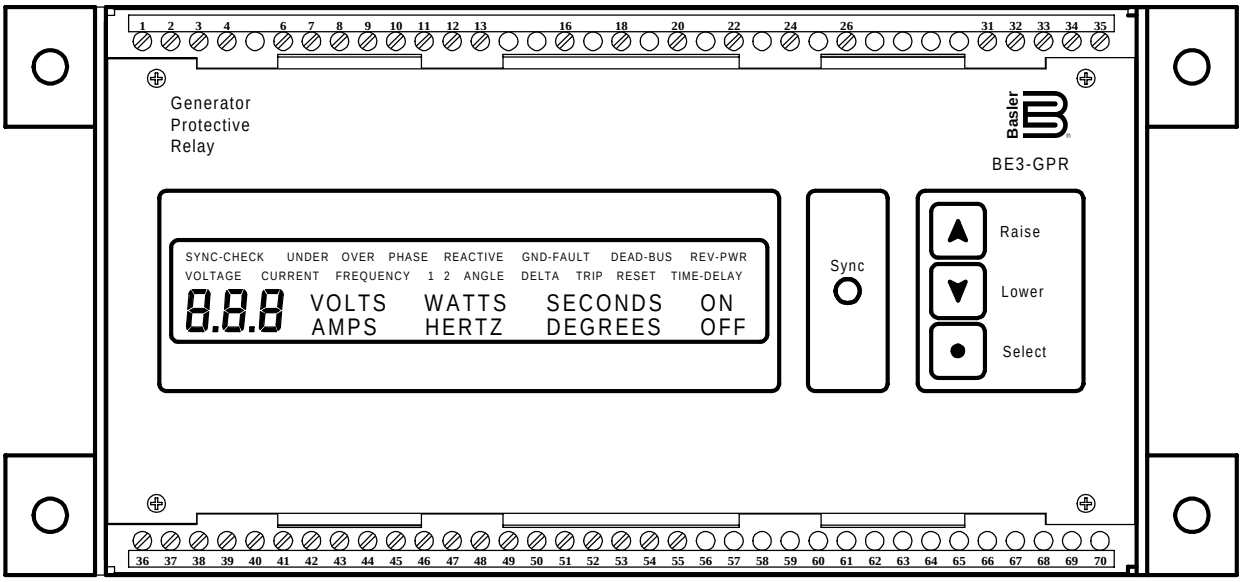
INSTRUCTION MANUAL

FOR

GENERATOR PROTECTIVE RELAY

BE3-GPR



Basler Electric

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INTRODUCTION

This manual provides information concerning the operation and installation of BE3-GPR Generator Protective Relays. To accomplish this, the following is provided.

- Specifications
- Functional Description
- Mounting Information
- Communications
- Testing Procedures

WARNING

TO AVOID PERSONAL INJURY OR EQUIPMENT DAMAGE, ONLY QUALIFIED PERSONNEL SHOULD PERFORM THE PROCEDURES PRESENTED IN THIS MANUAL.

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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 Company, Highland, Illinois.

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SECTION 1 • GENERAL INFORMATION

DESCRIPTION

BE3-GPRs (Generator Protective Relays) use microprocessor based technology to provide total generator protection in a single package. This microprocessor design allows for exact setpoint adjustment and precise generator system protection. BE3-GPRs allow for quick and simple setup via a personal computer or front panel human machine interface. Because the BE3-GPRs have low sensing burdens, no dedicated PTs and CTs are required. Optional protective features allow for customizing the BE3-GPRs to meet your system requirements. The BE3-GPR provides multiple functions in a single case -- a combination that yields significant savings in installation and setup.

CAPABILITIES

BE3-GPRs are packaged in metal cases for improved electromagnetic compatibility. They are moisture and dust resistant. Each device provides protection for stand-alone, isolated generating systems or paralleled generating systems. Models with the following protective functions are available.

Basic Stand-Alone Generator Version

- 27/59 Under/Over voltage protection
- 81O/U Under/Over frequency protection
- 81U Underfrequency

Basic Paralleled Generator Version:

- 27/59 Under/Over voltage protection
- 81O/U Under/Over frequency protection
- 81U Underfrequency
- 32R Reverse power protection

Optional Protective Functions

- 51V Time Overcurrent
- 51N Neutral fault current protection
- 40 Reactive current (loss of excitation) protection (Paralleled Version Only)
- 47 Phase balance protection
- 25 Sync-check/dead bus closing (Paralleled Version Only)

Model combinations depend on the selected style.

Control Enables

Four hardware jumpers enable the following special protective features. Each feature is continuously monitored by software within the microprocessor. They are:

- Trip reset
- Program enable
- Failsafe enable
- Output enable

Watchdog Timer

The watchdog timer monitors the microprocessor for proper software and microprocessor operation. If there is an occurrence that inhibits proper operation, the watchdog timer de-energizes the watchdog timer output contacts to annunciate the problem to the system.

Indicators

There are two indicators mounted on the front panel of the relay. The **SYNC** LED (present only in the BE3-GPR P units with the sync-check option) indicates that the generator and bus inputs are within the synchronization window set by the user. The liquid crystal display (LCD) is the main human-machine interface and has capabilities to show any and all information necessary for programming and interpreting relay actions.

Communications

Communication capability provides a remote serial interface between the relay and a computer. Basler Electric offers a software package that enhances communications to BE3-GPRs. This software package also provides a real time metering capability for monitoring generator voltage, frequency, current, watts, power factor, and volt-amperes.

OUTPUTS

There are eleven isolated form C output contact arrangements. One for each of the nine protective functions, the sync-check/dead bus function, and the watchdog timer.

SPECIFICATIONS

Timing Accuracy: (All Functions Except 51V)	Accuracy is ±1% or ±50 milliseconds, whichever is greater.
27 *Undervoltage*	Trip point and reset set points are settable from 70 to 600 Vac in one volt steps, and trip timing is adjustable from 0 to 20 seconds in one second steps. Accuracy is ±2%. Repeatability is ±1.0 %.
59 *Overvoltage*	Trip point and reset set points are settable from 70 to 600 Vac in one volt steps, and trip timing is adjustable from 0 to 20 seconds in one second steps. Accuracy is ±2%. Repeatability is ±1.0 %.
81O *Overfrequency*	Trip point and reset points are settable from 35 to 75 hertz in 0.1 hertz steps. Trip timing is adjustable from 0 to 20 seconds in steps of one second. Accuracy is ±0.025 Hz. Repeatability is ±0.01 Hz.
81U *Underfrequency*	Trip point and reset points are settable from 35 to 75 hertz in 0.1 hertz steps. Trip timing is adjustable from 0 to 20 seconds in one second steps. Accuracy is ±0.025 Hz. There are two independent 81U functions available. Repeatability is ±0.01 Hz.
32R *Reverse Power*	Measures three-phase reverse power. Trip point and reset points are settable from 50 to 999 watts in one watt steps. Trip timing is adjustable from 0 to 20 seconds in one second steps. At power factors equal to or greater than the absolute value of 0.5, and at 25°C, accuracy is ±2% or ±10W whichever is greater. At temperatures from -25 to 60°C, accuracy is ±5% or ±10W whichever is greater. This function is available only in the paralleled generator version. Repeatability is ±1.0 %.

25
Sync-Check With Dead Bus

Phase angle is settable from 2 to 20 degrees in one degree steps, and voltage difference is adjustable from 1 to 100 Vac in one volt steps. Both the time delay (which is variable from 0.2 to 2 seconds in 0.1 second steps), and the slip frequency (which is variable from 0.1 hertz to 1.0 hertz in 0.1 hertz steps) qualify the in-sync condition. Dead Bus is settable from 10 to 50 volts in increments of one volt. Accuracy is: Delta Voltage — ±2% or ±1 V, whichever is greater throughout operating range of 5 to 100 volts; Delta (slip) Frequency — ±0.02 Hz throughout operating range of 0.1 to 0.5 Hz, Delta phase angle — ±0.5 degrees. This function is an option available only on the paralleled generator version of the relay. Repeatability is ±1.5 %.

47
Phase Balance

Phase balance measures the maximum voltage difference between any two line-to-line phases. Trip point and reset points are settable from 5 to 100 volts in 1 volt steps. The timing is settable from 0 to 20 seconds in one second steps. Accuracy is ±3% or ±2 V, whichever is greater throughout operating range of 5 to 100 volts. Repeatability is ±1.0 %.

40
Loss of Excitation

Measures the reactive current into the generator. In the five ampere CT setting, trip point and reset points are settable from 0.15 to 2.5 amperes in 0.01 ampere steps. In the one ampere CT setting, trip point and reset points are settable from 0.03 to 0.5 amperes in 0.01 ampere steps. Trip timing is adjustable from 0 to 20 seconds in one second increments. Accuracy is ±3.5% or ±0.05 ampere, whichever is greater throughout operating range of 0.15 to 2.5 amperes. This is an option available only in the paralleled version. Repeatability is ±1.0 %.

51N
Neutral Ground Fault (NGF)

Provides protection from ground fault occurrence by measuring RMS neutral currents. In the five ampere CT configuration, trip point and reset points are settable from 0.2 to 3 amperes in 0.01 ampere steps. Trip point and reset points are settable from 0.04 to 0.6 amperes in 0.01 amperes increments, in the one ampere CT configuration. Trip timing is adjustable from 0 to 2 seconds in 0.1 second steps. Accuracy is ±2% or ±0.01A whichever is greater throughout operating range of 0.2 to 3.0 amperes.

51V
Time Overcurrent (TOC) with Voltage Restraint

Provides protection from overcurrent occurrence by measuring RMS line currents. In the five ampere CT configuration, trip point and reset points are settable from 0.1 to 9.99 amperes in 0.01 ampere steps. Trip point and reset points are settable from 0.10 to 2.00 amperes in 0.01 amperes increments, in the one ampere CT configuration. Accuracy is ±2.5% or ±0.05A whichever is greater throughout operating range of 0.1 to 5.0 amperes.

Time-Current Characteristic Curves

Sixteen inverse time functions and one fixed time function can be selected. Characteristic curves for the inverse and definite time functions are defined by the following equation.

$$T_T = \frac{A \cdot D}{M^N - C} + B \cdot D + K$$

T_T = Time to trip when $M \geq 1$
D = TIME DIAL setting (0.0 to 9.9)
M = Multiple of PICKUP setting (0 to 40)
A, B, C, N, K = Constants for the particular curve

See Table 1-1 for the time characteristic curve constants.

Timing Accuracy (51V Functions)

Within ±5% or 50 mSec, 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 A for 5 A CT units or 6 A for 1 A CT units.
* 3-40 times pickup for the A-curve.

Voltage Restraint:

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 falls below 25% of nominal, the time overcurrent pickup point will be 25% of the actual time overcurrent setting (see Figure 1).

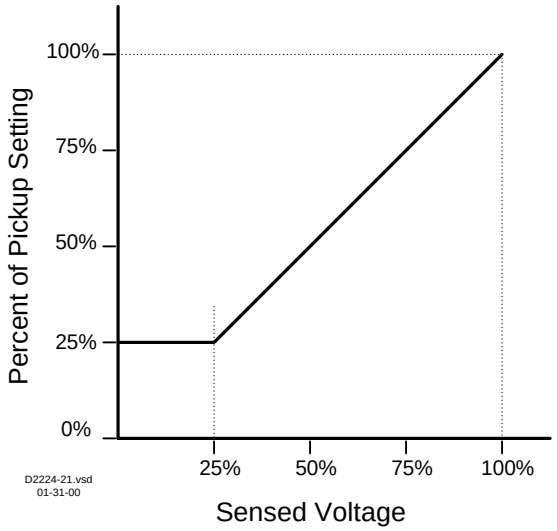


Figure 1-1. Voltage Restraint

Power Supply:

Power input (battery)

12 Vdc nominal systems (8 to 16 Vdc)
24 Vdc nominal systems (16 to 32 Vdc)
Power dissipated is 6.5 watts

Inputs:

Voltage Sensing Inputs

100 to 480 Vac nominal, 50 to 60 hertz, @ less than 1 VA per phase
1.2 times nominal continuously
1.5 times nominal for 10 seconds
May be: single-phase; three-phase, three wire; or three-phase, four wire

Current Sensing Inputs

1 or 5 ampere input @ 1 VA per phase
2 times nominal continuously
10 times nominal for 1 second

Outputs:

Contact Ratings

Resistive:

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

Inductive:

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

UL Recognized/CSA Certified — UL Recognized per Standard 508, UL File No. E97033. CSA Certified per Standard CAN/CSA-C22.2 No. 14-M91, CSA File No. LR 23131.

Patent — Patented in U.S., 1997, U.S. Patent No. 5,309,312.

Isolation — 2000 Vac for one minute between ground and voltage sensing inputs. 500 Vac for one minute between ground and any of the following groups or between any of the following groups. Surge suppression components are used on all case output terminals. Nominal leakage currents as shown in the following paragraph will result.

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	6 mAac or 1 mAdc
Contact outputs	31 mAac or 1 mAdc

Table 1-1. 51V Time Characteristic Curve Constants

Curve Number	BE3-GPR Curve Selection	BE Curve Name	Trip Characteristic Constants				
			A	B	C	N	K
1	**S1**	S1, Short Inverse	0.2663	0.03393	1.000	1.2969	0.028
2	**S2**	S2, Short Inverse	0.0286	0.0280	1.000	0.9844	0.028
3	**L1**	L1, Long Inverse	5.6143	2.18592	1.000	1.000	0.028
4	**L2**	L2, Long Inverse	2.3955	0.00000	1.000	0.3125	0.028
5	**D**	D, Definite Time	0.4797	0.21359	1.000	1.5625	0.028
6	**M**	M, Moderately Inverse	0.3022	0.12840	1.000	0.5000	0.028
7	**I1**	I1, Inverse Time	8.9341	0.17966	1.000	2.0938	0.028
8	**I2**	I2, Inverse Time	0.2747	0.10426	1.000	0.4375	0.028
9	**V1**	V1, Very Inverse	5.4678	0.10814	1.000	2.0469	0.028
10	**V2**	V2, Very Inverse	4.4309	0.09910	1.000	1.9531	0.028
11	**E1**	E1, Extremely Inverse	7.7624	0.02758	1.000	2.0938	0.028
12	**E2**	E2, Extremely Inverse	4.9883	0.01290	1.000	2.0469	0.028
13	**A**	Standard Inverse	0.01414	0.00000	1.000	0.0200	0.028
14	**B**	B, Very Inverse (It)	1.4636	0.00000	1.000	1.0469	0.028
15	**C**	Extremely Inverse (I^2t)	8.2506	0.00000	1.000	2.0469	0.028
16	**G**	Long Time Inverse	12.1212	0.00000	1.000	1.0000	0.028

Curve Number	BE3-GPR Curve Selection	BE Curve Name	Trip Characteristic Constants				
			A	B	C	N	K
17	**F**	Fixed Time	0.0000	1.00000	0.000	0.0000	0.028

Impulse Qualified to IEC 255-5

Radio Frequency Interference (RFI) Field tested using a 5 watt, hand held transceiver operating at random frequencies centered around 144 Mhz and 440 Mhz, with the antenna located 6 inches from the relay in both horizontal and vertical planes.

Surge Withstand Capability:

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

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

Vibration: 10 to 500 Hz at 2 Gs in three mutually perpendicular planes.

Shock: 15 Gs in each of three mutually perpendicular axes.

Temperature:

Operating Range: -25°C (-13°F) to +60°C (+140°F)

Storage Range: -40°C (-40°F) to +85°C (+185°F)

Weight: 4 lb.

STYLE CHART

BE3-GPR relays are identified by a combination of letters and numbers that make up the style number and define the electrical characteristics and operational features. The model number, together with the style number, describe the options included in a specific device and appear on a relay side panel.

Upon receipt of a relay, be sure to check the style number against the requisition and the packing list to ensure that they agree.

Figure 1-2 is the style number identification chart and defines the electrical characteristics and operational features included in BE3-GPR relays. In this example, a BE3-GPR P2BVSF is specified and has the following features:

P - Paralleled generator protection
2 - Neutral ground fault protection
B- Phase balance
V - Reactive current
S - Sync check function
F - Semi-flush mounting

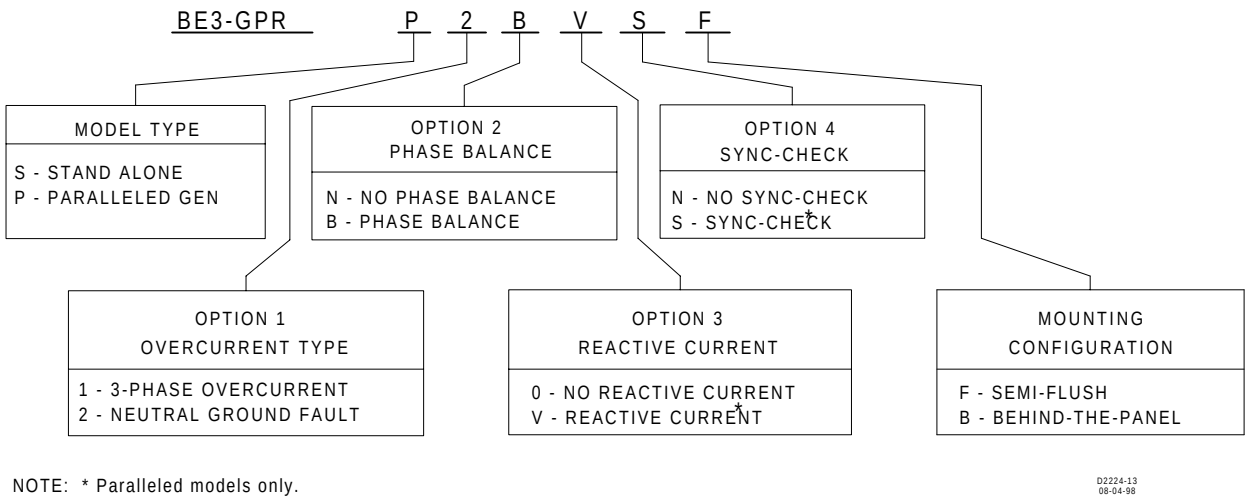


Figure 1-2. BE3-GPR Style Chart

TIME OVERCURRENT CHARACTERISTIC CURVES

Figures 1-2 through 1-17 illustrate the characteristic curves that are programmed into the nonvolatile memory of this relay. A drawing number is given under each caption and listed in Table 1-2. Table 1-2 also cross references the BE3-GPR curves to existing electromechanical relay characteristics. Contact Customer Service Department of the Power Systems Group, Basler Electric, and request the drawing number to order a full-size (10 inch x 12 inch) Characteristic Curve graph on transparent paper (vellum).

Table 1-2. Characteristic Curve Cross Reference

Curve Number	BE3-GPR Curve	Curve Name	Drawing NO.	Similar To
1	**S1**	S1, Short Inverse	99-1369	ABB CO-2
2	**S2**	S2, Short Inverse	99-1595	GE IAC-55
3	**L1**	L1, Long Inverse	99-1370	ABB CO-5
4	**L2**	L2, Long Inverse	99-1594	GE IAC-66
5	**D**	D, Definite Time	99-1371	ABB CO-6
6	**M**	M, Moderately Inverse	99-1372	ABB CO-7
7	**I1**	I1, Inverse Time	99-1373	ABB CO-8
8	**I2**	I2, Inverse Time	99-1597	GE IAC-51
9	**V1**	V1, Very Inverse	99-1374	ABB CO-9
10	**V2**	V2, Very Inverse	99-1596	GE IAC-53
11	**E1**	E1, Extremely Inverse	99-1375	ABB CO-11
12	**E2**	E2, Extremely Inverse	99-1598	GE IAC-77
13	**A**	Standard Inverse	99-1621	BS, IEC Standard Inverse
14	**B**	B, Very Inverse (It)	99-1376	BS, IEC Very Inverse (It)
15	**C**	Extremely Inverse (I^2t)	99-1377	BS, IEC Extremely Inverse (I^2t)
16	**G**	Long Time Inverse	99-1622	BS, IEC Long Time Inverse
17	**F**	Fixed Time		

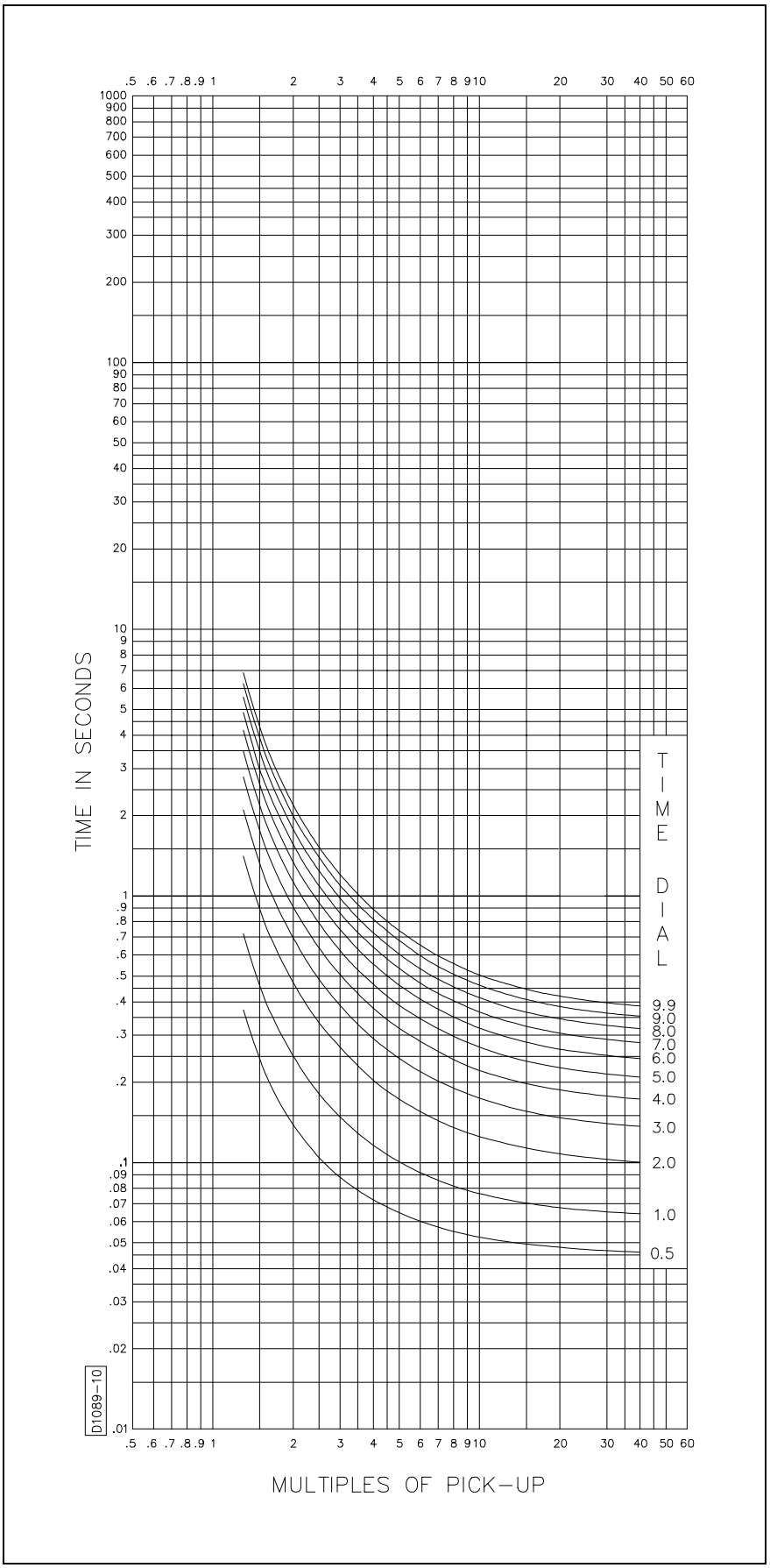

TIME IN SECONDS
MULTIPLES OF PICK–UP
TIME DIAL
9.9
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.5
D1089–10

Figure 1-2. Time Characteristic Curve S1, Short Inverse, 99-1369, (Similar to ABB CO-2)

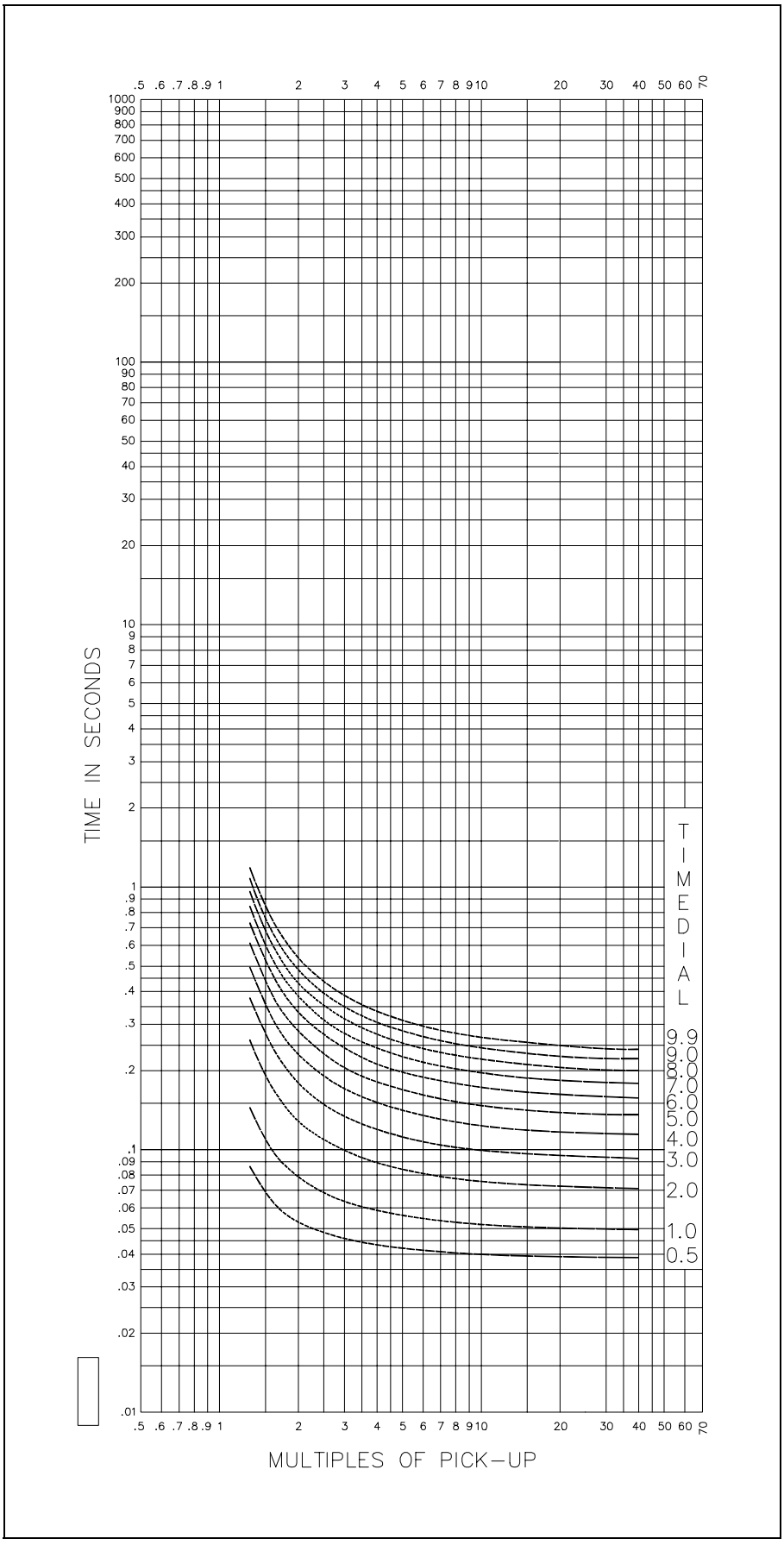


Figure 1-3. Time Characteristic Curve S2, Short Inverse, 99-1595 (Similar To GE IAC-55)

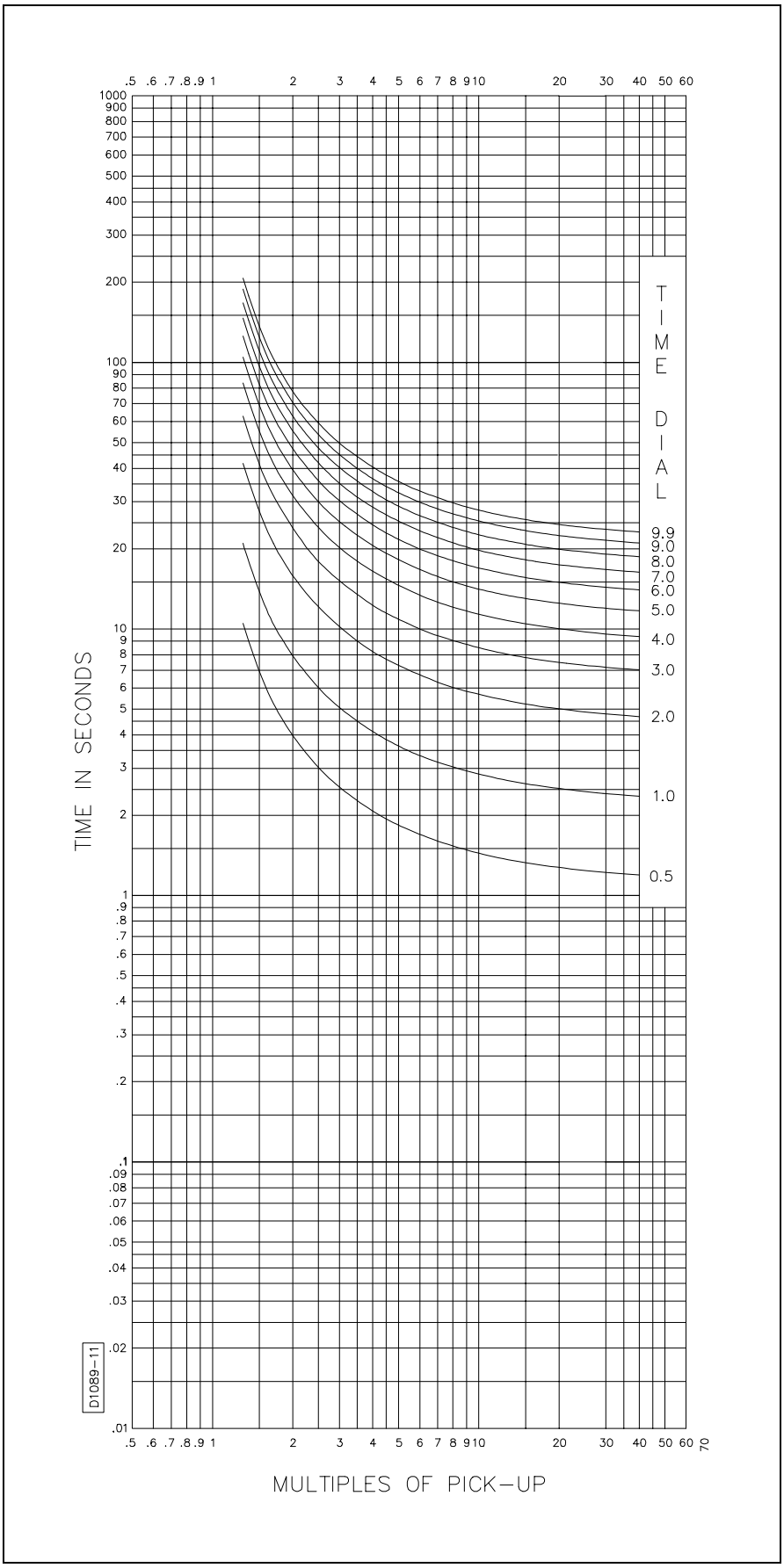


Figure 1-4. Time Characteristic Curve L1, Long Inverse, 99-1369, (Similar to ABB CO-5)

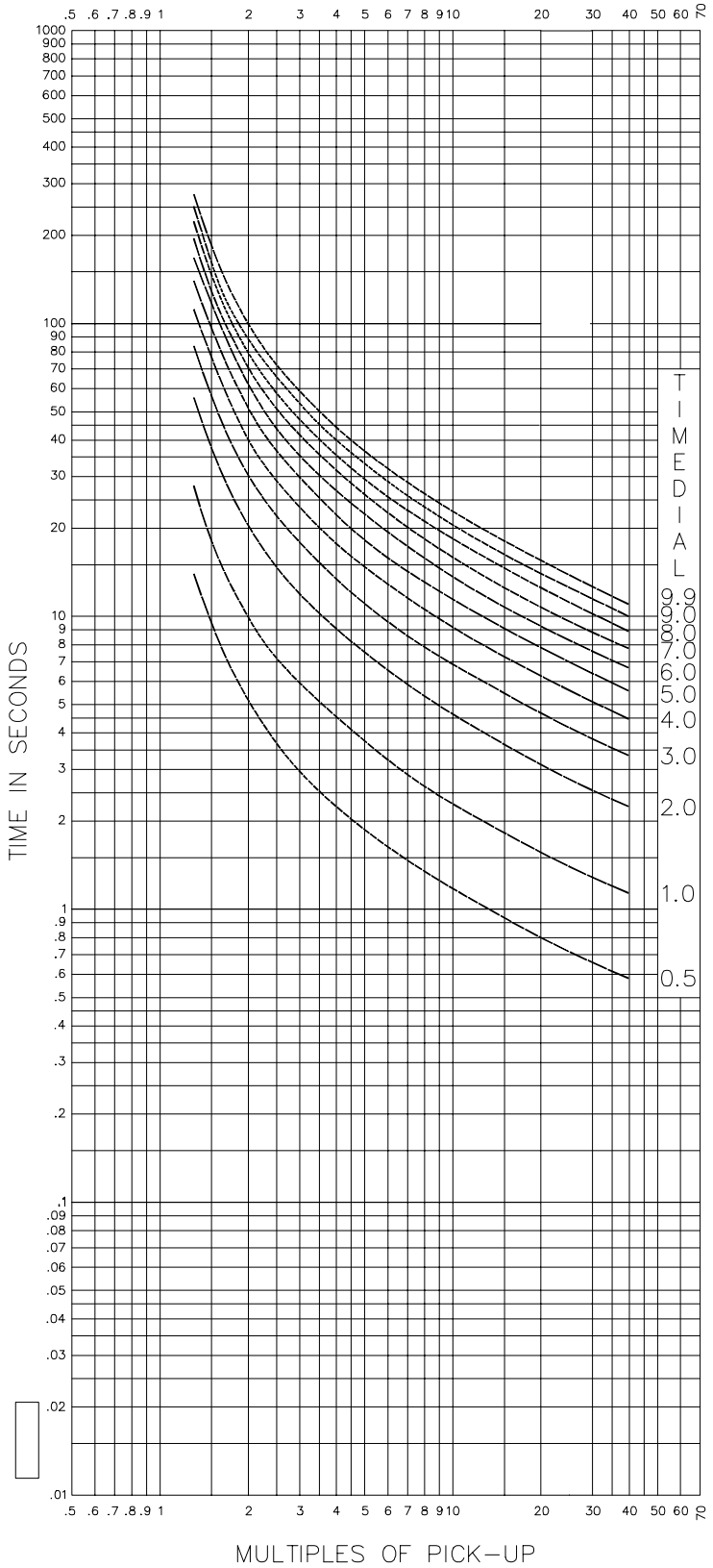

TIME IN SECONDS
MULTIPLES OF PICK–UP
TIMEDIAL
.5 .6 .7 .8 .9 1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70
1000 900 800 700 600 500 400 300 200 100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1 .9 .8 .7 .6 .5 .4 .3 .2 .1 .09 .08 .07 .06 .05 .04 .03 .02 .01
9.0 8.0 7.0 6.0 5.0 4.0 3.0 2.0 1.0 0.5

Figure 1-5. Time Characteristic Curve L2, Long Inverse, 99-1594, (Similar To GE IAC-66)

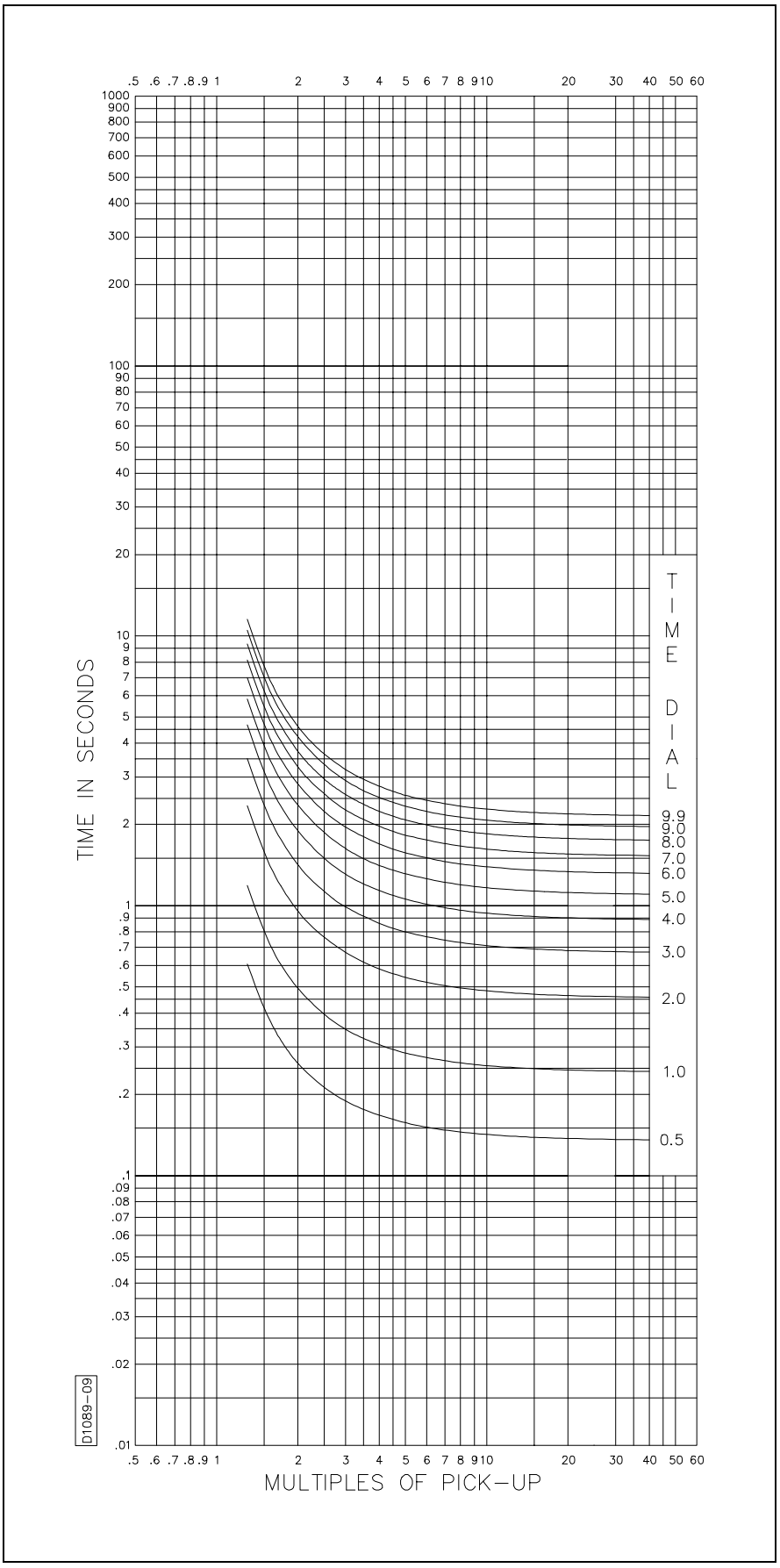


Figure 1-6. Time Characteristic Curve D, Definite Time, 99-1371, (Similar To ABB CO-6)

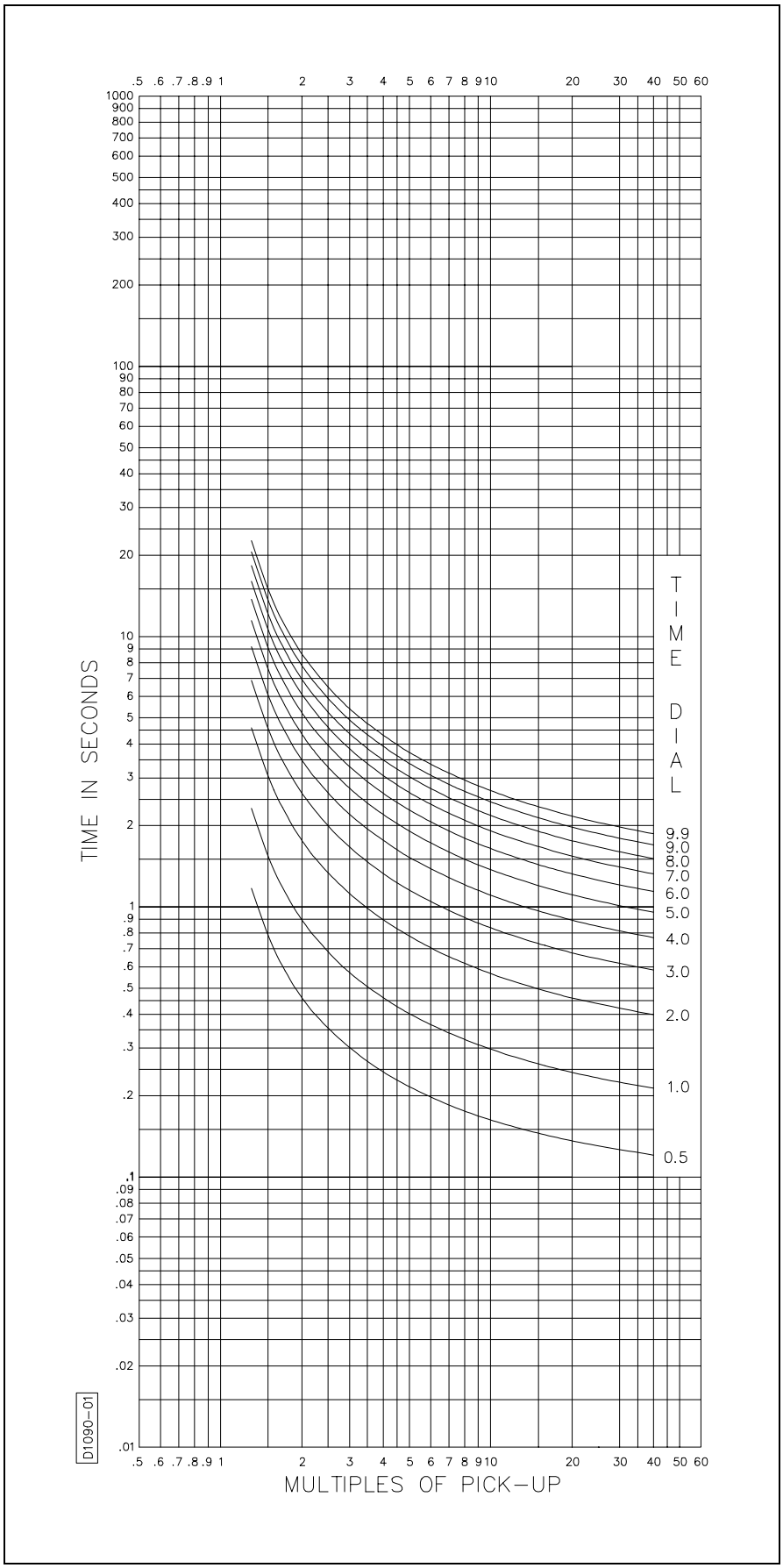


Figure 1-7. Time Characteristic Curve M, Moderately Inverse, 99-1372, (Similar to ABB CO-7)

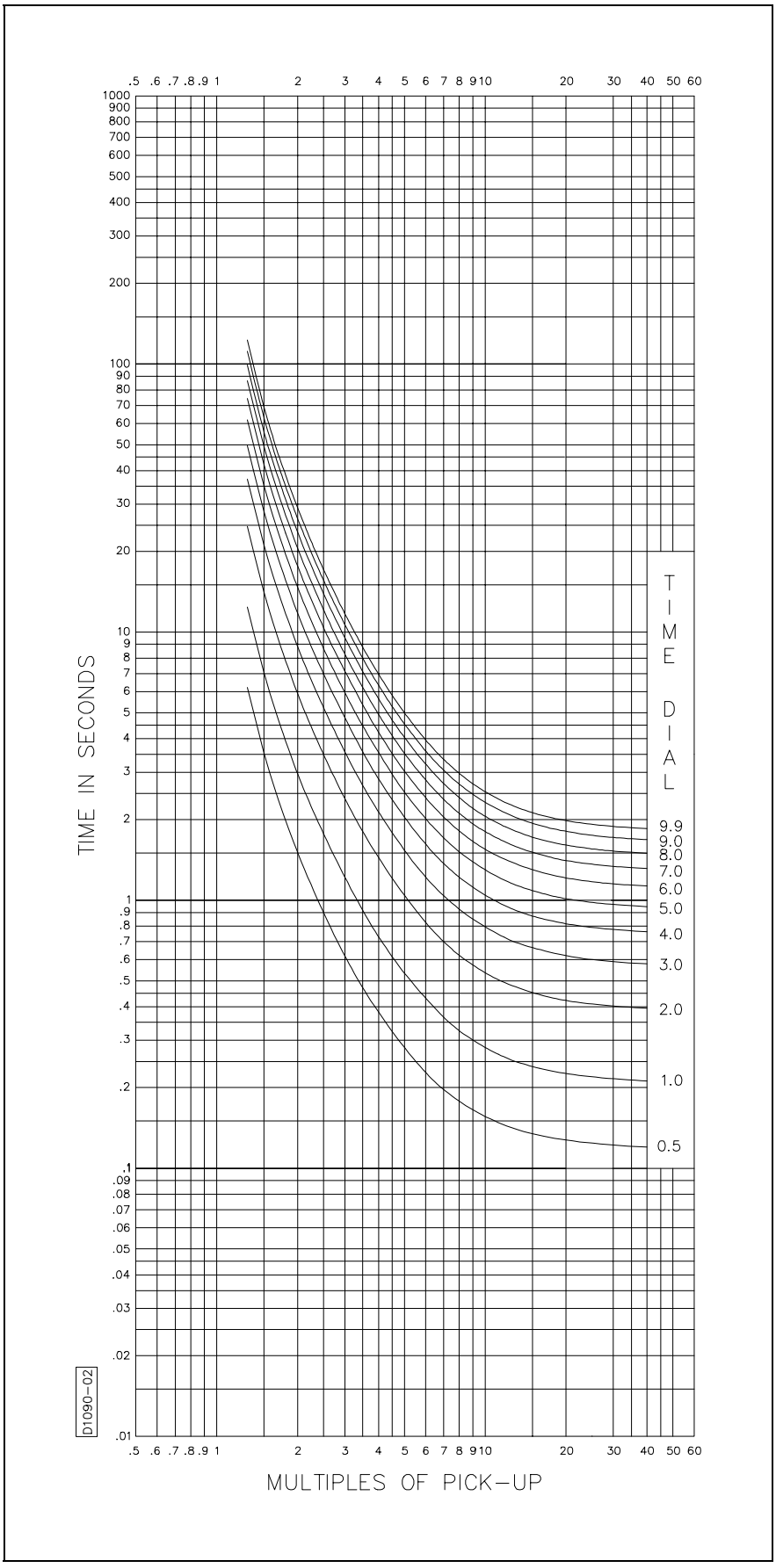


Figure 1-8. Time Characteristic Curve I1, Inverse Time, 99-1373 (Similar to ABB CO-8)

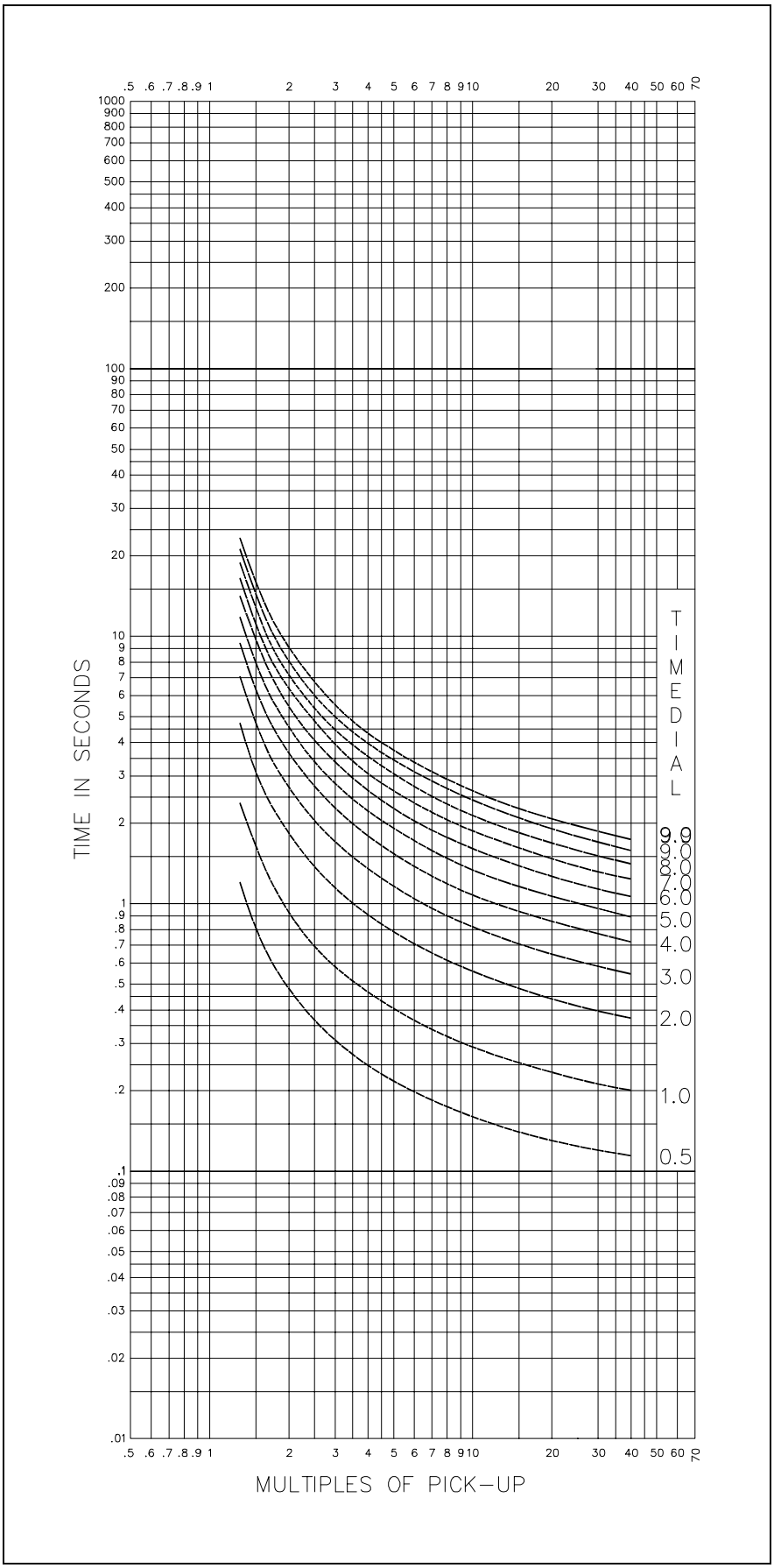


Figure 1-9. Time Characteristic Curve I2, Inverse Time, 99-1597 (Similar to GE IAC-51)

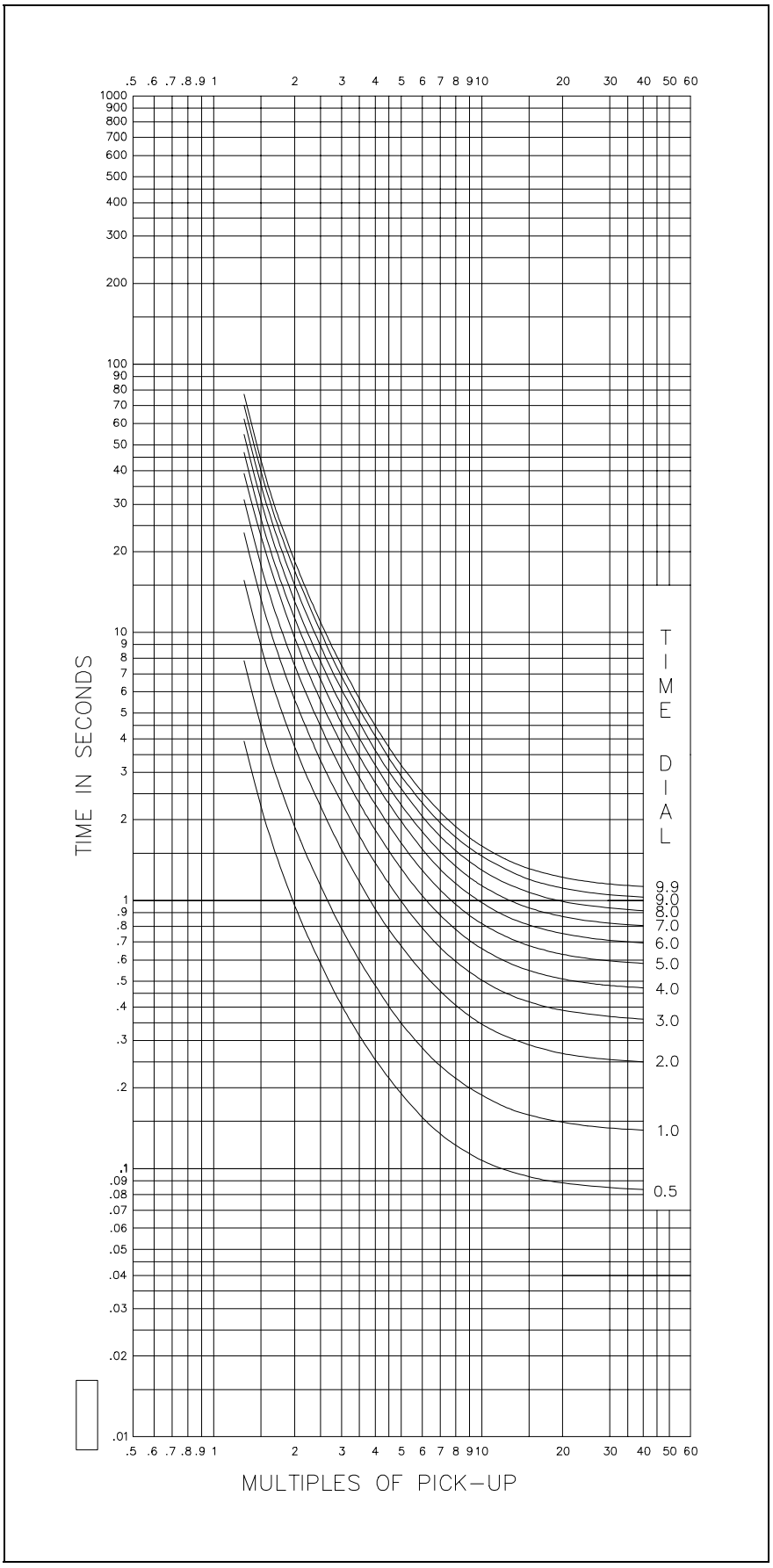


Figure 1-10. Time Characteristic Curve V1, Very Inverse, 99-1374 (Similar to ABB CO-9)

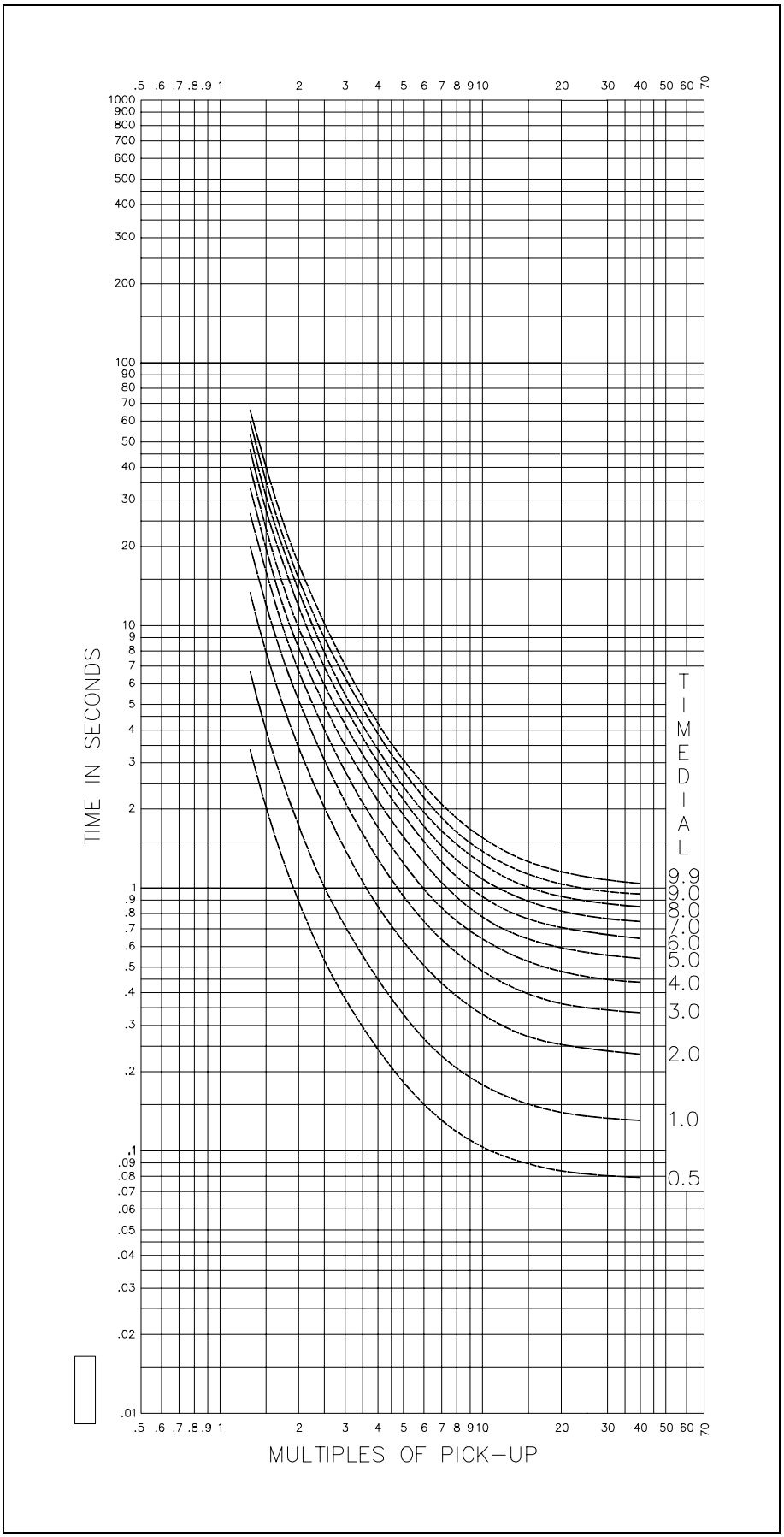


Figure 1-11. Time Characteristic Curve V2, Very Inverse, 99-1596 (Similar to GE IAC-53)

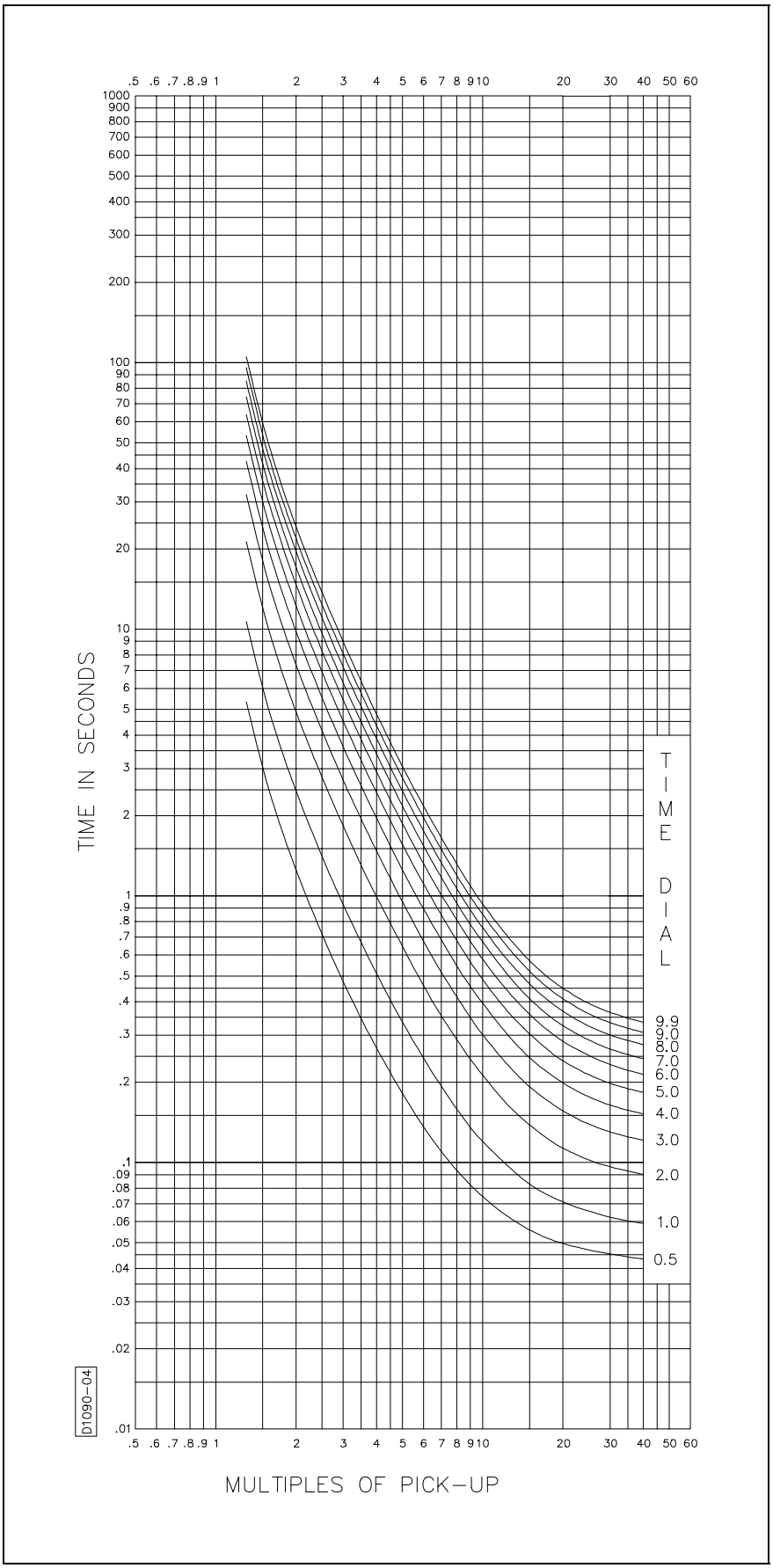


Figure 1-12. Time Characteristic Curve E1, Extremely Inverse, 99-1375 (Similar to GE IAC-11)

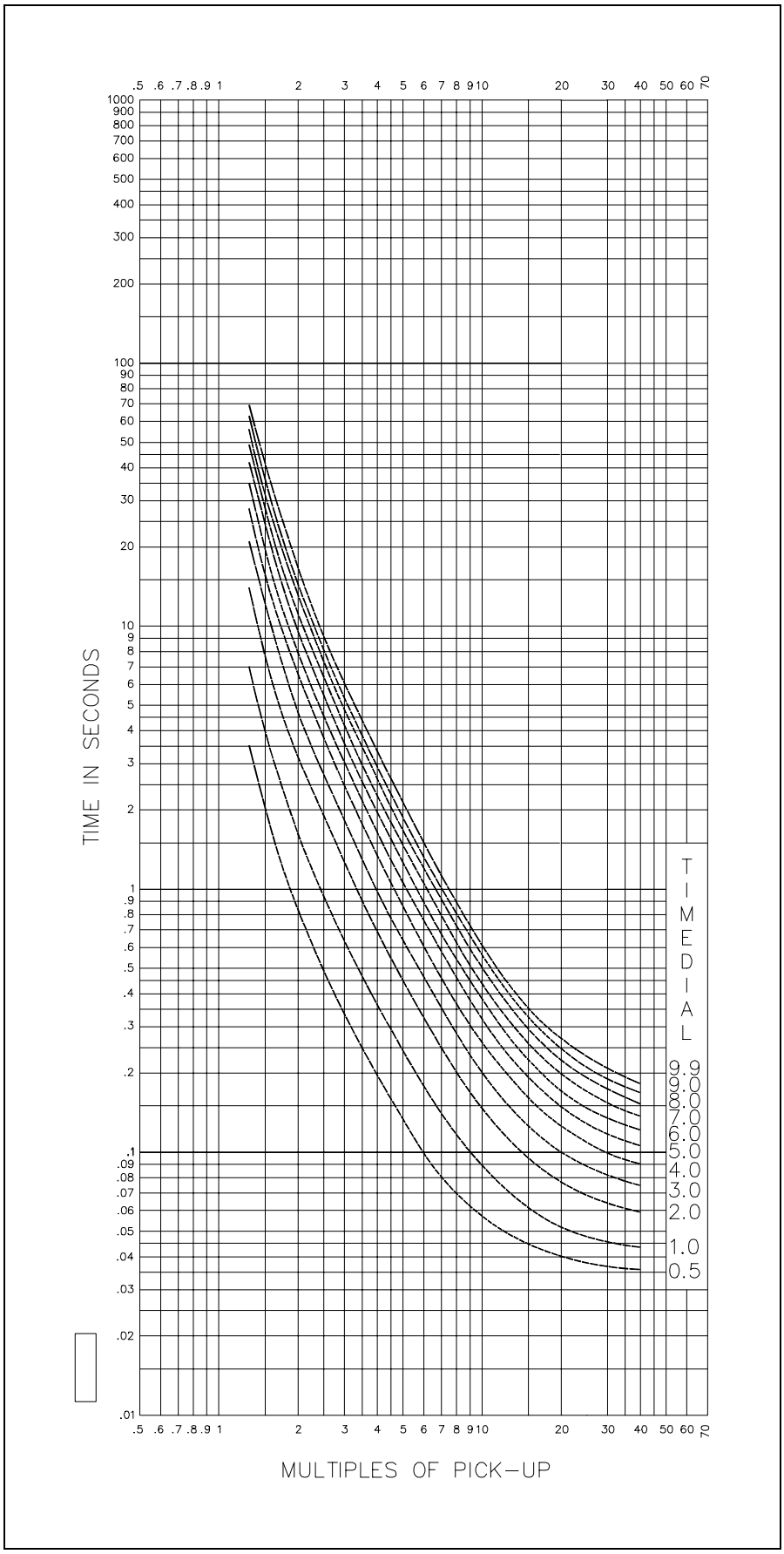


Figure 1-13. Time Characteristic Curve E2, Extremely Inverse, 99-1598 (Similar to GE IAC-77)

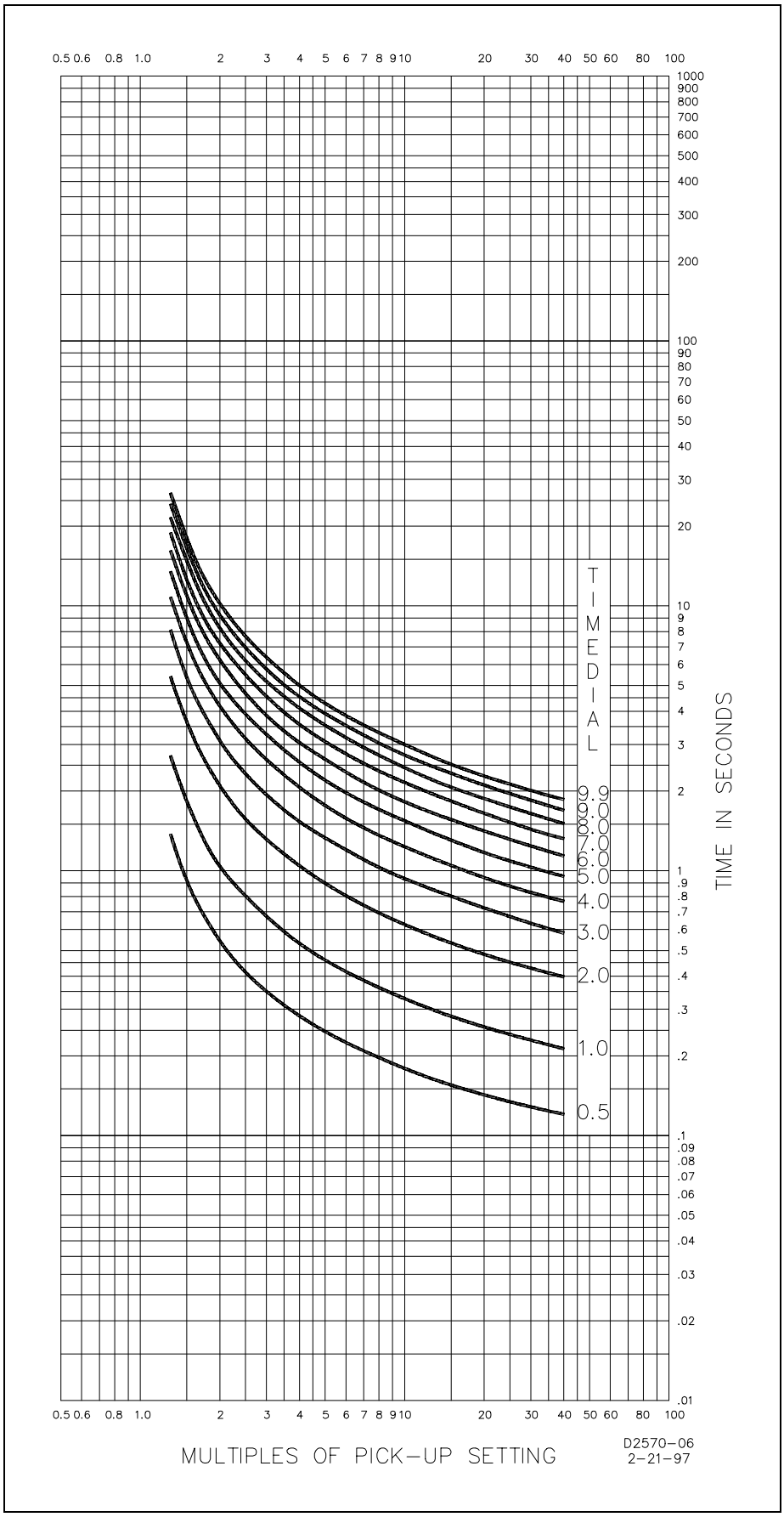


Figure 1-14. Time Characteristic Curve A, Standard Inverse, 99-1621

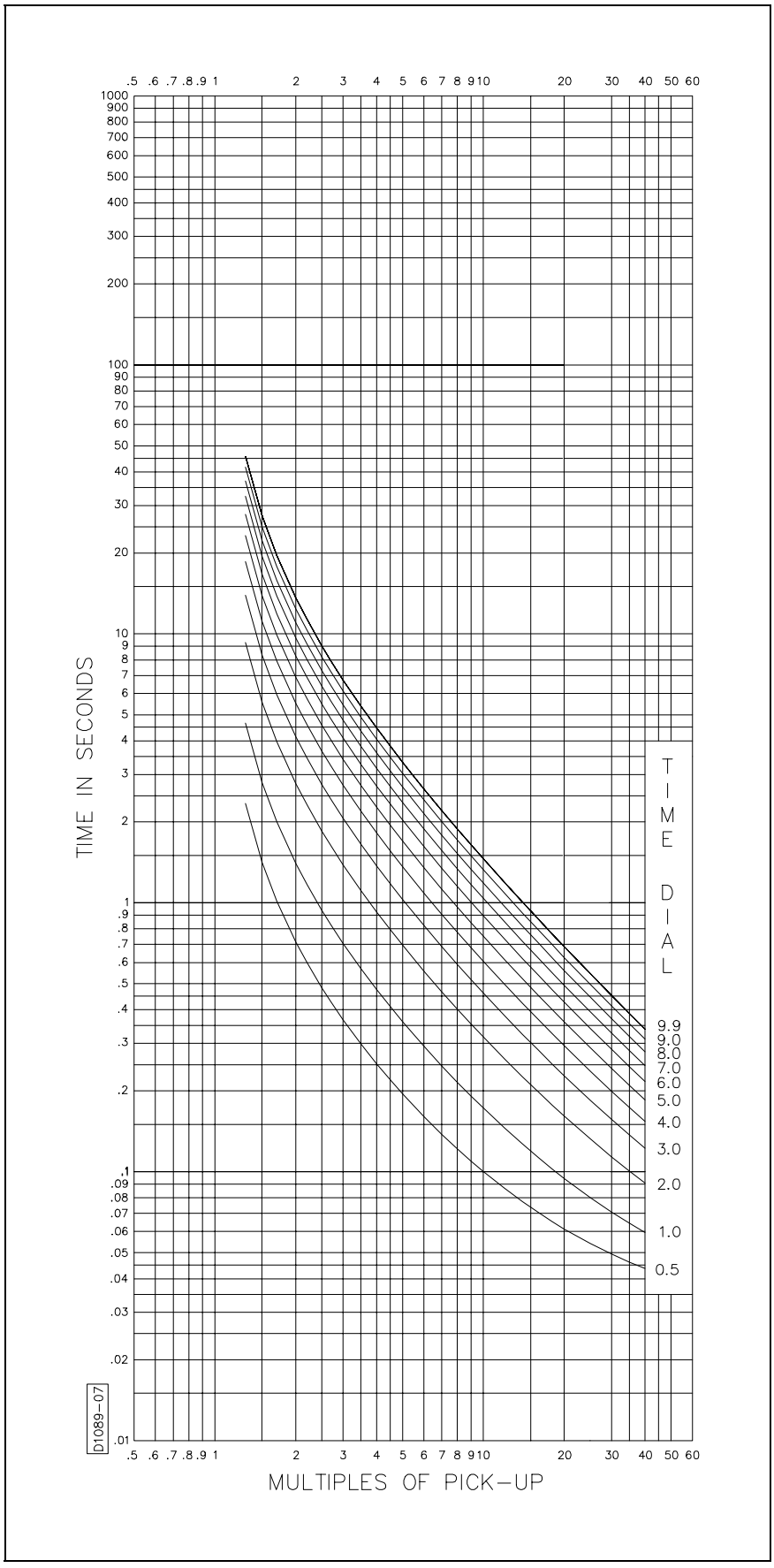


Figure 1-15. Time Characteristic Curve B, Very Inverse, 99-1376

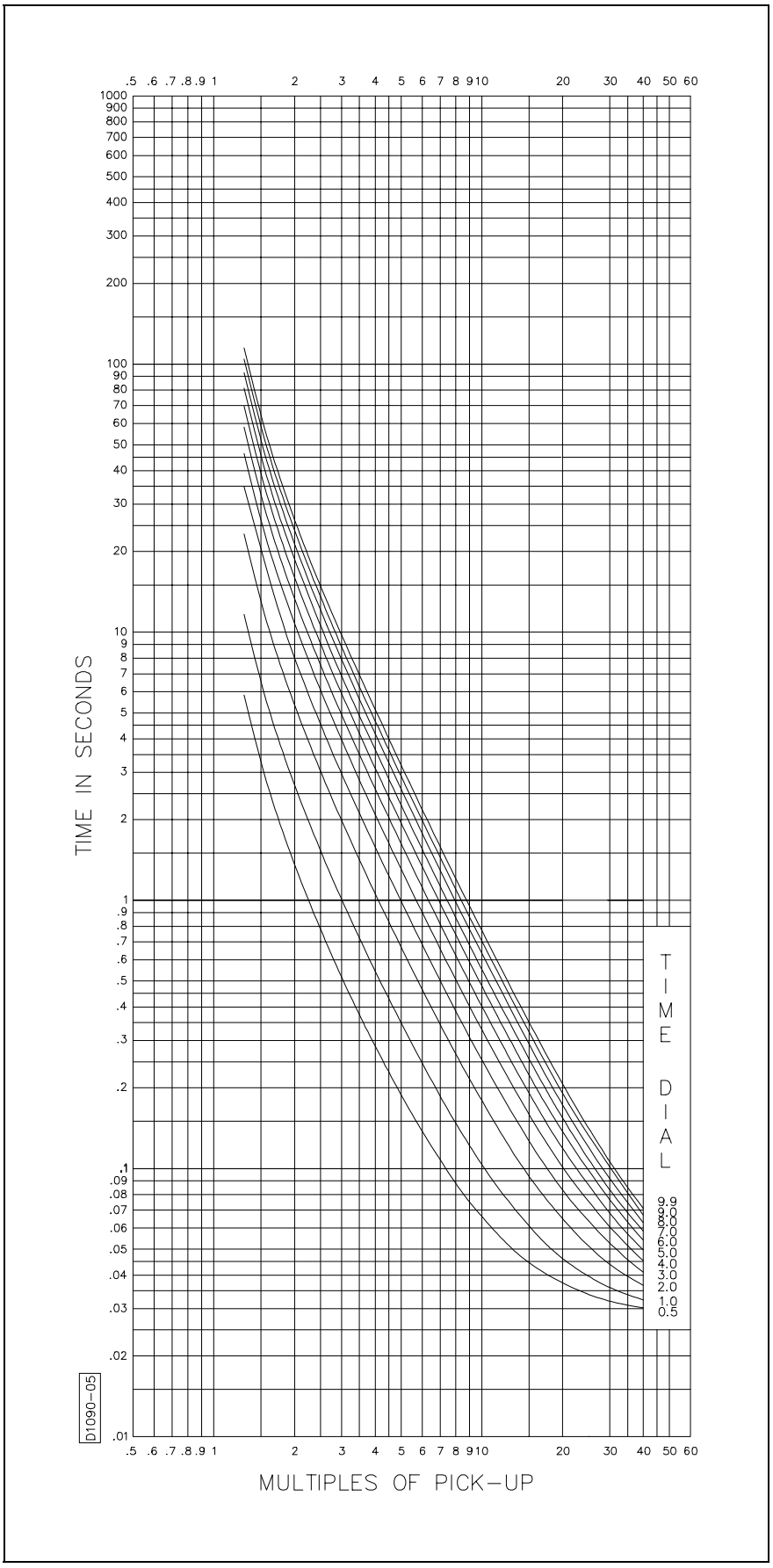


Figure 1-16. Time Characteristic Curve C, Extremely Inverse, 99-1377

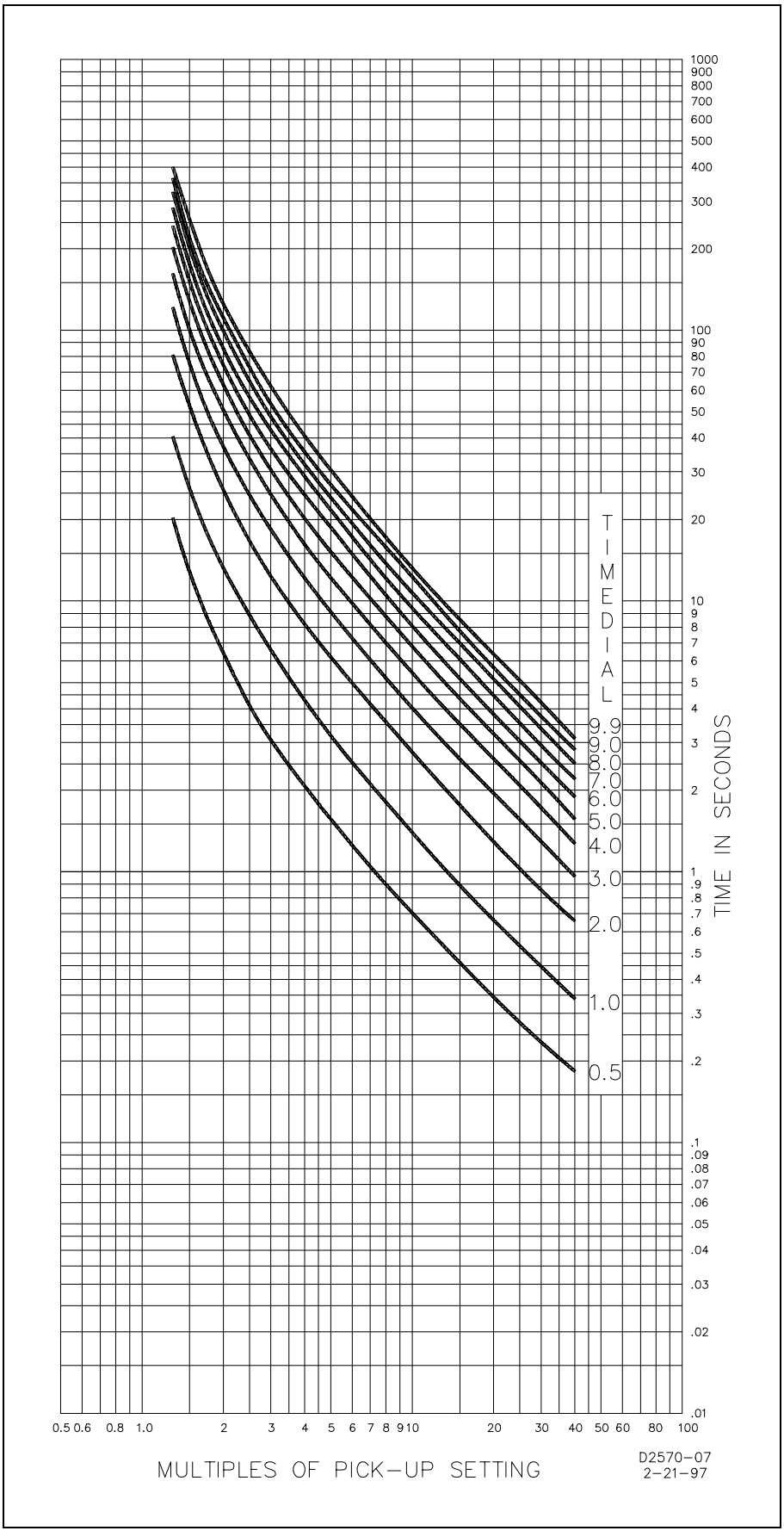


Figure 1-17. Time Characteristic Curve G, Long Time Inverse, 99-1622

SECTION 2 • HUMAN-MACHINE INTERFACE (Controls And Indicators)

FRONT PANEL DISPLAY

Figure 2-1 shows the front panel human-machine interface.

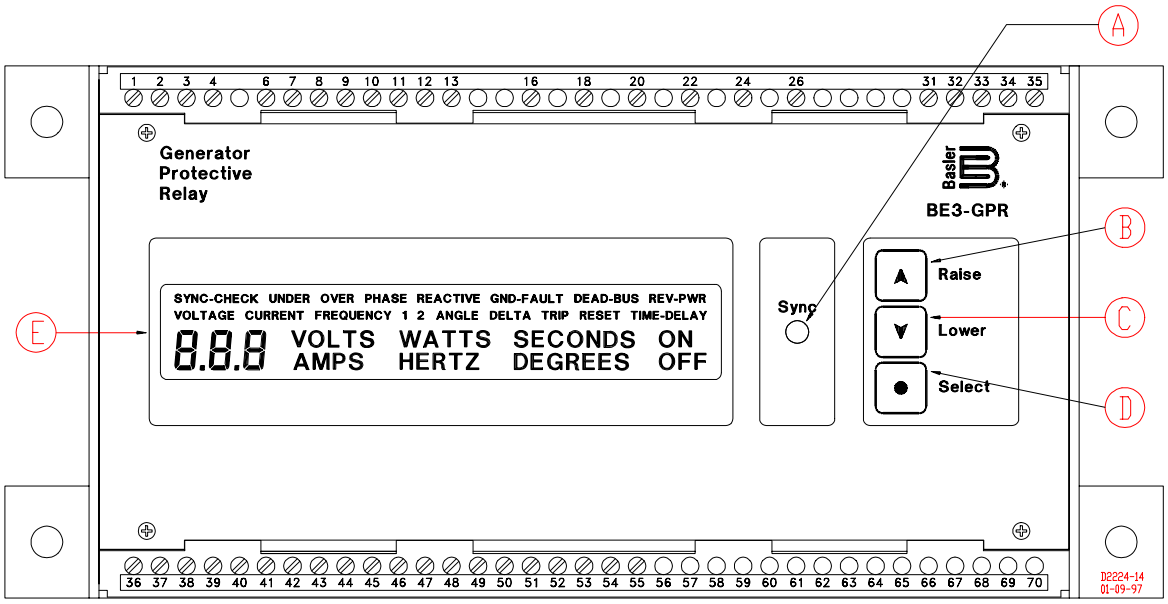


Figure 2-1. BE3-GPR Typical Front Panel

A Red LED illuminates for a sync or a deadbus condition and output contacts closed (**Note:** LED present only on the BE3-GPR P units with the sync-check feature).

B Pushbutton used to toggle the menu selections, scroll for setpoint adjustments, fast scroll by pressing for one second, and, when pressed after holding the **SELECT** pushbutton down, makes the menu selection sequence move in the forward direction.

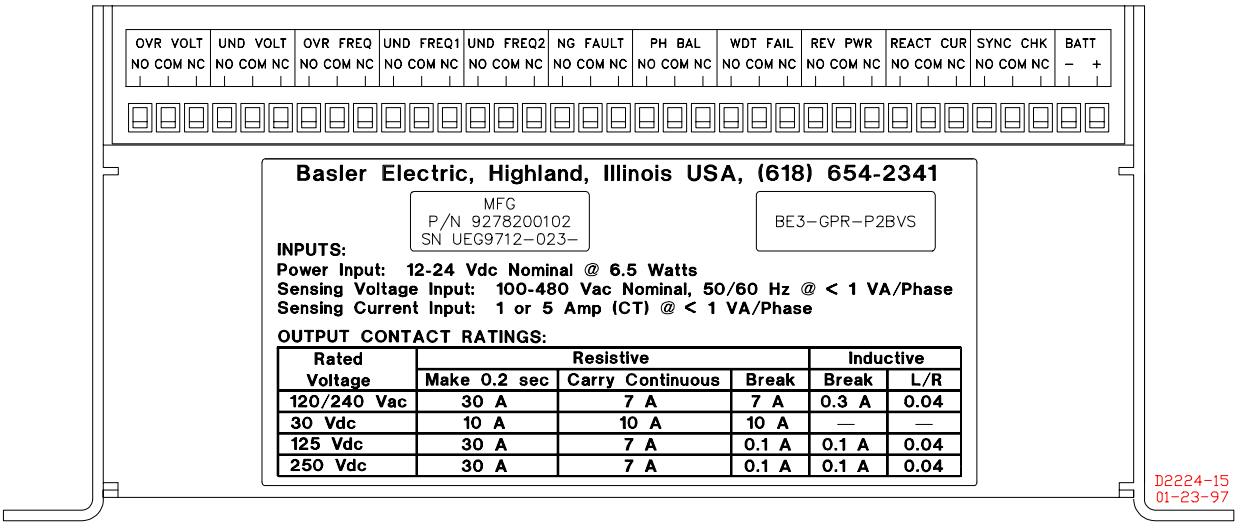
C Pushbutton used to scroll and fast scroll (by holding for one second) for setpoint adjustments, and, when pressed after holding the **SELECT** pushbutton down, to reverse the menu selection sequence from the forward direction.

D Pushbutton used to simultaneously save settings in the nonvolatile memory and move on to the next selection sequence. Also, when held down before pressing either the **Raise** or **Lower** pushbutton, the direction of the user option sequence can be forced forward or reverse, respectively.

E LCD provides the primary visual interface to the user. Used when setting and monitoring relay functions.

PANEL CONNECTIONS

Figures 2-2 through 2-5 show the bottom and top panel connections for the BE3-GPR (NGF and TOC).



Rated Voltage	Resistive			Inductive	
	Make 0.2 sec	Carry Continuous	Break	Break	L/R
120/240 Vac	30 A	7 A	7 A	0.3 A	0.04
30 Vdc	10 A	10 A	10 A	—	—
125 Vdc	30 A	7 A	0.1 A	0.1 A	0.04
250 Vdc	30 A	7 A	0.1 A	0.1 A	0.04

Figure 2-2. BE3-GPR (NGF) Bottom Panel

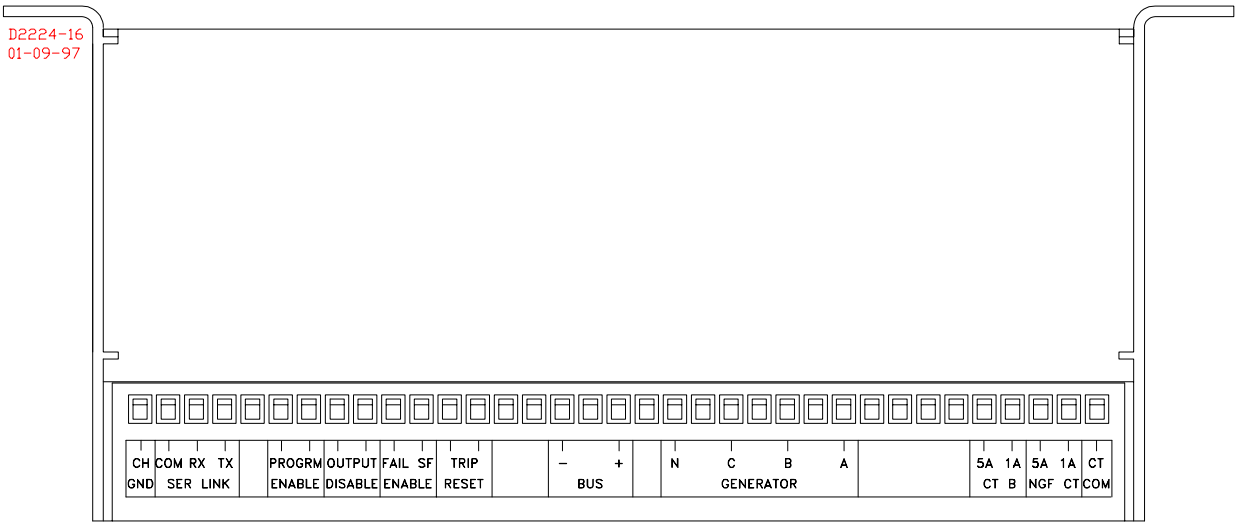
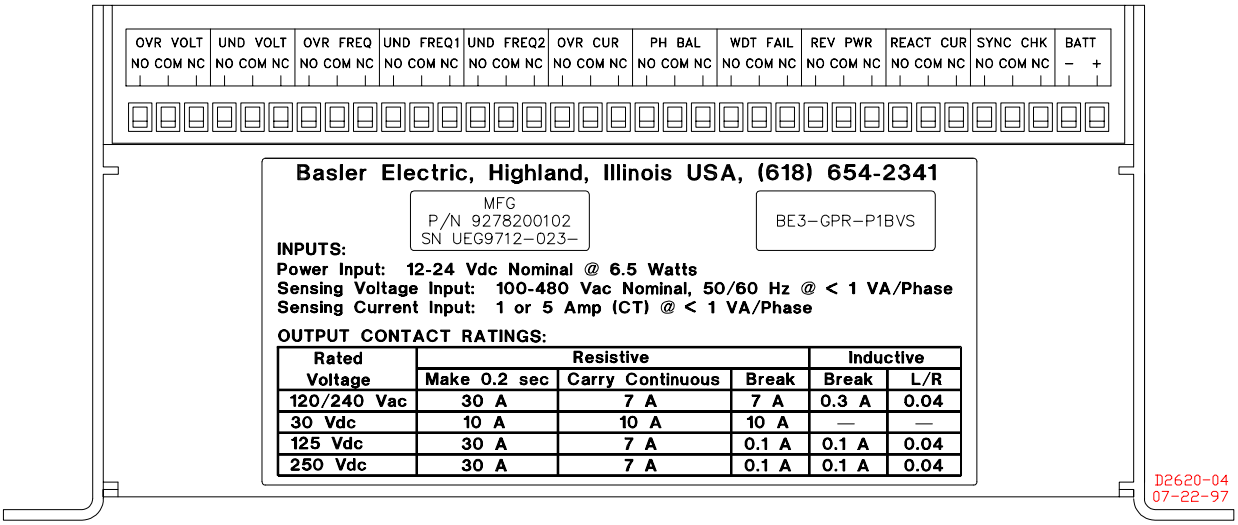


Figure 2-3. BE3-GPR (NGF) Top Panel



Rated Voltage	Resistive			Inductive	
	Make 0.2 sec	Carry Continuous	Break	Break	L/R
120/240 Vac	30 A	7 A	7 A	0.3 A	0.04
30 Vdc	10 A	10 A	10 A	—	—
125 Vdc	30 A	7 A	0.1 A	0.1 A	0.04
250 Vdc	30 A	7 A	0.1 A	0.1 A	0.04

Figure 2-4. BE3-GPR (TOC) Bottom Panel

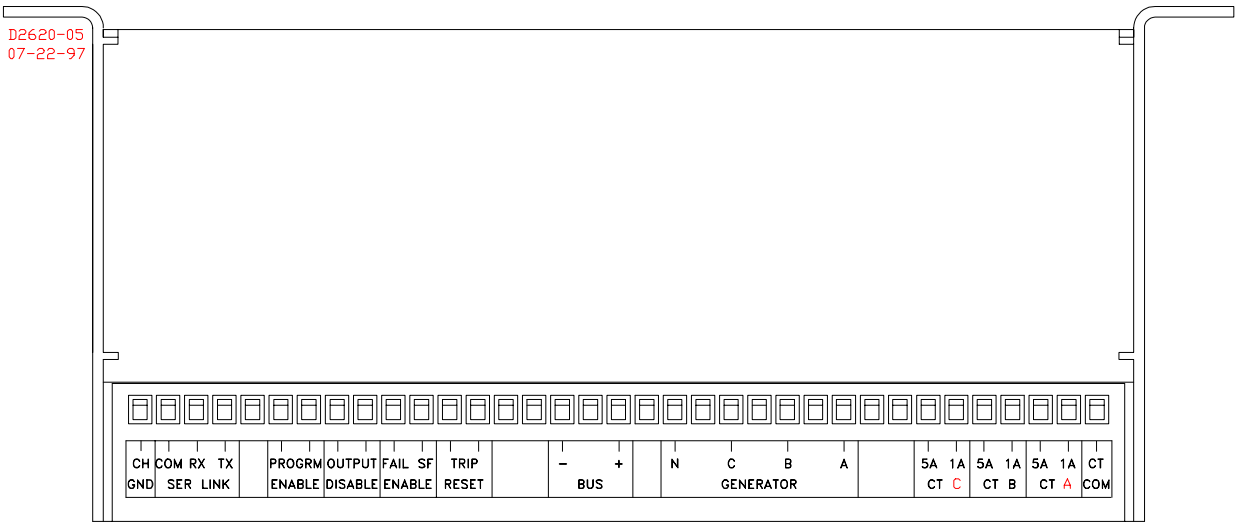


Figure 2-5. BE3-GPR (TOC) Top Panel

Compression type terminal strips make wiring simple. These connections accept one #10 AWG wire or two #14 AWG wires. These operations are made even more simple by the user friendly labeling of the terminals.

SECTION 3 • FUNCTIONAL DESCRIPTION

GENERAL

BE3-GPR Generator Protective Relays are microprocessor based devices that provide multifunction protection for genset systems. There are two basic BE3-GPR models: BE3-GPR S for standalone systems and BE3-GPR P for paralleled systems. Each model comprises a basic set of capabilities. This section describes the hardware and software functional descriptions for a BE3-GPR P with all available protective features.

FUNCTIONAL DESCRIPTION

Figure 3-1 illustrates the BE3-GPR P circuit functions described in the following paragraphs.

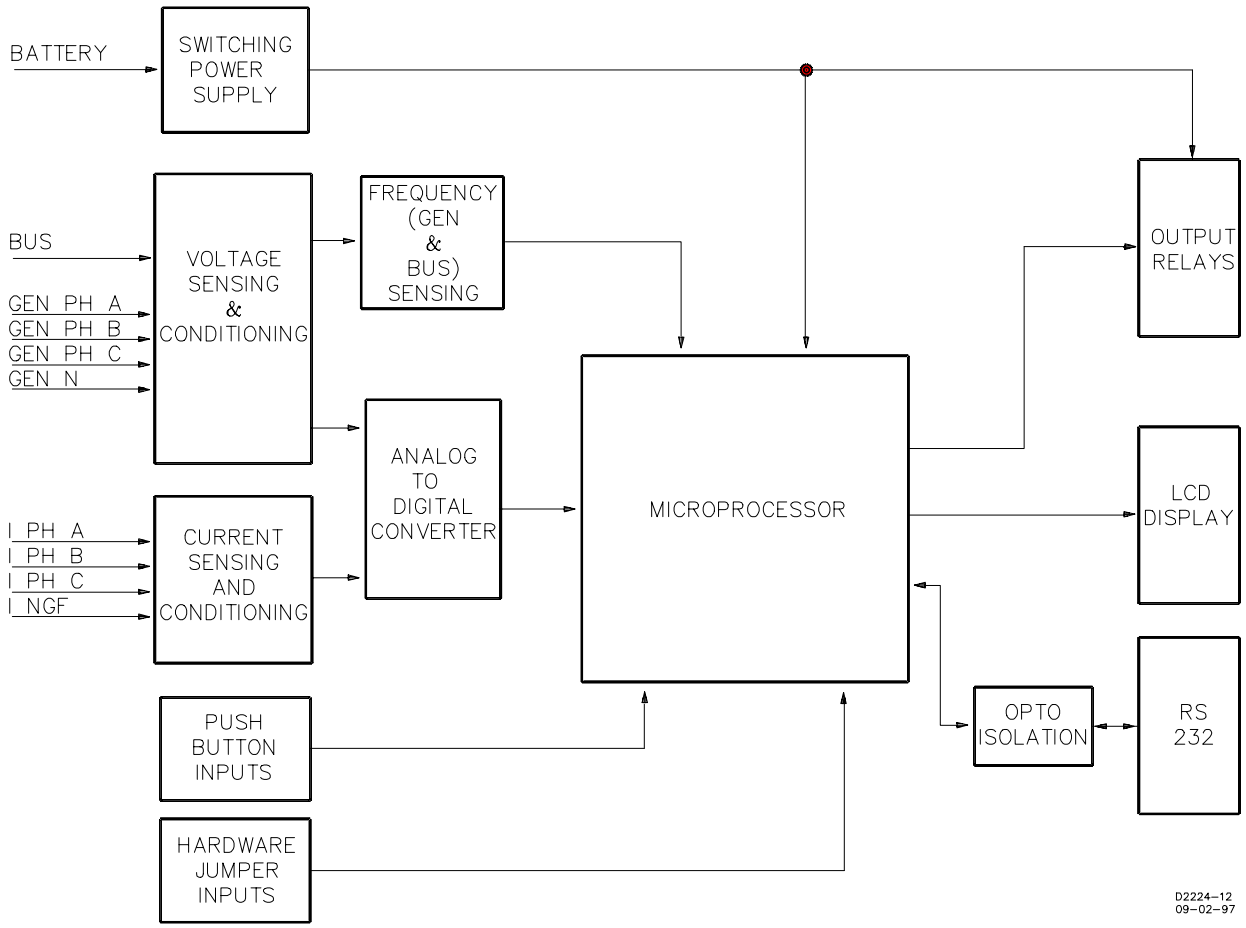


Figure 3-1. BE3-GPR Block Diagram

Switching Power Supply

The internal switching power supply uses the +12 Vdc or +24 Vdc input to generate the ±6 Vdc, +5 Vdc, a stable +5 Vdc reference for the analog to digital converter, 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 opto-isolated RS-232 channel.

Voltage Sensing And Conditioning

Monitored 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. The BE3-GPR requires a minimum sensing voltage of 10 volts to be applied for normal operation.

NOTE

Any loss of voltage sensing (≤10 volts) causes the:
Undervoltage output to trip if enabled.
Phase balance 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, and if the sync-check function is present, bus frequency and generator-bus phase difference.

Current Sensing And Conditioning

Monitored generator currents are sensed and scaled down to suitable internal circuit levels. These internal current transformers provide isolation from the monitored currents. Two taps located on the primary side accommodate connections to either one ampere or five ampere circuits.

Control (Pushbutton) Inputs

A three-pushbutton keypad provides the user with the capability to program the relay when used in conjunction with the LCD based setup menu.

Hardware (Jumper) Inputs

When connected, the eight terminal block pins provide the following relay functions:

1. Program Enable. Allows the user to make changes to the relay settings using the front panel keypad and the LCD menu. When the program enable is not installed (jumpered), the keypad is locked out and changes can only be made using the communications link.
2. Output Disable. Disables relay trip activity and prevents nuisance tripping on power system buildup.
3. Fail-safe Enable. Changes the output relays coils so that they are energized in the normal state (untripped) and deenergized when operated (tripped). The power system then detects loss of power as simultaneous trips on all of the outputs.
4. Trip Reset. When auto reset is disabled, momentary connection to a common pin causes the clearing of tripped functions.

Analog To Digital Converter

Scaled down outputs from the voltage and current sensing circuits are sampled and digitized by the twelve bit analog to digital converter under the microprocessor control. Sampling occurs 26 times per cycle with 60 hertz nominal operating power. Each sample is stored in microprocessor RAM and processed on a cycle-by-cycle basis.

Microprocessor

Embedded software in the microprocessor controls the overall functionality of the relay and makes all decisions based on programming and system inputs. The RMS values for current, voltage, and power are calculated by the microprocessor from the analog to digital converter samples. The formulas used to calculate these values are provided in the following paragraphs.

For phase B and neutral ground fault current sensing:

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

For phase A, B, and C current sensing:

$$I_A = \sqrt{\frac{\sum_{n=1}^{num} I_{An}^2}{num}} \qquad I_B = \sqrt{\frac{\sum_{n=1}^{num} I_{Bn}^2}{num}} \qquad I_C = \sqrt{\frac{\sum_{n=1}^{num} I_{Cn}^2}{num}}$$

For single phase or 3 phase 3 wire sensing:

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

For 3 phase 4 wire sensing:

$$V_{LN} = \sqrt{\frac{\sum_{n=1}^{num} V_n^2}{num}} \qquad P = \frac{3 \cdot \sum_{n=1}^{num} V_n \cdot I_n}{num}$$

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: $PF = \frac{P}{VA}$ where: $VA = V \cdot I_B$

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

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

Reverse Power: $P_R = \sqrt{3} \cdot V_{AB} \cdot I_B \cdot \cos\phi$

I_{NGF}: Neutral Ground Fault

Output Relays

There are eleven form C output contacts available for external connection. They are all electrically isolated from each other (that is, they do not share common connections). There is one set of contacts for each of the nine relay protective functions and one each for the sync-check and watchdog timer (fail-safe) 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 Channel

The serial link present in the microprocessor connects to an opto-isolated RS-232 level shifting circuit. This permits direct connection to the interface on the side panel of the relay using a personal computer for programming. Communications protocol is compatible with readily available modem software that emulates a dumb terminal.

LCD Display

The front panel liquid crystal display (LCD) is a customized display with both descriptive word segments and a three digit numerical display area. Software in the microprocessor controls which segments are on at any given time. The user interface and the protective functions are the major uses for the display, which is shown below in Figure 3-2.

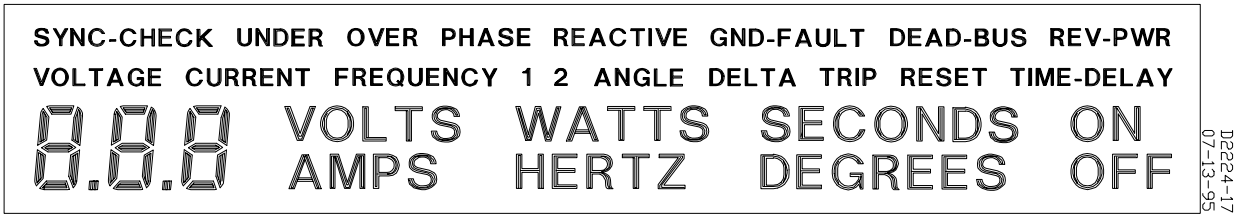


Figure 3-2. LCD Display

Timing Functions

The relay has a time delay function for each of the different protective functions (overvoltage, underfrequency, sync-check, etc.). All of the delays serve to allow for any abnormal occurrences to correct themselves. For instance, if an over voltage occurs, the time delay may be between zero and twenty seconds (as programmed). If the overvoltage condition returns to normal within the delay window, the system ignores the previous overvoltage and instantly resets. The timing functions give a standard delay range of 0 to 20 seconds, except for the following.

- Sync-Check 0.0 to 2.0 seconds
- Neutral Ground Fault 0.2 to 2.0 seconds
- Overcurrent Timing Curves

SOFTWARE

Software embedded in the microprocessor controls all aspects of BE3-GPR functionality. This comprises power-up initialization, user front panel setup and configuration, hardware jumper input detection, protective function trip detection and annunciation, sync-check monitoring and annunciation, and remote RS-232 communications support.

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 EEPROM into the main memory of the relay. Then, all segments on the front panel LCD and the sync-check LED illuminate for one second to allow the user to visually check the 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 display will show this last trip for ten seconds. Following this sequence, the LCD displays **ON** and the software immediately activates the enabled functions and monitors the generator and bus inputs.

Relay Setup And Configuration

Function setup and system configuration is organized in a menu format on the front panel display. In order to scan through the current settings, the user must press the **SELECT** pushbutton. The user can only perform changes to these settings while the program enable hardware jumper is installed. (**Note:** The program enable hardware jumper is not required when using a personal computer to program relay settings.) Although the menu shown in Figures 3-3 through 3-8, shows only forward progression through the sequence, the user can adjust from this default at any of the function ON/OFF menus, by simultaneously holding down the **SELECT** pushbutton and either the **Raise** or the **Lower** pushbutton for forward and reverse progression, respectively. If a particular function that is shown is not available because of relay selection, the display will automatically move on to the next available function in the progression.

NOTE

The phase balance option is only available if the relay is user configured for three-phase line-to-line or three-phase line-to-neutral generator voltage sensing.

The following Figures 3-3 through 3-8 are applicable for both NGF and TOC. A small section of the menu shown in Figure 3-6 shows the menu specific for the NGF version. The TOC version is similar.

The first four user options are described in the following paragraphs and shown in Figure 3-3.

TRIP RESET - Determines whether or not the relay will automatically reset any trip condition whenever the fault condition has cleared. The user can toggle this **ON** and **OFF** by pressing the **Raise** pushbutton. Pressing the **SELECT** key saves the configuration in the nonvolatile memory and moves on to the next selection display.

CT **CURRENT** Level - Selects either five amperes or one ampere for the current level. This is required so that the relay applies the correct weighting to the internal currents to calculate neutral ground fault current, reactive current, and reverse power levels. Pressing the **Raise** key toggles the option. Pressing the **SELECT** key saves the setting in the nonvolatile memory and moves on to the next menu.

VOLTAGE PHASE - Selects how the relay will interpret the generator voltages. The three possibilities are:

PHASE VOLTAGE = 1	Single-phase line-to-line in which the connection **must** be made between the generators phase A and B terminals.
PHASE VOLTAGE = 3	Three-phase, three wire, line-to-line in which connections must be made between the generators phase A, B, and C terminals.
PHASE VOLTAGE = 4	Three-phase, four wire, line-to-neutral in which connections must be made between the generators phase A, B, C, and N 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 user must press the **SELECT** key to save the settings in nonvolatile memory and to step to the next user option.

OVER VOLTAGE TRIP and **RESET** - Adjusts the settings for the over voltage protective function. The user can toggle this function **ON** and **OFF** by pressing the **Raise** pushbutton. Once the preferred choice has been made, the user can press the **SELECT** pushbutton to save the selection and move ahead. If the protective function is enabled, the user can adjust the trip level by one volt using the **Raise** and **Lower** keys. A fast scroll feature is given and can be accessed by holding the **Raise** or **Lower** pushbutton for one second for a step of ten volts. Once again, pressing the **SELECT** key saves the setting and moves to the next selection screen. Here, the user may adjust the **TIME DELAY** in steps of one second, or, using the fast scroll feature, in ten second steps. The **SELECT** pushbutton saves the configuration and moves on to the next protective function.

All of the protective functions contain relatively the same menu format. The first screen allows for the enabling or disabling of the function by toggling between **ON** and **OFF**, with the **Raise** pushbutton. The user can reach the next screen and update the nonvolatile memory by pressing the **SELECT** pushbutton.

If the function is enabled, the LCD displays the trip level for the function which the user can adjust through the use of the **Raise** and **Lower** keys. The incorporation of a fast scroll feature makes the adjustments less cumbersome; the user can access this feature by holding the **Raise** or **Lower** pushbutton for one second for each step of ten times the normal adjustment level. Pressing the **SELECT** pushbutton stores the setting and progresses the menu to the reset level, where the user can adjust the settings as previously described. Once the display shows the preferred reset level, pressing **SELECT** will move on to the time delay for the protective function. This can range from zero seconds (instantaneous) to a maximum specific to the function for which it is being set. The user can manipulate the time delay 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 protective 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 keys are pressed for two minutes, the relay exits the setup display menus, and any incomplete setups will be lost.

The sync-check option, if applicable, follows the selection of the protective functions. The first screen allows the user to either enable or disable the sync-check option in the usual manner. If sync-check is disabled, the LCD display shows the **ON** screen (normal operation). If the function is enabled, the next menu screen allows the user to synchronize on either a generator fast or a generator fast or slow condition. Repeatedly pressing the **Raise** key toggles between the **OVER FREQUENCY** (generator fast) and **UNDER OVER FREQUENCY** (generator slow or fast). When satisfied with the selection, the user can go on to the next screen 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 an in-sync condition. The following screen defines whether sync window time or slip frequency qualifies the sync-check. Once the setting is chosen 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 sync-check condition using the dedicated form C output contact and illuminate the LED, regardless of the sync-check window parameters. This dead bus voltage can be adjusted in the same manner as the previous settings. Pressing the **SELECT** pushbutton will save all sync-check functions in the nonvolatile memory, exit the user setup menu, and begin sync-check monitoring.

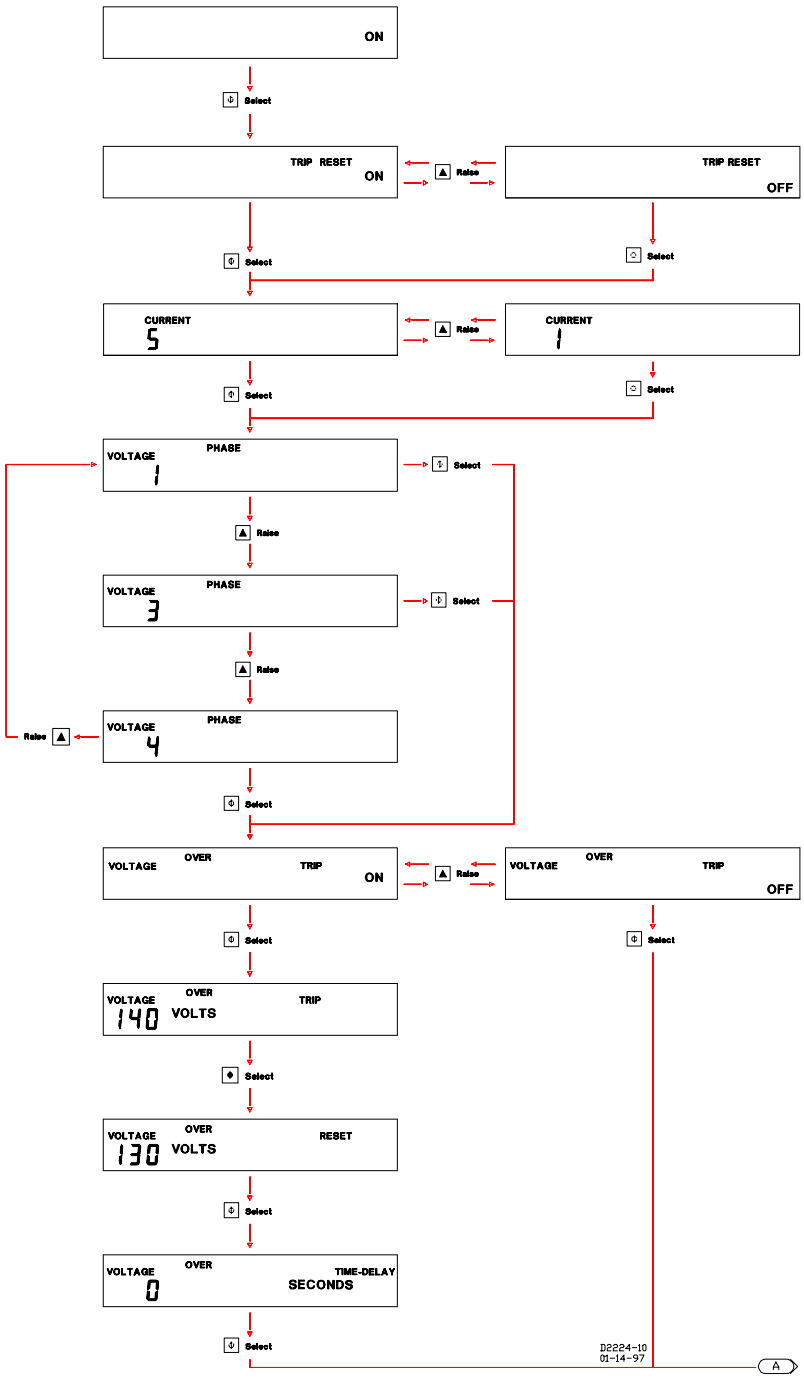


Figure 3-3. Selection Menu (Sheet 1 of 6)

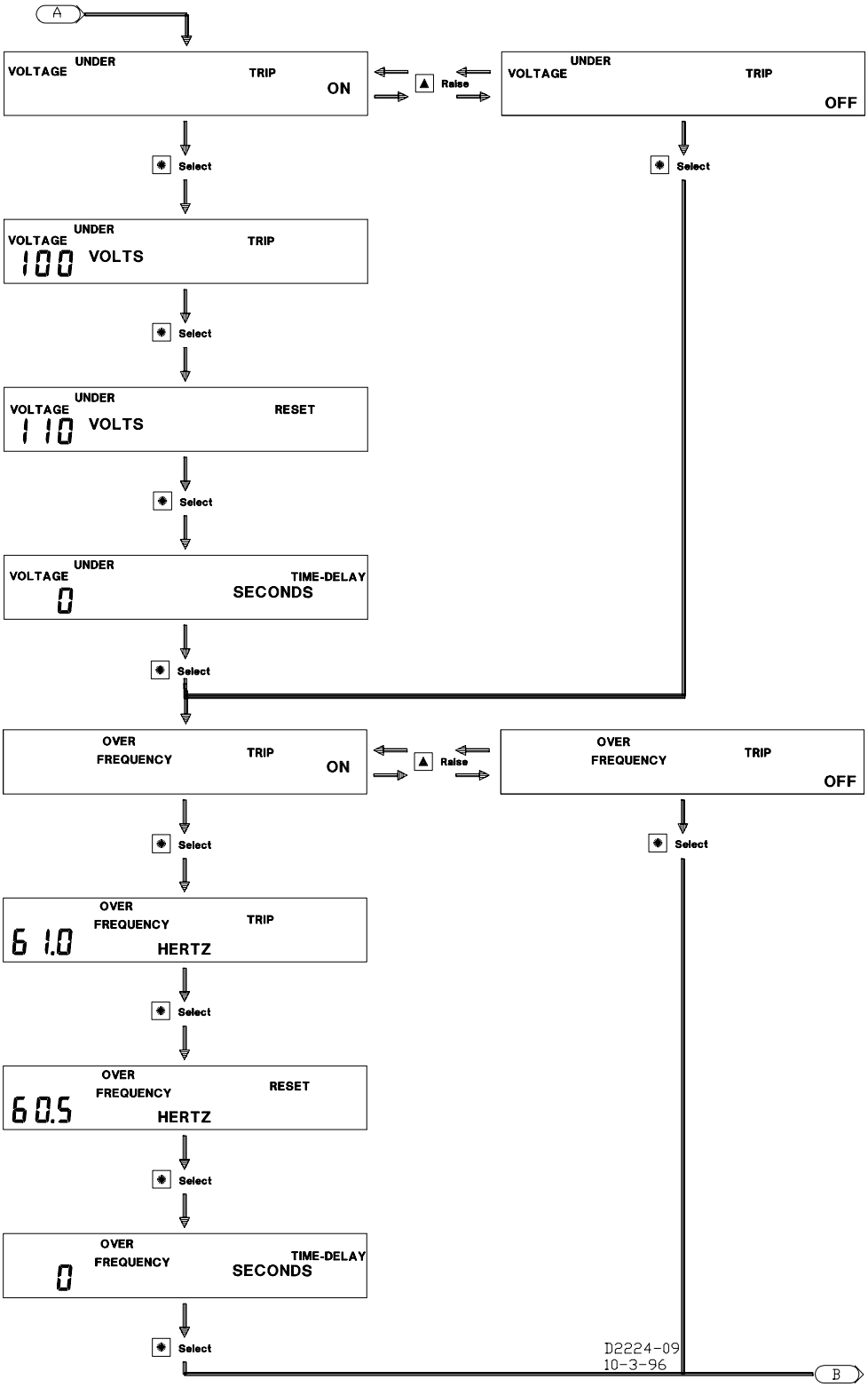


Figure 3-4. Selection Menu (Sheet 2 of 6)

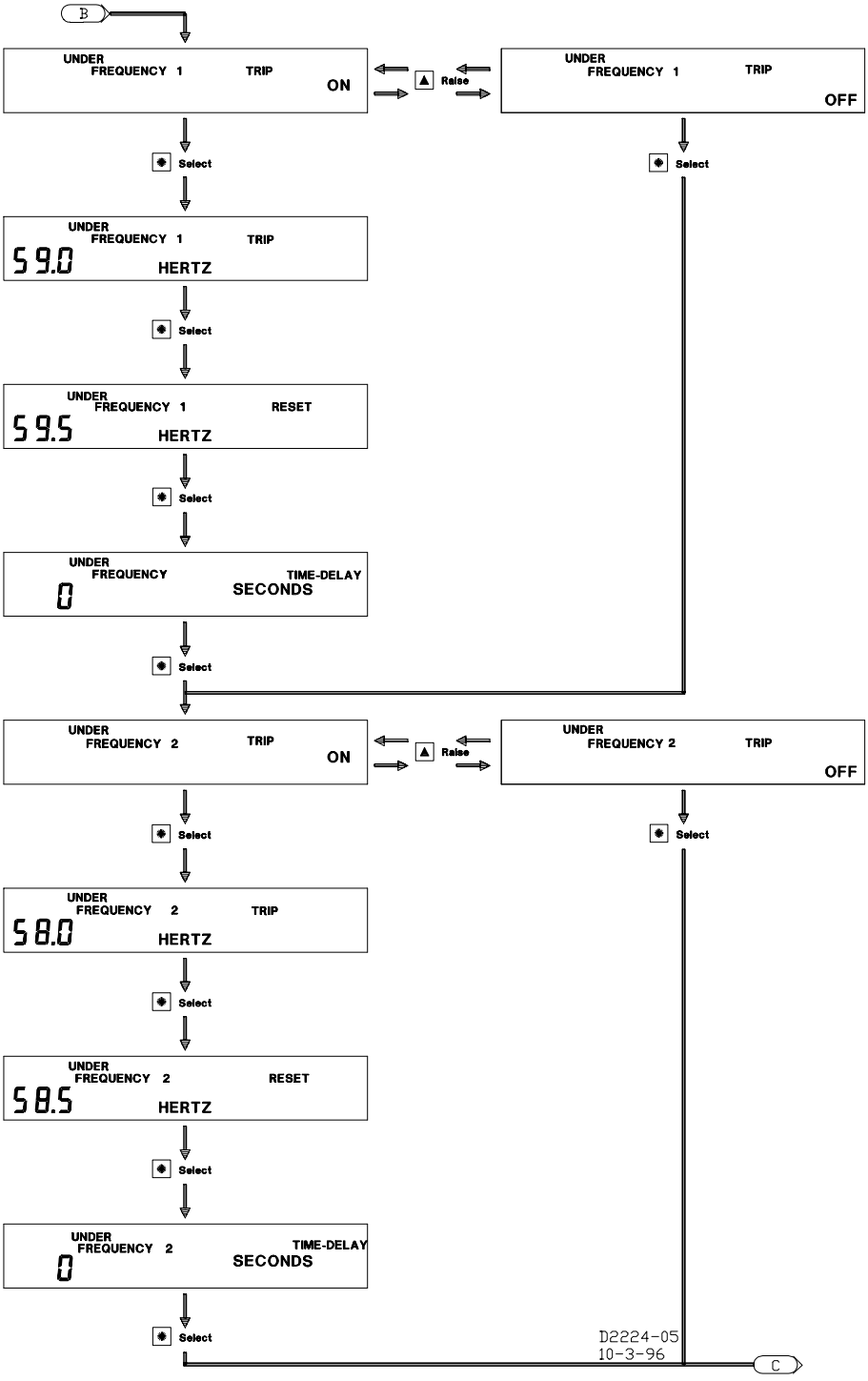


Figure 3-5. Selection Menu (Sheet 3 of 6)

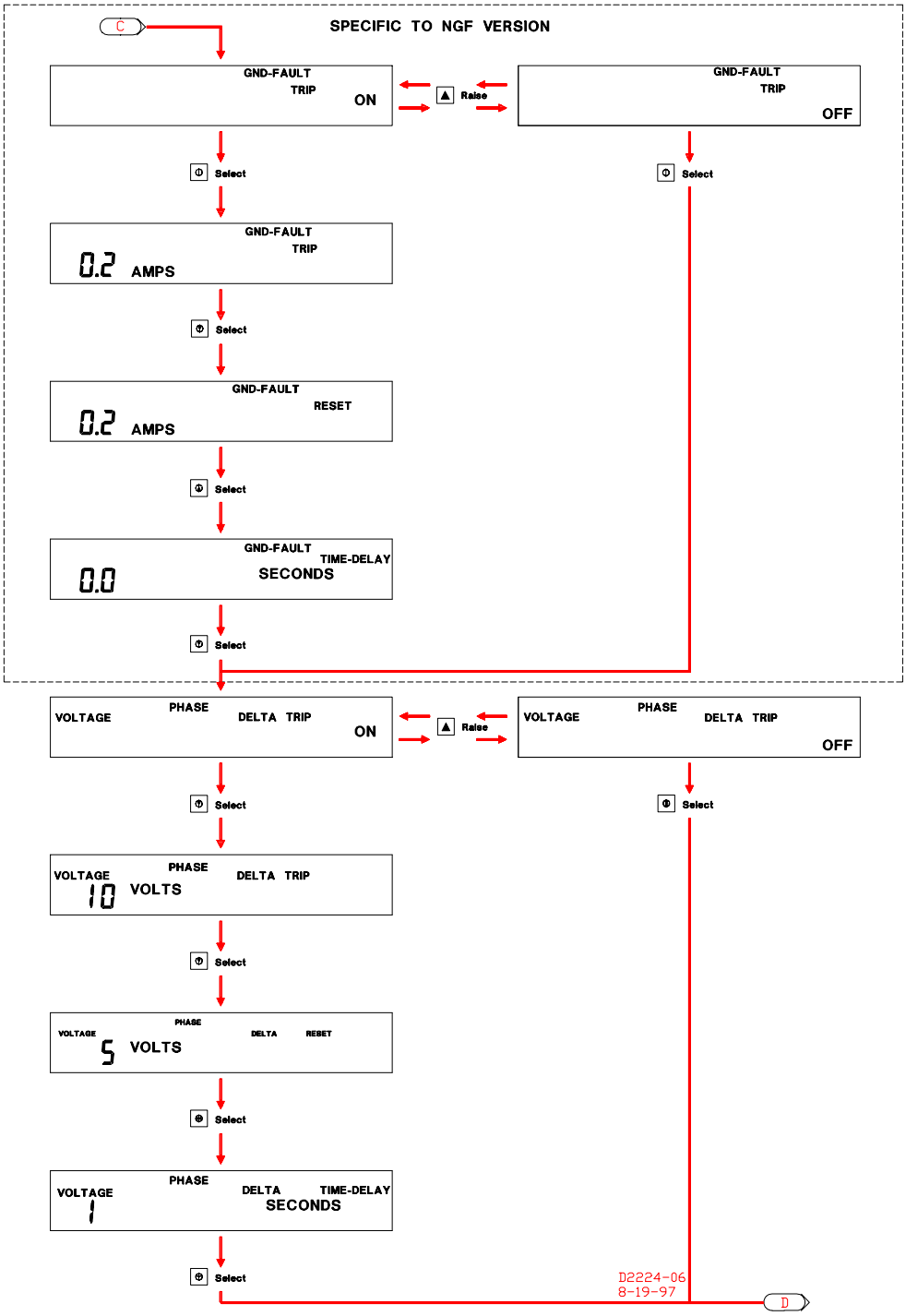


Figure 3-6. Selection Menu (Sheet 4 of 6)

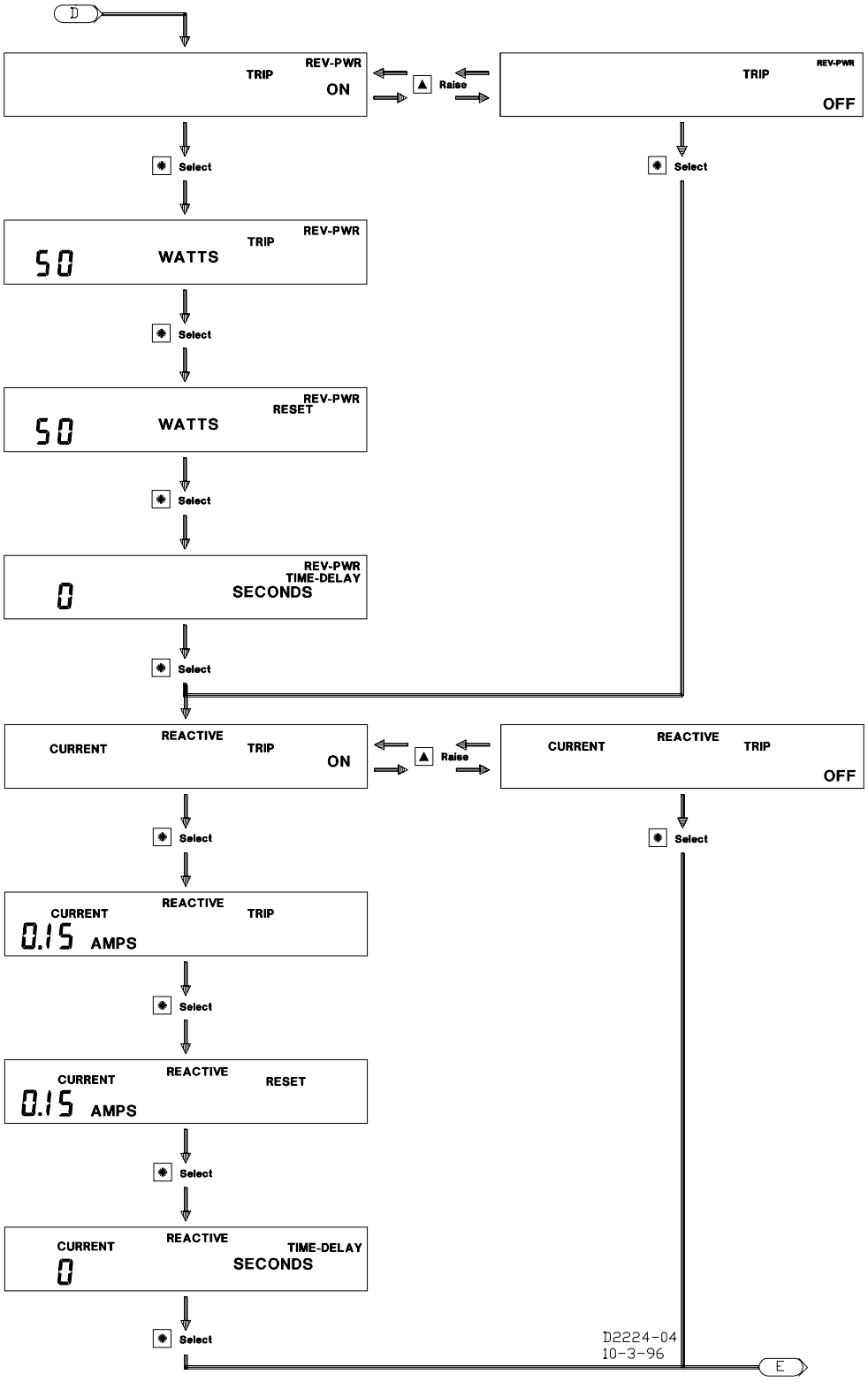


Figure 3-7. Selection Menu (Sheet 5 of 6)

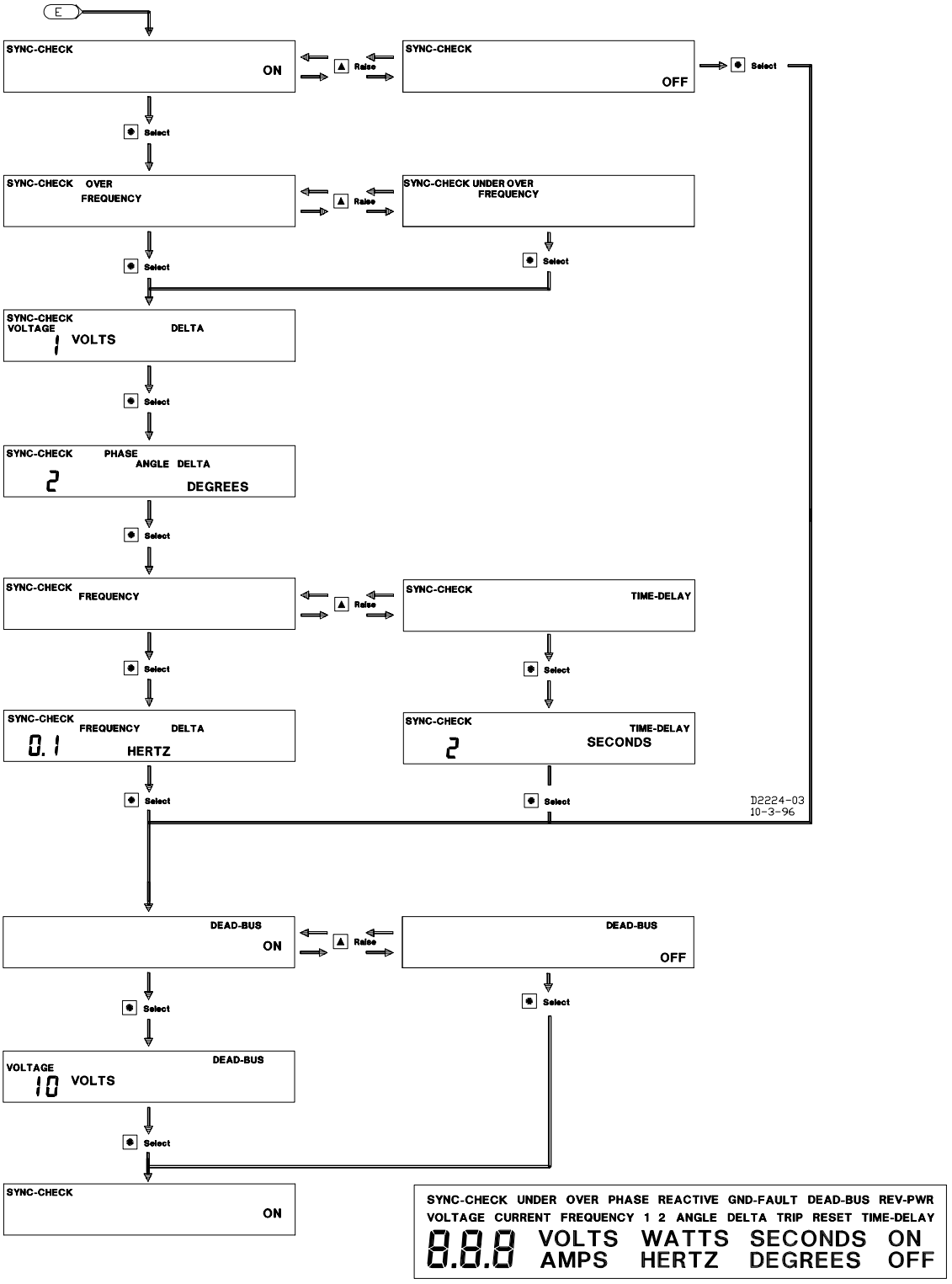


Figure 3-8. Selection Menu (Sheet 6 of 6)

REMOTE RS-232 COMMUNICATIONS AND SUPPORT

Users can program the relay settings using a remote personal computer connected to the isolated terminal blocks. This allows the user to program the relay without directly accessing the buttons on the front panel. Remote programming does not interfere with normal operation. In order for remote pushbutton operations to begin, the personal computer must be running a terminal emulation program (e.g. Procom®, Telix, or Windows™) to send (type) and receive (display) 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™ - Terminal, the following terminal 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 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 completely).

Logon

To initiate the communications routine, the user must enter HELLOBE3GPR. The terminal emulator screen will reply with the message **BE3GPR PROGRAMMING UTILITY ENTERED**, and the front panel LCD on the relay will display **SLC**, representative of Serial Link Communication.

Logoff

To terminate the communications routine, 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 numerical segments will return to the 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 (uppercase (capitol letters) are not required), followed by an equal symbol, 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**, indicating that the present over voltage is disabled, but with a trip level set for 150 volts, a reset level of 100 volts, and a zero second time delay. By then entering OV = 1, 140, 130, 1, and striking the **Enter** key, the user has enabled the over voltage function and changed trip level to 140 volts, the reset level to 130 volts, and the time delay to 1 second. Since this is a valid command and setup, the relay will implement the change and acknowledge it with the response **OV = 1, 140, 130, 1**. If the command or setup was incorrect, the response would have been an error message (Table 3-2).

Table 3-1. Available 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

Table 3-1. Available Commands

Command	Description
V	V = d1 d1 = software version identification number (For Basler Electric Company 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)
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)

Table 3-1. Available Commands

Command	Description
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

BE3-GPR default settings when displayed using the **S** command.

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

Default settings interpreted in the order displayed.

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

Optional Communications Software

Basler Electric offers a Windows™ software package that Enhances communications to BE3-GPRs. This software package also provides a real time metering capability for monitoring generator voltage, frequency, current, watts, power factor, and volt-amperes. BE3-GPR Windows™ interface software serves two primary functions. One, it provides a user friendly environment to change or make relay settings. Without the software, you must be familiar with the BE3-GPR terminal commands to program relay settings. With the software, on-screen displays guide you through the setting process. Two, the software provides a means to monitor the metering results through the communications interface. Metered data is displayed on the computer screen and refreshed approximately every second. Real time monitoring provides critical generator data for evaluating system performance. The interface software also allows the user to save setup configurations to a disk. This allows a user to save multiple setups for later use and saves setup time when configuring multiple units. Please contact your sales representative or the Customer Service Department, Power Systems Group, Basler Electric, Highland, Illinois.

Hardware Jumper Inputs

The software monitors the status of the hardware jumper terminal block inputs in order to determine what the required operations are for any given condition.

Program Enable

Software continuously reads this input to determine when the user may make changes to the settings. If installed, the relay settings may be altered as described in earlier in this section. If the jumper is not installed, changes at the front panel are locked out. A program enable is only required when programming at the front panel. It is not required when programming using the communications link.

Fail-Safe Enable

Software reads this input continuously to determine if the output contact status needs to be toggled to provide deenergized output contacts on a trip. If it is enabled, the relay implements the fail-safe feature.

Output Disable

Software reads this input during trip decision making operations. If the jumper is installed, all terminal trip time delay counters are impaired and no trip decisions can be made until the jumper has been removed.

Trip Reset

Software reads this input during trip decision making operations. If the jumper is connected the following occurs:

- All output contacts are reset to the untripped condition (this depends on the fail-safe 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

This reset condition persists until the jumper is removed, regardless of any existing trip conditions sensed by the relay.

SECTION 4 • INSTALLATION

GENERAL

BE3-GPR relays are delivered in sturdy cartons to prevent shipping damages. Upon receipt of the relay, check the Model and Style Number against the requisition and packaging list for agreement. Inspect for damage, and if there is evidence of such, immediately file a claim with the carrier and notify the Basler Electric Regional Sales Office, your Sales Representative or Sales Representative at Basler Electric, Highland, Illinois.

If the relay is not installed immediately, store it in the original shipping package in a moisture and dust free environment. Performing the Operational Test Procedure is recommended prior to installation.

MOUNTING

BE3-GPRs are surface mountable behind a panel or semi-flush mounted. Overall dimensions and hole locations for surface mounting are shown in Figure 4-1. Figure 4-2 shows overall dimensions and hole locations for semi-flush mounting. Metric dimensions are shown in parentheses.

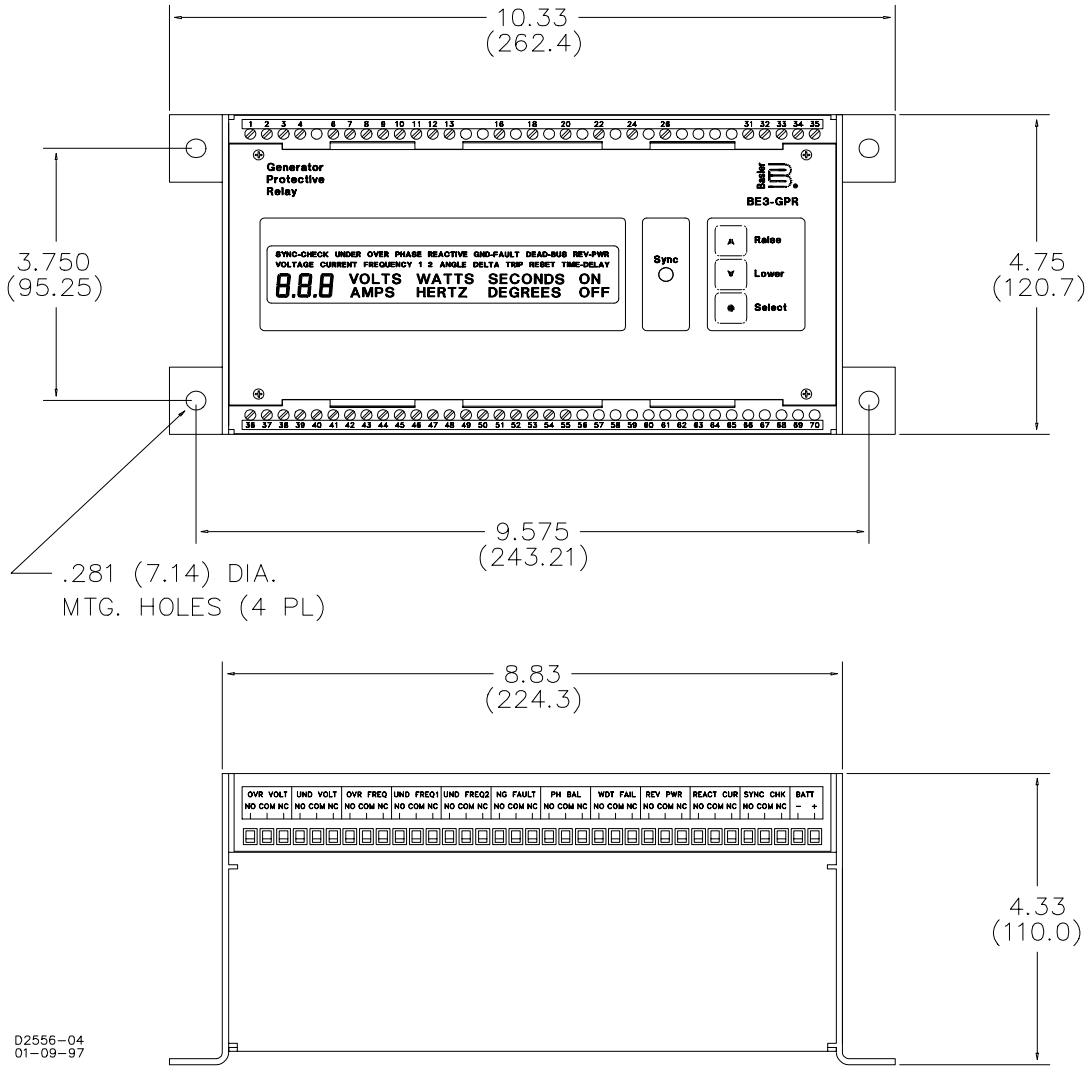


Figure 4-1. BE3-GPR Typical Overall Dimensions And Hole Locations (Surface Mounting)

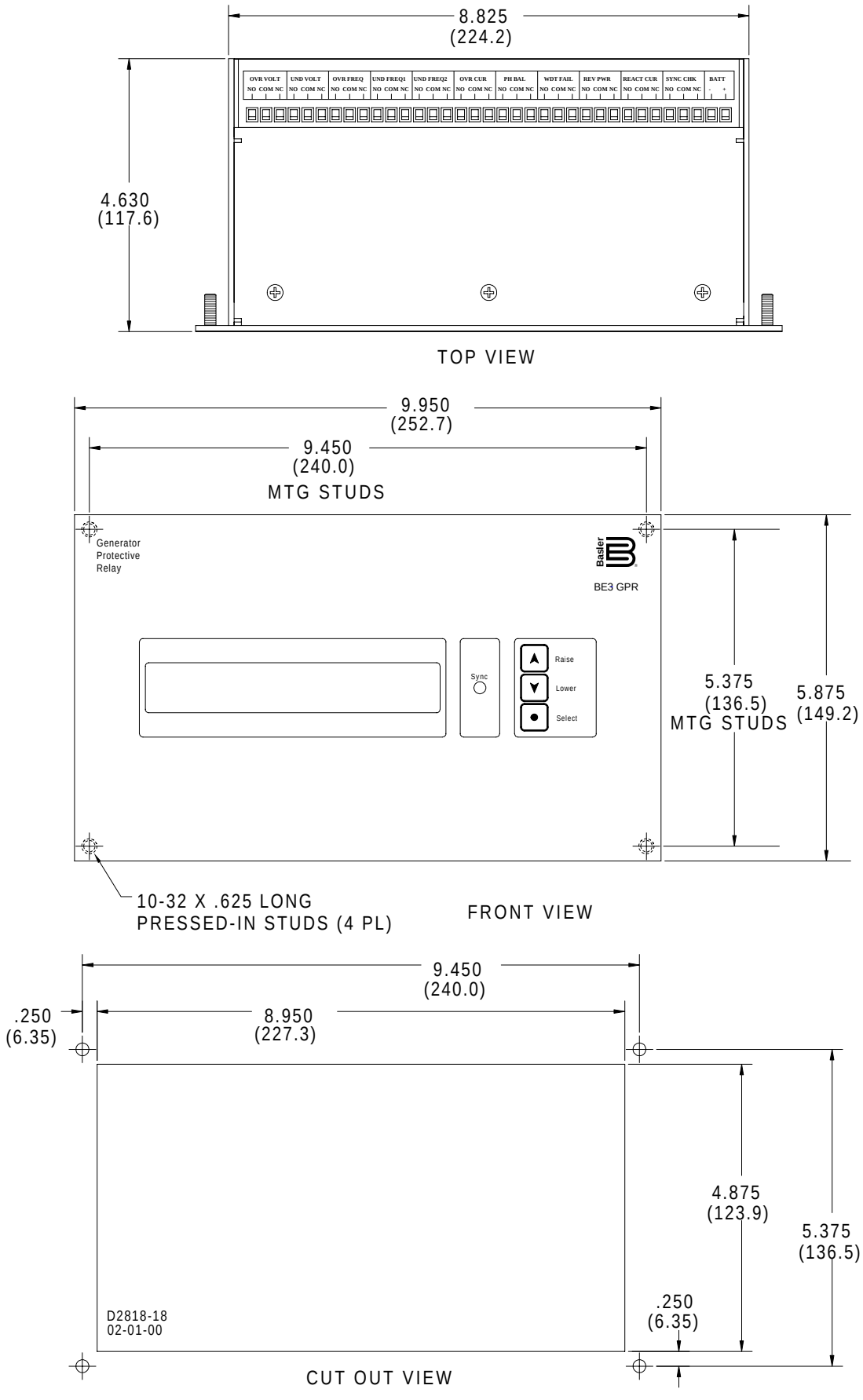


Figure 4-2. BE3-GPR Typical Overall Dimensions and Hole Locations (Semi-Flush Mounting)

CONNECTIONS

General

Compression type terminals are used to facilitate wiring. These terminals accept one #10 AWG wire or two #14 AWG wires.

Communications Link

Figure 4-3 provides pinouts for connecting the RS-232-C link for terminals with Windows™ software or other conventional software. If you are using the Windows™ software, loopbacks (jumpers for pins 4 to 6 and pins 7 to 8) are required.

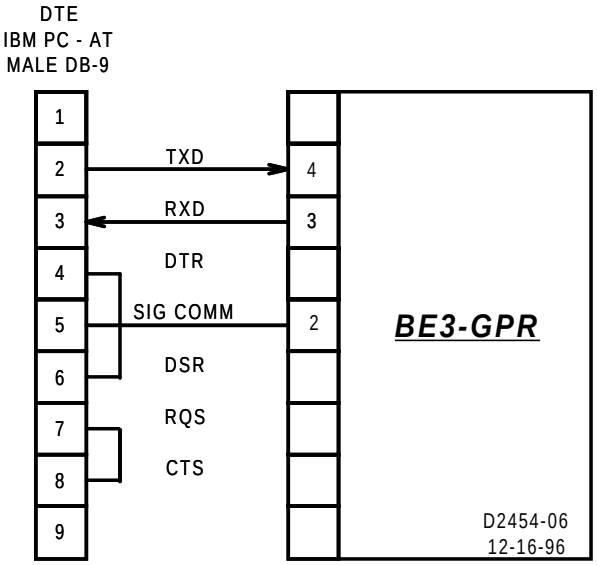
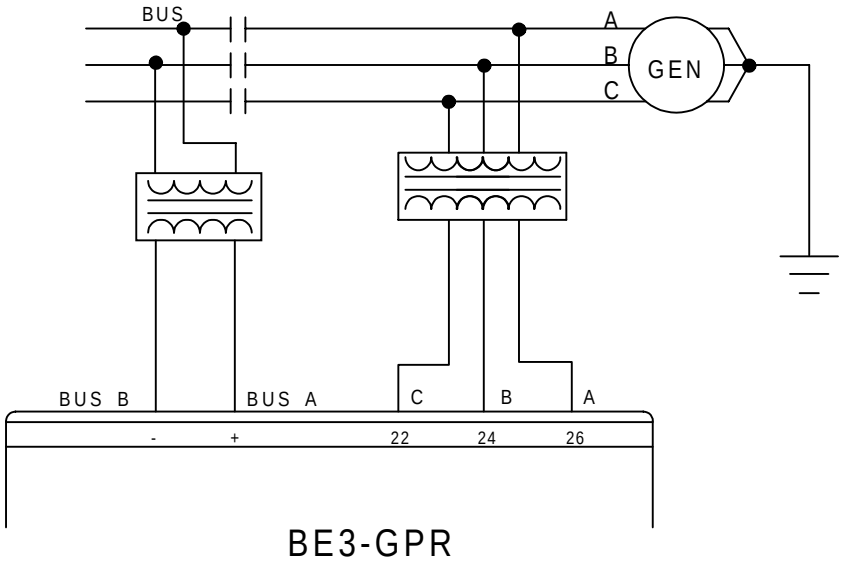


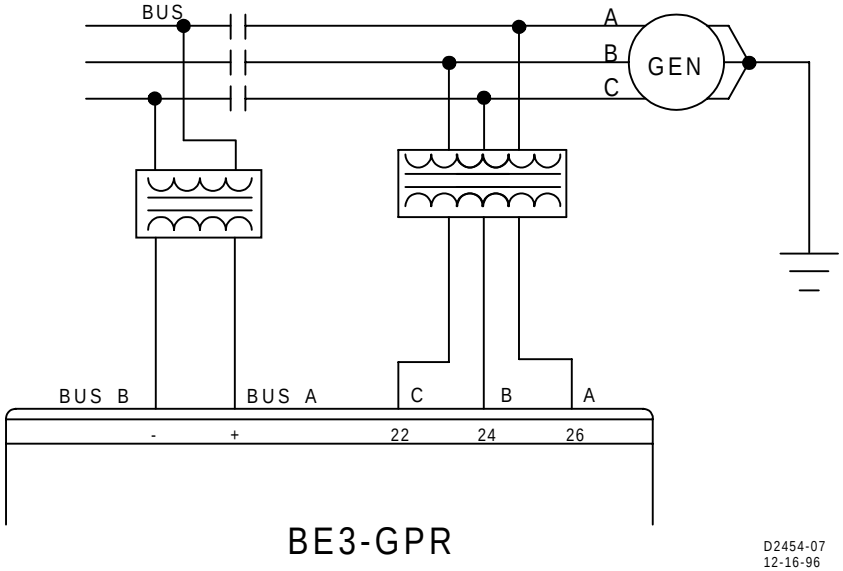
Figure 4-3. RS-232 Serial Communications Cable Connections

System

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



CONNECTIONS FOR THREE-PHASE SYSTEMS WITH ABC ROTATION.



CONNECTIONS FOR THREE-PHASE SYSTEMS WITH ACB ROTATION.

Figure 4-4. Connections For Three-Phase Rotations

The following figures show the BE3-GPR (NGF and TOC) relay unit connections.

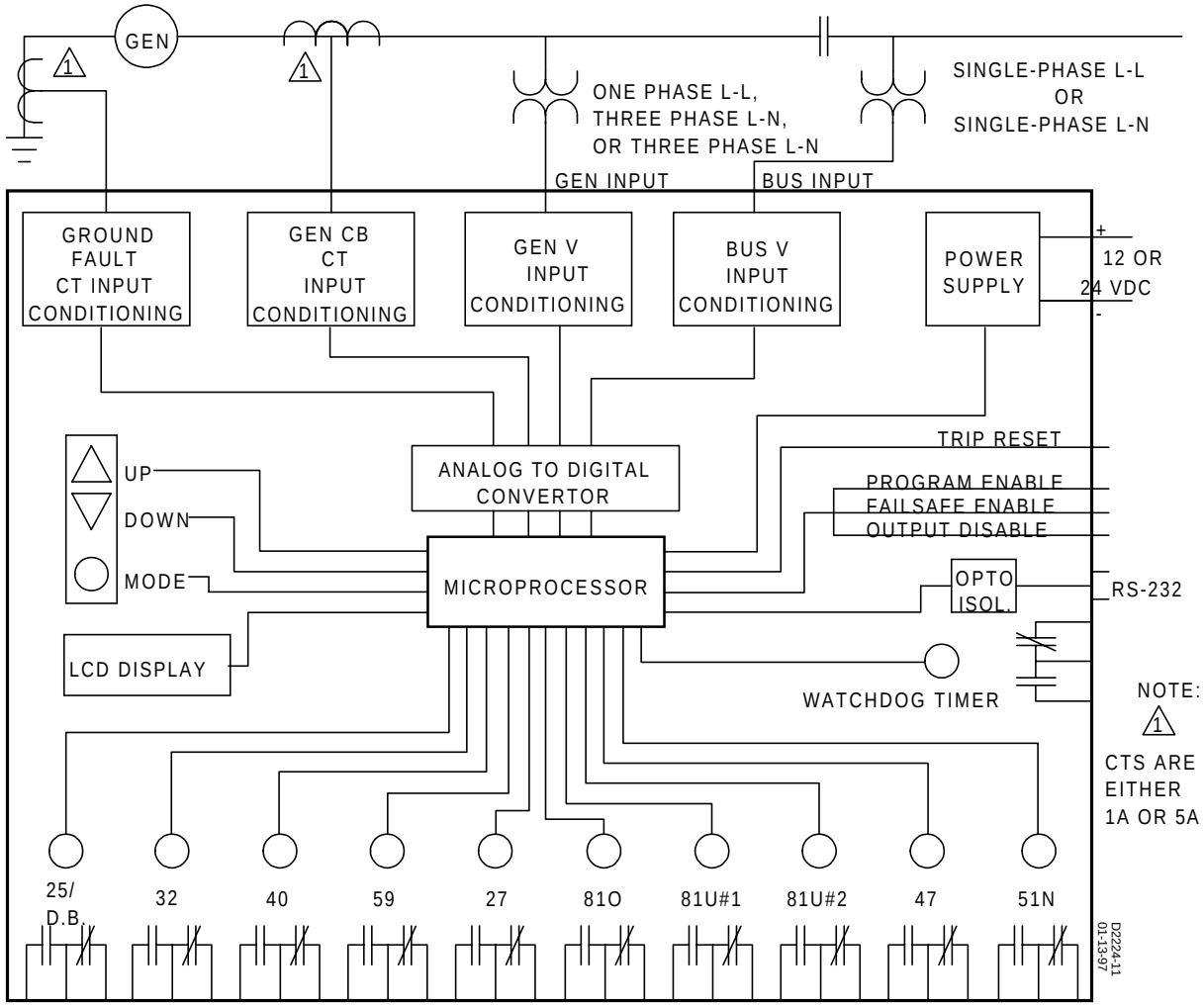


Figure 4-5. BE3-GPR, NGF, Inputs And Outputs

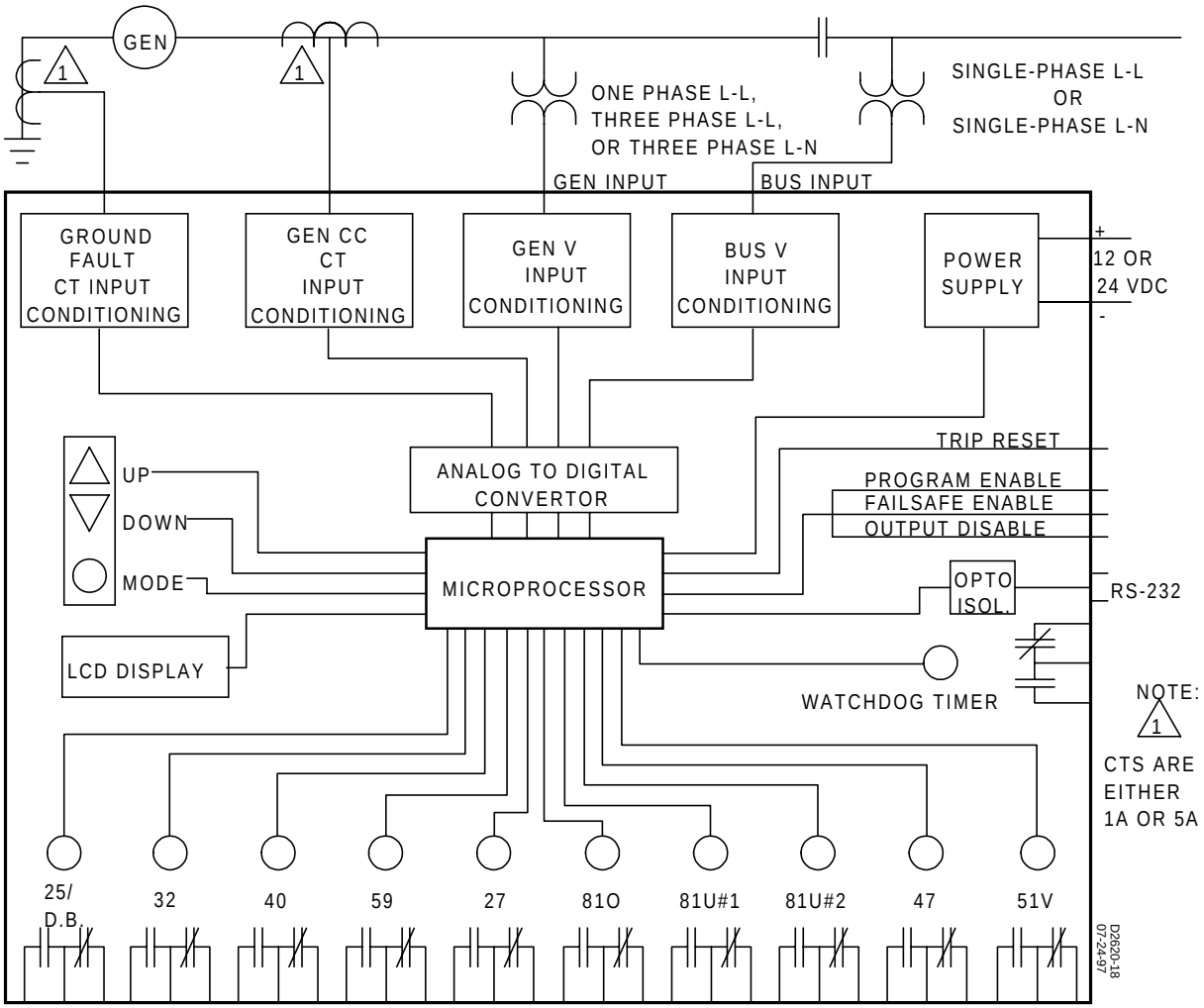


Figure 4-6. BE3-GPR, TOC, Inputs and Outputs

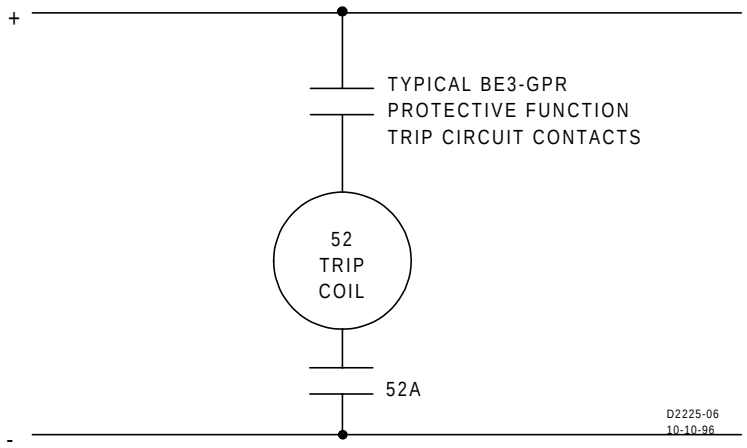


Figure 4-7. BE3-GPR Typical DC Control Circuit

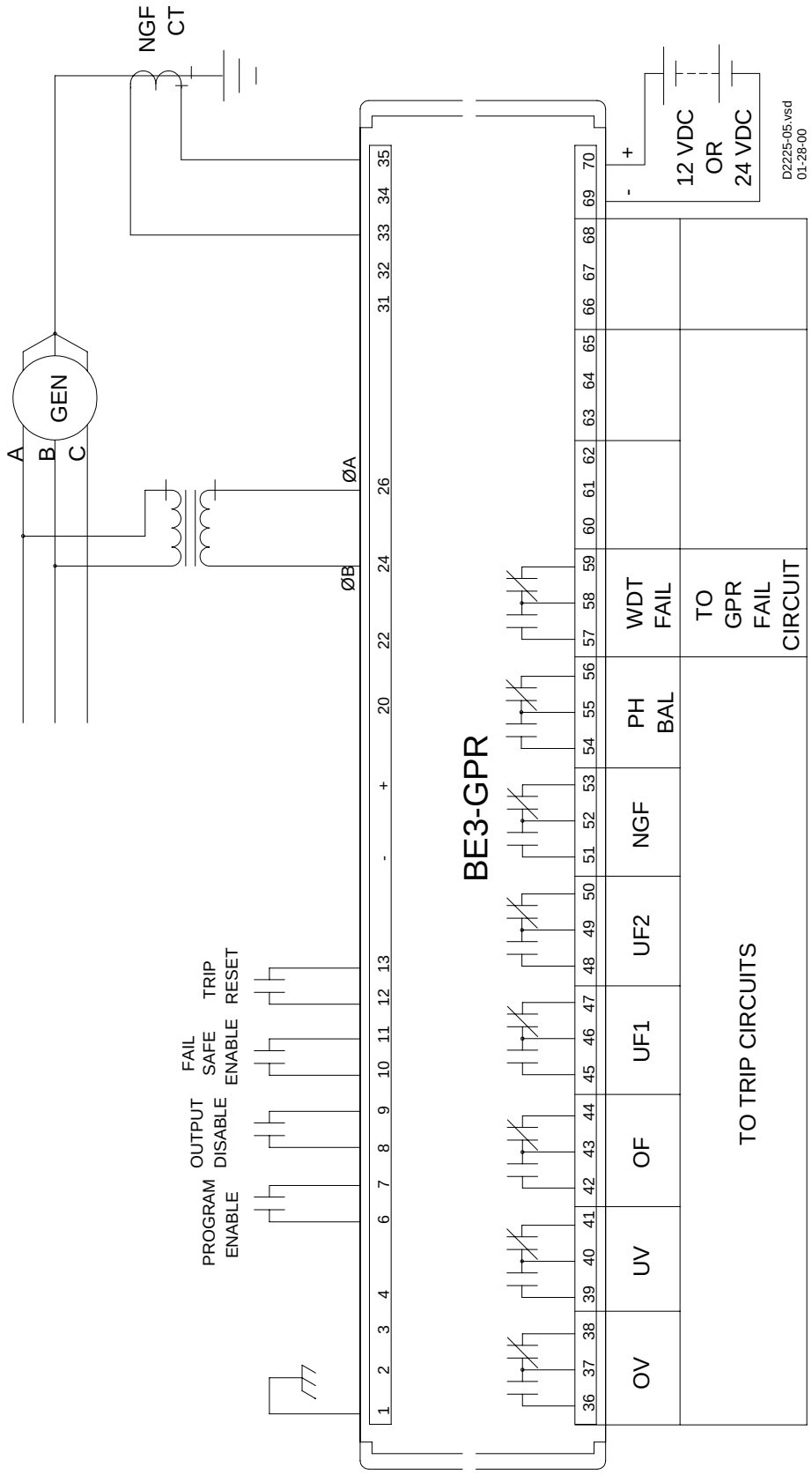


Figure 4-8. BE3-GPR (NGF) S-2 With Single-Phase, Line-To-Line Sensing and Conditioning, and 5A CT.

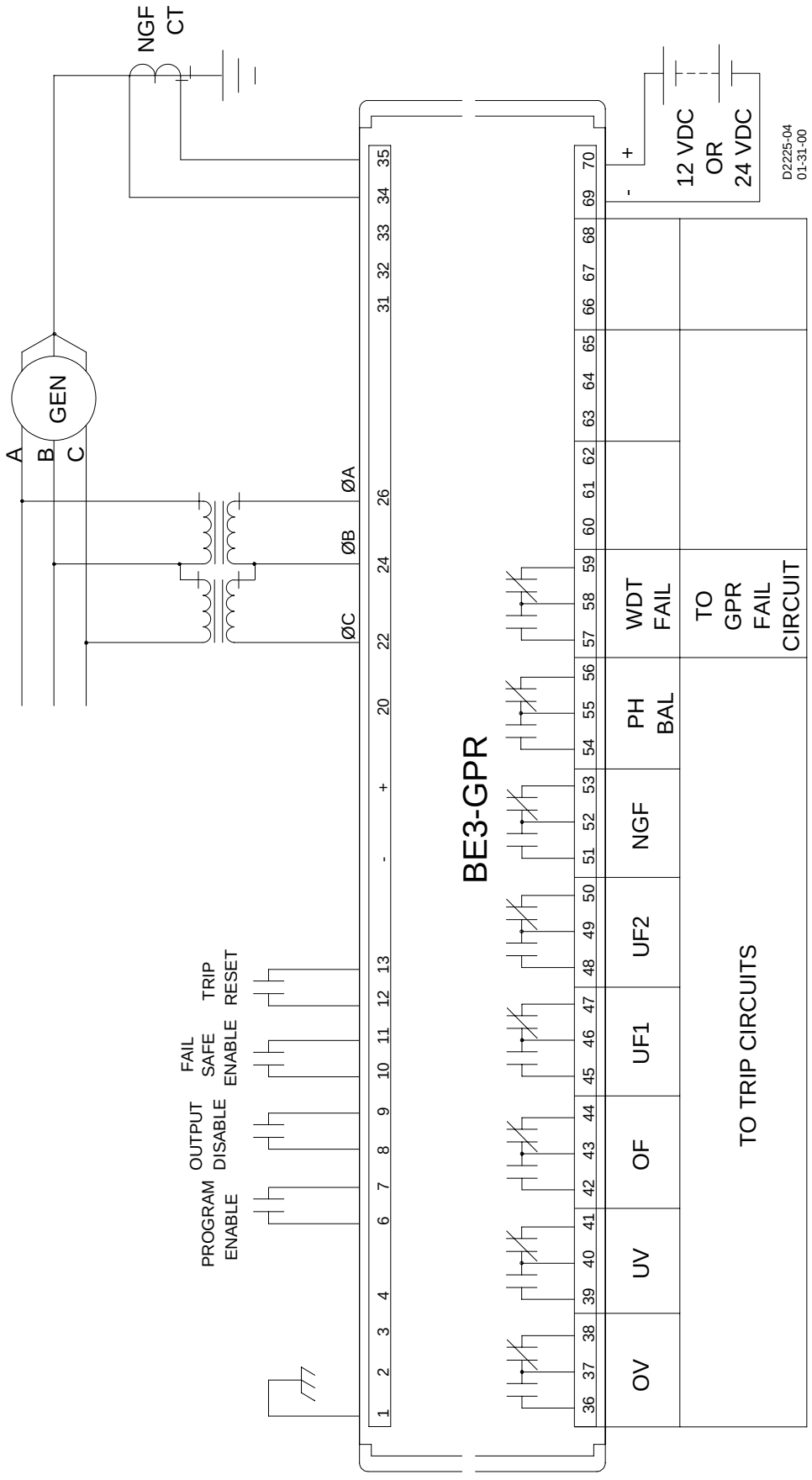


Figure 4-9. BE3-GPR (NGF) S-2 With Three-Phase, Line-to-Line Sensing, and 1A CT

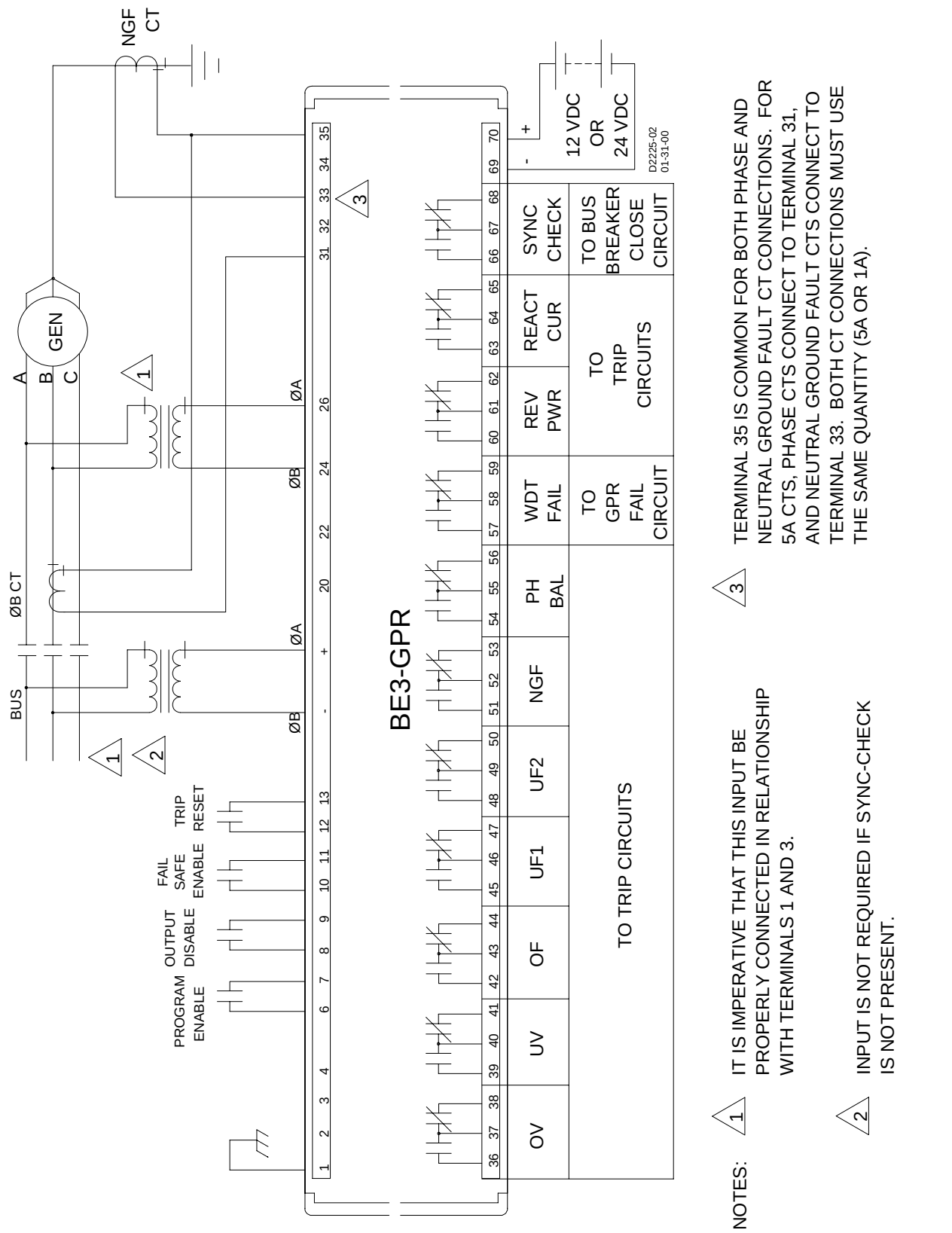
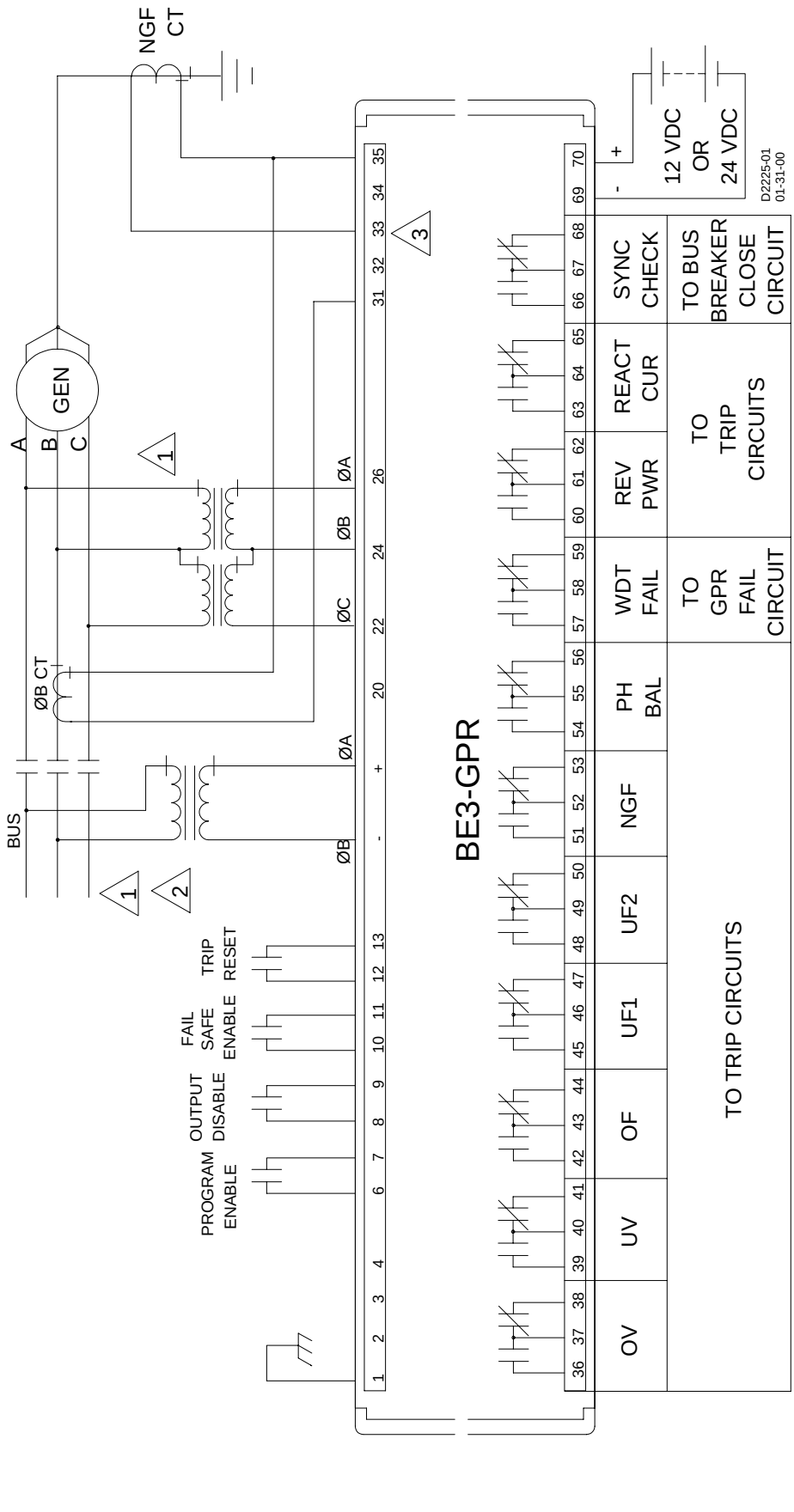


Figure 4-10. BE3-GPR (NGF) P-2 With Single-Phase, Line-to-Line Sensing and Conditioning, and 5A CTs.



NOTES:

1. IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 22, 24, AND 26.
2. INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.
3. TERMINAL 35 IS COMMON FOR BOTH PHASE AND NEUTRAL GROUND FAULT CT CONNECTIONS. FOR 5A CTS, PHASE CTS CONNECT TO TERMINAL 31, AND NEUTRAL GROUND FAULT CTS CONNECT TO TERMINAL 33. BOTH CT CONNECTIONS MUST USE THE SAME QUANTITY (5A OR 1A).

Figure 4-11. BE3-GPR (NGF) P-2 With Three-Phase, Three Wire, Line-to-Line Sensing, and 5A CTs

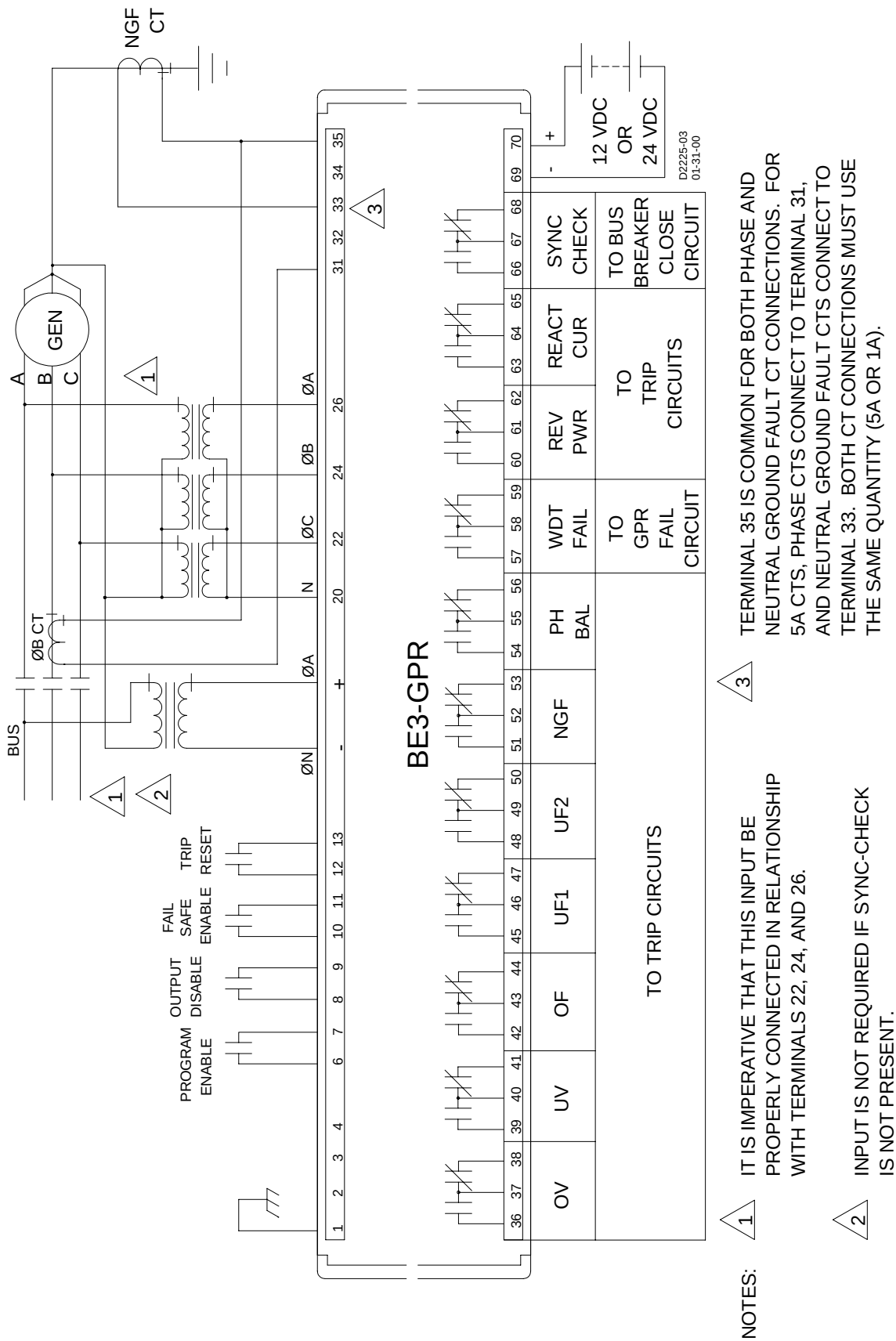


Figure 4-12. BE3-GPR (NGF) P-2 With Three-Phase, Four Wire, Line-to-Neutral Sensing and Conditioning, and 5A CTs

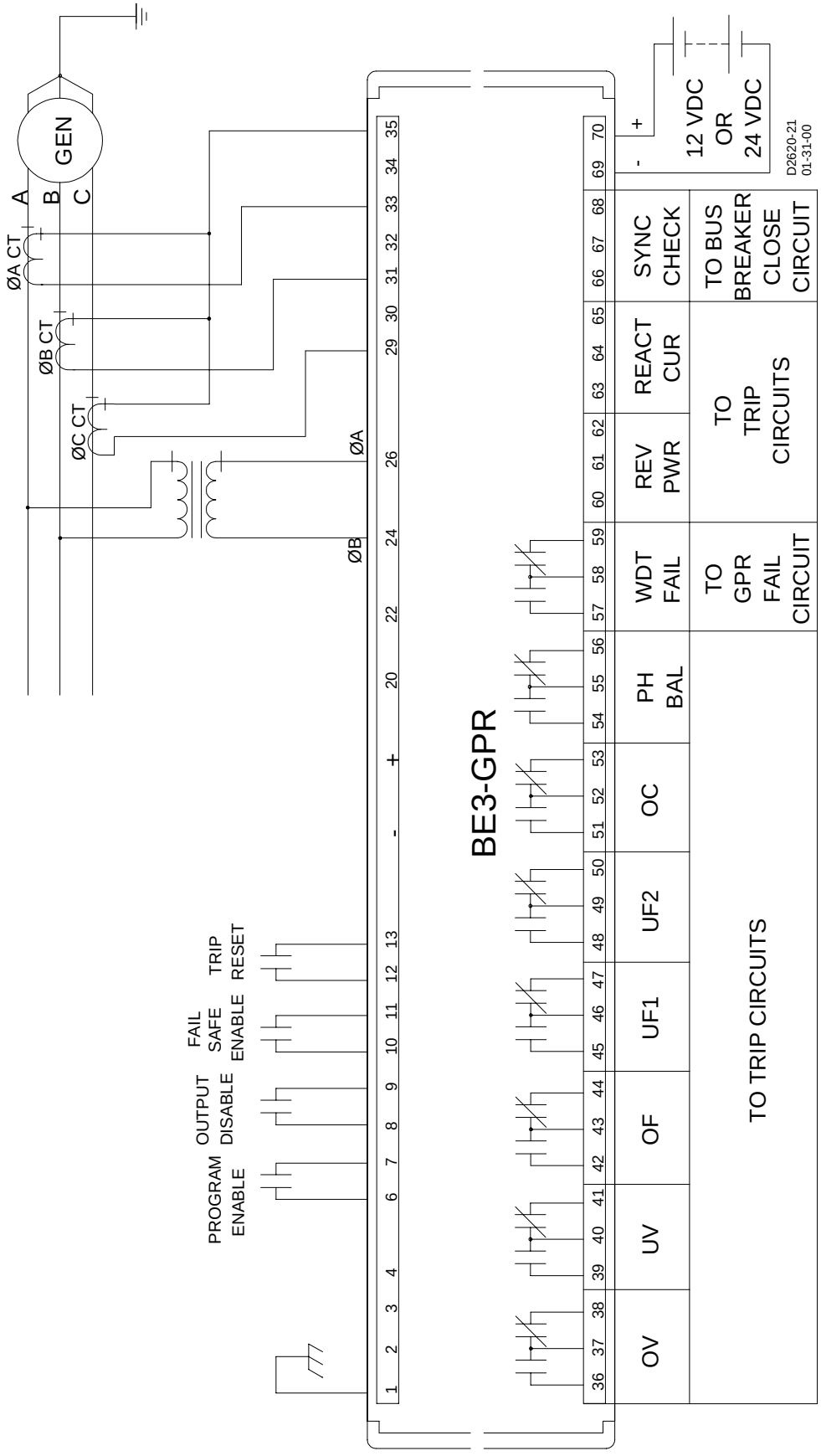


Figure 4-13. BE3-GPR (TOC) S-1 With Single-Phase, Line-To-Line Sensing and Conditioning, and 5A CT.

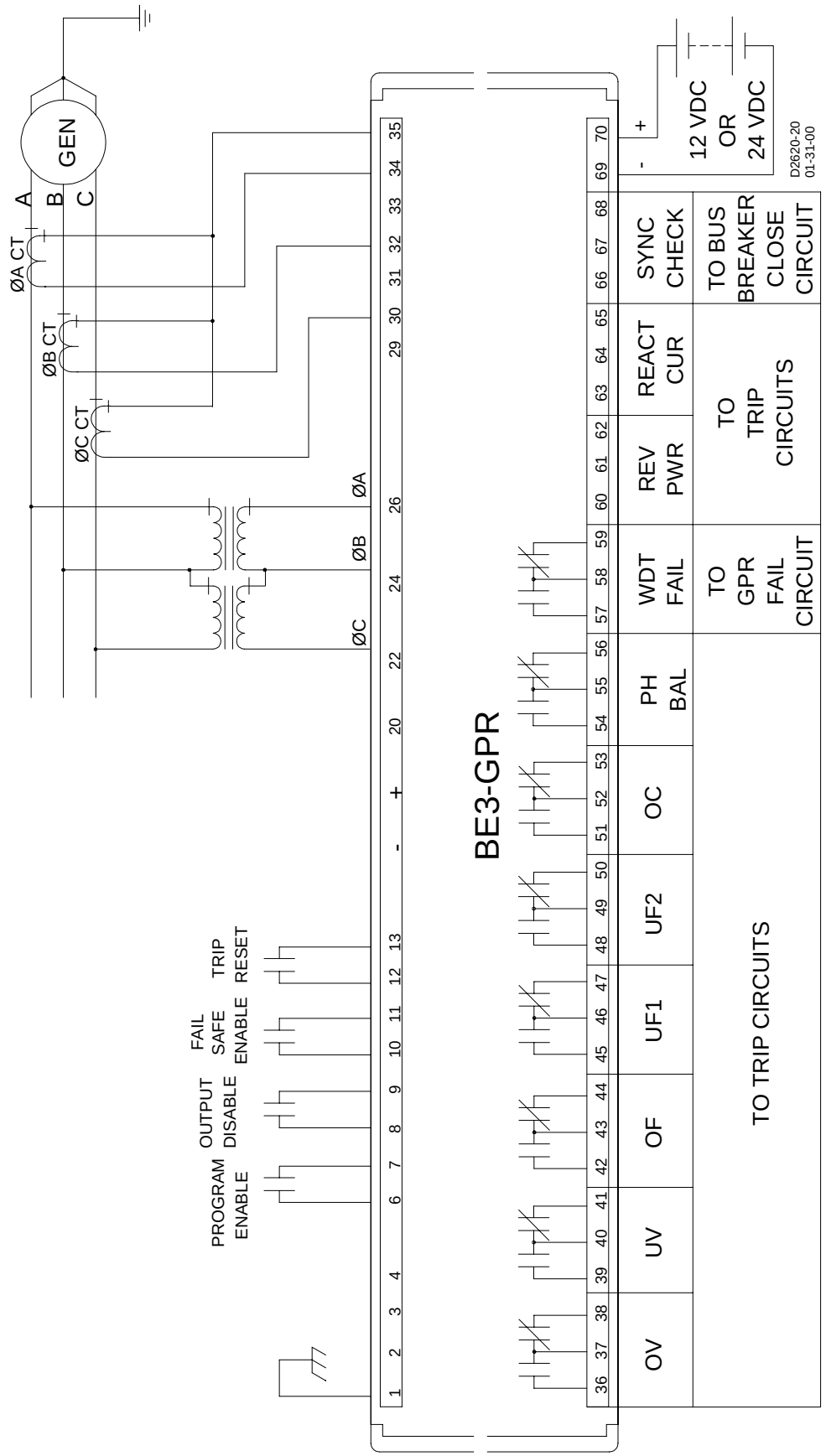
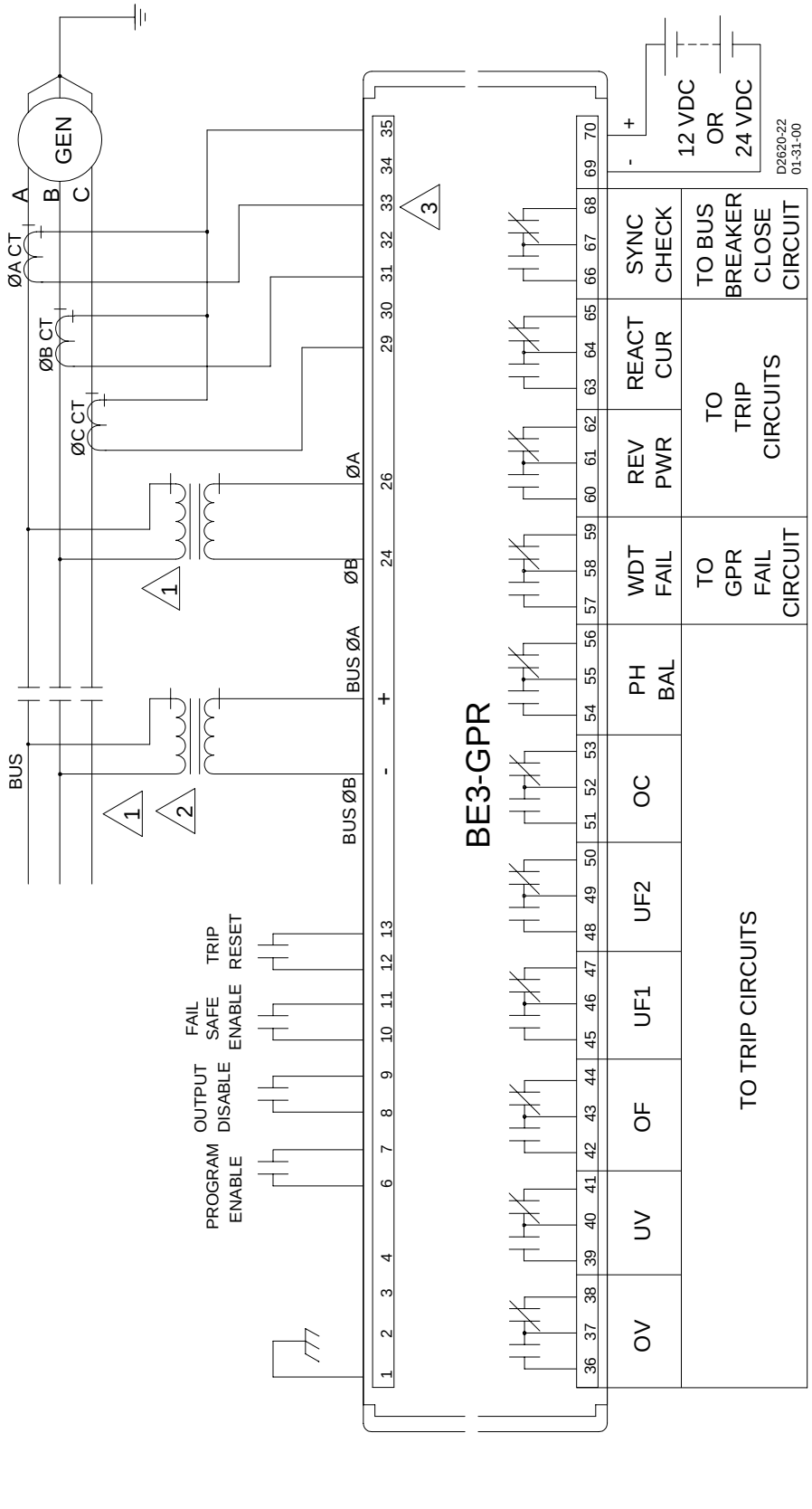


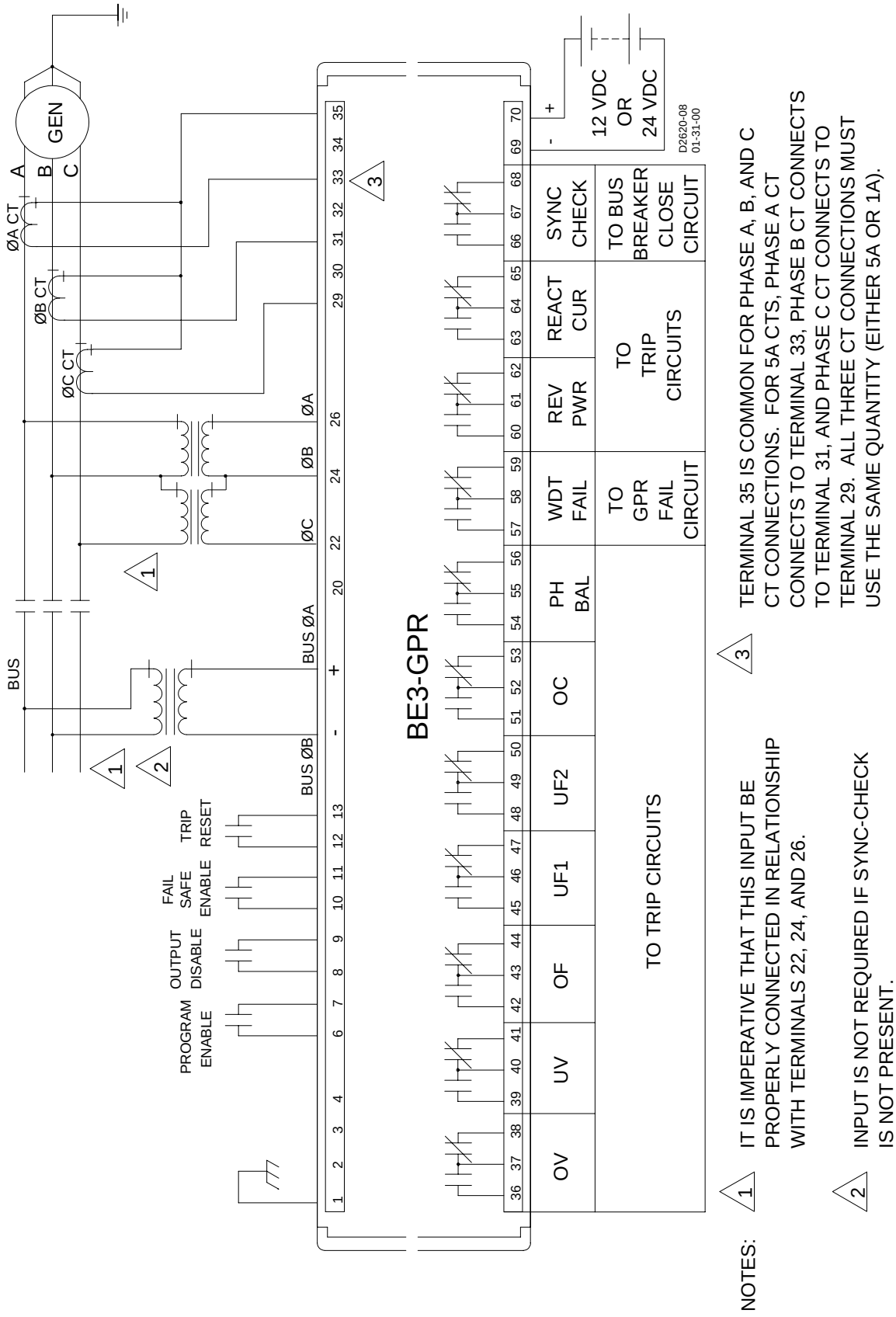
Figure 4-14. BE3-GPR (TOC) S-1 With Three-Phase, Line-to-Line Sensing, and 1A CT



NOTES:

1. IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 22, 24, AND 26.
2. INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.
3. TERMINAL 35 IS COMMON FOR PHASE A, B, AND C CT CONNECTIONS. FOR 5A CTS, PHASE A CT CONNECTS TO TERMINAL 33, PHASE B CT CONNECTS TO TERMINAL 31, AND PHASE C CT CONNECTS TO TERMINAL 29. ALL THREE CT CONNECTIONS MUST USE THE SAME QUANTITY (EITHER 5A OR 1A).

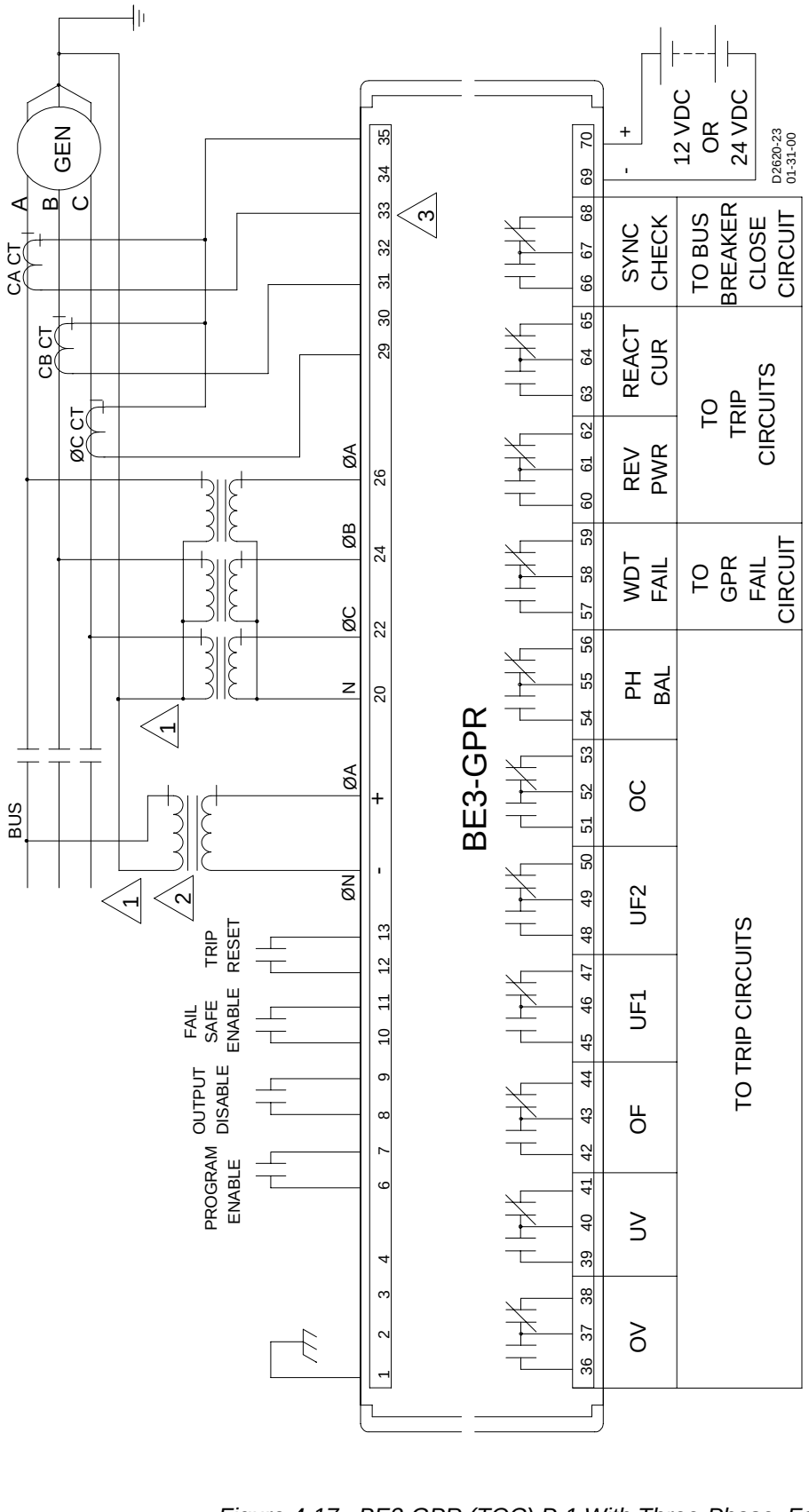
Figure 4-15. BE3-GPR (TOC) P-1 With Single-Phase, Line-to-Line Sensing and Conditioning, and 5A CTs.



NOTES:

1. IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 22, 24, AND 26.
2. INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.
3. TERMINAL 35 IS COMMON FOR PHASE A, B, AND C CT CONNECTIONS. FOR 5A CTS, PHASE A CT CONNECTS TO TERMINAL 33, PHASE B CT CONNECTS TO TERMINAL 31, AND PHASE C CT CONNECTS TO TERMINAL 29. ALL THREE CT CONNECTIONS MUST USE THE SAME QUANTITY (EITHER 5A OR 1A).

Figure 4-16. BE3-GPR (TOC) P-1 With Three-Phase, Three Wire, Line-to-Line Sensing, and 5A CTs



NOTES:

1. IT IS IMPERATIVE THAT THIS INPUT BE PROPERLY CONNECTED IN RELATIONSHIP WITH TERMINALS 22, 24, AND 26.
2. INPUT IS NOT REQUIRED IF SYNC-CHECK IS NOT PRESENT.
3. TERMINAL 35 IS COMMON FOR PHASE A, B, AND C CT CONNECTIONS. FOR 5A CTS, PHASE A CT CONNECTS TO TERMINAL 33, PHASE B CT CONNECTS TO TERMINAL 31, AND PHASE C CT CONNECTS TO TERMINAL 29. ALL THREE CT CONNECTIONS MUST USE THE SAME QUANTITY (EITHER 5A OR 1A).

Figure 4-17. BE3-GPR (TOC) P-1 With Three-Phase, Four Wire, Line-to-Neutral Sensing and Conditioning, and 5A CTs

SECTION 5 • NGF COMMUNICATIONS

INTRODUCTION

BE3-GPR Windows™ Software is a software application program that enhances communication between users and BE3-GPRs. This program also provides a real time metering capability for monitoring generator voltage, frequency, current, watts, power factor, and volt-amperes. BE3-GPR Windows™ interface software serves two primary functions. One, it provides a user friendly environment to change or make relay settings. Without the software, you must be familiar with the BE3-GPR terminal commands to program relay settings. With the software, on-screen displays guide you through the setting process. Two, the software provides a means to monitor the metering results through the communications interface. Metered data is displayed on the computer screen and refreshed approximately every second. Real time monitoring provides critical generator data for evaluating system performance. The interface software also allows the user to save setup configurations to a disk. This allows a user to save multiple setups for later use and saves setup time when configuring multiple units.

INSTALLATION

BE3-GPR Windows™ Software contains a setup utility that installs the program on your personal computer (PC). When it installs the program, an uninstall icon is created that you may use to uninstall (remove) the program from your PC. If your PC has the minimum operating requirements listed in the following paragraph, then choose either *Installing The Program On Your PC Using Windows™ 3.1* or *Installing The Program On Your PC Using Windows®95.*

Operating Requirements

To use BE3-GPR Windows™ Software, you will need the following:

- IBM compatible PC, 486DX2 or faster with a minimum of four megabytes of RAM.
- Microsoft Windows™ version 3.1 or Windows®95.
- 3.5 inch floppy drive.
- Serial port.

Installing The Program On Your PC Using Windows™ 3.1

1. Insert disk 1 in the 3.5 inch floppy drive.
2. From Windows **File Manager**, select **File** then **Run**.
3. At the Command Line type in **a:be3gpr16**.and stroke the **Enter** key. The setup utility automatically installs the BE3-GPR Windows™ Software.

Installing The Program On Your PC Using Windows®95

1. Insert disk 1 in the 3.5 inch floppy drive.
2. From Windows, select **Start** then **Run**.
3. At the Command Line type in **a:be3gpr32**.and stroke the **Enter** key. The setup utility automatically installs the BE3-GPR Windows®95 Software.

Configuring The System

Verify that the receive and transmit lines are connected correctly. Section 4, *Installation,* provides pinouts for connecting the RS-232 serial link. Also verify that the host computer is configured for 2400 baud rate, 8 data bits, 1 stop bit, and no parity.

INITIALIZING COMMUNICATIONS WITH THE BE3-GPR

Review what we have done up to this point. You have loaded the software on your computer and you have the Basler Electric directory with the BE3-GPR icon. You have also connected the BE3-GPR unit to the computer, the system, and supplied operating power. Now you are ready to initialize communications.

Initialize Communications

Select the BE3-GPR icon to start the BE3-GPR software program. A momentary dialog box (splash screen) opens that displays the Basler Electric Logo, program application, and revision identification. After the splash screen, the initial screen (Figure 5-1) is shown.

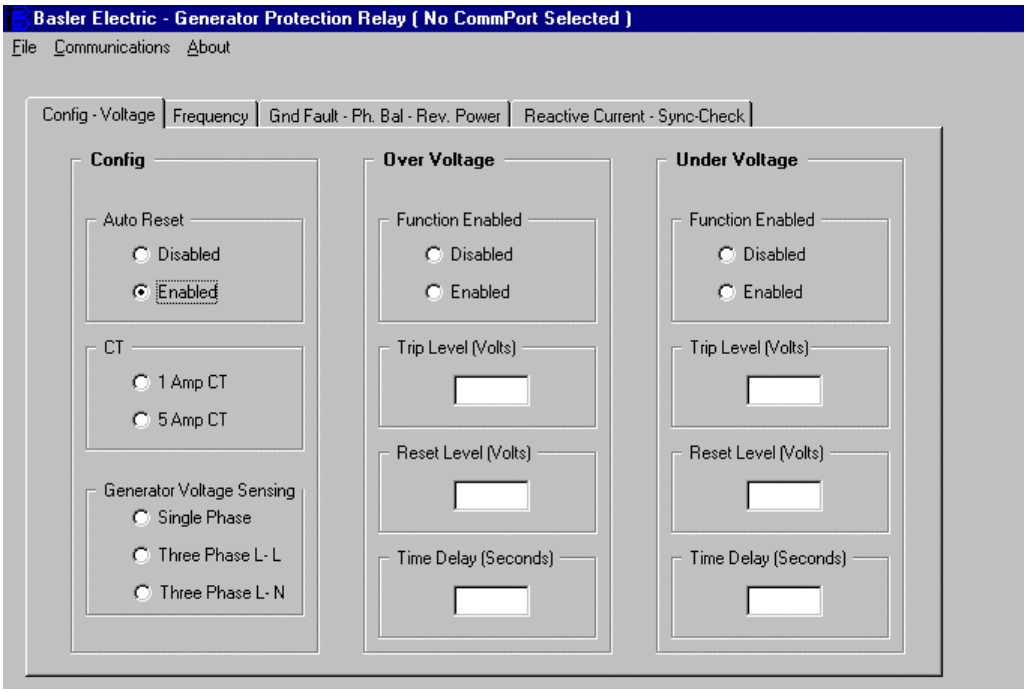


Figure 5-1. BE3-GPR Communications Software Initial Screen

Pull down the **Communications** menu and select **Open** (Figure 5-2). This should open a Comm Port screen like the one shown in Figure 5-3.

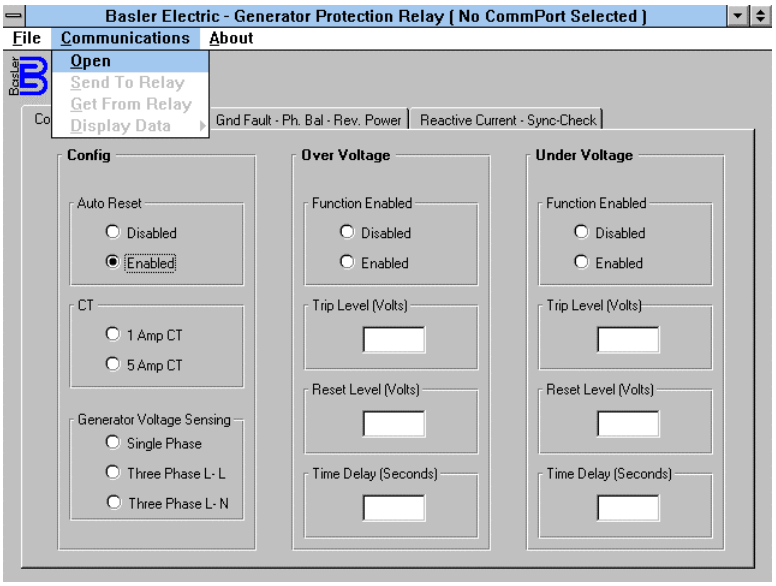


Figure 5-2. BE3-GPR Communications Open Screen

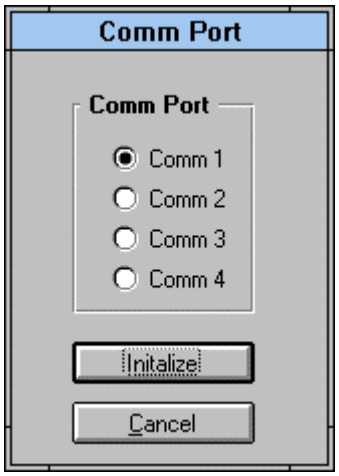


Figure 5-3. Comm Port

Select a comm port (like Comm 1 in Figure 5-3) and Initialize it. This opens the communication port and returns the current settings from the BE3-GPR unit. You do not have to select the communication protocol parameters because the software application program does that for you. Figure 5-4 is a sample of the screen showing the settings returned from the BE3-GPR unit.

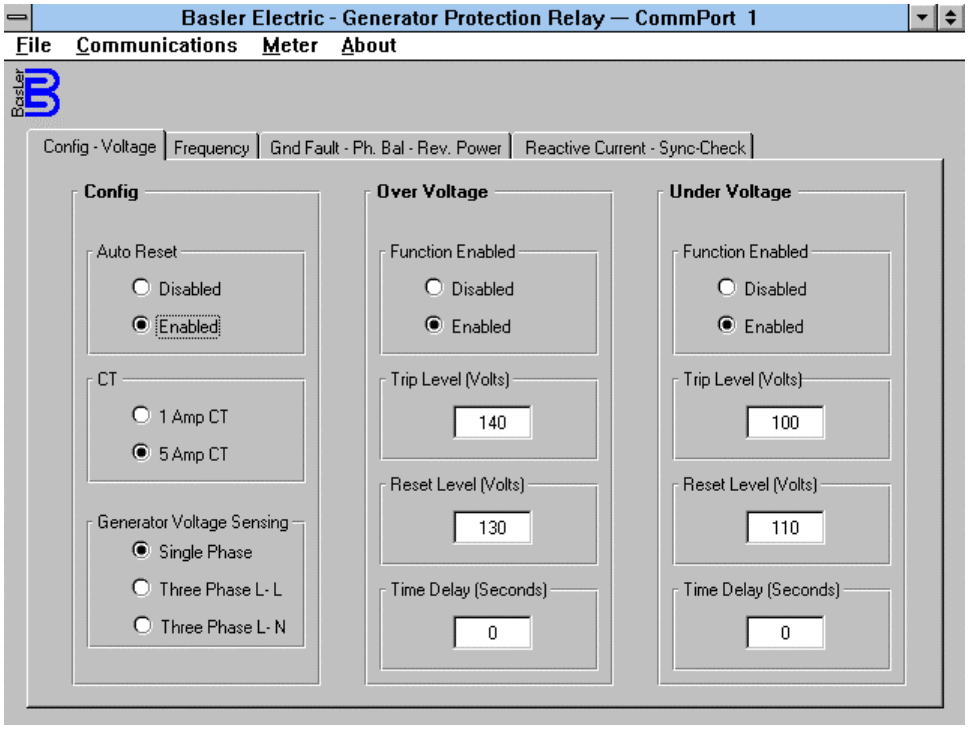


Figure 5-4. BE3-GPR Sample Settings Screen

CHANGING SETTINGS

Settings are arranged in four groups. They are:

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

To change settings, you must first select the group (if it is different from the default) by selecting the tab associated with that group. To change the settings, select (click on and highlight) the setting to be modified. Enter the new setting. Once all the settings have been entered, the new settings can be sent to the relay or saved to a file.

> **NOTE**
> Relay settings are only updated after a **Communications, Send To Relay** has been executed.

SENDING, GETTING, AND DISPLAYING DATA

When communications is in progress and you pull down the Communications menu, there are four choices. We want to describe all of those choices now **except** the **Close** choice.

Send To Relay

Executing this communications command updates the BE3-GPR unit with the settings currently displayed on the settings screens.

Get From Relay

Executing this communications command retrieves the settings from the BE3-GPR unit and displays those settings on the settings screens.

Display Data

When you select Display Data from the Communications pull down menu, you are given two choices. You may choose **As Displayed on Screen** or **As Received from Relay**. Figure 5-5 illustrates this screen.

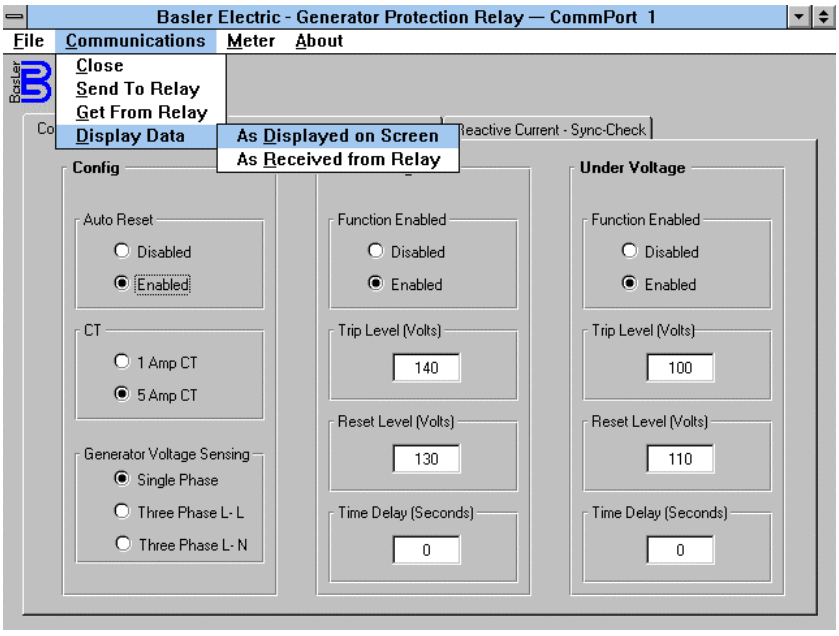


Figure 5-5. Display Data Choices

Either choice, **As Displayed**

on Screen or **As Received from Relay**. displays a snapshot of the relay or screen settings in a single line, compact format. Figure 5-6 illustrates that format.

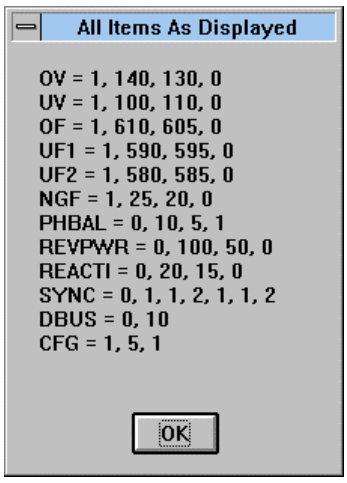


Figure 5-6. Snapshot Format

SAVING, PRINTING, AND OPENING FILES

BE3-GPR software also allows the user to save setup configurations to a disk. This allows a user to save multiple setups for later use and saves setup time when configuring multiple units. These files may also be printed for a hard copy reference and opened in several different ways.

File Save

If you have changed the settings on a specific BE3-GPR unit, you may want to save those settings for reference or future use. For example, you make the changes to a unit that is in your test system and you want to save the file as *Test1*. Open the pull down **File** menu and select **Save**. Now use normal Windows techniques and save the file with the default extension (*.GPR). Your file is now saved in the directory that you selected.

File Print

While the *Test1* settings are still shown on the screen, we should create a paper copy of those settings so that we can use them as a reference. To do this, open the **File** pull down menu and select **Print**. When you execute the Print command, you will get a dialog box similar to Figure 5-7.

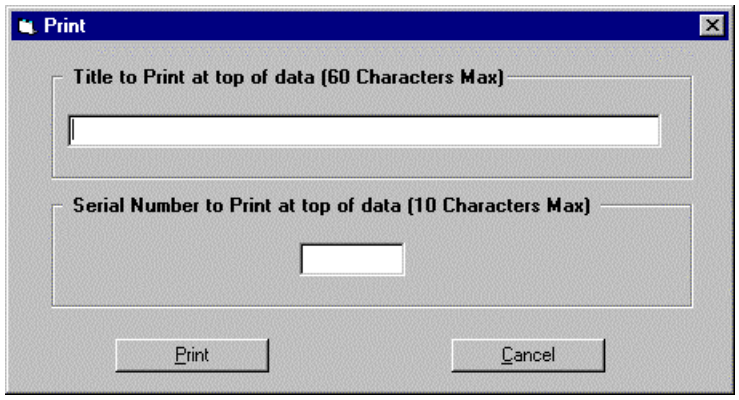


Figure 5-7. Print Dialog Box

You may fill in the appropriate information for your records, and then complete the Print command. Now you have a record for reference. The printed file lists on separate lines the date, time, title, and serial number. The date and time are referenced to the computers date and time and the time stamp that the BE3-GPR unit screens were last updated.

File Open

Suppose that after you reviewed either the BE3-GPR unit performance or the actual settings, you wanted to make a change in those settings but did not have the BE3-GPR unit available. Open the *Test1* file using a word processor such as Windows™ NoteBook, WordPerfect®, or Microsoft® Word. Use normal editing techniques to change the settings values and then save the file with either the same name or a new name.

To get this new file into the BE3-GPR, initiate communications with the BE3-GPR as you did previously. Now open the **File** pull down menu and select **Open**. Use normal Windows techniques to select the new file. When you execute the Open command, the new settings are displayed on the BE3-GPR screens. To save these new settings, execute the Communications, Send To Relay command.

METERING

BE3-GPR Windows™ software provides a means to monitor the metering results through the communications interface. Metered data is displayed on the computer screen and refreshed approximately every second. Real time monitoring provides critical generator data for evaluating system performance.

Enable Metering

To enable metering, pull down the **Meter** menu (Figure 5-8) and select **Enable Metering**.

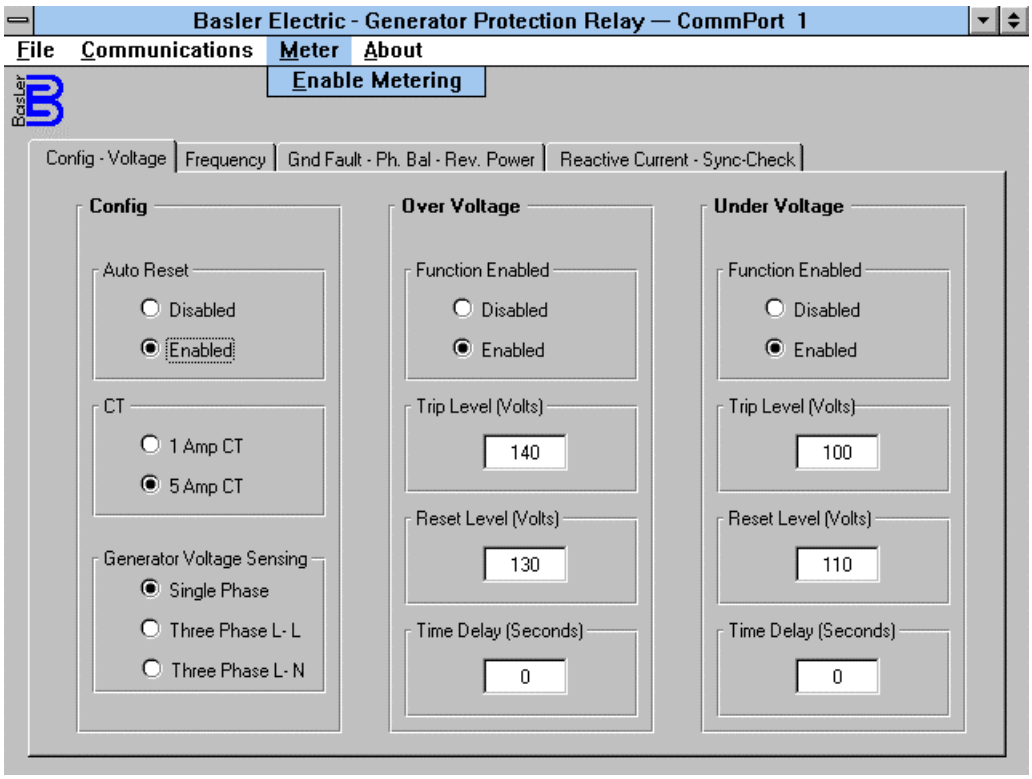


Figure 5-8. Enabling Metering Screen

Metering Screen

This screen (Figure 5-9) provides real time metering data from the generator system. Data is displayed in green when active and operating normally. the display changes to gray and is zero'ed out when the generator voltage drop is below approximately 10 volts. Metering screen status indicators are displayed only for neutral ground fault sensing BE3-GPR relays with Version 1.01 or later software.

PT and CT ratios can be entered to correct for external Pts and Cts used on the system. PT ratios up to 100:1 and CT ratios up to 2000:1 are allowed.

To return to the setting screens, pull down the **Meter** menu (Figure 5-8) and select **Disable Metering**.

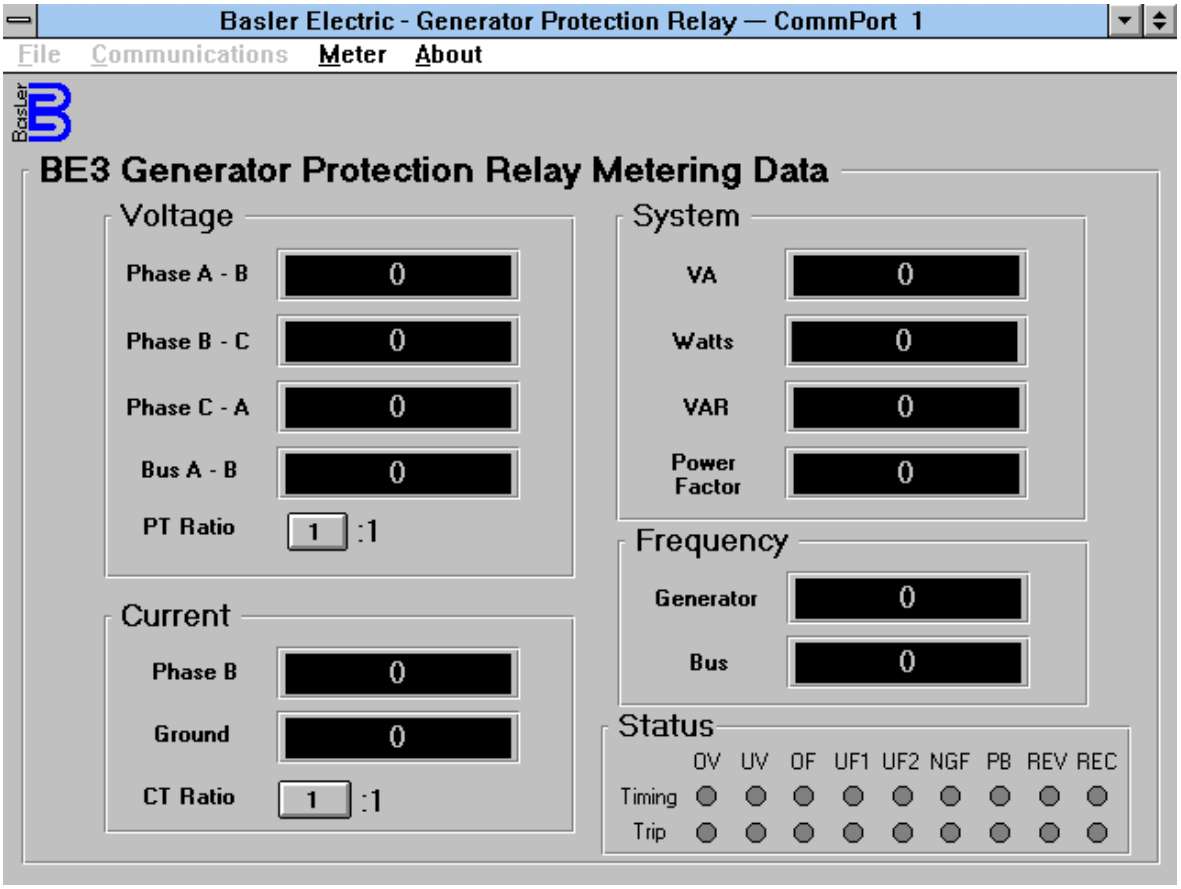


Figure 5-9. Metering Screen

TERMINATING COMMUNICATIONS WITH THE BE3-GPR

Pull down the **Communications** menu and select **Close** (Figure 5-10). When you execute the Close command, the communications and the BE3-GPR Windows™ software are terminated.

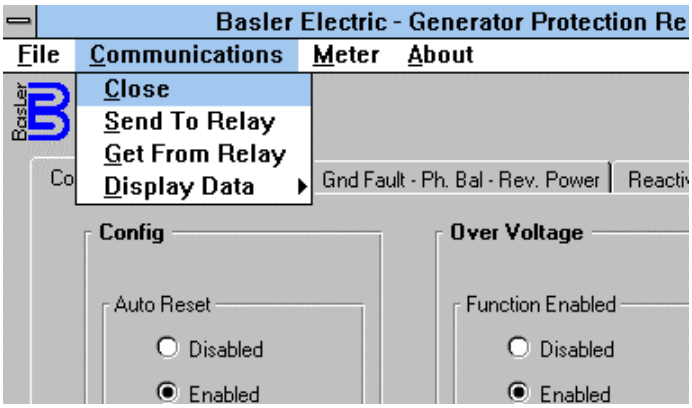


Figure 5-10. Terminating Communications

SECTION 6 • TOC COMMUNICATIONS

INTRODUCTION

BE3-GPR Windows™ Software is a software application program that enhances communication between users and BE3-GPRs. This program also provides a real time metering capability for monitoring generator voltage, frequency, current, watts, power factor, and volt-amperes. BE3-GPR Windows™ interface software serves two primary functions. One, it provides a user friendly environment to change or make relay settings. Without the software, you must be familiar with the BE3-GPR terminal commands to program relay settings. With the software, on-screen displays guide you through the setting process. Two, the software provides a means to monitor the metering results through the communications interface. Metered data is displayed on the computer screen and refreshed approximately every second. Real time monitoring provides critical generator data for evaluating system performance. The interface software also allows the user to save setup configurations to a disk. This allows a user to save multiple setups for later use and saves setup time when configuring multiple units.

INSTALLATION

BE3-GPR Windows™ Software contains a setup utility that installs the program on your personal computer (PC). When it installs the program, an uninstall icon is created that you may use to uninstall (remove) the program from your PC. If your PC has the minimum operating requirements listed in the following paragraph, then choose either *Installing The Program On Your PC Using Windows™ 3.1* or *Installing The Program On Your PC Using Windows®95.*

Operating Requirements

To use BE3-GPR Windows™ Software, you will need the following:

- IBM compatible PC, 486DX2 or faster with a minimum of four megabytes of RAM.
- Microsoft Windows™ version 3.1 or Windows®95.
- 3.5 inch floppy drive.
- Serial port.

Installing The Program On Your PC Using Windows™ 3.1

1. Insert disk 1 in the 3.5 inch floppy drive.
2. From Windows **File Manager**, select **File** then **Run**.
3. At the Command Line type in **a:be3gpr16**.and stroke the **Enter** key. The setup utility automatically installs the BE3-GPR Windows™ Software.

Installing The Program On Your PC Using Windows®95

1. Insert disk 1 in the 3.5 inch floppy drive.
2. From Windows, select **Start** then **Run**.
3. At the Command Line type in **a:be3gpr32**.and stroke the **Enter** key. The setup utility automatically installs the BE3-GPR Windows®95 Software.

Configuring The System

Verify that the receive and transmit lines are connected correctly. Section 4, *Installation,* provides pinouts for connecting the RS-232 serial link. Also verify that the host computer is configured for 2400 baud rate, 8 data bits, 1 stop bit, and no parity.

INITIALIZING COMMUNICATIONS WITH THE BE3-GPR

Review what we have done up to this point. You have loaded the software on your computer and you have the Basler Electric directory with the BE3-GPR icon. You have also connected the BE3-GPR unit to the computer, the system, and supplied operating power. Now you are ready to initialize communications.

Initialize Communications

Select the BE3-GPR icon to start the BE3-GPR software program. A momentary dialog box (splash screen) opens that displays the Basler Electric Logo, program application, and revision identification. After the splash screen, the initial screen (Figure 6-1) is shown.

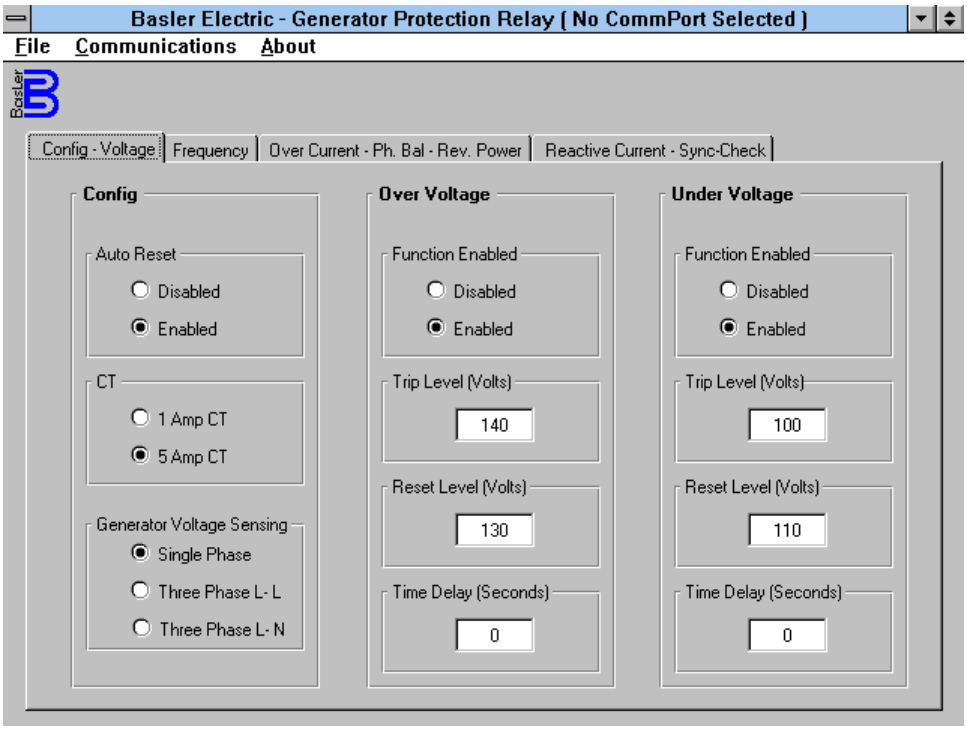


Figure 6-1. BE3-GPR Communications Software Initial Screen

Pull down the **Communications** menu and select **Open** (Figure 6-2). This should open a Comm Port screen like the one shown in Figure 6-3.

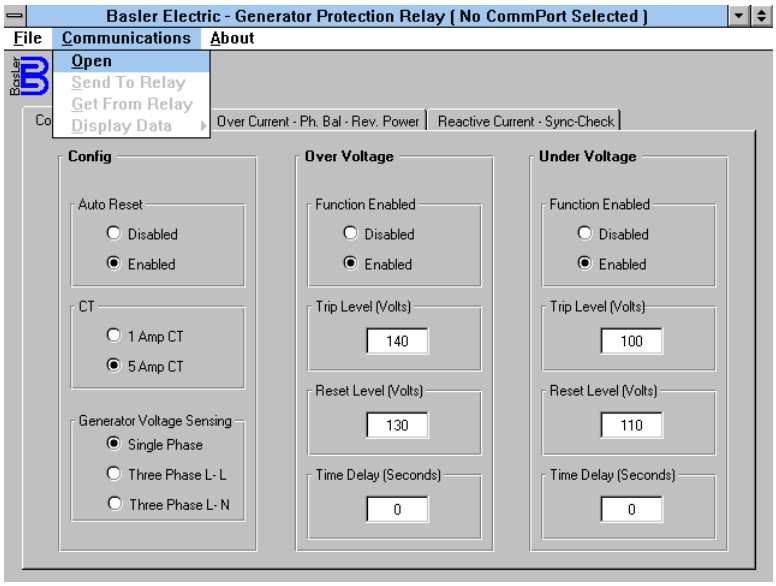


Figure 6-2. BE3-GPR Communications Open Screen

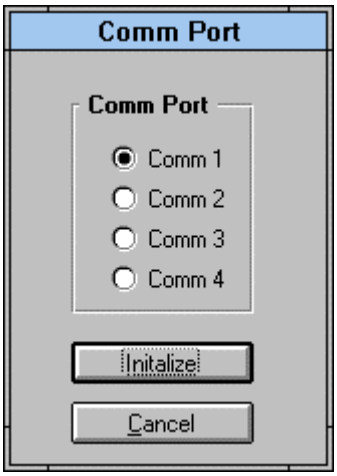


Figure 6-3. Comm Port

Select a comm port (like Comm 1 in Figure 6-3) and Initialize it. This opens the communication port and returns the current settings from the BE3-GPR unit. You do not have to select the communication protocol parameters because the software application program does that for you. Figure 6-4 is a sample of the screen showing the settings returned from the BE3-GPR unit.

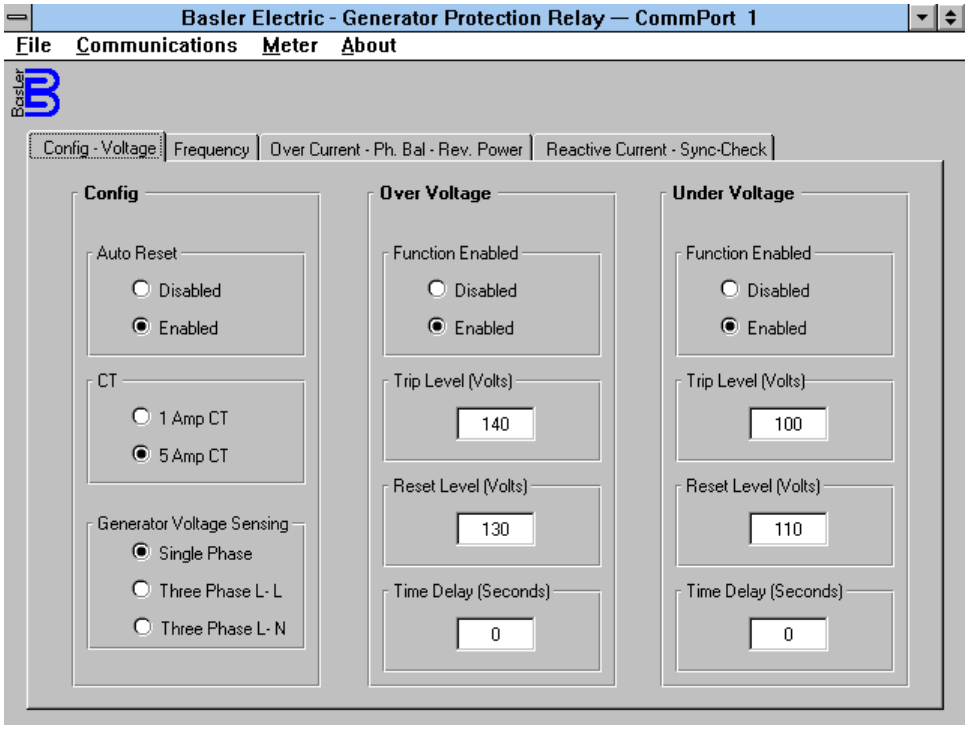


Figure 6-4. BE3-GPR Sample Settings Screen

CHANGING SETTINGS

Settings are arranged in four groups. They are:

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

To change settings, you must first select the group (if it is different from the default) by selecting the tab associated with that group. To change the settings, select (click on and highlight) the setting to be modified. Enter the new setting. Once all the settings have been entered, the new settings can be sent to the relay or saved to a file.

> **NOTE**
> Relay settings are only updated after a **Communications, Send To Relay** has been executed.

SENDING, GETTING, AND DISPLAYING DATA

When communications is in progress and you pull down the Communications menu, there are four choices. We want to describe all of those choices now **except** the **Close** choice.

Send To Relay

Executing this communications command updates the BE3-GPR unit with the settings currently displayed on the settings screens.

Get From Relay

Executing this communications command retrieves the settings from the BE3-GPR unit and displays those settings on the settings screens.

Display Data

When you select Display Data from the Communications pull down menu, you are given two choices. You may choose **As Displayed on Screen** or **As Received from Relay**. Figure 6-5 illustrates this screen.

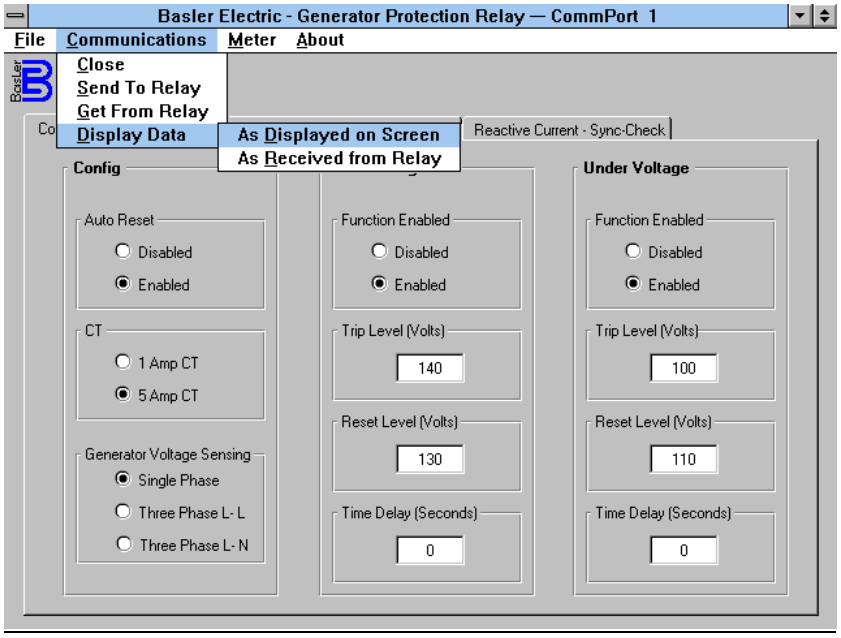


Figure 6-5. Display Data Choices

Either choice, **As Displayed on Screen** or **As Received from Relay**. displays a snapshot of the relay or screen settings in a single line, compact format. Figure 6-6 illustrates that format.

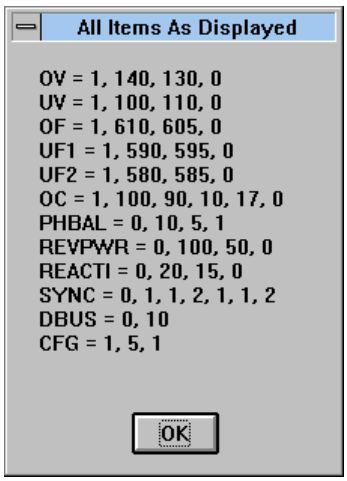


Figure 6-6. Snapshot Format

SAVING, PRINTING, AND OPENING FILES

BE3-GPR software also allows the user to save setup configurations to a disk. This allows a user to save multiple setups for later use and saves setup time when configuring multiple units. These files may also be printed for a hard copy reference and opened in several different ways.

File Save

If you have changed the settings on a specific BE3-GPR unit, you may want to save those settings for reference or future use. For example, you make the changes to a unit that is in your test system and you want to save the file as *Test1*. Open the pull down **File** menu and select **Save**. Now use normal Windows techniques and save the file with the default extension (*.GPR). Your file is now saved in the directory that you selected.

File Print

While the *Test1* settings are still shown on the screen, we should create a paper copy of those settings so that we can use them as a reference. To do this, open the **File** pull down menu and select **Print**. When you execute the Print command, you will get a dialog box similar to Figure 6-7.

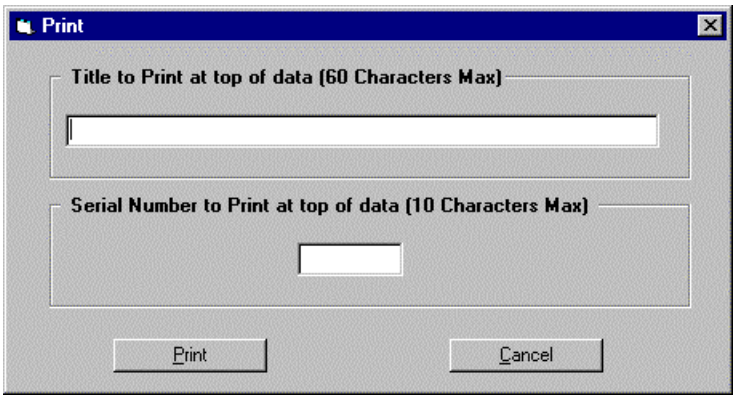


Figure 6-7. Print Dialog Box

You may fill in the appropriate information for your records, and then complete the Print command. Now you have a record for reference. The printed file lists on separate lines the date, time, title, and serial number. The date and time are referenced to the computers date and time and the time stamp that the BE3-GPR unit screens were last updated.

File Open

Suppose that after you reviewed either the BE3-GPR unit performance or the actual settings, you wanted to make a change in those settings but did not have the BE3-GPR unit available. Open the *Test1* file using a word processor such as Windows™ NoteBook, WordPerfect®, or Microsoft® Word. Use normal editing techniques to change the settings values and then save the file with either the same name or a new name.

To get this new file into the BE3-GPR, initiate communications with the BE3-GPR as you did previously. Now open the **File** pull down menu and select **Open**. Use normal Windows techniques to select the new file. When you execute the Open command, the new settings are displayed on the BE3-GPR screens. To save these new settings, execute the Communications, Send To Relay command.

METERING

BE3-GPR Windows™ software provides a means to monitor the metering results through the communications interface. Metered data is displayed on the computer screen and refreshed approximately every second. Real time monitoring provides critical generator data for evaluating system performance.

Enable Metering

To enable metering, pull down the **Meter** menu (Figure 6-8) and select **Enable Metering**.

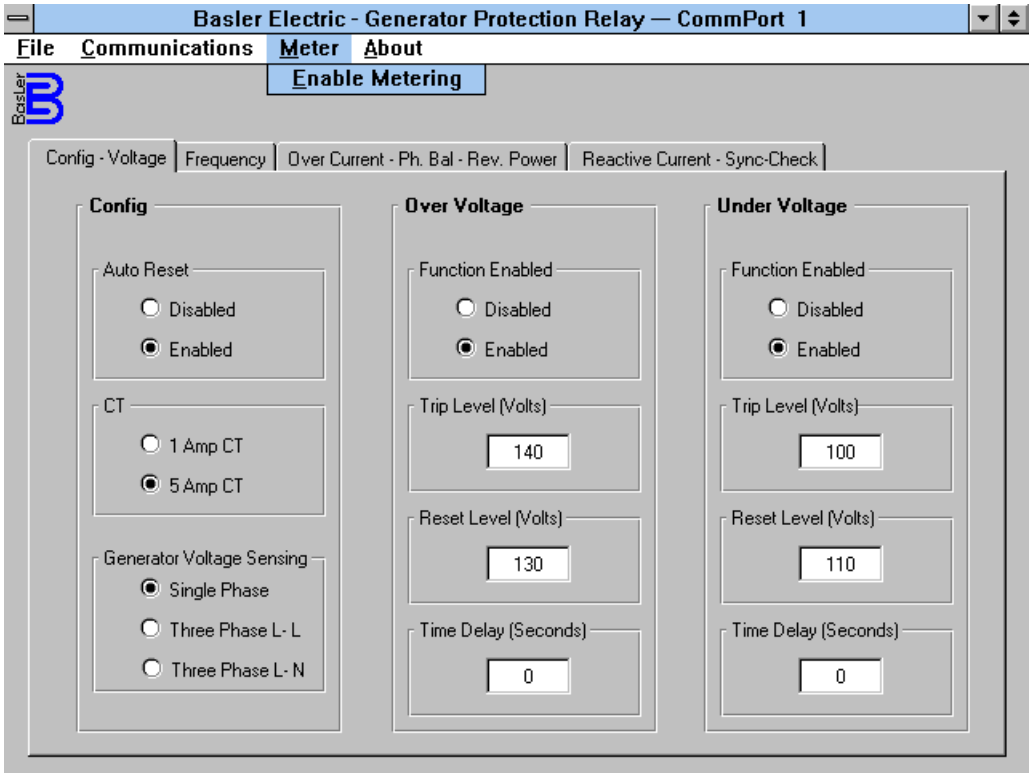


Figure 6-8. Enabling Metering Screen

Metering Screen

This screen (Figure 6-9) provides real time metering data from the generator system. Data is displayed in green when active and operating normally. the display changes to gray and is zero'ed out when the generator voltage drop is below approximately 10 volts.

PT and CT ratios can be entered to correct for external Pts and Cts used on the system. PT ratios up to 100:1 and CT ratios up to 2000:1 are allowed.

To return to the setting screens, pull down the **Meter** menu (Figure 6-8) and select **Disable Metering**.

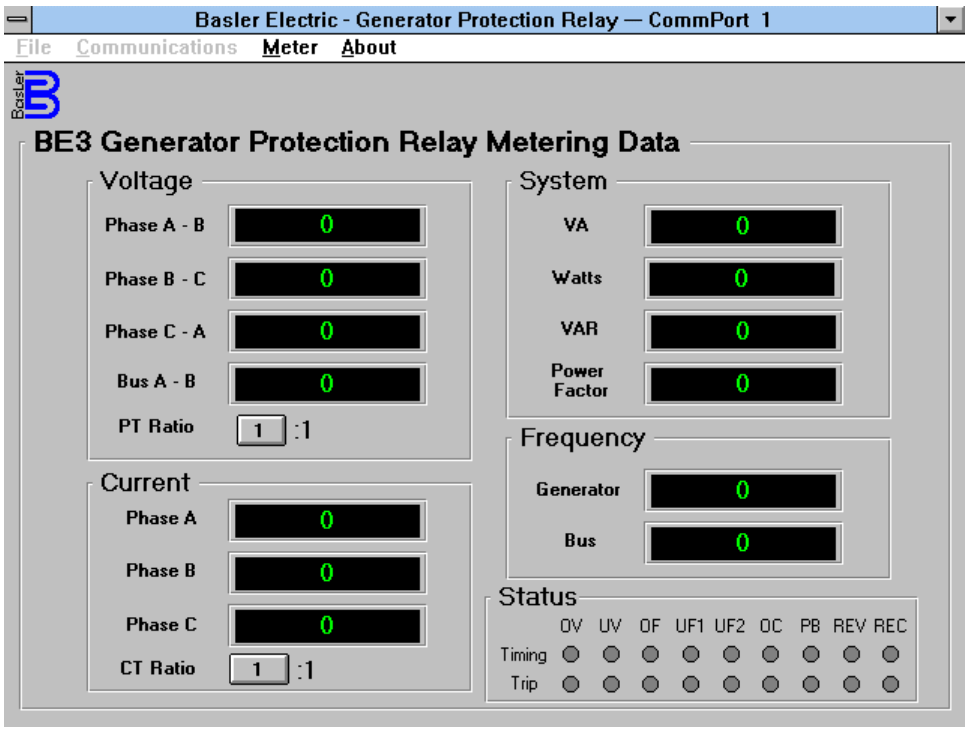


Figure 6-9. Metering Screen

TERMINATING COMMUNICATIONS WITH THE BE3-GPR

Pull down the **Communications** menu and select **Close** (Figure 6-10). When you execute the Close command, the communications and the BE3-GPR Windows™ software are terminated.

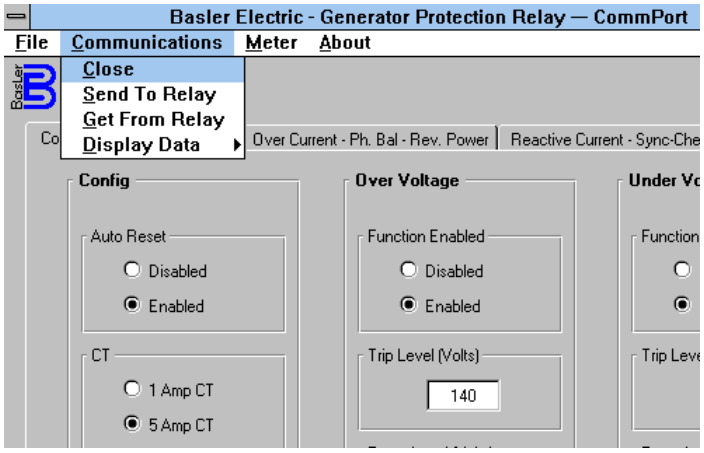


Figure 6-10. Terminating Communications

SECTION 7 • TESTING

GENERAL

This Section provides a simple test procedure for testing BE3-GPR relays.

EQUIPMENT REQUIRED

- Personal computer with RS-232-C serial link and running a terminal emulator program.
- DC Power Supply: 12-24 VDC adjustable, 0.5A.
- Three-Phase line-to-neutral AC Voltage Source, 50-70 Hz adjustable, 0-120 V_{RMS} line-to-neutral adjustable.
- A 60 Hz, single or three-phase, AC Current Source, with a current adjustable range of 0 to 2 ampere RMS and the voltage-current phase relationship phase adjustable.
- Digital Voltmeter 4 1/2 digits (Fluke 8050A or equivalent).
- Continuity Tester.
- Toggle Switch, SPST sufficient.
- Hardware Jumpers.

Test Setup

Step 1. Set the DC Power Supply to 12 Vdc and connect to the relay Batt + input (terminal 70) and the Batt - input (terminal 69).

Step 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.

Step 3 Connect the 3-phase AC voltage source to the GEN inputs as follows: terminal 26 = phase A terminal 24 = phase B, terminal 22 = phase C and terminal 20 = neutral. Adjust the frequency to 60 Hz and set the voltage to 69.3 V_{RMS} line-to-neutral (120 V_{RMS} line-to-line).

Step 4. For (NGF) Connect the AC Current source to the 5A NGF CT input (terminal 33) and CT COM input (terminal 35). Leave current set to 0 Amps for now.

For (TOC) Connect the AC Current source to the 5A A, B, or C CT input (terminals 29, 31, or 33) and CT COM input (terminal 35). Leave current set to 0 Amps 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)

Step 1. Monitor the OVR VOLT output contacts, terminals 37 and 38, for the trip condition.

Step 2. Increase phase A, line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD and contacts should return to the un-tripped ON display.

Step 3. Increase phase B, line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD and contacts should return to the un-tripped ON display.

Step 4. Increase phase C, line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD and contacts should return to the un-tripped ON display.

Undervoltage Trip

Step 1. Monitor the UND VOLT output contacts, terminals 40 and 41, for the trip condition.

Step 2. Reduce phase A, line-to-neutral voltage from 69.3 V_{RMS} to 50 V_{RMS}. The relay should be flashing the undervoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD should return to the un-tripped ON display.

Overfrequency Trip (Line-To-Neutral Frequency Sensing)

Step 1. Monitor the OVR FREQ output contacts, terminals 43 and 44, for the trip condition.

Step 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

Step 1. Monitor the UND FREQ1 output contacts, terminals 46 and 47, for the underfrequency 1 trip condition.

Step 2. Reduce 3-phase voltage frequency 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.

Step 3. Monitor the UND FREQ2 output contacts, terminals 49 and 50, for the underfrequency 2 trip condition. It should be open at this point in the test.

Step 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

Step 1. Monitor the PH BAL output contacts, terminals 55 and 56, for the trip condition.

Step 2. Use the front panel keypad to scroll though 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.

Step 3. Increase phase A, line-to-neutral voltage from 69.3 V_{RMS} to 80 V_{RMS}. The relay should be flashing the phase balance tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD should return to the un-tripped ON display.

Step 4. Disable the Phase Balance Trip function using the front panel keypad.

Overvoltage Trip (Line-To-Line Voltage Sensing)

Step 1. Use the front panel keypad to change from 3-phase line-to-neutral sensing to 3-phase line-to-line sensing.

Step 2. Monitor the OVR VOLT output contacts, terminals 37 and 38, for the trip condition.

Step 3. Increase phase A, line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. (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 V_{RMS} to 173 V_{RMS})). The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD should return to the un-tripped ON display.

Step 4. Increase phase B, line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD should return to the un-tripped ON display.

Step 5. Increase phase C, line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the LCD should return to the un-tripped ON display.

Overfrequency Trip (Line-To-Line Frequency Sensing)

Step 1. Monitor the OVR FREQ output contacts, terminals 43 and 44, for the trip condition.

Step 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)

Step 1. Use the front panel keypad to change from 3-phase line-to-line sensing to single phase line-to-line sensing.

Step 2. Monitor the NG FAULT output contacts, terminals 52 and 53, for the trip condition.

Step 3. Increase AC current from 0 to 0.3 Amps. The relay should be flashing the neutral ground fault tripped condition on the front panel LCD. Return the current to 0 Amps and the LCD should return to the un-tripped ON display.

Overcurrent Trip (5A A, B, or C CT Current Sensing)

Step 1. Use the front panel keypad to change from 3-phase line-to-line sensing to single phase line-to-line sensing.

Step 2. Monitor the OVR CUR output contacts, terminals 52 and 53, for the trip condition.

Step 3. Increase AC current from 0 to 2.0 Amps 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 B Current Sensing)

Step 1. Connect the AC Current source to the 5A CT B input (terminal 31) and the CT COM input (terminal 35).

Step 2. Monitor the REACT CUR output contacts, terminals 64 and 65, for the trip condition.

Step 3. Use the front panel keypad to scroll though 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.

Step 4. Set AC current phase angle to 90° relative to phase B-to-Neutral voltage. Increase AC current from 0 to 0.2 Amps. The relay should be flashing the reactive current tripped condition on the front panel LCD. Return the current level to 0 Amps and the LCD should return to the un-tripped ON display.

Reverse Power Trip (5A CT B Current Sensing)

Step 1. Monitor the REV PWR output contacts, terminals 61 and 62, for the trip condition.

Step 2. Use the front panel keypad to scroll though 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.

Step 3. Set AC current phase angle to 180° relative to phase B-to-Neutral voltage. Increase AC current from 0 to 0.5 Amps. The relay should be flashing the reverse power tripped condition on the front panel LCD. Return the current level to 0 Amps and the LCD should return to the un-tripped ON display.

Reverse Power Trip (1A CT B Current Sensing)

Step 1. Use front panel keypad to change from 5A CT sensing to 1A CT sensing.

Step 2. Connect the AC Current source to the 1A CT B input (terminal 32) and the CT COM input (terminal 35).

Step 3. Monitor the REV PWR output contacts, terminals 61 and 62, for the trip condition.

Step 4. Set AC current phase angle to 180° relative to phase B-to-Neutral voltage. Increase AC current from 0 to 0.5 Amps. The relay should be flashing the reverse power tripped condition on the front panel LCD. Return the current level to 0 Amps and the LCD should return to the un-tripped ON display.

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

Step 1. Connect the AC Current source to the 1A NGF CT input (terminal 34) and the CT COM input (terminal 35).

Step 2. Monitor the NG FAULT output contacts, terminals 52 and 53, for the trip condition.

Step 3. Increase AC current from 0 to 0.05 Amps. The relay should be flashing the neutral ground fault tripped condition on the front panel LCD. Return the current to 0 Amps and the LCD should return to the un-tripped ON display.

Step 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 A, B, or C CT Current Sensing)

Step 1. Connect the AC Current source to the 1A A, B, or C CT input (terminal 30, 32, or 34) and the CT COM input (terminal 35).

Step 2. Monitor the OVR CUR output contacts, terminals 52 and 53, for the trip condition.

Step 3. Increase AC current from 0 to 0.40 Amps. The relay should be flashing the neutral ground fault tripped condition on the front panel LCD. Return the current to 0 Amps and the LCD should return to the un-tripped ON display.

Step 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 subsections 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

Step 1. Reduce the 3-phase AC voltage source to 0 V_{RMS}.

Step 2. Connect a jumper between GEN B input (terminal 24) and BUS - input (terminal 16).

Step 3. Connect the SPST toggle switch between GEN A input (terminal 26) and BUS + input (terminal 18). Leave the switch in the open position.

Step 4. Increase the 3-phase AC voltage to 69.3 V_{RMS} line-to-neutral.

Step 5. Monitor the SYNC CHK output contacts, terminals 67 and 68, for the in-sync condition.

Step 6. Use the front panel keypad to scroll though 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.

Step 7. With the toggle switch open, the in-sync LED should be OFF and the sync output contacts should be open.

Step 8. Close the toggle switch. The in-sync LED should come ON and the sync output contacts should close.

Dead Bus

Step 1. Open the toggle switch. The in-sync led should be OFF and the sync output contactor should be open.

Step 2. Use the front panel keypad to scroll though the LCD based setup menu and enable the Dead Bus function, but leave its voltage setting at the default level.

Step 3. Upon exiting the setup menu, the in-sync LED should come ON and the sync output contacts should close.

Step 4. Use the front panel keypad to scroll though the LCD based setup menu and disable the Sync-Check function.

Step 5. Upon exiting the setup menu, the in-sync LED should go OFF and the sync output contacts should open. Closing the toggle switch should have no effect on the LED or sync output contact status.

Step 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

Step 1. Reduce the 3-phase AC voltage source to 0 V_{RMS}.

Step 2. Remove the toggle switch from the relay and connect it across TRIP RESET input (terminal 12 and 13). Leave the switch in the open position.

Step 3. Increase the 3-phase AC voltage back to 69.3 V_{RMS} line-to-neutral. The relay should be in its normal un-tripped condition.

Step 4. Use the front panel keypad to scroll though the LCD based setup menu and disable the auto trip reset function.

Step 5. Monitor the OVR VOLT output contacts, terminals 37 and 38, for an overvoltage trip condition.

Step 6. Increase phase A line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should be flashing the overvoltage tripped condition on the front panel LCD. Return the voltage to 69.3 V_{RMS} and the relay should remain in the tripped condition.

Step 7. Cycle the toggle switch. The relay should reset back to its normal ON condition.

Step 8. Close the toggle switch and re-apply 100 V_{RMS} to phase A line-to-neutral. The relay should remain in the normal ON condition.

Step 9. Return the phase A voltage to 69.3 V_{RMS}.

Step 10. Open the toggle switch connection.

Step 11. Use the front panel keypad to scroll though the LCD based setup menu and re-enable the auto trip reset function.

Failsafe Enable

Step 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.

Step 2. Close the toggle switch to enable the failsafe mode. The monitored overvoltage trip contacts should close.

Step 3. Open the toggle switch connection.

Output Disable

Step 1. Remove the toggle switch and connect it to the OUTPUT DISABLE input, terminals 8 and 9, and close the toggle switch.

Step 2. Increase phase A line-to-neutral voltage from 69.3 V_{RMS} to 100 V_{RMS}. The relay should remain in the normal ON condition.

Step 3. Open the toggle switch. The relay should be flashing the overvoltage tripped condition on the front panel LCD.

Step 4. Return the voltage to 69.3 V_{RMS} and the relay should return to the normal ON condition.

Program Enable

Step 1. Remove the jumper across terminals 31 and 28, previously installed in Section 4, *Installation*.

Step 2. Attempt to change any of the front panel menu settings. Changes should not be possible.

Step 3. Remove all input connections from the relay.

All functionality testing is completed.

SECTION 8 • MAINTENANCE

GENERAL

BE3-GPR Generator Protective Relays require no preventive maintenance. However, functional testing should be performed according to scheduled practices. If the relay fails to function properly, follow the procedures in *Table 8-1, Troubleshooting.* If addition maintenance is required, consult the Customer Service Department of the Power Systems Group, Basler Electric, for a return authorization number prior to shipping.

TROUBLESHOOTING

Table 8-1. Troubleshooting Procedures

Symptom	Recommended Procedure
No display	Check battery input connections and verify voltage applied is between 8 to 32 volts and that the polarity is correct.
No communications	Check serial port connections, verify that the host computer is configured for 2400 baud rate, 8 data bits, 1 stop bit, and no parity. Verify Rx and TX lines are connected correctly and not switched.
No data can be entered from the front panel.	Verify that the program enable jumper is installed.
Display always flashes a previous trip condition.	Momentarily close the trip reset input or enable the automatic trip reset option.
Reverse power pickups are not correct.	Verify sensing method is correct and is appropriate for the application. Verify **CT B** input is sensing phase B current and is in the correct polarity.
Reactive current pickups are not correct.	Verify sensing method is correct and is appropriate for the application. Verify **CT B** input is sensing phase B current and is in the correct polarity.
Trips occur during generator ramp-up or shutdown.	Close output disable to disable trips during ramp-up/down periods. Increase trip timing.
Phase balance always tripped.	Verify that the phase rotation is ABC and that the system application is appropriate.

SECTION 9 • MANUAL CHANGE INFORMATION

CHANGES

Substantive changes in this manual to date are summarized in Table 9-1.

Table 9-1. Summary of Changes

Revision	Summary of Changes	ECA/ECO No.	Date
A	Minor clarifications and error corrections were made.	15953	02/97
B	Manual was revised to include patent information.	16116	04/97
C	Manual was revised to incorporate the Time Overcurrent version of the relay.	16292	08/97
D	Figure 5-9 was replaced with a new illustration showing status indicators displayed for neutral ground fault units with version 1.01 or later software.	16361	10/97
E	Manual was revised to incorporate Semi-Flush Mounting information.	16931	08/98
F	Changed Section 1, *Specifications,* output contact ratings to reflect the additional capability of the relays, and added the specifications for the voltage and current sensing inputs, and added the burden data for the power supply input. Changed the interconnection diagrams in Section 4, *Installation*, to show the transformer polarity.	7538	01/2000