INSTRUCTION MANUAL

FOR

OVERCURRENT RELAY BE1-50/51B-219

Basler Electric
®Highland, Illinois

TIME	INST

MANUAL TRIP **PICKUP** **MANUAL TRIP**

TIME DIAL **PICKUP**
(0.5 MIN. SET) **RESET** **PICKUP**

UNITS + TENTHS CURVE UNITS + TENTHS TIME INST TENS + UNITS

BE1-50/51B-219
OVERCURRENT RELAY
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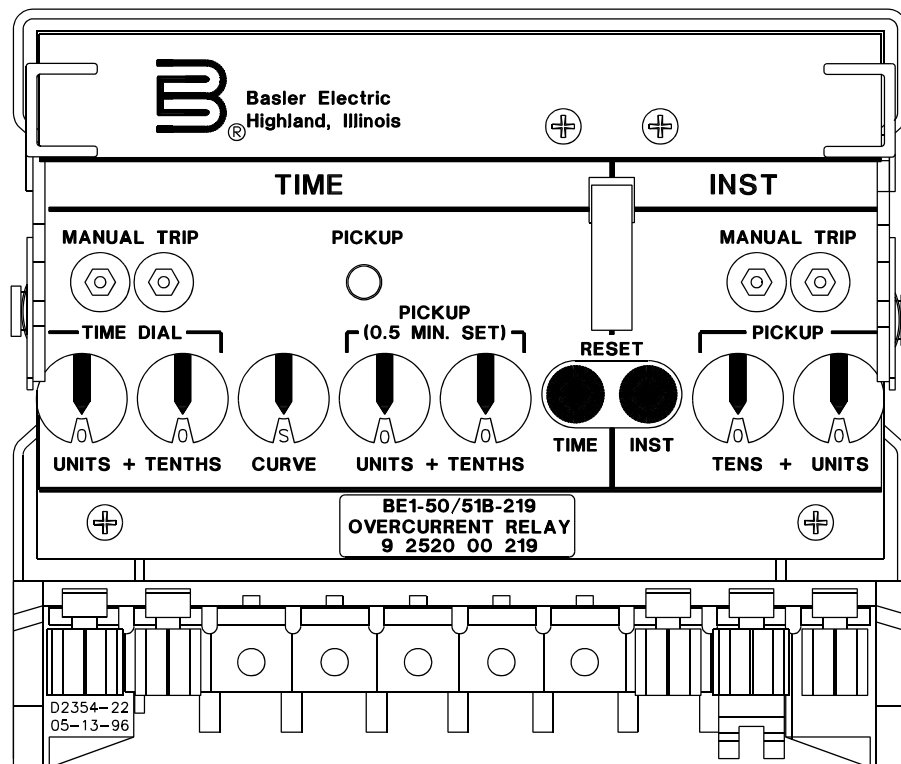
Basler Electric

INTRODUCTION

This manual provides information concerning the operation and installation of the BE1-50/51B-219 Overcurrent Relay. To accomplish this, the following is provided.

■ Specifications

■ Functional description

■ Mounting information

■ Setting procedure/example

W A R N I N G !
To avoid personal injury or equipment damage, only qualified personnel should perform the procedures presented in this manual.

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.

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

BE1-50/51B-219 Overcurrent Relays are direct replacements for Westinghouse/ABB type CO overcurrent relays. Specific relays by catalog number are shown in Table 1-1. To replace an existing Westinghouse/ABB type CO overcurrent relay (hereinafter referred to as ABB relay), perform the following steps.

- Select the desired relay settings on your new BE1-50/51B-219 relay.
- Remove the existing ABB relay cradle.
- Insert the new BE1-50/51B-219 relay cradle.
- Close the knife-blade switches.
- Install the new Basler Electric cover and secure with the captive thumb nut.

BE1-50/51B-219 Overcurrent Relays are self-powered, microprocessor based, non-directional phase or ground relays that monitor the magnitude of a single phase ac current to provide accurate instantaneous and time overcurrent protection for 50 hertz or 60 hertz power systems. One model offers fifteen popular time characteristics, a wide range of pickup settings, and field selectable instantaneous or integrating reset.

Table 1-1. ABB Relays Suitable For Direct Replacement

ABB Catalog Number	Curve Type
CO-2*11*1N	Short Time
CO-5*11*1N	Long Time
CO-6*11*1N	Definite
CO-7*11*1N	Moderately Inverse
CO-8*11*1N	Inverse
CO-9*11*1N	Very Inverse
CO-11*11*1N	Extremely Inverse

NOTE: * = Any character covering all pickup ranges, instantaneous, non-instantaneous, and 50 hertz or 60 hertz models.

APPLICATION

BE1-50/51B-219 Overcurrent Relays, with a wide range of pickup settings and front panel selectable time characteristics, are perfect for applications involving coordination with fuses, reclosers, cold load pickup, motor starting, and fixed time requirements. Also, a field selectable integrating reset function that simulates the disk reset of electromechanical relays or instantaneous reset to avoid ratcheting makes the BE1-50/51B-219 Overcurrent Relay ideal for almost every application.

Features

BE1-50/51B-219 Overcurrent Relays have the following standard features.

- Independent time and instantaneous elements.
- A secure method to manually trip the breaker at the relay front panel.
- Direct reading front panel controls.
- Time characteristics extend to a pickup multiple of 40.
- Rugged draw-out construction.
- Magnetic latching targets retain indication without power.
- Built-in accuracy eliminates internal adjustments.
- Minimum transient overreach.
- Field selectable instantaneous or integrating reset.
- Field selectable characteristic curve selection similar to either GE IAC or ABB CO curves.
- Field selectable 50 or 60 hertz operation.
- Field selectable 0.0 or 0.1 second delay on the instantaneous element.

Internal switches provide for selecting system operating frequencies of 50 or 60 hertz, instantaneous element delays of 0.0 or 0.1 second, characteristic curve group selection for either ABB CO or GE IAC type curves, and instantaneous or integrating reset characteristics. Switch location and description is provided in Section 2.

Advantages

BE1-50/51B-219 Overcurrent Relays have many advantages over other overcurrent relays. Six primary advantages are:

- Minimum transient overreach.
- Time characteristics are defined by equations and graphs.
- Field selectable time characteristics.
- Very low burden extends the linear range of the CTs.
- Self powered from the sensed current.
- Continuous automatic calibration.

BE1-50/51B-219 Overcurrent Relays may be tested without removing the relay from the case. Test plugs provide a quick, easy method of testing relays without removing them from the case. This provides access to the external stud connections as well as to the internal circuitry. Shorting contacts are provided for current inputs when the knife blade switches are opened or the relay chassis is removed from the relay case.

SPECIFICATIONS

BE1-50/51B-219 Overcurrent Relays have the following features and capabilities.

Current Sensing Input	Continuous current: 14 amperes. One second current: 400 amperes.
TIME PICKUP Range	Setting the TIME PICKUP to the minimum pickup (0.5 ampere), places the relay in the most sensitive state and may be used as a safety setting during new equipment installation.
	0.5 to 15.9 amperes in 0.1 ampere steps.
TIME Dropout	Dropout occurs at 95% of pickup value.
TIME PICKUP	
Accuracy	±2% ±25 milliamperes at or above 0.5 ampere settings.
Frequency Response	A change of ±5 hertz from the nominal 50/60 hertz current causes less than 0.5% change in the current required for pickup. (The relay is not frequency selective and functions at frequencies as low as 20 hertz.)

TIME DIAL Range	0.0 to 9.9, in 0.1 steps.

INST PICKUP Range   Setting the INST PICKUP to the minimum pickup (1.0 ampere), places the relay in the most sensitive state and may be used as a safety setting during new equipment installation.

1 to 99 amperes in 1 ampere steps.

INST Dropout   Dropout occurs at 95% of pickup value.

INST PICKUP

Accuracy   ±2% ±25 milliamperes at or above 1.0 ampere settings.

Frequency Response   A change of ±5 hertz from the nominal 50/60 hertz current causes less than 0.5% change in the current required for pickup.

INST Transient Response   Less than 10% overreach with system time constants up to 40 milliseconds

Burden   Burden is non-linear. (Figure 1-1 illustrates the device burden.)
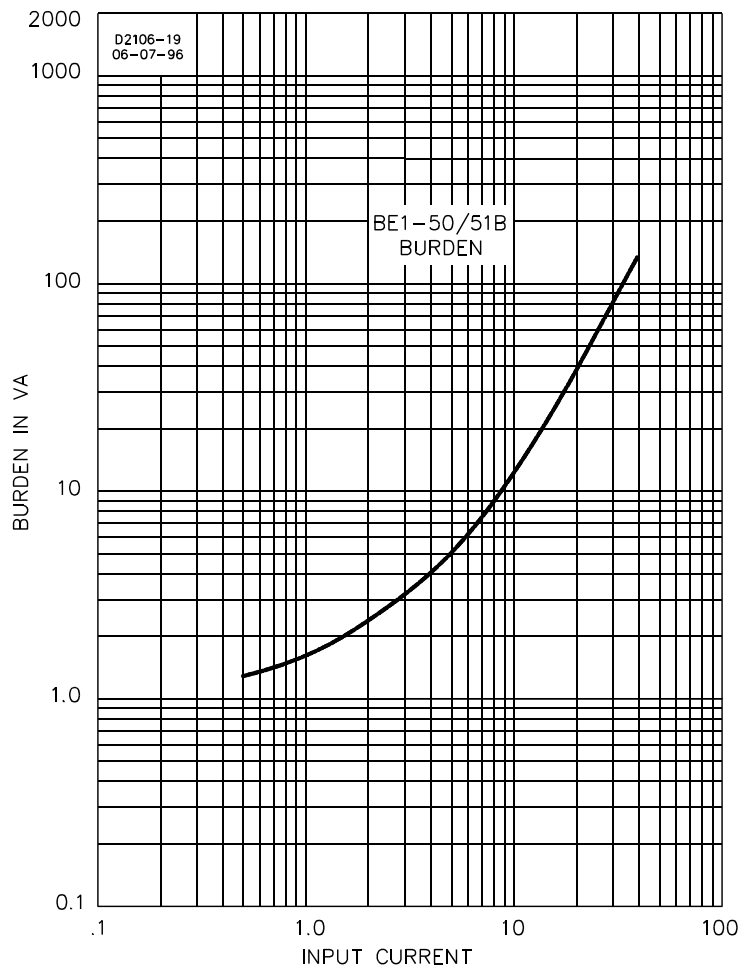At 0.5 amperes, Z = 4.8 ohms. At 5.0 amperes, Z = 0.2 ohms.

Figure 1-1. Device Burden Characteristics

Harmonic Response   Harmonic rejection is illustrated in Figure 1-2.

Figure 1-2 shows that a relay set for one ampere pickup would pickup at

0.96 ampere on a current containing 40% seventh harmonic. This corresponds to a ten-to-one rejection ratio. Other conditions may be evaluated in the same manner.
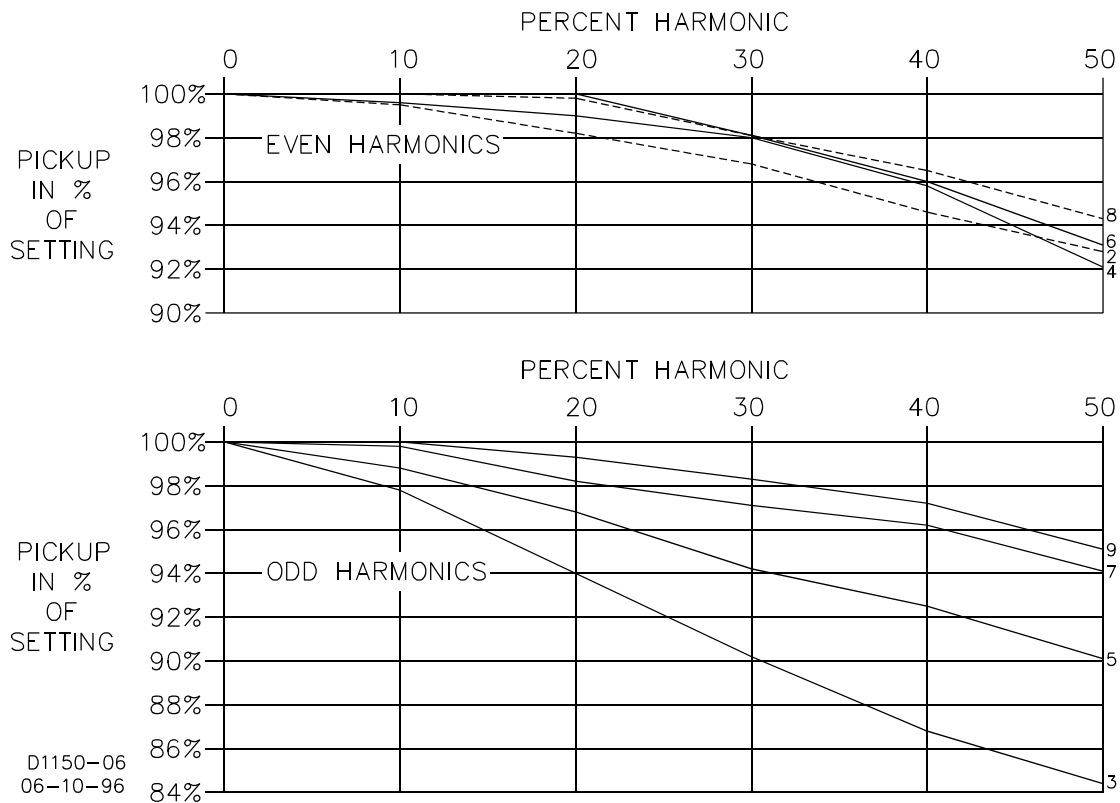
PERCENT HARMONIC

PICKUP IN % OF SETTING

EVEN HARMONICS

PERCENT HARMONIC

PICKUP IN % OF SETTING

ODD HARMONICS

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Figure 1-2. Harmonic Rejection

INST Characteristics

Instantaneous characteristic curves are similar to standard electromechanical instantaneous units. However, the time to trip for applications where the initial current through the relay is less than 0.4 ampere (5 ampere relay) or 0.08 ampere (1 ampere relay) may be slightly longer. This may occur on a very lightly loaded circuit or when the relay is providing ground protection and is connected to measure neutral current. Figure 1-3 shows the instantaneous characteristic curves for maximum time to trip.

An additional fixed delay of 0.1 second may be added with internal switch SW8-2. This delay applies to both phase and ground applications. Closing switch SW8-2 provides an additional delay of 0.1 second. Section 2 illustrates the location of SW8.

The instantaneous element in BE1-50/51B-219 relays may be set lower than the instantaneous element in ABB relays and still have the same reach. This is because the BE1-50/51B-219 instantaneous element effectively eliminates the fault current transient overreach components. When calculating BE1-50/51B-219 relay instantaneous element settings, calculate the symmetrical value without any adder for transient overreach.
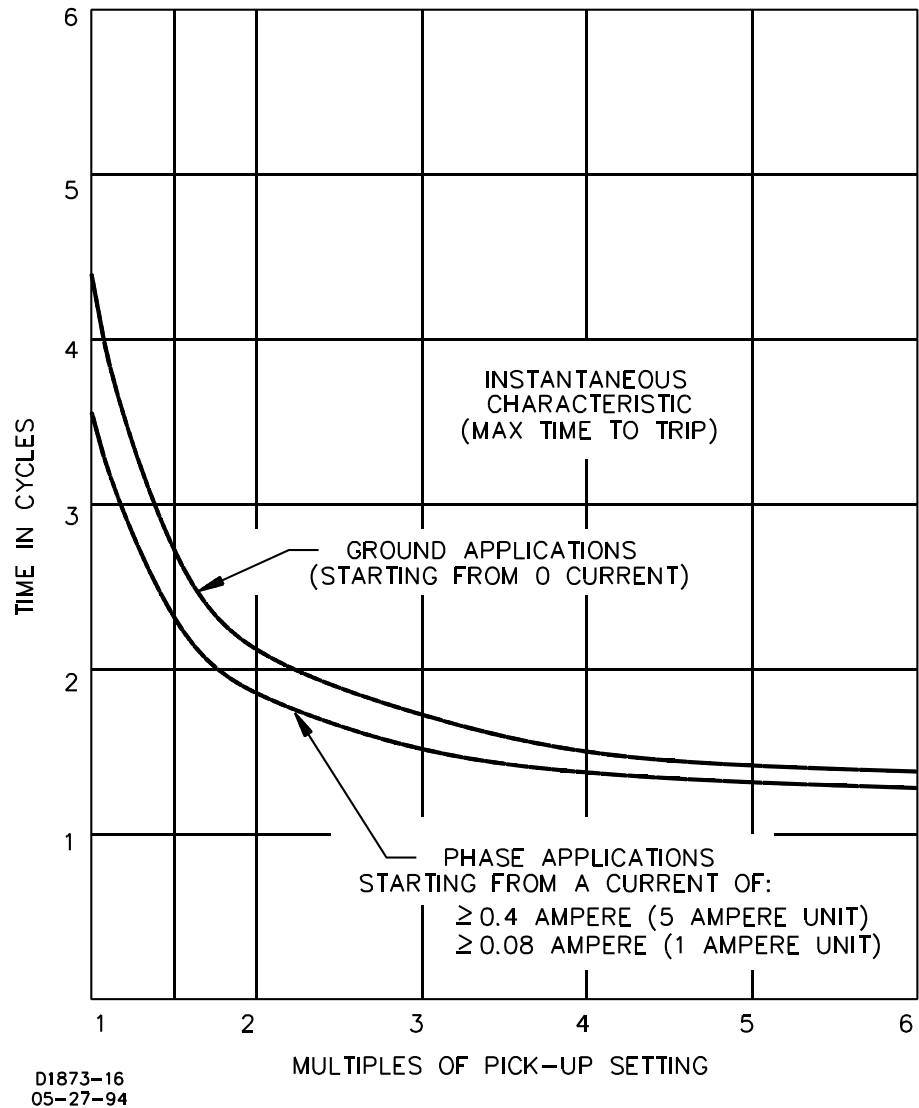
D1873-16
05-27-94

Figure 1-3. Instantaneous Characteristic Curves

Time Characteristics

Nine inverse time functions and one fixed time function can be selected by a front panel switch. Characteristic curves for the inverse and definite time functions are defined by the following equation.

$$T_T = \frac{AD}{M^N - C} + BD + K$$

Where: T_T = Time to trip in seconds
D = TIME DIAL setting
M = Multiple of PICKUP
A, B, C, N, K = Constants for the particular curve

Refer to Tables 1-2 or 1-3 for the time characteristic curve constants. Constants have been selected to conform to the characteristics of electromechanical relays over a range of pickup multiples from 1.3 to 40. Values of the constants are provided for use in computer relay setting programs. Timing accuracy is ±1 cycle ±2% of time to trip.

Time Characteristics
Continued

The fixed time characteristic provides delays of 0.0 to 9.9 seconds corresponding to the time dial setting. The time set is constant over a range of pickup multiples from 1.0 to 40. Accuracy is ±1 cycle ±2% of time to trip for time dial settings of 0.1 and greater.

Table 1-2. Time Characteristic Curve Constants With SW8-3 Open (OFF)

Curve Type		Figure	Constants					
BE1	Similar To	Number	A	B	C	N	K	R
S	ABB CO-2	1-5	0.2663	0.03393	1.000	1.2969	0.028	0.500
L	ABB CO-5	1-6	5.6143	2.18592	1.000	1.000	0.028	15.750
D	ABB CO-6	1-7	0.4797	0.21359	1.000	1.5625	0.028	0.875
M	ABB CO-7	1-8	0.3022	0.12840	1.000	0.5000	0.028	1.750
I	ABB CO-8	1-9	8.9341	0.17966	1.000	2.0938	0.028	9.000
V	ABB CO-9	1-10	5.4678	0.10814	1.000	2.0469	0.028	5.500
E	ABB CO-11	1-11	7.7624	0.02758	1.000	2.0938	0.028	7.750
B	BS142-B*	1-12	1.4636	0.00000	1.000	1.0469	0.028	3.250
C	BS142-C*	1-13	8.2506	0.00000	1.000	2.0469	0.028	8.000
F	None**	None	0.0000	1.00000	0.000	0.0000	0.000	1.000

* Curves B and C are defined in British Standard BS142 and IEC 255-4 (International Electrotechnical Commission)

** Fixed time from 0.1 to 9.9 seconds.

BE1 Curve Types:

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

Table 1-3. Time Characteristic Curve Constants With SW8-3 Closed (ON)

Curve Type		Figure	Constants					
BE1	Similar To	Number	A	B	C	N	K	R
S	GE IAC 55	1-14	0.0286	0.0208	1.000	0.9844	0.028	0.0940
L	GE IAC 66	1-15	2.3955	0.00002	1.000	0.3125	0.028	7.8001
D	ABB CO-6	1-7	0.4797	0.21359	1.000	1.5625	0.028	0.8750
M	ABB CO-7	1-8	0.3022	0.12840	1.000	0.5000	0.028	1.7500
I	GE IAC 51	1-16	0.2747	0.1042	1.000	0.4375	0.028	0.8868
V	GE IAC 53	1-17	4.4309	0.0991	1.000	1.9531	0.028	5.8231
E	GE IAC 77	1-18	4.9883	0.0129	1.000	2.0469	0.028	4.7742
B	BS142-B*	1-12	1.4636	0.00000	1.000	1.0469	0.028	3.2500
C	BS142-C*	1-13	8.2506	0.00000	1.000	2.0469	0.028	8.0000
F	None**	None	0.0000	1.00000	0.000	0.0000	0.000	1.0000

Integrating Time Reset Characteristic

Reset begins when the current drops below 95% of pickup. Integrating reset simulates the disk reset of electromechanical relays. BE1-50/51B-219 relays provide the integrating reset function even when input current falls to zero.

Integrating reset characteristics are defined by the following equation and shown in Figure 1-4. Equation constants are provided in Tables 1-2 or 1-3.

$$T_R \left(\text{Time To Reset} \right) = \frac{RD}{M^2 - 1}$$

Where: R = Constant for the particular curve
               D = TIME DIAL setting
               M = Multiple of PICKUP

Time characteristic curve equation.

$$T_T = \frac{AD}{M^N - C} + BD + K$$

Where: D = TIME DIAL setting
               M = Multiple of PICKUP

Reset characteristic curve equation.

$$T_R = \frac{RD}{M^2 - 1} = \text{Time To Reset}$$

Instantaneous Time Reset Characteristic

Resets within 16 milliseconds when current drops below pickup.

Target Indicators

Magnetically latched, manually reset targets indicate that current of 0.2 amperes or greater was present in the trip circuit. Target coil resistance is less than 0.1 ohms and operate time is less than one millisecond. See 50/51 Output specifications for maximum current rating.

50/51 Output

Output contacts are surge protected and rated as follows:

Resistive:
    120/240 Vac

Make 30 amperes for 0.2 seconds, carry 7 amperes for 2 minutes, 3 amperes continuously, and break 5 amperes.

    125/250 Vdc

Make 30 amperes for 0.2 seconds, carry 7 amperes for 2 minutes, 3 amperes continuously, and break 0.3 ampere.

Inductive:
    120/240 Vac,
    125/250 Vdc

Make and carry 30 amperes for 0.2 seconds, carry 7 amperes for 2 minutes, 3 amperes continuously, and break 0.3 ampere. (L/R = 0.04).

Isolation Meets IEC 255-5 and exceeds IEEE C37.90-1989, one-minute dielectric (high potential) tests as follows:

All circuits to ground:	2828 Vdc
Input to output circuits:	2000 Vac or 2828 Vdc
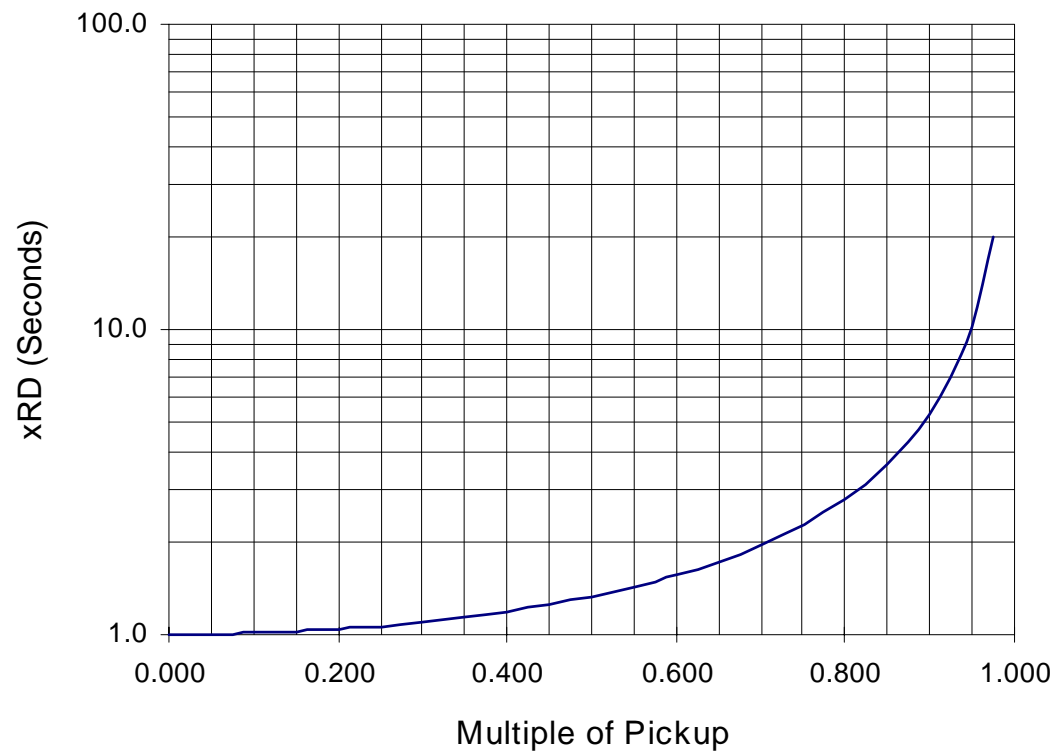
This chart vertical axis **xRD (Seconds)** is applicable for all curves and is derived from multiplying the constant **R** for the curve selected times **D** (the TIME DIAL setting).

Figure 1-4. Integrating Reset Characteristic Curve

Surge Withstand Capability

Oscillatory 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 *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay*

Fast Transient Qualified to IEEE C37.90.1-1989.

Impulse Test Qualified to IEC 255-5.

Radio Frequency Interference (RFI) Field tested using a five watt, hand-held transceiver operating at random frequencies centered around 144 megahertz and 440 megahertz, with the antenna located six inches from the relay in both horizontal and vertical planes.

Patent Patented in U.S., 1998, U.S. Patent No. 5751532.

Temperature	<u>Operating Range</u> -40°C (-40°F) to 70°C (158°F) <u>Recommended Storage Range</u> -50°C (-58°F) to 50°C (122°F).
Shock	15 g in each of three mutually perpendicular planes.
Vibration	2 g in each of three mutually perpendicular planes swept over the range of 10 to 500 hertz for a total of six sweeps, 15 minutes each sweep.
Case Size	S1.
Weight	6.1 pounds.

CHARACTERISTIC CURVES

Figures 1-5 through 1-18 illustrate the characteristic curves that are programmed into the nonvolatile memory of this relay. To order full-size drawings of these characteristic curves, contact the Customer Service Department of the Power Systems Group, Basler Electric, and request publication 9 2520 00 999. This publication contains fourteen full size characteristic curves on transparent paper (vellum).
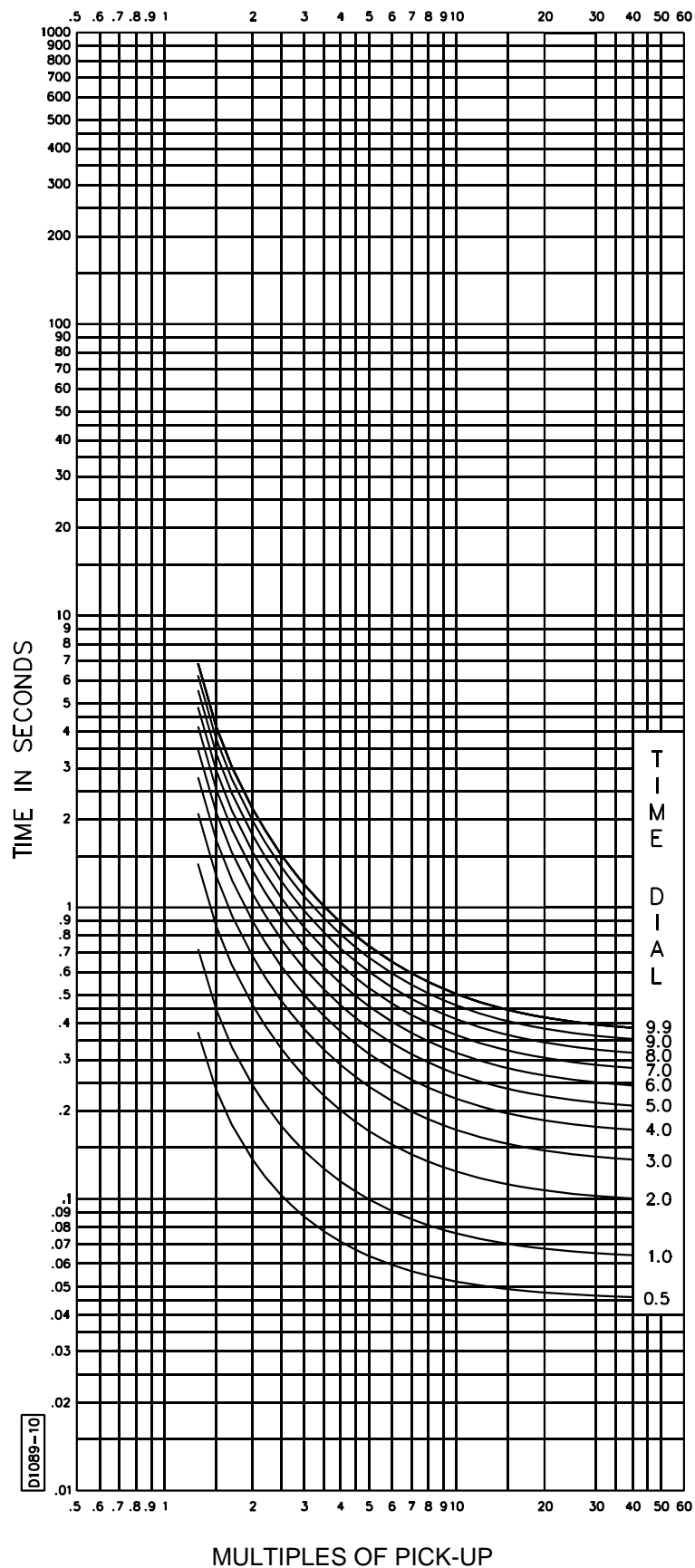
Figure 1-5. Time Characteristic Curve, 99-1369, S-Short Inverse (SW8-3 OFF, Similar to ABB CO-2)
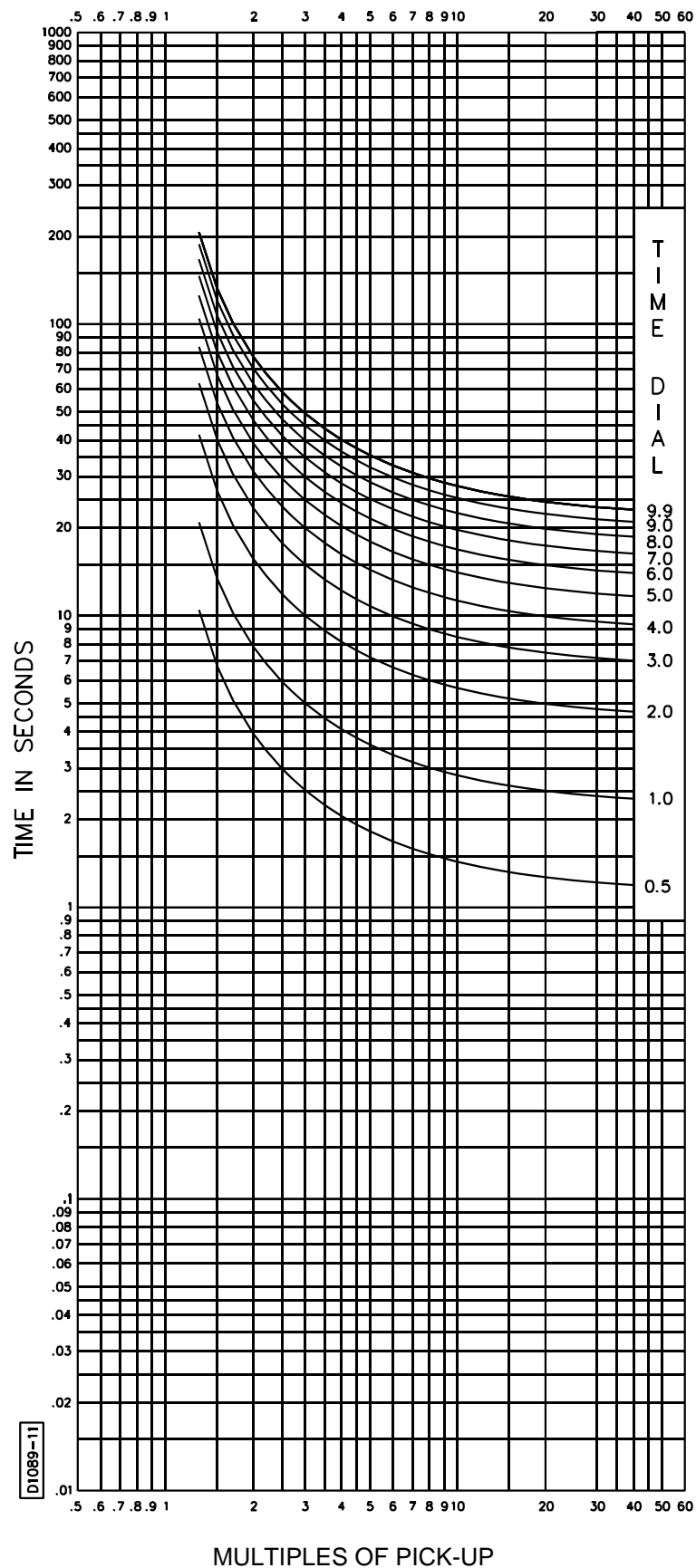
Figure 1-6. Time Characteristic Curve, 99-1370, L-Long Inverse (SW8-3 OFF, Similar to ABB CO-5)
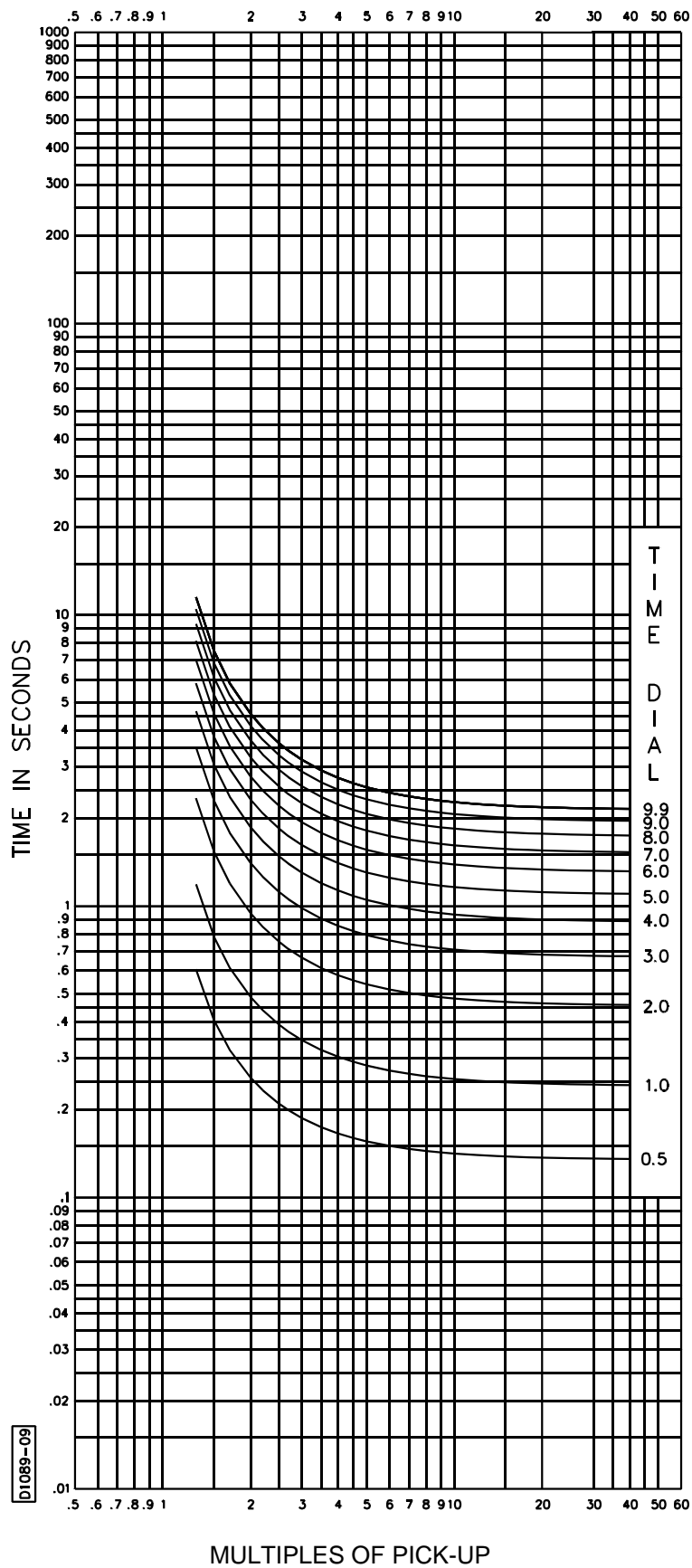
Figure 1-7. Time Characteristic Curve, 99-1371, D-Definite Time (Similar to ABB CO-6)
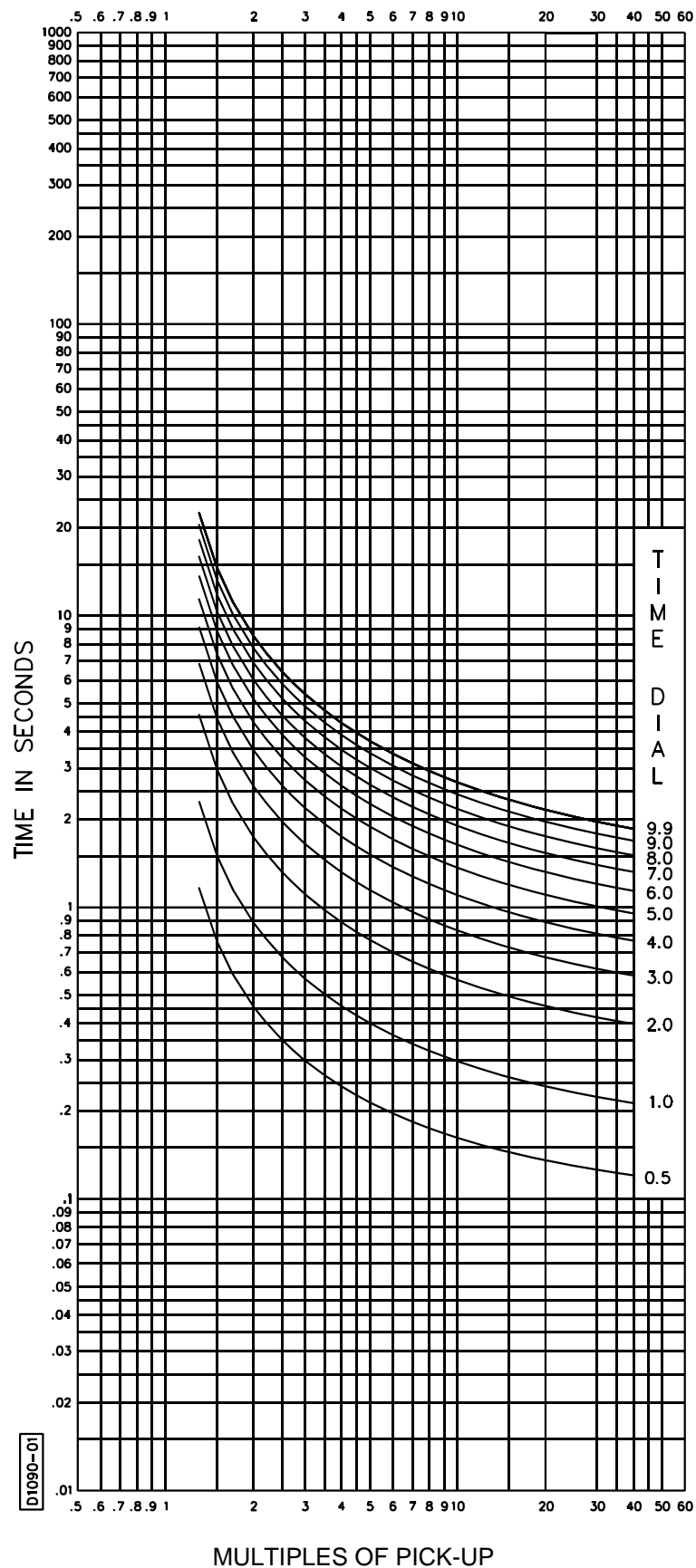
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Figure 1-8. Time Characteristic Curve, 99-1372, M-Moderately Inverse (Similar to ABB CO-7)
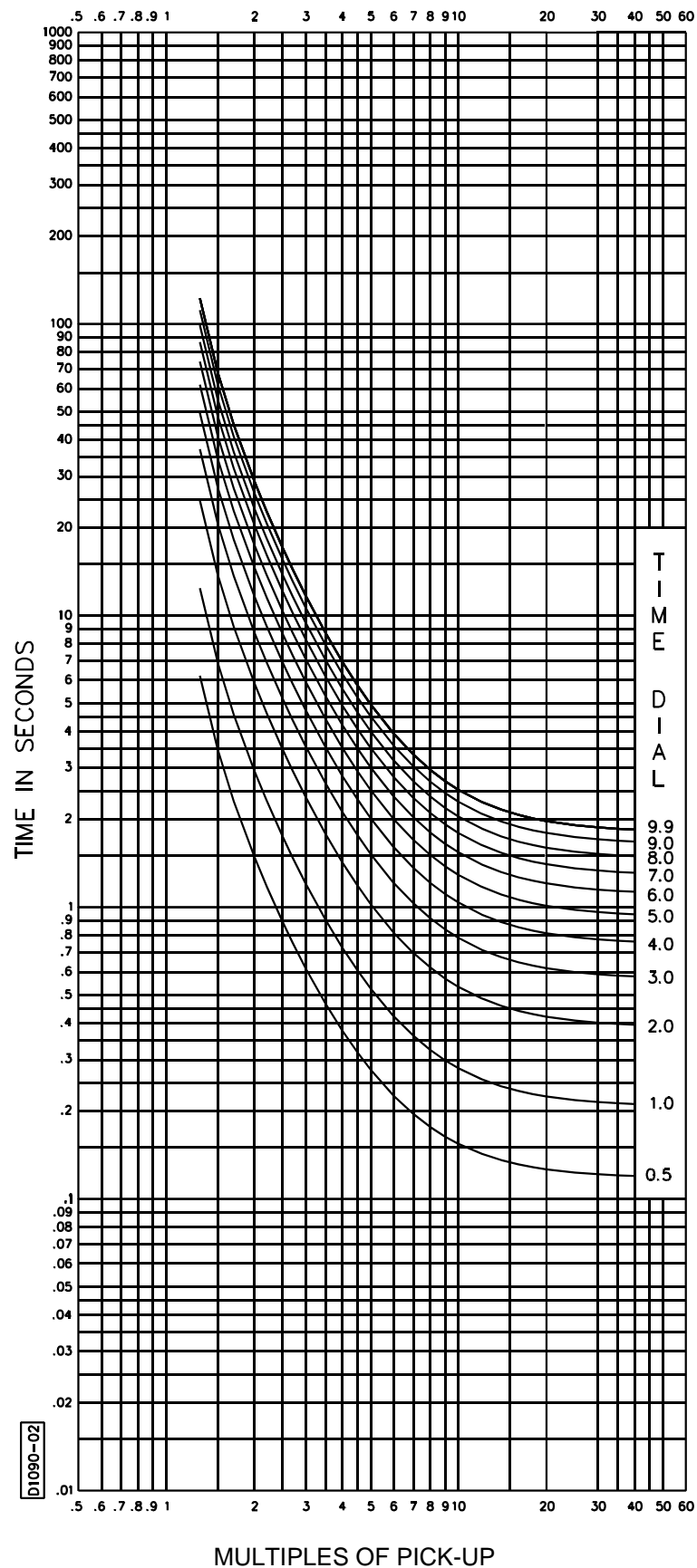
Figure 1-9. Time Characteristic Curve, 99-1373, I-Inverse (SW8-3 OFF, Similar to ABB CO-8)
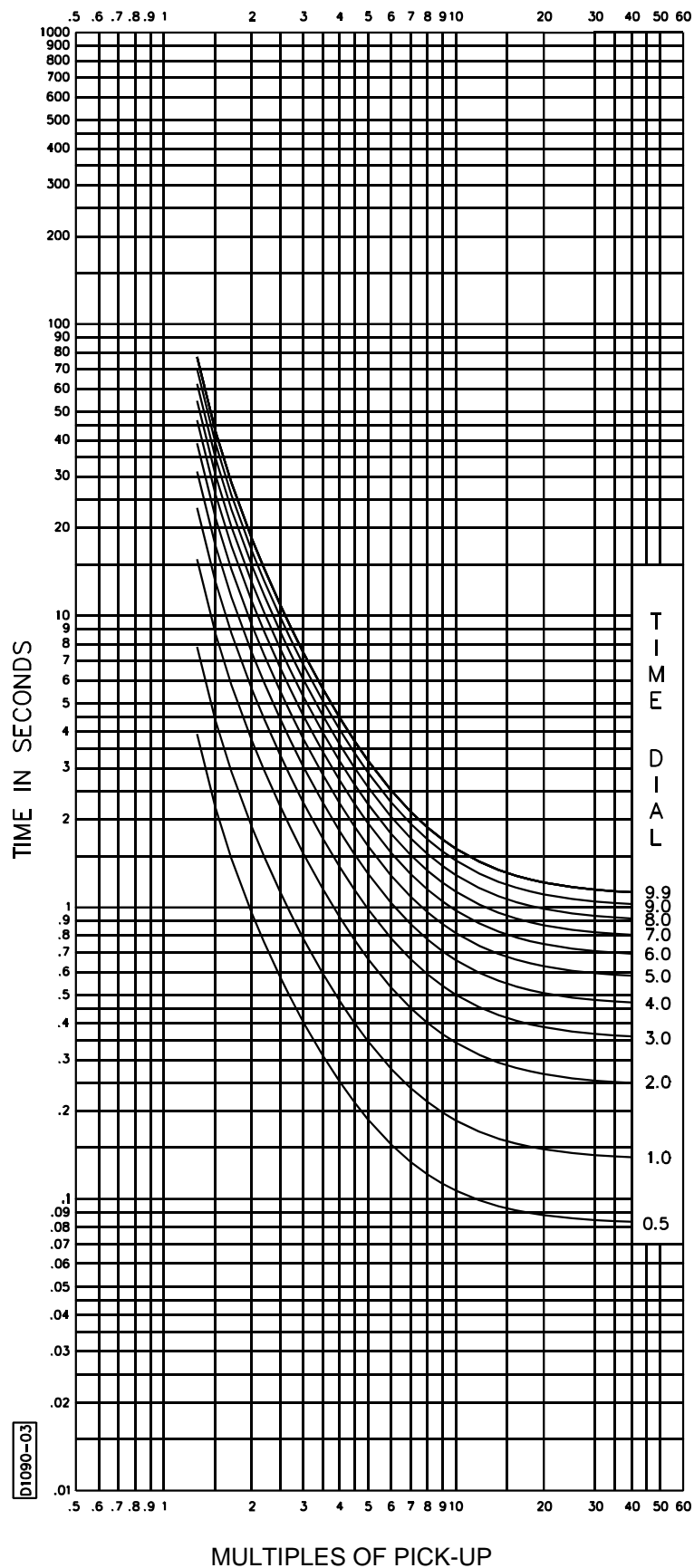
Figure 1-10. Time Characteristic Curve, 99-1374, V-Very Inverse (SW8-3 OFF, Similar to ABB CO-9)
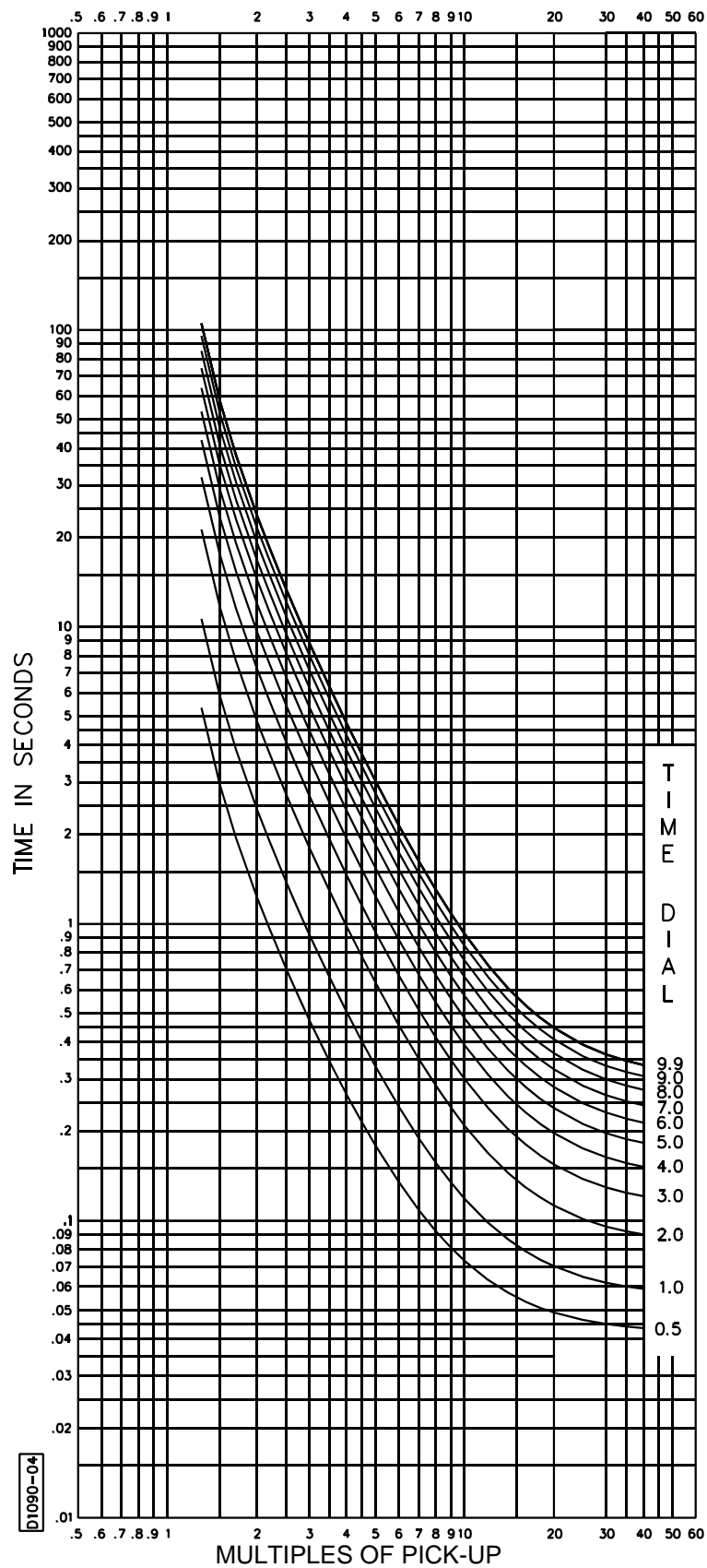
Figure 1-11. Time Characteristic Curve, 99-1375, E-Extremely Inverse
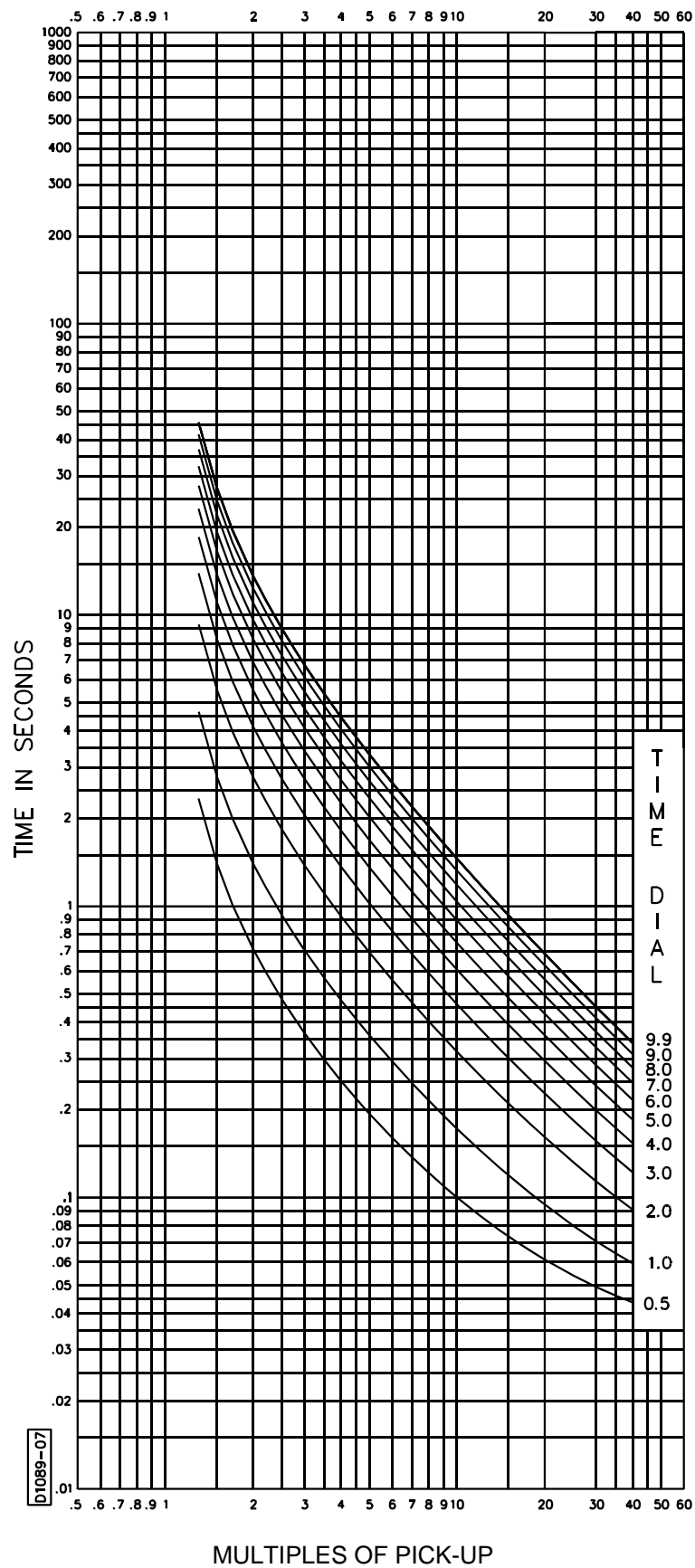(SW8-3 OFF, Similar to ABB CO-11)

Figure 1-12. Time Characteristic Curve, 99-1376, BS142-B (BS142 Very Inverse)
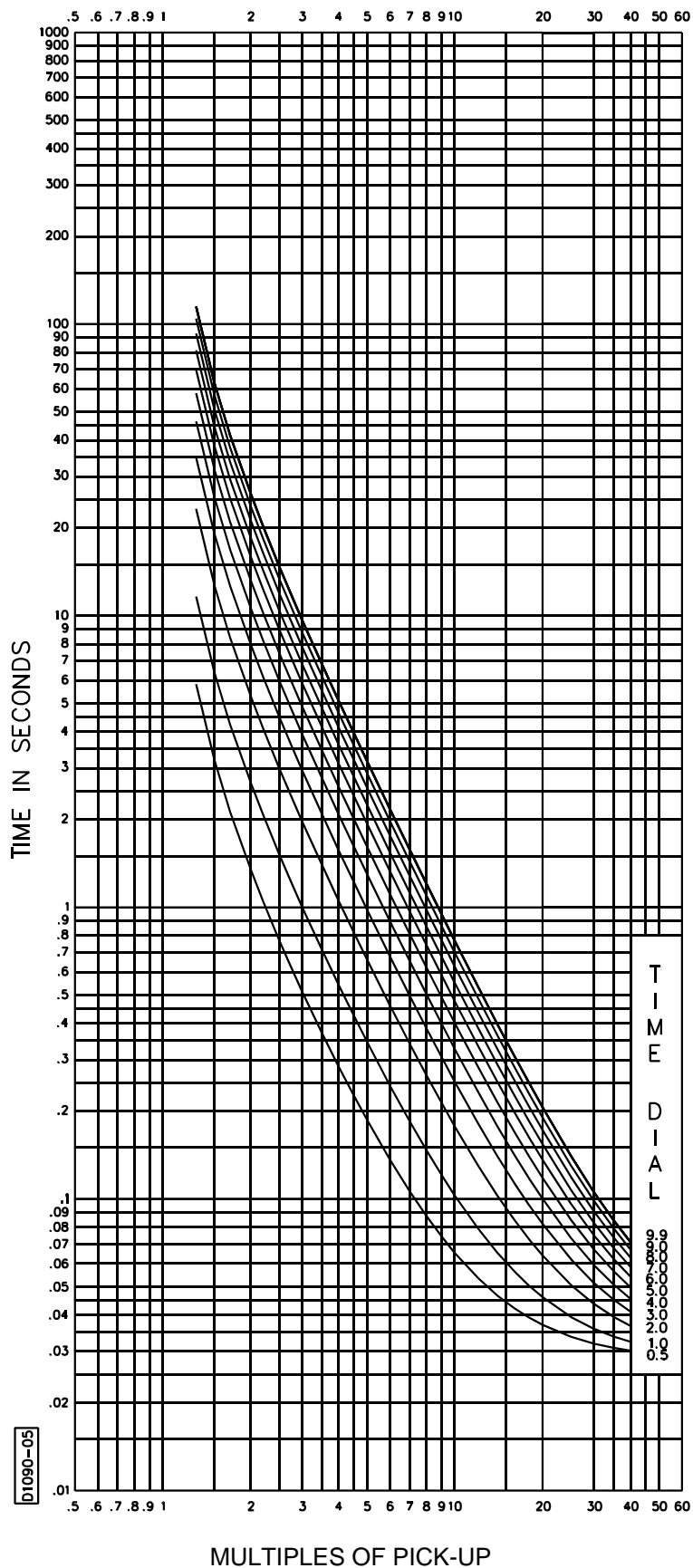
Figure 1-13. Time Characteristic Curve, 99-1377, BS142-C (BS142 Extremely Inverse)

Figure 1-14. Time Characteristic Curve, 99-1595, S2-Short Inverse (SW8-3 ON, Similar to GE IAC 55)

Figure 1-15. Time Characteristic Curve, 99-1594, L2-Long Inverse (SW8-3 ON, Similar To GE IAC 66)
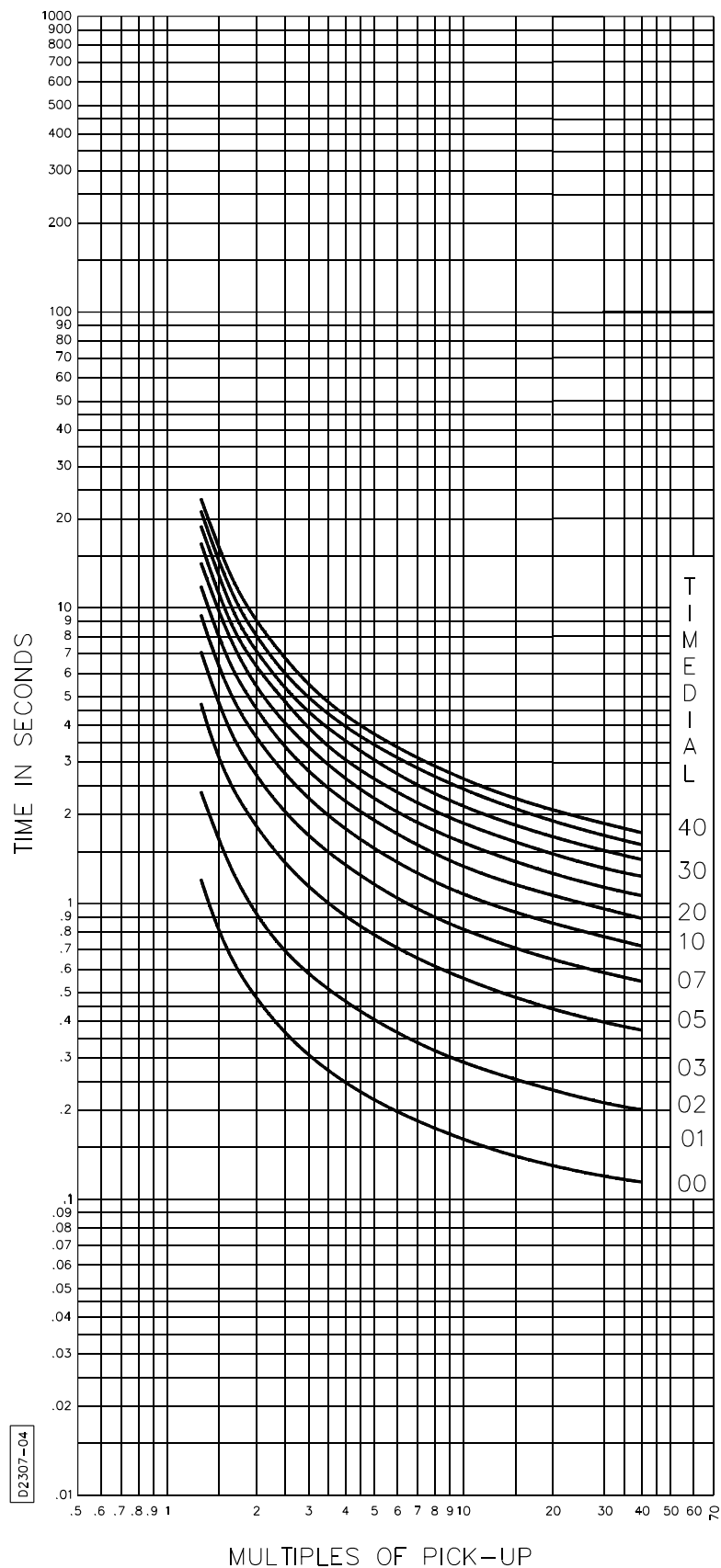
Figure 1-16. Time Characteristic Curve, 99-1597, I2-Inverse (SW8-3 ON, Similar To GE IAC 51)

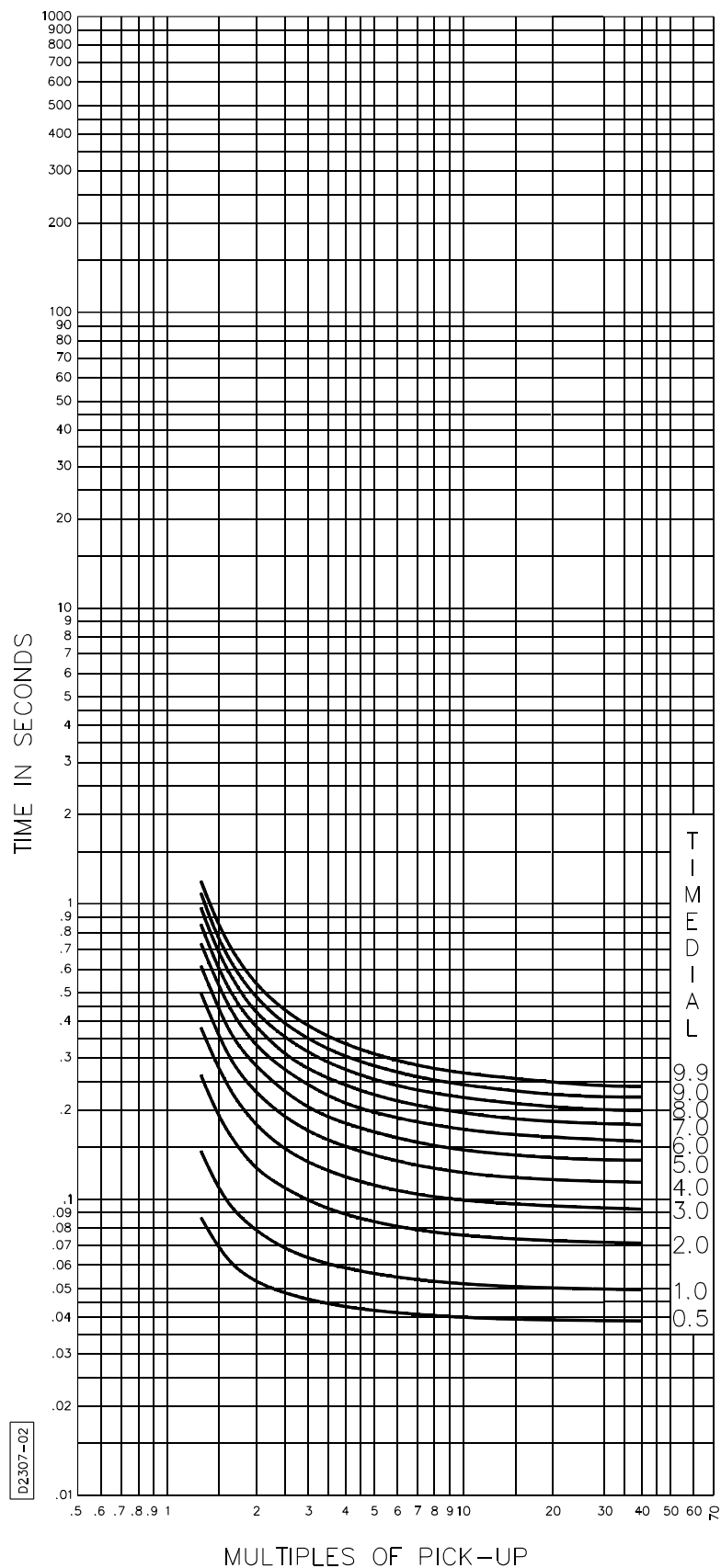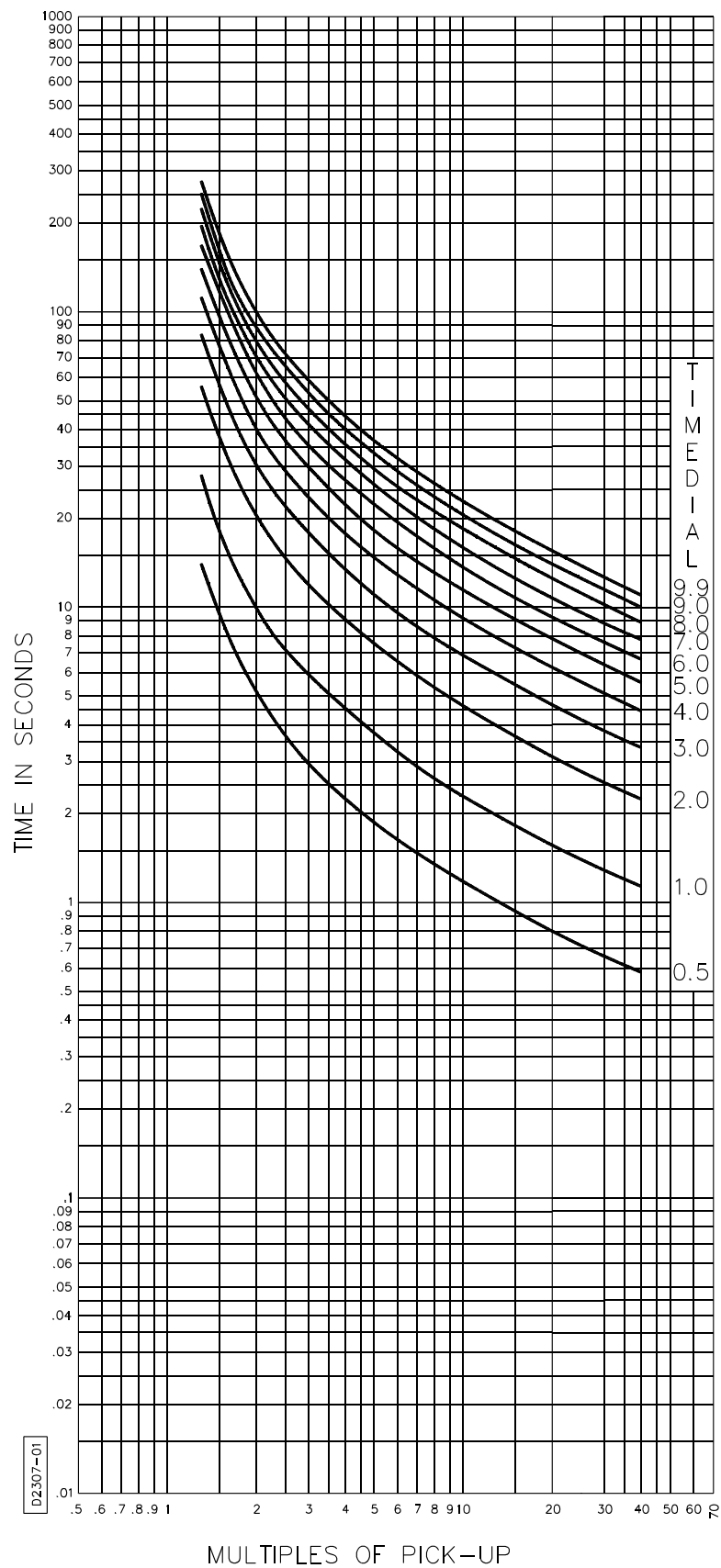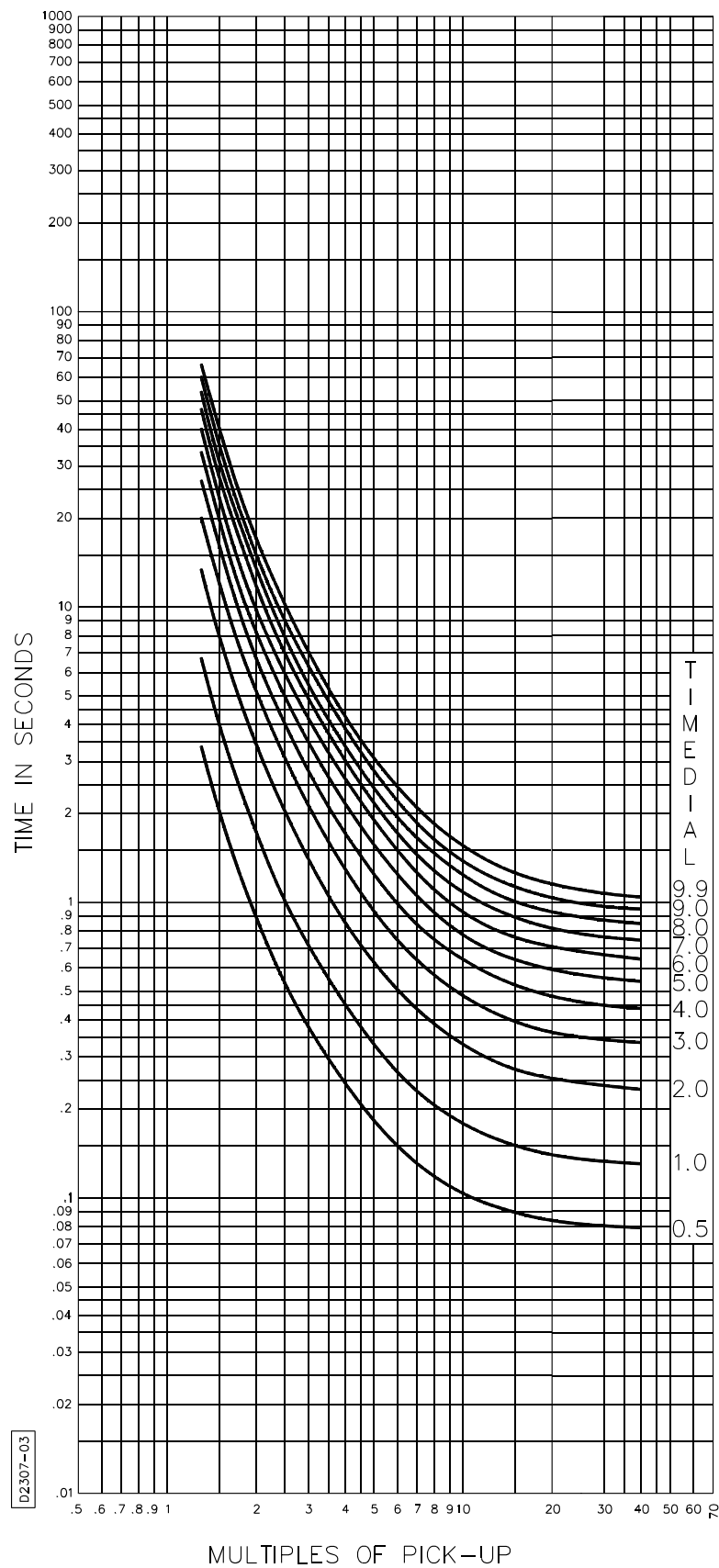*Figure 1-17. Time Characteristic Curve, 99-1596, V2-Very Inverse (SW8-3 ON, Similar To GE IAC 53)*
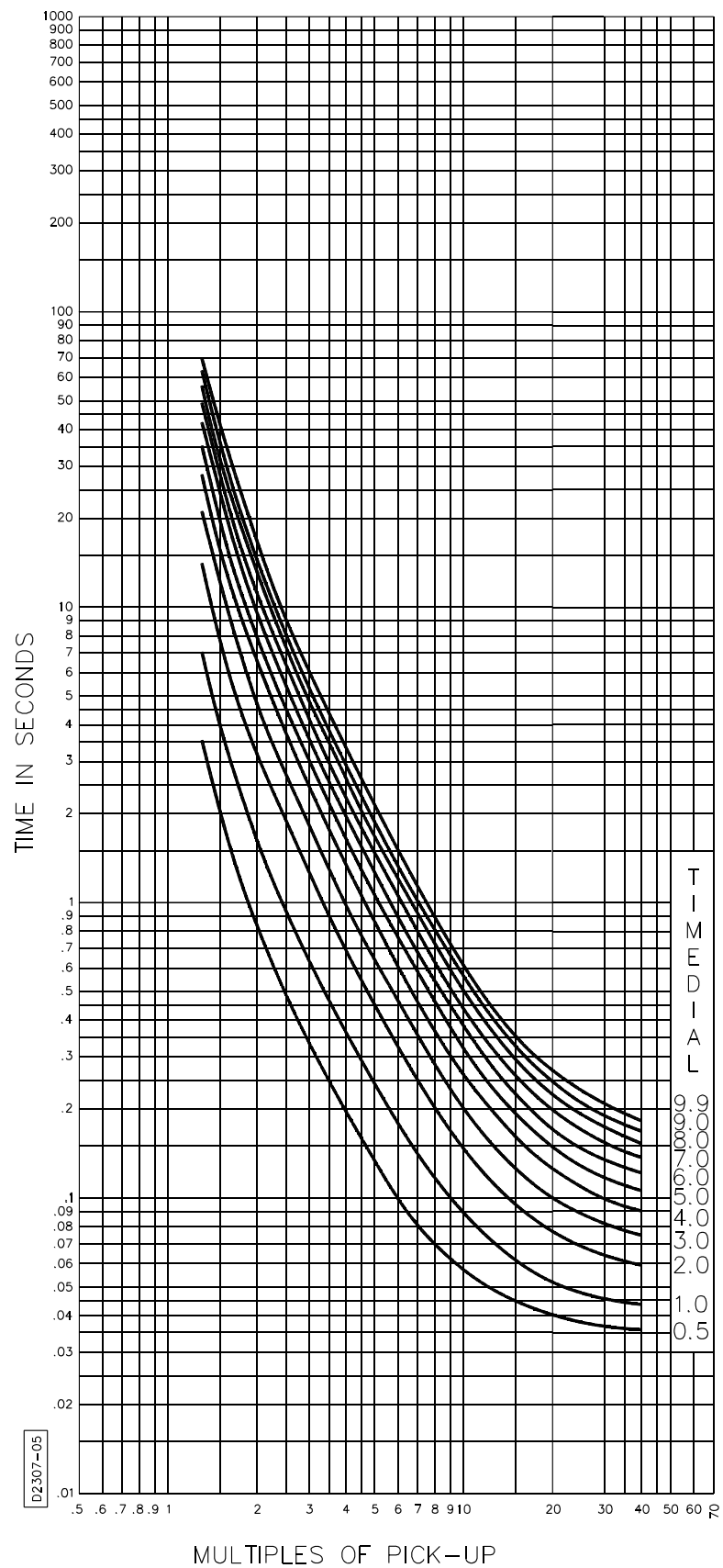
*Figure 1-18. Time Characteristic Curve, 99-1598, E2-Extremely Inverse
(SW8-3 ON, Similar To GE IAC 77)*

SECTION 2 • HUMAN MACHINE INTERFACE (CONTROLS AND INDICATORS)

GENERAL

Table 2-1 lists and briefly describes the BE1-50/51B-219 controls and indicators. Reference the callouts to Figures 2-1, 2-2 , and 2-3.

Table 2-1. BE1-50/51B-219 Controls and Indicators

Locator	Control or Indicator	Function
A	**INST MANUAL TRIP** Test Points	When shorted, the test points (jacks) provide a secure means to manually trip the controlled breaker. Jacks accept a standard 0.080 inch diameter phone tip plug.

Figure 2-1. Location of Controls and Indicators

Table 2-1. BE1-50/51B-219 Controls and Indicators - Continued

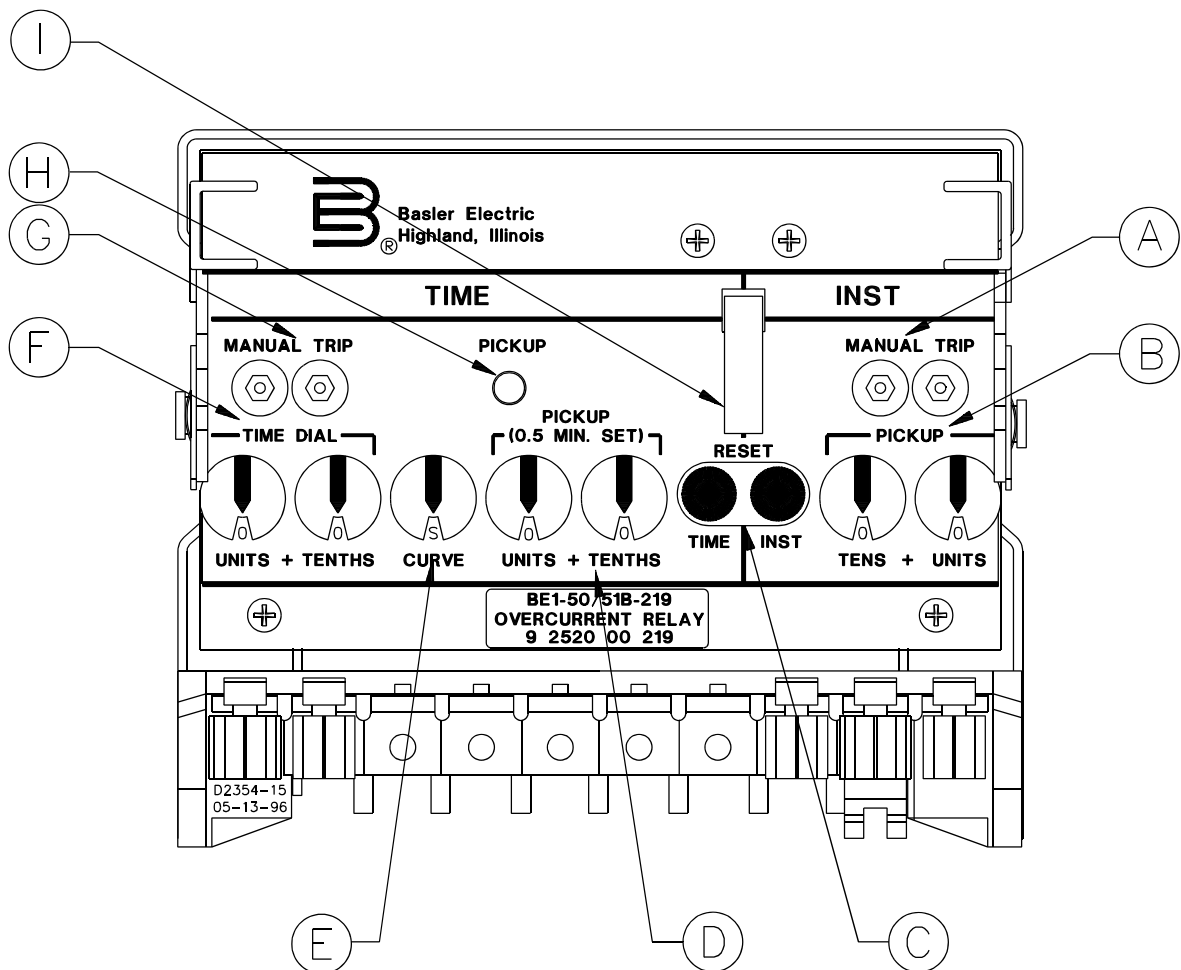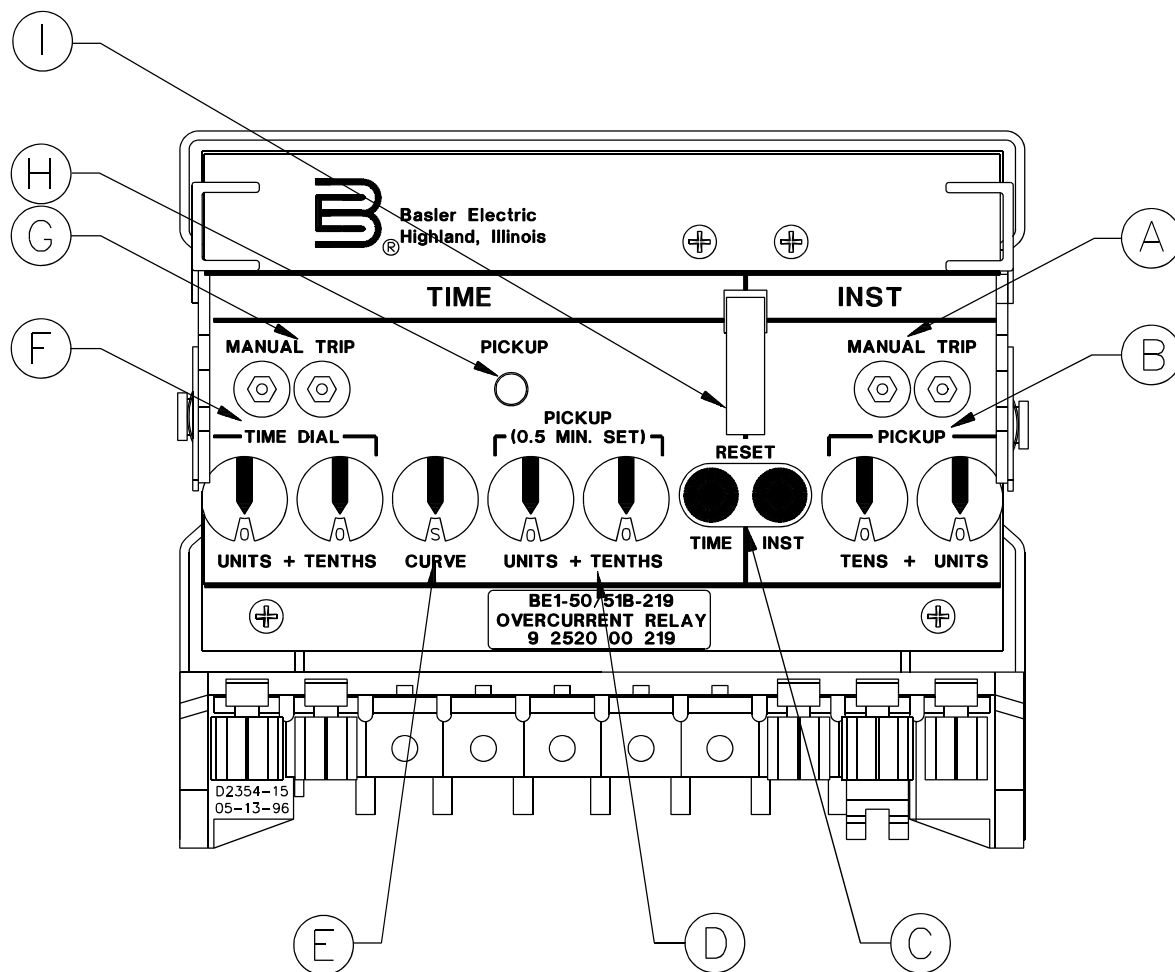| Locator	Control or Indicator	Function
B	**INST PICKUP** Selectors	Two switches (TENS and UNITS) to select pickup current in amperes. Changing switch selectors while the relay is in service may cause tripping.
C	**Targets**	Black target indicators trip to red and magnetically latch when the trip circuit current is greater than 0.2 amperes. One target each for TIME and INST.
D	**TIME PICKUP** Selectors	Two switches (TENS and UNITS) to select pickup current in amperes. Changing switch selectors while the relay is in service may cause tripping.
E	**CURVE** Selector	Ten position selector switch to select one of nine inverse functions or one fixed time function.
F	**TIME DIAL** Selectors	Two selector switches (TENS and UNITS) to select the desired characteristic curve. A setting of 0.0 results in instantaneous operation without any intentional delay. A setting of 9.9 corresponds to the typical time provided by an electromechanical relay at its maximum dial setting.
G	**TIME MANUAL TRIP** Test Points	When shorted, the test points provide a secure means to manually trip the controlled breaker. Jacks accept a standard 0.080 inch diameter phone tip plug.
H	**PICKUP** LED	Red LED indicates sensed current has exceeded the TIME PICKUP setting. LED turns OFF when sensed current falls below 95% of pickup setting.
I	**Target Reset** Lever	Linkage extends through back of front cover to reset both magnetically latched target indicators.
J	**SW8 -1**	SW8-1 selects the system operating frequency. SW8-1 open (OFF) selects 60 hertz operation. SW8-1 closed (ON) selects 50 hertz operation.
	SW8-2	SW8-2 provides additional time delay for the instantaneous element. Closing switch SW8-2 (ON) provides an additional instantaneous delay of 0.1 second.
	SW8-3	SW8-3 provides selection of GE IAC type curves or ABB type curves. Closing switch SW8-3 (ON) selects GE IAC type curves (refer to Table 1-3). Opening switch SW8-3 (OFF) selects ABB type curves (refer to Table 1-2).
	SW8-4	SW8-4 provides selection of either instantaneous or integrating reset characteristics. Closing SW8-4 (ON) selects integrating reset characteristics. Opening SW8-4 (OFF) selects instantaneous reset characteristics.

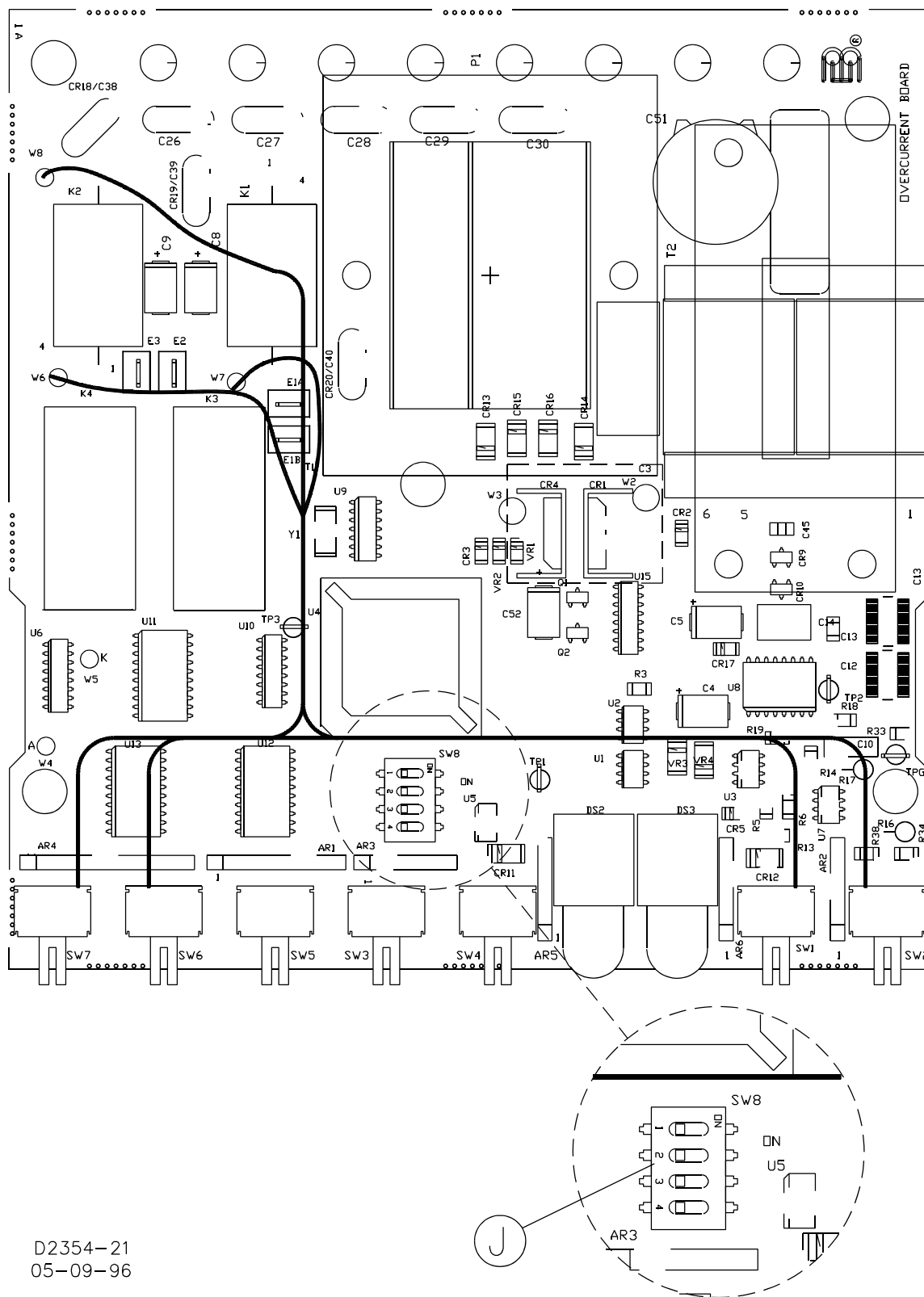*Figure 2-2. Location of Controls and Indicators*

Figure 2-3. Location of Controls and Indicators

SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

BE1-50/51B-219 Overcurrent Relays are microprocessor based non-directional relays that measure ac current to provide secure and reliable instantaneous and time overcurrent protection for power systems.

FUNCTIONAL DESCRIPTION

Sensing Input

Single phase ac current from system current transformers (CT) is brought into the BE1-50/51B-219 Overcurrent Relay at terminals five and six. Refer to Figure 3-1 to follow the functional description. The input current is applied to internal power and signal CTs.

Power Supply

Current from the power CT is rectified, filtered, and supplied to all relay internal circuitry for operating power. A precision +5 Vdc supply also serves as a reference for automatic calibration.

Instantaneous Signal

Current from the signal CT is rectified and applied to the instantaneous scaling resistors controlled by the INST PICKUP selector switches. The analog voltage of the instantaneous input signal developed across the scaling resistors is filtered and applied to the multiplexor (MUX).

Time Signal

Current from the signal CT is also rectified and applied to the time scaling resistors controlled by the TIME PICKUP selector switches. The analog voltage of the time input signal is also filtered and applied to the multiplexor.

Microprocessor

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. A microprocessor watchdog feature resets the microprocessor program when the program flow is interrupted.

Information from the TIME DIAL selector switches, the TIME CURVE selector switch, and the 50/60 Hz, INST DELAY, and RESET CHAR switches is also applied to the microprocessor. The microprocessor uses these inputs to set the operating parameters.

When the microprocessor is ready for analog information from the multiplexor, microprocessor control signals cause the multiplexor to route the desired input through to the output. The output is converted from an analog value to a digital value and applied to the microprocessor.

The microprocessor performs the program operations based on the inputs and the internal software program. When the sensed current exceeds the TIME PICKUP setting, the TIME PICKUP LED is turned ON. TIME contacts (51) are closed in accordance with the time characteristic equation. If the sensed current exceeds the INST PICKUP setting, the INST contacts (50) are closed.

Power-Off Sensing

Power-off sensing circuits measure the voltage across a capacitor at power-down and at power-up. These circuits determine how long power has been removed based on the difference voltage and the circuit RC time constant. This provides information for the integrating reset function even when power has been entirely removed.

Outputs

Instantaneous And Timed

System circuit breakers controlled by the output contacts can be manually tripped by applying a short across the TIME or INST MANUAL TRIP front panel test points. Current flow in the trip circuit is indicated by the operation of the target. The targets will not operate without adequate operating power for the relay.

CAUTION

Trip circuit voltage is present at the front panel test points. When shorting the test points, use insulated jumpers to avoid contact with these voltages.
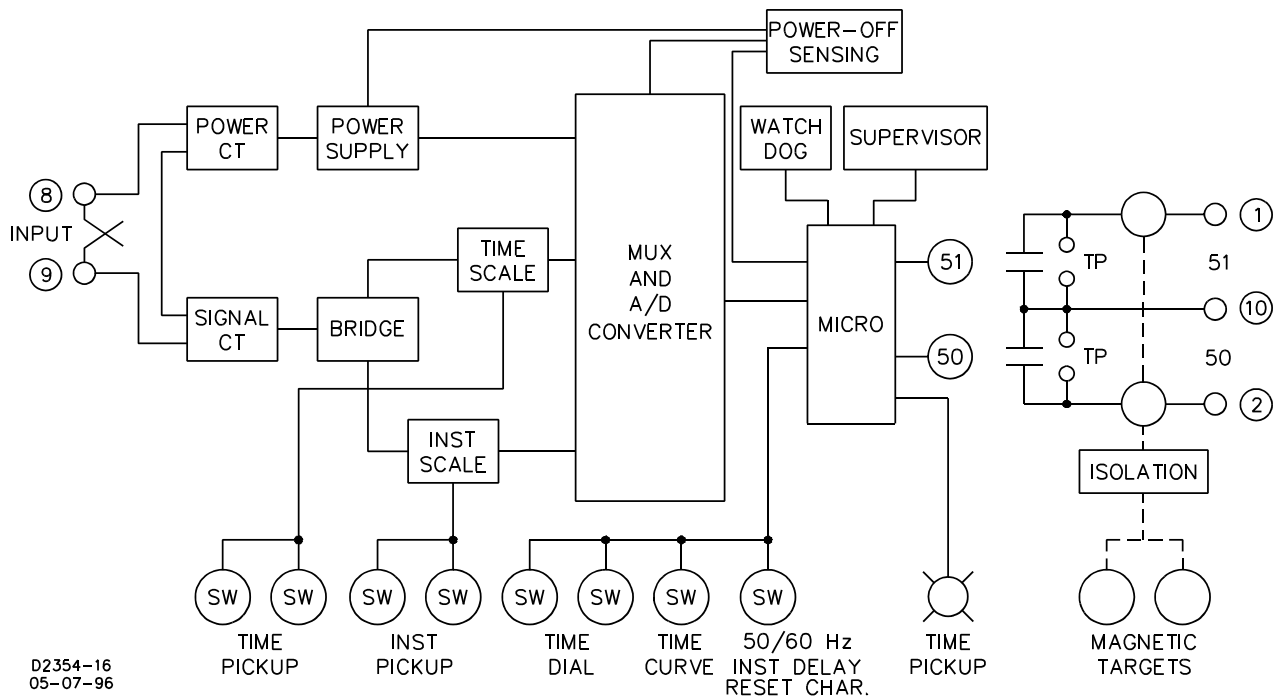

Figure 3-1. Functional Block Diagram

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 part 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 evidence of damage, immediately file a claim with the carrier and notify the Regional Sales Office, or contact the Sales Representative at Basler Electric, Highland, Illinois.

Proper operation of the relay may be confirmed by performing the operational test procedure (Section 5). 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.

DIELECTRIC TEST

In accordance with IEC 255-5 and ANSI/IEEE C37.90-1989, one-minute dielectric (high potential) tests may be performed as shown in the following paragraphs. Output contacts are surge protected.

        All circuits to ground: 2828 Vdc
        Input to output circuits: 2000 Vac or 2828 Vdc

MOUNTING

Because the relay is of solid state design, it does not have to be mounted vertically. Any convenient mounting angle may be chosen.

FACTORY SETTINGS

Factory settings for the internal switches of SW8 are as follows:

- SW8-1 — OFF (60 hertz operation).
- SW8-2 — OFF (0.0 additional fixed delay for the instantaneous element).
- SW8-3 — ON (Westinghouse/ABB type characteristic curves).
- SW8-4 — ON (Integrating reset characteristics).

INSTALLATION

Select the desired relay settings before putting the relay into service. Changing pickup current settings while the relay is in service may cause tripping. Perform the following procedures to install the BE1-50/51B-219 relay.

- Select the desired relay settings on your new BE1-50/51B-219 relay.
- Remove the existing ABB relay cradle.
- Insert the new BE1-50/51B-219 relay cradle and close the cradle latches locking the relay into the case.

> **CAUTION**
> **Close all BLACK handle switches before closing any RED handle switches.**
> **Insure that the RED handle switches are closed last.**

- Close knife-blade switches.
- To install the new cover, position the interlocking bracket at the top of the cover into the mating receptacle at the top of the case. Close the cover and secure the captive thumb nut fastener at the bottom of the cover.

APPLICATION COORDINATION

In a typical application coordination scheme, a BE1-50/51B-219 is being used to provide primary protection for a radial distribution feeder. An electromechanical overcurrent relay with extremely inverse timing provides protection for the transformer and bus. To improve coordination with the electromechanical relay, the BE1 relay with integrating reset characteristic has the time characteristic curve E (extremely inverse) selected (SW8-3 set to OFF) and the TIME DIAL set to 2.0. The feeder reclosing relay is set for two reclose attempts at 3 and 15 seconds after the initial trip. If a permanent fault occurs (magnitude ten times pickup), calculate the feeder breaker trip time for each of the three operations. Refer to Section 1 for characteristic curve constants.

From the time characteristic curve equation.

$$T_{Trip} = \frac{AD}{M^N - C} + BD + K$$

$$= \frac{7.7624 \times 2}{10^{2.0938} - 1} + (0.02758 \times 2) + 0.028$$

$$= \frac{15.5248}{124.10806 - 1} + (0.05516) + 0.028$$

$$= 0.209 \ seconds$$

From the reset characteristic curve equation.

$$T_{Reset} = \frac{RD}{M^2 - 1}$$

$$= \frac{7.75 \times 2}{0^2 - 1} = -15.5 \ seconds$$

M = 0 if current goes to zero.
Negative result indicates reset time.

Results: Full trip = 0.209 seconds and full reset = 15.5 seconds if current goes to zero.

In Figure 4-1,

T_A = 0.209 seconds (relay was at reset).
T_B = value < T_A because rewind has not gone to zero.
T_C = value < T_A because rewind has not gone to zero.
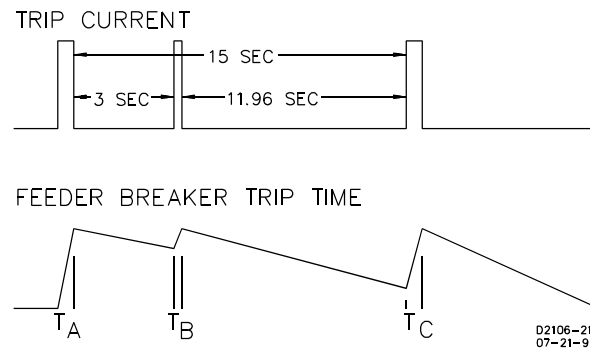
Figure 4-1. Coordination Timing Diagram

Equation for time to trip during rewind (before relay is reset).

$$T_{Trip\ This\ Occurance} = \frac{(Full\ Trip)(Rewind\ Time)}{Full\ Rewind}$$

Second Operation

$$T_B = \frac{(0.209)(3)}{15.5}$$

$$T_B = 0.040\ seconds$$

Third Operation

$$T_C = \frac{(0.209)(11.96)}{15.5}$$

$$T_C = 0.161\ seconds$$

CONNECTIONS

Typical ac input and dc control connections are shown in Figures 4-2 and 4-3. Refer to Section 3, block diagram for relay internal connections.

Figure 4-2. AC Input Connections

Figure 4-3. DC Control Connections

SECTION 5 • TESTING

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 a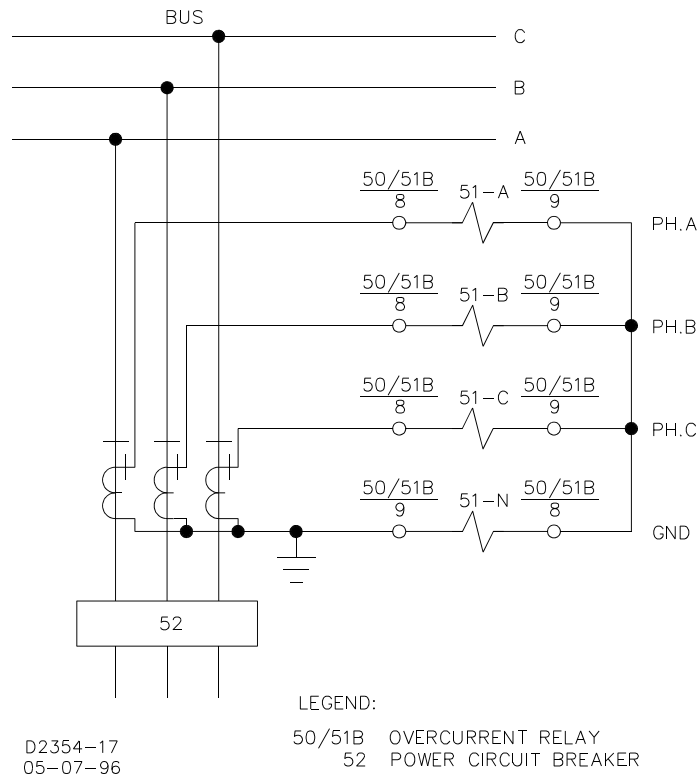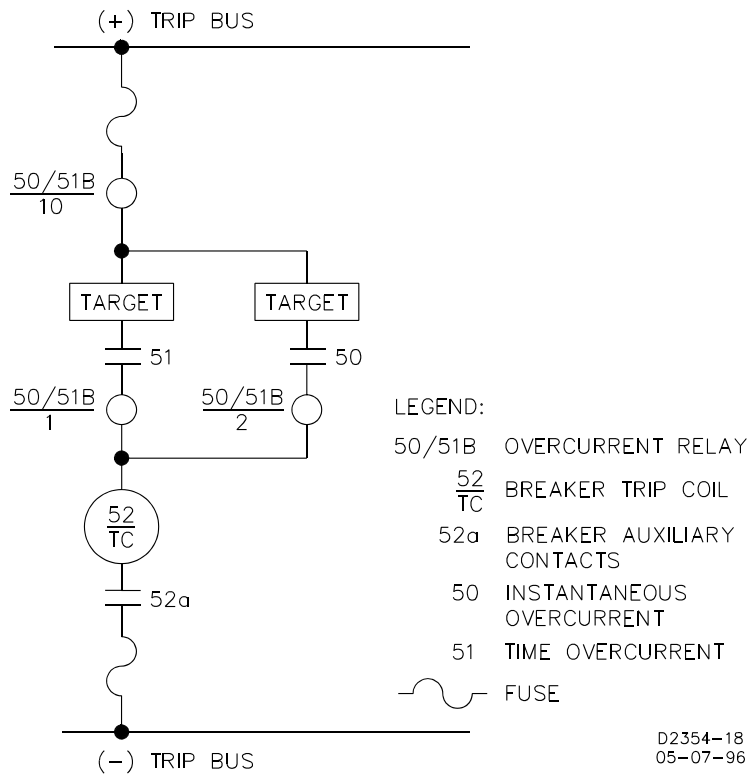nd part number against the requisition and packing list to see that they agree. Visually inspect the relay for damage that may have occurred during shipment. If there is evidence of damage, immediately file a claim with the carrier and notify the Regional Sales Office, or contact the Sales Representative at Basler Electric, Highland, Illinois.

Proper operation of the relay may be confirmed by performing the operational test procedures in this Section. 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.

DIELECTRIC TEST

In accordance with IEC 255-5 and IEEE C37.90-1989, one-minute dielectric (high potential) tests may be performed as follows:

All circuits to ground:	2828 Vdc.
Input to output circuits:	2000 Vac or 2828 Vdc.

Output contacts are surge protected.

OPERATIONAL TEST PROCEDURE

The following procedure verifies operation of the relay. The test setup of Figures 5-1 and 5-2 are intended primarily as an illustration of the principles involved. Other test setups known to be capable of testing with the stated and implied tolerances (including equipment specifically designed for testing relays) may be used.

Test Equipment Required

- Current source with a range from 0 to 20 amperes ac (sensing input current).
- Current source 0.2 to 3 amperes ac (target operation).
- Timer or counter.

> **CAUTION**
> To ensure proper timing during testing, before each test, remove the current from the unit for R times D seconds (refer to *Section 1, Specifications, Time Reset* for R and D definitions).
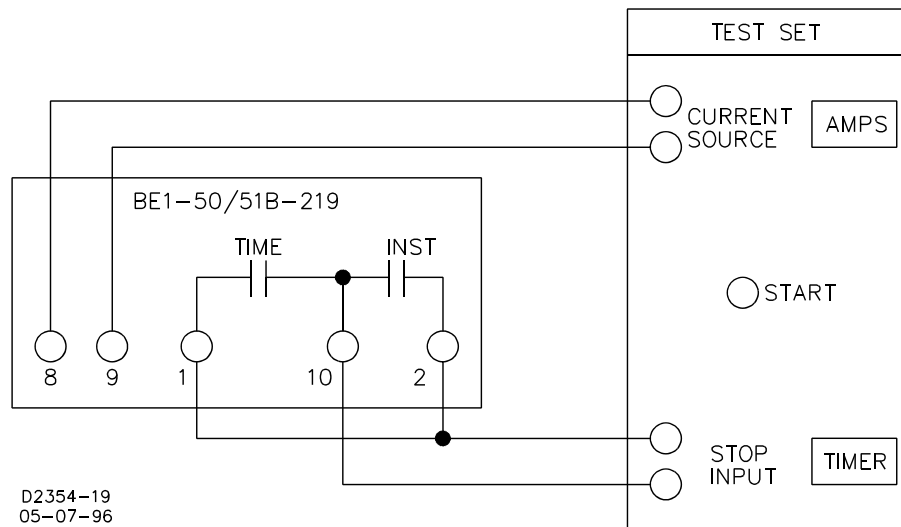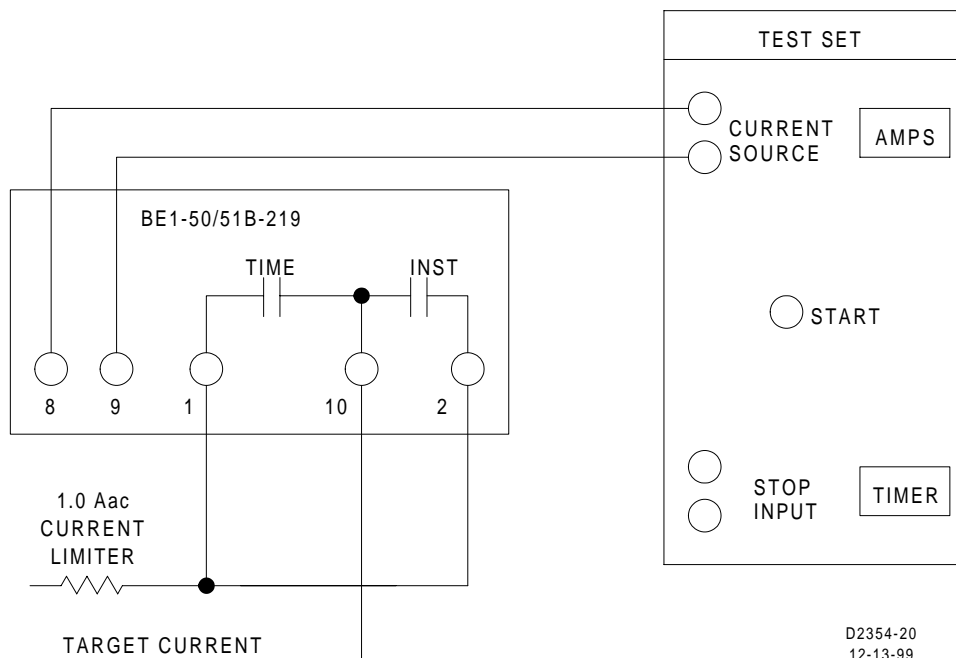
Figure 5-1. Pickup and Timing Test Setup

Figure 5-2. Target Operational Test Setup

```
+--------------------------------------------------------------------------+
|                               NOTE                                       |
| When testing TIME overcurrent functions, INST PICKUP settings of 00 will |
| affect the calibration of the TIME functions.  TIME PICKUP settings of   |
| 00 also affect INST functions.                                           |
+--------------------------------------------------------------------------+
```

Test Procedure, Model BE1-50/51B-219

Time Pickup Test

Perform preliminary setup:

• Connect test setup as shown in Figure 5-1.
• Insure that SW8 switches are set correctly: SW8-1 for operating frequency, SW8-2 to OFF (no instantaneous delay), SW8-3 to OFF (ABB type curves selected), and SW8-4 to OFF (selects instantaneous reset).
• Set TIME DIAL to 0.0.
• Set CURVE to S
• Set TIME PICKUP to 0.5.
• Set INST PICKUP to 90.

Step 1. Slowly increase current to terminals 5 and 6. PICKUP LED should turn ON at a maximum input current of 0.550 ampere.

Step 2. Decrease input current until PICKUP LED turns OFF.

Step 3. Set TIME PICKUP to 2.2.

Step 4. Slowly increase current to terminals 5 and 6. PICKUP LED should turn ON at an input current of 2.131 to 2.269 amperes.

Step 5. Decrease input current until PICKUP LED turns OFF.

INST Pickup Test

Perform preliminary setup:

• Connect test setup as shown in Figure 5-1.
• Insure that SW8 switches are set correctly: SW8-1 for operating frequency, SW8-2 to OFF (no instantaneous delay), 8-3 to OFF (ABB type curves selected), and SW8-4 to OFF (selects instantaneous reset).
• Set TIME DIAL to 0.0.
• Set CURVE to S
• Set TIME PICKUP to 15.1.
• Set INST PICKUP to 01.

Step 1. Slowly increase current to terminals 8 and 9. INST contacts should close at an input current of 0.955 to 1.045 amperes.

Step 2. Decrease input current until INST output contacts open.

Step 3. Set INST PICKUP to 08.

Step 4. Slowly increase current to terminals 8 and 9. INST contacts should close at an input current of 7.815 to 8.185 amperes.

Step 5. Decrease input current until INST output contacts open.

Time Dial Test

Perform preliminary setup:
- Connect test setup as shown in Figure 5-1.
- Insure that SW8 switches are set correctly: SW8-1 for operating frequency, SW8-2 to OFF (no instantaneous delay), 8-3 to OFF (ABB type curves selected), and SW8-4 to OFF (selects instantaneous reset).
- Set TIME DIAL to 4.5.
- Set CURVE to S
- Set TIME PICKUP to 1.0.
- Set INST PICKUP to 90.

Step 1. Prepare to apply 1.5 amperes input current to terminals 8 and 9 and record the elapsed time from when current is applied until TIME output contacts close.

Step 2. Apply the current (step from 0 to 1.5 amperes) and record the elapsed time. Elapsed time should be 1.754 to 2.084 seconds. (This tolerance is greater than ±2 % because it is the accumulation of both pickup and timing tolerances.)

Step 3. Remove input current.

Target Test

Perform preliminary setup:
- Connect test setup as shown in Figure 5-2.
- Insure that SW8 switches are set correctly: SW8-1 for operating frequency, SW8-2 to OFF (no instantaneous delay), 8-3 to OFF (ABB type curves selected), and SW8-4 to OFF (selects instantaneous reset).
- Set TIME DIAL to 4.5.
- Set CURVE to S
- Set TIME PICKUP to 1.0.
- Set INST PICKUP to 01.

Step 1. Set target current source to 1.0 ampere, ac.

Step 2. Apply 5 amperes input current to terminals 8 and 9. Check that both TIME and INST targets operate.

Step 3. Remove input current and reset targets.

Manual Trip Test

Perform preliminary setup:
- Connect test setup as shown in Figure 5-2.
- Insure that SW8 switches are set correctly: SW8-1 for operating frequency, SW8-2 to OFF (no instantaneous delay), 8-3 to OFF (ABB type curves selected), and SW8-4 to OFF (selects instantaneous reset).
- Set TIME DIAL to 4.5.
- Set CURVE to S
- Set TIME PICKUP to 1.0.
- Set INST PICKUP to 01.

> **CAUTION**
> Trip circuit voltage is present at the front panel test points. When shorting the test points, use insulated jumpers to avoid contact with these voltages.

Step 1. Set target current source to 1.0 ampere, ac.

Step 2. Apply 0.9 ampere input current to terminals 8 and 9. (0.9 ampere provides input power but stays below pickup.)

Step 3. Connect a jumper between TIME MANUAL TRIP test points. Check that TIME target operates.

Step 4. Connect a jumper between INST MANUAL TRIP test points. Check that INST target operates.

Step 5. Reset targets.

Integrating Reset Test

Perform preliminary setup:

- Connect test setup as shown in Figure 5-1.
- Insure that SW8 switches are set correctly: SW8-1 for operating frequency, SW8-2 to OFF (no instantaneous delay), 8-3 to OFF (ABB type curves selected), and **SW8-4 to ON** selects integrating reset).
- Set TIME DIAL to 4.5.
- Set CURVE to I.
- Set TIME PICKUP to 1.0.
- Set INST PICKUP to 90.

Step 1. Set target current source to 1.0 ampere, ac.

Step 2. Read all of Step 3 before beginning Step 3.

Step 3. Apply 4.0 amperes input current to terminals 8 and 9. After the unit trips, remove the input current for 20 ±0.25 seconds, then reapply the 4.0 amperes input current. Record the elapsed time from the reapplication of input current to the output retrip.

   Result: Elapsed time should be 1.55 ±0.3 seconds.

SETTING THE RELAY

Select the desired relay settings before putting the relay into service. Changing pickup current settings while the relay is in service may cause tripping.

PERIODIC TESTS

General

All relays should be tested periodically to identify and correct any problems that are found.

Single phase relays such as the BE1-50/51B-219 are normally used in groups of four (three phase and ground) on the protected circuit. This relay scheme allows each unit to be withdrawn one at a time for testing purposes without losing protection. Only three are required at any one time to sense all types of faults on a grounded wye system. Refer to Figures 5-1 and 5-2 for recommended test setups.

Periodic Test

Periodic testing should consist of the following procedures.

Step 1. Verify that the instantaneous pickup is within ±2% of the value set on the dials. Pickup occurs when the INST output contacts close.

Step 2. Verify that the time pickup is within ±2% of the value set on the dials. Pickup occurs when the LED turns ON.

Step 3. Verify that the time to trip for the curve and time dial settings at a multiple of six is the same as the time given on the characteristic curve. Refer to Section 1 for the characteristics curves.

Step 4. Verify that the time to trip for the instantaneous element at a pickup multiple of 2 is not greater than the time given on the instantaneous characteristic curve. Refer to Section 1 for the instantaneous characteristic curve.

Step 5. Verify that the targets operate with one ac ampere of trip current in the trip circuits and that they can be reset using the RESET LEVER.

This completes the periodic test.

SECTION 6 • MAINTENANCE

GENERAL

BE1-50/51B-219 Overcurrent Relays require no preventive maintenance. However, periodic checks should be performed according to scheduled practices. A recommended periodic test is provided in this section. If the relay fails to function properly and in-house repair is considered, contact the Customer Service Department of the Power Systems Group, Basler Electric, for a return authorization number prior to shipping.

IN-HOUSE REPAIR

In-house replacement of individual components should be performed by qualified technicians.

CAUTION

Substitution of printed circuit boards or individual components does not necessarily mean the relay will operate properly. Always test the relay before placing it in operation.

When complete boards or assemblies are needed, the following information is required.

1. Relay model number
2. Relay serial number

STORAGE

This protective relay contains long life aluminum electrolytic capacitors. Life in excess of 20 years may be expected if the storage temperature does not exceed 40°C (72°F).

PERIODIC TESTS

General

All relays should be tested periodically to identify and correct any problems that are found.

Single phase relays such as the BE1-50/51B-219 are normally used in groups of four (three phase and ground) on the protected circuit. Only three are required at any one time to provide complete protection. The fourth one assures that protection is maintained even if one relay failed.

This protection scheme also allows one unit at a time to be withdrawn from service for testing purposes without losing protection during the test. Refer to Section 5 for recommended test setups.

Periodic Test

Periodic testing should consist of the following procedures.

Step 1. Verify that the instantaneous pickup is within ±2% of the value set on the dials. Pickup occurs when the INST output contacts close.

Step 2. Verify that the time pickup is within ±2% of the value set on the dials. Pickup occurs when the LED turns ON.

Step 3. Verify that the time to trip for the curve and time dial settings at a multiple of six is the same as the time given on the characteristic curve. Refer to Section 1 for the characteristics curves.

Step 4. Verify that the time to trip for the instantaneous element at a pickup multiple of 2 is not greater than the time given on the instantaneous characteristic curve. Refer to Section 1 for the instantaneous characteristic curve.

Step 5. Verify that the targets operate with one ac ampere of trip current in the trip circuits and that they can be reset using the RESET LEVER.

This completes the periodic test.

SECTION 7 • MANUAL CHANGE INFORMATION

SUMMARY AND CROSS REFERENCE GUIDE

This section contains information concerning the previous editions of the manual. The substantive changes to date are summarized in Table 7-1.

Table 7-1. Changes

Revision	Summary of Changes	ECA/Date
A	Added Patent number to *Specifications*. Changed manual format to reflect the current style and added Section 7.	16780/05-27-98
B	Corrected Figures 3-1, 4-2, 4-3, 5-1, and 5-2. Changed all references to the current for testing the targets to an ac only type of current.	7389/12-13-99

Table 7-1. Changes - Continued

Revision	Summary of Changes	ECA/Date