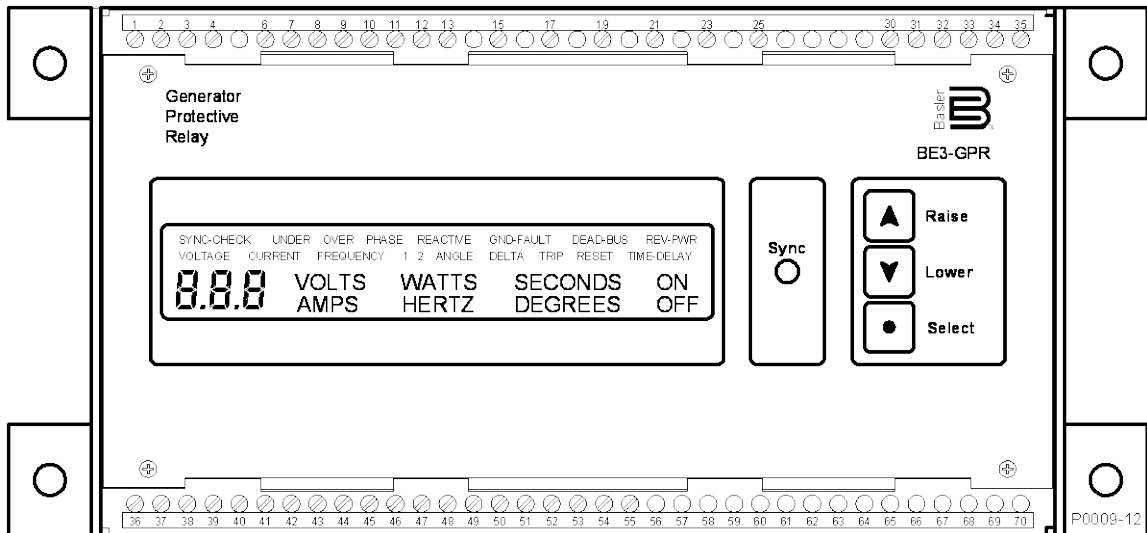


INSTRUCTION MANUAL

FOR

GENERATOR PROTECTIVE RELAY

BE3-GPR



INTRODUCTION

This instruction manual provides information about the operation and installation of the BE3-GPR Generator Protective Relay. To accomplish this, the following information is provided:

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

WARNING!

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

NOTE

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

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It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric.

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The following information provides a historical summary of the changes made to BE3-GPR instruction manual 9278200993. Revisions are listed in chronological order.

Manual Revision and Date	Change
—, 04/01	<ul style="list-style-type: none">• Initial release
A, 10/04	<ul style="list-style-type: none">• Updated and corrected default settings listed in Section 3.• Clarified wording of test procedures in Section 7.• Added test connections diagram to Section 7
B, 01/07	<ul style="list-style-type: none">• Removed stand-alone model choice from style chart and all text.• Added material describing style number consolidation and table listing the replacement style numbers for the style numbers being obsolete.• Added Gost certification.• Consolidated communication software sections into one section.• Corrected and clarified software installation procedures.• Corrected terminal numbering throughout test procedures.• Characteristic curve material relocated to Appendix A.
C, 09/17	<ul style="list-style-type: none">• Added caution box about nonvolatile memory in Section 5.• Removed GOST-R Certification from Section 1.• Minor text edits throughout manual.

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SECTION 1 • GENERAL INFORMATION

INTRODUCTION

Basler Electric's BE3-GPR Generator Protective Relay provides total generator protection in a single package. Its microprocessor-based design provides high accuracy, reliability, and repeatability. The BE3-GPR provides protection for paralleled generating systems or stand-alone, isolated generating systems.

BE3-GPR setup and configuration can be performed using the provided Windows®-based setup software or the front panel interface.

Because of the BE3-GPR's low sensing input burdens, no dedicated PTs or CTs are required. All current sensing inputs are isolated.

A set of Form C (SPDT) output contacts are provided for each protection function and the internal diagnostics function.

The enclosure for the BE3-GPR is dust- and moisture-resistant. Metal case construction enhances the BE3-GPR's resistance to electromagnetic interference.

FEATURES

BE3-GPR features include protection functions, contact inputs, internal diagnostics, front panel indicators, and communication capabilities.

Protection Functions

BE3-GPR protection functions include:

- Overcurrent (51): style selectable as either three-phase or neutral ground fault
- Phase balance (47)
- Loss of excitation (40)
- Sync-check (25)
- Overfrequency (81O)
- Underfrequency (two 81U elements)
- Reverse power (32R)
- Dead bus

Contact Inputs

Four continuously monitored contact inputs accept switch inputs or jumpers and perform the following functions.

Trip Reset. Clears all tripped functions when auto reset is disabled.

Program Enable. Enables setting changes to be made at the front panel.

Failsafe Enable. Changes output contact operation to failsafe mode (output relays are energized during normal, non-tripped conditions).

Output Enable. Disables the output contacts. This feature prevents nuisance tripping during generator buildup.

Internal Diagnostics

Internal diagnostics are provided by a watchdog timer. The watchdog timer monitors for proper firmware execution and microprocessor operation. If an internal operating error occurs, the Watchdog Timer (WDT Fail) output contacts change state to annunciate the problem.

Front Panel Indicators

Front panel indicators consist of a liquid crystal display (LCD) and a Sync LED indicator.

The front panel LCD serves as the main user interface and displays all information necessary for programming and interpreting BE3-GPR actions.

The Sync LED lights to indicate that the generator is synchronized with the bus. The Sync LED also lights when a dead bus condition exists.

Communication

An RS-232 serial port enables communication between the BE3-GPR and a PC operating the BE3-GPR communication software. BE3-GPR communication enables relay configuration and real-time metering of power system parameters.

STYLE CHART

BE3-GPR relays are identified by a combination of letters and numbers that make up the style number and define the electrical and physical characteristics. The style number appears on the back panel of the relay. Figure 1-1 illustrates the BE3-GPR style number chart.

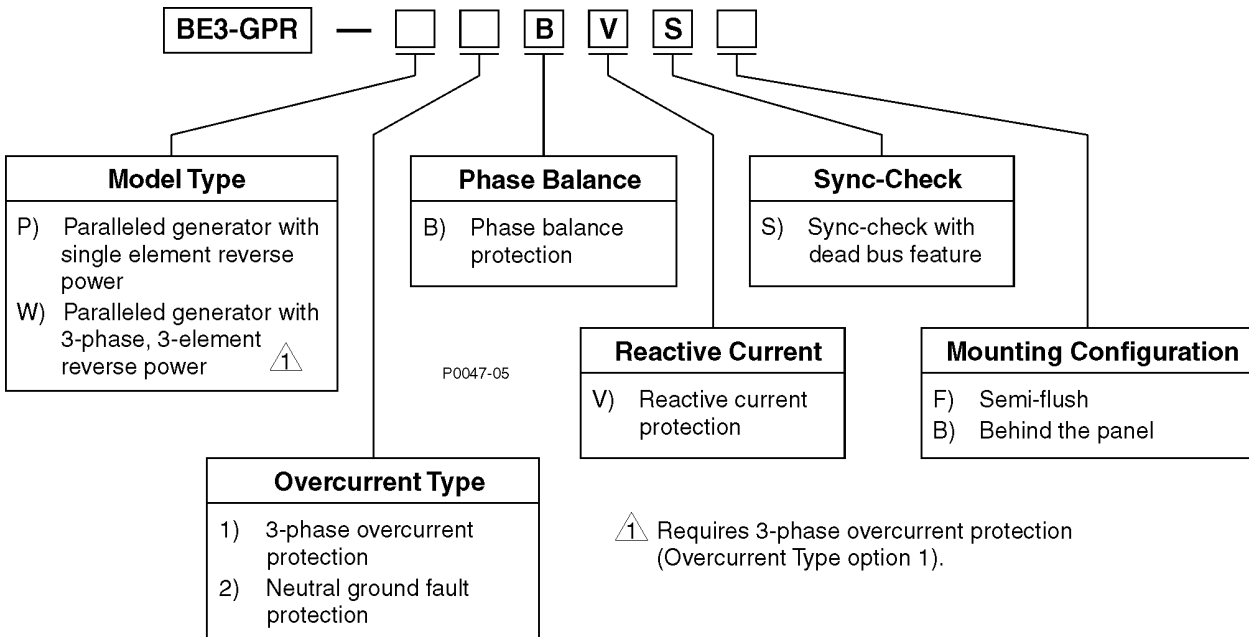


Figure 1-1. BE3-GPR Style Chart

Style Number Example

As an example, a BE3-GPR relay with a style number of W1BVSF has the following features:

- W..... Paralleled generator protection with three-phase, three-element reverse power protection
- 1..... Three-phase overcurrent protection
- B..... Phase balance protection
- V..... Reactive current (loss of excitation) protection
- S..... Sync-check with dead bus feature
- F..... Semi-flush mounting

Style Number Consolidation

As of January 1, 2007, stand-alone models (style Sxxxxx) are no longer available. BE3-GPR relays produced after January 1, 2007 are fully optioned with protection elements for paralleled generators. Functions that were previously optional are now standard. These functions include phase balance protection, reactive current protection, and the sync-check feature. The fully optioned versions provide all of the functionality of previous models, making them completely backward compatible as replacement units. Features that are not required for a given application can be disabled. From both a functional and physical standpoint, one of the available styles produced after January 1, 2007 will replace all styles that are no longer available. Table 1-2 serves as a cross-reference for specifying a BE3-GPR style number to provide the same functionality as a style that is no longer available.

Table 1-2. BE3-GPR Style Number Cross-Reference

Obsolete Style Numbers									Current Style Number
P1B0NF	P1B0SF	P1BVNF	P1N0NF	P1N0SF	P1NVNF	P1NVSF	S1N0NF	S1B0NF	P1BVSF
P1B0NB	P1B0SB	P1BVNB	P1N0NB	P1N0SB	P1NVNB	P1NVSB	S1N0NB	S1B0NB	P1BVSB
P2B0NB	P2B0SB	P2BVNB	P2N0NB	P2N0SB	P2NVNB	P2NVSB	S2N0NB	S2B0NB	P2BVSF
P2B0NF	P2B0SF	P2BVNF	P2N0NF	P2N0SF	P2NVNF	P2NVSF	S2N0NF	S2B0NF	P2BVSF
W1B0SF	W1BVNF	W1B0NF	W1N0NF	W1NVNF	W1NVSF	W1N0SF			W1BVSF
W1B0NB	W1B0SB	W1NVNB	W1NVSB	W1NONB	W1N0SB	W1BVNB			W1BVSB

SPECIFICATIONS

BE3-GPR electrical and physical characteristics are listed in the following paragraphs.

Operating Power Input

Nominal Voltage:	12 Vdc or 24 Vdc
Voltage Range:	8 to 32 Vdc
Power Dissipation:	6.5 W
Terminals:	69 (-), 70 (+)

Voltage Sensing Inputs

Configuration:	1-phase, 3-phase, 3-wire, or 3-phase, 4-wire
Nominal Voltage:	100 to 480 Vac
Continuous Rating:	1.2 times nominal
10 Second Rating:	1.5 times nominal
Frequency Range:	50 to 60 Hz
Burden:	<1 VA per phase
Terminals	
Generator Sensing:	20 (N), 22 (C), 24 (B), 26 (A)
Bus Sensing:	16 (-), 18 (+)

Current Sensing Inputs

Nominal Current:	1 Aac or 5 Aac
Continuous Rating:	2 times nominal
1 Second Rating:	10 times nominal
Burden:	1 VA per phase
Terminals	
1 A Nominal Sensing:	34 (A), 32 (B), 30 (C), 35 (COM)
5 A Nominal Sensing:	33 (A), 31 (B), 29 (C), 35 (COM)

Output Contacts

Resistive Ratings

120/240 Vac:	Make 30 A for 0.2 s, carry 7 A continuously, break 7 A
125/250 Vdc:	Make and carry 30 A for 0.2 s, carry 7 A continuously, break 0.3 A
30 Vdc:	10 A

Inductive Ratings

120/240 Vac, 125 Vdc:	Make and carry 30 A for 0.2 s, carry 7 A continuously, break 0.3 A (L/R = 0.04)
30 Vdc:	5 A

Protection Functions

Undervoltage (27) and Overvoltage (59)

Trip and Reset Level

Setting Range:	70 to 600 Vac
Setting Increment:	1 Vac
Accuracy:	±2%
Repeatability:	±1%

Trip Time

Setting Range:	0 to 20 s
Setting Increment:	1 s
Accuracy:	±1% or ±50 ms, whichever is greater

Overfrequency (81O) and Underfrequency (81U)

One overfrequency function and two independent underfrequency functions.

Trip and Reset Level

Setting Range:	35 to 75 Hz
Setting Increment:	0.1 Hz
Accuracy:	±0.025%
Repeatability:	±0.01%

Trip Time

Setting Range:	0 to 20 s
Setting Increment:	1 s
Accuracy:	±1% or ±50 ms, whichever is greater

Reverse Power (32R)

Measures three-phase reverse power.

Trip and Reset Level

Setting Range:	50 to 999 W
Setting Increment:	1 W
Accuracy	
PF ≥ 0.5, 25°C:	±2% or ±10 W, whichever is greater
PF ≥ 0.5, -25 to 60°C:	±5% or ±10 W, whichever is greater
Repeatability:	±1%

Trip Time

Setting Range:	0 to 20 s
Setting Increment:	1 s
Accuracy:	±1% or ±50 ms, whichever is greater

Sync-Check (25)

Phase Angle

Setting Range:	2 to 20°
Setting Increment:	1°

Voltage Difference

Setting Range:	1 to 100 Vac
Setting Increment:	1 Vac

Slip Frequency

Setting Range:	0.1 to 1 Hz
Setting Increment:	0.1 Hz

Dead Bus

Setting Range:	10 to 50 Vac
Setting Increment:	1 Vac

Accuracy

ΔV:	±2% or ±1 Vac, whichever is greater throughout 5 to 100 Vac operating range
-----	---

ΔPhase Angle:	±0.5°
---------------	-------

Repeatability:	±1.5%
----------------	-------

Phase Balance (47)

Measures the maximum voltage difference between any two line-to-line phases.

Trip and Reset Level

Setting Range:	5 to 100 Vac
Setting Increment:	1 Vac
Accuracy:	$\pm 3\%$ or $\pm @$ Vac, whichever is greater throughout 5 to 100 Vac operating range
Repeatability:	$\pm 1\%$

Trip Time

Setting Range:	0 to 20 s
Setting Increment:	1 s
Accuracy:	$\pm 1\%$ or ± 50 ms, whichever is greater

Loss of Excitation (40)

Measures the reactive current into the generator.

Trip and Reset Level

Setting Range:	0.03 to 0.5 Aac for 1 Aac nominal current sensing 0.15 to 2.5 Aac for 5 Aac nominal current sensing
Setting Increment:	0.01 Aac
Accuracy:	$\pm 3.5\%$ or ± 0.05 Aac, whichever is greater throughout 0.15 to 2.5 Aac operating range
Repeatability:	$\pm 1\%$

Trip Time

Setting Range:	0 to 20 s
Setting Increment:	1 s
Accuracy:	$\pm 1\%$ or ± 50 ms, whichever is greater

Neutral Ground Fault (51N)

Monitors for ground faults by measuring the rms neutral current.

Trip and Reset Level

Setting Range:	0.04 to 0.6 Aac for 1 Aac nominal current sensing 0.2 to 3 Aac for 5 Aac nominal current sensing
Setting Increment:	0.01 Aac
Accuracy:	$\pm 2\%$ or ± 0.01 Aac, whichever is greater throughout 0.2 to 3.0 Aac operating range

Trip Time

Setting Range:	0 to 2 s
Setting Increment:	0.1 s
Accuracy:	$\pm 1\%$ or ± 50 ms, whichever is greater

Time Overcurrent with Voltage Restraint (51V)

Monitors for overcurrent conditions by measuring the rms current. A decrease of the sensed generator voltage causes the voltage restraint function to proportionally decrease the 51V pickup point.

Trip and Reset Level

Setting Range:	0.04 to 0.6 Aac for 1 Aac nominal current sensing 0.1 to 9.99 Aac for 5 Aac nominal current sensing
Setting Increment:	0.01 Aac
Accuracy:	$\pm 2.5\%$ or ± 0.05 Aac, whichever is greater throughout 0.1 to 5.0 Aac operating range

Trip Time

Setting Range:	0 to 2 s
Setting Increment:	0.01 s
Accuracy:	$\pm 5\%$ or 50 ms, whichever is greater for time dial settings of D greater than 0.1 and multiples of 2 to 40* times the pickup setting but not over 30 Aac (5 Aac nominal sensing) or 6 Aac (1 Aac nominal sensing).

* 3 to 40 times pickup for the A curve

Characteristic Curves:

Sixteen inverse time functions and one fixed time function can be selected. See Appendix A, *Characteristic Curves* for the curve definitions.

Voltage Restraint:

Compares the sensed voltage with the nominal voltage level. A decrease of the sensed voltage (between 100% and 25% of nominal) results in a proportional decrease of the time overcurrent pickup point. When the sensed voltage decreases below 25% of nominal, the time overcurrent pickup point will be 25% of the actual time overcurrent setting (see Figure 1-2).

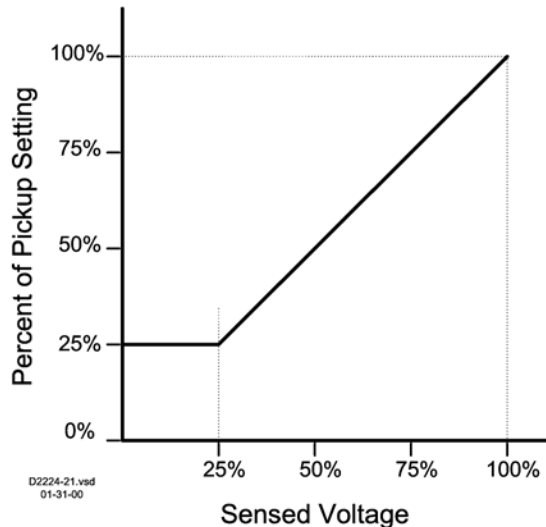


Figure 1-2. Voltage Restraint Characteristic

Type Tests

Surge Withstand Capability—Oscillatory and Fast Transient

Qualified to IEEE C37.90.1-1989

Impulse

Qualified to IEC 255-5

Radio Frequency Interference (RFI)

Field tested using a 5 W, hand-held transceiver, operating at random frequencies centered around 144 MHz and 440 MHz, with the antenna located 6 inches (15 centimeters) from the relay in both horizontal and vertical planes.

Dielectric Strength

Withstands 2,000 Vac for 1min. between ground and the voltage sensing inputs.

Withstands 500 Vac for 1 min. between ground and the groups listed in Table 1-1 or between one group to another. Nominal leakage currents are shown in Table 1-1.

Table 1-1. Nominal Dielectric Testing Leakage Currents

Group	Nominal Leakage Current
Voltage sensing inputs	63 mAac or 30 mAdc
Battery and contact sensing inputs	20 mAac or 7 mAdc
Current transformer inputs	5 mAac or 1 mAdc
RS-232 terminals	5 mAac or 1 mAdc
Contact outputs	31 mAac or 1 mAdc

Vibration

Withstands 2 G at 10 to 500 Hz in three mutually perpendicular planes.

Shock

Withstands 15 G in each of three mutually perpendicular axes.

Agency Recognition

UL: Recognized per standard 508, UL file E90735
CSA: Certified per standard CAN/CSA-C22.2 No. 14, report LR23101-136S

Physical

Temperature
 Operating: -25 to 60°C (-13 to 140°F)
 Storage: -40 to 85°C (-40 to 185°F)
Weight: 4 lb (1.8 kg)

Patent

Patented in US, 1997, No. 5309312

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SECTION 2 • CONTROLS AND INDICATORS

GENERAL

BE3-GPR controls and indicators are illustrated in Figure 2-1 and described in Table 2-1. The locators and descriptions of Table 2-1 correspond to the locators shown in Figure 2-1.

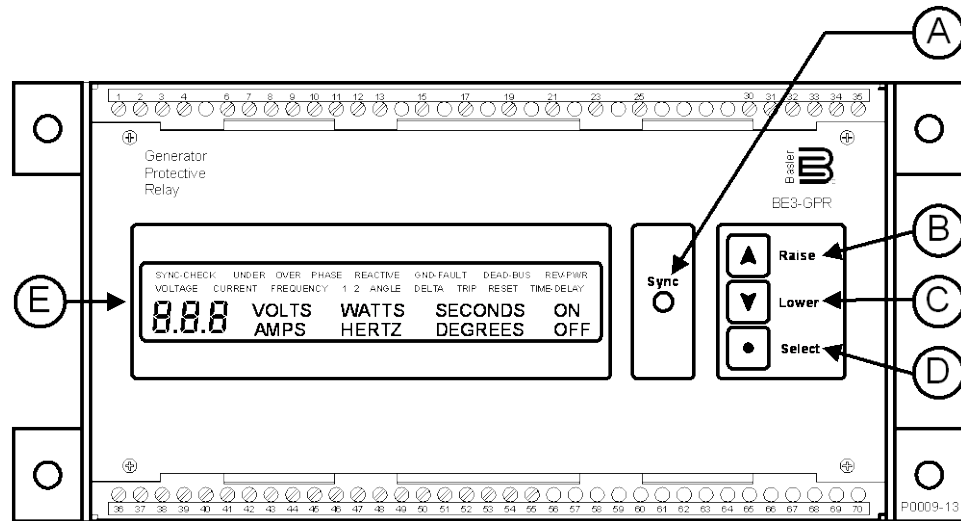


Figure 2-1. Controls and Indicators

Table 2-1. Control and Indicator Descriptions

Locator	Description
A	<i>Sync Indicator.</i> This red LED lights when a generator/bus synchronism condition or dead bus condition exists and the Sync-Check output contacts change state.
B	<i>Raise Pushbutton.</i> This pushbutton toggles the LCD (locator E) menu selections and scrolls through setpoint adjustments. Pressing and holding the button for one second or more enables fast scrolling through the setpoints. Pressing the Raise pushbutton after holding the Select pushbutton (locator D) down makes the menu selection sequence move in the forward direction.
C	<i>Lower Pushbutton.</i> This pushbutton scrolls and fast scrolls (by holding for one second) for setpoint adjustments. Pressing the Lower pushbutton after holding the Select pushbutton (locator D) down reverses the menu selection sequence from the forward direction.
D	<i>Select Pushbutton.</i> Pressing this button simultaneously saves settings in nonvolatile memory and moves on to the next selection sequence. Holding the Select pushbutton down before pressing the Raise or Lower pushbuttons forces the direction of the user option sequence forward or reverse respectively.
E	<i>Display.</i> The liquid crystal display (LCD) serves as the primary, visual user interface. The LCD displays settings and parameters that are organized in a menu format.

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SECTION 3 • FUNCTIONAL DESCRIPTION

INTRODUCTION

BE3-GPR Generator Protective Relays are microprocessor-based devices that provide multifunction protection for genset systems. This section describes a functional description of BE3-GPR hardware and firmware.

FUNCTIONAL DESCRIPTIONS

BE3-GPR circuit functionality is illustrated in Figure 3-1 and described in the following paragraphs.

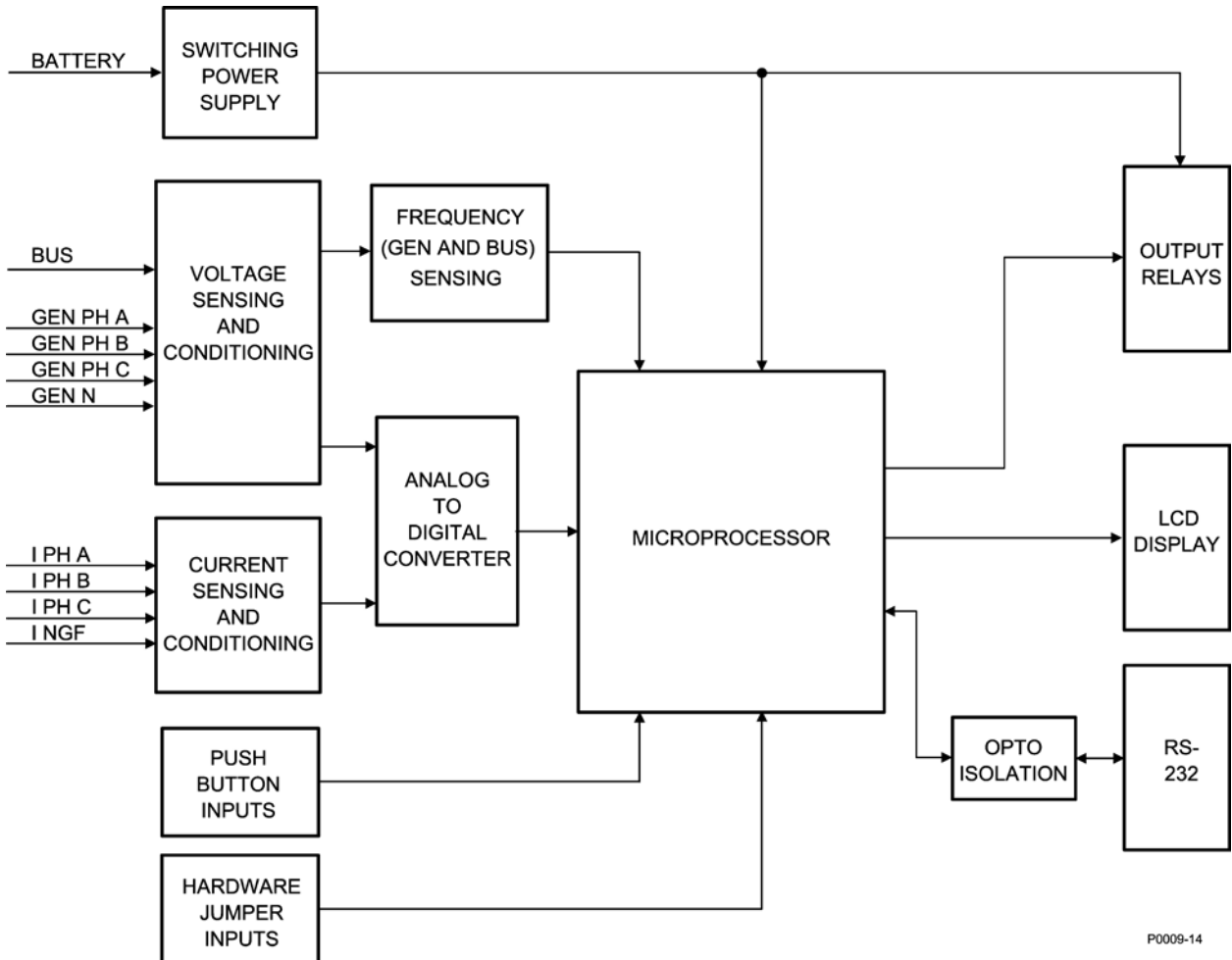


Figure 3-1. Function Block Diagram

Switching Power Supply

The internal switching power supply uses the +12 Vdc or +24 Vdc battery voltage input to generate the ± 6 Vdc, +5 Vdc, a stable +5 Vdc reference for the analog-to-digital converter (ADC), and a pulse-width modulated signal to drive the output relays. In addition, it provides a separate and isolated 5 Vdc module to give power to the optically isolated RS-232 channel.

Voltage Sensing and Conditioning

Generator and bus voltages are sensed and scaled down to suitable, internal circuit levels. Internal solid-state analog switches select whether the generator voltage differential levels represent line-to-line or line-to-neutral values. The user determines these selections through menu options. For normal operation, the BE3-GPR requires a minimum sensing voltage of 10 volts to be applied.

NOTE

Any loss of voltage sensing (≤ 10 volts) causes the:

- Undervoltage output to trip (if enabled)
- Phase balance output to trip if enabled and the undervoltage is disabled, and if configured for three-phase, four-wire operation

Frequency Sensing

Filtered zero-crossing detectors connected to outputs from the voltage conditioning circuits generate timing waveforms. The microprocessor uses these timing waveforms to calculate generator line frequency, the bus frequency, and generator-bus phase difference.

Current Sensing and Conditioning

Generator currents are sensed and scaled down to suitable, internal circuit levels. Internal current transformers (CTs) provide isolation from the monitored generator current. Two taps on the primary side of each CT accommodate connections to either one ampere or five ampere nominal circuits.

Control (Pushbutton) Inputs

Three pushbuttons, in conjunction with the front panel display, enable the user to program settings and view system metering values.

Hardware (Jumper) Inputs

Four continuously monitored contact inputs accept switch inputs or jumpers and perform the following functions.

Program Enable

Contact closure at this input enables relay settings changes to be made using the front panel pushbuttons and display. When this contact input is open, the front panel pushbuttons are disabled and settings changes can be made only through the rs-232 communication interface.

Output Disable

Contact closure at this input disable the output contacts. This feature prevents nuisance tripping during generator buildup.

Failsafe Enable

Contact closure at this input changes the output contact operation to failsafe mode. In failsafe mode, the output relay coils are energized in the normal state (untripped) and de-energized when operated (tripped). The power system then detects loss of power as simultaneous trips on all of the outputs.

Trip Reset

When auto reset is disabled, momentary contact closure at this input clears all tripped functions. When a contact input is received by the Trip Reset input, the following occurs:

- All output contacts are reset to the untripped condition (this depends on the failsafe enable feature)
- All internal time delay counter and trip pending flags are cleared
- The reason for the last trip is cleared
- The front panel display returns to the On condition

NOTE

A reset condition persists until the Trip Reset contact input is removed, regardless of any existing trip conditions sensed by the relay.

Analog-to-Digital Converter (ADC)

Scaled down outputs from the voltage and current sensing circuits are sampled and digitized by the 12-bit ADC under microprocessor control. Sampling occurs 26 times per cycle with 60 hertz nominal operating power. Each sample is stored in microprocessor random-access memory (RAM) and processed on a cycle by cycle basis.

Microprocessor

Embedded firmware in the microprocessor controls overall relay function and makes all decisions based on programming and system inputs. The rms values of voltage, current, and power are calculated by the microprocessor from the ADC samples. The formulas used to calculate power system values are provided in the following paragraphs.

The rms values of voltage, current, and power are determined directly from the ADC samples:

$$I_B = \sqrt{\frac{\sum_{n=1}^{\text{num}} I_{Bn}^2}{\text{num}}} \qquad I_{NGF} = \sqrt{\frac{\sum_{n=1}^{\text{num}} I_{NGFn}^2}{\text{num}}}$$

For single-phase sensing:

$$V_{LL} = \sqrt{\frac{\sum_{n=1}^{\text{num}} V_n^2}{\text{num}}} \qquad P = \frac{\sqrt{3} \cdot \sum_{n=1}^{\text{num}} V_n \cdot I_n}{\text{num}} \qquad VA = \sqrt{3} \cdot V_{AB} \cdot I_B$$

For 3-phase, 3-wire sensing:

$$V_{LL} = \sqrt{\frac{\sum_{n=1}^{\text{num}} V_n^2}{\text{num}}} \qquad P = \frac{\sum_{n=1}^{\text{num}} (V_{ABn} I_{An} - V_{BCn} I_{Cn})}{\text{num}} \qquad VA = \frac{(V_{AB} I_A + V_{BC} I_B + V_{CA} I_C)}{\sqrt{3}}$$

For 3-phase 4,-wire sensing:

$$V_{LN} = \sqrt{\frac{\sum_{n=1}^{\text{num}} V_n^2}{\text{num}}} \qquad P = \frac{\sum_{n=1}^{\text{num}} (V_{An} I_{An} + V_{Bn} I_{Bn} + V_{Cn} I_{Cn})}{\text{num}} \qquad VA = V_A I_A + V_B I_B + V_C I_C$$

For phase balance:

$$V_{AB} = \sqrt{V_A^2 + V_A V_B + V_B^2} \qquad V_{BC} = \sqrt{V_B^2 + V_B V_C + V_C^2} \qquad V_{CA} = \sqrt{V_C^2 + V_C V_A + V_A^2}$$

Power Factor: $PF = \frac{P}{VA}$

Power Angle: $\phi = \cos^{-1}(PF)$

Reactive Current: $I_R = I_B \cdot \sin \phi$

Output Relays

Eleven Form C (SPDT) sets of output contacts are provided for external connection. All outputs are electrically isolated from each other. That is, they do not share common connections. One set of contacts is provided for each of the nine protection functions, one set of contacts is provided for the sync-check function, and one set of contacts is provided for the watchdog timer (failsafe) annunciation. If auto reset is disabled, the output contacts are sealed in. If auto reset is enabled, the output contacts remain closed only as long as the relay detects a fault.

RS-232 Interface

The serial link of the microprocessor connects to an optically isolated, level shifting RS-232 circuit. This permits direct connection of a PC to the relay for relay programming purposes. The relay's communication protocol is compatible with readily available modem software that emulates a dumb terminal.

Liquid Crystal Display (LCD)

The front panel LCD consists of both descriptive word segments and a three-digit numerical display area. All LCD operation is controlled by the microprocessor. The user interface and protective functions are the major uses for the display (shown in Figure 3-2).

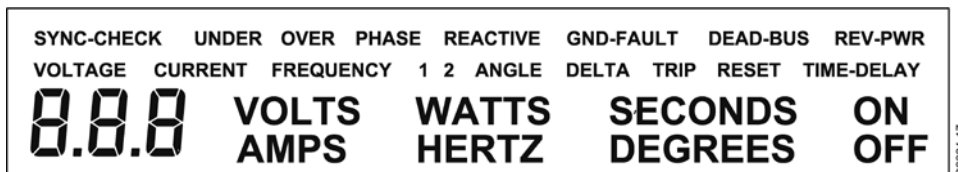


Figure 3-2. LCD

Timing Functions

Each protection function has an adjustable time delay. The time delay for each protection function allows for any abnormal occurrences to correct themselves. For example, a time delay of zero to 20 seconds may be programmed for the overvoltage protection function. If an overvoltage condition arises but returns to normal within the time delay window, the system ignores the previous overvoltage and instantly resets. The time delay of each relay function has a range of 0 to 20 seconds except for the sync-check function which has a 0 to 2.0 second range, the neutral ground fault function which has a 0.2 to 2.0 second range and the overcurrent function which is determined by the selected timing curve.

FIRMWARE

Firmware embedded in the microprocessor controls all aspects of BE3-GPR functionality. This comprises power-up initialization, front panel setup and configuration, contact input detection, protection function trip detection and annunciation, sync-check monitoring and annunciation, and RS-232 communication.

Power-Up Initialization

When battery power is first applied, the relay initiates a power-up sequence. This loads all unit configuration data stored in nonvolatile memory (EEPROM) into the main memory of the relay. Then all LCD segments and the Sync LED are turned on for one second to allow the user to visually confirm display operation. Following this sequence, the LCD displays ON (shown as the first display in Figure 3-3, sheet 1 and referred to as the ON screen). If the last power down occurred during a tripped condition, the LCD will display this last trip for 10 seconds. Following this sequence, the LCD displays ON and the firmware immediately activates the enabled functions and monitors the generator and bus sensing inputs.

Relay Setup and Configuration

Function setup and system configuration is organized in a menu format on the front panel display. In order to scroll through the current settings, the Select pushbutton is pressed. Changes can be made at the front panel only when the program enable contact input detects a closed contact or jumper. (A program enable jumper or contact input is not required when using a PC to configure the relay settings.)

The menus shown in Figures 3-3 through 3-8 show only forward progression through the sequence. However, the default forward progression can be deviated from at any of the function On/Off menus. By simultaneously holding down the Select pushbutton and then pressing the Raise or Lower pushbutton,

forward or reverse progression can be achieved. If a particular function that is show is not available because of relay selection, the display will automatically move on to the next available function in the progression.

NOTE

Figures 3-3 through 3-8 are applicable for relays with three-phase overcurrent protection (style x1xxxx) or neutral ground fault protection (style x2xxxx). Figure 3-6 illustrates a menu specific to relays with neutral ground fault protection. The menu for relays with three-phase overcurrent protection is similar.

The first four relay configuration options are described in the following paragraphs and illustrated in Figure 3-3.

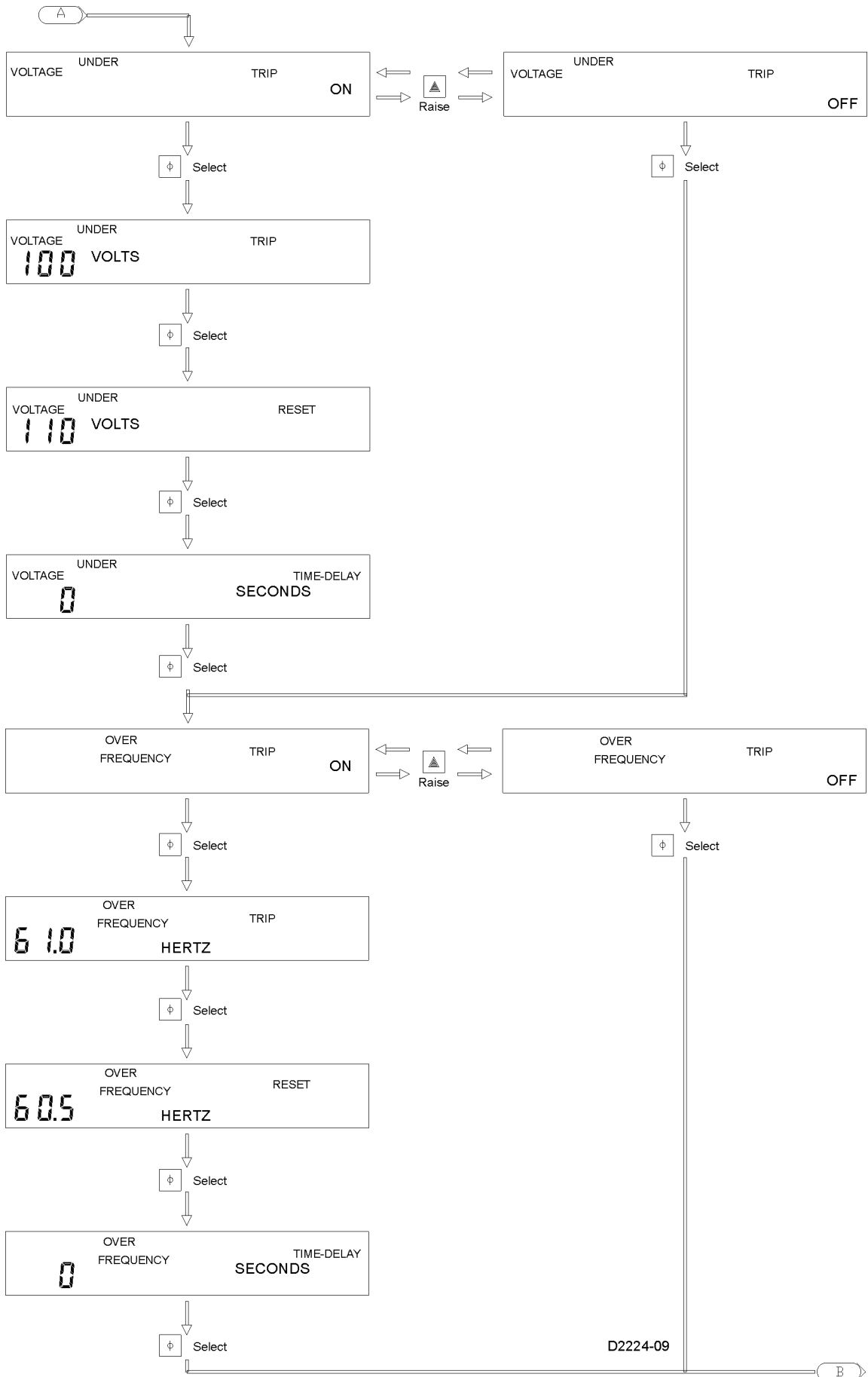


Figure 3-4. Selection Menu, Sheet 2 of 6

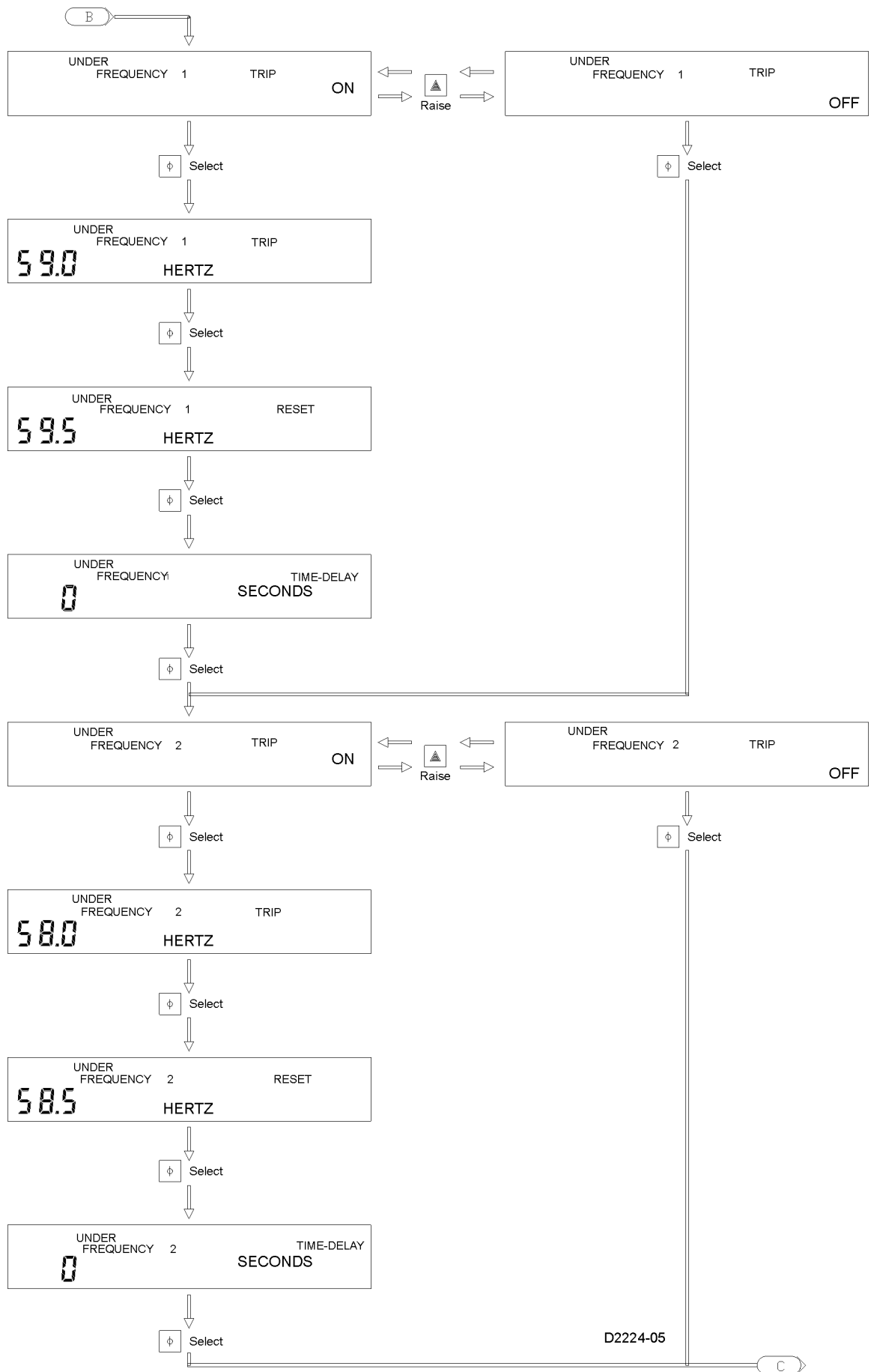


Figure 3-5. Selection Menu, Sheet 3 of 6

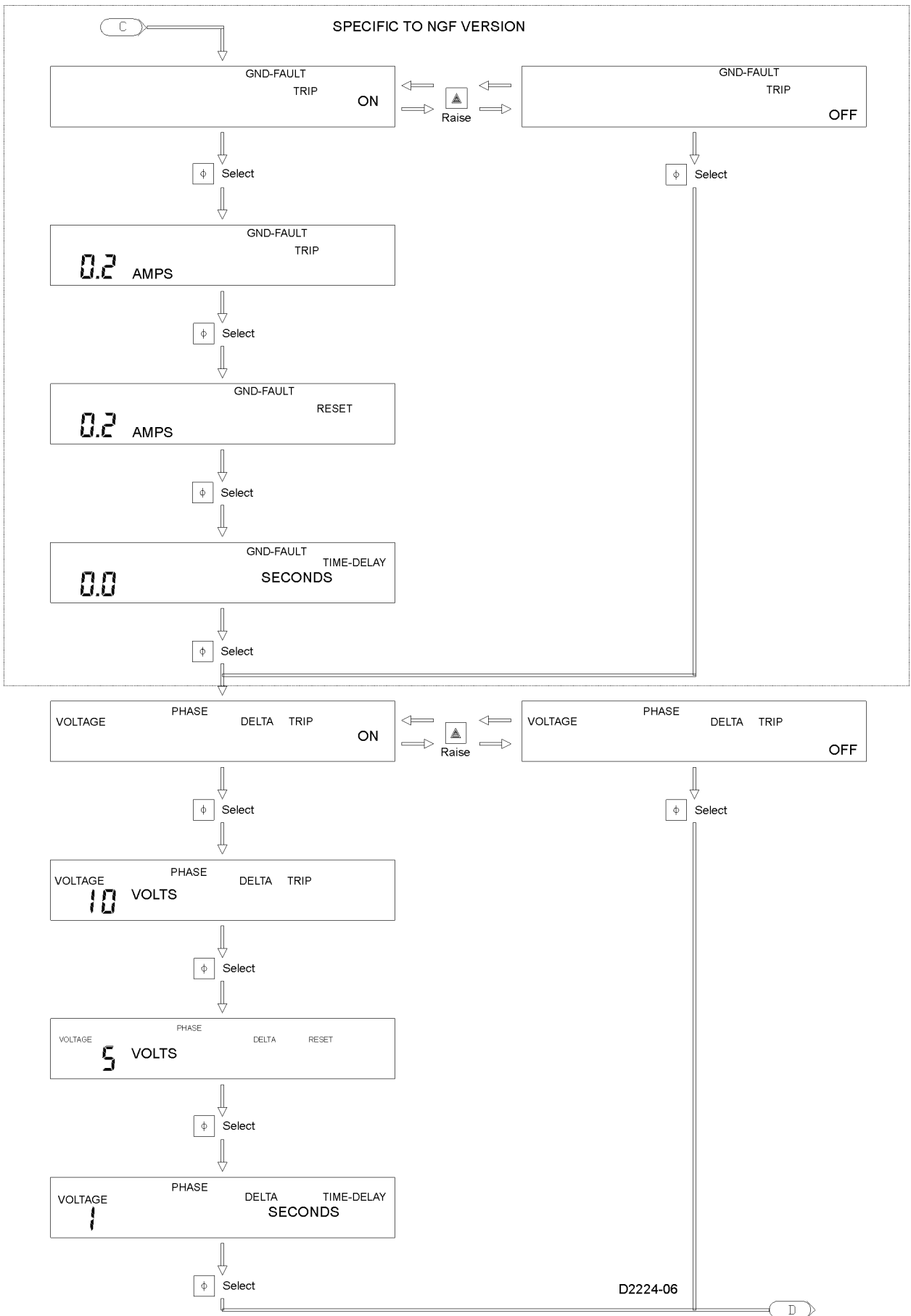


Figure 3-6. Selection Menu, Sheet 4 of 6

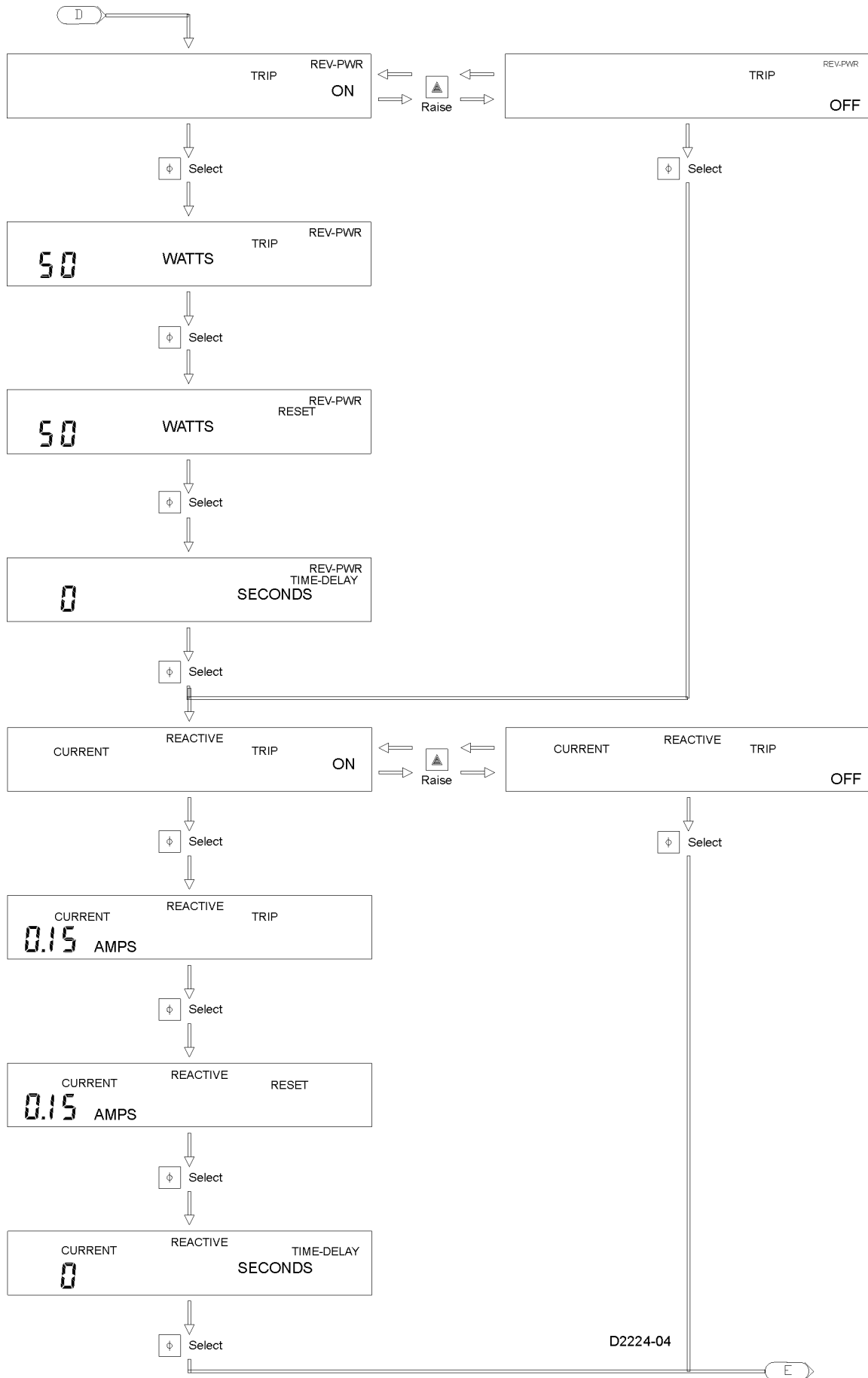


Figure 3-7. Selection Menu, Sheet 5 of 6

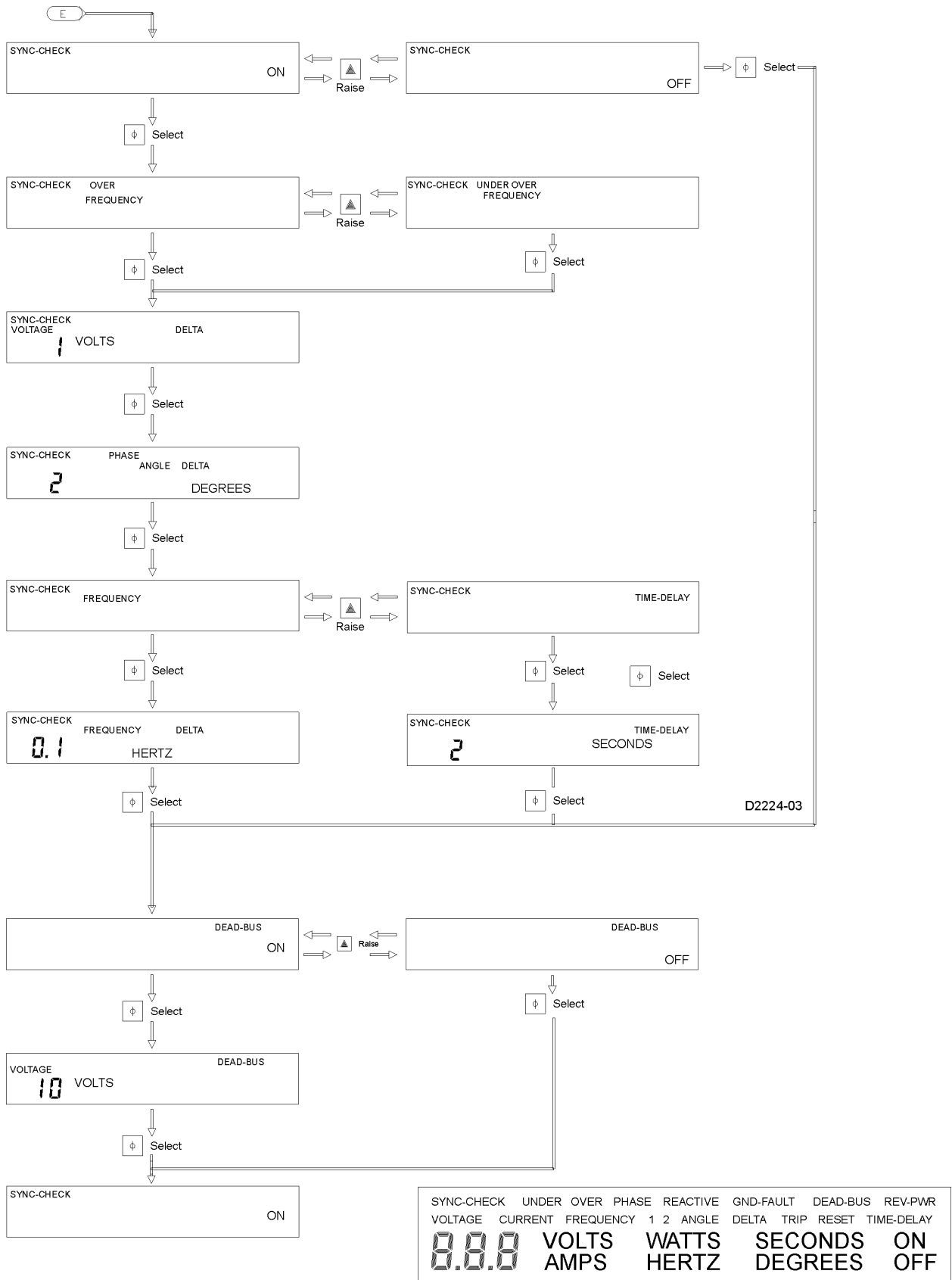


Figure 3-8. Selection Menu, Sheet 6 of 6

Trip Reset

The trip reset option determines whether or not the relay will automatically reset any trip condition whenever a fault condition has cleared. This option is toggled on and off by pressing the Raise pushbutton. Pressing the Select button saves the configuration in nonvolatile memory and advances the display to the next selection.

CT Current Level

A nominal CT current level of 5 amperes or 1 ampere can be selected. This setting establishes the correct weighting to the internal currents when calculating neutral ground fault current, reactive current, and reverse power levels. Pressing the Raise button toggles the option. Pressing the Select button saves the setting in nonvolatile memory and advances to the next menu.

Voltage Phase

The voltage phase option selects how the relay interprets the sensed generator voltages. One of three selections is possible:

- | | |
|-------------------|---|
| PHASE VOLTAGE = 1 | Single-phase, line-to-line voltage in which the connection must be made between the generator A-phase and B-phase terminals. |
| PHASE VOLTAGE = 3 | Three-phase, three-wire, line-to-line voltage in which connections must be made between the generator A-, B-, and C-phase terminals. |
| PHASE VOLTAGE = 4 | three-phase, four-wire, line-to-neutral voltage in which connections must be made between the generator A-phase, B-phase, C-phase, and Neutral terminals. |

Repeatedly pressing the Raise pushbutton toggles the menu options from 1 to 3, 3 to 4, and 4 to 1. When the LCD displays the preferred option, the Select button is pressed to save the settings in nonvolatile memory and advance to the next option.

Overvoltage Trip and Reset

This option adjusts the settings for the overvoltage protection function. This function is toggled on and off by pressing the Raise pushbutton. Once the preferred selection is made, the Select pushbutton is pressed to save the selection and advance to the next option. If the protective function is enabled, the user can adjust the trip level in 1 volt increments with the Raise and Lower buttons. A fast scroll feature is accessed by holding the Raise or Lower pushbutton for one second and increments/decrements the setting in 10 volt steps. Once again, pressing the Select button saves the setting and moves to the next selection screen. Here, the time delay may be adjusted in one second increments or 10 second increments (fast scroll). The Select pushbutton saves the configuration and moves on to the next protection function.

The menu format for each protection function is relatively similar. The first screen enables the function by toggling between On and Off with the Raise pushbutton. Nonvolatile memory is updated and the next screen is accessed by pressing the Select pushbutton. If the function is enabled, the LCD displays the trip level for the function which is adjusted by the Raise and Lower buttons. The fast scroll feature speeds setup and is invoked by holding the Raise or Lower pushbutton for one second for each step of 10 times the normal adjustment increment. Pressing the Select pushbutton stores the setting and progresses the menu to the reset level, where the settings can be adjusted as previously described. Once the display shows the preferred reset level, pressing Select moves on to the time delay for the protection function. The time delay can range from zero seconds (instantaneous) to a maximum specific to the function being set. The time delay setting is manipulated in the same manner as the other options. The nonvolatile memory then stores these selections and the relay immediately begins monitoring the operation of the protection function.

NOTE

The relay does provide protection while you are setting user options. If a protective trip occurs during menu activities, the relay will exit the menu display to announce the trip. Any user changes not yet saved in nonvolatile memory will be lost. Similarly, if no buttons are pressed for two minutes, the relay exits the setup display menus and discards any settings not saved.

Sync-Check

The sync-check function follows the selection of the protective functions. The sync-check function is enabled and disabled in the usual manner on the first screen. If the sync-check function is disabled, the LCD displays the On screen (normal operation). If the sync-check function is enabled, the next menu screen selects synchronization on either a generator-fast or generator-slow condition. Repeatedly pressing the Raise button toggles between the OVER FREQUENCY (generator-fast) and UNDER OVER FREQUENCY (generator slow or fast) settings. When the desired selection is made, the next screen is accessed by pressing the Select pushbutton. The next two screens define the voltage and phase window that the generator and bus inputs must remain within in order to announce a synchronism condition. The following screen defines whether sync window time or slip frequency qualifies the sync-check. Once the setting is selected and adjusted, the menu gives the option of enabling or disabling the dead bus function. If enabled, the screen displays the dead bus voltage level. If the sensed bus voltage is less than this setting, the relay will announce a synchronism condition using the dedicated SPDT output contacts and the front panel Sync LED (regardless of the sync-check window parameters). The dead bus voltage can be adjusted in the same manner as the previous settings. Pressing the Select pushbutton saves all sync-check functions in nonvolatile memory, exits the user setup menu, and begins sync-check monitoring.

RS-232 COMMUNICATION

BE3-GPR settings can be configured with a PC connected to the isolated RS-232 communication terminals. RS-232 communication enables relay setup without the need to directly access the front panel pushbuttons. Remote programming does not interfere with normal relay operation.

Communication Software

The Windows® based setup software supplied with the BE3-GPR provides the preferred method of relay setup and interrogation.

This software provides a user-friendly environment to configure relay settings. The software setting screens greatly simplify the task of configuring the relay. Without the software, you must be familiar with the BE3-GPR terminal commands to program relay settings.

The software provides real-time metering of generator voltage, frequency, current, apparent power, true power, and power factor. Real-time metering provides critical generator data for evaluating system performance.

The software also enables the user to save BE3-GPR setup configurations in a computer file. Multiple setup configurations can be saved for later use, saving setup time when configuring multiple relays.

ASCII Communication

ASCII communication requires that the PC connected to the BE3-GPR be running a terminal emulation program (such as Windows® HyperTerminal) to send and receive ASCII characters in serial data format. The following parameters are required for the serial data format. Typical values for these parameters are as shown.

Baud Rate = 2400

Parity = NONE

Data Bits = 8

Stop Bits = 1

When using Windows HyperTerminal, the following preferences are recommended:

LOCAL = ON

CR→CR/LF = ON for both inbound and outbound

Communication procedures must follow a specific syntax. Within that syntax is the use of certain commands and the disuse of any additional keystrokes, such as the backspace or delete keys. That is, all commands must be entered once and entered exactly, or the user can expect an announcement of an incorrect input (except in the case of the logon command, where it would be ignored).

Logon

To initiate communication, the user must enter HELLOBE3GPR. The terminal emulator screen will reply with the message "BE3GPR PROGRAMMING UTILITY ENTERED" and the front panel LCD will display SLC (serial link communication).

Logoff

To terminate communication, the user should enter BYE. A successful logoff will be acknowledged on the terminal emulator screen by the message "BE3GPR PROGRAMMING UTILITY TERMINATED" and the front panel LCD will return to its normal display.

Programming

When the logon sequence is complete, the user can program the relay. Entering one of the commands listed in Table 3-1 followed by an equal sign (=), the set of numbers separated by commas, and a return alters the relay settings. For example, upon entering OV, the relay responds with "OV=0,150,100,0". This indicates that overvoltage protection is disabled, but the trip level is set for 150 volts, the reset level is set for 100 volts, and the time delay is set at zero. By entering OV=1,140,130,1 and pressing the Enter key, overvoltage protection is enabled, the trip level is set to 140 volts, the reset level is set to 130 volts, and the time delay is set to 1 second. Since this is a valid command and setup, the relay implements the change and acknowledges it with the response "OV=1,140,130,1". If the command or setup was incorrect, the relay would respond with an error message (see Table 3-2).

Table 3-1. Available BE3-GPR ASCII Commands

Command	Description
HELP	Supplies a list of the command set supported by the relay
HELLOBE3GPR	Logon
BYE	Logoff
S	Supplies a list of all of the current relay settings
V	V = d1 d1 = software version identification number (For Basler Electric use only)
CFG (System Configuration)	CFG = d1, d2, d3 d1 = auto reset: 0 (disabled) or 1 (enabled) d2 = CT Configuration: 1 (1A CT) or 5 (5A CT) d3 = generator voltage sensing: 1 (single phase line-to-line) 3 (three phase line-to-line) 4 (three phase line-to-neutral)
OV (Overvoltage)	OV = d1, d2, d3, d4 d1 = over voltage trip enable: 0 (disable) or 1 (enable) d2 = over voltage trip level (volts) d3 = over voltage reset level (volts) d4 = over voltage time delay (seconds)
UV (Undervoltage)	UV = d1, d2, d3, d4 d1 = under voltage trip enable: 0 (disable) or 1 (enable) d2 = under voltage trip level (volts) d3 = under voltage reset level (volts) d4 = under voltage time delay (seconds)
OF (Overfrequency)	OF = d1, d2, d3, d4 d1 = over frequency trip enable: 0 (disable) or 1 (enable) d2 = over frequency trip level (Hertz * 10) d3 = over frequency reset level (Hertz * 10) d4 = over frequency time delay (seconds)
UF1 (Underfrequency)	UF1 = d1, d2, d3, d4 d1 = under frequency 1 trip enable: 0 (disable) or 1 (enable) d2 = under frequency 1 trip level (Hertz * 10) d3 = under frequency 1 reset level (Hertz * 10) d4 = under frequency 1 time delay (seconds)
UF2 (Underfrequency)	UF2 = d1, d2, d3, d4 d1 = under frequency 2 trip enable: 0 (disable) or 1 (enable) d2 = under frequency 2 trip level (Hertz * 10) d3 = under frequency 2 reset level (Hertz * 10) d4 = under frequency 2 time delay (seconds)

Command	Description
NGF (Neutral Ground Fault)	NGF = d1, d2, d3, d4 d1 = neutral ground fault trip enable: 0 (disable) or 1 (enable) d2 = neutral ground fault trip level (Amps * 100) d3 = neutral ground fault reset level (Amps * 100) d4 = neutral ground fault time delay (seconds * 10)
OC (Overcurrent)	OC = d1, d2, d3, d4, d5, d6 d1 = overcurrent trip enable: 0 (disable) or 1 (enable) d2 = overcurrent trip level (Amps * 100) d3 = overcurrent reset level (Amps * 100) d4 = overcurrent time dial (seconds * 10) d5 = curve (Refer to Table 1-1) d6 = voltage restraint nominal: 0 (disable) or (volts)
REVPWR (Reverse Power)	REVPWR = d1, d2, d3, d4 d1 = reverse power trip enable: 0 (disable) or 1 (enable) d2 = reverse power trip level (Watts) d3 = reverse power reset level (Watts) d4 = reverse power time delay (seconds)
REACTI (Reactive Current)	REACTI = d1, d2, d3, d4 d1 = reactive current trip enable: 0 (disable) or 1 (enable) d2 = reactive current trip level (Amps * 100) d3 = reactive current reset level (Amps * 100) d4 = reactive current time delay (seconds)
SYNC (Sync-Check)	SYNC = d1, d2, d3, d4, d5, d6, d7 d1 = sync-check enable: 0 (disable) or 1(enable) d2 = generator bus fast: 0 (fast or slow) or 1 (fast) d3 = sync-check delta voltage (volts) d4 = sync-check phase delta (degrees) d5 = time or frequency: 0 (time delay) or 1 (slip frequency) d6 = slip frequency (Hertz * 10) d7 = time delay (seconds * 10)
DBUS (Dead Bus)	DBUS = d1, d2 d1 = dead bus enable: 0 (disable) or 1 (enable) d2 = dead bus voltage (volts)

Table 3-2. Error Messages

Error Message	Description
unrecognized keyword	Input is not a command or contains invalid characters (that is, backspace, etc.).
function not alterable	Setting cannot be changed by the user.
number of operands incorrect	The user has attempted to make setting changes but has not supplied the correct number of values.
operand(s) out of range	The user has attempted to change a setting to a value outside the functions domain.
bad trip-reset combination	The user has attempted to setup an illogical trip and reset combination.
functions not supported	The user has attempted to access a function that is not supported.
must enable sync first	The user has attempted to enable DBUS with sync disabled.
not supported in single phase sensing	The user has attempted to enable PHBAL in single phase sensing mode.

Default Settings

The following list of default BE3-GPR settings are obtained with the S command.

OV = 1, 140, 130, 1
UV = 1, 100, 110, 1
OF = 1, 610, 605, 1
UF1 = 1, 590, 595, 1
UF2 = 1, 580, 585, 1
NGF = 1, 25, 20, 10 (NGF version)
OC = 1, 100, 90, 10, 17, 0 (TOC version)
PHBAL = 0, 10, 5, 1
REVPWR = 0, 100, 50, 1
REACTI = 0, 20, 15, 1
SYNC = 0, 1, 1, 2, 1, 1, 2
DBUS = 0, 10
CFG = 1, 5, 1

The following is an interpretation of the default settings in the order returned by the relay.

OV = Over Voltage	Enabled	Trip=140 V	Reset=130 V	TD=1 s
UV = Under Voltage	Enabled	Trip=100 V	Reset=110 V	TD=1 s
OF = Over Frequency	Enabled	Trip=61.0 Hz	Reset=60.5 Hz	TD=1 s
UF1 = Under Frequency 1	Enabled	Trip=59.0 Hz	Reset=59.5 Hz	TD=1 s
UF2 = Under Frequency 2	Enabled	Trip=58.0 Hz	Reset=58.5 Hz	TD=1 s
NGF = Neutral Gnd Fault I (NGF version)	Enabled	Trip=0.25 A	Reset=0.20 A	TD=1 s
OC = Overcurrent (TOC version)	Enabled	Trip=1.00 A	Reset=0.90 A	TD=1 s
	Curve = 17	Voltage Restraint = 0		
PHBAL = Phase Balance	Disabled	Trip=10 V	Reset=5 V	TD=1 s
REVPWR = Reverse Power	Disabled	Trip=100 W	Reset=50 W	TD=1 s
REACTI = Reactive I	Disabled	Trip=0.20 A	Reset=0.15 A	TD=1 s
SYNC = Sync	Disabled	Fast=1	Delta V=1 V	Delta Ph=2°
	Window=1	Delta F=0.1 Hz	TD=0.2 s	
DBUS = Dead Bus	Disabled	Trip=10 V		
CFG = Configuration	Auto Reset	5A CTs	Single-Phase Sensing	

SECTION 4 • INSTALLATION

INTRODUCTION

Upon receipt of a BE3-GPR relay, check the model and style number against the requisition and packing list for agreement. If there is evidence of shipping damage, file a claim with the carrier and notify your sales representative or Basler Electric. If the relay won't be installed right away, store it in the original shipping package in a moisture- and dust-free environment.

MOUNTING

BE3-GPR relays are configured for semi-flush (surface) mounting (style xxxxF) or behind-the-panel mounting (style xxxxB). Overall dimensions and mounting hole locations for surface-mounted relays are shown in Figure 4-1. Overall dimensions and panel cutting/drilling dimensions for relays mounted behind the panel are illustrated in Figure 4-2. All dimensions are shown in inches with millimeters in parenthesis.

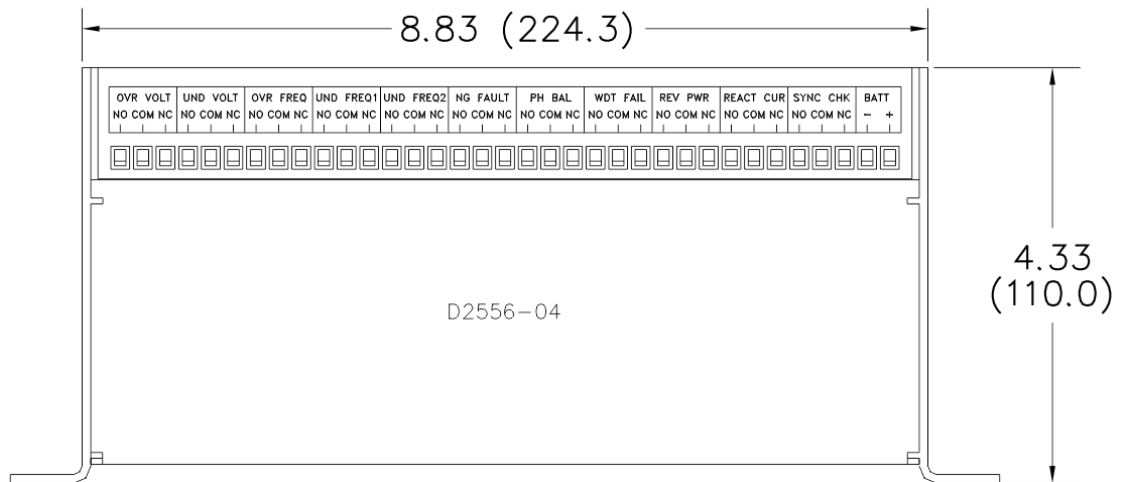
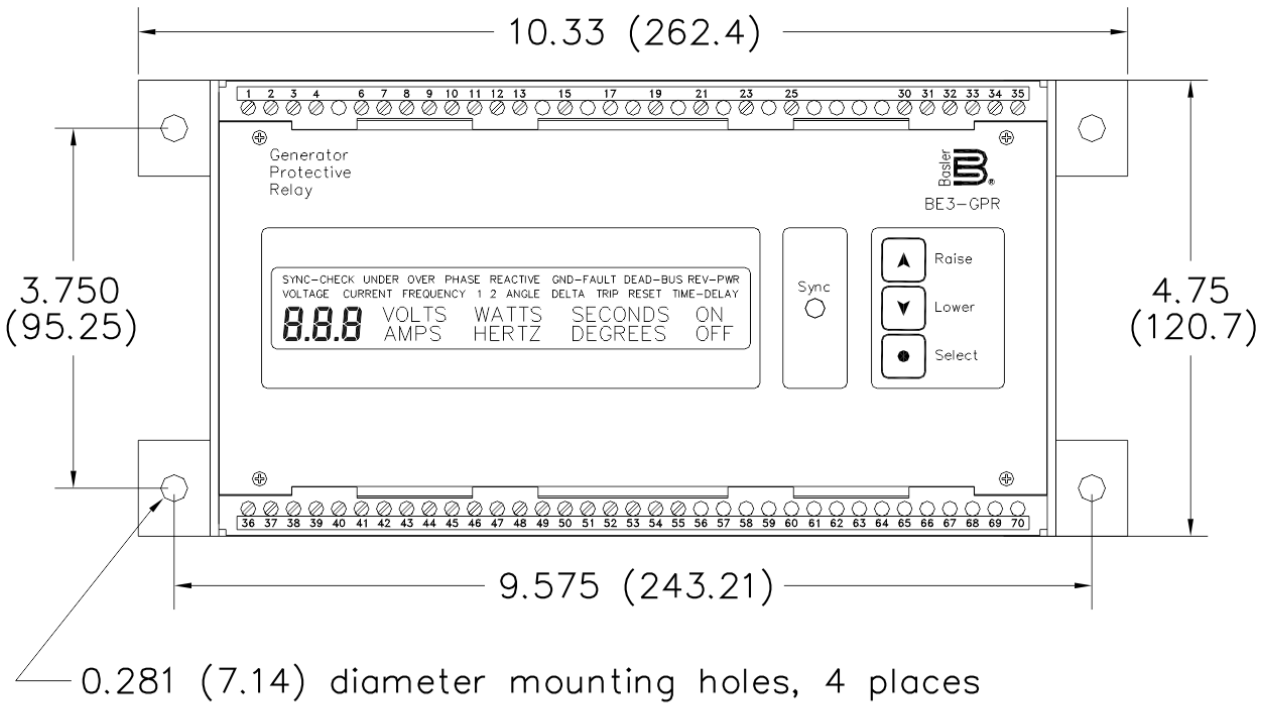


Figure 4-1. Overall and Mounting Dimensions, Surface Mounting (Style xxxxF)

CONNECTIONS

BE3-GPR connections are dependent on the application used. Observe the following guidelines when making BE3-GPR connections:

- A given application may not require the use of all BE3-GPR inputs and outputs.
- Incorrect wiring may result in damage to the unit.
- Applying incorrect operating power or sensing values may damage the unit.

NOTE

The BE3-GPR must be hard-wired to earth ground with no smaller than 12 AWG copper wire attached to the chassis ground terminal (CH GND). When the BE3-GPR is configured in a system with other devices, a separate lead should be used to connect each device to the ground bus.

All BE3-GPR terminations consist of screw compression terminals. These terminals accept one 10 AWG wire or two 14 AWG conductors.

Terminal Assignments

BE3-GPR terminal assignments vary according to the style of the relay. Relays with three-phase overcurrent protection (style x1xxxx) have different terminal assignments than relays with neutral ground fault protection (style x2xxxx). Table 4-1 lists the terminal assignments for a BE3-GPR with three-phase overcurrent protection. The terminal assignment differences for a relay with neutral ground fault protection are listed in Table 4-2.

Table 4-1. Terminal Assignments, BE3-GPR with Three-Phase Overcurrent Protection

Panel	Terminal	Label	Description
	1	CH GND	Chassis ground
	2	SER LINK COM	RS-232 common connection
	3	SER LINK RX	RS-232 receive connection
	4	SER LINK TX	RS-232 transmit connection
	6	PROGRAM ENABLE	
	7	PROGRAM ENABLE	
	8	OUTPUT DISABLE	
	9	OUTPUT DISABLE	
	10	FAIL SF ENABLE	
	11	FAIL SF ENABLE	
	12	TRIP RESET	
	13	TRIP RESET	
	16	BUS –	
	18	BUS +	
	20	GENERATOR N	Neutral generator sensing voltage input
	22	GENERATOR C	C-phase generator sensing voltage input
	24	GENERATOR B	B-phase generator sensing voltage input
	26	GENERATOR A	A-phase generator sensing voltage input
	27	CT C 5A	C-phase generator current sensing input, 5 Aac nominal
	28	CT C 1A	C-phase generator current sensing input, 1 Aac nominal
	29	CT C COM	C-phase generator current sensing common connection
	30	CT B 5A	B-phase generator current sensing input, 5 Aac nominal
	31	CT B 1A	B-phase generator current sensing input, 1 Aac nominal
	32	CT B COM	B-phase generator current sensing common connection
	33	CT A 5A	A-phase generator current sensing input, 5 Aac nominal
	34	CT A 1A	A-phase generator current sensing input, 1 Aac nominal
	35	CT COM	Generator current sensing common connection

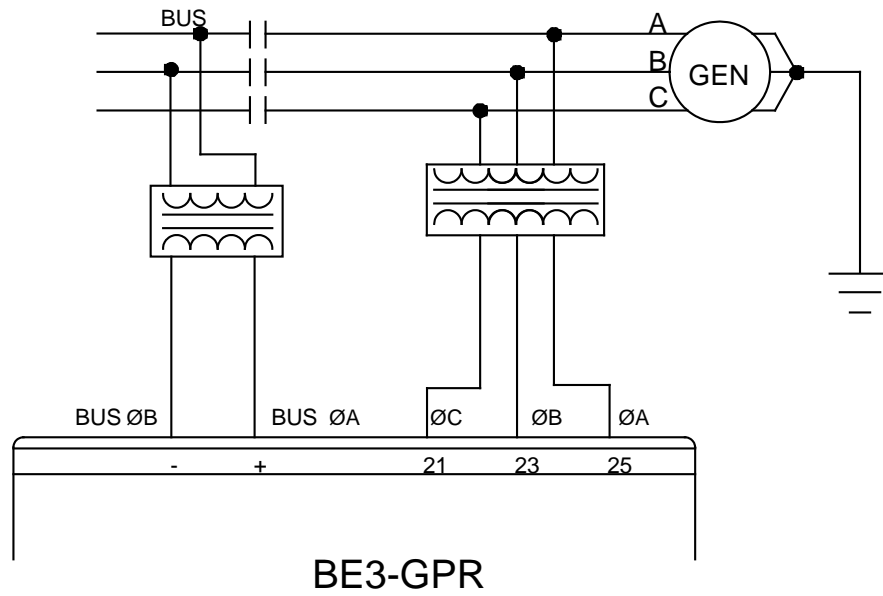
Panel	Terminal	Label	Description
BOTTOM PANEL	36	OVR VOLT NO	Overvoltage protection function SPDT output contacts
	37	OVR VOLT COM	
	38	OVR VOLT NC	
	39	UND VOLT NO	
	40	UND VOLT COM	
	41	UND VOLT NC	
	42	OVR FREQ NO	
	43	OVR FREQ COM	
	44	OVR FREQ NC	
	45	UND FREQ1 NO	
	46	UND FREQ1 COM	
	47	UND FREQ1 NC	
	48	UND FREQ2 NO	
	49	UND FREQ2 COM	
	50	UND FREQ2 NC	
	51	OVR CUR NO	
	52	OVR CUR COM	
	53	OVR CUR NC	
	54	PH BAL NO	
	55	PH BAL COM	
	56	PH BAL NC	
	57	WDT FAIL NO	
	58	WDT FAIL COM	
	59	WDT FAIL NC	
	60	REV PWR NO	
	61	REV PWR COM	
	62	REV PWR NC	
	63	REACT CUR NO	
	64	REACT CUR COM	
	65	REACT CUR NC	
66	SYNC CHK NO		
67	SYNC CHK COM		
68	SYNC CHK NC		
69	BATT -	Operating (battery) power negative connection	
70	BATT +	Operating (battery) power positive connection	

Table 4-2. Terminal Assignment Differences, BE3-GPR with Neutral Ground Fault Protection

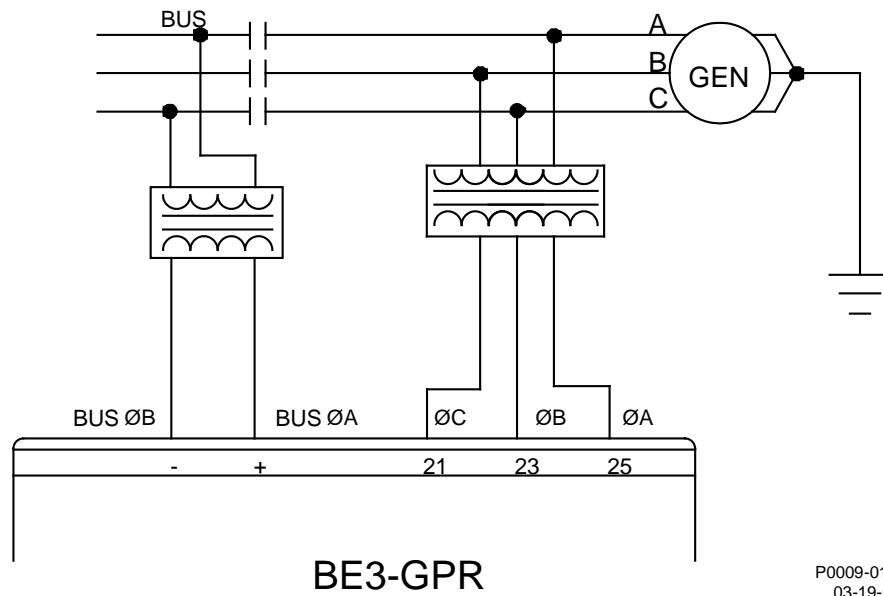
Panel	Terminal	Label	Description
	27	N/A	
	28	N/A	
	29	N/A	
	51	NG FAULT NO	
	6	NG FAULT COM	
	7	NG FAULT NC	

Three-Phase Sensing Connections

Figure 4-3 illustrates the connections for three-phase systems with either ABC or ACB rotation. Unless otherwise noted, all connection diagrams in this manual assume ABC rotation.



CONNECTIONS FOR THREE-PHASE SYSTEMS WITH ABC ROTATION.



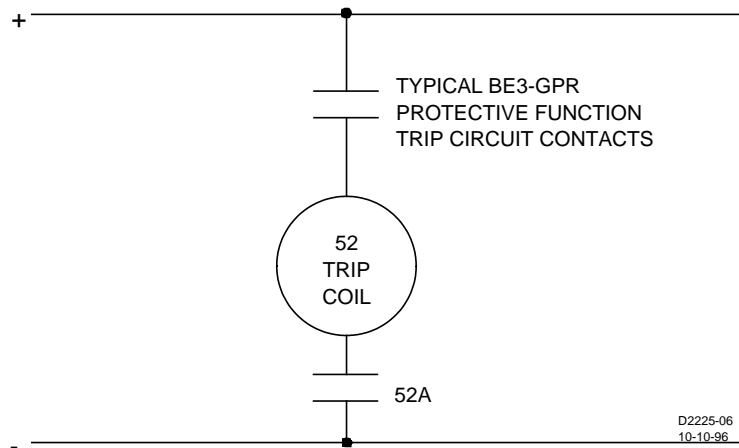
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CONNECTIONS FOR THREE-PHASE SYSTEMS WITH ACB ROTATION.

Figure 4-3. Connections for Three-Phase Rotations

DC Control Circuit Connections

Figure 4-4 illustrates typical connections for BE3-GPR protection function output contacts in a dc trip circuit.



D2225-06
10-10-96

Figure 4-4. Typical DC Control Circuit

Typical Application Drawings

Typical BE3-GPR application drawings are illustrated in Figures 4-5 through 4-14. To locate the appropriate drawing for your application and relay version see Table 4-1.

Table 4-1. Application Drawing Cross-Reference

Overcurrent Type	Generator Configuration	Sensing Configuration	Nominal CT Rating	Figure
	Stand Alone	1-phase, L-L	5 Aac	4-5
	Stand Alone	3-phase, L-L	1 Aac	4-6
	Paralleled	1-phase, L-L	5 Aac	4-7
	Paralleled	3-phase, 3-wire, L-L	5 Aac	4-8
	Paralleled	3-phase, 4-wire, L-N	5 Aac	4-9
	Stand Alone	1-phase, L-L	5 Aac	4-10
	Stand Alone	3-phase, L-L	1 Aac	4-11
	Paralleled	1-phase, L-L	5 Aac	4-12
	Paralleled	3-phase, 3-wire, L-L	5 Aac	4-13
	Paralleled	3-phase, 4-wire, L-N	5 Aac	4-14

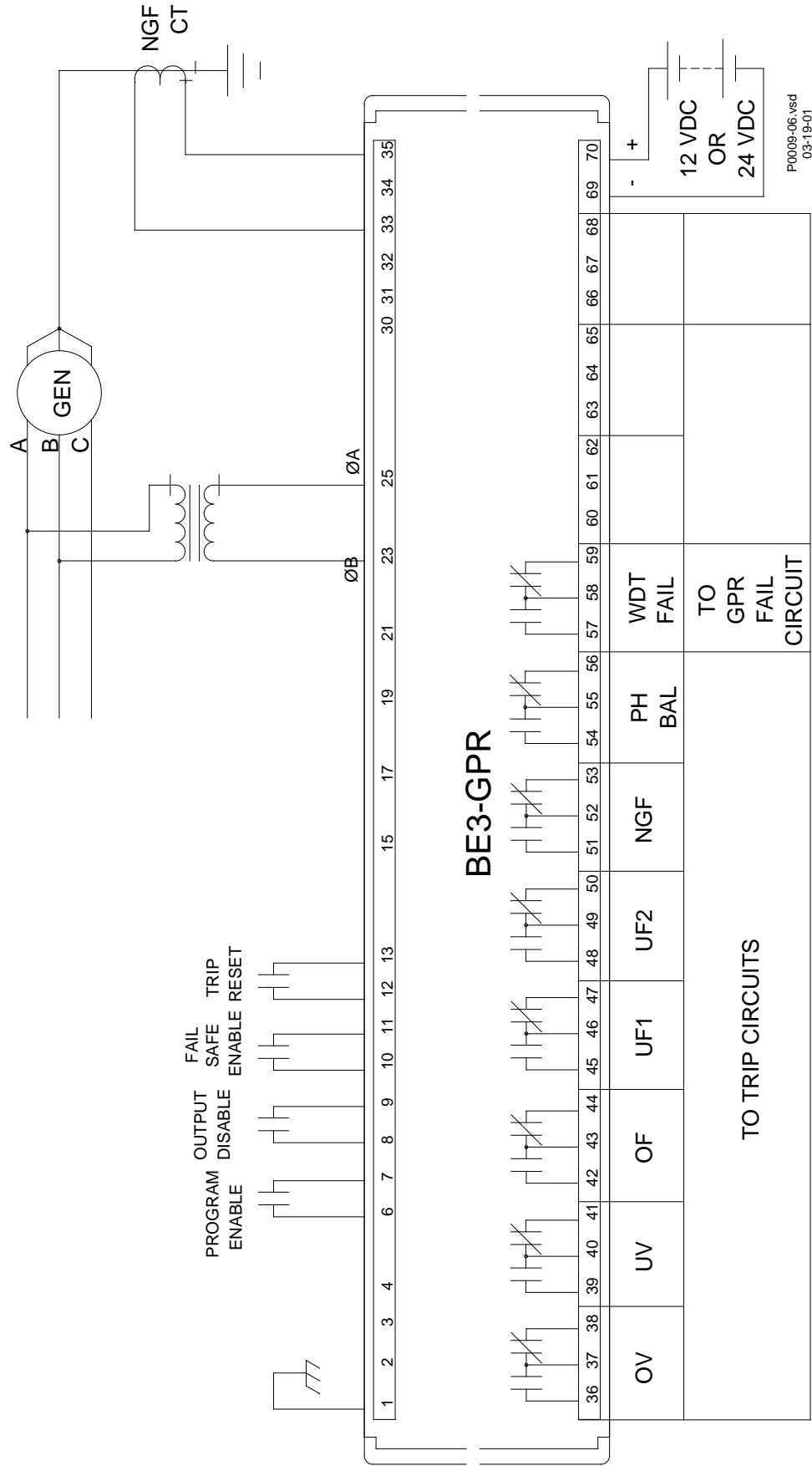
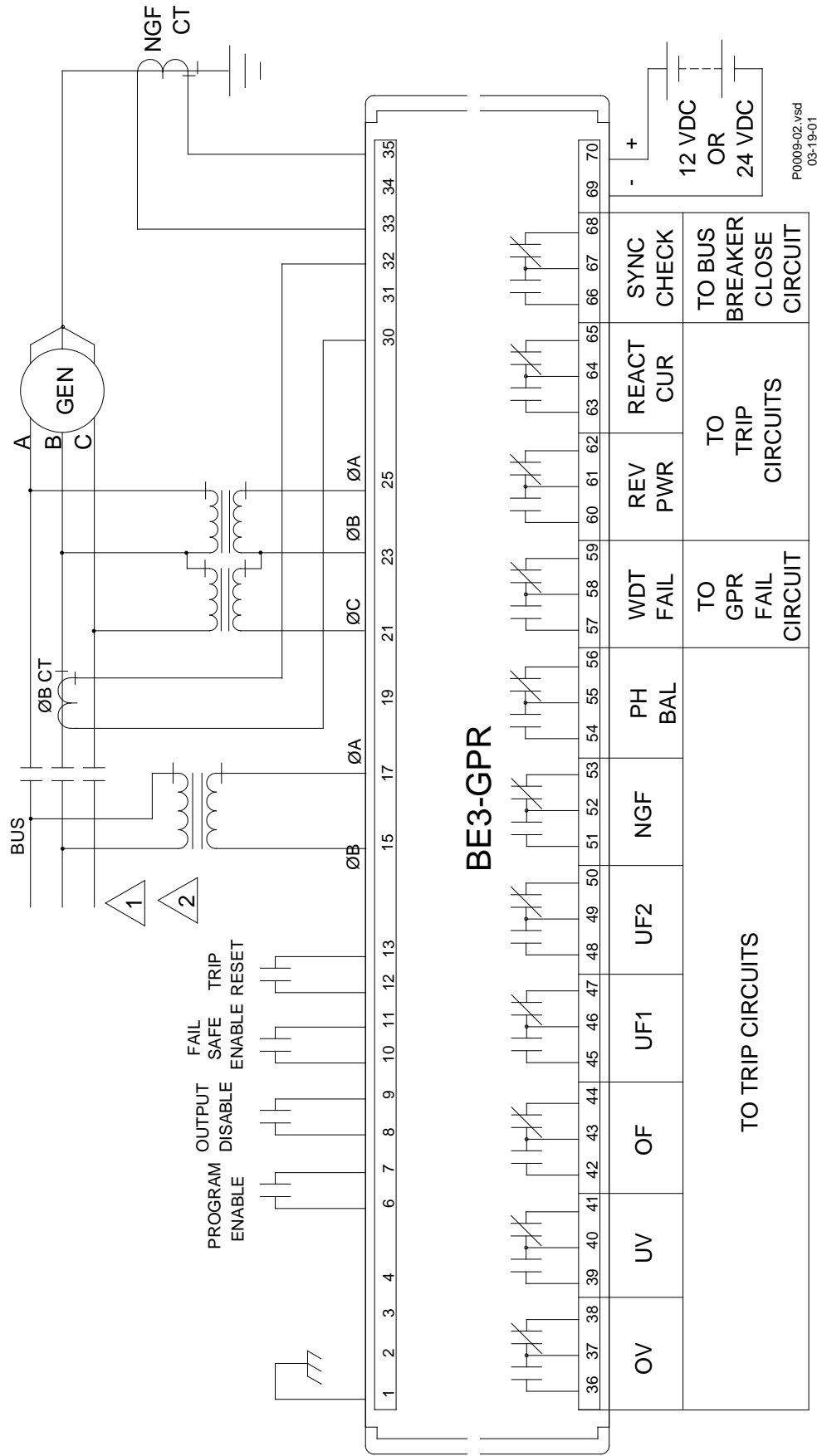


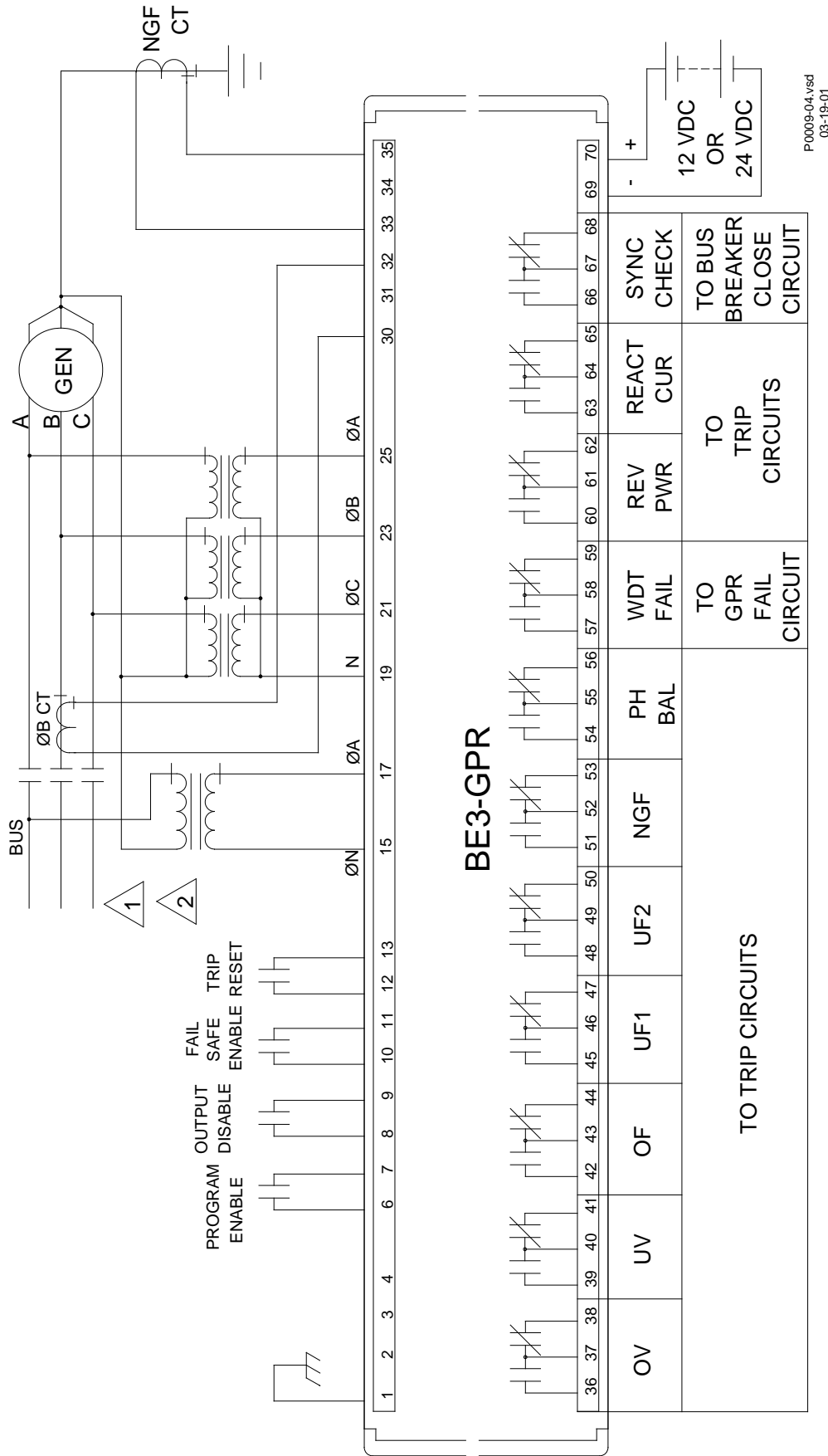
Figure 4-5. Stand-Alone Generator Application, Neutral Ground Fault Overcurrent Protection, Single-Phase, Line-to-Line Sensing, 5 Aac CT



NOTES: 1 IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 21, 23, AND 25.

2 INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.

Figure 4-8. Paralleled Generator Application, Neutral Ground Fault Overcurrent Protection, Three-Phase, Three-Wire, Line-to-Line Sensing, 5 Aac CT



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- NOTES:
- 1 IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 21, 23, AND 25.
 - 2 INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.

Figure 4-9. Paralleled Generator Application, Neutral Ground Fault Overcurrent Protection, Three-Phase, Four-Wire, Line-to-Neutral Sensing, 5 Aac CT

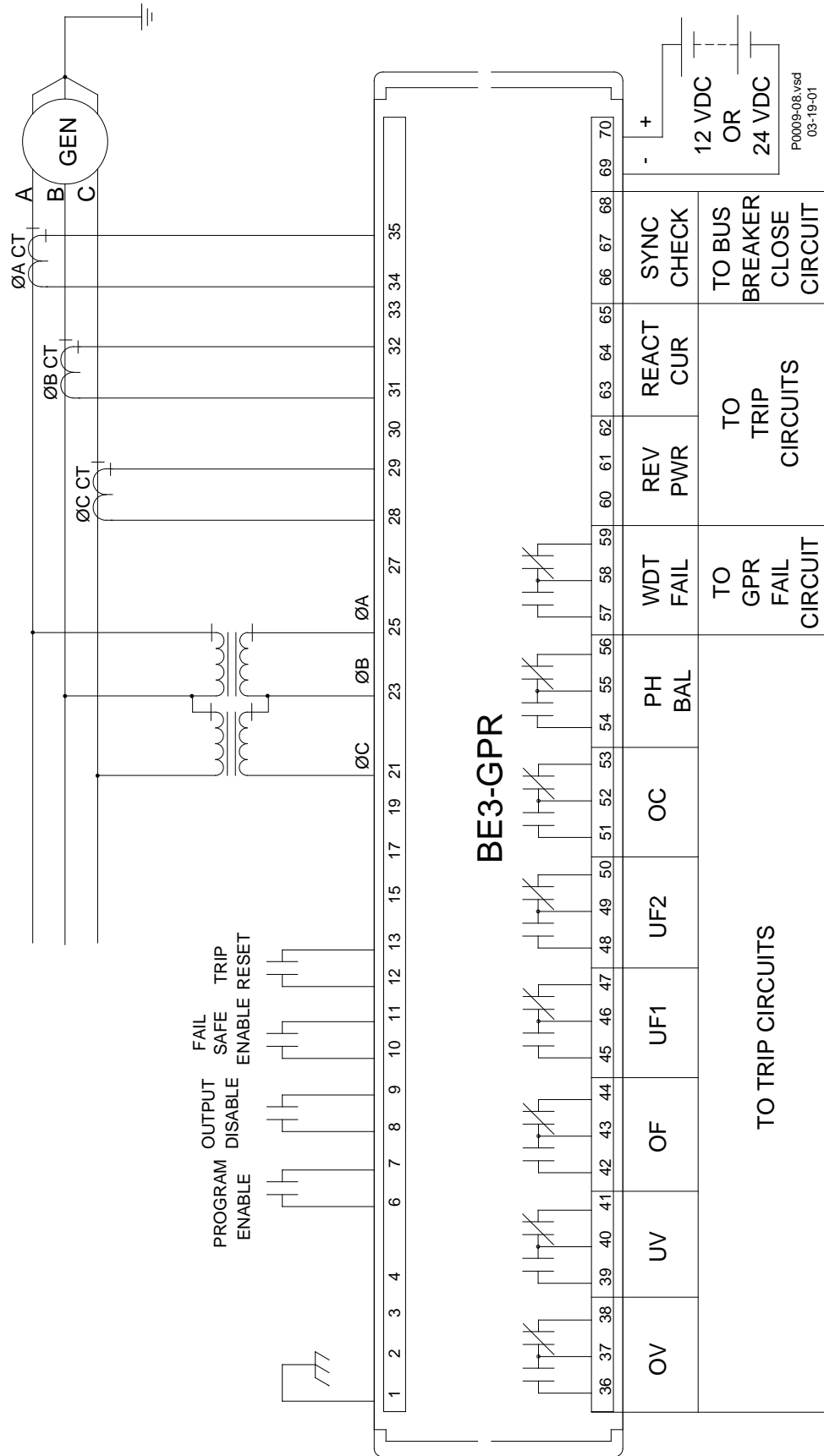
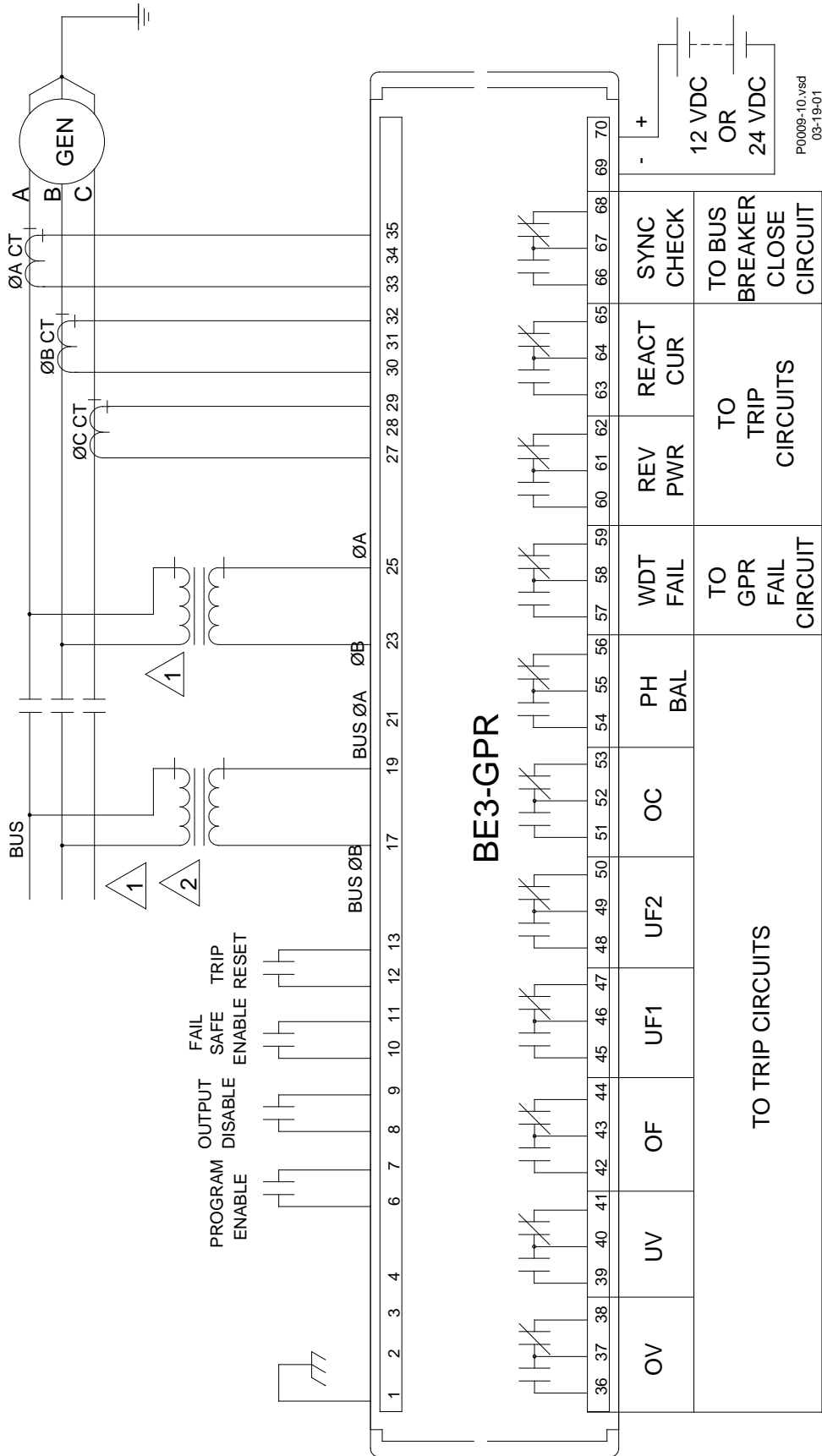


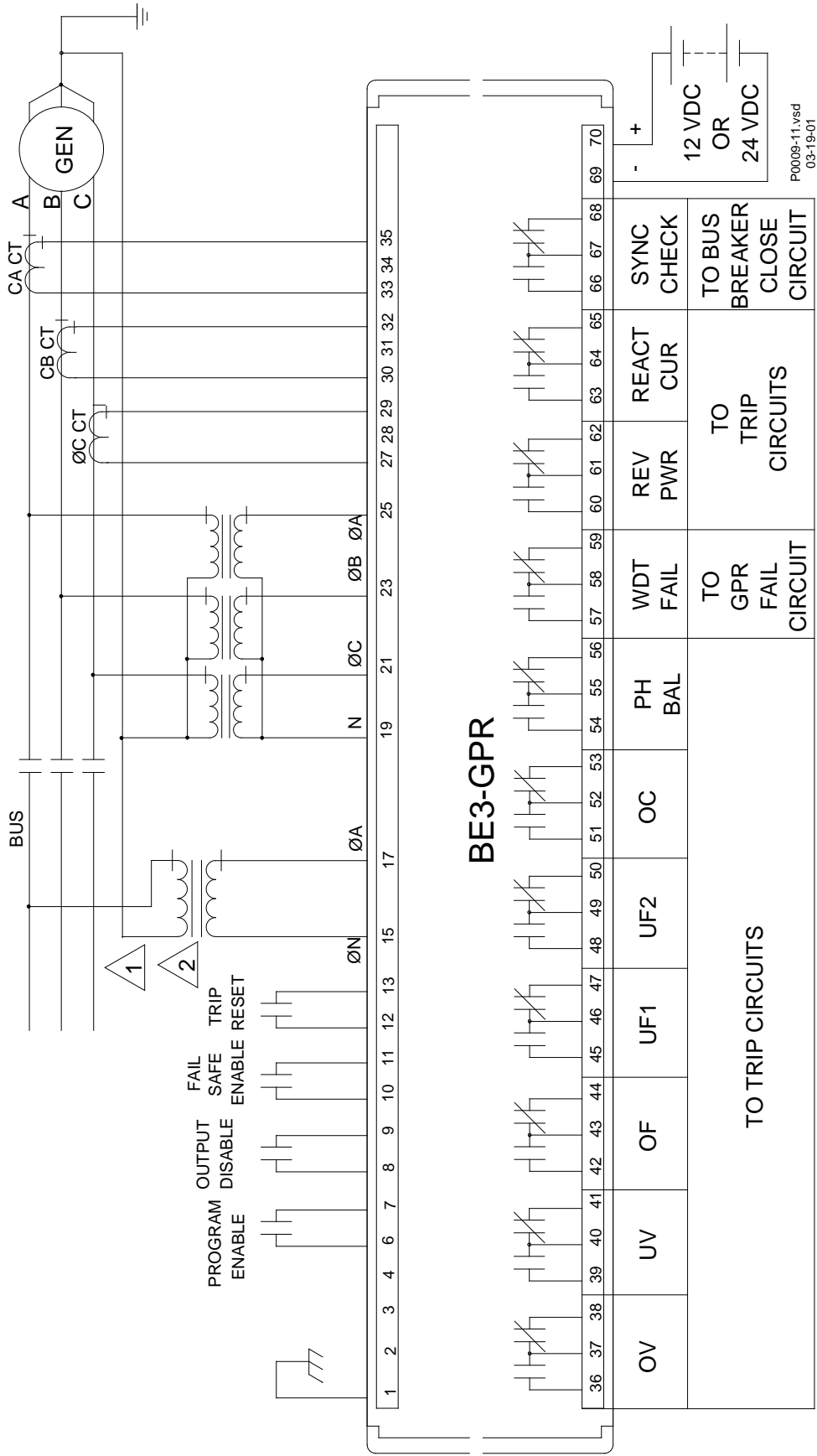
Figure 4-11. Stand-Alone Generator Application, Three-Phase Overcurrent Protection, Three-Phase, Line-to-Line Sensing, 1 Aac CT



NOTES: **1** IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 23 AND 25.

2 INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.

Figure 4-12. Paralleled Generator Application, Three-Phase Overcurrent Protection, Single-Phase, Line-to-Line Sensing, 5 Aac CT



P0009-11.vsd
03-19-01

NOTES: 1 IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 21, 23, AND 25.

2 INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.

Figure 4-14. Paralleled Generator Application, Three-Phase Overcurrent Protection, Three-Phase, Four-Wire, Line-to-Neutral Sensing, 5 Aac CTs

RS-232 Communication Port

PC to BE3-GPR connections for RS-232 communication are shown in Figure 4-15. If you are using Windows software, loopbacks (jumpers for pins 4 to 6 and pins 7 to 8) are required.

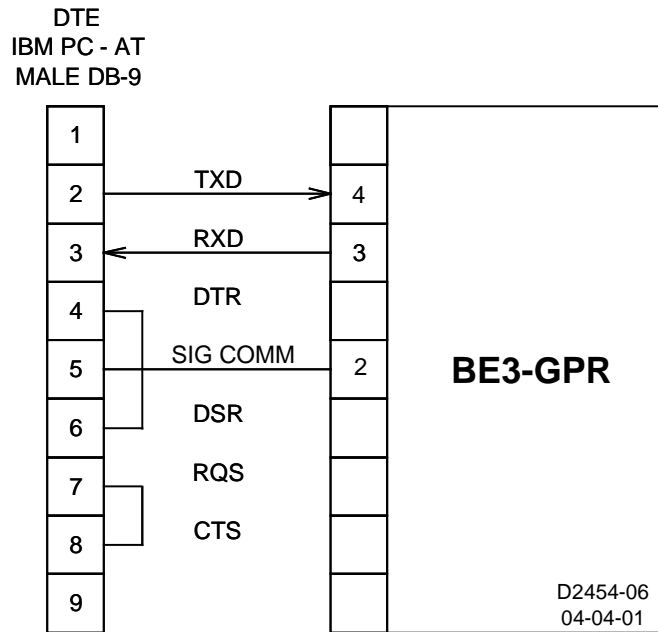


Figure 4-15. RS-232 Serial Communication Connections

RS-232 Communication Settings

The serial communication settings of the PC used to communicate with the PC must be adjusted to match the fixed communication settings of the BE3-GPR. The BE3-GPR communication settings are as follows:

- 2400 baud
- 8 data bits
- 1 stop bit
- No parity

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SECTION 5 • BE3-GPR COMMUNICATION SOFTWARE

INTRODUCTION

BE3-GPR communication software provides a user-friendly environment for setting the BE3-GPR and metering generator system parameters. The software enables a BE3-GPR's setup configuration to be saved in a file as a backup of for configuring other BE3-GPR relays with the same settings.

BE3-GPR communication software is compatible with PCs operating most versions of the Windows® operating system and uses the PC's serial port to communicate with the BE3-GPR.

CAUTION

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 1,000,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

INSTALLATION

A PC with the following minimum requirements is needed for installation of BE3-GPR communication software:

- IBM compatible PC, 486DX2 or faster with 4 MB of RAM minimum
- Microsoft Windows® 95, 98, Me, 2000, or XP operating system
- 3½" diskette drive
- Serial port

BE3-GPR communication software is provided on two 3½" diskettes that contain two setup utilities that install one of two software versions on your PC. The style number of your BE3-GPR determines which version of software must be installed. Relays with three-phase overcurrent protection (style x1xxxx) require the installation of the Time Overcurrent version of BE3-GPR communication software. Relays with neutral ground fault overcurrent protection (style x2xxxx) require the installation of the Neutral Ground Fault version of BE3-GPR communication software.

Software Installation

BE3-GPR communication software is installed by performing the following steps:

1. Insert disk 1 into the PC diskette drive
2. In Windows, select **Start, Run**.
3. In the Run field, type **A:\setup** and click **OK**. The setup utility will start the installation process.
4. During the installation process, a dialog box (Figure 5-1) will appear and require that you select the version of software to be installed. If your relay style number is x1xxxx, select the Time overcurrent version for installation. If your relay style number is x2xxxx, select the Neutral Ground Fault version for installation.

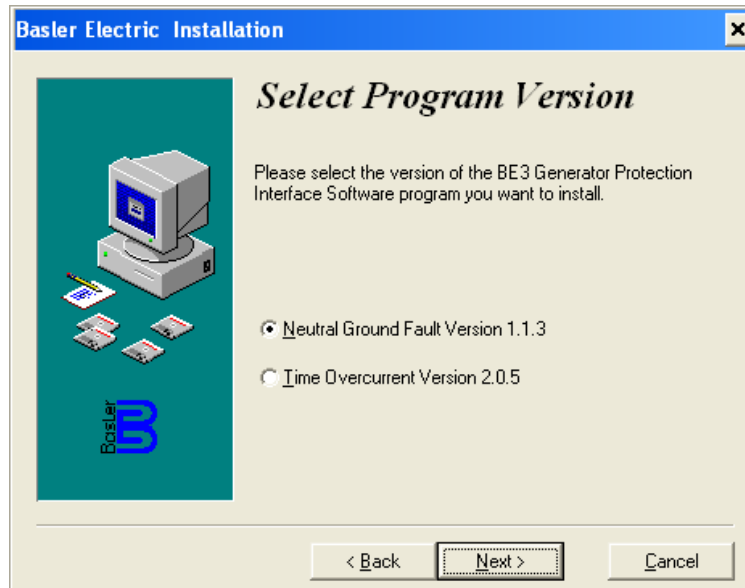


Figure 5-1. Select Program Version Dialog Box

Once installation is complete, a program icon for starting the software will be available by selecting **Start, Programs, Basler Electric**.

COMMUNICATION

Proper serial communication connections are required for communication between the BE3-GPR and PC. For a diagram of BE3-GPR communication connections, refer to Section 4, *Installation, Connections, RS-232 Connections*.

The serial communication settings of the PC must be adjusted to match the fixed communication settings of the BE3-GPR. BE3-GPR communication settings are as follows:

- 2400 baud
- 8 data bits
- 1 stop bit
- No parity

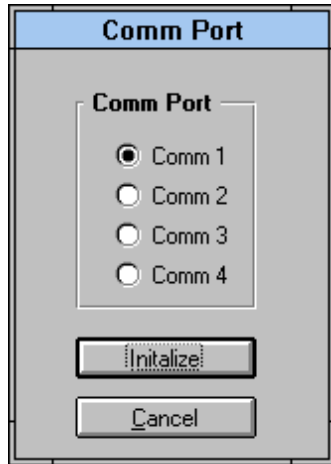
Initializing Communication

With the proper communication connections and PC communication settings in place, and the BE3-GPR communication software running, communication between the BE3-GPR and PC can be initialized.

To initialize communication, click **Communications** on the file menu and then click **Open** (see Figure 5-2). After Open is clicked, the Comm Port window (Figure 5-3) appears. Select the appropriate PC communication port and click the Initialize button. This opens communication between the PC and BE3-GPR. At the start of communication, the software reads and displays the current, active BE3-GPR settings.



Figure 5-2. Initializing Communication, Part 1



Terminating Communication

To terminate communication, click **Communications** on the file menu and then click **Close**.

SETTINGS

BE3-GPR settings are arranged into four groups within the software. Each group is contained on a tab within the software. The Time Overcurrent version of software (relay style x1xxxx) has the following setting tabs:

- Config. – Voltage
- Frequency
- Over Current – Ph. Bal. – Rev. Power
- Reactive Current – Sync-Check

The Neutral Ground Fault version of software (relay style x2xxxx) has the following setting tabs:

- Config. – Voltage
- Frequency
- Gnd Fault – Ph. Bal. – Rev. Power
- Reactive Current – Sync-Check

In the following paragraphs, BE3-GPR settings are arranged and defined according to the organization of the software tabs.

Changing Settings

To change BE3-GPR settings, you first select the settings group by clicking the appropriate software tab. To enable a setting controlled by a radio button, you click the radio button adjacent to the setting. To change the value of a setting, you click the setting field and enter the new value.

Sending, Getting, and Displaying Settings

Settings are sent to the relay, retrieved from the relay, and displayed in a special format through three commands accessed through the Communications menu (Figure 5-2).

Send To Relay

Executing this command updates the BE3-GPR settings with the settings displayed on the software screens.

NOTE

Relay settings are updated only after the **Send To Relay** command is executed.

Get From Relay

Executing this command retrieves the settings from the BE3-GPr and displays those settings on the software screens.

Display Data

Selecting Display Data from the Communications menu gives two choices: As Displayed on Screen or As Received from Relay. Selecting either choice displays a snapshot of the relay or screen settings in a compact format (Figure 5-4).

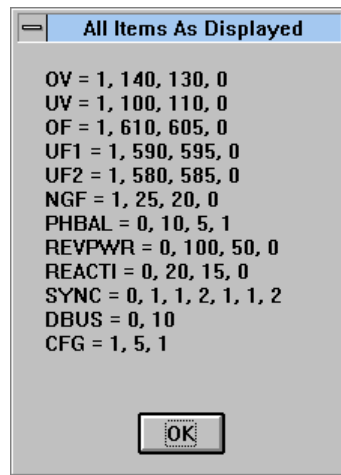


Figure 5-4. Settings Snapshot Format

Config. – Voltage Tab

The Config. – Voltage tab in both versions of software contains Configuration, Overvoltage, and Undervoltage settings. Config. – Voltage tab settings are shown in Figure 5-5.

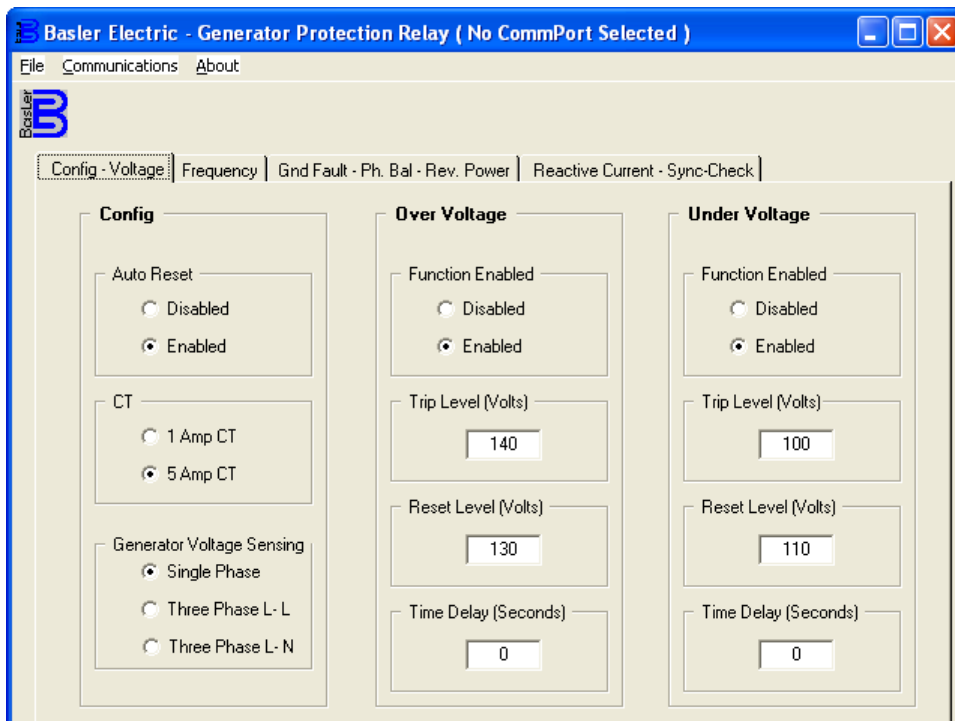


Figure 5-5. Config. - Voltage Tab Settings

Frequency Tab

The Frequency tab in both versions of software contains Overfrequency settings and settings for both underfrequency functions. Frequency tab settings are shown in Figure 5-6.

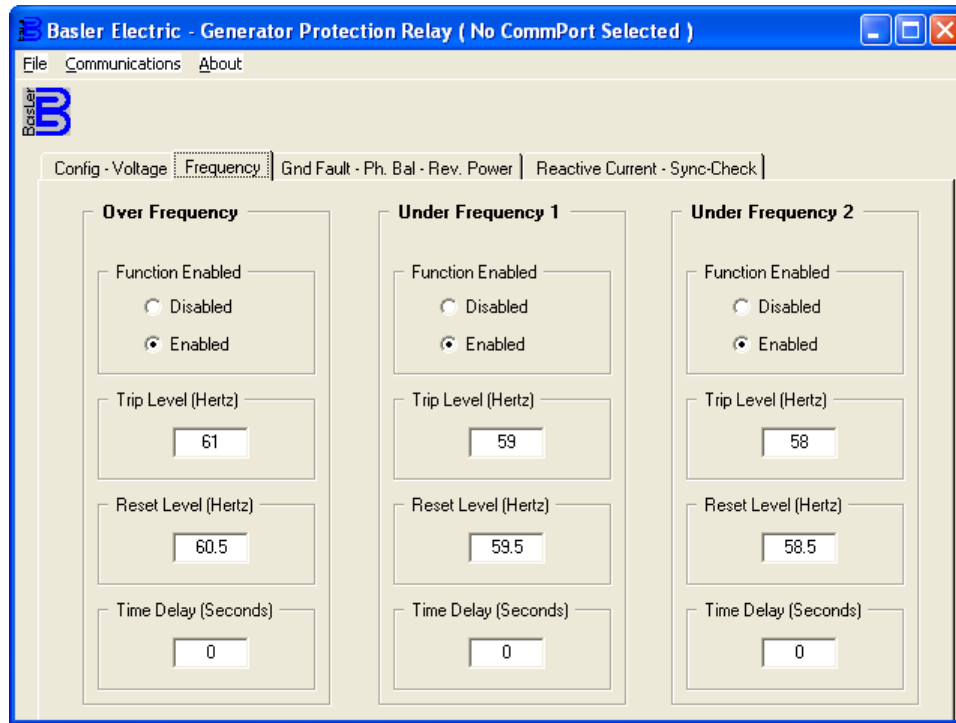


Figure 5-6. Frequency Tab Settings

Over Current – Ph. Bal – Rev. Power Tab (Time Overcurrent Software Only)

This tab exists only in the Time Overcurrent version of the software and is used with relays that have style number x1xxxx. This tab contains Time Overcurrent (51V), Phase Balance (47), and Reverse Power (32R) protection settings. Over Current – Ph. Bal – Rev. Power tab settings are shown in Figure 5-7.

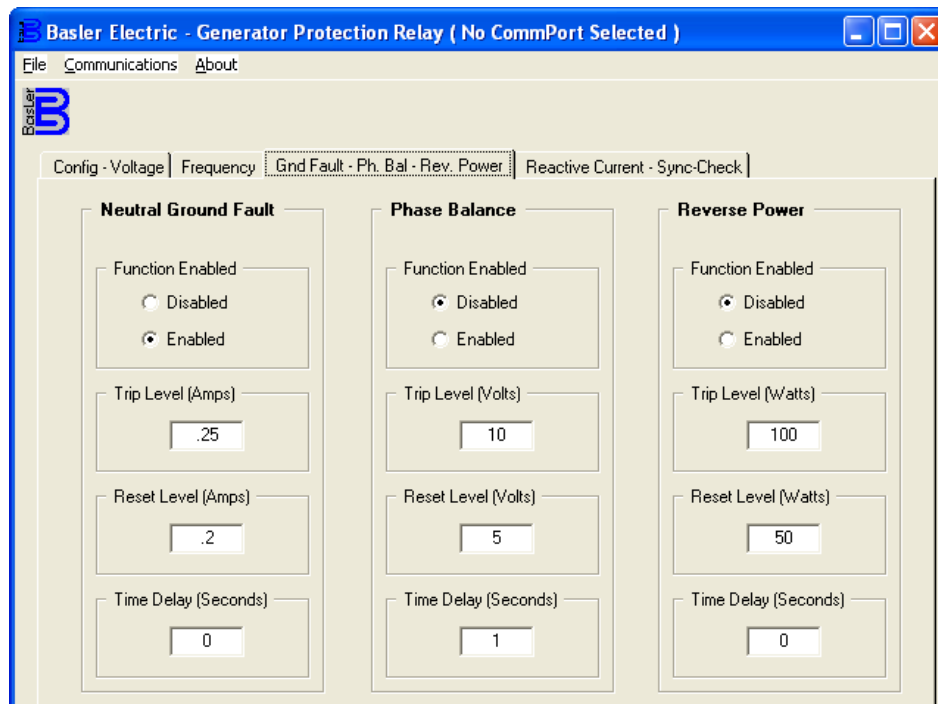


Figure 5-7. Over Current - Ph. Bal - Rev. Power Tab Settings

Gnd Fault – Ph. Bal – Rev. Power Tab (Neutral Ground Fault Overcurrent Software Only)

This tab exists only in the Neutral Ground Fault Overcurrent version of the software and is used with relays that have style number x2xxxx. This tab contains Neutral Ground Fault (51N), Phase Balance (47),

and Reverse Power (32R) protection settings. Gnd Fault – Ph. Bal – Rev. Power tab settings are shown in Figure 5-8.

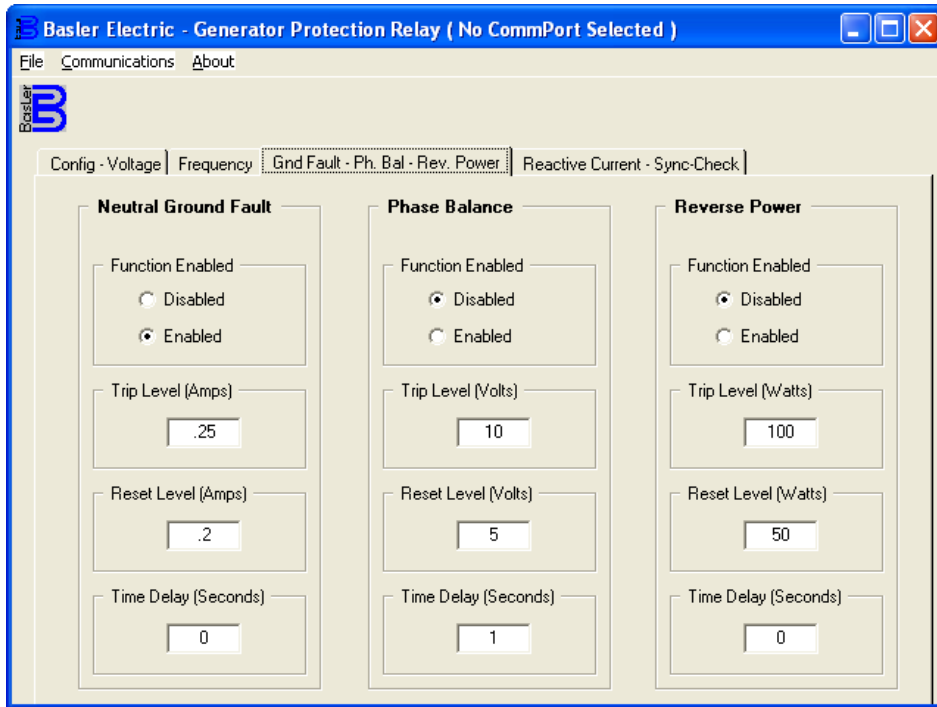


Figure 5-8. Gnd Fault - Ph. Bal - Rev. Power Tab Settings

Reactive Current – Sync-Check Tab

The Reactive Current – Sync-Check tab in both version of software contains reactive current (loss of excitation (40)), synchronism-check, and dead bus protection settings. Reactive Current – Sync-Check tab settings are shown in Figure 5-9.

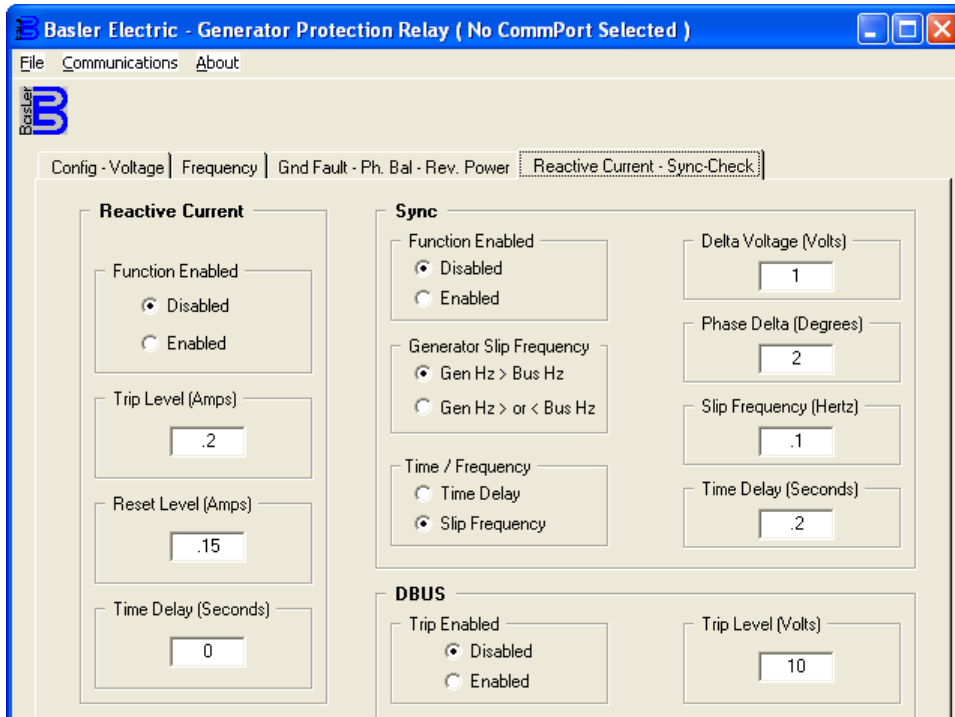


Figure 5-9. Reactive Current - Sync-Check Tab Settings

METERING

BE3-GPR communication software provides metering capability for monitoring generator voltage, frequency, current, true power, apparent power, and power factor. Metered data is updated approximately once per second.

Enabling Metering

Before metering can be enabled, communication between the BE3-GPr and PC must be established. See *Initializing Communication*. To enable metering, click **Meter** on the file menu and then click **Enable Metering**.

Metering Screen

The metering screen from the Neutral Ground Fault Overcurrent version of software is illustrated in Figure 5-10 and the metering screen from the Time Overcurrent version of software is illustrated in Figure 5-11.

Metering values are displayed in green when the BE3-GPR is active and operating normally. The metering display changes to gray and is zeroed out when the generator voltage decreases below approximately 10 volts.

To compensate for the PTs and CTs used in the generator system, the metering screen provides PT ratio and CT ratio adjustments. Pt ratios up to 100:1 and CT ratios up to 2000:1 can be entered.

NOTE

For the Neutral Ground Fault Overcurrent version of software, status indicators are provided only on software versions 1.01 and later.

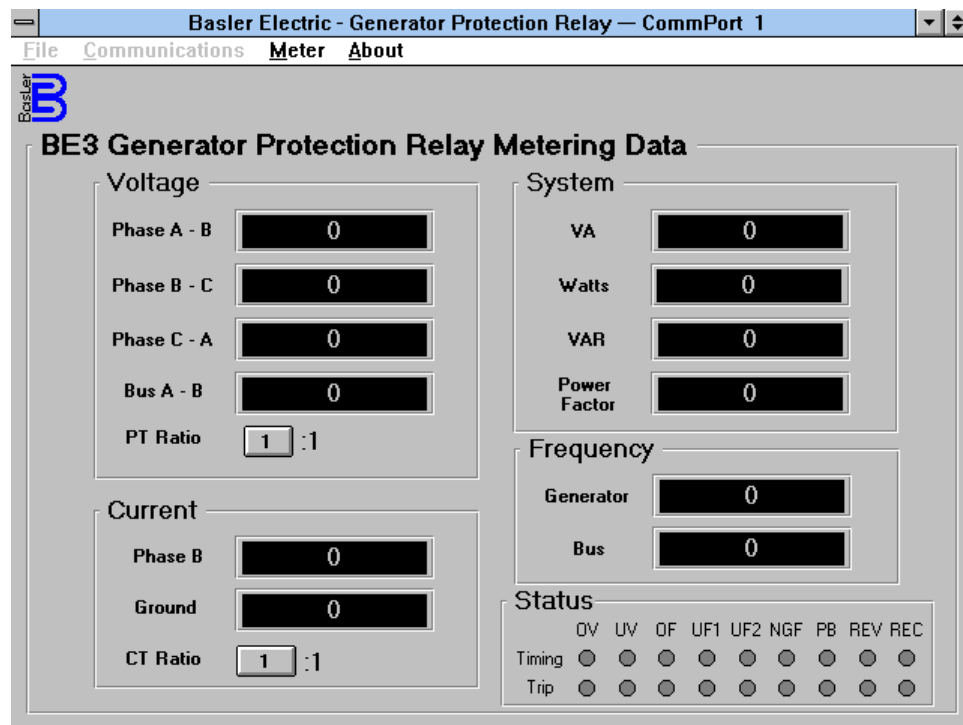


Figure 5-10. Metering Screen, Neutral Ground Fault Overcurrent Software

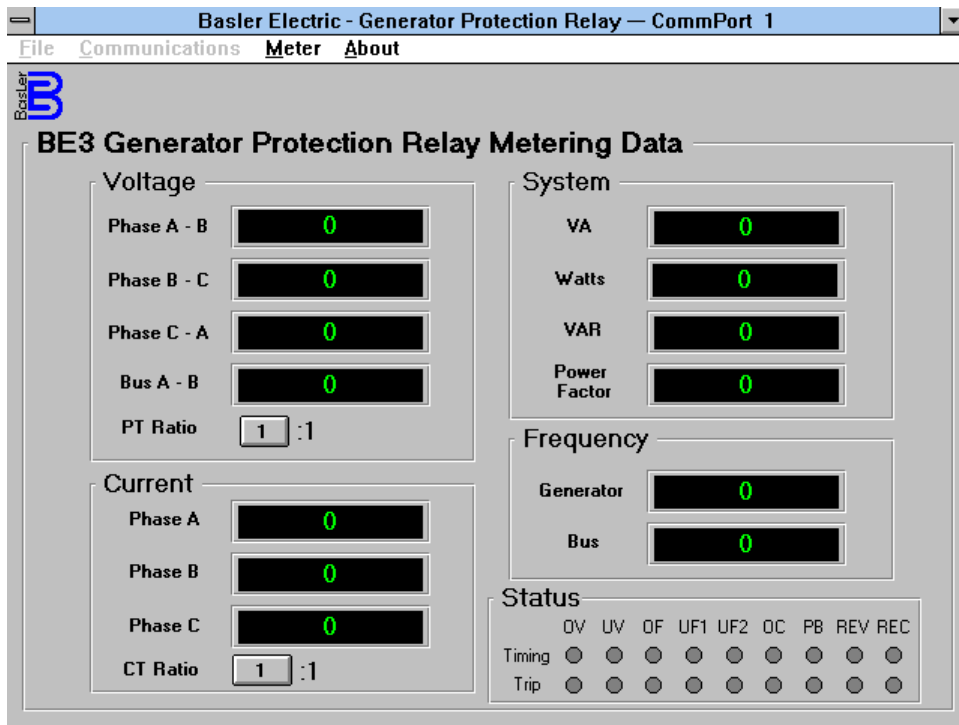


Figure 5-11. Metering Screen, Time Overcurrent Software

Disabling Metering

To exit the metering screen and return to the settings screens, click **Meter** on the file menu and click **Disable Metering**.

SETTINGS FILES

BE3-GPR communication software enables BE3-GPR setting configurations to be saved in a file. This feature allows a user to save multiple relay setups for later use and saves setup time when configuring multiple units. Settings files may also be printed for reference.

Saving Settings Files

To save settings displayed in BE3-GPR communication software, click **File** on the file menu and click **Save**. Then use standard Windows techniques to name the file and save it in the desired folder. When the file is named, it must have a *.gpr* file extension.

Printing Settings

To print settings, click **File** on the file menu and click **Print**. A dialog box will enable you to assign a title to the printout and include a unit serial number. Clicking the Print button sends the settings to your printer.

SECTION 6 • TESTING

INTRODUCTION

Procedures for testing the BE3-GPR are provided in the following paragraphs.

EQUIPMENT REQUIRED

- PC with RS-232 serial port and running a terminal emulation program
 - Power supply, 12 Vdc or 24 Vdc, 0.5 Adc
 - Three-phase, line-to-neutral ac voltage source, 50 to 70 Hz, 0 to 120 Vrms line-to-neutral
 - Single- or three-phase ac current source, 60 Hz, 0 to 2 Aac (rms), adjustable phase relationship
 - Digital voltmeter, 4½ digits (Fluke 8050A or equivalent)
 - Continuity tester
 - SPST toggle switch
 - Hardware jumpers
-

TEST SETUP

Make the test setup connections shown in Figure 7-1.

1. Set the dc Power Supply to 12 Vdc and connect to the relay Batt+ input (terminal 70) and the Batt- input (terminal 69).
2. Install a jumper across the PROGRM ENABLE input (terminals 6 and 7) to enable relay front panel programming. The jumper should remain installed for all tests unless noted otherwise.
3. Connect the three-phase ac voltage and current sources to the GEN inputs as shown. Adjust the frequency to 60 Hz and set the voltage to 69.3 Vrms line-to-neutral (120 Vrms line-to-line).
4. For relay style x2xxxx: Connect the ac current source to the 5A NGF CT input (terminal 33) and CT COM input (terminal 35). Leave current set to 0 amperes for now.

For relay style x1xxxx: Connect the ac current source to the 5A A, B, or C CT inputs (terminals 33, 30, or 27) and CT COM inputs (terminals 35, 32, or 29 respectively). Leave current set to 0 amperes for now.

PROTECTIVE FUNCTIONS

The following subsections are designed to efficiently check the hardware/software operation for each of the individual protective functions, using a step application and removal of a known fault level, specifically to test output contact operation and NOT relay accuracy. For each subsection a continuity tester should be used to monitor that the specified contacts close upon trip application and open upon removal.

Overvoltage Trip (Line-To-Neutral Voltage Sensing)

1. Monitor the OVR VOLT output contacts, terminals 36 and 37, for the trip condition.
2. Use the front panel keypad and LCD to select CFG=1,5,4
3. Increase phase A, line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD and contacts should return to the un-tripped ON display.
4. Increase phase B, line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD and contacts should return to the un-tripped ON display.
5. Increase phase C, line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD and contacts should return to the un-tripped ON display.

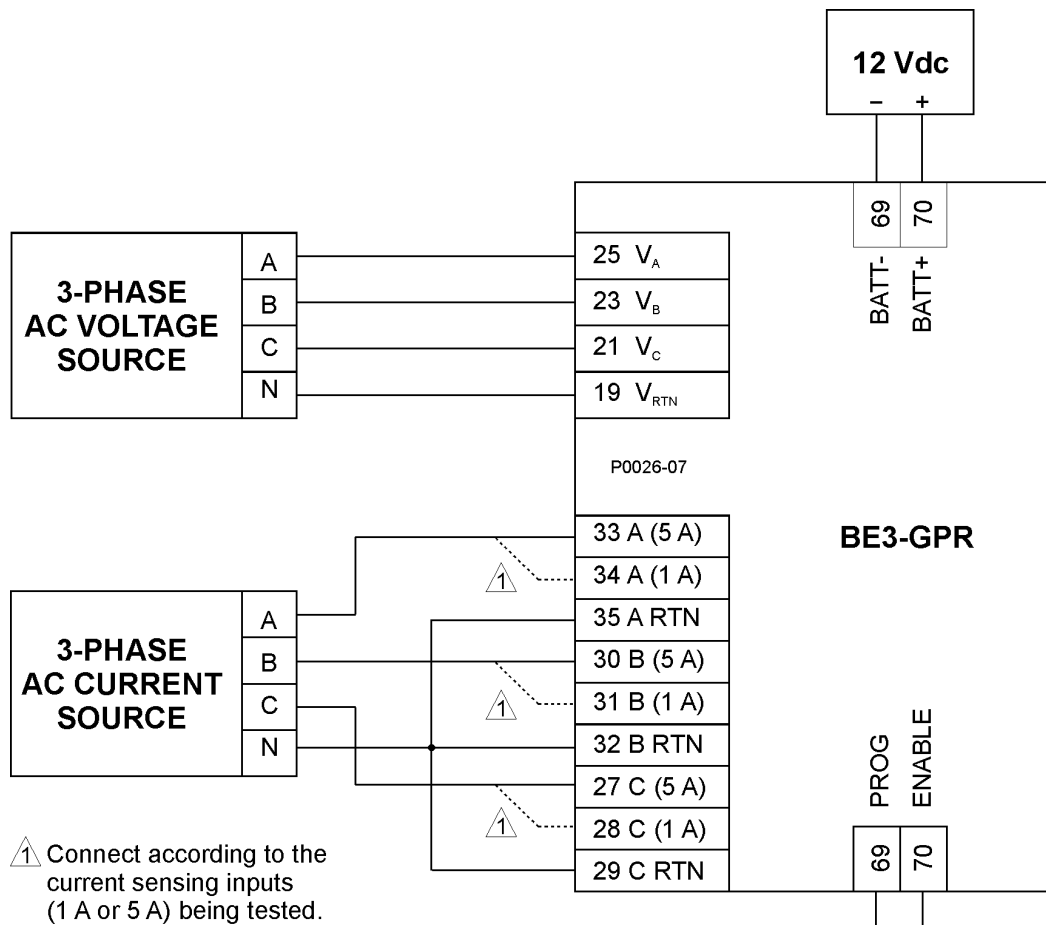


Figure 6-1. BE3-GPR Test Connections

Undervoltage Trip (Line-to-Neutral Voltage Sensing)

1. Monitor the UND VOLT output contacts, terminals 39 and 40, for the trip condition.
2. Reduce phase A, line-to-neutral voltage from 69.3 Vrms to 30 Vrms. The relay should be flashing the undervoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD should return to the un-tripped ON display.

Overfrequency Trip (Line-To-Neutral Frequency Sensing)

1. Monitor the OVR FREQ output contacts, terminals 42 and 43, for the trip condition.
2. Increase 3-phase voltage frequency from 60 Hz to 62 Hz. The relay should be flashing the overfrequency tripped condition on the front panel LCD. Return the frequency to 60 Hz and the LCD should return to the un-tripped ON display.

Underfrequency 1 And Underfrequency 2 Trips

1. Monitor the UND FREQ1 output contacts, terminals 45 and 46, for the underfrequency 1 trip condition.
2. Reduce the frequency of the three-phase voltage from 60 Hz to 58.5 Hz. The relay should be flashing the underfrequency 1 tripped condition on the front panel LCD. Return the frequency to 60 Hz and the LCD should return to the un-tripped ON display. Return the frequency to 58.5 Hz to re-instate the underfrequency 1 trip condition.
3. Monitor the UND FREQ2 output contacts, terminals 48 and 49, for the underfrequency 2 trip condition. It should be open at this point in the test.
4. Further reduce the frequency from 58.5 Hz to 57.5 Hz. The output contacts should close to indicate the underfrequency 2 tripped condition. Note that the display will still be flashing the underfrequency 1 trip message as it did not reset prior to this lower frequency test. Increase the frequency back to 58.5 Hz and the output contacts should open. Return the frequency to 60 Hz and the display should return to the un-tripped ON display.

Phase Balance Trip

1. Monitor the PH BAL output contacts, terminals 54 and 55, for the trip condition.
2. Use the front panel keypad to scroll through the LCD based setup menu and enable the Phase Balance Trip function, but leave the trip, reset and time delay values at their default levels.
3. Increase phase A, line-to-neutral voltage from 69.3 Vrms to 80 Vrms. The relay should be flashing the phase balance tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD should return to the un-tripped ON display.
4. Disable the Phase Balance Trip function using the front panel keypad.

Overvoltage Trip (Line-To-Line Voltage Sensing)

1. Use the front panel keypad to change from 3-phase line-to-neutral sensing (CFGd3=4) to 3-phase line-to-line sensing (CFGd3=3).
2. Monitor the OVR VOLT output contacts, terminals 36 and 37, for the trip condition.
3. Increase phase A, line-to-neutral voltage from 69.3 Vrms to 100 Vrms. (The relay is sensing line-to-line voltage but this test setup is measuring line-to-neutral voltage. If you prefer, you may change the voltmeter measurement points for line-to-line and substitute line-to-line voltages (120 Vrms to 173 Vrms)). The front panel LCD should be flashing the overvoltage tripped condition. Return the voltage to 69.3 Vrms and the LCD should return to the un-tripped ON display.
4. Increase phase B, line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD should return to the un-tripped ON display.
5. Increase phase C, line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the LCD should return to the un-tripped ON display.

Overfrequency Trip (Line-To-Line Frequency Sensing)

1. Monitor the OVR FREQ output contacts, terminals 42 and 43, for the trip condition.
2. Increase 3-phase voltage frequency from 60 Hz to 62 Hz. The relay should be flashing the overfrequency tripped condition on the front panel LCD. Return the frequency to 60 Hz and the LCD should return to the un-tripped ON display.

Neutral Ground Fault Trip (5A NGF CT Current Sensing)

1. Use the front panel keypad to change from 3-phase line-to-line sensing to single-phase line-to-line sensing.
2. Monitor the NG FAULT output contacts, terminals 51 and 6, for the trip condition.
3. Increase ac current from 0 to 0.3 amperes. The relay should be flashing the neutral ground fault tripped condition on the front panel LCD. Return the current to 0 amperes and the LCD should return to the un-tripped ON display.

Overcurrent Trip (5A CT Current Sensing)

1. Use the front panel keypad to change from three-phase line-to-line sensing to single-phase line-to-line sensing.
2. Monitor the OVR CUR output contacts, terminals 51 and 52, for the trip condition.
3. Increase ac current from 0 to 2.0 amperes on any phase. After a 1 second delay the relay should be flashing the overcurrent tripped condition on the front panel LCD. Return the current to 0 Amps and the LCD should return to the un-tripped ON display.

Reactive Current Trip (5A CT Current Sensing)

1. Using Figure 6-1 as a guide, connect the ac current source to the 5A CT B input. NOTE: On three-phase, model type W units, all three-phase currents must be connected.
2. Monitor the REACT CUR output contacts, terminals 63 and 64, for the trip condition.
3. Use the front panel keypad to scroll through the LCD based setup menu and enable the Reactive Current Trip function, but leave the trip, reset, and time delay values at their default levels (REACTI=1,20,15,1).

4. Set each ac current phase angle at 90° lagging relative to its corresponding voltage. Increase all ac currents from 0 to 0.2 amperes. The relay should be flashing the reactive current tripped condition on the front panel LCD. Return the current level to 0 amperes and the LCD should return to the un-tripped ON display.

Reverse Power Trip (5A CT Current Sensing)

1. Monitor the REV PWR output contacts, terminals 60 and 61, for the trip condition. NOTE: On three-phase, model type W units, all three-phase currents must be connected.
2. Use the front panel keypad to scroll through the LCD-based setup menu and enable the Reverse Power Trip function, but leave the trip, reset and time delay values at their default levels (REVPWR=1,100,50,1).
3. Set each ac current phase angle at 0° relative to its corresponding voltage. Increase all ac currents from 0 to 0.5 amperes. The relay should be flashing the reverse power tripped condition on the front panel LCD. Return the current level to 0 amperes and the LCD should return to the un-tripped ON display.

Neutral Ground Fault Trip (1A NGF CT Current Sensing)

1. Using Figure 7-1 as a guide, connect the ac current source to the 1A NGF CT input.
2. Monitor the NG FAULT output contacts, terminals 51 and 6, for the trip condition.
3. Increase ac current from 0 to 0.05 amperes. The relay should be flashing the neutral ground fault tripped condition on the front panel LCD. Return the current to 0 amperes and the LCD should return to the un-tripped ON display.
4. Use the front panel keypad to change from 1A CT sensing back to 5A CT sensing and also to disable Reverse Power and Reactive Current Trip functions.

Overcurrent Trip (1A CT Current Sensing)

1. Using Figure 6-1 as a guide, connect the ac current source to the 1A A, B, or C CT input.
2. Monitor the OVR CUR output contacts, terminals 51 and 52, for the trip condition.
3. Increase ac current from 0 to 0.40 amperes. The relay should be flashing the neutral ground fault tripped condition on the front panel LCD. Return the current to 0 amperes and the LCD should return to the un-tripped ON display.
4. Use the front panel keypad to change from 1A CT sensing back to 5A CT sensing and also to disable Reverse Power and Reactive Current Trip functions.

SYNC-CHECK FUNCTIONS

The following paragraphs are designed to efficiently check the hardware/software operation of the sync-check and dead bus paralleling functions but NOT the relay accuracy.

Sync-Check

1. Reduce the 3-phase ac voltage source to 0 Vrms.
2. Connect a jumper between GEN B input (terminal 24) and BUS - input (terminal 16).
3. Connect the SPST toggle switch between GEN A input (terminal 26) and BUS + input (terminal 18). Place the switch in the open position.
4. Increase the 3-phase ac voltage to 69.3 Vrms line-to-neutral.
5. Monitor the SYNC CHK output contacts, terminals 66 and 67, for the in-sync condition.
6. Use the front panel keypad to scroll through the LCD based setup menu and enable the Sync-Check function, but leave all sync related settings, including dead bus disabled, at their default levels.
7. With the toggle switch open, the SYNC LED should be OFF and the SYNC CHK output contacts should be open.
8. Close the toggle switch. The SYNC LED should come ON and the SYNC CHK output contacts should close.

Dead Bus

1. Open the toggle switch. The SYNC LED should be OFF and the SYNC CHK output contactor should be open.
2. Use the front panel keypad to scroll through the LCD based setup menu and enable the Dead Bus function, but leave its voltage setting at the default level.
3. Upon exiting the setup menu, the SYNC LED should come ON and the SYNC CHK output contacts should close.
4. Use the front panel keypad to scroll through the LCD based setup menu and disable the Sync-Check function.
5. Upon exiting the setup menu, the SYNC LED should go OFF and the SYNC CHK output contacts should open. Closing the toggle switch should have no effect on the LED or sync output contact status.
6. Use the front panel keypad to change from single-phase line-to-line sensing to the default 3-phase line-to-neutral sensing.

CONTACT SENSING

Trip Reset

1. Reduce the three-phase ac voltage source to 0 Vrms.
2. Remove the toggle switch from the relay and connect it across the TRIP RESET input (terminals 12 and 13). Leave the switch in the open position.
3. Increase the three-phase ac voltage back to 69.3 Vrms line-to-neutral. The relay should be in the normal, un-tripped condition.
4. Use the front panel keypad to scroll through the LCD based setup menu and disable the auto trip reset function.
5. Monitor the OVR VOLT output contacts, terminals 36 and 37, for an overvoltage trip condition.
6. Increase phase A line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 Vrms and the relay should remain in the tripped condition.
7. Cycle the toggle switch. The relay should reset back to the normal ON condition.
8. Close the toggle switch and re-apply 100 Vrms to phase A line-to-neutral. The relay should remain in the normal ON condition.
9. Return the phase A voltage to 69.3 Vrms.
10. Open the toggle switch connection.
11. Use the front panel keypad to scroll through the LCD based setup menu and re-enable the auto trip reset function.

Failsafe Enable

1. Remove the toggle switch and connect it to the FAIL SF ENABLE input (terminals 10 and 11). With the toggle switch in the open position the monitored overvoltage trip contacts should also be open.
2. Close the toggle switch to enable the failsafe mode. The monitored overvoltage trip contacts should close.
3. Open the toggle switch connection.

Output Disable

1. Remove the toggle switch and connect it to the OUTPUT DISABLE input, terminals 8 and 9, and close the toggle switch.
2. Increase phase A line-to-neutral voltage from 69.3 Vrms to 100 Vrms. The relay should remain in the normal ON condition.
3. Open the toggle switch. The relay should be flashing the overvoltage tripped condition on the front panel LCD.
4. Return the voltage to 69.3 Vrms and the relay should return to the normal ON condition.

Program Enable

1. Remove the jumper across terminals 6 and 7, previously installed in Section 4, Installation.
2. Attempt to change any of the front panel menu settings. Changes should not be possible.
3. Remove all input connections from the relay.

SECTION 7 • MAINTENANCE

RELAY MAINTENANCE

BE3-GPR relays require no preventive maintenance. However, functional testing should be performed according to scheduled practices.

TROUBLESHOOTING

If the BE3-GPR fails to function properly, follow the procedures listed in Table 7-1. If repairs are required, contact Basler Electric Technical Support.

Table 7-1. BE3-GPR Troubleshooting Procedures

Symptom	Recommended Procedure
No display	<ul style="list-style-type: none">• Check the battery input connections and polarity• Verify that the applied voltage is between 8 and 32 Vdc
No communication	<ul style="list-style-type: none">• Check the serial port connections• Verify that the PC is configured for 2400 baud, 8 data bits, 1 stop bit, and no parity• Verify that the RX and TX lines are connected correctly and not reversed
No data can be entered at the front panel	<ul style="list-style-type: none">• Verify that the Program Enable jumper is installed across terminals 6 and 7
Display always flashes a previous trip condition	<ul style="list-style-type: none">• Momentarily close the Trip Reset input or enable the Automatic Trip Reset option
Reverse power pickups are not correct	<ul style="list-style-type: none">• Confirm that the sensing method is correct and appropriate for the application• Verify that the CT B input is sensing B-phase current in the correct polarity
Reactive current pickups are not correct	<ul style="list-style-type: none">• Confirm that the sensing method is correct and appropriate for the application• Verify that the CT B input is sensing B-phase current in the correct polarity
Trips occur during generator ramp-up or shutdown	<ul style="list-style-type: none">• Close Output Disable contact input to disable trips during startup and shutdown• Increase the trip timing
Phase balance always tripped	<ul style="list-style-type: none">• Verify that the phase rotation is ABC and that the system application is appropriate

STORAGE

This device contains long-life aluminum electrolytic capacitors. For devices that are not in service (spares in storage), the life of these capacitors can be maximized by energizing the device for 30 minutes once per year.

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APPENDIX A • CHARACTERISTIC CURVES

TIME-CURRENT CHARACTERISTICS

Sixteen inverse time functions and one fixed (definite) time function can be selected. Curves are identified and selected by a number designator of 1 through 17 that corresponds to a specific curve type. A BE3-GPR characteristic curve cross-reference is provided in Table A-1.

Table A-1. Characteristic Curve Cross-Reference

Curve Number	Curve Name	Similar To
1	S1, Short Inverse	ABB CO-2
2	S2, Short Inverse	GE IAC-55
3	L1, Long Inverse	ABB CO-5
4	L2, Long Inverse	GE IAC-66
5	D, Definite Time	ABB CO-6
6	M, Moderately Inverse	ABB CO-7
7	I1, Inverse Time	ABB CO-8
8	I2, Inverse Time	GE IAC-51
9	V1, Very Inverse	ABB CO-9
10	V2, Very Inverse	GE IAC-53
11	E1, Extremely Inverse	ABB CO-11
12	E2, Extremely Inverse	GE IAC-77
13	Standard Inverse	BS, IEC Standard Inverse
14	Very Inverse (It)	BS, IEC Very Inverse (It)
15	Extremely Inverse (I ² t)	BS, IEC Extremely Inverse (I ² t)
16	Long Time Inverse	BS, IEC Long Time Inverse
17	Fixed Time	

Inverse and Definite Time Functions

Characteristic curves for the inverse and definite time functions are defined by the following equation:

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

Where:

- T_T = time to trip in seconds
- D = time dial setting
- M = multiple of pickup setting
- A, B, C, N, K = constants for the particular curve

Characteristic Curve Constants

Table A-2 lists the time characteristic curve constants used by the BE3-GPR. Constants have been selected to conform to the characteristics of electromechanical relays over a range of pickup multiples from 1.3 to 40. Values of the constants are provided for use in PC relay setting applications.

Table A-2. 51V Time Characteristic Curve Constants

Curve Number	Figure Number	BE Curve Name	Trip Characteristic Constants				
			A	B	C	N	K
1	A-1	S1, Short Inverse	0.2663	0.03393	1.000	1.2969	0.028
2	A-2	S2, Short Inverse	0.0286	0.0280	1.000	0.9844	0.028
3	A-3	L1, Long Inverse	5.6143	2.18592	1.000	1.000	0.028
4	A-4	L2, Long Inverse	2.3955	0.00000	1.000	0.3125	0.028
5	A-5	D, Definite Time	0.4797	0.21359	1.000	1.5625	0.028
6	A-6	M, Moderately Inverse	0.3022	0.12840	1.000	0.5000	0.028
7	A-7	I1, Inverse Time	8.9341	0.17966	1.000	2.0938	0.028
8	A-8	I2, Inverse Time	0.2747	0.10426	1.000	0.4375	0.028
9	A-9	V1, Very Inverse	5.4678	0.10814	1.000	2.0469	0.028
10	A-10	V2, Very Inverse	4.4309	0.09910	1.000	1.9531	0.028
11	A-11	E1, Extremely Inverse	7.7624	0.02758	1.000	2.0938	0.028
12	A-12	E2, Extremely Inverse	4.9883	0.01290	1.000	2.0469	0.028
13	A-13	Standard Inverse	0.01414	0.00000	1.000	0.0200	0.028
14	A-14	Very Inverse (It)	1.4636	0.00000	1.000	1.0469	0.028
15	A-15	Extremely Inverse (I ² t)	8.2506	0.00000	1.000	2.0469	0.028
16	A-16	Long Time Inverse	12.1212	0.00000	1.000	1.0000	0.028
17	N/A	Fixed Time	0.0000	1.00000	0.000	0.0000	0.028

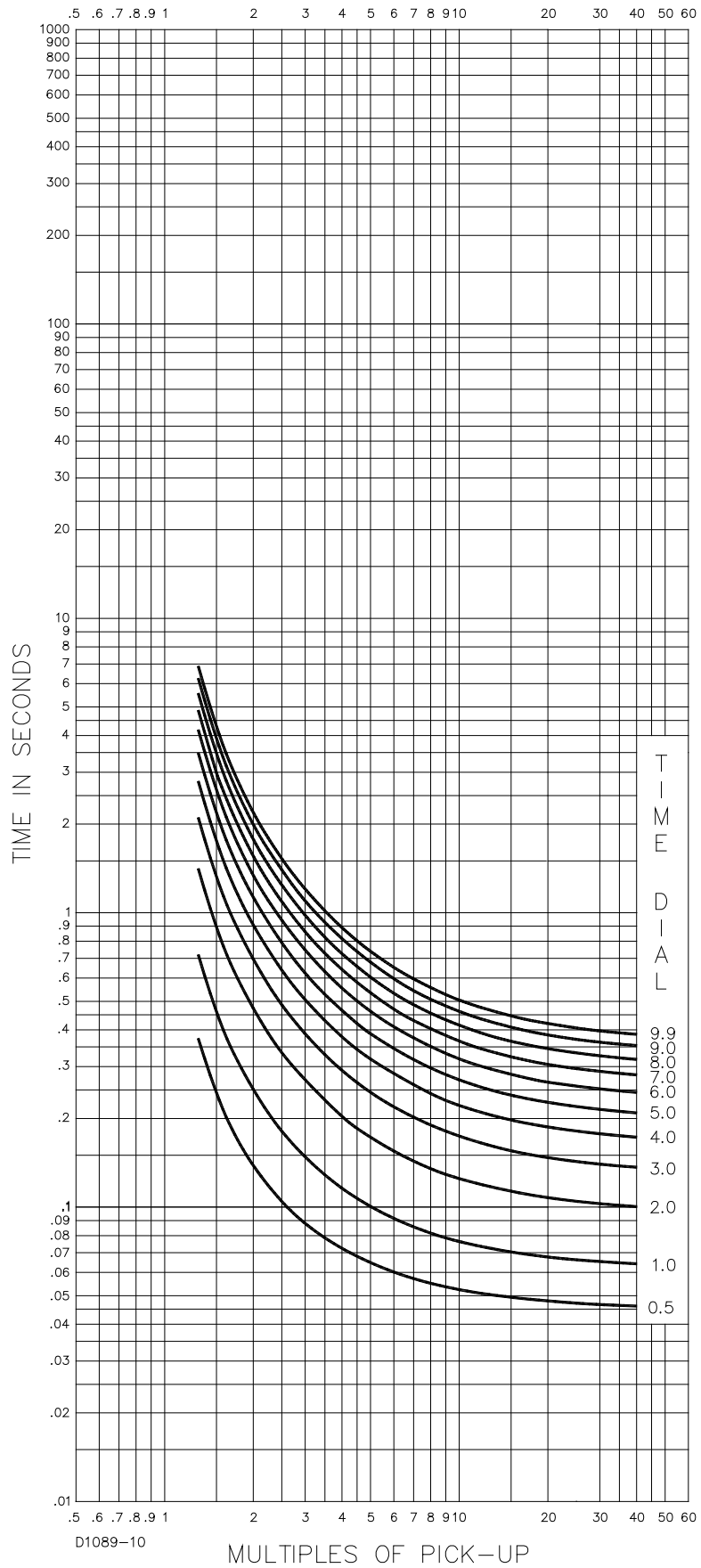


Figure A-1. Curve 1, Short Inverse, S1 (Similar to ABB CO-2)

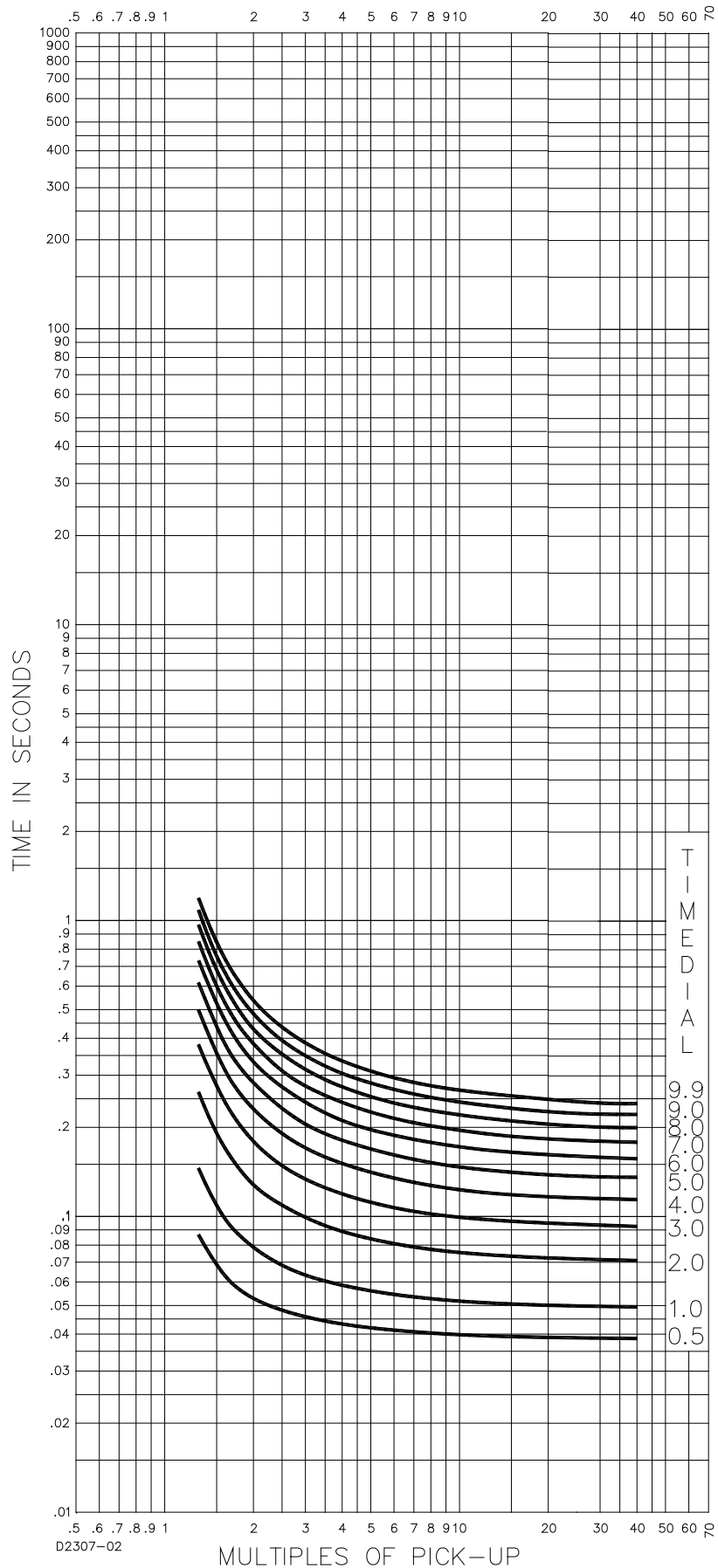


Figure A-2. Curve 2, Short Inverse, S2 (Similar to GE IAC-55)

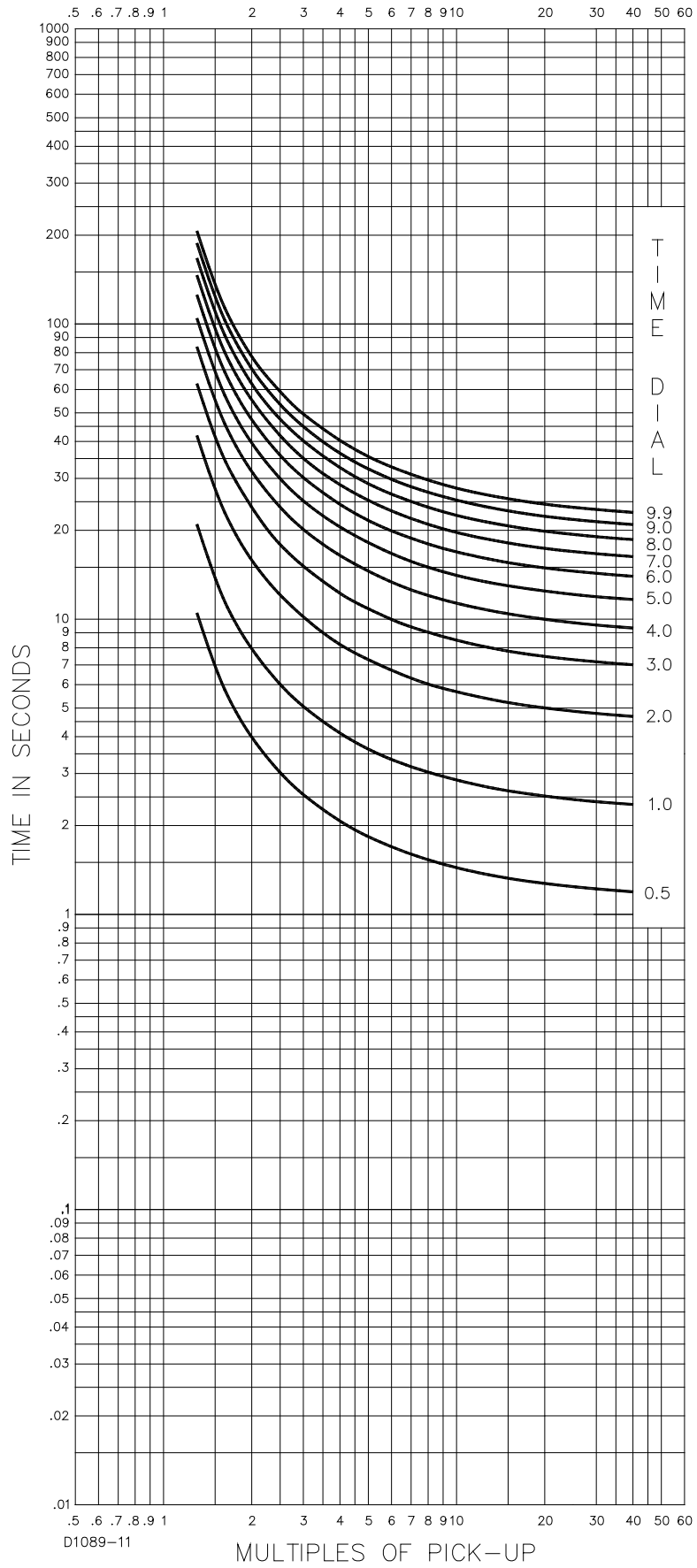


Figure A-3. Curve 3, Long Inverse, L1 (Similar to ABB CO-5)

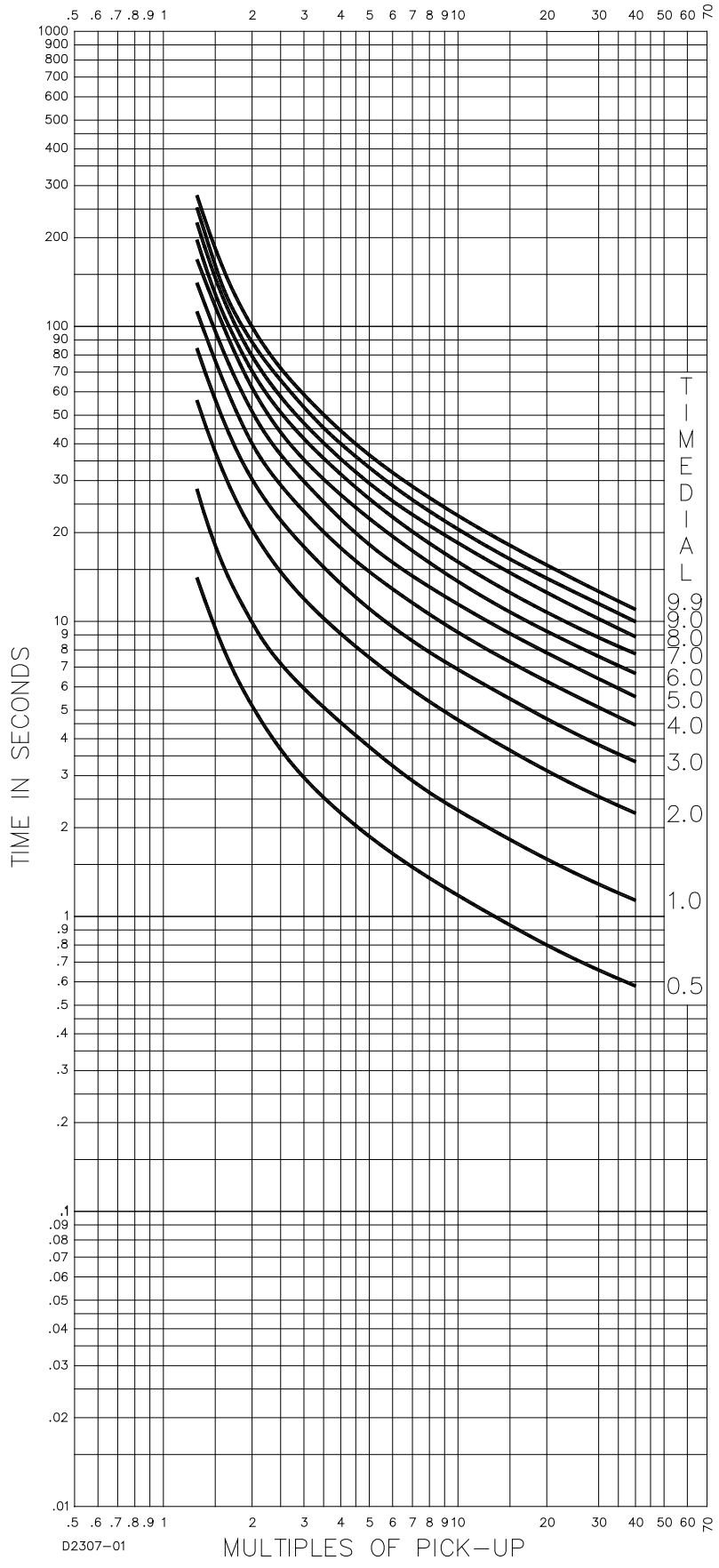


Figure A-4. Curve 4, Long Inverse, L2 (Similar to GE IAC-66)

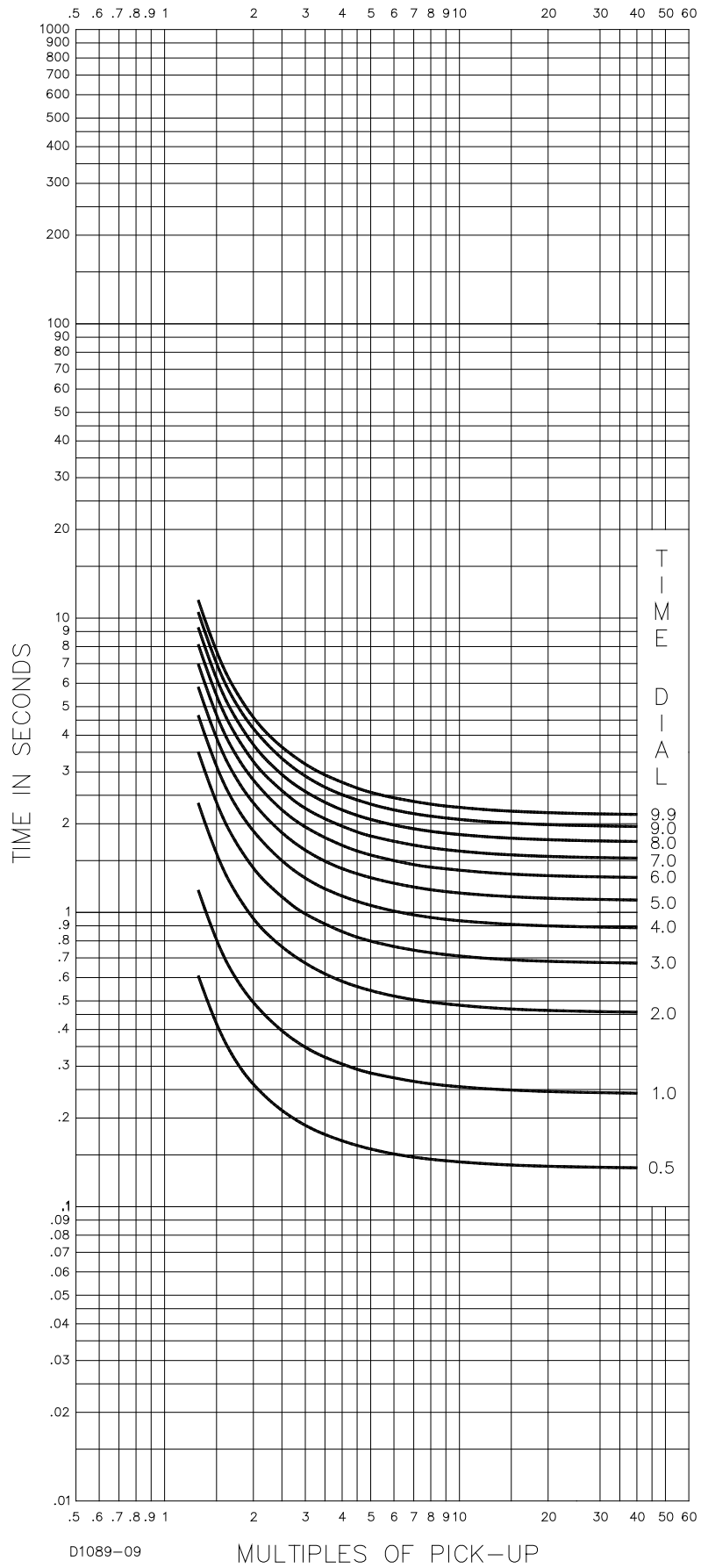


Figure A-5. Curve 5, Definite Time, D (Similar to ABB CO-6)

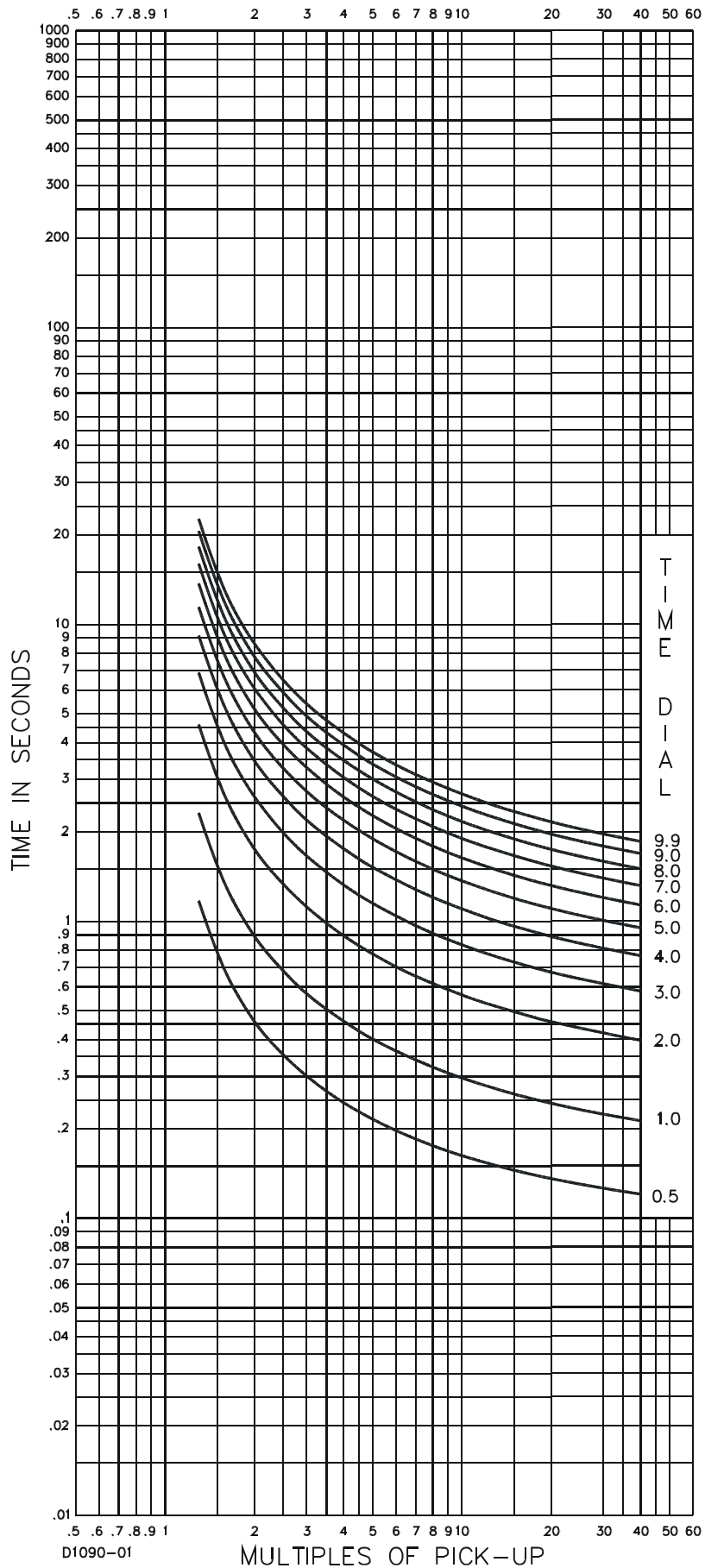


Figure A-6. Curve 6, Moderately Inverse, M (Similar to ABB C07)

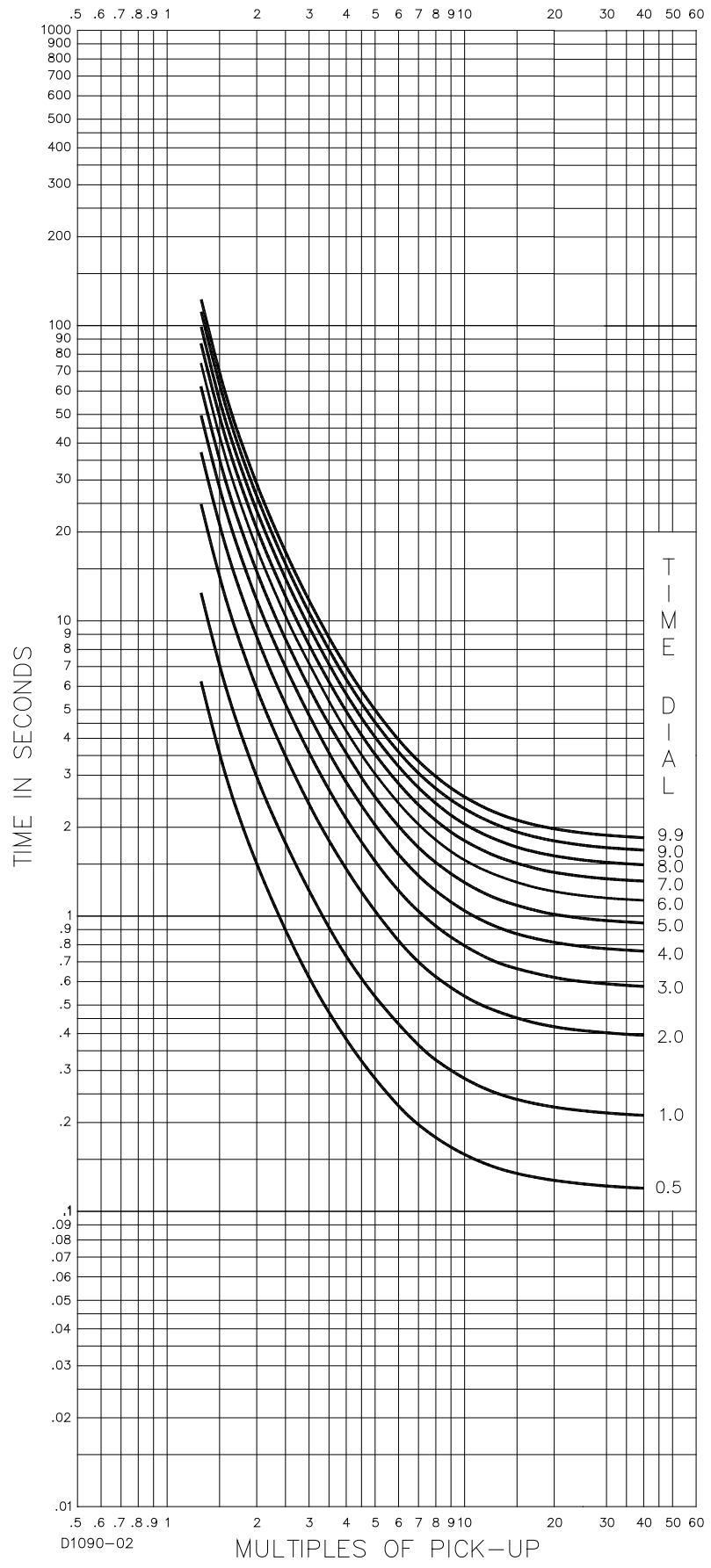


Figure A-7. Curve 7, Inverse Time, I1 (Similar to ABB CO-8)

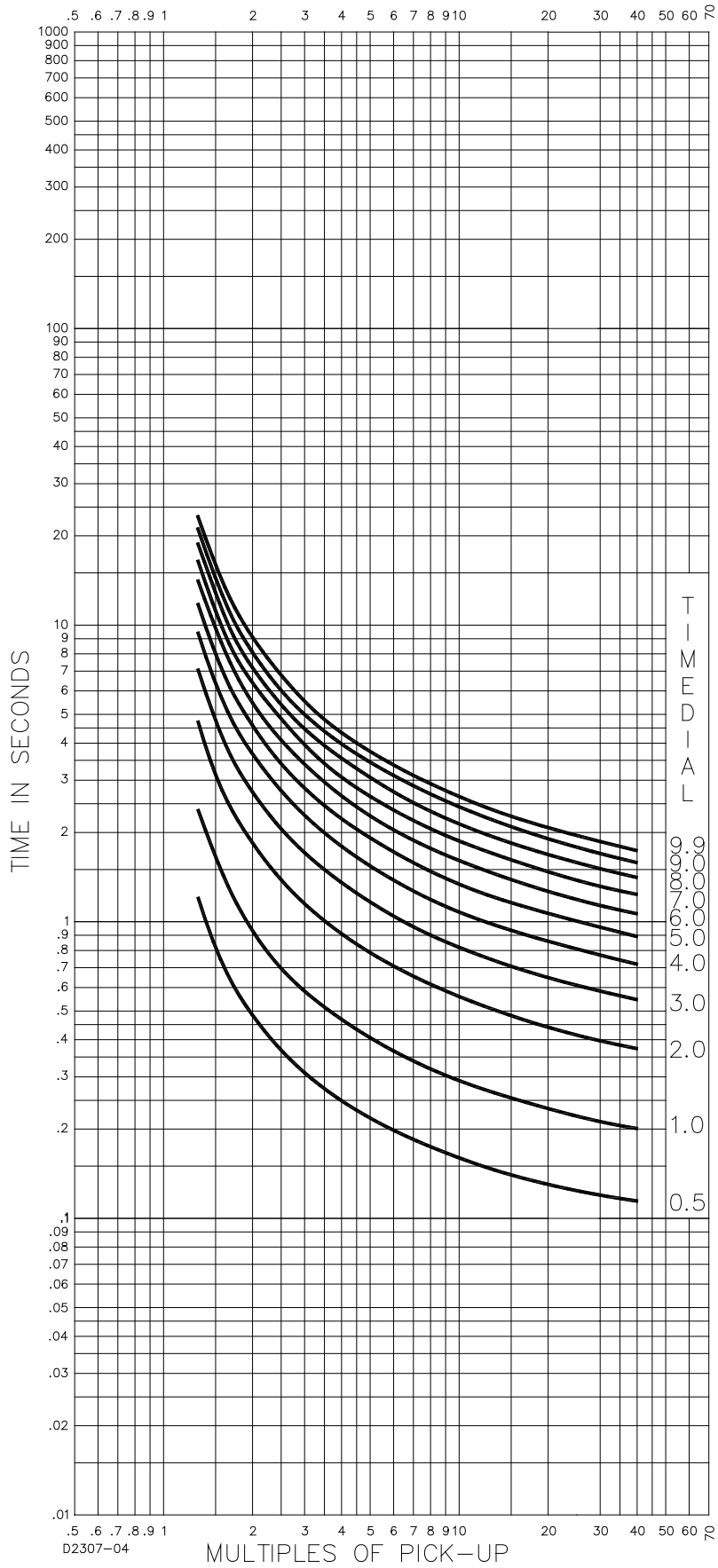


Figure A-8. Curve 8, Inverse Time, I_2 (Similar to GE IAC-51)

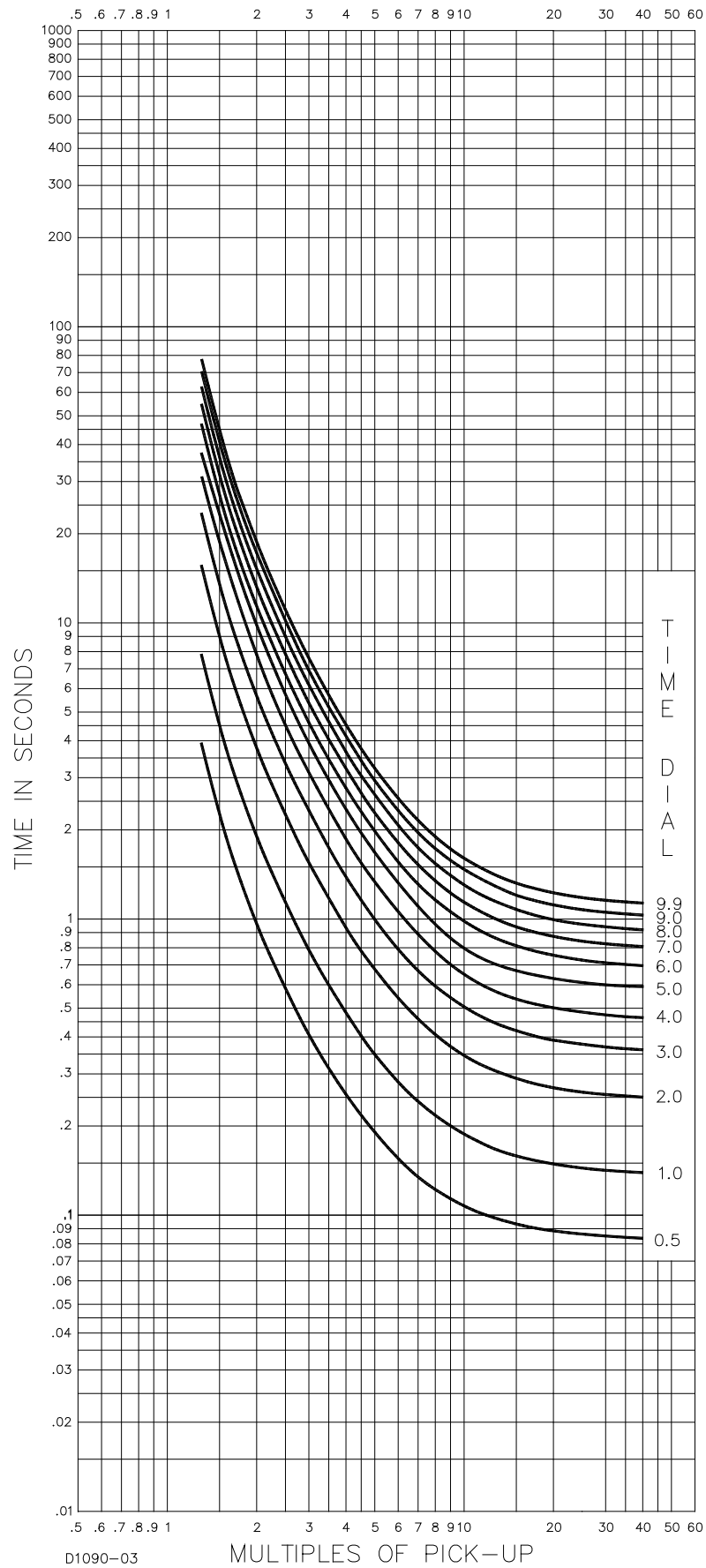


Figure A-9. Curve 9, Very Inverse, V1 (Similar to ABB CO-9)

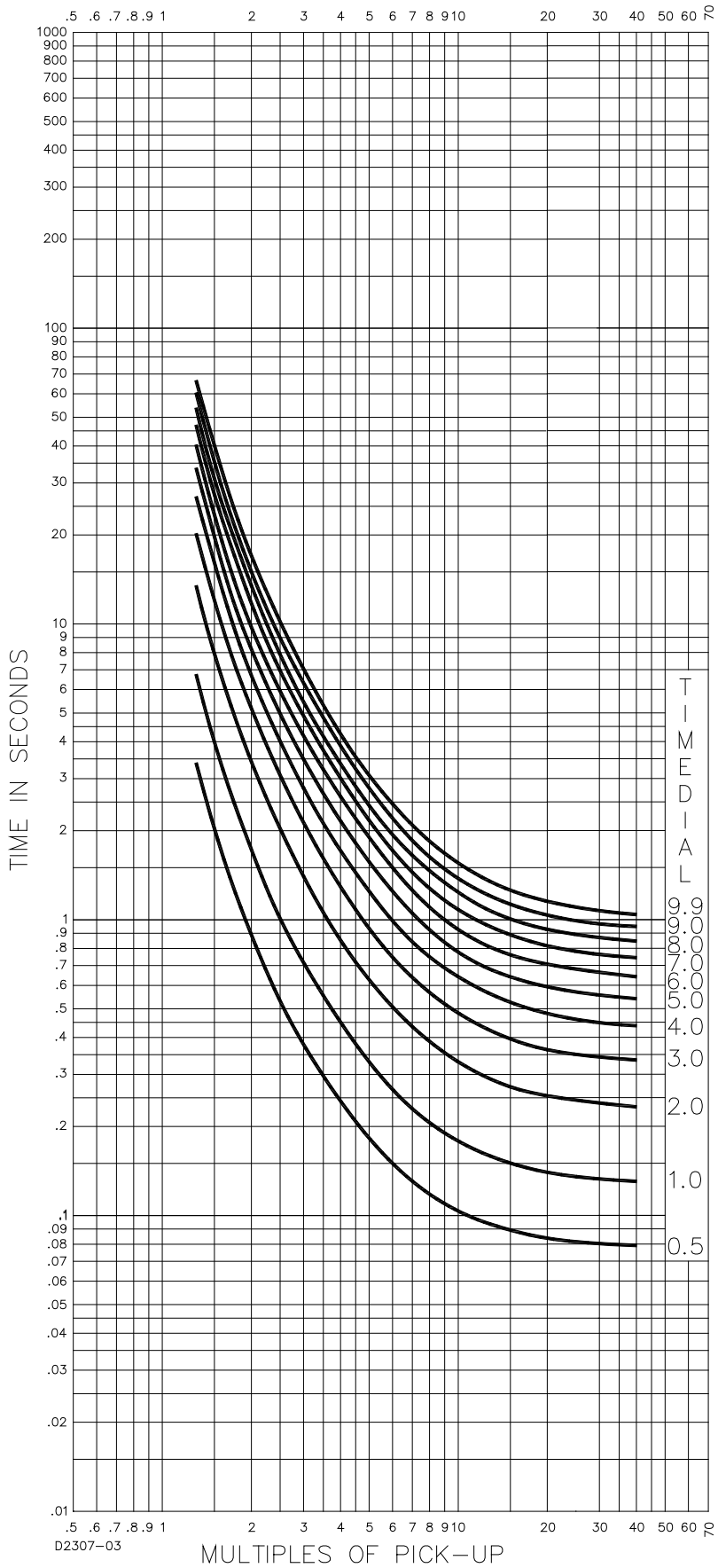


Figure A-10. Curve 10, Very Inverse, V2 (Similar to GE IAC-53)

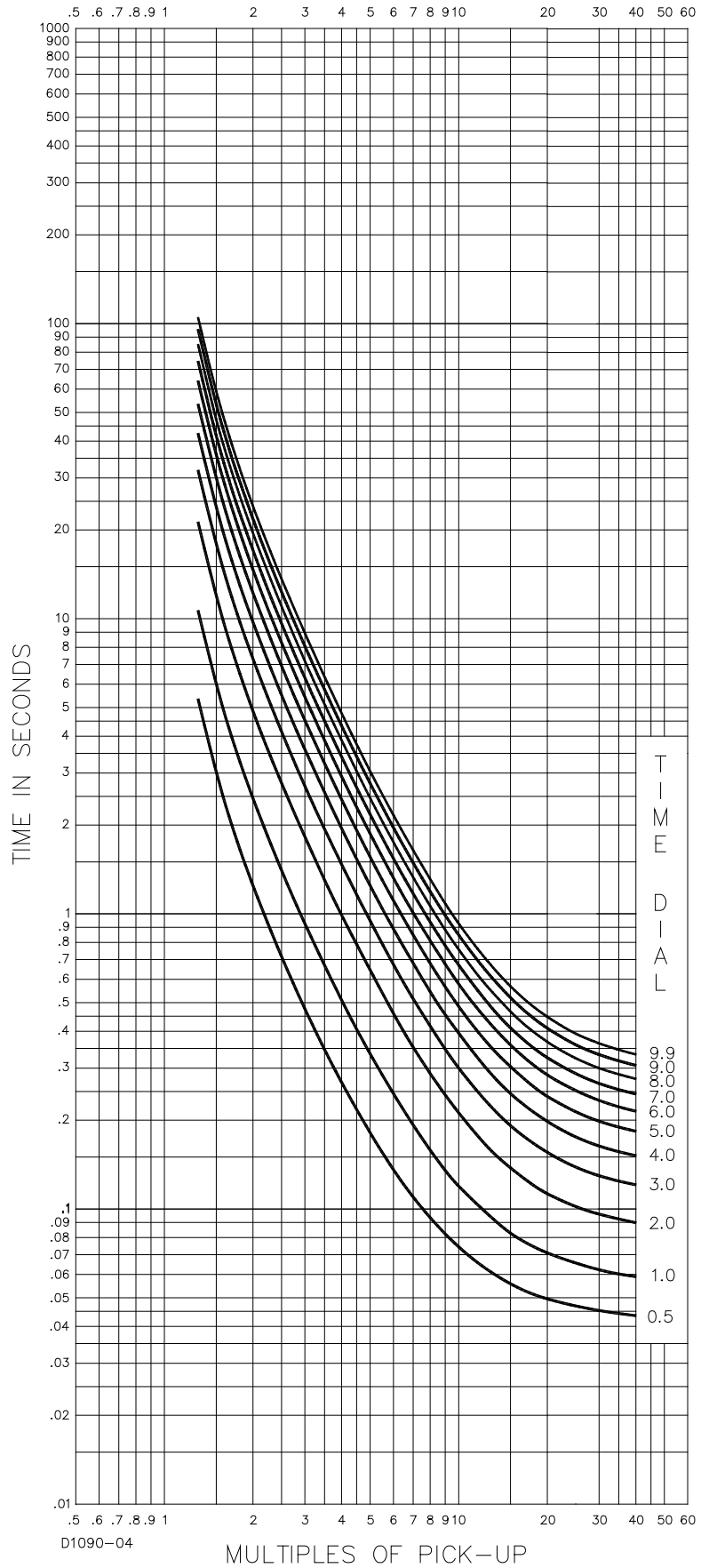


Figure A-11. Curve 11, Extremely Inverse, E1 (Similar to ABB CO-11)

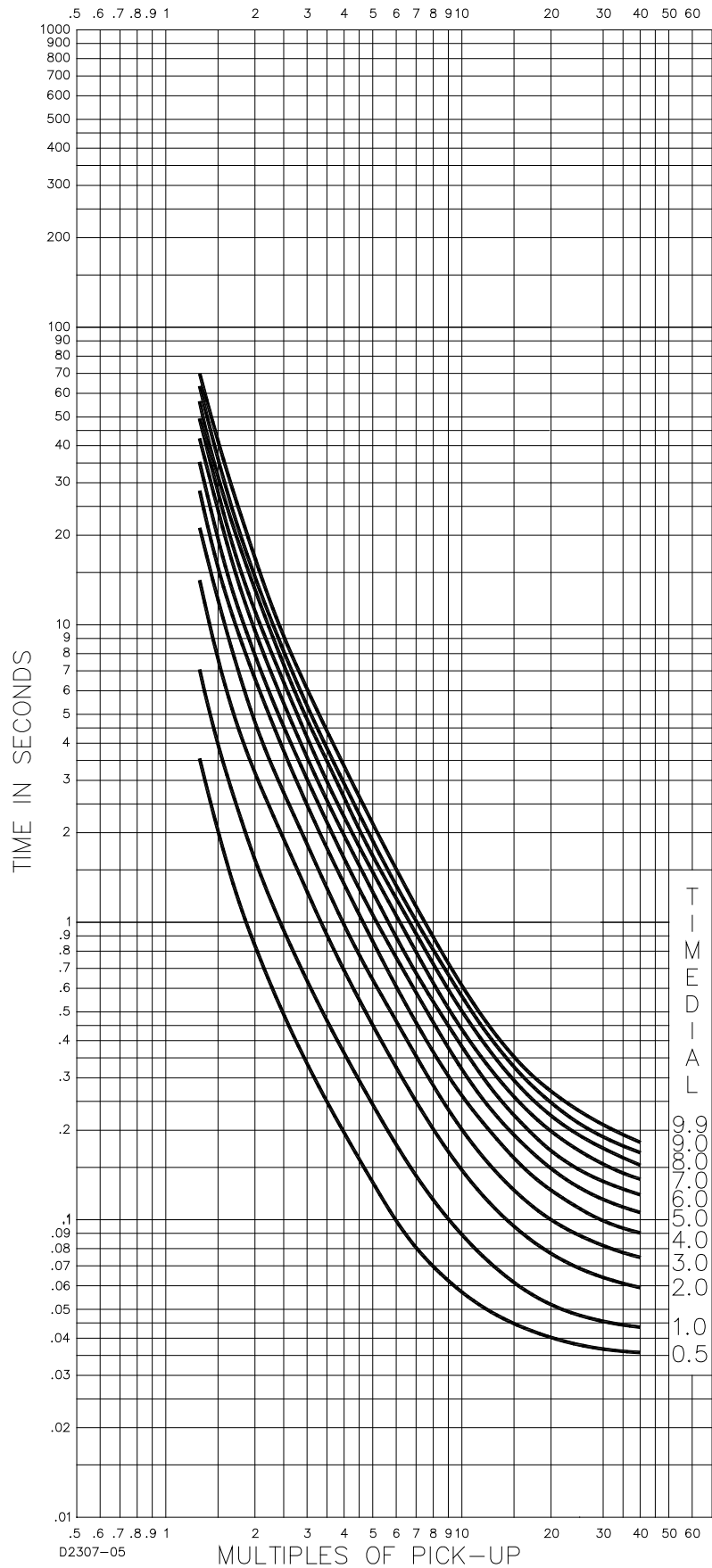


Figure A-12. Curve 12, Extremely Inverse, E2 (Similar to GE IAC-77)

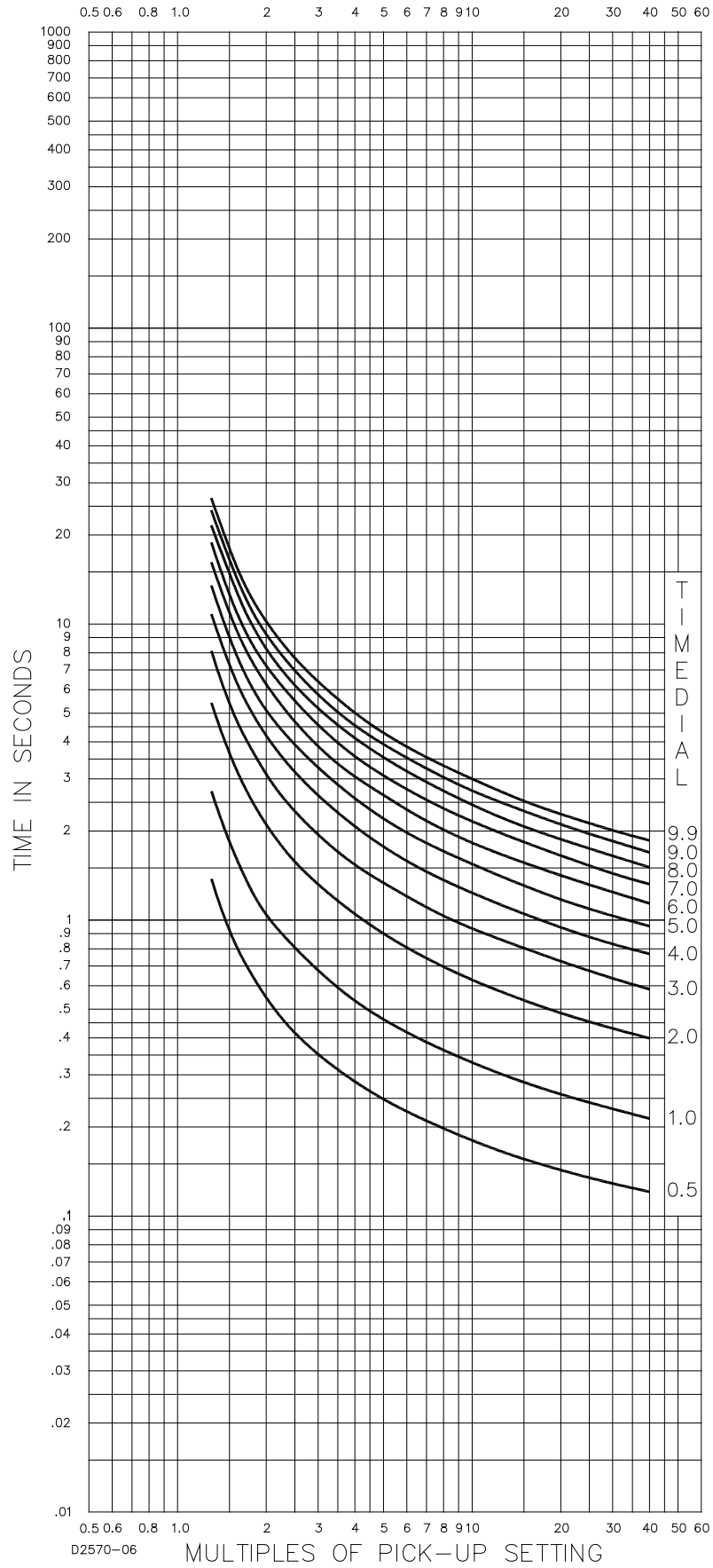


Figure A-13. Curve 13, Standard Inverse, (Similar to BS, IEC Standard Inverse)

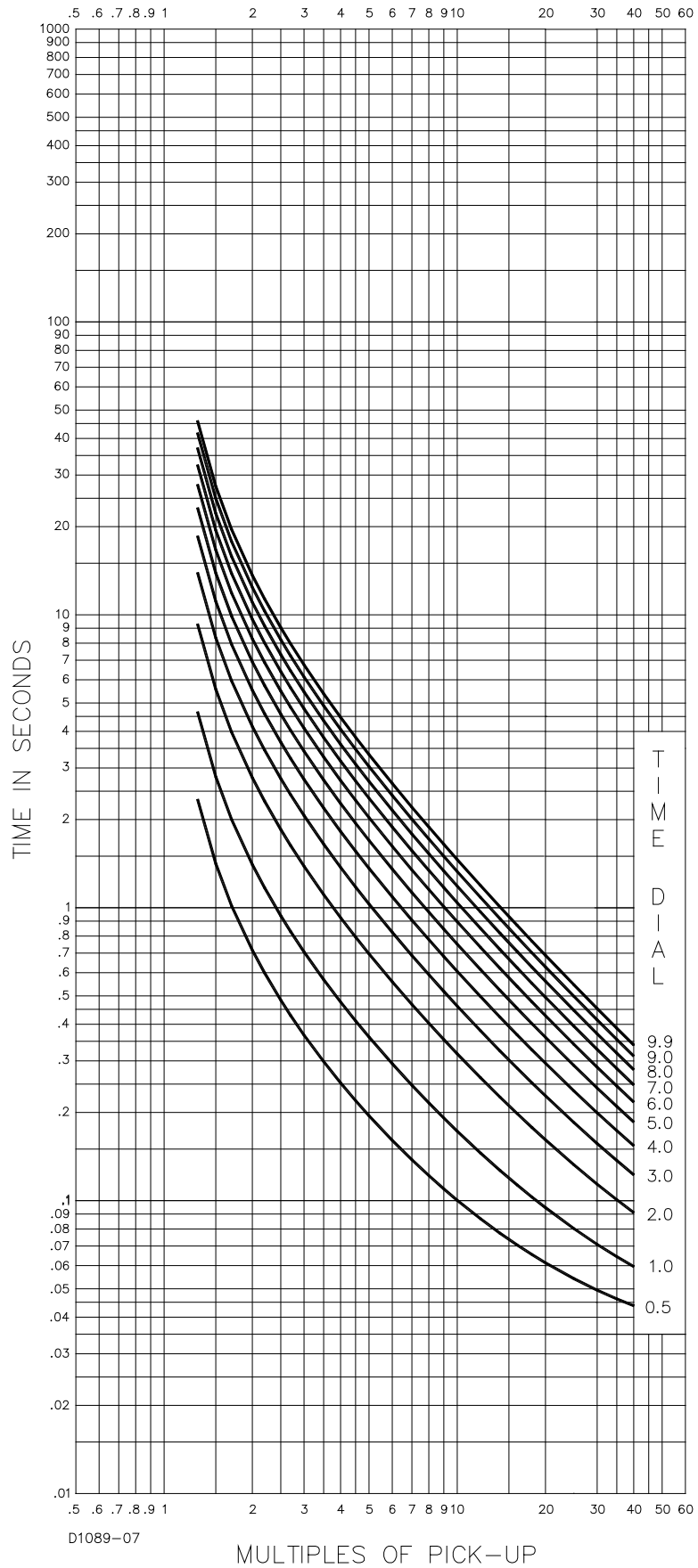


Figure A-14. Curve 14, Very Inverse (Similar to BS, IEC Very Inverse (It))

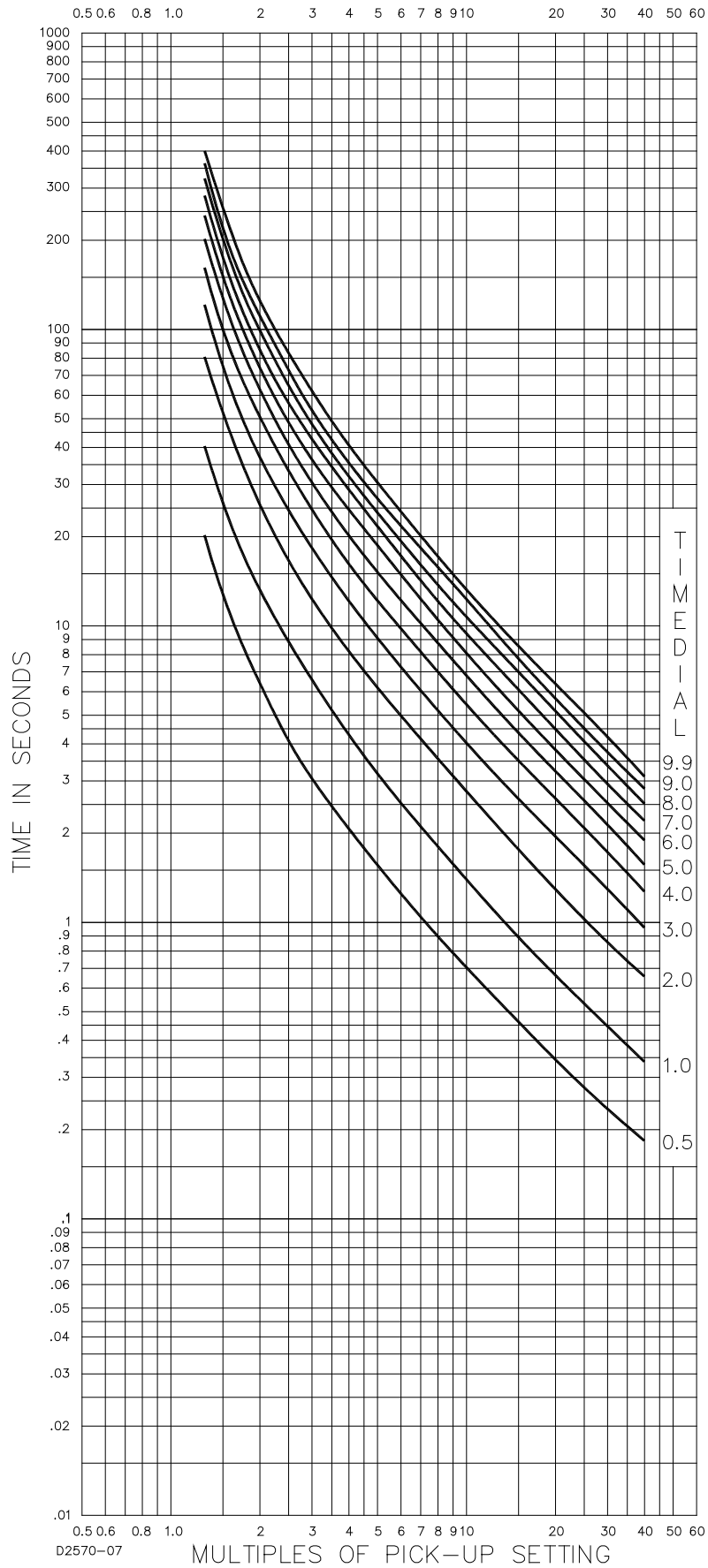


Figure A-16. Curve 16, Long Time Inverse (Similar to BS, IEC Long Time Inverse)

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