Instructions for Installation, Operation and Maintenance of the Cutler-Hammer Digitrip 3000 Protective Relay

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SECTION 1: INTRODUCTION

1-1 PRELIMINARY COMMENTS AND SAFETY PRECAUTIONS

This technical document is intended to cover most aspects associated with the installation, application, operation and maintenance of the Cutler-Hammer Digitrip 3000 Protective Relay. This document is provided as a guide for authorized and qualified personnel only in the selection and application of the Digitrip 3000 Protective Relay. Please refer to the specific WARNING and CAUTION in Section 1-1.2 before proceeding. If further information is required by the purchaser regarding a particular installation, application or maintenance activity, a Cutler-Hammer representative should be contacted.

1-1.1 WARRANTY AND LIABILITY INFORMATION

NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OF MERCHANTABILITY, OR WARRANTIES ARISING FROM COURSE OF DEALING OR USAGE OF TRADE, ARE MADE REGARDING THE INFORMATION, RECOMMENDATIONS AND DESCRIPTIONS CONTAINED HEREIN. In no event will Cutler-Hammer be responsible to the purchaser or user in contract, in tort (including negligence), strict liability or otherwise for any special, indirect, incidental or consequential damage or loss whatsoever, including but not limited to damage or loss of use of equipment, plant or power system, cost of capital, loss of power, additional expenses in the use of existing power facilities, or claims against the purchaser or user by its customers resulting from the use of the information and descriptions contained herein.

1-1.2 SAFETY PRECAUTIONS

All safety codes, safety standards and/or regulations must be strictly observed in the installation, operation and maintenance of this device.

WARNING

THE WARNINGS AND CAUTIONS INCLUDED AS PART OF THE PROCEDURAL STEPS IN THIS DOCUMENT ARE FOR PERSONNEL SAFETY AND PROTECTION OF EQUIPMENT FROM DAMAGE. AN EXAMPLE OF A TYPICAL WARNING LABEL HEADING IS SHOWN ABOVE TO FAMILIARIZE PERSONNEL WITH THE STYLE OF PRESENTATION. THIS WILL HELP TO INSURE THAT PERSONNEL ARE ALERT TO WARNINGS, WHICH MAY APPEAR THROUGHOUT THE DOCUMENT. IN ADDITION, CAUTIONS ARE ALL UPPER CASE AND BOLDFACE.

CAUTION

COMPLETELY READ AND UNDERSTAND THE MATERIAL PRESENTED IN THIS DOCUMENT BEFORE ATTEMPTING INSTALLATION, OPERATION OR APPLICATION OF THE EQUIPMENT. IN ADDITION, ONLY QUALIFIED PERSONS SHOULD BE PERMITTED TO PERFORM ANY WORK ASSOCIATED WITH THE EQUIPMENT. ANY WIRING INSTRUCTIONS PRESENTED IN THIS DOCUMENT MUST BE FOLLOWED PRECISELY. FAILURE TO DO SO COULD CAUSE PERMANENT EQUIPMENT DAMAGE.

1-2 GENERAL INFORMATION

The Digitrip 3000 Protective Relay is a panel mounted multi-function, microprocessor based overcurrent relay, designed for both ANSI and IEC applications (Figures **1-1** and **1-2**). It is a self-contained device which operates

Figure 1-1 Digitrip 3000 Protective Relay (Front View)

from either AC or DC control power, and provides true RMS sensing of each phase and ground current. Only one relay is required per three-phase circuit. Current monitoring and operator selectable protective functions are integral to each device.

CAUTION

THE LOSS OF CONTROL VOLTAGE WILL CAUSE THE DIGITRIP 3000 TO BE INOPERATIVE. IF AC CONTROL VOLTAGE IS USED, AN APPROPRIATE RELIABLE POWER SOURCE/SCHEME SHOULD BE SELECTED (POSSIBLY A UPS SYSTEM) TO SUPPLY POWER TO THE RELAY.

The Digitrip 3000 Protective Relay provides protection for most types of medium voltage electrical power distribution systems. It was designed for use with Cutler-Hammer Type VCP-W vacuum circuit breakers, as well as other manufacturers' medium and high voltage circuit breakers (Figure **1-3**). Digitrip 3000 Protective Relays are compatible for use with all circuit breakers utilizing a shunt trip coil. Thermal curves, plus ANSI and IEC inverse time overcurrent curves provide close coordination with both downstream and upstream protective devices. One Digitrip 3000 Protective Relay replaces the normal complement of three or four conventional electro-mechanical overcurrent relays, an ammeter, a demand ammeter, an ammeter switch, and, in some situations, a lockout relay switch (device 86). All Digitrip 3000 Protective Relays include a built-in INCOM communication capability compatible with the Cutler-Hammer IMPACC system.

1-3 FUNCTIONS/FEATURES/OPTIONS

The primary function of the Digitrip 3000 Protective Relay is overcurrent protection. This is achieved by analyzing the secondary current signals received from the switch-gear current transformers. When predetermined current levels and time delay settings are exceeded, the closing of trip contact(s) is used to initiate breaker tripping.

The Digitrip 3000 Protective Relay operates from the secondary output of standard switchgear current transformers rated at I_n = 5 amperes. It is operator configured

Figure 1-2 Digitrip 3000 Protective Relay (Rear and Side Views)

to fit specific distribution system requirements. The current transformer ratio information is programmed into Digitrip 3000 by setting pushbuttons located on the faceplate of the relay. The phase and ground CT ratios can be independently programmed over a range of 5:5 to 5000:5. Refer to Table **2.4** for all available CT ratio settings.

Protective functions are also configured by using the pushbuttons on the faceplate of the relay. These protective functions can be programmed with the circuit breaker in the open or closed position. DIP Switch S2, located on the rear of the relay, is used to control closed breaker setting ability (Figure **1-4**). Refer to paragraph 2-2.2 and Table **5.1** for additional information. Inverse time overcurrent protection for the phase element cannot be disabled. This insures that all phase protection cannot be disabled. The relay also automatically exits the program mode, if there is no programming activity for 2-1/2 minutes. Programming and test mode security is provided by a sealable, hinged access cover on the front of the relay. Direct reading displays indicate the value currently being considered, while multi-colored LEDs indicate operational conditions and specific functions (Figure **1-1**).

In addition to performing a continuous self-testing of internal circuitry as a part of normal operation, all Digitrip 3000 Protective Relays include a front accessible, integral field testing capability. In the integral test mode, a test current simulates an overload or short circuit condition, to check that all tripping features are functioning properly. The test function is user selectable to trip or not trip the breaker. Refer to Paragraph 2-1.5 for additional information.

The Digitrip 3000 Protective Relay provides five protective functions for both phase and ground protection. The ground element is capable of a residual, an external source ground or a zero sequence connection. If ground protection is not desired, the ground element does not have to be connected.

The five protective settings are:

- Inverse Time Overcurrent Pickup
- Inverse Time Overcurrent Time Multiplier
- Short Delay Pickup
- Short Delay Time
- Instantaneous Pickup

Each of the protective functions are independently programmed for various combinations to fit specific system requirements. For protective functions not required, the relay will allow all of the protective functions on ground

Figure 1-3 A Digitrip 3000 Protective Relay (right) Installed on a Metal Assembly Panel with a DP-4000 (left)

Figure 1-4 Digitrip 3000 Protective Relay with DIP Switches Shown in Upper Left (Rear View)

and all but the inverse time overcurrent function on phase to be disabled. When the Digitrip 3000 is not set for an instantaneous trip function, a true making current release (discriminator) is available. If not desired, the discriminator can be disabled.

Digitrip 3000 Protective Relays provide greater selective coordination potential by providing 11 different curve shapes (Figure **1-5**).

- ***Thermal Curves (4 shapes***)
  - It
  - I^2t
  - I^4t
  - Flat
- ***ANSI Curves (3 shapes per ANSI C37.112)***
  - Moderately Inverse
  - Very Inverse
  - Extremely Inverse
- ***IEC Curves (4 shapes per IEC 255-3)***
  - IEC-A (Moderately Inverse)
  - IEC-B (Very Inverse)
  - IEC-C (Extremely Inverse)
  - IEC-D (Definite Time)

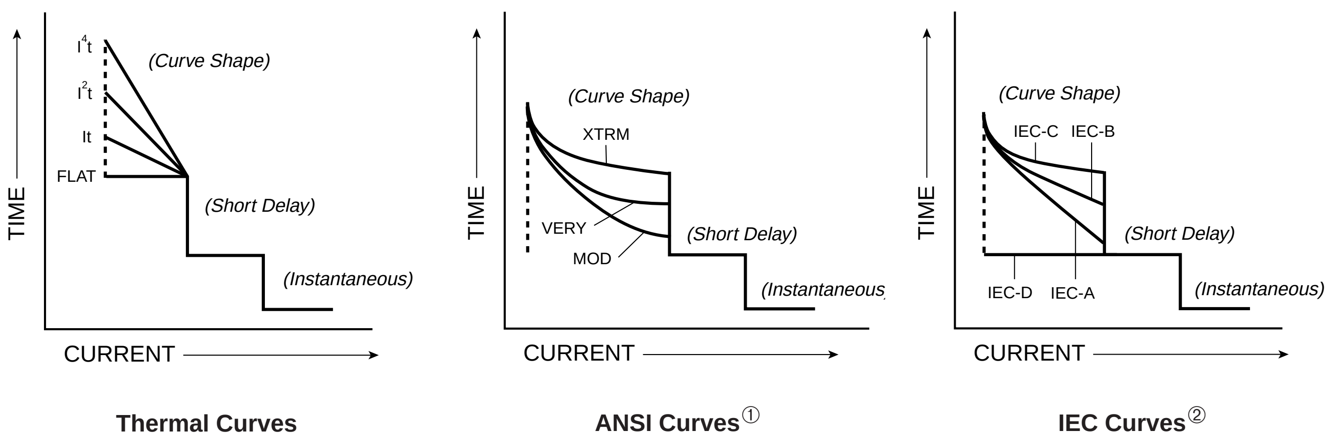
The ground element of Digitrip 3000 can have a curve shape independent of the phase element, providing for a more versatile ground protection.

With this vast selection of Curve Shapes, Digitrip 3000 provides protection capable of coordinating with most any existing electro-mechanical overcurrent relay or power fuse.

A pictorial representation of characteristic curve shapes is provided on the face of the relay for reference purposes (Figure **1-1**).

All Digitrip 3000 Protective Relays have zone selective interlocking capabilities for phase and ground fault protection. Zone selective interlocking is a means by which two or more coordinated trip devices can communicate to alter their pre-set tripping modes to provide a faster response for certain upstream fault conditions. The relay is shipped with the zone selective interlocking feature disabled by the use of the two jumpers on the rear mounted terminal strip TB1(Figure **1-6**).

Digitrip 3000 Protective Relays operating parameters and troubleshooting information are displayed on the front of the relay, via the two display windows. This is considered “ON DEVICE” information. In addition, all relay information can be transmitted to a remote location via the built-in INCOM communication system. This type of information is referred to as “COMMUNICATED INFORMATION.” In addition to being able to provide a circuit breaker “OPEN” or “CLOSED” status to the remote location, the Digitrip 3000 displays and remotely transmits parameters, such as:



① *ANSI Curve shapes defined by ANSI C37.112.*
② *IEC Curve shapes defined by IEC 255-3.*

Figure 1-5 Digitrip 3000 Curve Shape Possibilities

- Individual phase currents
- Ground current
- Maximum current for each phase and ground since last reset (Amp. Demand)
- Magnitude and phase of current causing trip
- Cause of trip
- Current transformer ratio
- Existing setpoint settings

The remote communications capability is made possible by the Cutler-Hammer Integrated Communications (INCOM) Chip and Protocol compatible with the IMPACC Monitor and Control System. The protocol permits a remote master computer to perform:

(1) Interrogation of relay data
(2) Execution of circuit breaker "Close" and"Trip" commands
(3) "Reset" of the relay after a trip
(4) Downloading of settings

Reliable two-way communications can be provided over a twisted pair communications network. The Digitrip 3000 Protective Relay is supplied with a built-in communications capability compatible with the Cutler-Hammer IMPACC system.

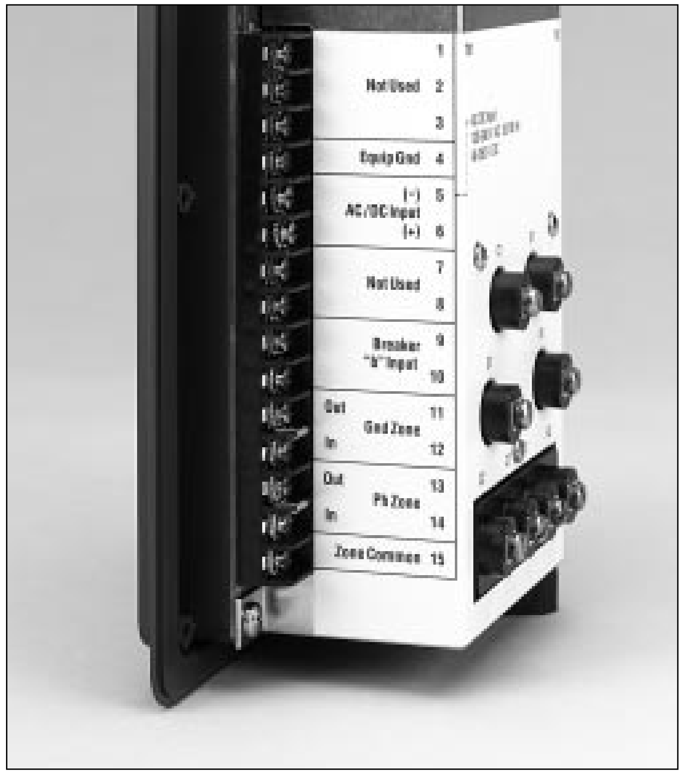


Figure 1-6 Installed Jumpers in Place on Terminal Block TB-1 Disabling the Zone Interlocking Feature

1-4 STANDARDS

Digitrip 3000 Protective Relays are "Component Recognized" by the Underwriters Laboratory, Inc.® under UL File E154862. Refer to Section 2-3 UL Testing and Specification Summary for more information.

SECTION 2: FUNCTIONAL DESCRIPTION

2-1 PROTECTION, TESTING AND COMMUNICATION CAPABILITIES

2-1.1 RMS SENSING

Digitrip 3000 Protective Relays provide true RMS sensing for proper correlation with the thermal characteristics of conductors and equipment. The root mean square (rms) value is determined by a microprocessor calculation of discrete sampled points of the current waveform. This root mean square value is used for the protection response and metering displays of the relay.

2-1.2 PICKUP SETTING

A Digitrip 3000 Protective Relay pickup setting is a discrete, preselected value of current used to initiate a tripping action. The Digitrip 3000 has several current based tripping functions:

- Phase inverse time overcurrent tripping - Thermal, ANSI, and IEC Curves.
- Ground inverse time overcurrent tripping - Thermal, ANSI, and IEC Curves. Ground selection is independent of phase selection.
- Phase and ground short delay tripping.
- Phase and ground instantaneous tripping.

NOTICE

As shown in Figure 3-2, the ANSI and IEC "Curve Shapes" are in terms of multiples of I_{pu} (Pickup Current of the CT Primary), whereas "short delay" and "instantaneous" are in terms of multiples of I_n (5A secondary of CT primary current). The thermal curve is represented in terms of multiples of I_n for its curve shape, short delay, and instantaneous settings. This must be considered in the coordination study and in the programming of the Digitrip 3000 Protective Relay.

Example: *Thermal Curves, Short Delay and Instantaneous settings using I_n*

CT Rating = I_n = 1200A.
Pickup Setting = 1.5
Pickup (amps) = (1200)(1.5)
= 1800A.

Table 2.1 Curve Selection

Curve Type	Selection	Result
Thermal	It	Moderately Inverse
	I^2t	Inverse
	I^4t	Extremely Inverse
	FLAT	Definite or Fixed Time
ANSI	MOD	Moderately Inverse
	VERY	Very Inverse
	XTRM	Extremely Inverse
IEC	IEC-A	Moderately Inverse
	IEC-B	Very Inverse
	IEC-C	Extremely Inverse
	IEC-D	Definite Time

Example: *ANSI and IEC curves using I_{pu}*

CT Rating = 1200A.
I_{pu} = Pickup Current = 1800A.
CT Ratio = 1200:5 *(Entered as "1200")*
Actual secondary current at pickup =
7.5A. = (1800/1200) x 5

2-1.3 TIME SETTING

A Digitrip 3000 Protective Relay time setting is a preselected time delay initiated when a pickup point on the long or short curve is exceeded. If the current value drops below the pickup value, the timing function resets. No memory is provided. If the current value does not drop below pickup, the amount of delay before tripping occurs is a function of the current magnitude and the time setting. The delay can be determined from the appropriate time-current curves.

2-1.4 PROTECTION CURVE SETTINGS

Curve Selection: Extensive flexibility on inverse time overcurrent (phase and ground) curve shaping is possible with eleven available curve types. The selection and associated result is determined by the type of curve shape that best fits the coordination requirements (Figure **1-5**, Table **2.1**). Different curve shape settings

Table 2.2 Characteristic for Phase Element

TYPE SETTING	AVAILABLE SETTINGS	TOLERANCE	CURVE #
CURVE SHAPE	IT, I^2T, I^4T, FLAT, MOD, VERY, XTRM, IECA, IECB, IECC, IECD		
INVERSE TIME OVERCURRENT PICKUP	0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.10, 1.20, 1.30, 1.40, 1.50, 1.60, 1.70, 1.80, 1.90, 2.00, 2.10, 2.20	± 5%	
INVERSE TIME OVERCURRENT TIME MULTIPLIER	***Curve = IT, I^2T, I^4T:*** 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, 27.5, 30.0, 35.0, 40.0	±10%① ②	IT SC-5392-92B I^2T SC-5391-92B I^4T SC-5390-92B
	Curve = FLAT: 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.25, 1.50, 1.75, 2.00	± 0.05 SEC	FLAT SC 5393-92B
	Curve = ANSI MOD, VERY, XTRM: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0	±10%① ③	MOD SC-6685-96 VERY SC-6686-96 XTRM SC-6687-96
	Curve = IECA, IECB, IECC, IECD: 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00	±10%① ③ ④	IECA SC-6688-96 IECB SC-6689-96 IECC SC-6690-96 IECD SC-6691-96
SHORT DELAY PICKUP	1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.0, 11.0, NONE	± 10%	SC-5394-92B
SHORT DELAY TIME (In Seconds)	0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.25, 1.50	± 0.05 SEC	SC-5394-92B
INSTANTANEOUS PICKUP	1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, NONE	± 10%	SC-5396-92B
DISCRIMINATOR (If Phase INST set to NONE)	D ON Fixed At 11 x I_n D OFF	± 10%	

NOTES: ① Curves go to constant operating time above 30 x I_n.

② Tolerance: ± 10% or 0.09 seconds, whichever is larger. Minimum operating trip time is 0.05 seconds.

③ Tolerance: ± 10% or 0.09 seconds, whichever is larger (>1.5 x I_{pu}). Minimum trip time is 2 power line cycles.

④ For IECD, the Time Multiplier Tolerance is ±0.05 seconds.

Table 2.3 Characteristic for Ground Element

TYPE SETTING	AVAILABLE SETTINGS	TOLERANCE	CURVE #
CURVE SHAPE	IT, I^2T, I^4T, FLAT, MOD, VERY, XTRM, IECA, IECB, IECC, IECD		
INVERSE TIME OVERCURRENT PICKUP	0.100, 0.125, 0.150, 0.175, 0.200, 0.225, 0.250, 0.275, 0.300, 0.350, 0.400, 0.450, 0.500, 0.550, 0.600, 0.650, 0.700, 0.750, 0.800, 0.850, 0.900, 0.950, 1.00, 1.25, 1.50, 1.75, 2.00, NONE	± 5%	
INVERSE TIME OVERCURRENT TIME MULTIPLIER Ground Time Multiplier setting options depend upon Ground Curve setting selection.	***Curve = IT, I^2T, I^4T:*** 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5, 25.0, 27.5, 30.0, 35.0, 40.0	±10%① ② ⑤	IT SC-5401-92B I^2T SC-5400-92B I^4T SC-5399-92B
	Curve = FLAT: 0.20, 0.25, 0.30, 0.35, 0.40, 0.45,0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.25, 1.50, 1.75, 2.00	± 0.05 SEC	FLAT SC-5402-92B
	Curve = ANSI MOD, VERY, XTRM: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0, 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9, 4.0, 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 5.0	±10%① ③ ⑤	MOD SC-6685-96 VERY SC-6686-96 XTRM SC-6687-96
	Curve = IECA, IECB, IECC, IECD: 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00	±10%① ③ ④ ⑤	IECA SC-6688-96 IECB SC-6689-96 IECC SC-6690-96 IECD SC-6691-96
SHORT DELAY PICKUP	0.100, 0.125, 0.150, 0.175, 0.200, 0.225, 0.250, 0.275, 0.300, 0.350, 0.400, 0.450, 0.500, 0.550, 0.600, 0.650, 0.700, 0.750, 0.800, 0.850, 0.900, 0.950, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 7.50, 8.00, 8.50, 9.00, 9.50, 10.0, 11.0, NONE	± 10%	SC-5403-92B
SHORT DELAY TIME (In Seconds)	0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00, 1.25, 1.50	± 0.05 SEC	SC-5403-92B
INSTANTANEOUS PICKUP	0.50, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85,0.90, 0.95, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00, 3.50, 4.00, 4.50, 5.00, 5.50, 6.00, 6.50, 7.00, 8.00, 8.50, 9.00, 9.50, 10.0, 11.0, NONE	± 10%	SC-5396-92B

NOTES: ① Curves go to constant operating time above 30 x I_n.

② Tolerance: ± 10% or 0.09 seconds, whichever is larger. Minimum operating trip time is 0.05 seconds.

③ Tolerance: ± 10% or 0.09 seconds, whichever is larger (>1.5 x I_{pu}). Minimum trip time is 2 power line cycles.

④ For IECD, the Time Multiplier Tolerance is ±0.05 seconds.

⑤ For Ground Pickup ≤0.2_{pu}: trip time tolerance is ±15%.

Table 2.4 Miscellaneous Settings

TYPE SETTING	AVAILABLE SETTINGS
HIGHLOAD TIME (pickup fixed @ 0.85 X Phase Time Overcurrent Setting)	0 Sec, 5 Sec, 10 Sec, 30 Sec, 1 min, 2 min, 5 min,
FREQUENCY	50 Hz, 60 Hz
PHASE CT RATIO	5, 10, 25, 50, 75, 100, 150, 200, 250, 300, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1500, 1600, 2000, 2400, 2500, 3000, 3200, 4000, 5000
GROUND CT RATIO	5, 10, 25, 50, 75, 100, 150, 200, 250, 300, 400, 500, 600, 630, 800, 1000, 1200, 1250, 1500, 1600, 2000, 2400, 2500, 3000, 3200, 4000, 5000
TEST	
Phase	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P12, P14, P16 P18, P20, P22, P25
Phase Trip	P3T, P10T, P25T
Ground	G.1, G.2, G.3, G.4, G.5, G.6, G.7, G.8, G.9, G1, G2, G3, G4 G5, G6, G8, G10
Ground Trip	G1T, G3T, G10T

can be applied to phase and ground to maximize coordination flexibility. The curves are discussed in more detail in paragraph 3-3.1.

Phase Inverse Time Overcurrent Pickup: The available pickup settings, shown in Table **2.2**, range from 0.20 to 2.2 times (I_n).

Phase Inverse Time Overcurrent Time Multiplier: The available time settings, shown in Table **2.2**, depend on the curve shape selected. For the thermal curves, the settings represent relay operating times at a current value equal to 3 times (I_n). For ANSI and IEC curves, the settings represent the relay's time multiplier for the current value equal to I/I_{pu}.

Phase Short Delay Pickup: The available pickup settings, shown in Table **2.2**, range from 1 to 11 times (I_n) or NONE. If NONE is selected, the short delay protective function is disabled.

Phase Short Delay Time: The available time settings, shown in Table **2.2**, range from 0.05 to 1.5 seconds at currents equal to or above the short delay pickup setting selected. If NONE was selected for the Phase Short Delay Pickup Setting, the relay will bypass requesting the time setting.

Phase Instantaneous: The available pickup settings, shown in Table **2.2**, range from 1 to 25 times (I_n) or NONE. If NONE is selected, the instantaneous protective function is disabled and a choice of whether to turn the discriminator option on (DON) or off (DOFF) is offered. The discriminator is a true making current release. When the circuit breaker closes, the discriminator function, if selected to be on, is functional in an instantaneous trip mode for 10 cycles after the breaker closes. The breaker will trip instantaneously via the discriminator, if the fault current is above 11 times (I_n). After the 10 cycle period has passed, the discriminator will no longer be functional. It becomes functional again only when the breaker opens and then is reclosed.

Ground Fault: After the phase instantaneous setting is established, the ground curve shape, the ground inverse time overcurrent pickup, ground inverse time overcurrent time, ground short delay pickup, ground short delay time and ground instantaneous settings are selected. The available settings are shown in Table **2.3**. Note that the ground curve settings are independent of the phase curve and are programmed separately.

Programming the ground settings is done in the same manner as the phase settings, except there is no discriminator option for ground instantaneous, and there is a NONE selection for the inverse time overcurrent pickup setting.

High Load: The available high load time-out settings are shown in Table **2.4**. At a current 85% or above the

Table 2.5 Factory Set Defaults

DIP SWITCH SETTINGS		
Type	**Default Setting**	
S1:	ON	(Digitrip 3000 IMPACC Buffers)
S2:	OFF	(Program with Breaker Open Only)
S3:	OFF	(Standard Relay Configuration - OC/Instantaneous)
S4:	ON	(Enable Remote Open/Close)
S5:	OFF	(Reserved)
S6:	OFF	(Reserved)
S7:	OFF	(Reserved)
S8:	OFF	(Disable Download Setpoints)
S9:	OFF	(Manual Reset)
S10:	OFF	(Reserved)

PHASE SETTINGS	
Type	**Default Setting**
Curve Shape:	It
LDPU:	1.0
LDT:	5 sec.
SDPU:	1.5
SDT:	1.0 sec.
INST:	1.75

GROUND SETTINGS	
Type	**Default Setting**
Curve Shape:	It
LDPU:	0.5
LDT:	5 sec.
SDPU:	0.75
SDT:	1.0 sec.
INST:	1.0

MISCELLANEOUS SETTINGS	
Type	**Default Setting**
DISC:	OFF
HILD:	10 sec.
FREQ:	60 Hz
PCT:	500
GCT:	500

inverse time overcurrent phase setting value, the high load function will begin timing to the time setting selected and the High Load LED will blink. If the current drops below the 85% value, the high load timer will reset, and only start again when the 85% value is again reached. When the high load timer times out, the “High Load” LED on the front of the relay lights continuously and an alarm signal is sent over the communication network.

System Frequency Selection: Either 60Hz or 50Hz may be selected (Table **2.4**).

Phase and Ground CT Ratio Selection: The available CT ratio’s, shown in Table **2.4**, range from 5:5 to 5000:5.

Defaults: In the unlikely event of missing or invalid settings, the Operational LED will blink Red instead of Green and the relay will display “PRGM” in the Settings Display window. This means that the program of settings should be re-entered and saved.

2-1.5 INTEGRAL TESTING

Digitrip 3000 Protective Relays have a front accessible, integral field testing capability. This feature introduces a selected level of internal test current to simulate an overload or short circuit. It checks proper functioning of the relay and verifies that curve settings have been set-up correctly. The integral test function provides selectable “Trip” and “No Trip” test settings for both phase and ground testing. Refer to Table **2.4** for available test settings. The “P” used in Table **2.4** refers to a phase current test setting, while the “G” refers to a ground current test setting. “T” in the table means that the test will initiate a breaker trip. All settings are in per unit current values times the In value, which is the selected CT rating.

CAUTION

THE TEST MODE SHOULD NOT BE USED TO TRIP LIVE CURRENT CARRYING CIRCUITS. IF A LIVE CURRENT OF GREATER THAN 0.1 TIMES THE (I_n) VALUE IS FLOWING IN EITHER A PHASE OR GROUND CIRCUIT, THE TEST MODE IS AUTOMATICALLY EXITED, ACCOMPANIED BY AN ERROR MESSAGE IN THE SETTINGS/TEST TIME/ TRIP CAUSE WINDOW.

2-1.6 COMMUNICATIONS

An important function of the Digitrip 3000 Protective Relay is communications and control via the Cutler-

Hammer Integrated Communications (INCOM) Protocol. It allows the combining of electrical distribution and control products with personal computers into a comprehensive communications and control network.

The Digitrip 3000's communications chip permits the interrogation of relay data, remote tripping and closing of breaker, the Reset of the relay after a trip, and downloading of set points from a remote master computer. Communications is accomplished from the relay to the master computer via a 115.2 KHz. frequency carrier signal over a shielded twisted pair of conductors. The receiving terminal is a remote mounted master computer (IBM compatible). Refer to Figure **2-1** for a typical communications wiring diagram.

NOTICE

Ground shielding should be provided at one place only, with the computer end being the recommended location.

2-2 PROTECTIVE RELAY HARDWARE

2-2.1 FRONT OPERATIONS PANEL

The operations panel, which is normally accessible from the outside of the switchgear panel door, provides a means to program, monitor and test the unit (Figure **1-1**). For the purpose of familiarization, the panel is divided into three sub-sections:

1. Pushbuttons
2. LEDs
3. Display Windows

Pushbuttons: The front operations panel supports eleven membrane pushbuttons. Pushbuttons are color coded (red, white, blue, yellow) by their function to be operational friendly. For example, blue pushbuttons are associated with actual program functions, yellow pushbuttons with integral testing functions, and white pushbuttons are common to both operations or are independent. White pushbuttons accomplish their function when depressed. They can be held down and not released to accelerate their function. Blue and Yellow pushbuttons accomplish their function after having been pressed and released.

Reset Pushbutton (Red)
The Reset pushbutton is used to reset any of the following: the trip relays (overcurrent and instantaneous), the trip alarm relay, the trip LEDs, and the ampere demand current. Reset applies to both normal operations and integral testing. If the unit is in the auto-reset mode, as set by DIP switch #9 on the back of the unit, the trip relays and the trip alarm relay will automatically reset when the circuit breaker is opened after a trip.

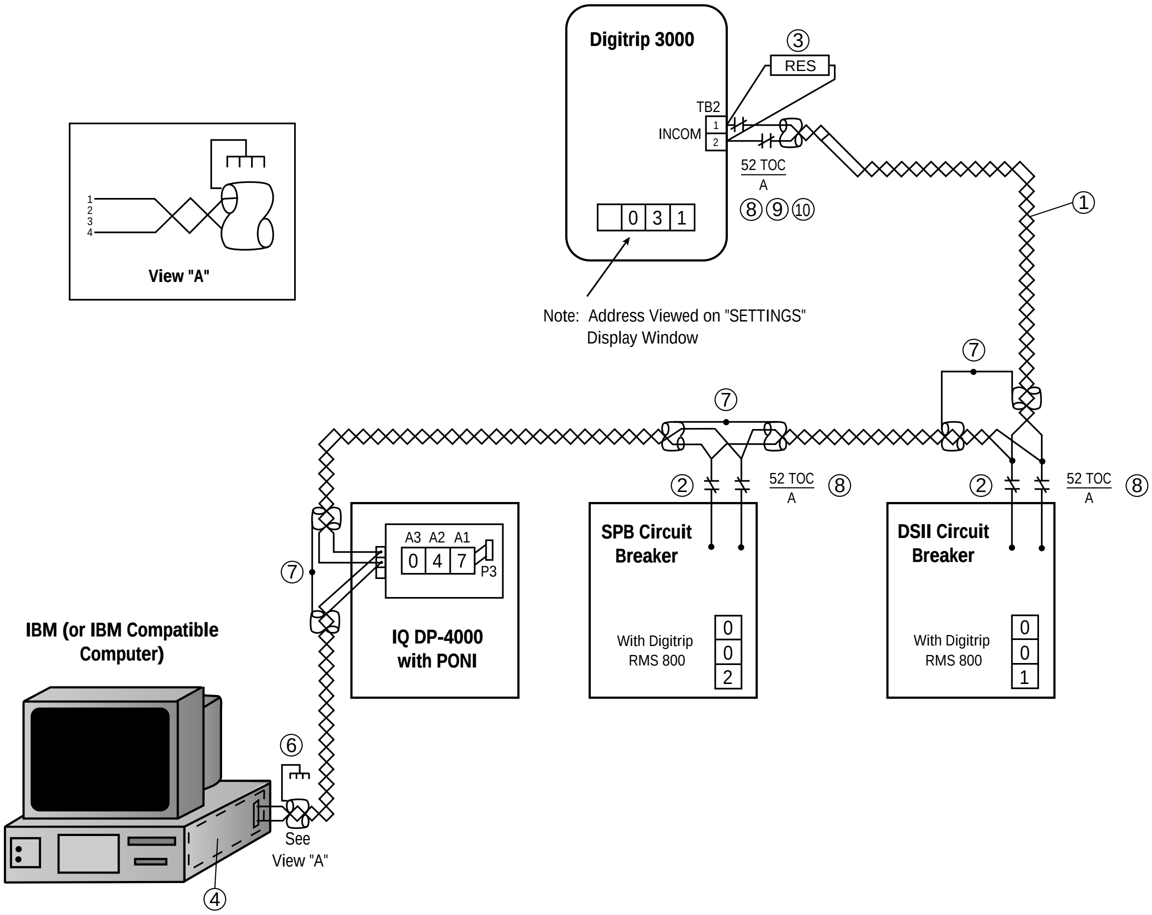
Program Mode Pushbutton (Blue)
The Program Mode pushbutton, which is accessed by opening the sealable, hinged access cover, is used to enter and exit the program mode. When this pushbutton is pressed and released, the program LED flashes and setpoints can be altered. DIP Switch S2 establishes when the Program Mode can be entered. With S2 set to "off," the Program Mode can only be entered when the breaker is open. With S2 set to "on," the Program Mode can be entered with the breaker open or closed. Any selections made in the program mode are only saved when the Save Settings pushbutton, which is described later, is depressed. When programming is concluded, the Program Mode pushbutton should be pressed to exit the program mode. Note that if the Save Settings pushbutton is not depressed prior to exiting the program mode, the previous settings will be retained. The program mode is also exited if the Reset pushbutton is pressed or if there is no programming activity for approximately 2-1/2 minutes.

Note: *Each Digitrip 3000 is shipped from the factory with nominal protection settings. The relay should be programmed by the user before being put into service, as these nominal values may not give optimum system protection or coordination. Remove tag from security door to access the "Program Mode" pushbutton.*

Test Mode Pushbutton (Yellow)
Also located behind the sealable hinged access cover is the Test Mode pushbutton. This pushbutton is used to enter and exit the test mode. When the pushbutton is pressed and released, the word TEST will appear in the Settings/Test Time/Trip Cause display window. If there is more than 0.1 times (I_n) current flowing in either the phase or the ground circuit, the Test Mode cannot be initiated and the error message "ERR" will appear in the display window. The test mode will also automatically be exited if there is no activity for 2-1/2 minutes.

Select Test Pushbutton (Yellow)
The Select Test pushbutton is used, after the test mode has been entered, to select the type of test. There are phase and ground tests to trip or not trip the breaker. (See Section 3-3.4).

Test Pushbutton (Yellow)
The selected test operation is initiated by pressing and releasing the Test pushbutton.



① FOR NETWORK INTERCONNECTION CABLE, SEE CABLE SPECIFICATIONS ON FIG. **3-1**.

② REFER TO CIRCUIT BREAKER WIRING DIAGRAMS FOR ACTUAL CONNECTIONS.

③ CARBON COMPOSITION RESISTOR **MUST** BE INSTALLED ON THE MOST REMOTE DEVICE AS SHOWN:
- 150 OHM, 1/2 WATT FOR 1200 BAUD RATE COMMUNICATIONS.
- 100 OHM, 1/2 WATT FOR 9600 BAUD RATE COMMUNICATIONS.

④ A CUTLER-HAMMER CONI (COMPUTER OPERATED NETWORK INTERFACE) OR CONI-3 CARD MUST BE INSERTED INTO THE COMPUTER ISA BUS.

⑤ CUSTOMER TO SUPPLY A COMPUTER AND MODULAR TELEPHONE CONNECTOR TYPE RJ11 AND WIRE PER VIEW A

⑥ GROUND SHIELDING AT ONE PLACE ONLY (COMPUTER END RECOMMENDED).

⑦ WHERE DEVICES ARE DAISY CHAINED, TIE SHIELDING TOGETHER FOR END-TO-END CONTINUITY. SOME PRODUCTS WILL PROVIDE AN EXTRA TERMINAL FOR A TIE POINT FOR THE CABLE SHIELD LEADS.

⑧ CIRCUIT BREAKER TRUCK OPERATED CELL TOC SWITCH (SHOWN FOR CIRCUIT BREAKER IN “CONNECTED” POSITION) IS OPTIONAL TO AUTOMATICALLY DISCONNECT RELAY FROM THE COMMUNICATION NETWORK WHEN CIRCUIT BREAKER IS IN THE “TEST” POSITION.

⑨ ON LAST DEVICE IN NETWORK, TIE BACK SHIELD AND TAPE.

⑩ WHEN TOC SWITCH IS USED, DOWNLOADING OF PROTECTION SETTINGS FROM THE COMPUTER WILL NOT BE POSSIBLE WITH BREAKER IN THE “TEST” POSITION.

Figure 2-1 Typical Communications Wiring Diagram

Select Settings Pushbutton (Blue)
In the program mode of operation, the Select Settings pushbutton is used to step to the next setpoint by pressing and releasing the pushbutton. This pushbutton steps forward. To step back, the Select Settings pushbutton can be pressed and held, while pressing and releasing the Lower pushbutton.

Raise/Lower Pushbutton (White)
The Raise and Lower pushbuttons are used during the program and test modes to increase or decrease the value of the displayed setpoint. The Lower pushbutton also serves a dual function in conjunction with the Select Settings pushbutton, as described under Select Settings Pushbutton.

Save Settings Pushbutton (Blue)
While in the program mode, selected setpoints can be saved by depressing and releasing the Save Settings pushbutton. Settings can be saved individually or one time as a group. If the Save Settings pushbutton is not used, the previous setpoints will remain when the program mode is exited.

View Settings Pushbutton (Blue)
The View Settings pushbutton is functional only when the unit is in the normal operating mode, not the program or test modes. It functions to display the unit's setpoints, including the phase and ground current transformer ratio selected via programming.

Select Pushbutton (White)
The Select pushbutton is used to step between any of the eight current values that are displayed in the RMS Amperes window. The eight currents are IA, IB, IC, IG, IA ampere demand, IB ampere demand, IC ampere demand, and IG ampere demand. Stepping with this pushbutton is in the sequence just given. The currents displayed are the present RMS values; the ampere demand currents are the averaged RMS values sensed over a 5 minute period of time. The demand value is the largest 5 minute average measured since the amp demand was last reset.

LEDs: LEDs are used to indicate a number of functions, operations and/or warnings. Many of the LEDs used provide different indication messages. The specific message is determined by the color and a constant on or blinking operation. Several of the LEDs are bi-colored and can be lit green or red.

Operational LED
The Operational LED at the top of the relay should be green and blink on for approximately one second and then off for one second. This indicates that the relay is functioning properly in its normal operation mode. If this LED is blinking red, it indicates the relay may need reprogramming. If this LED is lit in any color shade other than a definite green or red, or if it is not blinking at all, an internal problem has been detected requiring replacement of the relay.

High Load LED
The High Load LED will blink green when high load settings are being selected in the program mode. In the operational or test modes, the High Load LED will blink red when a load current of 85% or above the inverse time overcurrent phase pick-up setting is reached. If the load current remains at 85% or above the inverse time overcurrent phase pickup setting for the time interval setting, the LED will change to steady red at the end of the time interval. Whenever the load current drops below the 85% level, the timer will reset and the LED will turn off.

Communication Trip LED
This LED, will be continuous red when the breaker has been tripped by the master computer via INCOM. The LED will turn off when the Reset pushbutton is pressed or the circuit breaker is reclosed.

Curve Shape LED
This LED will blink green when the slope setpoint is displayed in the Settings/Test Time/Trip Cause window while in the program mode. When the curve shape setpoint is being viewed in the unit's normal operating mode, this LED will be a continuous green.

Time Overcurrent Setting LED
This LED is bi-colored. While in the program mode, the LED will blink green when the inverse time overcurrent pickup setpoint is displayed in the Settings/Test Time/Trip Cause window. It will be a continuous green when the inverse time overcurrent pickup setpoint is being viewed in the unit's normal operating mode. The LED will blink red whenever the load current exceeds the inverse time overcurrent pickup setpoint. If the relay trips on inverse time overcurrent, the LED will be continuous red.

Inverse Time Overcurrent Time LED
This LED will blink green when the LED time overcurrent time setpoint is displayed in the Settings/Test Time/Trip Cause window while in the program mode. When the time multiplier is being viewed in the unit's normal operating mode, the LED is continuous green.

Short Delay Setting LED
This LED is bi-colored and operates like the time overcurrent setting LED.

Short Delay Time LED
The short delay time LED, when lit is green, and operates like the inverse time overcurrent time LED.

Instantaneous LED
This LED is bi-colored and operates like the inverse time overcurrent setting LED.

Phase LED
The phase LED is bi-colored. The LED will blink green when the phase inverse time overcurrent setting, inverse time multiplier, short delay setting, short delay time, and instantaneous setpoints are displayed in the Settings/Test Time/Trip Cause window while in the program mode. When these setpoints are viewed in the normal operating mode, this LED will be continuous green.

The LED will blink red, along with the time overcurrent setting LED whenever the phase load current exceeds the inverse time overcurrent pickup setpoint.

The LED will be continuous red, whenever a trip is initiated by the phase inverse time overcurrent, short delay, or instantaneous protective functions.

Ground LED
The ground LED is also bi-colored (green/red). The ground LED operates exactly like the phase LED for all ground associated functions.

Amp Demand LED
This LED will be continuous green when an ampere demand current is being viewed in the RMS Amperes window.

I_A, I_B, I_C, I_G LEDs
The specific phase or ground current LEDs will be continuous green when that phase or ground current is being displayed in the RMS Amperes window. When the Amp Demand LED is also lit, the displayed current is the Ampere Demand Current.

Program LED
This LED is continuous green when the relay is in the program mode.

Test LED
This LED is continuous green when the relay is in the test mode.

Display Windows: Two windows are used to display all of the relay's data, setpoints and messages. One window is located in the upper portion of the relay's faceplate and is labeled RMS Amperes. A second window is located in the lower portion of the faceplate adjacent to the program and test LEDs. It is labeled Settings/Test Time/Trip Cause.

RMS Amperes Window
This window has a five digit numeric display. It is used to show:

1. Present phase or ground currents
2. Largest phase or ground demand currents since last reset
3. Fault current (displayed after a trip until a reset action is initiated)
4. Phase and ground current transformer CT setting (when "View Settings" pushbutton is used with the relay in the normal operating mode)

Settings/Test Time/Trip Cause Window
This window is a four character Trip Cause Window alphanumeric display used to show the value of the setpoints, the test time, or the cause of trip.

2-2.2 REAR ACCESS PANEL

WARNING

THE BACK OF DIGITRIP 3000, WHEN ENERGIZED, OFFERS EXPOSURE TO LIVE PARTS WHERE THE HAZARD OF A FATAL ELECTRIC SHOCK IS PRESENT. ALWAYS DISCONNECT SOURCE AND CONTROL POWER SUPPLY BEFORE TOUCHING ANYTHING ON THE REAR OF THE DIGITRIP 3000. FAILURE TO DO SO COULD RESULT IN INJURY OR DEATH.

The rear access panel of Digitrip 3000 is normally accessible from the rear of an open panel door (Figure **1-2**). All wiring connections to the Digitrip 3000 Protective Relay are made at the chassis' rear. For the sake of uniform identification, the frame of reference when discussing the rear access panel is facing the back of the relay. The DIP switches, for example, are located on the upper left of the rear panel (Figure **1-4**). Become familiar with the functions and connections involved, especially the following:

DIP Switches: A set of ten DIP switches are located in the upper left portion of the rear panel. Refer to Table **5.1** for DIP switch positions. Their basic functions are as follows:

1. Switch S1 is used to select whether the IMPACC buffers are set for the Digitrip 3000 configuration or the Digitrip MV configuration. (Refer to Section 5 for configuring the Digitrip 3000 as a replacement for a Digitrip MV.)

2. Switch S2 is used to enable/disable the ability to program the setpoints when the breaker is in the open or closed position.

CAUTION

CARE MUST BE TAKEN WHEN PROGRAMMING THE DIGITRIP 3000 WHILE THE BREAKER IS CLOSED AND CURRENT IS FLOWING. AN INCORRECT SETTING CONFIGURATION COULD CAUSE THE RELAY TO TRIP THE BREAKER WHEN SETTINGS ARE SAVED.

3. Switch S3 is used to configure the trip contacts as shown below:

Trip Contacts	Dip Sw. OFF Pos.	Dip Sw. ON Pos.
TB 12 & 13	Phase & Ground Trip Inst.	Ground Trip Inst./OC
TB 14 & 15	Phase & Ground Trip OC/ Communications	Phase Trip Inst./OC/ Communications

4. Switch S4 is used to enable/disable the ability to open or close the breaker remotely from the communications interface (host computer).
5. Switch S8 is used to enable/disable the ability to download setpoints from the communication interface (host computer).
6. Switch S9 is used to select whether the relay should be self-reset or manually reset (lock out function). For additional details refer to the following paragraphs entitled “Manual Reset” and “Auto Reset.”
7. Switches S5, S6, S7 and S10 are reserved.

Manual Reset: (DIP Switch S9 OFF) In this mode the Trip Instantaneous contact (TB2 12 and 13), Trip Overcurrent contact (TB2 14 and 15) and the Trip Alarm contact (TB2 6, 7 and 8) change state after a protection trip operation. The contacts stay in that state until the “Reset” Pushbutton is depressed. In addition, the front panel will hold the cause of trip in the “Trip Cause” window and the fault current magnitude in the “RMS Ampere” window until the “Reset” pushbutton is depressed. A RESET COMMAND can be sent to the Digitrip 3000 by a master computer to remotely reset the Digitrip 3000.

Auto Reset: (DIP Switch S9 ON) In this mode the Trip Instantaneous contacts (TB2 12 and 13) or Trip Overcurrent contacts (TB2 14 and 15) are momentarily closed after a protection trip operation. The contacts will remain closed until the breaker’s 52b auxiliary switch contact closes. The Trip Alarm Relay, however, remains energized until the “Reset” Pushbutton is depressed or a RESET COMMAND is received from a communication system master. In this mode after a trip is initiated and the breaker has opened, the display will BLINK the cause of the trip in the “Trip Cause” window and the “RMS Ampere” window will show the fault current magnitude. Both displays clear when the circuit breaker is reclosed.

Communicating LED: A red LED just above terminal block (TB2) is used when the relay is communicating. If the relay is the type designed to accept field installation of a communication module at a later date, this LED is not functional at any time.

Terminal Block One (TB1): TB1 is located on the left side of the rear panel, and is numbered 1 through 15, with 1, 2, 3, 7 and 8 not used.

Terminals 5 and 6 are provided for the AC or DC input control power connections and Terminal 4 is the connection for equipment ground.

Terminal 9 and 10 provide for connection to a required dry 52b contact and to a 52 TOC contact from the circuit breaker.

NOTICE

When the relay has input control power, Terminals 9 and 10 will have this potential on them.

Terminals 11 and 12 are used for ground zone interlocking, inverse time overcurrent protection and short delay protection. The zone interlocking function is a low level DC signal used to coordinate with “downstream” and “upstream” breakers that see or do not see the fault. If the function is not used but a inverse time overcurrent or short delay time is desired, the two terminals should stay jumpered as they were when shipped from the factory.

Terminals 13 and 14 are used for phase zone interlocking, inverse time overcurrent protection and short delay protection.

Terminal 15 is the zone signal common. **Zone common should never be connected to earth ground.**

Refer to Figure **4-1** for a typical phase zone interlocking/wiring scheme.

Note: *Digitrip 3000 Protective Relays are shipped with a phase zone interlocking jumper (across terminals TB1-13 and 14) and a ground zone interlocking jumper (across terminals TB1-11 and*

12). For phase or ground zone capability, the respective jumpers must be removed.

Terminal Block Two (TB2): TB2 is located on the right side of the rear panel and is numbered 1 through 15. Terminals 1 and 2 are used for the internal INCOM communications interface. Terminal 3 can be used for an INCOM shield tie point. It is not connected to ground or any electrical circuit in the Digitrip 3000. Terminals 4 and 5 are a N.O. contact from an output relay and are wired in to the circuit breaker close circuit, if a communication interface is present and it is desired to be able to close the circuit breaker from the remote master computer.

Terminals 6, 7 and 8 are Form "C" contacts on the trip alarm relay and change state whenever any protective trip is initiated by the relay. They do not change state when the master computer initiates an opening of the circuit breaker via the communication interface. After a protective trip, the contacts remain in the changed state until the "Reset" Pushbutton is depressed, whether the relay is in the Manual Reset Mode or the Auto Reset Mode. For additional details about Manual and Auto Reset Modes, refer to specific paragraphs earlier in this section.

Terminals 9, 10 and 11 are Form "C" contacts on the protection off alarm relay. The contacts change state when nominal control power is applied to the relay and no internal errors are detected.

Terminals 12 and 13 are a "NO" configurable contact. DIP Switch S3 is used to configure the trip contacts. With DIP Switch S3 in the "on" position, this contact closes when the relay detects a need for the circuit breaker to trip due to either a phase or ground instantaneous fault or the discriminator function. With DIP Switch S3 in the "off" position, this contact closes when the relay detects a need for the circuit breaker to trip due to any type of ground fault.

Terminals 14 and 15 are also a "NO" configurable contact. With DIP Switch S3 in the "on" position, this contact closes when the relay detects a need for the circuit breaker to trip due to an inverse time overcurrent or short time function. The contact also operates when the communication interface initiates an action to open the circuit breaker. With DIP Switch S3 in the "off" position, this contact closes when the relay detects a need for the circuit breaker to trip due to any type of phase fault or communications.

Rear Surface Terminals: The rear surface terminals, identified as (A1, A2), (B1, B2), (C1, C2) and (G1, G2) provide the current transformer input connection points and are rated for 5 ampere inputs. (A1, A2), (B1, B2) and (C1, C2) are phase A,B,C current inputs respectively, while (G1, G2) is the ground current input.

2-2.3 EXTERNAL HARDWARE

The Digitrip 3000 Protective Relay requires that a customer supplied source of input control power be wired into the TB1 terminal block located on the rear panel. Refer to the typical wiring diagram in Figure **3-1**. A power supply can be either AC or DC voltage within the acceptable voltage ranges outlined in Paragraph 2-3 entitled "UL Testing and Specification Summary."

2-3 UL TESTING AND SPECIFICATION SUMMARY (CONTINUED NEXT PAGE)

ANSI C37.90 (TOTAL COMPLIANCE): (UL Required) ■ Make and Carry Ratings Sec. 6.7 ■ Temperature Test Sec. 7 ■ Dielectric Test Sec. 8 ■ Surge Withstand Test Sec. 9	**ADDITIONAL TESTS (UL REQUIRED):** ■ Hot and Cold Calibration of Phase Elements ■ Meter Readout Accuracy ■ Zone Interlocking Functionality
UL 1053 (UL REQUIRED): ■ Current Withstand Test Sec. 27 ■ Control Power Test Sec. 18 ■ Output Test Sec. 19 ■ Temperature Test Sec. 20 ■ Calibration of Ground Element Sec. 21 ■ Overvoltage Sec. 22 ■ Overload Sec. 23 ■ Endurance – Verify with Calibration Tests Sec. 24 ■ Dielectric Voltage Withstand Test Sec. 25	**EMC TESTS:** ■ IEC 255-22-2, Electrostatic Discharge Test (ESD), Rating of 8kV ■ IEC 255-22-3 (ENV50140), Radiated RF Immunity ■ ENV 50141, Conducted RF Immunity ■ CISPR 11 Class A ■ CFR 47 FCC Part 15 Subpart b Class A

2-3 UL TESTING AND SPECIFICATION SUMMARY (CONTINUED FROM PREVIOUS PAGE)

CURRENT INPUTS:

■ CT's:	5 Amp Secondary
■ CT Burden:	<0.004 ohm <0.1VA @ Rated Current(5A)
■ I_n:	5A(Secondary) or CT(Primary)
■ Saturation:	30 x I_n
■ Momentary:	100 x I_n for 1 Second

CT(PRIMARY) SETTINGS AVAILABLE:

■ Phase and Ground:	5/10/25/50/75/100/150/200/250/300/400/500/600/630/800/1000/1200/1250/1500/1600/2000/2400/2500/3000/3200/4000/5000

ZONE SELECTIVE INTERLOCKS:

■ Phase:	Inverse Time Overcurrent and Short Delay
■ Ground:	Inverse Time Overcurrent and Short Delay

CONTROL POWER:

■ Input Voltage:	<u>Nominal</u>: 48 to 250VDC 120 to 240VAC 50/60Hz <u>Operating Range</u>: 28 to 280VDC 90 to 254VAC 50/60Hz

■ Power Consumption:

48 VDC	125 VDC	250 VDC	120 VAC	240 VAC
10W	17W	18W	18VA	25VA

OUTPUT TRIP CONTACTS:

■ Trip OC/Communication: [Time Delay]	Make 30 Amps for 0.25 Seconds 0.25 Amp Break @ 250VDC
■ Trip Instantaneous	5 Amp Break @ 120/240VAC
■ Communications Close	Meets ANSI C37.90, Paragraph 6.7

ENVIRONMENT:

■ Operating Temperature:	-30 to +55 Degrees C
■ Operating Humidity:	0 to 95% Relative Humidity [Non-condensing]
■ Storage Temperature:	-40 to +70 Degrees C

AUXILIARY ALARM CONTACTS:

■ Protection Off Alarm:	5 Amp Continuous
■ Trip Alarm	5 Amp Break @ 120/240 VAC

TESTS:

■ Dielectric Strength:	<u>Current Inputs</u>: 3000VAC for 1 Minute Phase to Phase
■ Seismic Test:	Meets requirements for UBC and California Building Code Zone 4. ZPA=3.5

PHASE AND GROUND TIME-CURRENT CURVES:

■ Thermal:	It	[Moderately Inverse]
	I^2t	[Very Inverse]
	I^4t	[Extremely Inverse]
	FLAT	[Definite Time]
■ ANSI: (Per ANSI C37.112, 1996)	Moderately Inverse Very Inverse Extremely Inverse	
■ IEC: (Per IEC 255-3, 1989)	IEC-A	[Moderately Inverse]
	IEC-B	[Very Inverse]
	IEC-C	[Extremely Inverse]
	IEC-D	[Definite Time]

PHASE OVERCURRENT PICKUP RANGES:

■ Inverse Time Overcurrent Setting:	(0.2 to 2.2) x I_n [28 settings]
■ Short Delay Setting:	(1 to 11) x I_n, None [25 settings]
■ Instantaneous Setting:	(1 to 25) x I_n, None [30 settings]

GROUND OVERCURRENT PICKUP RANGES:

■ Inverse Time Overcurrent Setting:	(0.1 to 2.0) x I_n, None [26 settings]
■ Short Delay Setting:	(0.1 to 11) x I_n, None [45 settings]
■ Instantaneous Setting:	(0.5 to 11) x I_n, None [33 settings]

TIME DELAY SETTINGS:

■ Inverse Time Overcurrent Time Multiplier:	It, I^2t, I^4t Curve: 0.2 to 40 [47 Settings] FLAT: 0.2 to 2 [21 Settings] ANSI (all): 0.1 to 5.0 [50 settings] IEC (all): 0.05 to 1.00 [20 settings]
■ Short Delay Time:	0.05 to 1.5 sec. [22 Settings]

CURRENT MONITORING:

■ True RMS Sensing:	3-Phase and Ground
■ Display Accuracy:	±1% of Full Scale [I_n] from 0.04 x I_n to 1 x I_n ±2% of Full Scale [I_n] from 1 x I_n to 2 x I_n
■ Amp Demand:	Average Demand over 5 Minute Sampling Window
■ High Load:	85% of Inverse Time Overcurrent Setting

TIMING ACCURACY: ①

■ Inverse Time Overcurrent Time:	±10% @ >1.5 x Pickup
■ Short Delay Time:	±50ms

COMMUNICATIONS:

■ IMPACC Compatible	
■ Baud Rate:	1200 or 9600 Baud
■ Catalog DT3000:	Built In INCOM

① *For Ground Pickup ≤ 0.2pu; Time Tolerance ±15%.*

SECTION 3: OPERATION

3-1 INTRODUCTION

This section specifically describes the operation and functional use of the Digitrip 3000 Protective Relay. It does not address in detail rear power connections and DIP switch settings. These topics are covered in SECTION 5 entitled “INSTALLATION/TESTING/STARTUP.” It would be helpful, however, to become familiar with the relay’s wiring diagram before proceeding with the rest of this section (Figure **3-1**).

3-2 POWER-UP AND SELF TESTING

When the proper AC or DC control voltage is applied to terminals 5 and 6 of TB1, the unit will initiate a “Power On Reset” to its chip circuitry. This causes the unit’s firmware to perform some self-testing and initialization of its ROM, RAM and E^2 (non-volatile) memory. If any problem exists, a diagnostic message will be displayed in the Settings/Test Time/Trip Cause Window. A complete list of messages and their meanings are given in Table **3.2**. Additionally, if a problem does exist, the “Operational LED” will light red and the “Protection Off Alarm” relay will not energize. When all self checks are good, the “Protection Off Alarm” relay will energize, and the “Operational LED” will blink green.

3-3 PANEL OPERATIONS

Begin by reviewing the material presented in SECTION 2 entitled “FUNCTIONAL DESCRIPTION.” Since basic definitions and explanations were given in SECTION 2, no further explanation as to function will be offered in this section. It is assumed that the operator is now familiar with Digitrip 3000 terms, available settings and overall capabilities.

3-3.1 CHARACTERISTIC CURVE

Digitrip 3000 Protective Relays provide circuit breakers with an extensive degree of selective coordination potential and permit curve shaping over a wide range. Available pickup settings, inverse time overcurrent time multiplier settings and inverse time overcurrent (phase and ground) curve selections are addressed here with respect to their effect on the resultant characteristic curve. In general, there are three different families of curves to choose from as shown in Table **3.1**. These curves were discussed briefly in Sections 1 and 2. The operating characteristics of the relay are graphically represented by time-current characteristic curves shown in Figure **3-2**.

Table 3.1 Digitrip 3000 Curve Shapes

Thermal Curves	ANSI Curves (Per ANSI C37.112)	IEC Curves (Per IEC 255-3)
It	Moderately Inverse	IEC-A
I^2t	Very Inverse	IEC-B
I^4t	Extremely Inverse	IEC-C
FLAT		IEC-D

NOTICE

As shown in Figure 3-2, the ANSI and IEC “Curve Shapes” are in terms of multiples of I_{pu} (Pickup Current of the CT Primary), whereas “short delay” and “instantaneous” are in terms of multiples of I_n (5A secondary of CT primary current). The thermal curve is represented in terms of multiples of I_n for its curve shape, short delay, and instantaneous settings. This must be considered in the coordination study and in the programming of the Digitrip 3000 Protective Relay.

The ANSI curves are defined by ANSI C37.112 and IEC curves are defined by IEC 255-3. These curve shapes combine with the customized capability of the short delay and instantaneous functions to allow for very versatile coordinated protection schemes. The thermal curve shape is also customized by the user to any desired type of coordinated protection scheme.

These curves show how and when a particular relay will act for given values of time and current. The more versatile the relay, the easier it is to accomplish close coordination and achieve optimum protection. Since the Digitrip 3000 Protective Relay is very versatile, the makeup of a typical curve is presented for clarification purposes.

For the sake of simplification, the curve discussion will center around a single line curve. Keep in mind, however, that a characteristic curve in reality is represented by a band of minimum and maximum values, not a line (Figure **3-3**). Minimum and maximum values are generally the result of tolerances introduced by the manufacturing process for components and the relay’s accuracy. Any expected value of tripping current or time could be the nominal value anticipated within the plus or minus tolerance. The tolerances just mentioned are usually stated in terms of the relay’s accuracy and frequently highlighted on the actual working curves. Accuracy is stated in terms

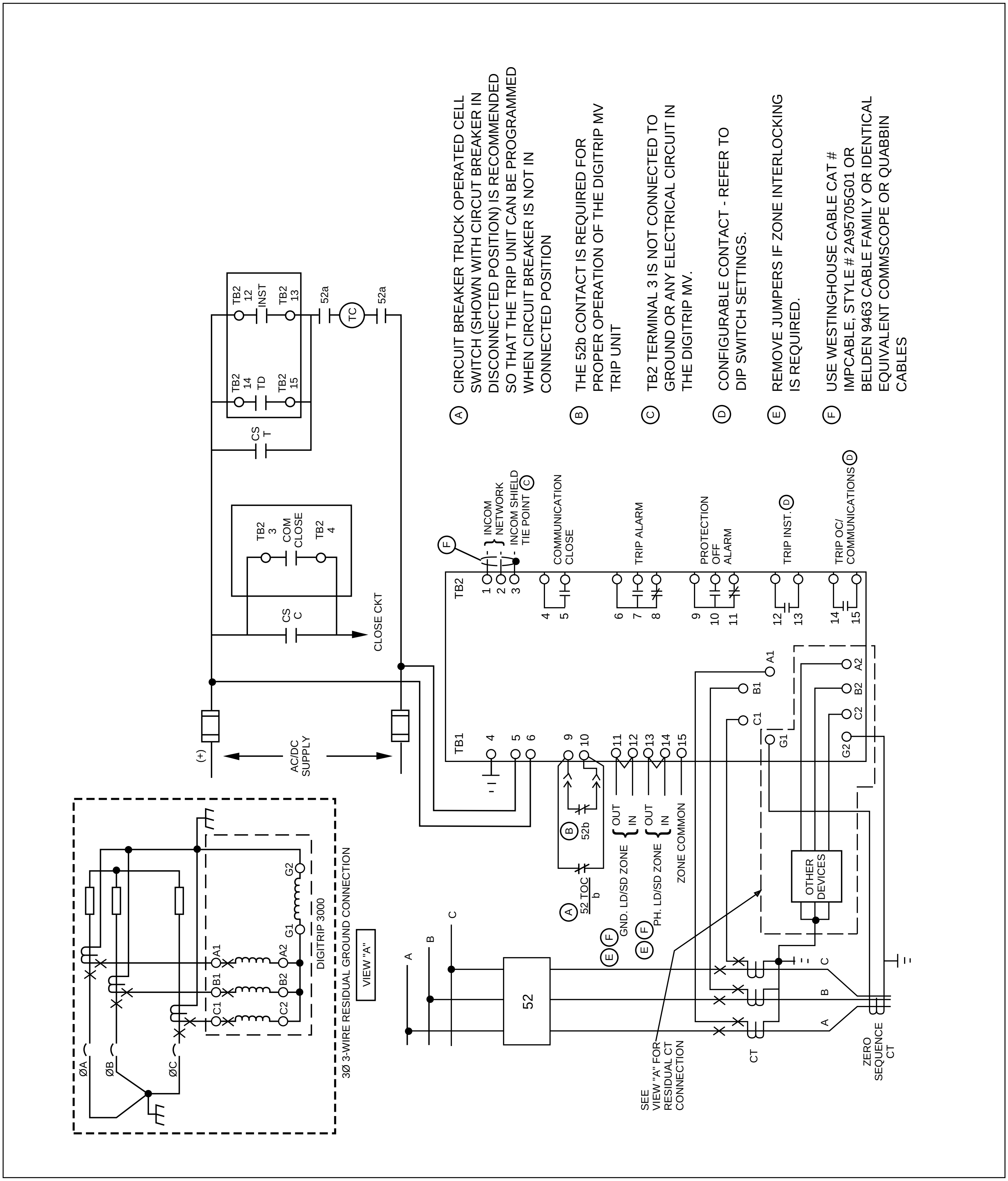


Figure 3-1 Digitrip 3000 Typical Wiring Diagram

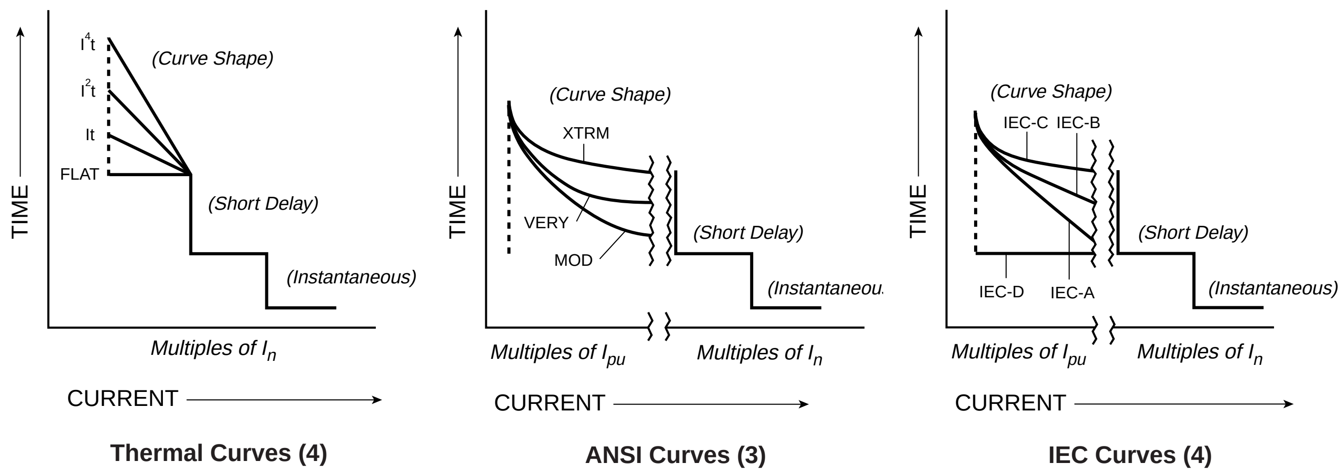


Figure 3-2 Digitrip 3000 Time-Current Characteristic Curves

of a plus or minus percentage and represents a permitted fluctuation on either side of the nominal tripping point for a family of relays, like the Digitrip 3000.

The adjustability and continuous current of the Digitrip 3000 Protective Relay are two factors that contribute significantly to the great flexibility of the relay.

a) Adjustability: The adjustability of the relay permits movement of its characteristic curve or parts of the curve. This movement can be done in both a horizontal and vertical direction on the time current grid. The actual shape of the curve can be changed along with the curve movement. This adjustability permits distinct curves to be established that will better match the electrical protection to the application need (Figures **3-4** through **3-9**) Notice that there is no horizontal movement of the ANSI and IEC curve shapes. Only the point at which the relay starts to time out moves along the curve shape.

b) Nominal Continuous Current: The Digitrip 3000's nominal continuous primary current (I_n) is established by the ratio of the selected current transformers. The current transformer ratio must by set via the initial programming of the relay. These settings must agree with the circuit current transformers to which the relay is connected. Therefore, I_n is established by the current transformer ratio used and becomes the primary scale factor for the trip functions and readouts.

Before proceeding with the curve explanation, it should be noted that combining functional capabilities, such as inverse time overcurrent, short delay and instantaneous, is a coordination activity. The effects of one set of settings on another setting should always be evaluated to determine if the results under all possible circumstances are acceptable. This helps to avoid unexpected operations or non-operations in the future. Such possibilities are highlighted at the end of this discussion as a reminder when establishing relay characteristic parameters.

Inverse Time Overcurrent Protection

Inverse time overcurrent protection consists of a curve shape pickup setting and an inverse time multiplier setting. The inverse time overcurrent function offers eleven possible curve shape types as previously described (Figure **3-2** and Table **3.1**.). When programming the relay, this will be the first choice to make. The curve shape and its effect on the characteristic curve will be covered with the time multiplier explanations.

The pickup setting establishes the current level pickup at which the relay's inverse time overcurrent tripping function begins timing. If, after a predetermined amount of time, the current condition that started the timing process still exists, the relay's trip relay is energized. Pickup settings can be adjusted from 0.20 to 2.20 times I_n. Refer to Tables **2.2** and **2.3** for a complete set of available settings. Figure **3-4** graphically illustrates how the Inverse Time Overcurrent Pickup portion of the overall curve can be moved horizontally on the time current grid by means of the pick-up settings. The Inverse Time Overcurrent Pickup is represented by the dotted lines, while the rest of the curve is represented by a solid line.

Note: Pickup and Tripping will occur within ±% of any selected trip point.

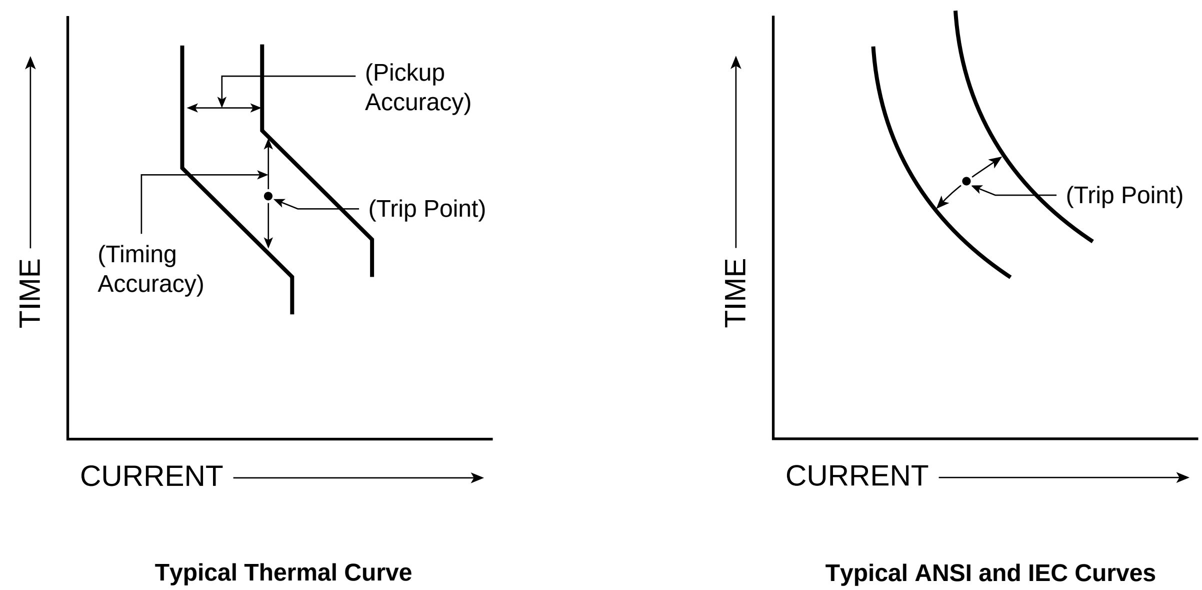


Figure 3-3 Sample Electronic Trip Curves

The Time Multiplier setting is used to select a predetermined amount of time a sustained overload condition will be carried before the breaker trips. For the Thermal Curves, a value of (3 x I_n) is the reference point where the programmed time multiplier setting is fixed on the curve. A wide range of time settings are available and depend upon the curve shape selection. Refer to Tables **2.2** and **2.3** for a complete list of available time multiplier settings. As Time Multiplier settings are varied, the Time Multiplier portion of the overall curve is moved vertically up or down on the time current grid. This movement is also independent of the other portions of the curve. Figure **3-5** graphically illustrates the vertical time line movement with an I^2t curve shape selection. Similar movement occurs for the remaining curve shapes.

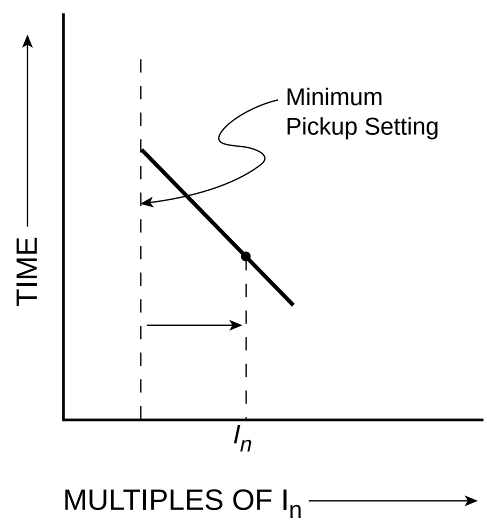


Figure 3-4 Typical Inverse Time Overcurrent Pickup Horizontal Movement

Short Time Protection

Short time (fault) protection responds to short circuit conditions. Similar to the inverse time overcurrent function, the short time function is comprised of a short time current pickup setting and a short delay time setting. The Short Delay pickup setting establishes the current level at which the relay's short time tripping function begins timing. The Short Delay Time setting establishes the amount of time a short-circuit will be carried before

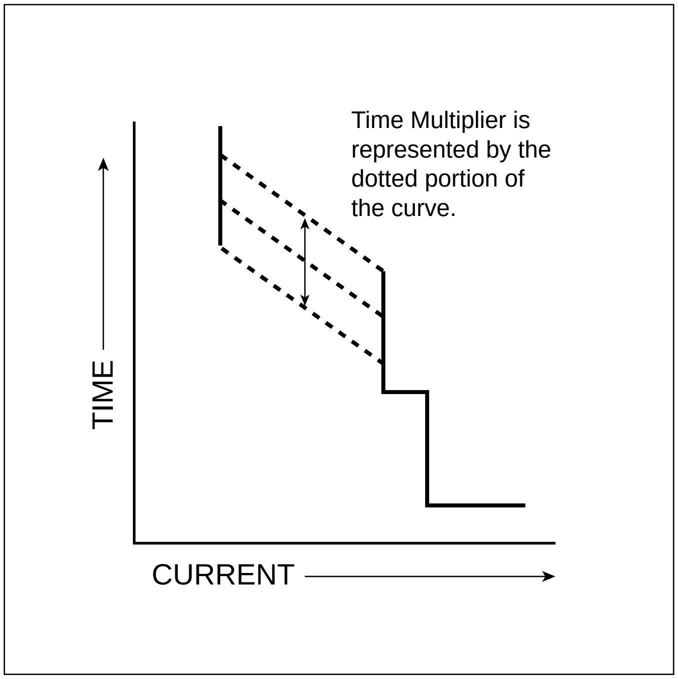


Figure 3-5 Typical Time Multiplier Adjustment (I^2T Response)

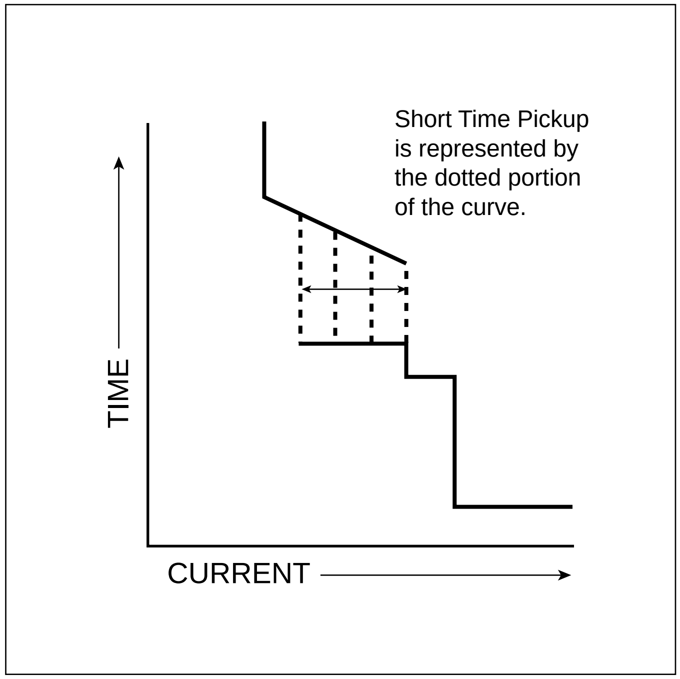


Figure 3-6 Short Delay Setting Adjustment

the protective relay's trip relay is energized. As is the case with inverse time overcurrent protection, short delay protection also offers a range of settings for both pickup and time. Refer to Tables **2.2** and **2.3** for available selections.

Two points should be made concerning the available selections: 1) In Table **2.2** covering Short Delay Pickup settings, “NONE” is one of the available selections. If “NONE” is selected, the Short Delay function is disabled and there will be no Short Delay protection. Also, if “NONE” is selected, a Short Delay Time selection is not offered. 2) There is no curve shape selection for the Short Delay Time portion of the curve. A flat response curve is automatic.

When a short delay pickup setting other than “NONE” is selected, the Short Delay pickup and the Short Delay Time portions of the overall curve are moved horizontally and vertically in a similar manner to the inverse time protection functions. Refer to Figures **3-6** and **3-7** for graphic illustrations of this movement.

Note that the scope of protection offered by Digitrip 3000 is a coordinated effort. This is especially true when

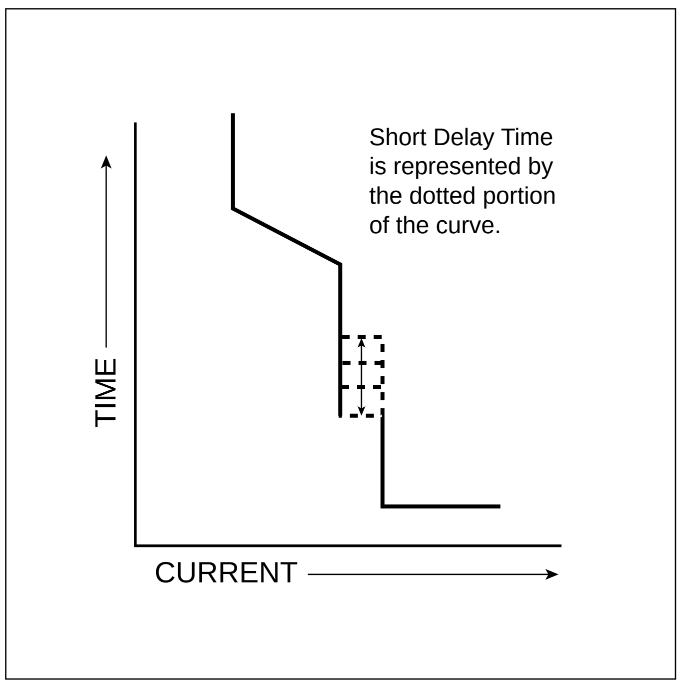


Figure 3-7 Short Delay Time Adjustment

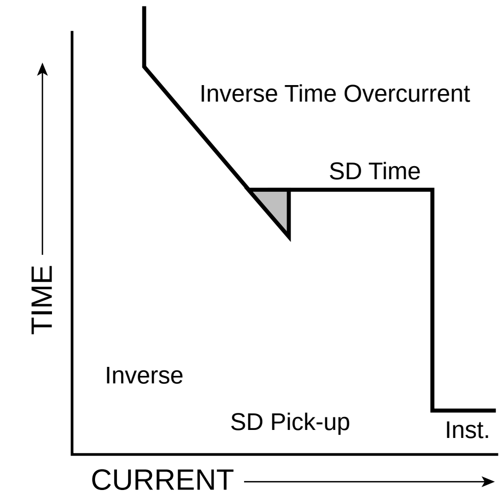


Figure 3-8 Typical Curve with I^2t Shape

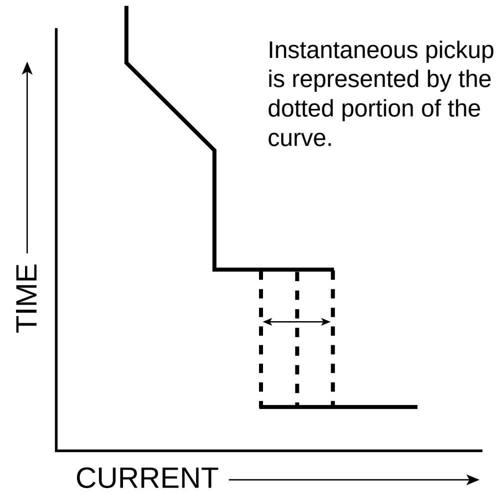


Figure 3-9 Instantaneous Setting Adjustment

a number of protective functions, such as inverse time overcurrent and short delay protection are combined into one cooperative curve. Figure **3-8** shows a typical time-current curve which has both inverse time overcurrent and short delay protection, and an I^2T curve shape selected. Because of the pickup, time and curve shape selections made for this illustration, a triangle (shaded area on the illustration) is formed by the intersection of the different time and pickup lines. Internally, the Digitrip 3000 design looks at this particular curve as if the shaded triangular area does not exist. Therefore, in an actual performance situation, the short delay time function would take precedence over that portion of the inverse time overcurrent line forming the one leg of the triangle. This does not create a problem from a protection or coordination standpoint. In fact, it is recommended on certain applications to set the minimum time the Digitrip 3000 Protective Relay can respond and where it will intersect the inverse time overcurrent curve. If only the Short Delay Time is required, it is recommended that the Short Delay setting be set at 11 times (I_n). It could, however, cause confusion if the combination of protection functions is not viewed as a coordinated activity. For example, an individual might expect a tripping action based on a selected low value for Inverse Time Overcurrent Time Multiplier. The expected tripping action will not take place at the expected time, if the Short Delay Time selected is in the higher end of time selection possibilities. It should also be noted that this situation is similar for other curve selections. The only thing that changes with different curve selections is the general shape of the triangle. When the Short Delay Time setting is low enough, this situation will not exist. In summary, for a inverse time and short time cooperative curve, the minimum trip time cannot be less than the short delay time setting.

Instantaneous Protection

Instantaneous (short circuit) protection reacts to high level fault currents. The instantaneous pickup setting establishes the current level at which the relay's instantaneous trip relay will be energized with no time delay and is the instantaneous setting times (I_n).

Table **2.2** specifies the possible settings, which are from 1 through 25 and "NONE." If "NONE" is selected, the instantaneous trip function is disabled and the discriminator option is offered. See paragraph 2-1.4 (Phase Instantaneous) to review the discriminator option details.

If an Instantaneous Setting other than "NONE" is selected, the instantaneous portion of the overall curve can be moved independently in a horizontal direction. Figure **3-9** graphically illustrates this horizontal movement.

The instantaneous protection (INST) is designed to provide a minimum 2 cycle total response time. To provide this fast response time the rms current detection level and display readout may differ somewhat from a true rms ampere value, if a significant percentage harmonic current is present.

Ground Fault Protection
The ground fault protection function can be a composite of the ground: 1) inverse time overcurrent curve shape, pickup, and time, 2) short delay pickup and time, 3) instantaneous pickup. Its curve shape is independent of the phase curve. There are two differences between Digitrip 3000 phase and ground functions: 1) Inverse time overcurrent time multiplier values for the ground function of the thermal curves are for ($1 \times I_n$) while the phase is ($3 \times I_n$). 2) The short delay settings are more sensitive and can be set from ($0.1 \times I_n$) to ($11 \times I_n$). Movement of the pickup portion of the curve in a horizontal direction and the time portion of the curve in a vertical direction is similar to phase inverse time overcurrent, short delay and instantaneous functions previously described. Therefore, ground fault curve movement is not graphically illustrated. Refer to Table **2.3** for the available ground fault settings. When programming ground fault protection, keep in mind that if "NONE" is selected, the ground fault protection is disabled. Even if the ground fault protection is disabled, a detectable ground current will still be displayed.

Characteristic Curve Reminders
As previously mentioned, combining protective capabilities is a matter of coordination. The effects of one selection should always be evaluated against other selections to determine if the overall desired result is obtained. For this reason, keep in mind the following Digitrip 3000 selection possibilities and relay design features when programming the unit to closely coordinate with system protective needs:

1. When "NONE" is selected as a setting, the associated tripping function is disabled.

2. When "NONE" is selected for the Phase Instantaneous Setting, a Phase Discriminator option is offered.

3. The internal design of the Digitrip 3000 Protective Relay is such that the Short Delay Time setting might take precedence over the Inverse Time Overcurrent Time. This is graphically illustrated in Figure **3-8**.

3-3.2 PROGRAM MODE

CAUTION

DIGITRIP 3000 PROTECTIVE RELAY SETTINGS MUST BE PROGRAMMED BEFORE THE RELAY IS PUT INTO OPERATION. CARE MUST BE TAKEN WHEN PROGRAMMING THE DIGITRIP 3000 WHILE THE BREAKER IS CLOSED AND CURRENT IS FLOWING. AN INCORRECT SETTING CONFIGURATION COULD CAUSE THE RELAY TO TRIP THE BREAKER WHEN SETTINGS ARE SAVED.

Notes:

1. *The Program Mode can be entered with the circuit breaker open or closed, depending on how DIP switch S2 is set. Refer to Table **5.1** for DIP switch settings. The circuit breaker position is determined via the normally closed breaker "b" contact on terminals 9 and 10 of TB1. Refer to the typical wiring diagram in Figure **3-1**.*

2. *The settings that are altered during a programming session will not be saved until the Save Settings pushbutton is pressed and released.*

3. *If the circuit breaker is closed during a programming session and DIP Switch S2 is set to "off," the unit will exit the Program Mode without saving any new setpoint values and the message "ERR" will appear in the Settings/Test Time/Trip Cause window.*

4. *When programming is concluded and new setpoints saved, the Program Mode pushbutton should be pressed and released to exit the Program Mode.*

5. *The Program Mode is also exited if the Reset pushbutton is pressed and released or if there is no programming activity for approximately 2-1/2 minutes.*

Refer to Section 3-3.3 (Programming Overview) and the following specific details to become familiar with the programming process.

To enter the Program Mode, open the protective access cover and press and release the Program Mode On/Off pushbutton. The Program LED will blink green, indicating that the Program Mode has been entered. The present value of the first setpoint to be programmed (Curve Shape) will appear in the Settings/Test Time/Trip Cause Window, which will be referred to as the Alpha-numeric Display for the rest of this discussion. The Curve Shape LED will be blinking green. The Raise or Lower pushbuttons can now be used to change the value of the setpoint. Keep in mind that the Raise and Lower pushbuttons will roll over from highest to lowest and lowest to highest respectively. If either of the pushbuttons is held down and not released, their function is accelerated. This is true for all white pushbuttons on the panel face.

The curve shape setting is selectable for both the phase and ground curves. Refer to Section 2-1.4 and Table **2.1** to review the curve shape selection possibilities.

Pressing and releasing the Select Settings pushbutton will cause the unit to step to the next setpoint. This is the Phase Inverse Time Overcurrent Pickup setting. The Inverse Time Overcurrent Pickup LED will blink green. Simultaneously, the Phase LED will be blinking green, indicating that this setting is associated with the phase protection curve.

After the Raise and/or Lower pushbuttons are used to arrive at the desired Phase Inverse Time Overcurrent Pickup, the Select Settings pushbutton can be pressed and released to step to the next setpoint, which is the Phase Time Multiplier. The Time Multiplier setting LED will blink green along with the Phase LED. Refer to Table **2.2** for the available settings and note that the available settings can vary, depending upon which curve shape was previously selected.

Pressing and releasing the Select Settings pushbutton will cause the unit to step to the Phase Short Delay Pickup setting. Refer to Table **2.2** for the available settings. This function can be disabled by selecting the “NONE” setting. The Short Delay Pickup LED and the Phase LED will blink green. After the Raise and/or Lower pushbuttons are used to arrive at the desired setting, the Select Settings pushbutton is pressed and released to move to the next setpoint. The next setpoint is Short Delay Time setting (Table **2.2**), unless “NONE” was selected for the Short Delay Pickup. If “NONE” was selected, the Short Delay Time setting will automatically be bypassed in favor of the next in order setting, Phase Instantaneous Pickup.

When at the Phase Instantaneous Pickup setting, both the Instantaneous Pickup LED and the Phase LED will blink green. Refer to Table **2.2** for the available instantaneous settings. Once a selection other than “NONE” is made and the Select Settings pushbutton is pressed and released, the unit steps to the next setpoint. If “NONE” is the setting selected and the Select Settings pushbutton is pressed and released, the Phase and Instantaneous LEDs remain on and the unit will now offer a choice of whether to turn the discriminator option on or off. Refer to Section 2-1.4 to review the discriminator option details. Once the discriminator option selection is made and the Select Settings pushbutton is pressed and released, the unit steps to the next setpoint.

Ground Inverse Time Overcurrent setting is the next setpoint. The Ground Curve Shape LED and the Ground LED will blink green. Use the Raise and/or Lower pushbuttons to arrive at the desired Ground Curve Shape Setting.

Programming the ground setpoints is handled in the same manner as was used in selecting the phase setpoints, except for the following:

1. The Ground Inverse Time Overcurrent Pickup can be disabled by selecting “NONE.” This is not possible on the Phase Inverse Time Overcurrent Pickup.

2. If “NONE” is selected for the Ground Instantaneous Pickup setting, there is no discriminator option, as was the case for Phase Instantaneous Pickup setting.

For a complete listing of all the available ground setpoints, refer to Table **2.3**.

When all of the ground setpoints are established and the Select Settings pushbutton is pressed and released, the unit steps to the High Load Setting. The High Load LED will blink green and the last programmed value for the High Load time setting will appear in the alphanumeric display. Refer to Section 2-1.4 and Table **2.3** to review the High Load function and/or to select the appropriate High Load time setting. Once this selection is made and the Select Settings pushbutton is pressed and released, the unit steps to the next setpoint.

The next setpoint selection to be made is the Frequency. The choices are 60Hz and 50Hz. When this selection is made and the Select Settings pushbutton is pressed and released, the relay steps to the Phase CT Ratio Setting.

The Phase LED will blink green and the programmed value for the phase CT will appear in the alphanumeric display. Refer to Table **2.4** to select the desired CT ratio. Once this selection is made and programmed, the Select Settings pushbutton is pressed and released to move to the last setpoint.

The last setpoint selection to be made is the Ground CT Ratio Setting. Refer to Table **2.4** to select the desired

CT ratio. Once this selection is made and programmed, the Select Settings pushbutton is pressed and released. The relay will cycle back to the first setpoint, Curve Shape.

It is possible to step backwards through the setpoints by pressing and holding down the Select Settings pushbutton, while pressing and releasing the Lower pushbutton.

To save the new settings at any time, press and release the Save Settings pushbutton. When the Save Settings pushbutton is pressed and released, the unit will blank the alphanumeric display for two seconds, and then display the last setting. At this moment, the unit will use the new setpoints for protection. After pressing the Save Settings pushbutton, the Program Mode can be exited by any one of three ways:

1. Press and release the Program Mode On/Off pushbutton.
2. Press and release the Reset pushbutton.
3. Perform no programming activity for 2 1/2 minutes.

CAUTION

THE SAVE SETTINGS PUSHBUTTON MUST BE PRESSED AND RELEASED BEFORE EXITING THE PROGRAM MODE. OTHERWISE, THE CHANGED SETPOINTS WILL NOT BE SAVED. IN ADDITION, AFTER THE PROGRAMMING OF SETTINGS IS COMPLETE, IT IS VERY IMPORTANT TO VERIFY ALL THE SETTINGS BY DEPRESSING THE "VIEW SETTINGS" PUSHBUTTON AND STEPPING THROUGH THE SETTINGS.

3-3.3 PROGRAMMING OVERVIEW

An overview of the programming function is presented here in terms of two flow charts. These flow charts are intended as quick references after the material presented in Section 3-3.2 has been reviewed.

The flow chart entitled "Programming Sequence Preview" (Figure **3-10**) presents the general programming steps the Digitrip 3000 follows, always beginning with the "Curve Shape" selection. Each time the "Select Settings" pushbutton is pressed and released, the relay advances to the next sequential step.

The flow chart entitled "Local Programming Sequence Flow Chart" (Figure **3-11**) presents details of the programming function. A specific setting decision is called for at each DIAMOND SHAPED decision point. After a decision is made to either accept or change the dis-

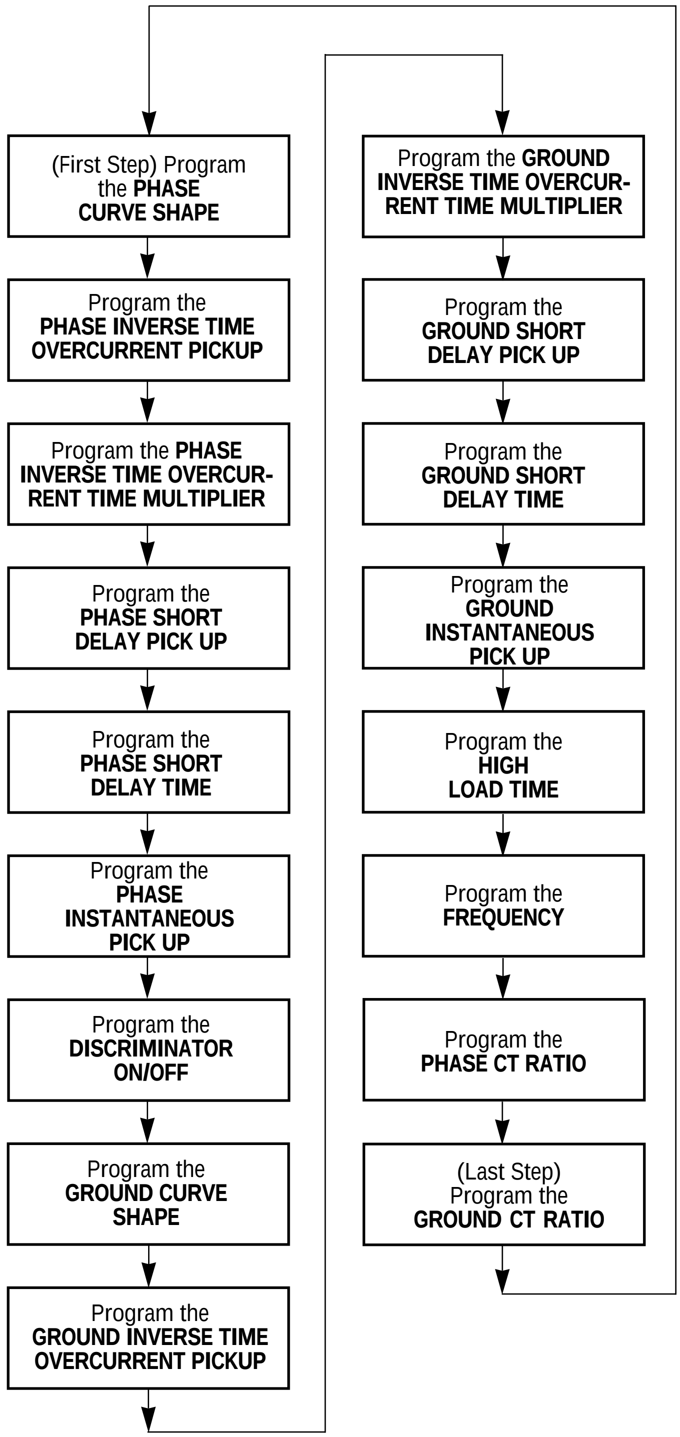


Figure 3-10 Programming Sequence Preview

played setting, the “Select Settings” pushbutton is pressed and released to move to the next setting in the programming order. Notes to the right of the flow chart and connected by dotted lines to the “Select Settings” pushbutton boxes are used to highlight what displays will be activated and observed as the relay moves through the programming steps.

3-3.4 TEST MODE

The Test Mode is not intended for live primary current interruption. The intent is to permit the periodic performance of simple tests that verify the functional performance of the relay. To enter the Test Mode, open the protective access cover. Press and release the Test Mode On/Off pushbutton. The following should be verified before proceeding:

1. The word TEST appears in the alphanumeric display.
2. The Test LED is blinking green.
3. The RMS Amperes (numeric display window is blank.
4. An error message (ERR) does not appear in the alphanumeric display.

If there is greater than 0.1 per unit of current flowing on either a phase or ground circuit, the error message (ERR) will appear and there will be an automatic exit from the Test Mode. This maximum current value can be determined by multiplying 0.1 times the CT primary current amperes rating.

Table **2.4** shows the test matrix that can be performed. A translation of the test matrix elements is as follows:

a) “P” signifies a phase current test.
b) “G” signifies a ground current test.
c) “T” signifies that the test will initiate closing of the unit's trip contacts.
d) The numerical values are the per unit values referenced to the I_n value, which is determined by the CT rating setting.

Tests can be done on both phase and ground elements. For either of these tests a trip or no trip mode can be selected. A trip test will activate the trip coil while a no trip test exercises the trip function without activating the trip coil.

When in the Test Mode, the Select Tests pushbutton is pressed and released to step between the four groups of settings shown vertically in Table **2.4**.

The Raise and Lower pushbuttons will move the display between the setpoints for each of the four groups. Within a group, the setpoints move horizontally (Table **2.4**).

Pressing and releasing the Test pushbutton will initiate the selected test.

When the initiated test is complete, the appropriate front panel LEDs will be red to indicate the cause of the trip. The alphanumeric display shows the time to trip, and the numeric display shows the magnitude of the trip current. The Test Mode can be exited as follows:

1. Press and release the Test Mode On/Off pushbutton.
2. Press and release the Reset pushbutton.
3. Perform no testing activity for approximately 2 1/2 minutes.

3-4 COMMUNICATIONS FUNCTION

The communication function can deliver all the data and flags that can be viewed locally on the relay to a host computer equipped with an appropriate software package. In addition, the host computer can initiate a “Communication Trip” and “Communication Close” control type command.

The Digitrip 3000 Protective Relay has a built in INCOM communication network port that is available on terminals 1 and 2 of TB2 (Figure **3-1**). The device Address and the desired BAUD Rate are programmed using the following pushbuttons located on the front panel: “Select Tests,” “Test,” “Raise” and “Lower” and “Select Settings.”

To enter the mode that permits changing the device Address and/or BAUD Rate, depress and hold the “Test” Pushbutton and then depress and release the “Select Tests” Pushbutton. The BAUD Rate and Address respectively will appear in the Settings/Test Time/Trip Cause Window. The “Test” Pushbutton can now be released. The last digit on the right flashes. Press and release “Select Settings” Pushbutton to shift the flashing portion of the display horizontally from the lowest address digit on the right to the last display on the left, which is the BAUD rate. The BAUD rate will flash with an “H” (High BAUD Rate = 9600) or an “L” (Low BAUD Rate = 1200). To increase or decrease the flashing digit or flashing baud rate, press and release the “Raise” or “Lower” Pushbuttons. When completed, depress the “Save Setpoints” Pushbutton to save and exit this mode. Table **3.2** outlines display possibilities and their meanings.

Programming Notes:

1) New Settings can be saved individually at anytime during the programming process or in total at the end of the programming process by pressing the "Save Settings" pushbutton. This must be done prior to exiting the "Program Mode."

2) Any pushbutton used during programming must be pressed and released to accomplish its function.

3) In some instances, use of the "Select Setting" pushbutton can result in movement to 1 of 2 possible next programming setpoints. It depends on the last selection made.

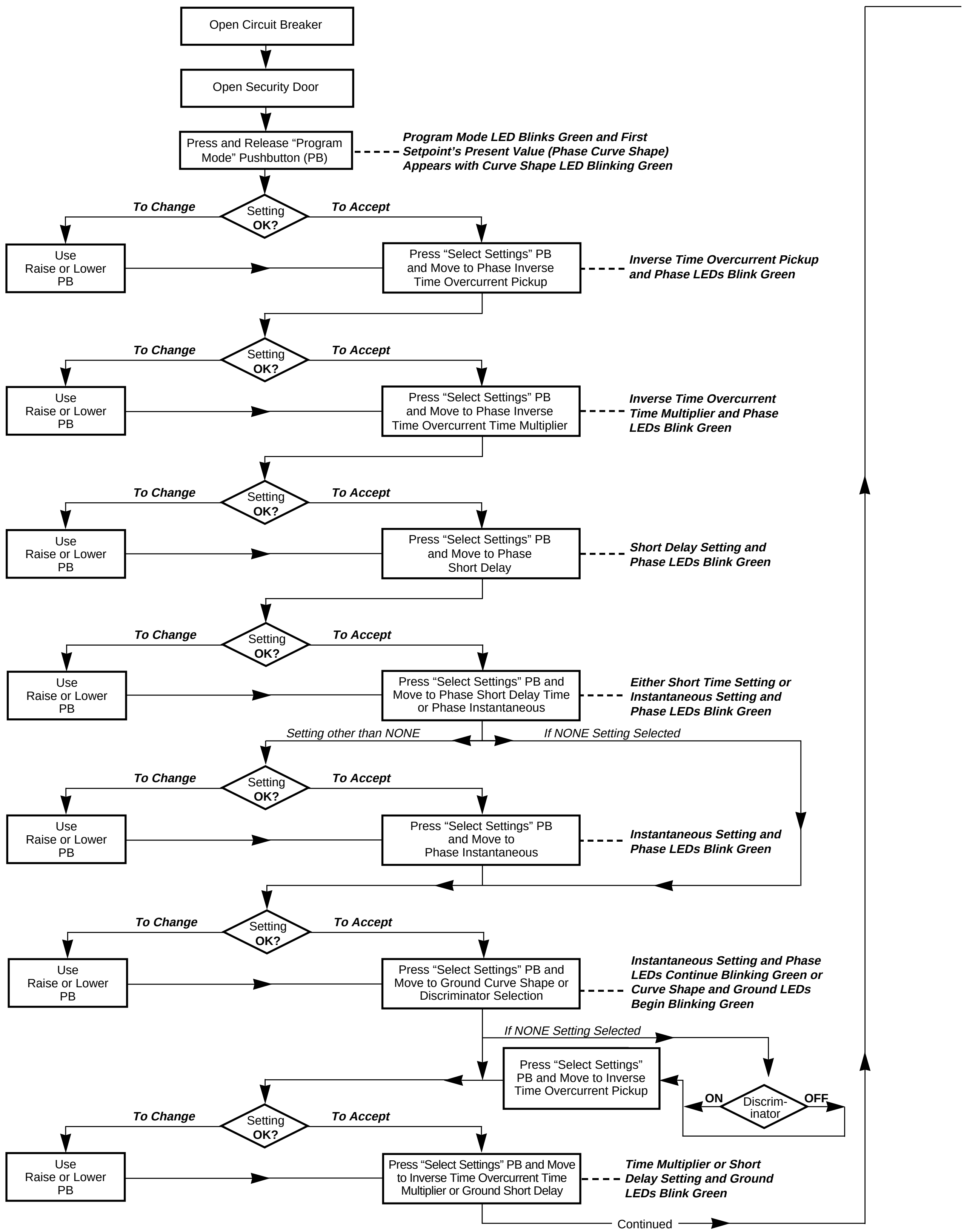
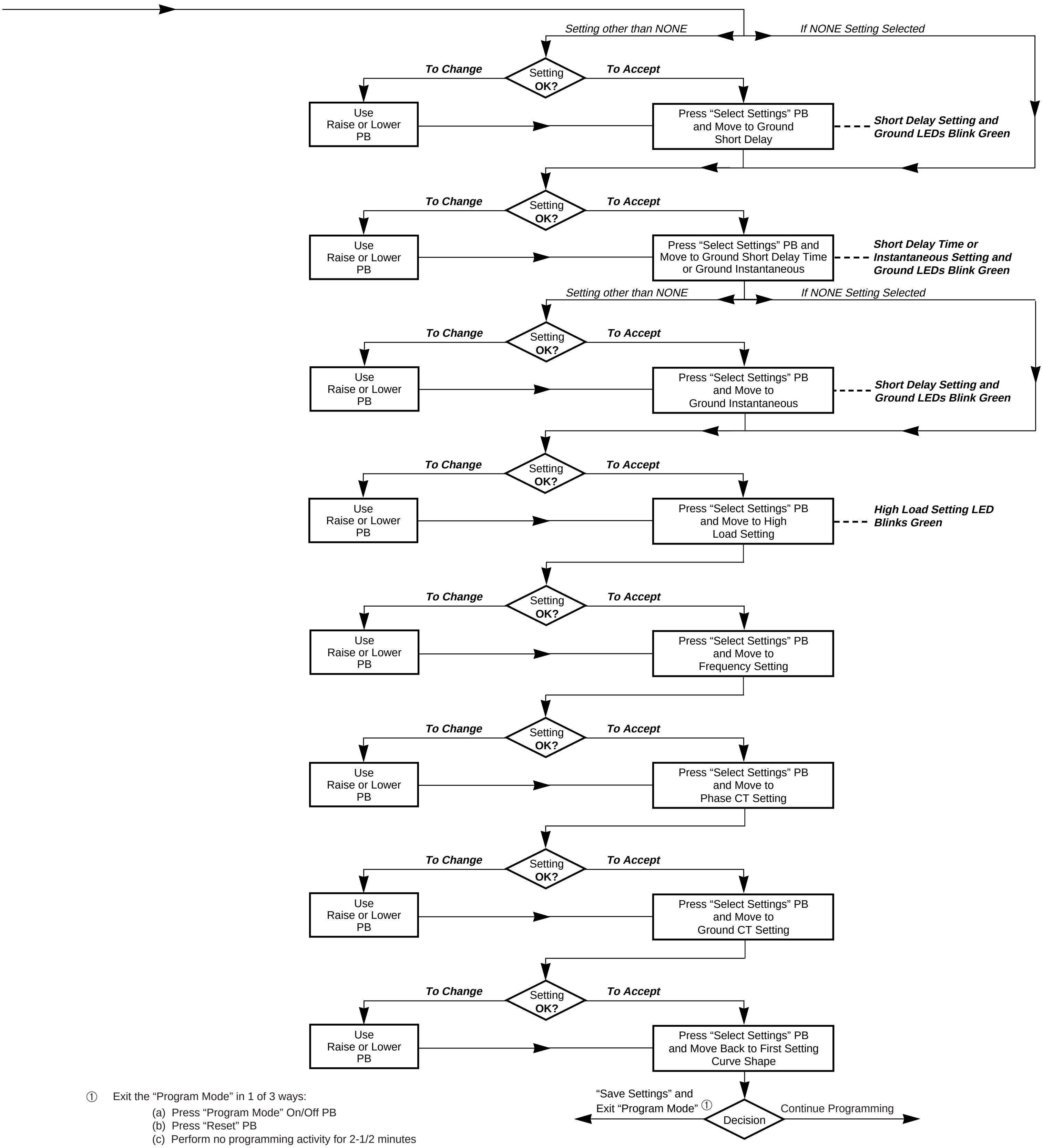


Figure 3-11 Local Programming Sequence Flow Chart



① Exit the "Program Mode" in 1 of 3 ways:
- (a) Press "Program Mode" On/Off PB
- (b) Press "Reset" PB
- (c) Perform no programming activity for 2-1/2 minutes

Table 3.2 Digitrip 3000 Display Messages

Message	Meaning
"TEST"	Entered test mode.
"RAM"	A ram check error was detected.
"ERR"	An error in the test mode has occurred/or an error in the EPROM setpoints was detected.
"PRGM"	Entered the program mode.
"LDT"	Digitrip 3000 tripped via the inverse time overcurrent function.
"SDT"	Digitrip 3000 tripped via the short delay function.
"INST"	Digitrip 3000 tripped via the instantaneous function.
"DISC"	Digitrip 3000 tripped via the discriminator function.
"EXTT"	External trip via INCOM communications.
"OVER"	Override trip (Digitrip 3000 tripped via 100 per unit fixed instantaneous).
"ORNG"	Overrange value (trip value is greater than 28 per unit).

SECTION 4: APPLICATION CONSIDERATIONS

4-1 ZONE INTERLOCKING CAPABILITIES

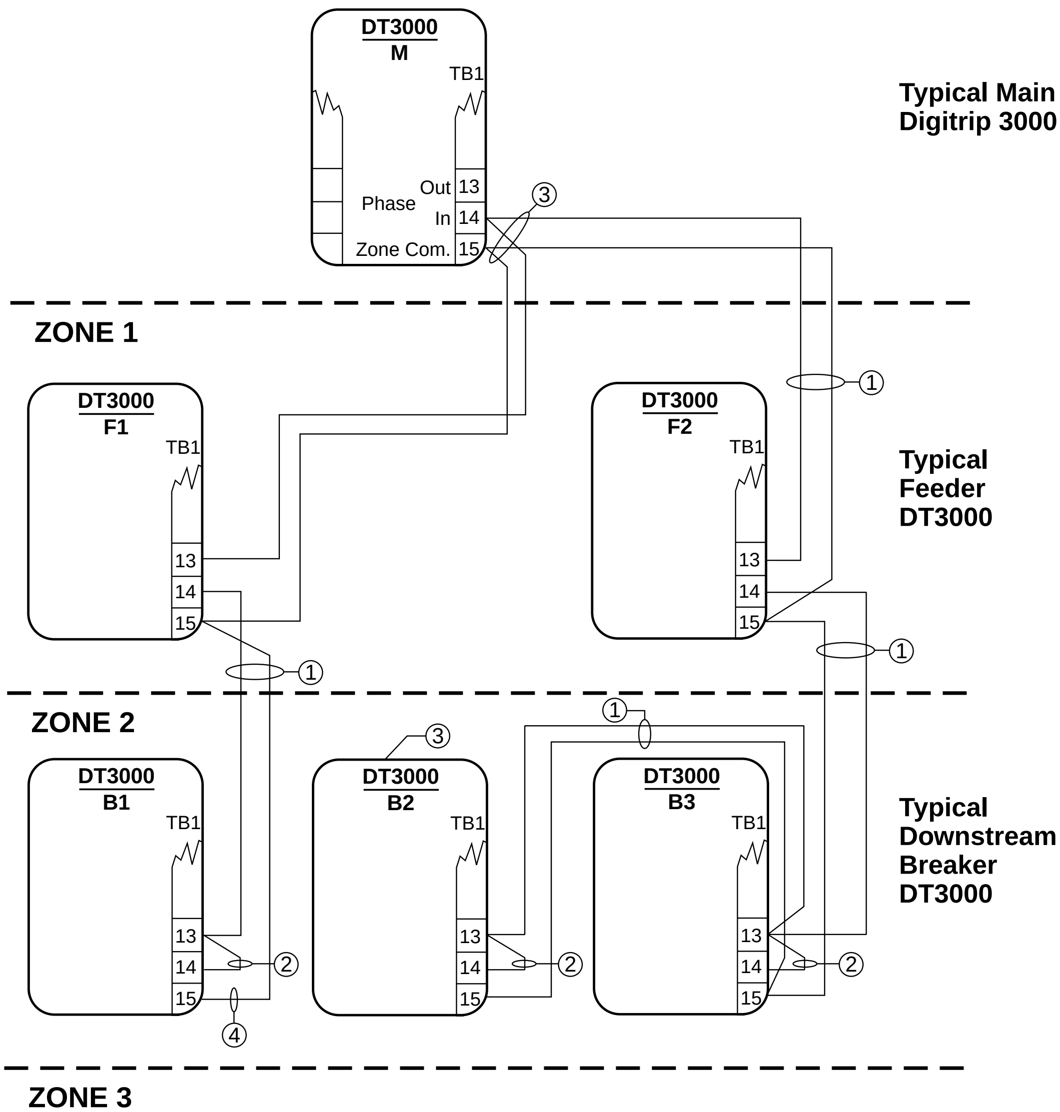
To minimize damage to the system, faults should be cleared as quickly as possible. Zone selective interlocking provides this capability better than a system with only selective coordination.

When the “Ground Zone Interlocking” feature is utilized, an immediate trip is initiated when the fault is in the breaker’s zone of protection, regardless of its preset time delay. When the “Phase Zone Interlocking” feature is utilized, the inverse time overcurrent and short delay phase elements work as follows. The short delay phase element will initiate an immediate trip when the fault is in the breaker’s zone of protection, regardless of its preset time delay. **For the inverse time overcurrent phase element, the current sensed by the Digitrip 3000 must exceed 300 percent (3 x I_n) for the zone selective interlocking to initiate an immediate trip signal.** This interlocking signal requires only a pair of wires from the downstream breaker to the upstream breaker.

When a Digitrip 3000 initiates a trip signal, the zone interlocking signal stays active for an additional 175 milliseconds. Therefore, if a downstream Digitrip 3000 is zone interlocked to an upstream Digitrip 3000, the downstream breaker will have 175 milliseconds to clear the fault before the upstream Digitrip 3000 is allowed to react to that same fault.

Zone interlocking, therefore, provides fast tripping in the zone of protection, but gives positive coordination between mains, feeders and downstream breakers. For faults outside the zone of protection, the Digitrip 3000 on the breaker nearest the fault sends an interlocking signal to the Digitrip 3000 protective devices of the upstream breakers. This interlocking signal restrains tripping of the upstream breakers until their set coordination times are reached. Thus zone interlocking, applied correctly, can result in minimum damage with a resultant minimum disruption of service.

Zone selective interlocking is available on Digitrip 3000 Protective Relays for the inverse time and short time functions on the phase and ground elements. Refer to Figure **4-1** for a typical phase zone selection interlocking wiring diagram or refer to Figure **4-2** for a typical ground zone selection interlocking wiring diagram.



NOTES:

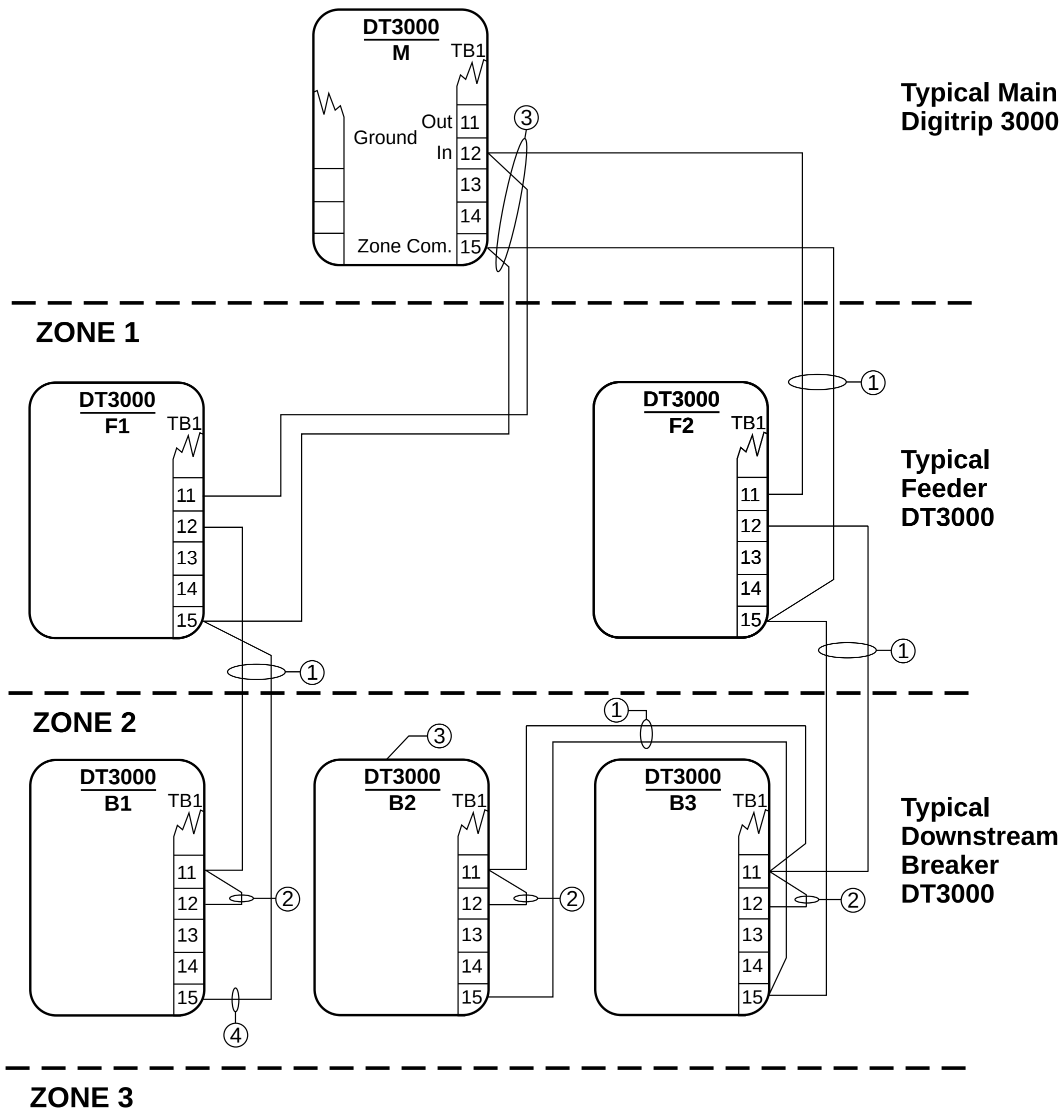
① FOR PHASE ZONE INTERCONNECTION CABLE, SEE CABLE SPECIFICATIONS ON FIG. 3-1. MAXIMUM DISTANCE BETWEEN FIRST AND LAST ZONE SHOULD BE 250 FEET. ROUTE SEPARATE FROM POWER CONDUCTORS.

② JUMPER ON DEVICES IN LAST ZONE USED TO PROVIDE TIME DELAY PER INVERSE TIME OVERCURRENT OR SHORT DELAY TIME SETTING. IF JUMPER NOT USED DIGITRIP 3000 WILL INITIATE TRIP WITHOUT TIME DELAY (NOMINALLY 0.1 SECONDS).

③ UP TO 10 DIGITRIP DEVICES MAY BE WIRED IN PARALLEL TO PROVIDE A SINGLE UPSTREAM RESTRAINT SIGNAL.

④ ONLY 1 ZONE COMMON USED FOR BOTH PHASE AND GROUND. **DO NOT CONNECT ZONE COMMON TO EARTH GROUND.**

Figure 4-1 Connection Diagram for Typical Phase Zone Selective Interlocking



NOTES:

① FOR GROUND ZONE INTERCONNECTION CABLE, SEE CABLE SPECIFICATIONS ON FIG. 3-1. MAXIMUM DISTANCE BETWEEN FIRST AND LAST ZONE SHOULD BE 250 FEET. ROUTE SEPARATE FROM POWER CONDUCTORS.

② JUMPER ON DEVICES IN LAST ZONE USED TO PROVIDE TIME DELAY PER INVERSE TIME OVERCURRENT OR SHORT DELAY TIME SETTING. IF JUMPER NOT USED DIGITRIP 3000 WILL INITIATE TRIP WITHOUT TIME DELAY (NOMINALLY 0.1 SECONDS).

③ UP TO 10 DIGITRIP DEVICES MAY BE WIRED IN PARALLEL TO PROVIDE A SINGLE UPSTREAM RESTRAINT SIGNAL.

④ ONLY 1 ZONE COMMON USED FOR BOTH PHASE AND GROUND. **DO NOT CONNECT ZONE COMMON TO EARTH GROUND.**

Figure 4-2 Connection Diagram for Typical Ground Zone Selective Interlocking

SECTION 5: INSTALLATION, STARTUP AND TESTING

5-1 INTRODUCTION

This section describes mounting, wiring, startup and miscellaneous testing details associated with the Digitrip 3000 Protective Relay.

WARNING

INSURE THAT THE INCOMING AC POWER AND FOREIGN POWER SOURCES ARE TURNED OFF AND LOCKED OUT BEFORE PERFORMING ANY WORK ON THE DIGITRIP 3000 TRIP UNIT OR ITS ASSOCIATED EQUIPMENT. FAILURE TO OBSERVE THIS PRACTICE COULD RESULT IN SERIOUS INJURY, DEATH AND/OR EQUIPMENT DAMAGE.

5-2 PANEL PREPARATION

This section describes the panel preparation and mounting of the Digitrip 3000 Protective Relay.

5-2.1 CUTOUT

Since the Digitrip 3000 Protective Relay is typically mounted on a cabinet door, it is necessary to prepare a cutout in which it will be placed. The dimensions for this cutout, along with the location of the six mounting holes, are shown in Figure **5-1**. Before actually cutting the panel, be sure that the required 3-dimensional clearances for the relay chassis allow mounting in the desired location. Digitrip 3000 Protective Relay dimensions are shown in Figure **5-2**.

It is necessary to hold the tolerances shown when making the cutouts and placing the holes for the mounting screws. In particular, the horizontal dimensions between the center of the mounting holes and the vertical edge of the cutout must be within 0 and +0.050 in. (0.13 cm).

5-2.2 MOUNTING

Do not use a tap on the face of the relay since this will remove excessive plastic from the holes, resulting in less threaded material to secure the relay to it mounting panel.

Place the Digitrip 3000 Protective Relay through the cutout in the panel. Be sure the Operator Panel faces outward. Use the 0.38 in. (0.9 cm) long screws included with the relay to mount the unit on a single-thickness panel. Be sure to start the screws from INSIDE the panel, so they go through the metal first.

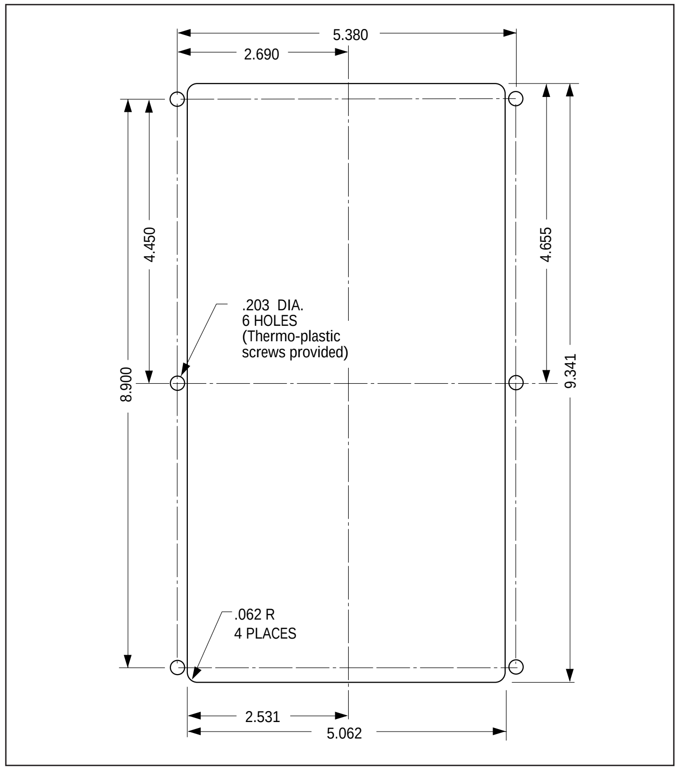


Figure 5-1 Cutout Dimensions (Inches)

5-3 REPLACING DIGITRIP MV WITH DIGITRIP 3000

The Digitrip 3000 can be installed as a direct replacement for the Digitrip MV with proper DIP switch settings as shown in Table **5.1**. The five following important points must be considered when configuring a Digitrip 3000 to function as a Digitrip MV.

1. DIP switches S1, S2 and S3 must be set to the OFF position.
2. The selected curve shape must be It, I^2t, I^4t or FLAT.
3. The phase and ground curves must be set the same.
4. The CT settings must be set from the front panel. They cannot be set via IMPACC.
5. The thermal curves only are used for system coordination.

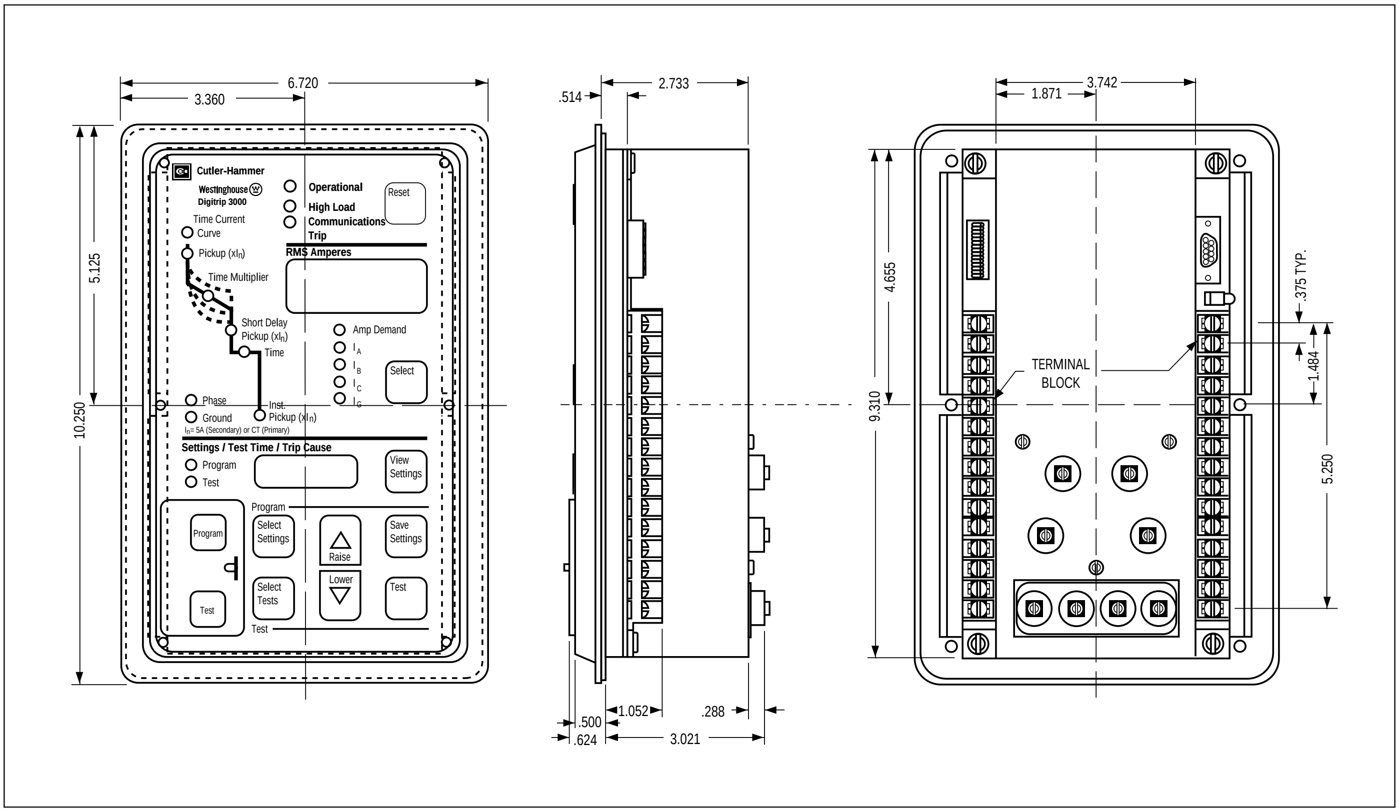


Figure 5-2 Digitrip 3000 Protective Relay Dimensions (Inches)

5-4 WIRING

The wiring of the Digitrip 3000 Protective Relay must follow a suitable “wiring plan drawing.” The term wiring plan, as used here, refers to the drawings made for the specific application. It describes all electrical connections between the Digitrip 3000 and external equipment. This drawing is made by the user. It may also be helpful to refer to the relay’s specific wiring diagram shown in Figure **3-1**. An example of a typical wiring plan is shown in Figure **2-1**. Note the following:

1. The wires to the terminal blocks must not be larger than AWG No. 14. Larger wire will not connect properly to the terminal block. However, larger size wires can be used for the CT connections, with appropriate ring terminal.

2. The terminal block has No. 6-32 sems pressure saddle screws.

3. All contacts are shown in their de-energized position. Note that the Protection Off Alarm Relay is energized when control power is applied.

4. The Digitrip 3000 comes with zone interlocking jumpers installed (TB1 Terminals 11 to 12 and 13 to 14). Depending on the application of zone interlocking, these jumpers may have to be removed.

All wiring must conform to applicable federal, state and local codes.

5-5 INITIAL STARTUP

The information here is intended to be used when first applying control power to the Digitrip 3000 Protective Relay.

5-5.1 BEFORE POWER APPLICATION

a) Verify that all wiring is correct, as shown on the wiring plan drawing.

b) Set the DIP switches per Table **5.1** to configure the Digitrip 3000.

5-5.2 INITIAL POWER APPLICATION

a) Apply control power to the Digitrip 3000 Protective Relay. Refer to Paragraph 3-2 entitled “Power-up And Self Testing.”

b) Insure that the Operational LED on the front of the relay is blinking green.

5-6 MISCELLANEOUS TESTING

CAUTION

DO NOT PERFORM DIELECTRIC TESTING BETWEEN THE DIGITRIP’S METAL BACKPLATE OR THE EARTH GROUND TERMINAL (TB1-4) AND EITHER OF THE CONTROL VOLTAGE INPUT TERMINALS (TB1-5,TB1-6) AND AUXILIARY “52B” INPUT TERMINALS (TB1-9, TB1-10). BOTH OF THESE SETS OF TERMINALS HAVE SURGE PROTECTION MOVS INSTALLED TO EARTH GROUND AND COULD BE ADVERSELY AFFECTED BY SUCH TESTING.

Dielectric Notes:

1. The current transformer input terminals labeled (A1,A2), (B1,B2), (C1,C2) and (G1,G2) are 5 ampere type current, transformer inputs. These inputs have a 3000 volt ac breakdown rating for 1 minute between phases.

2. The relay output contacts COMMUNICATIONS CLOSE, TRIP INST AND TRIP OC/COMMUNICATIONS have a 2000 volt ac breakdown rating for 1 minute between open contacts. The relays trip alarm and protection off alarm have a 1000 volt ac breakdown rating.

3. All other terminals have a 1500 volt ac breakdown voltage for 1 minute to earth ground except for the above CAUTION restraint.

Table 5.1 Digitrip 3000 Dip Switch Settings ①

Switch	Function	Switch Positions	
		ON	OFF
S1	IMPACC Buffers	Digitrip 3000	Digitrip MV
S2	Program with Breaker	Open or Closed	Open Only
S3	Trip Relay Configuration	Phase/Ground	OC/Inst
S4	Remote Open/Close	Enable	Disable
S5	Reserved	XXX	XXX
S6	Reserved	XXX	XXX
S7	Reserved	XXX	XXX
S8	Download Setpoints	Enable	Disable
S9	Auto-Reset	Auto	Manual
S10	Reserved	XXX	XXX

① *For additional DIP Switch information, refer to Paragraph 2-2.2.*

SECTION 6: MAINTENANCE AND STORAGE

6-1 GENERAL

The Digitrip 3000 Protective Relay is designed to be a self contained and maintenance free unit. The printed circuit boards are calibrated and conformally coated at the factory. They are intended for service by factory trained personnel only. The Troubleshooting Guide (Table **6-1**) is intended for service personnel to identify whether a problem being observed is external or internal to the unit. If a problem is identified to be internal, the unit should be returned to the factory for repair or replacement as described in Paragraph 6-3.

6-1.1 STORAGE

The Digitrip 3000 Protective Relay should be stored in an environment that does not exceed the specified storage temperature range of -40°C to +70°C. The environment should also be free of excess humidity. There are no aluminum electrolytic capacitors used in the relay, therefore it is not a requirement to power the unit occasionally. If possible, the relay should be stored in its original packing material and container.

6-2 TROUBLESHOOTING GUIDE (TABLE 6-1)

WARNING

ALL MAINTENANCE PROCEDURES MUST BE PERFORMED ONLY BY QUALIFIED PERSONNEL WHO ARE FAMILIAR WITH THE DIGITRIP 3000 PROTECTIVE RELAY, THE ASSOCIATED BREAKER AND CURRENT LINES BEING MONITORED. FAILURE TO OBSERVE THIS WARNING COULD RESULT IN SERIOUS INJURY, DEATH AND/OR EQUIPMENT DAMAGE.

TROUBLESHOOTING PROCEDURES MAY INVOLVE WORKING IN EQUIPMENT AREAS WITH EXPOSED LIVE PARTS WHERE THE HAZARD OF A FATAL ELECTRIC SHOCK IS PRESENT. PERSONNEL MUST EXERCISE EXTREME CAUTION TO AVOID INJURY OR EVEN DEATH.

ALWAYS DISCONNECT AND LOCK OUT THE CURRENT SOURCE AND CONTROL POWER SUPPLY BEFORE TOUCHING THE COMPONENTS ON THE REAR OF THE DIGITRIP 3000 PROTECTIVE RELAY.

6-3 REPLACEMENT

Follow these procedural steps to replace the Digitrip 3000 Protective Relay.

Step 1: Turn off control power at the main disconnect or isolation switch of the control power supply. If the switch is not located in view from the relay, lock it out to guard against other personnel accidentally turning it on.

Step 2: Verify that all “foreign” power sources wired to the relay are deenergized. These may also be present on the alarm terminal block. Current transformer inputs must be temporarily shorted at a point prior to the relay’s terminals before attempting to open these terminals on the Digitrip 3000.

Step 3: Before disconnecting any wires from the unit, make sure they are individually identified to assure that reconnection can be correctly performed. Make a sketch to help with the task of terminal and wire identification.

Step 4: Remove wires by loosening or removing the screw terminal where there is a wire connection.

Step 5: Remove the 6 mounting screws holding the unit against the door or panel. These are accessed from the rear of the relay.

CAUTION

SUPPORT THE PROTECTIVE RELAY FROM THE FRONT SIDE WHEN THE SCREWS ARE LOOSENED OR REMOVED. WITHOUT SUCH SUPPORT, THE PROTECTIVE RELAY COULD FALL OR THE PANEL COULD BE DAMAGED.

Step 6: Carefully lay the screws aside for later use.

Step 7: Mount the replacement unit. Read paragraph 5-2.2 before attempting this.

Step 8: Reverse the procedure outlined in Steps 4 and 5.

Step 9: Using the sketch mentioned in Step 3, replace each wire at the correct terminal. Be sure that each is firmly tightened. Remove temporary shorts on incoming current transformers.

Step 10: Restore control power. Refer to paragraphs 5-4.2 entitled “Initial Power Application.”

Table 6.1 Troubleshooting Guide (continued on next page)

Symptom	Probable Cause	Possible Solution(s)	Reference
Operational LED is Off	Protective Relay’s Control Power is Deficient or Absent	Verify that Control Power is Connected Between TB1-5 and TB1-6 and that it is within Specifications	Figure 3-1 and Paragraph 2-3
	Protective Relay is Malfunctioning	Replace the Protective Relay	Paragraph 6-3
Operational LED is On but Does not Blink	Protective Relay’s Control Power is Deficient or Absent	Verify that Control Power is Connected Between TBI-5 and TBI-6 and it is within Specifications	Figure 3-1 and Paragraph 2-3
	Protective Relay is Malfunctioning	Replace the Protective Relay	Paragraph 6-3
Operational LED Blinks Red or is any Color other than a Definite Red or Green	Internal Problem Detected	Press Reset Pushbutton	Paragraphs 2-2.1 and 3-2
		Reprogram Setpoints	Paragraph 3-3.2
		Replace Protective Relay if Symptom Persists	Paragraph 6-3
“PGRM” Appears in Settings Display Window	Setpoints are Invalid	Reprogram Setpoints	Paragraph 3-3.2
	Check sum did not Match	Replace Protective Relay if “PGRM” Reappears After Saving Settings	Paragraph 6-3
“ERR” Appears in Setting	There was an Error During Setpoint Programming	Make Sure DIP switch S2 is in Correct Position	Table 5.1
	There was an Error While in the Test Mode	More than 0.1 Per Unit of Current Cannot Flow While in Test Mode	Paragraph 3-3.3
“RAM” Appears in Settings Display Window	An Internal RAM Check Failed	Remove Power from the Protective Relay and then Reapply Power – If the Symptom Persists, Replace the Protective Relay	Paragraph 6-3
Current Readings Appear Incorrect	Incorrect CT Ratio used in Equipment	Verify CT Ratio in Equipment	Paragraphs 1-3 and 3-3.2
	Incorrect Current Wiring	Verify Connections on CT Wiring	Figure 3-1
Current Readings Appear Incorrect	Incorrect System Frequency Programmed	Set to Correct Frequency	Paragraph 3-3.2
	Breaker “b” Contact to trip unit not functioning	Insure “b” Contact Type is Connected to Protective Relay and Functioning	Figure 3-1

Table 6.1 Troubleshooting Guide

Symptom	Probable Cause	Possible Solution(s)	Reference
Circuit Breaker Trips Much Faster than Expected on Inverse Time Overcurrent	Incorrect Settings	Check Settings	Paragraph 3-3.2 and Table 5.1
	Phase Zone Interlocking not used and Jumper Missing	Check for Phase Zone Interlocking Jumper Between TB1-13 and TB1-14	Figure 3-1
	Ground Zone Interlocking not Used and Jumper Missing	Check for Ground Zone Interlocking Jumper Between TB1-11 and TB1-12	Figure 3-1
	Zone Interlocking Used	Check for Absence of Blocking Signal from “Down-Stream” Breaker ***NOTE:*** *During an Internal Test, there is No Blocking Signal from a “Down-Stream” Breaker, therefore, add jumper for test.*	Paragraph 4-2
Circuit Breaker Trips Much Slower than Expected on Inverse Time Overcurrent	The Short Delay Time Setting Determines the Minimum Inverse Time Overcurrent	Check Coordination Curves for Short Delay and Inverse Time Overcurrent Settings	Section 7, Paragraph 3-3.1
Protective Relay Indicates a Trip, but Circuit Breaker Doesn't Open	Improper Wiring from Protective Relay	Check Trip Relay Wiring ***NOTE:*** *Instantaneous and Override Trip Functions Close the Contact Between TB2-12 and TB2-13, while Inverse Time Overcurrent and External Trip Functions Close the Contact Between TB2-14 and TB2-15*	Figure 3-1
		Check that Trip Contact on Protective Relay makes	Figure 3-1
	Unit in Test Mode with “No Trip Test Selected”	Select Trip Test while in the Test Mode	Paragraph 3-3.3
		Check Wiring from Protective Relay to Circuit Breaker Trip Coil	Wiring Plan Drawing
		Check that Circuit Breaker has Source of Tripping Power	Wiring Plan Drawing
Auto-Reset Function not Operational	Breaker “b” Contact to Protective Relay not Functioning	Check wiring from Breaker “b” Dry Contact to TB1-9 and TB1-10 of Protective Relay Terminal Block	Figure 3-1 and 5-3
	DIP Switch S9 not set correctly	Check DIP Switch S9 Setting	Table 5.1
		Check that “b” Contact is Operational	Figure 5-3
Caution: When the Digitrip 3000 Protective Relay is Powered, it Supplies Voltage to the “b” Contacts			
Manual Reset Function not Operational	Dip Switch S9 not set correctly	Check DIP Switch Setting	Table 5.1
	Damaged Reset Pushbutton	Replace Protective Relay	Paragraph 6-3

SECTION 7: TIME-CURRENT CURVES

7-1 DIGITRIP 3000 INVERSE TIME OVERCURRENT CURVES

The specific time-current curves applicable to the Digitrip 3000 Protective Relay are included in this section.

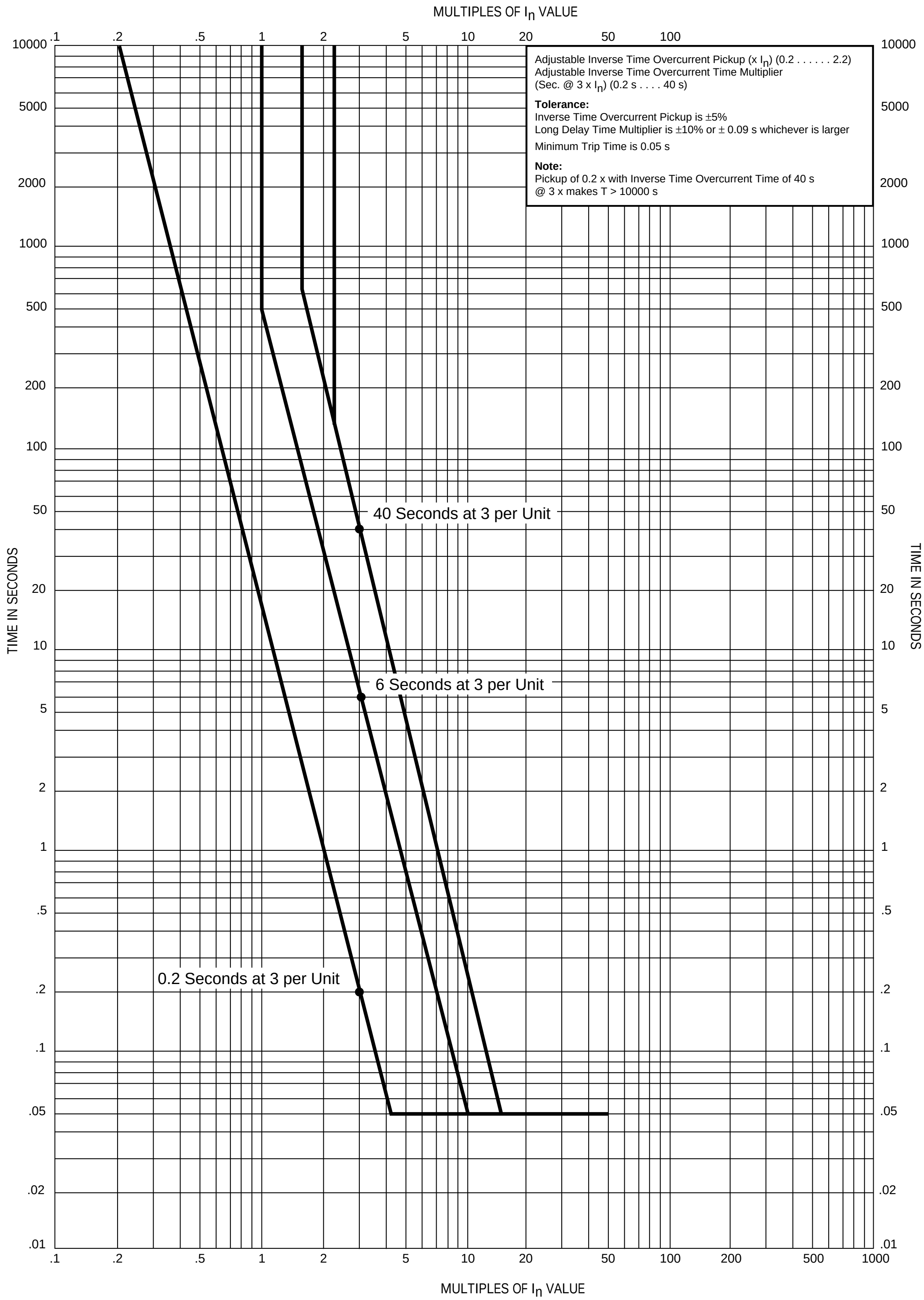


Figure 7-1 Inverse Time Overcurrent Phase, I^4T Curves (SC-5390-92B)

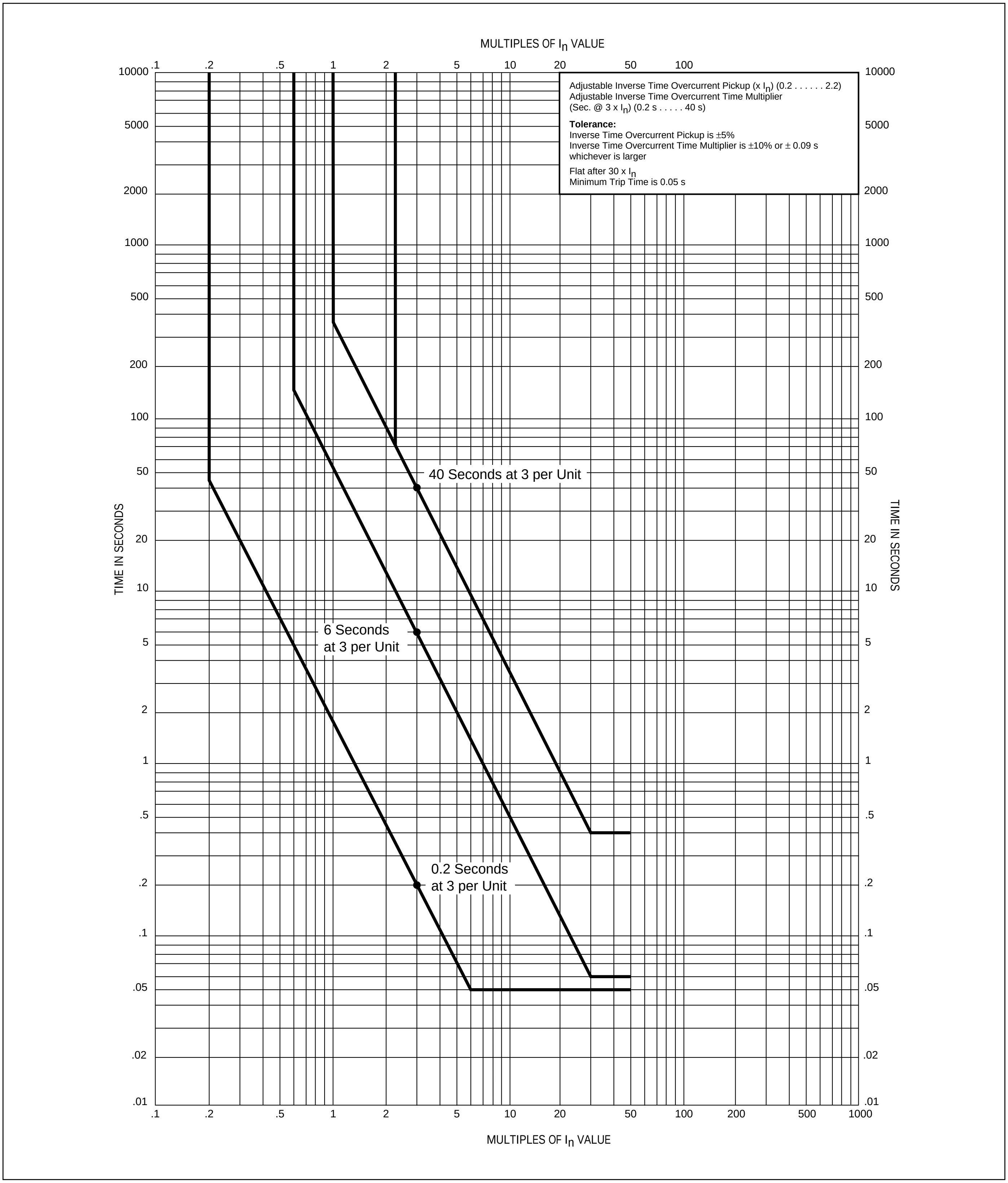


Figure 7-2 Inverse Time Overcurrent Phase, I^2T Curves (SC-5391-92B)

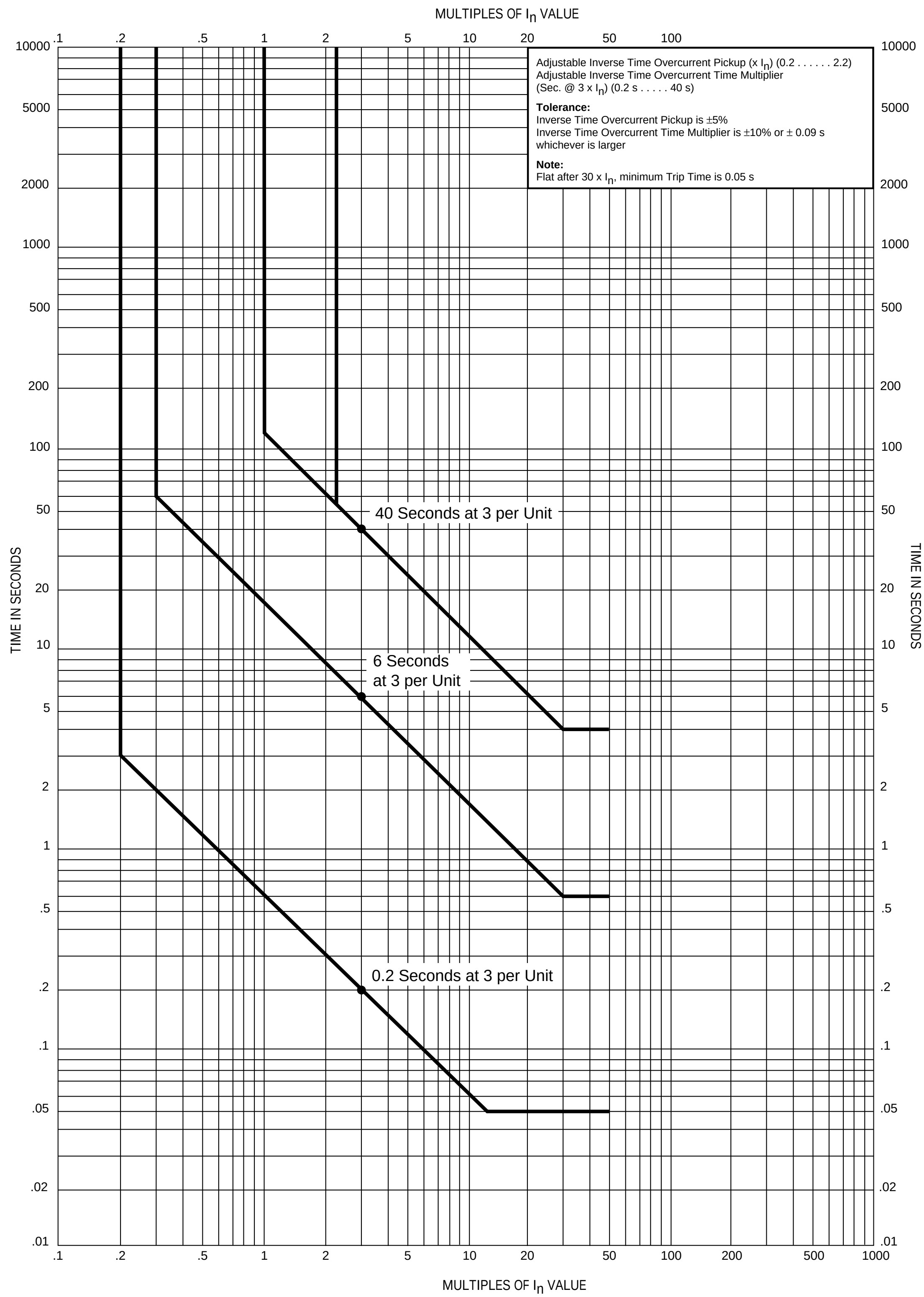


Figure 7-3 Inverse Time Overcurrent Phase, IT Curves (SC-5392-92B)

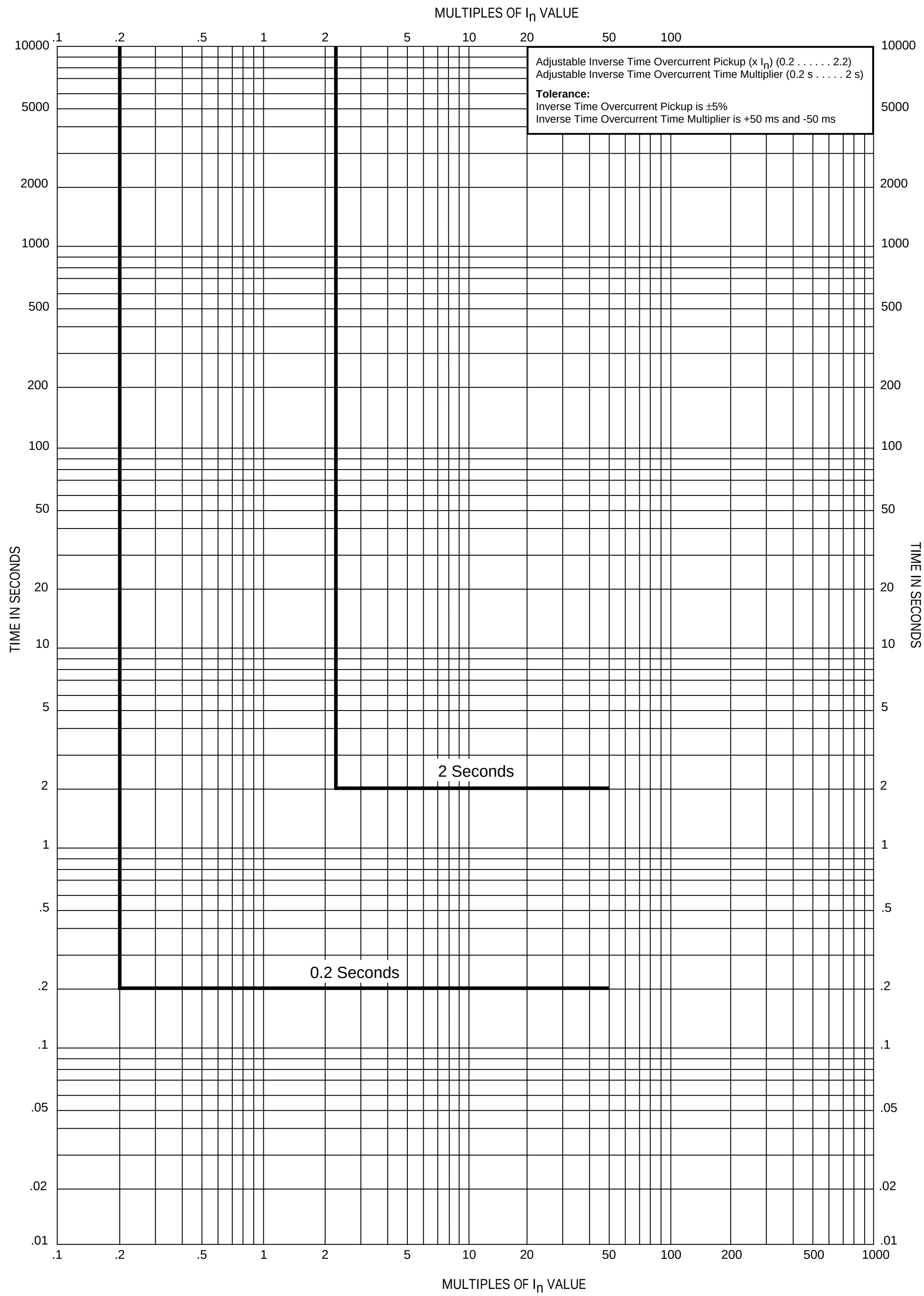


Figure 7-4 Inverse Time Overcurrent Phase, Flat Curves (SC-5393-92B)

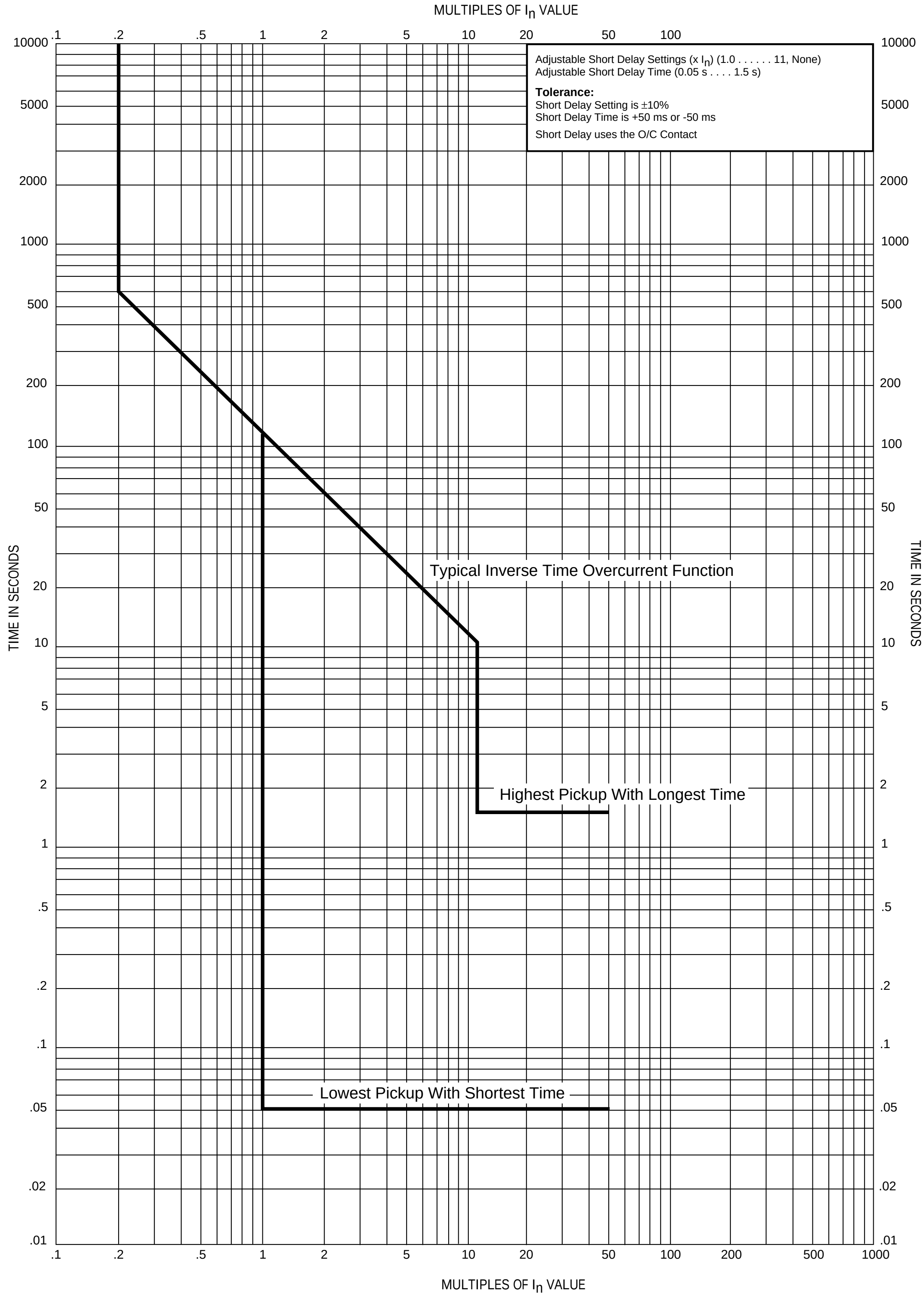


Figure 7-5 Short Delay Phase Curves (SC-5394-92B)

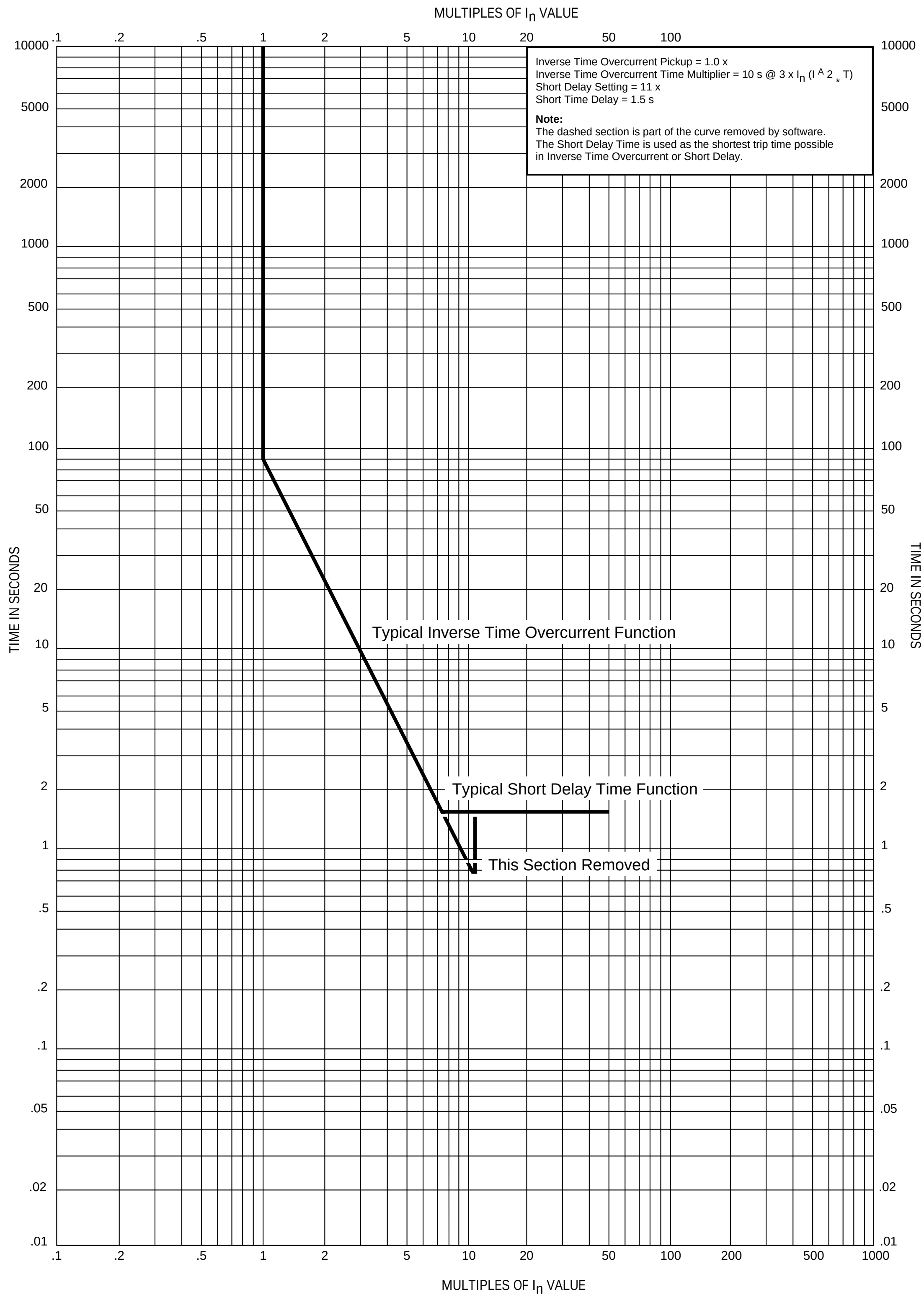


Figure 7-6 Inverse Time Overcurrent/Short Delay Curves (SC-5395-92B)

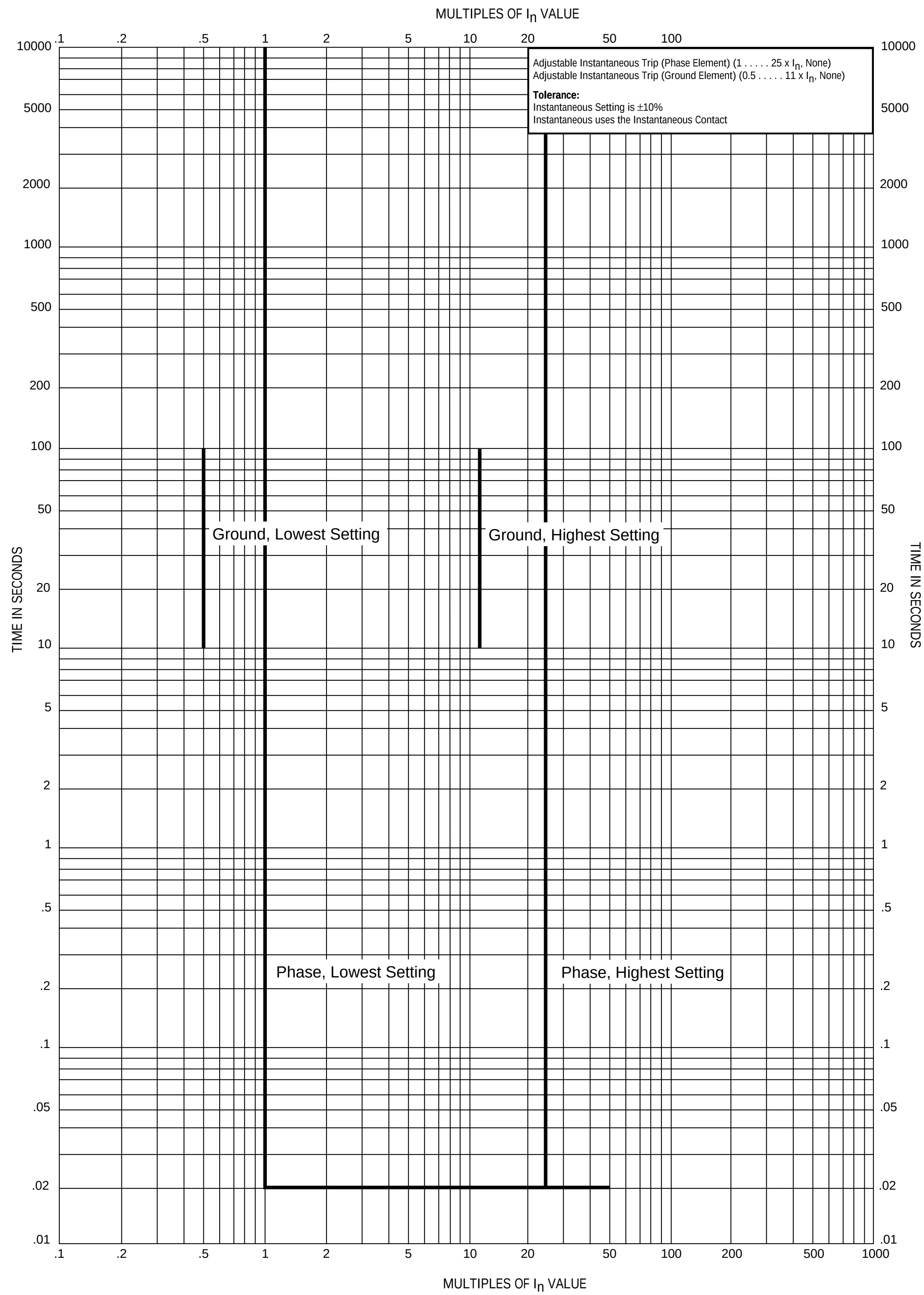


Figure 7-7 Instantaneous Curves (SC-5396-92B)

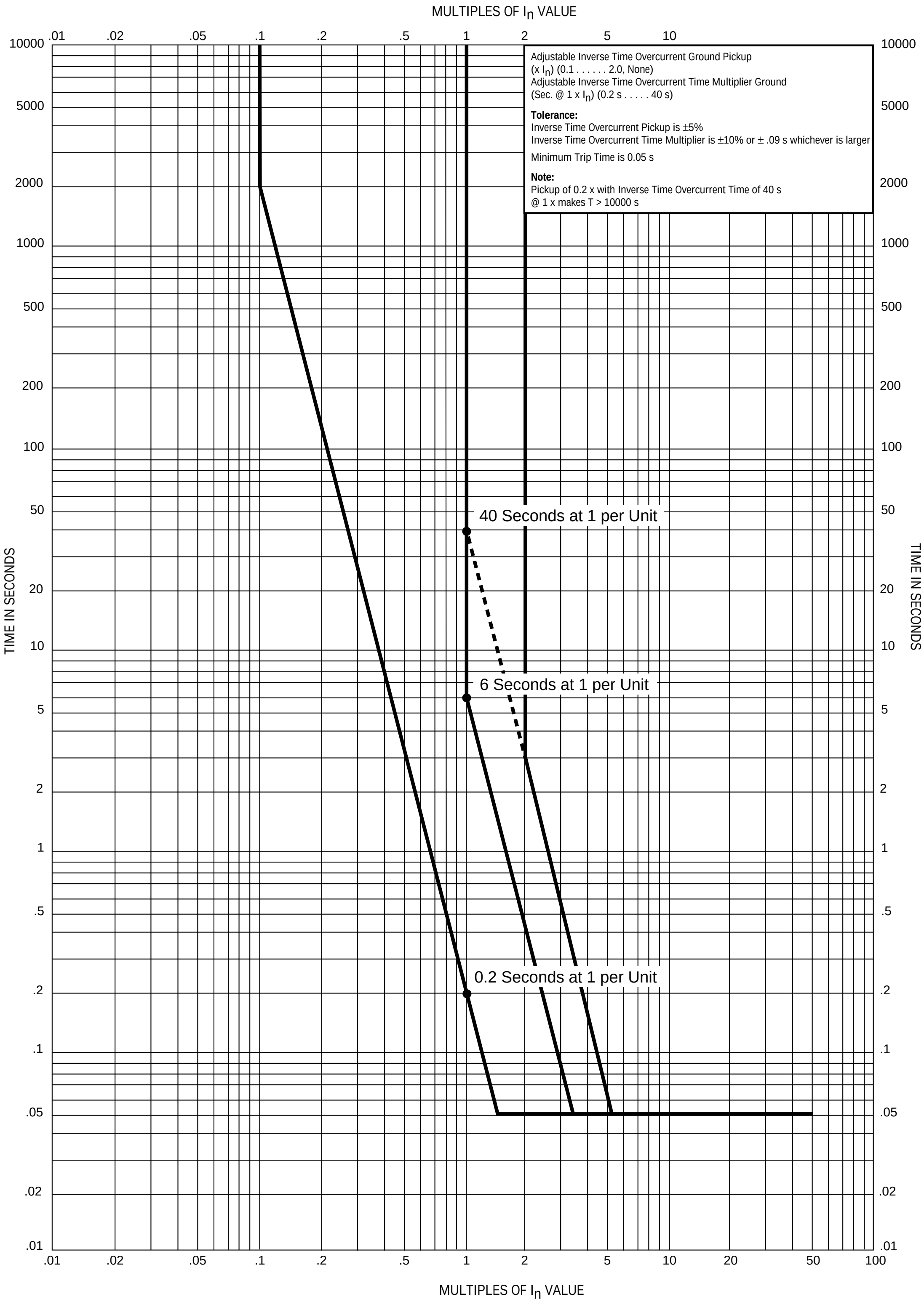


Figure 7-8 Inverse Time Overcurrent Ground, I^4T Curves (SC-5399-92B)

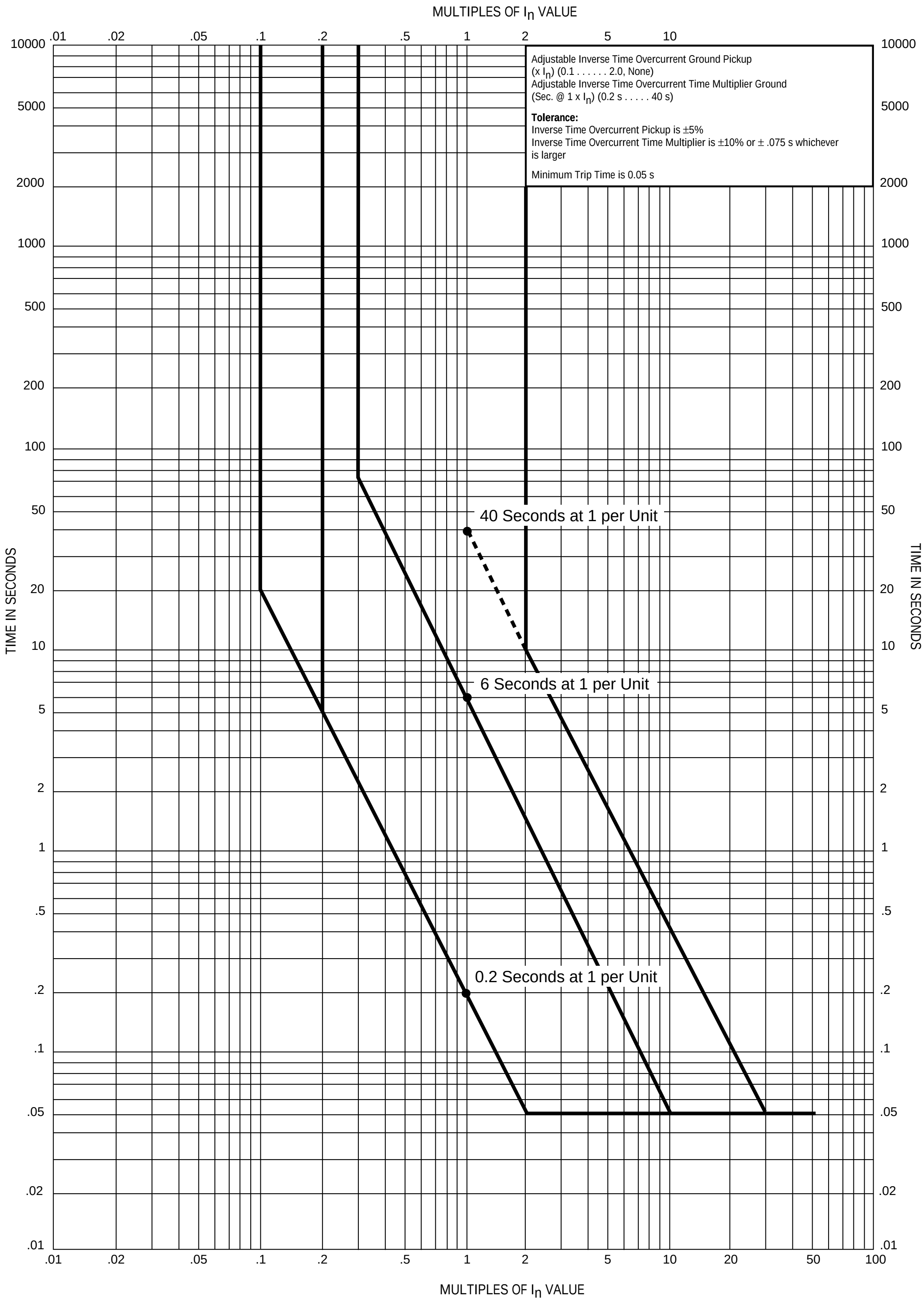


Figure 7-9 Inverse Time Overcurrent Ground, I^2T Curves (SC-5400-92B)

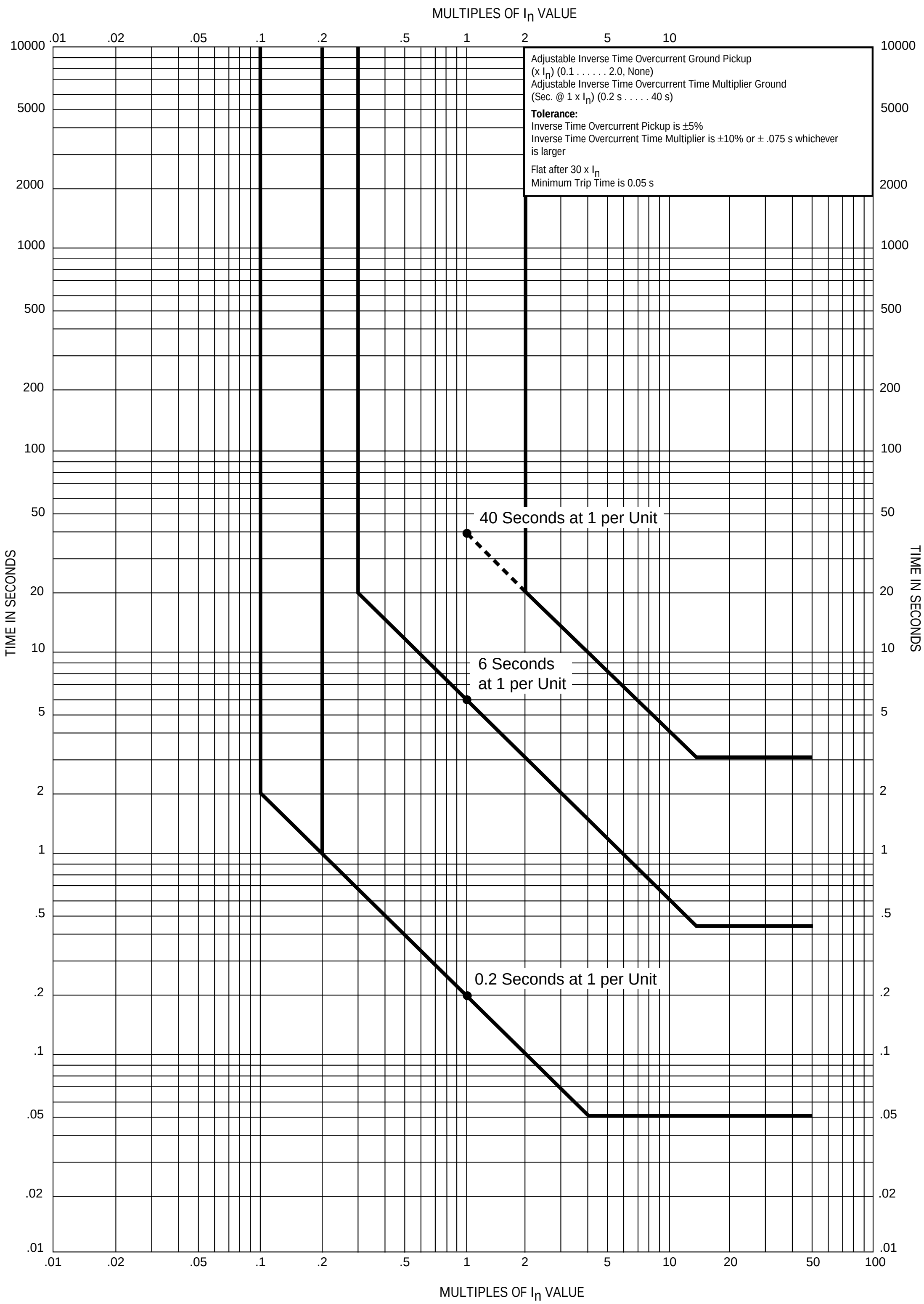


Figure 7-10 Inverse Time Overcurrent Ground, IT Curves (SC-5401-92B)

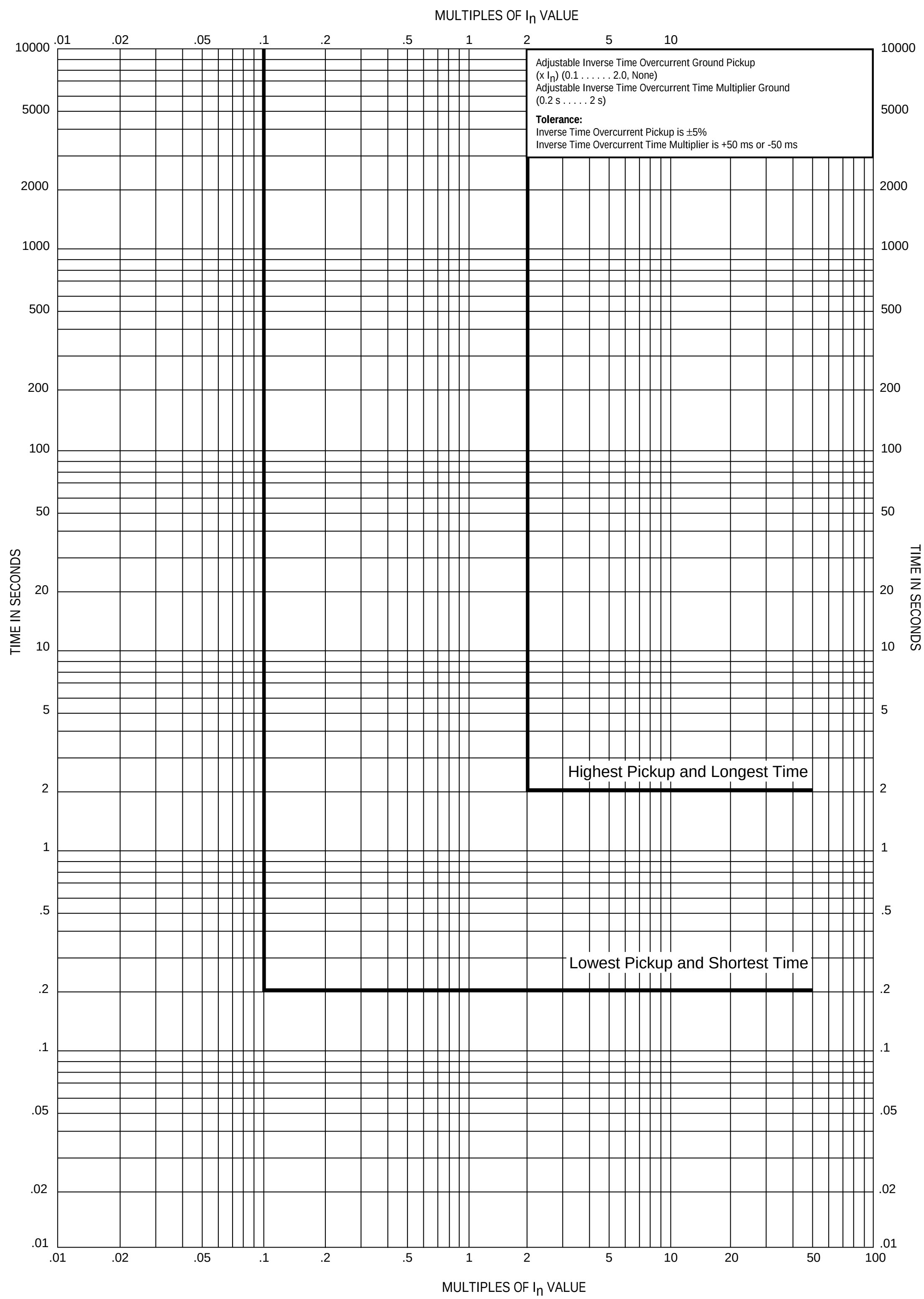


Figure 7-11 Inverse Time Overcurrent Ground, Flat Curves (SC-5402-92B)

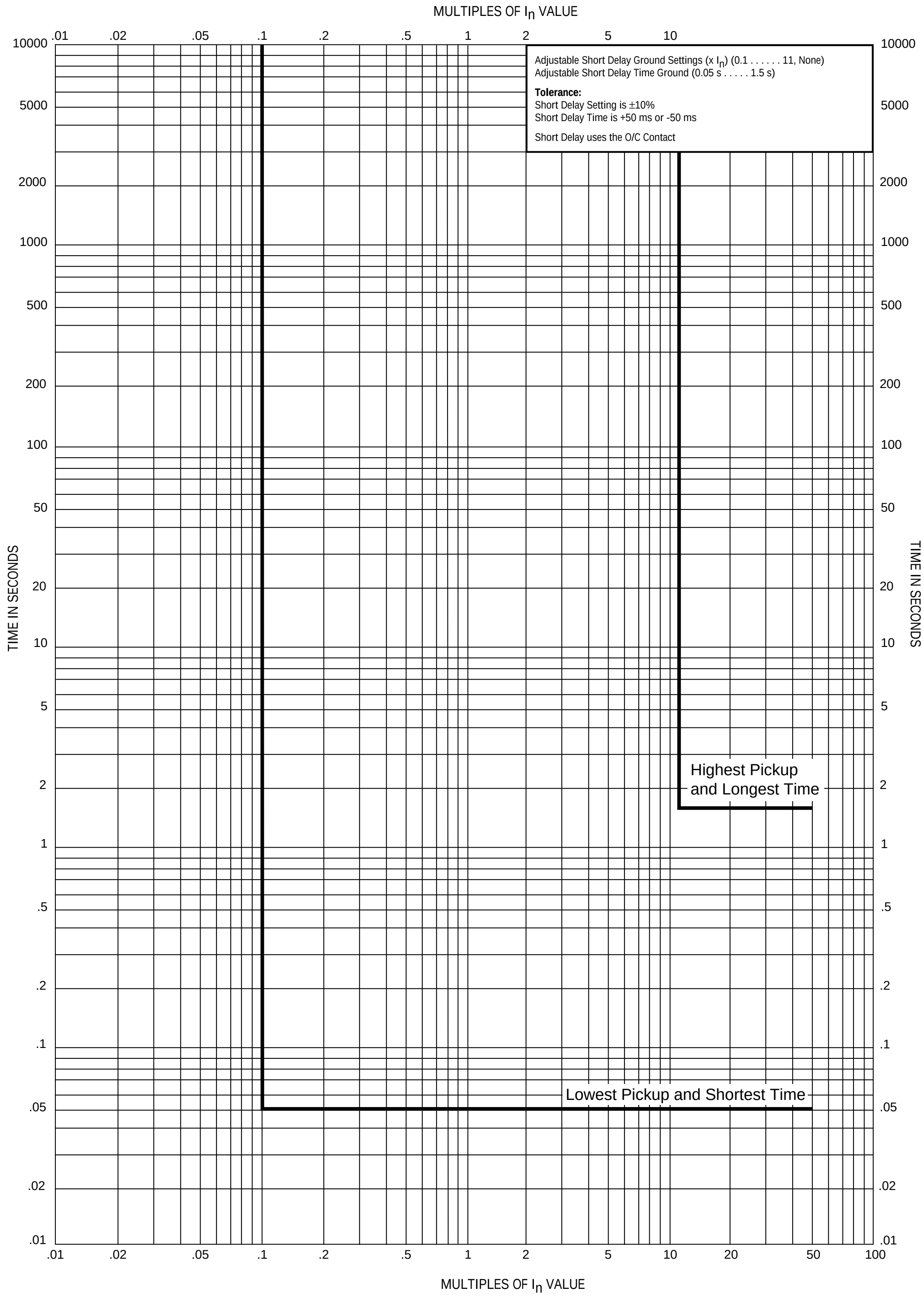


Figure 7-12 Short Delay Ground Curves (SC-5403-92B)

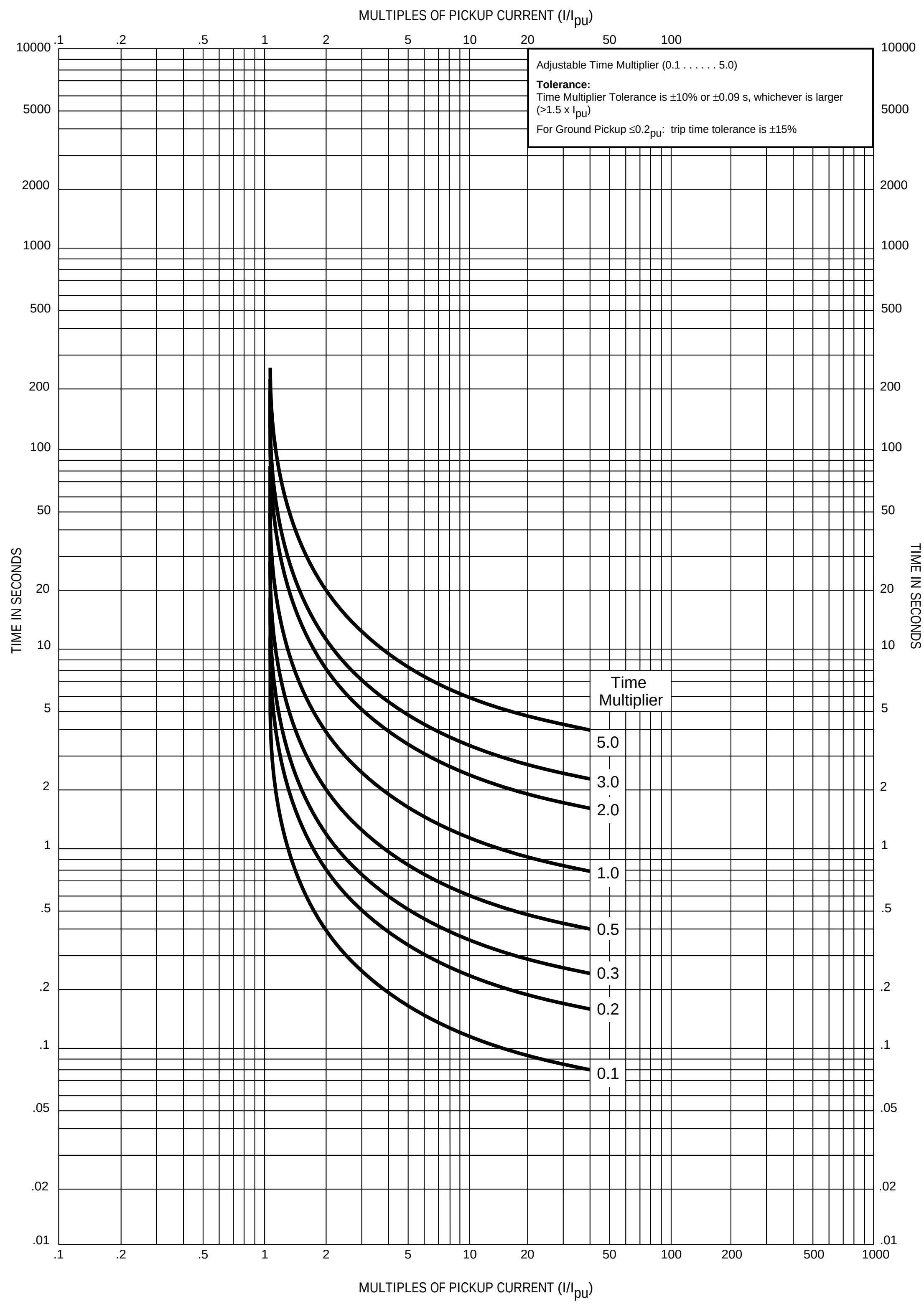


Figure 7-13 ANSI Moderately Inverse Curves (SC-6685-96)

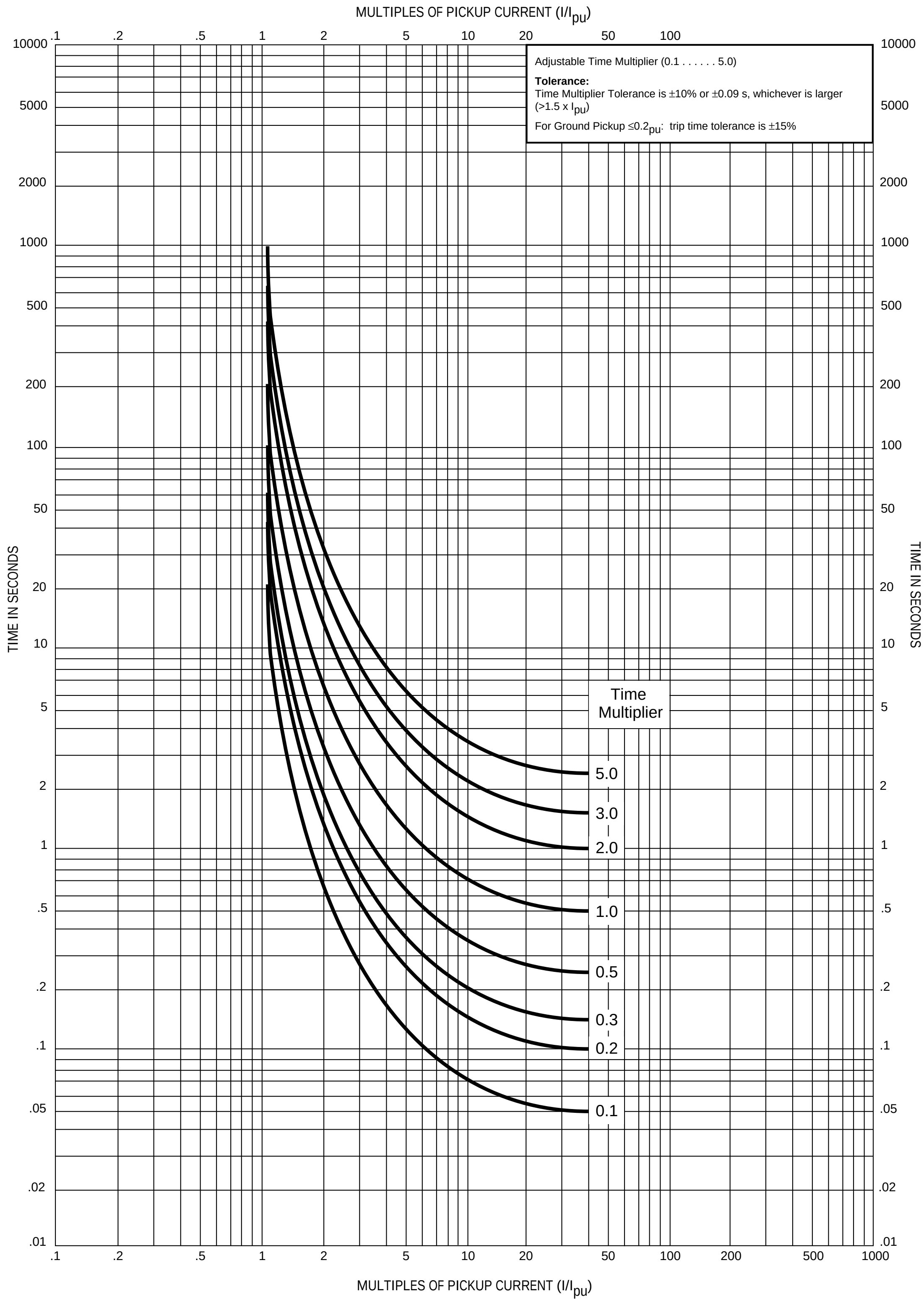


Figure 7-14 ANSI Very Inverse Curves (SC-6686-96)

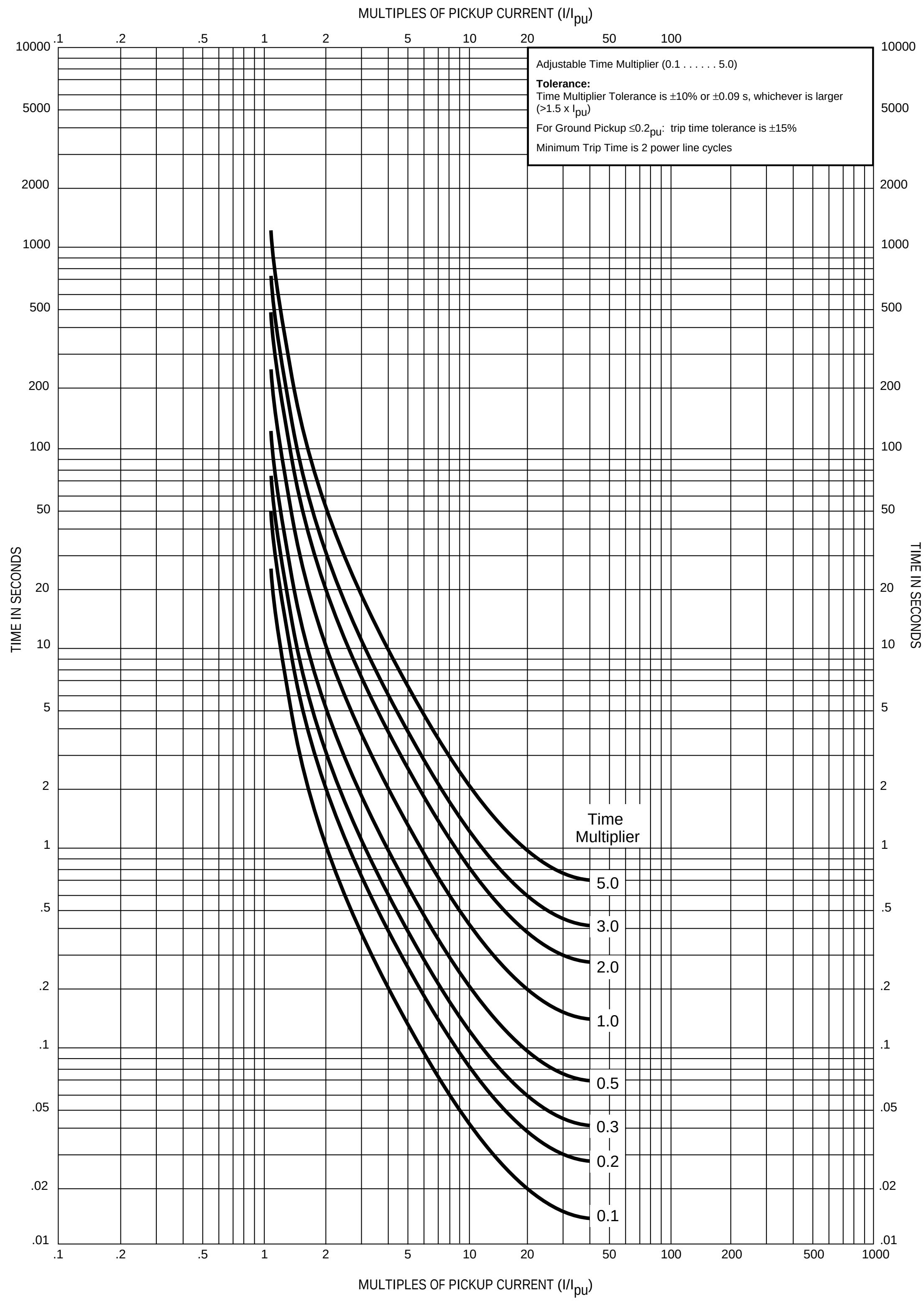


Figure 7-15 ANSI Extremely Inverse Curves (SC-6687-96)

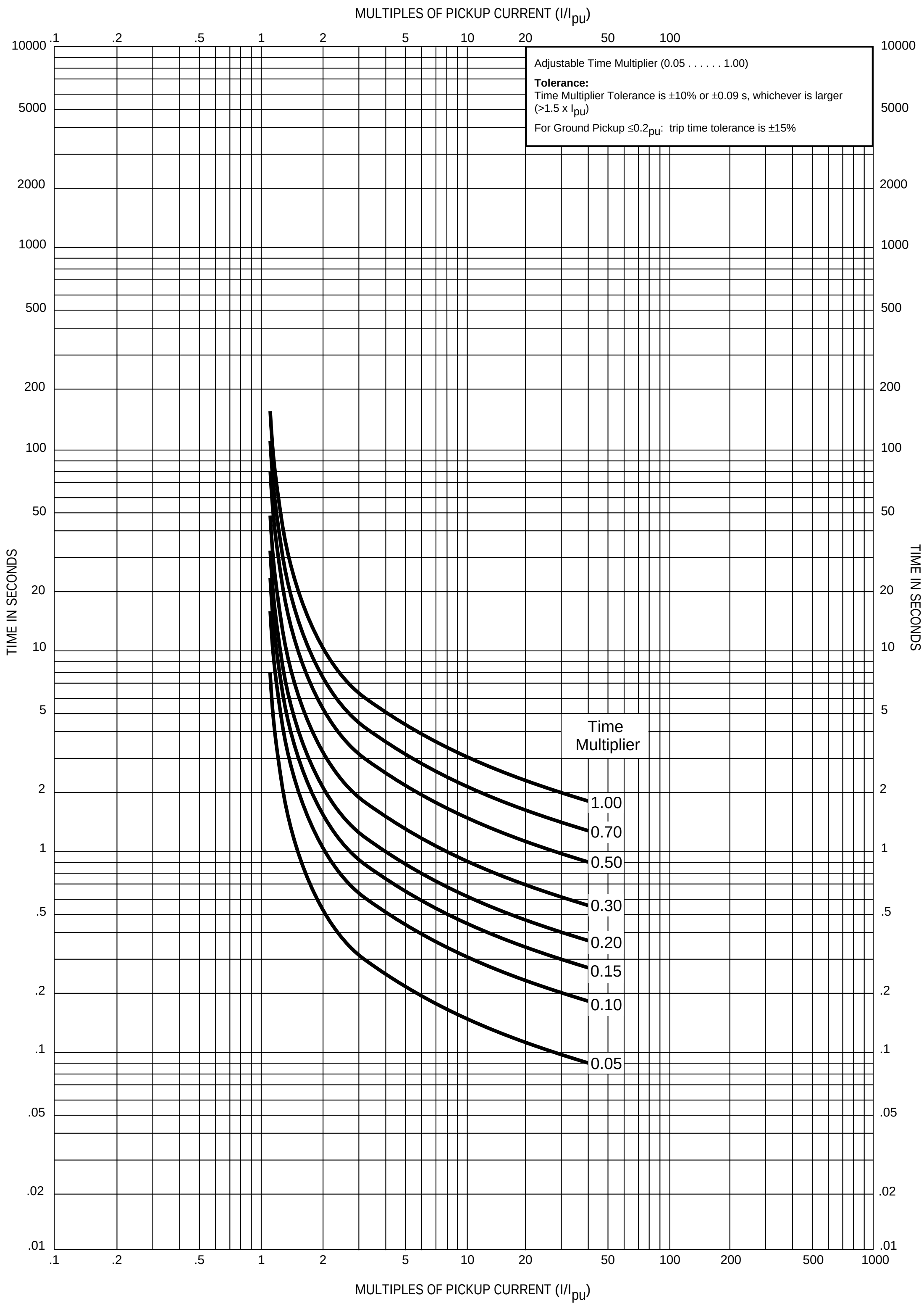


Figure 7-16 IEC-A Moderately Inverse Curves (SC-6688-96)

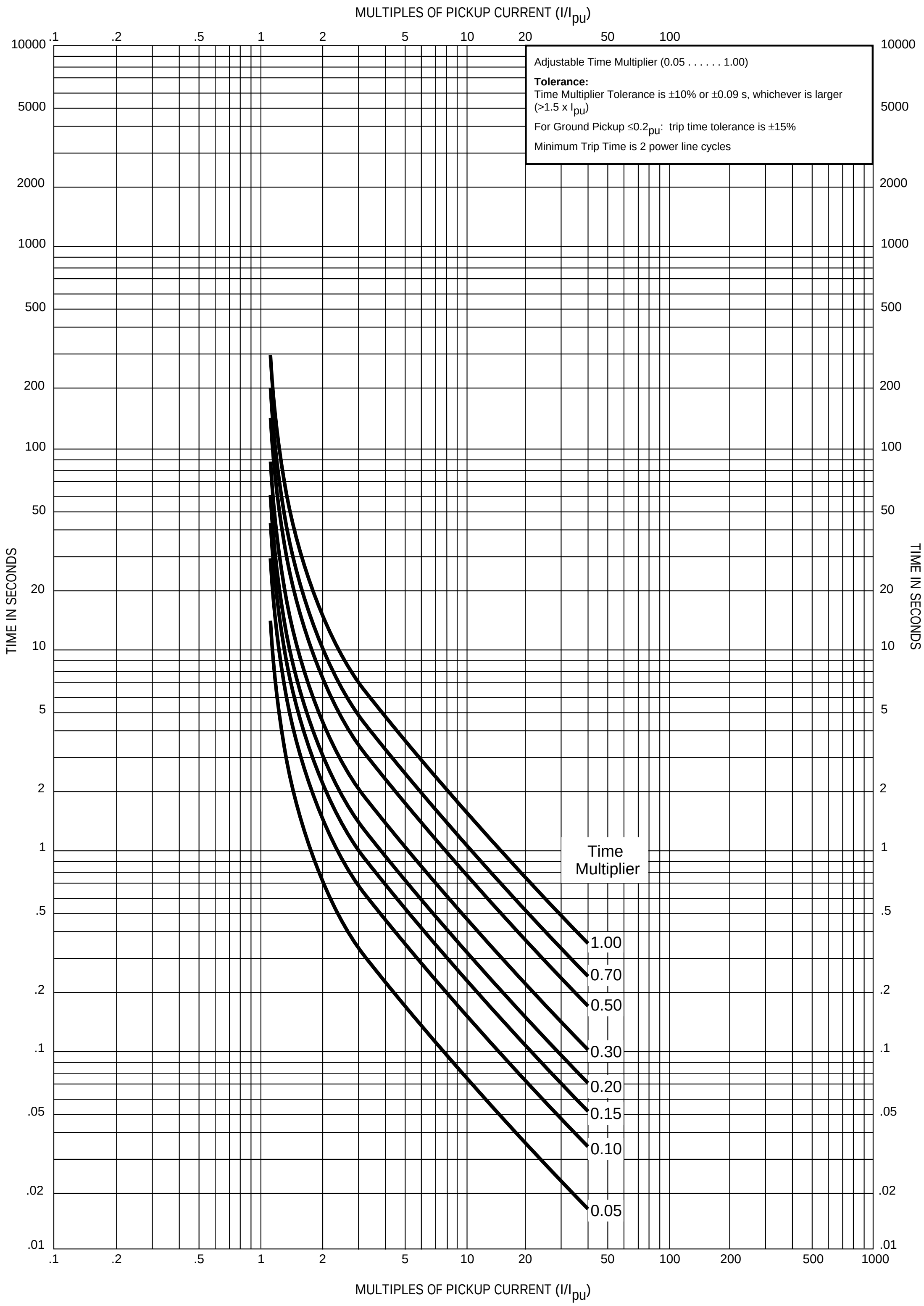


Figure 7-17 IEC-B Very Inverse Curves (SC-6689-96)

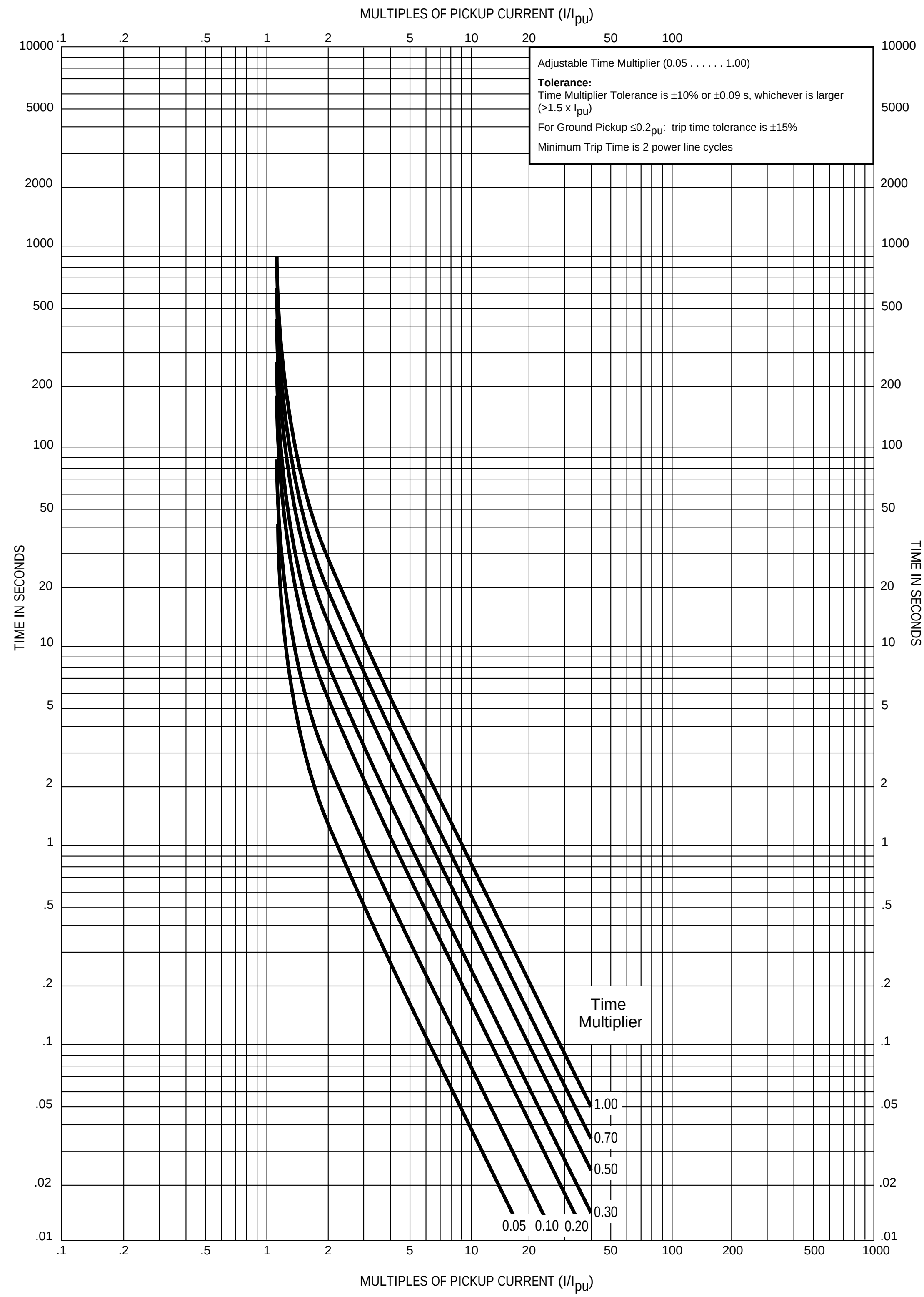


Figure 7-18 IEC-C Extremely Inverse Curves (SC-6690-96)

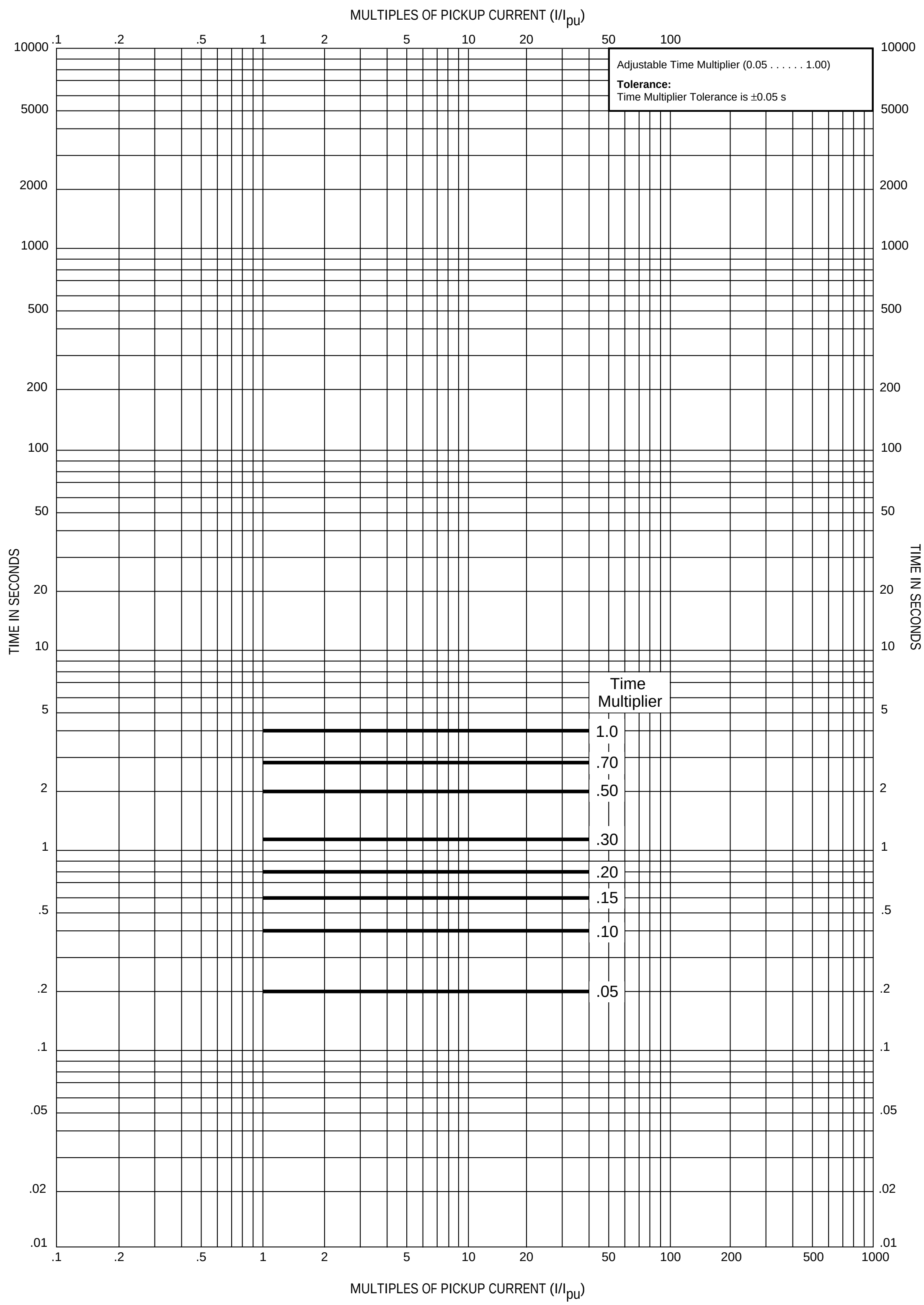


Figure 7-19 IEC-D Flat Curves (SC-6691-96)

7-2 DIGITRIP 3000 CURVE EQUATIONS

Low Voltage Breaker Curve Equation

$$T = \frac{D * K^M}{\left(\frac{I}{I_n}\right)^M}$$

T = Trip Time
D = Time Multiplier (0.2 to 40)
I = Input Current
M = Slope (0 = FLAT, 1 = IT, 2 = I^2T, 4 = I^4T)
K = 3 for phase, 1 for ground

SLOPE	M
IT	1
I^2T	2
I^4T	4
FLAT	0

ANSI/IEC Curve Equation

$$T = D * \left[\frac{A}{\left(\frac{I}{I_{pu}}\right)^P - 1} + B\right]$$

Where:
I = Input Current
I_{pu} = Pickup Current Setting
D = Time Multiplier Setting

		P	A	B	
ANSI MOD	Moderately Inverse	0.02	0.0515	0.114	D = 0.1 to 3 0.1 - 5.0, step of 0.1
ANSI VERY	Very Inverse	2	19.61	0.491	
ANSI XTRM	Extremely Inverse	2	28.2	0.1217	
IEC-A	Normal Inverse	0.02	0.14	0	D = 0.5 to 1.0 step of 0.05
IEC-B	Very Inverse	1	13.5	0	
IEC-C	Extremely Inverse	2	80	0	
IEC-D	Definite Time		0	4	

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