal Mounting C1 Size Case Drawout Construction	BE1-50/51M-104 BE1-50/51M-204
Semi-Flush Vertical Mounting C1 Size Case Drawout Construction	BE1-50/51M-109 BE1-50/51M-209
For 1 Amp System CT Secondaries Semi-Flush Horizontal Mounting C1 Size Case Drawout Construction	BE1-50/51M-100 BE1-50/51M-200
Semi-Flush Vertical Mounting C1 Size Case Drawout Construction	BE1-50/51M-108 BE1-50/51M-208

NOTE: Model numbers ending in 200 series include memory to replicate the decaying reset characteristic of electromechanical relay disks even while the input current is zero. Model numbers ending in 100 series reset instantaneously (regardless of settings) when the input current drops below the minimum TOC pickup value.

ORDERING INFORMATION

All units are self powered and supplied with 10 switch selectable curves, TIME and INST functions and outputs, magnetically latched targets, and an auxiliary output contact.

STANDARD ACCESSORIES:

A rack mounting plate is available to vertically mount four BE1-50/51M units in a standard 19 inch rack. Requires four rack units of space (7.0 inches high). Order Basler part number: 9252012001.

