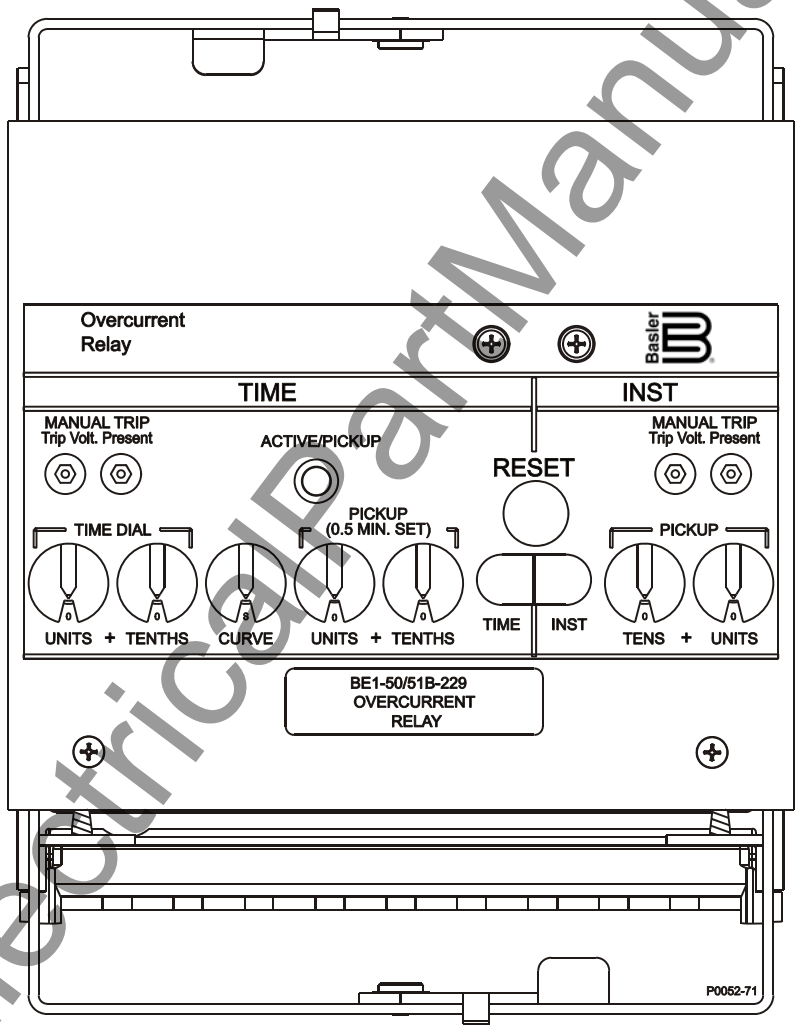
INSTRUCTION MANUAL

FOR

OVERCURRENT RELAY

BE1-50/51B-229



Basler Electric

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INTRODUCTION

This instruction manual provides information about the operation and installation of the BE1-50/51B-229 Overcurrent Relay. To accomplish this, the following information is provided:

- General Information and Specifications
- Controls and Indicators
- Functional Description
- Installation and Maintenance
- Testing

WARNING!

To avoid personal injury or equipment damage, only qualified personnel should perform the procedures in this manual.

NOTE

Be sure that the relay is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the relay is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

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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.

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REVISION HISTORY

The following information provides a historical summary of the changes made to this instruction manual (9252000892). Revisions are listed in reverse chronological order.

Manual Revision and Date	Change
A, 03/08	• Updated front panel drawings. • Added publication number and revision level to the footer of each page. • Added GOST-R to Section 1.
—, 06/03	• Initial release

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SECTION 1 • GENERAL INFORMATION

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SECTION 1 • GENERAL INFORMATION

INTRODUCTION

BE1-50/51B-229 Overcurrent Relays are self-powered, microprocessor-based, non-directional phase or ground relays that monitor single-phase ac current and provide accurate instantaneous and time-over-current protection for 50 or 60 Hz power systems.

BE1-50/51B-229 relays are direct replacements for General Electric Type SFC relays. BE1-50/51B relays offer true plug and play convenience; they can be installed in an existing SFC relay case with no wiring changes required. Table 1-1 lists the SFC relays that can be replaced by the BE1-50/51B-229.

Table 1-1. Type SFC Relays Suitable for Direct Replacement

SFC Model	Time Curve Type	Output Contact Circuits
SFC151∗∗A	Inverse	1
SFC153∗∗A	Very Inverse	1
SFC177∗∗A	Extremely Inverse	1

∗ Represents any allowed character per GE publication GEK-36807.

An existing SFC relay is replaced with a BE1-50/51B-229 relay by performing the following simple steps.

1. Configure your new BE1-50/51-229 relay with the desired settings.
2. Remove the existing SFC relay.
3. Attach the cover adapter plate to the existing case.
4. Insert the BE1-50/51B-229 relay into the case.
5. Install the existing SFC connection plug.
6. Install the new Basler Electric relay cover.

FEATURES

BE1-50/51B-229 Overcurrent Relays have the following standard features.

- Independent time and instantaneous elements
- Secure breaker tripping from the relay front panel
- Direct-reading front panel controls
- Minimum pickup setting for safety during installation
- Time characteristics extend to a pickup multiple of 40
- Rugged draw-out construction
- Gravity latching targets retain indication without power
- Built-in accuracy eliminates internal adjustments
- Minimum transient overreach
- Field-selectable characteristic curves similar to either GE IAC or ABB type curves
- Field-selectable instantaneous or integrating reset function
- Field-selectable 50 or 60 Hz operation
- Field-selectable 0.0 or 0.1 second fixed, instantaneous time delay

Advantages

BE1-50/51B-229 Overcurrent Relays have many advantages over other overcurrent relays. The primary advantages are listed below.

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

APPLICATION

The BE1-50/51B-229 has a wide range of pickup settings and front panel selectable time characteristics. This makes the relay compatible with applications involving coordination with fuses, reclosers, cold-load pickup, motor starting, and fixed time requirements. Two switch-selectable reset functions are provided: instantaneous and integrating. The instantaneous reset function avoids ratcheting. The integrating reset function simulates the disk reset characteristic of electromechanical relays.

SPECIFICATIONS

BE1-50/51B-229 electrical and physical specifications are listed in the following paragraphs.

Current Sensing Input

Nominal Rating:	5 Aac
Continuous Rating:	14 Aac
One-Second Rating:	400 Aac

Time Overcurrent (51) Element

Setting the TIME PICKUP control at the minimum pickup setting places the relay in the most sensitive state and may be used as a safety setting.

Pickup

Setting Range:	0.5 to 15.9 Aac
Setting Increment:	0.1 Aac
Accuracy:	±2%, ±25 mAac at or above 0.5 Aac setting

Dropout

Dropout occurs at 95% of pickup value.

Timing Range

0.0 to 9.9 seconds in 0.1 second steps.

Timing Accuracy

The timing accuracy is the sum of ±1 cycle, ±2 percent over the range of 1.3 to 40 times tap. This accuracy is for a given measured multiple of tap. The measurement of the multiple of tap has an accuracy that is the sum of ±2 percent, ±25 milliamperes.

Timing Accuracy Example

Pickup Setting:	5 Aac
Current Applied:	6.5 Aac
+Multiple Tolerance:	6.655 Aac
–Multiple Tolerance:	6.345 Aac
Time Curve:	E
Time Dial:	5.0
Minimum Time (6.655 Aac):	46.5470 sec
Maximum Time (6.345 Aac):	61.3968 sec
Curve Time (6.5 Aac):	53.1800 sec

Curve Characteristics

Nine inverse time functions and one fixed time function can be selected by the front-panel Curve 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 setting
A, B, C, N, K = constants for the particular curve

Time characteristic curve constants are listed in Tables 1-2 and 1-3. 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 software. Timing accuracy is ±1 cycle, ±2 percent of time to trip.

Table 1-2. Time Characteristic Curve Constants with SW3-3 Open (Off)

Curve Type *		Figure Number †	Constants					
BE1	**Similar To**		**A**	**B**	**C**	**N**	**K**	**R**
S	ABB CO-2	A-1	0.2663	0.03393	1.000	1.2969	0.028	0.500
L	ABB CO-5	A-2	5.6143	2.18592	1.000	1.000	0.028	15.750
D	ABB CO-6	A-3	0.4797	0.21359	1.000	1.5625	0.028	0.875
M	ABB CO-7	A-4	0.3022	0.12840	1.000	0.5000	0.028	1.750
I	ABB CO-8	A-5	8.9341	0.17966	1.000	2.0938	0.028	9.000
V	ABB CO-9	A-6	5.4678	0.10814	1.000	2.0469	0.028	5.500
E	ABB CO-11	A-7	7.7624	0.02758	1.000	2.0938	0.028	7.750
B	BS142-B ‡	A-8	1.4638	0.00000	1.000	1.0469	0.028	3.250
C	BS142-C ‡	A-9	8.2506	0.00000	1.000	2.0469	0.028	8.000
F	None §	N/A	0.0000	1.00000	0.000	0.0000	0.000	1.000

Table 1-3. Time Characteristic Curve Constants with SW3-3 Closed (On)

Curve Type *		Figure Number †	Constants					
BE1	**Similar To**		**A**	**B**	**C**	**N**	**K**	**R**
S	GE IAC 55	A-10	0.0286	0.0208	1.000	0.9844	0.028	0.0940
L	GE IAC 66	A-11	2.3955	0.00002	1.000	0.3125	0.028	7.8001
D	ABB CO-6	A-3	0.4797	0.21359	1.000	1.5625	0.028	0.8750
M	ABB CO-7	A-4	0.3022	0.12840	1.000	0.5000	0.028	1.7500
I	GE IAC 51	A-12	0.2747	0.1042	1.000	0.4375	0.028	0.8868
V	GE IAC 53	A-13	4.4309	0.0991	1.000	1.9531	0.028	5.8231
E	GE IAC 77	A-14	4.9883	0.0129	1.000	2.0469	0.028	4.7742
B	BS142-B ‡	A-8	1.4636	0.00000	1.000	1.0469	0.028	3.2500
C	BS142-C ‡	A-9	8.2506	0.00000	1.000	2.0469	0.028	8.0000
F	None §	N/A	0.0000	1.00000	0.000	0.0000	0.000	1.0000

Notes for Tables 1-2 and 1-3

* 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 Delay

† Figure numbers refer to the characteristic curves located in Appendix A, *Time Characteristic Curves.*

‡ Curves B and C are defined in British Standard BS142 and IEC Standard IEC 255-4.

§ Fixed time delay, adjustable from 0.1 to 9.9 seconds.

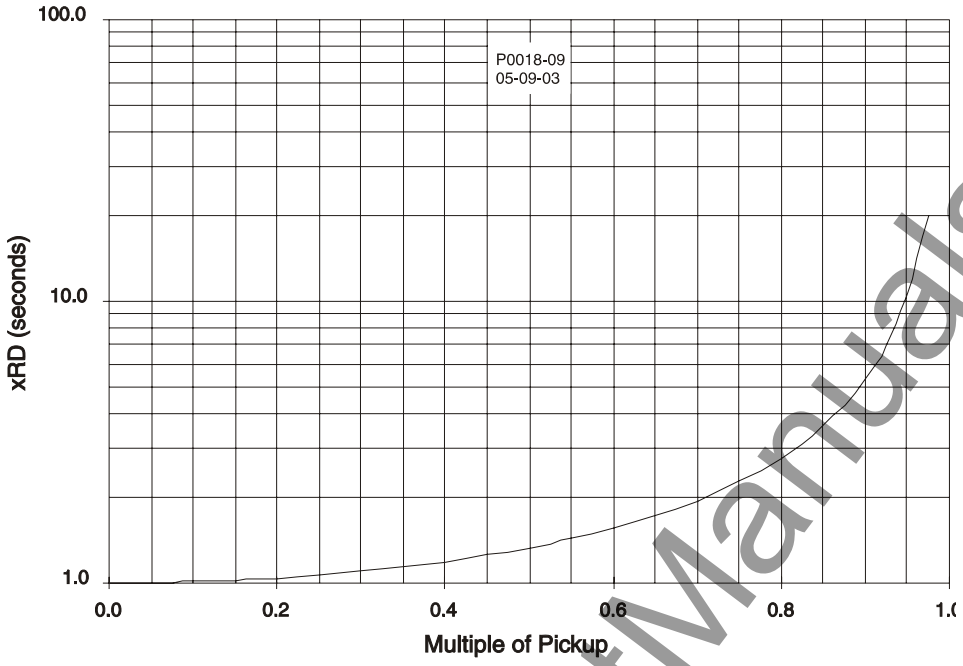
Integrating Reset

Reset begins when the current decreases below 95 percent of pickup. Integrating reset simulates the disk reset of electromechanical relays. BE1-50/51B-229 relays provide the integrating reset function even when input current decreases to zero.

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

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

Where:
T_R = time to reset in seconds
R = constant for the particular curve
D = time dial setting
M = current in multiples of pickup setting during reset



Note: Vertical axis xRD is applicable for all curves and is derived from multiplying the constant R for the curve selected times D (time dial setting).

Figure 1-1. Integrating Reset Characteristic Curve

Instantaneous Overcurrent (50) Element

Setting the INST PICKUP control at the minimum pickup setting places the relay in the most sensitive state and may be used as a safety setting.

Pickup

Setting Range:	1 to 99 Aac
Setting Increment:	1 Aac
Accuracy:	±2%, ±25 mAac at or above 1.0 Aac setting

Dropout

Dropout occurs at 95% of pickup value.

Curve Characteristics

The instantaneous characteristic curves of the BE1-50/51B-229 are similar to those of standard electromechanical relays. However, the trip time may be slightly longer in applications where the initial current through the relay is less than 0.4 amperes. This may occur in a very lightly loaded circuit or when the relay is pro-viding ground protection and is connected to measure neutral current. Figure 1-2 shows the instantaneous characteristic curves for maximum time to trip.

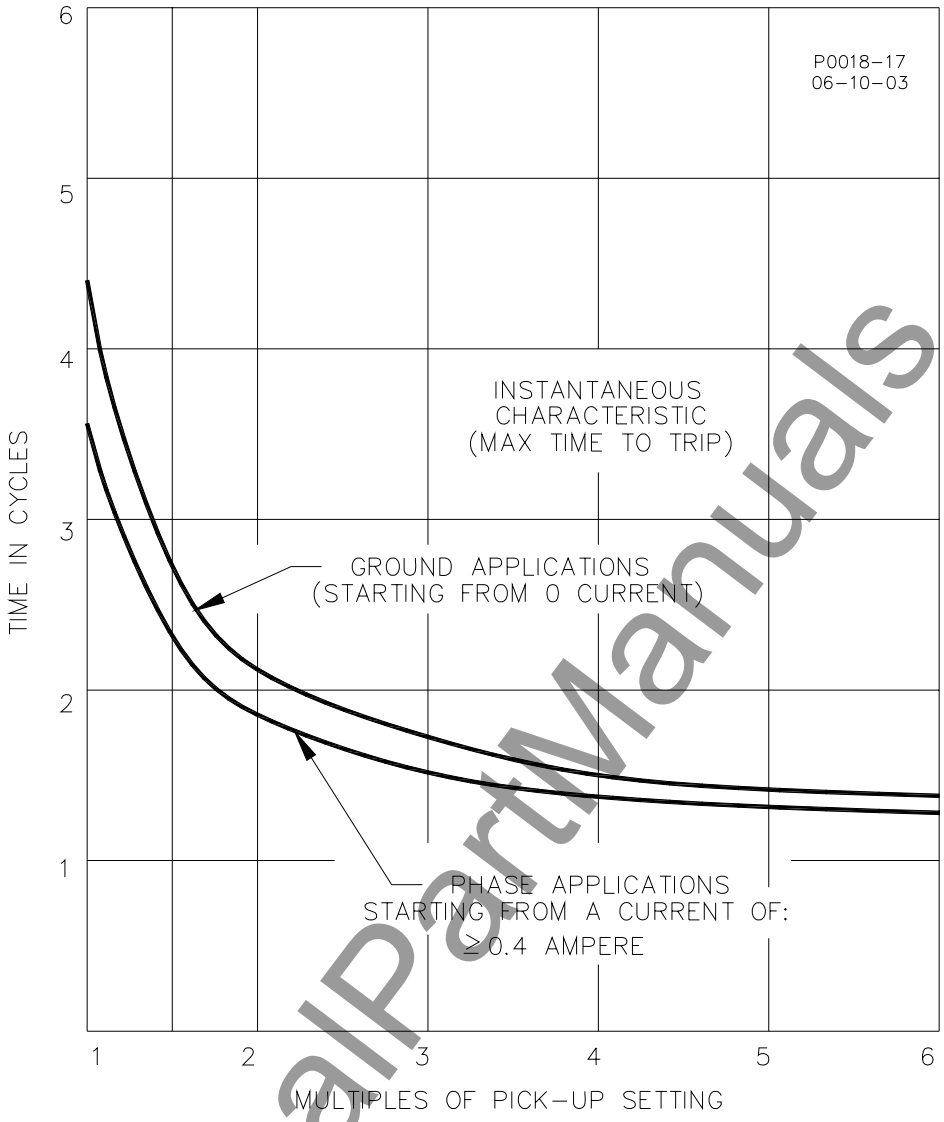


Figure 1-2. Instantaneous Characteristic Curves

An additional, fixed delay of 0.1 second may be added with internal switch SW3-2. This delay applies to both phase and ground applications. Closing switch SW3-2 provides an additional delay of 0.1 second. For the location of SW3, refer to Section 2, *Controls and Indicators*.

The instantaneous (50) element in the BE1-50/51B-229 relay may be set lower than the instantaneous element in SFC relays and still have the same reach. This is because the BE1-50/51B-229 instantaneous element effectively eliminates the fault current transient overreach components. When calculating BE1-50/51B-229 instantaneous element settings, calculate the symmetrical value without any adder for transient overreach.

Instantaneous Reset

The relay resets within 16 milliseconds when the sensed current decreases below the pickup setting.

Burden

Burden is nonlinear and is illustrated in Figure 1-3.

At 0.5 Aac:	4.8 Ω
At 5.0 Aac:	0.2 Ω

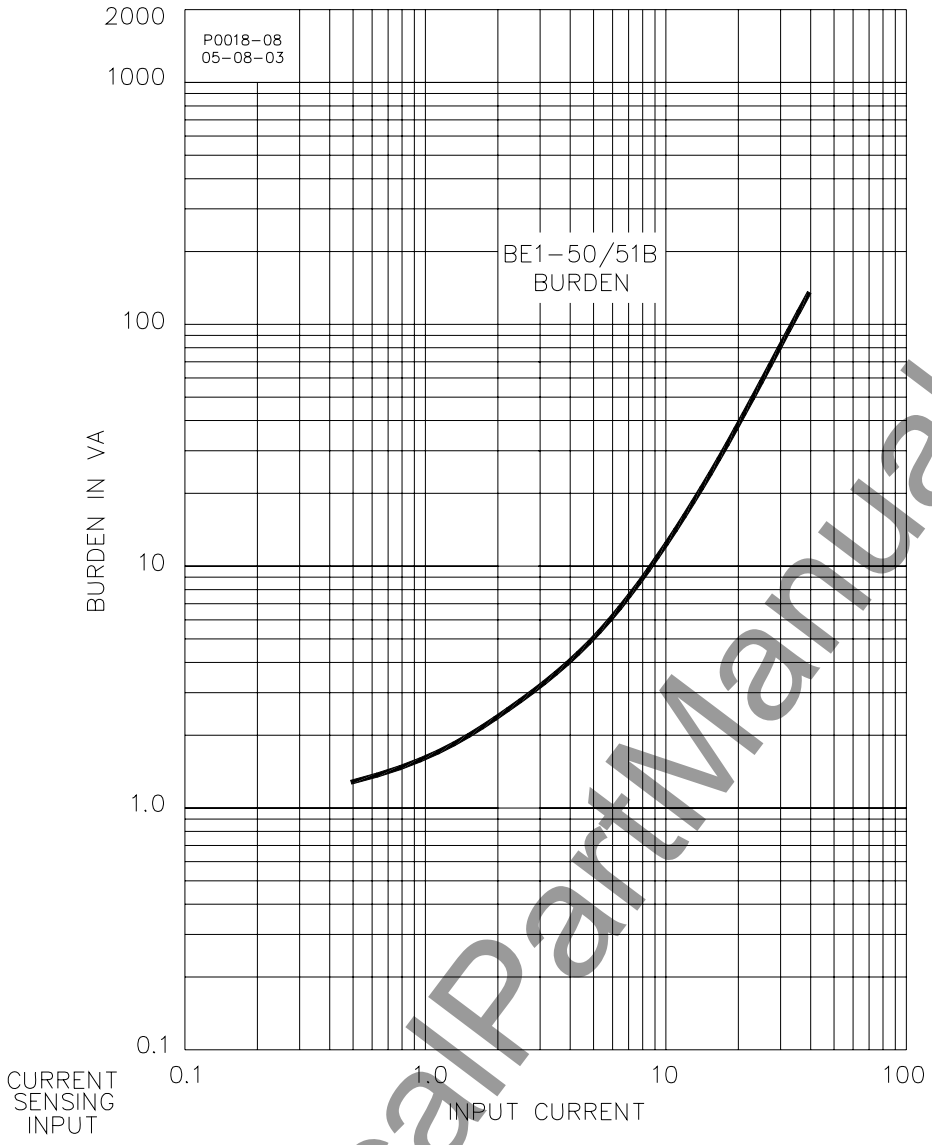


Figure 1-3. BE1-50/51B-229 Burden Characteristics

Frequency Response

A change of ±5 Hz from the nominal 50/60 Hz current causes <0.5% change in the current required for pickup.

Transient Response

<10% overreach with system time constants up to 40 ms.

Harmonic Response

Figure 1-4 illustrates harmonic rejection and shows that a relay with a 1 ampere pickup setting would pick up at 0.96 amperes when the current contains 40 percent seventh harmonic. This corresponds to a 10:1 rejection ratio. Other conditions may be evaluated in the same manner.

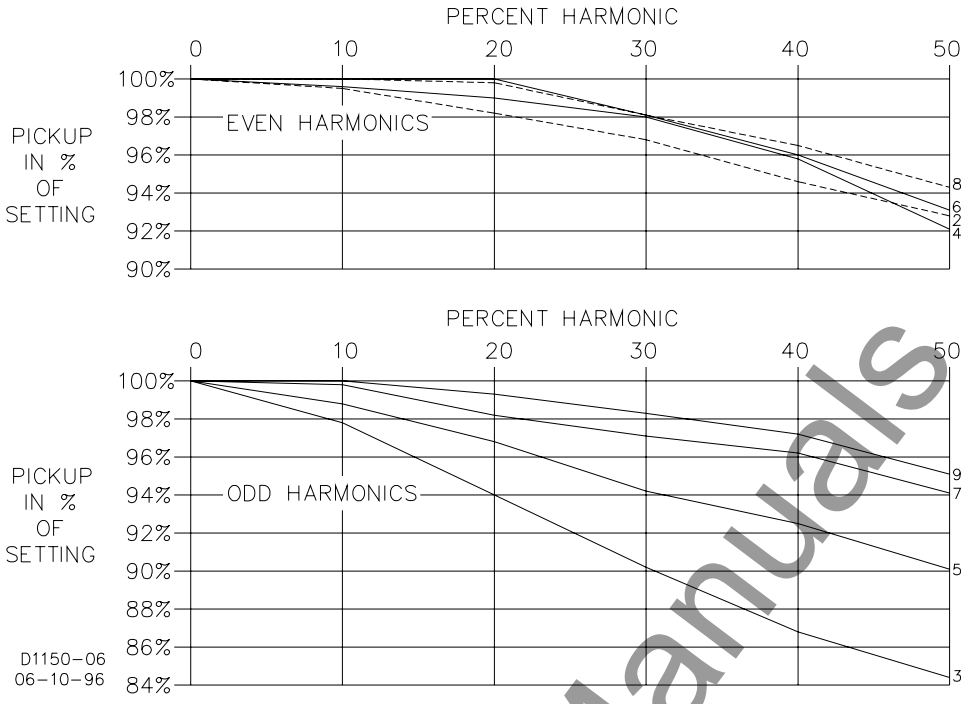


Figure 1-4. Harmonic Rejection

Target Indicators

Gravity 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 *Output Contacts* for maximum current rating.

Output Contacts

Output contacts are surge protected and rated as follows.

Resistive Ratings

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 Ratings

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).

Type Tests

Isolation

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

All Circuits to Ground: 2,828 Vdc
Input to Output Circuits: 2,000 Vac or 2828 Vdc

Surge Withstand Capability

Qualified to IEEE C37.90.1-1989, *Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems*.

Impulse

Qualified to IEC 255-5.

Radio Frequency Interference (RFI)

Field-tested using a 5-watt, handheld transceiver operating at random frequencies centered around 144 MHz and 440 MHz, with the antenna located 6 inches from the relay in both horizontal and vertical planes.

Vibration

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

Shock

Withstands 15 G in each of three mutually perpendicular planes.

Environment

Operating Temperature:	–40°F to 158°F (–40°C to 70°C)
Storage Temperature:	–50°F to 122°F (–58°C to 50°C)

Agency Recognition

GOST-R Certification

GOST-R certified No. POCC US.ME05.B03391; complies with the relevant standards of Gosstandart of Russia. Issued by accredited certification body POCC RU.0001.11ME05.

Physical

Weight: 6.1 lb (2.77 kg)

Patent

Patented in U.S., 1998, Number 5751532

SECTION 2 • CONTROLS AND INDICATORS

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SECTION 2 • CONTROLS AND INDICATORS

INTRODUCTION

BE1-50/51B-229 controls and indicators are located on the front panel and on the relay circuit board.

FRONT PANEL

Front panel controls and indicators are shown in Figure 2-1. The locator letters in Figure 2-1 correspond to the descriptions listed in Table 2-1.

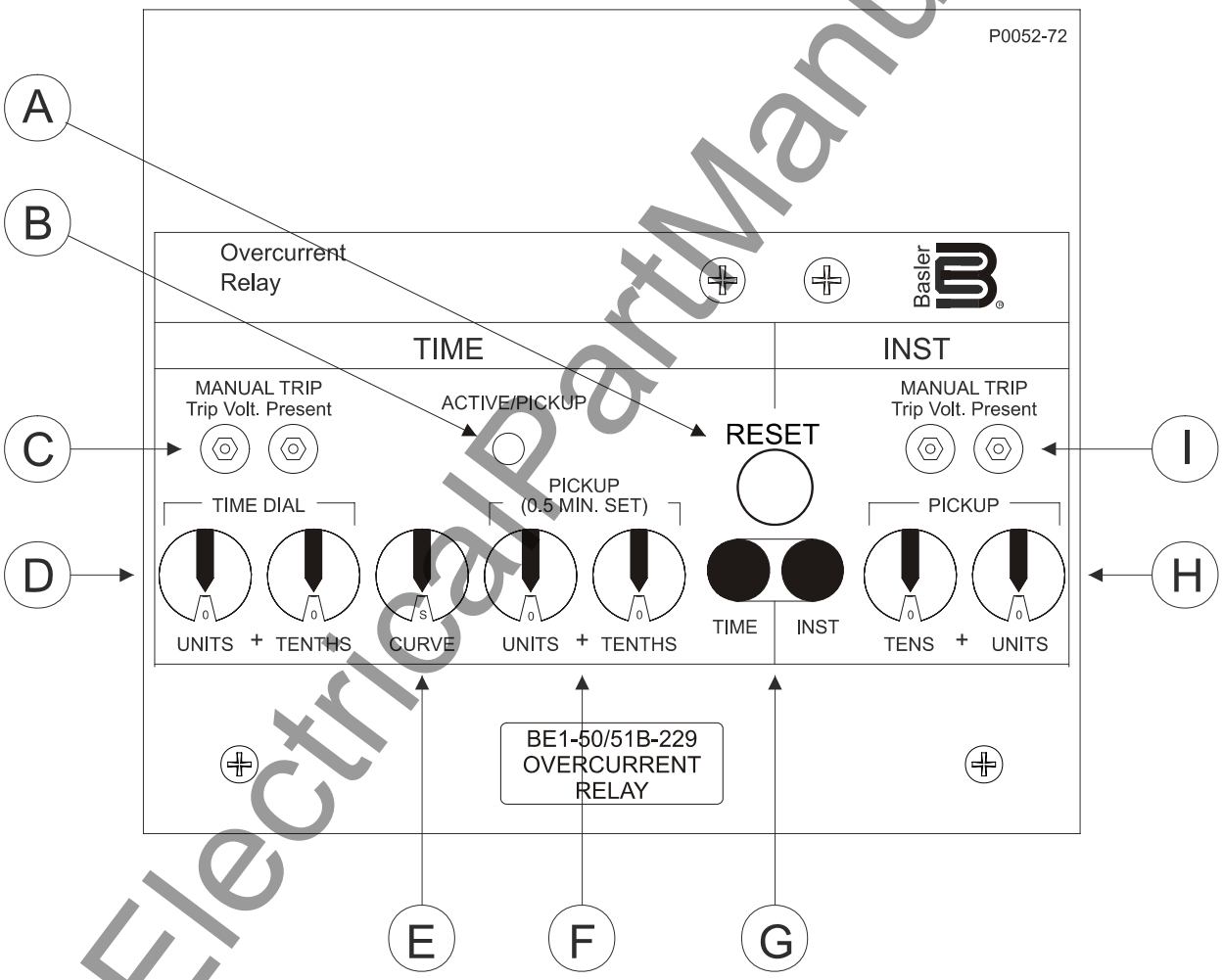

Figure 2-1. Front Panel Controls and Indicators

Table 2-1. Front Panel Control and Indicator Descriptions

Locator	Control/Indicator	Description
A	Target Reset Button	The target reset button is pressed to reset the gravity-latched target indicators.
B	Active/Pickup LED	The LED turns red when the sensed current exceeds the Time Pickup setting (H). The LED turns green when the sensed current decreases below 95% of the Time Pickup setting. A green LED indicates that the relay is active, but not picked up.
C	Time (51) Manual Trip Test Jacks	Short-circuiting the test jacks provides a secure method to manually trip the controlled circuit breaker. The jacks accept a standard 0.08 inch diameter banana plug. **WARNING!** Trip circuit voltage is present at the front panel test jacks. When short-circuiting the test jacks, use insulated jumpers to avoid contact with this voltage.
D	Time Dial Switches	Two selector switches, units and tenths, select the desired characteristic curve. A setting of 0.0 gives instantaneous operation without any intentional delay. A setting of 9.9 corresponds to the typical time delay provided by an electromechanical relay set at its maximum time dial setting.
E	Curve Switch	This switch selects one of nine inverse time functions or one fixed time function.
F	Time (51) Pickup Switches	Two selector switches, units and tenths, set the time overcurrent pickup level in amperes. Changing the pickup setting while the relay is in service may cause tripping.
G	Targets	Gravity-latched target indicators are provided for the time overcurrent (51) function and the instantaneous overcurrent (50) function. Red targets latch when the corresponding overcurrent element trips. For proper target operation, the trip circuit current must exceed 200 milliamperes.
H	Instantaneous (50) Pickup Switches	Two selector switches, tens and units, set the instantaneous overcurrent pickup level in amperes. Changing the pickup setting while the relay is in service may cause tripping.
I	Instantaneous (50) Manual Trip Test Jacks	Short-circuiting the test jacks provides a secure method to manually trip the controlled circuit breaker. The jacks accept a standard 0.08 inch diameter banana plug. **WARNING!** Trip circuit voltage is present at the front panel test jacks. When short-circuiting the test jacks, use insulated jumpers to avoid contact with this voltage.

CIRCUIT BOARD

Circuit board controls consist of control switch assembly SW3. The location of SW3 is shown in Figure 2-2 and SW3 functions are described in Table 2-2.

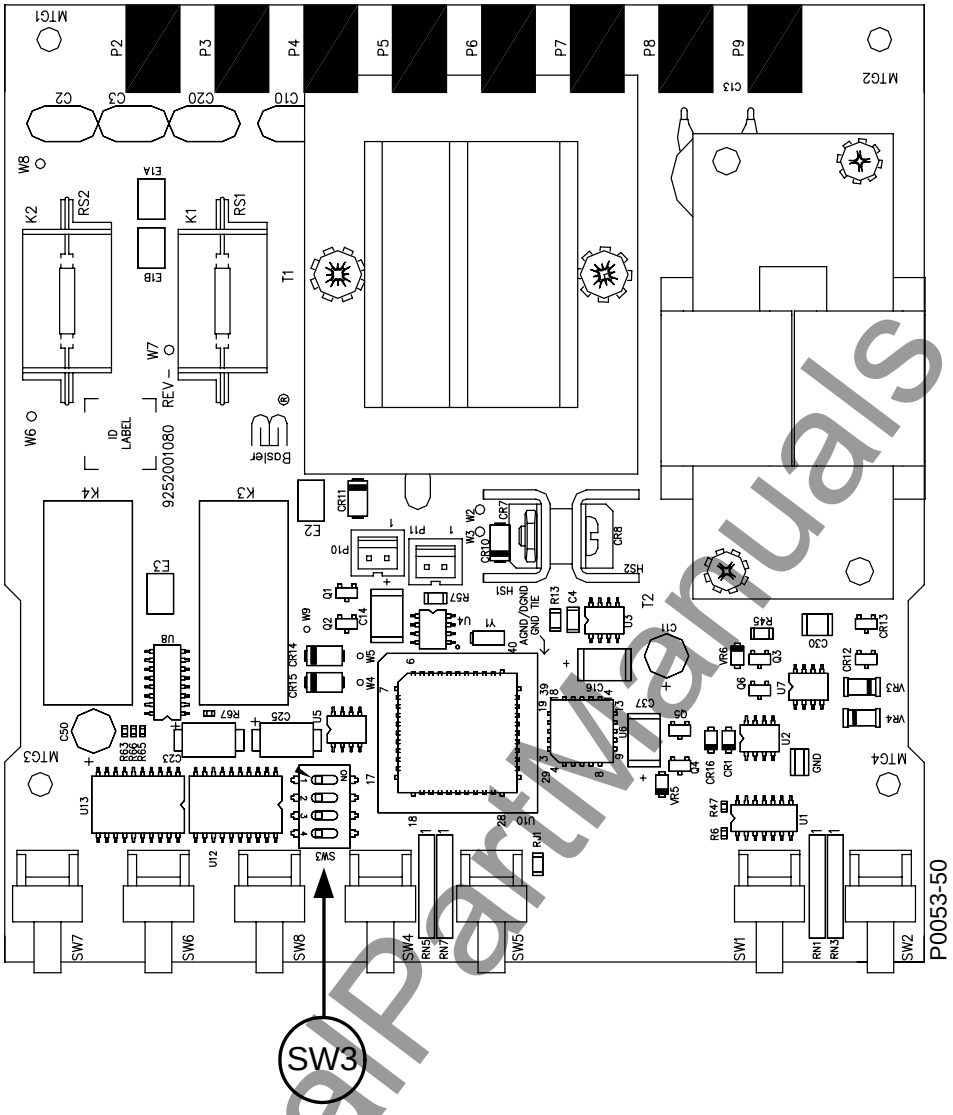

Figure 2-2. Circuit Board Controls

Table 2-2. Circuit Board Control Descriptions

Control	Description
SW3	SW3-1 selects the system operating frequency. Placing SW3-1 in the off (open) position selects 60 Hz operation. Placing SW3-1 in the on (closed) position selects 50 Hz operation. SW3-2 provides additional time delay for the instantaneous element. Placing SW3-2 in the on (closed) position adds 100 milliseconds to the instantaneous time delay. SW3-3 selects either GE IAC type curves (see Table 1-4)or ABB type curves (see Tables 1-3 and 1-4). Placing SW3-3 in the on (closed) position selects GE IAC type curves. Placing SW3-3 in the off (open) position selects ABB type curves. SW3-4 selects either instantaneous or integrating reset characteristics. Placing SW3-4 in the on (closed) position selects integrating reset characteristics. Placing SW3-4 in the off (open) position selects instantaneous reset characteristics.

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SECTION 3 • FUNCTIONAL DESCRIPTION

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SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

This section describes how the BE1-50/51B-229 Overcurrent Relay functions and explains its operating features. Relay function blocks are illustrated in the block diagram of Figure 3-1.

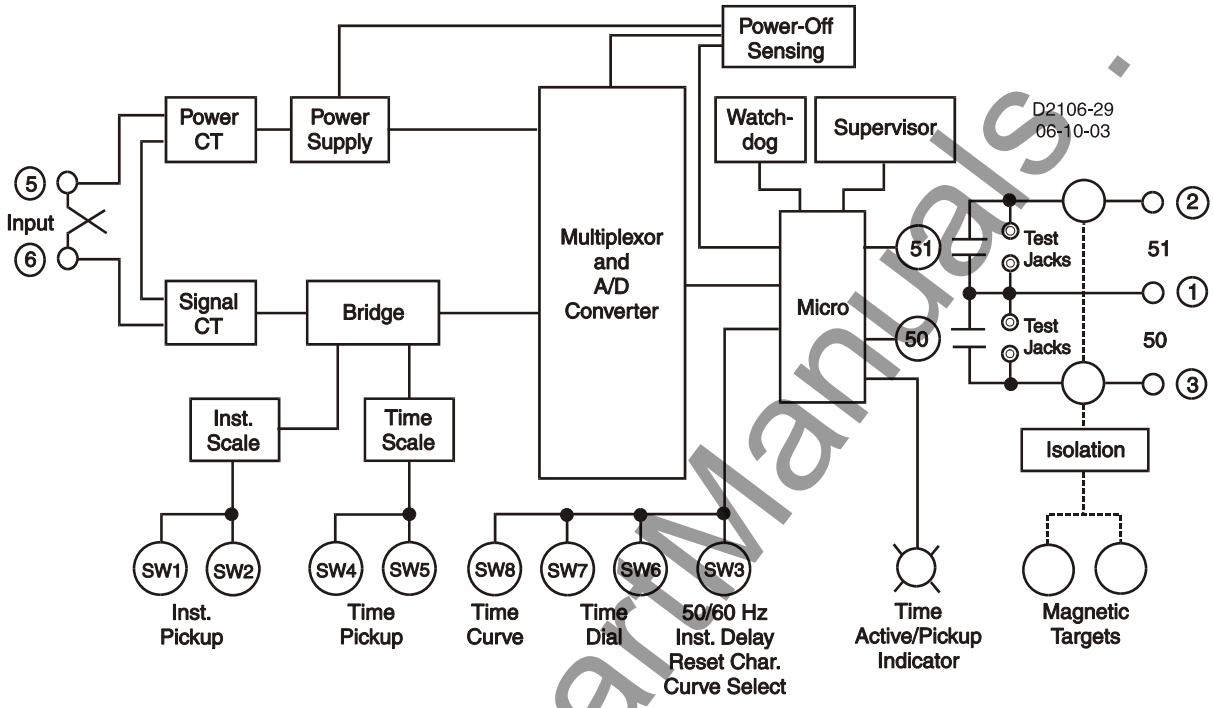

Figure 3-1. BE1-50/51-229 Function Block Diagram

RELAY FUNCTIONS AND OPERATING FEATURES

The following paragraphs describe BE1-50/51B-229 relay functions and operating features.

Sensing Input

Single-phase ac current from a user-supplied, system current transformer (CT) is brought into the relay at terminals 5 and 6. The sensing current is applied to the internal Power CT and Signal CT.

Power Supply

Current from the Power CT is rectified, filtered, and supplied to all internal relay circuitry for operating power. A precision, 5 Vdc output from the Power Supply 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 Instantaneous Pickup Selector Switches (SW1 and SW2). The analog voltage of the instantaneous input signal developed across the Instantaneous Scaling Resistors is filtered and applied to the Multiplexor.

Time Signal

Current from the Signal CT is rectified and applied to the Time Scaling Resistors controlled by the Time Pickup Selector Switches (SW4 and SW5). The analog voltage of the time input signal is filtered and applied to the Multiplexor.

Microprocessor

Operating power from the Power Supply is applied to the Microprocessor Supervisor Circuit. When the Microprocessor is active and executing code, the Active/Pickup LED is green. If the input current decreases below an acceptable level, the Supervisor Circuit interrupts the Microprocessor, halts further

operation, and turns off the Active/Pickup LED. The Microprocessor Watchdog feature resets the Microprocessor when the flow of program code is interrupted.

The Microprocessor also receives information from the Time Dial Selector Switches (SW7 and SW8) and the 50/60 Hz/Instantaneous Delay/Reset Characteristic/Curve Select Switch (SW3). These inputs are used by the Microprocessor to set the operating parameters.

When the Microprocessor is ready to receive 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 received inputs and the internal software program. When the sensed current exceeds the setting of the Time Pickup Selector Switches (SW4 and SW5), the Active/Pickup LED changes from green to red and the Time (51) output contacts close in accordance with the time characteristic equation. If the sensed current exceeds the setting of the Instantaneous Pickup Selector Switches (SW1 and SW2), the Instantaneous (50) output contacts close.

Power-Off Sensing

Power-Off Sensing circuitry measures the voltage across a capacitor at power-up and power-down. This circuitry determines how long power has been absent based on the voltage difference and the circuit RC time constant. This provides information for the Integrating Reset Function even when power has been removed entirely.

Relay Outputs

Circuit breakers controlled by the relay can be tripped manually by applying a short-circuit across the Time Manual Trip Test Jacks or Instantaneous Manual Trip Test Jacks. Current flow in the trip circuit is indicated by the operation of the appropriate target indicator. The targets will not operate without adequate operating power for the relay.

WARNING!

Trip circuit voltage is present at the front panel test jacks. When short-circuiting the test jacks, use insulated jumpers to avoid contact with this voltage.

SECTION 4 • INSTALLATION

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SECTION 4 • INSTALLATION

RECEIPT AND INSPECTION

BE1-50/51B-229 Overcurrent Relays are shipped in sturdy cartons to prevent damage during transit. Upon receipt of a relay, check the model and part number against the requisition and packing list. Inspect the relay for any damage that may have occurred during shipment. If there is evidence of damage, file a claim with the carrier, and notify your regional sales office or a sales representative at Basler Electric.

If the relay will not be installed immediately, place the relay in its original shipping carton and store in a dry, dust-free environment.

Proper relay operation may be confirmed by performing the test procedures of Section 5, *Testing*.

CONNECTIONS

Typical ac connections for the BE1-50/51B-229 relay are shown in Figure 4-1. Figure 4-2 shows typical dc connections for the relay.

NOTE

Be sure that the relay is hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the ground terminal on the rear of the unit case. When the relay is configured in a system with other devices, it is recommended to use a separate lead to the ground bus from each unit.

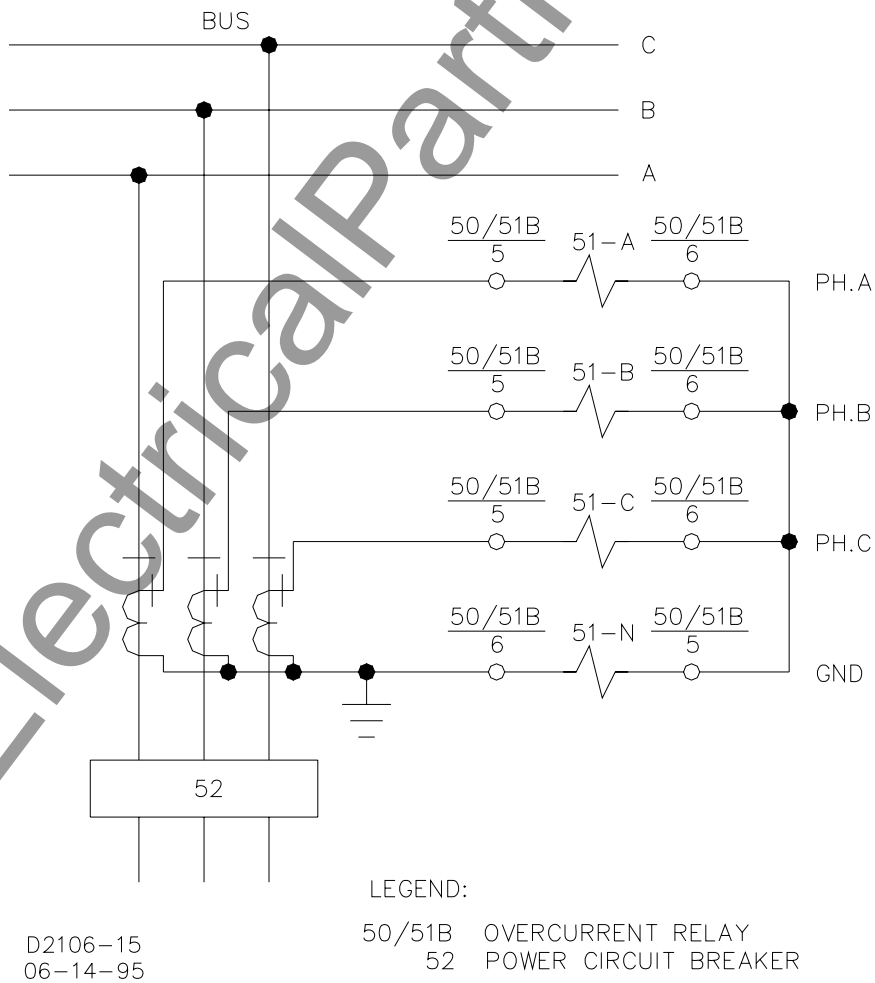

Figure 4-1. AC Connections

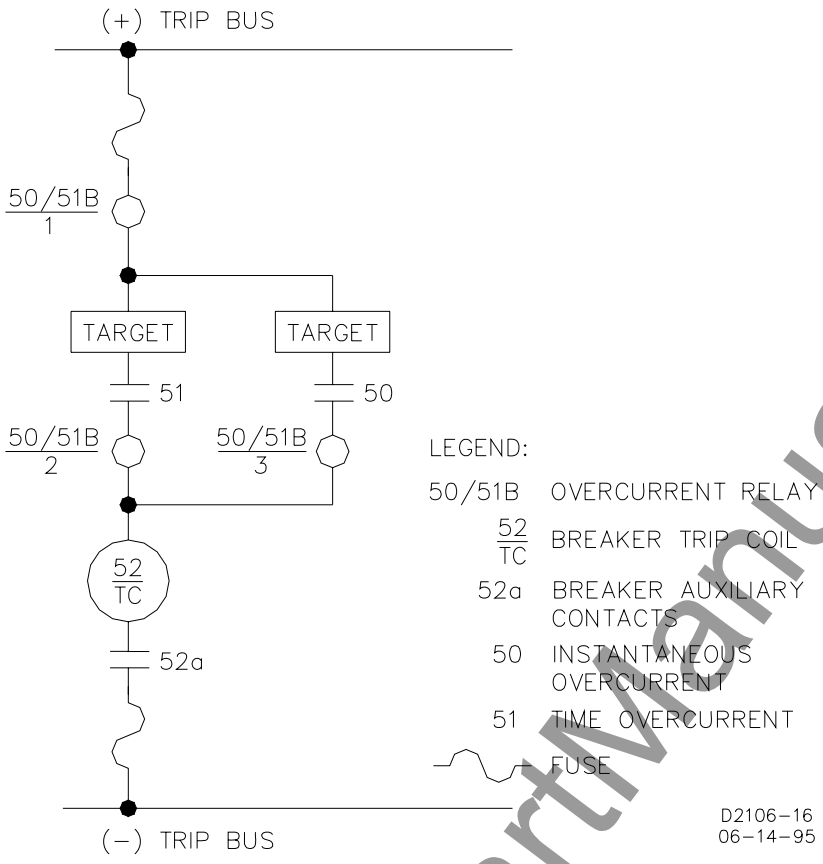

Figure 4-2. DC Connections

SETTING THE RELAY

Before placing the relay in service, the relay should be configured with the desired settings. Changing pickup current settings while the relay is in service may cause tripping.

The four switches of SW3 must be adjusted for the desired operation before the relay is installed in the case. Refer to Section 2, *Controls and Indicators* for the location of SW3 and the operating characteristics controlled by the four switches of SW3.

Application Coordination Example

In the following example of a typical application coordination scheme, a BE1-50/51B-229 relay is providing 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 BE1-50/51B-229 relay, with integrating reset characteristic, has the time characteristic curve E (extremely inverse) selected (SW3-3 open or off) and the time dial set at 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 of 10 times pickup), calculate the feeder breaker trip time for each of the three operations. Refer to Appendix A, *Time Overcurrent Curves* for the characteristic curve constants.

From the time characteristic curve equation:

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

$$T_{Trip} = \frac{7.7624 \times 2}{(10^{2.0938} - 1)} + 0.02758 \times 2 + 0.028 \qquad T_{Trip} = 0.209 \text{ seconds}$$

From the reset characteristic curve equation:

$$T_{\text{Re set}} = \frac{RD}{(M^2 - 1)} \qquad T_{Trip} = \frac{7.75 \times 2}{0^2 - 1} \qquad T_{Trip} = -15.5 \text{ seconds}$$

M equals zero if the current decreases to zero. A negative result indicates reset time.

The results from the two equations give a full trip time of 0.209 seconds and a full reset time of 15.5 seconds if the current goes to zero.

In the coordination timing diagram of Figure 4-3: 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

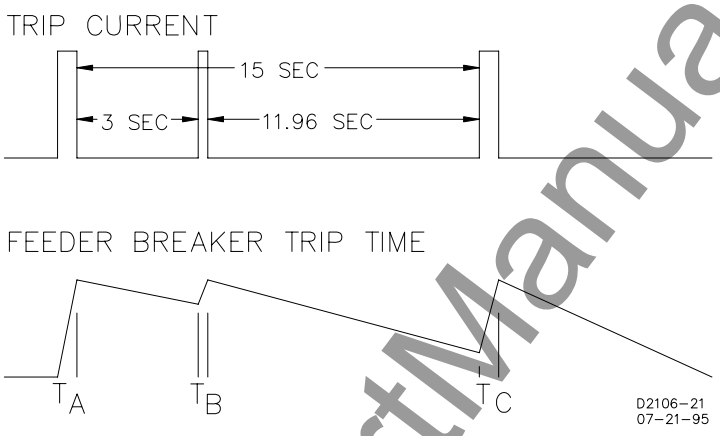

Figure 4-3. Coordination Timing Diagram

The equation for the time to trip during rewind (before relay is reset) is:

$$T_{Trip\ This\ Occurance} = \frac{FullTrip \times RewindTime}{FullRewind}$$

Second Operation:

$$T_B = \frac{0.209 \times 3}{15.5} \qquad T_B = 0.040 \text{ seconds}$$

Third Operation:

$$T_C = \frac{0.209 \times 11.96}{15.5} \qquad T_c = 0.161 \text{ seconds}$$

INSTALLING THE RELAY

Once the BE1-50/51B-229 relay is configured with the desired settings, it can be installed by performing the following steps.

1. Remove the existing SFC relay from the case.
2. Attach the cover adaptor to the existing SFC relay case with the four screws provided.
3. Insert the BE1-50/51B-229 relay in the case and lock the relay in place with the cradle latches.
4. Install the connection plug from the SFC relay.
5. Install the BE1-50/51B-229 relay cover by positioning the interlocking bracket at the top of the cover into the mating receptacle at the top of the cover adaptor plate. Secure the cover by tightening the knob at the bottom of the cover.

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SECTION 5 • TESTING

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SECTION 5 • TESTING

INTRODUCTION

Proper relay operation may be confirmed by performing the test procedures of this section. When the relay is not in service, it should be stored in its original carton in a dry, dust-free environment.

DIELECTRIC TESTING

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 circuits to output circuits: 2000 Vac or 2828 Vdc

Output contacts are surge protected.

OPERATIONAL TESTING

The following procedures verify operation of the BE1-50/51B-229 Overcurrent Protection Relay. The test setups illustrated in Figures 5-1 and 5-2 are intended 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, 0 to 20 Aac (for sensing input current)
- Current source, 0.2 to 3 Aac (for target operation)
- Timer or counter

NOTE

To ensure proper timing, before each test, remove the current from the relay for R times D seconds (refer to Section 1, *General Information, Specifications, Integrating Time Reset Characteristic* for R and D definitions).

When testing time overcurrent functions, instantaneous pickup settings of 00 will also affect the calibration of the time functions. Time pickup settings of 00 will also affect instantaneous functions.

Time Pickup Test

1. Perform the following preliminary steps.
    a. Connect test setup as shown in Figure 5-1.
    b. Configure SW3 as follows: SW3-1 off for 60 Hz operation, on for 50 Hz operation, SW3-2 off, SW3-3 on, and SW3-4 on.
    c. Set the time dial at 0.0.
    d. Set the curve at S.
    e. Set the time pickup at 0.5.
    f. Set the instantaneous pickup at 90.
2. Slowly increase the current applied to terminals 5 and 6. The Active/Pickup LED should turn red at a maximum input current of 0.55 Aac.
3. Decrease the input current until the Active/Pickup LED turns green, then off.
4. Set the time pickup at 2.2.
5. Slowly increase the current applied to terminals 5 and 6. The Active/Pickup LED should change from green to red at an input current of 2.131 to 2.269 Aac.
6. Decrease the input current until the Active/Pickup LED turns off.

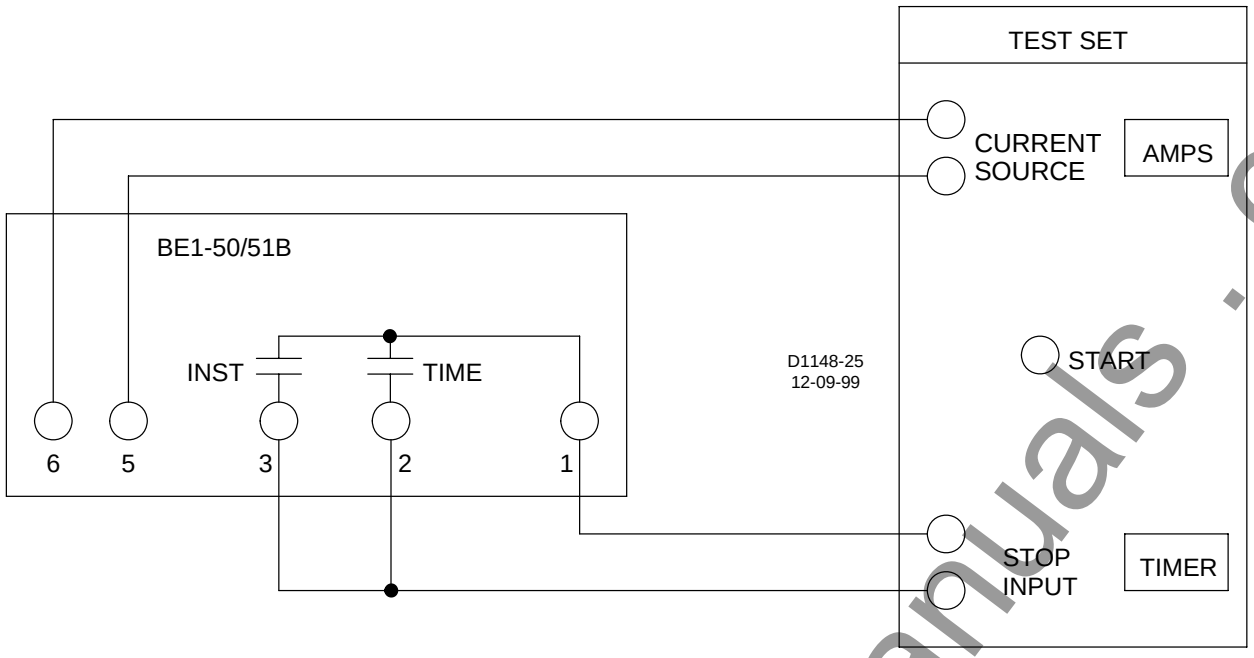

Figure 5-1. Pickup and Timing Test Setup

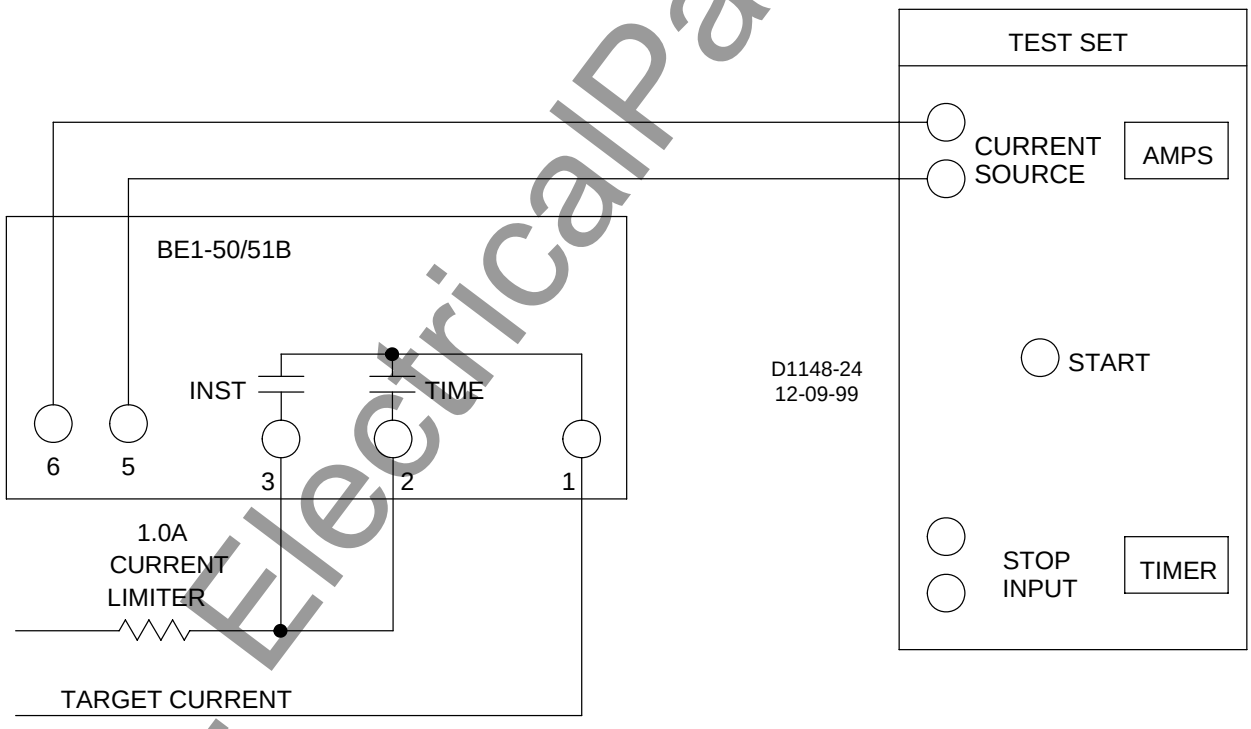

Figure 5-2. Target Operational Test Setup

Instantaneous Pickup Test

1. Perform the following preliminary steps.
    a. Connect test setup as shown in Figure 5-1.
    b. Configure SW3 as follows: SW3-1 off for 60 Hz operation, on for 50 Hz operation, SW3-2 off, SW3-3 on, and SW3-4 on.
    c. Set the time dial at 0.0.
    d. Set the curve at S.
    e. Set the time pickup at 1.0.
    f. Set the instantaneous pickup at 01.
2. Slowly increase the current applied to terminals 5 and 6. The instantaneous output contacts should close at an input current of 0.955 to 1.045 Aac.
3. Decrease the input current until the instantaneous output contacts open.
4. Set the instantaneous pickup at 08.
5. Slowly increase the current applied to terminals 5 and 6. The instantaneous contacts should close at an input current of 7.815 to 8.185 Aac.
6. Decrease the input current until the instantaneous output contacts open.

Time Dial Test

1. Perform the following preliminary steps.
    a. Connect test setup as shown in Figure 5-1.
    b. Configure SW3 as follows: SW3-1 off for 60 Hz operation, on for 50 Hz operation, SW3-2 off, SW3-3 on, and SW3-4 on.
    c. Set the time dial at 4.5.
    d. Set the curve at S.
    e. Set the time pickup at 1.0.
    f. Set the instantaneous pickup at 90.
2. Prepare to apply 1.5 Aac to terminals 5 and 6 and record the elapsed time from when current is applied until the time output contacts close.
3. Apply the current (step from 0 to 1.5 Aac) and record the elapsed time. The elapsed time should be between 0.345 and 0.424 seconds. (This tolerance is greater than ±2% because it is the accumulation of both pickup and timing tolerances.)
4. Remove the input current.

Target Test

1. Perform the following preliminary steps.
    a. Connect test setup as shown in Figure 5-2.
    b. Configure SW3 as follows: SW3-1 off for 60 Hz operation, on for 50 Hz operation, SW3-2 off, SW3-3 on, and SW3-4 on.
    c. Set the time dial at 4.5
    d. Set the curve at S.
    e. Set the time pickup at 1.0.
    f. Set the instantaneous pickup at 01.
2. Set the target current source at 1.0 Aac.
3. Apply 5 Aac to terminals 5 and 6. Verify that the Time and Instantaneous targets operate.
4. Remove the input current and reset the targets.

Manual Trip Test

1. Perform the following preliminary steps.
    a. Connect test setup as shown in Figure 5-2.
    b. Configure SW3 as follows: SW3-1 off for 60 Hz operation, on for 50 Hz operation, SW3-2 off, SW3-3 on, and SW3-4 on.
    c. Set the time dial at 4.5
    d. Set the curve at S.
    e. Set the time pickup at 1.0.
    f. Set the instantaneous pickup at 01.

WARNING!

Trip circuit voltage is present at the front panel test jacks. When short-circuiting the test jacks, use insulated jumpers to avoid contact with this voltage.

2. Set the target current source at 1.0 Aac.
3. Apply 0.9 Aac to terminals 5 and 6. (0.9 Aac provides input power, but remains below pickup.)
4. Connect a jumper between the Time Manual Trip test jacks. Verify that the Time target operates. Remove the jumper.
5. Connect a jumper between the Instantaneous Manual Trip test jacks. Verify that the Instantaneous target operates. Remove the jumper.
6. Reset the targets.

Integrating Reset Test

1. Perform the following preliminary steps.
    a. Connect test setup as shown in Figure 5-1.
    b. Configure SW3 as follows: SW3-1 off for 60 Hz operation, on for 50 Hz operation, SW3-2 off, SW3-3 on, and SW3-4 on.
    c. Set the time dial at 9.9.
    d. Set the curve at V.
    e. Set the time pickup at 1.0.
    f. Set the instantaneous pickup at 90.
2. Set the target current source at 1.0 Aac.
3. Apply 4.0 Aac to terminals 5 and 6. After the relay trips, remove the input current for 29 ±0.25 seconds, then reapply the 4.0 Aac input current. The elapsed time from the reapplication of input current to the output re-trip should be 2.08 seconds, ±0.4 seconds.

PERIODIC TESTING

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

Single-phase relays such as the BE1-50/51B-229 are normally used in groups of four (three phases and ground) on the protected circuit. This scheme allows one relay to be withdrawn and tested without losing protection. Only three relays are required at any given 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 testing should consist of the following procedures.

1. Verify that the instantaneous pickup is within ±2% of the value set on the dials. Pickup occurs when the instantaneous output contacts close.
2. Verify that the time pickup is within ±2% of the value set on the dials. Pickup occurs when the LED turns green, then red.
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 Appendix A, *Time Overcurrent Curves* for the characteristic curves.
4. Verify that the time to trip for the instantaneous element, at a pickup multiple of two, is not greater than the time given on the instantaneous characteristic curve. Refer to Appendix A, *Time Overcurrent Curves* for the characteristic curves.
5. Verify that the targets operate with 1 Aac of trip current in the trip circuits and that they can be reset using the reset button.

APPENDIX A • TIME CHARACTERISTIC CURVES

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Figures

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APPENDIX A • TIME CHARACTERISTIC CURVES

INTRODUCTION

Figures A-1 through A-14 illustrate the characteristic curves that are programmed into the nonvolatile memory of the BE1-50/51B-229 relay.

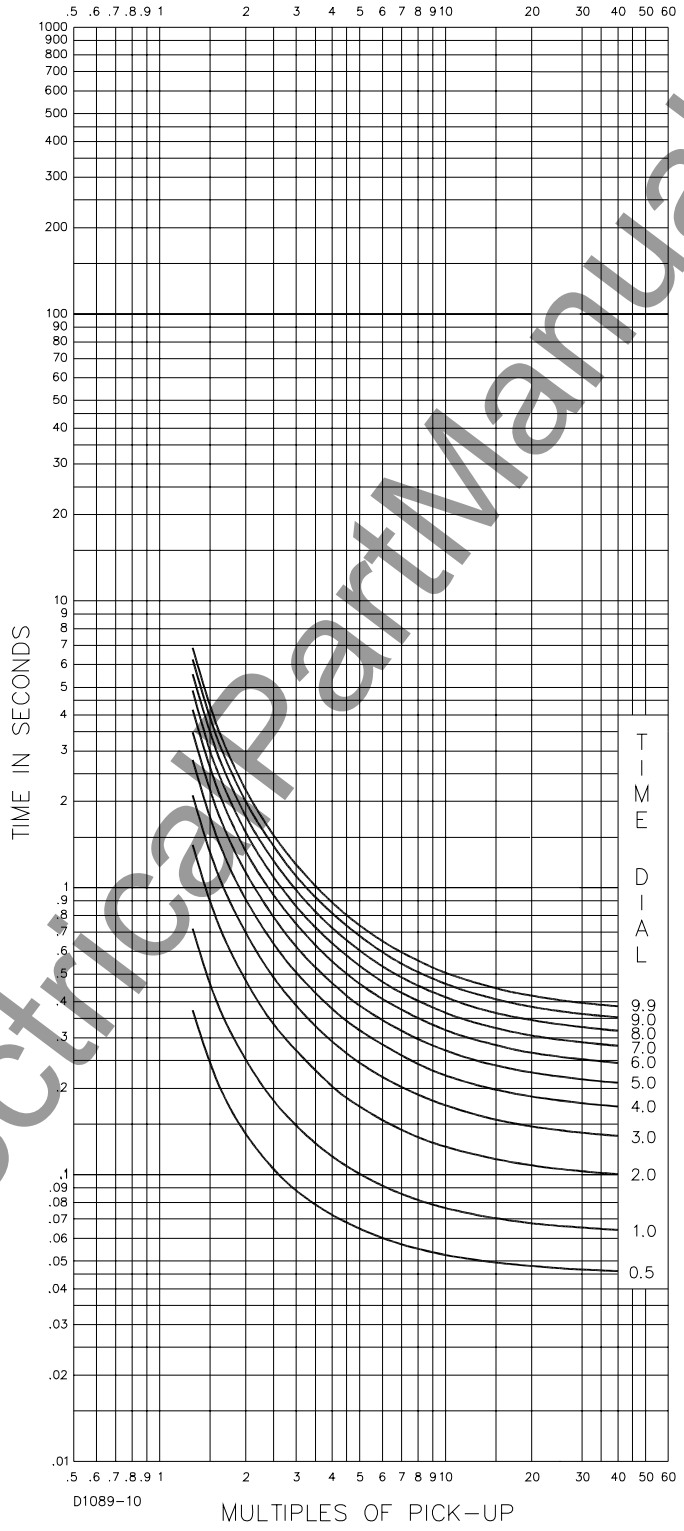

Figure A-1. S-Short Inverse, SW3-3 Off, Similar to ABB CO-2

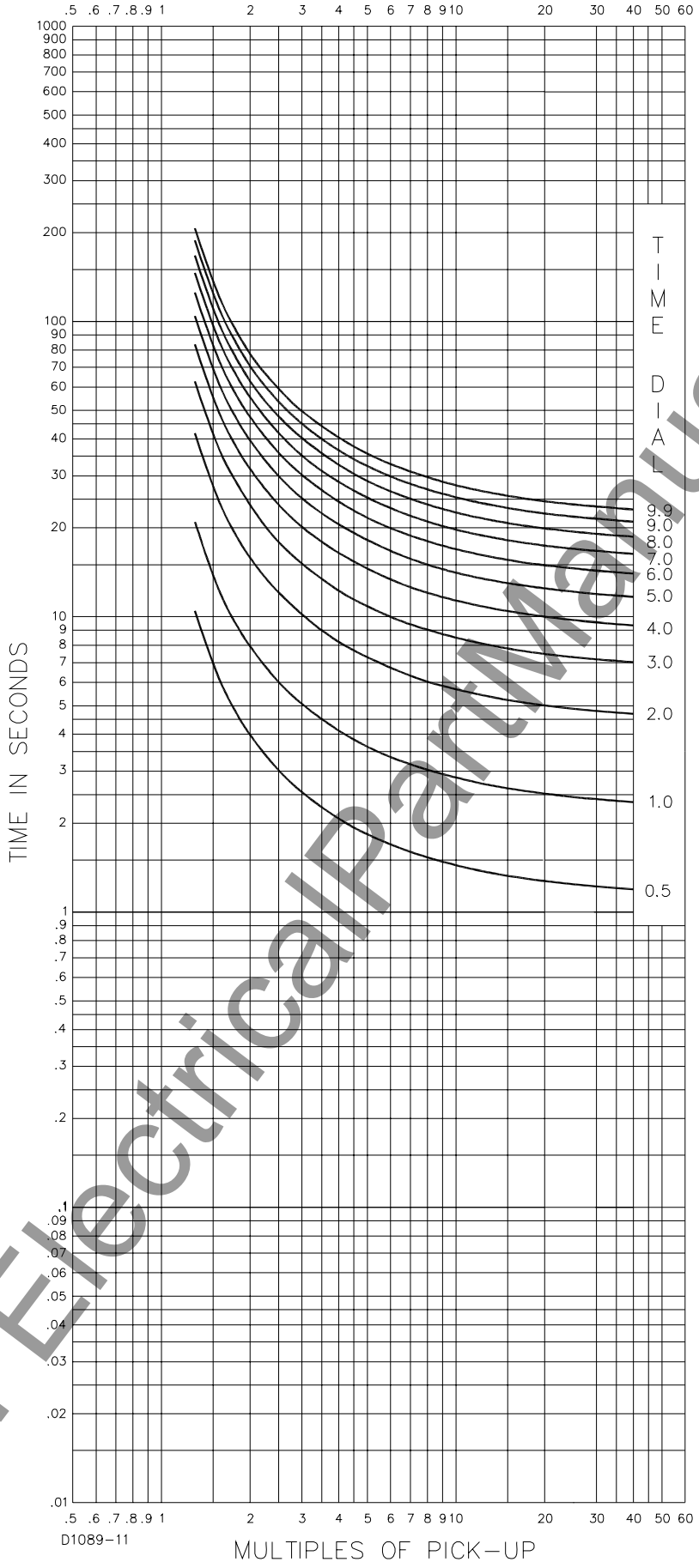

Figure A-2. L-Long Inverse, SW3-3 Off, Similar to ABB CO-5

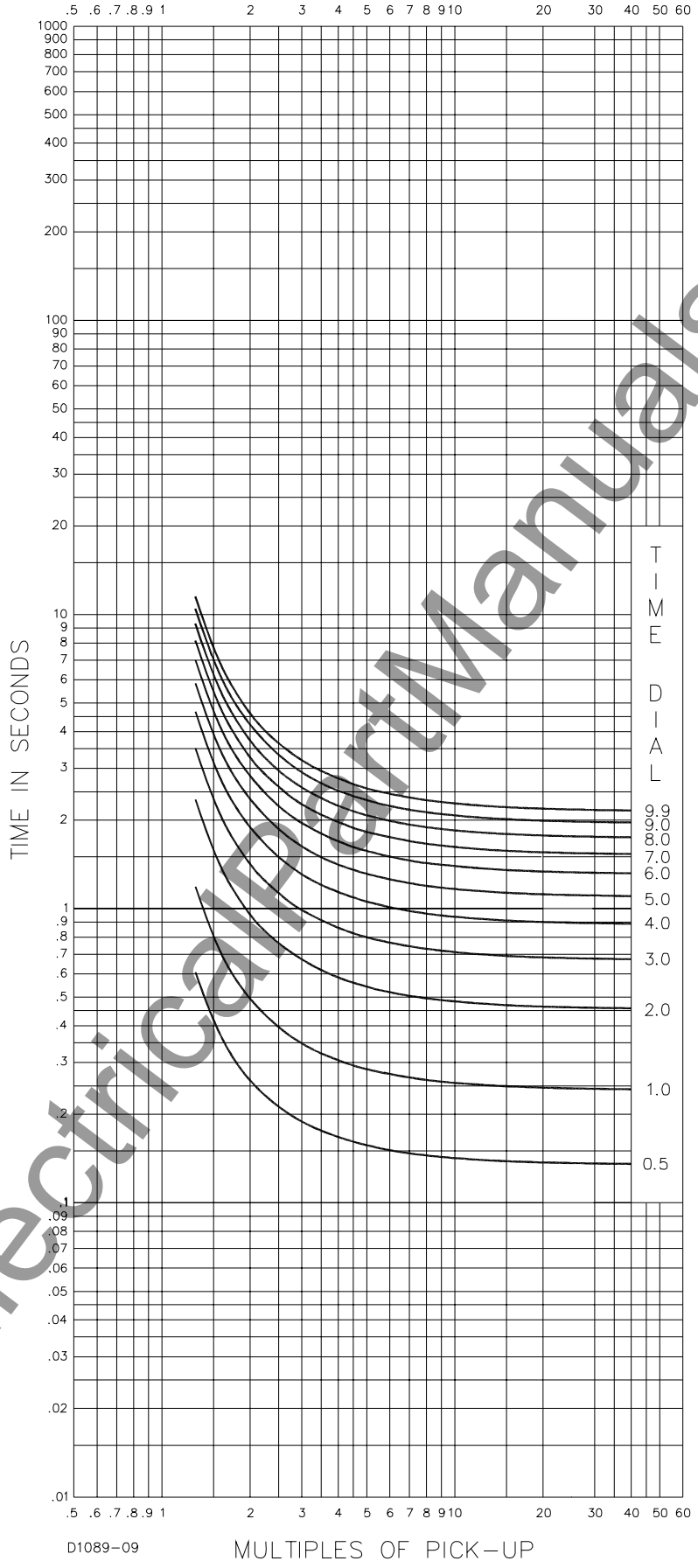

Figure A-3. D-Definite Time, Similar to ABB CO-6

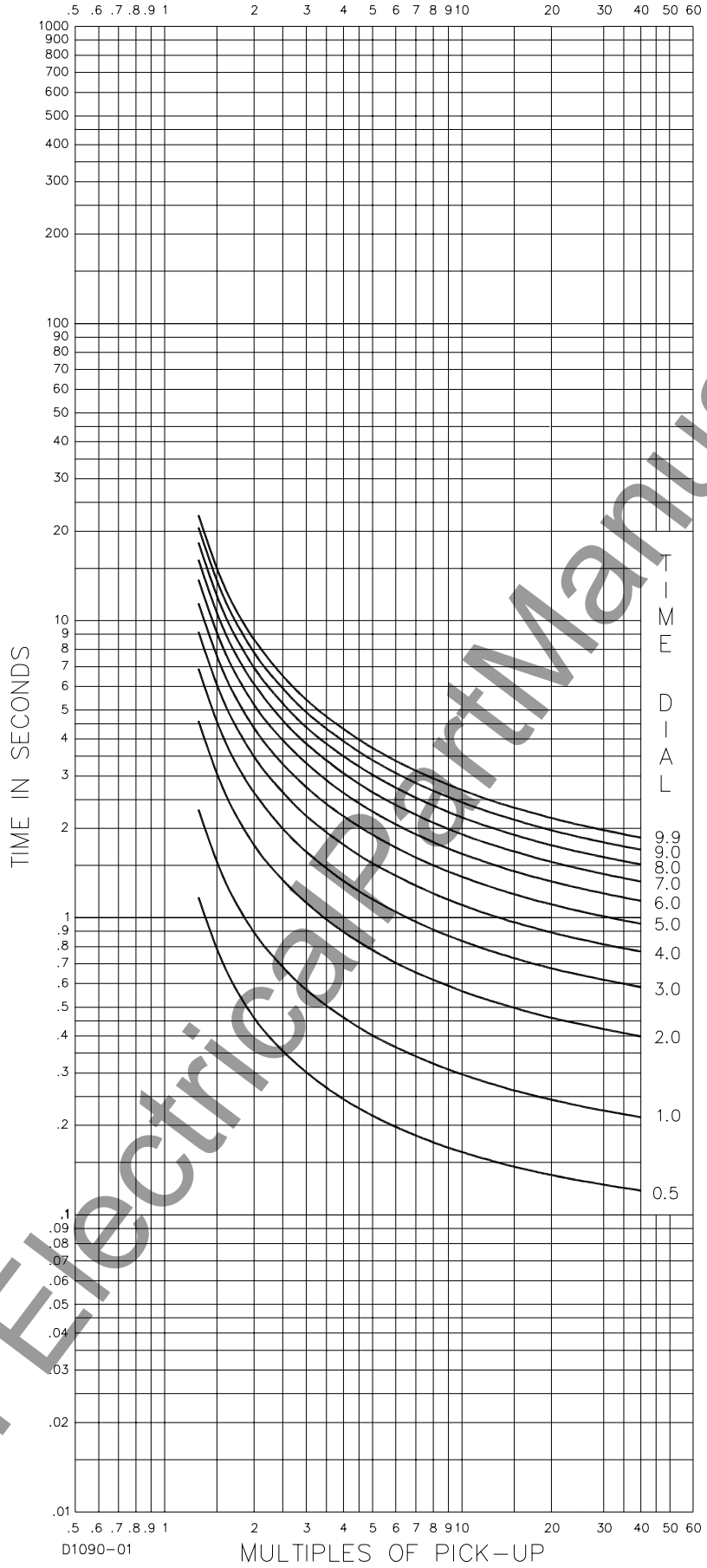

Figure A-4. M-Moderately Inverse, Similar to ABB CO-7

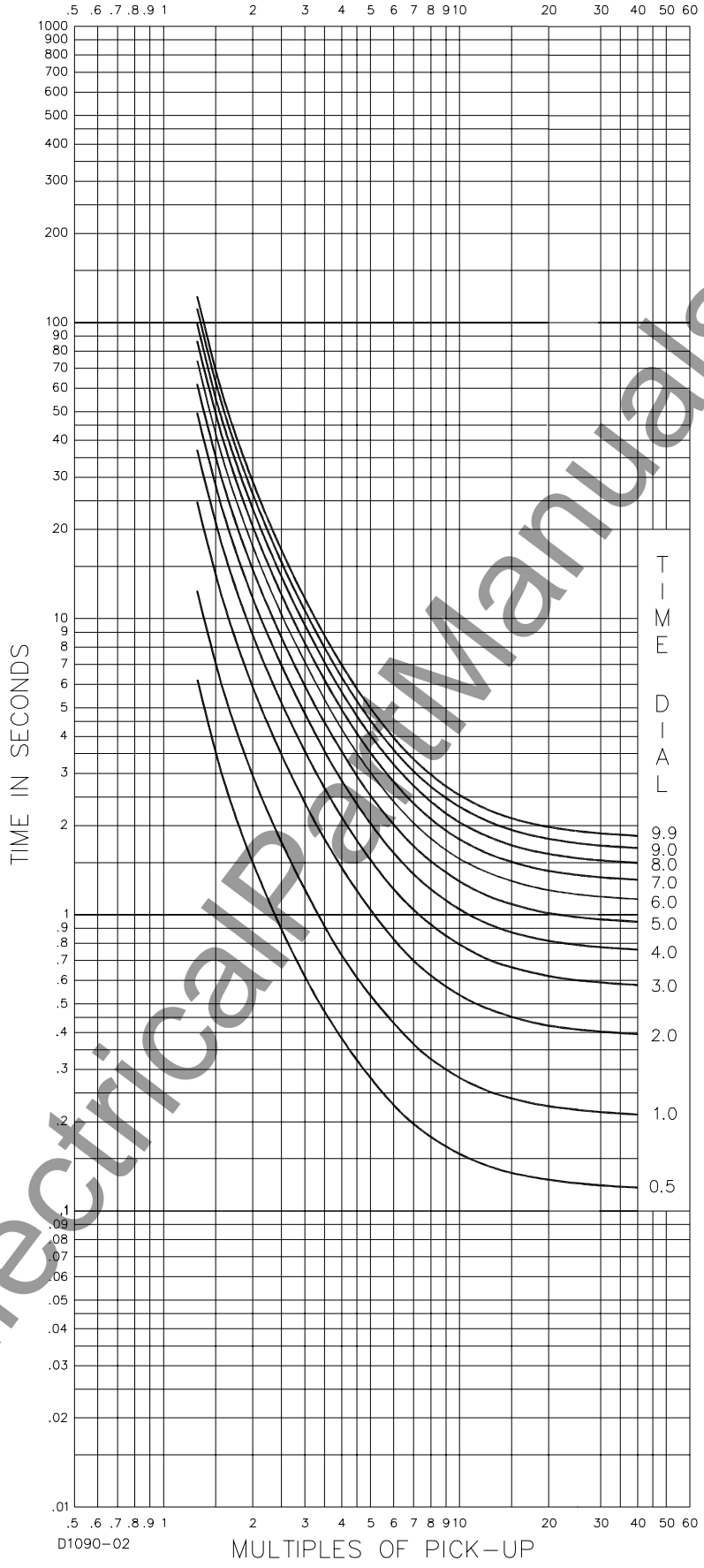

Figure A-5. I-Inverse, SW3-3 Off, Similar to ABB CO-8

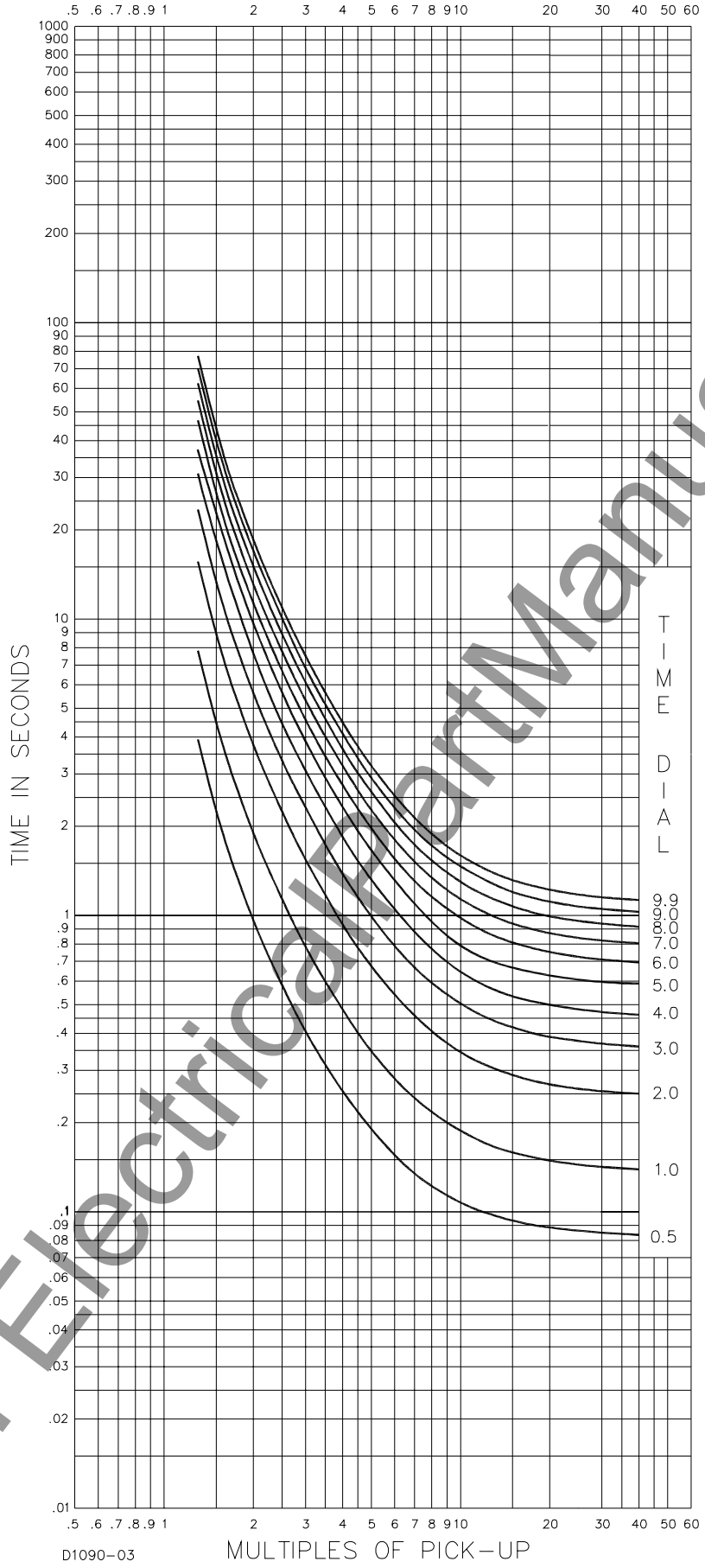

Figure A-6. V-Very Inverse, SW3-3 Off, Similar to ABB CO-9

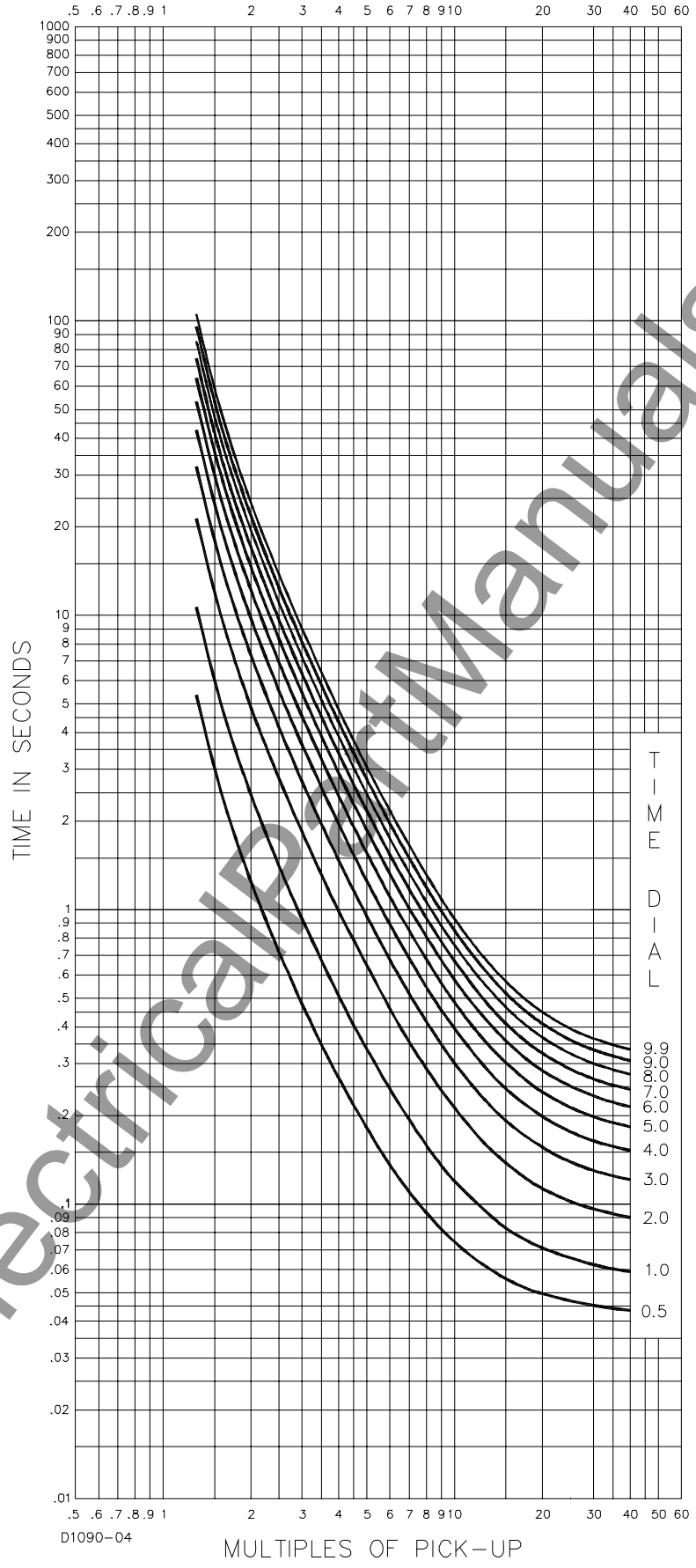

Figure A-7. E-Extremely Inverse, SW3-3 Off, Similar to ABB CO-11

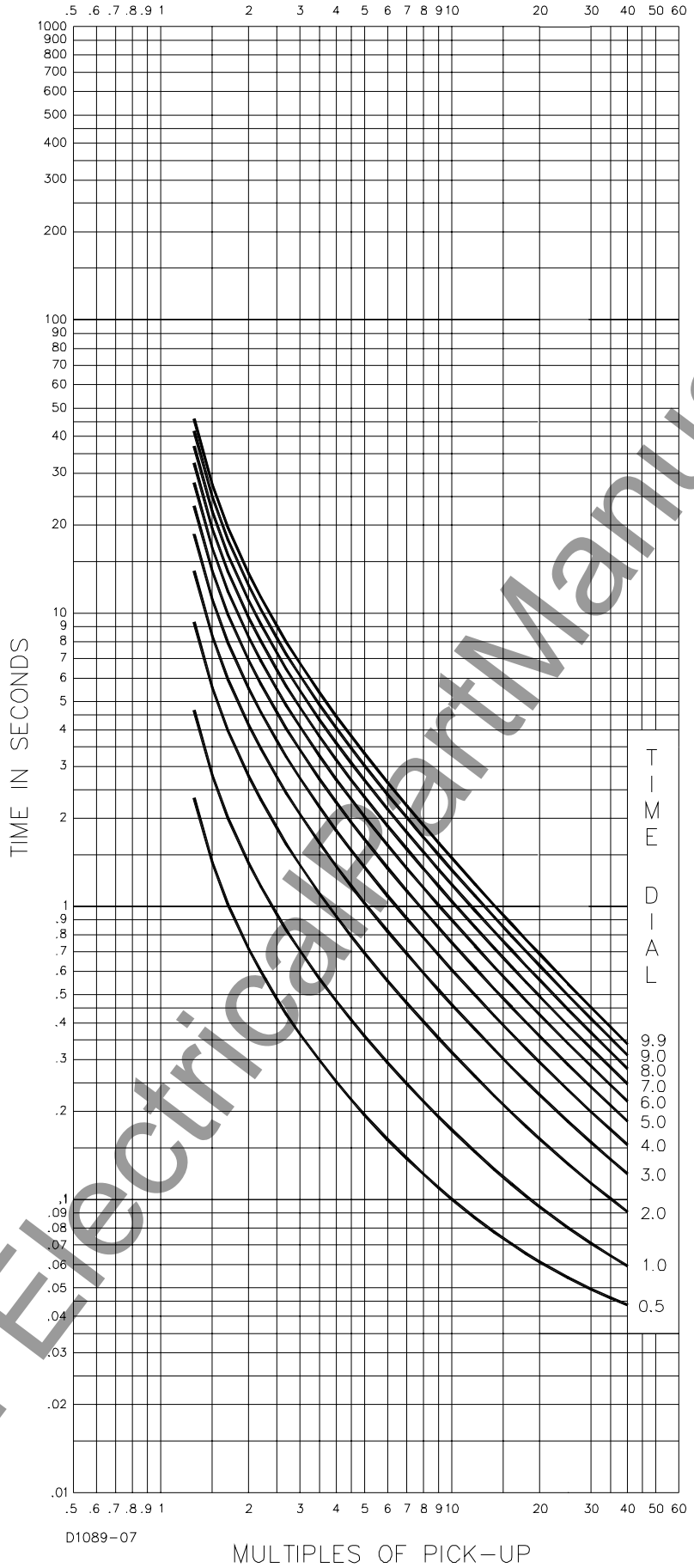

Figure A-8. BS142-B, Very Inverse

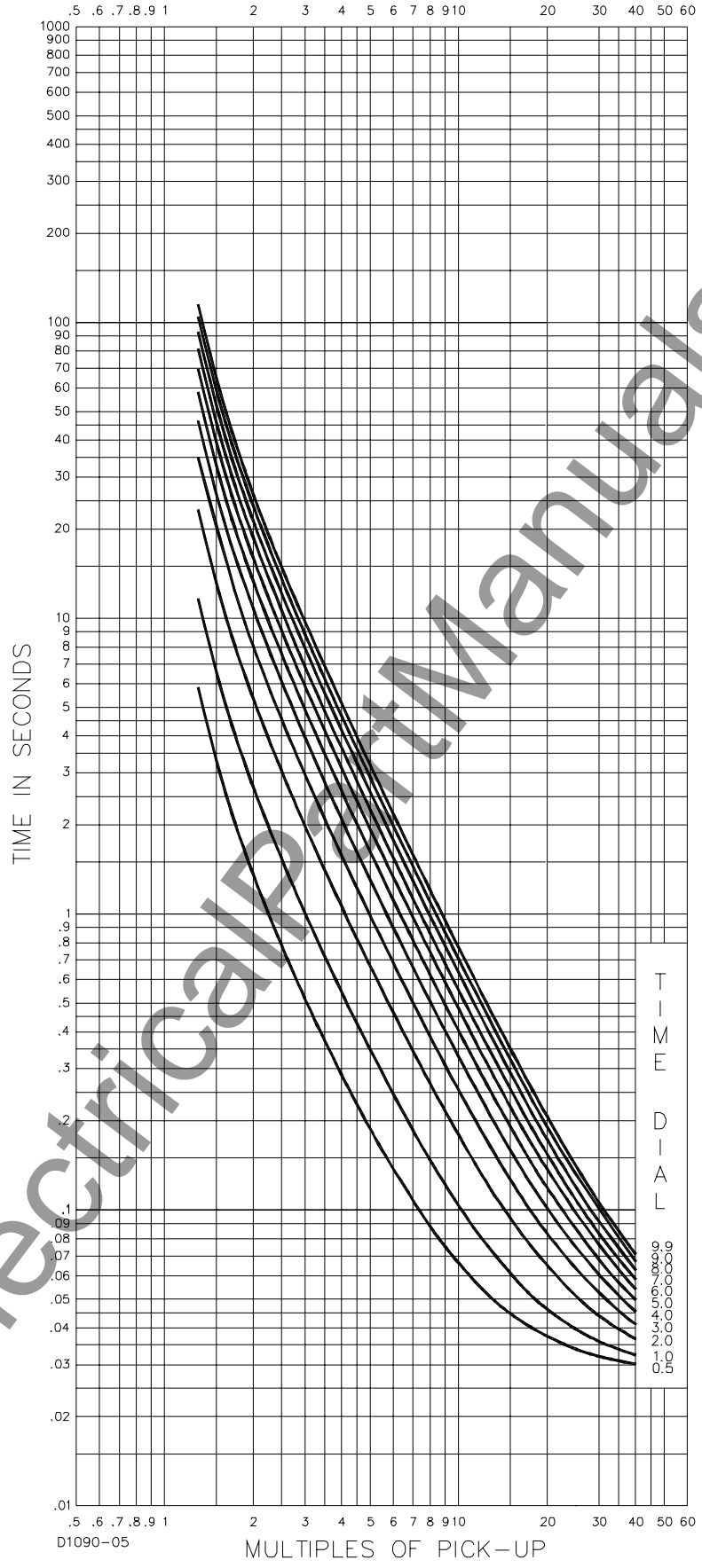

Figure A-9. BS142-C, Extremely Inverse

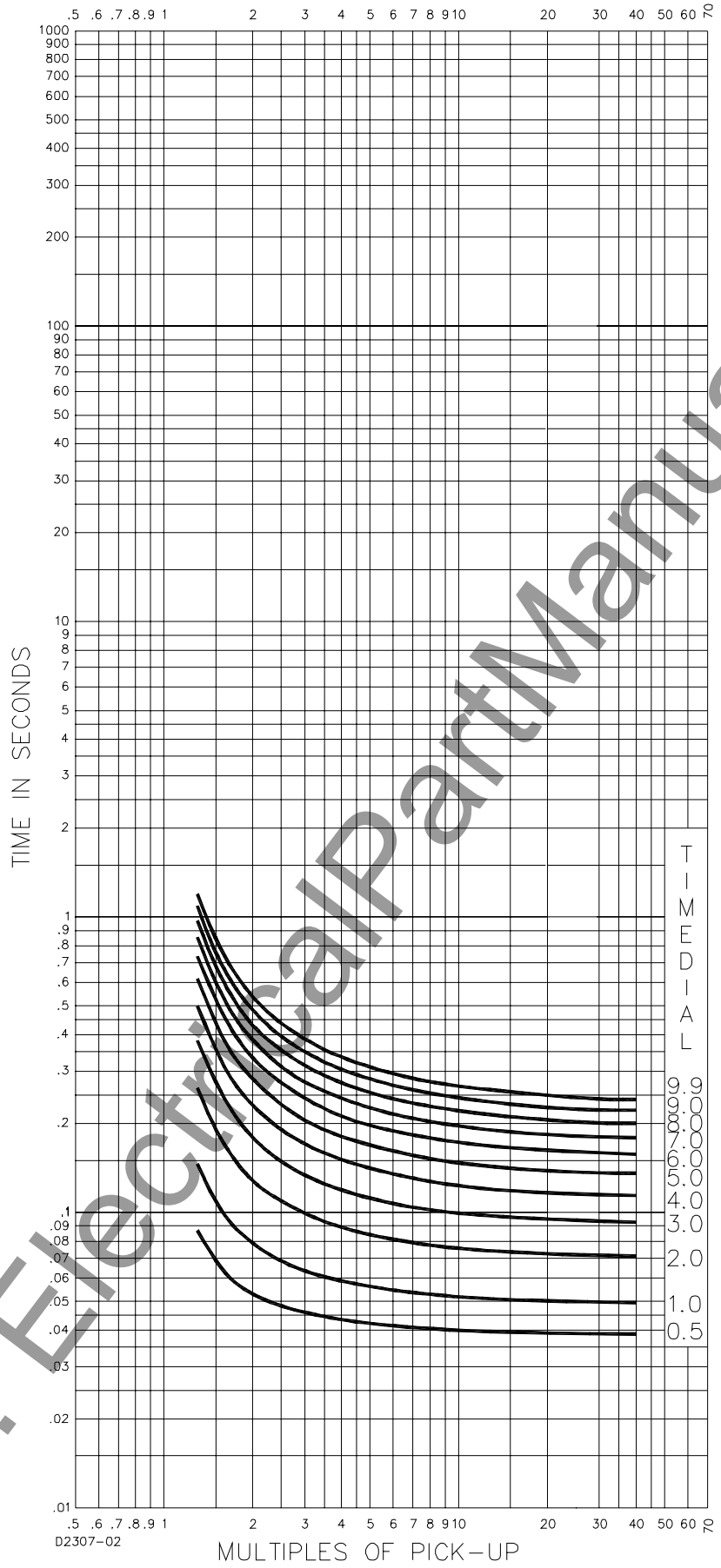

Figure A-10. S2-Short Inverse, SW3-3 On, Similar to GE IAC 55

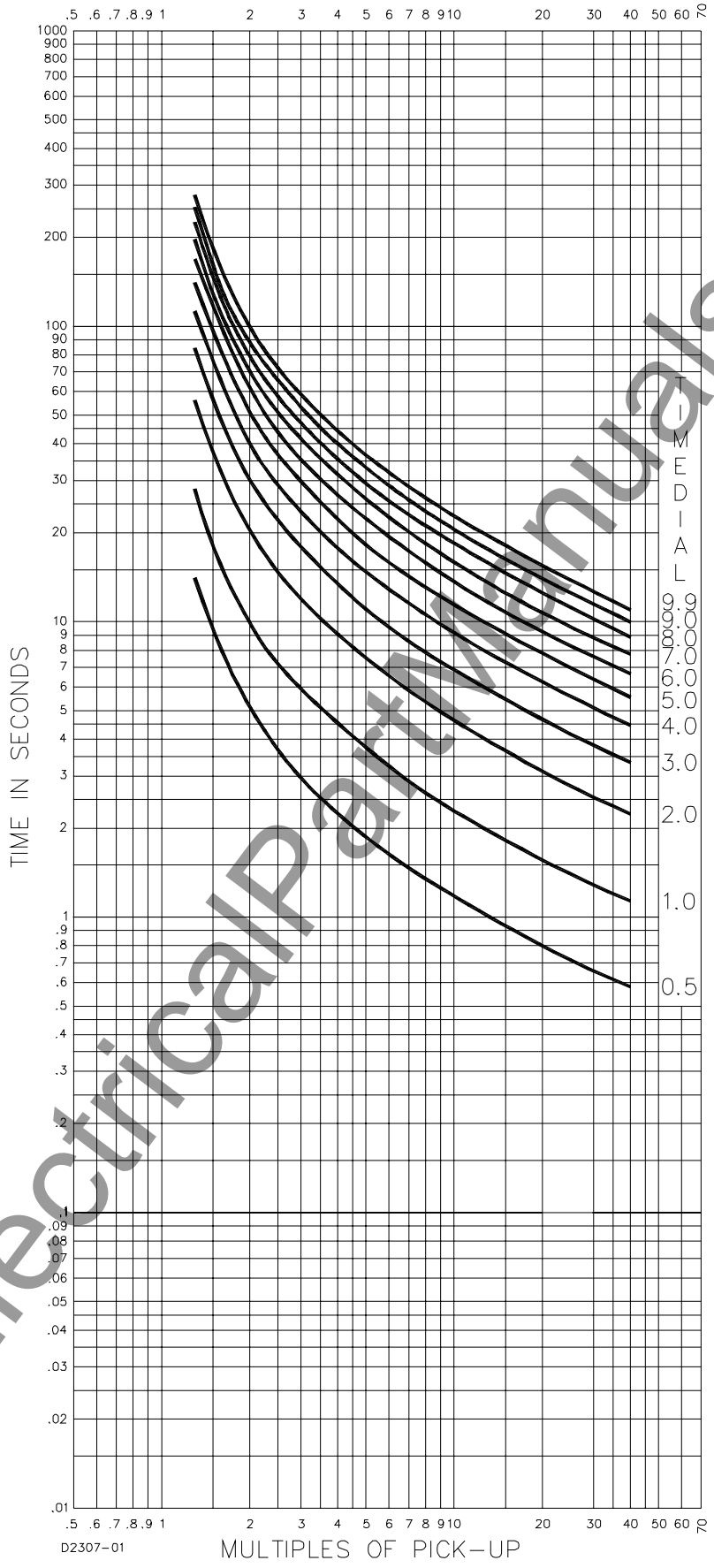

Figure A-11. L2-Long Inverse, SW3-3 On, Similar to GE IAC 66

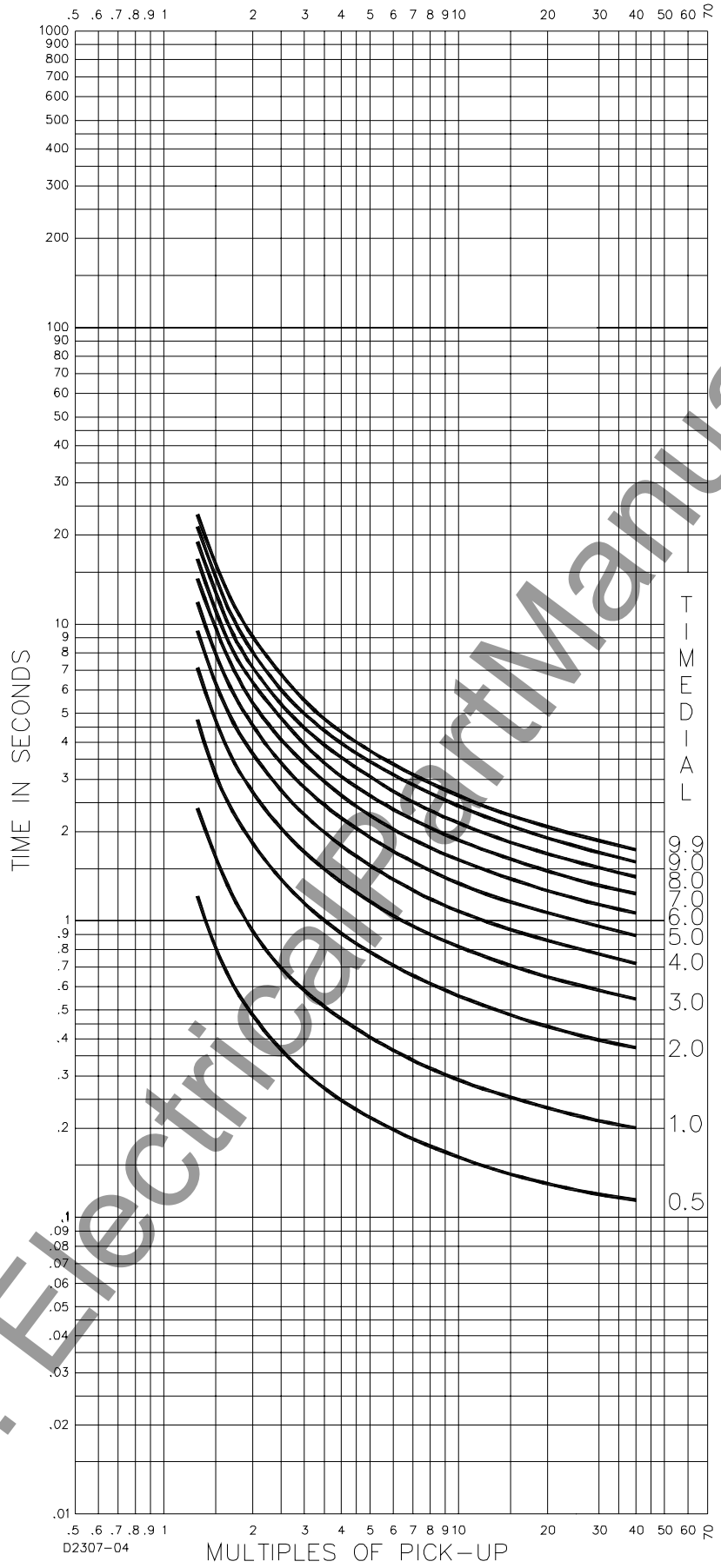

Figure A-12. I2-Inverse, SW3-3 On, Similar to GE IAC 51

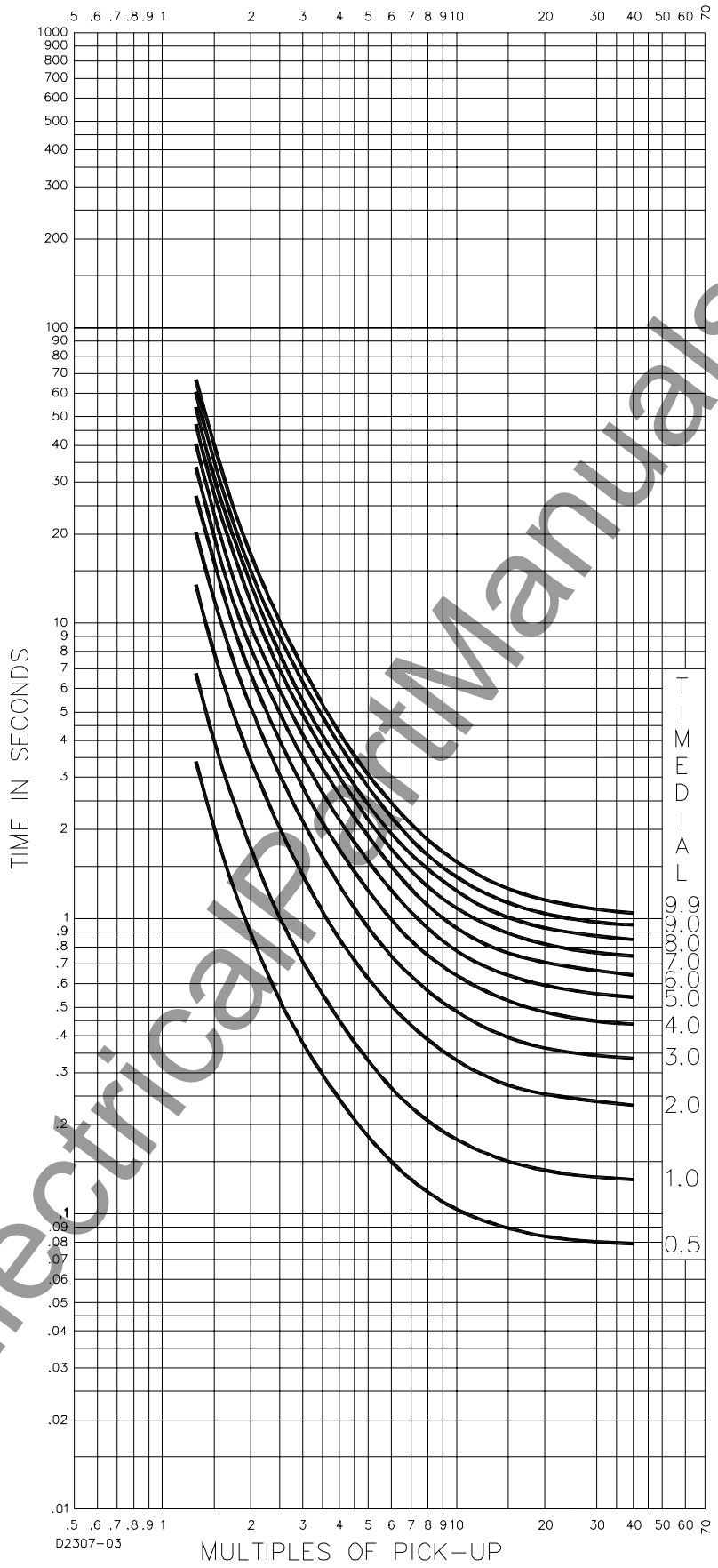

Figure A-13. V2-Very Inverse, SW3-3 On, Similar to GE IAC 53

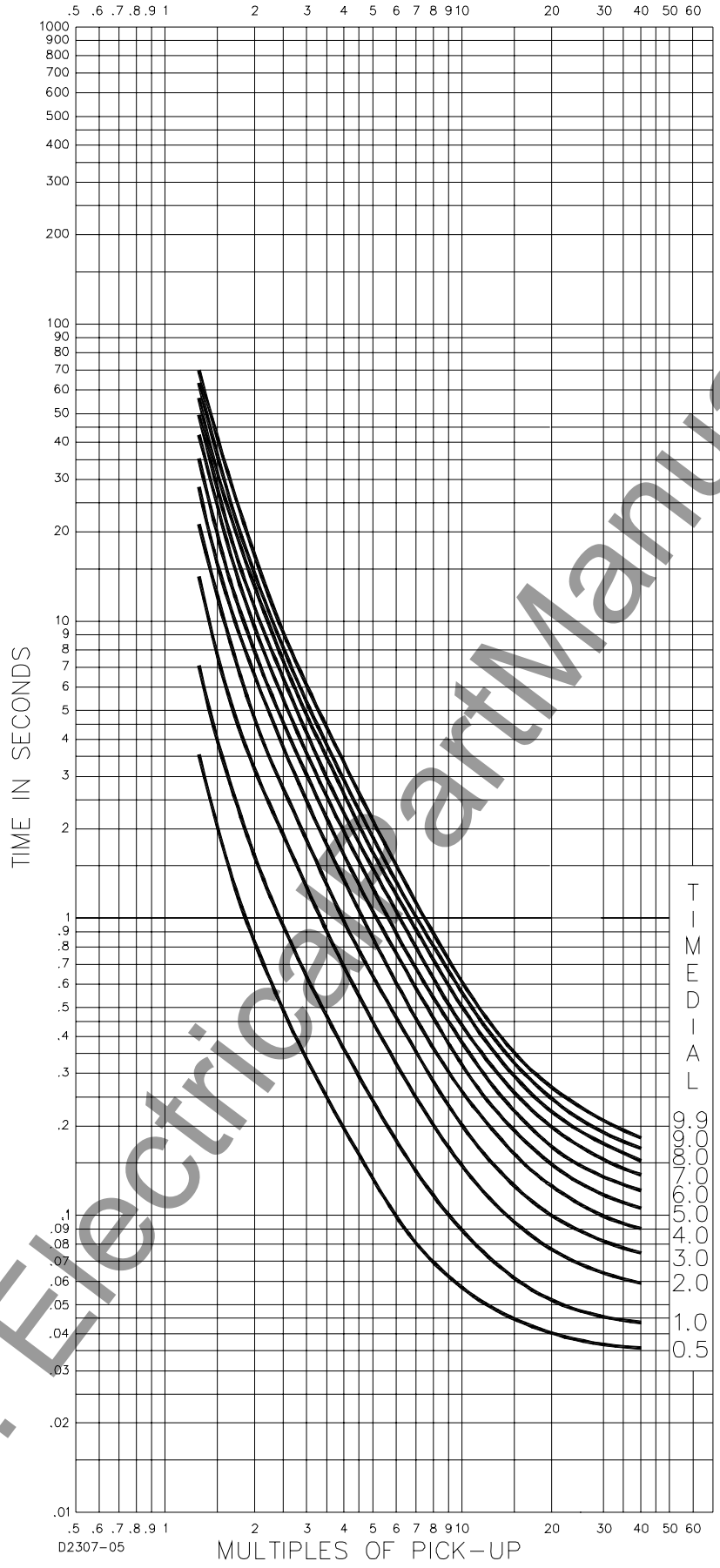

Figure A-14. E2-Extremely Inverse, SW3-3 On, Similar to GE IAC 77

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