GE Power Management

LPS-D
Line Protection™ System
Instruction Manual

Firmware Revision: V0004.04AA33 (Rev. A models)
V0005.01AA10 (Rev. B models)

Manual P/N: GEK-106159B

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Note: All relays must be powered up at least once per year to avoid deterioration of electrolytic capacitors and subsequent relay failure.

GE Power Management

215 Anderson Avenue, Markham, Ontario

Canada L6E 1B3

Tel: (905) 294-6222 Fax: (905) 294-8512

Internet: http://www.GEindustrial.com/pm

ISO9000 REGISTERED

Manufactured under an
ISO9002 Registered system.

These instructions do not purport to cover all details or variations in equipment nor provide for every possible contingency to be met in connection with installation, operation, or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the General Electric Company.

To the extent required the products described herein meet applicable ANSI, IEEE, and NEMA standards; but no such assurance is given with respect to local codes and ordinances because they vary greatly.

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1.1.1 UNPACKING THE RELAY

CAUTION

Before attempting to install or use this relay, it is imperative that all WARNINGS and CAUTIONS in this manual are reviewed to help prevent personal injury, equipment damage, and/or downtime.

Unpack the relay, the mounting brackets, and the hardware for attaching the mounting brackets to the sides of the relay. Examine the relay for any damage sustained in transit, and if damage is evident, notify the shipping company and the nearest GE sales office immediately.

Prior to applying power, ensure that the model number of the relay listed on the front panel corresponds to the model ordered. Make sure that the DC supply power matches the rated voltage listed on the front panel. Refer to the elementary diagram in Figure 1–23: ELEMENTARY DIAGRAM on page 1–48 for the locations of the DC power inputs.

Instructions on how to use the keypad to change settings and put the relay into test mode can be found in Section 4.1.7: SETTING CHANGES on page 4–4. Complete instructions on how to operate the keypad are found in Chapter 8: LOCAL USER INTERFACE.

GE Power Management contact information:

GE Power Management
215 Anderson Avenue
Markham, Ontario
Canada L6E 1B3

Telephone:	Toll Free North America:	(800) 547-8629
	Europe:	+34 94 485 88 54
	Other Areas:	(905) 294-6222
	Emergency:	(416) 414-4941
Fax:	(905) 201-2098	
E-mail:	info.pm@indsys.ge.com	
Home Page:	www.GEindustrial.com/pm	

1.1.2 PASSWORDS: FACTORY SET

The LPS-D relay requires the use of passwords to change Settings or to perform Actions. No password is required to obtain information from the relay, including viewing the existing settings. The relay is shipped from the factory with the following Local User Interface (LUI) passwords:

SETTINGS: 123.

ACTIONS: 456.

MASTER: 789.

NOTE

The decimal point following the digits is part of the password. Factory passwords MUST be changed before the user can modify settings or initiate Actions!

To change the default password, follow these steps:

1. Press the ACTIONS [ACT] key.
2. Press the ENTER [ENT] key.
3. Scroll to the **CHANGE PASSWORD** option.
4. Select the Password Privilege level to be changed.

5. Press [ENT].
6. Enter the factory password (for example: 789. for Master Password).
7. Enter your password.
8. Re-enter your password.
9. Press [END], press [ENT], then press [CLR].

The keypad passwords stored in the relay may be viewed, in encoded format, via remote communications.

1.1.3 REMOTE COMMUNICATIONS VIA LOCAL PC

To communicate with the relay via a local PC, connect the relay to a serial port of an IBM compatible computer with a null-modem cable. Connection can be made either to the 25 pin D-connector on the back of the relay (PL2A) or the 9 pin D-connector on the front (PL1). Detailed cable diagrams are shown in the following figures:

- Figure 8–2: MODEM CABLE on page 8–27
- Figure 8–3: 25-PIN NULL MODEM CABLE on page 8–27
- Figure 8–4: 25-PIN NULL MODEM CABLE on page 8–31
- Figure 8–5: NULL MODEM CABLE FOR PORT PL1 on page 8–31

The communications software required to access the relay, ALPS-Link, is included on the accompanying GE Power Management Products CD. Follow instructions in Section 11.2.4: SOFTWARE INSTALLATION on page 11–4 to load ALPS-Link onto the PC.

NOTE

ALPS-Link is used with both the ALPS and LPS-D series of relays.

1.1.4 PASSWORDS WITH ALPS-LINK

The ALPS-Link program requires the use of passwords to obtain information from the relay, to change Settings, or to perform Actions. The relay is shipped from the factory with the following communications passwords:

VIEW: VIEW!

SETTINGS: SETTING!

ACTIONS: CONTROL!

MASTER: MASTER!

NOTE

The exclamation point following the letters is part of the factory password. The factory passwords MUST be changed before the user can modify Settings or initiate Actions. The user can log into the relay at any password level. After logging into the relay, the password may be changed under the ACTIONS menu by selecting CHANGE PASSWORD.

Before the user can change another password it is necessary to logout from the LPS-D. The user can then change the remaining passwords by first logging into the LPS-D using another default password. The communications passwords may be viewed, in an encoded format, via the keypad with the [INF] (Information) key.

To log into the relay, follow the instructions in Section 4.1.9: USING COMMUNICATIONS (OPTIONAL) on page 4–5. Any one of the factory passwords can be used to log in to the relay. The Unit ID (General Setting 101: **UNITID**) is factory set to 0.

Table 1–1: ORDER CODES FOR THE LPS-D

	LPS	*	*	*	*	*	*	*	*	*	*	*	*	–	*	
Base Unit	LPS	|	|	|	|	|	|	|	|	|	|	|	|		|	Base Unit
Distance Relay		D	|	|	|	|	|	|	|	|	|	|		|	Distance and ground distance relay.
Software			A	|	|	|	|	|	|	|	|	|		|	Revision Level A
			B	|	|	|	|	|	|	|	|	|		|	Revision Level B
Tripping Logic				1	|	|	|	|	|	|	|	|		|	Single Phase Tripping Logic
				3	|	|	|	|	|	|	|	|		|	Three Phase Tripping Logic
Current Rating					1	|	|	|	|	|	|	|	|		|	1 Ampere rated current
					5	|	|	|	|	|	|	|		|	5 Ampere rated current
Series Caps.						U	|	|	|	|	|	|	|		|	For applications without series capacitors
Battery Voltage							0	|	|	|	|	|	|		|	48V DC battery voltage
							1	|	|	|	|	|	|		|	110/125 V DC battery voltage
							2	|	|	|	|	|	|		|	220/250 V DC battery voltage
Trip Outputs								1	|	|	|	|	|		|	SCR trip outputs & contact channel interface
								2	|	|	|	|	|		|	Contact trip outputs & contact channel interface
								3	|	|	|	|	|		|	SCR Trip outputs and 5 V/20 mA channel interface
								4	|	|	|	|	|		|	Contact Trip outputs and 5 V/20 mA channel interface
Comm Ports									2	|	|	|	|		|	Front RS232 port & 1 selectable RS232/485 rear port (LPS-DA only) †
									3	|	|	|	|		|	Front RS232 port & 2 selectable RS232/485 rear ports (GEmodem/ASCII)
Mounting										H	|	|	|		|	Horizontal mounting
										V	|	|	|		|	Vertical mounting
Oscillography											E	|	|		|	Extended oscillography memory
OST												0	|		|	No out-of-step tripping
Recloser													N		|	No recloser
													R		|	Recloser without sync-check
													S		|	Recloser with sync-check
Protocol														AC		Modbus RTU communication †

† Available for Revision A models only.

EXAMPLE: LPSDA35U23VE0N–AC = LPS-D Digital Line Protection Distance Relay; revision A; three phase tripping logic; rated at 5 amperes; without series capacitor protection; 110/125 VDC supply; contact tripping outputs; 3 communications ports; vertical mounting; with extended memory; no OST functions, no recloser, and Modbus communications.

1.2.1 DESCRIPTION

The Line Protection System (LPS) is a microprocessor-based digital relay system that uses waveform sampling with appropriate algorithms to provide either three phase or single phase tripping schemes for transmission line protection, fault location, and related features. The LPS-D models covered by this instruction book are intended for either three phase or single phase tripping applications. The LPS-D relay samples the current and voltage inputs from the power system 64 times per cycle. The protection algorithms process this sampled data in sets of four, sixteen times per cycle. The LPS-D uses advanced Fourier calculation techniques and adaptive measuring functions to achieve high-speed tripping for severe faults.

The LPS-D is packaged in a compact 3 Rack Unit high (one RU = 1.75 Inch) 19-inch rack mount case which is available for either horizontal or vertical mounting. The case outline and mounting dimensions for the LPS-D are shown in Figure 3–1: DIMENSIONS on page 3–1.

All LPS-D models include a full keypad and a liquid crystal display (LCD) for local access to relay data and settings. In addition, up to three communication ports are provided for both local and remote access via a PC. Each port may be independently set for an ASCII protocol or GEmodem protocol.

1.2.2 APPLICATION

The LPS-D models covered by this instruction book are designed to be used on transmission lines of any voltage level where either single or three phase tripping is required. Detailed application considerations are described in this chapter and in Chapter 2: CALCULATION OF SETTINGS.

The LPS-D can provide high speed detection and clearing of power system faults, and includes logic for step distance and five standard pilot tripping schemes. The scheme logic diagrams are shown and discussed in Section 1.8: PROTECTION SCHEME DESCRIPTIONS on page 1–26. The external connections for the LPS-D are shown in the elementary diagram of Figure 1–23: ELEMENTARY DIAGRAM on page 1–48.

The LPS-D is available with either a contact interface to the pilot channel equipment or an electronic (5 V, 20 mA) interface, so that the relay may be applied with a wide variety of channel equipment. Typical channels include: AM and FSK via power line carrier (PLC), FSK via microwave, and multiplexed fiber optic cable.

1.2.3 PROTECTION FUNCTIONS

The measurement functions included are listed in Table 1–2: LPS-D MEASUREMENT FUNCTIONS below.

The Zone 1 distance functions provide secure tripping for all fault types over most of the protected line. The Zone 1 ground distance functions can be selected to be either ground variable-Mho distance functions or ground-reactance distance functions. A unique *adaptive reach* for the supervising Mho characteristic is used when ground-reactance functions are selected.

Overreaching Zone 2 phase and ground distance functions are used for pilot tripping schemes. Ground-directional overcurrent functions can be selected to replace or supplement the overreaching zone (Zone 2) ground-distance functions in any of the pilot schemes. For revision level B models of the LPS-D, the Zone 2 ground quadrilateral characteristic may also be selected. The Zone 2 phase and ground distance functions are provided with independent timers for time delayed backup protection.

Overreaching Zone 3 phase and ground distance functions are provided with independent timers for time delayed backup protection. The LPS-D with revision B firmware also has the option for quadrilateral ground distance functions

Table 1–2: LPS-D MEASUREMENT FUNCTIONS

Zone or Type	Functions
Zone 1	• 3 Variable-Mho phase distance functions • 3 Variable-Mho ground distance functions **or** 3 Reactance ground distance functions with “adaptive reach” Mho supervision **or** 3 Quadrilateral ground distance functions (Revision B relays only)
Zone 2 (Pilot Zone)	• 3 Variable-Mho phase distance functions • 3 Variable Mho ground-distance functions **and/or** Ground directional-overcurrent functions consisting of: IPT: Ground Trip overcurrent NT: Negative Sequence Directional Trip IPB: Ground Block overcurrent NB: Negative Sequence directional block or 3 Quadrilateral ground distance functions (Revision B relays only)
Zone 3	• 3 Variable-Mho phase-distance functions • 3 Variable-Mho ground-distance functions, **or** 3 Quadrilateral ground distance functions (Revision B relays only)
Zone 4	• 3 Reversible variable-Mho phase-distance functions • 3 Reversible variable-Mho ground-distance functions
Out of Step Blocking (OSB)	3 Variable-Mho phase-distance functions
Overcurrent Backup	50 — Phase-overcurrent direct trip (directional or nondirectional 50G — Ground-overcurrent direct trip (directional or nondirectional) 51G — Ground time-overcurrent direct trip (directional or nondirectional)
Overcurrent Supervision	IT — Trip-supervision overcurrent IB — Block-supervision overcurrent
Fault Detector	FD
Line-Pickup Overcurrent	I1
Remote-Open Detectors	ROD
Line-Overload Detectors	Level 1 Overcurrent Level 2 Overcurrent

The Zone 4 variable-mho distance functions can be reversed in direction when a reversed or blocking function is required. When the POTT2, Blocking or Hybrid scheme is selected, Zone 4 is automatically set to the reverse direction, because these schemes require a reverse-looking blocking function. The Zone 4 phase and ground distance functions are provided with independent timers for time delayed backup protection. Revision B models also have the ability to use Zone 4 ground quadrilateral distance functions for time-delayed backup protection.

When both phase and ground distance functions are used for a zone of protection, six individual measuring functions are available: three for phase distance and three for ground distance. The algorithm that implements the variable-mho measuring functions is derived from designs that have evolved through several different families of static analog and digital relay systems which have accumulated decades of dependable and secure in-service experience.

An instantaneous overcurrent tripping function (50G) provides direct tripping for severe phase-to-ground faults. A time-overcurrent tripping function (51G) provides time-delayed backup tripping for phase-to-ground faults. Either or both of these ground-overcurrent functions can be controlled by the NT negative-sequence directional trip unit, at the customer's discretion.

1.2.4 GROUND QUADRILATERAL CHARACTERISTICS

The LPS-D relay has been modified to include the option to use either quadrilateral characteristics or variable Mho characteristics for all zones of ground distance protection. The model numbers affected by this modification are: LPSDB*xxxxxxxxx* (where *x* represents any valid character) with firmware version V0005.00AA00 or higher. A new version of ALPS-Link may be required to access the new settings via remote communications (it must be version 3.5 or higher). If required, the updated version of ALPS-Link may be downloaded from the GE Power Management website at www.ge.com/indsys/pm.

Many protective relay engineers prefer to use a quadrilateral (polygonal) characteristic for ground distance functions, as it provides more fault resistance coverage than the circular Mho characteristic. A typical quadrilateral characteristic is shown in Figure 1–1: GROUND DISTANCE QUADRILATERAL CHARACTERISTIC. The characteristic is comprised of four straight lines; the trip zone is the area bounded by all four characteristic lines. The upper boundary (the reactance characteristic) may also be used with a variable Mho function. The variable Mho provides both directional supervision for reverse faults and resistive limits to prevent operation on load.

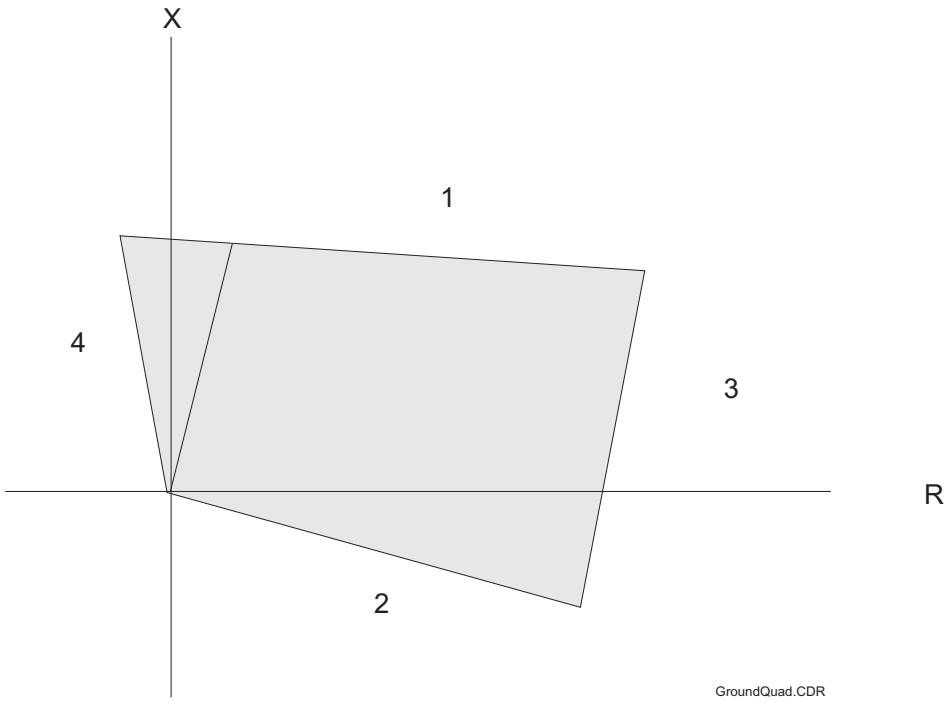


Figure 1–1: GROUND DISTANCE QUADRILATERAL CHARACTERISTIC

In the LPS-D relay, the four straight lines of the quadrilateral characteristic are developed from a combination of the following three characteristics:

1. The reactance characteristic (section 1). The tilt of the reactance characteristic is determined by the characteristic timer setting. The range of this setting is 80° to 155° in 1° steps.
2. The restricted directional characteristic (sections 2 and 4)
3. The right (positive) resistive blinder (section 3)

The following definitions pertain to all the distance functions:

I_A = phase A current at relay
I_B = phase B current at relay
I_C = phase C current at relay
I_0 = zero-sequence current at relay
V_A = phase A to ground voltage at relay
V_B = phase B to ground voltage at relay
V_C = phase C to ground voltage at relay
X_1 = positive-sequence component of X
X_2 = negative-sequence component of X
X_M = memory (pre-fault) value of X
Zx_1 = Zone x positive-sequence reach setting - $ZxR \angle$ POSSEQANG
Zx_0 = Zone x zero-sequence reach setting - $ZxR \angle$ ZERSEQANG

Note: The magnitudes of Zx_1 and Zx_0 are identical - these quantities differ in phase angle only.

$K_0$1 = Zone 1 zero-sequence compensation factor - Z1K0
K_0 = zero-sequence compensation factor

a) REACTANCE CHARACTERISTIC

The reactance characteristic used for the ground quadrilateral is the similar as the existing negative / zero sequence phase angle comparator reactance characteristic. The function has been modified by the addition of a fourth comparator input (Pol. #3). The operate and polarizing signals used in this function are:

Operate: $I\phi' Z - V\phi$

Pol.# 1: $I_0 Z_1$

Pol.# 2: $I_2 Z_1$

Pol.# 3: $I_{1F} Z_1$

where:

$I\phi' Z$ is the compensated IZ product
Z_1 is the positive sequence replica impedance
$V\phi$ is the phase to ground voltage
I_0 is the zero sequence current component
I_2 is the negative sequence current component, referenced to the proper phase.
I_{1F} is the fault component of the positive sequence current component, referenced to the proper phase. The pre-fault load current is removed from this quantity.

All zones of ground reactance characteristics will have a characteristic timer with a pickup range of 90° to 155° in 1° steps. The characteristic timer will be used to “tilt” the reactance characteristic (Tent) to prevent overreach on non-homogeneous systems, as shown below in Figure 1–2: TENT CHARACTERISTIC. Note that the “tent”

is not the same as tilting the reactance, since it also tilts down to the left of the maximum reach balance point. By adjusting the angle of the phase angle comparator rather than the angle of “maximum torque”, the transient overreach is not increased.

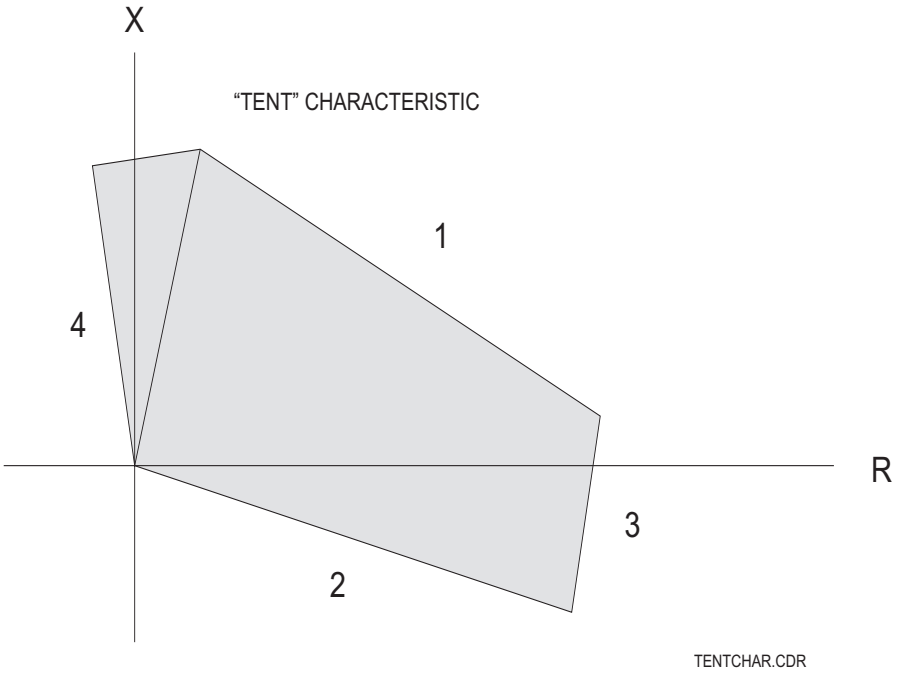


Figure 1–2: TENT CHARACTERISTIC

For the Zone 1 ground function, the signals are:

Phase A: $(I_A - I_0)\cdot Z1_1 + K_0 1\cdot I_0\cdot Z1_0 - V_A$
$I_{A2}\cdot Z1_1$
$I_0\cdot Z1_1$
$I_{A1F}\cdot Z1_1$

Phase B: $(I_B - I_0)\cdot Z1_1 + K_0 1\cdot I_0\cdot Z1_0 - V_B$
$I_{B2}\cdot Z1_1$
$I_0\cdot Z1_1$
$I_{B1F}\cdot Z1_1$

Phase C: $(I_C - I_0)\cdot Z1_1 + K_0 1\cdot I_0\cdot Z1_0 - V_C$
$I_{C2}\cdot Z1_1$
$I_0\cdot Z1_1$
$I_{C1F}\cdot Z1_1$

b) RESTRICTED DIRECTIONAL CHARACTERISTIC

The restricted directional characteristic for the ground quadrilateral requires a separate directional unit for each phase. No settings are required for this characteristic. The input signals to the comparator are:

Phase A: $I_A\cdot ZD$
V_A

Phase B: $I_B\cdot ZD$
V_B

Phase C: $I_C\cdot ZD$
V_C

where *ZD* is the angle of “maximum torque” and is equal to 65°.

The characteristic timer angle will be fixed at 115°. That is, the function will operate when the input signals are within ±65° of each other.

If the faulted phase voltage magnitude is too low (as for a close-in Zone 1 fault), the phase directional function will not operate. This might also occur for a remote fault when the relay is located near a strong source. Therefore, if the phase voltage is less than the minimum threshold voltage, the positive-sequence memory voltage from the ground Mho functions is used in place of the phase voltage to polarize the directional function.

c) RIGHT RESISTIVE BLINDER

The right resistive blinder is a two input phase angle comparator. The input signals for the comparator are:

Operate: $I\phi' \cdot RB1 - V\phi$

Polarize: $I\phi' \cdot RB1$

where:

The magnitude of *RB*1 (**R**ight **B**linder for Zone **1**) is the point at which the characteristic intersects the R axis. The range of adjustment will be 0.1 to 500.0 Ω in 0.1 Ω steps.

The angle of *RB*1 is be fixed based on the positive sequence line angle, the zero sequence line angle, and the *K*0 factor. The angle is:

$$\frac{2 \cdot \text{POSSEQANG} + K0 \cdot \text{ZERSEQANG}}{2 + K0}$$

$I\phi'$ is the compensated phase current, $(I_A - I_0) + K_0 1 \bullet I_0$

The characteristic timer angle will be fixed at 90°. For the Zone 1 ground function, the operate and polarizing signals are:

Phase A: $I_A' \cdot RB1 - V_A$ / $I_A' \cdot RB1$

Phase B: $I_B' \cdot RB1 - V_B$ / $I_B' \cdot RB1$

Phase C: $I_C' \cdot RB1 - V_C$ / $I_C' \cdot RB1$

where:

$I_A' = (I_A - I_0) + K_0 1 \cdot I_0$

$I_B' = (I_B - I_0) + K_0 1 \cdot I_0$

$I_C' = (I_C - I_0) + K_0 1 \cdot I_0$

$K_0 1 = |K_0 1| - (\text{ZERSEQANG} - \text{POSSEQANG})$

1.2.5 LINE PROTECTION SCHEMES

The LPS-D provides four zones of distance protection with overcurrent backup functions. The LPS-D is a highly flexible system: along with predefined protection schemes, it also has the ability to be programmed by the user. The custom programmability of the LPS-D is discussed in the next section.

The LPS-D pilot protection schemes are as follows:

- Permissive Underreach Transfer Trip (PUTT)
- Permissive Overreach Transfer Trip (POTT1)
- Permissive Overreach Transfer Trip with blocking functions (POTT2)
- Blocking
- Hybrid

In addition, each of the above schemes includes up to four zones of step distance backup with individual timers for phase and ground zones.

1.3.1 INTRODUCTION

The LPS-D offers a high degree of custom programmability. Custom programming of the LPS-D is accomplished using Xpression Builder software. Xpression Builder allows the user to graphically design programmable logic and make I/O (input/output) assignments for the LPS-D and other GE Power Management relays. Xpression Builder is included with the LPS-D software suite on the GE Power Management CD. A complete description of Xpression Builder is included in Chapter 13: XPRESSION BUILDER.

1.3.2 CONFIGURABLE INPUTS

All of the contact converters (Digital Inputs) in the LPS-D are user configurable. However, each LPS-D relay is shipped with the default contact converter assignments shown in the table below and on Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47.

Table 1–3: LPS-D DEFAULT CONTACT CONVERTER ASSIGNMENTS

INPUT	DESCRIPTION	MNEMONIC	INDEX #	NOTE
LPS-D WITH SINGLE PHASE TRIPPING MODELS				
CC1	RECEIVER #1	RCVR1	12	
CC2	RECEIVER #2	RCVR2	13	(if used)
CC3	EXTERNAL STOP CARRIER	STCR	10	(Blocking Scheme Only)
CC4	BLOCK PILOT TRIPPING	BLPTRP	11	(Blocking Scheme Only)
CC5	ENABLE 3 PHASE TRIPPING	ETRP3P	7	
CC6	REMOTE TARGET RESET	RESET	20	
CC7	BKR1 52b PHASE A	52B_1A	1	
CC8	BKR1 52b PHASE B	52B_1B	2	
CC9	BKR1 52b PHASE C	52B_1C	3	
CC10	BKR2 52b PHASE A	52B_2A	4	
CC11	BKR2 52b PHASE B	52B_2B	5	
CC12	BKR2 52b PHASE C	52B_2C	6	
LPS-D WITH THREE PHASE TRIPPING MODELS				
CC1	RECEIVER #1	RCVR1	12	
CC2	RECEIVER #2	RCVR2	13	(if used)
CC3	EXTERNAL STOP CARRIER	STCR	10	(Blocking Scheme Only)
CC4	BLOCK PILOT TRIPPING	BLPTRP	11	(Blocking Scheme Only)
CC5	BKR1 52b	52B_1A	1	
CC6	BKR2 52b	52B_2A	4	
CC7	REMOTE TARGET RESET	RESET	20	
CC8	SPARE			
CC9	SPARE			
CC10	SPARE			
CC11	SPARE			
CC12	SPARE			

1.3.3 CONFIGURABLE OUTPUTS

All of the LPS-D output relays, except for the alarm output relays, are user-configurable. However, each LPS-D is shipped with default output relay assignments as shown in the Table below and Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47.

Table 1–4: LPS-D DEFAULT OUTPUT CONTACT ASSIGNMENTS (Sheet 1 of 2)

RELAY	DESCRIPTION	MNEMONIC	INDEX #
LPS-D WITH SINGLE PHASE TRIPPING MODELS			
T1	PHASE A TRIP CIRCUIT #1	TRIPA	33
T2	PHASE B TRIP CIRCUIT #1	TRIPB	34
T3	PHASE C TRIP CIRCUIT #1	TRIPC	35
T4	PHASE A TRIP CIRCUIT #2	TRIPA	33
T5	PHASE B TRIP CIRCUIT #2	TRIPB	34
T6	PHASE C TRIP CIRCUIT #3	TRIPC	35
A1	PHASE A BREAKER FAILURE INITIATE #1	TRIPA	33
A2	PHASE A BREAKER FAILURE INITIATE #2	TRIPA	33
A3	PHASE B BREAKER FAILURE INITIATE #1	TRIPB	34
A4	PHASE B BREAKER FAILURE INITIATE #2	TRIPB	34
A5	PHASE C BREAKER FAILURE INITIATE #1	TRIPC	35
A6	PHASE C BREAKER FAILURE INITIATE #2	TRIPC	35
A7	SINGLE POLE RECLOSE INITIATE #1	RI_1P	36
A8	SINGLE POLE RECLOSE INITIATE #2	RI_1P	36
A9	THREE POLE RECLOSE INITIATE #1	RI_3P	37
A10	THREE POLE RECLOSE INITIATE #2	RI_3P	37
A11	BLOCK RECLOSING	BLK-RI	144
A12	INHIBIT RECLOSING	INH-RI	145
KT1	KEY TRANSMITTER 1 / CARRIER START #1	KEY1	39
KT2	KEY TRANSMITTER 2 / CARRIER STOP #1	KEY2	40
KT3	KEY TRANSMITTER 1 / CARRIER START #1	KEY1	39
KT4	KEY TRANSMITTER 2 / CARRIER START #2	KEY2	40
C1	NON-CRITICAL ALARM	NCALM	52
C2	PT FUSE FAILURE ALARM	FF	115

Table 1–4: LPS-D DEFAULT OUTPUT CONTACT ASSIGNMENTS (Sheet 2 of 2)

RELAY	DESCRIPTION	MNEMONIC	INDEX #
LPS-D WITH THREE PHASE TRIPPING MODELS			
T1	TRIP CIRCUIT #1	TRIPA	33
T2	TRIP CIRCUIT #2	TRIPA	33
T3	TRIP CIRCUIT #3	TRIPA	33
T4	TRIP CIRCUIT #4	TRIPA	33
T5	Spare		
T6	Spare		
A1	MANUAL CLOSE CIRCUIT BREAKER #1	MNCLS1	58
A2	MANUAL CLOSE CIRCUIT BREAKER #2	MNCLS2	59
A3	BREAKER FAILURE INITIATE #1	TRIPA	33
A4	BREAKER FAILURE INITIATE #2	TRIPA	33
A5	RECLOSE INITIATE #1	RI_3P	37
A6	RECL OSE INITIATE #2	R1_3P	37
A7	RECLOSE CANCEL	CANCL	38
A8	RECLOSE CANCEL	CANCL	38
A9	Spare		
A10	Spare		
A11	Spare		
A12	Spare		
KT1	KEY TRANSMITTER 1 / CARRIER START #1	KEY1	39
KT2	KEY TRANSMITTER 2 / CARRIER STOP #1	KEY2	40
KT3	KEY TRANSMITTER 1 / CARRIER START #1	KEY1	39
KT4	KEY TRANSMITTER 2 / CARRIER START #2	KEY2	40
C1	NON-CRITICAL ALARM	NCALM	52
C2	PT FUSE FAILURE ALARM	FF	115

1.3.4 PROGRAMMABLE LOGIC

In addition to the pre-programmed line protection schemes and configurable I/O previously discussed, the LPS-D relay includes the capability for the user to design custom logic. This logic may be used to supplement or to replace the built-in scheme logic. The programmable logic includes the following: up to 40 logic gates (AND, OR, NOT), each with up to 4 inputs; 8 programmable timers, each with a settable pickup and dropout delay; 8 counters; and 8 latches.

1.4.1 POTENTIAL TRANSFORMER FUSE FAILURE (PTFF)

Because a distance or directional function may operate for a full or partial loss of AC potential caused by one or more blown fuses, PTFF is provided to block distance and directional function tripping when a fuse failure is detected. If the backup overcurrent functions 50, 50G, and 51G are not directionally controlled, they are allowed to trip during a potential fuse failure condition. If any of the backup, overcurrent functions, 50, 50G or 51G, is directionally supervised, then that function is not allowed to trip. Rather, a second overcurrent function, 50_FF, 50G_FF, or 51G_FF is placed in service during the fuse failure condition. The pickup level setting of these functions is independent from the normal pickup setting. The PTFF functional logic is shown below.

If AC potential is lost on one or more phases, the Any Phase Under Voltage signal produces a logic 1 output, and the upper input is present at AND1. The phase undervoltage pickup setting is fixed at 75% of nominal and the pickup-to-dropout ratio is virtually 100%. The lower input to AND1 is dependent upon whether the fault detector FD has operated or whether one or more phases of the protected line are de-energized (open). When one or more phases of protected line are open, PTFF is disabled.

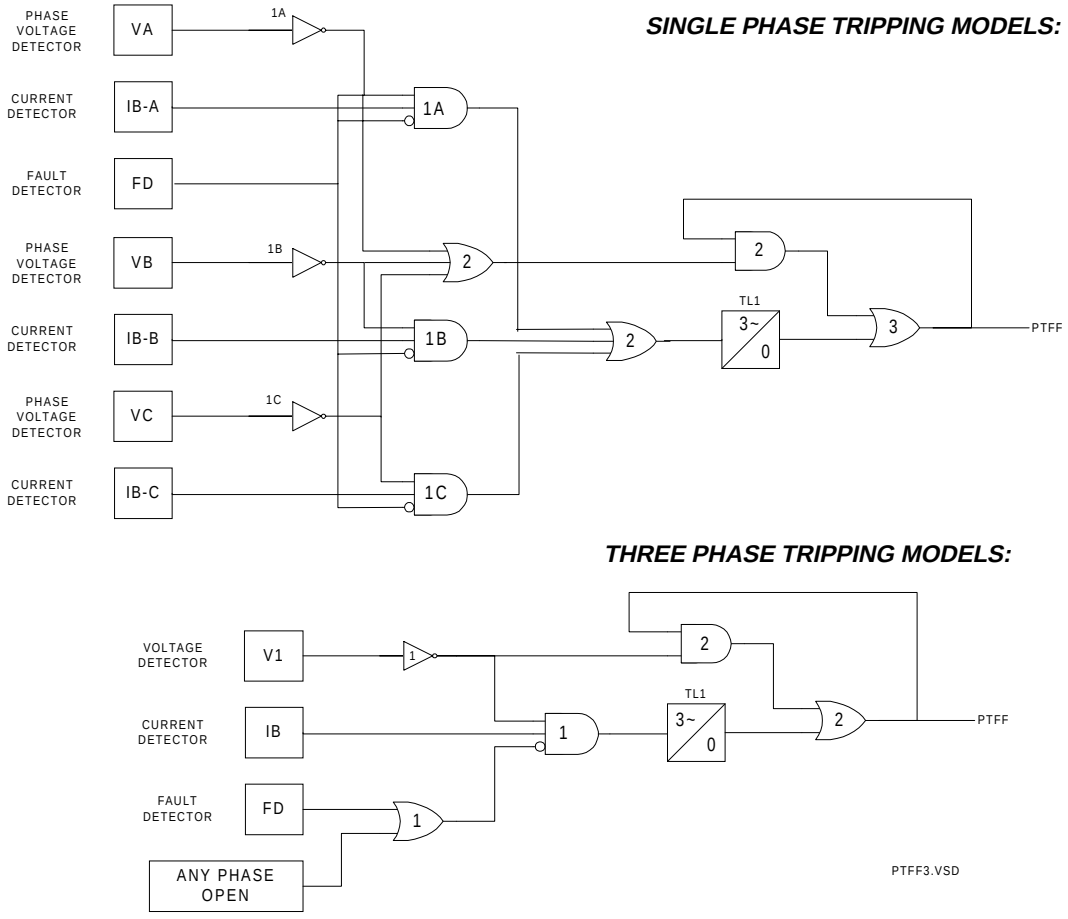


Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS

If AC potential is lost for any reason, including a blown fuse or fuses, and there is no disturbance on the power system that operates the fault detector, the AND1 output causes timer TL1 to time out and produce a PTFF output via OR2. The output of OR2 is routed to AND2 to seal-in the PTFF output, based on the Any Phase Under Voltage signal, so that PTFF output is maintained as long as the potential is below normal. Setting 714: **FUSEFAIL** determines whether PTFF operation blocks distance/directional tripping (**FUSEFAIL** = YES) or merely issues an event (**FUSEFAIL** = NO). When the potential returns to normal, the Any Phase Under Voltage signal resets to remove the seal-in, allowing the PTFF output to reset.

1

When a fault occurs, with an attendant drop in potential, the Any Phase Under Voltage signal picks up, but the fault detector operates to prevent an output from AND1. PTFF does not operate on fault conditions.

1.4.2 LINE PICKUP

a) THREE PHASE TRIPPING

The Line Pickup (Close-onto-Fault) logic provides tripping in the event that the breaker is closed into a zero-voltage bolted fault, such as occurs if the grounding chains were left on the line following maintenance. For this three phase zero voltage fault, the mho distance functions cannot operate because they lack a source of polarizing voltage. The figure below shows the functional logic for LPS-D Line Pickup.

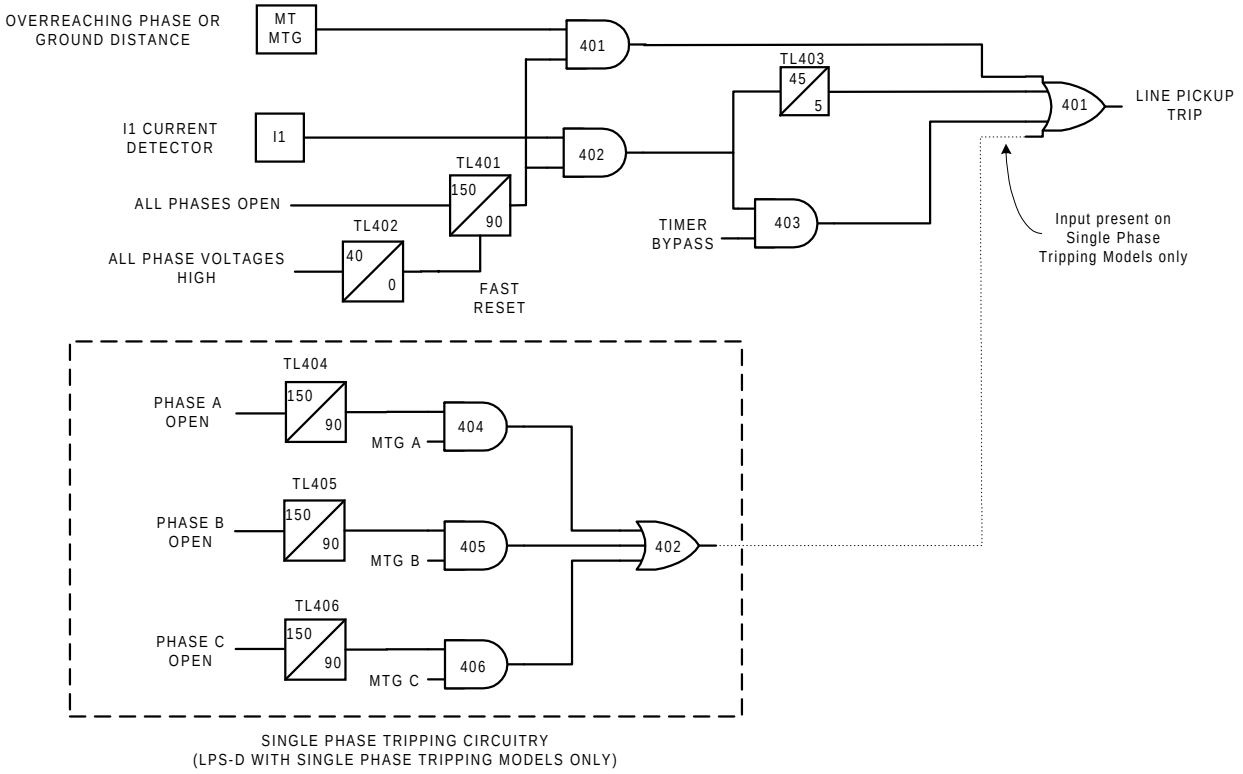


Figure 1–4: LINE PICKUP LOGIC DIAGRAM

When the line is de-energized, the open breaker is detected by the All phases Open input. The resulting output causes timer TL401 to pickup 150 ms later. Consequently, when the line is energized and a fault current higher than the setting of I1 exists, current detector I1 picks up and AND402 produces an output. If the Timer Bypass setting is set to YES, AND403 immediately produces an output to initiate tripping of the breaker. If the Timer Bypass setting is set to NO, then tripping occurs after the 45 ms pickup delay of timer TL403. Line Pickup is primarily intended to trip for closing into zero-voltage bolted faults where the distance functions connected to line-side potential will not operate. However, regardless of the I1 pickup setting, it can also be used to trip on any type of permanent fault along the entire line length that produces voltage at the relay location that is sufficient to operate a Zone 2 distance function, but not enough to pickup the All Phase Voltages High signal. This is accomplished by routing Zone 2 phase-distance or ground-distance function outputs to AND401. The step distance backup timers are bypassed by the Line Pickup logic.

If the line is energized and no fault exists, the all Phase Voltages High signal picks up and timer TL401 will begin timing; 40 ms later the output of TL401 resets timer TL401 via the fast reset input. AND401 and AND402 have their lower input removed at that time to take the three phase Line Pickup out of service.

Timer TL403 is provided for those cases where simultaneous high-speed reclosing is employed at both ends of the line, and where the I1 function must be set to pick up below the maximum load current that can occur at that time. TL403 then allows time for the voltage to return to normal and take Line Pickup out of service before it can trip on load current. If simultaneous high-speed reclosing is not used, timer TL403 can be permanently bypassed.

b) SINGLE PHASE TRIPPING

Logic is also included in the LPS-D with single phase tripping models to provide high-speed tripping when a single phase reclose onto a permanent fault occurs. When a phase of the circuit breaker is open, the associated timer (TL404, TL405, and TL406) picks up to provide one input to an AND gate (AND404, AND405, or AND406). This AND gate allows the associated Zone 2 ground distance function to trip without time delay, and without receiving a permissive channel signal from the remote terminal. The single phase line pickup logic will be blocked 90 ms after the breaker pole has been closed by the dropout of the timer.

1.4.3 REMOTE-OPEN DETECTOR

The Remote-Open Detector (ROD) function issues a trip signal when the remote breaker opens during an unbalanced internal fault. This function detects that the remote breaker has opened by recognizing charging current on one or more phases following opening of the remote breaker. As shown in the functional logic diagram below, the ROD output trips via OR2, AND1, OR2, AND2, OR3, and AND4. The Remote-Open Detector will not operate when a balanced three-phase fault is present.

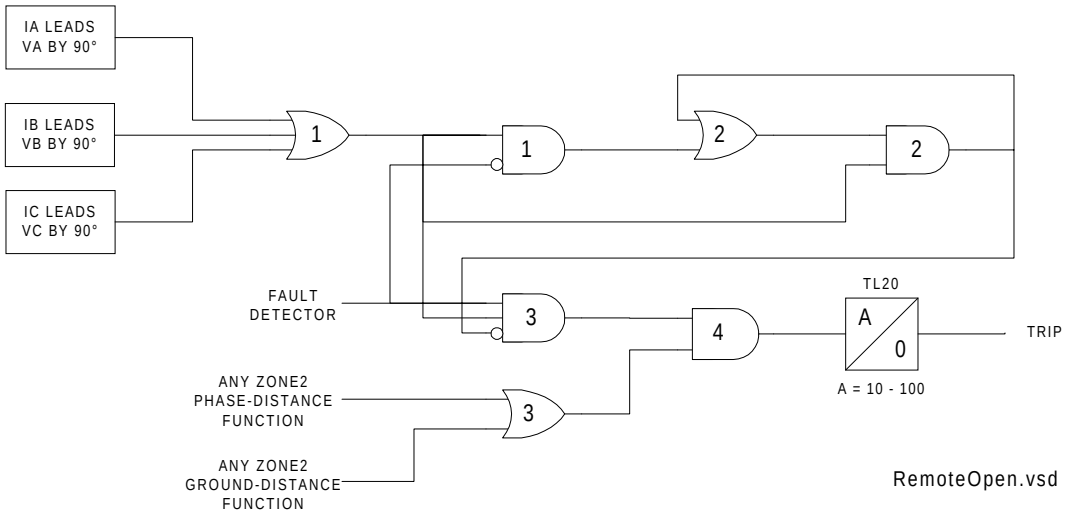


Figure 1–5: REMOTE-OPEN DETECTOR LOGIC

The Remote-Open detector can speed up tripping at the end of the line that otherwise would be the slowest to respond in a sequential-tripping condition. In a Step Distance scheme, ROD tripping is beneficial for any unbalanced internal fault not detected by Zone 1. In a Blocking scheme, ROD tripping is beneficial where system conditions are such that the fault current redistribution following breaker opening at one end is normally required before the other end(s) operates. The ROD function should not be considered as a replacement or substitute for a pilot scheme.

Figure 1–5: REMOTE-OPEN DETECTOR LOGIC above is a functional logic diagram of the ROD function. The sequence of events that results in an ROD output is as follows:

1. No charging current is detected prior to the fault – logic 0 output from AND2.
2. A fault is detected – logic 1 output from OR3.
3. The remote breaker opens – logic 1 output from AND3.

4. The fault is still present, so the two inputs to AND4 persist for the time-delay setting of timer TL20.

If charging current is initially detected but the fault detector (FD) is not picked up, indicating no fault on the power system, then OR1 and AND1 produce outputs. AND2 produces an output and seals itself in on the output of OR1 via OR2. AND3 is now blocked from producing an output as long as charging current is detected, regardless of whether FD is picked up or not. If a subsequent fault occurs and the remote breaker opens, ROD is prevented from producing an output.

If sufficient load current is flowing prior to the fault, there is no output from OR1, indicating that no charging current is detected, and AND3 is not blocked, since there is no output from AND2. If an unbalanced fault subsequently occurs, FD blocks AND1 to prevent an AND2 output. AND3 is allowed to produce an output when the remote breaker opens, provided there is sufficient charging current to operate one or more of the three charging-current-detectors that are the inputs to OR1. The capacitive charging current must be 60 mA or more (secondary phase current) to assure operation of ROD. If the fault is still present, as indicated by an output from OR3, an ROD trip follows the expiration of the TL20 security time delay.

1.4.4 OUT-OF-STEP BLOCKING

Figure 1–6: OSB R-X DIAGRAM and Figure 1–7: OSB LOGIC DIAGRAMS contain the functional logic for out-of-step blocking and an R-X diagram depicting an assumed swing-impedance locus superimposed on the associated distance relay characteristics. For an out-of-step condition, the impedance locus will first enter the MOB characteristic, then later enters the MT (phase-distance trip function) characteristic.

When MOB (A-B) picks up during the power swing, it applies the middle input to AND201. The top input is present from the NOT via OR201, since MT (A-B) has not operated yet. The bottom NOT input of AND201 is satisfied, since it is assumed that no phase is open, and the AND201 output energizes timer TL1 via OR207.

If the impedance stays between the MOB and MT characteristics for the pickup time of TL1, an OSB output results. The OSB output is routed back to the top input of AND202 via OR202 to seal-in the OSB output for as long as MOB is picked up. The OSB output resets 50 ms after the swing-impedance locus leaves the MOB characteristic. The same logic is repeated for the distance functions associated with phase pairs B-C and C-A, and all three phase-pair outputs energize TL1 via OR207. OSB is always routed to block tripping of.

1. All functions (Protection Setting 1603: **BLOCKWHAT** = BLKALL)
2. All distance functions (Protection Setting 1603: **BLOCKWHAT** = BLKDIST)
3. Only the phase distance functions (Protection Setting 1603: **BLOCKWHAT** = BLKPHAS)
4. No functions (Protection Setting 1603: **BLOCKWHAT** = BLKNONE)

For selections 2 and 3 above, each of the four distance zones (Zone 1, 2, 3, or 4) may be individually selected to be blocked (or not) via Protection Settings 1604 through 1607 (**BLOCKZ1**, **BLOCKZ2**, **BLOCKZ3**, and **BLOCKZ4**)

Timer TL1 has an adaptive pickup feature with an initial pickup setting of 30 ms for the first slip cycle, and the pickup delay becomes progressively lower during successive slip cycles. This adaptive pickup provides improved capability to maintain the out-of-step output during the increasing slip frequencies that are typically encountered after the first slip cycle.

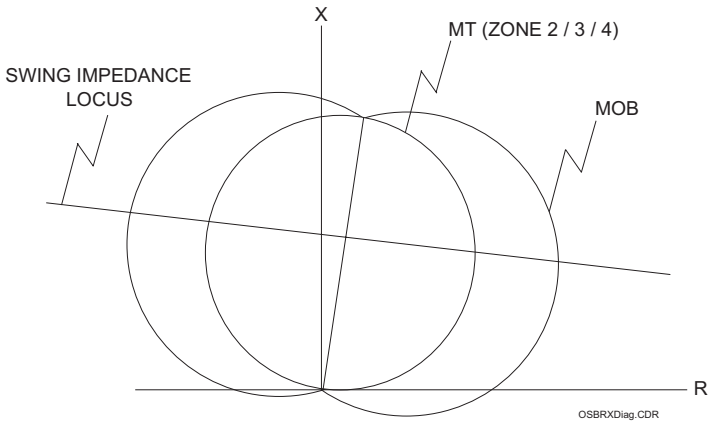
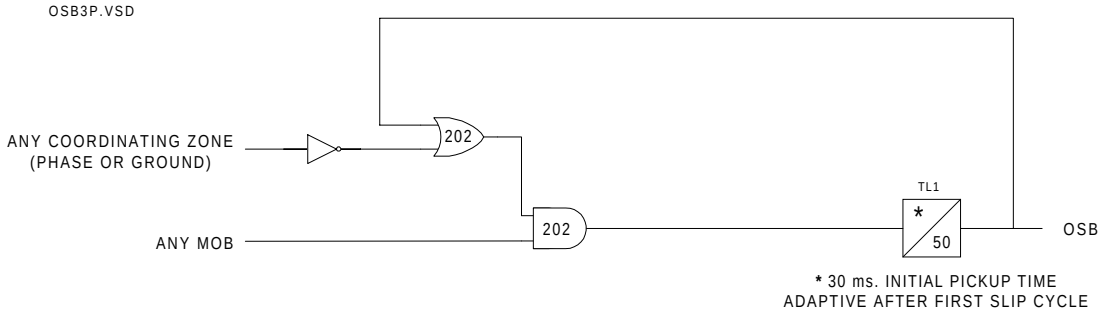


Figure 1–6: OSB R-X DIAGRAM

LPS-D WITH THREE-PHASE TRIPPING:



LPS-D WITH SINGLE-PHASE TRIPPING:

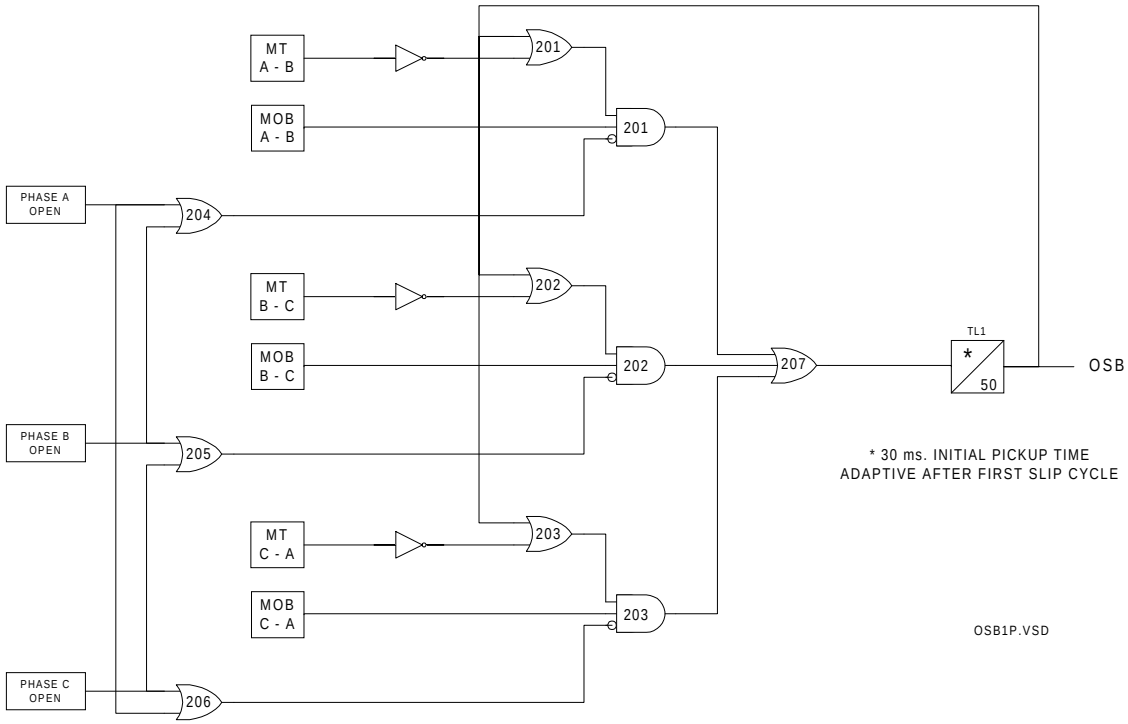


Figure 1–7: OSB LOGIC DIAGRAMS

1.5.1 FLASH MEMORY

The program code resides in Flash memory rather than EPROM. This new technology provides the same functionality during normal operations of the relay. The advantage to the Flash Memory is it can be changed for software upgrades without opening the relay. The contents can be overwritten through the communications ports already provided in the relay. The ability to change the contents requires special software and does not come with any of the standard LPS-D communications packages.

1.5.2 LINE OVERLOAD

The Line Overload function provides an event and a programmable signal. This signal can be used to provide alarm indication (contact closure) that the load current on the protected line has exceeded a set level for a set time interval. Two alarm levels are included. Level 1 is generally set with a lower pickup setting and a longer time delay than level 2.

1.5.3 CURRENT UNBALANCE DETECTION

If the Fault Detector, FD, remains pickup up for 60 seconds, a non-critical alarm is issued and an event message generated. This function indicates sustained unbalanced current conditions such as an open or shorted current transformer.

1.5.4 FAULT LOCATION

A separate algorithm provides fault-location information, which is presented as miles, kilometers, or percent of line from the relay location to the fault. The distance to the fault is based on a line length provided by the user as a setting. Fault location output is displayed on the front panel liquid crystal display as part of the target information following a relay trip, and it is also contained in the Fault Report described below.

1.5.5 FAULT REPORT

When a fault or oscillography trigger occurs, pertinent information, consisting of unit ID, date and time, operating time, prefault currents, fault currents and voltages, fault type, trip type, distance to fault, and selected events, is stored in memory. The number of fault events that are stored is selectable by the user and may be set for: 6, 12, 24, or 36 fault reports. Each fault report is associated with an oscillography data file. See Section 8.2.3: REQUEST FAULT INFORMATION on page 8–20 for obtaining a fault report via the local user interface and Section 11.8: INFORMATION on page 11–18 for fault reports using ALPS-Link.

1.5.6 OSCILLOGRAPHY

Oscillography data are stored in memory each time the LPS-D issues a trip and, optionally when an internal oscillography trigger flag is set or an external contact is closed. Protection Setting 2026: **CONFOSC** allows a configurable oscillography trigger to be assigned by Xpression Builder.

Note that OSC Trigger stores oscillography data, but does not necessarily set $t = 0$, the time sample that delineates between prefault and postfault oscillography cycles. The term *disturbance period* is defined as the number of cycles of oscillography data (prefault plus postfault) as determined by General Setting 301: **NUMFLTS**. If the internal Fault Detector, FD, comes up initially and OSC Trigger follows within the disturbance period, oscillography data are stored whether or not the LPS-D issues a trip.

If the LPS-D issues a trip, then a normal fault report is stored as part of the oscillography data. If the LPS-D does not issue a trip, a pseudofault report is created. The trip type is listed as OSC, the trip time is set to when the OSC Trigger occurred, the operating time is set to zero, and the fault type and location are computed,

based on post-OSC Trigger data. The local LCD display does not show target information, but an event message and fault report are stored in memory. In either case above, $t = 0$ is determined by the internal Fault Detector (FD).

If OSC Trigger comes up initially and FD follows within the disturbance period, the same actions occur and FD determines $t = 0$. If only OSC Trigger occurs, then a pseudofault report is created and OSC Trigger determines $t = 0$. This arrangement assures that the oscillography function always captures an LPS-D trip, with FD determining $t = 0$, regardless of whether an optional internal or external trigger is used.

Oscillography data include station and line identification, a complete list of the active relay settings, the fault report, internal flags, and a selectable number of prefault and postfault data samples. Further description of this function is found in Chapter 11: ALPS-LINK USER GUIDE.

The LPS-D does not store flags for functions that are disabled. For example, if Protection Setting 104: **Z1GROUND** = NO and a Zone 1 ground fault is applied, the Zone 1 ground flag will not operate or be stored.

1.5.7 PLAYBACK

The LPS-D can replay stored digital current and voltage signals from oscillography files through the protection algorithms. The currents and voltages may be obtained from a factory stored file, from any oscillography file currently stored in the relay, or from an oscillography file stored on a PC. See Sections 8.1.20: PLAYBACK on page 8–16 for further information on the Playback feature.

1.5.8 SEQUENCE OF EVENTS

This function time tags and stores the last 150 events in memory. The resolution of the time-tagging is 1 millisecond. The event list contains power system events, operator actions, and self-test alarms. The sequence of events can be accessed remotely via the front panel port, PL-1 or PL-2, and a PC. Further information is contained in Section 8.2.7: EVENT INFORMATION on page 8–22.

1.5.9 EQUIPMENT DUTY

When the LPS-D is applied with a single breaker, it incorporates the ability to monitor the number of breaker operations and the breaker duty. Alarm levels can be set for both the total number of breaker operations and the total equipment duty. See Section 2.2.4: EQUIPMENT DUTY on page 2–8 for a complete description of the Equipment Duty feature.

1.5.10 SELECTABLE GROUPS OF SETTINGS

Four separate groups of protection settings may be stored in nonvolatile memory. Only one group can be active at a given time, but the active group may be selected by external contacts, by a command issued from the local keypad, or remote communication software. If the selection is to be made by an external switch, then two of the digital inputs (contact converters) are used for this purpose. A four position SB1 or SBM switch with two stages (two effective contacts) could be used to select the active group of settings, as shown in Figure 1–8: SWITCH SELECTION OF ACTIVE SETTING GROUP below.

NOTE

For this example CC5 has been assigned to “CGST2” (Change Setting Group Input, Bit 1), and CC6 has been assigned to “CGST1” (Change Setting Group Input, Bit 0). Other contact converters may be assigned to these functions.

1

TRUTH TABLE

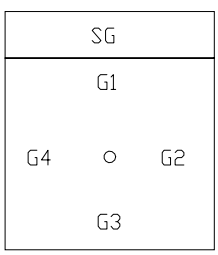
CC5 --> bit 1

CC6 --> bit 0

CC5	CC6	SETTINGS GROUP
0	0	G1
0	1	G2
1	0	G3
1	1	G4

SG

SETTINGS GROUP SWITCH 16SB1_____					
CONTACT NUMBER		G4	G3	G2	G1
1 ⊣⊢ ⊣⊢ 2	1	X	X		
	2				
3 ⊣⊢ ⊣⊢ 4	3	X		X	
	4				



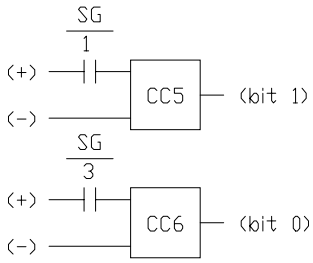


Figure 1–8: SWITCH SELECTION OF ACTIVE SETTING GROUP

1.5.11 TIME SYNCHRONIZATION

The LPS-D includes a clock that can run freely from the internal oscillator or be synchronized from an external signal. An unmodulated IRIG-B signal connected to the IRIG-B terminals, located on terminal block “D” on the rear panel, may be used to synchronize the clock. The clock in a given LPS-D is synchronized to within ±1 ms of any other LPS-D clock if the two relays are wired to the same synchronizing signal.

1.5.12 TRIP BUS CHECK

After a settings change is made in the active settings group, the LPS-D automatically returns to its normal protection-on mode following:

- Storage of the new setting values in nonvolatile memory.
- A Trip Bus Check to determine that the changed settings have not caused any of the trip functions to operate for system conditions (that is, current and voltage at the relay) at that instant.

A Trip Bus Check also occurs before a newly selected settings group is allowed to become the active settings group. If Trip Bus Check finds a picked-up trip function, protection is turned off and a critical alarm is issued.

This check provides a degree of confidence in the new settings, but it does not guarantee that one or more trip functions might not operate as system conditions change. For example, a subsequent increase in load current might cause the Zone 3 phase-distance function to operate, even though it did not operate at the instant the Trip Bus Check was made.

1.5.13 TRIP CIRCUIT MONITOR

Within the LPS-D, the DC battery voltage across each of the open trip contacts (or SCRs) may be continuously monitored to determine if the associated trip circuit is intact. If the monitored DC voltage drops to zero, then the trip circuit has failed to open, or the breaker 52/a contact, which is normally wired in series with the trip coil, has opened. This function is intended to replace the red light indicator typically used for trip-circuit monitoring, and it can be selectively disabled for each breaker.

There are four trip contacts (or SCRs) in the LPS-D. The voltage across each contact (or SCR) is monitored separately. Any combination of trip circuits may be monitored by General Setting 107: **NUM_MON**.

Operation of the Trip Circuit Monitor causes a noncritical alarm event. If one or more breaker poles are opened in some manner other than by a trip issued by the LPS-D, then the 52/a contact normally wired in series with the trip coil opens and drops the voltage across the open contact to zero. To avoid a noncritical alarm for this condition, closure of the associated 52/b contact disables the Trip Circuit Monitor function for the involved pole.

1.5.14 ALARMS

Two separate alarms are provided. The output relays associated with these alarms are not user programmable. Both of these alarms have form C contacts and are energized under normal conditions.

- The *critical alarm* de-energizes when the relay self-test logic detects a problem that warrants taking the relay system out of service.
- The *power supply alarm* de-energizes when the power supply fails or is turned off.

A user programmable non-critical alarm is also provided. Operation of the non-critical alarm will cause an event to be logged, and may be programmed to a user-assigned output contact. The non-critical alarm is de-energized in normal conditions. The default inputs to the non-critical alarm include the following conditions:

1. Trip Circuit Alarm
2. Zone Flags On Alarm
3. Overcurrent Alarm
4. Unbalance Current Alarm Detector

Additional inputs, such as line over load alarm, may be added by the user via Xpression Builder.

1.5.15 METERING

Metering values may be obtained by using the keypad, or through remote communications. The following quantities are available: RMS voltage and current, phasor voltage and current, Watts, Vars, Power Factor, system frequency, and Breaker health. The voltage and current values are accurate to 1% of reading. Refer to Chapter 8.1.3: CONTROL KEYS on page 8–2 for a description on how to use the metering function.

1.5.16 BREAKER CONTROL

Two different breakers may be selectively tripped or closed via the local keypad or a remote PC connected to the RS232 port. The commands are as follows:

- Trip Breaker 1 and Trip Breaker 2 use the same output contacts or SCRs as a fault trip command.
- Close Breaker 1 and Close Breaker 2 use separate auxiliary relays. The contact of each auxiliary relay must be wired to the appropriate breaker's close circuit.

Remote breaker tripping and closing are enabled or disabled with a jumper on the Processor module as shown in Figure 3–5: INPUT BOARD DIAGRAM on page 3–7. The LPS-D is shipped from the factory with this jumper removed and Breaker Control enabled. Install the jumper to disable Remote Breaker Control.

1.6.1 KEYPAD AND DISPLAY

A local user interface, incorporating a keypad and liquid crystal display (LCD), is provided to enter settings, display present values, view fault target information, and access stored data. This feature is fully described in Chapter 8: LOCAL USER INTERFACE.

Passwords provide security for the local user interface (keypad). Three different passwords provide local keypad security against inadvertent breaker operations and settings changes. No password is required to view data stored in the relay. The three levels of password protection are:

- **CONTROL**: Allows control operations (trip and close the breakers).
- **SETTINGS**: Allows settings changes.
- **MASTER**: Allows both control operations and settings changes.

Refer to Section 8.1.22: ENABLE/DISABLE PASSWORDS on page 8–18 for a description of the keypad password usage.

1.6.2 SERIAL COMMUNICATIONS

Two serial communications ports are standard, and a third is optional. A DB-9 plug RS232 port (Port 1) located on the front panel of the unit provides local serial communication with the LPS-D via an IBM PC-compatible computer. One or two rear ports are provided for serial communications is either RS232 or RS485. Port 2 is standard on all LPS-D models. When Port 2 is configured as an RS232 port, connection is made using a DB25 plug; when Port 2 is configured as an RS485, connection is made using a 4-pin Phoenix plug. Port 3 is optional and uses a DB25 plug for either RS232 or RS485. The communications protocol for each port may be selected independently as either GE-Modem or ASCII. Each port may be set independently for data communications from 300 to 19200 bps. In addition, Port 3 has the ability to accept a plug in communication module that can support other communications protocols.

Four different passwords provide remote serial communications security. The four levels of password protection are:

- **VIEW**: Allows remote access to the LPS-D to view and retrieve stored data.
- **CONTROL**: Allows control operations (trip and close the breakers).
- **SETTINGS**: Allows settings changes.
- **MASTER**: Allows both control operations and settings changes.

Refer to Chapter 11: ALPS-LINK USER GUIDE for a description of ALPS-Link and ASCII port password usage.

1.6.3 SCADA DIGITAL TO ANALOG (DTA) INTERFACE

An internal DTA function, standard on the LPS-D, provides the following:

- An analog output proportional to the distance from the relay to the fault as calculated by the fault-location algorithm.
- Four contact outputs that provide fault-type information.

The analog output is intended to be wired into an analog port of a SCADA RTU to provide remote indication of distance to the fault. The four contact outputs are designated phase A, phase B, phase C, and neutral and are intended to be wired into four separate RTU digital ports. A particular contact closes when its phase (or neutral) is involved in the fault. For a phase B-to-C-to-ground fault, the phase B, phase C, and neutral contacts close.

The DTA provides either a nominal 0 to 1 mA DC output or a nominal 0 to 5 V DC output. The choice of output ranges is made by a switch located on the Processor Board. The Processor Board must be removed from the LPS-D chassis to access this switch. For the proper sequence, see Chapter 9: SERVICING.

When the fault location is calculated to be 100% of the line length, the DTA output is either 0.8 mA DC or 4.0 V DC. The DTA output goes to full scale (either 1 mA DC or 5 V DC) when the fault location is calculated to be greater than 110% of the line length. Consequently, the usable output ranges are 0 to 0.88 mA DC or 0 to 4.4 V DC, which covers the 0 to 110% fault-location range. The SCADA system should be programmed to recognize a full-scale output as an indication of an invalid output, resulting from either an out-of-limit fault-location calculation or a DTA reset.

There are two settings associated with the SCADA DTA Interface. Protection Setting 1501: **FLTLOCK** specifies a time period after a fault during which fault-location calculations resulting from subsequent faults are prevented from updating the fault-location information stored in the DTA logic. Protection Setting 1502: **FLTRESET** specifies the time after a fault at which the fault-location information stored in the DTA logic is reset (output forced to full-scale value) and those fault-type contacts that have closed will open. Note when either the LPS-D date or time is changed the timers associated with **FLTLOCK** and **FLTRESET** are reset and the DTA function is reset.

Fault phase identification dry contacts for A, B, C, and N phases must be programmed by the user. Refer to Chapter 3: HARDWARE DESCRIPTION for details.

1.7.1 START-UP SELF-TESTS

The most comprehensive testing of the LPS-D is performed during a power-up. Since the LPS-D is not performing any protection activities at that time, tests (such as RAM tests) that would be disruptive to run-time processing are performed.

Both processors participate in the start-up self-testing. The processors communicate their results to each other so that any failures can be reported and so that each processor successfully completes its assigned self-tests before the LPS-D begins protection activity.

During power-up, both microprocessors perform start-up self-tests on its associated hardware (including flash memory, EPROM, local RAM, shared RAM, interrupt controller, timer chip, serial I/O ports, nonvolatile memory, analog and digital I/O circuitry, and keypad/LCD display hardware). In addition, the LPS-D verifies that the PROM version numbers on both processor boards are compatible, and that the model number stored in nonvolatile memory agrees with the unit's configuration. The components tested at start-up are listed in Table 9–1: COMPONENTS TESTED DURING START-UP TESTS on page 9–2.

In most cases, if any critical self-test failure is detected, the LPS-D discontinues start-up and does not reset. It attempts to store the LPS-D status and initialize the KEYPAD/LCD DISPLAY and remote communications hardware/software to communicating its status. The critical alarm output is energized.

If no failures are detected, the LPS-D completes initialization of its hardware and software; this includes reading information from the serial non-volatile RAM (NVRAM) in the magnetic module, stored during the manufacturing process, to determine the current rating of the magnetic in the unit (1 A or 5 A). Next, the i960 processor enables the outputs. As the final step, the LPS-D checks the results of all the tests to determine whether to turn on the green status LED on the front panel.

The start-up procedure takes approximately one minute. As soon as the i960 CPU successfully completes its PROM test and initializes the display hardware, the message **INITIALIZING** appears on the display. When all LPS-D initialization is completed satisfactorily the LPS-D begins acquiring and processing data.

1.7.2 RUN-TIME SELF-TESTS

Both of the processors have idle time when the LPS-D is not performing fault or post-fault processing. During this idle time, each processor performs background self-tests that do not interfere with the foreground tasks' use of serial and parallel ports and that do not inhibit interrupts to any processor. If any background self-test fails, the test is repeated. For a component to be declared as failed, the test must fail three consecutive times. In the case of most critical failures, the LPS-D forces a reset to attempt to get the failed component working again.

The LPS-D is able to distinguish between a start-up (power-up) and a reset caused automatically by an LPS-D malfunction. The reset is a fault-tolerant feature of the LPS-D; it is performed as an attempt to resume operation after an intermittent failure. The reset activities are identical to the start-up activities except that not all start-up self-tests are performed. If the reset was caused by failure of a specific background self-test, then only the start-up self-tests associated with that same hardware are performed.

A reset is not reported by the LPS-D. If the reset is successful no failure status is recorded and the critical alarm output is not energized; however, during the reset procedure, the red LED on the front panel is lit and a failure code may appear on the display. Therefore, if the reset is not successful, the processor board is shut down, leaving the error information on the display. Refer to Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5. To prevent continual resets in the case of a solid failure, both hardware and software permit only four resets in a one-hour period. On the fifth reset, the LPS-D does not initialize, but attempts to initialize the display, communications, and the critical-alarm output, as in the case of a start-up with a critical self-test failure. The reset procedure takes approximately one second, depending upon which start-up self-tests are to be run.

The components tested in the background are listed in Table 9–2: RUN-TIME BACKGROUND SELF-TESTS on page 9–2. Testing of I/O hardware is done in the foreground, so that the processors know when a given component or port is in use and therefore not available for testing. The components tested in the foreground are listed in Table 9–3: RUN-TIME FOREGROUND SELF-TESTS on page 9–2. Some foreground tests are performed every sample period, while others are performed less frequently.

As with background self-tests, any failed foreground test is repeated and must fail three consecutive times to be considered a failure. Although not specifically a self-test, the trip circuit continuity monitoring is performed as a foreground test. Refer to Section 1.5.13: TRIP CIRCUIT MONITOR on page 1–21.

The operator may initiate a visual-response test of the keypad and LCD display components. Refer to Chapter 4: ACCEPTANCE/PERIODIC TESTS for details.

1.7.3 CONTINUOUS MONITOR

The LPS-D relay includes a continuous monitor feature in addition to its self-test features. The continuous monitor is intended to detect any LPS-D tripping units (Zone 2 or Zone 3 distance functions, 50G or 50 overcurrent functions) that are in the picked-up condition without a corresponding operation of the Fault Detector. If such a condition occurs and persists for 1 second, the LPS-D relay will issue a non-critical alarm and log a continuous monitor event.

These continuous monitor alarm points can be found in Table 2–7: INDEX NUMBERS – scheme, recloser, & programmable logic on page 2–54. The Index numbers used for the continuous monitor are as follows:

- 48 – Trip Circuit alarm
- 49 – Zone flags on alarm
- 50 – Overcurrent Alarm
- 51 – Unbalanced Current Detector alarm

They are assigned in the default settings as inputs to the non-critical alarm. These flags may also be used in configurable logic or assigned to other alarm contacts if required.

1.8.1 INTRODUCTION

The six standard protection schemes are described in this section. Functional logic diagrams, (Figure 1–9: STEP DISTANCE LOGIC DIAGRAM through Figure 1–17: HYBRID LOGIC DIAGRAM) show the scheme logic for the protection schemes using conventional AND/OR combinational logic. The elementary diagram in Figure 1–23: ELEMENTARY DIAGRAM on page 1–48 shows the external connections to the LPS-D relay. Note that all of the output relays and input contact converters included in the LPS-D are fully programmable by the user. However, for ease of application, the LPS-D relay is shipped with the inputs and outputs assigned in Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47. The programmability of the LPS-D is discussed in Chapter 13: XPRESSION BUILDER. Figure 1–10: PUTT/POTT INTERCONNECTION DIAGRAM WITH NS40A, Figure 1–15: BLOCKING SCHEME INTERCONNECTION WITH CS28A, and Figure 1–15: BLOCKING SCHEME INTERCONNECTION WITH CS28A show typical interconnections between the LPS-D and appropriate carrier/tone equipment for three pilot schemes:

- BLOCKING with CS28A
- POTT with NS40A
- HYBRID with Unblocking

1.8.2 STEP DISTANCE

Figure 1–9: STEP DISTANCE LOGIC DIAGRAM on page 1–27 is the logic diagram for the Step Distance scheme. Since this non-pilot scheme overlays the other protection schemes in the LPS-D, it is in essence a part of all of them. The Zone 1 distance functions are set to reach no greater than 90% of the positive-sequence impedance of the protected line. All of the ground-distance functions are provided with self-compensation so that they see only the positive-sequence impedance to a ground fault when the compensation setting is properly selected to reflect the difference between the zero-sequence and positive-sequence impedance of the line. This setting is explained in Section 2.3: PROTECTION SETTINGS on page 2–10.

There can be as many as three time-delayed zones. At a minimum, Zone 2 should be selected to provide protection for the last 10% of the protected line not covered by Zone 1. If the application permits, a forward-looking third zone can be used to provide backup protection for adjacent line sections out of the remote bus. If a reverse-looking zone is desired, the Zone 4 functions can be reversed. For some applications it may be desirable to implement both a forward-looking Zone 3 and a forward-looking Zone 4.

The phase-distance functions can be placed in or out of service by specifying a separate setting for each protection zone. The same is true for the ground-distance functions. Zone 2, Zone 3, and Zone 4 each have two independently set zone timers. One timer is associated with the phase functions, the other with the ground functions.

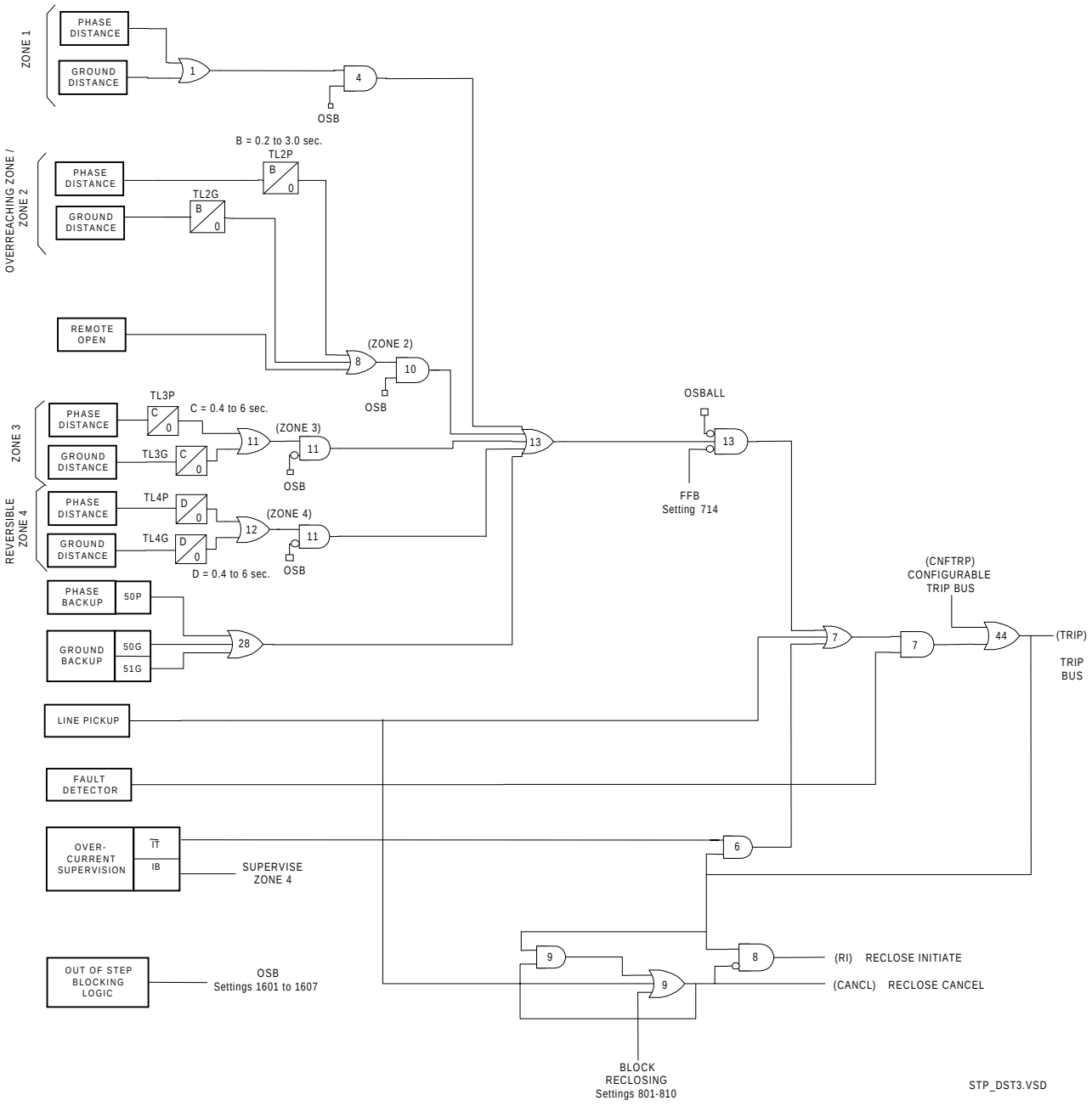


Figure 1–9: STEP DISTANCE LOGIC DIAGRAM

1.8.3 PERMISSIVE UNDERREACH TRANSFER TRIP (PUTT)

Figure 1–11: PUTT LOGIC DIAGRAM on page 1–29 is the logic diagram for the PUTT scheme. A PUTT scheme requires Zone 1 functions as well as overreaching zone functions. Zone 1 trips directly via OR1, AND4, OR25, OR3, OR4, AND3, OR13, AND13, OR35, and AND35 and keys the transmitter to the trip frequency via OR5. Tripping for internal faults not seen by the Zone 1 functions occurs when an overreaching function operates and the receiver(s) produce an output, satisfying the input conditions of the AND1 comparator.

The considerations for receiver connections for a three-terminal line application and 52/b contact keying of the transmitter with one end open are different from those described above under the POTT scheme. As with a POTT scheme, a PUTT three-terminal line application requires two receivers and one transmitter at each terminal, with each frequency-shift transmitter operating at a different frequency. However, the two receivers are ORed together at OR21, rather than ANDed together as with a POTT scheme. This is necessary since the Zone 1 functions at only one end of the three-terminal line may respond for an internal fault.

For a three-terminal PUTT application, do not use 52/b contact keying of the transmitter. Because the two receivers are ORed together, a continuous trip signal sent from the open end, when only one end is open, results in over-tripping for external faults within the reach of the pilot overreaching functions. Unfortunately, this means a portion of the line is not protected by the pilot scheme. In the LPS-D, 52/b contact keying of the transmitter is automatically prevented if Protection Setting 1201: **PICKSCHEME** = 2 [PUTT] and Protection Setting 1202: **NUMRCVR** = 2 [2 RCVRS], as indicated in Figure 1–11: PUTT LOGIC DIAGRAM by the link between AND5 and OR5. 52/b contact keying of the transmitter should be used for a two-terminal PUTT application.

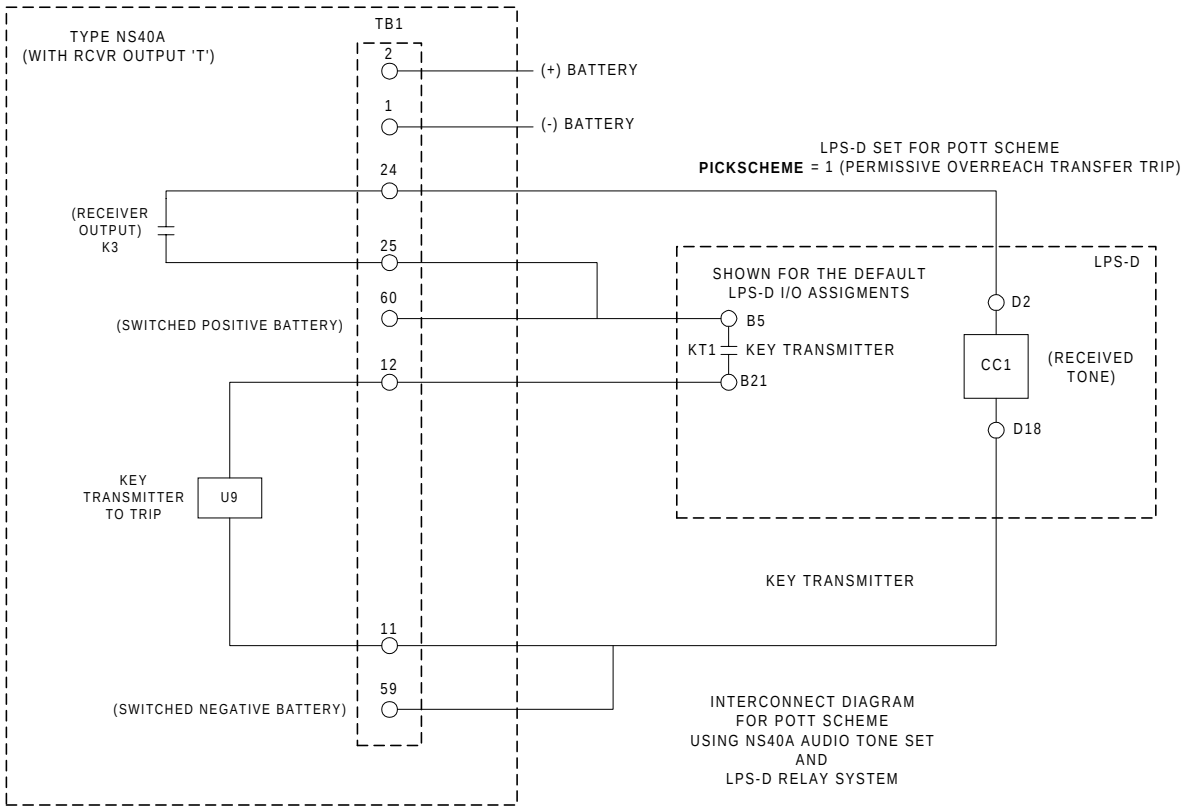


Figure 1–10: PUTT/POTT INTERCONNECTION DIAGRAM WITH NS40A

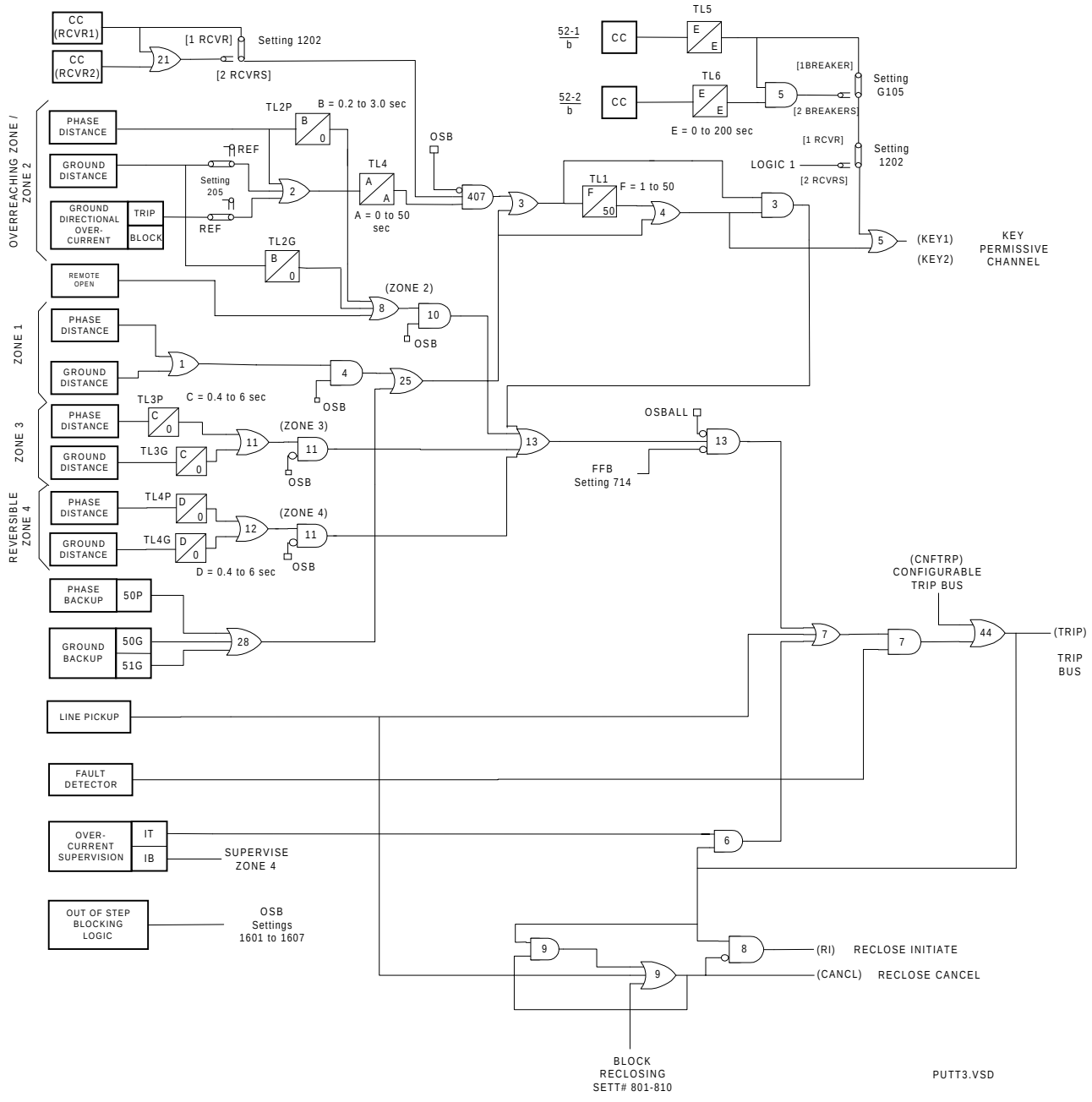


Figure 1–11: PUTT LOGIC DIAGRAM

1.8.4 PERMISSIVE OVERREACH TRANSFER TRIP (POTT1)

Figure 1–12: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1) on page 1–31 is the logic diagram for the POTT1 scheme. The POTT1 scheme requires receipt of a tripping signal from the remote end(s) to permit tripping at the local end. The channel equipment is generally a frequency-shift (FSK) type. When a power-line carrier channel is used, it is possible that an internal fault may attenuate the carrier signal sufficiently to preclude receipt of the trip signal. For such cases, an unblocking channel that provides a time window of trip permission for an attenuated signal caused by an internal fault should be considered.

For any multiphase fault on the protected line, one or more of the overreaching zone variable-Mho functions operates at each terminal and applies one of the inputs of AND407, via OR2 and TL4. The output from OR2 also keys the transmitter to the trip frequency via OR5. The receiver produces a trip output at each terminal of a two-terminal line. This received permissive trip signal is supplied to the relay logic via one of the contact converters (CC1, as shipped). Assuming that the out-of-step blocking function has not operated, an AND407 output results in a trip output via OR3, TL1, OR4, AND3, OR13, AND13, OR7, and AND7.

The same sequence of operations occurs for an internal ground fault when an overreaching zone ground-distance variable-mho function or the ground-directional-overcurrent function (or both) operates at each line terminal. Note that if the fault-current contribution at one end is insufficient to pick up the overreaching trip function there, then neither end can trip via the POTT1 logic. A hybrid scheme is preferable for such a weak- or zero-in-feed condition.

Timer TL1 allows the relay to ride through spurious outputs that might be produced from the channel during external faults within the reach of the overreaching trip functions. Timer TL4, in conjunction with timer TL1, prevents a possible misoperation when a fault-current reversal occurs as a result of sequential clearing of a fault on a parallel line. Note that tripping is supervised by the Fault Detector at AND7, thus confirming that tripping occurs only after a fault on the power system.

The above description assumes a two-terminal line. When a POTT1 scheme is applied on a three-terminal line, each terminal has two receivers and one transmitter, with each frequency-shift transmitter operating at a different frequency. Now the trip signal must be received from each of the two remote terminals, as indicated by an output from AND21.

On a line protected by a POTT1 scheme, a problem arises if the line is operated with the breaker at one end open, but the breaker(s) at the other end(s) closed. For this condition, the relay at the closed end(s) cannot operate for a fault on the line unless the transmitter at the open end is keyed to the trip frequency. A 52/b contact from the breaker is used to key the transmitter continuously to the trip frequency when the breaker is open. The default, or As-Shipped, contact converter for the first breaker is CC5; if two breakers are involved, as in a ring bus or breaker-and-a-half bus arrangement, then CC6 is combined with CC5 at AND5 to indicate that the line is open.

The sequence of operations is similar for an internal ground fault. Ground-distance, ground-directional-overcurrent, or both functions acting in parallel may be selected for ground-fault protection. Ground distance and ground-directional-overcurrent each have separate trip and block functions as well as separate transient blocking circuits.

1.8.5 PERMISSIVE OVERREACH TRANSFER TRIP WITH BLOCKING FUNCTIONS (POTT2)

Figure 1–13: POTT WITH BLOCKING FUNCTIONS (POTT2) LOGIC DIAGRAM on page 1–32 is the logic diagram for the POTT2 scheme. The POTT2 scheme performs exactly the same as the POTT1 scheme for all internal faults. In the POTT2 scheme, the Zone 4 distance functions are set as reverse looking blocking units. The Zone 4 distance functions provide transient blocking for when a fault-current reversal occurs as a result of sequential clearing of a fault on a parallel line. This logic is the same as that used in the Hybrid scheme.

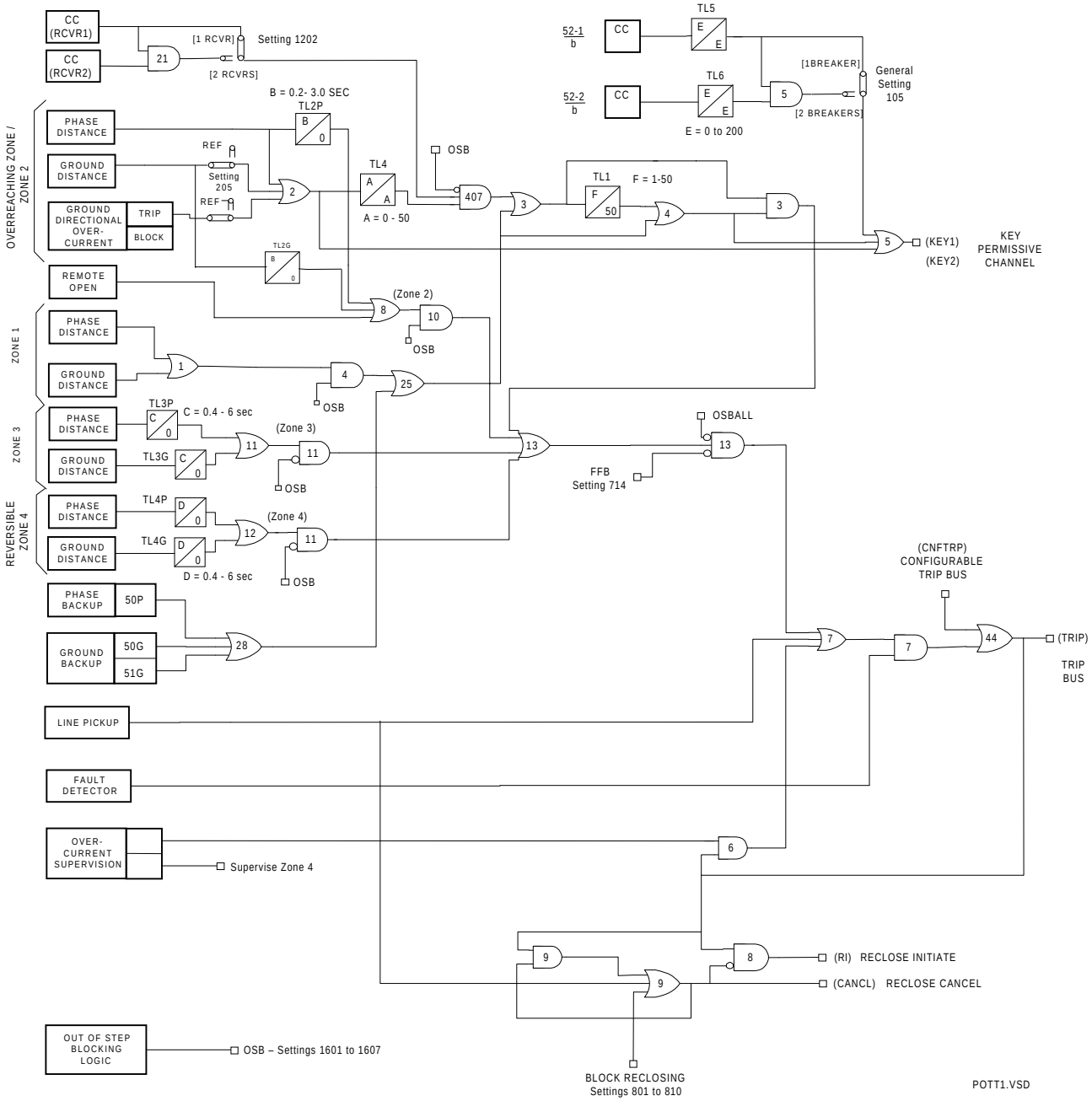


Figure 1–12: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1)

1

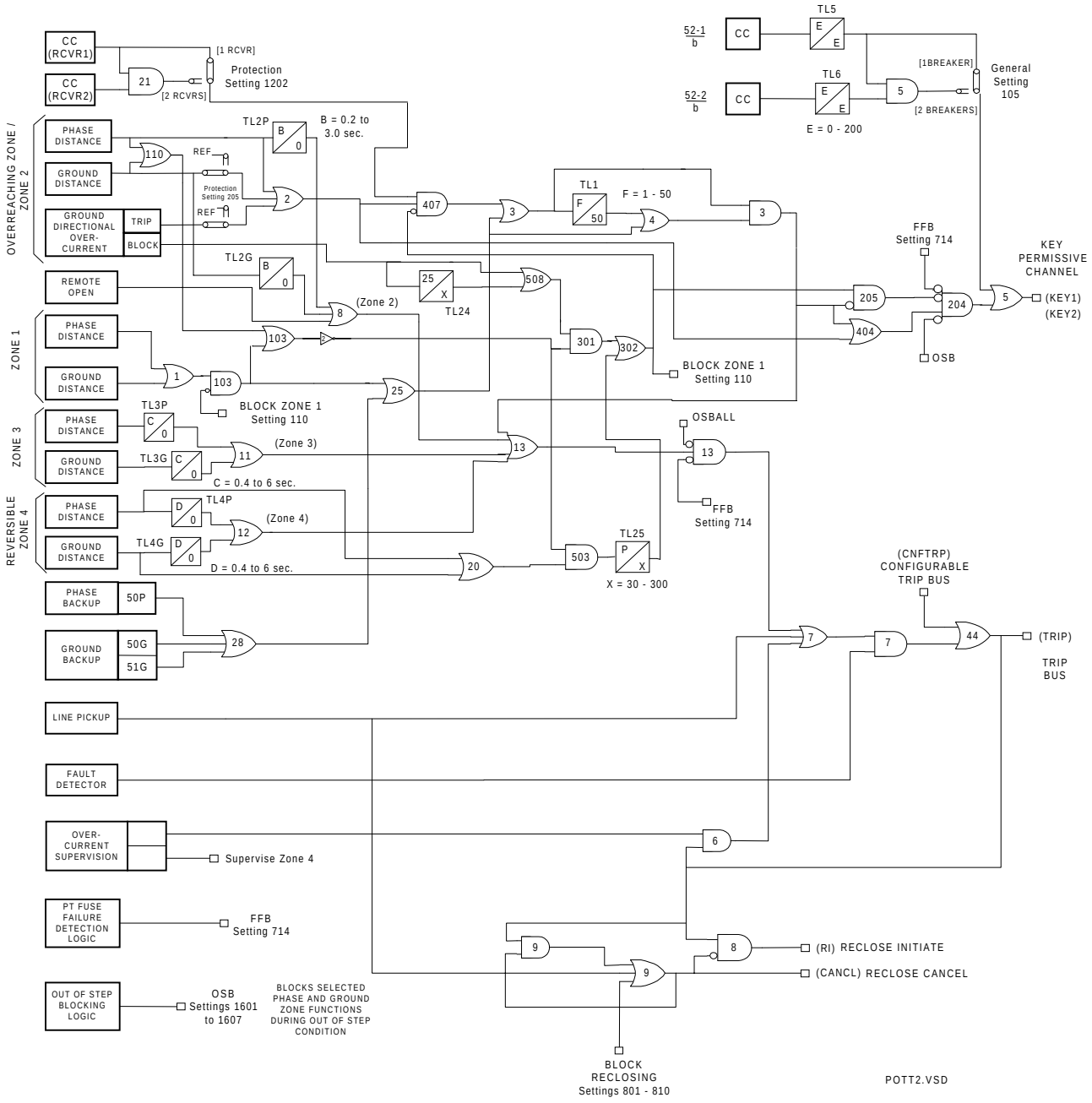


Figure 1–13: POTT WITH BLOCKING FUNCTIONS (POTT2) LOGIC DIAGRAM

Figure 1–14: BLOCKING SCHEME LOGIC DIAGRAM on page 1–34 is the logic diagram for the Blocking scheme. Since a reverse-looking blocking function is required in this scheme, the Zone 4 distance functions are automatically set for reversed reach when the Blocking scheme is selected. As far as channel operation is concerned, a blocking scheme has opposite sense from a PUTT, POTT or Hybrid scheme.

For an external fault, the blocking functions at the line end nearest the fault key the transmitter, and the receipt of this blocking signal at the other end of the line prevents a trip output. For an internal fault, the transmitters are not keyed or, if keyed on initially at fault inception, they are quickly turned off by operation of the overreaching trip functions. Therefore, receiver output is not required for tripping at either end.

The channel equipment generally used is an ON-OFF carrier set. The sequence of operations is similar for an internal ground fault. Ground-distance, ground-directional-overcurrent, or both functions acting in parallel may be selected for ground-fault protection. Ground-distance and ground-directional-overcurrent each have separate trip and block functions as well as separate transient blocking circuits.

The LPS-D Blocking scheme has provisions for different logics to start the carrier for ground faults. The carrier starting option is determined by Protection Settings 1204: **CARRSTART** and 505: **IPBKFACTOR**. **CARRSTART** may be set to DIR, IPB, or FD. The DIR option used the IPB function ANDed with the NB function to start the carrier in the GDOC and MHOGDOC schemes. The IPB option uses the IPB overcurrent detector without NB supervision as a non-directional carrier start function. In the DIR and IPB options, the IPB function may be selected to operate on the zero-sequence current without positive sequence current restraint by setting **IPBKFACTOR** = 0.0, or to operate on zero-sequence current with positive sequence current restraint by setting **IPBKFACTOR** = 0.066.

For any multiphase fault on the protected line, one or more of the overreaching zone variable-mho functions operates at each end of the line and applies one of the inputs to the comparator AND407 via OR2. An output from OR110 inhibits the blocking functions at AND503 via OR103 and NOT2, and any carrier that may have been started is stopped via OR2, AND209, and OR213. Consequently, the carrier is stopped or is not started at any terminal of the line; there is no receiver output and no blocking input applied to comparator AND407 via CC1 and NOT3.

Assuming that the out-of-step blocking function has not operated, AND407 produces an output to initiate tripping following the coordination time-delay pickup set on timer TL1. The coordinating time is required to allow time for receiving a blocking signal from the remote terminal(s) to prevent misoperation on external faults. The required setting is described in Chapter 2: CALCULATION OF SETTINGS Note that tripping, as in all the schemes, is supervised by the Fault Detector at AND35, thus confirming that a trip only occurs when a disturbance is present on the power system.

For remote external faults within the reach of the local overreaching zone tripping functions, one of the remote blocking functions operates to key the transmitter ON, sending a blocking signal to the local end. The receiver output is supplied to the LPS-D via one of the contact converter inputs. The default, or as shipped contact converter assigned to the receiver is CC1. An input from the receiver blocks tripping at the local end by removing the upper input to AND407 via CC1 and NOT3. At the remote end, the output of the blocking functions is applied to the lower NOT input of AND407 to block tripping there. This lower NOT input to AND407 forms part of the transient blocking logic that blocks tripping when clearing external faults or during current reversals that occur when clearing faults on a parallel line.

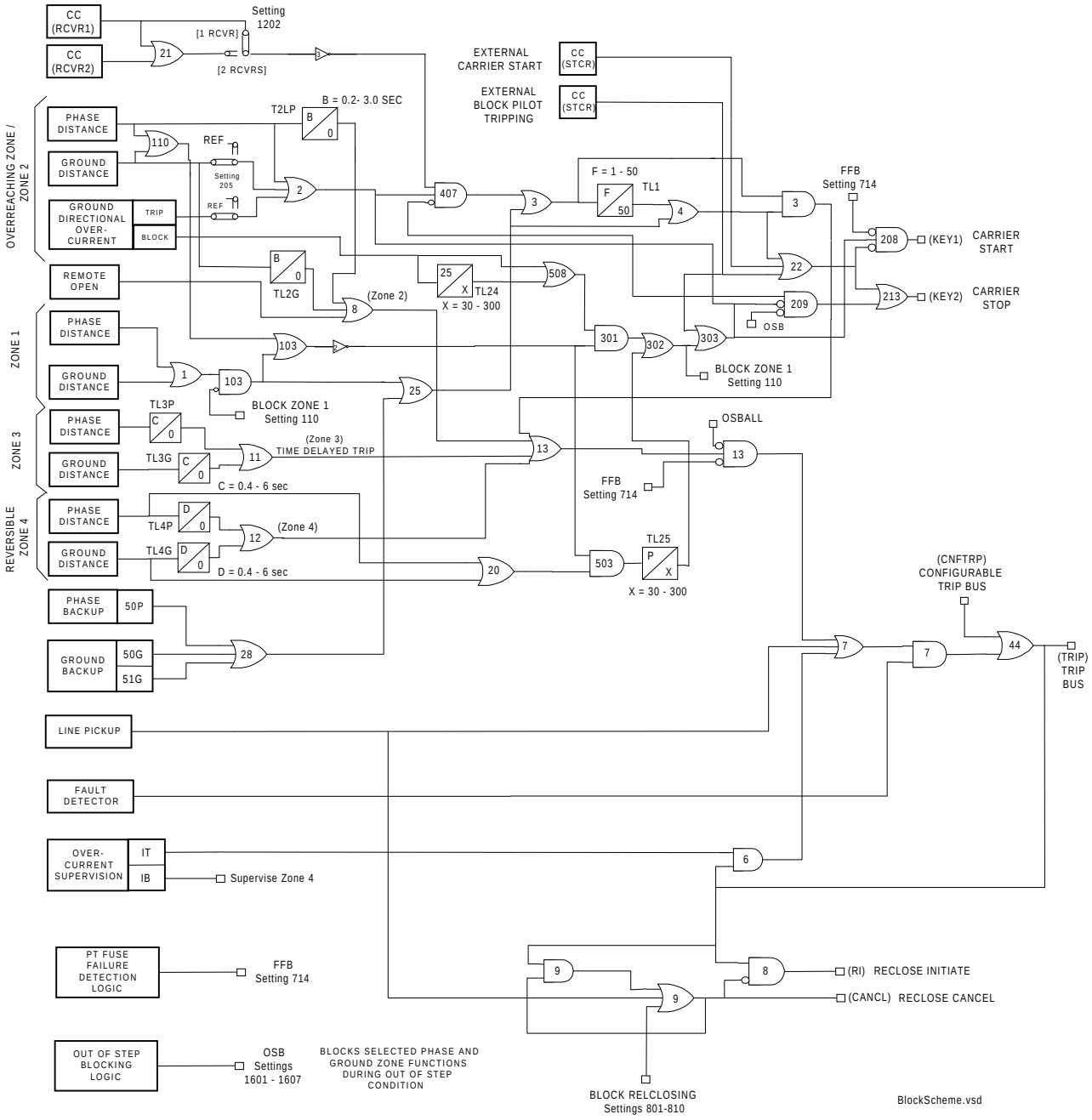


Figure 1–14: BLOCKING SCHEME LOGIC DIAGRAM

The ground-directional overcurrent (GDOC) transient blocking logic consists of TL24, OR508, AND301, and OR302. After an external fault, the GDOC blocking function starts the carrier and applies a blocking input to the comparator. If the external fault persists for 25 ms, TL24 produces an output. At this point the GDOC blocking function is set up with an extended dropout time so that the carrier is maintained and tripping is blocked at the comparator for at least 30 ms following the clearing of the external fault.

The ground-distance and phase-distance transient blocking logic consists of OR20, AND503, TL25, and OR302. It operates in a similar manner to the GDOC transient blocking logic. Thus, if any of the overreaching zone tripping functions operate as a result of a current reversal or a fault-clearing transient, tripping is initiated

because of the blocking output maintained by the blocking function(s). TL24 never picks up on internal ground faults. On internal phase faults, the tripping functions take priority over the blocking functions and prevent them from operating, or cause them to reset if an internal fault occurs following an initial external fault.

In a typical application with ON-OFF carrier sets, only one receiver is used at each terminal of the line, regardless of the number of line terminals. The contact converter (RCVR 1 in Figure 1–14: BLOCKING SCHEME LOGIC DIAGRAM on page 1–34) converts the receiver output into a blocking signal usable by the LPS-D.

Some blocking schemes use frequency-shift tone channels, such as the GE type NS40. For a three-terminal application employing FSK tones, each terminal has two receivers and an additional contact converter must be assigned. In the default settings, CC2 is used.

External contacts may be used to supervise the relay-channel interface. The EXTERNAL STOP CARRIER signal is assigned to contact converter CC3 in the default settings. EXTERNAL STOP CARRIER turns the local transmitter OFF. This feature is typically used when the remote breaker must trip to clear a fault following a breaker failure. An external contact closure, indicating a breaker failure, produces an output from CC3 that turns the transmitter OFF, permitting the remote end to trip.

The BLOCK PILOT TRIPPING signal is assigned to contact converter CC4 in the default settings. BLOCK PILOT TRIPPING disables the pilot scheme logic, while allowing the backup Zone 1, Zone 2, etc. to function. Typically, an external contact wired to CC4 is closed when the associated carrier set is removed from service to prevent overtripping on external faults.

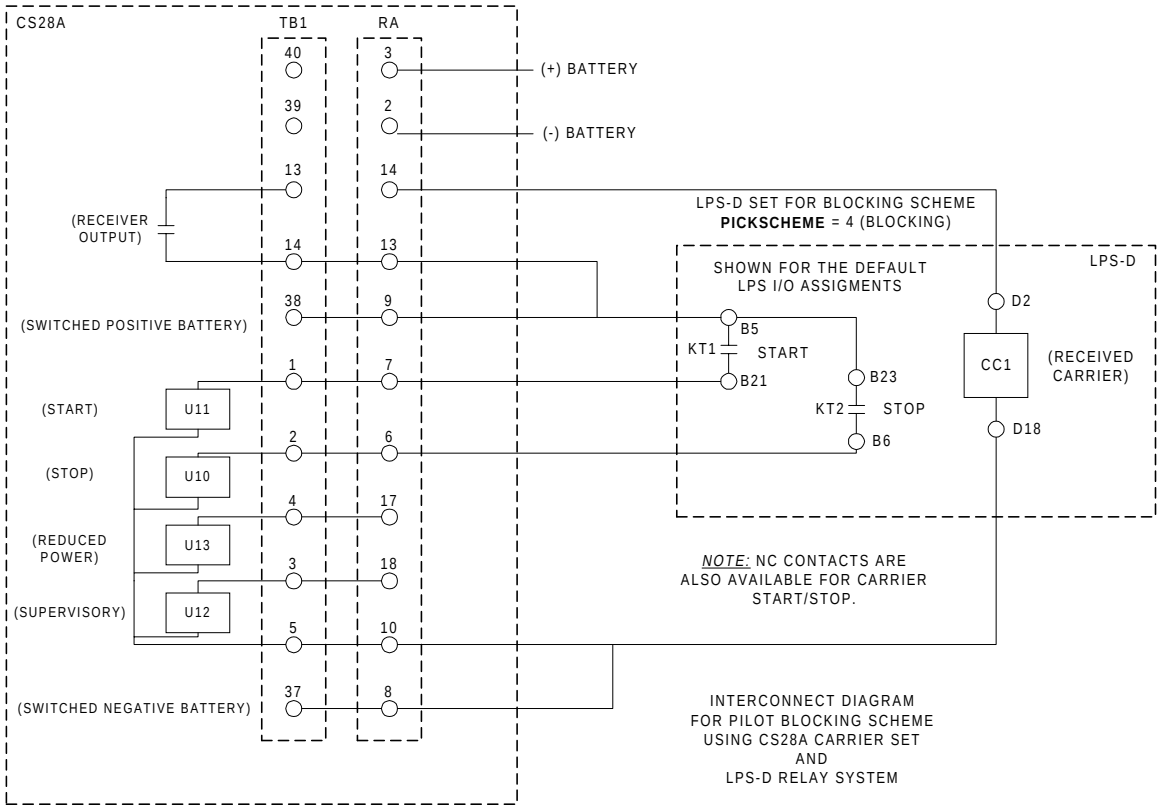


Figure 1–15: BLOCKING SCHEME INTERCONNECTION WITH CS28A

1.8.7 HYBRID SCHEME

Figure 1–17: HYBRID LOGIC DIAGRAM on page 1–37 is the logic diagram for the Hybrid scheme. A Hybrid scheme combines aspects of a tripping scheme with aspects of a blocking scheme, but it is perhaps easiest to explain as an enhanced POTT scheme.

A pure POTT scheme cannot trip any terminal of the protected line for an internal fault that produces little or no fault current at one terminal, such that the trip functions there do not operate. A Hybrid scheme incorporates an echo or repeat transmitter-keying circuit that permits the strong in-feed end(s) to trip. A weak in-feed trip circuit permits the weak in-feed end to trip almost simultaneously with the strong in-feed end.

A Hybrid scheme requires reverse-looking blocking functions to implement these enhancements and the same transient blocking logic used in a Blocking scheme. Like a POTT scheme, a Hybrid scheme generally uses a frequency-shift (FSK) channel.

When an internal fault produces sufficient fault current to operate the tripping functions at each terminal of the line, the Hybrid scheme operates exactly like the POTT1 scheme described earlier. When a weak- or zero-in-feed condition exists at one terminal, then the echo keying circuit is used to permit the strong in-feed terminal to trip. A selectable weak in-feed tripping circuit may be used to trip the weak in-feed terminal.

Assume that an internal fault on the protected line is not detected at a weak in-feed terminal. At the strong in-feed terminal(s), the transmitter is keyed to the trip frequency. At the weak in-feed terminal, the blocking functions have not operated and the receiver produces an output when it receives the trip frequency. This output is applied to timer TL11 and AND102 via OR101. AND102 produces an output until timer TL11 times out 80 ms after receipt of the trip signal. An AND102 output initiates keying of the transmitter via OR404 and AND204. Transmission (echo) of the trip signal then allows the strong terminal(s) to trip.

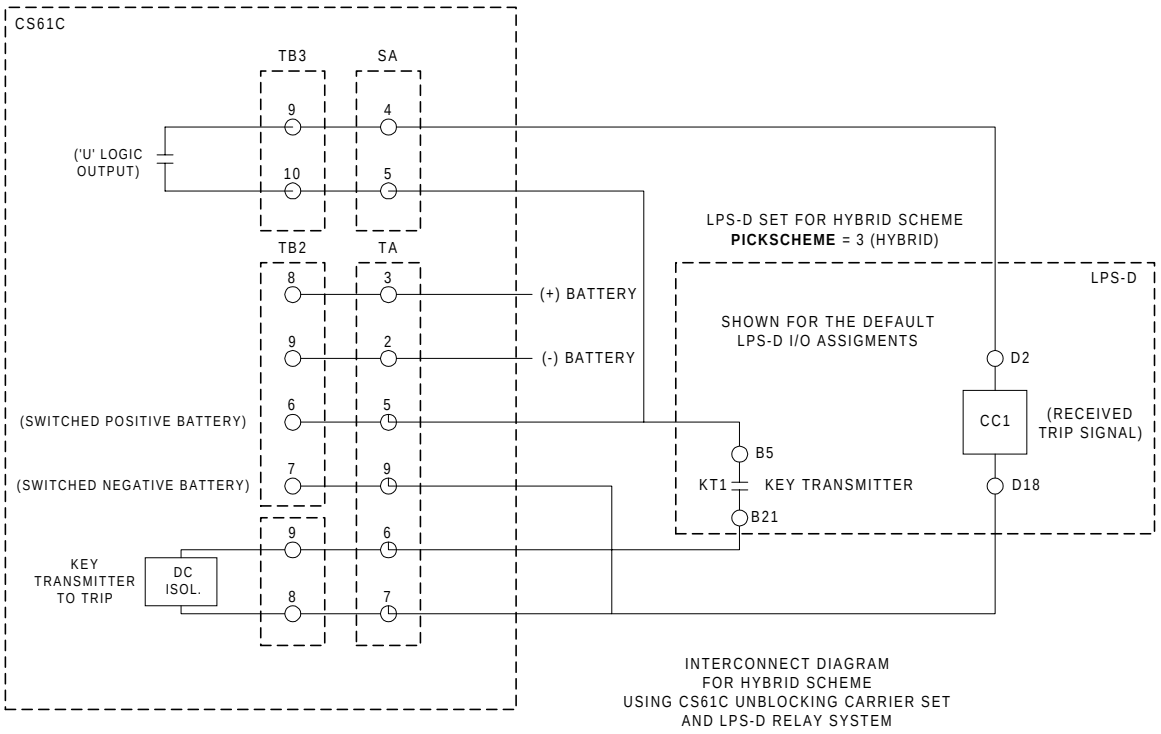


Figure 1–16: HYBRID SCHEME INTERCONNECTION WITH CS61C

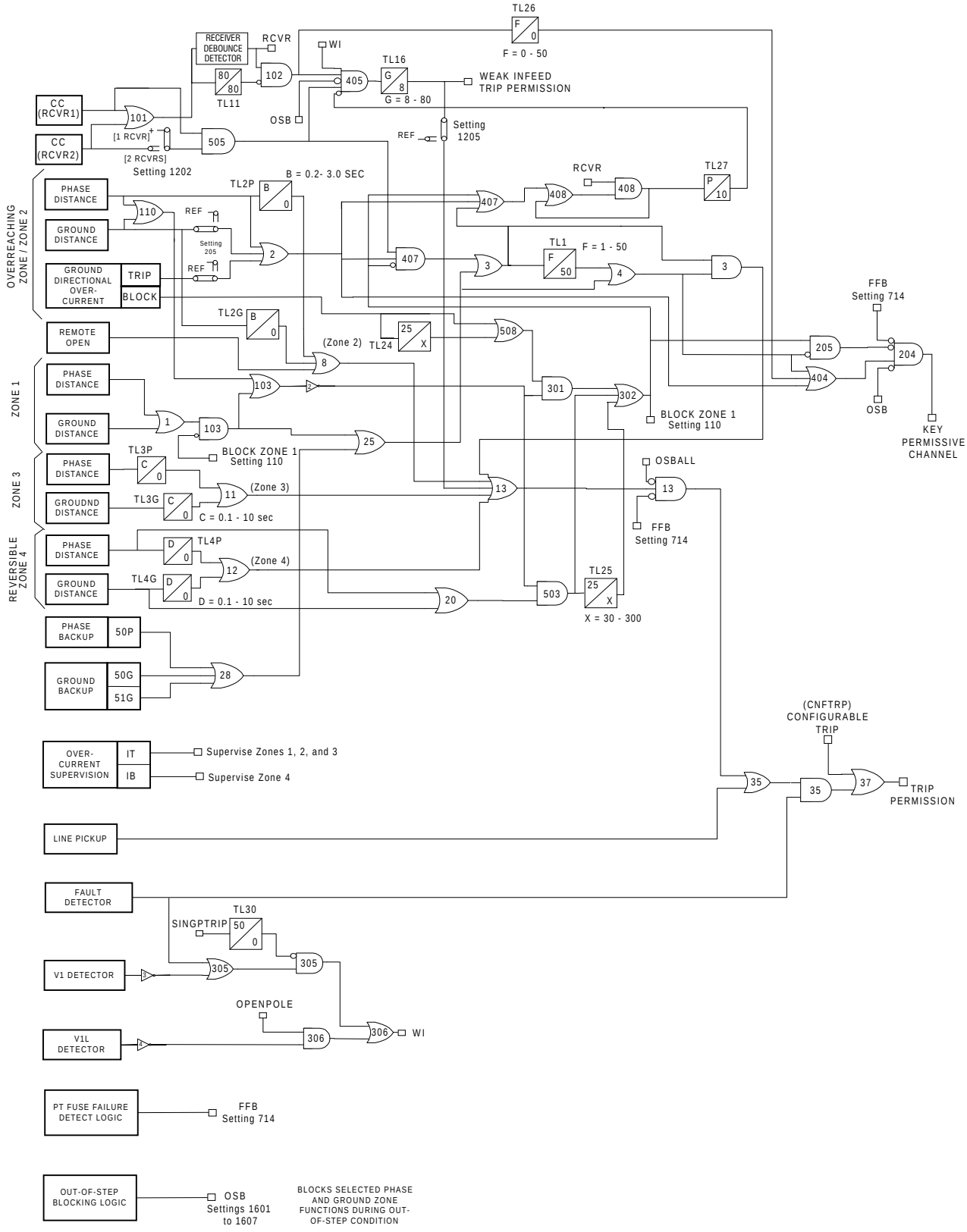


Figure 1–17: HYBRID LOGIC DIAGRAM

For three terminal line applications, the pickup time of TL11 is decreased from 80 to 50 ms and the dropout time of TL25 is increased from 30 to 60 ms to maintain security when an external fault is cleared quickly. These changes occur automatically when Protection Setting 1202: **NUMRCVR** (Number of Receivers) is set at 2, provided that Protection Setting 1201: **PICKSCHEME** is set for HYBRID.

The echo circuit plus OR305, OR306, AND305, AND306, TL27, AND405, and TL16 comprise the weak in-feed tripping circuit. For the same internal fault condition outlined in the previous paragraph, AND405 produces an output because of the following:

- The NOT input to AND405 is satisfied because there is no output from the blocking or tripping functions.
- There is an output from OR306, since either:

  a) FD has operated,

  b) V1 has dropped out.
- The other two inputs to AND405 are satisfied, since a trip signal is being received and timer TL11 has not timed out yet.

The output from AND406 energizes timer TL16, which produces a trip output when it times out. The adjustable time-delay pickup of timer TL16 is provided for security against any spurious receiver output that might occur during fault conditions supplied by NOT63.

Protection Setting 1205: **WKINFTRIP** (Select Weak Infeed Tripping) can be used to disable the Weak Infeed Tripping logic. If **WKINFTRIP** is set to NO, the weak infeed tripping logic is disabled, but the Channel Repeat (echo) logic is still in service to allow the strong end to trip as described previously.

1.8.8 OUT-OF-STEP OSCILLOGRAPHY CAPTURE

The Out-of-Step Blocking option also includes an Out of Step oscillography feature. The OS data file contains the real and imaginary components of the phase currents and voltages, sampled once per cycle for 180 cycles. 60 pre-trigger samples and 120 post-trigger samples are stored. Data is stored whenever an Out-of-Step Block (OSB) condition is detected. Only one OS data file is stored in the LPS-D. Once the data is captured, it will not be overwritten until it is retrieved from the LPS-D, or cleared by an OS data reset Action command.

This section applies to the LPS-D with Single Phase Tripping only.

NOTE

When used in a single phase tripping application, the LPS-D is designed so that only the faulted phase is tripped for a single line-to-ground fault, but all phases will be tripped for any multi-phase fault. To accomplish this goal, the LPS-D includes a faulted phase determination algorithm. This algorithm uses a combination of distance measuring functions and current-only faulted phase selection algorithms to select the fault type. The output of this algorithm, along with other logic, determines which trip outputs are energized for each fault. The trip output logic for the LPS-D is shown below for all logic schemes except the Hybrid; the trip output logic for the Hybrid scheme is shown in Figure 1–19: SINGLE PHASE TRIPPING LOGIC (HYBRID SCHEME).

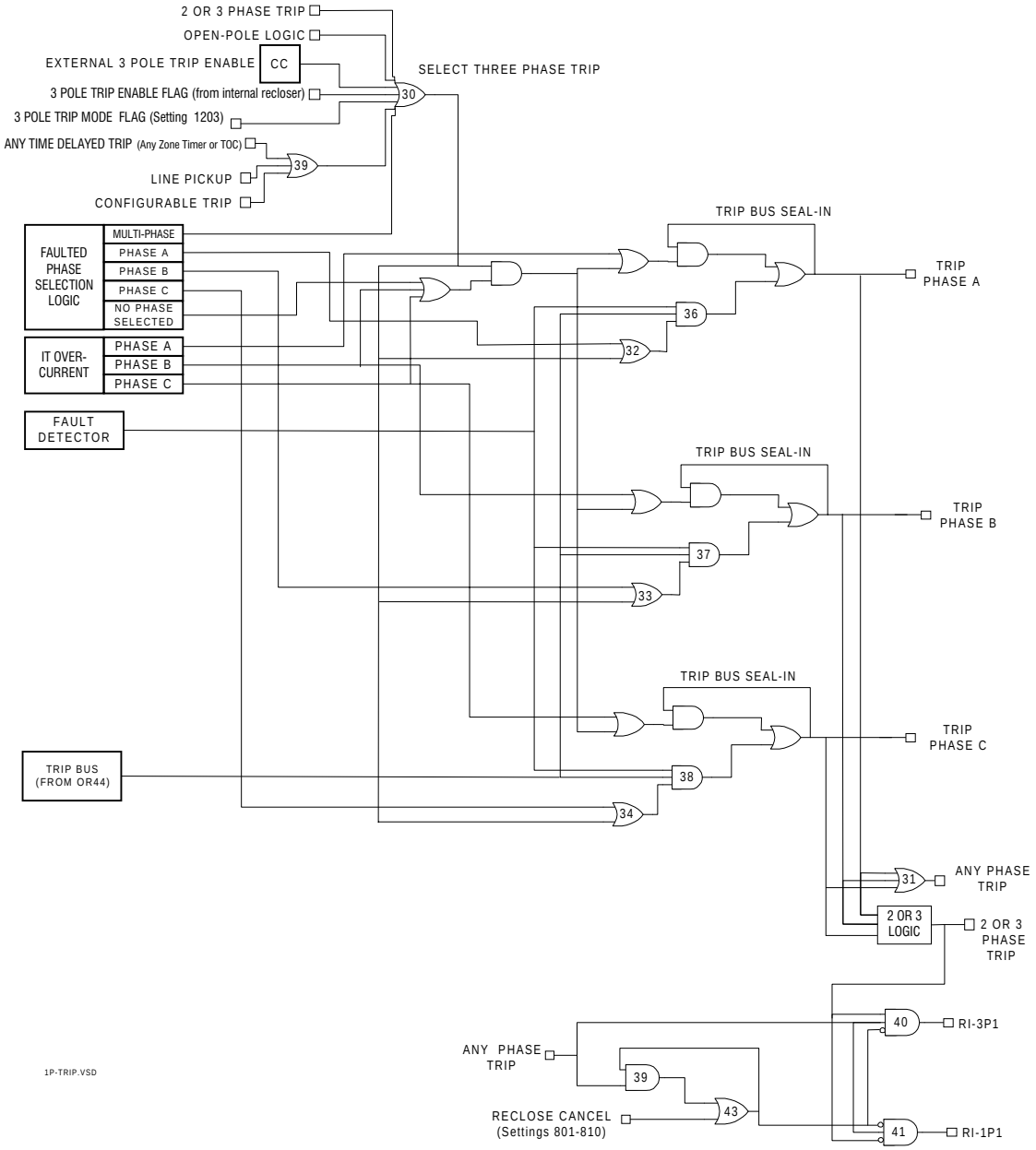


Figure 1–18: SINGLE-PHASE TRIPPING LOGIC (EXCEPT FOR HYBRID SCHEME)

In the Hybrid scheme trip output logic, the phase selection algorithm is supplemented with undervoltage detectors in the case of a weak infeed trip in which there is insufficient current to operate either the ground distance functions or the current-only phase selection function.

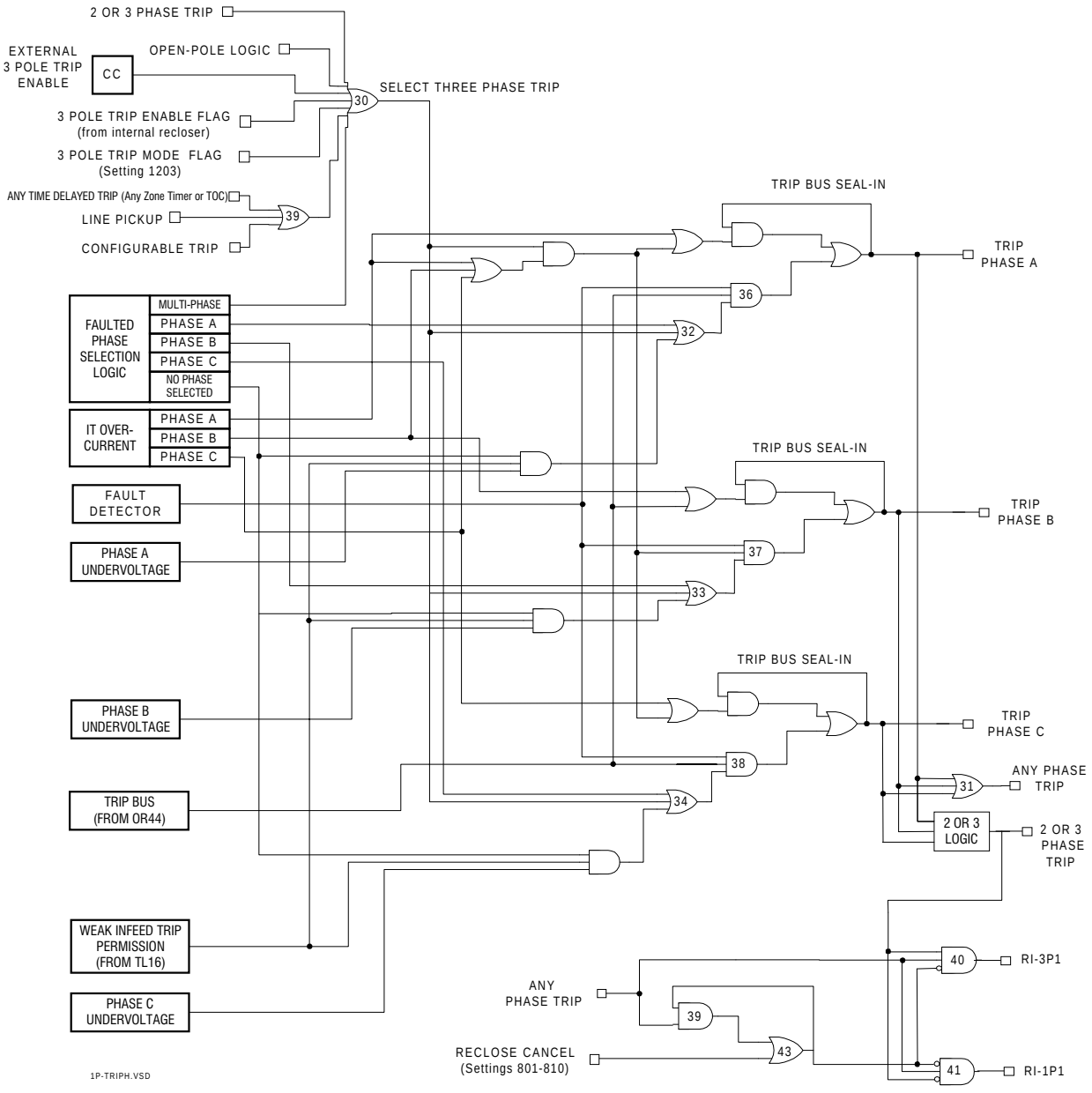


Figure 1–19: SINGLE PHASE TRIPPING LOGIC (HYBRID SCHEME)

1.9.2 OPEN POLE DETERMINATION

The LPS-D includes logic to detect when one or more poles of the circuit breaker is open. This logic is depicted in Figure 1–20: OPEN POLE DETECTION LOGIC. The logic uses a combination of current and voltage detectors and breaker auxiliary contacts. The breaker auxiliary contacts (52/b) are not required for the relay to function correctly. The Open Pole logic detects when any pole is open, when only one pole is open, and when all three poles are open.

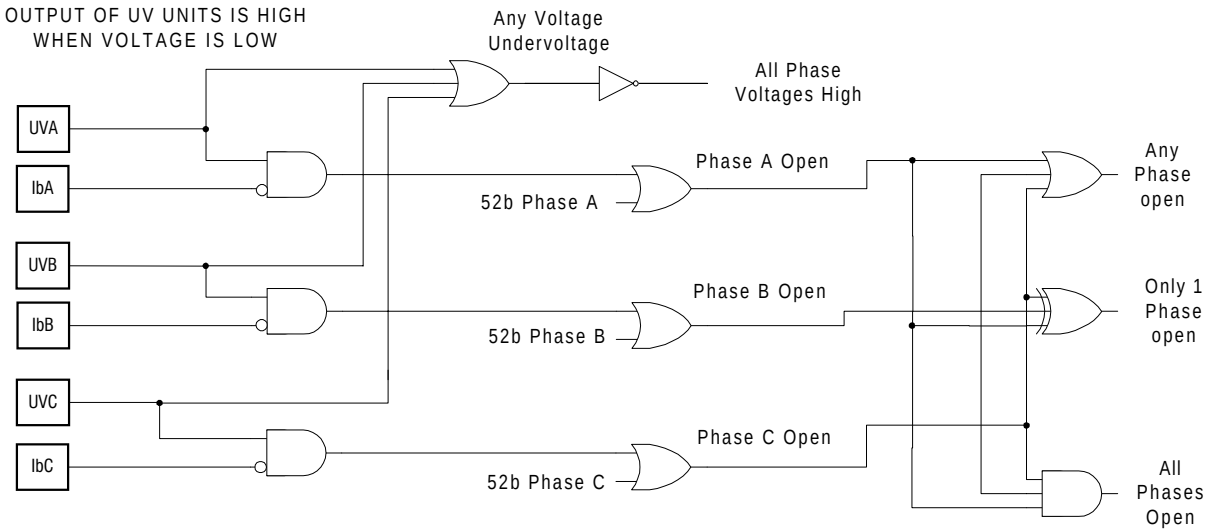


Figure 1–20: OPEN POLE DETECTION LOGIC

1.9.3 OPEN POLE OPERATION

The functional logic diagrams do not depict all the logical interactions that occur in the software algorithms during the period that one pole is open. Two software flags and two associated masks control the operation during an open-pole period. The single-phase-trip flag, SINGPTRIP, is set when the LPS-D issues a single-phase trip. The open-pole flag, OPENPOLE, is set when the pole-disagreement logic detects that one pole is open.

A primary function of SINGPTRIP is to disable all the phase-distance function phase pairs that are involved with the open pole. If pole A is open, then SINGPTRIP disables phase pairs A-B and C-A but allows phase-pair B-C to remain in service for all zones of protection. This prevents inadvertent operation of the A-B and C-A distance functions during the time that pole A is open when line-side potential is used. The SINGPTRIP mask disables the ground-distance functions associated with the open pole.

The OPENPOLE flag is shown on all the functional logic diagrams as one input to OR30. This indicates that once the OPENPOLE flag is set, any subsequent fault will cause a three-phase trip regardless of the fault type. The Fault Detector (FD) measurement is modified when the OPENPOLE flag is set. With all poles closed, FD operates on the magnitude of I_2 and I_0, as well as the change in I_1, I_2, and I_0. When the OPENPOLE flag is set, FD operates on the change in the three sequence currents but does not operate on the magnitude of I_2 and I_0, since an open pole will produce some steady-state level of I_2 and I_0.

The Potential Transformer Fuse Failure Detection function (FFB on the logic diagrams). For a Hybrid scheme, the weak-infeed logic is modified as shown in Figure 1–19: SINGLE PHASE TRIPPING LOGIC (HYBRID SCHEME) on page 1–40 and described above. The operation of the Out-of-Step Blocking logic is modified as explained below. If the ground directional overcurrent functions are used as part of a pilot scheme, they are disabled. The ground backup overcurrent functions, 50G and 51G, are disabled.

As indicated on the logic diagrams, the Phase Selector function indicates the faulted phase for single-phase-to-ground faults and produces a multi-phase output for all other fault types. Tripping for the initial fault is the faulted phase for single-phase-to-ground faults and all three phases for multiphase faults. Subsequent faults during the open-pole period are tripped three-phase regardless of fault type.

1.9.4 RECLOSE CONTROL

The LPS-D includes two Reclose Initiation outputs. RI-1P picks up when the LPS-D selects to trip only one of the three phase trip outputs. RI-3P picks up whenever the LPS-D selects to trip all three poles of the breaker.

1.10.1 DESCRIPTION

The optional recloser can be used with the LPS-D alone, separately with an external relay system, or it can be used simultaneously with the LPS-D and an external relay system. It can be used in single-pole or three-pole tripping applications to provide up to 4 reclose attempts. When used in single-pole tripping and reclosing applications, the recloser requires the following inputs from the associated relays system(s):

1. A single-pole reclose input (1PRI) following tripping for single-line-to-ground faults
2. A three-pole reclose input (3PRI) following tripping for multi-phase faults.

The LPS-D produces these inputs internally. The external relay system, if used, must be capable of producing the 1PRI and 3PRI signals as contact outputs for use as inputs into the recloser.

1.10.2 RECLOSING MODE

The recloser can be set to operate in one of the following modes (Protection Setting 1801: **RECLMODE**):

1. NONE: No reclosing is selected. The three-pole trip enable signal (see outputs) will not be set up at this time. This mode should be selected when the LPS-D recloser is not used.
2. INTERNAL: Reclosing will be controlled by the LPS-D relay only. No external inputs will be recognized.
3. EXTERNAL: Reclosing will be controlled by external inputs (from other relays/systems) only. Inputs from the LPS-D will be ignored.
4. BOTH: Reclosing will be controlled by signals from the LPS-D as well as from external inputs (other relays/systems).
5. OFF: No reclosing, either by internal or external control, is allowed. The three-pole trip enable output (see outputs) will be set up at this time. This mode should be selected when automatic reclosing is disabled.

1.10.3 RECLOSING PROGRAMS

When reclosing is selected, the recloser can be set to operate in one of the following programs (Protection Setting 1802: **RECLTYPE**):

1. **1POLE**. In this mode of operation, up to four reclosing attempts can be made following an initial single phase trip; there will be no reclosing following an initial three phase trip. The first reclosing attempt requires a 1PRI input, thus indicating that single-pole tripping was initiated. Each subsequent reclose (if used) requires a 3PRI signal. Following the initial single-pole reclose, a three-pole trip enable signal is issued so that if a fault is closed into, the relay system(s) will initiate three-pole tripping of the breaker regardless of the fault type. This three-pole trip enable signal is issued internally to the LPS-D, but it must be programmed to drive one of the output relays for use with an external relay system, if such a relay system is used with the recloser. Four separate timers are provided so that each of the reclosing attempts can be set with a different time if required. For proper operation of the recloser in the 1POLE program, the LPS-D must be programmed for single phase tripping (Protection Setting 1203: **TRIPMODE** = 1POL or 1POLZ2).
2. **3POLE**. In this mode of operation, up to four reclosing attempts (all three-pole) can be made following an initial three phase trip; there will be no reclosing following an initial single phase trip. Each reclosing attempt requires a 3PRI signal that indicates three-pole tripping was initiated. In this mode, the three-pole trip enable signal will be issued at all times, so that the relays will issue a three-pole trip signal to trip all three poles of the breaker regardless of the fault type. This three-pole trip enable signal is issued internally to the LPS-D system, but it must be programmed to drive one of the output relays for use with an external relay system, if such a relay system is used with the recloser. Four separate timers are provided so that each of the four reclosing attempts can be set with a different time if required. For proper operation of the recloser in the 3POLE program, the LPS-D must be programmed for three phase tripping (Protection Setting 1203: **TRIPMODE** = 3POL).

3. **1POLE3POLE** - If this mode of operation is selected, the recloser will operate as follows:

   a) The program described under the 1POLE mode of operation will be followed if a single-pole reclose initiate (1PRI) signal is received by the recloser thus indicating that a single-pole trip occurred.

   b) The program described under the 3POLE mode of operation will be followed if a three-pole reclose initiate (3PRI) signal is received by the recloser thus indicating that a three-pole trip has occurred.

NOTE

The recloser settings (Protection Setting 1801: **RECLTYPE**) and the relay settings (Protection Setting 1203: **TRIPMODE**) must be compatible. Thus, if the LPS-D is set for single-pole tripping, then the recloser must be set to 1POLE if single-pole reclosing only is to be used, or it must be set to 1POLE3POLE if both modes of reclosing are to be used. If the LPS-D is set for single-pole tripping and the recloser is set to 3POLE, then the recloser will issue the three-pole trip enable signal to tell the LPS-D to trip three-pole regardless of the fault type, and the recloser will be immediately sent to lockout following any trip. If the LPS-D is set for three-pole tripping and the recloser is set to the 1POLE type, then the recloser will go to lockout following any trip, regardless of the fault type.

One to four reclose attempts may be selected for each of the reclosing modes. For 1POLE3POLE, the number of 1POLE and 3POLE reclose attempts may be set independently. Each of the reclose attempts has an independent time delay setting with a range of 0.1 to 300.0 seconds. The reclose delay time begins when the recloser receives either a single pole reclose initiate signal (1PRI), or a three pole reclose initiate signal (3PRI).

The reset time setting (Protection Setting 1813: **RESSETTIME**; range: 0.1 to 300 seconds) establishes the time that the recloser will wait before going to reset following:

- *Programmed reclose attempt*. If there are no faults following any of the programmed reclosures, then the recloser will go to the reset state at the end of the reset time delay. If a fault is closed into or occurs during the reset time and there is a subsequent reclosure programmed, then the recloser will produce an output to reclose the breaker following the time delay associated with the next programmed reclose. If a fault is closed into or occurs during the reset time following the last programmed reclose attempt, then the recloser will go immediately to lockout.
- *Manual close*. With this operation, the recloser starts from the lockout state, therefore, if a fault is closed into or occurs during the reset time, then the recloser will remain in the lockout state. If there are no faults, then the recloser will go to the reset state at the end of the reset time delay.

The dwell time setting (Protection Setting 1814: **DWELLTIME**; range: 0.1 to 2.0 seconds) establishes the time that the close contacts will remain closed when a reclose is called for by the recloser.

1.10.4 RECLOSER INPUTS

a) BREAKER STATUS

In order to function properly, the recloser requires breaker “b” auxiliary switches to determine whether the breaker is in the open or closed position. Because all of the inputs to the LPS-D are programmable it is necessary that the correct number of contact converter(s) be programmed for use as the breaker “b” switch inputs. In three-pole tripping schemes, only one “b” switch input is required, therefore only one contact converter need be programmed for that input. In single-pole tripping schemes, three “b” switch inputs are required (one for each phase) therefore three contact converters must be programmed for those inputs.

b) SINGLE POLE RECLOSE INITIATE (1PRI)

The 1PRI input starts the single-pole reclosing mode. The LPS-D provides this input directly to the recloser. If the recloser is set to operate for EXTERNAL or BOTH, then one of the contact converter inputs must be programmed to accept this 1PRI input, and the external relaying system must be capable of supplying it.

c) THREE POLE RECLOSE INITIATE (3PRI)

The 3PRI input starts the three-pole reclosing mode of operation. The LPS-D will provide this input directly to the recloser. If the recloser is set to operate for EXTERNAL or BOTH, then one of the contact converter inputs must be programmed to accept this 3PRI input, and the external relay system must be capable of supplying it.

d) HOLD

The hold input controls the reclose output when the hold feature is selected (Protection Setting 1815: **HOLD** = YES). This feature allows an external contact to supervise the close output of the LPS-D recloser. When the Hold feature is selected the recloser waits a preset time for a hold input (Protection Setting 1816: **HOLDTIME**, range: 1 to 1000 sec.) at the end of a programmed reclose time. If the hold input is applied during this time delay, then the reclose contacts operate to initiate closing of the breaker. If the hold input is not applied during the hold time delay, then the recloser will go to lockout when the hold time ends. The hold input can be programmed to accept either a normally closed or a normally open contact. If a normally closed contact is used, then the hold time will only start when a reclose is called for if the contact is open and will only be stopped to allow reclosing when contact closes. Note that if the hold input contact is closed when a reclose is called for, then reclosing will be initiated immediately (there will be no hold time). Conversely, if a normally open contact is used, then the hold time will only start when a reclose is called for if the contact is closed and will only be stopped to allow reclosing when the contact opens. Note that if the hold input contact is open when a reclose is called for, then reclosing will be initiated immediately (there will be no hold time). Note that when the hold feature is selected (**HOLD** = YES), that it applies to all selected reclosures.

e) RECLOSE CANCEL

The reclose cancel signal produces different effects depending on the recloser state when this signal goes ON.

- In Reset, the recloser disregards any reclose initiate while Reclose Cancel is ON and stays in Reset.
- During a reclose cycle, Reclose Cancel sends the recloser to Lockout.
- During the **DWELLTIME**, reclose cancel waits until the dwell time has elapsed and the close relay has reset and then sends the recloser to Lockout.
- In Lockout, the Reclose Cancel signal has no effect.

To use this feature one of the contact converters must be programmed to accept the reclose cancel input.

f) LOCKOUT

The lockout input will immediately send the recloser to the lockout state. The recloser will remain in the lockout state as long as the lockout input is present. When the lockout input is removed the recloser will:

1. Go to the reset state if the breaker is closed.
2. Remain in the lockout state if the breaker is open.

If this feature is used, then one of the contact converters must be programmed to accept the lockout input.

g) RESET

The reset input attempts to send the recloser from Lockout to Reset without counting the reset time. It will take the recloser out of lockout if the breaker is closed (as indicated by the “b” switch status) but will be ignored and keep the recloser in lockout if the breaker is open.

If this feature is to be used, then one of the contact converters must be programmed to accept the reset input.

1.10.5 RECLOSER OUTPUTS

All the outputs provided by the recloser are programmable. Therefore, if any of these outputs are to be used externally, it must be insured that an appropriate output relay is assigned to each of the used outputs. Assignment can be made through ALPS-Link, Xpression Builder, or the keyboard. The following outputs are provided:

a) CLOSE

The close output controls reclosing of the breaker. The dwell time setting (Protection Setting 1814: **DWELLTIME**) controls the time that the output contacts remain closed following a close command from the recloser.

b) THREE POLE TRIP ENABLE

This output is enabled whenever a reclose cycle is started and maintained until the recloser resets. If the recloser goes to lockout following an unsuccessful reclose cycle, then the three-pole trip enable output is maintained. If the recloser goes to lockout for any other reason, the three-pole trip enable output is set at that time. The three-pole trip enable output is maintained as long as the recloser stays in the lockout mode.

The three-pole trip enable output is also produced when **RECLTYPE** = 3POLE or when the recloser is turned off (Protection Setting 1801: **RECLMODE** = OFF).

This output is internally routed to the LPS-D and is used to ensure that three-pole tripping will be initiated for all faults (regardless of fault type) as long as the three-pole trip enable output is maintained. If the recloser is used externally with another relay system, then the NOT of the three-pole trip enable output must be programmed (as shown in Figure 1–21: THREE POLE TRIP ENABLE OUTPUT) to drive a form “b” contact, so that the contact will be closed whenever the three-pole trip enable output is produced, and will otherwise remain open.

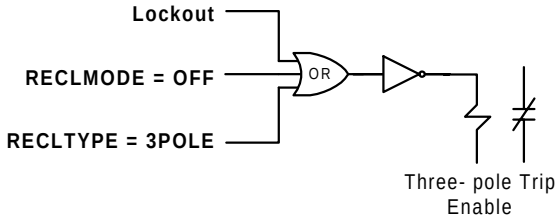


Figure 1–21: THREE POLE TRIP ENABLE OUTPUT

A form “b” contact is required so that it will close and remain closed during the time that the recloser is in lockout, when three-pole tripping is required. Similarly, the contact will also be closed when the recloser is turned **OFF** or if power is lost to the recloser, both situations in which three-pole tripping is also required.

c) RECLOSE IN PROGRESS (RIP)

This output is produced whenever a reclosing cycle is started and it will reset when the recloser goes to reset if reclosing is successful, or to lockout if reclosing is unsuccessful.

d) LOCKOUT

This output will be produced whenever the recloser is in the lockout state.

1.10.6 SYNCHRONISM CHECK (OPTIONAL)

An optional synchronism check function is available for use with the recloser function. The function provides synchronism check and/or voltage supervision of any or all three-pole reclosures. Protection Setting 1818: **SYNCCHECK** (range: YES or NO) establishes whether the synchronism check function is to be used.

The synchronism check function requires voltage inputs from both the BUS and LINE side of the circuit breaker. The LPS-D relay requires three phase potential for proper operation of its protective functions; this three phase voltage may be supplied from either the bus or the line. In addition to this three phase potential, the synchronism check function requires a single phase voltage from the other side of the breaker. This single phase voltage may be VA, VB, VC, VAB, VBC or VCA.

Protection Setting 1821: **BUSLINE** (range: BUS, LINE) tells the recloser where the three-phase voltage used by the relay system is located, bus or line. Protection Setting 1822: **SYNCPHASE** (range: VA, VB, VC, VAB, VBC, VCA) establishes which phase or phase pair is used to make the angle and voltage check measurements.

In addition to the synchronism check supervision, this option includes voltage supervision. The three voltage supervision modes are:

- LBUSDLINE (live bus dead line)
- DBUSLLINE (dead bus live line)
- DBUSDLINE (dead bus dead line)

Four voltage Protection Settings (1832: **VBUSLIVE**, 1833: **VBUSDEAD**, 1834: **VLINELIVE**, and 1835: **VLINEDEAD**) are required for the synchronism check function to establish live and dead voltage levels for the bus and line potential. Each of these levels has a range 0.1 to 130 V. The live voltage setting for the line and bus also establish the minimum voltage that must be present before the synchronism check functions are allowed to operate.

Protection Setting 1819: **CLOSEANG** (range: 0 to 75°) establishes the angle that the BUS and LINE voltages must be within before reclosing will be permitted. In addition, the slip frequency between the BUS and LINE voltages must be less than Protection Setting 1820: **SLIPFREQ** (range: 0.1 to 5 Hz), and both criteria must be satisfied within the time specified by Protection Setting 1823: **SYNCHOLD** (range: 1 to 100 seconds). If the closing angle and slip frequency requirements are not met before the **SYNCHOLD** time ends, then the recloser will go to lockout.

The synchronism check function also measures the difference in magnitude between the bus voltage and the line voltage. If the delta voltage supervision is desired, Protection Setting 1840: **DELTAVBLK** is set to YES**.** Protection Setting 1839: **DELTAV** (range: 0.1 to 30 V) establishes the maximum difference for which reclosing is allowed. If the voltage difference is greater than the **DELTAV** setting, then reclosing will be blocked even if the bus and line voltages are within the angle established by the **CLOSEANG** setting.

- *SYNCHRONISM CHECK INPUTS* - The only additional input required to run the synchronism check function is the single-phase voltage input. No contact inputs are required.
- *SYNCHRONISM CHECK OUTPUTS* - The only output produced by the synch check function is the synchronism check/voltage check permission output. This output is run directly to the internal recloser to supervise reclosing. The output is also programmable, therefore, if an external synch check signal is required. it may be programmed to drive one (or more) of the output contacts in the LPS-D either through the ALPS-Link or Xpression Builder programs or through the keypad.

1.10.7 LPS-D RECLOSING PROGRAM SUMMARY

TRIPMODE (Prot. Setting 1203)	RECLTYPE (Prot. Setting 1802)	INITIAL TRIP TYPE	PROGRAM
1POLZ / 1POLZ2	1POLE	Single phase	Up to 4 reclose attempts using 1P delays
		Three Phase	Lockout
3POL	1POLE	Any trip	Lockout
3POL	3POLE	Any trip	Up to 4 reclose attempts using 3P delays
1POL / 1POLZ2	3POLE	Any trip	Lockout
1POL / 1POLZW	1POLE3POLE	Single phase	Up to 4 reclose attempts using 1P delays
		Three phase	Up to 4 reclose attempts using 3P delays
3POL	1POLE3POLE	Single phase	Up to 4 reclose attempts using 1P delays
		Three phase	Up to 4 reclose attempts using 3P delays

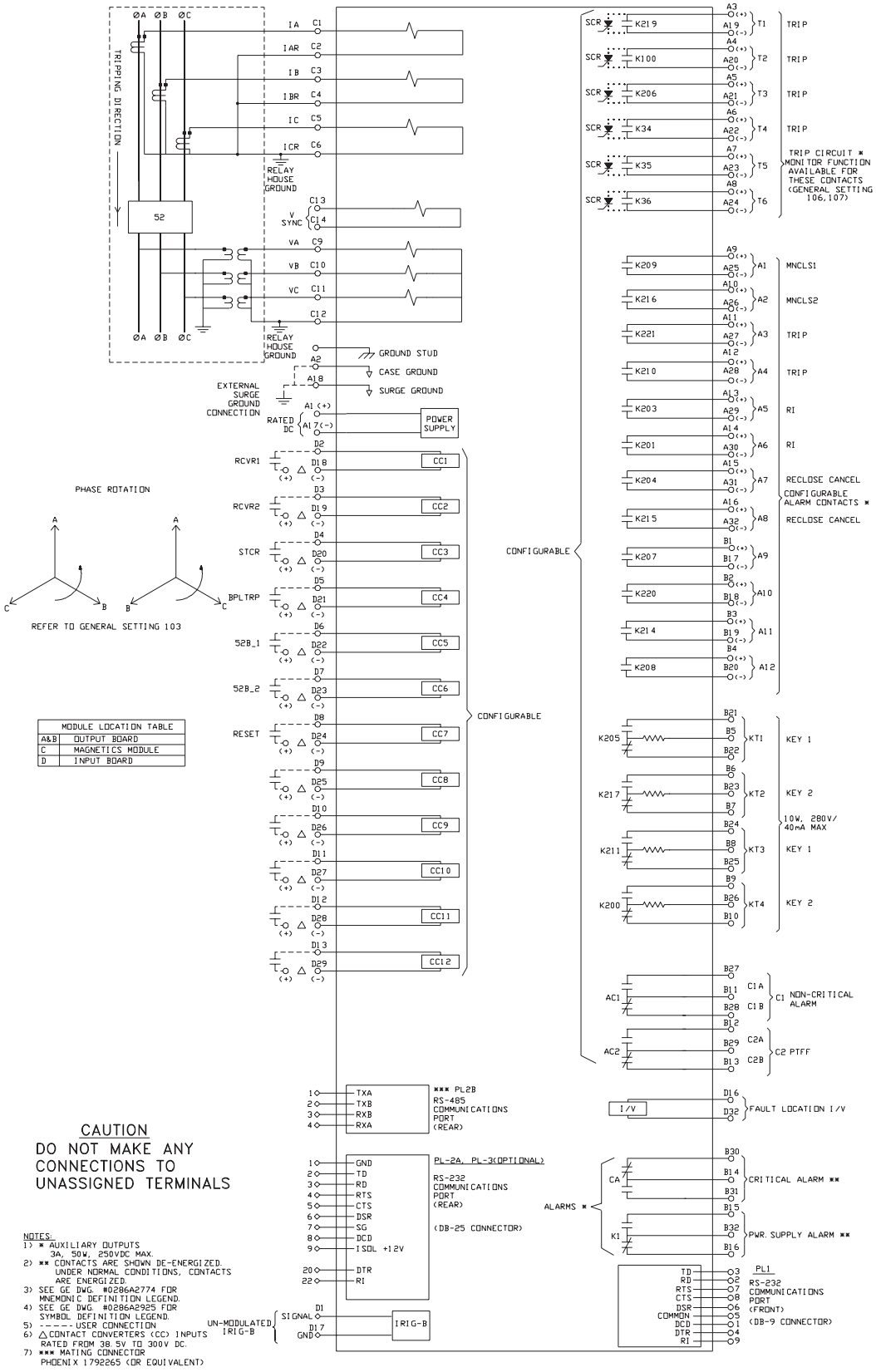


Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS

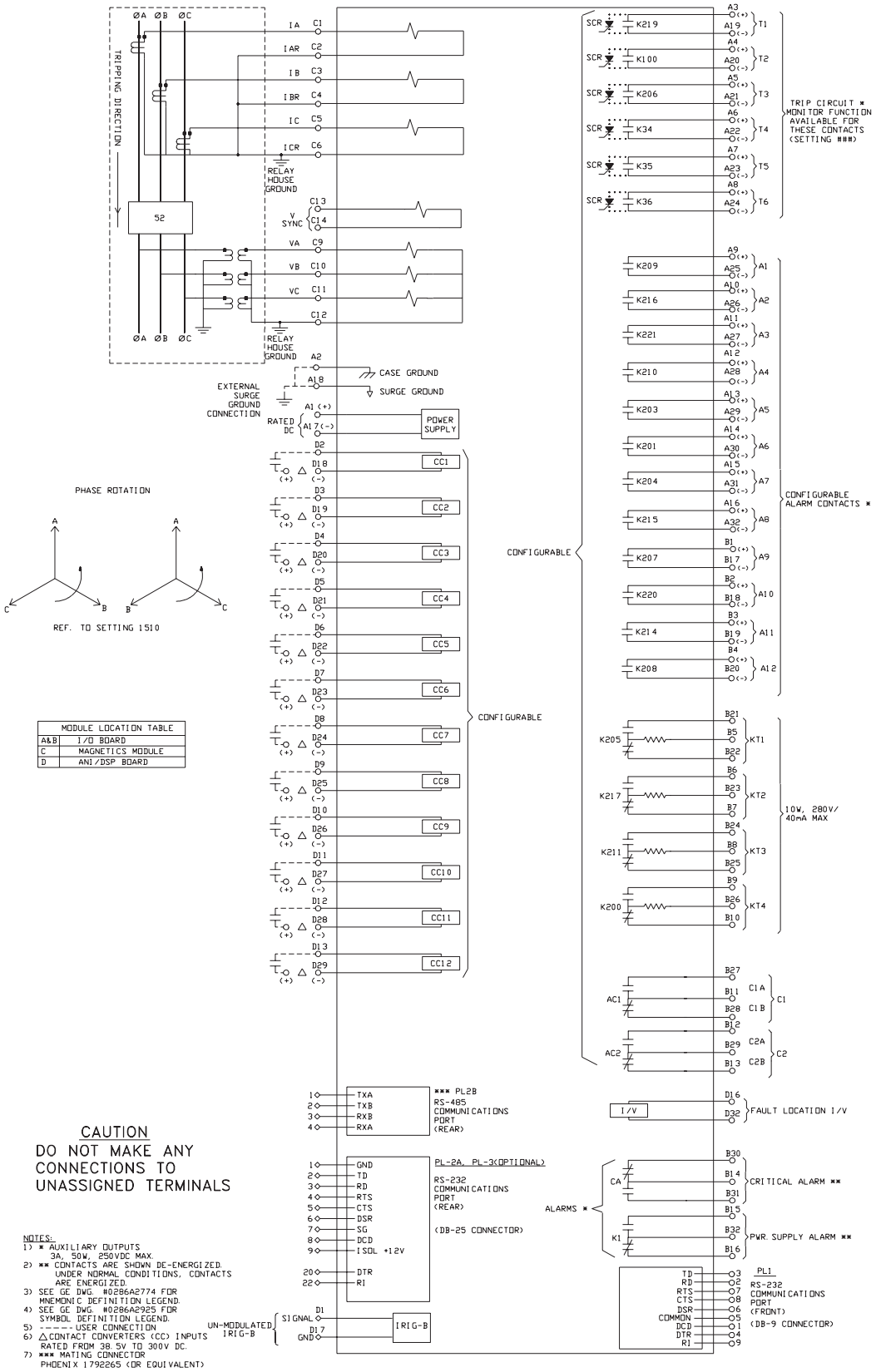


Figure 1–23: ELEMENTARY DIAGRAM

2.1.1 DESCRIPTION

There are a number of settings that must be made in the LPS-D relaying system. These settings are divided into two categories, with each category divided into the sub-groups shown below:

a) GENERAL SETTINGS CATEGORIES

- CONFIGURATION
- COMMUNICATIONS
- OSCILLOGRAPHY
- EQUIPMENT DUTY
- PROGRAMMABLE INPUTS

b) PROTECTION SETTINGS CATEGORIES

- Z1DISTANCE
- Z2DISTANCE
- Z3DISTANCE
- Z4DISTANCE
- CURSUPVISN
- OVERCURRNT
- VOLTAGE
- BLK RECLOS
- LINEPICKUP
- REMOTEOPEN
- LINEOVERLD
- SCHEME
- SCHEMETIMERS
- LINE INFO
- SCADA_DTA
- OS BLOCKING
- RECLOSER
- NONCRIT_AL
- OUTPUTS

The sub-categories (defined by their mnemonic) are given in the order that they appear when scrolled in the display provided on the front of the LPS-D.

Up to four separate and distinct **Protection Settings** Groups can be programmed and stored in the LPS-D. Selection of the settings group to be used can be made via the keypad, through the communications link or through external contacts applied to selected programmable inputs.

The **General Settings** category applies to all schemes and all settings groups regardless of which Settings Group is selected.

The **General Settings** category will be discussed first, followed by the **Protection Settings** category. Scheme specific requirements (when applicable to a particular setting) will be discussed when that setting is described. A blank settings form is provided at the end of this section, which may be copied and used to record the settings for any application.

All of the settings used in the LPS-D are listed in Table 2–8: PROTECTION SETTINGS GUIDE on page 2–61 and Table 2–9: GENERAL SETTINGS GUIDE on page 2–70. These tables also show setting ranges for 5 Ampere and 1 Ampere rated systems. Note that each specific setting in a subgroup has a distinctly assigned number in addition to a unique mnemonic. These identification numbers can be used to facilitate entering or changing a setting via the keypad or through the ALPS-Link communications program provided with the GE Power Management Products CD.

NOTE

All settings must be entered in secondary values (ohms, amperes, volts) unless per unit (p.u.) or other values are called for.

This calculation of settings section can be used to determine and calculate the settings for a particular application. Two methods can be followed:

1. Go through this section, setting-by-setting, and manually record each setting in the blank forms provided (see Section 2.5.4: PROTECTION SETTINGS DATA SHEETS on page 2–73 and Section 2.5.5: GENERAL SETTINGS DATA SHEET on page 2–82). Once the form is completed, enter the settings individually via the keypad located on the front of the LPS-D or through the ASCII communications port (a long and laborious process and not recommended). Alternatively, use the ALPS-Link communications program to access and modify an existing settings file (a sample settings file is included with the LPS-D software). This file can then be downloaded to the LPS-D and saved for possible modification in the future.
2. Use the ALPS-SET setting program (the easiest method when first starting). This program goes through each category setting by setting and allows specific settings to be determined and stored into a file which may then be saved and downloaded to the LPS-D via the ALPS-Link program. This file will then be available for future modification if required.

101: UNITID - Unit ID Number

The **UNITID** is a decimal number between 0 and 9999 that uniquely identifies an LPS-D relay. When the LPS-D is accessed via one of the serial ports the **UNITID** must be known to establish communication, thus providing an additional measure of security. **UNITID** can only be changed via the keypad. It is not possible to change **UNITID** with the ALPS-Link communications program.

102: SYSFREQ - System Frequency

SYSFREQ establishes the operating frequency of the LPS-D. It can be set to either 50 Hz or 60 Hz. When this setting is changed it will only be implemented by turning the DC power off and then on to re-initialize the relay.

103: PHASRROTATE - Phase Rotation

PHASRROTATE can be set to ABC or ACB to match the positive-sequence phase rotation for the power system where the LPS-D is installed. This setting permits proper reporting the faulted phase or phase pair.

104: TIMESYNCH - Select Time Synchronization

TIMESYNCH determines the method of synchronizing the LPS-D internal clock; it can be set to 0 (INTERNAL) or 1 (IRIG-B). **TIMESYNCH** = 0 lets the clock run freely from the internal oscillator. **TIMESYNCH** = 1 synchronizes the clock using an IRIG-B signal connected directly to the LPS-D via the assigned port.

105: NUM_BKR - Number of Breakers

NUM_BKR can be set to either 1 or 2. When set to 1, the TRIP and CLOSE commands can only be used to activate the BREAKER 1 trip and close outputs. When set to 2, the TRIP and CLOSE commands can selectively be used to activate either the BREAKER 1 or BREAKER 2 outputs. When a POTT or PUTT scheme is selected, this setting also determines whether 52/b contacts from one breaker or two breakers are used to key the transmitter with the breaker(s) open.

106: NUM_TC - Number of Trip Circuits

The LPS-D has 6 high-speed (SCR or relay contact) trip outputs available, labeled T1 to T6. Assignment of trip outputs is made via the **NUM_TC** setting and is directly coupled to General Setting 105: **NUM_BKR**.

With the Single Phase Tripping model, all six outputs (T1 to T6) are available and are assigned per the **NUM_TC** setting as shown below in Table 2–1: NUM_TC SETTING (SINGLE PHASE MODELS). In this case, outputs T4 to T6 are available for assignment through Xpression Builder only when one breaker with one set of trip coils is being controlled (**NUM_TC** = 1).

With the Three Phase Tripping model, four of the six outputs (T1 to T4) are available for tripping and are assigned per the **NUM_TC** setting as shown below in Table 2–2: NUM_TC SETTING (THREE PHASE MODELS). If one breaker with a single trip circuit is being used (**NUM_TC** = 1), then outputs T2 to T6 are available for assignment to different tasks through the Xpression Builder program provided with the LPS-D. Outputs T3 and T4 are used only if two breakers are being controlled and if each of the breakers has two independent trip circuits (**NUM_TC** = 2). If independent trip coils are not being used, then the T3 to T6 contacts can be reassigned through Xpression Builder.

The LPS-D has the capability (when enabled) to trip the breaker(s) locally through the keypad, or remotely via the ALPS-Link program or ASCII commands. For the LPS-D to recognize which breaker should be tripped, the **NUM_TC** setting must be set as shown in the tables below and the trip outputs connected to the appropriate trip coils assigned in the tables. For example, if a three phase tripping scheme is employed and **NUM_TC** = 2, then trip output T1 must be connected to the trip coil TC-1 of breaker number 1 and the output T2 must be connected to the trip coil TC-1 of breaker number 2.

Table 2–1: NUM_TC SETTING (SINGLE PHASE MODELS)

Number of Breakers NUM_BKR	Number of Trip Circuits NUM_TC	Breaker No. 1						Breaker No. 2		
		Trip Circuit 1			Trip Circuit 2			Trip Circuit 1		
		ΦA TC1-1	ΦB TC1-2	ΦC TC1-3	ΦA TC2-1	ΦB TC2-2	ΦC TC2-3	ΦA TC1-1	ΦB TC1-2	ΦC TC1-3
1	1	T1	T2	T3	-	-	-	-	-	-
1	2	T1	T2	T3	T4	T5	T6	-	-	-
2	1	T1	T2	T3	-	-	-	T4	T5	T6

where: TC1, TC2 = Trip Coils; T1 to T6 = LPS-D Trip Outputs

Table 2–2: NUM_TC SETTING (THREE PHASE MODELS)

Number of Breakers NUM_BKR	Number of Trip Circuits NUM_TC	Breaker No. 1		Breaker No. 2	
		Trip Circuit 1 TC-1	Trip Circuit 2 TC-2	Trip Circuit 1 TC-1	Trip Circuit 2 TC-2
1	1	T1	-	-	-
1	2	T1	T2	-	-
2	1	T1	-	T2	-
2	2	T1	T2	T3	T4

where: TC1, TC2 = Trip Coils; T1 to T4 = LPS-D Trip Outputs

107: NUM_MON - Trip Outputs To Be Monitored

Trip circuit monitoring can be used to check the integrity of the trip circuit to which the selected trip output is connected. It does this by sensing the voltage across the trip output as shown below. If the trip circuit is intact, almost full DC voltage will be detected across the trip output. If the trip circuit is open for some reason, there will be no voltage, or very little voltage, across the trip output. The monitoring circuit will detect this condition, store an event and can be programmed to close an alarm contact if so desired.

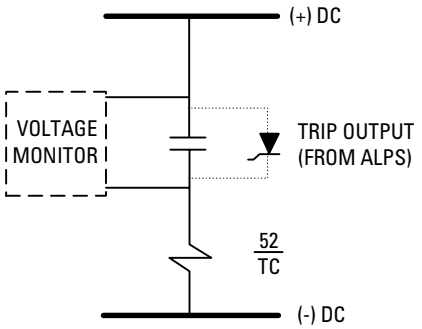


Figure 2–1: TRIP CIRCUIT MONITOR

The trip contacts are also monitored when the LPS-D initiates a trip. If the voltage across the contacts does not drop when the trip is initiated, it is assumed that the trip circuit is not intact and an alarm is issued. If the voltage drop concurrently with the trip initiation, the trip circuit is considered activated and no alarm is issued.

Any or all of the outputs (T1 to T6) can be monitored regardless of whether or not they are used in a trip circuit. The setting format for **NUM_MON** is *abcdef*, where any position can be a zero (0) or a one (1) as shown in in the table below:.

Table 2–3: SETTING FORMAT FOR NUM_MON

Position	a	b	c	d	e	f
Output	T6	T5	T4	T3	T2	T1
ON	1	1	1	1	1	1
OFF	0	0	0	0	0	0

As an example, if you are using an LPS-D for three phase tripping, and if outputs T1 and T3 are to be monitored and T2 and T4 are not, the following setting would be used:

NUM_MON = 000101

This setting is entered in to the relay from the LUI in decimal format (that is, **NUM_MON** = 5).

108: DISPLAYVAL - Present Value Display Mode

This setting determines the mode in which present values (*I*, *V*, etc.) are displayed. Two settings are possible: PRI displays the values in primary quantities, whereas SEC allows secondary values to be displayed.

109: LANGUAGE

Two settings are possible: ENGLISH or SPANISH.

110: SYSTEM INPUTS - Virtual Inputs

Four virtual inputs are available: SYSIN1 to SYSIN4.

Virtual inputs are memory locations within the relay that can be assigned values via communications or the local user interface. If the value stored in virtual memory is a 1 (or YES), the virtual input is ON; likewise, if the value is 0 (or NO), the virtual input is OFF. The virtual input states are written to like settings: these values are non-volatile and are available in the memory map.

Each virtual input has two settings in ALPS-Link: YES for asserted 1, NO for non-asserted 0. From the front keypad, the virtual inputs can be set by following the path SET \ Edit Gen Settings \ Configure \ SYSIN1-4. The setting range is 0 to 15 (decimal) or 0000 to 1111 (binary), where the least-significant digit represents SYSIN1 and the most-significant digit represents SYSIN4. This value must be entered in decimal format.

The System Inputs can be incoporated into the relay logic with Xpression Builder, allowing for greater control of the overall logic. They can be treated like any digital input or flag. For example, System Inputs can provide supervisory functions for dedicated logic segments by disabling or enabling these segments. As such, Xpression Builder is mandatory for the successful implementation of System Inputs in the relay logic.

201: COMPORT1 - Communications Port 1

COMPORT1 sets the baud rate, parity, and stop bits of RS232 serial port 1. The setting format is **xxyz** where:

Baud Rate	= **xx**	= 03, 12, 24, 48, 96 (x 10)
Parity	= **y**	= 0 (none), 1 (odd), 2 (even)
Stop Bits	= **z**	= 1, 2

The baud rate setting of 300, 1200, 2400, 4800, or 9600 must be set to match the baud rate of the modem or serial device connected to the serial port of the LPS-D. The parity and stop bits must match those selected for the serial port of the remote PC. Normally 1 stop bit is selected. However, certain modems or other types of communications hardware might dictate using 2 stop bits. ALPS-Link communications software can be configured to match this LPS-D setting for baud rate, parity, and stop bits.

202: COMPORT2 - Communications Port 2

COMPORT2 sets the baud rate, parity, and stop bits of serial port 2. The setting format is **ixxyz** where:

interface	= **i**	= 0 (RS232), 1 (RS485)
Baud Rate	= **xx**	= 03, 12, 24, 48, 96, 19
Parity	= **y**	= 0 (none), 1 (odd), 2 (even)
Stop Bits	= **z**	= 1, 2

The baud rate setting of 300, 1200, 2400, 4800, 9600, or 19200 must be set to match the baud rate of the modem or serial device connected to the serial port of the LPS-D. The parity and stop bits must match those selected for the serial port of the remote PC. Normally 1 stop bit is selected. However, certain modems or other communications hardware might dictate using 2 stop bits. ALPS-Link communications software can be configured to match this LPS-D setting for baud rate, parity, and stop bits.

203: COMPORT3 - Communications Port 3

COMPORT3 sets the baud rate, parity, and stop bits of RS232 serial port 3. The setting format is **ixxyz** where:

interface	= **i**	= 0 (RS232), 1 (RS485)
Baud Rate	= **xx**	= 03, 12, 24, 48, 96, 19
Parity	= **y**	= 0 (none), 1 (odd), 2 (even)
Stop Bits	= **z**	= 1, 2

The baud rate setting of 300, 1200, 2400, 4800, 9600, or 19200 must be set to match the baud rate of the modem or serial device connected to the serial port of the LPS-D. The parity and stop bits must match those selected for the serial port of the remote PC. Normally 1 stop bit is selected. However, certain modems or other communications hardware might dictate using 2 stop bits. ALPS-Link communications software can rate, parity, and stop bits.

204: PROTOCOL1 - Communication Port No. 1 Protocol
205: PROTOCOL2 - Communication Port No. 2 Protocol
206: PROTOCOL3 - Communication Port No. 3 Protocol

Three values are possible for each of these settings:

1. GE-MODEM. Use this setting to communicate via ALPS-Link (see Chapter 11: ALPS-LINK USER GUIDE).
2. ASCII. Use this setting to communication via the ASCII commands (see Chapter 12: ASCII COMMUNICATIONS for details).
3. DNP 3.0. Use this setting for DNP 3.0 communications (see Appendix C for details)

301: NUMFAULTS - Number Of Faults To Be Captured

NUMFAULTS selects the maximum number of oscillography "storage events" (faults) that may be stored in memory. When the maximum number are stored in memory, the oscillography data associated with a subsequent storage event will overwrite the data from the oldest event.

This setting allows the user to apportion a fixed amount of memory into different sized blocks for oscillography storage. Table 2–4: OSCILLOGRAPHY CYCLES PER STORAGE EVENT shows the total number of oscillography cycles allowed per storage event as a function of the **NUMFAULTS** setting.

Table 2–4: OSCILLOGRAPHY CYCLES PER STORAGE EVENT

NUMFAULTS	STORAGE CYCLES
6	72
12	36
24	18
36	12

302: PREFAULT - Number Of Pre-Fault Cycles To Capture

PREFAULT selects the number of pre-fault or pre-trigger cycles to be stored in each oscillography record. It can be set over the range from 1 to 8. **NUMFAULTS,** as explained above, determines the total number of cycles per oscillography record, and **PREFAULT** determines how many of these will be pre-fault cycles.

303: SPLITREC - Split Oscillography Record For Long Duration Faults

The LPS-D allows a pre-defined number of oscillographic records to be captured per the **NUMFAULTS** setting described above. Each record is a specific number of cycles long as determined by this setting. If a fault occurs that is greater in length than the number of cycles set to be captured, the **SPLITREC** setting will allow the record to be split so that the beginning and the end of the fault can be captured. Note that **SPLITREC** does not affect the number of pre-fault cycles that are captured as determined by the **PREFAULT** setting. **SPLITREC** applies only the fault record exclusive of the pre-fault cycles. **SPLITREC** is set as a percentage with a range of 0 to 100 percent, and splits the record so that the end of the record is equal to the **SPLITREC** percentage and the beginning of the record is equal to (100 – **SPLITREC**). For example, assume that **NUMFAULTS** is set to 4 and **PREFAULT** is set to 4. This means that the record will capture 4 cycles of pre-fault data and 28 cycles of fault data. The LPS-D samples at 64 times per cycle, therefore, 2048 samples (64 x 32) of fault data will be captured. Further assume that **SPLITREC** is set to 30%. If the fault lasts longer than 32 cycles (2048 samples), then 28 cycles (1792 samples) of the oscillographic record will be split and the display will show 8.4 cycles (538 samples) at the end and 23.6 cycles (1510 samples) at the beginning. If the fault is less than the set number of cycles then **SPLITREC** has no effect and the total fault record will be displayed.

Use a setting for **SPLITREC** that will display the information most desired in a long duration fault. (more at the beginning and less at the end or vice versa).

The LPS-D counts the total number of breaker operations and calculates and accumulates the total breaker duty on a per phase basis according to the following equation:

$$\text{Total Duty} = \sum I^x t$$

where, I = RMS current
t = breaker operating time
x = user settable exponent

The number of operations and accumulated duty will be compared to set values (entered by user). When the respective value is reached, an event will be recorded and the non-critical alarm will be initiated if programmed to do so. The number of operations and the total duty can start from zero, or if the existing number of operations or total duty is known, those values can be entered into the LPS-D to use as a starting point. The following settings (General Settings 400 through 410) need to be made.

401: EXPONENT - Exponent *x* to use in $I^x t$ Calculation

EXPONENT can be set from 1 to 2 in 0.1 steps. Use a value that meets the specific breaker used in the application.

402: MAX_OP - Maximum Number Of Breaker Operations Permitted

This number can be set from 0 to 9999. Enter the maximum number of operations that the breaker can tolerate before maintenance is required.

403: MAX_IXT - Maximum Breaker Duty

This number can be entered in the range of 0 to 999.9M in steps of 0.1K. Enter a number equal to the maximum duty recommended by the breaker manufacturer. Index Flag 139 Breaker Equipment Duty Alarm (BRMNDT) is set when the Breaker duty equals 80% of the set value. This flag may be directly assigned to an output contact, or used in configurable logic.

404: IXTPHASEA - Accumulated Duty, Breaker Phase A

IXTPHASEA can be set over the range of 0 to 999.9M with a step of 0.1K. If the accumulated duty to that point in time is known, enter that value, otherwise, enter an estimated value or use the default value of zero (0).

405: IXTPHASEB - Accumulated Duty, Breaker Phase B

IXTPHASEB can be set over the range of 0 to 999.9M with a step of 0.1K. If the accumulated duty to that point in time is known, enter that value, otherwise, enter an estimated value or use the default value of zero (0).

406: IXTPHASEC - Accumulated Duty, Breaker Phase C

IXTPHASEC can be set over the range of 0 to 999.9M with a step of 0.1K. If the accumulated duty to that point in time is known, enter that value, otherwise, enter an estimated value or use the default value of zero (0).

407: NUM_OP - Present Number Of Breaker Operations (Three Phase Tripping models only)

NUM_OP can be set over the range of 0 to 9999 with a step of 1. If the number of operations to that point in time is know, enter that value, otherwise, enter an estimated value or use the default value of zero (0). Index Flag 138: Number of Breaker Operations Alarm (BRMNOP) is set when the Breaker duty equals the set value. This flag may be directly assigned to an output contact, or used in configurable logic.

408: NUM_OP_A - Present Number of Breaker Operations for Phase A
409: NUM_OP_B - Present Number of Breaker Operations for Phase B
410: NUM_OP_C - Present Number of Breaker Operations for Phase C
(Single Phase Tripping Models Only)

NUM_OP_1, **NUM_OP_2**, and **NUM_OP_3** can be set over the range of 0 to 9999 with a step of 1. If the number of operations to that point in time is know, enter that value, otherwise enter an estimated value or use the default value of zero (0).

2.2.5 PROGRAMMABLE INPUTS

There are 12 contact converters provided with the LPS-D. These contact converters are used to convert contact inputs into the relays into logic signals for use within the scheme logic. Each of the contact converters can be programmed to be driven by any of the signals defined by the first 32 Index Numbers given in Table 2–6 at the end of this chapter.

501: CC1 - Contact Converter 1
502: CC2 - Contact Converter 2
503: CC3 - Contact Converter 3
504: CC4 - Contact Converter 4
505: CC5 - Contact Converter 5
506: CC6 - Contact Converter 6
507: CC7 - Contact Converter 7
508: CC8 - Contact Converter 8
509: CC9 - Contact Converter 9
510: CC10 - Contact Converter 10
511: CC11 - Contact Converter 11
512: CC12 - Contact Converter 12

Use any of the first 32 signals given in Table 2–6 on page 2–52 to define the function of these contact converters.

101: Z1PHASE - Zone 1 Phase Distance Functions

- *PUTT Scheme*

  The Zone 1 functions are required in the PUTT scheme to key the transmitter to insure tripping by the remote terminal. The following setting must be used:

  Z1PHASE = YES

- *All Other Schemes*

  Set **Z1PHASE** equal to YES if Zone 1 protection for phase faults is desired. Otherwise set **Z1PHASE** equal to NO. It is highly desirable to use Zone 1 protection in all schemes because it provides independent, high speed direct tripping for all phase faults within the reach setting.

102: Z1PREACH

If potential transformers (PTs) are used, use a reach setting that is no greater than 90% of the positive sequence impedance of the line to be protected.

103: NOT USED

104: Z1GROUND - Zone 1 Ground Distance Functions

- *PUTT Scheme*

The Zone 1 functions are required in the PUTT scheme to key the transmitter to insure tripping by the remote terminal. The following setting must be used:

Z1GROUND = YES

- *Blocking, Hybrid, POTT1 and POTT2 Schemes*

Set **Z1GROUND** equal to YES to use Zone 1 protection for ground faults. Otherwise set **Z1GROUND** equal to NO. It is highly desirable to use Zone 1 protection in all schemes because it provides independent, high speed direct tripping for all ground faults within the reach setting.

105: Z1GRDREACH - Zone 1 Ground Reach Setting

If potential transformers (PTs) are used, use a reach setting no greater than 90% of the positive-sequence impedance of the line to be protected. If capacitor voltage transformers (CVTs) are used, refer to figure below to determine if additional reduction of the Zone1 reach is required. If single phase tripping is employed *and* the application involves a parallel line (bussed at both ends) where single phase tripping is also employed, the Zone 1 ground distance functions should not be set greater than 80% of the line impedance or 80% of the setting determined using the Figure 2–2: ALLOWABLE ZONE 1 REACH (WHEN USED WITH CVTS).

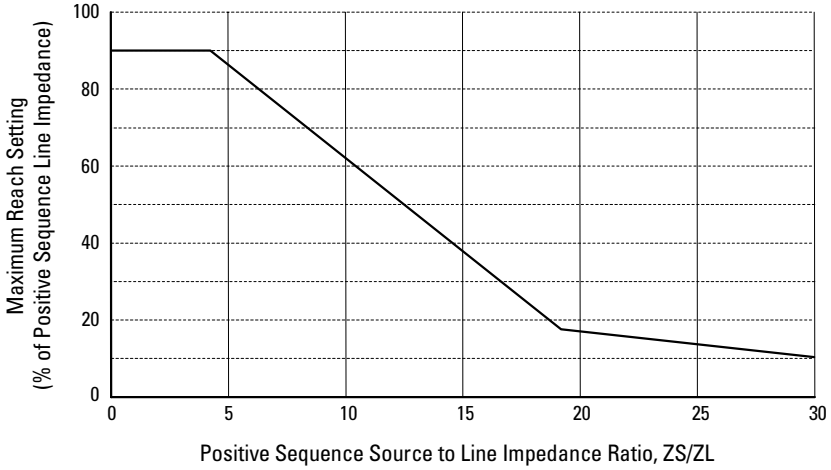


Figure 2–2: ALLOWABLE ZONE 1 REACH (WHEN USED WITH CVTS)

106: Z1GRDCHAR - Zone 1 Ground Characteristic

Z1GRDCHAR can be set to either MHO, REACT or QUAD. This setting determines the type of measuring unit used for the Zone 1 ground-distance functions, either a Mho function, a reactance function, or a quadrilateral function. Except for very short lines, it is recommended that the Mho function be used, since its operating time is slightly faster than that of the reactance or quadrilateral functions. A “very short line” is one where the positive sequence source impedance (equivalent source impedance behind the relay location) divided by the positive sequence impedance of the protected line is greater than 5. Note that the value of 5 is a suggested boundary value, not an absolute cutoff, and that a reactance function can be selected for a long line if desired.

107: Z1SUREACH - Mho Supervision of Ground Reactance Function

This setting is relevant only when the Zone 1 ground-distance functions have been set as reactance functions (see Protection Setting 106: **Z1GRDCHAR**). Since the reactance function is nondirectional, it must be supervised by a Mho function as shown in Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13. This supervision is automatically implemented whenever the reactance function is selected via the **Z1GRDCHAR** setting.

Z1SUREACH sets the *minimum* reach that can be made on the supervising Mho function. This setting can be easily calculated if the maximum load flow across the line is known. The criterion used for establishing the minimum reach is based on maintaining a 40° angular margin between angles A and B as shown in Figure 2–4: MAXIMUM ALLOWABLE REACH. Note that B is the “constant chord” angle of the characteristic where the minimum reach is the chord. Since the supervising Mho unit has a circular characteristic, angle B is 90°.

The LPS-D uses an adaptive feature to adjust the reach of the supervising Mho function as the load flow changes. The reach can never be less than **Z1SUREACH**, but it can be larger. As the load flow decreases, the load impedance becomes larger, and the reach is increased while maintaining the 40° difference between angles A and B. If the load now increases, the reach will be decreased but will never be made less than **Z1SUREACH**. This adaptive feature allows the reactance function to provide the maximum possible coverage for ground fault impedance.

108: Z1GROUNDK0 - Z1GROUND Zero Sequence Compensation Factor

Z1GROUNDK0 determines the amount of zero-sequence current used in the Zone 1 ground-distance functions to provide "self-compensation." This permits the reach setting to be based on the positive-sequence impedance to a ground fault. It should be set to the following:

$$\textbf{Z1GROUNDK0} = 0.95 \times (Z_{0L} / Z_{1L})$$

where: Z_{0L} = zero-sequence impedance of line
Z_{1L} = positive-sequence impedance of line

109, 110: NOT USED

111: Z1GCHARANG - Zone 1 Ground Characteristic Timer Angle (Revision B models only)

Z1GCHARANG can be set from 80 to 155° in increments of 1°. This setting determines the "tilt" of the reactance portion of the quadrilateral ground distance characteristic.

A ground distance function employing a reactance/quadrilateral characteristic provides excellent protection on a homogeneous system where the fault current at the relay location is essentially in phase with the total fault current for a single line to ground fault at the remote end of the line (or if the fault current at the relay location is more lagging than the total fault current for a single line to ground fault at the remote end of the line). On a non-homogeneous system where the fault current at the relay location is more leading than the total fault current for a single line to ground fault at the remote end of the line, a conventional reactance/quadrilateral characteristic will tend to overreach, especially when fault resistance is present. In this situation, the "tent" characteristic shown below should be used.

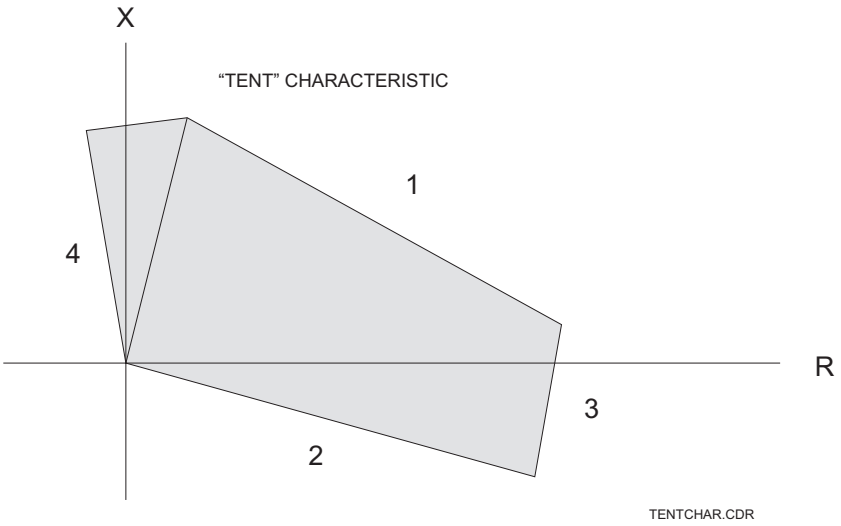


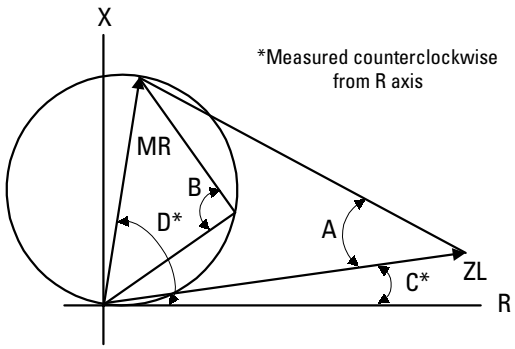
Figure 2–3: TENT CHARACTERISTIC

112: Z1RGREACH - Zone 1 Resistive Ground Reach (Revision B models only)

Z1RGREACH can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. If Zone 2 is also set to Quad mode, this setting should be calculated as 0.8 or less of the Zone 2 Resistive Ground Reach (Protection Setting 211: **Z2RGREACH**). If Zone 2 is not set to Quad mode, the setting should be calculated at 0.8 (if "tent" characteristics are used) or less (0.6 to 0.7 if "tent" characterstics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 105: **Z1GRDREACH**) for this zone.

The reach setting to be used on the Mho type distance functions will be established by the specific application. It must not exceed the maximum allowable reach which is dependent on the following:

1. Shape of the characteristic – circle or lens,
2. Angle of maximum reach, and
3. Maximum amount of load flow transferred across the transmission line.



MR = Maximum Allowable Reach
ZL = Load Impedance
D = Angle of Maximum Reach
B = Characteristic Angle; < 90 = Lens
C = Load Impedance Angle

Figure 2–4: MAXIMUM ALLOWABLE REACH

The maximum allowable reach (*MR*) is based on the criteria shown above and is calculated as follows:

$$MR = \frac{\sin(B - 40°) \times Z_L}{\sin(220° - B - E)}$$

where Z_L = minimum load impedance (ohms)

B = Characteristic angle (degrees)
= 90° for a circle
> 90° for a lens

C = angle of minimum load impedance (degrees)

D = angle of maximum reach (degrees)

$E = |D - C|$

Note that this is the maximum reach that can be safely made based on the given parameters. It is based on maintaining a 40° margin between the angle B and the angle A shown in Figure 2–4: MAXIMUM ALLOWABLE REACH. A circular Mho characteristic (B = 90°) should be used when possible. However, for larger load flows (smaller load impedances) and for longer reaches, it may be necessary to resort to a lenticular characteristic (B > 90°) to remain within the allowable limit. Lenticular settings greater than 120° should never be used. Similarly, the characteristic angle should never be set less than 90° except in the case of the Zone 4 functions when they are applied as blocking functions in available schemes. In those applications, it is permissible to set the characteristic angle for Zone 4 down to a minimum of 80°.

For each application, a desired reach should be determined and checked against the *MR* using a circular Mho characteristic. If the desired reach is less than the *MR*, then the setting is acceptable. If the desired reach is greater than the *MR*, then the angle *B* should be increased until *MR* equals, or just exceeds the desired reach.

201: Z2PHASE - Zone 2 Phase Distance Function

The choice of settings is YES or NO. Set **Z2PHASE** = YES if the Zone 2 phase functions are to be used, otherwise set **Z2PHASE** = NO.

202: Z2PHREACH - Zone 2 Phase Distance Reach

- *Step Distance Scheme*

  In this scheme, the Zone 2 functions must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach that may be caused by intermediate fault current sources. Typically, on a two-terminal line, **Z2PHREACH** would be set for 125 to 150% of the positive sequence impedance of the protected line. **Z2PHREACH** should never be set so large as to:

  1. Exceed the maximum allowable reach (*MR*), or,
  2. Cause the Zone 2 functions to lose selectivity with the second zone phase distance functions on the shortest adjoining line section. If this requirement cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer **PUTL2P** with additional time delay.

- *Blocking, Hybrid PUTT, POTT1, and POTT2 Schemes*

  The primary purpose of the Zone 2 functions in any of the pilot relaying schemes is to detect a fault anywhere on the transmission line and to work with the pilot channel to provide fast and secure tripping. To this end, the functions must be set to reach beyond the remote terminal of the transmission line and this requirement may be met by setting the functions with a reach of 125 to 200% of the transmission line. Although the reach requirement would be met with such settings, the operating time might not be at the optimum when taking into account the operating characteristics of the distance functions as shown below.

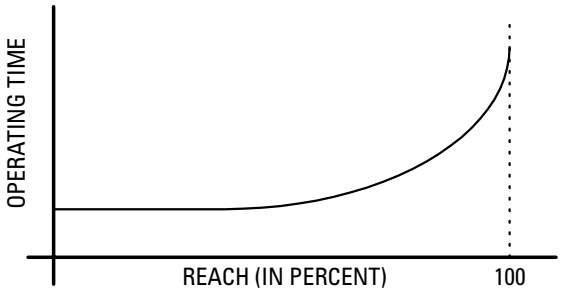


Figure 2–5: OPERATING TIME CHARACTERISTIC

For example if the reach of the Zone 2 functions is set to 125% of line impedance, then the operating time for remote faults would fall in the area of the upturn of the operating time characteristic, and tripping will be affected accordingly. On the other hand, if the reach of the Zone 2 functions is set to 300% of the line or greater, then the operating time for any line fault would fall along the flat part of the time characteristic, and the fastest possible pilot tripping will be obtained for any fault. It is especially beneficial to use the settings just described on short lines wherein the fastest possible tripping is required in terms of system stability.

With settings just described, the Zone 2 functions lose their usefulness to provide Zone 2 time-delayed backup protection because coordination with Zone 2 functions in adjoining lines will not be achieved. In that event, the Zone 2 timers can be turned off, or they can be set with a time delay corresponding to Zone 3 time if a third zone of protection is required. To obtain Zone 2 time-delayed protection, use the Zone 3 functions and set them with a Zone 2 reach (125% of line) and set the respective Zone 3 timers with a Zone 2 time delay.

In any event, the Zone 2 functions should not be set with a reach any longer than the maximum allowable reach (*MR*) described earlier.

203: Z2PCHARANG - Zone 2 Phase Characteristic Angle

This setting determines the characteristic shape and, consequently, the area of resistance coverage provided by the Zone 2 phase distance functions. **Z2PCHARANG** can be set to 90° to 120° in 5° steps. A 90° setting is recommended. If the desired reach, **Z2PHREACH**, with a 90° characteristic causes the Zone 2 functions to pick up on the maximum load flow, then a "lens-shaped" characteristic must be used to prevent operation on load without having to reduce the reach. The settings of both **Z2PHREACH** and **Z2PCHARANG** may be evaluated by using the formula associated with the method of Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13.

204: Z2GROUND - Zone 2 Ground Distance Function

The choice of settings is YES or NO. Set **Z2GROUND** = YES if the Zone 2 ground distance functions are to be used, otherwise set **Z2GROUND** = NO.

205: Z2GRDCHAR - Zone 2 Ground Function Characteristic

This setting permits choosing either Mho ground distance (MHO), ground directional-overcurrent (GDOC), or both (MHOGHDOC), for the overreaching functions in a pilot scheme. The following ground directional overcurrent functions are placed in service whenever **Z2GRDCHAR** is set to MHOGDOC or GDOC.

1. NT: forward looking negative sequence directional function.
2. IPT: zero sequence overcurrent tripping function (with or without positive sequence current restraint, depending on scheme type.
3. NB: reverse looking negative sequence directional function.
4. IPB: zero sequence overcurrent blocking function (with or without positive sequence current restraint).

NT is used to supervise IPT and NB is used to supervise IPB. The directional overcurrent functions can be used to provide more sensitive protection for high resistance ground faults. Because of their sensitivity, however, they will operate for more faults beyond the remote terminal of the line and thus system security will be reduced to some extent.

- *Step Distance Scheme*

  For a Step Distance scheme, this setting has no affect on the scheme logic, and **Z2GRDCHAR** may be set to any value.

- *PUTT Scheme*

  In this scheme,. operation of the scheme is dependent on the Zone 1 ground distance functions to key the transmitter for ground faults, thus the increased sensitivity provided by the IPT function is of no significant benefit. The following setting is proposed:

  Z2GRDCHAR = MHO

- *Blocking, Hybrid, POTT1 and POTT2 Schemes*

  If high resistance ground faults are of concern, the following setting is proposed:

  Z2GRDCHAR = MHOGDOC

206: Z2GRDREACH - Z2 Ground Distance Function Reach

See discussion for the **Z2PHREACH** phase distance function reach setting (Protection Setting 202); the same philosophy applies.

207: Z2GCHARANG - Z2 Ground Distance Function Characteristic Angle

Z2GCHARANG is adjustable from 90° to 120° and determines the shape of the Zone 2 ground characteristics – circle or lens. Set **Z2GCHARANG** equal to **Z2PCHARANG** as determined earlier.

208: Z2TIMERS - Z2 Timers

Z2TIMERS can be set to YES or NO and determines if the independent Zone 2 timers associated with the Zone 2 phase and ground distance functions are to be used. If time-delayed backup protection is required, set **Z2TIMERS** = YES, otherwise, set **Z2TIMERS** = NO.

209: Z2P_TIME - Z2 Phase Timer

Z2P_TIME can be set over the range of 0.1 to 3.0 seconds and establishes the time delay that the Zone 2 phase functions can be picked up before tripping is initiated. If the Zone 2 phase-distance functions are set to provide traditional Zone 2 protection, then set **Z2P_TIME** with the normal Zone 2 time delay. If the Zone 2 functions are to be used to provide Zone 3 tripping as described earlier under the **Z2PHREACH** setting, then set **Z3P_TIME** with the normal Zone 3 time delay. If **Z2TIMERS** is set to NO, then this setting is irrelevant and can be ignored.

210: Z2G_TIME - Z2 Ground Timer (Revision B models only)

Z2G_TIME can be set over the range of 0.1 to 3.0 seconds and establishes the time delay that the Zone 2 phase functions can be picked up before tripping is initiated. If the Zone 2 phase distance functions are set to provide traditional Zone 2 protection then set **Z2G_TIME** with the normal Zone 2 time delay. If the Zone 2 functions are to be used to provide Zone 3 tripping as described earlier under the **Z2GRDREACH** setting, then set **Z2G_TIME** with the normal Zone 3 time delay. If **Z2TIMERS** is set to NO, then this setting is irrelevant, and can be ignored.

211: Z2RGREACH - Zone 2 Resistive Ground Reach (Revision B models only)

Z2RGREACH can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. If Zone 3 is also set to Quad mode, this setting should be calculated at 0.8 or less of the Zone 3 Resistive Ground Reach (Protection Setting 310: **Z3RGREACH**). If Zone 3 is not set to Quad mode, the setting should be calculated as 0.8 (if “tent” characteristics are used) or less (0.6 to 0.7 if “tent” characterstics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 206: **Z2GRDREACH**) for this zone.

2.3.4 Z3DISTANCE

301: Z3PHASE - Select Zone 3 Phase

Z3PHASE can be set to either YES or NO. When Zone 3 is used as part of a Step Distance scheme, and Zone 3 phase distance functions are required then set **Z3PHASE** = YES. If Zone 3 is not used required, set **Z3PHASE** = NO.

302: Z3PHREACH - Zone 3 Phase Reach

In a Step Distance scheme Zone 3 provides backup protection for adjoining line sections out of the remote bus, and **Z3PHREACH** should be set to see a multi-phase fault at the end of the longest adjoining line section out of the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. **Z3PHREACH** should never be set so large as to:

1. Exceed the maximum allowable reach (*MR*), or,
2. Cause the Zone 3 functions to lose selectivity with the third zone phase-distance functions on the shortest adjoining line section. If this requirement cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer **Z3P_TIME** with additional time delay.

303: Z3PCHARANG - Zone 3 Phase Characteristic Angle

This setting determines the characteristic shape and, consequently, the area of resistance coverage provided by the Zone 3 phase-distance functions. **Z3PCHARANG** can be set to 90° to 120° in 5° steps. A 90° setting is recommended. If the desired reach, **Z3PHREACH**, with a 90° characteristic and with maximum load flow does not allow the maximum allowable reach criteria to be met, then a "lens-shaped" characteristic must be used. The settings of both **Z3PHREACH** and **Z3PCHARANG** may be evaluated by using the formula associated with the method of Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13.

304: Z3GROUND - Select Zone 3 Ground

Z3GROUND can be set to either YES or NO. When Zone 3 is used as part of a Step Distance scheme, and Zone 3 ground distance functions are required then set **Z3GROUND** = YES. If Zone 3 is not required, set **Z3GROUND** = NO.

305: Z3GRDREACH - Zone 3 Ground Reach

In a Step Distance scheme, Zone 3 provides backup protection for adjoining line sections out of the remote bus. **Z3GRDREACH** should be set to see a multi-phase fault at the end of the longest adjoining line section out of the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. **Z3GRDREACH** should never be set so large as to:

1. Exceed the maximum allowable reach (*MR*), or,
2. To cause the Zone 3 functions to lose selectivity with the third zone ground distance functions on the shortest adjoining line section. If this requirement cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer **Z3G_TIME** with additional time delay.

306: Z3GCHARANG - Zone 3 Ground Characteristic Angle

This setting determines the characteristic shape and, consequently, the area of resistance coverage provided by the Zone 3 phase distance functions. **Z3GCHARANG** can be set to 90° to 120° in 5° steps. A 90° setting is recommended. If the desired reach, **Z3GRDREACH**, with a 90° characteristic and with maximum load flow does not allow the maximum allowable reach criteria to be met, then a "lens-shaped" characteristic must be used. The settings of both **Z3GRDREACH** and **Z3GCHARANG** may be evaluated by using the formula associated with the method of Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13.

307: Z3P_TIME - Z3 Phase Timer

Z3P_TIME can be set from 0.10 to 10.00 seconds. If the Zone 3 phase distance functions are applied to provide traditional third zone protection, then the **Z3P_TIME** time delay should be set long enough to coordinate with the second zone timers in adjoining line sections. If the Zone 3 phase distance functions are used to provide traditional second zone protection (described earlier), set **Z3P_TIME** with the appropriate time delay.

308: Z3G_TIME - Z3 Phase Timer

Z3G_TIME can be set over the range of 0.10 to 10.00 seconds. If the Zone 3 ground-distance functions are applied to provide traditional third zone protection, then the **Z3G_TIME** time delay should be set long enough to coordinate with the second zone timers in adjoining line sections. If the Zone 3 ground-distance functions are used to provide traditional second zone protection (described earlier), set **Z3G_TIME** with the appropriate time delay.

309: Z3GRDCHAR - Zone 3 Ground Characteristic (Revision B models only)

Z3GRDCHAR can be set to MHO or QUAD. This setting determines the measuring unit used for the Zone 3 ground distance functions. The distance function may be set as an Mho (MHO) or as a quadrilateral (QUAD).

310: Z3RGREACH - Zone 3 Resistive Ground Reach (Revision B models only)

Z3RGREACH can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. If Zone 4 is also set to Quad mode looking forward, this setting should be calculated at 0.8 or less of the Zone 4 Resistive Ground Reach (Protection Setting 413: **Z4RGREACH**). If Zone 3 is not set to Quad mode, the setting should be calculated as 0.8 (if "tent" characteristics are used) or less (0.6 to 0.7 if "tent" characterstics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 305: **Z3GRDREACH**) for this zone.

2.3.5 Z4DISTANCE

The settings to be used on the Zone 4 distance functions in the LPS-D depend on the application and he scheme selected. The Zone 4 phase and ground-distance functions can be set to look in the reverse direction relative to the Zone 1, Zone 2 and Zone 3 phase and ground-distance functions (see the figure below). The reverse direction is required in certain applications and/or schemes as described below.

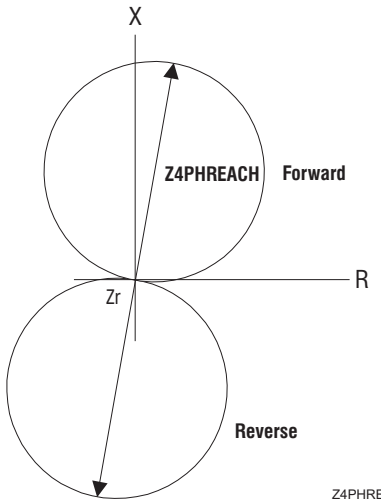


Figure 2–6: GROUND DISTANCE FUNCTION CHARACTERISTIC

Historically, Zone 4 distance functions have been provided with offset to include the origin of the R-X diagram within their characteristics (see Figure 2–7: R-X DIAGRAM FOR ZONE 4 DISTANCE FUNCTIONS below). Without the offset, memory would have to be relied on to provide an output for a zero voltage fault right at the relay location, and the output would last only as long as the memory lasted. With the offset, the function will

operate on current alone and thus provide a continuous output for a zero voltage fault right at the relay location. A continuous output is required from the Zone 4 functions in some schemes to insure that incorrect tripping does not occur for certain fault conditions.

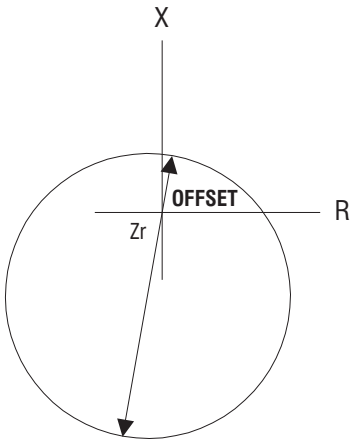


Figure 2–7: R-X DIAGRAM FOR ZONE 4 DISTANCE FUNCTIONS

For example, consider the fault at F1 in Figure 2–8: ZONE 4 FAULT EXAMPLE and assume that a blocking scheme is being used in the protected line. A continuous blocking signal must be sent to the remote terminal to block tripping there until the fault is cleared. Offset in the Zone 4 functions will assure this condition. Offset will also assure that Zone 4 time-delayed backup (when used) will also be provided for zero voltage faults.

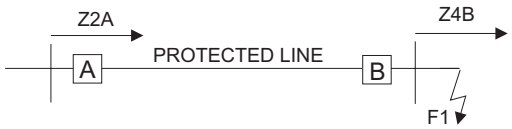


Figure 2–8: ZONE 4 FAULT EXAMPLE

The Zone 4 phase distance functions in the LPS-D are not provided with offset because they use an adaptive memory feature to provide the operation needed for bolted three-phase faults at the relay location. The adaptive memory works as follows:

1. If the fault voltage is less than 10 percent of rated voltage then the voltage prior to the fault will be used to polarize the Zone 4 functions. This voltage will be held, and the functions will remain picked up, until the fault is cleared, at which time they will reset.
2. If the voltage is greater than 10 percent of rated voltage, then the voltage prior to the fault will be held for 5 cycles and will then revert to the actual fault voltage. The functions will stay picked up for the duration of the fault and will reset when the fault clears.

In either case, the functions will provide a continuous output for the duration of the fault and will thus meet the requirements of the particular application.

401: Z4PHASE - Zone 4 Phase Distance

Z4PHASE can be set to YES or NO and determines whether or not the functions are to be used in the application.

- *Blocking, Hybrid and POTT2 Schemes*

  The Zone 4 phase distance functions are always required in these schemes, therefore, set:

  Z4PHASE = YES

- *Step Distance and POTT1 Schemes*

  If the Zone 4 phase distance functions are to be used to provide time-delayed backup protection, then set **Z4PHASE** = YES; otherwise, set **Z4PHASE** = NO.

402: Z4PHREACH - Zone 4 Phase Distance Reach

- *Blocking, Hybrid and POTT2 Schemes*

  In a blocking scheme, the Zone 4 functions key the transmitter to send a blocking signal to the remote terminal of the line to block tripping for an external fault (F1, for example) within reach of the Zone 2 functions located at the remote terminal.

  In a hybrid scheme, the Zone 4 functions prevent keying of the transmitter to block echoing of the trip signal that was received as a result of the operation of the remote Zone 2 functions for an external fault (at F1 for example) within their reach.

  In a POTT2 scheme the Zone 4 functions establish transient blocking circuitry to prevent tripping during fault clearing and fault current reversals.

  In all of these schemes, it is therefore imperative that blocking functions be set with a reach that will allow them to see all faults that the remote Zone 2 functions will see. The following guidelines are proposed:

  1. If the reach of the Zone 2 phase distance function (**Z2PHREACH$_R$**) at the remote end of the line is less than twice the positive-sequence impedance of the line, then the proposed setting is:

     Z4PHREACH = 0.85 x **Z2PHREACH$_R$**

  2. If the reach of the Zone 2 functions at the remote end is greater than twice the positive-sequence impedance of the line, then the proposed settings are:

     Z4PHREACH = 1.7 x (**Z2PHREACH$_R$** - Z_{1L})

  where:

  Z2PHREACH$_R$ = reach of phase Zone 2 functions at remote line terminal
  Z_{1L}= positive sequence impedance of protected line

  With these proposed settings, proper coordination will be obtained between the tripping and blocking functions at the remote terminal of the line. It may be possible to use a shorter setting or a longer setting than proposed, but,

  1. If a longer setting is used, the reach should be checked per the maximum allowable reach procedure given under Section 2.3.2: ZONE 2, 3, AND 4 DISTANCE FUNCTIONS on page 2–13. See Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13.
  2. If a shorter reach setting is used, then the reach should be checked to assure that the function will operate for all faults that the remote Zone 2 function can operate for.

  When series capacitors are used on the protected line or in lines adjacent to the protected line, set the Zone 4 phase distance functions with a reach that is equal to or greater than the reach of the phase distance pilot tripping functions (normally Zone 2) at the remote end of the transmission line. For example:

  Z4PHREACH ≥ Z2PHREACH$_R$

  where **Z2PHREACH$_R$** is the reach of the pilot tripping functions (Zone 2 in this example) at the remote end of the line.

- *Step Distance and POTT2 Schemes*

  In all other schemes, the Zone 4 phase distance functions can provide an additional zone of time-delayed backup protection. They can be used to provide a fourth zone of protection in a straight Step Distance scheme, or they can be reversed in direction to provide the so-called “reversed third zone” of protection.

The Zone 4 functions should be set with a reach commensurate with the application, considering underreach caused by intermediate fault current sources. **Z4PHREACH** should never be set so large as to:

1. Exceed the maximum allowable reach (*MR*), or,
2. To cause loss of selectivity with phase-distance functions providing time-delayed backup on any adjoining line section. If this requirement cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer **Z4P_TIME** with additional time delay.

403: Z4PCHARANG - Zone 4 Phase Characteristic Angle

- *Blocking, Hybrid and POTT2 Schemes:*

  Set the Zone 4 characteristic angle to 10° less than the characteristic angle setting (**Z2PCHARANG$_R$**) of the Zone 2 functions at the remote terminal of the line; that is:

  Z4PCHARANG = **Z2PCHARANG$_R$** – 10°

- *Step Distance and POTT1 Schemes:*

  This setting determines the characteristic shape and, consequently, the area of resistance coverage provided by the Zone 4 phase distance functions. **Z4PCHARANG** can be set to 80° to 120° in 5° steps. A 90° setting is recommended; values lower than 90° should not be used except in blocking, hybrid and POTT2 types of schemes. If the desired reach, **Z4PHREACH**, with a 90° characteristic and with maximum load flow does not allow the maximum allowable reach criteria to be met, then a "lens-shaped" characteristic must be used. The settings of both **Z4PHREACH** and **Z4PCHARANG** may be evaluated by using the formula associated with the method of Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13.

405: Z4GRND - Zone 4 Ground Distance

Z4GRND can be set to YES or NO and determines whether or not Zone 4 ground-distance functions are used in the application.

- *Blocking, Hybrid, and POTT2 schemes*

  The Zone 4 ground distance functions are always required in these schemes; therefore, set

  Z4GRND = YES

- *Step Distance and POTT1 Schemes*

  If the Zone 4 ground distance functions are to be used to provide time-delayed backup protection, then set **Z4GRND** = YES; otherwise, set **Z4GRND** = NO.

406: Z4GRDREACH - Z4 Ground Reach

- *Blocking, Hybrid, and POTT2 Schemes*

  In a blocking scheme, the Zone 4 functions key the transmitter to send a blocking signal to the remote terminal of the line to block tripping for an external fault (F1 for example) within reach of the Zone 2 functions located at the remote terminal (see Figure 2–8: ZONE 4 FAULT EXAMPLE on page 2–19).

  In a hybrid scheme, the Zone 4 functions prevent keying of the transmitter to block echoing of the trip signal that was received as a result of the operation of the remote Zone 2 functions for an external fault (at F1 for example) within their reach.

  In a POTT2 scheme the Zone 4 functions establish transient blocking circuitry to prevent tripping during fault clearing and fault current reversals.

  In all of these schemes, it is imperative that the blocking functions be set with a reach that will allow them to see all faults that the remote Zone 2 functions will see. The following guidelines are proposed:

1. If the reach of the Zone 2 ground distance functions (**Z2GRDREACH**) at the remote end of the line is less than twice the positive-sequence impedance of the line, then the proposed setting is:

   Z4GRDREACH = 0.85 x $\mathbf{Z2GRDREACH_R}$

2. If the reach of the Zone 2 ground distance functions at the remote end is greater than twice the positive-sequence impedance of the line, then the proposed settings are:

   Z4GRDREACH = 1.7 x $\mathbf{Z2GRDREACH_R} - Z_{1L}$

where $\mathbf{Z2GRDREACH_R}$ = reach of phase Zone 2 functions at remote line terminal

Z_{1L} = positive sequence impedance of protected line

With these proposed settings, proper coordination will be obtained between the tripping and blocking functions at the remote terminal of the line. It may be possible to use a shorter setting or a longer setting than proposed, but

1. If a longer settings is used, then the reach should be checked per the maximum allowable reach procedure given under Section 2.3.2: ZONE 2, 3, AND 4 DISTANCE FUNCTIONS on page 2–13.
2. If a shorter reach setting is used, then the reach should be checked to assure that the function will operate for all faults that the remote Zone 2 function can operate for.

When series capacitors are used on the protected line or in lines adjacent to the protected line, set the Zone 4 ground distance functions with a reach that is equal to or greater than the reach of the ground distance pilot tripping functions (normally Zone 2) at the remote end of the transmission line. For example:

$\mathbf{Z4GRDREACH} \geq \mathbf{Z2GRDREACH_R}$

where $\mathbf{Z2GRDREACH_R}$ is the reach of the ground distance pilot tripping functions (Zone 2 in this example) at the remote end of the line.

- *Step Distance and POTT1 Schemes*

In all other schemes, the Zone 4 ground distance functions can provide an additional zone of time-delayed backup protection. They can be used to provide a fourth zone of protection in a straight Step Distance scheme, or they can be reversed in direction to provide the so-called “reversed third” of protection.

The Zone 4 ground distance functions should be set with a reach commensurate with the application, considering underreach caused by intermediate fault current sources. **Z4GRDREACH** should never be set so large as to:

1. Exceed the maximum allowable reach (*MR*), or
2. Cause loss of selectivity with any ground distance functions providing time-delayed backup on any adjoining line section. If this requirement cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer **Z4G_TIME** with additional time delay.

407: Z4GCHARANG - Zone 4 Ground Characteristic Angle

- *Blocking and Hybrid Schemes*

Set the Zone 4 characteristic angle to 10° less than the characteristic angle setting ($\mathbf{Z2GCHARANG_R}$) of the Zone 2 functions at the remote terminal of the line; that is:

Z4CHARANG = $\mathbf{Z2CHARANG_R}$ – 10°

- *Step Distance, POTT1, and POTT2 Schemes:*

This setting determines the characteristic shape and, consequently, the area of resistance coverage provided by the Zone 4 phase distance functions. **Z4PCHARANG** can be set to 80° to 120° in 5° steps. A 90° setting is recommended and lower than 90° should not be used except in blocking, hybrid and POTT2 types of schemes. If the desired reach, **Z4GRDREACH**, with a 90° characteristic and with maximum load

flow does not allow the maximum allowable reach criteria to be met, then a "lens-shaped" characteristic must be used. The settings of both **Z4GRDREACH** and **Z4GCHARANG** may be evaluated by using the formula associated with the method of Figure 2–4: MAXIMUM ALLOWABLE REACH on page 2–13.

408: Z4DIRECTN - Zone 4 Direction

Z4DIRECTN determines the direction of the principle reach of the Zone 4 phase and ground distance functions. The direction can be set to FORWRD or REVERS with the direction to be used dictated by the particular scheme/application.

- *Blocking, Hybrid, POTT2 Schemes, and Reversed Third Zone Applications.*

  Z4DIRECTN = REVERS

- *All other schemes*

  Z4DIRECTN = FORWRD

409: Z4_TIMERS - Zone 4 Timers

Z4_TIMERS can be set to either YES or NO. If the Zone 4 functions are to be used to provide time-delayed backup protection, set **Z4_TIMERS** = YES. Set **Z4_TIMERS** = NO to put both the phase and ground timers out of service.

410: Z4P_TIME - Zone 4 Phase Time

If **Z4_TIMERS** = YES and if the Zone 4 phase distance functions are to provide time-delayed backup protection, then the **Z4P_TIME** time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of phase-distance relays in adjacent line sections. If **Z4_TIMERS** = NO then the **Z4P_TIME** can be set to any value within its range with no affect on scheme operation.

411: Z4G_TIME - Zone 4 Ground Timer

If **Z4_TIMERS** = YES and if the Zone 4 ground distance functions are to provide time-delayed backup protection, then the **Z4G_TIME** time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of ground-distance relays in adjacent line sections. If **Z4_TIMERS** = NO then the **Z4G_TIME** can be set to any value within its range with no affect on scheme operation.

412: Z4GRDCHAR - Zone 4 Ground Characteristic (Revision B models only)

Z4GRDCHAR can be set to either MHO or QUAD. This setting determines the measuring unit used for Zone 4 ground-distance functions. The distance function may be set as an Mho (MHO) or as a quadrilateral (QUAD).

413: Z4RGREACH - Zone 4 Resistive Ground Reach (Revision B models only)

Z4RGREACH can be set from 0.01 to 100.00 Ω for a 5 A rated relay (0.05 to 500 Ω for a 1 A rated relay). It determines the position of the right resistive blinder for the ground distance quadrilateral characteristic to provide coverage for resistive ground faults. This setting should be a balance between desired fault resistance coverage and load enchroachment. It should be calculated as 0.8 (if “tent” characteristics are used) or less (0.6 to 0.7 if “tent” characterstics are not used) of the positive-sequence resistance seen by the relay under maximum load conditions and unity power factor. Also, to maintain zone accuracy, it is recommended that the resistive reach is not greater than 10 times the Ground Distance Reach (Protection Setting 406: **Z4GRDREACH**) for this zone.

501: IT_PICKUP - Trip Supervision Current
502: IB_PICKUP - Block Supervision Current

- *Step Distance, PUTT, POTT1 and POTT2 Schemes*

  These two overcurrent functions provide supervision for the distance functions. IT is also used in the trip bus seal-in circuit. To obtain maximum sensitivity, the following settings are proposed:

  IT_PICKUP = *minimum*

  IB_PICKUP = *minimum*

- *Blocking and Hybrid Schemes*

  The IT overcurrent function provides supervision for the tripping-zone distance functions, and is also used in the trip bus seal-in circuit. The IB overcurrent function provides supervision for the reversed phase and ground distance functions. For a Blocking or Hybrid scheme, the local IT and remote IB functions must coordinate. This is accomplished by setting IB more sensitively (with a lower pickup) than IT. To obtain maximum sensitivity, the following settings are proposed:

  IB_PICKUP = *minimum*

  IT_PICKUP = 1.3 x $\mathbf{IB_PICKUP_R}$ + I_c

  where: $\mathbf{IB_PICKUP_R}$ = pickup setting of IB function at remote terminal of line
  I_c = positive-sequence line charging current (include effect of any non-switched shunt reactors)

503: IPT_PICKUP - GDOC Trip Current
504: IPB_PICKUP - GDOC Block Current

The IPT and IPB functions are placed in service whenever **Z2GRDCHAR** is set to GDOC or MHOGDOC.

The use of these functions will provide more sensitive protection for high resistance ground faults than can be obtained with ground distance functions alone.

- *Step Distance Scheme*

  These functions only work with the pilot channel. Therefore, when this type of scheme is selected, they will have no effect regardless of what setting is used for **Z2GRDCHAR** and what setting is made for these functions. In simple terms, don't worry about IPT and IPB if a Step Distance scheme is selected.

- *PUTT Scheme*

  The IPT and IPB functions should not be used in this scheme. Therefore, insure that **Z2GDCHAR** is set to MHO as proposed under the **Z2GDCHAR** setting description.

- *POTT1 Scheme*

  IPT is logically ANDed with the forward looking negative sequence directional function, NT, to form the pilot tripping. The IPT operating quantity is:

  $$IPT_{op} = 3 \cdot I_0$$

  It is proposed that **IPT_PICKUP** be set to its minimum value of 0.25 A.

  IPB is not used; therefore, any setting that is made regarding IPB is irrelevant.

- *Hybrid and POTT2 Schemes*

  IPT is logically ANDed with the forward looking negative-sequence directional function, NT, to form the pilot tripping. The IPT operating quantity is:

  $$IPT_{op} = 3I_0 - 0.3I_1$$

IPB is logically ANDed with the reverse looking negative sequence directional function, NB, to form the pilot blocking function. The IPB operating quantity is:

$$IPT_{op} = 3 \cdot I_0 - \textbf{IPBKFACTOR} \times 3 \cdot I_1$$

The **IPBKFACTOR** controls the amount of positive-sequence current restraint that is used with the *IPB* function. **IPBKFACTOR** can be set equal to 0 or 0.066. A setting of 0.066 is proposed for these schemes.

Positive sequence current restraint is used in both the tripping and blocking functions to provide increased security for any current unbalance that may occur during load flow or external fault conditions.

IPT and IPB must be set so as to provide proper coordination. This is done by setting the IPB function more sensitively than the IPT function. The following settings are proposed:

IPB_PICKUP = minimum

$$\textbf{IPT_PICKUP} = 1.3 \times \textbf{IPB_PICKUP}_{\textbf{R}} + I_{oc}$$

where: $\textbf{IPB_PICKUP}_{\textbf{R}}$ = setting of IPB function at remote terminal of transmission line.
I_{oc} = zero sequence line charging current (include effect of any non-switched shunt reactors)

- *Blocking Scheme*

IPT is logically ANDed with the forward looking negative sequence directional function, NT, to form the pilot tripping function. The IPT operating quantity is:

$$IPT_{op} = 3 \cdot I_0 - (0.3) \cdot I_1$$

Positive sequence current restraint is used to provide increased security for any current unbalance that may occur during load flow or external fault conditions.

Depending on the **CARRSTART** setting (1204) described under the SCHEME category, IPB may be:

1. Logically ANDed with the negative sequence blocking function NB to form the pilot tripping function.
2. Used alone to form the carrier start function.
3. Not be used at all in the carrier start circuit.

When IPB is used, either alone or with NB, the operating quantity is:

$$IPT_{op} = 3 \cdot I_0 - \textbf{IPBKFACTOR} \times 3 \cdot I_1$$

The **IPBKFACTOR** controls the amount of positive sequence current restraint that is used with the *IPB* function. **IPBKFACTOR** can be set equal to 0 or 0.066. The proposed settings for a blocking scheme are dependent on the **CARRSTART** setting and are given in Table 2–5: PROPOSED SETTINGS FOR BLOCKING SCHEME below.

Table 2–5: PROPOSED SETTINGS FOR BLOCKING SCHEME

CARRSTART	IPBKFACTOR
DIR (NB and IPB)	0.066
IPB (IPB alone)	0.0
FD (Fault Detector)	Don’t Care

505: IPBKFACTOR - IPB I1 Restraint

The IPB operating quantity is:

$$IPB_{op} = 3 \cdot I_0 - \textbf{IPBKFACTOR} \times 3 \cdot I_1$$

The **IPBKFACTOR** controls the amount of positive sequence current restraint that is used in the IPB function. **IPBKFACTOR** can be set to 0 or 0.066. Please refer to the description for Protection Setting 504: **IPB_PICKUP** to determine the **IPBKFACTOR** setting to be used.

506: NT_OFFSET: NT/NB Offset

The NT/NB functions use an offset to provide a reliable polarizing quantity for the conditions shown in Figure 2–9: NT/NB FUNCTIONS.

In this system, the voltage (V) at the relay is in the proper direction to provide correct directional sensing, but, depending on the source to line impedance ration (Zs/ZL), the magnitude of the voltage may not be sufficient to provide a reliable polarizing quantity. The problem is most onerous on a long transmission line with a strong source impedance behind the relay (Zs/ZL is quite small). The effect of the offset in this case is to add a component to the actual voltage so as to replicate the voltage at a point some distance down the transmission line.

NT_OFFSET can be determined as follows:

$$\textbf{NT_OFFSET} = (0.005)\cdot(Z_1)\cdot(I_n)$$

where Z_1 = positive sequence impedance of protected line (in secondary ohms)
I_n = Magnetics Module CT rating (1A or 5A)

If the calculated value is greater than 0.05, set **NT_OFFSET** = 0.05. Otherwise, use the calculated value and make the next lowest available setting. For example, if the calculated setting is 0.027, set **NT_OFFSET** = 0.02.

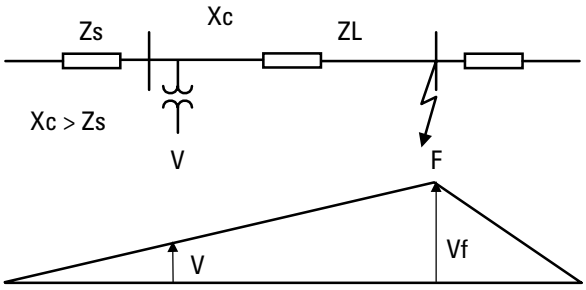


Figure 2–9: NT/NB FUNCTIONS

507: UNBALALARM - Unbalanced Current Alarm

The LPS-D is supervised by a fault detector (FD) that uses the following operating quantity:

$$FD_{op} = \Delta I_1 + I_2 + I_0$$

Tripping will not be permitted unless there is a concurrent output from the fault detector, therefore an increase in security is obtained. The LPS-D monitors the output of the fault detector – if it produces an output that lasts for more than 60 seconds, then it is an indication that:

1. there is an unbalance in the current on the system as indicated by the presence of negative-sequence current (I_2) and/or zero-sequence current (I_0), or
2. the fault detector has failed (unlikely).

If either of these conditions is detected, then an **UNBALARM** signal is produced. This signal can be routed via the Xpression Builder program to drive one of the programmable outputs, or it may be used as an input to one of the programmable outputs that may already have been selected for alarm duty.

601: 50 - Phase Instantaneous Overcurrent

The **50** function can be used in many applications to provide high speed, direct tripping for heavy close-in faults. To use the phase instantaneous overcurrent trip function, set **50** = YES, otherwise set **50** = NO. See Protection Settings 602 and 603 for further discussion on use of **50** function. Also, Protection Setting 201: **Z2PHASE** must be set to YES.

602: 50_DIRCNL - Directional Control Of 50

The **50** function can be set to be either directional or nondirectional. Directionality is obtained through the use of the Zone 2 phase distance functions. Protection Setting 201 must be set to **Z2PHASE** = YES to make the **50** function directional.

If **50** is made directional, the setting to be made on the function is based on the maximum fault current for a fault at the remote end of the line. When **50** is made non-directional, then the setting is based on the maximum fault current for a fault at either end of the line. If the maximum fault current for a fault at either end of the line is approximately the same, then it is proposed that the **50** function be made non-directional.

603: 50PICKUP - 50 Pickup Setting

50 provides direct tripping for multi-phase faults, and it operates on the highest of the three delta currents, IA-IB, IB-IC, or IC-IA. This permits **50** to have the same response for all multi-phase faults at the same location. If **50PICKUP** is non-directional, then it should be set at least 25% greater than the maximum delta three-phase fault current for a fault at either terminal of the line. If **50PICKUP** is directional, then it should be set at least 25% greater than the maximum delta three-phase fault current for a fault at the remote terminal of the line. The setting is calculated on the basis of the delta current which for a three phase fault is equal to the square root of three times the phase current.

604: 50PICKUPFF - 50 Pickup During Fuse Failure

If **50** is made directional and potential is lost to the relay, then directional control will be lost and the **50** function will not be able to provide any protection. To overcome this drawback, a second setting (**50PICKUPFF**) can be made on the **50** function to provide some backup during a loss of potential. A **50PICKUPFF** setting must always be made and it must always be set at least 25% greater than the maximum delta three-phase fault current for a fault at either terminal of the line.

605: 50G - Ground Instantaneous Overcurrent

The **50G** function can be used in many applications to provide high speed, direct tripping for heavy close-in faults. To use the ground instantaneous overcurrent trip function, set **50G** = YES, otherwise set **50G** = NO. See Protection Settings 606 and 607 for further discussion on use of **50G** function.

606: 50G_DIRDNL - Directional Control Of 50G

The **50G** function can be set to be either directional or nondirectional. Directionality is obtained through the use of the negative-sequence directional functions by requiring operation of the NT (forward looking) function *and* non-operation of the NB (reverse looking) function.

If **50G** is made directional, the setting to be made on the function is based on the maximum fault current for a fault at the remote end of the line. When **50G** is made nondirectional, the setting is based on the maximum fault current for a fault at either end of the line. If the maximum fault current for a fault at either end of the line is approximately the same, then it is proposed that the **50** function be made nondirectional.

607: 50GPICKUP - 50G Pickup Setting

The considerations used to determine the **50G** setting depend on whether **50G** is nondirectional or directionally controlled. If **50G** is nondirectional, then it must be set not to operate on the worst case external fault at *either* end of the line. If **50G** is controlled by the negative-sequence directional functions, then it must be set not to operate for the worst case external fault at the *remote* end of the line. In general, directional control should be used when the operating current for a fault behind the relay location is much greater than the operating current for a fault at the remote end of the line.

50G provides direct tripping for single-line-to-ground faults, and its operating quantity is:

$$\mathbf{50G}_{op} = 3 \times |I_0| \text{ - } \mathbf{50GRESTNT} \text{ x } 3 \times |I_1|$$

where **50GRESTNT** = 0 or 0.3

When **50GRESTNT** is set to 0.3, positive-sequence current restraint is used to provide secure operation during steady-state unbalances, error currents, and external faults. The **50G** setting is established by first determining the *maximum positive value* of the operating quantity listed above (taking into account the **50GRESTNT** setting). **50GPICKUP** is then this maximum operate signal plus a margin of 25% of the $3 \times I_0$ value from this same maximum operate signal.

$$\mathbf{50GPICKUP} = 3 \times |I_0| \text{ - } \mathbf{50GRESTNT} \times 3 \times |I_1| + 0.25 \times 3 \times |I_0|$$

608: 50GPCKUPFF - Pickup During Fuse Failure

If **50G** is made directional and potential is lost to the relay, then directional control will be lost and the **50G** function will not be able to provide any protection. To overcome this drawback, a second setting (**50GPCKUPFF**) can be made on the **50G** function to provide some backup during a loss of potential. A **50GPCKUPFF** setting must always be made and it must always be set as given above and based on the maximum operating quantity that can be obtained for a fault at either end of the line.

609: 50GRESTNT - 50G Restraint Setting

50GRESTNT can be set to 0 or 0.3, and it determines whether or not a portion of the positive-sequence current, is used to restrain the operating quantity, $3 \times |I_0|$. The effect of positive sequence current restraint is to make the **50G** function more secure during external faults, steady-state unbalances and/or error currents.

610: 51G - Select Ground Time Overcurrent (TOC)

51G can be set to either YES or NO. This setting determines whether the **51G** function is in service (YES) or out of service (NO).

611: 51G_DIRCNL - Select Directional Control of TOC

51G_DIRCNL can be set to either YES or NO. This setting determines whether **51G** is directionally controlled (YES) or not directionally controlled (NO).

612: 51GPICKUP - Ground Time Overcurrent Setting

51G provides time-delayed backup tripping for single-line-to-ground faults. Its operating quantity is:

$$3 \times |I_0|$$

The curve shape used for **51G** is determined by the **51GCURVE** setting as described below. The pickup and time-dial settings should be selected to provide coordination with similar functions in adjacent line sections.

613: 51GPCKUPFF - 51G Pickup During Fuse Failure

If **51G** is directional and potential is lost to the relay, then directional control will be lost and the **51G** function will not provide any protection. To overcome this drawback, a second setting (**51GPCKUPFF**) provides some backup during a loss of potential. A **51GPCKUPFF** setting must always be set as given above and is based on the maximum operating quantity that can be obtained for a fault at either end of the line.

614: 51GCURVE - Select 51G Characteristic Curve

51GCURVE determines the characteristic curve shape for the **51G** function. The choices are inverse curve (INV**;** see Figure 2–15: INVERSE CURVE on page 2–49), very inverse curve (V-INV; see Figure 2–16: VERY INVERSE CURVE on page 2–50), extremely inverse (E-INV; see Figure 2–17: EXTREMELY INVERSE CURVE on page 2–51), user-defined custom curve (CUSTOM), and definite time (DEFT).

615: 51GTIMDIAL - Ground Time Overcurrent Time Dial

51GTIMDIAL selects the **51G** time-dial setting. **51GTIMDIAL** can be set from 0.5 to 10.0. The pickup and time-dial settings should be selected to provide coordination with similar functions in adjacent line sections.

616: DEFTIMDELY - Definite Time Delay

When the 51G function is selected to have a definite time characteristic, **DEFTIMDELY** determines the associated fixed time delay. Select a time that meets the specific application.

617: 51G_RESET - Select Time Overcurrent Reset Characteristic

The **51G** function can be set to have a very fast reset (approximately 50 milliseconds for the definite time curve and 4 milliseconds for the variable time curves) following its pickup, or it can be set to have a reset characteristic that emulates the reset time of an electromechanical device with a similar time curve. Select FAST for the fast reset or EM to emulate an electromechanical function.

2.3.8 VOLTAGE

701: RATEDVOLTS - Rated Per Unit Voltage

This setting establishes the voltage on which per unit voltage values are based. **RATEDVOLTS** can be set to 100, 105, 110, 115 or 120 volts. Use a setting that is closest to the voltage applied to the LPS-D.

702: PHASEOVER - Select Phase Overvoltage

If the phase overvoltage function is to be used, set **PHASEOVER** = YES, otherwise set **PHASEOVER** = NO.

703: PHOVPICKUP - Phase Overvoltage Pickup

PHOVPICKUP can be set from 0.0 to 1.4 per unit based on the **RATEDVOLTS** setting. Use a setting that meets the specific application.

704: PHOVTMDLY - Phase Overvoltage Time Delay

PHOVTMDLY establishes a time delay that is started when the phase overvoltage function operates. **PHOVTMDLY** can be set from 0.0 to 10.0 seconds. Use a setting that meets the specific application.

705-713: NOT USED

714: FUSEFAIL - Potential Fuse Failure Blocking

Since a distance or directional function may operate for a full or partial loss of AC potential caused by one or more blown fuses, **FUSEFAIL** is provided to block distance and directional function tripping when a fuse failure is detected. If the backup overcurrent functions **50**, **50G**, and **51G** are nondirectional they will be allowed to trip. If **50**, **50G** or **51G** are directional, then they will not be allowed to trip. The figure below shows the functional logic for the **FUSEFAIL** function.

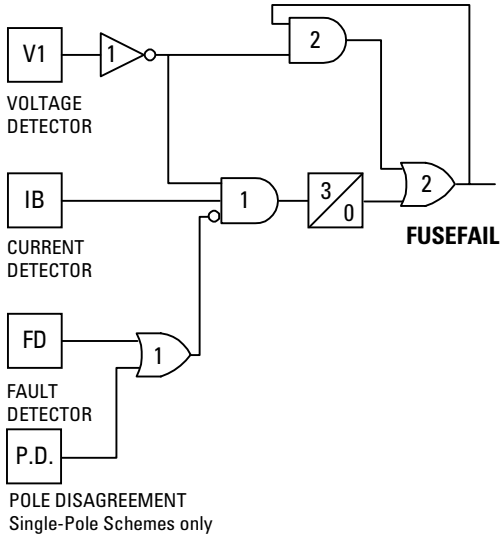


Figure 2–10: FUSEFAIL FUNCTION LOGIC DIAGRAM

If AC potential is lost, the positive-sequence voltage detector V1 drops out, NOT1 produces a logic 1 output, and the upper input is present at AND1. The V1 pickup setting is fixed at 75% of **RATEDVOLTS**. The middle input to AND1 is present if load current is sufficient to operate the current detector IB, while the bottom input is dependent upon whether the fault detector FD has operated or whether one or more poles of the breaker are open. When the POLE DISAGREEMENT logic detects that one or more poles of the circuit breaker(s) are open, **FUSEFAIL** is disabled.

If AC potential is lost for any reason, including a blown fuse or fuses, and there is no disturbance on the power system, so that the fault detector has not operated, AND1 produces an output that causes timer TL1 to time out and produce a **FUSEFAIL** output via OR2. The output of OR2 is routed to AND2 to seal in the **FUSEFAIL** output, based on the output of V1, so that **FUSEFAIL** output is maintained as long as the potential is below normal. When the potential returns to normal, V1 and NOT1 reset to remove the seal-in, allowing the **FUSEFAIL** output to reset.

When a fault occurs, with an attendant drop in potential, the V1 function resets, but the fault detector operates to prevent an output from AND1. **FUSEFAIL** does not operate on fault conditions.

FUSEFAIL can be set to NO or YES. If BLOCK is selected, then an output will be prevented from any function that requires potential to operate (distance, directional and any directionally controlled function). If NO is selected, nothing will be blocked in the event a potential failure occurs.

The following Protection Settings (801 to 810) determine which functions or logic outputs are used to block the Reclose Initiate (RI) output and to operate the Reclose Cancel (RC) output. Each of the settings may be set to YES or NO to select or not select the function/logic output respectively.

801: ALL_BELOW - Block Reclosing for all Selectable Functions

Setting **ALL_BELOW** to YES will block reclosing and energize the reclose cancel contacts for all of the functions controlled by Settings 802 through 810.

802: OUTOFSTEP - Block For Out Of Step

Set **OUTOFSTEP** = YES if reclosing is to blocked for a trip resulting during an out of step condition.

803: ALL_3_Z2PH - Block For Three Phase Faults

Set **ALL_3_Z2PH** = YES if reclosing is to be blocked for all three-phase faults as indicated by the operation of all three (AB, BC and CA) of the Zone 2 phase distance functions.

804: 50G_BLOCK - Block For 50G

Set **50G_BLOCK** = YES if reclosing is to be blocked following a trip initiated by the **50G** ground overcurrent function.

805: Z2TIMETRIP - Block For Zone 2 Time-Delayed Trip

Set **Z2TIMETRIP** = YES if reclosing is to be blocked following a Zone 2 time-delayed trip.

806: Z3TIMETRIP - Block For Zone 3 Time-Delayed Trip

Set **Z3TIMETRIP** = YES if reclosing is to be blocked following a Zone 3 time-delayed trip.

807: Z4TIMETRIP - Block For Zone 4 Time-Delayed Trip

Set **Z4TIMETRIP** = YES if reclosing is to be blocked following a Zone 4 time-delayed trip.

808: Z1PHASTRIP - Block For Zone 1 Phase Trip

Set **Z1PHASTRIP** = YES if reclosing is to be blocked following a Zone 1 instantaneous trip.

809: ANYZ2PHASE - Block For Any Zone 2 Phase Fault

Set **ANYZ2PHASE** = YES if reclosing is to be blocked for following any trip in which any Zone 2 phase distance function operates.

810: CONFGTRIP - Block For Configurable Trip Logic

The LPS-D logic can be configured so that tripping can be initiated via an external contact input. Set **CONFGTRIP** = YES if reclosing is to be blocked following a configurable trip.

Line Pickup provides tripping in the event that the breaker is closed into a zero-voltage bolted three-phase fault, such as occurs if the grounding chains are left on the line following maintenance. Figure 2–11: LINE PICKUP FUNCTIONAL LOGIC shows the functional logic for Line Pickup.

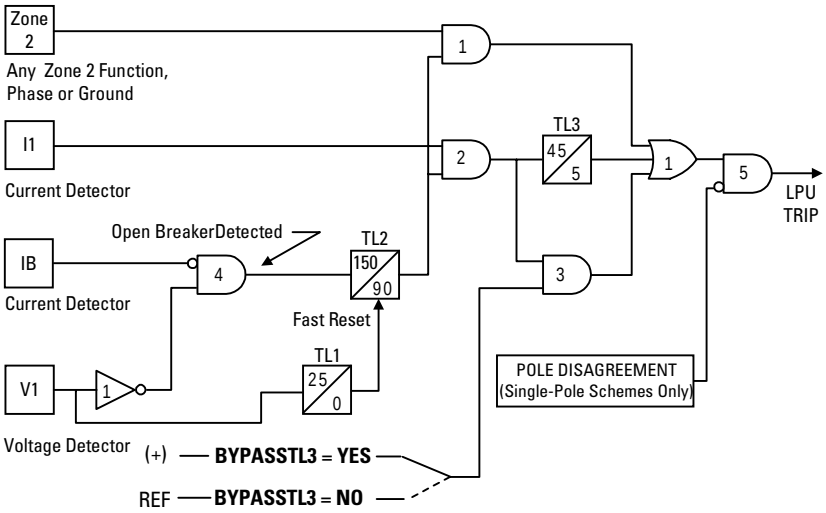


Figure 2–11: LINE PICKUP FUNCTIONAL LOGIC

When the line is de-energized, the open breaker detector (formed by IB and the positive-sequence voltage detector V1) produces an output indicating that the line is dead. The resulting output from AND4 causes timer TL2 to operate 150 ms later.

If the line is energized and no fault exists, V1 picks up and timer TL1 will begin timing; 25 ms later the output of TL1 resets timer TL2 via the fast reset input. AND1 and AND2 have the lower inputs removed at that time to take Line Pickup out of service. If the line is energized and a fault exists, current detector I1 or one of the Zone 2 distance functions will operate and AND1 and/or AND2 will produce an output.

If **BYPASSTL3** = YES, then the bottom input of AND3 is connected to (+), and AND3 immediately produces an output to initiate tripping of the breaker. If **BYPASSTL3** = NO then the bottom input of AND3 is connected to reference (REF), and tripping will occur after the 45 ms pickup delay of timer TL3.

Timer TL3 is provided for cases where simultaneous high-speed reclosing is employed at both ends of the line, and where the I1 function must be set to pick up below the maximum load current that can occur at that time. TL3 then allows time for the voltage to return to normal and take Line Pickup out of service before it can trip on load current. If simultaneous high-speed reclosing is not used, timer TL3 can be permanently bypassed.

Line Pickup via the I1 function is intended primarily to trip for zero-voltage bolted faults wherein the distance functions connected to line-side potential will not operate. As an additional feature, operation of any one of the Zone 2 distance functions will also initiate a line pickup trip. This is accomplished by routing the Zone 2 phase-distance or ground-distance function outputs to the upper input of AND1. The other input to AND1 comes from the normal line-pickup-enable output of timer TL2 as previously described. Operating time for the distance functions will be slower than normal since the pre-fault voltage is zero (assuming line-side potential) and it takes the relay several cycles to establish a memory polarizing voltage. However, this feature still results in faster tripping for permanent faults past the Zone 1 reach, and below the pickup of the I1 function.

901: LINEPICKUP - Select Line Pickup

Set **LINEPICKUP** = YES if the line pickup logic is to be used, otherwise set **LINEPICKUP** = NO.

902: BYPASSTL3 - Bypass Line Pickup Time Delay

If simultaneous reclosing is used and if **I1PICKUP** (Protection Setting 903) must be set below full load, then set **BYPASSTL3** = NO, otherwise set **BYPASSTL3** = YES.

903: I1PICKUP - I1 Pickup Setting

I1 is the overcurrent trip unit used in the Line Pickup function, and it operates on the magnitude of the positive-sequence current.

I1PICKUP should be set no greater than 2/3 of the minimum fault current for an internal three-phase fault at the relay location. If the minimum fault current is greater than the maximum load current on the protected line, then the I1 setting can be reduced to provide greater coverage of the line. For this case, a setting of 110% of the maximum load current is proposed.

2.3.11 REMOTEOPEN

The Remote-Open Detector (ROD) function issues a trip signal when the remote breaker opens during an unbalanced internal fault. This function detects that the remote breaker has opened by recognizing charging current on one or more phases following opening of the remote breaker. The Remote-Open Detector will not operate for a balanced three phase fault.

ROD can speed up tripping at the end of the line that otherwise would be the slowest to respond in a sequential-tripping condition. In a Step Distance scheme, ROD tripping is beneficial for any unbalanced internal fault not detected by Zone 1. In a Blocking scheme, ROD tripping is beneficial where system conditions are such that the fault current redistribution following breaker opening at one end is normally required before the other end(s) operates. The ROD function is not considered as a replacement or substitute for a pilot scheme.

Figure 2–12: ROD LOGIC DIAGRAM is a functional logic diagram of the ROD function. The sequence of events that results in an ROD output is as follows:

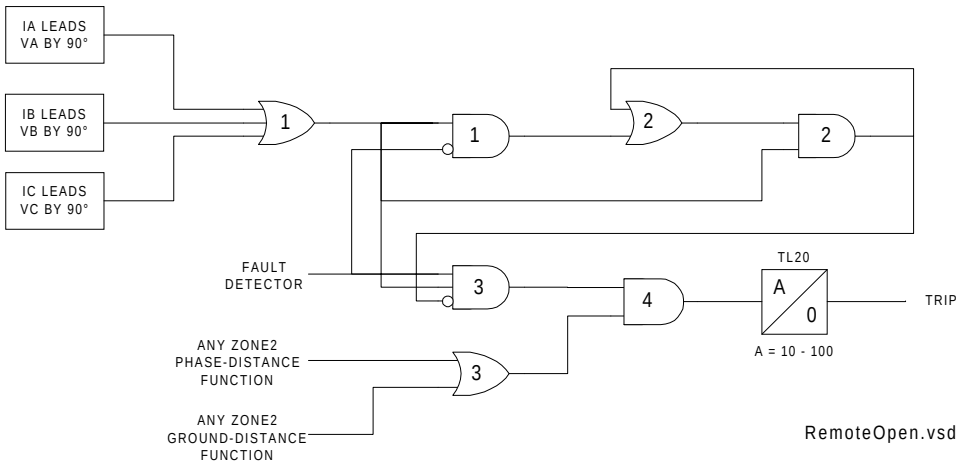


Figure 2–12: ROD LOGIC DIAGRAM

1. No charging current is detected prior to the fault – logic 0 output from AND2.
2. A fault is detected – logic 1 output from OR3.
3. The remote breaker opens and charging current is detected – logic 1 output from AND3.
4. The fault is still present, so the two inputs to AND4 persist and a trip output will be produced following the time-delay setting of timer TL20.

If charging current is initially detected but the fault detector (FD) is not picked up, indicating no fault on the power system, then OR1 and AND1 produce outputs. AND2 produces an output and seals itself in on the output of OR1 via OR2. AND3 is now blocked from producing an output as long as charging current is detected, regardless of whether FD is picked up or not. If a subsequent fault occurs and the remote breaker opens, ROD is prevented from producing an output.

If sufficient load current is flowing prior to the fault, there is no output from OR1, indicating that no charging current is detected, and AND3 is not blocked, since there is no output from AND2. If an unbalanced fault subsequently occurs, FD blocks AND1 to prevent an AND2 output. AND3 is allowed to produce an output when the remote breaker opens, provided there is sufficient charging current to operate one or more of the three charging-current-detectors that are the inputs to OR1. The capacitive charging current must be 60 milliamperes or more (secondary phase current) to assure operation of ROD. If the fault is still present, as indicated by an output from OR3, a ROD trip is initiated following TL20 security time delay setting.

1001: REMOTEOPEN - Select Remote Open Detector

Set **REMOTEOPEN** = YES if the remote open detection function is to be used, otherwise set **REMOTEOPEN** = NO.

1002: TL20PICKUP - Remote Open Detector Time Delay

TL20PICKUP the time required for a remote open trip to be initiated following opening of the remote breaker and subsequent detection of charging current flow. Longer settings will provide greater security but slower tripping and vice versa. Use a **TL20PICKUP** setting that meets the specific application.

2.3.12 LINEOVRLD

The Line Overload function consists of two overcurrent units, Level 1 and Level 2, with independent time delays. Level 1 is intended to be used with the lower pickup and longer time delay. Level 2 is intended to be used with the higher pickup and shorter time delay. The pickup and time delay settings should be based on short time and emergency loading situations for the protected line.

1101: LINEOVERLD - Select Line Overload Protection

Set **LINEOVERLD** = YES if line overload protection is to be used, otherwise set **LINEOVERLD** = NO. If **LINEOVERLD** = NO, ignore Protection Settings 1102 to 1105.

1102: LEVEL1PU - Level 1 Pickup Current

Use a **LEVEL1PU** setting that meets the specific application.

1103: LEVEL2PU - Level 2 Pickup Current

Use a **LEVEL2PU** setting that meets the specific application.

1104: LEVEL1TDLY - Level 1 Time Delay

Use a **LEVEL1TDLY** setting that meets the specific application.

1105: LEVEL2TDLY - Level 2 Time Delay

Use a **LEVEL2TDLY** setting that meets the specific application.

1201: PICKSCHEME - Select Scheme Logic

Any one of the following schemes can be selected:

1. STEPDST - Step Distance
2. PUTT - Permissive Underreaching Transfer Trip
3. POTT1 - Permissive Overreaching Transfer Trip (uses traditional transient blocking for current reversals)
4. POTT2 - Permissive Overreaching Transfer Trip (uses blocking functions to establish transient blocking)
5. HYBRID - Hybrid Scheme (uses channel repeat circuitry and weak infeed tripping if desired)
6. BLOCK - A directional comparison Blocking scheme

Set **PICKSCHEME** to the desired scheme.

1202: NUMRCVR - Select Number Of Receivers

Set **NUMRCVR** equal to the number of receivers to be used with the selected scheme.

1203: TRIPMODE - Select 1-Phase / 3-Phase Trip Mode (Single Phase Tripping model only)

Any one of the following modes of tripping can be selected:

1. 3POLE -with this selection, three phase tripping will be initiated for all faults regardless of the fault type
2. 1POLE -with this selection, single phase tripping will be initiated for single line to ground faults and three-pole tripping will be initiated for all multi-phase faults
3. 1POLEZ2 - with this selection, tripping will be the same as with the 1POLE setting with the additional feature that single phase tripping will also be initiated for Zone 2 time delayed single-line-to-ground faults

1204: CARRSTART - Function to Start Carrier in BLOCKING Scheme

This setting determines the function that will be used to start carrier (in addition to the phase and ground distance blocking functions) when a BLOCKING scheme is selected. Any one of the following can be selected:

1. DIR - with this selection, carrier will be started by the operation of the NB and IPB functions.
2. IPB - with this selection carrier will be started by the operation of the IPB function.
3. FD - with this selection will be started by the operation of the fault detector (FD) function.

1205: WKINFTRIP - Select Weak Infeed Tripping in HYBRID Scheme

This setting determines if the Weak Infeed Trip logic will be used when a HYBRID scheme is selected. One of the following can be selected:

1. YES - with this selection, the Weak Infeed Tripping logic is enabled.
2. NO - with this selection, the Weak Infeed Tripping logic is disabled, but the Channel Repeat (Echo) logic remains in service.

1301: TL1PICKUP - Trip Integrator

- *Step Distance Scheme*

  Timer TL1 is not used in a Step Distance scheme, therefore it is not necessary to make a setting because any setting that is made will be ignored.

- *Blocking Scheme*

  For a Blocking scheme, TL1 delays tripping at the local end until a blocking signal can be received from the remote end for an external fault beyond the remote terminal. The setting is determined by two factors:

  1. The worst-case time coordination between the remote blocking functions and the local pilot tripping functions.
  2. The total remote-transmitter-keying to local-receiver-output time delay, which is equal to the back-to-back channel time plus the channel propagation time.

  Based on the above, use the following setting:

  TL1PICKUP = 3 + channel time + propagation time

  where channel time and propagation time are entered in milliseconds.

- *PUTT, POTT1, POTT2 and Hybrid Schemes*

  For these schemes, timer TL1 provides security against spurious channel output during external faults within the reach of the overreaching trip functions. **TL1PICKUP** should be based on the maximum output, if any, expected from the channel under these conditions.

1302: TL4PICKUP: POTT1 Coordination Timer Pickup

- *POTT1 Scheme*

  For a POTT1 scheme, the pickup time delays of timers TL4 and TL1 provide transient-blocking coordination to prevent a misoperation for current reversals that can occur when a fault on a parallel line is cleared sequentially. If there is no parallel line, set **TL4PICKUP** to 0 and set **TL1PICKUP** as described above under **TL1PICKUP**. If there is a parallel line, then use the following settings:

  TL1PICKUP = 4 ms
  TL4PICKUP = 13 ms + channel release time

  Channel release time is defined as the time for the receiver at one end to drop out (release) after transmitter keying at the other end has stopped.

- *PUTT Scheme*

  A PUTT scheme does not require a transient-blocking time delay. Since Zone 1 functions are used to key the transmitter, the transmitter is not keyed to the TRIP frequency during an external fault, and there is no race between the reset of the receiver and pickup of a local pilot overreaching function following current reversals associated with sequential clearing of faults on a parallel line. As such, set **TL4PICKUP** to 0.

1303: TL4DROPOUT - POTT1 Coordination Timer Dropout

- *PUTT and POTT1 Schemes*

  Set **TL4DROPOUT** to 0.

- *Step Distance, POTT2, Blocking and Hybrid Schemes*

  Timer TL4 is not used in these schemes therefore any **TL4DROPOUT** setting that is made is irrelevant and will be ignored.

1304: TL5PICKUP - BKR1 b sw Coordination Timer Pickup

- *POTT1, POTT2 and PUTT Schemes*

The breaker 52/b contacts are required to key the local transmitter to the TRIP frequency when all three poles of the breaker(s) are open. TL5 and TL6 provide coordinating times to synchronize the breaker 52/b switch contact operation with the opening and closing of the breaker's main interrupting contacts. The pickup times (**TL5PICKUP** and **TL6PICKUP**) should be set so that an output will be produced just after the main contacts of the breaker open. The dropout times (**TL5DROPOUT** and **TL6DROPOUT**) should be set so that the timer output resets just before the main contacts of the breaker close. The outputs of the timers are ANDed together when two breakers are used. The switch shown in the figure belowis not a physical switch but is just a logical representation that is controlled digitally by General Setting 105: **NUM_BKR,** described in Section 2.2.1: CONFIGURATION on page 2–3.

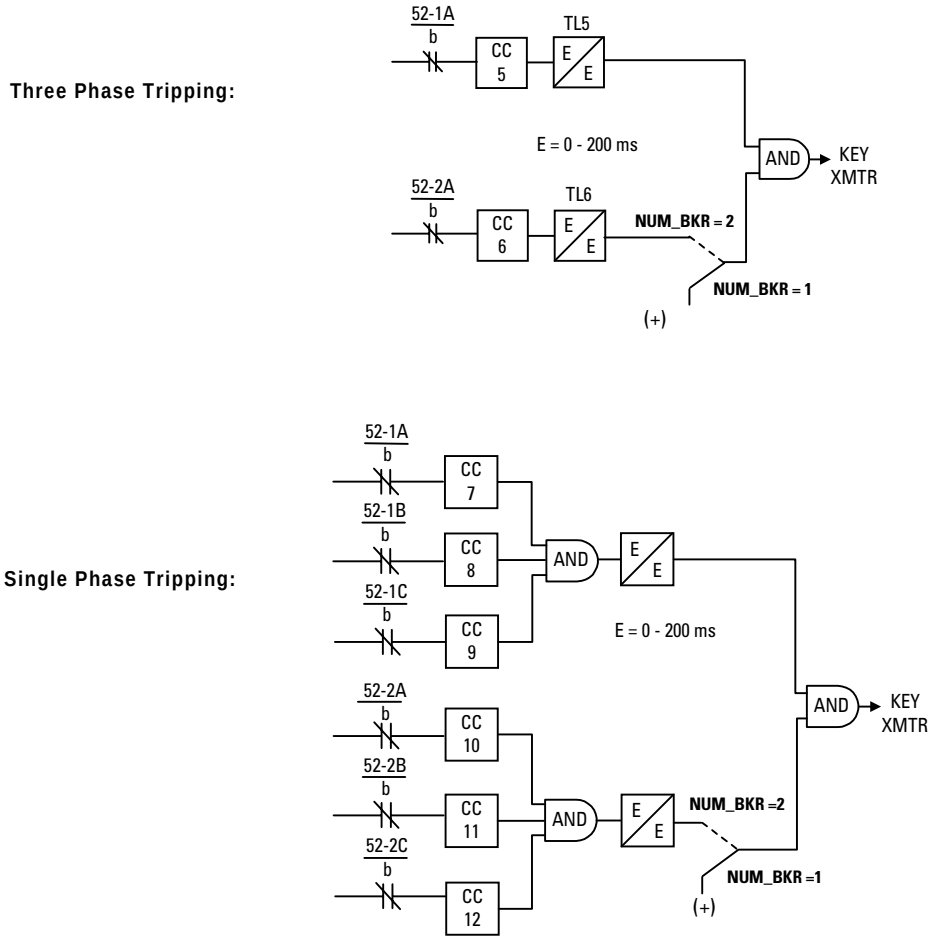


Figure 2–13: TL5PICKUP / TL6PICKUP REPRESENTATION

The figure above shows the connections for single and three phase tripping schemes. For three phase tripping, the 52/b contacts are wired from breaker 1 to CC5 and from breaker 2 to CC6. for single phase tripping, the 52/b contacts are wired from breaker 1 to CC7 (phase A), CC8 (phase B), and CC9 (phase C) and from breaker 2 to CC10 (phase A), CC11 (phase B), and CC12 (phase C).

The output of TL5 and TL6 are also used by the LPS-D to provide a time-tagged event to indicate that the breaker is either open or closed.

- *Blocking and Hybrid Schemes*

  Keying of the transmitter is not required in these schemes; however, the LPS-D uses these timer outputs to provide a time-tagged event to indicate that the breaker is either open or closed. If these events are required, then wire the 52/b contacts as shown above. The setting requirements for TL5 and TL6 are the same as described above.

1305: TL5DROPOUT - BKR1 b sw Coordination Timer Dropout

See description for **TL5PICKUP** (Protection Setting 1304).

1306: TL6PICKUP - BKR2 b sw Coordination Timer Pickup

See description for **TL5PICKUP** (Protection Setting 1304).

1307: TL6 DROPOUT - BKR2 b sw Coordination Timer Dropout

See description for **TL5PICKUP** (Protection Setting 1304).

1308: TL16PICKUP - Weak Infeed Trip Timer

The pickup delay of timer TL16 provides security in the weak infeed tripping logic. **TL16PICKUP** should be set long enough to ride over any outputs from the receiver during weak fault conditions wherein weak infeed tripping is not desired (low level faults beyond the remote line terminal for example).

If weak infeed tripping is used, **TL16PICKUP** should never be set greater than the pickup delay of timer TL11. For a Hybrid scheme the pickup delay of TL11 is automatically set to 80 milliseconds for two-terminal applications (**NUMRCVR** = 1) and 50 milliseconds for three terminal applications (**NUMRCVR** = 2).

If weak infeed is employed and if the Zone 2 ground distance characteristic (Protection Setting 205) is set to GDOC or MHOGDOC, then TL16 should never be set less than 16 milliseconds.

If weak infeed tripping is not required, it can be turned off by setting **WKINFTRIP** = NO (Protection Setting 1205).

1309: TL24DRPOUT - GDOC Blocking Timer

- *Step Distance and POTT1 Schemes*

  Timer TL24 is not used in these schemes, therefore it will be ignored. Any setting made is irrelevant.

- *Blocking, Hybrid and POTT2 Schemes*

  Timer TL24 is used to establish transient blocking for the ground directional overcurrent functions (GDOC). Transient blocking is used to prevent tripping during

  1. current reversals that can occur as a result of sequential clearing of faults on a parallel line,
  2. voltage reversals that can occur for faults near capacitors on series compensated lines, and
  3. transients that can occur for external fault clearing.

  The following setting is proposed:

  TL24DRPOUT = 30 ms

1310: TL25DRPOUT - Distance Blocking Timer

- *Step Distance and POTT1 Schemes*

  Timer TL25 is not used in these schemes, therefore it will be ignored. Any setting made is irrelevant.

- *Blocking, Hybrid and POTT2 Schemes*

  Timer TL25 is used to establish transient blocking for the phase and ground distance functions (**Z4PHASE** and **Z4GROUND**). Transient blocking is used to prevent tripping during:

  1. Current reversals that can occur as a result of sequential clearing of faults on a parallel line,
  2. voltage reversals that can occur for faults near capacitors on series compensated lines, and
  3. transients that can occur for external fault clearing.

  The following settings are proposed:

  Single phase tripping schemes:

  TL25DRPOUT = 30 ms

  Three phase tripping schemes:

  TL25DRPOUT = 50 ms

1311: TL26PICKUP - Repeat Delay Timer

- *Step Distance, Blocking, POTT1 and POTT2 Schemes*

  Timer TL26 is not used in these schemes, therefore it will be ignored. Any setting made is irrelevant.

- *Hybrid Scheme*

  Timer TL26 is used to delay repeat of the channel trip signal that is received from the remote terminal of the line. It is included to provide coordination with a scheme other than an LPS-D that may be used at the remote terminal of the line.

  The following settings are proposed:

  With an LPS-D relay at the remote terminal of the line:

  TL26PICKUP = 0 ms

  With other than an LPS-D relay at the remote terminal of the line:

  $$\textbf{TL26PICKUP} = \left|Z_{Blocal} - Z_{Tremote}\right| + P + C$$

  where $\left|Z_{Blocal} - Z_{Tremote}\right|$ is the maximum difference in operating time between the blocking functions in the LPS-D relay and the tripping functions in the system at the remote end of the line. If $Z_{Blocal} < Z_{Tremote}$, ignore this term in the calculation.
  C is the channel time of the communications channel.
  P is the channel propagation time from the remote terminal to the local terminal.

2.3.15 LINE INFO

1401: POSSEQANG - Positive Sequence Impedance Angle

POSSEQANG is common to all of the distance functions and establishes the positive sequence angle of maximum reach. Set **POSSEQANG** to a value that is equal to or just larger than the angle of the positive-sequence impedance of the protected line.

1402: ZERSEQANG - Zero Sequence Impedance Angle

ZERSEQANG is common to all of the ground-distance functions and establishes the zero sequence angle of maximum reach. Set **ZERSEQANG** to a value that is equal to, or just larger than, the angle of the zero-sequence impedance of the protected line.

1403: ZLINE - Positive Sequence Line Impedance

ZLINE is used in determining fault location. Set **ZLINE** equal to the positive-sequence impedance of the protected line.

1404: ZEROSEQK0 - Zero Sequence Current Compensation

ZEROSEQK0 establishes the amount of zero-sequence current that is used in all of the ground-distance functions (except Zone 1) to provide "self-compensation." This permits the reach setting for the ground-distance functions to be based on the positive-sequence impedance of the protected line. Use the following setting:

ZEROSEQK0 = Z_{0L} / Z_{1L}

where: Z_{0L} = zero-sequence impedance of line
Z_{1L} = positive-sequence impedance of line

1405: LINELENGTH - Line Length

LINELENGTH is used as part the fault location algorithm and allows the LPS-D to report the location of the fault in miles or kilometers (see Protection Setting 1406 below) relative to the relay location. Set **LINELENGTH** equal to the length of the line in terms of the units used in Protection Setting 1406.

1406: LINEUNIT - Unit Of Length

The LPS-D will report the distance to the fault relative to the relay location. Set **LINEUNIT** equal to MILES if location in miles is required, otherwise set **LINEUNIT** equal to KM.

1407: CTRATIO - Current Transformer Ratio

The LPS-D will report present values in terms of secondary values or primary values as determined by General Setting 108: **DISPLAYVAL**. The ratio of the of the current transformers used to supply the system is used in this procedure. Set **CTRATIO** equal to the CT ratio used with the LPS-D.

1408: PTRATIO - Potential Transformer Ratio

The LPS-D will report present values in terms of secondary values or primary values as determined by General Setting 108: **DISPLAYVAL**. The ratio of the of the potential transformers used to supply the system is used in this procedure. Set **PTRATIO** equal to the PT ratio used with the LPS-D.

2.3.16 SCADA DTA

An internal DTA (digital to analog) function, standard on the LPS-D, provides the following:

1. An analog output proportional to the distance from the relay to the fault as calculated by the fault-location algorithm.
2. Four contact outputs that provide fault-type information (configurable).

The analog output is intended to be wired into an analog port of a SCADA RTU to provide remote indication of distance to the fault. The four contact output assignments are designated phase A (Index 60), phase B (Index 61), phase C (Index 62), and neutral (Index 63) and are intended to be wired into four separate RTU ports. A particular contact closes when its phase (or neutral) is involved in the fault. For a phase B-to-C-to-ground fault, the phase B, phase C, and neutral contacts close. The contact assignments can be made from the keypad, or by using Xpression Builder.

The DTA provides either a nominal 0 to 1 mA DC output or a nominal 0 to 5 V DC output. The choice of output ranges is made by a switch located on the Processor Board.

When the fault location is calculated to be 100% of the line length, the DTA output is either 0.8 mA DC or 4.0 V DC. The DTA output goes to full scale (either 1 mA DC or 5 V DC) when the fault location is calculated as greater than 110% of the line length. Consequently, the usable output ranges are 0 to 0.88 mA DC or 0 to 4.4 V DC, covering the 0 to 110% fault-location range. The SCADA system should be programmed to recognize a full-scale output as an indication of an invalid output, resulting from either an out-of-limit fault-location calculation or a DTA reset.

There are two settings associated with the SCADA DTA Interface. **FLTLOCK** specifies a time period after a fault during which fault-location calculations resulting from subsequent faults are prevented from updating information stored in the DTA logic. **FLTRESET** specifies the time after a fault at which the fault-location information stored in the DTA logic is reset (output forced to full-scale value) and all fault-type contacts will open.

1501: FLTLOCK - Hold Time

Set **FLTLOCK** to the time following a fault during which fault location calculations resulting from subsequent faults will not be updated.

1502: FLTRESET - Fault Location Reset Time

Set **FLTRESET** to the time following a when the fault location information stored in the DTA module is reset (output forced to full-scale value) and those fault-type contacts that have closed will open. A setting of 0 refers to an infinite time. For example:

FLTLOCK = 10 seconds
FLTRESET = 5 minutes

With these settings, once the first fault occurs, the DTA module output will not change for subsequent faults that occur within 10 seconds of the first fault, and the DTA module output will be reset 5 minutes after the last fault that caused the DTA to produce an output.

2.3.17 OS BLOCKING

Out-of-step blocking (OSB) is a standard feature of the LPS-D. Refer to Section 1.4.4: OUT-OF-STEP BLOCKING on page 1–16 for a complete description of OSB logic. The OSB function is implemented through the LPS-D distance functions as shown below. For an out-of-step condition, the apparent impedance seen by the relay will follow a typical swing line as shown in the OSB characteristic. The LPS-D recognizes an out-of-step condition by sensing that the MOB function operates first, and that the coordinating function (Zone 2, 3 or 4) operates a short time later. The **MOBZONE** setting is used to select which of the zones (Zone 2, 3 or 4) is used as the coordinating zone. Note that Zone 4 can only be used as the coordinating zone when it is set to look in the forward direction (**Z4DIRECTN** = FORWRD).

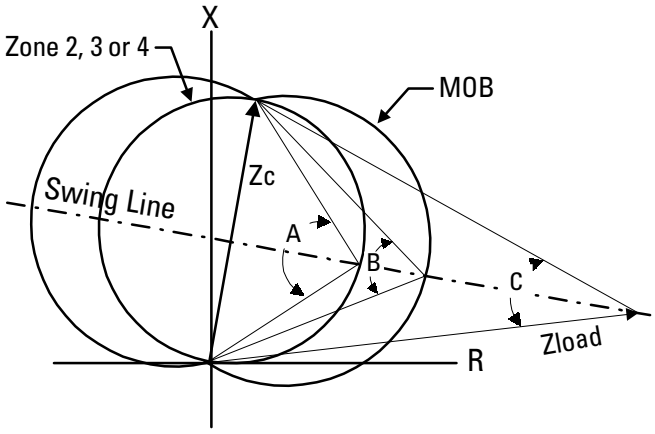


Figure 2–14: OSB FUNCTION CHARACTERISTIC

Angles A, B and C are determined as a function of the reach (Zc) of the coordinating zone, the maximum load flow (minimum Zload) and the fastest swing (first slip cycle). Angle A in the figure is selected via the **ZxPCHARANG** (**x** = 2, 3 or 4) setting and determines the shape of the coordinating zone characteristic. Angle B is selected via the **MOBCHARANG** setting and determines the shape of the MOB characteristic. Angle B should be set so that the time for the fastest swing to traverse from angle B to angle A is not less than 30 milliseconds. In addition, the A and B angle settings must be selected so that the difference between angle B and angle C is never less than 20°. Note that angle C is determined as a function of the minimum load impedance (Zload) and the reach (Zc) of the coordinating zone. Load flow and stability studies may have to be run to determine the settings necessary to establish out-of-step blocking.

1601: MOBZONE - Coordinating Zone

Set **MOBZONE** to select a coordinating zone per the criteria described above.

1602: MOBCHARANG - MOB Characteristic Angle

Use the criteria described above to select an appropriate **MOBCHARANG** setting.

1603: BLOCKWHAT - Functions to Block during Out-of-Step Tripping

BLOCKWHAT is used to select which of the following are to be blocked during an out-of-step condition:

1. BLKALL - Block all tripping regardless of what operated to initiate the trip.
2. BLKDIST - Block tripping for operation of any of the distance functions.
3. BLKPHAS - Block tripping by any of the phase distance functions.
4. BLKNONE - allow tripping for any trip condition.

1604: BLOCKZ1 - Block All Zone 1 Functions

Set **BLOCKZ1** = YES to block tripping by any of the Zone 1 distance functions, otherwise set **BLOCKZ1** = NO.

1605: BLOCKZ2 - Block All Zone 2 Functions

Set **BLOCKZ2** = YES to block tripping by any of the Zone 2 distance functions, otherwise set **BLOCKZ2** = NO.

1606: BLOCKZ3 - Block All Zone 3 Functions

Set **BLOCKZ3** = YES to block tripping by any of the Zone 3 distance functions, otherwise set **BLOCKZ3** = NO.

1607: BLOCKZ4 - Block All Zone 4 Functions

Set **BLOCKZ4** = YES to block tripping by any of the Zone 4 distance functions, otherwise set **BLOCKZ4** = NO.

2.3.18 RECLOSER

The LPS-D is available with an optional recloser, described in Section 1.10: RECLOSER (OPTIONAL) on page 1–42. Note that if another relaying system is going to be used with or without the LPS-D to control the recloser, then that relaying system must be capable of supplying a 1PRI (single phase reclose) and a 3PRI (three phase reclose) input to the recloser. The following settings must be made when the recloser is supplied.

1801: RECLMODE - Select Reclosing Option

Set one of the following reclosing options:

1. NONE - no reclosing selected. The three phase trip enable output is not enabled at this time.

2. OFF - no internal or external reclosing allowed. The three phase trip enable output (see Protection Setting 2025: **CONFTRIP** for details) will be enabled at this time.
3. INTERNAL - controlled by LPS-D only.
4. EXTERNAL - controlled by external relays only.
5. BOTH - controlled by LPS-D or external relays.

1802: RECLTYPE - Select Reclosing Type

Set one of the following three reclosing types:

1. 1POLE - With this type of reclosing selected, the first trip must be single-pole so that a 1PRI signal is supplied to the recloser to start the first reclose. If the first trip is three-pole, then the 3PRI signal will cause the recloser to go to lockout. When 1POLE reclosing is used, the three-pole trip enable signal (see recloser outputs in product description section) will be set after the first reclose signal is issued, but not until at least 30 milliseconds after the 1PRI signal is removed from the recloser. The three-pole trip enable signal will be maintained until the recloser resets or goes to lockout. This will insure that three-pole tripping will be initiated for any subsequent faults that may occur during the remainder of the reclosing cycle. Up to three subsequent three-pole reclosures with independent time delays can be selected (Protection Setting 1803: **NUM1P**). These subsequent reclosures will be started by an input from the three-pole reclose initiate (3PRI) signal. This mode of operation requires four independent timers which hereafter will be referred to as **1PDELAY1**, **1PDELAY2**, **1PDELAY3** and **1PDELAY4** (Protection Settings 1804 to 1807).
2. 3POLE - With this type of reclosing selected, the first trip must be three-pole so that a 3PRI signal is supplied to the recloser to start the first reclose. If the first trip is single-pole, then the 1PRI signal will cause the recloser to go to lockout. All reclosures will be started by an input from the three-pole reclose initiate (3PRI) signal. Up to four reclosures with independent time delays can be selected (Protection Setting 1808: **NUM3P**). In this mode of operation, the three-pole trip enable signal will be set at all times. This mode of operation requires four independent timers which hereafter will be referred to as **3PDELAY1**, **3PDELAY2**, **3PDELAY3** and **3PDELAY4** (Protection Settings 1809 to 1812).
3. 1POLE/3POLE - This mode of operation is a combination of modes 1 and 2 above. If a 1PRI input is first applied to the recloser, then the program by the 1POLE setting will be followed. On the other hand, if a 3PRI input is first applied to the recloser then the program described by the 3POLE setting will be followed. This mode of operation uses the same timers described by the 1POLE and 3POLE settings respectively. The number of reclose attempts for the 1POLE and 3POLE programs are set independently by **NUM1P** and **NUM3P** (Protection Settings 1803 and 1808).

1803: NUM1P - Number of Attempts following Single-Pole Trip

NUM1P establishes the number of reclosures to be attempted following a single-pole trip and can be set to the following:

1. one reclosing attempt (single-pole)
2. three reclosing attempts (first is single-pole, second and third are three-pole)
3. four reclosing attempts (first is single-pole, second, third and fourth are three-pole}

Select a setting suitable for the application.

1804: 1PDELAY1 - Single Pole First Reclose Delay

1PDELAY1 establishes the delay to be used for the first single-pole reclose attempt following a single-pole trip. The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1805: 1PDELAY2 - Single Pole Second Reclose Delay

1PDELAY2 establishes the delay to be used for the second reclose attempt following the initial single-pole trip (this will be a three-pole reclose). The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1806: 1PDELAY3 - Single Pole Third Reclose Delay

1PDELAY3 establishes the delay to be used for the third reclose attempt following the initial single-pole trip (this will be a three-pole reclose). The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1807: 1PDELAY4 - Single Pole Fourth Reclose Delay

1PDELAY4 establishes the delay to be used for the fourth reclose attempt following the initial single-pole trip (this will be a three-pole reclose). The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1808: NUM3P - Number Of Attempts Following a Three-pole Trip

NUM3P establishes the number of reclosures to be attempted following a three-pole trip. **NUM3P** can be set to the following:

1. one reclosing attempt (three-pole)
2. two reclosing attempts (all three-pole)
3. three reclosing attempts (all three-pole)
4. four reclosing attempts (all three-pole)

Select a setting suitable for the application.

1809: 3PDELAY1 - Three Pole First Reclose Delay

3PDELAY1 establishes the delay to be used for the first three-pole reclose attempt. The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1810: 3PDELAY2 - Three Pole Second Reclose Delay

3PDELAY2 establishes the delay to be used for the second three-pole reclose attempt. The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1811: 3PDELAY3 - Three Pole Third Reclose Delay

3PDELAY3 establishes the delay to be used for the third three-pole reclose attempt. The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1812: 3PDELAY4 - Three Pole Fourth Reclose Delay

3PDELAY4 establishes the delay to be used for the fourth three-pole reclose attempt. The delay time can be set over a range of 0.1 to 300.0 seconds. Select a setting suitable for the application.

1813: RESETTIME - Reset Time

RESETTIME is the time after the reclose signal has been produced that the recloser waits before going to the reset position. If a trip occurs during **RESETTIME**, the recloser goes to the next programmed reclose, or to lockout, if the trip occurred following the last programmed reclose attempt. The reset time delay can be set over a range of 0.1 to 300.0 seconds.

1814: DWELLTIME - Contact Dwell Time

DWELLTIME establishes the time that the closing contacts will stay closed following a reclose output. Select a time suitable for the application. The dwell time can be set over a range of 0.1 to 2.0 seconds.

1815: HOLD: Inhibit Hold Select

HOLD can be set to YES or NO and determines whether the HOLD feature of the recloser will be employed.

1816 HOLDTIME - Inhibit Hold Time

If **HOLD** is set to YES, then **HOLDTIME** establishes the time that the recloser will wait for hold input as defined by the **HOLDSENSE** (Setting 1817) to occur before sending the recloser to lockout. **HOLDTIME** has a setting range of 1 to 1000 seconds.

1817 HOLDSENSE - Contact Input Status

HOLDSENSE can be set to:

- CC - contact closed
- CO - contact open

With **HOLDSENSE** set to CC, the recloser will wait for a contact closure at the inhibit input to stop the hold timer (Protection Setting 1816: **HOLDTIME**) and allow the recloser to provide a close output to the breaker. If no contact closure occurs during the hold time, then the recloser will go to lockout when the hold time expires. In other words, the hold timer will be started only if there HOLD contact input is open, and will be stopped only if the HOLD input contact closes before the hold time expires.

With **HOLDSENSE** set to CO, the recloser will wait for a contact opening at the HOLD input to stop the hold timer (Protection Setting 1816: **HOLDTIME**) and allow the recloser to provide a close output to the breaker. If no contact opening occurs during the hold time, then the recloser will go to lockout when the hold time expires. In other words, the hold timer will be started only if HOLD contact input is closed, and will be stopped only if the HOLD contact input opens before the hold time expires.

1818: SYNCCHECK - Synch Check Supervision Select

SYNCCHECK can be set to YES or NO and establishes if synchronism check is to be used during any of the selected reclosures. The synchronism check function includes angle supervision, slip frequency supervision, and voltage difference supervision, as well as bus and line voltage supervision.

1819: CLOSEANG - Closing Angle

CLOSEANG establishes the closing angle for which the synchronism check function will allow the recloser to produce an output to close the breaker. The **CLOSEANG** setting has a range of 0 to 75°. Select an angle suitable to the application.

1820: SLIPFREQ - Slip Frequency

SLIPFREQ establishes the slip frequency for which the synchronism check function will allow the recloser to produce an output to close the breaker (provided the closing angle requirement is met). The SLIPFREQ setting has a range of 0.1 to 5.0 Hz. Select a slip frequency suitable to the application.

1821: BUSLINE - Bus or Line Voltage

BUSLINE can be set to BUS or LINE and identifies the source of the three phase voltage (bus or line) used to supply the protective relay system. This allows the synchronism check function to ascertain which is bus potential and which is line potential.

1822: SYNCPHASE - Voltage used by SYNCHECK

SYNCPHASE can be set to VA, VB, VC, VAB, VBC or VCA and establishes which phase or phase-pair bus and line voltage is to be used by the synchronism check function. Select a setting that matches the synchroism check voltage input to the relay system.

1823: SYNCHOLD - SYNCHECK Hold Time

SYNCHOLD sets the time that the recloser will wait for a synchronism check input to be applied. If the sync check input is not applied during this time, the recloser will go to lockout when the time delay ends. The range of the **SYNCHOLD** time setting is 1 to 100 seconds. Make a setting that is suitable to the application.

1824: SP1PDELAY2 - Supervise Second Reclose

SP1PDELAY2 can be set to YES or NO and establishes whether the first three-pole reclose (if selected) following an initial single-pole trip will be supervised by the synchronism check function.

1825: SP1PDELAY3 - Supervise Third Reclose

SP1PDELAY3 can be set to YES or NO and establishes whether the second three-pole reclose (if selected) following an initial single-pole trip will be supervised by the synchronism check function.

1826: SP1PDELAY4 - Supervise Fourth Reclose

SP1PDELAY4 can be set to YES or NO and establishes whether the third three-pole reclose (if selected) following an initial single-pole trip will be supervised by the synchronism check function.

1827: SP3PDELAY1 - Supervise First Three-pole Reclose

SP3PDELAY1 can be set to YES or NO and establishes whether the first three-pole reclose (if selected) following an initial three-pole trip will be supervised by the synchronism check function.

1828: SP3PDELAY2 - Supervise Second Three-pole Reclose

SP3PDELAY2 can be set to YES or NO and establishes whether the second three-pole reclose (if selected) following an initial three-pole trip will be supervised by the synchronism check function.

1829: SP3PDELAY3 - Supervise Third Three-pole Reclose

SP3PDELAY3 can be set to YES or NO and establishes whether the third three-pole reclose (if selected) following an initial three-pole trip will be supervised by the synchronism check function.

1830: SP3PDELAY4 - Supervise Fourth Three-pole Reclose

SP3PDELAY4 can be set to YES or NO and establishes whether the fourth three-pole reclose (if selected) following an initial three-pole trip will be supervised by the synchronism check function.

1831: SYNCMANCLS - Supervise Manual Close

SYNCMANCLS can be set to YES or NO and establishes whether manual closing of the breaker will be supervised by the synchronism check function.

1832: VBUSLIVE - Live Bus Voltage

VBUSLIVE establishes the voltage at which the bus voltage must be greater than before the synchronism check function and the functions requiring live bus supervision are allowed to operate. The voltage level can be set over a range of 0.1 to 130.0 V.

1833: VBUSDEAD - Dead Bus Voltage

VBUSDEAD establishes the voltage at which the bus voltage must be less than before the functions requiring dead bus supervision are allowed to operate. The voltage level can be set over a range of 0.1 to 130.0 V.

1834: VLINELIVE - Live Line Voltage

VLINELIVE establishes the voltage at which the line voltage must be greater than before the synchronism check function and the functions requiring live line supervision are allowed to operate. The voltage level can be set over a range of 0.1 to 130.0 V.

1835: VLINEDEAD - Dead Line Voltage

VLINEDEAD establishes the voltage at which the line voltage must be less than before the functions requiring dead line supervision are allowed to operate. The voltage level can be set over a range of 0.1 to 130.0 V.

1836: LBUSDLINE - Live Bus Dead Line

With this setting, reclosing will be permitted if the line is dead (**VLINEDEAD** setting) and the bus is live (**VBUSLIVE** setting). If this operation is desired, set **LBUSDLINE** = YES, otherwise set **LBUSDLINE** = NO.

1837: DBUSLLINE - Dead Bus Live Line

With this setting, reclosing will be permitted if the line is live (**VLINELIVE** setting) and the bus is dead (**VBUSDEAD** setting). If this operation is desired, set **DBUSLLINE** = YES, otherwise set **DBUSLLINE** = NO.

1838: DBUSDLINE - Dead Bus Dead Line

With this setting, reclosing will be permitted if the line is dead (**VLINEDEAD** setting) and the bus is dead (**VBUSDEAD** setting). If this operation is desired, set **DBUSDLINE** = YES, otherwise set **DBUSDLINE** = NO.

1839: DELTAV - Voltage Difference

DELTAV establishes the difference that must exist between the magnitudes of the bus and line voltages before a **DELTAVBLK** output (Protection Setting 1840) is produced. **DELTAV** can be set over a range of 0.1 to 30.0 V.

1840: DELTAVBLK - Block Synch Check by DELTAV

DELTAVBLK can be set to YES or NO and establishes whether the synchronism check function is allowed to operate. Set **DELTAVBLK** = YES to block the synchronism check function, otherwise set **DELTAVBLK** = NO.

2.3.19 NONCRIT_AL

Up to eight of the signals listed in the Index Tables given at the end of this section can be used to produce a non-critical alarm signal (Index Number 52). This signal, when produced, will always be reported as an event and it can also be programmed to drive one of the output relays if an external alarm is required.

1901: NCAIN1 - Non-Critical Alarm Input #1
1902: NCAIN2 - Non-Critical Alarm Input #2
1903: NCAIN3 - Non-Critical Alarm Input #3
1904: NCAIN4 - Non-Critical Alarm Input #4
1905: NCAIN5 - Non-Critical Alarm Input #5
1906: NCAIN6 - Non-Critical Alarm Input #6
1907: NCAIN7 - Non-Critical Alarm Input #7
1908: NCAIN8 - Non-Critical Alarm Input #8

Set these Protection Settings to one of the available Index numbers given in Table 2–7: INDEX NUMBERS – scheme, recloser, & programmable logic on page 2–54.

2.3.20 OUTPUTS

All 24 output contacts (Protection Settings 2001 to 2024) in the LPS-D are configurable. They can be driven by any one of the functions as described by an index number provided in the Index Number Tables on pages 2–52 to 2–54. Each of the contacts has a default setting shown in Table 2–8: PROTECTION SETTINGS GUIDE on page 2–61. The default settings are established through an Xpression Builder file that is downloaded to the LPS-D in the factory. Any of the settings can be changed by modifying this logic via the Xpression Builder program, by settings changes through the ALPS-Link program, or by settings changes with the keypad. Note that any index number settings that are changed through the keypad or ALPS-Link will be reflected in the configurable logic file, while any settings that are changed through the configurable logic will be reflected in the settings file.

2001: T1 - T1 Contact
2002: T2 - T2 contact
2003: T3 - T3 Contact
2004: T4 - T4 Contact
2005: T5 - T5 Contact
2006: T6 - T6 Contact
2007: A1 - A1 Contact
2008: A2 - A2 Contact
2009: A3 - A3 Contact
2010: A4 - A4 Contact
2011: A5 - A5 Contact
2012: A6 - A6 Contact
2013: A7 - A7 Contact
2014: A8- A8 Contact
2015: A9 - A9 Contact
2016: A10 - A10 Contact
2017: A11 - A11 Contact
2018: A12 - A12 Contact
2019: C1 - C1 Contact
2020: C2 - C2 Contact
2021: KT1 - KT1 Contact
2022: KT2 - KT2 Contact
2023: KT3 - KT3 Contact
2024: KT4 - KT4 Contact

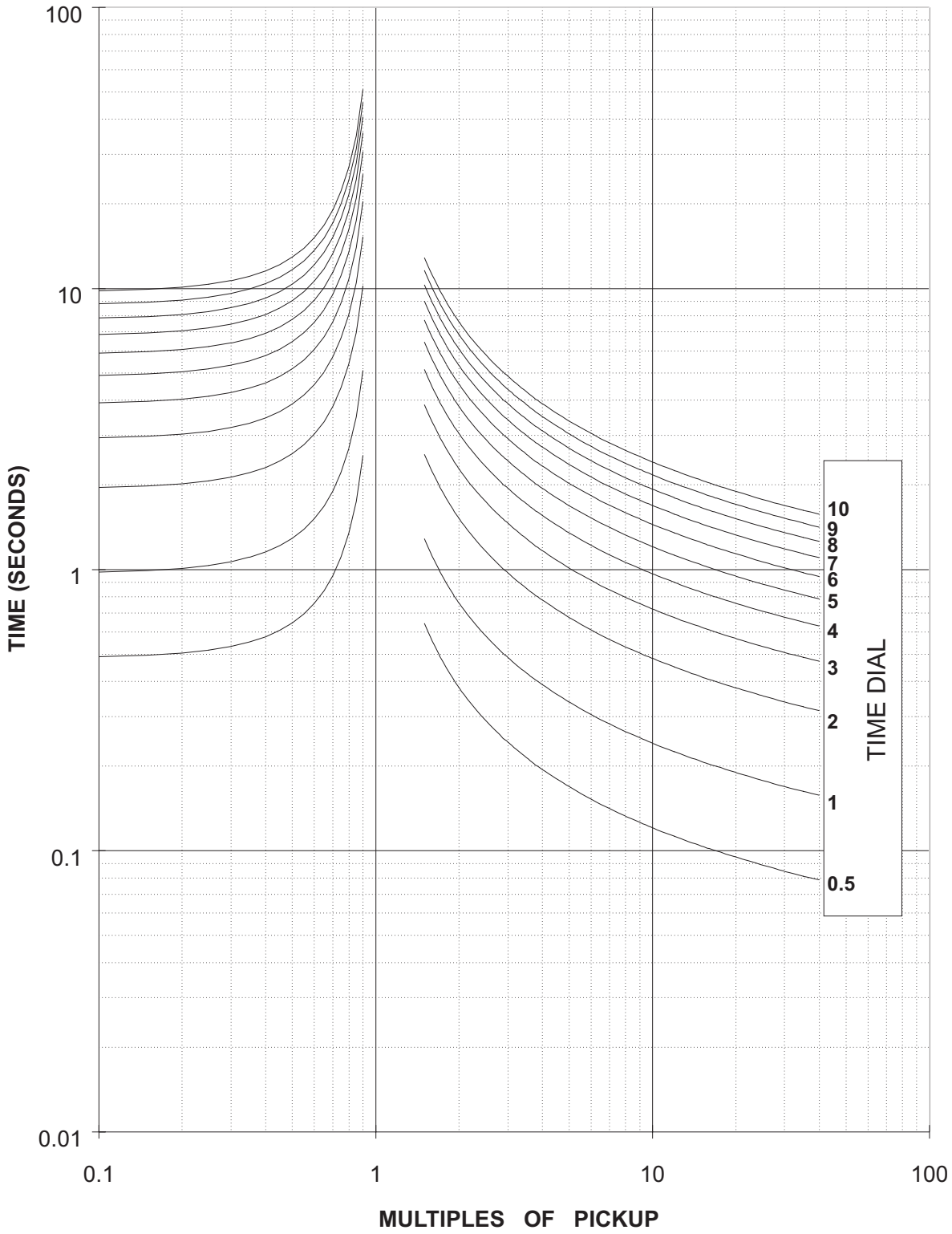
If other than the default setting is to be for any of these Protection settings, change the configurable logic or select an index number reflecting the function by which the contact is to be driven.

2025: CONFTRIP - Initiate Three Pole Trip

The **CONFTRIP** setting allows tripping to be initiated through the trip output contacts that are used by the scheme logic. **CONFTRIP** can be driven by any one of the functions as described by an index number provided in the Table 2–7: INDEX NUMBERS – scheme, recloser, & programmable logic on page 2–54, or separate logic can be designed using the Xpression Builder program.

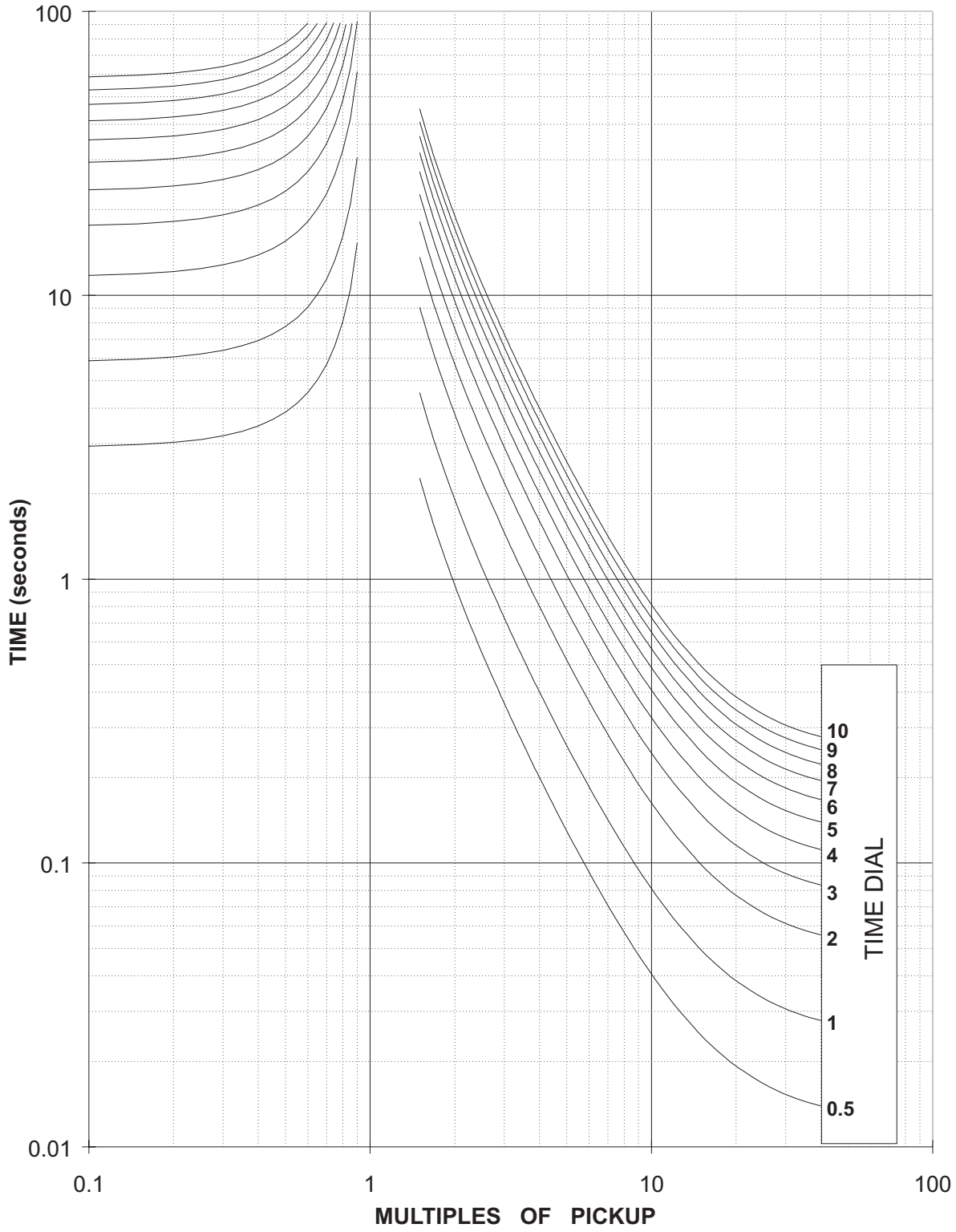
2026: CONFOSC - Trigger Oscillography

The **CONFOSC** setting allows oscillography data capture to be initiated by the operation of selected signals within the LPS-D logic, or via external input through a contact converter. Regardless of the setting of **CONFOSC**, oscillography data capture will always occur when the LPS-D issues a trip output. Care should be taken to ensure that the signals chosen; if one of the selected triggers can operate frequently, trip oscillography data may be overwritten and lost. **CONFOSC** can be driven by any one of the functions as described by an index number provided in Table 2–7: INDEX NUMBERS – scheme, recloser, & programmable logic on page 2–54, or separate logic can be designed using the Xpression Builder program.



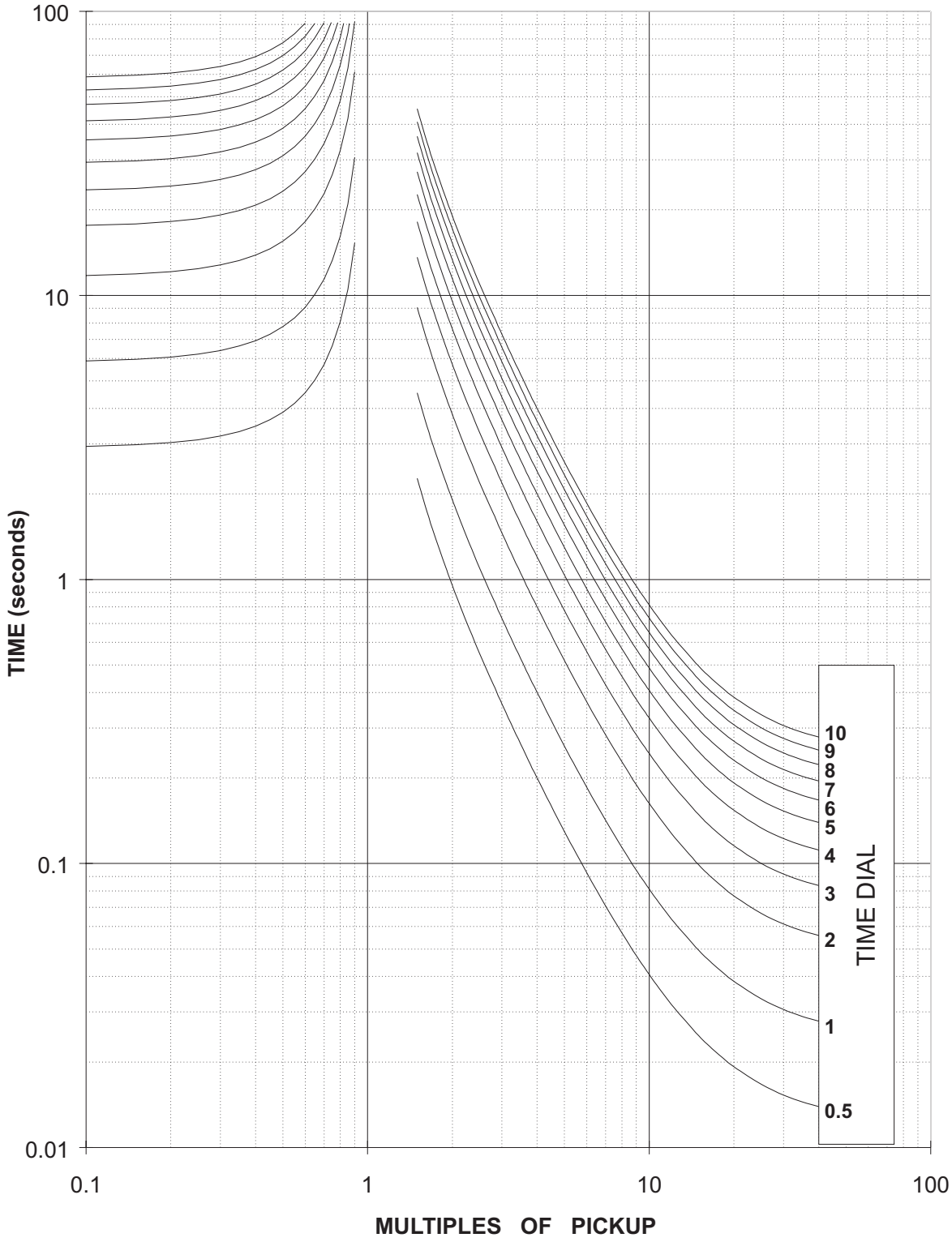
$$t(RESET) = TD\left[\frac{0.97}{1-M^2}\right] \qquad t(PU) = TD\left[\frac{0.0103}{M^{0.02}-1} + 0.0228\right]$$

Figure 2–15: INVERSE CURVE



$$t(RESET) = TD\left[\frac{4.32}{1-M^2}\right] \qquad t(PU) = TD\left[\frac{3.922}{M^2-1} + 0.0982\right]$$

Figure 2–16: VERY INVERSE CURVE



$$t(RESET) = TD\left[\frac{5.82}{1-M^2}\right] \qquad t(PU) = TD\left[\frac{5.64}{M^2-1} + 0.02434\right]$$

Figure 2–17: EXTREMELY INVERSE CURVE

Table 2–6: INDEX NUMBERS – CONTACT CONVERTER INPUT ASSIGNMENT (Sheet 1 of 2)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
1	Breaker #1 52b Contact Input Phase A	52B_1A	1	Breaker #1 52b Contact Input	52B_1
2	Breaker #1 52b Contact Input Phase B	52B_1B	2	Spare	
3	Breaker #1 52b Contact Input Phase C	52B_1C	3	Spare	
4	Breaker #2 52b Contact Input Phase A	52B_2A	4	Breaker #2 52b Contact Input	52B_2
5	Breaker #2 52b Contact Input Phase B	52B_2B	5	Spare	
6	Breaker #2 52b Contact Input Phase C	52B_2C	6	Spare	
7	Enable Three Phase Tripping	EXTRP3P	7	Spare	
8	Change Setting Group Input (BIT0)	CGST1	8	Change Setting Group Input (BIT0)	CGST1
9	Change Setting Group Input (BIT1)	CGST2	9	Change Setting Group Input (BIT1)	CGST2
10	External Contact Input to Stop Carrier *	STCR	10	External Contact Input to Stop Carrier *	STCR
11	External Contact Input to Block Pilot Tripping *	BPLTRP	11	External Contact Input to Block Pilot Tripping*	BLPTRP
12	Receiver 1 Input	RCVR1	12	Receiver 1 Input	RCVR1
13	Receiver 2 Input	RCVR2	13	Receiver 2 Input	RCVR2
14	External Reclose Initiate 1 Pole	EXRI1P	14	Spare	
15	External Reclose Initiate 3 Pole	EXRI3P	15	Spare	
16	External Reclose Inhibit	EXRINH	16	Spare	
17	External Reclose Cancel	EXRCNL	17	Spare	
18	Reclose Reset	RCLRST	18	Spare	
19	External Phase 3 Reclose	CLOS3P	19	Spare	
20	External Contact Input to Reset LPS-D Trip Target Display	RESET	20	External Contact Input to Reset LPS-D Trip Target Display	RESET
21	External Contact Input to Disable Protection	DISPRT	21	External Contact Input to Disable Protection	DISPRT

Note: Any of the above signals (1 to 32) may be assigned to the 8 available LPS-D Contact Converter Inputs (CC1 to CC8). Those 8 signals will also be available for use for the Programmable Outputs and/or the Configurable Logic. Unassigned signals will NOT be available.
* Applies to Blocking Scheme Only

Table 2–6: INDEX NUMBERS – CONTACT CONVERTER INPUT ASSIGNMENT (Sheet 2 of 2)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
22	External Contact Input to Disable Outputs	DISOUT	22	External Contact Input to Disable Outputs	DISOUT
23	External Contact Input to Trigger Oscillography Capture	OSCTRG	23	External Contact Input to Trigger Oscillography Capture	OSCTRG
24	Manual Reclose	MANRCL	24	Spare	
25	CONFIGURABLE INPUT1	CNFDI1	25	CONFIGURABLE INPUT1	CNFDI2
26	CONFIGURABLE INPUT2	CNFDI2	26	CONFIGURABLE INPUT2	CNFDI2
27	CONFIGURABLE INPUT3	CNFDI3	27	CONFIGURABLE INPUT3	CNFDI3
28	CONFIGURABLE INPUT4	CNFDI4	28	CONFIGURABLE INPUT4	CNFDI4
29	CONFIGURABLE INPUT5	CNFDI5	29	CONFIGURABLE INPUT5	CNFDI5
30	CONFIGURABLE INPUT6	CNFDI6	30	CONFIGURABLE INPUT6	CNFDI6
31	CONFIGURABLE INPUT7	CNFDI7	31	CONFIGURABLE INPUT7	CNFDI7
32	CONFIGURABLE INPUT8	CNFDI8	32	CONFIGURABLE INPUT8	CNFDI8

Note: Any of the above signals (1 to 32) may be assigned to the 8 available LPS-D Contact Converter Inputs (CC1 to CC8). Those 8 signals will also be available for use for the Programmable Outputs and/or the Configurable Logic. Unassigned signals will NOT be available.
* Applies to Blocking Scheme Only

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 1 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
33	Trip Bus Phase A	TRIPA	33	Trip Bus	TRIP
34	Trip Bus Phase B	TRIPB	34	Not used	
35	Trip Bus Phase C	TRIPC	35	Not used	
36	1P Reclose Initiate	RI-1P	36	Not used	
37	3P Reclose Initiate	RI-3P	37	Initial Reclose from Scheme Logic	RI
38	Reclose Cancel Output from Scheme Logic	CANCL	38	Reclose Cancel Output from Scheme Logic	CANCL
39	KEY XMTR1/CARR START Output from Scheme Logic	KEY1	39	KEY XMTR1/CARR START Output from Scheme Logic	KEY1
40	KEY XMTR2/CARR STOP Output from Scheme Logic	KEY2	40	KEY XMTR2/CARR STOP Output from Scheme Logic	KEY2
41	3 Phase Trip Enable	TRIP3P	41	Not used	
42	Spare		42	Spare	
43	Spare		43	Spare	
44	Reclose in Progress	RIP	44	Spare	
45	Line Over Load Alarm Output	LNOVLD	45	Line Over Load Alarm Output	LNOVLD
46	Critical Alarm Output	CRTALM	46	Critical Alarm Output	CRTALM
47	Spare		47	Spare	
48	Trip Circuit Alarm	TCMALM	48	Trip Circuit Alarm	TCMALM
49	Zone Flags On Alarm	ZNALM	49	Zone Flags On Alarm	ZNALM
50	Overcurrent Alarm	OVRALM	50	Overcurrent Alarm	OVRALM
51	Unbalanced Current Detector Alarm Output	UNBAL	51	Unbalanced Current Detector Alarm Output	UNBAL
52	Non-Critical Alarm Output	NCALM	52	Non-Critical Alarm Output	NCALM
53	Spare		53	Spare	
54	Spare		54	Spare	
55	Spare		55	Spare	
56	MANUAL OPEN BRK1	MNOPN1	56	MANUAL OPEN BRK1	MNOPN1
57	MANUAL OPEN BRK2	MNOPN2	57	MANUAL OPEN BRK2	MNOPN2
58	MANUAL CLOSE BRK1	MNCLS1	58	MANUAL CLOSE BRK1	MNCLS1
59	MANUAL CLOSE BRK2	MNCLS2	59	MANUAL CLOSE BRK2	MNCLS2
60	Fault ID: Phase A Involved	DAFLTA	60	Fault ID: Phase A Involved	DAFLTA
61	Fault ID: Phase B Involved	DAFLTB	61	Fault ID: Phase B Involved	DAFLTB
62	Fault ID: Phase C Involved	DAFLTC	62	Fault ID: Phase C Involved	DAFLTC
63	Fault ID: Neutral Involved	DAFLTN	63	Fault ID: Neutral Involved	DAFLTN

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 2 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
64	Spare		64	DMA Overrun	DMAOVR
65	Zone 1 AB Distance Function	Z1AB	65	Zone 1 AB Distance Function	Z1AB
66	Zone 1 BC Distance Function	Z1BC	66	Zone 1 BC Distance Function	Z1BC
67	Zone 1 CA Distance Function	Z1CA	67	Zone 1 CA Distance Function	Z1CA
68	Zone 2 AB Distance Function	Z2AB	68	Zone 2 AB Distance Function	Z2AB
69	Zone 2 BC Distance Function	Z2BC	69	Zone 2 BC Distance Function	Z2BC
70	Zone 2 CA Distance Function	Z2CA	70	Zone 2 CA Distance Function	Z2CA
71	Zone 3 AB Distance Function	Z3AB	71	Zone 3 AB Distance Function	Z3AB
72	Zone 3 BC Distance Function	Z3BC	72	Zone 3 BC Distance Function	Z3BC
73	Zone 3 CA Distance Function	Z3CA	73	Zone 3 CA Distance Function	Z3CA
74	Zone 4 AB Distance Function	Z4AB	74	Zone 4 AB Distance Function	Z4AB
75	Zone 4 BC Distance Function	Z4BC	75	Zone 4 BC Distance Function	Z4BC
76	Zone 4 CA Distance Function	Z4CA	76	Zone 4 CA Distance Function	Z4CA
77	Any Z1 Phase Distance Function	Z1PH	77	Any Z1 Phase Distance Function	Z1PH
78	Any Z2 Phase Distance Function	Z2PH	78	Any Z2 Phase Distance Function	Z2PH
79	Any Z3 Phase Distance Function	Z3PH	79	Any Z3 Phase Distance Function	Z3PH
80	Any Z4 Phase Distance Function	Z4PH	80	Any Z4 Phase Distance Function	Z4PH
81	Zone 1 AG Distance Function	Z1AG	81	Zone 1 AG Distance Function	Z1AG
82	Zone 1 BG Distance Function	Z1BG	82	Zone 1 BG Distance Function	Z1BG
83	Zone 1 CG Distance Function	Z1CG	83	Zone 1 CG Distance Function	Z1CG
84	Zone 2 AG Distance Function	Z2AG	84	Zone 2 AG Distance Function	Z2AG
85	Zone 2 BG Distance Function	Z2BG	85	Zone 2 BG Distance Function	Z2BG
86	Zone 2 CG Distance Function	Z2CG	86	Zone 2 CG Distance Function	Z2CG
87	Zone 3 AG Distance Function	Z3AG	87	Zone 3 AG Distance Function	Z3AG
88	Zone 3 BG Distance Function	Z3BG	88	Zone 3 BG Distance Function	Z3BG
89	Zone 3 CG Distance Function	Z3CG	89	Zone 3 CG Distance Function	Z3CG
90	Zone 4 AG Distance Function	Z3AG	90	Zone 4 AG Distance Function	Z3AG
91	Zone 4 BG Distance Function	Z4BG	91	Zone 4 BG Distance Function	Z4BG
92	Zone 4 CG Distance Function	Z4CG	92	Zone 4 CG Distance Function	Z4CG
93	Any Z1 Ground Distance Function	Z1GRD	93	Any Z1 Ground Distance Function	Z1GRD
94	Any Z2 Ground Distance Function	Z2GRD	94	Any Z2 Ground Distance Function	Z2GRD
95	Any Z3 Ground Distance Function	Z3GRD	95	Any Z3 Ground Distance Function	Z3GRD
96	Any Z4 Ground Distance Function	Z4GRD	96	Any Z4 Ground Distance Function	Z4GRD
97	Phase A Open	AOPEN	97	Not used	

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 3 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
98	Phase B Open	BOPEN	98	Not used	
99	Phase C Open	COPEN	99	Not used	
100	All Phases Open	3OPEN	100	All Phases Open	3OPEN
101	Any Phases Open	ANYOPN	101	Any Phases Open	ANYOPN
102	1 Pole Open	1OPEN	102	Not used	
103	Any Phase Undervoltage	ANYUVT	103	Any Phase Undervoltage	ANYUVT
104	All Voltages High (No Phase Undervoltage)	ALLVLT	104	All Voltages High (No Phase Undervoltage)	ALLVLT
105	Fault Detector (FD)	FLTDET	105	Fault Detector (FD)	FLTDET
106	TL1 Timer Output	TL1	106	TL1 Timer Output	TL1
107	IT Detector	IT	107	IT Detector	IT
108	IB Detector	IB	108	IB Detector	IB
109	IPT Detector	IPT	109	IPT Detector	IPT
110	IPB Detector	IPB	110	IPB Detector	IPB
111	Remote Breaker Open Detector	REMOPN	111	Remote Breaker Open Detector	REMOPN
112	Ground Directional Trip (Nt·Ipt)	GRDTRP	112	Ground Directional Trip (Nt·Ipt)	GRDTRP
113	Ground Directional Block (Nb·Ipb)	GRDBLK	113	Ground Directional Block (Nb·Ipb)	GRDBLK
114	Line Pickup	LPU	114	Line Pickup	LPU
115	Fuse Failure Alarm	FF	115	Fuse Failure Alarm	FF
116	Instantaneous Phase Overcurrent (50P/Ph4)	PH4	116	Instantaneous Phase Overcurrent (50P/Ph4)	PH4
117	Instantaneous Ground Overcurrent (50G/Idt)	IDT	117	Instantaneous Ground Overcurrent (50G/Idt)	IDT
118	Ground Time Overcurrent Pick Up	TOCACT	118	Ground Time Overcurrent Pick Up	TOCACT
119	Ground Time Overcurrent Trip (51G/Toc)	TOCTRP	119	Ground Time Overcurrent Trip (51G/Toc)	TOCTRP
120	Out of Step Blocking	OSB	120	Out of Step Blocking	OSB
121	Spare		121	Spare	
122	Configurable Trip Bus Input	CNFTRP	122	Configurable Trip Bus Input	CNFTRP
123	Configurable Oscillography Trigger	CNFOSC	123	Configurable Oscillography Trigger	CNFOSC
124	TL16 Timer Output	TL16	124	TL16 Timer Output	TL16
125	TL24 Timer Output	TL24	125	TL24 Timer Output	TL24
126	Ground Forward Flag (NT)	GRDFWD	126	Ground Forward Flag (NT)	GRDFWD
127	Ground Reverse Flag (NB)	GRDREV	127	Ground Reverse Flag (NB)	GRDREV
128	TL25 Timer Output	TL25	128	TL25 Timer Output	TL25

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 4 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
129	Z2 Ground Timer	Z2GTMR	129	Z2 Ground Timer	Z2GTMR
130	Z3 Ground Timer	Z3GTMR	130	Z3 Ground Timer	Z3GTMR
131	Z4 Ground Timer	Z4GTMR	131	Z4 Ground Timer	Z4GTMR
132	Z2 Phase Timer	Z2PTMR	132	Z2 Phase Timer	Z2PTMR
133	Z3 Phase Timer	Z3PTMR	133	Z3 Phase Timer	Z3PTMR
134	Z4 Phase Timer	Z4PTMR	134	Z4 Phase Timer	Z4PTMR
135	Any Trip Bus	TRPBUS	135	Any Trip Bus	TRPBUS
136	Weak Infeed Trip	WITRIP	136	Weak Infeed Trip	WITRIP
137	Sync Check	SYNC	137	Sync Check	SYNC
138	Number of Breaker Operation Alarm	BRMNOP	138	Number of Breaker Operation Alarm	BRMNOP
139	Breaker Equipment Duty Alarm	BRMNDT	139	Breaker Equipment Duty Alarm	BRMNDT
140	Any Phase Over Voltage Pickup	OVRVPU	140	Any Phase Over Voltage Pickup	OVRVPU
141	Positive Sequence Over Voltage Pickup	V1TPU	141	Spare	
142	Compensated Positive Sequence Over Voltage Pickup	V1CPU	142	Spare	
143	I1 Line Pickup	I1PU	143	Spare	
144	Block Reclose Initiate	BLK_RI	144	Spare	
145	Inhibit Reclose Initiate	INH_RI	145	Spare	
146	Block Reclose	BK RCLS	146	Spare	
147	Trip Circuit #1 Voltage Monitor Status	T1TC	147	Trip Circuit #1 Voltage Monitor Status	T1TC
148	Trip Circuit #2 Voltage Monitor Status	T2TC	148	Trip Circuit #2 Voltage Monitor Status	T2TC
149	Trip Circuit #3 Voltage Monitor Status	T3TC	149	Trip Circuit #3 Voltage Monitor Status	T3TC
150	Trip Circuit #4 Voltage Monitor Status	T4TC	150	Trip Circuit #4 Voltage Monitor Status	T4TC
151	Trip Circuit #5 Voltage Monitor Status	T5TC	151	Spare	
152	Trip Circuit #6 Voltage Monitor Status	T6TC	152	Spare	
153	PHASE A OVERVOLTAGE	AVOVR	153	PHASE A OVERVOLTAGE	AVOVR
154	PHASE B OVERVOLTAGE	BVOVR	154	PHASE B OVERVOLTAGE	BVOVR
155	PHASE C OVERVOLTAGE	CVOVR	155	PHASE C OVERVOLTAGE	CVOVR
156	Instantaneous Positive Sequence Overvoltage	V1IOVR	156	Instantaneous Positive Sequence Overvoltage	V1IOVR

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 5 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
157	Time Delayed Positive Sequence Overvoltage	V1TOVR	157	Time Delayed Positive Sequence Overvoltage	V1TOVR
158	Instantaneous Compensated Positive Sequence Overvoltage	V1COVR	158	Spare	
159	Time Delayed Compensated Positive Sequence Overvoltage	V1CTOV	159	Spare	
160	Any Phase Overvoltage	OVRVLT	160	Any Phase Overvoltage	OVRVLT
161	Programmable Logic Gate #1 Output	G1	161	Programmable Logic Gate #1 Output	G1
162	Programmable Logic Gate #2 Output	G2	162	Programmable Logic Gate #2 Output	G2
163	Programmable Logic Gate #3 Output	G3	163	Programmable Logic Gate #3 Output	G3
164	Programmable Logic Gate #4 Output	G4	164	Programmable Logic Gate #4 Output	G4
165	Programmable Logic Gate #5 Output	G5	165	Programmable Logic Gate #5 Output	G5
166	Programmable Logic Gate #6 Output	G6	166	Programmable Logic Gate #6 Output	G6
167	Programmable Logic Gate #7 Output	G7	167	Programmable Logic Gate #7 Output	G7
168	Programmable Logic Gate #8 Output	G8	168	Programmable Logic Gate #8 Output	G8
169	Programmable Logic Gate #9 Output	G9	169	Programmable Logic Gate #9 Output	G9
170	Programmable Logic Gate #10 Output	G10	170	Programmable Logic Gate #10 Output	G10
171	Programmable Logic Gate #11 Output	G11	171	Programmable Logic Gate #11 Output	G11
172	Programmable Logic Gate #12 Output	G12	172	Programmable Logic Gate #12 Output	G12
173	Programmable Logic Gate #13 Output	G13	173	Programmable Logic Gate #13 Output	G13
174	Programmable Logic Gate #14 Output	G14	174	Programmable Logic Gate #14 Output	G14
175	Programmable Logic Gate #15 Output	G15	175	Programmable Logic Gate #15 Output	G15
176	Programmable Logic Gate #16 Output	G16	176	Programmable Logic Gate #16 Output	G16
177	Programmable Logic Gate #17 Output	G17	177	Programmable Logic Gate #17 Output	G17
178	Programmable Logic Gate #18 Output	G18	178	Programmable Logic Gate #18 Output	G18
179	Programmable Logic Gate #19 Output	G19	179	Programmable Logic Gate #19 Output	G19
180	Programmable Logic Gate #20 Output	G20	180	Programmable Logic Gate #20 Output	G20

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 6 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
181	Programmable Logic Gate #21 Output	G21	181	Programmable Logic Gate #21 Output	G21
182	Programmable Logic Gate #22 Output	G22	182	Programmable Logic Gate #22 Output	G22
183	Programmable Logic Gate #23 Output	G23	183	Programmable Logic Gate #23 Output	G23
184	Programmable Logic Gate #24 Output	G24	184	Programmable Logic Gate #24 Output	G24
185	Programmable Logic Gate #25 Output	G25	185	Programmable Logic Gate #25 Output	G25
186	Programmable Logic Gate #26 Output	G26	186	Programmable Logic Gate #26 Output	G26
187	Programmable Logic Gate #27 Output	G27	187	Programmable Logic Gate #27 Output	G27
188	Programmable Logic Gate #28 Output	G28	188	Programmable Logic Gate #28 Output	G28
189	Programmable Logic Gate #29 Output	G29	189	Programmable Logic Gate #29 Output	G29
190	Programmable Logic Gate #30 Output	G30	190	Programmable Logic Gate #30 Output	G30
191	Programmable Logic Gate #31 Output	G31	191	Programmable Logic Gate #31 Output	G31
192	Programmable Logic Gate #32 Output	G32	192	Programmable Logic Gate #32 Output	G32
193	Programmable Logic Gate #33 Output	G33	193	Programmable Logic Gate #33 Output	G33
194	Programmable Logic Gate #34 Output	G34	194	Programmable Logic Gate #34 Output	G34
195	Programmable Logic Gate #35 Output	G35	195	Programmable Logic Gate #35 Output	G35
196	Programmable Logic Gate #36 Output	G36	196	Programmable Logic Gate #36 Output	G36
197	Programmable Logic Gate #37 Output	G37	197	Programmable Logic Gate #37 Output	G37
198	Programmable Logic Gate #38 Output	G38	198	Programmable Logic Gate #38 Output	G38
199	Programmable Logic Gate #39 Output	G39	199	Programmable Logic Gate #39 Output	G39
200	Programmable Logic Gate #40 Output	G40	200	Programmable Logic Gate #40 Output	G40

TABLE 2–7: INDEX NUMBERS – SCHEME, RECLOSER, & PROGRAMMABLE LOGIC (Sheet 7 of 7)

LPS-D with Single Phase Tripping			LPS-D with Three Phase Tripping		
Index	**Description**	**Mnemonic**	**Index**	**Description**	**Mnemonic**
201 to 224	Spare		201 to 224	Spare	
225	Programmable Logic Timer 1 Output	TM1	225	Programmable Logic Timer 1 Output	TM1
226	Programmable Logic Timer 1 Reset	TM1RST	226	Programmable Logic Timer 1 Reset	TM1RST
227	Programmable Logic Timer 2 Output	TM2	227	Programmable Logic Timer 2 Output	TM2
228	Programmable Logic Timer 2 Reset	TM2RST	228	Programmable Logic Timer 2 Reset	TM2RST
229	Programmable Logic Timer 3 Output	TM3	229	Programmable Logic Timer 3 Output	TM3
230	Programmable Logic Timer 3 Reset	TM3RST	230	Programmable Logic Timer 3 Reset	TM3RST
231	Programmable Logic Timer 4 Output	TM4	231	Programmable Logic Timer 4 Output	TM4
232	Programmable Logic Timer 4 Reset	TM4RST	232	Programmable Logic Timer 4 Reset	TM4RST
233	Programmable Logic Timer 5 Output	TM5	233	Programmable Logic Timer 5 Output	TM5
234	Programmable Logic Timer 5 Reset	TM5RST	234	Programmable Logic Timer 5 Reset	TM5RST
235	Programmable Logic Timer 6 Output	TM6	235	Programmable Logic Timer 6 Output	TM6
236	Programmable Logic Timer 6 Reset	TM6RST	236	Programmable Logic Timer 6 Reset	TM6RST
237	Programmable Logic Timer 7 Output	TM7	237	Programmable Logic Timer 7 Output	TM7
238	Programmable Logic Timer 7 Reset	TM7RST	238	Programmable Logic Timer 7 Reset	TM7RST
239	Programmable Logic Timer 8 Output	TM8	239	Programmable Logic Timer 8 Output	TM8
240	Programmable Logic Timer 8 Reset	TM8RST	240	Programmable Logic Timer 8 Reset	TM8RST
241	Programmable Logic Counter 1	CNTR1	241	Programmable Logic Counter 1	CNTR1
242	Programmable Logic Counter 2	CNTR2	242	Programmable Logic Counter 2	CNTR2
243	Programmable Logic Counter 3	CNTR3	243	Programmable Logic Counter 3	CNTR3
244	Programmable Logic Counter 4	CNTR4	244	Programmable Logic Counter 4	CNTR4
245	Programmable Logic Counter 5	CNTR5	245	Programmable Logic Counter 5	CNTR5
246	Programmable Logic Counter 6	CNTR6	246	Programmable Logic Counter 6	CNTR6
247	Programmable Logic Counter 7	CNTR7	247	Programmable Logic Counter 7	CNTR7
248	Programmable Logic Counter 8	CNTR8	248	Programmable Logic Counter 8	CNTR8
249	Programmable Logic LATCH 1	LATCH1	249	Programmable Logic LATCH 1	LATCH1
250	Programmable Logic LATCH 2	LATCH2	250	Programmable Logic LATCH 2	LATCH2
251	Programmable Logic LATCH 3	LATCH3	251	Programmable Logic LATCH 3	LATCH3
252	Programmable Logic LATCH 4	LATCH4	252	Programmable Logic LATCH 4	LATCH4
253	Programmable Logic LATCH 5	LATCH5	253	Programmable Logic LATCH 5	LATCH5
254	Programmable Logic LATCH 6	LATCH6	254	Programmable Logic LATCH 6	LATCH6
255	Programmable Logic LATCH 7	LATCH7	255	Programmable Logic LATCH 7	LATCH7
256	Programmable Logic LATCH 8	LATCH8	256	Programmable Logic LATCH 8	LATCH8

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 1 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
Z1DISTANCE					
101	Z1PHASE	Z1 Phase Distance	NO, YES		YES
102	Z1PHREACH	Z1 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	5.40Ω at 5A 27.0Ω at 1A
103	Not used				
104	Z1GROUND	Z1 Ground Distance	NO, YES		YES
105	Z1GRDREACH	Z1 Ground Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	5.40Ω at 5A 27.0Ω at 1A
106	Z1GRDCHAR	Z1 Ground Characteristic	MHO, REACT, QUAD †		MHO
107	Z1SUREACH	Z1 Ground Reaction Mho Supervision Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250 Ω step 0.05	20.0Ω at 5A 100Ω at 1A
108	Z1GROUNDK0	Z1 Ground K0	1.0 to 7.0 step 0.01		2.7
109	Not used				
110	Z1BLOCK	Blocking Supervision of Z1	NO, YES		NO
111 †	Z1GCHARANG	Z1 Ground Characteristic Timer Angle	80° to 155° step 1		90°
112 †	Z1RGREACH	Z1 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	8.1 Ω at 5A 40.5 Ω at 1A
Z2DISTANCE					
201	Z2PHASE	Z2 Phase Distance	NO, YES		YES
202	Z2PHREACH	Z2 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	9.00Ω at 5A 45.0Ω at 1A
203	Z2PCHARANG	Z2 Phase Characteristic Angle	90° to 120° step 5		90°
204	Z2GROUND	Z2 Ground Distance	NO, YES		YES
205	Z2GRDCHAR	Z2 Ground Characteristic	MHO, GDOC, MHOGDOC, QUAD †		MHO
206	Z2GRDREACH	Z2 Ground Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	9.00Ω at 5A 45.0Ω at 1A
207	Z2GCHARANG	Z2 Ground Characteristic Angle	80° to 155° step 5		90°
208	Z2TIMERS	Z2 Timers	NO, YES		YES
209	Z2P_TIME	Z2 Phase Timer	0.10 to 3.0 sec. step 0.01		1.0 sec.
210	Z2G_TIME	Z2 Ground Timer	0.10 to 3.0 sec. step 0.01		1.0 sec.

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 2 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
211 †	Z2RGREACH	Zone 2 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	13.5 Ω at 5A 67.5 Ω at 1A
Z3DISTANCE					
301	Z3PHASE	Z3 Phase Distance	NO, YES		YES
302	Z3PHREACH	Z3 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	12.0Ω at 5A 60.0Ω at 1A
303	Z3PCHARANG	Z3 Phase Characteristic Angle	90° to 120° step 5		90°
304	Z3GROUND	Z3 Ground Distance	NO, YES		YES
305	Z3GRDREACH	Z3 Ground Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	12.0Ω at 5A 60.0Ω at 1A
306	Z3GCHARANG	Z3 Ground Characteristic Angle	80° to 155° step 5		90°
307	Z3P_TIME	Z3 Phase Timer	0.10 to 10.0 sec. step 0.01		2.0 sec.
308	Z3G_TIME	Z3 Ground Timer	0.10 to 10.0 sec. step 0.01		2.0 sec.
309 †	Z3GRDCHAR	Z3 Ground Characteristic	MHO, QUAD †		MHO
310 †	Z3RGREACH	Z3 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	18.0 Ω at 5A 90.0 Ω at 1A
Z4DISTANCE					
401	Z4PHASE	Z4 Phase Distance	NO, YES		YES
402	Z4PHREACH	Z4 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	18.0Ω at 5A 90.0Ω at 1A
403	Z4PCHARANG	Z4 Phase Characteristic Angle	80° to 120° step 5		90°
404	Not Used				
405	Z4GRND	Z4 Ground Distance	NO, YES		YES
406	Z4GRDREACH	Z4 Ground Reach	0.01 to 50.0 Ω step 0.01	0.01 to 250.0 Ω step 0.05	18.0Ω at 5A 90.0Ω at 1A
407	Z4GCHARANG	Z4 Ground Characteristic Angle	80° to 155° step 5		90°
408	Z4DIRECTN	Z4 Direction	FORWRD, REVERS		FORWRD
409	Z4_TIMERS	Z4 Timers	NO, YES		YES
410	Z4P_TIME	Z4 Phase Timer	0.10 to 10.0 sec. step 0.01		3.0 sec.
411	Z4G_TIME	Z4 Ground Timer	0.10 to 10.0 sec. step 0.01		3.0 sec.
412 †	Z4GRDCHAR	Z4 Ground Characteristic	MHO, QUAD †		MHO
413 †	Z4RGREACH	Z4 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	27 Ω at 5A 135 Ω at 1A

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 3 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
CURVSUPVISN					
501	IT_PICKUP	Trip Supervision Current	0.20 to 4.0 amps step 0.01	0.04 to 0.8 amps step 0.01	0.20 A at 5A 0.04 A at 1A
502	IB_PICKUP	Block Supervision Current	0.20 to 4.0 amps step 0.01	0.04 to 0.8 amps step 0.01	0.20 A at 5A 0.04 A at 1A
503	IPT_PICKUP	GDOC Trip Current	0.50 to 5.0 amps step 0.01	0.10 to 1.0 amps step 0.01	0.75 A at 5A 0.15 A at 1A
504	IPB_PICKUP	GDOC Block Current	0.25 to 3.75 amps step 0.01	0.05 to 0.75 amps step 0.01	0.25 A at 5A 0.05 A at 1A
505	IPBKFACTOR	IPB I1 Restraint	0.0, 0.066		0.066
506	NT_OFFSET	NT/NB Offset	0.0 to 20.0 Ω step 0.01	0.0 to 100 Ω step 0.01	0.05Ω at 5A 0.25Ω at 1A
507	UNBALALARM	Unbalanced Current Alarm	NO, YES		YES
OVERCURRNT					
601	50	Phase Instantaneous Overcurrent	NO, YES		NO
602	50_DIRCNL	Directional Control of 50	NO, YES		YES
603	50PICKUP	50 Pickup Setting	2.0 to 160.0 amps step 0.1	0.4 to 32.0 amps step 0.1	20.0 A at 5A 4.0A at 1A
604	50PICKUPFF	50 Pickup during fuse failure	2.0 to 160.0 amps step 0.1	0.4 to 32.0 amps step 0.1	30.0 A at 5A 6.0 A at 1A
605	50G	Ground Instantaneous Overcurrent	NO, YES		YES
606	50G_DIRCNL	Directional Control of 50G	NO, YES		YES
607	50GPICKUP	50G Pickup Setting	0.5 to 80.0 amps step 0.1	0.1 to 16.0 amps step 0.1	10.0 A at 5A 2.0 A at 1A
608	50GPCKPFF	50G Pickup during fuse failure	0.5 to 80.0 amps step 0.1	0.1 to 16.0 amps step 0.1	15.0 A at 5A 3.0A at 1A
609	50GRESTNT	50G Restraint Setting	0.0, 0.3		0.3
610	51G	Ground Time Overcurrent	NO, YES		YES
611	51G_DIRCNL	Directional Control of 51G	NO, YES		YES
612	51GPICKUP	51G Pickup Setting	0.20 to 15.0 amps step 0.01	0.04 to 3.0 amps step 0.01	1.0 A at 5A 0.2 A at 1A
613	51GPCKUPFF	51G Pickup during fuse failure	0.20 to 15.0 amps step 0.01	0.04 to 3.0 amps step 0.01	2.0 A at 5A 0.4 A at 1A

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 4 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
614	51GCURVE	51G Curve	INV, V-INV, E-INV, CUSTOM, DEFT		V-INV
615	51GTIMDIAL	51G Time Dial	0.5 to 10.0 step 0.1		5
616	DEFTIMDELY	Definite Time Delay	0.5 to 30.0 sec. step 0.1		1.0 sec.
617	51G_RESET	51G Reset Characteristic	FAST, EM		FAST
VOLTAGE					
701	RATEDVOLTS	Rated Per Unit Voltage	100, 105,110,115, 120 volts		115 volts
702	PHASEOVER	Select Phase Overvoltage	NO, YES		NO
703	PHOVPICKUP	Phase Overvoltage Pickup	0.0 to 1.4 p.u. volts step 0.01		1.4 V
704	PHOVTMDLY	Phase Overvoltage Time Delay	0.0 to 10.0 sec. step 0.01		0.50 sec.
705 to 713 Not used					
714	FUSEFAIL	Potential Fuse Failure Blocking	NO, YES		YES
BLK RECLOS					
801	ALL_BELOW	Block reclosing for any function	NO, YES		NO
802	OUTOFSTEP	Block for Out of Step	NO, YES		NO
803	ALL_3_Z2PH	Block for 3 phase faults	NO, YES		NO
804	50G_BLOCK	Block for 50G trip	NO, YES		NO
805	Z2TIMETRIP	Block for Z2 Time Delayed Trip	NO, YES		NO
806	Z3TIMETRIP	Block for Z3 Time Delayed Trip	NO, YES		NO
807	Z4TIMETRIP	Block for Z4 Time Delayed Trip	NO, YES		NO
808	Z1PHASTRIP	Block for any Z1 Phase Fault	NO, YES		NO
809	ANYZ2PHASE	Block for any Z2 Phase Fault	NO, YES		NO
810	CONFGTRIP	Block For Configurable Trip Logic	NO, YES		NO
LINEPICKUP					
901	LINEPICKUP	Select Line Pickup	NO, YES		NO
902	BYPASSTL3	Bypass Line Pickup Time Delay	NO, YES		NO
903	I1PICKUP	I1 Pickup	1.0 to 15.0 amps step 0.1	0.2 to 3.0 amps step 0.1	3.0 A at 5A 0.6 A at 1A
REMOTEOPEN (THREE PHASE SYSTEMS ONLY)					
1001	REMOTEOPEN	Select Remote Open Detector	NO, YES		NO

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 5 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
1002	TL20PICKUP	Remote Open Detector Time Delay	10 to 100 msec. step 1		100 msec.
LINE OVERLD					
1101	LINEOVERLD	Select Line Overload Protection	NO, YES		NO
1102	LEVEL1PU	Level 1 pickup current	2.5 to 20 amps step 0.1	0.5 to 4.0 amps step 0.1	10 A at 5A 2 A at 1A
1103	LEVEL2PU	Level 2 pickup current	5.0 to 40.0 amps step 0.1	1.0 to 8.0 amps step 0.1	20 A at 5A 4 A at 1A
1104	LEVEL1TDLY	Level 1 time delay	10 to 200 sec. step 1		50 sec.
1105	LEVEL2TDLY	Level 2 time delay	10 to 99 sec. step 1		25 sec.
SCHEME					
1201	PICKSCHEME	Select a scheme logic	STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK		STEPDST
1202	NUMRCVR	Select a number of receivers	0, 1, 2		0
1203^	TRIPMODE	1-phase / 3-phase Trip Mode	3POLE, 1POLE, 1POLEZ2		3POLE
1204	CARRSTART	Select Function to use to Start Carrier in BLOCKing scheme	DIR, IPB, FD		IPB
1205	WKINFTRIP	Select Weak Infeed Tripping for HYBRID scheme	NO, YES		NO
SCHEMETIMERS					
1301	TL1PICKUP	Trip Integrator	1 to 200 msec. step 1		5 msec.
1302	TL4PICKUP	POTT Coord Timer PU	0 to 50 msec. step 1		0 msec.
1303	TL4DROPOUT	POTT Coord Timer DO	0 to 50 msec. step 1		0 msec.
1304	TL5PICKUP	BKR1 b sw Coord Timer PU	0 to 200 msec. step 1		50 msec.
1305	TL5DROPOUT	BKR1 b sw Coord Timer DO	0 to 200 msec. step 1		50 msec.
1306	TL6PICKUP	BKR2 b sw Coord Timer PU	0 to 200 msec. step 1		50 msec.
1307	TL6DROPOUT	BKR2 b sw Coord Timer DO	0 to 200 msec. step 1		50 msec.
1308	TL16PICKUP	Weak Infeed Trip Timer	8 to 99 msec. step 1		8 msec.
1309	TL24DRPPOUT	GDOC Blocking Timer	30 to 500 msec. step 1		30 msec.
1310	TL25DRPOUT	Distance Blocking Timer	30 to 500 msec. step 1		30 msec.
1311	TL26PICKUP	Repeat Delay Timer	0 to 50 msec. step 1		0 msec.

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 6 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
LINEINFO					
1401	POSSEQANG	Positive Sequence Impedance Angle	25 to 90° step 1		85°
1402	ZERSEQANG	Zero Sequence Impedance Angle	25 to 90° step 1		75°
1403	ZLINE	Positive Sequence Line Impedance in sec.ohms	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	6 Ω at 5A 30 Ω at 1A
1404	ZEROSEQK0	Z0/Z1 Ratio	1.0 to 7.0 step 0.1		3.0
1405	LINELENGTH	Line Length	0.0 to 500.0 step 0.1		100.0
1406	LINEUNIT	Units of Length	MILES, KM		MILES
1407	CTRATIO	CT Ratio	1 to 5000 step 1		400 for 5A 2000 for 1A
1408	PTRATIO	PT Ratio	1 to 7000 step 1		3000
SCADA_DATA					
1501	FLTLOCK	Hold Time	0 to 99.9 sec. step 0.1		0 sec.
1502	FLTRESET	Fault Location Reset Time	0 to 999 minutes step 1		0 minutes
OS BLOCKING					
1601	MOBZONE	Coordinating Zone	ZONE2, ZONE3, ZONE4		ZONE3
1602	MOBCHARANG	MOB Characteristic Angle	30 to 130° step 1		70°
1603	BLOCKWHAT	Block during OS	BLKALL, BLKDIST, BLKPHAS, BLKNONE		BLKALL
1604	BLOCKZ1	Block all Zone 1 Functions	NO, YES		YES
1605	BLOCKZ2	Block all Zone 2 Functions	NO, YES		YES
1606	BLOCKZ3	Block all Zone 3 Functions	NO, YES		YES
1607	BLOCKZ4	Block all Zone 4 Functions	NO, YES		YES
RECLOSER					
1801	RECLMODE	Select Reclosing Option	OFF, NONE, INTERNAL, EXTERNAL, BOTH		NONE
1802	RECTYPE	Set Reclosing Type	1POLE, 3POLE, 1POLE/3POLE		3POLE
1803	NUM1P	Number of Attempts Following 1P Trip	1 to 4 step 1		1
1804	1PDELAY1	1 Pole First Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1805	1PDELAY2	1 Pole Second Delay	0.1 to 300 sec. step 0.1		0.1 sec.

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 7 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
1806	1PDELAY3	1 Pole Third Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1807	1PDELAY4	1 Pole Fourth Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1808	NUM3P	Number of Attempts Following 3P Trip	1 to 4 step 1		1
1809	3PDELAY1	3 Pole First Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1810	3PDELAY2	3 Pole Second Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1811	3PDELAY3	3 Pole Third Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1812	3PDELAY4	3 Pole Fourth Delay	0.1 to 300 sec. step 0.1		0.1 sec.
1813	RESETTIME	Reset Time	0.1 to 300 sec. step 0.1		1 sec.
1814	DWELLTIME	Contact Dwell Time	0.1 to 2 sec. step 0.1		0.1 sec.
1815	HOLD	Inhibit Hold Select	YES, NO		NO
1816	HOLDTIME	Inhibit Hold Time	1 to 1000 sec. step 1		1 sec.
1817	HOLDSENSE	Contact Input Status	CC, CO		CC
1818	SYNCCHECK	Synch Check Supervision	YES, NO		NO
1819	CLOSEANG	Closing Angle	0 to 75° step 1		30°
1820	SLIPFREQ	Slip Frequency	0.1 to 5 Hz step 0.1		1 Hz
1821	BUSLINE	Bus or Line Voltage	BUS, LINE		LINE
1822	SYNCPHASE	Voltage used by SYNCCHECK	VA, VB, VC, VAB, VBC, VCA		VA
1823	SYNCHOLD	SYNCCHECK Hold Time	1 to 100 sec. step 1		1 sec.
1824	SP1DELAY2	Supervise 2nd 3P Reclose after 1P Trip	YES, NO		NO
1825	SP1DELAY3	Supervise 3rd 3P Reclose after 1P Trip	YES, NO		NO
1826	SP1DELAY4	Supervise 4th 3P Reclose after 1P Trip	YES, NO		NO
1827	SP3DELAY1	Supervise 1st 3P Reclose after 3P Trip	YES, NO		NO
1828	SP3DELAY2	Supervise 2nd 3P Reclose after 3P Trip	YES, NO		NO
1829	SP3DELAY3	Supervise 3rd 3P Reclose after 3P Trip	YES, NO		NO
1830	SP3DELAY4	Supervise 4th 3P Reclose after 3P Trip	YES, NO		NO

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 8 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
1831	SYNCMANCLS	Supervise Manual Close	YES, NO		NO
1832	VBUSLIVE	Live Bus Voltage	0.1 to 130 volts step 0.1		50 V
1833	VBUSDEAD	Dead Bus Voltage	0.1 to 130 volts step 0.1		50 V
1834	VLINELIVE	Live Line Voltage	0.1 to 130 volts step 0.1		50 V
1835	VLINEDEAD	Dead Line Voltage	0.1 to 130 volts step 0.1		50 V
1836	LBUSDLINE	Live Bus Dead Line	YES, NO		NO
1837	DBUSLLINE	Dead Bus Live Line	YES, NO		NO
1838	DBUSDLINE	Dead Bus Dead Line	YES, NO		NO
1839	DELTAV	Voltage Difference	0.1 to 130 volts step 0.1		10 V
1840	DELTAVBLK	Block Synch Check by DELTAV	YES, NO		NO
NONCRIT_AL (IN ADDITION TO SELF-TEST ALARMS)					
1901	NCAIN1	Non-Critical Alarm Input #1 *These 8 inputs are ORed together and then outputted to the contact assigned to the Non-Critical Alarm*	0 to 256 step 1		48
1902	NCAIN2	Non-Critical Alarm Input #2	0 to 256 step 1		49
1903	NCAIN3	Non-Critical Alarm Input #3	0 to 256 step 1		50
1904	NCAIN4	Non-Critical Alarm Input #4	0 to 256 step 1		51
1905	NCAIN5	Non-Critical Alarm Input #5	0 to 256 step 1		0
1906	NCAIN6	Non-Critical Alarm Input #6	0 to 256 step 1		0
1907	NCAIN7	Non-Critical Alarm Input #7	0 to 256 step 1		0
1908	NCAIN8	Non-Critical Alarm Input #8	0 to 256 step 1		0
OUTPUTS					
2001	T1	T1 Contract	0 to 256 step 1		33
2002	T2	T2 Contact	0 to 256 step 1		34 ‡ ; 33 ^
2003	T3	T3 Contact	0 to 256 step 1		35 ‡ ; 33 ^
2004	T4	T4 Contact	0 to 256 step 1		33 ‡
2005	T5	T5 Contact	0 to 256 step 1		34 ‡
2006	T6	T6 Contact	0 to 256 step 1		35 ‡
2007	A1	A1 Contact (configurable)	0 to 256 step 1		33 ‡ ; 58 ^

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–8: PROTECTION SETTINGS GUIDE (Sheet 9 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	Default
2008	A2	A2 Contact (configurable)	0 to 256 step 1		33 ‡ ; 59 ^
2009	A3	A3 Contact (configurable)	0 to 256 step 1		34 ‡ ; 33 ^
2010	A4	A4 Contact (configurable)	0 to 256 step 1		34 ‡ ; 33 ^
2011	A5	A5 Contact (configurable)	0 to 256 step 1		35 ‡ ; 37 ^
2012	A6	A6 Contact (configurable)	0 to 256 step 1		35 ‡ ; 37 ^
2013	A7	A7 Contact (configurable)	0 to 256 step 1		36 ‡ ; 38 ^
2014	A8	A8 Contact (configurable)	0 to 256 step 1		36 ‡ ; 45 ^
2015	A9	A9 Contact (configurable)	0 to 256 step 1		37 ‡
2016	A10	A10 Contact (configurable)	0 to 256 step 1		37 ‡
2017	A11	A11 Contact (configurable)	0 to 256 step 1		144 ‡
2018	A12	A12 Contact (configurable)	0 to 256 step 1		145 ‡
2019	C1	C1 Contact (configurable)	0 to 256 step 1		52
2020	C2	C2 Contact (configurable)	0 to 256 step 1		115
2021	KT1	KT1 Contact (configurable)	0 to 256 step 1		39
2022	KT2	KT2 Contact (configurable)	0 to 256 step 1		40
2023	KT3	KT3 Contact (configurable)	0 to 256 step 1		39
2024	KT4	KT4 Contact (configurable)	0 to 256 step 1		40
2025	CONFTRIP	Initiate Three phase Trip with Input from Xpression Builder	0 to 256 step 1		0
2026	CONFOSC	Initiate Oscillography Capture with Xpression Builder Input	0 to 256 step 1		0

† Setting/value is applicable to LPS-D Revision B models only.
‡ Setting/value is applicable LPS-D Single Phase Tripping models only.
^ Setting/value is applicable to LPS-D Three Phase Tripping models only.

Table 2–9: GENERAL SETTINGS GUIDE (Sheet 1 of 3)

No.	Mnemonic	Description	Range (5A & 1A)	Step	Default
CONFIGURE					
101	UNITID	Unit ID	0000 to 9999	1	0000
102	SYSFREQ	System Frequency	50 Hz, 60 Hz	N/A	60Hz
103	PHASROTATE	Phase Rotation	ABC, ACB	N/A	ABC
104	TIMESYNCH	Time Synch Source	INTERNAL, IRIG-B	N/A	INTERNAL
105	NUM_BKR	Number of Breakers	1, 2	N/A	1
106	NUM_TC	Number of Trip Circuits	1, 2	N/A	1
107	NUM_MON	Number of Trip Circuit Monitors	(T6→T1) format = abcdef	a-f = 0 (on) or 1 (off)	**000000 (0)** T1 to T6 off
108	DISPLAYVAL	Value Display Mode	PRI, SEC	N/A	SEC
109	LANGUAGE	Language Option	ENGLISH, SPANISH	N/A	ENGLISH
110	SYSIN1-4	System Inputs 1 to 4	0000 to 1111 (bin) 0 to 15 (dec)	1	0000
COMMPORTS					
201	COMPORT1	Communications Port #1 Settings	Baud Rate (xx), Parity (y), Stop Bits (z) *format = xxyz*	xx = 03, 12, 24, 48, 96, 19; y = 1 (none), 1 (odd), 2 (even) z = 1, 2	9601
202	COMPORT2	Communications Port #2 Settings	Interface (i), Baud Rate (xx), Parity (y), Stop Bits (z) *format = ixxyz*	i = 0 (RS232), 1 (RS485), xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2	09601
203	COMPORT3	Communications Port #3 Settings	Interface (i), Baud Rate (xx), Parity (y), Stop bits (z) *format = ixxyz*	i = 0 (RS232), 1 (RS485), xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2	09601
204	PROTOCOL1	Communications Port #1 Protocol	GE-MODEM, ASCII, DNP 3.0	N/A	GE-MODEM
205	PROTOCOL2	Communications Port #2 Protocol	GE-MODEM, ASCII, DNP 3.0	N/A	GE-MODEM
206	PROTOCOL3	Communications Port #3 Protocol	GE-MODEM, ASCII, DNP 3.0	N/A	GE-MODEM

† Setting/value is applicable to LPS-D Three Phase Tripping models only.
‡ Setting/value is applicable to LPS-D Single Phase Tripping models only.

Table 2–9: GENERAL SETTINGS GUIDE (Sheet 2 of 3)

No.	Mnemonic	Description	Range (5A & 1A)	Step	Default
OSC_GRAPHY					
301	NUMFAULTS	Number of Fault Records	6, 12, 24, 36	N/A	N/A
302	PREFAULT	Number of Pre-fault Cycles	1 to 8	1	5
303	SPLITREC	Splits Fault Record and captures this percentage at end, with 1-SPLITREC captured at beginning	0 to 100%	1	0%
BRKR DUTY					
401	EXPONENT	Exponent in $I^x t$ calculation	1.0 to 2.0	0.1	2.0
402	MAX_OP	Maximum Number of Breaker Operations for a Breaker	0 to 9999	1	0
403	MAX_IXT	Maximum Breaker Duty for a Breaker	0 to 9999999 A^xsec.	100	0
404	IXTPHASEA	Accumulated Breaker Duty, Phase A	0 to 9999999 A^xsec.	100	0
405	IXTPHASEB	Accumulated Breaker Duty, Phase B	0 to 9999999 A^xsec.	100	0
406	IXTPHASEC	Accumulated Breaker Duty, Phase C	0 to 9999999 A^xsec.	100	0
407 †	NUM_OP	Present Number of Breaker Operations	0 to 9999	1	0
407 ‡	NUM_OP_A	Present Number of Breaker Operations for Phase A	0 to 9999	1	N/A
408 ‡	NUM_OP_B	Present Number of Breaker Operations for Phase B	0 to 9999	1	N/A
409 ‡	NUM_OP_C	Present Number of Breaker Operations for Phase C	0 to 9999	1	N/A
INPUTS					
501	CC1	Contact Converter 1	0 to 32	1	12
502	CC2	Contact Converter 2	0 to 32	1	13
503	CC3	Contact Converter 3	0 to 32	1	10
504	CC4	Contact Converter 4	0 to 32	1	11
505	CC5	Contact Converter 5	0 to 32	1	7 ‡, 1 †
506	CC6	Contact Converter 6	0 to 32	1	20 ‡, 4 †

† Setting/value is applicable to LPS-D Three Phase Tripping models only.
‡ Setting/value is applicable to LPS-D Single Phase Tripping models only.

Table 2–9: GENERAL SETTINGS GUIDE (Sheet 3 of 3)

No.	Mnemonic	Description	Range (5A & 1A)	Step	Default
507	CC7	Contact Converter 7	0 to 32	1	1 ‡, 20 †
508	CC8	Contact Converter 8	0 to 32	1	2 ‡
509	CC9	Contact Converter 9	0 to 32	1	3 ‡
510	CC10	Contact Converter 10	0 to 32	1	4 ‡
511	CC11	Contact Converter 11	0 to 32	1	5 ‡
512	CC12	Contact Converter 12	0 to 32	1	6 ‡

† Setting/value is applicable to LPS-D Three Phase Tripping models only.
‡ Setting/value is applicable to LPS-D Single Phase Tripping models only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 1 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
Z1DISTANCE					
101	Z1PHASE	Z1 Phase Distance	NO, YES		
102	Z1PHREACH	Z1 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
103	Not used				
104	Z1GROUND	Z1 Ground Distance	NO, YES		
105	Z1GRDREACH	Z1 Ground Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
106	Z1GRDCHAR	Z1 Ground Characteristic	MHO, REACT, QUAD †		
107	Z1SUREACH	Z1 Ground Reaction Mho Supervision Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250 Ω step 0.05	
108	Z1GROUNDK0	Z1 Ground K0	1.0 to 7.0 step 0.01		
109	Not used				
110	Z1BLOCK	Blocking Supervision of Z1	NO, YES		
111 ‡	Z1GCHARANG	Z1 Ground Characteristic Timer Angle	80° to 155° step 1		
112 ‡	Z1RGREACH	Z1 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	
Z2DISTANCE					
201	Z2PHASE	Z2 Phase Distance	NO, YES		
202	Z2PHREACH	Z2 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
203	Z2PCHARANG	Z2 Phase Characteristic Angle	90° to 120° step 5		
204	Z2GROUND	Z2 Ground Distance	NO, YES		
205	Z2GRDCHAR	Z2 Ground Characteristic	MHO, GDOC, MHOGDOC, QUAD †		
206	Z2GRDREACH	Z2 Ground Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
207	Z2GCHARANG	Z2 Ground Characteristic Angle	80° to 155° step 5		
208	Z2TIMERS	Z2 Timers	NO, YES		
209	Z2P_TIME	Z2 Phase Timer	0.10 to 3.0 sec. step 0.01		
210	Z2G_TIME	Z2 Ground Timer	0.10 to 3.0 sec. step 0.01		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 2 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
211 ‡	Z2RGREACH	Zone 2 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	
Z3DISTANCE					
301	Z3PHASE	Z3 Phase Distance	NO, YES		
302	Z3PHREACH	Z3 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
303	Z3PCHARANG	Z3 Phase Characteristic Angle	90° to 120° step 5		
304	Z3GROUND	Z3 Ground Distance	NO, YES		
305	Z3GRDREACH	Z3 Ground Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
306	Z3GCHARANG	Z3 Ground Characteristic Angle	80° to 155° step 5		
307	Z3P_TIME	Z3 Phase Timer	0.10 to 10.0 sec. step 0.01		
308	Z3G_TIME	Z3 Ground Timer	0.10 to 10.0 sec. step 0.01		
309 ‡	Z3GRDCHAR	Z3 Ground Characteristic	MHO, QUAD †		
310 ‡	Z3RGREACH	Z3 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	
Z4DISTANCE					
401	Z4PHASE	Z4 Phase Distance	NO, YES		
402	Z4PHREACH	Z4 Phase Reach	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
403	Z4PCHARANG	Z4 Phase Characteristic Angle	80° to 120° step 5		
404	Not Used				
405	Z4GRND	Z4 Ground Distance	NO, YES		
406	Z4GRDREACH	Z4 Ground Reach	0.01 to 50.0 Ω step 0.01	0.01 to 250.0 Ω step 0.05	
407	Z4GCHARANG	Z4 Ground Characteristic Angle	80° to 155° step 5		
408	Z4DIRECTN	Z4 Direction	FORWRD, REVERS		
409	Z4_TIMERS	Z4 Timers	NO, YES		
410	Z4P_TIME	Z4 Phase Timer	0.10 to 10.0 sec. step 0.01		
411	Z4G_TIME	Z4 Ground Timer	0.10 to 10.0 sec. step 0.01		
412 ‡	Z4GRDCHAR	Z4 Ground Characteristic	MHO, QUAD †		
413 ‡	Z4RGREACH	Z4 Resistive Ground Reach	0.01 to 100.00 Ω step 0.01	0.05 to 500 Ω step 0.01	

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 3 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
CURVSUPVISN					
501	IT_PICKUP	Trip Supervision Current	0.20 to 4.0 amps step 0.01	0.04 to 0.8 amps step 0.01	
502	IB_PICKUP	Block Supervision Current	0.20 to 4.0 amps step 0.01	0.04 to 0.8 amps step 0.01	
503	IPT_PICKUP	GDOC Trip Current	0.50 to 5.0 amps step 0.01	0.10 to 1.0 amps step 0.01	
504	IPB_PICKUP	GDOC Block Current	0.25 to 3.75 amps step 0.01	0.05 to 0.75 amps step 0.01	
505	IPBKFACTOR	IPB I1 Restraint	0.0, 0.066		
506	NT_OFFSET	NT/NB Offset	0.0 to 20.0 Ω step 0.01	0.0 to 100 Ω step 0.01	
507	UNBALALARM	Unbalanced Current Alarm	NO, YES		
OVERCURRNT					
601	50	Phase Instantaneous Overcurrent	NO, YES		
602	50_DIRCNL	Directional Control of 50	NO, YES		
603	50PICKUP	50 Pickup Setting	2.0 to 160.0 amps step 0.1	0.4 to 32.0 amps step 0.1	
604	50PICKUPFF	50 Pickup during fuse failure	2.0 to 160.0 amps step 0.1	0.4 to 32.0 amps step 0.1	
605	50G	Ground Instantaneous Overcurrent	NO, YES		
606	50G_DIRCNL	Directional Control of 50G	NO, YES		
607	50GPICKUP	50G Pickup Setting	0.5 to 80.0 amps step 0.1	0.1 to 16.0 amps step 0.1	
608	50GPCKPFF	50G Pickup during fuse failure	0.5 to 80.0 amps step 0.1	0.1 to 16.0 amps step 0.1	
609	50GRESTNT	50G Restraint Setting	0.0, 0.3		
610	51G	Ground Time Overcurrent	NO, YES		
611	51G_DIRCNL	Directional Control of 51G	NO, YES		
612	51GPICKUP	51G Pickup Setting	0.20 to 15.0 amps step 0.01	0.04 to 3.0 amps step 0.01	
613	51GPCKUPFF	51G Pickup during fuse failure	0.20 to 15.0 amps step 0.01	0.04 to 3.0 amps step 0.01	

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 4 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
614	51GCURVE	51G Curve	INV, V-INV, E-INV, CUSTOM, DEFT		
615	51GTIMDIAL	51G Time Dial	0.5 to 10.0 step 0.1		
616	DEFTIMDELY	Definite Time Delay	0.5 to 30.0 sec. step 0.1		
617	51G_RESET	51G Reset Characteristic	FAST, EM		
VOLTAGE					
701	RATEDVOLTS	Rated Per Unit Voltage	100, 105,110,115, 120 volts		
702	PHASEOVER	Select Phase Overvoltage	NO, YES		
703	PHOVPICKUP	Phase Overvoltage Pickup	0.0 to 1.4 p.u. volts step 0.01		
704	PHOVTMDLY	Phase Overvoltage Time Delay	0.0 to 10.0 sec. step 0.01		
705 to 713 Not used					
714	FUSEFAIL	Potential Fuse Failure Blocking	NO, YES		
BLK RECLOS					
801	ALL_BELOW	Block reclosing for any function	NO, YES		
802	OUTOFSTEP	Block for Out of Step	NO, YES		
803	ALL_3_Z2PH	Block for 3 phase faults	NO, YES		
804	50G_BLOCK	Block for 50G trip	NO, YES		
805	Z2TIMETRIP	Block for Z2 Time Delayed Trip	NO, YES		
806	Z3TIMETRIP	Block for Z3 Time Delayed Trip	NO, YES		
807	Z4TIMETRIP	Block for Z4 Time Delayed Trip	NO, YES		
808	Z1PHASTRIP	Block for any Z1 Phase Fault	NO, YES		
809	ANYZ2PHASE	Block for any Z2 Phase Fault	NO, YES		
810	CONFGTRIP	Block For Configurable Trip Logic	NO, YES		
LINEPICKUP					
901	LINEPICKUP	Select Line Pickup	NO, YES		
902	BYPASSTL3	Bypass Line Pickup Time Delay	NO, YES		
903	I1PICKUP	I1 Pickup	1.0 to 15.0 amps step 0.1	0.2 to 3.0 amps step 0.1	
REMOTEOPEN (THREE PHASE SYSTEMS ONLY)					
1001	REMOTEOPEN	Select Remote Open Detector	NO, YES		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 5 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
1002	TL20PICKUP	Remote Open Detector Time Delay	10 to 100 msec. step 1		
LINE OVERLD					
1101	LINEOVERLD	Select Line Overload Protection	NO, YES		
1102	LEVEL1PU	Level 1 pickup current	2.5 to 20 amps step 0.1	0.5 to 4.0 amps step 0.1	
1103	LEVEL2PU	Level 2 pickup current	5.0 to 40.0 amps step 0.1	1.0 to 8.0 amps step 0.1	
1104	LEVEL1TDLY	Level 1 time delay	10 to 200 sec. step 1		
1105	LEVEL2TDLY	Level 2 time delay	10 to 99 sec. step 1		
SCHEME					
1201	PICKSCHEME	Select a scheme logic	STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK		
1202	NUMRCVR	Select a number of receivers	0, 1, 2		
1203^	TRIPMODE	1-phase / 3-phase Trip Mode	3POLE, 1POLE, 1POLEZ2		
1204	CARRSTART	Select Function to use to Start Carrier in BLOCKing scheme	DIR, IPB, FD		
1205	WKINFTRIP	Select Weak Infeed Tripping for HYBRID scheme	NO, YES		
SCHEMETIMERS					
1301	TL1PICKUP	Trip Integrator	1 to 200 msec. step 1		
1302	TL4PICKUP	POTT Coord Timer PU	0 to 50 msec. step 1		
1303	TL4DROPOUT	POTT Coord Timer DO	0 to 50 msec. step 1		
1304	TL5PICKUP	BKR1 b sw Coord Timer PU	0 to 200 msec. step 1		
1305	TL5DROPOUT	BKR1 b sw Coord Timer DO	0 to 200 msec. step 1		
1306	TL6PICKUP	BKR2 b sw Coord Timer PU	0 to 200 msec. step 1		
1307	TL6DROPOUT	BKR2 b sw Coord Timer DO	0 to 200 msec. step 1		
1308	TL16PICKUP	Weak Infeed Trip Timer	8 to 99 msec. step 1		
1309	TL24DRPPOUT	GDOC Blocking Timer	30 to 500 msec. step 1		
1310	TL25DRPOUT	Distance Blocking Timer	30 to 500 msec. step 1		
1311	TL26PICKUP	Repeat Delay Timer	0 to 50 msec. step 1		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 6 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
LINEINFO					
1401	POSSEQANG	Positive Sequence Impedance Angle	25 to 90° step 1		
1402	ZERSEQANG	Zero Sequence Impedance Angle	25 to 90° step 1		
1403	ZLINE	Positive Sequence Line Impedance in sec.ohms	0.01 to 50.0 Ω step 0.01	0.05 to 250.0 Ω step 0.05	
1404	ZEROSEQK0	Z0/Z1 Ratio	1.0 to 7.0 step 0.1		
1405	LINELENGTH	Line Length	0.0 to 500.0 step 0.1		
1406	LINEUNIT	Units of Length	MILES, KM		
1407	CTRATIO	CT Ratio	1 to 5000 step 1		
1408	PTRATIO	PT Ratio	1 to 7000 step 1		
SCADA_DATA					
1501	FLTLOCK	Hold Time	0 to 99.9 sec. step 0.1		
1502	FLTRESET	Fault Location Reset Time	0 to 999 minutes step 1		
OS BLOCKING					
1601	MOBZONE	Coordinating Zone	ZONE2, ZONE3, ZONE4		
1602	MOBCHARANG	MOB Characteristic Angle	30 to 130° step 1		
1603	BLOCKWHAT	Block during OS	BLKALL, BLKDIST, BLKPHAS, BLKNONE		
1604	BLOCKZ1	Block all Zone 1 Functions	NO, YES		
1605	BLOCKZ2	Block all Zone 2 Functions	NO, YES		
1606	BLOCKZ3	Block all Zone 3 Functions	NO, YES		
1607	BLOCKZ4	Block all Zone 4 Functions	NO, YES		
RECLOSER					
1801	RECLMODE	Select Reclosing Option	OFF, NONE, INTERNAL, EXTERNAL, BOTH		
1802	RECTYPE	Set Reclosing Type	1POLE, 3POLE, 1POLE/3POLE		
1803	NUM1P	Number of Attempts Following 1P Trip	1 to 4 step 1		
1804	1PDELAY1	1 Pole First Delay	0.1 to 300 sec. step 0.1		
1805	1PDELAY2	1 Pole Second Delay	0.1 to 300 sec. step 0.1		
1806	1PDELAY3	1 Pole Third Delay	0.1 to 300 sec. step 0.1		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 7 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
1807	1PDELAY4	1 Pole Fourth Delay	0.1 to 300 sec. step 0.1		
1808	NUM3P	Number of Attempts Following 3P Trip	1 to 4 step 1		
1809	3PDELAY1	3 Pole First Delay	0.1 to 300 sec. step 0.1		
1810	3PDELAY2	3 Pole Second Delay	0.1 to 300 sec. step 0.1		
1811	3PDELAY3	3 Pole Third Delay	0.1 to 300 sec. step 0.1		
1812	3PDELAY4	3 Pole Fourth Delay	0.1 to 300 sec. step 0.1		
1813	RESETTIME	Reset Time	0.1 to 300 sec. step 0.1		
1814	DWELLTIME	Contact Dwell Time	0.1 to 2 sec. step 0.1		
1815	HOLD	Inhibit Hold Select	YES, NO		
1816	HOLDTIME	Inhibit Hold Time	1 to 1000 sec. step 1		
1817	HOLDSENSE	Contact Input Status	CC, CO		
1818	SYNCCHECK	Synch Check Supervision	YES, NO		
1819	CLOSEANG	Closing Angle	0 to 75° step 1		
1820	SLIPFREQ	Slip Frequency	0.1 to 5 Hz step 0.1		
1821	BUSLINE	Bus or Line Voltage	BUS, LINE		
1822	SYNCPHASE	Voltage used by SYNCCHECK	VA, VB, VC, VAB, VBC, VCA		
1823	SYNCHOLD	SYNCCHECK Hold Time	1 to 100 sec. step 1		
1824	SP1DELAY2	Supervise 2nd 3P Reclose after 1P Trip	YES, NO		
1825	SP1DELAY3	Supervise 3rd 3P Reclose after 1P Trip	YES, NO		
1826	SP1DELAY4	Supervise 4th 3P Reclose after 1P Trip	YES, NO		
1827	SP3DELAY1	Supervise 1st 3P Reclose after 3P Trip	YES, NO		
1828	SP3DELAY2	Supervise 2nd 3P Reclose after 3P Trip	YES, NO		
1829	SP3DELAY3	Supervise 3rd 3P Reclose after 3P Trip	YES, NO		
1830	SP3DELAY4	Supervise 4th 3P Reclose after 3P Trip	YES, NO		
1831	SYNCMANCLS	Supervise Manual Close	YES, NO		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 8 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
1832	VBUSLIVE	Live Bus Voltage	0.1 to 130 volts step 0.1		
1833	VBUSDEAD	Dead Bus Voltage	0.1 to 130 volts step 0.1		
1834	VLINELIVE	Live Line Voltage	0.1 to 130 volts step 0.1		
1835	VLINEDEAD	Dead Line Voltage	0.1 to 130 volts step 0.1		
1836	LBUSDLINE	Live Bus Dead Line	YES, NO		
1837	DBUSLLINE	Dead Bus Live Line	YES, NO		
1838	DBUSDLINE	Dead Bus Dead Line	YES, NO		
1839	DELTAV	Voltage Difference	0.1 to 130 volts step 0.1		
1840	DELTAVBLK	Block Synch Check by DELTAV	YES, NO		
NONCRIT_AL (IN ADDITION TO SELF-TEST ALARMS)					
1901	NCAIN1	Non-Critical Alarm Input #1 *These 8 inputs are ORed together and then outputted to the contact assigned to the Non-Critical Alarm*	0 to 256 step 1		
1902	NCAIN2	Non-Critical Alarm Input #2	0 to 256 step 1		
1903	NCAIN3	Non-Critical Alarm Input #3	0 to 256 step 1		
1904	NCAIN4	Non-Critical Alarm Input #4	0 to 256 step 1		
1905	NCAIN5	Non-Critical Alarm Input #5	0 to 256 step 1		
1906	NCAIN6	Non-Critical Alarm Input #6	0 to 256 step 1		
1907	NCAIN7	Non-Critical Alarm Input #7	0 to 256 step 1		
1908	NCAIN8	Non-Critical Alarm Input #8	0 to 256 step 1		
OUTPUTS					
2001	T1	T1 Contract	0 to 256 step 1		
2002	T2	T2 Contact	0 to 256 step 1		
2003	T3	T3 Contact	0 to 256 step 1		
2004	T4	T4 Contact	0 to 256 step 1		
2005	T5	T5 Contact	0 to 256 step 1		
2006	T6	T6 Contact	0 to 256 step 1		
2007	A1	A1 Contact (configurable)	0 to 256 step 1		
2008	A2	A2 Contact (configurable)	0 to 256 step 1		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–10: PROTECTION SETTINGS DATA SHEET (Sheet 9 of 9)

No.	Mnemonic	Description	Range (5A)	Range (1A)	User Setting
2009	A3	A3 Contact (configurable)	0 to 256 step 1		
2010	A4	A4 Contact (configurable)	0 to 256 step 1		
2011	A5	A5 Contact (configurable)	0 to 256 step 1		
2012	A6	A6 Contact (configurable)	0 to 256 step 1		
2013	A7	A7 Contact (configurable)	0 to 256 step 1		
2014	A8	A8 Contact (configurable)	0 to 256 step 1		
2015	A9	A9 Contact (configurable)	0 to 256 step 1		
2016	A10	A10 Contact (configurable)	0 to 256 step 1		
2017	A11	A11 Contact (configurable)	0 to 256 step 1		
2018	A12	A12 Contact (configurable)	0 to 256 step 1		
2019	C1	C1 Contact (configurable)	0 to 256 step 1		
2020	C2	C2 Contact (configurable)	0 to 256 step 1		
2021	KT1	KT1 Contact (configurable)	0 to 256 step 1		
2022	KT2	KT2 Contact (configurable)	0 to 256 step 1		
2023	KT3	KT3 Contact (configurable)	0 to 256 step 1		
2024	KT4	KT4 Contact (configurable)	0 to 256 step 1		
2025	CONFTRIP	Initiate Three phase Trip with Input from Xpression Builder	0 to 256 step 1		
2026	CONFOSC	Initiate Oscillography Capture with Xpression Builder Input	0 to 256 step 1		

† Setting value QUAD applies to LPS-D Revision B models only.
‡ Setting is applicable to Revision B models only.
^ Setting is applicable to LPS-D models with three phase tripping only.

Table 2–11: GENERAL SETTINGS DATA SHEET (Sheet 1 of 3)

No.	Mnemonic	Description	Range (5A & 1A)	Step	User Setting
CONFIGURE					
101	UNITID	Unit ID	0000 to 9999	1	
102	SYSFREQ	System Frequency	50 Hz, 60 Hz	N/A	
103	PHASROTATE	Phase Rotation	ABC, ACB	N/A	
104	TIMESYNCH	Time Synch Source	INTERNAL, IRIG-B	N/A	
105	NUM_BKR	Number of Breakers	1, 2	N/A	
106	NUM_TC	Number of Trip Circuits	1, 2	N/A	
107	NUM_MON	Number of Trip Circuit Monitors	(T6→T1) format = abcdef	a-f = 0 (on) or 1 (off)	
108	DISPLAYVAL	Value Display Mode	PRI, SEC	N/A	
109	LANGUAGE	Language Option	ENGLISH, SPANISH	N/A	
110	SYSIN1-4	System Inputs 1 to 4	0000 to 1111 (bin) 0 to 15 (dec)	1	
COMMPORTS					
201	COMPORT1	Communications Port #1 Settings	Baud Rate (xx), Parity (y), Stop Bits (z) *format = xxyz*	xx = 03, 12, 24, 48, 96, 19; y = 1 (none), 1 (odd), 2 (even) z = 1, 2	
202	COMPORT2	Communications Port #2 Settings	Interface (i), Baud Rate (xx), Parity (y), Stop Bits (z) *format = ixxyz*	i = 0 (RS232), 1 (RS485), xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2	
203	COMPORT3	Communications Port #3 Settings	Interface (i), Baud Rate (xx), Parity (y), Stop bits (z) *format = ixxyz*	i = 0 (RS232), 1 (RS485), xx = 03, 12, 24, 48, 96, 19; y = 0 (none), 1 (odd), 2 (even); z = 1, 2	
204	PROTOCOL1	Communications Port #1 Protocol	GE-MODEM, ASCII, DNP 3.0	N/A	
205	PROTOCOL2	Communications Port #2 Protocol	GE-MODEM, ASCII, DNP 3.0	N/A	
206	PROTOCOL3	Communications Port #3 Protocol	GE-MODEM, ASCII, DNP 3.0	N/A	

† Setting/value is applicable to LPS-D Three Phase Tripping models only.
‡ Setting/value is applicable to LPS-D Single Phase Tripping models only.

Table 2–11: GENERAL SETTINGS DATA SHEET (Sheet 2 of 3)

No.	Mnemonic	Description	Range (5A & 1A)	Step	User Setting
OSC_GRAPHY					
301	NUMFAULTS	Number of Fault Records	6, 12, 24, 36	N/A	
302	PREFAULT	Number of Pre-fault Cycles	1 to 8	1	
303	SPLITREC	Splits Fault Record and captures this percentage at end, with 1-SPLITREC captured at beginning	0 to 100%	1	
BRKR DUTY					
401	EXPONENT	Exponent in $I^x t$ calculation	1.0 to 2.0	0.1	
402	MAX_OP	Maximum Number of Breaker Operations for a Breaker	0 to 9999	1	
403	MAX_IXT	Maximum Breaker Duty for a Breaker	0 to 9999999 A^xsec.	100	
404	IXTPHASEA	Accumulated Breaker Duty, Phase A	0 to 9999999 A^xsec.	100	
405	IXTPHASEB	Accumulated Breaker Duty, Phase B	0 to 9999999 A^xsec.	100	
406	IXTPHASEC	Accumulated Breaker Duty, Phase C	0 to 9999999 A^xsec.	100	
407 †	NUM_OP	Present Number of Breaker Operations	0 to 9999	1	
407 ‡	NUM_OP_A	Present Number of Breaker Operations for Phase A	0 to 9999	1	
408 ‡	NUM_OP_B	Present Number of Breaker Operations for Phase B	0 to 9999	1	
409 ‡	NUM_OP_C	Present Number of Breaker Operations for Phase C	0 to 9999	1	
INPUTS					
501	CC1	Contact Converter 1	0 to 32 *	1	
502	CC2	Contact Converter 2	0 to 32 *	1	
503	CC3	Contact Converter 3	0 to 32 *	1	
504	CC4	Contact Converter 4	0 to 32 *	1	
505	CC5	Contact Converter 5	0 to 32 *	1	
506	CC6	Contact Converter 6	0 to 32 *	1	

† Setting/value is applicable to LPS-D Three Phase Tripping models only.
‡ Setting/value is applicable to LPS-D Single Phase Tripping models only.

Table 2–11: GENERAL SETTINGS DATA SHEET (Sheet 3 of 3)

No.	Mnemonic	Description	Range (5A & 1A)	Step	User Setting
507	CC7	Contact Converter 7	0 to 32 *	1	
508	CC8	Contact Converter 8	0 to 32 *	1	
509	CC9	Contact Converter 9	0 to 32 *	1	
510	CC10	Contact Converter 10	0 to 32 *	1	
511	CC11	Contact Converter 11	0 to 32 *	1	
512	CC12	Contact Converter 12	0 to 32 *	1	

† Setting/value is applicable to LPS-D Three Phase Tripping models only.
‡ Setting/value is applicable to LPS-D Single Phase Tripping models only.

CAUTION

Power down the relay by turning off the front panel power switch and disconnecting power from the rear connector (A1–A17) before disassembling the unit. Failure to do so can permanently damage the relay.

The relay case is constructed from an aluminum alloy. It consists of a main frame with mounting brackets and a front, top and rear cover. The relay may be mounted either vertically or horizontally. The mounting ears may be placed in 6 positions (see Figure 3–1: DIMENSIONS).

An outline drawing is shown in Figure 3–2: FRONT AND REAR VIEW on page 3–2, presenting the front and rear views of the horizontal mount LPS-D. The figure provides a panel cutout and drill pattern for mounting the LPS-D.

The front cover attaches with four thumb screws. A hole in each of the screws permits a tamper proof installation when a sealing wire is passed through two or four thumbscrews. The Target Reset / Metering button is accessible via a hole in the front cover. place by restraining screws on the front of the module trays.

Each board is mounted on an aluminum plate. Proper alignment of the boards to their sockets is maintained by card guides. The aluminum plate supporting each board fits into these guides. The magnetics module, due to its weight, is rigidly mounted to the bottom of the case.

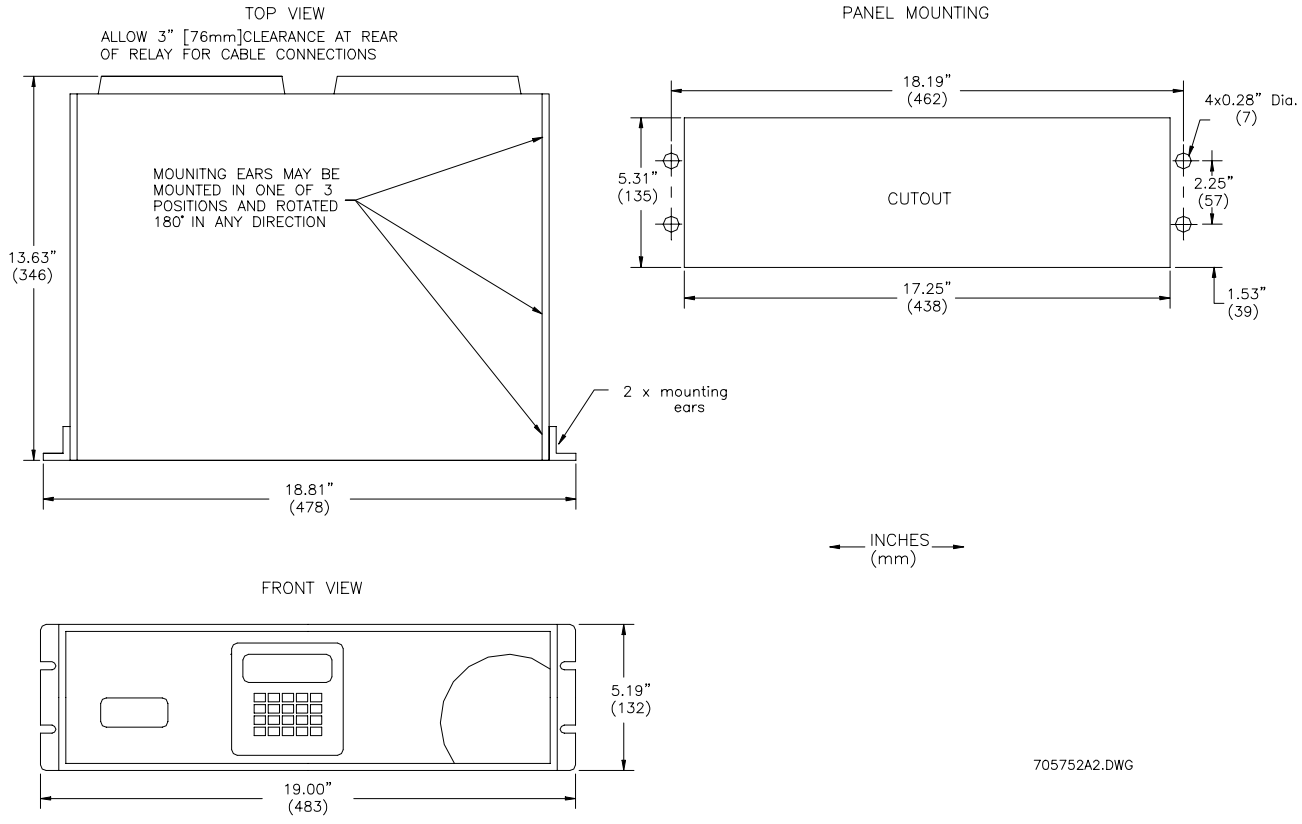
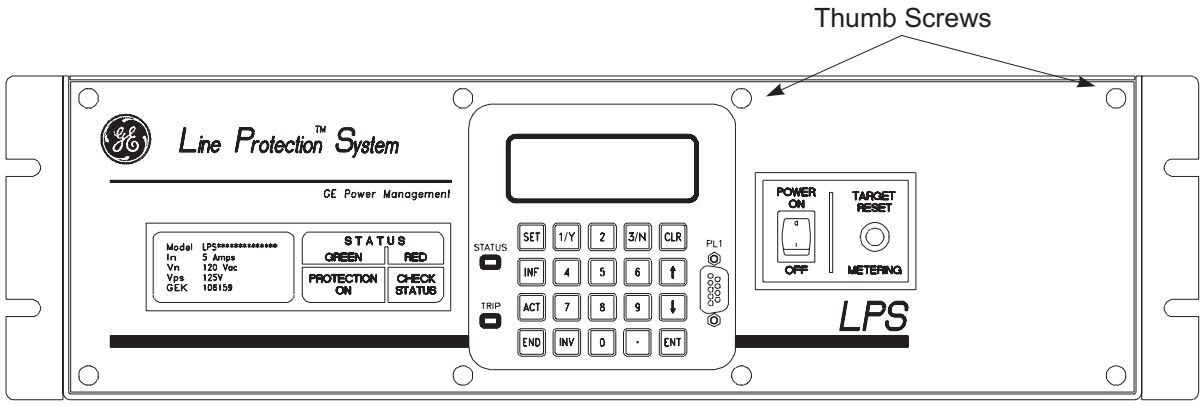


Figure 3–1: DIMENSIONS

3



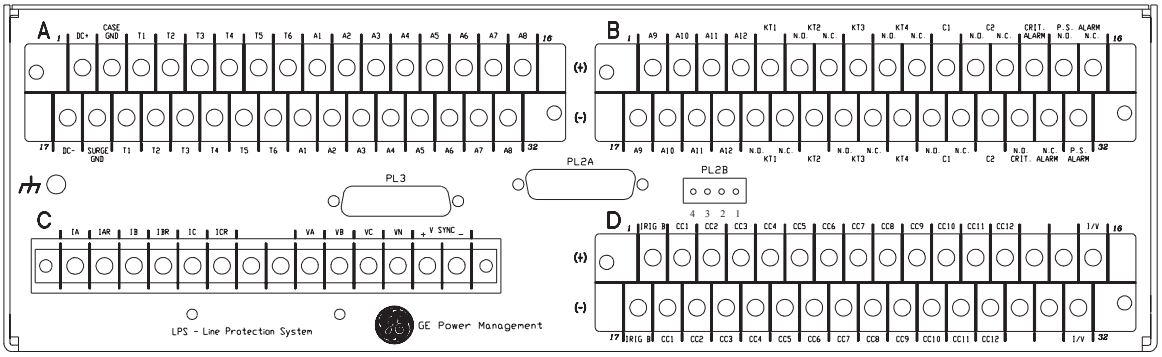


Figure 3–2: FRONT AND REAR VIEW

3.1.2 ELECTRICAL CONNECTIONS AND WIRING

Electrical connections are made to the case through four terminal blocks (A, B, C, D) mounted on the rear cover plate. Terminal blocks A, B and C contain 32 terminal points, which consist of a #6 screw threaded into a flat contact plate. Terminal D contains 14 terminal points, which consist of a #6 screw threaded into a flat contact plate.

The top and bottom printed circuit boards connect directly to terminal blocks A, B and C via edge connectors along the rear of the boards. The magnetics module is wired directly to terminal block D.

The middle printed circuit board is connected to the top and bottom circuit boards via the Bus Card connected on the front side of the circuit boards. The magnetics module is connected via a card edge connector to the bottom circuit board (input board). The current block contacts are rated to handle current transformer (CT) secondary currents.

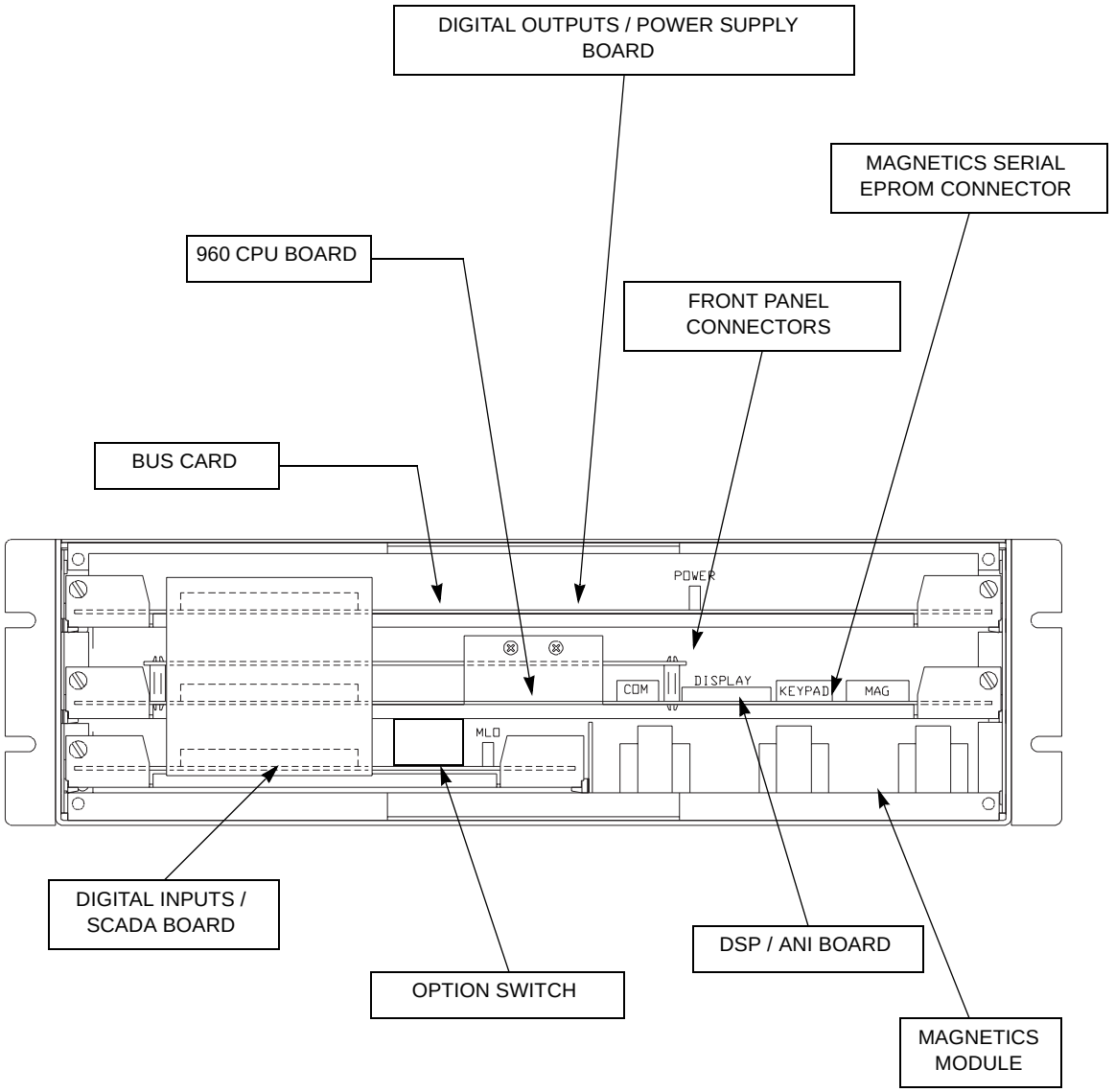


Figure 3–3: CIRCUIT BOARD LOCATIONS

3.1.3 IDENTIFICATION

The LPS-D system model number label is located on the front cover. The terminal blocks located on the rear cover plate are uniquely identified by a label that is found along the side of each terminal block Each terminal is also identified.

Four connectors, PL1, PL2 (A & B), and PL3 are used for serial communication between the LPS-D and a PC or modem. PL3 is an optional communications port. All three communications ports work independently.

3.1.4 SYSTEM BLOCK DIAGRAM

The diagram below illustrates the external connections and the interconnections between the system modules.

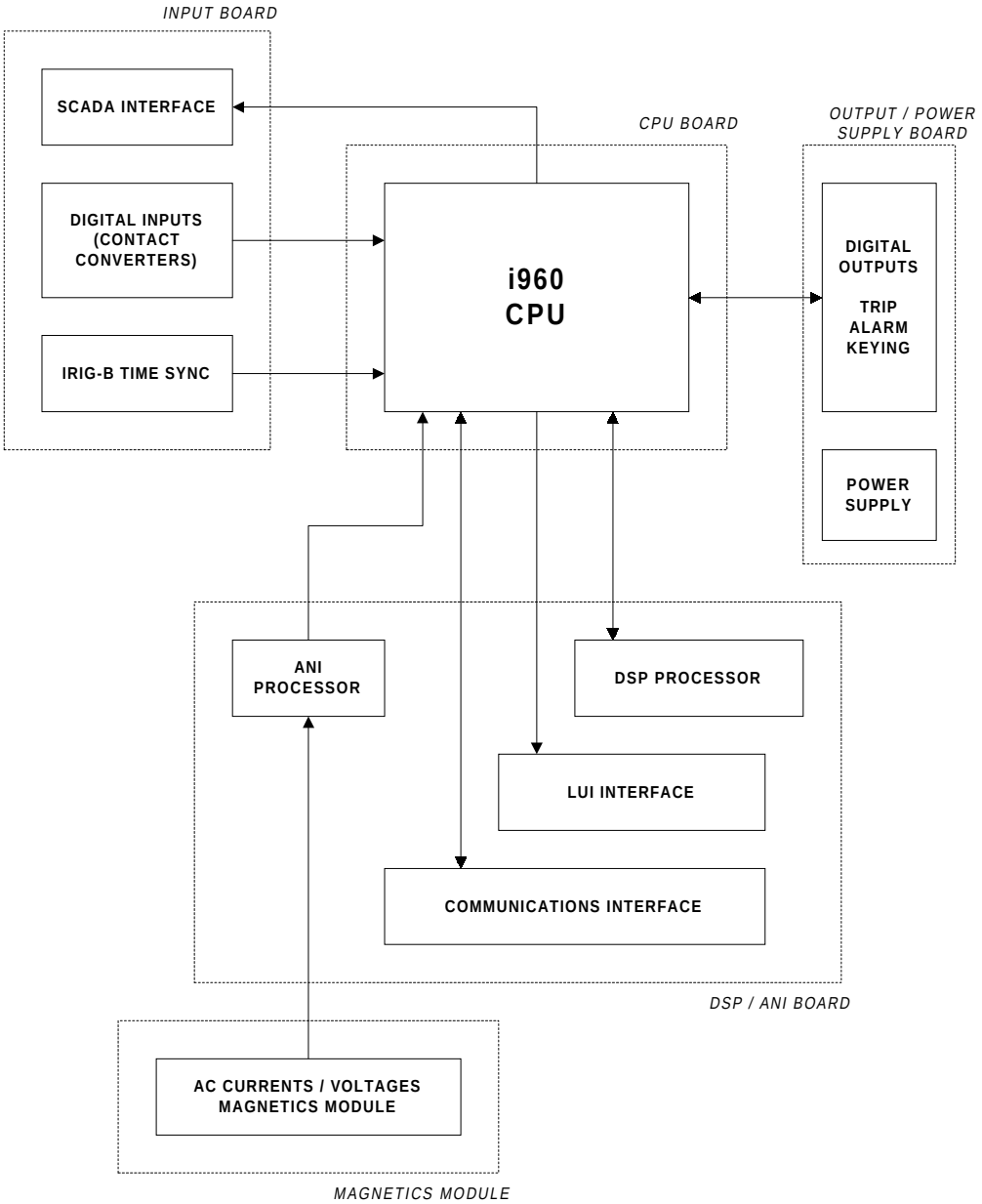


Figure 3–4: LPS-D SYSTEM BLOCK DIAGRAM

3.2.1 RECEIVING, HANDLING, AND STORAGE

Immediately upon receipt, the equipment should be unpacked and examined for any damage sustained in transit. If damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest GE Sales Office.

If the equipment is not to be installed immediately, it should be stored indoors in a location that is dry and protected from dust, metallic chips, and severe atmospheric conditions.

3.2.2 ENVIRONMENT

The LPS-D should be installed in a clean and dry location, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

3.2.3 MOUNTING

The LPS-D case has been designed for standard rack mounting. The case is three Rack Units (3 RU) high. Figure 3–2: FRONT AND REAR VIEW on page 3–2 shows the outline and mounting dimensions.

3.2.4 EXTERNAL CONNECTIONS

External connections are made according to the elementary diagrams, Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47 and Figure 1–23: ELEMENTARY DIAGRAM on page 1–48. These are default diagram incorporating all of the available options. Since the relay is programmable, some outputs and inputs may need to be re-programmed. Refer to Chapter 2: CALCULATION OF SETTINGS for more details.

3.2.5 SURGE GROUND CONNECTIONS

LPS-D Terminals A2 (case ground) and A18 (surge ground) must be tied together, with terminal A18 tied to station ground, as shown in the elementary diagrams, Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47 and Figure 1–23: ELEMENTARY DIAGRAM on page 1–48. The connection to the ground bus must be made as short as possible, using #12 wire or larger.

3.3.1 WARNING

CAUTION

This relay contains electronic components that can be damaged by electrostatic discharge currents. The main source of electrostatic discharge currents is the human body, and low humidity, carpeted floors, and isolating shoes are conducive to the generation of electrostatic discharge currents. Care should be exercised when removing and handling the modules. Each person handling the printed circuit boards must ensure that their body through a grounding wrist strap or similar apparatus tied to ground potential *before* touching any of the components on the boards or the boards themselves.

The printed-circuit boards are located inside the case in the positions shown in Figure 3–3: CIRCUIT BOARD LOCATIONS on page 3–3.

3.3.2 BASIC CONSTRUCTION

Each module consists of a printed-circuit board and aluminum plate. The printed circuit board is securely mounted to five stand-offs on the plate with five screws. There are two tabs on the front of the aluminum plate for removing and inserting the module. Electrical connection is made by an edge connector on the rear of the input and output boards and ribbon cables and the bus card connector on the front of the boards.

3.3.3 MODULE IDENTIFICATION

Each module is identified by silk screen description on the printed circuit board.

CAUTION

Power down the relay by removing any DC voltage to the relay before removing or inserting modules. Failure to do so can permanently damage the relay.

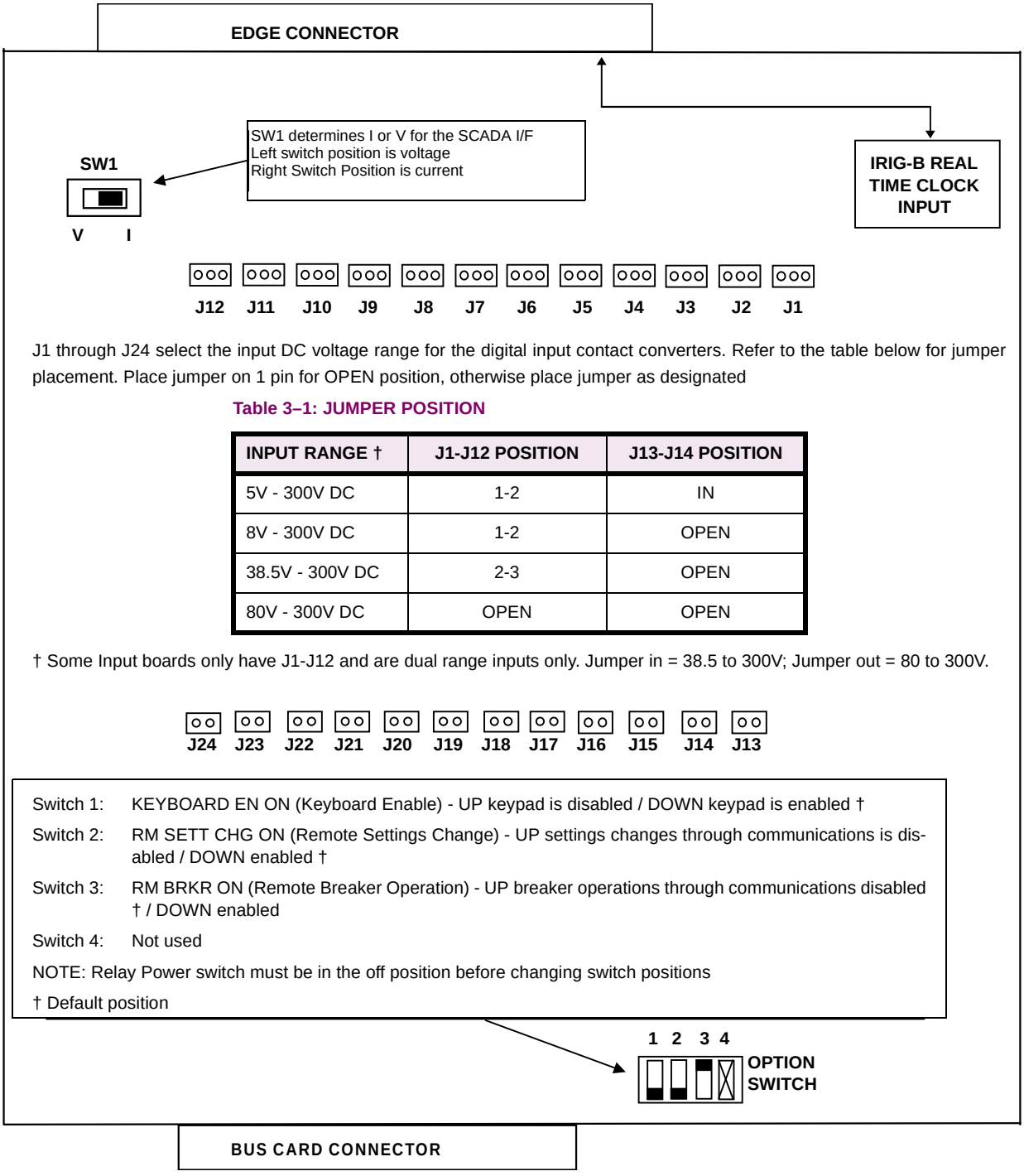
3.3.4 LOCAL USER INTERFACE (LUI)

The Keypad / Display Interface contains a 4-line, 20-character LED display, a green/red status LED, a red trip LED, a 9-pin RS232 port, and the 20-character keypad. The interface logic is contained on two printed circuit boards (DSP/ANI and LUI).

- LUI module board contains all of the items listed above except the keyboard decoding logic which is on the DSP/ANI board.
- The Output board contains the LPS-D communications interface (RS232 / ASCII), a Critical Alarm Timer, various output relay drivers, and user-selectable switches to enable remote functions.

3.3.5 INPUT BOARD

The input board contains the input logic which includes the programmable contact converter optocouplers. The SCADA I/V (current/voltage) selection switch, SW1, is in the back, left corner on this board. The IRIG-B input is also on this board. Figure 3–5: INPUT BOARD DIAGRAM is the block diagram of the input board.



J1 through J24 select the input DC voltage range for the digital input contact converters. Refer to the table below for jumper placement. Place jumper on 1 pin for OPEN position, otherwise place jumper as designated

Table 3–1: JUMPER POSITION

INPUT RANGE †	J1-J12 POSITION	J13-J14 POSITION
5V - 300V DC	1-2	IN
8V - 300V DC	1-2	OPEN
38.5V - 300V DC	2-3	OPEN
80V - 300V DC	OPEN	OPEN

† Some Input boards only have J1-J12 and are dual range inputs only. Jumper in = 38.5 to 300V; Jumper out = 80 to 300V.

Figure 3–5: INPUT BOARD DIAGRAM

3.3.6 MAGNETICS MODULE

The magnetics module (MGM) contains the input current transformers and voltage transformers. The MGM also contains an EEPROM with factory-stored LPS-D model information (DC voltage rating, AC current rating) and gain-calibration information for the analog channels

The relay driver logic located on the output board contains the alarm, BFI, RI, RC, breaker close, key transmitter, and phase A tripping contacts (or SCRs). Figure 3–7 is a block diagram of the magnetics module and the relay driver.

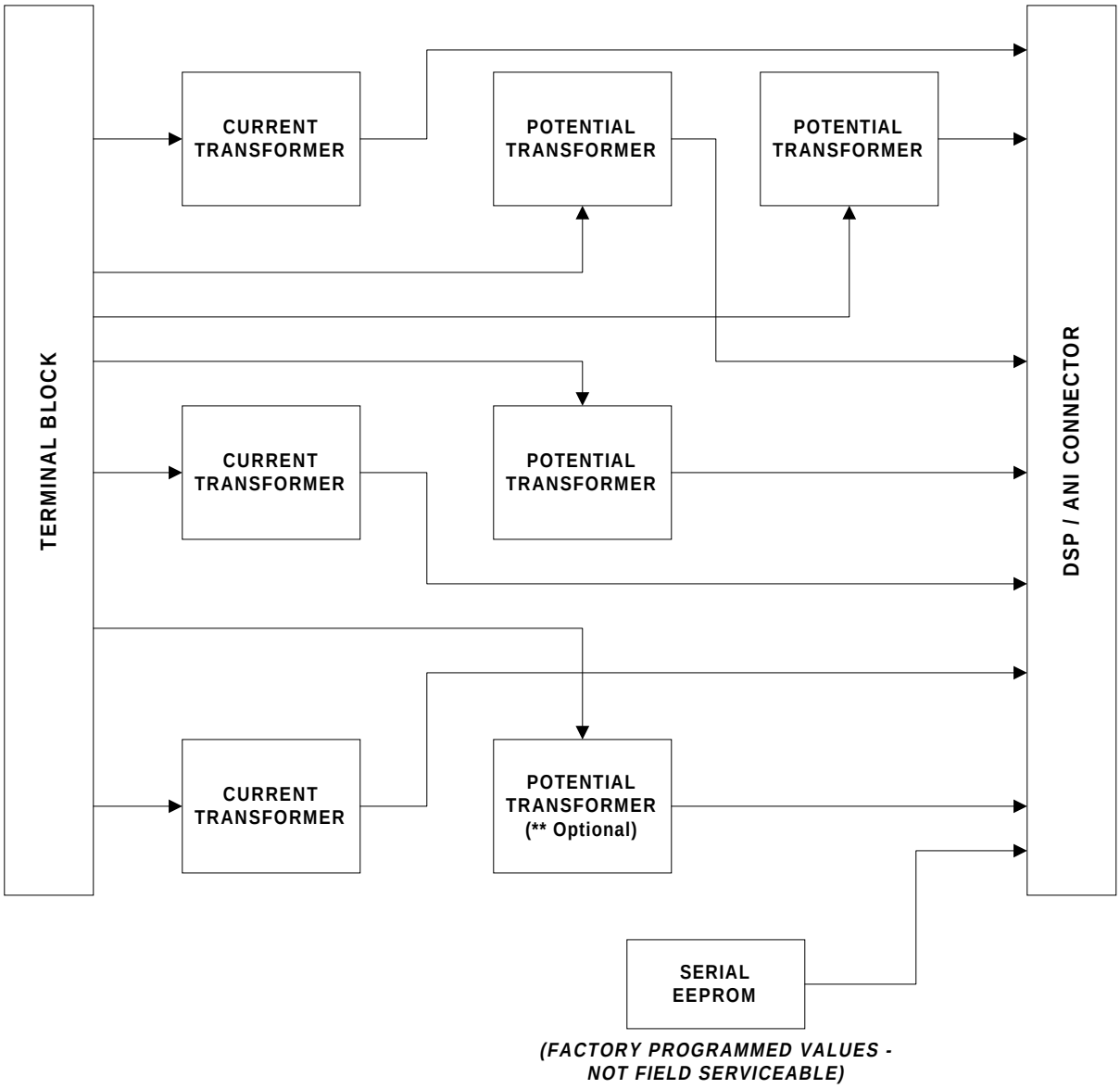
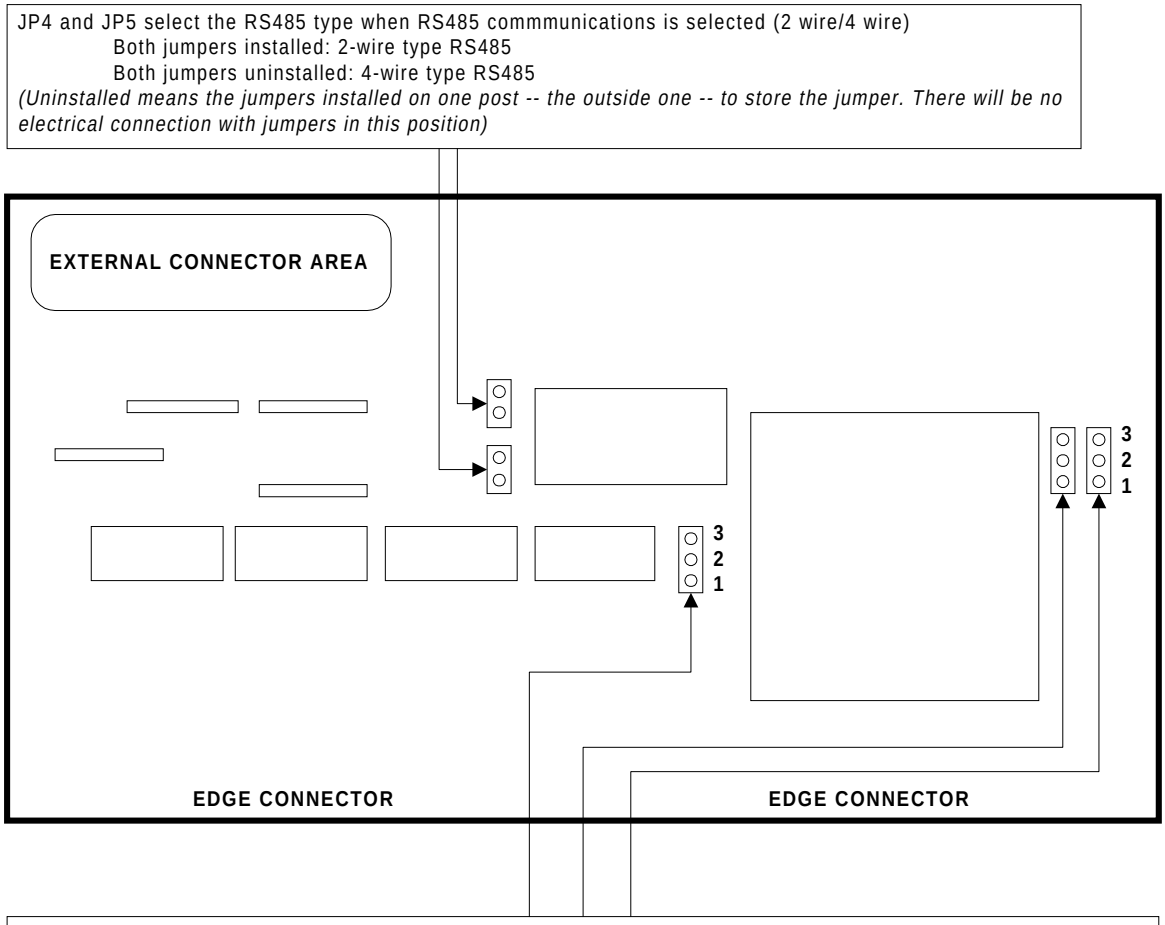


Figure 3–6: BLOCK DIAGRAM OF THE MAGNETICS MODULE

3.3.7 COMMUNICATIONS INTERFACE

The communications interface resides on plug-in modules with user selectable jumpers to configure the interface for the communications application. The two communications types that can be chosen are RS232 and RS485. See the description below for details. Figure 3–8 is the block diagram of the PC card for the communications interface.



Jumpers JP1, JP2, and JP3 are used to determine the types of communications

JP1	JP2	JP3	TYPE OF COMMUNICATIONS
OPEN	2-3	OPEN	RS232
2-3	OPEN	2-3	RS485
1-2	1-2	1-2	Programmable from keypad or communications (refer to Chapters 2 and 12)

Figure 3–7: BLOCK DIAGRAM OF THE COMMUNICATIONS MODULE

3.3.8 DIGITAL OUTPUT / POWER SUPPLY BOARD

The Digital Outputs, which are programmable are located on this board. The logic to select and write a digital output is located on this board. The power supply circuitry is also contained on this board.

Figure 3–9 is a block diagram of the Digital Output/Power Supply board.

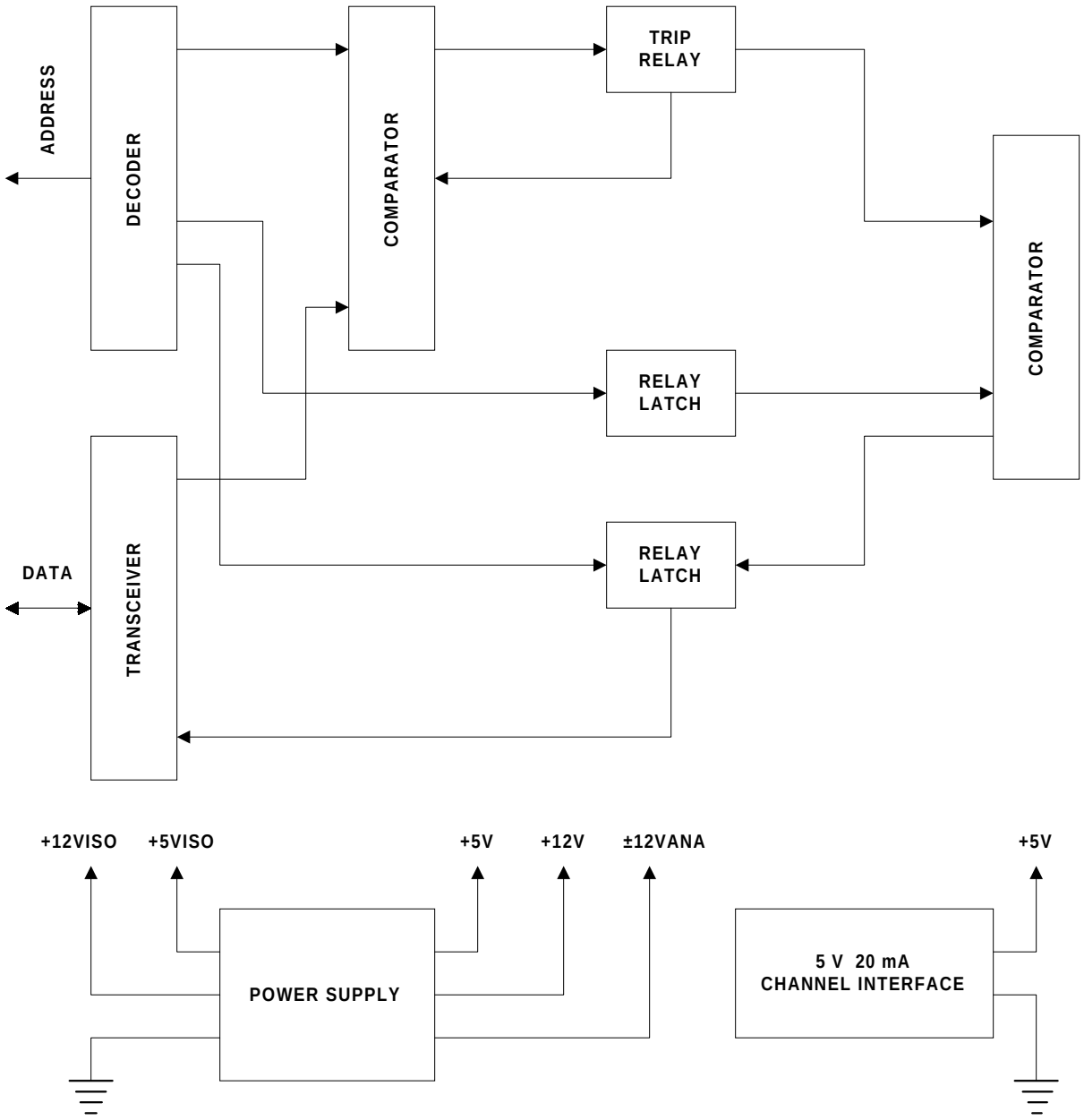


Figure 3–8: BLOCK DIAGRAM OF THE DIGITAL OUPUT / POWER SUPPLY

3.3.9 DSP / ANI / COMM / LUI

The digital signal processor (DSP), located on the DSP/ANI board, contains the TMS320C52 digital signal processor chip and its required memory. The DSP is responsible for most of the numerical calculations in the LPS-D. It performs a recursive Fourier transform calculation to transform the digitized waveforms into phasor quantities. It also handles the data acquisition through the ANI section of the board. The keypad, display and communications interfaces are all on the DSP/ANI Board, as well. Figure 3–9: BLOCK DIAGRAM OF THE DSP / COMM / LUI MODULE is the block diagram of the DSP/ANI Board.

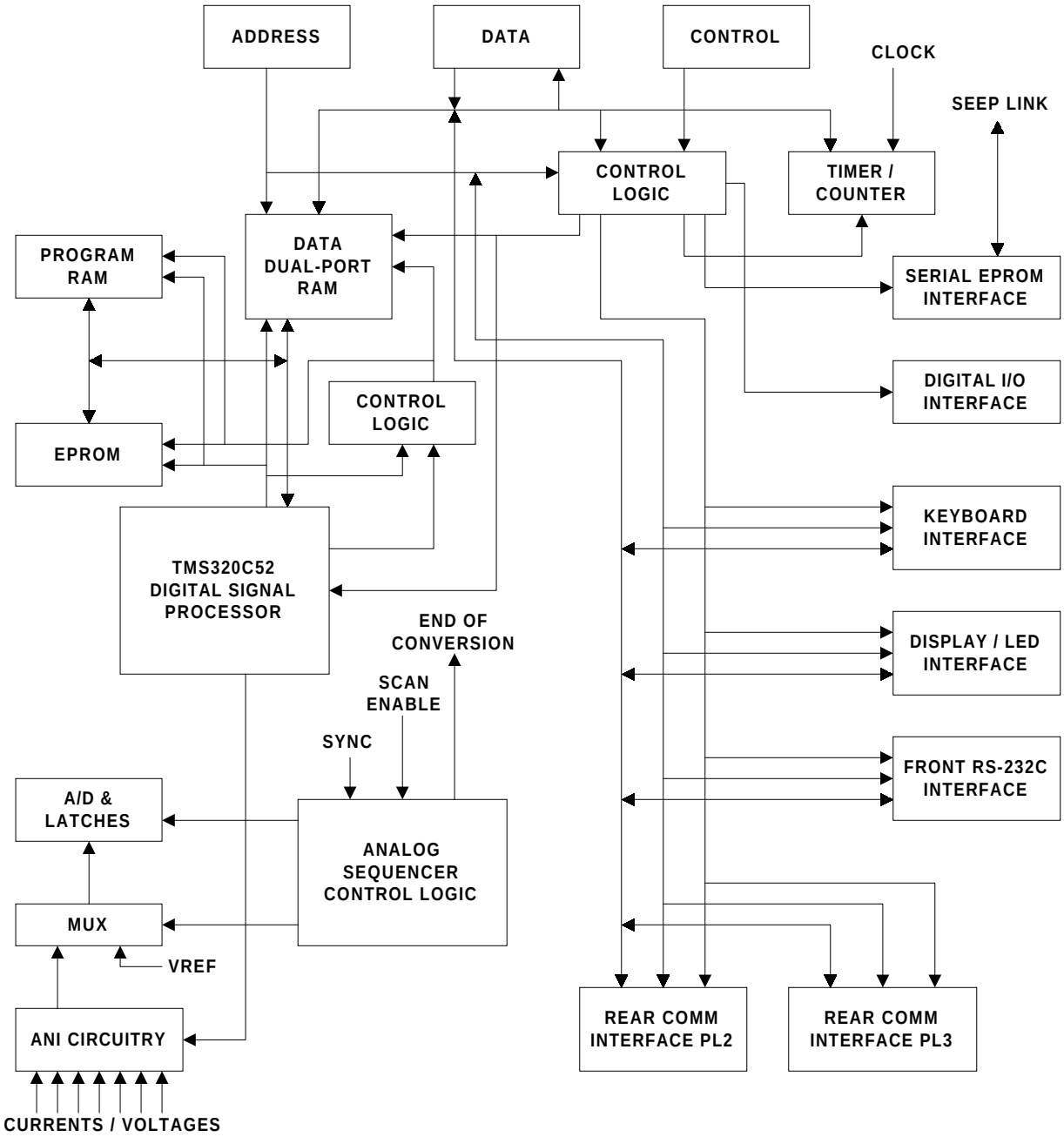


Figure 3–9: BLOCK DIAGRAM OF THE DSP / COMM / LUI MODULE

3.3.10 960 CPU BOARD

The 960 CPU board contains the 960 processor used in the LPS-D, EEPROM for storage of user settings, CAPRAM for storage of fault data and oscillography, and controls data transfer to other modules. The following functions are performed by the 960 CPU board:

- Scheme Logic
- Test Mode
- Peripheral Protection Trip Logic
- Digital Output Logic
- Fault Reporting
- Power System Alarming
- Communications and Printer Control

Figure 3–10: BLOCK DIAGRAM OF THE SYSTEM PROCESSOR (i960 CPU) contains the block diagram of the CPU logic.

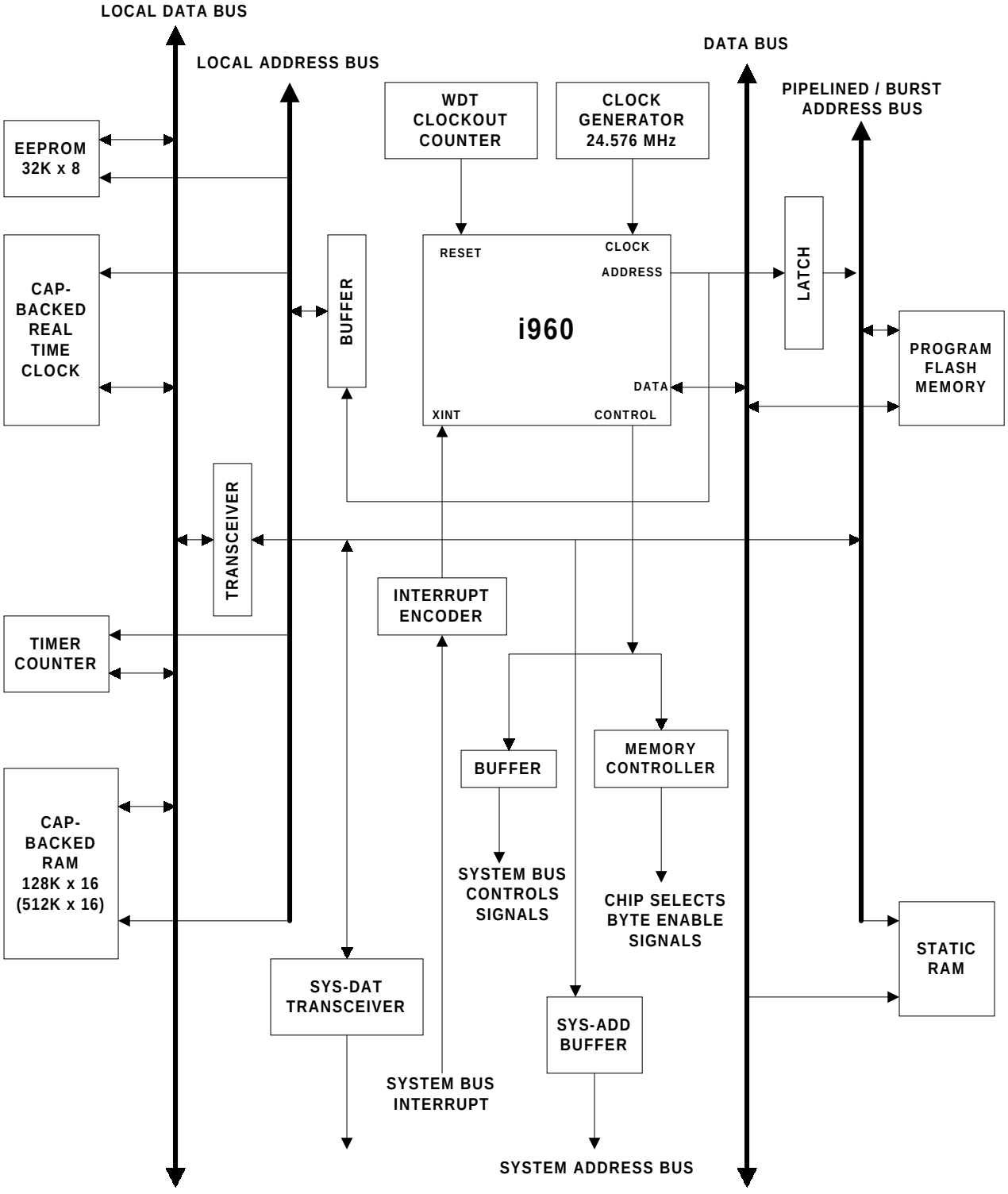


Figure 3–10: BLOCK DIAGRAM OF THE SYSTEM PROCESSOR (i960 CPU)

4.1.1 INTRODUCTION

WARNING

Remove all power from the relay by disconnecting the DC control power and removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous or lethal voltages may be present inside the unit even if the power switch is OFF.

This section is a guide for testing the LPS-D. These tests are not necessary for incoming inspection as the relay was tested at the factory with automated test equipment. The LPS-D is controlled by self-checking software. If a system failure is detected, it is reported through the display and Status LED.

The tests in this section include self-tests of the relay status, display, and keypad/display interface (Local User Interface). Tests of backup protection functions, measuring units, and zone timers are also included and can be performed at the customer's discretion.

General Relay Tests:

- T1 – Relay Status and Display Tests (Self Tests)
- T2 – Digital Output Test
- T3 – Configurable Input and Output Test
- T4 – AC System Input Test

4.1.2 TEST EQUIPMENT

The following test equipment is required:

- A three-phase source of voltage and current at rated frequency.
- A DC Control voltage source.
- Three AC voltmeters.
- Three AC ammeters.
- A continuity tester or ohmmeter.
- An IBM PC-compatible computer with a serial port and mouse.
- An RS232 null modem cable to connect the PC to the LPS-D.
- A precision timer for testing timed events.

Specific equipment requirements are listed in the instructions for each test and associated circuit diagrams.

The three-phase AC sinusoidal voltage must be balanced and undistorted. Similarly, the DC power should come from a "good" source with less than 5% ripple. A good source is within the voltage range listed in Chapter 7: SPECIFICATIONS.

Alternatively, a three-phase electronic test source may be used. In many cases, these devices allow simplification of the test circuits.

4.1.3 DRAWINGS AND REFERENCES

The following drawings should be used for reference during testing.

Elementary Diagrams

- Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47
- Figure 1–23: ELEMENTARY DIAGRAM on page 1–48

Logic Diagrams:

- Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS on page 1–13
- Figure 1–4: LINE PICKUP LOGIC DIAGRAM on page 1–14
- Figure 1–5: REMOTE-OPEN DETECTOR LOGIC on page 1–15
- Figure 1–7: OSB LOGIC DIAGRAMS on page 1–17
- Figure 1–9: STEP DISTANCE LOGIC DIAGRAM on page 1–27
- Figure 1–11: PUTT LOGIC DIAGRAM on page 1–29
- Figure 1–12: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1) on page 1–31
- Figure 1–13: POTT WITH BLOCKING FUNCTIONS (POTT2) LOGIC DIAGRAM on page 1–32
- Figure 1–14: BLOCKING SCHEME LOGIC DIAGRAM on page 1–34
- Figure 1–17: HYBRID LOGIC DIAGRAM on page 1–37

51G curves:

- Figure 2–15: INVERSE CURVE on page 2–49
- Figure 2–16: VERY INVERSE CURVE on page 2–50
- Figure 2–17: EXTREMELY INVERSE CURVE on page 2–51

The following Chapters should also be used for reference:

- Chapter 11: ALPS-LINK USER GUIDE
- Chapter 12: ASCII COMMUNICATIONS

4.1.4 EQUIPMENT GROUNDING

All equipment used in testing the relay should be connected to a common grounding point to provide noise immunity. This includes the voltage and current sources and the LPS-D itself.

The ground connection on the LPS-D is terminal A2. The common for surge protection is terminal A18.

NOTE

A2 should be connected to A18 with #12 wire or larger during test as well as operation (The separate surge ground is for Hi-Pot testing purposes).

4.1.5 REQUIRED SETTINGS

Most tests use the default settings. Any required setting changes are listed with the test procedure. For details on performing the relay test with user-specific settings during periodic testing, see Chapter 6: FUNCTIONAL TESTS (USER SETTINGS).

4.1.6 GENERAL INSTRUCTIONS

1. Tests are performed using the test mode of the LPS-D which allows viewing of the internal measuring units and functions. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

   The test mode selects and isolates various relaying functions and measuring units, then routes their status to the A1 (programmable alarm 1) contact. When the particular function under test has picked up, the A1 contact closes. Target information is displayed for tests that cause tripping.

   Testing can be performed with outputs disabled. The A1 contact still closes whenever a trip condition exists, however the tripping contacts do not operate. Disabling outputs can be accomplished from the ACTIONS menu or at the start of Relay Test mode.

   CAUTION **Contact A1 will chatter when the unit under test is near its threshold. *Do not let it continue to chatter.* Remove the test current. A single contact closure is enough to determine that the unit picked up.**

   In tests that cause tripping, the trip target type may not match the unit being tested. For example, if a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. Keep this in mind during the tests.

   Use a continuity tester with high input impedance, such as a digital ohmmeter, to monitor the A1 contact during relay testing.

   Tripping contacts will operate while the relay is in test mode unless outputs are disabled.

2. Where appropriate, current levels are defined with two numbers as *xx(yy)*; *xx* is the value to be used for relays rated at 5 amperes and (*yy*) is the value to be used for 1 ampere relays.

3. One or more of the electronic current sources may not be used during a test. If the source is not used, it must be set to zero, in addition to being disabled. Also, the currents should always be set at or near zero whenever a current source is powered on or off.

4. The phase angles of the test sources are shown relative to phase A voltage. A positive phase angle indicates the referenced quantity is leading phase A voltage. A negative phase angle indicates the referenced quantity is lagging phase A voltage.

5. All test voltages are phase-to-ground measurements unless otherwise specified.

6. Entries at the keypad are shown as KEY, with the label of the key to be pressed. For tests that require a setting change, the setting number is shown in parentheses next to the setting. This is performed by pressing the SET key, choosing the setting type (Protection or General), the group (if necessary), the setting number (*nnnn*), and ENT. The new setting may then be entered.

   Operation of Potential Transformer Fuse Failure (PTFF) will activate the Critical Alarm.

7. When testing the relay using the ALPS-Link, information will automatically appear on the display only after the relay has tripped or to report a detected error. Relay status and test mode information will not appear.

8. At the end of testing, make sure that all settings are returned to their initial values. This can be done through the ALPS-Link by uploading the settings to the PC before testing begins and then downloading them back to the relay when testing has been completed. If a PC is not available, scroll through all settings using the keypad and verify each one with the settings table in Chapter 2.

4.1.7 SETTING CHANGES

Setting changes required for a particular test are listed before the test. A sample setting change is shown below. Refer to Chapter 8: LOCAL USER INTERFACE for further details on making setting changes.

a) EXAMPLE SETTING CHANGE

This example illustrates changing the reach of the Zone 1 Ground Unit to 5.6 Ohms.

1. Apply rated DC and wait for relay initialization to complete, indicated by a solid green status LED on the front of the relay.
2. Press the SET key:

   Enter Password:

   is displayed.

   If this is the first time the Settings level functions are used, the password has the factory value "123.". This password must be changed before any setting functions can be accessed. See Chapter 8: LOCAL USER INTERFACE for details on changing the password.
3. Enter the current settings level password. If it is not known, see Chapter 12: ASCII COMMUNICATIONS for details on viewing passwords. When the correct password is entered, the settings menu is displayed.
4. Press the [1/Y] and [ENT] keys to select **Protection settings**.
5. Scroll with the arrow key until the cursor is on

   1. Z1DISTANCE

   then press the ENT key.
6. Scroll through the Z1DISTANCE menu until

   Z1GRDREACH = #.#

   appears on the display.
7. Press the [ENT] key and then press 5.6 on the keypad. The inputs appear on the display and the "**=**" sign changes to a blinking colon (**:**) to indicate that a change has been made but not yet entered.
8. When the correct reach is entered, press the [ENT] key. The blinking colon (**:**) will change back to an "**=**". This indicates that the change is entered into the settings buffer, but not permanently changed in the relay.
9. To complete the setting change, press the [END] key followed by the [ENT] key. If these keys are not pressed after setting changes, the settings are not stored in memory.
10. Restore the **Z1GRDREACH** setting to its original value before beginning the test. You will have to enter the settings level password again.

4.1.8 ENTERING TEST MODE

Before a test can be performed, the LPS-D must be put in test mode and select the function to be tested. The test mode is set as follows:

1. Apply rated DC and wait for relay initialization to complete (if this has not already been done), indicated by the green status LED on the front of the relay.
2. Press the [ACT] key and

   Enter Password:

   is displayed.

If this is the first time the Actions Level functions are used, the password has the factory value “456.”. This password must be changed before any Control functions can be accessed. See Chapter 8: LOCAL USER INTERFACE for details on changing the password.

3. If using Remote Communications, enter the current Control Level password. If the password is not known, see Chapter 11: ALPS-LINK USER GUIDE or Chapter 12: ASCII COMMUNICATIONS for details on viewing the password. When the correct password is entered, the actions menu is displayed.
4. Scroll with the arrow keys until

   5. Relay Test

   is displayed, then press the [ENT] key.
5. Scroll through the different test mode functions or enter the number of the desired test, such as 38 for the Fault Detector. Press [ENT] and the cursor will be placed on the fault detector test. Press [ENT] again and the test is started. When the LPS-D picks up for the selected function it closes the A1 contacts.
6. To exit test mode, press the [ACT] key. Scroll with an arrow key until

   5. Relay Test

   is displayed, then press the [ENT] key. Scroll until the display indicates

   1. END TEST MODE

   and press the [ENT] key. The user will be prompted to Enable Outputs. Press [1/Y] and [ENT]. The status LED should return to green, indicating that normal operation has resumed.

4.1.9 USING COMMUNICATIONS (OPTIONAL)

The relay can be tested without using the keypad. A PC and a communications program, either ALPS-Link or an ASCII terminal emulator, are required to establish communications, change the passwords, change settings for the tests, and place the unit into test mode. The example used here is for ALPS-Link. All the functions available at the keypad are also available through communications.

This section contains a step-by-step procedure to test the relay, from setting up communications to the application of the voltage and current inputs. You must be familiar with the ALPS-Link software. Refer to Chapter 11: ALPS-LINK USER GUIDE for more details on using ALPS-Link.

a) HARDWARE SETUP

The appropriate cable to connect the PC to the relay depends on the connections the PC and the LPS-D require. The LPS-D front port PL-1 accepts a 9-pin male D-connector. Port PL-2 and the optional PL-3 accept a 25-pin male D-connector. The PC used may require a 9- or 25-pin connector. A null modem cable is used to connect two communications ports without a modem. Null modem cables are shown in Chapter 8: LOCAL USER INTERFACE for connecting to the LPS-D to a PC.

b) PC SOFTWARE SETUP

The software setup consists of starting Windows, loading the software into the PC, starting the program, and configuring the program to the port and baud rate of the PC and LPS-D. ALPS-Link is a Windows program. Refer to Chapter 11: ALPS-LINK USER GUIDE or Chapter 12: ASCII COMMUNICATIONS or the manuals that came with your computer for directions on using a mouse, menu bars, dialog boxes and windows.

c) LOAD & START ALPS-LINK

1. Use the installation guide in Chapter 11: ALPS-LINK USER GUIDE or Chapter 12: ASCII COMMUNICATIONS for directions for loading ALPS-Link into the PC.
2. Double-click on the group icon that contains ALPS-Link to open the window. Start the program by double-clicking the ALPS-Link icon.

d) SET LOCAL PC CONFIGURATION

1. When you start ALPS-Link the main menu bar is displayed.
2. Click on the **SupportFunc > Host Setup > Ports** menu item.
3. Enter the communications port number that you are using on your PC by clicking in the box and typing the number. Do not hit the ENTER key yet.
4. Type in the port number that matches the PC port connected to the LPS-D. If port 3 or 4 is selected, the **IRQ** number must also be selected.
5. Select **OK** when the port is configured.

e) CREATE TEST UNIT DESCRIPTION

The next step is to create a new Unit Description that matches the baud rate, phone number, and switch code of the LPS-D. Usually, the LPS-D is accessed locally during testing; therefore, the **Phone Number** and **Switch Code** are left blank. The **Baud Rate** is set to the factory setting of 2400 with one stop bit and no parity.

1. Select **Device > Device Setup** from the main menu and click the **Add** button.
2. In the text box for the **Device Name**, type TEST. A new unit description called TEST is created and must now have parameters set for it. Note that the **Device Setup** dialog box contains spaces for **Phone Number**, **Switch Code**, **Baud Rate**, **Stop Bits**, and **Parity**.
3. At **Phone Number**, type in 10 zeros and press TAB (This is the default used when there is no phone).
4. At the **Switch Code** prompt, press TAB.
5. At the **Baud Rate** prompt, select 2400 and press TAB.
6. At the **Stop Bits** prompt, select 1 and press TAB.
7. At the **Parity** prompt, select None and press TAB.

The Unit Description for TEST is complete. Click **OK** to return to the **Device Directory** dialog box.

f) RELAY SETUP

Before shipment, the relay is set with factory default settings. These include the Unit ID, the Baud Rate, and the Factory Passwords. The default communications parameters are listed in the table below.

Table 4–1: FACTORY DEFAULT COMMUNICATIONS PARAMETERS

PARAMETER	SETTING
Unit ID	0
View Password	VIEW!
Control Password	CONTROL!
Settings Password	SETTING!
Master Password	MASTER!
Baud Rate	9600

g) LOGGING INTO THE RELAY

1. Select **Connect** from the **Device** menu.
2. Select the test device just created. ALPS-Link will prompt for a password. If this is the relay login, the passwords listed in Table 4–1: FACTORY DEFAULT COMMUNICATIONS PARAMETERS must be changed before any relay functions except CHANGE PASSWORD and LOGOUT will operate. See Chapter 12: ASCII COMMUNICATIONS for details on changing a password.

3. Type in the current password and click **OK**. If the password is not known, refer to Chapter 8: LOCAL USER INTERFACE for details on displaying the current password.
4. ALPS-Link prompts for the unit ID. Type 0 and press TAB.
5. Select **OK**. ALPS-Link responds with the message **SUCCESSFUL LOGIN**. If this was an initial login, you must log out at this point and log in again, in order to get a complete display of all the LPS-D menus.
6. Select **Logout** from the **Device** menu and select **OK**.

h) SETTING CHANGES

Setting changes required for a particular test are listed before the test. A setting can be changed either by category or individually, by selecting either **Device > Settings** or **Device > Local Settings** from the ALPS-Link menu bar. Informatin on changing settings is provided in Chapter 11: ALPS-LINK USER GUIDE.

It is important to remember to click **End** from the LPS-D Settings list menu after all settings changes for a particular test are complete. This is necessary because settings are stored in a buffer so that they can all be downloaded at once. Clicking **End** changes the settings in the relay itself.

i) ENTERING TEST MODE

Before most tests it is necessary to set the relay in test mode according to the function to be tested. The test mode is set as follows:

1. Select **Change Access Level** from the **Actions** menu.
2. Enter the Control Level password. If the password is not known, see Chapter 8: LOCAL USER INTERFACE for details on viewing the current password.
3. When the password is accepted, the message **CONTROL LEVEL** appears at the bottom of the screen.
4. Select **Relay Test Mode** from the **LPS Actions** menu. The **Relay Test** list box appears.
5. Select the test you wish to enter from the menu and then select **OK**.
6. The **Status LED** changes from green to red when the LPS-D is in test mode.

j) EXITING TEST MODE

To end test mode and turn relay protection on, select **End Test Mode** from the **Relay Test** list box and then select **OK**. The **Status LED** changes from red to green, indicating that normal operation has resumed.

k) INITIAL TEST SETUP

Before beginning a test, the relay settings should be checked for reference and verification. The factory settings are listed in Chapter 2: CALCULATION OF SETTINGS. You may use either the communications ports or scroll through the settings to ensure they all match the defaults.

For testing with ALPS-Link, the relay settings should be uploaded from the LPS-D and printed for reference and verification. Verify that each LPS-D setting matches the default setting listed. If no printer is available, use the **Device > Settings** command for verification.

Once uploaded, the current LPS-D settings can be saved to a disk file so that they can be downloaded to the LPS-D when testing is completed. Click **Save LPS** in the LPS-D Settings window. ALPS-Link prompts for a name for the file, after which you should enter a valid MS-DOS filename. More information on how to use this command can be found in Chapter 11: ALPS-LINK USER GUIDE.

4.2.1 T1 – RELAY STATUS AND DISPLAY TESTING

The LPS-D Status is reported through the Keypad/Display Interface, the noncritical alarm contact, and the critical alarm contact. If a system error causes relaying functions to cease, the status LED turns red and the critical alarm contact closes. A failure that does not interrupt relaying is indicated by closing the noncritical alarm contact and displaying a WARN message.

a) STATUS CHECK

This test demonstrates the use of the Keypad/Display Interface to check relay status. See Chapter 11: ALPS-LINK USER GUIDE or Chapter 12: ASCII COMMUNICATIONS for further details.

1. Only the DC power supply voltage is required for this test. Apply the rated DC power and wait for initialization to complete (if this has not been done already), as indicated by the green LED.
2. Press the INF key, then use the ARROW keys to scroll until the cursor in on

   1. LPS STATUS
3. Press the ENT key. The display should contain the message

   STATUS: OK

   indicating that the relay is operational and there are no errors.
4. Verify the setting of the trip circuit monitor (#107 in General Settings) is:

   NUM_MON = 0011 (000111)

   Be sure to press the END and ENT keys after the setting is changed. When this is done, the relay expects wetting voltage across the trip contacts.
5. Press the INF key and scroll with ARROW keys until the display contains the message

   1. LPS STATUS
6. Press the ENT key. The display should contain the message

   STATUS: FAIL

   FAIL: TRIP CKT #1 CONTINUITY ERROR

   This verifies that the relay detected the absence of wetting voltage across the trip contact.
7. Change the setting of the trip circuit monitor to

   NUM_MON = 0000 (000000)

   to re-check the status. The display should read

   STATUS: OK
8. Change the setting of the trip circuit monitor back to **NUM_MON** = 0011 (000111) before starting the next test.

4.2.2 DISPLAY AND KEYPAD TESTS

The Keypad/Display Interface (LUI) Test is built into the software and allows testing the keypad and the display.

1. Apply rated DC power and wait for initialization to complete, as indicated by the green LED, if necessary.
2. Press the ACT key, then scroll with the arrow keys until the display contains the heading

   7. LUI TEST
3. Press the ENT key. The display should contain three choices to test the display, LEDs and keyboard.

4. Select

   1. Display

   and press the ENT key.

5. Check that the display has two rows filled completely with rectangles and press the ENT key. The display changes to the last two rows filled with rectangles. When the display has been checked press the ACT key. If any other key is pressed the display will not return to the LUI Test menu.

6. Use the ARROW keys to select

   2. LEDs

   and press the ENT key. The selected LED will change. Press ENT after verifying each LED state. When the test is finished the LUI Test menu will be displayed.

7. Use the ARROW keys to select

   3. Keyboard

   and press ENT. A map of the key board will be displayed on the screen.

8. At this point the relay is in the keyboard test. Press every key on the keypad, except for the CLR key. As you press each key, verify that the display indicates the key that was pressed. For example, pressing the up arrow is indicated on the displayed by the up arrow flashing. The display corresponding to the other keys is the legend that is on printed the key itself.

9. When all the keys have been checked, press the CLR key.

10. When the test is completed, press the END followed by the ENT key. Press the CLR key to clear the message. This ends the Keypad/Display Interface Test.

4.2.3 T2 – DIGITAL OUTPUT TEST

This test checks all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults. Protection can be enabled or disabled, as deemed necessary.

NOTE

If this test is run remotely through ALPS-Link, then switch RM BRKR must be in the down position to allow the outputs to operate. Refer to Section 8.4.1: HARDWARE SWITCHES for details on changing the switch position. Note that the relay is shipped from the factory with the switch in the down position allowing the outputs to operate.

1. Connect the relay as shown in Figure 4–1: DIGITAL OUTPUT TEST CONNECTIONS on page 4–11.

2. Press the ACT key and enter the control level password.

3. Use the ARROW key to select

   8. Digital Output Test

4. Press the ENT key. Before a contact is allowed to be tested, the display prompts

   DISABLE PROTECT?

5. Press the 1/Y key followed by the ENT key to turn protection off. Protection remains off until the test mode is ended (if desired, protection can be left enabled during the test).

6. Select the output to test by using the ARROW keys to scroll to the desired output, such as T1, and press the ENT key. When the digital output is chosen, the selected relay output closes. Verify that the output under test has closed, using an ohmmeter or other suitable device.

7. After the output is tested, scroll to the next output to test, then press the ENT key. This output closes and the previously selected output opens. Continue in this fashion until all outputs are tested.
8. End the test mode by scrolling to the

   END TEST MODE

   selection, then press the ENT key. Alternatively, press END followed by the ENT key to end the test and re-enable protection.

Table 4–2: DIGITAL OUTPUTS TEST CONNECTIONS

DIGITAL OUPTUT	X	Y
T1	A3	A19
T2	A4	A20
T3	A5	A21
T4	A6	A22
T5	A7	A23
T6	A8	A24
A1	A9	A25
A2	A10	A26
A3	A11	A27
A4	A12	A28
A5	A13	A29
A6	A14	A30
A7	A15	A31
A8	A16	A32
A9	B1	B17
A10	B2	B18
A11	B3	B19

DIGITAL OUTPUT	X	Y
A12	B4	B20
KT1 (no)	B5	B21
KT1 (nc)	B5	B22
KT2 (no)	B5	B21
KT2 (nc)	B23	B7
KT3 (no)	B8	B24
KT3 (nc)	B8	B25
KT4 (no)	B26	B9
KT4 (nc)	B26	B10
C1A (no)	B11	B27
C1B (nc)	B11	B28
C2A (no)	B29	B12
C2B (nc)	B29	B13
CA (nc)	B14	B30
CA (no)	B14	B31
PWR (nc)	B32	B15
PWR (no)	B32	B16

Tx - TRIPPING contacts (programmable)
Ax - Alarm contacts (programmable)
KTx - Key Transmitter contacts (programmable)
Cxy - C Form contacts with one NO/NC contact pair (programmable)
CA - Critical Alarm
PWR - Power Supply Alarm

† These digital outputs apply to the Single Phase Tripping model only.

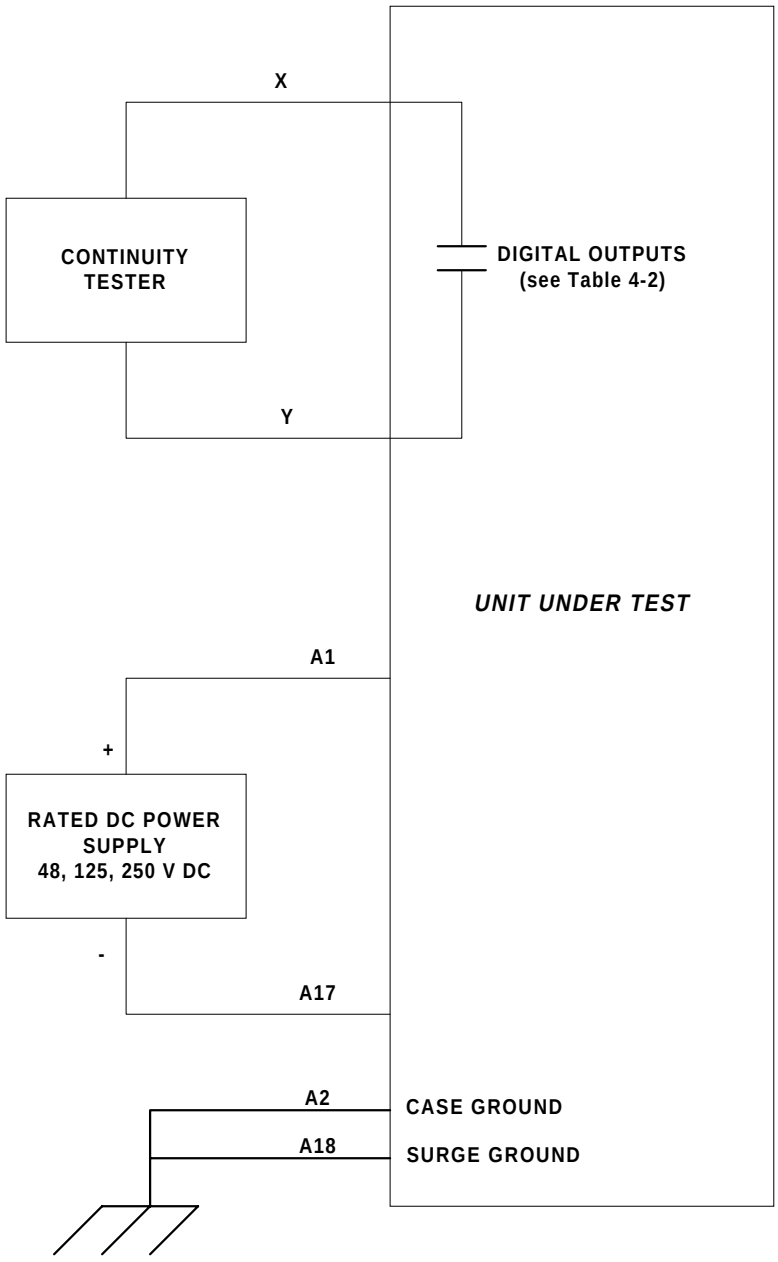


Figure 4–1: DIGITAL OUTPUT TEST CONNECTIONS

4.2.4 T3 – CONFIGURABLE INPUT AND OUTPUT TEST

The LPS-D includes 8 configurable inputs and 18 configurable outputs. They provide great flexibility in applying and testing the relay. The configurable inputs and outputs are user-programmed to determine their use. For example, one input could be used to trigger oscillography, while another could be used to select a settings group. Each output can be set as one of the 217 different flags available in the relay.

a) TEST T3 PROCEDURE

1. Connect the relay as shown in Figure 4–2: CONFIGURABLE INPUT/OUTPUT TEST CONNECTIONS on page 4–13 with default configurable logic installed.

2. Apply rated DC across CC1 (D2-D18). Using the keypad and the INFORMATION: “CC status” command, verify that CC1 is ON. Remove the DC from CC1.
3. Apply rated DC across CC2 (D3-D19). Using the keypad and the INFORMATION: “CC status” command, verify that CC2 is ON. Remove the DC from CC2.
4. Apply rated DC across CC3 (D4-D20). Using the keypad and the INFORMATION: “CC status” command, verify that CC3 is ON. Remove the DC from CC3.
5. Apply rated DC across CC4 (D5-D21). Using the keypad and the INFORMATION: “CC status” command, verify that CC4 is ON. Remove the DC from CC4.
6. Apply rated DC across CC5 (D6-D22). Using the keypad and the INFORMATION: “CC status” command, verify that CC5 is ON. Remove the DC from CC5.
7. Apply rated DC across CC6 (D7-D23). Using the keypad and the INFORMATION: “CC status” command, verify that CC6 is ON. Remove the DC from CC6.
8. Apply rated DC across CC7 (D8-D24). Using the keypad and the INFORMATION: “CC status” command, verify that CC7 is ON. Remove the DC from CC7.
9. Apply rated DC across CC8 (D9-D25). Using the keypad and the INFORMATION: “CC status” command, verify that CC8 is ON. Remove the DC from CC8.
10. Apply rated DC across CC9 (D10-D26). Using the keypad and the INFORMATION: “CC status” command, verify that CC9 is ON. Remove the DC from CC10.
11. Apply rated DC across CC10 (D11-D27). Using the keypad and the INFORMATION: “CC status” command, verify that CC10 is ON. Remove the DC from CC10.
12. Apply rated DC across CC11 (D12-D28). Using the keypad and the INFORMATION: “CC status” command, verify that CC11 is ON. Remove the DC from CC11.
13. Apply rated DC across CC12 (D13-D29). Using the keypad and the INFORMATION: “CC status” command, verify that CC12 is ON. Remove the DC from CC12.

4.2.5 T4 – AC SYSTEM INPUT TEST

This test uses Present Values to determine that voltages and currents are properly connected to the terminal strip. The VALUES function can be used any time during the test to verify the relay voltages and currents.

1. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
2. Set VA to 67 V rms ∠0°, VB to 57 V rms ∠–120°, and VC to 47 V rms ∠120°.
3. Press the INF key on the keypad. Scroll, using the arrow keys, to the heading:

   1. Present values

   and press the ENT key. The present values are now displayed.
4. Scroll to the values of VA, VB, and VC and verify that the voltages are within ±2 volts of the voltage source setting. This verifies the connections of the voltage sources.

   ***NOTE*: Alternately, whenever the display is blank, press the CLR key to have the relay automatically scroll through the present values.**
5. Set I_{op} to 1.0 amp rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
6. Verify the value of IA, IB, or IC depending on connection Y. Verify that the current reading is between 0.9 and 1.1 amps rms.
7. Reduce the test current to zero amps.

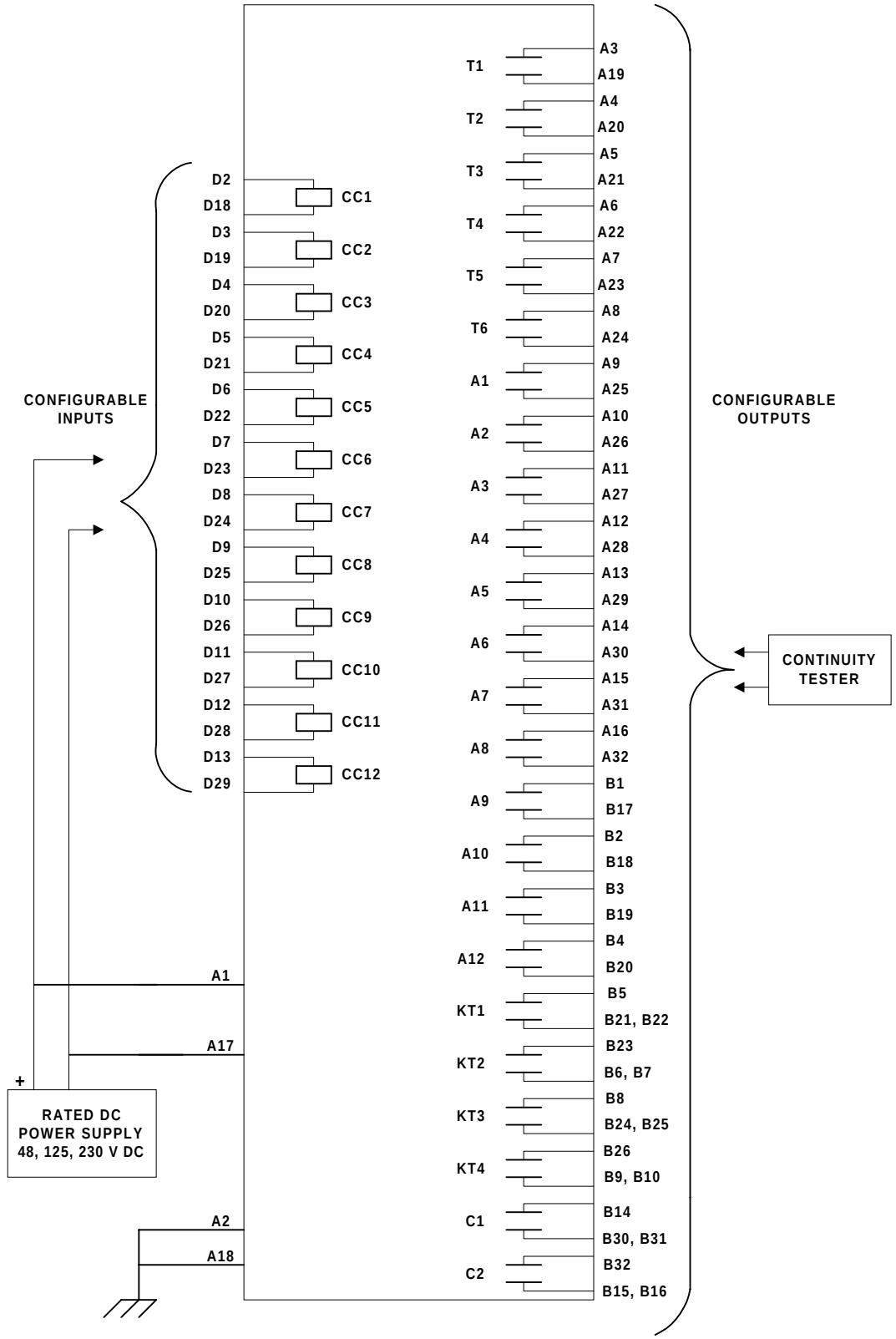
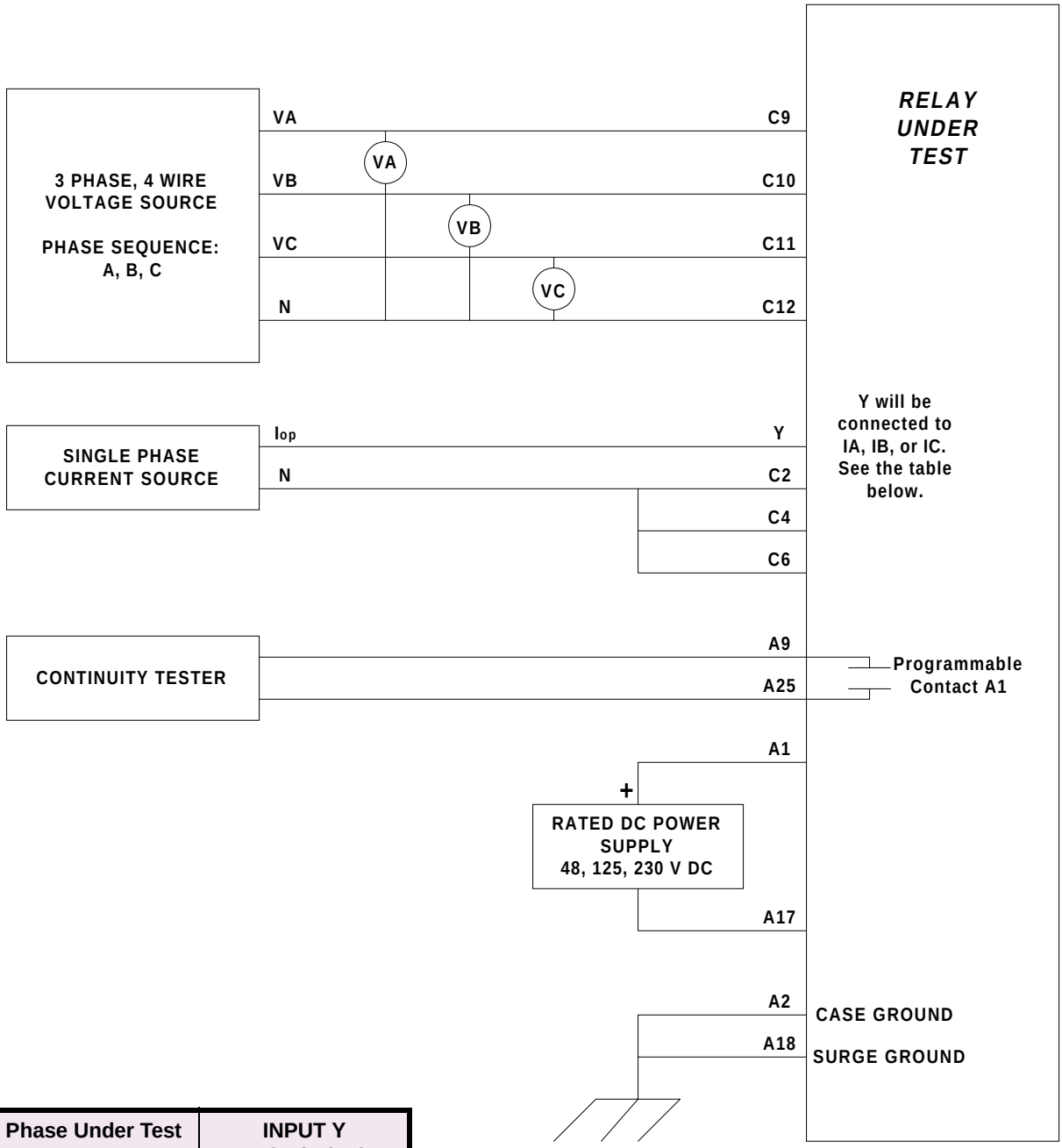


Figure 4–2: CONFIGURABLE INPUT/OUTPUT TEST CONNECTIONS



Phase Under Test	INPUT Y Terminal Block #
AG	C1
BG	C3
CG	C5

Figure 4–3: PHASE TO GROUND TEST CONNECTIONS

5.1.1 DESCRIPTION

a) MEASURING UNIT TESTS

- T1 – FD Fault Detector Test
- T2 – IT Trip Supervision Test
- T3 – IB Blocking Supervision Test
- T4 – Ground Directional Trip Test, IPT & NT
- T5 – Ground Directional Block Test, IPB & NB
- T6 – Phase Instantaneous Overcurrent Test
- T7 – Ground Instantaneous Overcurrent Test
- T8 – Ground Time Overcurrent Test
- T9 – Undervoltage Test
- T10 – Overvoltage Test

b) ZONE REACH AND TIMER TESTS

- T11 – Zone 1 Ground Reach, M1G Ground Faults Test
- T12 – Zone 2 Ground Reach, MTG Ground Faults Test
- T13 – Zone 3 Ground Reach, M3G Ground Faults Test
- T14 – Zone 4 Ground Reach, M4G Ground Faults Test
- T15 – Ground (Zone Backup) Timer Tests

c) PHASE-TO-PHASE ZONE REACH TESTING

- T16 – Zone 1 Phase Reach Test
- T17 – Zone 2 Phase Reach Test
- T18 – Zone 3 Phase Reach Test
- T19 – Zone 4 Phase Reach Test
- T20 – Phase (Zone Backup) Timer Tests
- T21 – Out-of-step Reach Test

Refer to Section 4.1: OVERVIEW on page 4–1 for information on beginning functional tests.

Contact A1 will chatter when the unit under test is near the threshold. *Do not allow this to continue!* Remove the test current. A single contact closure is enough to determine that the unit picked up.

Before starting to test the LPS-D relay, download all the relay settings to your PC using the ALPS-Link program

5.2.1 T1 – FAULT DETECTOR TEST

The Fault Detector responds to sudden changes in current levels. Slow changes are not picked up.

1. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
2. Set the relay into test mode 38 (the fault detector). The relay displays

   FAULT DETECTOR ON

3. Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GROUND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

   OVERCURRENT

   (605) **50G** = NO
   (610) **51G** = NO

4. Set the voltages as follows:

   VA = 67 V rms ∠0°
   VB = 67 V rms ∠–120°
   VC = 67 V rms ∠+120°

5. Slowly increase I_{op} to 1.2 (0.4) A rms, at approximately 0.1 (0.01) A per second. Slowly decrease the current to 0 A. The A1 contact should not close.
6. Immediately increase I_{op} to 1.5 (0.3) A rms. The A1 contact should close momentarily.
7. Immediately increase I_{op} to 2.5 (0.5) A rms. The A1 contact should close until current is removed.
8. Reduce I_{op} to 0.

5.2.2 T2 – IT TRIP SUPERVISION TEST

1. Settings:

   Z1DISTANCE

   (104) **Z1GROUND** = YES

   CURSUPVIS

   (501) **IT_PICKUP** = 0.25 (0.05) amps
2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set the relay into test mode 34 (IT Detector). The LUI should display

   IT DETECTOR ON
4. Set the voltages as follows:

   VA = 67 V rms ∠0°
   VB = 67 V rms ∠–120°
   VC = 67 V rms ∠+120°.
5. Set I_{op} to 0.40 (0.08) A rms and apply to the relay. The A1 contact should close. Lower I_{op} to 0.15 (0.03) A rms, at which point the A1 contact should open.
6. Reduce I_{op} to 0.

5.2.3 T3 – IB BLOCKING SUPERVISION TEST

1. Setting:

   CURSUPVIS

   (502) **IB_PICKUP** = 0.2 (0.04) amps
2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set the relay into test mode 35 (IB Detector). The LUI should display

   IB DETECTOR ON
4. Set the voltages as follows:

   VA = 67 V rms ∠0°
   VB = 67 V rms ∠–120°
   VC = 67 V rms ∠+120°
5. Set I_{op} to 0.30 (0.06) A rms and apply to the relay. The A1 contact should close. Lower I_{op} to 0.10 (0.02) A rms, at which point the A1 contact should open.
6. Reduce I_{op} to 0.

5.2.4 T4 – GROUND DIRECTIONAL TRIP TEST, IPT + NT

1. Setting:

   Z2DISTANCE

   (204) **Z2GROUND** = YES
   (205) **Z2GRDCHAR** = GDOC

   CURSUPVIS

   (503) **IPT_PICKUP** = 0.5 (0.1) Amps

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set the voltages as follows:

   VA = 55 V rms ∠0°
   VB = 67 V rms ∠–120°
   VC = 67 V rms ∠+120°.

4. Set the relay into test mode 36 (Ground Directional Trip). The LUI should display

   GRD DIR TRIP ON

5. Set IA, the current of I_{op}, to 0.70 (0.14) A rms ∠–85°, and apply to the relay. The A1 contact should close. Lower I_{op} to 0.40 (0.08) A rms, at which point the A1 contact should open.
6. Reduce I_{op} to 0.

5.2.5 T5 – GROUND DIRECTIONAL BLOCK TEST, IPB + NB

1. Settings:

   CURSUPVIS

   (504) **IPB_PICKUP** = 0.25 (0.05) Amps

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set VA to 55 V rms ∠0°, VB to 67 V rms ∠-120°, and VC to 67 V rms ∠+120°.
4. Set the relay into test mode 37 (Ground Directional Block). The LUI should display

   GRD DIR BLK ON

5. Set IA, the current of I_{op}, to 0.40 (0.08) A rms ∠–265° and apply to the relay. The A1 contact should close. Lower I_{op} to 0.15 (0.03) A rms, and the A1 contact should open.
6. Reduce I_{op} to 0 A.

5.2.6 T6 – PHASE INSTANTANEOUS OVERCURRENT 50

1. Protection settings:

   OVERCURRNT

   (601) **50** = YES
   (602) **50_DIRCNL** = NO
   (603) **50PICKUP** = 5.0 (1.0)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for a phase AB, BC, or CA fault. Note that the leading phase is 180 degrees out of Phase with the line to which it is shorted.

3. Set the relay into test mode 43 (Phase Overcurrent). The LUI should display

   INST PHS OVRC ON

4. Set I_{op} to 2.8 (0.6) A rms and apply to the relay. The A1 contact should close. Lower I_{op} to 2.0 (0.4) A rms, at which point the A1 contact should open.

5. Reduce I_{op} to 0 A.

6. Restore the following Protection settings

   OVERCUR

   (602) **50_DIRCNL** = YES
   (603) **50PICKUP** = 20.0 (4.0) Amps

5.2.7 T7 – GROUND INSTANTANEOUS OVERCURRENT 50G

1. Protection settings:

   OVERCURRNT

   (605) **50G** = YES
   (606) **50G_DIRCNL** = NO (Directnl ctrl off)
   (607) **50GPICKUP** = 2.5 (0.5) Amps
   (608) **50GRESTNT** = 0

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.

3. Set the relay into test mode 44 (Ground Overcurrent). The LUI displays

   INST GND OVRC ON

4. Set I_{op} to 4.0 (0.80) A rms and apply to the relay. The A1 contact should close. Lower I_{op} to 2.4 (0.40) A rms, at which point the A1 contact should open.

5. Reduce I_{op} to zero.

6. Restore the following settings

   OVERCURRNT

   (605) **50G_DIRCNL** = YES
   (605) **50GPICKUP** = 10 (2.0) Amps

1. Record the pre-test values for Protection Settings 610, 611, 612, 614, and 615.
2. Settings:

   OVERCURRNT

   (610) **51G** = YES
   (611) **51G_DIRCNL** = NO (direct ctrl off)
   (612) **51GPICKUP** = 1.0 (0.2) Amps
   (614) **51GCURVE** = V-INV
   (615) **51GTIMDIAL** = 5.0
3. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–8.

   NOTE: Start the timer when I_{op} is applied, and stop the timer when A1 closes (the relay trips).
4. For this test remove the relay from test mode and assign TOCTRP to A1.

   (2007) **A1** = index 119; TOCTRP
5. Apply I_{op} at 3.0 (0.6) A rms and start the timer. Leave the current on until the A1 contact close and stop the timer. The **51G** should time out in 2.8 to 3.2 seconds.
6. Reduce I_{op} to zero.
7. Repeat steps 3 and 4 with the values for I_{op} from Table 5–1: TIME-OUT VALUES WHILE REPEATING T8 below. Verify that the **51G** times out within the specified time.

Table 5–1: TIME-OUT VALUES WHILE REPEATING T8

I_{op}, A rms	51G time out, s
3	2.8 to 3.2
6	0.9 to 1.1
10	0.6 to 0.8

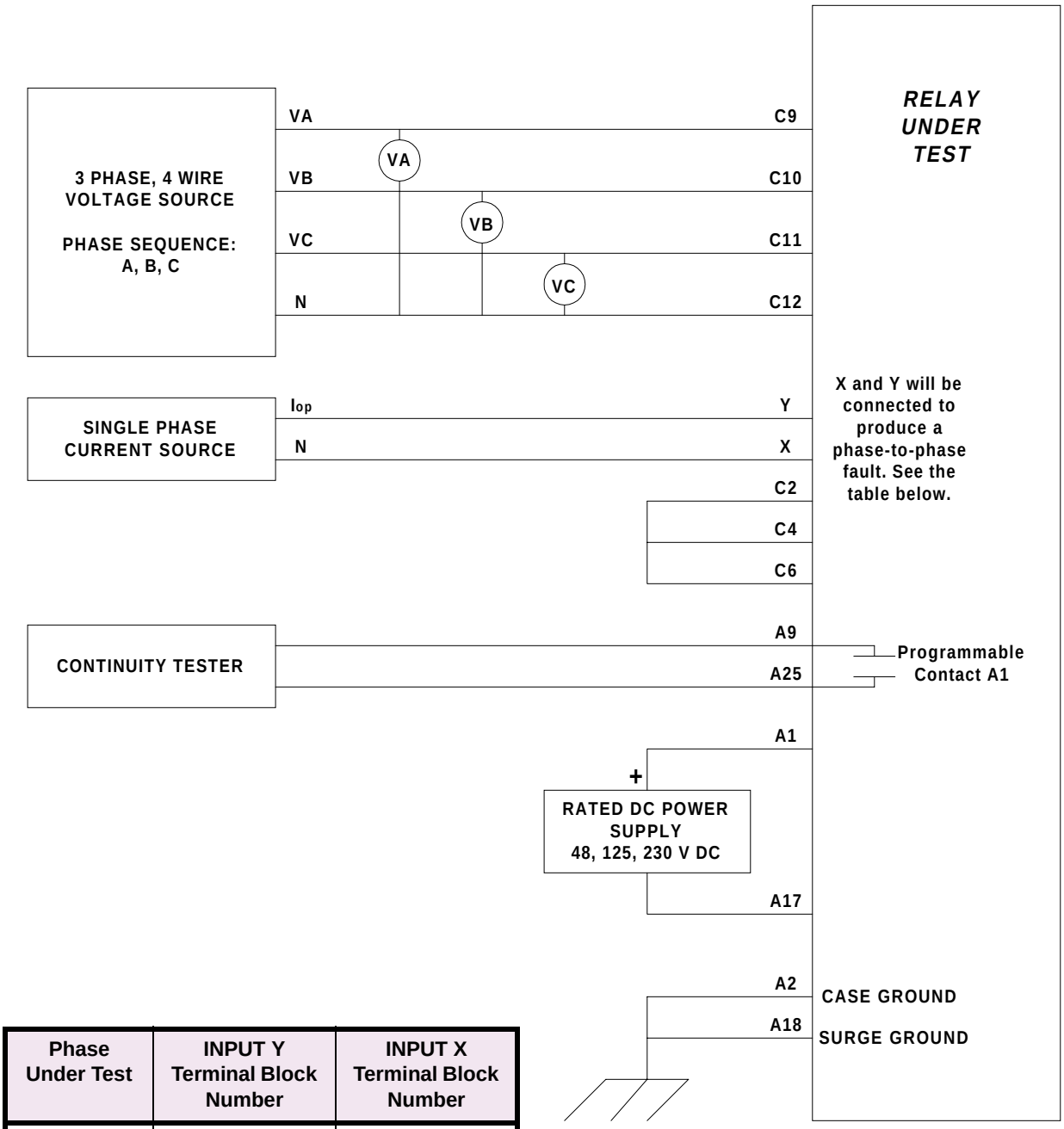
8. Restore these Protection settings

   OVERCURRNT

   (610) **51G** = *Pretest setting*
   (611) **51G_DIRCNL** = *Pretest setting*
   (612) **51GPICKUP** = *Pretest setting*
   (615) **51GTIMDIAL**= *Pretest setting*

   OUTPUTS

   (2007) **A1** = *Pretest setting*



Phase Under Test	INPUT Y Terminal Block Number	INPUT X Terminal Block Number
AB	C1	C3
BC	C3	C5
CA	C5	C1

Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS

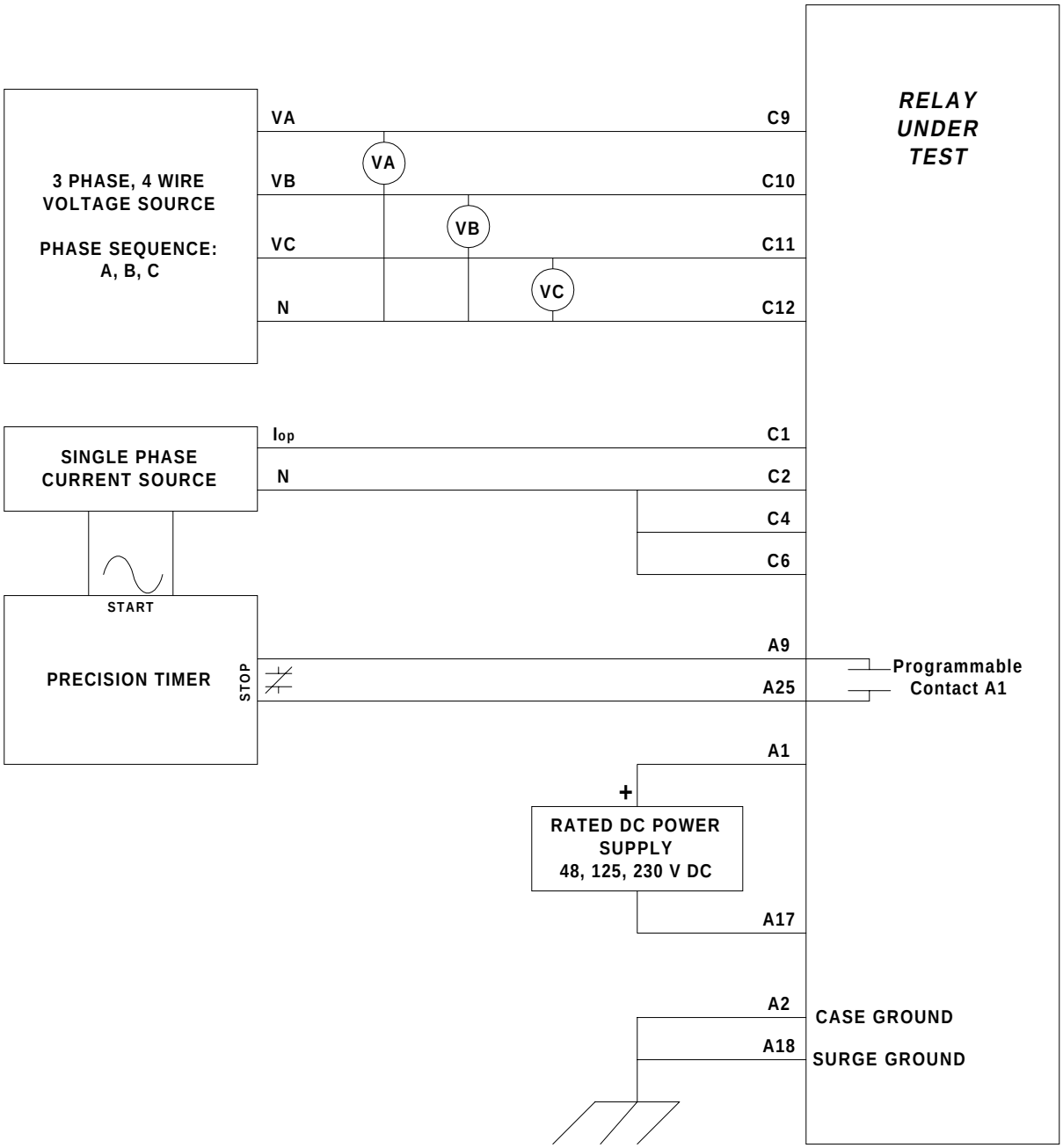


Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS

5.2.9 T9 – UNDERVOLTAGE TEST

1. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–8.
2. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°
   VB: 67 volts rms ∠–120°
   VC: 67 volts rms ∠+120°
3. Set I_{op} to zero Amps.
4. Set the relay into test mode 48 The LUI displays

   UNDERVOLTAGE ON
5. Set phase A voltage to 35 V and check that contact A1 closed. Set phase A voltage back to 67 V and check that contact A1 opens. Repeat for phase B and C.

5.2.10 T10 – OVERVOLTAGE TEST

1. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–8.
2. Protection settings:

   VOLTAGE

   (701) **RATEDVOLTS** = 115 (V rms)
   (702) **PHASEOVER** = YES
   (703) **PHOVPICKUP** = 1.10 (pu Volts)
   (704) **PHOVTMDLY** = 0.5
3. Set the relay into test mode 47. The LUI displays

   OVERVOLTAGE ON
4. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°
   VB: 67 volts rms ∠–120°
   VC: 67 volts rms ∠+120°.
5. Set I_{op} to zero Amps.
6. Set phase A voltage to 74 V and check that contact A1 is closed. Set phase A voltage back to 67 V and check that contact A1 opens. Repeat for phases B and C.

5.3.1 GENERAL ZONE REACH TESTING CONSIDERATIONS

1. The Zone measuring units are checked in the test mode of operation. The A1 (programmable alarm) contact indicates when the unit has operated. It is the only measure of whether the test passes or fails. The displayed target information is for reference only. Different test equipment methods can alter the output from what is shown.

   The display output is shown for reference only; it is not part of the test. The display includes the target information.

2. When a particular zone is under test, the other protection zones are disabled so that they do not time out and distort the results of the zone under test.

   The backup protection functions will cause the relay to trip during zone testing, as they should. They must be disabled to isolate the zone reach unit under test. Before doing any of the reach tests make the following protection settings changes:

   OVERCUR

   (601) **50** = NO
   (605) **50G** = NO
   (610) **51G** = NO

   OS BLOCKING

   (1603) **BLOCKWHAT** = 3 (BLKNONE)

NOTE

After the zone reach testing is completed, restore these settings to their pretest values.

1. Protection settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = YES

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.

3. Set the relay into test mode 14 (Any Zone1 Ground). The LUI displays

   ANY Z1 GRND ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°
   VB: 67 volts rms ∠–120°
   VC: 67 volts rms ∠+120°

5. Set the fault current, I_{op}, to the phase angle listed in the table below (Increase VA, VB, and VC to 75 V when $\angle I_{op} = -79°$).

∠I Degrees	Volts rms	Displayed Target†
–49	56 to 63	–
–79	65 to 73	82 to 88
–109	56 to 63	–

† Reference Only

6. Set the fault current, I_{op}, to 8.2 (1.6) A rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within the limits shown above.

7. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as

   TRIP: AG Z1 "DIST"

   where “DIST” is the displayed target.

8. Repeat the test for BG and CG faults.

1. Protection settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = YES

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.

3. Set the relay to test mode 15 (Any Zone 2 Ground). The LUI displays:

   ANY Z2 GRND ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°,
   VB: 67 volts rms ∠–120°,
   VC: 67 volts rms ∠+120°.

5. Set the fault current, I_{op}, to the phase-angle value listed in the table below. (Increase VA, VB, and VC to 75 V when $\angle I_{op} = -79°$).

∠I Degrees	Volts rms	Displayed Target†
–49	56 to 63	–
–79	65 to 72	146 to 154
–109	56 to 63	–

† Reference only

6. Set the fault current to 4.6 (0.9) amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within the limits in the table above.

7. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as

   TRIP AG Z2 "DIST"

   where “DIST” is the displayed target.

8. Repeat the test for BG and CG faults.

1. Setting:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = YES

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.

3. Set the relay to test mode 16 (Any Z3 Ground). The LUI displays:

   ANY Z3 GRND ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠ 0°,
   VB: 67 volts rms ∠–120°,
   VC: 67 volts rms ∠+120°.

5. Set the fault current, I_{op}, to the phase-angle value listed below (Increase VA, VB, and VC to 75V when ∠ I_{op} = – 79°).

∠I Degrees	Volts rms	Displayed Target†
–49	57 to 64	–
–79	66 to 73	195 to 205
–109	57 to 64	–

† Reference only

6. Set the fault current to 3.5 (0.7) amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within the limits above.

7. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault will be displayed as follows:

   TRIP: AG Z3 "DIST"

   where “DIST” is the displayed target.

8. Repeat the test for phase BG and CG faults.

1. Setting:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = YES

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.
3. Set the relay into test mode 17 (Any Zone 4 Ground). The LUI displays

   ANY Z4 GRD ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms ∠0°,
   VB: 67 volts rms ∠–120°,
   VC: 67 volts rms ∠+120°.

5. Set the fault current, I_{op}, to the phase-angle value listed in the table below (Increase VA, VB, VC to 75V when $\angle I_{op} = -79°$.)

∠I Degrees	Volts rms	Displayed Target†
–49	56 to 63	–
–79	62 to 72	290 to 310
–109	56 to 63	–

† Reference only

6. Set the fault current to 2.3 (0.5) amperes rms. Reduce the faulted phase voltage and check that the A1 contact closes when the voltage is within the limits shown above.
7. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as

   TRIP AG Z3 “DIST”

   where “DIST” is the displayed target.

8. Repeat the test for BG and CG faults.

1. For this test, remove the relay from test mode. Record the pre-test values for all Protection Settings used in the test.
2. Protection settings:

   LINEPICKUP

   (901) **LINEPICKUP** = NO

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = YES
   (209) **Z2P_TIME** = 1.0
   (210) **Z2G_TIME** = 1.0

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = YES
   (307) **Z3P_TIME** = 3.0
   (308) **Z3G_TIME** = 3.0

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = YES
   (410) **Z4P_TIME** = 5.0
   (411) **Z4G_TIME** = 5.0

   OUTPUTS

   (2007) **A1** = Z2GTMR; Index 129

a) ZONE 2 TIMER

3. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–8 for the appropriate phase under test.
4. Set the voltage inputs to the following values:

   VA: 55 volts rms ∠0°,
   VB: 67 volts rms ∠–120°,
   VC: 67 volts rms ∠+120°.

5. Set the phase angle of the fault current I_{op} to –55°.
6. Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer (the fault current should not be ramped, but should be applied at the required level). This is an AG fault that is within pickup of all four zones.
7. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE2 trip, such as: AG Z2. This verifies that the second zone tripped. The time for the trip should be in the range 0.9 to 1.1 seconds.
8. Leave the voltages at the values of step 4.

b) ZONE3 TIMER

9. Settings:

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   OUTPUTS

   (2007) **A1** = Z3GTMR; Index 130

10. Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer (the fault current should not be ramped, but should be applied at the required level) This is an AG fault that is within pickup of all four zones.

11. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE3 trip, such as: AG Z3. This verifies that the third zone tripped. The time for the trip should be in the range 2.9 to 3.1 seconds.

12. Leave the voltages at the values of step 4.

c) ZONE4 TIMER

13. Settings:

    Z3DISTANCE

    (301) **Z3PHASE** = NO
    (304) **Z3GRND** = NO

    OUTPUTS

    (2007) **A1** = Z4GTMR; Index 131

14. Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer (the fault current should not be ramped, but should be applied at the required level). This is an AG fault that is within pickup of all four zones.

15. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE4 trip, such as: AG Z4. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8 to 5.2 seconds.

16. If you are not continuing with Phase Reach testing, return all settings to their pretest values.

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = YES
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

   OVERCUR

   (601) **50** = NO
   (605) **50G** = NO
   (610) **51G** = NO

   OS BLOCKING

   (1603) **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for the appropriate phases under test. Set the relay to test mode 30 (Any Zone 1 Phase). The LUI displays:

   ANY Z1 PHASE ON

3. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.

4. Set the phase angle of the fault current I_{op} to the phase-angle value listed in the table below. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.

∠I Degrees	Volts rms	Displayed Target†
–25	51 to 57	–
–55	59 to 66	82 to 88
–85	51 to 57	–

† Reference only

5. Set the fault current to 10.0 (2.0) amps rms. Reduce the voltage of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown above.

6. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

   TRIP AB Z1 “DIST”

   where “DIST” is the displayed target.

7. Repeat the test for phase BC and CA faults.

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = YES
   (204) **Z2GROUND** = NO
   (209) **Z2P_TIME** = 0.1
   (210) **Z2G_TIME** = 0.1

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

   OVERCUR

   (601) **50** = NO
   (605) **50G** = NO
   (610) **51G** = NO

   OS BLOCKING

   (1603) **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for the appropriate phases under test. Set the relay to test mode 31 (Any Zone 2 Phase). The LUI displays:

   ANY Z2 PHASE ON

3. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.

4. Set the fault current, I_{op}, to the phase-angle value listed in below. Note that the leading phase angle is 180° out of phase with the line to which it is shorted (Increase VA, VB, and VC to 75 V when $\angle I_{op}$ = –55°).

∠I Degrees	Volts rms	Displayed Target†
–25	57 to 64	–
–55	65 to 73	146 to 154
–85	57 to 64	–

† Reference only

5. Set the fault current to 6.7 (1.4) amps rms. Reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown above.

6. Reduce I_{op} of the faulted phase to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

   TRIP AB Z2 "DIST"

   where “DIST” is the displayed target.

7. Repeat the test for phase BC and CA faults.

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND**=NO

   Z3DISTANCE

   (301) **Z3PHASE** = YES
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

   OVERCUR

   (601) **50** = NO
   (605) **50G** = NO
   (610) **51G** = NO

   OS BLOCKING

   (1603) **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for the appropriate phase under test. Set the relay to test mode 32 (Any Zone 3 Phase). The LUI displays:

   ANY Z3 PHASE ON

3. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.

4. Set the fault current, I_{op}, to the phase-angle value listed below. Note that the leading phase angle is 180° out of phase with the line to which it is shorted (increase VA, VB, and VC to 75 V when $\angle I_{op} = -55°$).

I Degrees	Volts rms	Displayed Target†
–25	56 to 63	–
–55	65 to 73	195 to 205
–85	56 to 63	–

† Reference only

5. Set the fault current to 5.0 (1.0) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown above.

6. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as:

   TRIP: AB Z3 "DIST"

   where “DIST” is the displayed target.

7. Repeat the test for phase BC and CA faults.

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = YES
   (405) **Z4GRND** = NO
   (410) **Z4P_TIME** = 0.1
   (411) **Z4G_TIME** = 0.1

   OVERCUR

   (601) **50** = NO
   (605) **50G** = NO
   (610) **51G** = NO

   OS BLOCKING

   (1603) **BLOCKWHAT** = 3 (BLKNONE)

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for the appropriate phase under test. Set the relay to test mode 33 (Any Zone 4 Phase). The LUI displays:

   ANY Z4 PHASE ON

3. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.

4. Set the fault current, I_{op}, to the phase-angle value listed below. Note that the leading phase angle is 180° out of phase with the line to which it is shorted. (increase VA, VB, and VC to 75 V when $\angle I_{op} = -55°$).

I Degrees	Volts rms	Displayed Target†
–25	56 to 63	–
–55	64 to 72	290 to 310
–85	56 to 63	–

† Reference only

5. Set the fault current to 3.3 (0.7) amps rms. Simultaneously reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown above.

6. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

   TRIP AB Z4 "DIST"

   where "DIST" is the displayed target.

7. Repeat the test for phase BC and CA faults.

1. For this test remove the relay from test mode.
2. Record the pre-test values for all Protection settings used in this test.
3. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE**= NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = YES
   (204) **Z2GROUND**= NO
   (209) **Z2P_TIME** = 1.0
   (210) **Z2G_TIME** = 1.0

   Z3DISTANCE

   (301) **Z3PHASE** = YES
   (304) **Z3GRND** = NO
   (307) **Z3P_TIME** = 3.0
   (308) **Z3G_TIME** = 3.0

   Z4DISTANCE

   (401) **Z4PHASE** = YES
   (405) **Z4GRND** = NO
   (410) **Z4P_TIME** = 5.0
   (411) **Z4G_TIME** = 5.0

   OVERCUR

   (601) **50** = NO
   (605) **50G** = NO
   (610) **51G** = NO

   OS BLOCKING

   (1603) **BLOCKWHAT** = 3 (BLKNONE)

   OUTPUTS

   (2007) **A1** = Z2PTMR; Index 132

a) ZONE2 TIMER

4. Connect the relay as shown in Figure 5–3: PHASE-REACH TIMER TEST CONNECTIONS on page 5–23 for an AB fault.
5. Set the voltage inputs as follows: VA: 55 V rms ∠0°, VB: 55 V rms ∠–120°, VC: 67 V rms ∠+120°.
6. Set the phase angle of the fault current, ∠ I_{op}, to –55°.
7. Apply the fault current at 6.7 (1.4) amps rms to the relay and start the Precision Timer (the fault current should not be ramped but applied at that level). This is an AB fault that is within pickup of all four zones.
8. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE2 trip, such as: **TRIP AB Z2**. This verifies that the second zone tripped. The time for the trip should be in the range 0.9 to 1.1 seconds.
9. Leave the voltages at the values of step 4.

b) ZONE3 TIMER

10. Settings:

    Z2DISTANCE

    (201) **Z2PHASE** = NO
    (204) **Z2GROUND** = NO

    OUTPUTS

    (2007) **A1** = Z3PTMR; Index 133

11. Apply the fault current at 5.0 (1.0) amps rms to the relay and start the Precision Timer (the fault current should not be ramped but applied at that level). This is an AB fault that is within pickup of all four zones.
12. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE3 trip, such as: **TRP AB Z3**. This verifies that the third zone tripped. The time for the trip should be in the range 2.9 to 3.1 seconds.
13. Leave the voltages at the values in step 4.

c) ZONE4 TIMER

14. Settings:

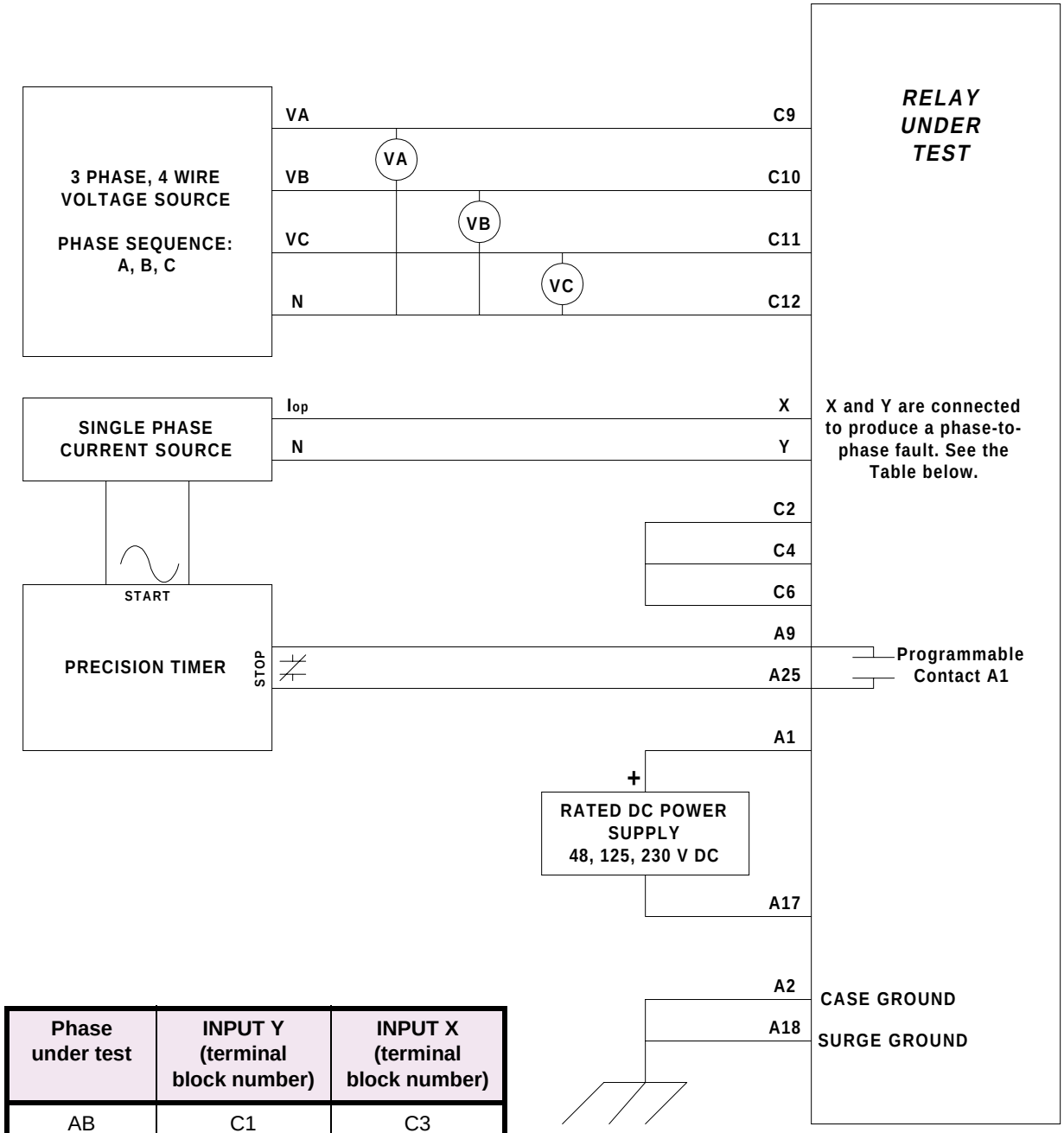
    Z3DISTANCE

    (301) **Z3PHASE** = NO
    (304) **Z3GRND** = NO

    OUTPUTS

    (2007) **A1**= Z4PTMR; Index 134

15. Apply a fault current of 3.3 (0.7) amps rms to the relay and start the Precision Timer. The fault current should not be ramped but applied at that level. This is an AG fault within pickup of all four zones.
16. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE4 trip, such as: TRP AB Z4. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8 to 5.2 seconds.
17. If you are not continuing with MOB testing, return all settings to their pre-test values.



Phase under test	INPUT Y (terminal block number)	INPUT X (terminal block number)
AB	C1	C3
BC	C3	C5
CA	C5	C1

Figure 5–3: PHASE-REACH TIMER TEST CONNECTIONS

5.5.1 T21 – OUT-OF-STEP REACH, MOB

1. Record the pre-test values of the Protection Settings used for this test.
2. Protection Settings:

   OS BLOCKING

   (1601) **MOBZONE** = 0 (ZONE 2)
   (1603) **BLOCKWHAT** = 0 (BLKALL)

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = NO

   Z2DISTANCE

   (201) **Z2PHASE** = YES
   (204) **Z2GROUND** = NO

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = NO

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = NO

3. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for the appropriate phase under test.
4. Set the relay to test mode 40 (Out of Step). The LUI displays the following:

   OUT OF STEP ON

5. Set the voltage inputs as follows: VA: 75 V rms ∠0°, VB: 75 V rms ∠–120°, VC: 75 V rms ∠+120°.
6. Set the fault current, I_{op}, to the phase-angle value listed in the table below. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.

∠I Degrees	Volts rms
–85	62 to 72
–25	62 to 72

7. Set the currents in the faulted phases to 6.3 (1.3) amps rms. Reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in the table above.
8. Reduce the current in the faulted phase to zero.
9. Repeat the test for phases BC and CA. Return settings to their pretest values when completed.

5.5.2 ENDING FUNCTIONAL TESTS

Make sure that the relay is no longer in test mode; select **END TEST MODE** from the test mode menu. Print out or scroll through all of the settings. Compare them with the initial settings of the relay, and change to initial values. If the initial settings were saved to a disk file with ALPS-Link before testing, download the file to the relay.

6.1.1 DESCRIPTION

CAUTION

Power down the relay, either with the power switch or by removing a connection plug, before removing or inserting modules. Failure to do so may permanently damage the relay.

This chapter contains formulas for the calculation of pickup currents and voltages for testing the LPS-D with settings specific to a particular application. The test circuits and procedures are the same as used and illustrated in Chapter 4: ACCEPTANCE/PERIODIC TESTS.

The customer must determine the extent of the testing to be performed. These tests are intended as guides; they are not required for every periodic test of the relay. The desired test procedures can be incorporated into the standard test procedures. However, it is suggested that the relay's built-in self tests be incorporated into the test procedures, since they test the operational status of the unit.

It is assumed in what follows that you are familiar with LPS-D testing. If not, refer to Chapter 4: ACCEPTANCE/PERIODIC TESTS for details.

a) GENERAL TESTS

- T1 – LUI Status Test (Built-In Self Tests)
- T2 – LUI Display Test (Built-In Self Tests)
- T3 – Digital Output Test
- T4 – AC System Input Test

b) MEASURING UNIT TESTS

- T5 – IT Detector Test
- T6 – IB Detector Test
- T7 – Ground Directional Trip Test, IPT + NT
- T8 – Ground Directional Block Test, IPB + NB

c) BACKUP PROTECTION TESTS

- T9 – Phase Instantaneous Overcurrent 50
- T10 – Ground Instantaneous Over-current 50G
- T11 – Ground Time Over-current 51G

d) ZONE GROUND / PHASE REACH MEASURING UNITS

- T12 – Zone1 Ground Reach M1G
- T13 – Zone2 Ground Reach MTG
- T14 – Zone3 Ground Reach M3G
- T15 – Zone4 Ground Reach M4G
- T16 – Zone1 Phase Reach M1
- T17 – Zone2 Phase Reach MT
- T18 – Zone3 Phase Reach M3
- T19 – Zone4 Phase Reach M4

6.1.2 DRAWINGS AND REFERENCES

a) DRAWINGS

The following drawings should be used for reference during testing:

Elementary Diagrams

- Figure 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS on page 1–47
- Figure 1–23: ELEMENTARY DIAGRAM on page 1–48

Logic Diagrams

- Figure 1–3: POTENTIAL FUSE FAILURE LOGIC DIAGRAMS on page 1–13
- Figure 1–4: LINE PICKUP LOGIC DIAGRAM on page 1–14
- Figure 1–5: REMOTE-OPEN DETECTOR LOGIC on page 1–15
- Figure 1–7: OSB LOGIC DIAGRAMS on page 1–17
- Figure 1–9: STEP DISTANCE LOGIC DIAGRAM on page 1–27
- Figure 1–11: PUTT LOGIC DIAGRAM on page 1–29
- Figure 1–12: PERMISSIVE OVERREACH TRANSFER TRIP (POTT1) on page 1–31
- Figure 1–13: POTT WITH BLOCKING FUNCTIONS (POTT2) LOGIC DIAGRAM on page 1–32
- Figure 1–14: BLOCKING SCHEME LOGIC DIAGRAM on page 1–34
- Figure 1–17: HYBRID LOGIC DIAGRAM on page 1–37

51G curves

- Figure 2–15: INVERSE CURVE on page 2–49
- Figure 2–16: VERY INVERSE CURVE on page 2–50
- Figure 2–17: EXTREMELY INVERSE CURVE on page 2–51

b) REFERENCE

- Chapter 11: ALPS-LINK USER GUIDE
- Chapter 12: ASCII COMMUNICATIONS

6.1.3 GENERAL INSTRUCTIONS

Tests are performed in test mode, which allows viewing of the internal measuring units and functions. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

The test mode selects and isolates various test functions and measuring units, then routes their status to the A1 (A9–A25) contact. When the particular function under test has picked up, the A1 contact closes. Target information is displayed for tests that cause tripping.

Testing can be performed with outputs disabled. The A1 contact still closes when a trip condition exists; however, the tripping contacts do not operate. Disabling outputs can be accomplished when test mode is entered.

CAUTION

The A1 contact will chatter when the unit under test is near its threshold. *Do not let it continue to chatter!* Remove the test current. A single contact closure is enough to determine that the unit picked up.

In tests that cause tripping, the trip target type may not match the unit under test. For example, if a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. It is important to remember this during the tests.

Use a continuity tester with high-input impedance, such as a digital ohmmeter, to monitor the A1 contact during relay testing.

NOTE

Tripping contacts will operate while the LPS-D is in test mode unless the outputs were disabled by the user.

6.1.4 ENTERING TEST MODE

Before a test can be performed, the LPS-D must be put in test mode and select the function to be tested. The test mode is set as follows:

1. Apply rated DC and wait for relay initialization to complete (if this has not already been done), indicated by the green status LED on the front of the relay.
2. Press the [ACT] key and

   Enter Password:

   is displayed. If this is the first time the Control Level functions are used, the password has the factory value "5678.". This password must be changed before any Control functions can be accessed. See Section 8.1.21: CHANGE PASSWORD on page 8–18 for details on changing the password.
3. Enter the current Control Level password. If the password is not known, see Section 11.8.13 LUI PASSWORD REPORT on page 11–20 or Chapter 12: ASCII COMMUNICATIONS for details on viewing the password. When the correct password is entered, the actions menu is displayed.
4. Scroll with the arrow keys until

   5. Relay Test

   is displayed, then press the [ENT] key.
5. Scroll through the different test mode functions or enter the number of the desired test, such as 38 for the Fault Detector. Press [ENT] and the cursor will be placed on the fault detector test. Press [ENT] again and the test is started. When the LPS-D picks up for the selected function it closes the A1 contacts.
6. To exit test mode, press the [ACT] key. Scroll with an arrow key until

   5. Relay Test

   is displayed, then press the [ENT] key. Scroll until the display indicates

   1. END TEST MODE

   and press the [ENT] key. The user will be prompted to Enable Outputs. Press [1/Y] and [ENT]. The status LED should return to green, indicating that normal operation has resumed.

6.1.5 USING ALPS-LINK (OPTIONAL)

The relay can be tested without using the keypad. A PC and communications program are required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Follow the procedure in Chapter 4: ACCEPTANCE/PERIODIC TESTS to test the relay with ALPS-Link or ASCII.

6.2.1 T1 – LUI RELAY STATUS

The LPS-D Status is reported through the LUI, the non-critical alarm contact, and the critical alarm contact. If a system error causes relaying functions to cease, the status LED turns red and the critical alarm contact closes. A failure that does not interrupt relaying closes the non-critical alarm and displays a FAIL or WARN message on the LUI.

If a STATUS error is detected, see Chapter 11: ALPS-LINK USER GUIDE or Chapter 12: ASCII COMMUNICATIONS for further information.

1. Apply rated DC power and wait for initialization to complete, as indicated by a green status LED.
2. Press the [INF] key, then scroll with the arrow keys until the following item is displayed.

   1. STATUS
3. Press the [ENT] key. The display should contain

   STATUS OK

   which means that the relay is operational and all self-tests pass.

6.2.2 T2 – LUI DISPLAY TEST

The LUI Test is built into the software and allows testing the keypad and the display.

1. Apply rated DC power and wait for initialization to complete, indicated by the green status LED.
2. Press the [ACT] key, then scroll with the arrow keys until the display contains the heading,

   7. LUI TEST
3. Press the [ENT] key.
4. Select 1. Display and press the [ENT] key.
5. Check that the display has two rows filled completely with rectangles and press the [ENT] key. The display changes to the last two rows filled with rectangles. When the display has been checked press the [ACT] key. If any other key is pressed the display will not return to the LUI Test menu.
6. Use the arrow keys to select

   2. LEDs

   and press the [ENT] key. Each LED will change. Press [ENT] after verifying each LED state. When the test is finished the LUI Test menu will be displayed.
7. Use the arrow keys to select

   3. KEYBOARD

   and press [ENT]. A map of the key board will be displayed on the screen.
8. At this point the LUI is in the keyboard test. Press every key on the keypad, except for the [CLR] key. As you press each key, verify that the display indicates the key that was pressed. For example, pressing the up arrow is indicated on the displayed by the up arrow flashing. The display corresponding to the other keys is the legend that is on printed the key itself.
9. When all the keys have been checked, press the [CLR] key.
10. When the test is completed, press the [END] followed by the [ENT] key. Press the [CLR] key to clear the message. This ends the LUI Test.

6.2.3 T3 – DIGITAL OUTPUT TEST

This test checks all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults. Protection can be enabled or disabled, as deemed necessary.

NOTE

If this test is run remotely through ALPS-Link, then switch RM BRKR must be in the down position to allow the outputs to operate. Refer to section 8.4.1: HARDWARE SWITCHES on page 8–28 for details on changing the switch position. Note that the relay is shipped from the factory with the switch in the down position allowing the outputs to operate.

1. Connect the relay as shown in Figure 4–1: DIGITAL OUTPUT TEST CONNECTIONS on page 4–11.
2. Press the [ACT] key and enter the control level password.
3. Use the arrow keys to select

   8. Digital Output Test

4. Press the [ENT] key. Before a contact is allowed to be tested, the display prompts

   DISABLE PROTECT?

5. Press the [1/Y] key followed by the [ENT] key to turn protection off. Protection remains off until the test mode is ended (if desired, protection can be left enabled during the test).
6. Select the output to test by scrolling with the arrow keys and press the [ENT] key. When the digital output is chosen, the selected relay output closes. Verify that the output under test has closed, using an ohmmeter or other suitable device.
7. After the output is tested, scroll to the next output to test, then press the [ENT] key. This output closes and the previously selected output opens. Continue in this fashion until all outputs are tested.
8. End the test mode by scrolling to the **END TEST MODE** selection, then press the [ENT] key. Alternatively, press [END] followed by the [ENT] key to end the test and re-enable protection.

6.2.4 T4 – AC SYSTEM INPUT TEST

This test uses present values to determine that voltages and currents are connected properly to the terminal strip. The VALUES function can be used any time during the test to verify the relay voltages and currents.

1. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
2. Set VA to 67 V rms ∠0°, VB to 57 V rms ∠–120°, and VC to 47 V rms ∠120°.
3. Press the INF key on the keypad. Scroll, using the arrow keys, to the heading,

   1. Present values

   and press the [ENT] key. The present values are now displayed.
4. Scroll to the values of VA, VB, and VC and verify that the voltages are within ±2 volts of the voltage source setting. This verifies the connections of the voltage sources.

   NOTE

   Alternately, whenever the display is blank, press the CLR key to have the relay automatically scroll through the present values.

5. Set I_{op} to 1.0 A rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
6. Verify IA, IB, or IC depending on connection Y. Verify that the current reading is 5% of the input current.
7. Reduce the test current to 0 A.

6.3.1 WARNING

CAUTION

The A1 contact will chatter when the unit under test is near its threshold. Do not allow this to continue. Remove the test current. A single contact closure is enough to determine that the unit has picked up.

At the start of each test is an area to record your specific setting for the function under test.

6.3.2 T5 – I_T TRIP SUPERVISION TEST

1. Protection Settings:

   CURSUPVISN

   (501) **IT_PICKUP** = [_____] amps,

   where I_T is set as follows:

   $I_T = I_A$, I_B, or I_C (eq. 6–1)

   The test current, I_{op}, is single-phase and applied to I_A. The LPS-D should pick up when I_{op} is equal to I_T.
2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set the relay into test mode 34 (IT Detector). The LUI display contains

   IT DETECTOR ON
4. Set the level of I_{op} to $I_T + 0.1$ = [_____] amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $I_T - 0.1$ = [_____] amps rms; the A1 contact should open.
5. Reduce I_{op} to zero.

6

6.3.3 T6 – I_B BLOCKING SUPERVISION TEST (BLOCKING SCHEMES)

1. Protection Settings:

   Z2 DISTANCE

   (205) **Z2GRDCHAR** = GDOC

   CURVSUPVIS

   (502) **IB_PICKUP** = [_____] amps,

   SCHEME

   (1201) **PICKSCHEME** = BLOCK

   where I_T is set as follows:

   $I_T = I_A$, I_B, or I_C (eq. 6–2)

   The test current, I_{op}, is single-phase and applied to I_A. The LPS-D should pick up when I_{op} is equal to I_B.
2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set the relay into test mode 35 (I_B Detector). The LUI display contains

   IB DETECTOR ON
4. Set the level of I_{op} to $I_B + 0.1$ = [_____] amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $I_B - 0.1$ = [_____] amps rms; the A1 contact should open.
5. Reduce I_{op} to zero.

This test applies to blocking schemes only.

NOTE

1. Protection Settings:

   Z2DISTANCE

   (205) **Z2GRDCHAR** = GDOC

   CURSUPVISN

   (503) **IPT_PICKUP** = [_____] amps,

   SCHEME

   (1201) **PICKSCHEME** = BLOCK

   The IPT operating quantity is given by

   $$3 \times |I_0| - 3 \times KTx|I_1| \qquad \text{(eq. 6–3)}$$

   where I_0 is equal to the Zero-Sequence Current; I_1 is equal to the Positive-Sequence Current; and KT is equal to 0.1 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes.

   Since the test current, I_{op}, is single-phase, I_0 and I_1 are given by

   $$I_0 = I_{op}/3 \qquad \text{(eq. 6–4)}$$

   $$I_1 = I_{op}/3 \qquad \text{(eq. 6–5)}$$

   Substituting equations 6–4 and 6–5 into equation 6–3 and assuming a Blocking or Hybrid scheme yields

   $$\begin{aligned} \text{PUIPT} &= I_{op} - 0.1\ I_{op} \qquad \text{(eq. 6–6)} \\ &= 0.9\ I_{op} \end{aligned}$$

   Therefore IPT will pick up when I_{op} = PUIPT / 0.9.

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.
3. Set the voltage inputs to the following values:

   VA: 55 V rms ∠0°
   VB: 67 V rms ∠–120°
   VC: 67 V rms ∠+120°

4. Set the relay into test mode 36 (Ground Directional Trip). The LUI should display

   GRD DIR TRIP ON

5. Set the current of I_{op} to (PUIPT / 0.9) + 0.10 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to (PUIPT / 0.9) – 0.1 = [_____] amps rms; the A1 contact should open.
6. Reduce I_{op} to zero.

This test applies to blocking schemes only.

NOTE

1. Protection Settings:

   Z2DISTANCE

   (205) **Z2GRDCHAR** = GDOC

   CURSUPVISN

   (504) **IPB_PICKUP** = [_____] amps,

   SCHEME

   (1201) **PICKSCHEME** = BLOCK

   The IPT operating quantity is given by

   $$3 \times |I_0| - 3 \times KB \times |I_1| \quad \text{(eq. 6–7)}$$

   where I_0 is equal to the zero-sequence current; I_1 is equal to the positive-sequence current; and KB is equal to 0.066 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes.

   Since the test current, I_{op}, is single-phase, I_0 and I_1 are given by

   $$I_0 = I_{op} / 3 \quad \text{(eq. 6–8)}$$

   and

   $$I_1 = I_{op} / 3 \quad \text{(eq. 6–9)}$$

   Substituting Equations 8 and 9 into Equation 7 and assuming a Blocking or Hybrid scheme yields

   $$\begin{aligned} \text{PUIPT} &= I_{op} - 0.066 \cdot I_{op} \quad \text{(eq. 6–10)} \\ &= 0.934 I_{op} \end{aligned}$$

   Therefore IPT will pick up when I_{op} = PUIPT / 0.934.

2. Connect the relay as shown in Figure 4–1: DIGITAL OUTPUT TEST CONNECTIONS on page 4–11.
3. Set the voltage inputs to the following values:

   VA: 55 V rms ∠0°
   VB: 67 V rms ∠–120°
   VC: 67 V rms ∠+120°.

4. Set the relay into test mode 37 (Ground Directional Block). The LUI should display

   GRD DIR BLK ON

5. Set the current of I_{op} to (PUIPB / 0.934) + 0.1 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to (PUIPB / 0.934) – 0.1 = [_____] amps rms; the A1 contact should open.
6. Reduce I_{op} to zero.

6.4.1 T9 – PHASE INSTANTANEOUS OVERCURRENT 50

1. Protection Settings:

   OVERCURRNT

   (601) **50** = YES
   (602) **50_DIRCNL** = NO
   (603) **50PICKUP** = [_____] amps,

   50 is calculated with the following equation:

   $$\mathbf{50} = (I_A - I_B) \text{ or } (I_B - I_C) \text{ or } (I_C - I_A) \qquad \text{(eq. 6–11)}$$

   where **50** is the difference in phase-to-phase current. The test current, I_{op}, is connected to one phase and returned through another to simulate a phase-to-phase fault. When an AB fault is applied, the difference $(I_A - I_B)$ equals $(I_{op} - (-I_{op})) = 2I_{op}$. Therefore **50** will pick up when I_{op} = 0.5 x **50**

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7, for a phase AB, BC, or CA fault.

3. Set the relay into test mode 43 (Phase Overcurrent). The LUI should display

   INST PHS OVRC ON

4. Set I_{op} = 0.5·**50** + 0.05·**50** = [_____] amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to 0.5·**50** – (0.05·**50**) = [_____] amps rms; the A1 contact should open.

5. Reduce I_{op} to zero.

6.4.2 T10 – GROUND INSTANTANEOUS OVERCURRENT 50G

1. Protection Settings:

   OVERCURRNT

   (605) **50G** = YES
   (606) **50G_DIRCNL** = NO
   (607) **50GPICKUP** = [_____] amps,

   50G is given by

   $$\mathbf{50G} = 3 \times I_0 - 0.9 \times |I_1| \qquad \text{(eq. 6–12)}$$

   where I_0 is the zero-sequence current and I_1 is the positive-sequence current.

   Since the test current, I_{op}, is single-phase, I_0 and I_1 are given by

   $$I_0 = I_{op} / 3 \qquad \text{(eq. 6–13)} \qquad \text{and} \qquad I1 = I_{op} / 3 \qquad \text{(eq. 6–14)}$$

   Substituting Equations 6–13 and 6–14 into Equation 6–12 yields

   $$\mathbf{50G} = I_{op} - 0.3I_{op} = 0.7I_{op} \qquad \text{(eq. 6–15)}$$

   Therefore IPT will pick up when I_{op} = **50G** / 0.7.

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14.

3. Set the relay into test mode 44 (Ground Overcurrent). The LUI displays

   INST GND OVRC ON

4. Set I_{op} to (**50G** / 0.7) + 0.5 = [_____] amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to (**50G** / 0.7) – 0.5 = [_____] amps rms; the A1 contact should open.

5. Reduce I_{op} to zero.

6. Change the setting of **50G_DIRCNL** back to YES to restore directional control, if required.

1. Protection Settings:

   OVERCURRNT

   (610) **51G** = YES
   (611) **51G_DIRCNL** = NO
   (612) **51GPICKUP** = [_____] amps,
   (615) **51GTIMDIAL** = [_____] Time dial,
   (614) **51GCURVE** = [_____] Curve,

   51G is calculated with the equation

   $$\mathbf{51G} = 3 \times I_0 \qquad \text{(eq. 6–16)}$$

   where I_0 is equal to the zero-sequence current. Since I_{op} is single-phase, I_0 is given by

   $$I_{op} / 3 = I_0 \qquad \text{(eq. 6–17)}$$

   Substituting Equation 6–17 into Equation 6–16 yields

   $$I_{op} = \mathbf{51G} \qquad \text{(eq. 6–18)}$$

   Therefore, **51G** will pick up when I_{op} = **51G**. The time it takes for **51G** to pick up is determined by the time-dial curve in Chapter 2: CALCULATION OF SETTINGS.

   CAUTION

   If the test current exceeds 2 x I_n (I_n is the rated current), then the current test should be applied with a 50% duty cycle. For instance, if current is applied for 5 minutes, it should be left off for 5 minutes before it is reapplied.

2. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–8.

   NOTE

   Start the timer when I_{op} is applied and stop the timer when the A1 closes (the relay trips).

3. For this test remove the relay from test mode and assign TOCTRP to A1.

   (2007) **A1** = index 119, TOCTRP

4. Apply I_{op} at 2·**51G** = [_____] amps rms and start the timer. Leave the current on until the A1 contact closes, then stop the timer. The time should be within ±7% of the value found on the LPS-D time-dial curve in use.
5. Reduce I_{op} to zero.
6. Repeat steps 4 and 5 for I_{op} at 6·**51G** = [_____] and 10·**51G** = [_____].
7. Change the setting of **51G_DRCNL** (0611) back to YES if directional control of **51G** is required.

6.5.1 GENERAL CONSIDERATIONS

Testing the reach of the relay requires a few organized steps, as follows:

1. Choosing a test current (IT) for the impedance of the reach.
2. Calculating the voltage range in which the unit will pick up.
3. Applying the test voltage and currents in accordance with the test procedure.

Equations are given for calculating the pickup voltage for a chosen current magnitude and phase. If you wish to test the complete characteristic, the software program, ALPS-Test, can be used to generate test currents and voltage pickups for the complete characteristic. ALPS-Test is included the LPS-D software suite on the GE Power Systems Products CD.

6.5.2 ZONE 1–4 PHASE-TO-GROUND CALCULATIONS

This section describes how to determine the test currents and voltages for Z1G, Z2G, Z3G and Z4G. The same procedure is used for each zone to determine the test values. The procedure is as follows:

1. Choose a test current.
2. Calculate the impedance of the zone.
3. Calculate the operate voltage at the test current and impedance.

The test current, I_T, is determined from Table 6–1: TEST CURRENT RANGES FOR PHASE-TO-GROUND REACH on page 6–12. The value of I_T is chosen according to the reach of the zone. The nominal pickup voltage, V_{NOM}, is calculated with respect to I_T and to several settings of the relay.

NOTE

The pickup voltage calculations at a particular magnitude and phase of I_T are referenced to the faulted phase under test. For instance, if a BG Fault was applied, the current angles would be with respect to the phase angle of VB.

The nominal pickup voltage is given by

$$V_{NOM} = \left(\frac{Z \cdot Z_R \cdot I_T}{\cos(\varnothing I - \varnothing Z - \varnothing T + 90°)}\right) \cdot \cos(\varnothing I - \varnothing Z - \varnothing T - 90°) \quad \text{(eq. 6–19)}$$

for $(\varnothing Z + \varnothing T - 180°) < \varnothing I < \varnothing Z$, or

$$V_{NOM} = \left(\frac{Z \cdot Z_R \cdot I_T}{\cos(\varnothing I - \varnothing Z - \varnothing T + 90°)}\right) \cdot \cos(\varnothing I - \varnothing Z + \varnothing T - 90°) \quad \text{(eq. 6–20)}$$

for $\varnothing Z < \varnothing I < (\varnothing Z - \varnothing T + 180°)$.

a) DEFINITIONS

Z = Calculated Impedance
Z_R = Relay reach for Z1GROUND, Z2GROUND, Z3GROUND, or Z4GRND
$øZ$ = Angle of maximum reach
I_T = Test current for I_{op}, chosen for the zone
$øT$ = Characteristic timer of the zone
$øI$ = Test current angle with respect to the faulted phase
K_0 = Zero-sequence compensation factor of the zone
POSSEQANG = Positive-sequence angle of maximum reach
ZERSEQANG = Zero-sequence angle of maximum reach.

b) SETTINGS AND CALCULATIONS

1. Record the following relay protection settings:

(1401), **POSSEQANG** = [_____]

(1402), **ZERSEQANG** = [_____]

(105), **Z1GRDREACH** = [_____] (Zone 1)

(206), **Z2GRDREACH** = [_____] (Zone 2)

(305), **Z3GRDREACH** = [_____] (Zone 3)

(406), **Z4GRDREACH** = [_____] (Zone 4)

(111), **Z1GCHARANG** = 90° (Fixed at 90° for Zone1)

(207), **Z2GCHARANG** = [_____] (Zone 2)

(306), **Z3GCHARANG** = [_____] (Zone 3)

(406), **Z4GCHARANG** = [_____] (Zone 4)

(108), **Z1GROUNDK0** = [_____] (Zone 1 only)

(1404), **ZEROSEQK0** = [_____] (Zones 2 to 4)

2. Determine the test current, I_T, for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 6–1: TEST CURRENT RANGES FOR PHASE-TO-GROUND REACH below.

I_T(Z1GR) = [_____] Amps rms

I_T(Z2GR) = [_____] Amps rms

I_T(Z3GR) = [_____] Amps rms

I_T(Z4GR) = [_____] Amps rms

Table 6–1: TEST CURRENT RANGES FOR PHASE-TO-GROUND REACH

Z_R Reach (I_n = 5 A)	I_T (A)	Z_R Reach (I_n = 1 A)	I_T (A)
0.1 to 2.5	10	0.5 to 12.5	2
2.5 to 6.0	7	12.5 to 30.0	1.4
6.0 to 12.0	3.5	30.0 to 60.0	0.7
12.0 to 20.0	2.1	60.0 to 100.0	0.4
20.0 to 30.0	1.4	100.0 to 150.0	0.3
30.0 to 40.0	0.8	150.0 to 200.0	0.2
40.0 to 50.0	1.0	200.0 to 250.0	0.2

3. Calculate the impedance, Z, for each zone, where Z equals the magnitude of the expression:

$$\left(\frac{2}{3}\right)\angle\text{POSSEQANG} + \left(\frac{K_0}{3}\right)\angle\text{ZERSEQANG}$$

The real and imaginary components of *Z* are given by

$$\text{real}(Z) = \frac{2}{3}\cos(\text{POSSEQANG}) + \frac{K_0}{3}\cos(\text{ZERSEQANG}) \quad \text{(eq. 6–21)}$$

$$\text{imag}(Z) = \frac{2}{3}\sin(\text{POSSEQANG}) + \frac{K_0}{3}\sin(\text{ZERSEQANG}) \quad \text{(eq. 6–22)}$$

The magnitude is then given by:

$$|Z| = \sqrt{\text{real}(Z)^2 + \text{imag}(Z)^2} \quad \text{(eq. 6–23)}$$

The settings are:

Z_1 = [_____] (Zone magnitude)

Z_n = [_____] (magnitude of Zones 2, 3, and 4)

4. Calculate the impedance angle, *øZ*, for each zone, where *øZ* is the phase angle of the expression,

$$\left(\frac{2}{3}\right)\angle\text{POSSEQANG} + \left(\frac{K_0}{3}\right)\angle\text{ZERSEQANG}$$

and is given by

$$\varnothing Z = \arctan\left(\frac{\text{imag}(Z)}{\text{real}(Z)}\right) \quad \text{(eq. 6–24)}$$

The settings are

$øZ_1$ = [_____]° (impedance angle of Zone 1)

$øZ_n$ = [_____]° (impedance angle of Zones 2, 3, and 4)

5. Choose the IT test angle (øI) for the zone:

$øI_1$ = [_____]° (Zone 1)

$øI_2$ = {_____]° (Zone 2)

$øI_3$ = [_____]° (Zone 3)

$øI_4$ = [_____]° (Zone 4)

6. Calculate VNOM for each zone by substituting the values of Z_R, *Z*, *øZ*, and *øI* into Equation 6–19 or 6–20.

V_{NOM1} = [_____] Volts rms (nominal test voltage Zone 1)

V_{NOM2} = [_____] Volts rms (nominal test voltage Zone 2)

V_{NOM3} = [_____] Volts rms (nominal test voltage Zone 3)

V_{NOM4} = [_____] Volts rms (nominal test voltage Zone 4)

NOTE

If Zone 4 is reversed (Protection Setting 408: Z4DIRECTN = REVERS), remember to add 180° to both the test angle $øI_4$ and the impedance angle $øZ_4$.

6.5.3 T12 – ZONE 1 GROUND REACH TEST, M1G GROUND FAULTS

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = NO
   (104) **Z1GROUND** = YES
   (105) **Z1GRDREACH** = [_____] Ω,
   V_{NOM1} = [_____] V,
   I_T = [_____] A,
   ϕI_1 = [_____]°

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.
3. Set the relay into test mode 14 (Any Zone1 Ground). The LUI displays

   ANY Z1 GRND ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.
5. Set the fault current, I_{op}, phase angle to ϕI = [_____], lagging.
6. Set the fault current, I_{op}, to I_T = [_____] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of V_{NOM}.
7. Reduce the fault current to zero.
8. Return the Zone 1 phase, **Z1PHASE**, to your specific setting.

6.5.4 T13 – ZONE 2 GROUND REACH, MTG GROUND FAULTS

1. Protection Settings:

   Z2DISTANCE

   (201) **Z2PHASE** = NO
   (204) **Z2GROUND** = YES
   (206) **Z2GRDREACH** = [_____] ohms,
   V_{NOM2} = [_____] V,
   I_T = [_____] A,
   ϕI_2 = [_____]°,

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.
3. Set the relay to the Zone 2 ground test mode for the appropriate phase under test. The LUI displays, for instance,

   ZONE 2 AG ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.
5. Set the fault current, I_{op}, phase angle to ϕI = [_____]°, lagging.
6. Set the fault current to I_T = [_____] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of V_{NOM}.
7. Reduce the fault current to zero.
8. Return Zone 2 phase, **Z2PHASE**, to your specific setting.

6.5.5 T14 – ZONE 3 GROUND REACH, M3G GROUND FAULTS

1. Protection Settings:

   Z3DISTANCE

   (301) **Z3PHASE** = NO
   (304) **Z3GRND** = YES
   (305) **Z3GRDREACH** = [_____] ohms,
   V_{NOM3} = [_____] V,
   I_T = [_____] A,
   ϕI_3 = [_____]°

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.
3. Set the relay to the Zone 3 ground test mode for the appropriate phase under test. The LUI displays, for instance:

   ZONE 3 AG ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.
5. Set the fault current, I_{op}, phase angle to ϕI = [_____]°, lagging.
6. Set the fault current to I_T = [_____] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of V_{NOM}.
7. Reduce the fault current to zero.
8. Return Zone 3 phase, **Z3PHASE**, to your specific setting.

6.5.6 T15 – ZONE 4 GROUND REACH, M4G GROUND FAULTS

1. Protection Settings:

   Z4DISTANCE

   (401) **Z4PHASE** = NO
   (405) **Z4GRND** = YES
   (406) **Z4GRDREACH** = [_____] ohms,
   V_{NOM4} = [_____] V,
   I_T = [_____] A,
   ϕI_4 = [_____]°,

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phase under test.
3. Set the relay to the Zone 4 ground test mode for the appropriate phase under test. The LUI displays, for instance:

   ZONE 4 AG ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.
5. Set the fault current, I_{op}, phase angle to ϕI = [_____]°, lagging.
6. Set the fault current to I_T = [_____] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of V_{NOM}.
7. Reduce the fault current to zero.
8. Return Zone 4 phase, **Z4PHASE**, to your specific setting.

6.5.7 ZONE 1 TO 4 PHASE-TO-PHASE REACH CALCULATIONS

This section describes how to determine the test currents and voltages for Z1PHASE, Z2PHASE, Z3PHASE, and Z4PHASE. The same procedure is used for each zone to determine the test values.

The test current, IT, is determined from Table 6–2: TEST CURRENT RANGES FOR PHASE-TO-PHASE REACH on page 6–17. The value of I_T is chosen according to the value of the reach of the zone. The nominal pickup voltage, V_{NOM}, is calculated with respect to I_T and to several settings of the relay.

V_{NOM} calculations are referenced to the leading phase-to-ground faulted voltage. When an AB fault is applied, the current angle is with respect to the phase angle of VA, not the phase-to-phase voltage. That is why the 1.732 (square root of three) factor and the added angle of 30° are included in Equations 6–25 and 6–26.

The nominal pickup voltage is given by

$$V_{NOM} = \left(\frac{(2/1.732)\cdot Z_R \cdot I_T}{\cos(90° - \varnothing T)}\right)\cdot \cos((\varnothing I + 30°) - \varnothing Z - \varnothing T + 90°) \quad \text{(eq. 6–25)}$$

for $(\varnothing Z + \varnothing T - 180°) < \varnothing I < \varnothing Z$, or

$$V_{NOM} = \left(\frac{(2/1.732)\cdot Z_R \cdot I_T}{\cos(90° - \varnothing T)}\right)\cdot \cos((\varnothing I + 30°) - \varnothing Z + \varnothing T - 90°) \quad \text{(eq. 6–26)}$$

for $\varnothing Z < \varnothing I < (\varnothing Z - \varnothing T + 180°)$.

where: Z_R = relay reach for Z1PHASE, Z2PHASE, Z3PHASE, or Z4PHASE.
$\varnothing Z$ = Angle of maximum reach.
I_T = Test current for I_{op}, chosen for the zone.
$\varnothing T$ = Characteristic timer of the zone.
$\varnothing I$ = Test current angle with respect to the faulted phase.
POSSEQANG = Positive sequence angle of maximum reach.

c) SETTINGS AND CALCULATIONS

1. Record the following relay settings:

   (1401), **POSSEQANG** = [_____]

   (102), **Z1PRREACH** = [_____] (Zone 1)

   (202), **Z2PHREACH** = [_____] (Zone 2)

   (302), **Z3PHREACH** = [_____] (Zone 3)

   (402), **Z4PHREACH** = [_____] (Zone 4)

   Z1PCHARANG = 90° (fixed for Zone 1)

   (203), **Z2PCHARANG** = [_____] (Zone 2)

   (303), **Z3PCHARANG** = [_____] (Zone 3)

   (403), **Z4PCHARANG** = [_____] (Zone 4)

2. Determine the test current, I_T, for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 6–2.

   I_T(Z1R) = [_____] Amps rms

   I_T(Z2R) = [_____] Amps rms

   I_T(Z3R) = [_____] Amps rms

   I_T(Z4R) = [_____] Amps rms

Table 6–2: TEST CURRENT RANGES FOR PHASE-TO-PHASE REACH

Z_G Reach (I_n = 5 A)	I_T (A)	Z_G Reach (I_n = 1 A)	I_T (A)
0.1 to 2.5	10	0.5 to 12.5	2
2.5 to 6.0	8	12.5 to 30.0	2
6.0 to 12.0	5	30.0 to 60.0	1
12.0 to 20.0	3	60.0 to 100.0	0.6
20.0 to 30.0	2	100.0 to 150.0	0.4
30.0 to 40.0	1.5	150.0 to 200.0	0.3
40.0 to 50.0	1.0	200.0 to 250.0	0.2

3. Choose ϕI (the I_T angle). V_{NOM} is at maximum when $\phi I = \phi Z - 30°$.

   ϕI_1 = [_____]° (Zone 1)

   ϕI_2 = [_____]° (Zone 2)

   ϕI_3 = [_____]° (Zone 3)

   ϕI_4 = [_____]° (Zone 4)

4. Calculate V_{NOM} for each zone by substituting the values of Z_R, ϕZ (**POSSEQANG**), I_T, and ϕI into Equations 25 and 26 for V_{NOM} according to zone.

   V_{NOM1} = [_____] Volts rms (nominal test voltage for Z1P)

   V_{NOM2} = [_____] Volts rms (nominal test voltage for Z2P)

   V_{NOM3} = [_____] Volts rms (nominal test voltage for Z3P)

   V_{NOM4} = [_____] Volts rms (nominal test voltage for Z4P)

   NOTE: If Zone 4 is reversed (Protection Setting 408: **Z4DIRECTN** = REVERS), remember to add 180° to both the test current angle, ϕI_4, and the impedance angle, ϕZ_4. If Zone 4 has a non-zero offset, use the ALPS-Test software to calculate V_{NOM4}.

5. Record V_{NOMn}, I_T, and ϕI_n in the space provided in the appropriate Zone reach test.

6.5.8 T16 – ZONE 1 PHASE REACH, M1 FAULTS

1. Protection Settings:

   Z1DISTANCE

   (101) **Z1PHASE** = YES
   (104) **Z1GROUND** = NO
   (102) **Z1PREACH** = [_____] Ω,
   V_{NOM1} = [_____] V,
   I_T = [_____] A,
   ϕI_1 = [_____]°.

2. Connect the relay as shown in Figure 4–3: PHASE TO GROUND TEST CONNECTIONS on page 4–14 for the appropriate phases under test.

3. Set the relay to test mode 30 (ANY ZONE 1 Phase). The LUI displays:

   ANY Z1 PHASE ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.

5. Set the fault current, I_{op}, phase angle to ϕI = [_____]°, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

6. Set the fault current to I_T = [_____] amps rms. Simultaneously reduce the voltage of the faulted phases and check that the A1 contact closes when the voltages are within 7% of V_{NOM}.

7. Reduce the fault current to zero.

8. Return Zone 1 ground **Z1GROUND** to your specific setting.

6.5.9 T17 – ZONE 2 PHASE REACH, MT FAULTS

1. Protection Settings:

   Z2DISTANCE

   (201) **Z2PHASE** = YES
   (204) **Z2GROUND** = NO
   (202) **Z2PHREACH** = [_____] ohms,
   V_{NOM2} = [_____] V,
   I_T = [_____] A,
   ϕI_2 = [_____]°,

2. Connect the relay as shown in Figure 5–2: GROUND REACH TIMER TEST CONNECTIONS on page 5–8 for the appropriate phases under test.

3. Set the relay to the Zone 2 Phase test mode for the appropriate phase under test. The LUI displays, for instance:

   ZONE 2 AB ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠–240°.

5. Set the fault current, I_{op}, phase angle to ϕI = [_____]°, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

6. Set the fault current to I_T = [_____] amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the A1 contact closes when the voltages are within 7% of V_{NOM}.

7. Reduce the current in the faulted phase to zero.

8. Return Zone 2 ground **Z2GROUND** to your specific setting.

6.5.10 T18 – ZONE 3 PHASE REACH, M3 FAULTS

1. Protection Settings:

   Z3DISTANCE

   (301) **Z3PHASE** = YES
   (304) **Z3GRND** = NO
   (302) **Z3PHREACH** = [_____] ohms,
   V_{NOM3} = [_____] V,
   I_T = [_____] A,
   ϕI_3 = [_____]°,

2. Connect the relay as shown in Figure 5--1 for the appropriate phase under test.
3. Set the relay to the Zone 3 Phase test mode for the appropriate phase under test. The LUI displays, for instance:

   ZONE 3 AB ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.
5. Set the fault current, I_{op}, phase angle to ϕI = [_____]°, lagging. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.
6. Set the fault current to I_T = [_____] amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the A1 contact closes when the voltages are within 7% of V_{NOM}.
7. Reduce the fault current to zero.
8. Return Zone 3 ground **Z3GRND** to your specific setting.

6.5.11 T19 – ZONE 4 PHASE REACH, M4 FAULTS

1. Setting:

   Z4DISTANCE

   (401) **Z4PHASE** = YES
   (405) **Z4GRND** = NO
   (402) **Z4PHREACH** = [_____] ohms,
   V_{NOM4} = [_____] V,
   I_T = [_____] A,
   ϕI_4 = [_____]°,

2. Connect the relay as shown in Figure 5–1: PHASE-TO-PHASE TEST CONNECTIONS on page 5–7 for the appropriate phase under test.
3. Set the relay into the Zone 4 Phase test mode for the appropriate phase under test. The LUI displays, for instance:

   ZONE 4 AB ON

4. Set the voltage inputs as follows: VA: 67 V rms ∠0°, VB: 67 V rms ∠–120°, VC: 67 V rms ∠+120°.
5. Set the fault current, I_{op}, phase angle to ϕI = [_____], lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.
6. Set the fault current to I_T = [_____] amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the A1 contact closes when the voltages are within 7% of V_{NOM}.
7. Reduce the fault current to zero.
8. Return Zone 4 ground **Z4GRND** to your specific setting.

6.5.12 ENDING FUNCTIONAL TESTS (USER SETTINGS)

When testing is completed, verify that all settings are returned to your specified values. It may be helpful to print out the settings and check them one by one.

ELECTRICAL RATINGS

Rated Frequency: 50 to 60 Hz

Rated Voltage: 100 to 120 V AC

Rated Current I_n: 1 A or 5 A

DC Control Voltage, operating range:

48 V DC	38.5 to 60 V DC
110/125 V DC	88 to 150 V DC
220/250 V DC	176 to 300 V DC

Maximum Permissible AC voltage:

Continuous	138 V AC (ph-n)
1 minute	208 V AC (ph-n)

Maximum Permissible current:

Continuous	3 x I_n
3 seconds	50 x I_n
1 second	100 x I_n

Sample Rate: 64 per cycle

Hi-Pot (DC Test): ANSI C37.90
IEC 255-5

Surge Withstand Capability:
ANSI C37.90.1
IEC 255-22-1

Impulse Voltage Withstand Fast Transient:
5 kV peak, 1.2/50 ms, 0.5 J
ANSI C37.90.1
IEC255-4

Radio Frequency Interference Withstand:
ANSI C37.90.1
IEC 255-22-3

Electrostatic Discharge: IEC255-22-2

Humidity: 95% without condensation

Ambient Temperature Range

Storage:	–30°C to 75°C
Operation:	–20°C to 65°C

BURDEN RATINGS

Current Circuit: I_n = 1 A: 0.12 Ω @ 30°
I_n = 5 A: 0.022 Ω @ 5°

Voltage Circuit: 0.15 VA @ 60 Hz
0.20 VA @ 50 Hz

DC Battery

(contact converters):	2.5 mA at rated DC input
(power supply):	< 20 W

Trip Circuit Motor: 150 mA for current-flow sensor

CONTACT RATINGS

Fault Location I/V: 0 to 1 mA, 10V load or 0 to 5 V output (4 V = full scale; 5 V = error)

Trip Outputs (T1 to T6)

Continuous Rating:	5 A
Make and Carry:	30 A (per ANSI C 37.90)
Interrupting:	25 VA
Pickup:	< 4 ms

SCR Outputs: same as Trip Outputs

Auxiliary Outputs (A1 to A12, C1, C2)

Continuous Rating:	5A
Make and Carry:	30 A (per ANSI C37.90)
Interrupting:	25 VA
Pickup:	< 8 ms

High Speed (KT1 to KT4)

Continuous Rating:	5A
Maximum Voltage:	280 V DC
Pickup:	< 8 ms

Contact Converter Inputs: 38.5 to 300 V DC

PROTECTION SCHEME SELECTION

Protection Schemes: Step Distance
POTT1 & POTT2
PUTT
Blocking
Hybrid
Programmable Logic

Directional Control: Forward or Reverse

Time Synchronization: by demodulated IRIG-B signal (5 V DC)

Out-of-Step Blocking

Reach:	The reach of MOB is that of the zone it is coordinated with: Zone 2, Zone 3, or Zone 4
Characteristic Angle:	30° to 130°

REACH SETTINGS

M1 (Zone 1 Phase Reach)
M1G (Zone 1 Ground Reach)

Range:	I_n = 1 A: 0.05 to 250 Ω I_n = 5 A: 0.01 to 50 Ω
Resolution:	I_n = 1A: 0.01 Ω I_n = 5 A: 0.01 Ω

MT (Zone 2 Phase Reach)
MTG (Zone 2 Ground Reach)

Range:	I_n = 1 A: 0.05 to 250 Ω I_n = 5 A: 0.01 to 50 Ω
Resolution:	I_n = 1A: 0.01 Ω I_n = 5 A: 0.01 Ω

M3 (Zone 3 Phase Reach)
M3G (Zone 3 Ground Reach)

Range:	I_n = 1 A: 0.05 to 250 Ω I_n = 5 A: 0.01 to 50 Ω
Resolution:	I_n = 1A: 0.01 Ω I_n = 5 A: 0.01 Ω

M4 (Zone 4 Phase Reach)
M4G (Zone 4 Ground Reach)

Range:	I_n = 1 A: 0.05 to 250 Ω I_n = 5 A: 0.01 to 50 Ω
Resolution:	I_n = 1A: 0.01 Ω I_n = 5 A: 0.01 Ω

CURRENT SUPERVISION FUNCTION

Function	Range A		Resolution A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1A
IPT	0.50 to 5.00	0.10 to 1.00	0.01	0.01
IPB	0.25 to 3.75	0.05 to 0.75	0.01	0.01
IT	0.20 to 4.00	0.20 to 4.00	0.01	0.01
IB	0.20 to 4.00	0.20 to 4.00	0.01	0.01

OVERCURRENT BACKUP

Function	Range A		Resolution A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1A
50	2.0 to 160.0	0.4 to 32.0	0.1	0.1
50G	0.5 to 80.0	0.1 to 16.0	0.1	0.1
51G	0.2 to 15.0	0.04 to 3.0	0.01	0.01

TOC TIME DIAL

Range: 0.5 to 10 times pickup setting

Steps: 0.1

LINE PICKUP

Function	Range A		Resolution A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1A
I1	1.0 to 15.0	0.2 to 3.0	0.1	0.1

REMOTE OPEN DETECTOR

Range: 10 to 100 ms

Step: 1 ms

LINE OVERLOAD

Overcurrent Settings:

Function	Range A		Resolution A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1A
Level 1 PU	2.5 to 20.0	0.5 to 4.0	0.1	0.1
Level 2 PU	5.0 to 40.0	1.0 to 8.0	0.1	0.1

Overload Settings:

LV1 timer LEVEL1TDLY

Range: 10 to 99 seconds

Resolution 0.01 sec.

LV2 timer LEVEL2TDLY

Range: 10 to 99 seconds

Resolution 0.01 sec.

COMPENSATION FACTOR

Range: 1.0 to 7.0

Resolution: 0.01

Note: K0 compensation for Zone 1 ground distance is a seperate setting the same range and resolution as above.

PROTECTION SCHEME LOGIC TIMERS

Timer	Description	Range	Resolution
TL1PICKUP	Trip integrator pickup	1 to 50 ms	1 ms
Z2P_TIME Z2G_TIME	Zone 2 timer	0.1 to 3.0 s	0.01 s
Z3P_TIME Z3G_TIME	Zone 3 timer	0.1 to 10.0 s	0.01 s
Z4P_TIME Z4G_TIME	Zone 4 timer	0.1 to 10.0 s	0.01 s
TL4	POTT/PUTT coordination	0.1 to 50 s	0.01 s
(TL5) TL5PICKUP TL5DRPOUT	**b** contact coordination for Breaker 1 (pickup & dropout timers)	0 to 200 ms	1 ms
(TL6) TL6PICKUP TL6DRPOUT	**b** contact coordination for Breaker 2 (pickup & dropout timers)	0 to 200 ms	1 ms
(TL16) TL16PICKUP	Weak infeed trip pickup	8 to 99 ms	1 ms
(TL24) TL24DROPOUT	GDOC Blocking Timer	30 to 500 ms	1 ms
(TL25) TL25DROPOUT	Distance Blocking Timer	30 to 500 ms	1 ms
(TL26) TL26PICKUP	Repeat Delay Timer	0 to 50 ms	1 ms

SYSTEM CONFIGURATION

Communications baud rate: 300, 1200, 2400, 4800, 9600, 19200

Number of breakers: 1 to 2

CT Ratios: 1 to 5000

PT Ratios: 1 to 7000

Distance Units: Miles or Kilometers

ACCURACIES

Distance measuring units: Reach: ±5% of setting at angle of maximum reach and rated current

Zone Timers: ±2 ms

Fault Locator: ±3% (typical)

RMS Values: ±1% of reading

Watts and Vars: ±3% of full-scale from 1A to MAX rated current

Data Sample time tag resolution: ±1 ms

DIMENSIONS AND WEIGHT

Height:	5.31" (135 mm) 3 standard rack-units
Width:	19.00" with ears (3 standard rack-units) 16.90" without ears (430 mm)
Depth:	13.63" (347 mm)
Weight:	The standard rack-mounted unit weighs 23 pounds.

SPECIFICATONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

8.1.1 DESCRIPTION

The Local User Interface (LUI) for the LPS-D Line Protection System consists of a 4-line liquid crystal display (LCD), a keypad, and trip and status LEDs.

There a few conventions used with the keypad and display that will be mentioned periodically in this section. However, to aid the user in using this section more effectively, they will be described briefly here.

- When a command key is pressed a menu will be displayed. There are several levels of choices and menus which will be needed to perform a certain task. If the user wishes to go back up through the different levels they just went down, that command key is used. For example, in ACTIONS, the [ACT] key will go back up through the levels needed to perform that action. The [SET] and [INF] keys work the same way.
- If you make a mistake when you are entering data, just press the [CLR] key once, verify what you just typed is gone and start re-typing the data or answer.
- Messages will be displayed at times. There may have been a mistake made in entering data or the relay may be simply informing the user of a state they have just put the relay in. These messages must be cleared before any other keypad input can be accepted. The [CLR] key will remove these messages but leave the user at the same level. Pressing the [ACT], [SET] or [INF] keys will let the user continue.
- If a message box or list of items is similar to one preceding it, the new one will not be shown.
- There are lists of items that have numbers next to them that appear on the display. If the number of an item is known the number can be pressed followed be the [ENT] key. This will position the cursor on the item. The user must press the [ENT] key one more time to actually enter the item the cursor is on.

8.1.2 DISPLAY AND KEYPAD

a) DISPLAY

The LCD display consists of four 20-character lines. The LCD character contrast can be adjusted through the [ACT] key on the keypad. For more information see Section 8.1.11: ACTIONS on page 8–9.

b) KEYPAD

The keypad consists of twenty keys: 10 numeric keys, a decimal point, eight function keys and an [INV] key (as shown below).

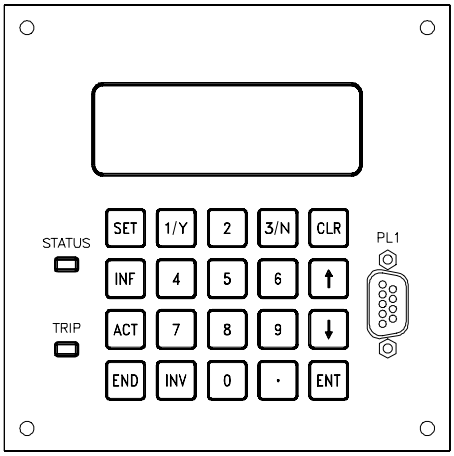


Figure 8–1: LPS-D KEYPAD

The keys are divided into three groups:

1. The **Command keys**: SETTINGS [SET], INFORMATION [INF], ACTIONS [ACT] and [END]. These keys begin or end a command sequence. They are discussed in detail later in this section.
2. The **Control keys**: ENTER [ENT], up-arrow [↑], down-arrow [↓], and CLEAR [CLR]. These keys may cause the relay to take some action.
3. The **Data Entry keys**: all the numeric keys, the decimal point and the [INV] key. These keys are used to enter data into the relay or answer prompts.

The keypad can be enabled or disabled by switch SW2 on the input board. If the switch is in the ON position, the keypad is enabled; if the switch is in the OFF position, the keypad is disabled. Only the [CLR] key functions when the keypad is disabled.

8.1.3 CONTROL KEYS

a) METERING/CLEAR KEY [CLR]

Depending on the current state of the display, the [CLR] key has the following uses: abort a key sequence in progress; clear an error message; activate scrolling of metering; and display recorded trip data.

If the [CLR] key is pressed while entering data, all or part of the display will be blanked. If there is user-entered data on the display, only the data will be blanked. For example, if the user is entering a Setting value or responding to an Action prompt when the [CLR] key is pressed, only the user's input will be blanked; the name of the setting or the prompt will remain on the display. If there is no user-entered data on the display when [CLR] key is pressed, the entire display will be blanked and the relay screen will be displayed.

When a keypad error message is displayed, the [CLR] key must be pressed to remove it (all other keys are ignored). When the error message is removed, the user is returned to the current operation being performed.

Pressing the [CLR] key while a TRIP message is displayed will produce the TRIP information on the LCD. Only the target information (**TRIP *message***) and date/time of the trip for each of the accumulated faults are displayed, starting from the most recent fault (that is, the one whose TRIP message was on display before pressing the [CLR] key). The trip time resolution is one millisecond as shown below:

```
          #1
19:10:01.259
06/29/95
TRIP AB Z2 145.0MI
```

If the [CLR] key is pressed again, the target information and trip time/date date for the next most recent fault is displayed. The user can scroll through all the accumulated trip information using the [CLR] key. The most recent trip message will flash. Pressing the [CLR] key after the last trip will display the relay screen. Scrolling through the trip information using arrow keys is not possible; thus the trip information may only be viewed from the most recent to the oldest when using the [CLR] key.

Pressing the [CLR] key when the screen is blank or when the relay screen is displayed causes Present Values/ Metering to be displayed. Each screen of values is displayed for 4 seconds before proceeding to the next screen. Screens containing breaker health present values are not displayed. After automatically scrolling through all the screens, the display returns to the relay screen. The items displayed are described in Section 8.2.4: REQUEST PRESENT VALUES on page 8–21. The arrow keys cannot be used to scroll through the present values.

Both the fault data display and the present value display are stopped by one of the following: TRIP, FAIL/ WARN message or a key being pressed.

b) ARROW KEYS

The arrow keys are used to scroll through the lists of commands and categories and adjust the contrast of the LCD display. By pressing the [↑] and [↓] keys, the user can select any item in the menu displayed. The display scrolls upward or downward when there are more items than can be displayed on three lines.

When the user reaches the desired category, pressing the [ENT] key will then produce the name of the category on the top line and the first three items in that category on the remaining three lines. The user can use [↑] or [↓] keys to scroll through the items.

The [↑] key scrolls in a reverse direction through a list of categories or items and the [↓] key scrolls forward through a list. The [↑] will select the item before it in a list (for example, from item 5 to item 4). The [↓] will select the item after it in a list (for example, from item 5 to item 6).

Both the [↑] and [↓] keys wrap. Wrapping happens when the top or bottom of a list are reached. The last item becomes the first and the first item becomes the last.

c) ENTER KEY [ENT]

The [ENT] key is used to enter data or a choice. When a category name or command is selected on the display and the [ENT] key is pressed, the user is "choosing" to scroll through that category. After an item is selected with the [ENT] key, the numeric keys and decimal point are used to enter a value. When the correct value has been entered, the [ENT] key is used to accept the new value for the selected item.

d) DATA ENTRY KEYS

The numeric keys 1 and 3 have two meanings depending on the context. If the user is entering numeric values, the [1/Y] and [3/N] keys represent the numbers 1 and 3. If the user is responding to a YES/NO prompt, the [1/Y] key interpreted as YES and the [3/N] key is interpreted as NO.

The [INV] (!) key is used to invert the values of logic signals used with the programmable outputs. For example, if the user needs to invert the value of the ZONE 1 AG logic signal (signal number 81) for input into programmable output A1, [INV] followed by “81” (display: **!81**) is entered.

8.1.4 MESSAGES

All display messages are the result of some keypad action, with four exceptions: the Trip message when the relay has caused a protective trip; the Fail message when the relay has discovered a critical self-test failure; the Warning message when the relay has discovered a non-critical self-test failure; and the Initialization messages when the relay is initializing during a power up.

If a protective trip occurs when there is no self-test message (Self-test Failure or Warning) on the display, the TRIP message will be displayed on four lines of the display. An example is shown below:

```
TRIP
ABG
Z1
50.5 MI
```

The TRIP message is displayed with the background flashing to indicate that the relay has caused a protective trip. The red trip LED will also be flashing to indicate the trip and that the trip has not been acknowledged. Three fields of information form the trip message: a 3-character fault type (e.g. ABG), a 3-character trip type (see Section 8.2.3: REQUEST FAULT INFORMATION on page 8–20 for a list of the trip types), and distance to the fault (in the user-specified units). The message will remain on the display until removed by a keypad operation or by the remote communications Target Reset command. If the relay restarts or is powered down and

up, the trip indicator will be remembered and redisplayed. In either case, as soon as any key on the keypad is pressed or remote communications resets the target, the LED indicating protective tripping by the relay will stop flashing and the trip message will be removed from display. The trip information is stored for later use.

When a system failure occurs, the fail message is always shown on the bottom two lines of the display and has the following format:

```
BBB FAIL–XXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXX
```

where **BBB** stands for the sub-system name issuing the message, and **XXX...XXX** is the text which describes the critical self-test failure. The fail message remains on the display until a key is pressed or until the relay restarts successfully (with no self-test failures).

If a trip message is already on display when a failure occurs, it is displayed on the top line instead of all four lines. The fail message is still shown on the bottom two lines of the display, as shown below:

```
TRIP AG Z1 50.5MI

BBB FAIL-XXXXXXXXXXX
XXXXXXXXXXXXXXXXXXX
```

Since a trip has occurred, the LCD background for all four lines will be flashing.

Warning messages are always displayed on the bottom two lines using the same format as failure messages. The warning message remains on the display until a key is pressed or the relay restarts successfully (with no self-test warnings). If a trip message is already displayed when a warning occurs, the display format will be the same as the fail message. Since a trip has occurred the LCD background will be flashing.

The Initialization messages are displayed while the relay is initializing itself during a power up (and not during a warm restart).

All other messages are the result of keypad operations and remain on the display until another key is pressed, or until no keys have been pressed for 15 minutes. At the end of this time-out interval, the display is blanked.

Though there are some exceptions (e.g. the display of present values and events), the following apply for any user-initiated interaction:

- The top line of the display shows the current category. For example, if the user is editing a setting item, the top line shows the name of the current category, the setting group number and the setting item number. If the user is viewing the status of the contact converters, the top line shows **CC STATUS**.
- The fourth line usually displays the response to the actions initiated by the user. The response will be either a success or error message.

When the user ends a session by pressing the [END] [ENT] sequence of keys, the display is cleared after 10 seconds. The KEYPAD/DISPLAY INTERFACE access privilege is then set to View Level.

8.1.5 SETTINGS

The [SET] command allows the user to edit Protection and General Settings, change the active settings group, and modify the date and time.

Pressing the [SET] key prompts the user for the Settings level password. If the password is not valid, **PASSWORD INVALID** is displayed on the bottom line of the display. The [CLR] key deletes this error message and prompts again for the password. If the password is valid, the user's privilege level is set to the one associated with the entered password.

NOTE:

1. The user is asked to key in a password only when they do not have SETTING or MASTER level access privilege at the time of pressing the [SET] key.
2. When the relay is first shipped, CONTROL, SETTING and MASTER passwords are loaded with factory values. The factory values for the passwords are: SETTINGS (123.), ACTIONS (456.) and MASTER (789.). Selecting *these* passwords does not increase the privilege level. All three passwords must first be changed to user-defined passwords. It is important to understand that the user will not obtain higher privilege levels until these default passwords have been changed. See the servicing section of this instruction book for details.

8.1.6 EDIT PROTECTION SETTINGS

```
   EDIT PROT
GROUP (1-4): 4
Lose Chgs to Gn?
Act Grp= #
```

This option allows the user to modify the protection settings. Four different groups of settings are provided. SETTING or MASTER privilege level must be selected in order to change settings. The settings can only be viewed with CONTROL or default privilege level.

The **Edit Protection Settings** command is used to display or change protection settings. Each of the four groups contain the same list of settings, but they may have different values. Only one group of settings can be used at a time. However, any of the four groups may be viewed or changed at any time. The Protection Settings are divided into categories. By using the arrow keys, the user can scroll through the categories and the settings within each category. Each setting has been assigned a number so that it may be directly accessed.

If the user selects **Edit Protection Settings** by positioning the cursor on that line and pressing the [ENT] key, the display will change to allow the user to select a group of settings.

The cursor will be positioned after the colon (see figure above). If a group was previously edited but not saved then its number will be displayed after the colon and blink. If no group has been previously selected, there will be no number after the cursor. A number must be entered after the colon or an error message will displayed. The **Act Grp=** displayed on the bottom line indicates which group of settings is being used for protection. This group number is only informational.

After the group has been selected, press the [ENT] key. If the blinking digit appears (indicating that there are settings changes that have not been saved for that group), the display changes to indicate the changed settings that will be lost if the new group selection is confirmed. *Unless the settings changes are saved using the [END] key, the changes are not permanent and can be lost!*

In the above figure, **n** is the settings group which was modified but not saved. The user presses [1/Y] (YES) to indicate that changes to previously selected group should be dropped, or [3/N] (NO) to keep the changes and select another group. If the user has pressed NO, the group selection prompt is redisplayed. It is recommended the settings changes be saved in the EEPROM by pressing the [END] key. It is still possible to re-select a group number which is blinking by pressing the [ENT] key.

When a group is finally selected, the display will have **SETTINGS** on the first line and the first three categories on the next three lines. The cursor is positioned on the second line.

A few things should be noted at this point:

- First, the user has the ability to directly enter a setting number. If this is done, the setting number will be displayed in the upper right-hand corner. To select the setting after typing the setting number the [ENT] key must be pressed. If the number is valid, the setting is selected. The [ENT] key must be pressed again to change the setting. If the setting number is invalid, an error message will be displayed on the bottom line of the display and must be cleared with the [CLR] key before proceeding.
- Second, there is a blinking square cursor on the left side of the display. This indicates the currently selected item. To select a different item using the cursor, use the [↑] and [↓] keys. Pressing the [ENT] key will activate the item in the current cursor position.

The [SET] key has an additional function – it will return to the level above the current menu level each time it is pressed until the top SETTINGS menu is reached. For example, if the user is currently entering a new setting value, pressing the [SET] key will return to the list of settings in the current category. Pressing it again will return to the list of settings categories.

Once a category is selected and the [ENT] key is pressed, the first three items in that category are displayed as 10-character mnemonics of the settings and their values. For example, if the [ENT] key was pressed when the cursor is positioned on the line displaying **Z3DISTANCE**, the following will be displayed:

```
Z3DISTANCE Gn S0301
Z3PHASE = YES
Z3PHREACH = 20.32
Z3PCHARANG = 105
```

with the cursor positioned on the second line from the top. **Gn** indicates the group number currently being edited and **S####** indicates the setting number on which the cursor is currently placed.

The setting number to be edited can be chosen by entering the number and pressing the [ENT] key. The entered number is echoed at the same place (right corner of the top line) where the current setting item number is displayed. After the [ENT] key is pressed, the number is checked for validity. If it is valid, the cursor will be positioned on the corresponding setting; if it is invalid, an error message is displayed.

To edit a setting, the item should be first be indicated with the cursor, then selected with the [ENT] key. The information related to the setting is displayed as follows.

- The cursor is positioned on the second line, at the first digit of the displayed value.
- When the first data entry key is pressed, the setting mnemonic will remain on the display but the equals sign (**=**) will be replaced by a blinking colon (**:**). Each data entry key will be displayed as it is pressed, and the colon (**:**) symbol will continue to blink. Remember that the [1/Y] key is also the YES key and the [3/N] is also the NO key. After the last digit of the new value is entered, the user presses the [ENT] key. If the new value is valid, then the blinking colon (**:**) will be replaced by the equals sign (**=**) and the relay will store and display the new setting. If the value is not valid, an error message will displayed on the fourth line and the old setting value will be retained, as shown below:

```
Z3DISTANCE Gn S0302
Z3PHREACH : 51.37
Zone 3 Ph reach(Ohm)
VALUE OUT OF RANGE
```

Two checks are made before accepting the user-entered value. When it is valid, the privilege level will be checked for either SETTING or MASTER level and communications must not be in the process of changing settings. If the check fails then an error message is displayed and the setting is not changed.

After changing a setting value, the setting name and value remain on the display. The arrow keys may be pressed to edit the next setting in the category or any Command key pressed to begin performing other operations. If the user presses the [SET] key, the next higher level menu consisting of the settings items in the present category is displayed with the cursor positioned on the last item edited. The arrow keys may then be used to select another setting item.

If the [SET] key is pressed again, the setting category screen with the cursor positioned on the latest edited category will be displayed. If the [SET] key is pressed for the third time, the group selection display, with the current group number blinking, will appear. If any of the other Command keys are pressed, the command menu associated with the Command key will be displayed.

It is important to note that the LPS-D continues its protection activities while setting values are being entered. Entered settings are stored in a temporary buffer until the user presses [END] and selects one of the save settings item. This will cause a transfer of settings from the buffer to EEPROM and the protection to re-initialize, if there is not a fault in progress at that time. If the settings are not saved and the relay is allowed to time out (15 minutes), all of the settings in temporary storage will be lost.

As soon as the user has made the first valid setting change, the LED which indicates LPS-D status starts blinking, to remind the user to save the settings after editing them. It continues to blink until the user saves the settings by pressing [END] or the relay times out. In order to safeguard changed settings the following message will be displayed whenever the [ACT] or [INF] keys are pressed after changing but not saving settings.

```
To Save Settings
Press END key
```

At this point the user can press the [END] key to save the changed settings in EEPROM. The user may also press the [ACT] or [INF] keys and proceed with the other operations. The setting changes will continue to reside in temporary memory until the user later presses the [END] key or the relay times out.

8.1.7 [END] KEY

```
END
1.Save settings & quit
2.Save settings
3.Quit
```

The [END] key has two purposes. The first is to transfer settings changes from the temporary area into the correct group. The other is to return the user to the VIEW or default privilege level. Each function can be accomplished without the other.

If no settings changes have been made, the only option when pressing [END] is **Quit**. This returns to the default privilege level. If settings changes were made, then three choices are available:

1. **Save set & quit** – The edited settings are saved and the privilege level is returned to default. The messages **SETTINGS SAVED** and **SESSION ENDED** are displayed, reporting the action taken (see below).
2. **Save settings** – The edited settings are saved and the current privilege level is retained. For this choice only **SETTINGS SAVED** is displayed
3. **Quit** – If the settings have not been saved, the relay prompts to save them. If [1/Y] (YES) and [ENT] are pressed, the settings are saved and the privilege level returns to default. Both **SETTINGS SAVED** and **SESSION ENDED** are displayed. If [3/N] (NO) and [ENT] are pressed, the settings are not saved and the privilege level returns to default.

```
END
Settings changed.
SETTINGS SAVED.
SESSION ENDED.
```

After the session is finished, the display clears after 10 seconds and the default privilege level is restored.

If no setting changes are made prior to pressing the [END] key, the only choice will be **Quit**. If the [ENT] key is pressed, **SESSION ENDED** is displayed and the default privilege level is restored.

NOTE:

1. If the Digital Output Test was started, it will be terminated when a choice containing **Quit** is selected.
2. If the settings are saved, they are copied to the EEPROM. If the saved settings affect protection and no fault is currently in progress the settings change is complete. Otherwise, an error message is issued.

When settings are saved, protection is turned ON if it is currently OFF. The status LED turns GREEN if disabling protection was the only reason to turn it RED.

If the settings saved are from the active settings group, a Trip Bus Check is made to ensure that the new settings are legitimate. If the check fails, the protection is turned off and the status LED turns RED indicating that the relay is no longer protecting the line.

8.1.8 EDIT GENERAL SETTINGS

```
EDIT GEN
1.CONFIGURE
2.COMMPORTS
3.OSC_GRAPHY
```

This option allows for changes to the General Settings (for example: Configuration, Communications, Oscillography, etc.). Unlike the Protection Settings, there is only one group of general settings. SETTING or MASTER privilege level must be active in order to change general settings. It is possible, however, to view settings with CONTROL or default privilege level.

Viewing/Editing of General Settings and the LPS-D response to key selection is similar to that described in Section 8.1.6: EDIT PROTECTION SETTINGS on page 8–5.

8.1.9 SELECT ACTIVE SETTING GROUP

This command allows selection of setting groups to be used by protection functions. When selected, the currently active group is displayed as follows:

```
SELECT ACT SETT GRP
Act Grp= n

Range: 0 - 4
```

The cursor is positioned on the second line and '**n**' indicates the current group number. If group number selection is controlled by Contact Converter inputs, the display will contain the word **EXTERNAL**.

When the active group number is changed, the equals sign (**=**) will be replaced by a blinking colon (**:**) until the [ENT] key is pressed. A value between 0 and 4 can be entered. Entering 1 to 4 followed by the [ENT] key selects Protection Settings group 1 to 4. Entering '0' informs the relay to read the active group number from Contact Converter inputs. If any number other than 0 to 4 is entered, an error message is displayed on the second line until the [CLR] key is pressed.

8.1.10 MODIFY DATE/TIME

This command is used to display or change the current date and/or time stored in the relay. SETTING or MASTER privilege level is required to make this change, however, users with any privilege level can view the date and time. When this item is selected, the display looks as shown below:

```
 MODIFY DATE/TIME
Date   = 12/10/95
Time   = 10:00:00
```

The cursor will be located on the second line. To change the date or the time, place the cursor on the line with the desired item and press the [ENT] key.

```
MODIFY DATE/TIME
Date   = 12/13/95

FORMAT: MM/DD/YY
```

Enter the 6 digits corresponding to the correct date or time from the numeric keypad and press the [ENT] key.

When the first digit is entered, the 6 digits on the display are blanked and the equals sign (**=**) is replaced by a blinking colon (**:**) until the [ENT] key is pressed. If the entered digits do not compose a valid date or time, the old date or time is retained and an error message is displayed.

In both cases, two checks are performed: privilege level must be SETTING or MASTER and entered data must be in the correct format. If the checks fail then an error message is displayed and the change is not performed.

8.1.11 ACTIONS

```
   ACTIONS
1.Disable outputs
2.Enable outputs
3.Trip breaker
```

The [ACT] key is used to select Action Commands. All Action Commands except **LUI Test** require either CONTROL or MASTER privilege level. The KEYPAD/DISPLAY INTERFACE Test can be performed with any privilege level. The PASSWORD ENABLE/DISABLE command and all relay tests require MASTER privilege level.

```
ACTIONS
Enter Password:
```

When the [ACT] key is pressed, the relay requests a password. The cursor is located at the beginning of the third line. A password is may be entered just the [ENT] key pressed. If the [ENT] key is pressed without entering a password, the current privilege level is retained and the [ACT] command category menu is displayed. When a password is entered, each character of the password is echoed on the display as an asterisk (*****). When the [ENT] key is pressed, the password is checked for validity. If the password is not valid, an error message is displayed which must be cleared with the [CLR] key. When the error message has been cleared, the password can be re-entered. If the password is valid, the privilege level is set accordingly.

NOTE:

1. The relay requests a password only if the privilege level is not CONTROL or MASTER when the [ACT] key is pressed.
2. When the relay is shipped from the factory, the CONTROL, SETTING and MASTER passwords are loaded with factory values. Selecting these passwords does not increase privilege level; it only allows them to be changed to custom passwords. Higher privilege levels can be obtained only after the factory passwords have been changed.

The following list describes the available LPS-D actions:

1. Disable outputs
2. Trip breaker
3. Relay test
4. LUI test
5. Playback
6. Enable/Disable passwords
7.
8. Enable outputs
9. Close breaker
10. Channel test
11. Digital output test
12. Change password
13. Reset data
14. Adjust contrast

The display will be similar to the settings display. The first line will display **ACTIONS** when in the Actions menu. The next three lines will contain the ACTIONS commands. Other menu items are selected by pressing the [↑] and [↓] keys. To go directly to a menu item, type the menu item number. The menu item number will appear in the right corner of the top line. If the number is valid when the [ENT] key is pressed, the cursor will be positioned on that action category. If the number is invalid when the [ENT] key is pressed, an error message will be displayed which must be cleared by the [CLR] key.

When an action category has been selected, press the [ENT] key. The first item in the selected category is displayed. The displayed list can be scrolled through with the arrow keys. To select another actions category, press the [ACT] key and repeat the previous steps.

8.1.12 DISABLE OUTPUTS

This command inhibits the relay from energizing any of the Digital Output contacts except for the critical alarm and power supply alarm outputs.

The relay will ask whether to disable the outputs. Press the [3/N] key for NO or the [1/Y] for YES followed by the [ENT] key. If NO is selected, **CANCELED** is displayed and no LPS-D action occurs. If YES is selected, two tests are performed: CONTROL or MASTER privilege level is verified and communication must not be in the process of performing an action. If the test fails then an error message is displayed and the action is not performed. If the test passes, the action is performed, **OUTPUTS DISABLED** is displayed, and the status LED on

the front of the relay will turn RED. If a key other than a [1/Y] or [3/N] is pressed, an error message is displayed and the outputs are not disabled. If this category is selected when outputs are already disabled, the following message is displayed and must be cleared with the [CLR] key.

```
  DISABLE OUTPUTS

OUTPUTS CURRENTLY
DISABLED.
```

8.1.13 ENABLE OUTPUTS

This command is used to permit the relay to enable the digital outputs of the relay.

The relay will ask whether to enable the outputs. Press [3/N] for NO or [1/Y] for YES and then press the [ENT] key. If NO is selected, **CANCELED** is displayed and no LPS-D action occurs. If YES is selected, two checks are performed: for the CONTROL or MASTER privilege level and whether communication is in the process of performing an action. If the test fails, an error message is displayed and the action is not performed. If the test passes, the action is performed and **OUTPUTS ENABLED** is displayed. The status LED on the front of the relay will turn GREEN if there are no status problems with the relay. If a key other than [1/Y] or [3/N] is pressed, an error message is displayed and the outputs are not enabled.

If this category is selected when outputs are already enabled, the relay will display a message which must be cleared with the [CLR] key.

8.1.14 TRIP BREAKER

This command manually trips a breaker. Each breaker controlled by the relay must be tripped individually. If the relay is controlling two breakers when this category is selected, the relay will request which breaker to trip.

To indicate the breaker, press [1] or [2] followed by the [ENT] key (any other Data Entry key will cause an error message to be displayed). If the relay is set to control one breaker, this query will be skipped.

The relay will then ask whether to trip the selected breaker. Select [3/N] (NO) or [1/Y] (YES) followed by the [ENT] key. If NO is chosen, **CANCELED** appears on the display and no LPS-D action occurs. If YES is chosen, two checks are performed: for the CONTROL or MASTER privilege level and whether communication is in the process of performing an action. If the checks fail, then an error message is displayed and the action is not performed. If the checks pass, then the action is performed and either **BREAKER x TRIPPED** or **NOT TRIPPED** appears on the bottom line of display (depending on the status of the breaker). If a Data Entry key other than [3/N] or [1/Y] is pressed, an error message is displayed and the breaker is not tripped.

```
  TRIP BREAKER
Trip Breaker 1/2?
```

The breakers are tripped as follows:

- For one breaker and one trip circuit, output contact T1 is energized.
- For one breaker and two trip circuits, output contact T1 and T2 are energized.
- For two breakers with one trip circuit each, output contacts T1 and T2 are energized.
- For two breakers with two trip circuits each, output contacts T1, T2, T3, and T4 are energized.

8.1.15 CLOSE BREAKER

This command is used to manually close the breaker. If two breakers are being controlled by the relay, each breaker must be closed individually. If the relay is controlling two breakers when this category is selected, the relay will request which breaker to close.

The user presses [1] or [2] (any other Data Entry key will cause an error message to be displayed) followed by the [ENT] key to indicate the breaker. If the relay is controlling only one breaker, this query is skipped.

The relay will ask whether to close the selected breaker. Press [3/N] (NO) or [1/Y] (YES) followed by the [ENT] key. If NO is selected, **CANCELED** appears on the display and no LPS-D action occurs. If YES is selected, the checks are performed for the control or master privilege level and whether Communication is in the process of performing an action. If the checks fail then an error message is displayed and the action is not performed. If the checks pass then the action is performed and either **BREAKER x CLOSED** or **NOT CLOSED** is displayed (depending on breaker status). If a key other than [3/N] or [1/Y] is pressed, an error message is displayed and the breaker is not closed.

8.1.16 RELAY TEST

This command tests the protection functions of the relay. MASTER password level privilege is required and protection must be enabled to perform this test. If protection has been turned off before entering this test, the relay will prompt to enable it. If the [3/N] (NO) key is pressed, **CANCELED** is displayed and the test is canceled. If the [1/Y] (YES) key is pressed, the user will be asked if the digital outputs should be disabled.

```
   RELAY TEST
1.End Test Mode
2.Zone 1 AG
3.Zone 1 BG
```

Whether protection was just turned on or was already on when this test was selected, the relay asks to disable the digital outputs. If the answer is YES, all outputs except contact A1 are disabled and the status LED turns RED to indicate the digital outputs have been disabled. They may be enabled when **End Test Mode** is selected. If the answer is NO, all the digital outputs will stay active during the test.

NOTE: During relay test, all results from the tests will be output to contact A1 whether the digital outputs are enabled or disabled.

When the relay test items are displayed, the cursor will be positioned on the second line. Additional tests can be displayed with the arrow keys or by entering the test number followed by the [ENT] key. The entered digits are echoed in the top right corner of the display. If the [ENT] key is pressed and the entered number is valid, the test item corresponding to that number is displayed. A test item can also be selected by moving the cursor to the item and pressing the [ENT] key. At this point a check is performed to make sure that communication is not in the process of performing an action. If the check fails then an error message is displayed and the test is not selected. When the test is selected, the word **ON** will be displayed to the right of the unit under test.

```
   RELAY TEST
31.ANY Z2 PHASE  ON
32.ANY Z3 PHASE
33.ANY Z4 PHASE
```

One test may be performed at a time. When a new test is selected, the previous test will be deselected.

Other activities using the [SET], [ACT] or [INF] keys may be performed during the relay test. When the relay test category is re-selected, the test started earlier will be remembered only if the [END] key has not been used. If the digital outputs were enabled, the relay will again ask if they should be disabled. If protection was disabled, the relay will prompt to enable it before proceeding with the tests again.

NOTE: The Disable Output? screen may appear first.

To remove the relay from test mode, the select **1. End Test Mode** and press the [ENT] key. The cursor can be moved to the item in two ways: by using the arrow keys or by entering [1] followed by [ENT] key. If **1. End Test Mode** is selected, the message **ON** will be removed from the display line of the item under test and the relay test terminated.

If outputs have been disabled before the relay test, a prompt appears after the selection of **1. End Test Mode** option, as shown below:

```
   RELAY TEST
Enable outputs?
```

If YES is chosen, the outputs are enabled, the status LED may turn GREEN (if disabling outputs or relay test was the cause to turn it RED), and the ACT command menu is displayed. If NO is chosen, the outputs remain disabled, the status LED stays RED and the ACT command menu is displayed. If any other key is pressed, an error message is generated and [CLR] key must be pressed to clear the message.

The available tests and their corresponding numbers are:

1: End Test Mode	17: ANY Z4 GND	33: ANY Z4 PHASE
2: ZONE 1 AG	18: ZONE 1 AB	34: IT DETECTOR
3: ZONE 1 BG	19: ZONE 1 BC	35: IB DETECTOR
4: ZONE 1 CG	20: ZONE 1 CA	36: GRD DIR TRIP
5: ZONE 2 AG	21: ZONE 2 AB	37: GRD DIR BLOCK
6: ZONE 2 BG	22: ZONE 2 BC	38: FAULT DETECTOR
7: ZONE 2 CG	23: ZONE 2 CA	39: REM OP DETCT
8: ZONE 3 AG	24: ZONE 3 AB	40: OUT OF STEP BLK
9: ZONE 3 BG	25: ZONE 3 BC	41: V1 DETECTOR
10: ZONE 3 CG	26: ZONE 3 CA	42: LINE OVERLOAD
11: ZONE 4 AG	27: ZONE 4 AB	43: INST PHS OVRC
12: ZONE 4 BG	28: ZONE 4 BC	44: INST GND OVRC
13: ZONE 4 CG	29: ZONE 4 CA	45: LINE PICKUP
14: ANY Z1 GND	30: ANY Z1 PHASE	46: OVER VOLTAGE
15: ANY Z2 GND	31: ANY Z2 PHASE	47: UNDER VOLTAGE
16: ANY Z3 GND	32: ANY Z3 PHASE	48:OUT OF STEP TRIP

8.1.17 CHANNEL TEST

This command is used to allow the user to key (turn on) the local transmitter when a channel scheme (POTT1, POTT2, PUTT, BLOCKING or HYBRID) is used. Protection must be enabled to perform a channel test. If protection is disabled when channel test is selected, the user will be prompted to enable protection.

```
CHANNEL TEST
Enable Protection?
```

If the [3/N] (NO) key is pressed, **CANCELED** is displayed and the test is canceled. If the [1/Y] (YES) key is pressed, the relay checks the outputs. If they are enabled, the test item is displayed. If the outputs are disabled, the user is prompted to enable them. If the user responds with [3/N] (NO), **CANCELED** is displayed and the test is canceled. If the user responds [1/Y] (YES), the outputs are enabled and the test item is displayed.

```
CHANNEL TEST
1.End Chnl Test
2.Channel Test
```

If **Channel Test** is selected, the privilege level must be CONTROL or MASTER and communications must not be performing an action. If either check fails, an error message is displayed and the test is not performed. The error message must be cleared by pressing the [CLR] key. When the checks pass and the test is started, the word **ON** will be displayed to the right of the item.

```
  CHANNEL TEST
1.End Chnl Test
2.Channel Test ON
```

When the user selects **End Chnl Test**, the test is terminated the user is returned to the Actions menu.

8.1.18 KEYPAD/DISPLAY INTERFACE TEST

This command will test the display, keypad, and LEDs. This test does not require a specific privilege level.

```
   LUI TEST
1.Display
2.LEDs
3.Keypad
```

The user can select an item by using the arrow keys followed by the [ENT] key.

If **Display** is chosen, the top two lines of the display will be filled to verify that all LCD dots are working. The display will prompt the user to press the [ENT] key. The bottom two lines of the display will now be filled. This is the end of the test. If the [CLR] key is pressed the relay screen is displayed. If the [ACT] key is pressed, the LUI TEST choices screen will be displayed.

If **LEDs** is chosen, both the STATUS and TRIP LEDs will be tested. The STATUS LED is tested first followed by the TRIP LED. The display will indicate the correct state of the LEDs. After each LED state the user will be prompted to press the [ENT] key and move to the next test. When the [ENT] key is pressed after the last test, the LEDs return to their pre-test state and the **LUI TEST** item menu is displayed.

If **Keypad** is chosen, the following screen appears:

```
SET 1/Y 2 3/N CLR
INF 4 5 6 UP
ACT 7 8 9 DN
END INV 0. ENT
```

When any key is pressed, the key label will blink on the display. If another key is pressed, the new key label will blink. Pressing the [CLR] key will terminate the keypad test and the test item menu is displayed.

8.1.19 DIGITAL OUTPUT TEST

This command tests the digital outputs of the relay. If the digital outputs are not enabled, the user is prompted to enable them. If the user enters [1/Y] (YES) and presses [ENT], the outputs are enabled. If the user presses [3/N] (NO), **CANCELED** is displayed and the test is terminated.

When the outputs are enabled, protection must be disabled (if it is currently enabled). If the user responds NO, **CANCELED** is displayed and the test is canceled. If user responds YES, protection is turned OFF, the status LED turns RED and the list of available tests is displayed.

To select a test item, scroll through the list using arrow keys or enter the test number. If the test pre-requisites are satisfied, the word **ON** will display to the right of test item. If the password privilege level is not MASTER or communications is performing an action, an error message is displayed and the test is not performed.

The contact being tested will close if it is normally open and it will open if it is normally closed. Only one output can be monitored at a time. When a new output is tested, the old output will be reset and the new output will either open or close.

Other activities using the [SET], [ACT] or [INF] keys may be performed at any time. When the user returns to the Digital Output tests, they are asked questions about Protection enable and then the selected test and its following tests are displayed, starting from the second line.

Press the arrow keys until **End Test Mode** is displayed or press the [1], [ENT] keys to stop the digital output test. Press [ENT] again. The digital output test is terminated and the following message will be displayed:

```
   DO TEST
Enable Protection?
```

The cursor will be stationed on the third line. If [1/Y] (YES), [ENT] is entered, protection is turned ON. The LED indicating LPS-D status turns green (if performing digital output test was the only cause for it being red) and the ACT command menu is displayed with the cursor positioned on **Dig output test**. The above prompt will be also displayed when the user tries to exit the digital output test category without ending the test.

If [3/N] (NO) is entered followed by [ENT] key, protection is not enabled and the status LED remains RED. The ACT command menu is displayed with the cursor positioned on the item **Dig output test**.

The test may be stopped by pressing the [END] [ENT] key sequence, ending the relay session with protection turned ON.

The available tests and their corresponding numbers are listed below.

1: End Test Mode	8: A1	15: A8	22: KT1
2: T1	9: A2	16: A9	23: KT2
3: T2	10: A3	17: A10	24: KT3
4: T3	11: A4	18: A11	25: KT4
5: T4	12: A5	19: A12	26: CA-A/B (Critical Alarm)
6: T5	13: A6	20: C1A/C1B	
7: T6	14: A7	21: C2A/C2B	

8.1.20 PLAYBACK

This category checks the relay logic and outputs by replaying oscillography data. The oscillography data can be the embedded factory test case, uploaded oscillography data, or oscillography data stored in the relay.

After this command is selected, the following message appears (if protection is currently disabled):

```
PLAYBACK
Enable Protection?
```

The cursor is positioned at the beginning of the third line. If the user responds NO, **CANCELED** is displayed and the test is canceled. If the user presses any keys other than [1/Y] or [3/N] and presses the [ENT] key, an error message is displayed. It can be cleared and a valid input can be entered using the [CLR] key.

If the user responds YES, protection is enabled and the relay asks whether to disable the outputs, if they are currently enabled. The user presses [1/Y] or [3/N] followed by [ENT] key. These keys are echoed on the display as **YES** or **NO** respectively. If [1/Y] is pressed, the outputs are disabled and then the playback mode is continued. The outputs can be enabled after the playback is complete. If [3/N] is pressed, the outputs remain enabled. Any control actions issued by the relay take place in this case.

If the outputs are disabled, the status LED turns RED since the relay is currently not protecting the line. If they remain enabled during playback, the status LED turns RED only for the duration of the playback. In that case, after the playback is complete, the status LED turns GREEN again.

The cursor will be located on the second line. The option **Factory test case** is chosen by moving the cursor to that line and pressing the [ENT] key.

The user is prompted to select the settings which used during playback. If [1/Y] is pressed followed by [ENT] key, the relay settings currently in effect will be used during playback. If [2] is pressed followed by [ENT], the settings stored with the oscillography data will be used.

The factory test case is a phase to phase fault at 50% of the line determined by the default factory settings, except for the configurable outputs which are all assigned a value of 0 (no assignment). The contact converters will respond to the levels in the uploaded file. After the response described above, playback is started and the word **ON** will be displayed on the top line. The cursor will be positioned on the top line. After the playback is over, the word **ON** is removed.

If the second choice, **Uploaded data**, is selected, a check is made to verify whether any uploaded oscillography data exists in the relay. If the data does not exist, an error message is displayed. If the data exists, the user is asked to select the settings to be used during playback, as explained for the item **Factory test case**. An oscillography file may be uploaded by using ALPS-Link (refer to Chapter 11: ALPS-LINK USER GUIDE). The playback is started after all prompts are answered. The word **ON** will be displayed as long as playback lasts.

The only data files that can be uploaded to the relay are 0SC files downloaded from another LPS-O, LPS-D, or ALPS model relay, or a binary or ASCII Commtrade file from another source (Commtrade details are explained below). These files contain the analog data, flags and settings to be uploaded to the relay.

Any file that meets the Commtrade format may be downloaded to the relay after it has been converted to 0SC format using the CTRD20SC.exe program provided with the LPS-D software suite. It will be installed into the same directory as ALPS-Link. This utility converts only the analog data from the file; all flag values are set to 0, and default settings will be added to the file. View the CTRD20SC.TXT text file for complete instructions on using the conversion utility. The only data used from a Commtrade file is the analog channel data. All other data are discarded and replaced with dummy values. The data must be sampled at a rate of 64 samples per power cycle or 3840 samples/second at 60 Hz.

The values of the oscillography setting are obtained from the current settings, not the ones in the playback fault. Therefore, the new fault report will correspond to the current settings. For example, if the playback fault has 36 cycles of data, but the current **NUMFAULT** is set to 8, only 18 cycles of data will appear in the new fault report. Conversely, if the playback fault has only 12 cycles of data and the current setting will generate 36 cycles, then 24 cycles of zero data will be processed at the end of playback.

If the third choice, **Data in relay,** is selected, the user is asked to select the settings (current/fault) for playback. After the settings have been selected, the summary of faults to be selected is displayed. If fault settings is selected, the settings active at the time of the fault will be used. The settings file is attached to the oscillography and is always saved with the oscillography data.

The cursor will be located on the second line. To move cursor to an item, use the arrow keys or enter the fault number followed by the [ENT] key. If entering a number, the digits pressed are echoed at the top right corner of the display. Pressing the [ENT] key after moving the cursor to the desired item starts playback. The top line changes to indicate that playback has started. The word **ON** will be removed from the display as soon as the playback is complete.

Two checks are made before starting playback: the privilege level must be MASTER and communications must not be in the process of performing an action. If either of these checks fails, an error message is displayed to the user and the test is canceled.

If **End Playback** is chosen and the outputs are disabled, the relay prompts with the dialogue:

```
Enable Outputs?
```

If YES is chosen, the outputs are enabled, the status LED turns GREEN (if playback test was the only reason to turn it RED), and the ACT command category selection is displayed. If NO is chosen, the outputs remain disabled, the status LED remains RED, and the ACT command category selection is displayed.

8.1.21 CHANGE PASSWORD

This category is used to change the SETTINGS, CONTROL and MASTER passwords. The arrow keys may be used to scroll to the desired item. To select an item press the [ENT] key. Once a password has been selected to be changed, only the number keys can be used to enter the old password. The digits are echoed with an asterisk (*****) for privacy. When the [ENT] key is pressed, the old password is checked for validity. If the password is valid, the relay will prompt for the new password.

Only the number keys can be used to enter the new password. Once the new password has been entered, the relay will prompt to re-enter the new password to ensure no mistakes were made while typing.

If the two password entries are identical then **PASSWD CHANGED** is displayed and the new password replaces the old one. Otherwise, **PASSWD NOT CHANGED** is displayed and the password is not changed.

No privilege level is needed to use this command and communications is not checked.

8.1.22 ENABLE/DISABLE PASSWORDS

This category is used to enable/disable LUI passwords. MASTER privilege level is required.

If passwords are currently enabled the relay will ask to disable the passwords; if passwords are currently disabled, the relay will ask to enable the passwords. In either case, if [3/N] (NO) is pressed, **CANCELED** is displayed and the command is terminated.

The [1/Y] (YES) is pressed, the current state for the operation of the passwords will be changed. If the current state is disabled, the relay will ask for the MASTER password. **PASSWORDS ENABLED** is displayed and passwords will be required to perform most of the relay commands through the keypad. When the passwords are enabled, the passwords in effect before disabling the passwords are restored. If the passwords are disabled when the command is executed, **PASSWORDS DISABLED** is displayed and no passwords will be required to perform most relay commands. Remember: a MASTER level password is required to perform this command whether or not passwords are enabled.

8.1.23 RESET DATA

This command is used to reset the fault, event, oscillography and breaker health data.

Use the arrow keys or choose the item number to select an item to be reset. Once an item has been selected, press the [ENT] key again. The user is prompted to reset the data. If [3/N] (NO), [ENT] is pressed, **CANCELED** is displayed and the data is not reset. If [1/Y] (YES), [ENT] is pressed, the data is reset and a message displayed which must be cleared with the [CLR] key. If a fault is in progress while attempting to reset fault data or equipment duty data, an error message is displayed and the data is not reset.

An event is logged for each successful reset operation. CONTROL or MASTER privilege is needed to perform this command and communications must not be executing an action command.

8.1.24 ADJUST CONTRAST

The contrast level of the LCD display can be adjusted using this command. The ↑ or ↓ keys are used to increase or decrease the contrast of the display, respectively. As the arrow keys are pressed, the contrast change will be visible on the display. Increasing the contrast will make the characters appear darker on the display; decreasing the contrast will make the characters lighter on the display.

If the minimum or maximum contrast limit has been reached, the relay will change the prompt to **INCREASE** or **DECREASE** only (depending on the limit reached). Pressing the other arrow will not affect the contrast.

An error message will be displayed if the data entry keys are used. CONTROL or MASTER privilege is required to use this command.

8.2.1 DESCRIPTION

The [INF] key is used to view information stored in the relay and can be used with any privilege level. Pressing the [INF] key on the keypad allows access to the following relay information.

1. LPS status information
2. Fault information
3. Present values
4. Contact Converter status
5. Digital output status
6. Events information
7. Communication Passwords
8. Station/Line ID
9. LPS-D Model/Version
10. Snaps hot oscillography

```
  INFORMATION
1.LPS status
2.Faults
3.Present values
```

Use the arrow keys to select the desired category. Categories may also be selected by entering the category number followed by the [ENT] key.

The user can scroll through the list of categories by pressing the [↑] or [↓] keys. The user can select a category by entering its number as well. If the user enters a category number, it is echoed in the upper right-hand corner. When the user presses the [ENT] key after selecting a category, the first three items of information of the selected category are displayed. Use the arrow keys to display information that is not currently display. The cursor will be visible only when the user is making a choice to view information. It is not visible while the user is viewing the information. The user may return to the category list by pressing the [INF] key at any time. Another category can be selected by using the arrow keys or entering a new category number and pressing the [ENT] key as above. If the text on a line is longer than 20 characters (the maximum number per line), the text continues on the next line with the first character blank, as shown below.

8.2.2 REQUEST STATUS INFORMATION


```
LPS STATUS
Trip Bus Check Fail
Setting changes
  started
```

When the user requests the relay status, the overall relay status is displayed on the second line. If the relay is working properly and protecting the line, the relay will display **STATUS: OK**. If there is a critical failure detected by self-test, the display will be **STATUS: FAIL**. If there are no critical failures but there is a non-critical failure, the display will be **STATUS: WARN**. Even if there are no hardware failures, there may still be miscellaneous status in which case the display will be **STATUS: MISC**.

The detailed status information is presented starting from the third line. The user may use the arrow keys to scroll through the information. Each time the arrow key is pressed, a full screen of detailed status information is displayed. Status information is presented in the following order: critical failure information, non-critical failure information and miscellaneous status information.

8.2.3 REQUEST FAULT INFORMATION

This category is used to display fault information.

When this category is selected, a summary of the fault information for the stored faults is displayed to facilitate the user choose a fault for viewing more information about it. An example is shown below:

```
  SELECT FAULT #1
XXX YYY MM/DD HH:MM
XXX YYY MM/DD HH:MM
XXX YYY MM/DD HH:MM
```

where: **XXX**: Fault type
YYY: Trip type
MM/DD HH:MM: Date and time of occurrence

The number in the top right-hand corner indicates the selected fault. When the category is entered, the number is #1 and the cursor is on the first fault. The arrow keys may be used to scroll through the list of accumulated faults. The number on the top line will change to match the currently selected fault. The user can also enter the fault number to view. If the number is valid when the user presses [ENT] key, the cursor will be placed on the selected fault description. An error message is displayed if the user enters an invalid number.

The user has to press [ENT] key to view all the fault information. An example is shown below:

```
FAULT   #1

Time : HH:MM:SS.XXX
Date : MM/DD/YY
```

Explanation of the information displayed for each fault is given below:

Time: **HH:MM:SS.XXX** (XXX = msec) – time of fault occurrence
Date: **MM/DD/YY** – date of fault occurrence
Fault Type: **XXX** – see the list below
Trip Type: **YYY** – see the list below
Distance: **zzz.z** MI/KM – distance to fault occurrence
Relay Op Time: **xxxxxx** – relay operating time in msec.
Brkr Op Time: **xxxxxx** – breaker opening time in msec.

Fault Types:

AG	(phase A to ground)	CAG	(phases C-A to ground)
BG	(phase B to ground)	AB	(phases A-B)
CG	(phase C to ground)	BC	(phases B-C)
ABG	(phases A-B to ground)	CA	(phases C-A)
BCG	(phases B-C to ground)	3PH	(3-phase)

Trip Types:

Z1	(Zone 1)	REM	(Remote open)
Z2	(Zone 2)	WI	(Weak Infeed)
Z3	(Zone 3)	OSC	(Oscillography Trigger)
Z4	(Zone 4)	SZ1	(Single Pole Zone 1 Trip)
PLT	(Pilot)	SZ2	(Single Pole Zone 2 Trip)
50G	(Ground instantaneous overcurrent)	SPI	(Single Pole Pilot Trip)
50P	(Phase instantaneous overcurrent)	SWI	(Single Pole Weak Infeed)
51G	(Ground time delayed overcurrent)	CTB	(configurable trip bus trip)
LPU	(Line pick up)		

8.2.4 REQUEST PRESENT VALUES

This category displays the present analog values. They are updated every 4 seconds while being displayed.

The present values information is displayed in six different screens. Each time the [↓] key is pressed, the next screen of information will be displayed. Using the [↑] key will display the information in reverse order.

The forward order of the information screens is: 1) RMS Values, 2) Power Factor, Frequency and Watts Vars, 3) Analog Values for Voltage, 4) Analog Values for Current, 5) Breaker Duty, and 6) Breaker Operations.

NOTE:

Currents and voltages are displayed in primary or secondary values depending on the value of General Setting 108. For secondary side values, the units of voltages will be V and the current units will be A. For primary side values, the voltage units will be KV and the current units will still be A. The RMS present values are always displayed in primary units, when primary display is selected. The asterisk symbol (*****) used for Watts; Vars can be: blank, K (for 1000), or M (for 1,000,000). The breaker duty is calculated according to the values in the Equipment Duty General Settings. In general, the units of breaker duty are $(\text{Amps})^{X}(\text{Seconds})$ where *X* is General Setting 401: **EXPONENT**. The breaker duty values are displayed with the units 'A' (A x sec.), 'K' (kA x sec., in thousands) or 'M' (MA x sec., in millions). In the ALPS-Link program, the voltages will be shown in secondary values only.

8.2.5 CONTACT CONVERTER STATUS

This category is used to display the state of each digital input monitored by the relay. They are updated every 4 seconds while they are displayed.

The number of the contact converter, the name of the digital input assigned to the contact converter and the status of the converter are displayed on the same line. Three contact converter status are displayed at a time.

```
CC STATUS
1.52B_1A : 0
2.52B_1B : 1
3.52B_1C : 0
```

NOTE:

1. The LPS-D has 12 contact converters.
2. The contact converter is OPEN if the status is a '0'. The contact converter is CLOSED if the status is a '1'.

3. If no digital input is assigned to a contact converter, its status information will still be displayed along with the contact converter number but the name will be blank.

8.2.6 DIGITAL OUTPUT STATUS

This command displays the definition and the state of each digital output in the relay. This information is displayed three lines at a time. Use the arrow keys to scroll through the digital outputs (displayed in groups).

The Trip Outputs have the letter T in front of the output contact number. Alarm Contacts have the letter A in front of the output contact number. The two Form C output contacts have the letter C in front of the number. The Critical Alarm is just labeled CA.

```
   DO STATUS
T1 - T4 : 1 0 1 1
T5 - T6 : 0 0
A1 - A4 : 0 1 0 0
```

If the DO status is shown as ‘0’ it means it is OPEN. If it is ‘1’, it is ‘CLOSED’.

8.2.7 EVENT INFORMATION

This category can be used to view event information logged when certain functions are performed by the relay. Information displayed for each event consists of: Event number and its time of occurrence on the top line Date of occurrence of event on the second line. Detailed event description on the third and fourth lines. The user may use the ARROW keys to view the event information. The user can also enter an event number followed by the [ENT] key to display the information for a specific event. An error message is displayed if the user enters an invalid event number. Listed below is a list of the possible event messages available:

EVENT LIST

- Fail: CPU board SRAM
- Fail: 960 access to DPRAM
- Fail: EEPROM
- Fail: Digital output test
- Fail: Interrupt test
- Fail: ANI ADC Control logic
- Fail: ANI ref. channel test
- Fail: DMA interrupt failure
- Fail: ANI board timer
- Fail: ANI board serial EEPROM test
- Fail: MAG module serial EEPROM test
- Fail: Digital output serial EEPROM test
- Fail: DTA serial EEPROM test
- Fail: DSP PROM failure
- Fail: DSP internal RAM
- Fail: DSP internal RAM checksum error
- Fail: DSP access to DPRAM
- Fail: DSP interrupt
- Fail: Digital input test
- Fail: Model number - critical in nature
- Fail: MAG module configuration mismatch
- Fail: ANI module configuration mismatch
- Fail: Digital input module configuration mismatch
- Fail: Digital output module configuration mismatch
- Fail: Trip circuit continuity monitor #1
- Fail: Trip circuit continuity monitor #2
- Fail: Trip circuit continuity monitor #3
- Fail: Trip circuit continuity monitor #4
- Fail: Trip circuit continuity monitor #5
- Fail: Trip circuit continuity monitor #6
- Fail: Software version error
- Fail: DSP software version error

- Fail: More than 4 warm restarts occurred in an hour
- Fail: i960 DSP interface
- Fail: Runtime flash test CRC check
- i960 Instruction fault
- i960 Arithmetic fault
- Too many bogus interrupts
- Warning: CPU board timer test
- Warning: Zero crossing logic
- Warning: CAPRAM failure
- Warning: RTC test failure
- Warning: Comm front port failure
- Warning: Comm rear port 1 failure
- Warning: Comm rear port 2 failure
- Warning: Watch dog timer failure
- Warning: LCD display failure
- Warning: IRIGB failure
- Warning: Rear port 2 absent
- Warning: Non critical field in model number
- Warning: CAPRAM size mismatch
- Warning: Frequency error
- Warm restart
- ANI reference corrected
- Digital input error corrected
- MAG module error corrected
- ANI module error corrected
- LCD display error corrected
- Remote communication login failure
- Passwords changed
- Outputs enabled
- Outputs disabled
- Manual trip
- Manual close
- Manual trip failed
- Manual close failed
- Manual recloser reset
- Setting changes started
- Setting changes completed
- Protection OFF
- Protection ON
- Fault queue in CAPRAM re-initialized
- Event queue in CAPRAM re-initialized
- OST oscillography data area re-initialized
- Equipment duty is reset
- Active setting group changed
- Protection re-initialized
- Request for protection re-initialization not serviced
- Factory settings done
- Error in constants used by protection
- Error in code area of configurable logic
- LPS Initialized
- Trip signals ON
- Trip signals reset
- Trip A signal ON
- Trip A signal reset
- Trip B signal ON
- Trip B signal reset
- Trip C signal ON
- Trip C signal reset
- Out of step block ON
- Out of step block OFF
- Breaker #1 open
- Breaker #1 closed
- Breaker #2 open
- Breaker #2 closed
- Fuse failure alarm ON
- Fuse failure alarm OFF
- Receive carrier ON
- Receive carrier OFF
- Key transmitter ON
- Key transmitter OFF
- Trip circuit #1 energized
- Trip circuit #2 energized

- Trip circuit #3 energized
- Trip circuit #4 energized
- Trip circuit #5 energized
- Trip circuit #6 energized
- Line overload alarm ON
- Line overload alarm OFF
- Trip circuit #1 monitor alarm ON
- Trip circuit #1 monitor alarm OFF
- Trip circuit #2 monitor alarm ON
- Trip circuit #2 monitor alarm OFF
- Trip circuit #3 monitor alarm ON
- Trip circuit #3 monitor alarm OFF
- Trip circuit #4 monitor alarm ON
- Trip circuit #4 monitor alarm OFF
- Trip circuit #5 monitor alarm ON
- Trip circuit #5 monitor alarm OFF
- Trip circuit #6 monitor alarm ON
- Trip circuit #6 monitor alarm OFF
- Pilot protection ON
- Pilot protection OFF
- Oscillography trigger
- Fail: Trip bus check
- Unbalanced system detection alarm ON
- Unbalanced system detection alarm OFF
- Zone measurement units alarm ON
- Zone measurement units alarm OFF
- Overcurrent monitor alarm ON
- Overcurrent monitor alarm OFF
- Trip circuit #1 not energized
- Trip circuit #2 not energized
- Trip circuit #3 not energized
- Trip circuit #4 not energized
- Trip circuit #5 not energized
- Trip circuit #6 not energized
- Manual recloser lockout ON
- TOC curve changed
- Runtime NO DMA interrupt
- Manual recloser lockout OFF
- External reclose initiate - 1P
- External reclose initiate - 3P
- External recloser reset
- Recloser lockout - reclose cancel
- Reclose lockout - breaker failure
- Out of step trip ON
- Out of step trip OFF
- Run time ANI controller error
- Run time ANI reference error
- Run time DSP H/W fail
- Run time DSP settings error
- Run time DSP table corrupted
- Recloser in reset
- Recloser in progress start
- Recloser in progress end
- Recloser Three Pole Cycle 1
- Recloser Three Pole Cycle 2
- Recloser Three Pole Cycle 3
- Recloser Three Pole Cycle 4
- RECL in Lockout No Sync Check
- RECL in Lockout No Inhibit Input
- RECL in Lockout Breaker Open
- RECL in Lockout REC Unsuccessful
- RECL in Lockout Reclose Cancel
- RECL in Lockout BRK Fail to Open
- RECL in Lockout Maximum Shots
- RECL in Lockout Invalid REC Type
- RECLOSE Output Issued
- RECL in Lockout Manual Lockout

An example of event information display is shown below:

```
13:45:21.240 Evt#100
09/12/88
LUI:MANUAL CLOSE
```

8.2.8 COMMUNICATION PASSWORDS

This category is used to view the communications passwords in encrypted form.

Viewing of encrypted passwords is determined by the user's current privilege level. With a default or factory password privilege level, the user will only see the VIEW password for communications. With settings privilege level, only the SETTINGS and VIEW passwords are displayed. With control privilege level, only the CONTROL and VIEW passwords are displayed. All passwords can be viewed with master privilege level.

If the relay is set for MASTER privilege level, use the arrow keys to view the second pair of passwords.

To change the privilege level in the relay, enter the SETTINGS or ACTIONS categories and enter the password. The [SET] key and the [ACT] key are the only two keys that allow you to set the privilege level. If only the SETTINGS privilege level is desired, the [SET] key must be used. The [ACT] key must be used only if CONTROL privilege level is desired. Either may be used for the MASTER privilege level. See the following table for decoding information.

Table 8–1: PASSWORD ENCRYPTION KEY TABLE

Displayed	Decoded
(space)	P
!	T
"	X
$	Q
%	U
&	Y
(	R
)	V
*	Z
,	S
-	W
1	D
2	H
3	L
4	A
5	E
6	I
7	M

Displayed	Decoded
8	B
9	F
:	J
;	N
<	C
=	G
>	K
?	O
@	0
A	4
B	8
D	1
E	5
F	9
H	2
I	6
L	3

Displayed	Decoded
M	7
P	(space)
Q	$
R	(
S	,
T	!
U	%
V	)
W	-
X	"
Y	&
Z	*
[	.
\	#
]	'
^	+
_	/

8.2.9 REQUEST STATION/LINE ID

This category is used to view the Station and Line ID strings which are set by the remote communications. These Ids allow the user to easily identify each relay by name while logged in through communications. Use the arrow keys to display the ID not currently on the screen.

NOTE: If the Station/Line ID string is longer than 20 characters, a check is made to see if the string can be smoothly separated to fit on two lines. If it is not possible, the first 20 characters of the station ID are displayed on the third line and the rest are displayed on the fourth line.

8.2.10 REQUEST LPS-D MODEL/VERSION

This category is used to display the Model and Version numbers for the relay.

8.2.11 OSCILLOGRAPHY SNAPSHOT

```
 OSC SNAPSHOT
Trigger Osc?
```

This command can be used to trigger the immediate collection of oscillography data. Oscillography can be triggered without at any privilege level. The user will be prompted to start the trigger.

Table 8–2: KEYPAD / DISPLAY INTERFACE ERROR MESSAGES

Error Message	Cause of Error
VAL OUT OF RANGE	The setting value is either greater than the upper limit or less than the lower limit.
SETT NUM INVALID	The setting number is not valid.
Y/N NOT ENTERED	A YES or NO response key was required, but the [1/Y] or [3/N] key was not pressed.
REQUEST INVALID	A key was pressed that is not valid for a sequence; for example: The [ENT] key is pressed to view events. The _ key is pressed during entry of a settings value.
CATEGORY INVALID	An incorrect category number was entered for an action or information item.
BKR NUM INVALID	A breaker number other than 1 or 2 was entered.
DATE INVALID	The day, month, or year entry is invalid.
TIME INVALID	The hour, minute, or seconds entry is invalid.
FAULT # INVALID	An out of range fault number was entered.
REMOTE LINK ACT	The remote communication link is in use for actions or settings; local settings or changes can't be done.
LUI KEY ERROR	The LUI received an invalid key code from the keyboard (hardware error).
ACT INVALID NOW	The current action is invalid because the setting's CRC code is in error.

8.3.1 DESCRIPTION

The pin-to-pin connections for the cable connectIng the ASCII port to plug PL2 on the back of the LPS-D are shown in Figure 8–2: MODEM CABLE. Virtually any standard communications package on a PC with a serial interface may be used. The ASCII serial interface must be programmed to the same parameters as the remote communications ports. The ASCII port's handshaking mode must be set to either XON/XOFF or DTR ready. The LPS-D setting COMFORT affects both the baud rate of the RS232 port (plug PL1) and the ASCII port PL2. Figure 8–3: 25-PIN NULL MODEM CABLE shows a Null modem cable for the 9-pin front port PL-1.

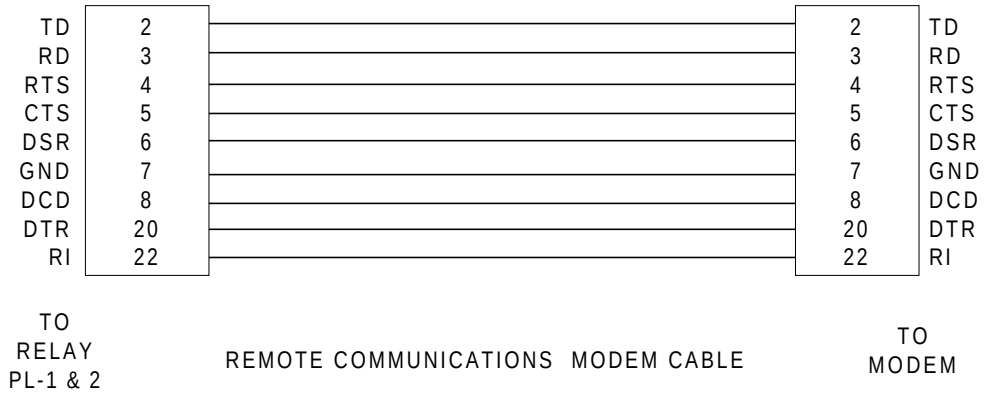


Figure 8–2: MODEM CABLE

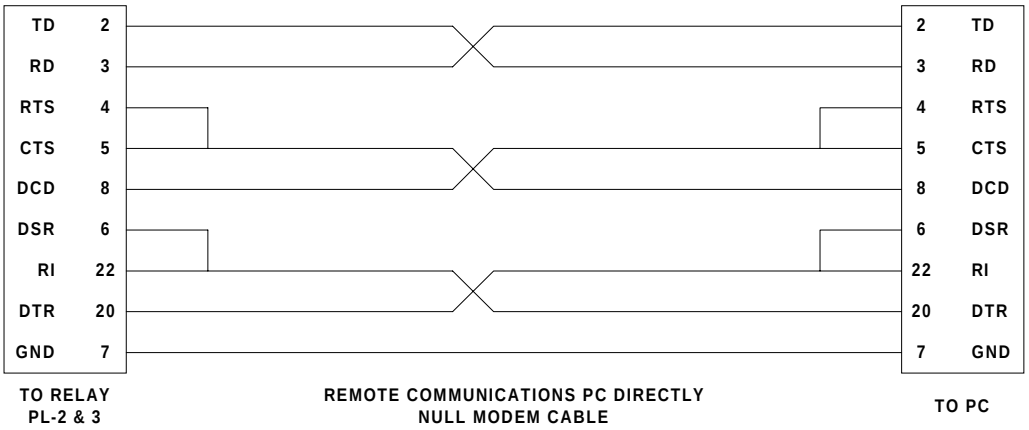


Figure 8–3: 25-PIN NULL MODEM CABLE

8.3.2 RECOMMENDED REMOTE COMMUNICATIONS PACKAGE

The following programs have been tested and known to support the ASCII interface on the LPS-D. Note that most any communications package that emulates a TTY type terminal should communicate successfully.

- Procomm Plus (vendor: Datastorm)
- Windows Terminal Program (vendor: Microsoft; included in Windows 3.1/95/98 systems)

8.4.1 HARDWARE SWITCHES

There are hardware switches on the Input Board (see Section 3.3.5: INPUT BOARD on page 3–6) that inhibit the Remote Breaker Operations, the Remote Settings Change and the Remote Enable/Disable Outputs functions. Please note that these switches are shipped from the factory in the down position and these functions are enabled.

1. The proper sequence for setting these switches is as follows:
2. Remove four thumbscrews holding the plastic cover in place and lay aside with plastic cover.
3. Turn the power switch off on the front panel.
4. Remove DC power from the LPS-D.

Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous or lethal voltages may be present inside the unit even if the power switch is OFF.

5. Remove the four 1/4” hex nuts at the four corners of the front panel and carefully remove the front panel.
6. Disconnect the power and the ribbon cables from the front panel and lay the panel aside
7. The Switches are located in the middle on the front edge of the board. Move the switches up to turn a function off. Figure 3–5: INPUT BOARD DIAGRAM on page 3–7 indicates the location of the jumpers on the board.
8. Reinstall the PC board retainers with the four phillips head screws.
9. Reinstall the power cable and the bus card on the PC boards.
10. Reconnect the LUI ribbon cable and the power cable to the front panel and install the front panel with the four 1/4” hex nuts.
11. Turn on the front panel power switch.
12. Restore DC power to the relay.
13. Reinstall the plastic cover with the four thumbscrews.
14. The hardware switches are defined below in Table 8–3: HARDWARE SWITCH DESCRIPTIONS.

Table 8–3: HARDWARE SWITCH DESCRIPTIONS

Switch	Function
KBD EN ON	Down position enables keyboard operations. Up position disables.
RM CHG SET ON	Down position enables remote settings changes. Up disables.
RM BRKR ON	Down position enables remote breaker operations. Up disables.

8.4.2 MODEM CONNECTIONS AND SETTINGS

When establishing communication between the relay and a remote PC, two modems connected by a phone line are required. One modem is located at the relay and the other modem at the PC. The pin connections for the cable that connects the modem with either the relay or the PC is shown in Figure 8–3. Both modems must be "Hayes-compatible," meaning that they accept standardized modem configuration commands first developed by Hayes. This is necessary since the ALPS-Link communications software that runs on the PC sends a Hayes-compatible command string to the modem located at the PC. The LPS-D does not send any configuration commands to its modem. Both the relay modem and the PC modem must be uniquely configured to permit logging into and communicating with the relay using ALPS-Link software.

The required configuration settings are presented as changes to the factory-default configuration settings for a Hayes V-Series 2400 SmartModem. The default settings are listed below.

B1	P	Y0	&K3	&S0	S7=30	S11=95	S26=1
E1	Q0	&C0	&L0	&T4	S8=2	S12=50	S36=1
L2	V1	&D0	&P0	&X0	S9=6	S18=0	S37=0
M1	W0	&G0	&Q5	S0=0	S10=14	S25=5	S38=20
N1	X4	&J0	&R0	S6=2			

Other "Hayes-compatible" modems may implement a subset of the full Hayes command set. It is the responsibility of the customer to determine the exact commands accepted by a particular modem. The proper syntax for entering the Hayes-compatible commands (sometimes referred to as the "AT" command set) is not described here. Refer to the modem manual for an explanation of this syntax.

8.4.3 PC MODEM

The PC modem must be configured for "intelligent" (command recognition enabled) operation. For the Hayes V-Series 2400 SmartModem, this setting is made with an internal jumper. The default settings listed in Section 8.4.2: MODEM CONNECTIONS AND SETTINGS are valid for ALPS-Link. The configuration settings critical to the operation of ALPS-Link are sent to the modem from the software:

```
+++
(delay 2 seconds)
ATE0L0Q0S7=60V0X4Y0
```

These commands are explained in the table below:.

Table 8–4: COMMAND SEQUENCE SENT BY ALPS-LINK TO MODEM

Command	Meaning
+++	Set modem to command mode
AT	Modem attention command
E0	disable command state echo
L0	Low speaker volume (desirable, not required)
Q0	Modem returns result codes
V0	Result codes returned in numeric form
X4	Enables result code features
Y0	Disable long-space disconnect
S7=60	Modem hangs up if no connection within 60 seconds

The S7=60 command is present starting with version 1.05 of ALPS-Link. Earlier versions of ALPS-Link do not send this command, leaving the time out at the default value, which is typically 30 seconds.

If any of the above commands are not recognized by the modem, then the modem will not operate properly. In addition to the required configuration settings listed in Table 8–4, it is suggested that the following two settings also be made:

&D3: the modem resets on the ON-to-OFF transition of DTR (Data Terminal Ready).

&C1: DCD (Data Carrier Detect) tracks the received carrier signal.

The modem will operate properly without these two settings, but it will not hang up if the appropriate handshaking signal is lost.

An ALPS-Link setting establishes the baud rate, which must match the baud rate setting of the LPS-D. ALPS-Link will then set the specified PC serial port (COM1, COM2) to the proper baud rate, parity, data bits, and stop bits. If the PC modem is capable of operating at more than one baud rate, then it must be able to automatically configure its baud rate, character length, and parity setting by examining the "AT" command prefix.

8.4.4 LPS-D MODEM

The LPS-D modem must be configured for "dumb" (command recognition disabled) operation. On the Hayes V-Series 2400 SmartModem, this setting is made with an internal jumper. Since the relay sends no configuration commands to its modem, the required configuration settings must be made before connecting the modem to the relay. Additionally, the modem must be initialized to the required configuration settings each time modem power is turned OFF and then ON. Depending on the design of the modem this is accomplished with switch settings via switches or by saving the settings in nonvolatile memory.

The required configuration settings are listed in Table 8–5: CONFIGURATION SETTINGS FOR THE MODEM CONNECTED TO THE RELAY.

Table 8–5: CONFIGURATION SETTINGS FOR THE MODEM CONNECTED TO THE RELAY

Command	Description
E0	Disable command state echo
L0	Low speaker volume (desirable, not required)
Q1	Disable result code display
&C1	DCD (Data Carrier Detect) tracks the received signal
&D0	Modem resets on the ON-OFF transition of DTR (Data Terminal Ready)
&Q0	Asynchronous mode
S0=1	Enable auto-answer

If any of the settings in Table 8–5 cannot be implemented the modem may not answer, the relay may not connect properly, or you may not be able to log into the relay. With a Hayes V-Series 2400 SmartModem or equivalent, the relay modem performs a modulation handshake with the PC modem to set the baud rate of the relay modem. The default setting of N1 permits handshaking to occur at any baud rate supported by both modems. This is one reason why it is better to use identical modems at each end.

Note that auto-answering is controlled by register S0:

- S0=0: disables auto-answer.

- S0=1: the relay modem answers incoming calls after one ring. S0 can be set for any value between 1 and 255, if it is desirable to delay modem answering. Note that ALPS-LINK (version 1.05 or higher) configures the PC modem to wait 60 seconds for the relay modem to answer. If the relay modem register S0 is set higher than 12 (answer after 12 rings), the PC modem may time out and hang up before the relay modem can answer. S0=12 corresponds approximately to the 60 second delay (S7=60) at the PC modem; however, you should verify the number of rings that correspond to 60 seconds for a particular application.

Table 8–7 lists the modem command set required to communicate to the relay from a remote PC.

8.4.5 NULL-MODEM CONNECTIONS

A PC can be connected directly to the relay without a modem through a null-modem cable. The required pin-to-pin connections for the PC null-modem cable are shown below in Figure 8–4: 25-PIN NULL MODEM CABLE. The pin-to-pin connections for a null-modem cable to the 9-pin connector on the KEYPAD/DISPLAY INTERFACE are shown below in Figure 8–5: NULL MODEM CABLE FOR PORT PL1. The null modem cable should be no more than 50 feet long.

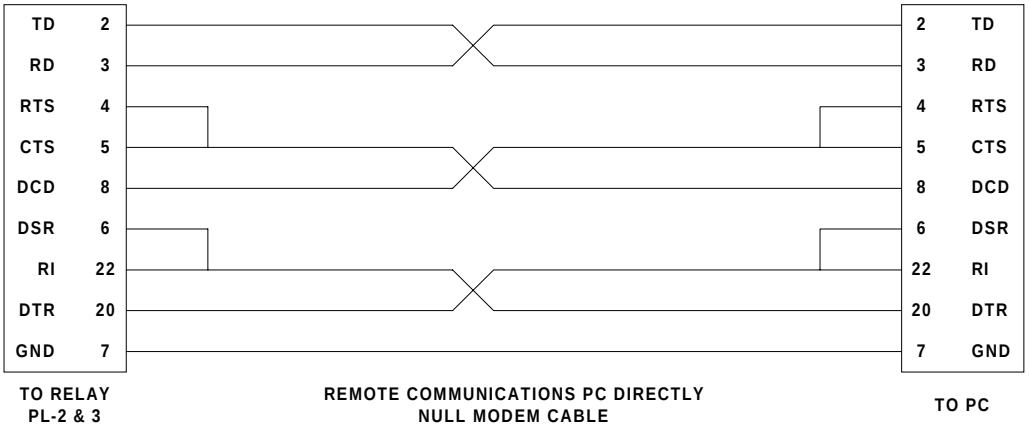


Figure 8–4: 25-PIN NULL MODEM CABLE

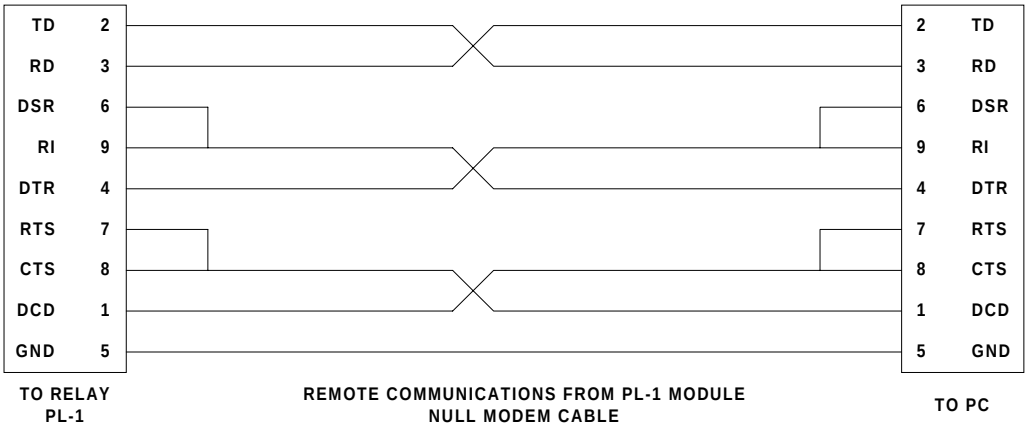


Figure 8–5: NULL MODEM CABLE FOR PORT PL1

Table 8–6: MODEM COMMANDS FOR COMMUNICATION BETWEEN RELAY AND PC

Function	ALPS Modem (remote)	PC Modem (local)
DTR Status	Follow DTR (&D3)	Follow DTR (&D3)
Result Code Format	Numeric (V0)	Numeric (V0)
Result Code Display	Disable (Q1)	Disable (Q1)
Command State Echo	Disable (E0)	Disable (E0)
Auto-Answer	Enable (S0=1)	Disable (S0=0)
Carrier Detect	Follow CD (&C1)	Follow CD (&C1)
Jack Type	RJ-11, etc. (&J0)	RJ-11, etc. (&J0)
Command Recognition	Disable (Dumb)	Enable (Smart)
Comm. Std. (@1200 bps)	Bell 212A (B1)	Bell 212A (B1)
Response to DTR	Ignore DTR (&D0)	Ignore DTR (&D0)
Fall Back to 4800Bd	AT#F1	
Pulse Dial Ratio	39%Mk/61%Bk (&P0)	39%Mk/61%Bk (&P0)

9.1.1 DESCRIPTION

There are two servicing methods for the LPS-D:

- Spare board replacement.
- Component level repair.

The preferred method is board replacement using the LPS-D automatic self-tests to isolate failed boards. When the defective board is found, it can be replaced with a spare, and the system can be returned to service. This method typically yields the shortest system down time. To further reduce down time, we recommend keeping a complete set of spare boards at the maintenance center.

We do not recommend servicing the relay at the component level. This requires a substantial investment in test and repair equipment and in technical expertise, and usually results in longer down time than board replacement. For those who do wish to trouble-shoot to the component level, drawings can be requested from the factory. When you request drawings, you must supply the following information:

- The name of the board. This is found on the component side of the printed circuit board with the assembly number and revision.
- The assembly number of the LPS-D is an eight-digit number with a letter inserted between the fourth and fifth digit and with a group-identification suffix, such as 0215B8011G001.
- The revision number is found adjacent to the assembly number of the board.

Power down the relay by turning off the front panel power switch and disconnecting power from the rear connector before disassembling the unit. High voltage levels can be accessed at the power supply inputs.

9.1.2 SERVICING WITH THE RELAY SELF-TEST

The LPS-D automatically performs tests of major functions and critical hardware components and reports their status via the LUI Display, status LED and the non-critical and critical alarm contacts. The failure report is dependent on the type or level of the failure. Some failures operate the critical alarm contact and the status LED, while others only operate the non-critical alarm contact.

There are three levels of self-test performed by the LPS-D:

1. The first level indicates severe relaying failures, indicated by a FAIL message on the display, the critical alarm contact opening, and the status LED turning red. These failures indicate that the relay is not providing protection.
2. The second level displays warning messages. They are indicated by a WARN message on the display and closure of the non-critical alarm contact. These failures indicate that the relay is still providing some degree of protection.
3. The third level indicates system status errors that are due to power system errors (Trip Circuit Open) or are caused by an LPS-D command that disables the relay (Disable Outputs). They are indicated by the closing of the non-critical alarm contact, a red LED, or by the opening of the critical alarm contact. However, nothing is displayed until the Information Status command is issued.

The types of self-tests performed are described in the Chapter 1: PRODUCT DESCRIPTION. The components tested during the start-up self-tests are listed in Table 9–1. The components tested during run-time background and foreground self-tests are listed in Tables 9–2 and 9–3, respectively.

Table 9–1: COMPONENTS TESTED DURING START-UP TESTS

COMPONENT	METHOD	PROCESSOR	NATURE
Flash Memory (PROM)	CRC-type check	960 CPU	Critical
EPROM	Checksum on DSP board	DSP	Critical
Local RAM	Patterns to check for stuck bits, stuck address lines, cross-talk between adjacent bits	960 CPU DSP	Critical
Shared RAM	Same as Local RAM	Both	Critical
Nonvolatile RAM CAPRAM Serial RAM	CRC-type check on settings area; checksum on fault storage area: duplicate locations on serial NVRAM	960 CPU	Critical if settings area or serial NVRAM
Timer Chip	Test all processor timers and their interrupts	960 CPU	Critical if ANI logic; non-critical if 960
Interrupt Controller	Test all 960 internal interrupts	960 CPU	Critical
Serial Chips	Wraparound and interrupt tests for serial interface	960 CPU	Non-critical
A/D Controller	DMA Interface	960 CPU	Critical
Digital Output Circuitry	Loop-back test	960 CPU	Critical
Digital Input Circuitry	Comparison of bits read via two separate optocouplers	960 CPU	Non-critical, turn off pilot protection
Real-Time Clock	Test of real-time clock operation and interrupts	960 CPU	Non-critical

Table 9–2: RUN-TIME BACKGROUND SELF-TESTS

COMPONENT	METHOD	PROCESSOR	NATURE
Flash Memory (PROM)	CRC-type check	960 CPU	Critical, restart
EPROM	Checksum type check	DSP	Critical, restart
RAM	Protection values checked for correctness; Configurable logic checked for validity	960 CPU	Critical, restart
Nonvolatile RAM	CRC-type check on settings area	960 CPU	Non-critical
CAPRAM	Checksum on fault storage area	960 CPU	

Table 9–3: RUN-TIME FOREGROUND SELF-TESTS

COMPONENT	METHOD	PROCESSOR	NATURE
A/D Controller	DMA interface	960 CPU	Critical
Digital Input Circuitry	Comparison of bits read via two separate optocouplers	960 CPU	Non-critical, turn off pilot protection
Digital Output Circuitry	Loop-back test	960 CPU	Critical, restart
Trip Circuit Continuity	Bit read via bus	960 CPU	Non-critical
LUI	Operator initiated, visual feedback	960 CPU	Non-critical

9.2.1 DESCRIPTION

Troubleshooting the LPS-D comprises three steps, as follows:

1. Determine the relay status as either critical, non-critical, or miscellaneous.
2. Use the list of failure codes and warning codes or the Information Status command to determine the defective board(s)
3. Replace the defective board(s) in accordance with safety and static-discharge precautions.

NOTE

Refer to Chapter 4: ACCEPTANCE/PERIODIC TESTS for tests of the Local User Interface (LUI) display, keypad, and the measuring units.

9.2.2 THE INFORMATION STATUS COMMAND

Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5 contains the failure and warning codes that appear on the LCD display. The Information Status command should be used to obtain complete data about the relay status. The Information Status command can be used at the relay or remotely over a modem link.

The Information Status command is invoked as follows:

1. Apply rated DC power to the relay and wait for initialization to complete (if necessary)
2. Press the [INF] key, then scroll with the [↑] and [↓] keys until the LCD display indicates

   LPS status

3. Press the [ENT] key. The display indicates a failure with the words

   STATUS: FAIL

Press the [↑] key to get a detailed report of all the failures. A complete list of the possible errors is found in Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5. The FAIL and WARN messages are also included. Their descriptions may also be displayed LCD display with the Information Status command.

NOTE

After initial power up or a loss of power exceeding 24 hours, the time and date reset to 00:00:00 01/01/96. All event and fault data are reset.

Table 9–4: SYSTEM STATUS ERROR MESSAGES

ERROR	INDICATION	DESCRIPTION
WARN	NCA	Warn condition
FAIL	CA/LED	Fail condition
MISC	LED	Miscellaneous condition

LED: Red Status LED
CA: Critical alarm contacts close.
NCA: Non-critical alarm contacts close.

9.2.3 SERVICING A CRITICAL FAILURE

A critical failure denotes total interruption of protection. When a failure occurs on one of the boards (excluding the power supply), the critical alarm contact opens and the status LED turns red. Remove and reapply DC power display the fail message. If the LPS-D successfully restarts, the status LED turns green.

If the failure still exists, the status LED will be red and the critical alarm contact will be open. A FAIL message may also be on the display. The Fail message indicates the nature of the critical failure. It remains on the display until a key is pressed or the LPS-D restarts successfully with no self-test failures. See Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5 for the list of mnemonic failure codes and their meanings.

NOTE

The Information–LPS Status command can be used to display all the current failures.

9.2.4 LOCATING THE DEFECTIVE BOARD

Use Section 9.2.7: SERVICE SYSTEM STATUS FAILURES on page 9–5 or the Information Status command to isolate the cause of the failure. Then refer to Figure 3–3: CIRCUIT BOARD LOCATIONS on page 3–3 to determine which board contains the defective logic module. When the suspected board is found, power down the LPS-D and replace the board.

The proper sequence for replacing a board is as follows:

1. Remove the four thumbscrews holding the plastic cover in place and lay aside with the plastic cover.
2. Turn the power switch off on the front panel.
3. Remove DC power from the LPS-D.

WARNING

Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous or lethal voltages may be present inside the unit *even if the power switch is OFF.*

4. Remove the four 3/16” hex nuts at the four corners of the front panel and carefully remove the front panel.
5. Disconnect the power and the ribbon cables from the front panel and lay the panel aside.
6. Remove the two ribbon cables and power cables from the front of the PC boards and lay aside.
7. Remove the PC board that connects the other PC board and lay aside in an anti-static bag.
8. Remove the defective PC board and place into an anti-static bag for storage or shipment.
9. Remove the replacement board from its anti-static container and insert into the LPS-D case.
10. Reinstall the connecting PC board.
11. Reinstall the ON/OFF switch cable and the two ribbon cables.
12. Reconnect the LCD display ribbon cable and the RESET/METERING cable to the front panel with the four 3/16” hex nuts.
13. Restore DC power to the LPS-D.
14. Turn on the front panel power switch.
15. Reinstall the plastic cover with the four thumbscrews.

If the FAIL message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that another board requires replacement.

9.2.5 SERVICING A NON-CRITICAL FAILURE

A non-critical failure indicates an interruption potential in the LPS-D protection, but not a total loss. When a non-critical failure occurs, the LPS-D non-critical alarm contact closes, but the LED remains green. Turn off the DC input power, then reapply it. The **WARN xxx** message reappears if the failure still exists.

The non-critical failure message has the format **WARN xxx**. The **xxx** field is the numeric code that indicates the nature of the failure. The WARN message remains on the display until a key is pressed or until the LPS-D restarts successfully with no self-test failures. See Section 9.2.7 SERVICE SYSTEM STATUS FAILURES for the list of Warning codes and their meanings.

NOTE

As an alternative, the Information Status command can be used to display the warning type directly on the LCD Display.

9.2.6 LOCATING THE DEFECTIVE BOARD

Use Section 9.2.7: SERVICE SYSTEM STATUS FAILURES or the Information Status command to isolate the cause of the failure. Power down the LPS-D and replace the suspected board, if appropriate. Reapply power; if the WARN message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that another board requires replacement.

9.2.7 SERVICE SYSTEM STATUS FAILURES

A system failure indicates a failure of a power system input or that the relay has been disabled by a user command. It is indicated by the closing of the non-critical alarm contact, by a red LED, or by the closing of the critical alarm contact. However, no LCD display is provided until the Information Status command is invoked.

Turn off and reapply the dc input power. The non-critical alarm contact is closed if the failure still exists. Use the Information Status command to determine the cause of the trouble.

a) FAILURE MESSAGES: 960 CPU BOARD

- FAIL-FLASH MEMORY
- FAIL-STATIC RAM
- FAIL-STATIC RAM CRC
- FAIL-DPRAM 960 ACCESS
- FAIL-I960 INTRPT CONTROLLER
- FAIL-CPU TIMER
- FAIL-CPU EEPROM
- FAIL-CPU CAPRAM
- FAIL-CPU RTC
- FAIL-CPU WATCHDOG TIMER
- FAIL-S/W PROT CONSTANTS
- FAIL-S/W CONFG. LOGIC
- FAIL-CONFIG S/W VERSION ERROR
- FAIL-CPU SYSTEM IN RESET
- FAIL-CPU SYSTEM SHUTDOWN
- FAIL-DO FEED BACK
- FAIL-LUI LCD DISPLAY
- FAIL-IRIGB
- FAIL-TRIP CKT #1 CONTINUITY ERROR
- FAIL-TRIP CKT #2 CONTINUITY ERROR
- FAIL-TRIP CKT #3 CONTINUITY ERROR
- FAIL-TRIP CKT #4 CONTINUITY ERROR
- FAIL-TRIP CKT #5 CONTINUITY ERROR*
- FAIL-TRIP CKT #6 CONTINUITY ERROR*
- FAIL-CONFIG H/W MISMATCH
- FAIL-NO DMA INTERRUPT
- FAIL-RUNTIME SETTINGS AREA
- FAIL-EEP CONTENTS ERROR
- STAT-DO DISABLED HARDWARE

b) FAILURE MESSAGES: MAGNETICS MODULE

- FAIL-MAG SEEPROM

c) FAILURE MESSAGES: COMMUNICATIONS WARNINGS

- FRONT PORT LOGIN FAILURE
- REAR PORT #1 LOGIN FAILURE
- REAR PORT #2 LOGIN FAILURE
- WARN-FRONT PORT FAIL
- WARN-REAR PORT #1 FAIL
- WARN-REAR PORT #2 FAIL
- WARN-REAR PORT 1 ABSENT
- WARN-REAR PORT 2 ABSENT

d) FAILURE MESSAGES: MISCELLANEOUS FAILURES

- CON MONITOR ALARM
- UNBALANCED SYS ALARM
- FUSE FAILURE
- TRIP BUS CHK FAIL
- TIME STROBE FAIL

e) FAILURE MESSAGES: MISCELLANEOUS MESSAGES

- WARN-LUI KEYPAD ERROR
- WARN--RTC
- WARN-DIGITAL INPUT LOGIC
- WARN-LCD DISPLAY
- ACTIVE GROUP SWITCH THROUGH CCs
- LUI PASSWORDS DISABLED
- DISABLED OUTPUTS
- DO DISABLED-SOFTWARE
- DO DISABLED-HARDWARE
- RELAY TEST
- DIGITAL OUTPUT TEST
- CHANNEL TEST
- PLAYBACK

f) FAILURE MESSAGES: ANI / DSP BOARD

- FAIL-ANI ADC CONTROLLER
- FAIL-ANI ADC SEEPROM
- FAIL-ANI REF. VOLTAGE
- FAIL-ANI ZERO CROSSING LOGIC
- FAIL-DMA NO INTERRUPT
- FAIL-DI INPUT LOGIC
- FAIL-SERIAL EEP READ
- FAIL-FREQUENCY OUT OF RANGE
- FAIL-DSP PROGRAM ROM
- FAIL-DSP INTERNAL RAM
- FAIL-DSP INTERNAL RAM CRC
- FAIL-DSP DPRAM DSP ACCESS
- FAIL-DSP 960-DSP INTERRUPT
- FAIL-RUN TIME DPRAM CHECKSUM
- FAIL-DI SERIAL EEPROM
- FAIL-DO SERIAL EEPROM
- FAIL-DSP SETTINGS
- FAIL-DSP TABLES
- FAIL DSP I960 HANDSHAKE
- FAIL-DSP IN RESET
- FAIL-DSP S/W VERSION
- FAIL-DSP IN SHUTDOWN
- FAIL - ANI VREF1
- FAIL - ANI VREF2
- FAIL - ANI VREF3
- WARN-COMM FRONT PORT FAIL
- WARN-COMM REAR PORT #1 FAIL
- WARN-COMM REAR PORT #2 FAIL
- WARN-COMM LUI KEYPAD ERROR
- STAT-DI ERROR CORRECTED

10.1.1 DESCRIPTION

ALPS-Test is used to generate test data for the measuring units in the LPS-D relay for the settings specified by the user. This data can be used to validate your test data. ALPS-Test was designed to work with both the ALPS and LPS-D series of relays.

In order to run the program, the following files need to be installed in a directory of the tester's choice.

ALPS_TST.EXE

ALPS_TST.INI

ALPS_TST.HLP

PUSHHELP.VBX

10.1.2 STARTING THE PROGRAM FOR THE FIRST TIME

Install the program from the GE Power Management Products CD or from the GE Power Management Web site at www.ge.com/indsys/pm. See Section 11.2.4: SOFTWARE INSTALLATION on page 11–4 for instructions on installing the LPS-D software suite. This installation procedure will install ALPS-TEST along with the ALPS-Set, ALPS-Link, and Xpression Builder software packages.

When the program is started, the following screen is displayed.

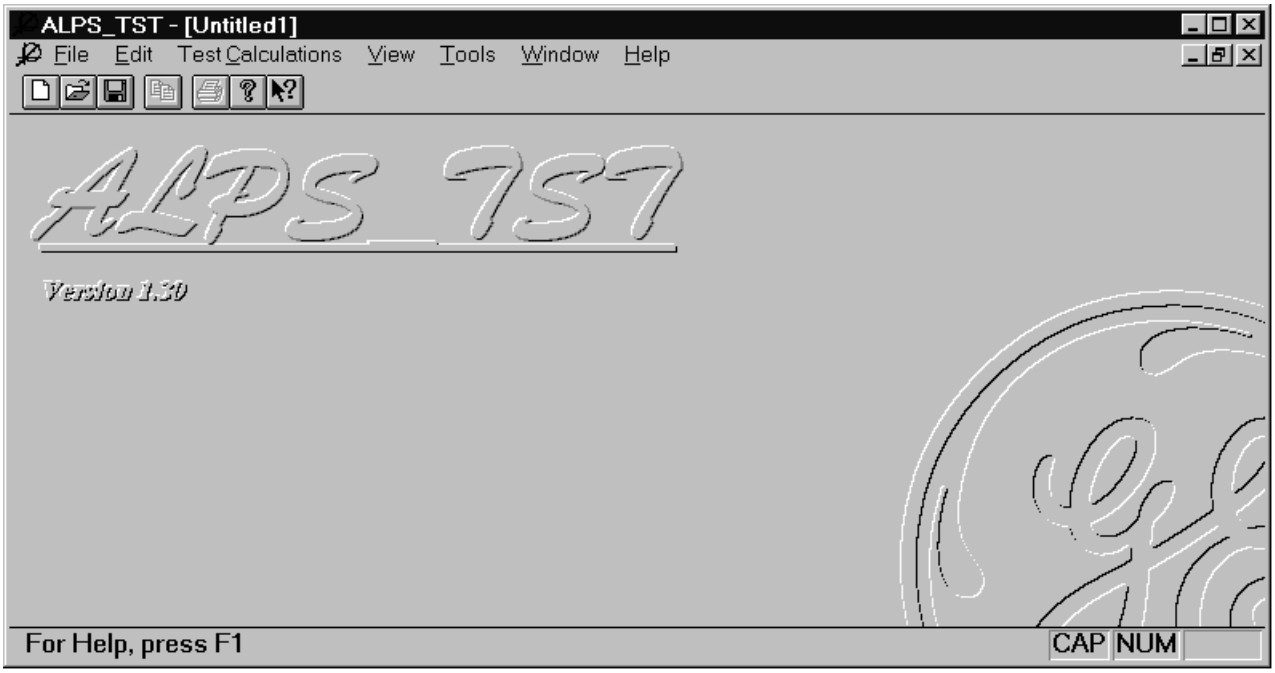


Figure 10–1: ALPS TEST INITIAL SCREEN

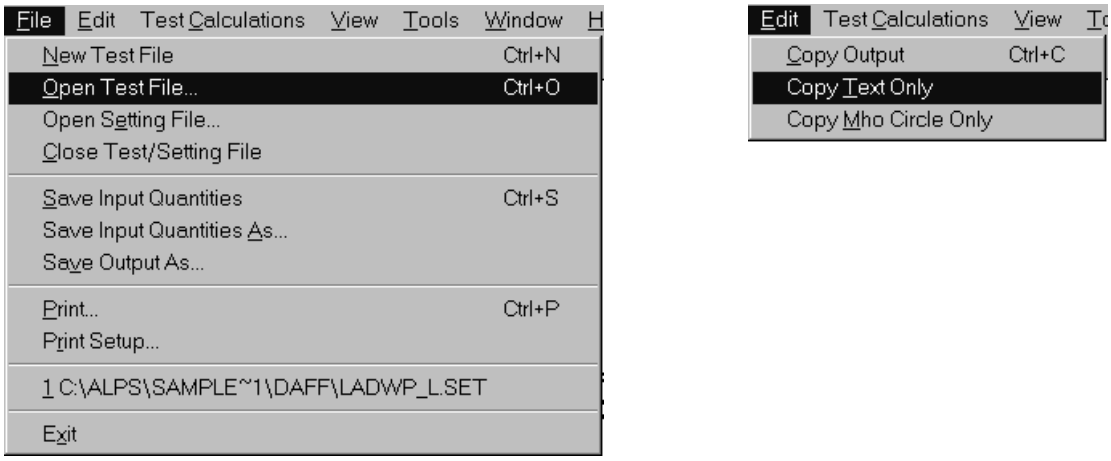


Figure 10–2: FILE AND EDIT MENUS

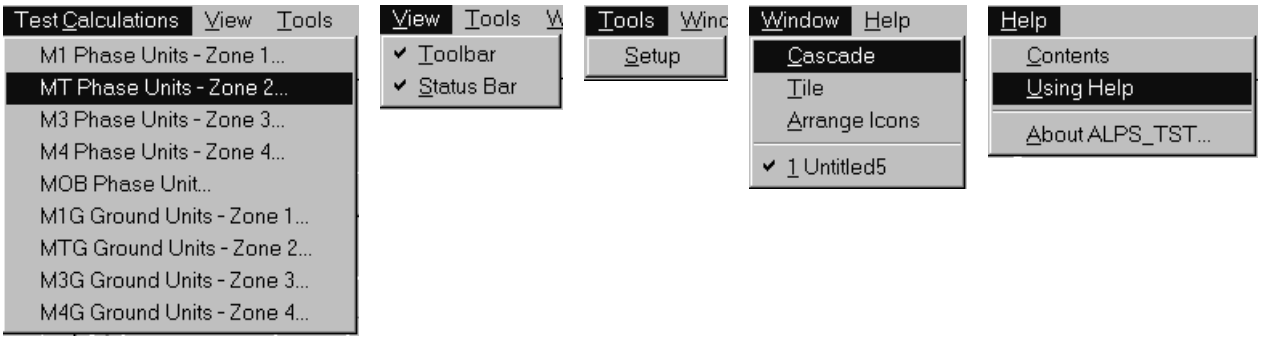


Figure 10–3: ADDITIONAL ALPS-TEST MENUS

10.1.3 STARTING PROGRAM AFTER THE FIRST TIME

Start the program as in the previous section. When the program is started, the opening screen is displayed as in Figure 10–1: ALPS TEST INITIAL SCREEN.

- The title bar of the main window has the currently opened file name which is the file name the user selected
- Pull down the **File** menu. The most recent file is this same file name.

10.2.1 DESCRIPTION

The following is the user input quantities and their ranges. Each test does not use all the quantities. The default values are used for only the first test dialog box displayed for each new test.

Table 10–1: INPUT QUANTITIES

INPUT QUANTITY	RANGE	DEFAULT VALUES
Rated current	1 or 5 A	1 A
Reach (reach in forward/reverse direction)	1 A: 0.01 to 250.00 5 A: 0.01 to 50.00	0.01
Positive Sequence Reach Angle	45° to 90°	45°
Characteristic Timer	M1: 90° MT: 90° to 120° in steps of 5° M3: 90° to 120° in steps of 5° M4: 90° to 120° in steps of 5° MOB: 30° to 130° M1G: 90° MTG: 80° to 155° in steps of 5° M3G: 80° to 155° in steps of 5° M4G: 80° to 155° in steps of 5°	90° for all
Test Current	calculated	high limit of range
Degrees to increment angle	5,10, 15	5
Phase angle reference	V[øG], V[øø]	V[øø]
Zero Sequence Reach Angle	45° to 90°	45
I0 Compensation Factor, K0	1.0 to 7.0	1.0
Direction	forward, reverse	reverse
Offset Reach (times main reach)	0 to 0.4	0
Replica Impedance Angle	Calculated for output only	N/A
Effective Test Reach	Calculated for output only	N/A

10.2.2 ENTERING INPUT QUANTITIES

When the user clicks on a **Select** button from a **TestCalculations** dialog box, the **Enter Value** dialog box is displayed. This dialog box has two modes, one is to enter a value for a continuous range of values and the other is to select a value from a list of values. Select the **Help** button from the **Enter Value** dialog box. A help screen is displayed describing how to use this dialog box.

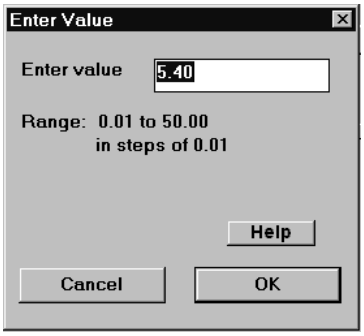


Figure 10–4: ENTER VALUE DIALOG BOX

10.2.3 ENTERING A VALUE

Click on a **Select** button from one of the test dialog boxes (**M1 Phase Units – Zone 1** is shown below) for an input quantity that has a continuous range.

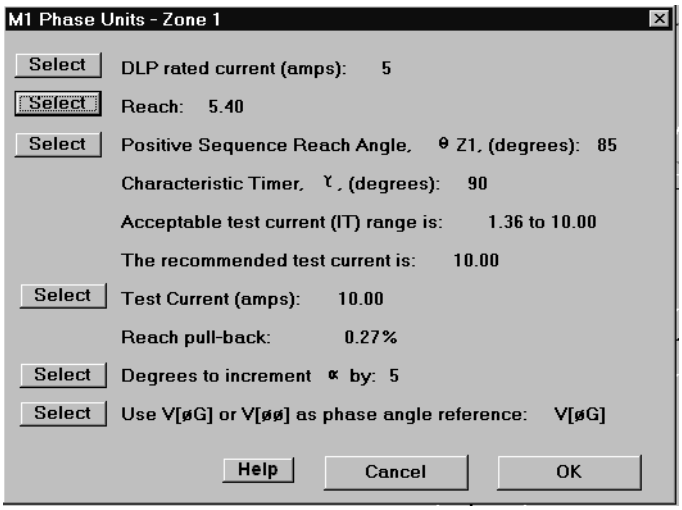


Figure 10–5: INPUT TEST DIALOG BOX: M1 PHASE UNITS – ZONE 1

Select **Test Current (amps)**, the display the **Enter Value** dialog box. Enter a valid new value and click **OK**. The dialog box clears from the screen and the value in the test dialog box is changed to the value just entered.

10.2.4 SELECTING A VALUE

Click on a **Select** button from one of the test dialog boxes (see above for example) for an input quantity that has a list of values. An **Enter Value** dialog box will appear. Select a new value and click on **Cancel**. The dialog box clears from the screen and the value in the test dialog box remains unchanged.

Select a new value and click on **OK**. The dialog box clears from the screen and the value in the test dialog box is changed to the value just entered.

10.2.5 M1 PHASE UNITS – ZONE 1

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

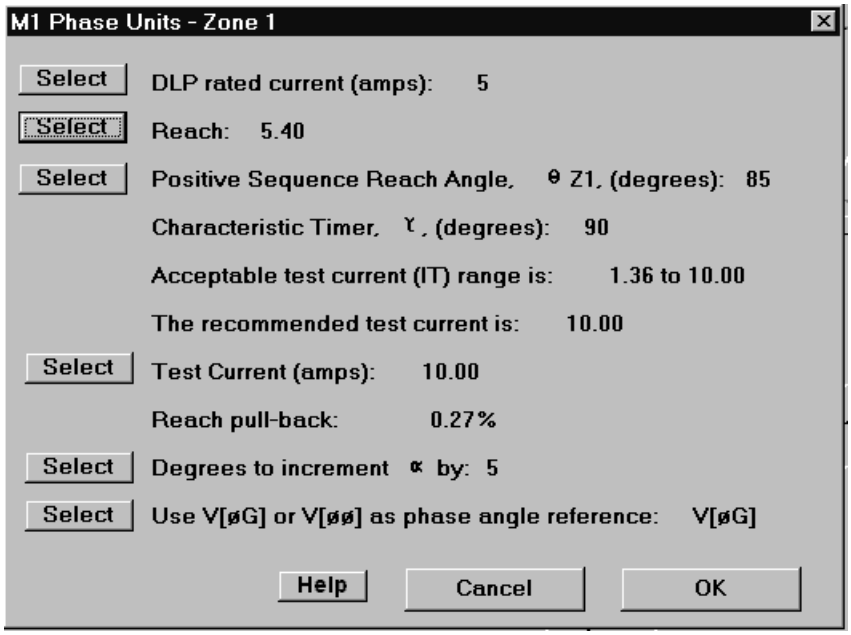


Figure 10–6: M1 PHASE UNITS – ZONE 1 DIALOG BOX

10.2.6 MT PHASE UNITS – ZONE 2

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

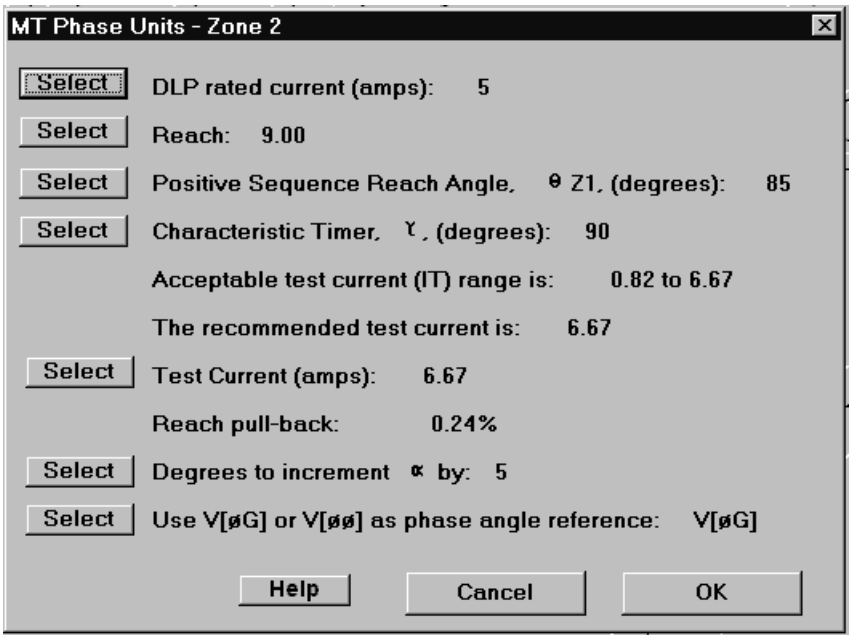


Figure 10–7: MT PHASE UNITS – ZONE 2 DIALOG BOX

10.2.7 M3 PHASE UNITS – ZONE 3

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

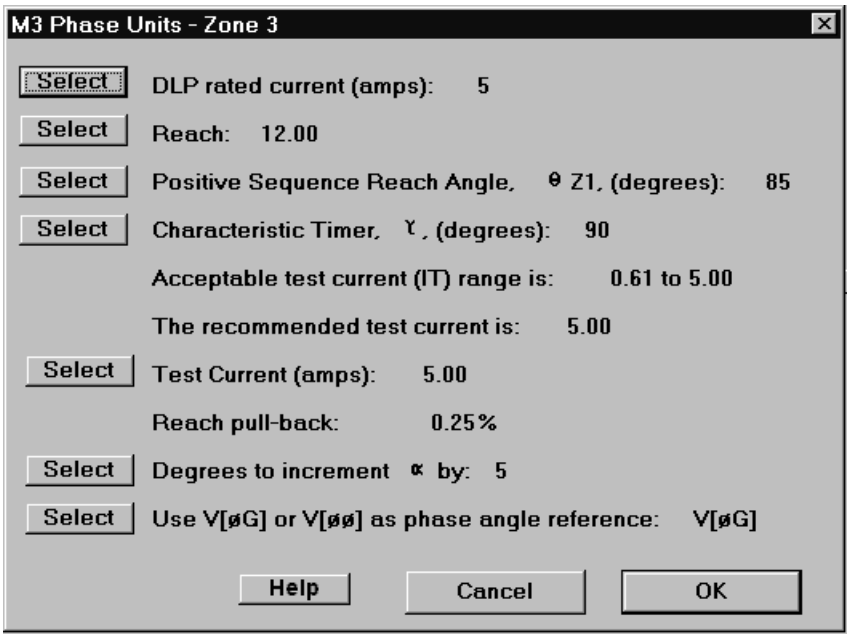


Figure 10–8: M3 PHASE UNITS – ZONE 3 DIALOG BOX

10.2.8 M4 PHASE UNITS – ZONE 4

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

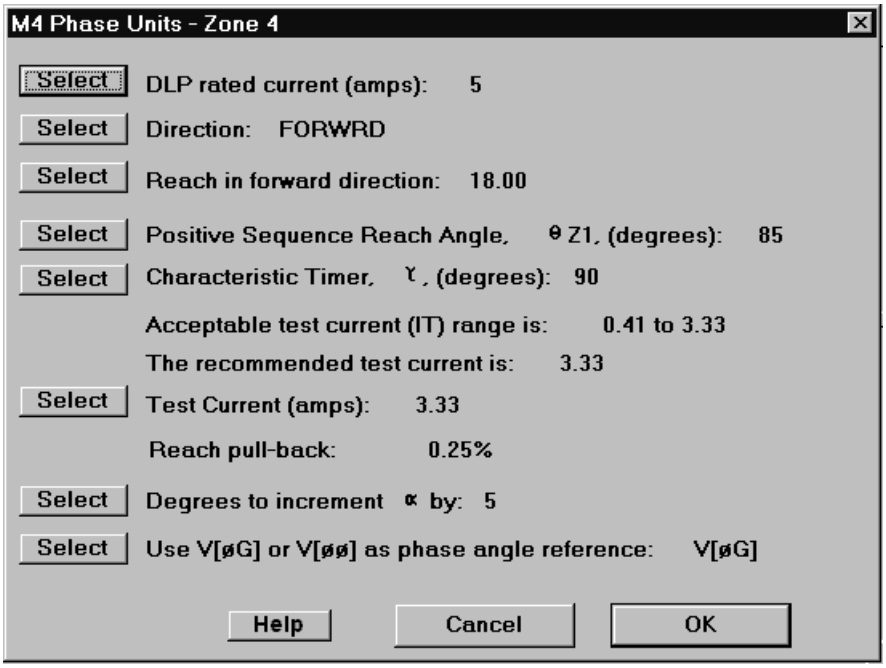


Figure 10–9: M4 PHASE UNITS – ZONE 4 DIALOG BOX

10.2.9 MOB PHASE UNIT

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

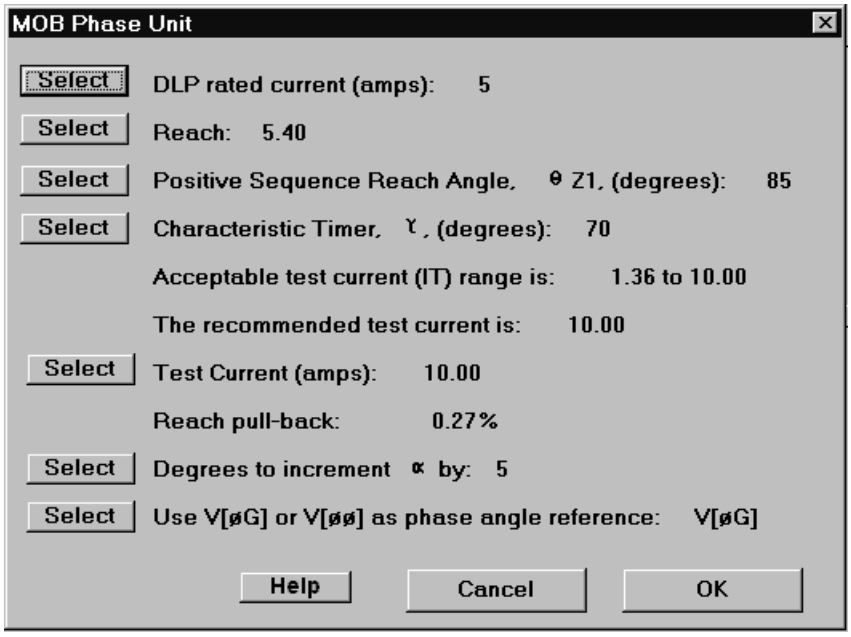


Figure 10–10: MOB PHASE UNIT DIALOG BOX

10.2.10 MIG GROUND UNITS – ZONE 1

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

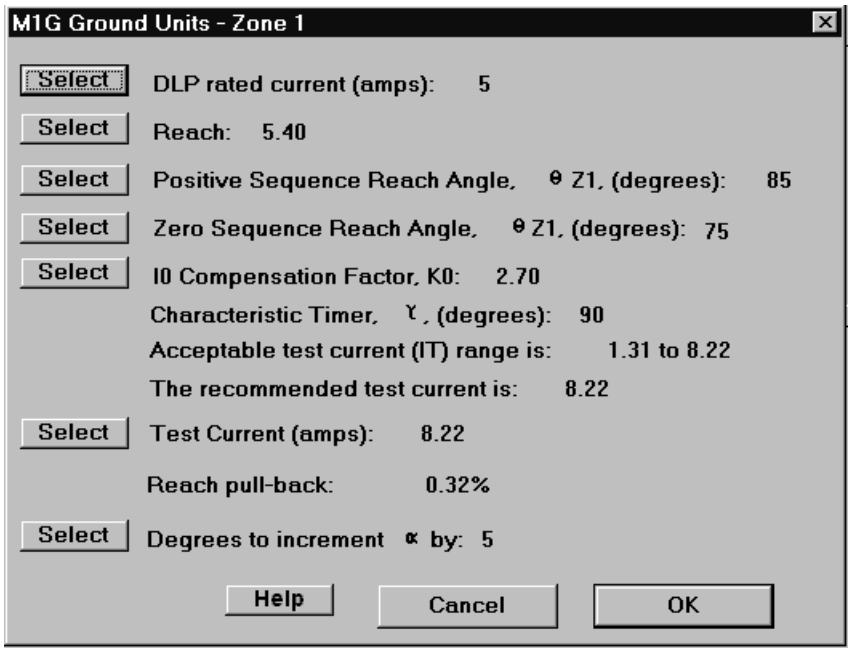


Figure 10–11: M1G GROUND UNITS – ZONE 2 DIALOG BOX

10.2.11 MTG GROUND UNITS – ZONE 2

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

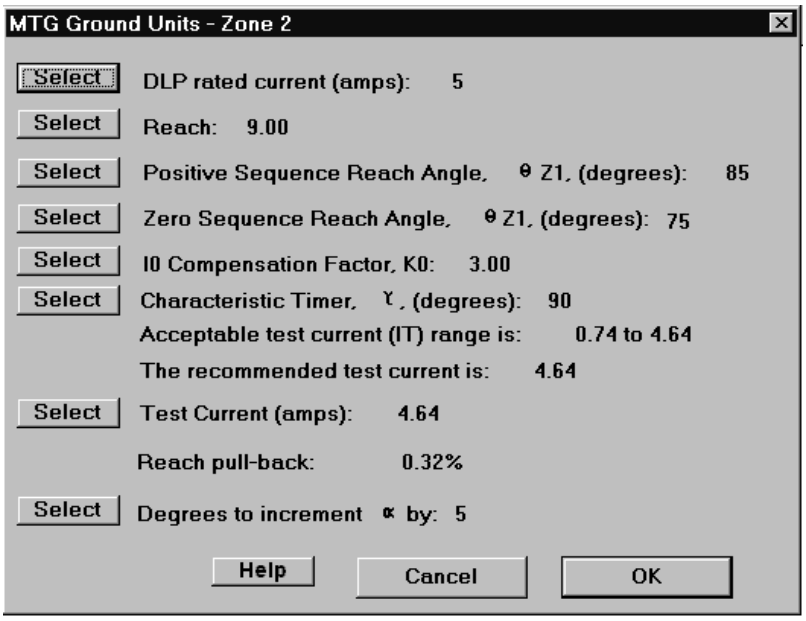


Figure 10–12: MTG GROUND UNITS – ZONE 2 DIALOG BOX

10.2.12 M3G GROUND UNITS – ZONE 3

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.

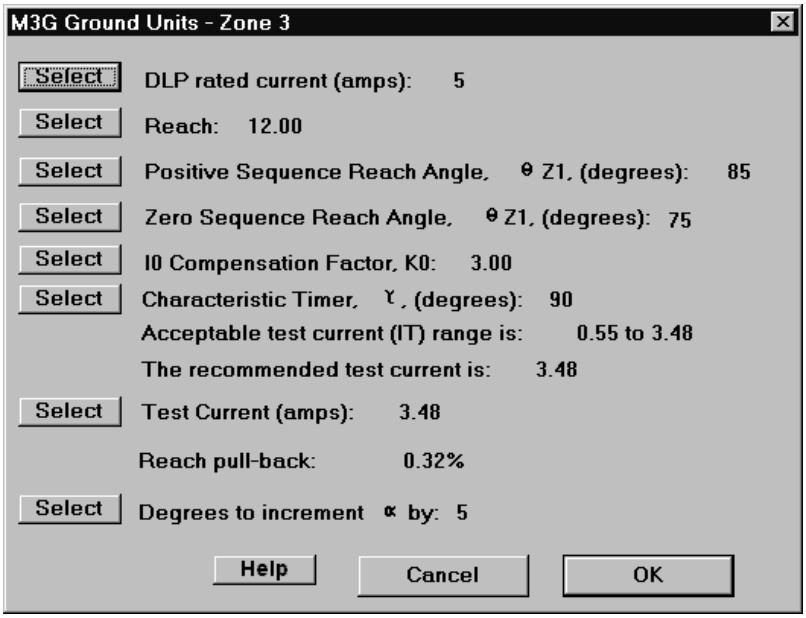
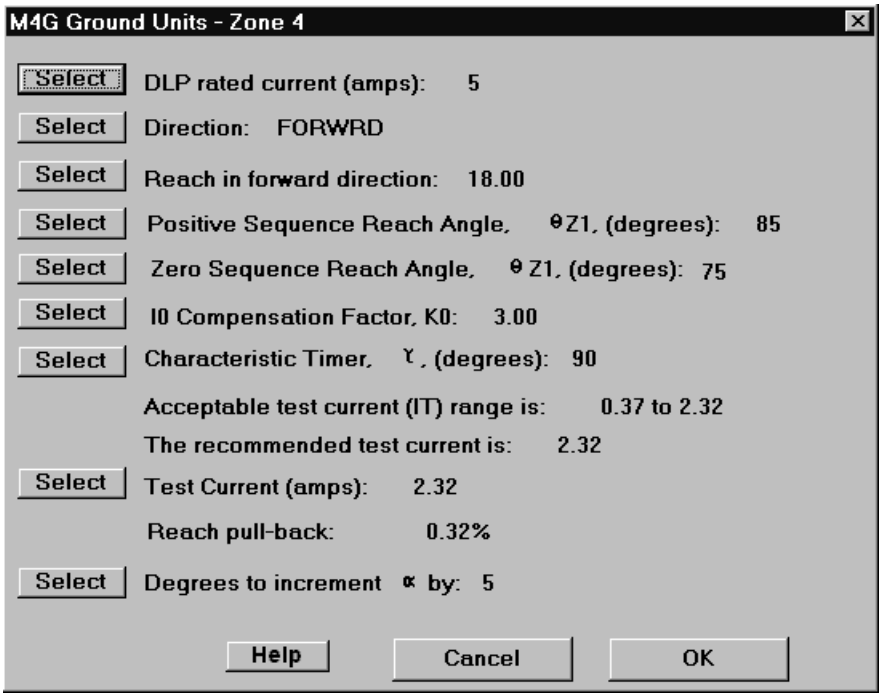


Figure 10–13: M3G GROUND UNITS – ZONE 3 DIALOG BOX

The following dialog box is displayed for this test. The values are the default values used when the user selects **New Test File** from the **File** menu.



Select **New Test File** from the **File** menu. This will create a new test which is indicated by the GE logo being displayed and the test name of **Untitledx** in the title bar. The **x** is a digit which indicates the number of new documents created.

10.3.1 NEW TEST FILE

The **File** menu is shown below:

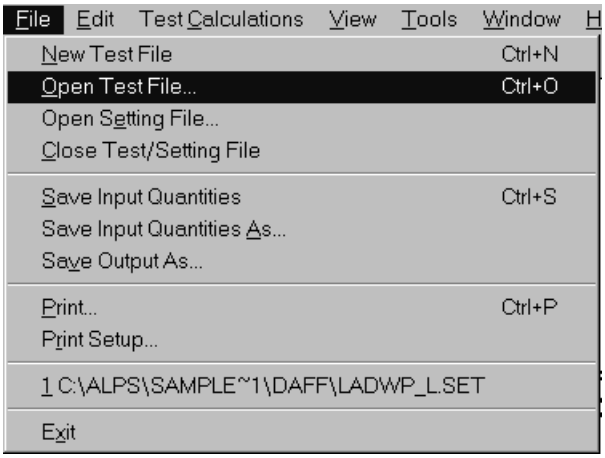


Figure 10–14: FILE MENU

Select **New Test File** from the **File** menu. This will create a new test which is indicated by the GE logo being displayed and the test name “Untitledx” in the title bar. The ‘x’ is a digit corresponding to the number of new documents created.

10.3.2 OPEN TEST FILE

This menu item results in a dialog box supplied by Microsoft. Therefore only the **OK** button of the dialog box is tested to make sure the file was properly opened.

Select **Open Test File** from the **File** menu. Select a file that is not a test file and not a setting file. A message box is displayed that explains the error. Verify that the currently active test has not changed from before the open command.

Edit an existing test file using a text editor. Add a line to the file. Select **Open Test File** from the **File** menu. Select the edited file. A message box is displayed that explains the error. Verify that the currently active test has not changed from before the open command.

Edit an existing test file using a text editor. Remove a line which contains a user entered value that is not a default value. Select **Open test File** from the **File** menu. Select the edited file. A message box is displayed explaining the error. Verify that the test file is still loaded and that the missing value has its default value.

Select **Open Test File** from the **File** menu. Select a test file containing no errors and click the **OK** button to open it. Select a test. Verify that the values in the dialog box are the same as those in the file (see the Save Input Quantities section).

The following is a list of protection setting numbers whose values are used by this test program.

102	**Z1PREACH**	Z1 Phase Reach
105	**Z1GRDREACH**	Z1 Ground Reach
108	**Z1GROUNDK0**	Z1 Ground K0
202	**Z2PHREACH**	Z2 Phase Reach
203	**Z2PCHARANG**	Z2 Phase Characteristic Angle
206	**Z2GRDREACH**	Z2 Ground Reach
207	**Z2GCHARANG**	Z2 Ground Characteristic Angle
302	**Z3PHREACH**	Z3 Phase Reach
303	**Z3PCHARANG**	Z3 Phase Characteristic Angle
305	**Z3GRDREACH**	Z3 Ground Reach
306	**Z3GCHARANG**	Z3 Ground Characteristic Angle
402	**Z4PHREACH**	Z4 Phase Reach
403	**Z4PCHARANG**	Z4 Phase Characteristic Angle
406	**Z4GRDREACH**	Z4 Ground Reach
407	**Z4GCHARANG**	Z4 Ground Characteristic Angle
408	**Z4DIRECTN**	Z4 Direction
1401	**POSSEQANG**	Pos. Seq. Impedance Angle
1402	**ZERSEQANG**	Zero Seq. Impedance Angle
1404	**ZEROSEQK0**	Z0 / Z1 ratio
1601	**MOBZONE**	Coordinating Zone
1602	**MOBCHARANG**	MOB Characteristic Angle

This menu item results in a dialog box supplied by Microsoft. Therefore only the **OK** button of the dialog box is tested to make sure the file was properly opened.

Select **Open Setting File** from the **File** menu. Select a file that is not a setting file and not a test file. Verify the following:

- A message box is displayed that explains the error.
- The currently active test has not changed from before the open command.

Select **Open Setting File** from the **File** menu. Select a setting file containing no errors and click the **OK** button to open it. Select each test.

Verify that the values in each dialog box which correspond to settings are the same as those in the setting file.

Edit an existing setting file using a text editor. Remove a setting line which contains a user entered value. Select **Open Setting File** from the **File** menu. Select the edited setting file. Select a test that uses the setting value that was deleted. Verify the following:

- No error message is displayed.
- The corresponding test value is the default value.

10.3.4 CLOSE TEST FILE

Save the currently active test file. Select **Close Test File** from the **File** menu. Window is cleared from the screen thus closing the test.

Modify the currently active test file. Select **Close Test File** from the **File** menu. A message box will be displayed asking if you want to save the file. Click the **OK** button. The file is saved under the current name. The window is cleared from the screen thus closing the test.

- Verify that the file contains the modified values by looking at the file with a text editor.

Modify the currently active test file. Select **Close Test File** from the **File** menu. A message box will be displayed asking if you want to save the file. Click the **Cancel** button. The file is not closed.

Verify the window is not cleared from the screen and that the test file contains the modified inputs.

Modify the currently active test file. Select **Close Test File** from the **File** menu. A message box will be displayed asking if you want to save the file. Click the **No** button. The file is not saved. The window is cleared from the screen thus closing the test.

- Verify that the file does not contain the modified values by looking at the file with a text editor.

Open a new test file. Select **Close Test File** from the **File** menu. A message box will be displayed asking if you want to save the file. Click the **OK** button. The **Save Input Quantities As** dialog box will be displayed. Enter a name for the test and select the **OK** button. The test is saved. The window is cleared from the screen thus closing the test.

- Verify that the file contains the values displayed in the test dialog boxes with a text editor.

10.3.5 SAVE INPUT QUANTITIES

Select a test where the input quantities have been changed and not saved. Select **Save Input Quantities** from the **File** menu. The test is saved.

Verify the file format:

- Read the file using any text editor. The saved file is in ASCII format.
- There is a line for each input quantity listed in Table 1 regardless of whether a particular input quantity was used for the test.
- Each line contains the value's ID number, the value, and a brief description of the quantity. Each item on the line is separated by spaces.
- There is one section for each test.

Verify file can be re-opened:

- Close the test file that was just saved.
- Open the saved test file.
- Select the menu item for the test.
- Verify that the quantities in the dialog box are the same as in the test just saved.

Create a new test. Select **Save Input Quantities** from the "**File**" menu. The **Save Input Quantities As** dialog box will be displayed. Enter a name for the test and select the **OK** button. The test is saved.

Verify the saved test as above.

10.3.6 SAVE INPUT QUANTITIES AS

This menu item results in a dialog box supplied by Microsoft. Therefore only the “OK” button of the dialog box is tested.

Select **Save Input Quantities As** from the **File** menu. Select a drive, path, and file name to save the input quantities of test.

Verify that this item worked by following the same procedure as for the **Save Input Quantities** menu item.

10.3.7 SAVE OUTPUT AS

This menu item results in a dialog box supplied by Microsoft. Therefore only the “OK” button of the dialog box is tested.

Select **Save Output As** from the **File** menu. Select a drive, path, and file name from the dialog box to save the test output. Click on **OK** and the file is saved.

10.3.8 PRINT

This menu item results in a dialog box supplied by Microsoft. Therefore only the **OK** button of the dialog box is tested.

Select **Print** from the **File** menu. This is a standard MS-Windows dialog box. It behaves however Microsoft and MS-Windows determines it should behave. There is one exception, both the **Selection** and **Pages** buttons are disabled. Click on **OK**. The output is printed as it appears on the screen.

10.3.9 PRINT SETUP

This menu item results in a dialog box supplied by Microsoft. It can be tested only to the extent that it does get displayed and that it behaves in the same manner as other similar dialog boxes in other programs.

Select **Print Setup** from the **File** menu. This is a standard MS-Windows dialog box. It behaves however Microsoft and Windows determines it should behave.

10.3.10 LAST 4 OPENED SETTINGS FILES

The last 4 opened settings files are displayed in the File menu, and may be selected here.

10.3.11 EXIT

Save all open test files (windows). Select **Exit** from the **File** menu. The program exits.

If you have not saved the current file, select **Exit** from the **File** menu. A message box is displayed asking if you want to save the modified test. Click on **OK**. The program saves the file and exits.

10.4.1 COPY

The **Edit** menu is shown below.

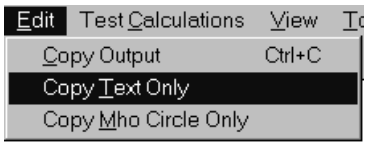


Figure 10–15: EDIT MENU

Select a test, set the input quantities to the desired values, and click the **OK** button.

Select **Copy** from the **Edit** menu.

10.4.2 COPY TEXT ONLY

Select a test, set the input quantities to the desired values, and click the "**OK**" button.

Select **Copy Text Only** from the **Edit** menu.

10.4.3 COPY MHO CIRCLE ONLY

Select a test, set the input quantities to the desired values, and click the **OK** button.

Select **Copy Mho Circle Only** from the **Edit** menu.

To use the output that is on the clipboard:

- Start Windows Application.
- Select **Paste Special** from the **Edit** menu. There is one item on the clipboard, a bitmap.
- Select the bitmap and paste into the current document.

10.5.1 DESCRIPTION

These menu items are supplied and manipulated by Microsoft. Therefore the testing will be brief as these items behave however Microsoft and the Windows operating system determines they should behave. The one exception is the items on the toolbar.

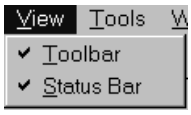


Figure 10–16: VIEW MENU

10.5.2 TOOLBAR

The items on the toolbar (shown below) are, from left to right:

Figure 10–17: ALPS TEST TOOLBAR

- Create a new test file.
- Open an existing test file.
- Save the current test file.
- Copy the current test output to the clipboard
- Print the current test output.
- Display the “About” dialog box.
- Context Help command.

Select the **View > Toolbar** menu item. The toolbar is removed from the display.

Select the **View > Toolbar** menu item again. The toolbar is displayed.

10.5.3 STATUS BAR

Verify the items on the status bar (shown below):

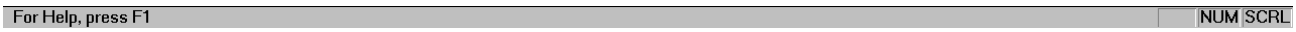


Figure 10–18: ALPS TEST STATUS BAR

- The left portion displays a short description of each menu item.
- The right most area displays **SCRL** if the scroll lock key has been selected and displays nothing if the scroll lock key has been de-selected.
- The area to the left of the scroll lock area displays **CAP** if the caps lock key has been selected and displays nothing if the caps lock key has been de-selected.
- The area to the left of the caps lock area displays **NUM** if the num lock key has been selected and displays nothing if the num lock key has been de-selected.

Select the **Status Bar** menu item. The status bar is removed from the display.

Select the **Status Bar** menu item again. The status bar is displayed.

There is one menu item **Setup**. Click on **Setup** and the following dialog box is displayed.

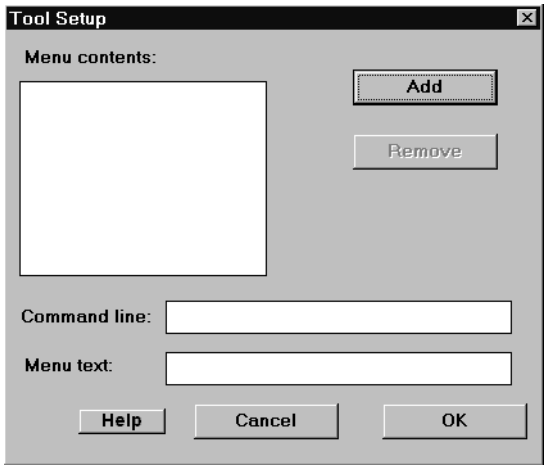


Figure 10–19: TOOL SETUP DIALOG BOX

The **Remove** button and the **Command line** and **Menu text** boxes are disabled, and that the focus is set to the **Add** button.

Type the **Enter** key or click on the **Add** button. The **Add Tool** dialog box is displayed. This is a standard MS-Windows dialog box. Select an executable windows program and click on the **OK** button.

- The full path and name is in the **Command line** text box
- The program name less the extension is in the **Menu text** box
- The program name less the extension is the **Menu contents** list box
- The **Remove** button is enabled
- The focus is set to the **Menu** text box.

Change the text in the **Menu** text box to text suitable for the tools menu. Click anywhere in the **Command line** text box.

- Verify that the new menu name is displayed in the **Menu contents** list box.

Change the command line so that it is invalid (for example, remove a character from the program name). Click on the **OK** button. Pull down the **Tools** menu.

Verify the following:

- There is one tool followed by a separator bar and the **Setup** menu item.
- The tool's name is correct.

Click on the tool.

- Verify that an error message is displayed indicating that the program couldn't be started.

Select the **Setup** menu item again.

- The focus is set to the first item in the **Menu contents** list box.
- The menu text is in the **Menu text** box.
- The **Command line** text box has the invalid path name.

Change the path name to the correct path. Click on the **OK** button. Pull down the **Tools** menu and click on the tool.

- Verify that the program started.

Select the **Setup** menu item again. Add a second tool.

- Verify that the tool gets added after the first tool.

Click on the **OK** button. Pull down the **Tools** menu.

Verify the following:

- There are two tools and they are in the correct order.
- The two tools are followed by a separator bar and the **Setup** menu item.

Select the **Setup** menu item again. Leave the first item in the **Menu contents** list box selected. Add a third tool.

Verify that the tool gets added after the first tool and before the second tool.

Click on the **OK** button. Pull down the **Tools** menu.

- There are three tools and they are in the correct order.
- The three tools are followed by a separator bar and the **Setup** menu item.

To Remove a tool, select the **Setup** menu item again. Select the second item in the **Menu contents** list box. Click on the **Remove** button.

- Verify that the selected item gets removed from the **Menu contents** list box and that the item immediately below the one removed is selected.

Click on the **OK** button. Pull down the **Tools** menu.

- Verify that there are two tools and they are in the correct order.
- The two tools are followed by a separator bar and the **Setup** menu item.

10.7.1 DESCRIPTION

These menu items are supplied and manipulated by Microsoft. Therefore the testing will be brief as these items behave however Microsoft and the Windows operating system determines they should behave.

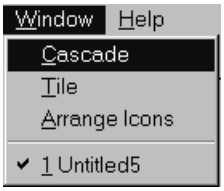


Figure 10–20: WINDOW MENU

10.7.2 CASCADE

Have more that one test file active in the program. Select the **Cascade** menu item. The windows are displayed in a cascaded style.

10.7.3 TILE

Have more that one test file active in the program. Select the **Tile** menu item. The windows are displayed in a tiled style.

10.7.4 ARRANGE ICONS

Select a test and click on its icon button (upper right corner of window). The window is reduced to an icon with its test name under it. Perform this action on several tests.

Move the icons around on the screen.

Select the **Arrange Icons** menu item. The icons are rearranged across the bottom of the screen.

10.7.5 VIEWING MULTIPLE TESTS

When more than one test file active in the program. Pull down the **Window** menu. The menu shows all the active test windows.

10.8.1 CONTENTS

The **Help** menu is shown below.

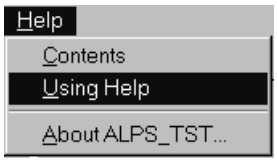


Figure 10–21: HELP MENU

Select **Contents** from the **Help** menu. A help screen is displayed that lists the contents of the help system. Any item that is green can be clicked on to view that topic.

10.8.2 ABOUT ALPS_TST

Select **About ALPS_TST** from the **Help** menu. The following dialog box is displayed:

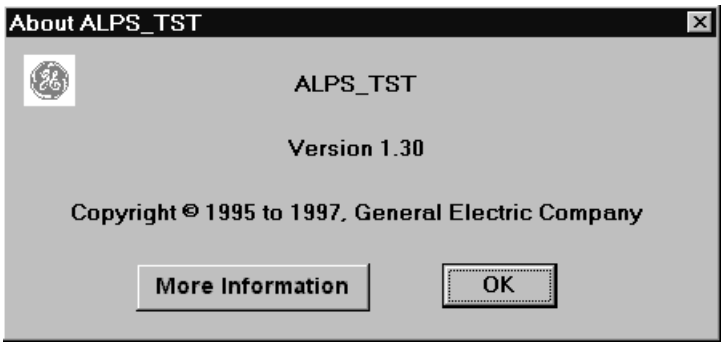


Figure 10–22: ABOUT ALPS_TST DIALOG BOX

Click on the **More Information** button. Information about who to contact is displayed.

Click on **OK**. The dialog box is cleared from the screen.

11.1.1 DESCRIPTION

The Advanced Line Protection System Link (ALPS-Link) User's Guide contains detailed information about using ALPS-Link.

The ALPS-Link software facilitates various operations with the data from the relay formatted for easy viewing. The link software has the capability of opening a dialog session for a remote device through a dial-up modem or directly over a serial link. The software uses the GEModem communications protocol to operate the relay remotely. All the operations performed on a device will be initiated by a user command. The responses from the relay will be formatted for easy viewing.

11.1.2 WHAT'S INCLUDED IN YOUR ALPS-LINK USER GUIDE

This guide is organized as a comprehensive reference. In addition to the information needed to help you use the ALPS-Link to interact with the relay, this manual also includes some basic information for those users with little experience of working with Windows applications

11.1.3 USING ON-LINE HELP

ALPS-Link software comes with on-line help for quick reference. It includes step-by-step procedures that you can follow as you work. You can view the ALPS-Link Contents window by choosing Contents from the Help menu. From this window, you can jump to more specific information. You can also press the F1 key on the keyboard to get the Help contents. Help information on any dialog box could be obtained by clicking the Help button in that dialog box.

11.2.1 DESCRIPTION

This section describes the required system hardware and software needed for installing ALPS-Link software on your machine.

11.2.2 SUPPORTED ARCHITECTURE

The minimum system configuration required to run ALPS-Link software is:

Personal Computer (PC) with an Intel 80386 or better processor with:

- 8 MB RAM
- minimum 200 MB of free Hard Disk space
- 3.5”, 1.44 MB Floppy Disk drive (or CD-ROM if using GE Products CD)
- VGA / EGA or better display card and monitor
- PC/AT keyboard
- One or more RS-232 serial ports
- One parallel port for printer
- Mouse
- Any printer supported by Microsoft Windows
- Windows 95, Windows 98, Windows NT, Windows 3.1

The LPS-D relays can be connected to the host machine directly or through a dial-up modem. The LPS-D may be connected directly to the hosts RS232 port; for connection via the LPS-D RS485 port, an RS485/RS232 converter is required. If you wish to connect to your LPS-D over a dial-up modem, the relays should be connected as follows:

- Each device must have its own modem.
- A Code Operated Switch (COS) is attached to the modem and a number of devices are connected to the multiplexor. If a device is on an RS485 line, a converter can be used between the device and the COS.

The printer is connected to the parallel port of the PC.

11.2.3 HARDWARE INSTALLATION

Before proceeding verify that your computer is working well and meets the requirements above.

Connect the printer to the parallel port of the PC. You may have to choose an appropriate printer driver using the Windows Print Manager. For more details refer to the printer’s installation manual.

It is assumed that the relay is installed and configured according to the Interface section of this instruction book.

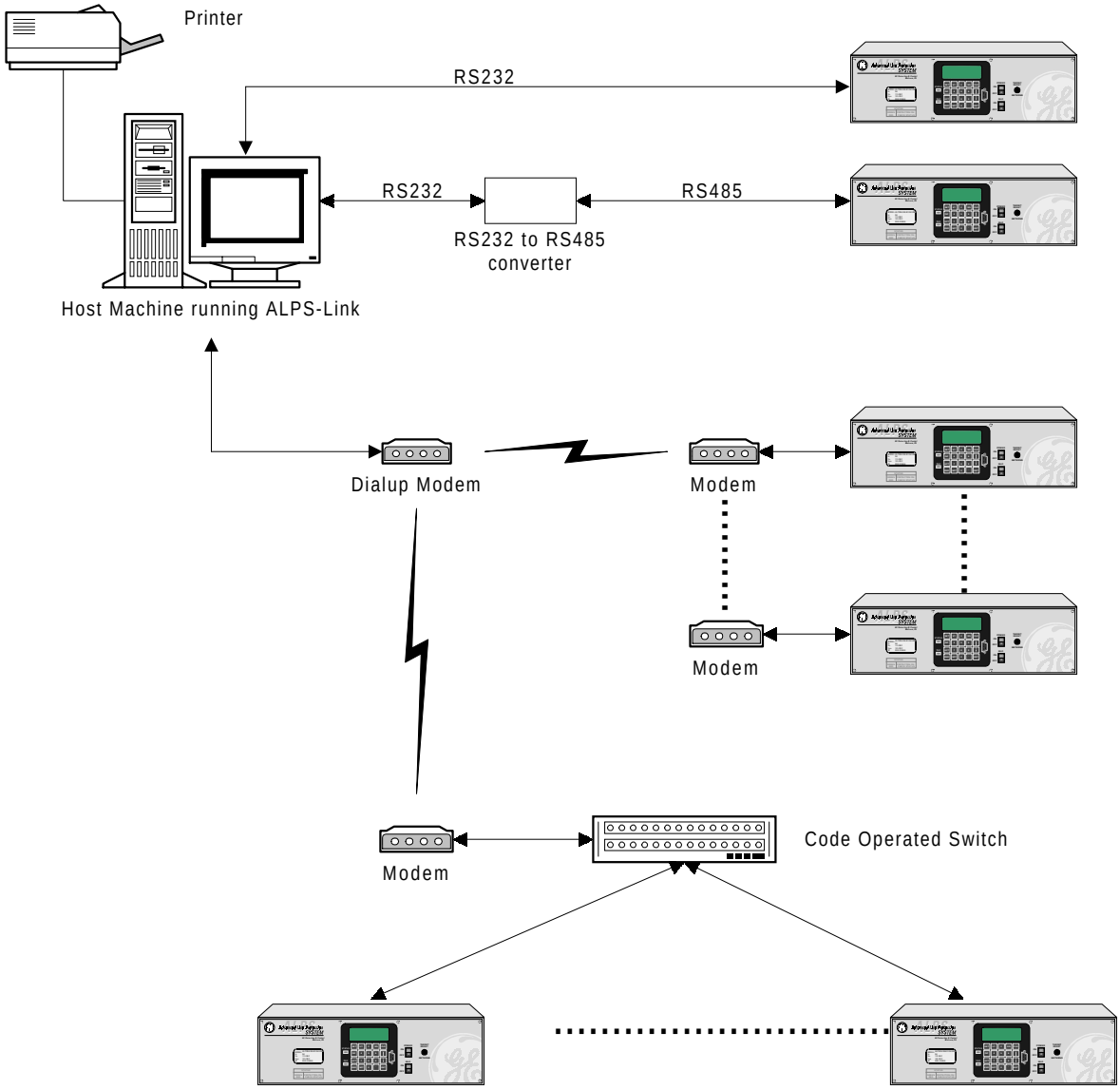


Figure 11–1: SUPPORTED ARCHITECTURE

11.2.4 SOFTWARE INSTALLATION

Installation of ALPS-Link and its accompanying software packages (ALPS-Set, Xpression Builder, and ALPS-Test) is accomplished as follows.

1. Ensure that Microsoft Windows® is running on the local PC.
2. Insert the GE Power Management CD into your CD-ROM drive or direct your web browser to the GE Power Management website at www.GEindustrial.com/pm. The Products CD is essentially a "snap-shot" of the GE Power Management website at the date indicated on the CD and should launch automatically in your default web browser (if not, it may be opened manually). As such, the procedures for installation from the CD and the Web are identical. To ensure the most recent software, installation from the Web is recommended.

Figure 11–2: GE POWER MANAGEMENT WELCOME SCREEN

3. Click the **Index by Product Name** menu item from the GE Power Management main page and then select **LPS Line Protection System** from the product list to open the LPS-D product page.
4. Select the Software item from the Product Resouces List to proceed to the LPS-D software page.
5. The latest version of the ALPS-Link software suite will be shown along with some support materials. Click on the ALPS/LPS PC Software menu item and download the installation package to your local PC. Run the downloaded installation program.

6. The following dialog box is displayed:

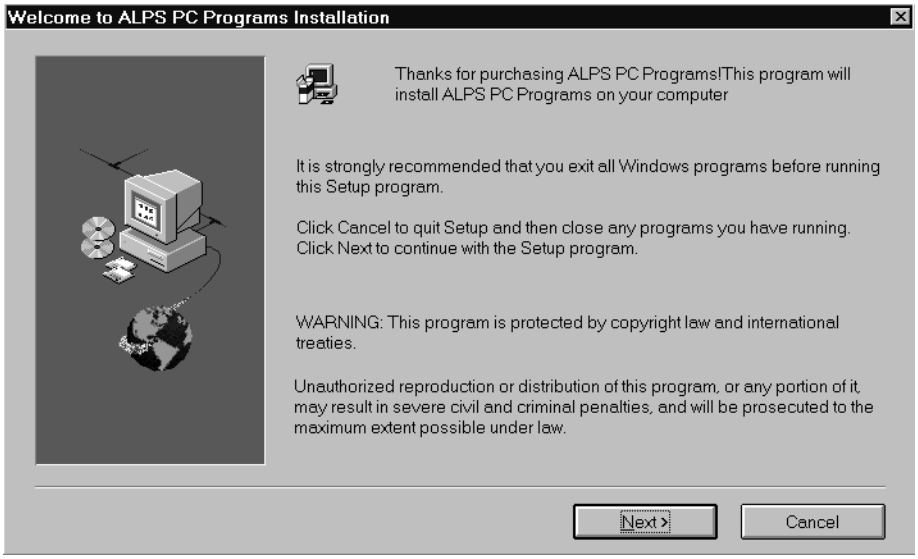


Figure 11–3: LPS SOFTWARE INSTALLATION WELCOME SCREEN

7. Click **Next** button to begin the installation.
8. The Software License dialog box will appear. Carefully read the Software license agreement. Click **Yes** if you agree with the terms of license; clicking **No** terminates the Setup program.
9. Setup will prompt for a directory to install the LPS-D software. Click **Browse** to choose an appropriate directory or **Next** to accept the default directory C:\GEPM\LPS.
10. The Setup Options dialog box will appear. Choose between **Complete**, **Custom**, or **Typical** installation. **Typical** is recommended.
11. Setup will then prompt for a Program Folder for the LPS-D software. Enter a folder or choose the default LPS PC Programs and click **Next**.
12. ALPS-Link Setup will now install the software and prompt for an appropriate directory for the Xpression Builder software. It is highly recommended to install Xpression Builder now. Choose an appropriate directory (e.g. C:\GEPM\XPRESS) and click **Next**.
13. The Installation Complete dialog box will appear. Check **Yes, I want to view the ReadMe file** to view the latest software information and click **Finish**. The software is now installed.

Once the ALPS-Link software is installed, set-up must be chosen from the Device menu to set-up to communicate to the relay.

NOTE

ALPS-Link may have difficulty operating with some Windows applications running. Therefore, it is recommended that any other runnng programs are terminated before starting ALPS-Link as they might affect its performance and that of related applications.

11.3.1 STARTUP

This sub-section describes the Startup procedure and explains the main screen details.

After a successful installation of ALPS-Link, the group window appears on the screen. This window consists of the ALPS-Link icon and the Help icon. Choose the ALPS-Link icon to start the ALPS-Link.

The ALPS-Link application starts and the ALPS-Link application window appears. The main window has a title bar with ALPS-Link, a menu bar, a tool bar and a status bar.

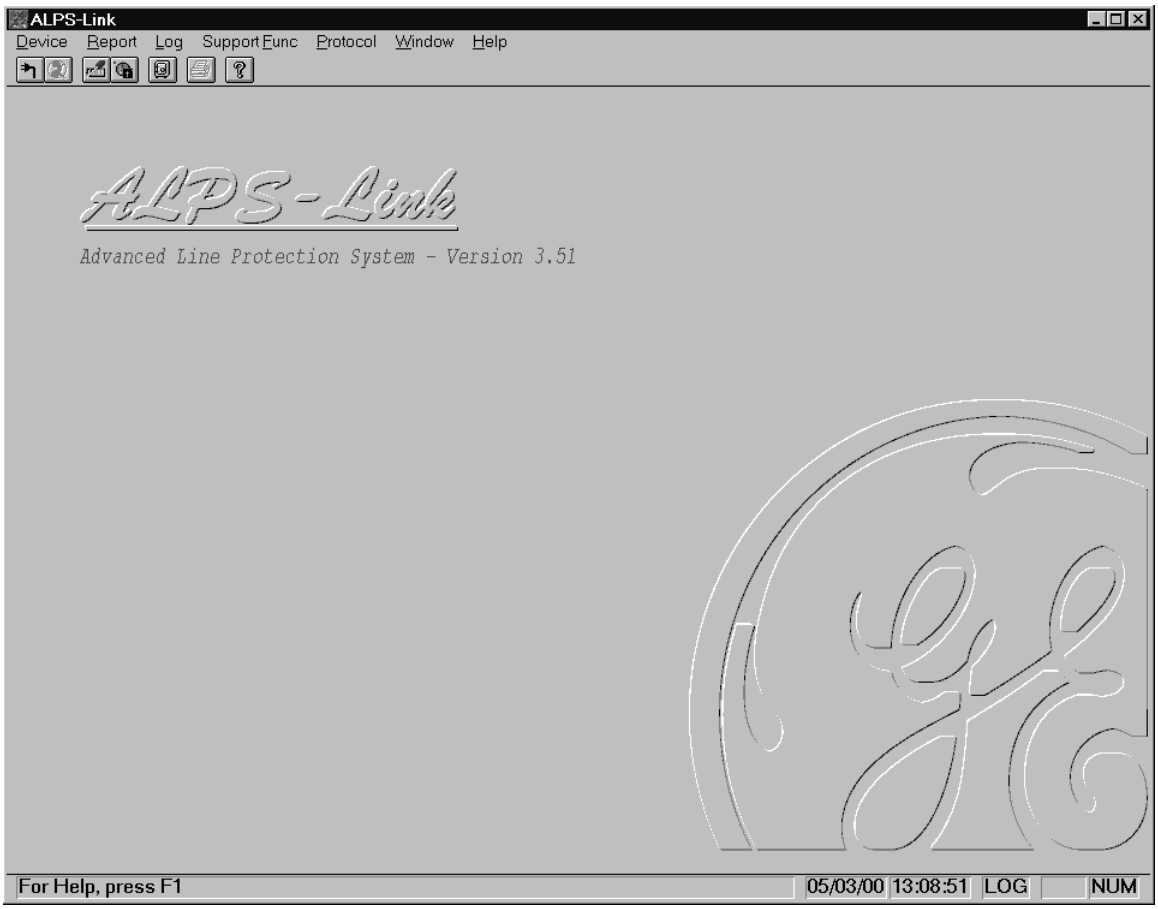


Figure 11–4: ALPS-LINK APPLICATION WINDOW

11.3.2 MENU BAR

The items in the ALPS-Link application window menu bar are: **Device**, **Report**, **Log**, **Support Func**, **Protocol**, **Window** and **Help**. The items in each menu change when a device is connected. For example, Log will not have the current item now but will display it when the device is connected.

11.3.3 TOOLBAR

Figure 11–5: ALPS-LINK TOOLBAR

The tool bar consists of icons which help choose some of the ALPS-Link activities quickly. The active icons at this time in the tool bar are, from left to right, **Connect**, **Hang-up** (if a telephone line is used), **Device Setup**, **Local Settings**, **archive**, **printer**, **Help** and **Context Sensitive Help**.

11.3.4 STATUS BAR

The status bar is divided in six parts. It is the bottom most row in the picture as shown in the ALPS-Link application window. Starting from the left, part one displays the information regarding any command selected, part two and three display the date and time respectively, part four indicates if Log is on or off, part five and six indicate the Caps Lock and Num Lock respectively.

Figure 11–6: ALPS-LINK STATUS BAR

11.4.1 DESCRIPTION

This is the preparation of the ALPS-Link software and the host machine for a trouble free and satisfactory operation with the LPS-D devices. Certain parameters of the serial (COM) port to which you wish to connect the device, the modem used for communication and the printer connected to the host machine are to be configured for ALPS-Link. ALPS-Link provides all the necessary user interface to set these parameters.

Keep the User's manuals for the serial port of your host machine, the modem and the printer handy for a quick reference.

11.4.2 COM PORT SETUP

For any operation with the LPS-D device, it is essential that the PC and the device have a physical link established between them. This physical link could be an RS232 line or an RS485 line. If required, dial-up modems can be used for this connection. On the host side, this can be connected to any of the serial (COM) ports of the host machine. To setup the serial (COM) port choose the **Support Functions > Host setup** menu item.

A pop up menu with **Ports**/**Modem**/**Printer** will be displayed. Choose the **Ports** item. The **Port Setup** dialog box will appear.

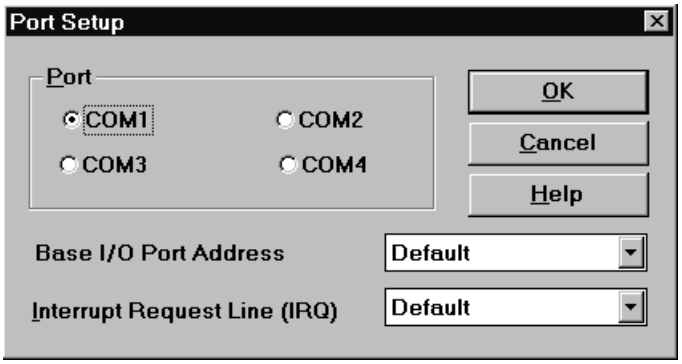


Figure 11–7: PORT SETUP DIALOG BOX

Change the **Base I/O Port Address** only if the device connected to your serial is not COM1 or COM2. Open the list to select an address.

Before assigning IRQ numbers to serial ports, determine which interrupts are used by the devices connected to the serial ports and which ones are not being used by other cards or boards installed in your computer. You may need to adjust your serial card to use available interrupts. For information, see your serial card documentation.

If you change the parameters of any port in this dialog box, these changes take effect only when you restart Windows. Choose the **OK** button to proceed with the selection or Cancel to quit without updating the selection.

When the device is connected to ALPS-Link through a dial-up modem, it is essential that ALPS-Link is supplied with information about the modem characteristics. This can be done using the Modem setup.

To setup the Modem, choose the **Support Functions > Host Setup** menu item. A pop up menu r will be displayed. Choose the **Modem** item from this menu. The **Modem Setup** dialog box will appear.

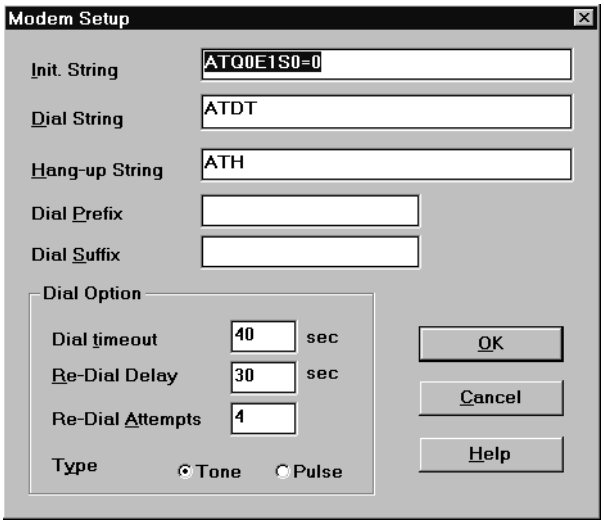


Figure 11–8: MODEM SETUP DIALOG BOX

The **Init. String**, **Dial String** and the **Hang-up String** text boxes are all modem dependent. Refer to your modem manual for the suitable strings. Up to 40 characters are accepted for each of these fields.

If any number or string is to be dialed or sent on the port before dialing the phone number, specify it as the **Dial Prefix**. Similarly any strings to be appended at the end of the phone number are to be entered in the **Dial Suffix** field. These are modem independent and can be left blank if not needed.

The amount of time for which the system has to wait before deciding the non-availability of the telephone line is the **Dial timeout**. A maximum of 99 seconds can be specified here. The host will re-dial if the maximum number of valid re-dials are not yet completed.

The **Re-dial Delay** is in addition to the timeout delay. This is the amount of time the host machine waits before a re-dial. A maximum of 99 seconds can be specified here.

Specify the number of **Re-dial Attempts** the host machine has to do before declaring the dialing operation a failure. A maximum of 9 re-dials can be specified.

Any modifications done in the modem setup actually take effect the next time you make a connection request with a device.

11.4.4 PRINTER SETUP

The hard copies for reports, logs and settings are made through the printer connected to the host machine. The host machine need to be configured with the printer setup.

The Printer setup is performed from the **SupportFunc** menu. Choose the **Host Setup** item from the **Support Func** pull down menu in the menu bar. From the pop-up menu choose the **Printer** item.

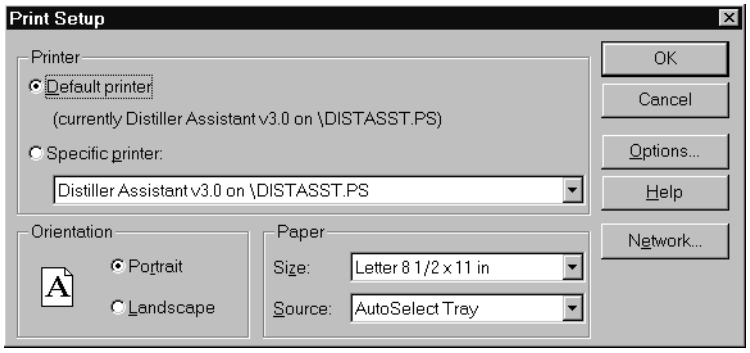


Figure 11–9: PRINTER SETUP DIALOG BOX

Select the printer you want to use. You can select the **Default Printer** by clicking that radio button or choose the **Specific Printer** option by clicking on that radio button and select one of the current installed printers shown in the box. Click on the **Options** button to get additional choices about printing, specific to the type of printer you have selected.

11.4.5 DEVICE SETUP

More than one LPS-D device could be connected to the host machine on the physical link. But, at any given time, ALPS-Link can communicate with a single device. It is possible that each of these devices are configured with various communication parameters: for example, telephone number, baud rate, etc. ALPS-Link should be setup with these details so that it can make proper connections with the devices. The Device Setup facilitates updating ALPS-Link with this information. If you need to add a device or modify the existing communication parameters of a device, Device Setup provides you the necessary interface.

11.4.6 ADDING A DEVICE

You can introduce a new device to ALPS-Link system or modify the setup of an existing device using the device setup feature.

1. Choose the **Device > Device Setup** menu item. A **Device Directory** dialog box shows the list of the devices already known to ALPS-Link. Click on the scroll button of the device name field to see this list.
2. To add a new device click on **Add**. The **Device Setup** dialog box appears with the default parameters.
3. Click in the **Device Name** text box and enter the name for the relay. Do the same for the **Unit ID** text box.
4. From the **Baud rate** list, select the communication speed that matches the relay Name (Device Name).
5. Specify the number of **Data Bits**, **Stop Bits** and the **Parity** in the specified fields for communication with this device.
6. The **Break Signal** is needed for communication with certain Code Operated Switches (COS) used on the other side of the communication line. Click this if the COS you are using needs this.
7. **Duration of Break** refers to the time gap required to specify a certain message is for the COS. This may be needed with or without the break signal.

8. The **Phone No**. text box is the phone number the host machine must dial to get connected to this device. A maximum of 60 characters can be entered in this field.

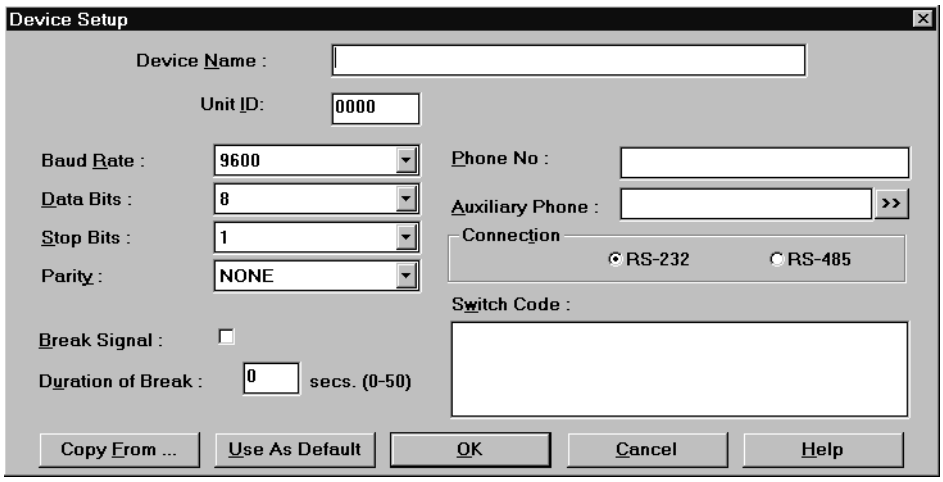


Figure 11–10: DEVICE SETUP DIALOG BOX

9. The **Auxiliary Phone** number specified is dialed before dialing the actual phone number. The Browse button (**>>**) will display a dialog box with a list of the existing auxiliary phone numbers. In this dialog box, you can add, delete and modify auxiliary phone numbers. For **Modify** and **Delete**, first select a number from the list and then choose the appropriate button. When you select **Add** and **Modify**, a dialog box appears with fields for the number and description. If no auxiliary phone number is necessary, leave this field blank.

   A maximum of 60 characters can be entered in each of these fields.

10. In the Device Setup dialog box, click on one of the radio buttons to indicate the mode of communication as the RS-232 or **RS-485**.

11. The **Switch Code** text box is a string of characters sent to the code operated switch. It accepts a maximum of six characters in Hexadecimal format.

12. These parameters take effect from the next time you make a connect request to the device specified. Choose the **OK** button to save these parameters for the specified device. Alternatively, choose the **Cancel** button to quit the dialog box without updating the device setup.

    Clicking on **Use As Default** button will save the parameters for the device and also makes them as the default values. By selecting the most common device parameters as default will simplify the addition of a device to the system. So, next time you want to add a device, the device setup dialog box appears with these default parameters.

If you want to setup a new device by copying information from an existing device setup to a new one, you can use the **Copy From** option. Choose this button to display a list box with the existing devices. Select a device and choose the **OK** button to proceed. All the device setup parameters of that device are displayed under the device currently being edited. If any modifications are required, you can do them. You can save the new device with these parameters or **Cancel** to quit without saving.

To modify the parameters for an already existing device, select the device from the Device Directory dialog box and choose the **Modify** button. The device setup dialog box appears with all the parameters of that device. Do the necessary modifications and save or quit.

To delete a device from the system, select the device from the **Device Directory** dialog box and choose the **Delete** button. A message box requesting the confirmation for the deletion appears. Choose the **Yes** button to proceed with the deletion. Choose the **No** button to quit deleting the device from the list.

11.5.1 DESCRIPTION

Once the host setup and device setup is completed, operations with the device may be performed. To start with, a connection has to be established with a device to perform any kind of operation on that device. Select the device you want to connect to from the user interface provided and ALPS-Link will provide the connection for you, taking care of all the parameters like the phone number, speed of communication etc.

11.5.2 CONNECT TO A DEVICE

To connect to a device, choose the **Connect** item in the **Device** menu.

A **Connect Device** dialog box appears. If there are more than one device configured in the ALPS-Link, the **Device Name** field will appear with a scroll button. Click this button to get the list of configured devices. From the list, select the device you desire a connection with and choose **OK** to proceed with the connection. Choose the **Cancel** button to quit the connection process.

Once the connection is established with the device, you are requested to enter a password to the device. The password determines the level of your privilege with the device. Enter password to the privilege at which you wish to interact with the device. Choose the **OK** button to proceed with the password entered or choose the **Cancel** button to quit the connection process.

The password you enter is sent to the device and if the login is successful, the menu bar and the tool bar change to incorporate the additional functions. **Reports**, **Settings** and **Actions** items will be added to the existing items in the menu bar.

Logging into the device is the start of a session. A session log starts and logs all the operations performed. The current item in the log menu is enabled and can be used to view the current session log. The tool bar also changes to display the Logout symbol in place of the connect symbol.

11.5.3 LOGOUT FROM A DEVICE

If the communication line is using a dial-up modem, the logout option will not hang-up the communication line.

To logout from a device, choose the **Logout** item from the **Device** menu. After a confirmation from the user, the device will be logged out. From the tool bar, the Logout icon also can be used.

The following conditions will be checked before the request for logout confirmation.

- If any settings were downloaded, was an END message sent?
- Are the outputs in disabled condition?
- Is the device in Test mode?

If any of the above conditions are true, ALPS-Link will display an appropriate message in the confirmation box. If you still want to proceed with the logout, choose the Yes button in the message box, or, if the END message is not sent, choose No, get back to the settings, send the END message. There is no need to download the settings again.

If the outputs are left in the disabled condition, choose the **Enable Outputs** item from the **Actions** menu. If the device is in the Test mode, choose the **End Test** item from the **Actions** menu.

To logout from a device when a modem is being used, a hang-up request must be explicitly made. You can request hang-up without logging out of a device. ALPS-Link will perform the necessary logout before hang-up.

WHY THIS EXPLICIT HANG-UP?:

When you have more than one device connected to the other end of the telephone line using a code operated switch, you need not hang-up the line to logout from one device and login to another on the same line. Even if the other device is not on the same line, ALPS-Link will automatically hang-up this line and dial the new number to connect to the new device you selected.

11.6.1 DESCRIPTION

The LPS-D performs protection functions in a power system according to the device settings values. The settings are grouped into categories. The LPS-D has four settings groups. ALPS-Link provides for uploading the settings from the device, modifying and these modified settings can either be downloaded to the device or stored in a local file. The settings can also be loaded from these local files for download, etc.

11.6.2 UPLOAD SETTINGS

The settings can be uploaded from a connected device for viewing and modifying. An upload command will get all the settings of all the categories from the connected device.

To upload settings, connect to the desired device. From the **Device** menu, choose the **Settings** item. From the drop down menu, choose the **Get Settings** item. Choose the **Upload** item in the pop up menu. The **Settings** dialog box with the uploaded settings will appear.

For an upload command, the device sends the latest settings available with it. That means, if you download settings to the device and request an upload before sending the END message, the device will send those downloaded settings.

In the **Settings** dialog box, you can modify the settings of a category you desire, save them locally, print them and/or download them to the device.

From the **Protection Category** field, you can select a particular category. Click the scroll button to see the list of available categories. Selecting a particular category displays only the settings of that category. You can view and modify the values of the settings in that category only. If you want to view and modify all the settings of all the categories, select **All** in the category field. See Figure 11–11: PROTECTION CATEGORY SCROLL LIST.

The dialog box has two parts, one has the list of all the settings selected in a category. This is more like a table with the setting number, setting name, the setting value, the units of that setting and the new value if entered.

Once a setting is selected from the list, the second part of the dialog box displays the description of the setting and the value(s) in that setting. You can change the value of a setting by entering the new value in the Change to field. For some settings you can only choose one of the available values. If the text box is a combo box, select the value from the list.

If the (**?**) button is displayed next to the field, the value is to be entered by you. Clicking on this button will display the valid ranges for that setting.

You can download the settings to the device by clicking the **Download** button. It is possible to download either all the settings of all categories or only the changed values. When you choose the **Download** button, a dialog box appears so that you can select between **All** and **Changed Values** only. Choose the **Cancel** button to quit the download operation. You can also download **Protection Settings**, **General Settings**, or both categories.

After a successful download, a dialog box displaying the download status of the settings and requesting confirmation for sending an END message will appear. If you want to send the END message immediately, choose the **Yes** button. If you do not want to send the END message immediately, choose the **No** button.

The END message can be sent explicitly by clicking on the END button in the settings dialog box.

The settings can be saved to a file. Choose the **Save Locally** button in the **Settings** dialog box. A **File Save** dialog box appears where you can select the name and location of the settings file.

The **Close** button will close the dialog box. Any modifications to the settings (downloaded or not) will be lost if not saved explicitly using the **Save Locally** button. If the settings are changed, a message box appears asking if you wish to save the changes. Choose **Yes** to save the changes and a **File Save** dialog box appears. You can choose **No** to quit without saving or choose **Cancel** to get back to the settings dialog box.

A hard copy of the settings can be obtained by choosing the **Print** button in the **Settings** dialog box.

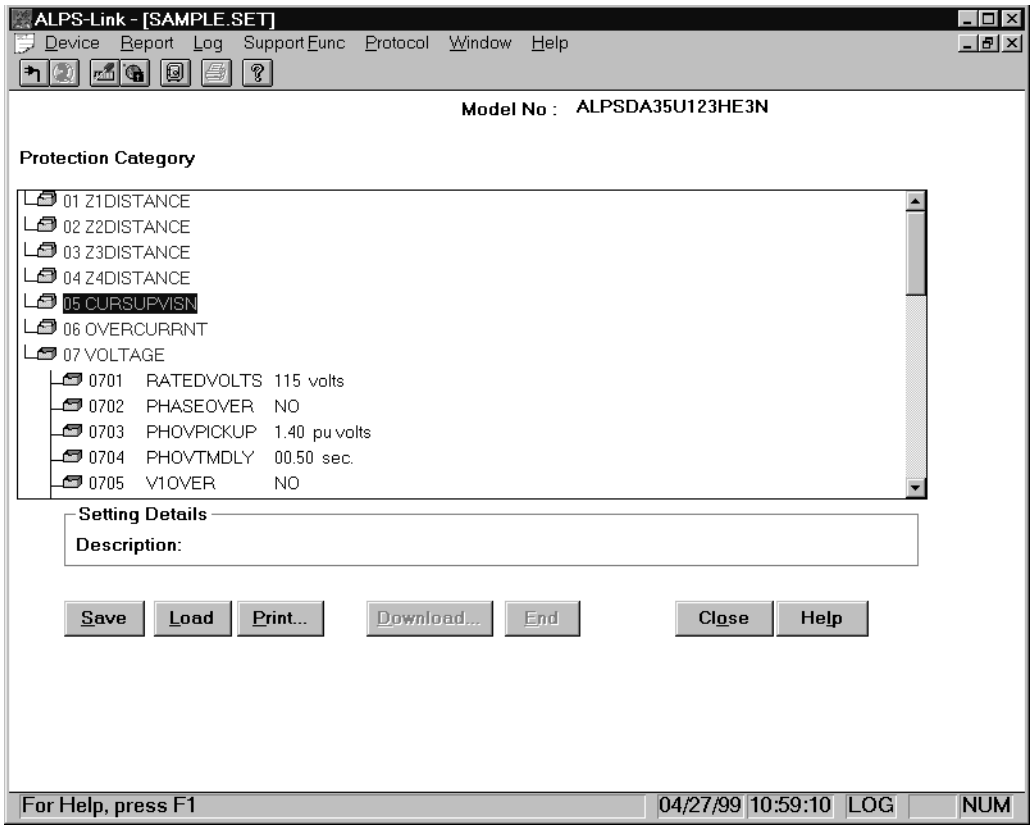


Figure 11–11: PROTECTION CATEGORY SCROLL LIST

While you are working on a set of settings uploaded from the device, if you wish to load the settings from a file and use them for modifications and download, choose the **Load** button. A **File Open** dialog box appears for you to choose the file.

NOTE

If more than one user is logged in to the relay, it may be possible to have more than one set of settings group being edited locally. However, only one user may download and end settings changes at a time.

11.6.3 LOAD LOCAL SETTINGS

You can view, modify and print settings loaded from a local file. It is not essential to connect to the device to load local settings. The settings file is user selectable. A file open dialog box helps in locating the necessary file. The download and END options in the settings dialog box will be disabled in this option.

To load local settings when not connected to a device:

- From the **Device** menu, choose the **Local Settings** item.

If you are already connected to a device,

- From the **Device** menu, choose **Settings**.
- From the drop down menu, choose **Get Settings**
- Choose **Load Local settings** from the pop up menu.

In both cases, a dialog box appears where you can select the file to load from with the settings dialog box with the settings. Multiple files can be opened simultaneously for viewing, modifying and printing. Refer to Section 11.6.2: UPLOAD SETTINGS for an explanation on the **Settings** dialog box features.

11.6.4 GET LOGIC

This command allows you to get configurable logic from the relay. This command automatically runs the Xpression Builder program installed on your hard drive from the Xpression Builder install disk located in this instruction book. See Chapter 13: XPRESSION BUILDER.

After configurable logic is downloaded from Xpression Builder, the program returns to ALPS-Link, but does not close Xpression Builder. Since Xpression Builder is still open, ALPS-Link will not let the user upload the configurable logic again. The uploaded logic window in Xpression Builder should be closed after the download by switching to the Xpression Builder application and closing the window corresponding to the uploaded logic. The same is true between any two consecutive logic upload operations.

11.6.5 SET DATE AND TIME

This feature helps you update the date and time in the device. Choose the **Set Date/Time** item from the **Settings** menu. The **Set Date/Time** dialog box will appear with the date and time of the host computer.

Modify the date and time as required. Choose **OK** to proceed with the downloading to the device.

The **Cancel** button ignores the modifications done and quits the dialog box. Any modification done here is only downloaded to the device and is not updated in the host computer.

11.6.6 CHANGE BUS/STATION ID

You can change the Bus and Station ID of a device. Choose the **Change Bus/Station ID** item from the **Settings** menu. A **Change Bus/Station ID** dialog box will appear.

This dialog box will display the current identifiers of the device. You can modify these strings. A maximum of 32 characters are accepted for each of them.

Choose **OK** to proceed with the download of these strings to the device or choose **Cancel** to quit.

11.6.7 TOC CURVES

ALPS-Link will facilitate uploading/downloading the TOC curves to/from the device. A separate software package will be used to view and edit the TOC curves. This package will not be a part of ALPS-Link. The interface between this package and ALPS-Link will be TOC curve files stored on the disk.

11.7.1 DESCRIPTION

ALPS-Link provides a mechanism to perform certain actions on a connected device. When necessary, the commands sent to a device to carry out these actions will follow 'Arm' and 'Execute' sequence defined in GEMODEM protocol. After a user confirmation for an action request, Arm and Execute sequence will be transparent to the user. You can not perform any of the actions before logging in to a device. It is also essential that you are logged in to the device with the appropriate privilege for performing actions.

11.7.2 ENABLE OUTPUTS

You can enable the device outputs by sending this request. This is an action that follows the Arm and Execute scheme. This scheme needs a user confirmation before executing the command.

To enable device outputs, click the **Enable Output** item in the **Actions** menu. A message box will be posted for your confirmation. Choose **OK** to proceed with enabling the outputs of the device. Choose **Cancel** if you wish to quit from enabling the outputs of the device.

Before logging out of the device, make sure the outputs are enabled.

11.7.3 DISABLE OUTPUTS

You can disable the outputs of a device by sending this request. This action follows the Arm and Execute Scheme. This needs a user confirmation before executing the command.

To disable device outputs, click the **Disable Output** item in the **Actions** menu. A message box will be posted for your confirmation. Choose **OK** to proceed with disabling the outputs of the device. Choose the **Cancel** button if you wish to quit from disabling the outputs of the device.

If the outputs are in disabled position, the ALPS-Link will inform you during logout.

11.7.4 CHANGE PASSWORD

You can change the password you use to log in to a device from ALPS-Link. Choose the **Change Password** item in the **Actions** menu. A **Change Password** dialog box appears.

Changing the password happens in three steps.

1. First you are asked to enter the old password. That is the password you are currently logged with. Enter the password and choose the **OK** button. Choose the **Cancel** button to quit the **Change Password** operation.
2. When you choose **OK** to proceed with changing password, ALPS-Link will post another dialog box asking you to enter the new password. Enter the new password and choose the **OK** button. Only alphanumeric characters are accepted for the password. Since the device accepts only upper case letters, all the characters are changed to upper case before sending to the device. The maximum length of the acceptable password is 16 characters.
3. For validation purpose, you are prompted to re-enter the new password. This is to take care of any typographical errors in your entering the password. Enter the new password again and choose the **OK** button.

The passwords are downloaded to the device for change. Any error from the device will be notified to you.

11.7.5 RESET DATA

This item helps you to reset specific data in a LPS-D device.

To reset any of the data, choose the **Reset Data** item in the **Actions** menu. A dialog box will appear with various data items which can be reset. Check the associated check boxes, for all the data items which you want to reset. Choose **OK** to proceed with resetting of selected items or choose Cancel to abort the reset operation. While you choose **OK** if the **Breaker Health Data** item is checked, another dialog box appears asking you to enter new breaker health values. If you choose **OK**, the ALPS-Link will send an appropriate message to the device. If you choose **Cancel** then ALPS-Link will uncheck the Breaker Health Data item and brings you back to the **Reset Data** dialog box.

11.7.6 DIGITAL OUTPUT TEST

When you choose this item from the **Actions** menu, a dialog box appears with the list of output types.

Select an output test from the list and choose **OK** to proceed or choose **Cancel** to quit. If you choose **OK**, ALPS-Link will send an appropriate command to the device.

11.7.7 RELAY TEST

When you choose **Relay Test** item from the **Actions** menu, a dialog box with a list of available test modes will appear. Select a test mode you want and choose **OK** to proceed with the test. Choose the **Cancel** button to quit the testing.

Select the **End Of Relay Test** item from the list to bring the device out of the test mode. If you leave the device in a test mode, during the logout from the device, ALPS-Link will remind you that you have left the device in the test mode.

NOTE: The error message *OTHER USER IS ACCESSING THIS RESOURCE* will appear if the relay is in test mode from another port, or the keypad.

11.7.8 OPEN BREAKER

Choose this menu item to open the breaker, this will prompt you with the confirmation message box. Click **Yes** to open the breaker. The LPS-D will send command to the device to open the breaker.

11.7.9 CLOSE BREAKER

Choose this menu item to close the breaker. This will prompt you with the confirmation message box. Click **Yes** to close breaker. The LPS-D will send command to the device to close the Breaker.

11.8.1 DESCRIPTION

Different types of information stored in the LPS-D can be fetched and viewed in a desired report format. ALPS-Link facilitates the acquisition and presentation of this information. Reports can be viewed, printed, or stored for later use. You can select the report you want from the **Reports** menu. A list of available reports will be displayed when you choose the **Open** item. You can also view an existing report from a local file. You should be logged into a device before you deal with any of the information.

11.8.2 OPEN REPORT

The reports item is not visible in the menu bar until you are logged into a device. ALPS-Link provides you with facilities to fetch a new report from the device, store the report, view a report acquired earlier and stored in a file and print the reports.

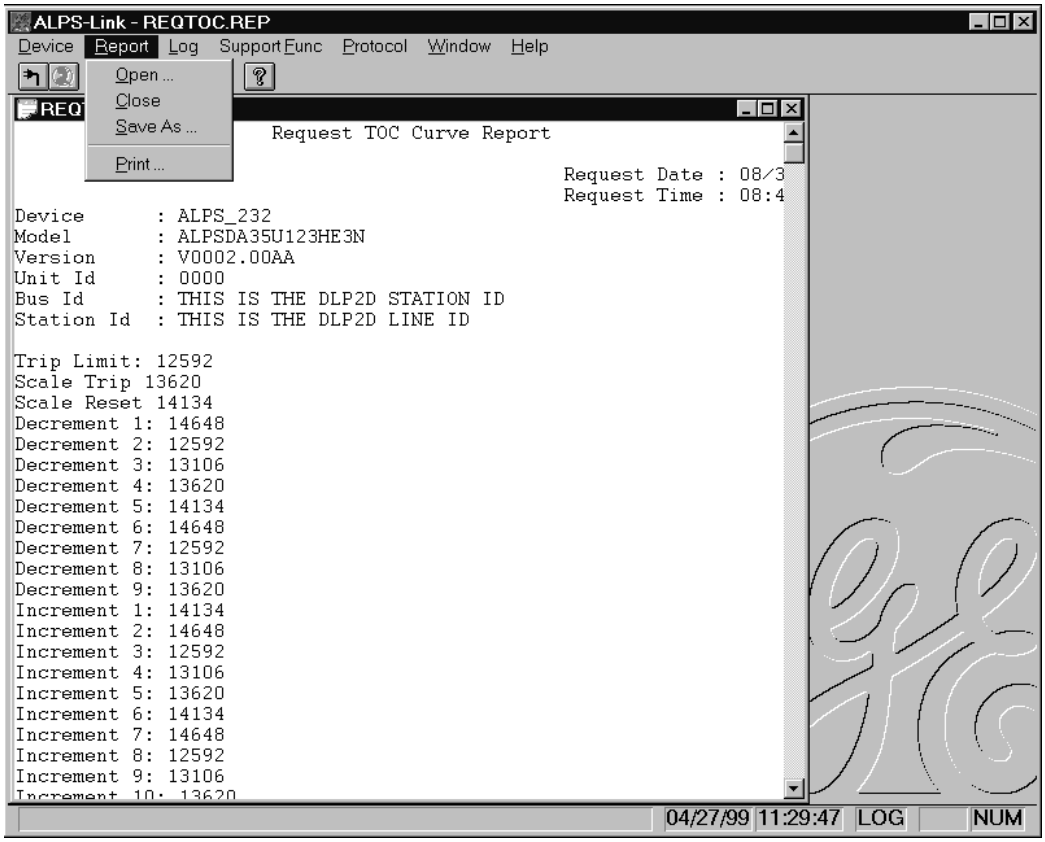


Figure 11–12: REPORT MENU WITH OPEN REPORT

11.8.3 NEW REPORT

Reports are the means of acquiring the current data from the device. For easy comprehensibility, the data is made available in various reports. The list of reports you can fetch from the device are displayed in the menu. Selecting **More** in the menu will post a dialog box from which you can select your choice including those which are not displayed in the above report menu.

When you select the **New** item in the **Reports** menu, this list will be displayed. Select the report you want and ALPS-Link will get that report data from the device and display it for you.

You cannot modify the contents of a report. You can save the report acquired from the device in a local file for viewing or printing later. To save a report, choose the **Save As** item in the **Reports** menu. A **File Save** dialog box appears where you can select the name and destination of the file in which you want to store the report.

The report can be printed by choosing the **Print** item in the **Reports** menu. You can acquire and view more than one report at a time. To do this, go through the same steps of getting a new report. You can also view some stored report by selecting the Open item. These multiple reports are displayed to you in multiple windows. To print or save a report when multiple reports are in view, ALPS-Link saves or prints the active report. Ensure that the desired report is in the active window before choosing the item.

Some reports need further input from the user. In all such cases data is acquired from user through a dialog and ALPS-Link validates this data wherever it is possible, before it proceed with the report. All of the reports and their associated dialog boxes (if any) are explained in the following sub-sections.

11.8.4 FAULT REPORT

When you choose the **Faults** report, a dialog box with the list of faults available with the device is displayed. Select the fault to report and choose **OK**. ALPS-Link will fetch relevant data from the device.

11.8.5 OSCILLOGRAPHY REPORT

To retrieve an oscillography report from the relay, select the **Report > Regular Oscillography** menu item. A list of available faults will appear. Select the fault to be downloaded. Enter the starting cycle and number of cycles required to be downloaded in the next window. A choice of DAF or COMTRADE file formats is available.

The .DAF file is formatted for use with the GE-DATA oscillography program. The .OSC format creates a binary COMTRADE file that can be viewed with any binary COMTRADE reader. You will be prompted for a name of this report when you close the fault report window, or, select the **Report > Save** (or **Save As**) menu item. Type in a descriptive file name, but do not add an extension. Five files will be saved and three files will be created to fit the COMTRADE standard. They are *.hdr (contains fault settings, fault report, and events), *.cfg (ASCII file containing definition of the data channels), *.dat (contains binary data). A *.osc file is also created that can be used for playback. See Section 8.1.20: PLAYBACK for complete description of the PLAYBACK function.

A *.rep is also created, the user may delete this file as it does not contain any useful information for the user. It is used by the LINK program during generation of the oscillography file.

11.8.6 BREAKER HEALTH REPORT

Select the **Report > Breaker Health** menu item to see the current breaker health values.

11.8.7 DEMAND REPORT

With **Demand Report** it is necessary to select the demand number (or range) for which you want demand data. Normally the allowed range is 1 to 192. If **Extended Demand Option** is set, then the valid range is 1 to 3360. If you want to see the report for a particular number and not the range, enter the same value in both the **Start Interval** and **End Interval** entries.

11.8.8 DIAGNOSTICS REPORT

Select **Diagnostics** from the **Report** menu to see a listing of all the diagnostic events occurred at the device.

11.8.9 EVENT REPORT

Select **Event** from the **Report** menu to see the events data fetched from a connected device.

11.8.10 PRESENT VALUES REPORT

When you select **Present Values** from the **Report** menu, ALPS-Link will pop-up a dialog box asking you to enter the period value in seconds. ALPS-Link will monitor the present values and update these values at the end of specified period continuously. These updated values are displayed through a special dialog box where you can monitor these as long as you want. You can get a report of these values at any moment by selecting the **Generate Report** option or stop monitoring by selecting **Close** option on the special dialog box monitoring these values.

NOTE

When General setting 108 is set to Primary (DISPLAYVAL = PRI), the Current values are in amps and the voltage values are in KV. The ALPS-Link Present Value display will show the units as V.

11.8.11 STATUS REPORT

Select **Status** from the **Report** menu to get the status report of various system components.

11.8.12 CONTACT STATUS REPORT

Select **Contact Status** from the **Report** menu to get the status of various contacts associated with the device. The status is conveyed in the On/Off or Open/Close terminology.

11.8.13 LUI PASSWORD REPORT

Select **LUI Password** to get a report on passwords of all the three levels.

11.8.14 OPEN REPORT

The report must have been fetched earlier from the device and stored in the file. When you choose the **Open** item in the **Report** menu, a **File Open** dialog box appears.

In the **File Open** dialog box, the **File** header part displays some information about the report file you are opening. This helps you in picking the right report file. Select the file name, directory and the source from where you want to read the report. The report will be displayed and you can print the report.

You can open multiple reports from multiple files and also can get new reports from the device for viewing simultaneously.

11.8.15 SAVE REPORT

Any report fetched from the device can be saved in a file. You can choose the name and location of the file in which you want to store the report. When you are in the report view, choose the **Save As** item from the **Report** menu. A **File Save** dialog box appears for the selection of the file name and path. If you wish to save a report when multiple reports are in view, ALPS-Link will save the report in the active window. So, make sure that the report you want to save is in the active window before choosing the item.

11.8.16 PRINT REPORT

You can take a hard copy of any of the report fetched from the device. You can do this before storing the report in a file or a report read from a file. When you are viewing multiple reports and choose the print item, ALPS-Link will print the report in the active window. So, make sure the report you want a hard copy of is in the active window.

11.9.1 SESSION LOG

ALPS-Link logs all the transactions done with a device. These logs are stored in disk files so that you can view them later. All the transactions in a session are stored in one log file. A session is defined as the time between logging into a device and logging out of a device. Up to 100 logs are stored in a cyclic manner, that is, after the 100th log, the overwriting re-starts from the first.

Each session log is stored in a different file. The log item is displayed in the menu bar before and after you are logged in to a device. To view the logs from the disk, you need not be logged in to a device. The current session log in the log menu is visible only when you are logged into a device. The LOG field in the status bar displays if the session log is on or off.

11.9.2 TURN OFF

By default, ALPS-Link has the session log on. If you wish to turn the log off, choose the **Turn Off** item in the **Log** menu. You can do this before and after logging in to a device. From the moment you turn the log off, ALPS-Link will not create any session log for any device until you turn it on.

If you choose **Turn Off**, a select mark will be displayed with that item in the menu. The LOG field in the Status bar will be empty. When you wish to turn the log on again, all you need to do is to choose this item again.

11.9.3 CURRENT SESSION LOG

This can be viewed only when you are connected to a device. This log contains all the transactions you have had with the device till this moment. You can add comments about your operations in the current log. This feature is only limited to the current log and you can not add comments to any previous logs.

As soon as you log out of a device, ALPS-Link automatically closes the log and stores it in the appropriate file.

You can print the current session log by choosing the print item in the Log menu.

To close the current log, choose the **Close** item in the **Log** menu. This will appear in the **Log** menu when you are in an active log window.

11.9.4 OPEN SESSION LOG

You can open a previous log for viewing and printing. You need not be logged into a device to invoke this option. Choose the **Open** item in the **Log** menu and a list box with all the available logs will appear.

The display consists of the log name, the date and time of occurrence and the device logged in during that session. You can scroll through the window and see the entire list. Select the log you wish to open and choose the **OK** button to view it. The session log will be displayed. Choose **Cancel** to quit the selection.

You can not add comments in any log opened from the list, but you can take a hard copy of the log by choosing the **Print** item in the **Log** menu.

You can view as many logs as you want using the **Open** option. If you choose the print item when you are viewing multiple logs, ALPS-Link will print the log that is in the active window.

To close a log, make sure that window is active and choose the **Close** item in the **Log** menu.

11.9.5 ARCHIVAL

Reports and Settings can be stored on the secondary storage by you, where as up to 100 log files are stored by ALPS-Link. It might be necessary to make an archival of some of these files. ALPS-Link supports this through the **Archival** option. The same option can be used to retrieve these backups.

11.9.6 ARCHIVE

When you want to take a backup of one of the Report, Settings or log files stored on the disk, use this option. Choose the **Archive** item in the **Support Functions** menu. An archives dialog box appears.

Enter the name of the source file along with the path and the destination file. Choose **OK** to proceed with the archival. You can also click the browse (**>>**) button to get a file common dialog box where you can select the file name. This browse button is available for both the source and destination.

11.9.7 RETREIVE

You can retrieve the archived files using the same dialog box. If you wish to retrieve any of the files, choose the Archive item in the support functions menu. The same archive menu will appear. You can select the source from where you want to retrieve (for example, floppy disk) and give the destination name and path.

If you are retrieving any of the log files, make sure you copy the file in to the directory `C:\ge_relay\LPS\link\data\log`. Since you would not want to destroy the log existing with the same name, you can give a name of your choice, but with an extension of .log, that is, you can name it test.log.

For **Report** and **Settings**, you can select the directory and name of your choice.

12.1.1 DESCRIPTION

The LPS-D has a built-in ASCII interface which can communicate using any standard terminal emulator. The user must initiate all commands by typing them. Some of the commands have abbreviations which are represented by the capital letters in a command. If there are no lower case letters in a command, the command does not have an abbreviation and the whole command must be typed.

Any keypad operation can also be performed through the ASCII communications interface. The communications passwords apply to the ASCII interface and must be used to gain the necessary privilege level. If the passwords are not known or forgotten, they are available from the Keypad using the INF key.

Once the terminal emulator has been started, the COM port the relay or modem is connected to must be setup to match the relay for bits (8), parity (none), stop bits (1) and Xon/Xoff flow control.

Once the terminal emulator is ready and the relay connected, press the [ENT] key. The standard error message should appear. If it does not, check the connections and settings. All the commands that follow can then be used. Use your ASCII communications program to save relay responses to a file.

12.1.2 ASCII INTERFACE

1. When a prompt says “Press”, this indicates that as soon as that key is pressed the relay will respond without the user pressing the ENTER key. When a prompt says “Enter”, the entered keystrokes will not be processed until the ENTER key is pressed.
2. The CAPITAL letters in a command name must be typed to execute the command. The lowercase letters that continue the command are optional. For any command to be executed the ENTER must be pressed.
3. If a mistake is made while entering commands, a message will be displayed and the correct information can be entered after the prompt at the end of the error message. No action that will cause the relay to change settings, operate a breaker, or change the relay operation in any way will be done without user verification (for example: TRIP BREAKER 1, are you sure (Y/N): ?).
4. The relay responses below are in order of appearance. Where there is a user choice, all possible responses may not be listed. However, any unlisted responses will be similar to others listed.
5. Help is available before typing a command by typing HELP at he LPS_xxx> prompt and pressing the ENTER key. Some commands have built-in help as well.
6. There are two kinds of command prompts. The colon (:) is used to indicate the relay is not logged in and is waiting for the LOGIN command. After a successful login, the prompt changes to depending on the privilege level. See Table 12–1: ASCII PROMPTS.

Table 12–1: ASCII PROMPTS

PRIVELEGE LEVEL	PROMPT
VIEW	LPS_INF>
ACTIONS	LPS_ACT>
SETTINGS	LPS_SET>
MASTER	LPS_MST>

Communication using the ASCII protocol presents oscillography data as directly readable ASCII characters. Oscillography data may contain 12 to 72 power cycles of data. Each power cycle contains 64 samples of data. The data structure of a sample is as shown in Table 12–2: OSCILLOGRAPHY DATA STRUCTURE. Each sample appears on a separate line.

Table 12–2: OSCILLOGRAPHY DATA STRUCTURE

ITEM	DATA FORMAT (ASCII CHARACTERS)	DESCRIPTION
Sample No	decimal integer	Sample number within the cycle
Ia	signed decimal (resolution of 0.01 units)	Inst. current in Phase A
Ib	signed decimal	Inst. current in Phase B
Ic	signed decimal	Inst. current in Phase C
Va	signed decimal (resolution of 0.1 units)	Inst. voltage in Phase A
Vb	signed decimal	Inst. voltage in Phase B
Vc	signed decimal	Inst. voltage in Phase C
Digital Flags	Eight 4 byte hexadecimal integers	The 252 digital flags represent system status

Table 12–3: ASCII COMMAND LIST (Sheet 1 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
LOGIN	Login to the relay	NONE	Unit ID? Password? Reports the access level granted **or** that the password entered is INVALID	Relay ID number; up to 10 character password
QUIT	Logs out from the relay, displays the relay status, and returns the privilege level to VIEW for the relay port used.	VIEW	Press ENTER to continue Do you want to logout? You have logged out from the relay	Press the enter key; Y or N
PASSword	Change the passwords used by ALPS-Link and ASCII; MMI passwords are not affected by this command	Level equal to the password being changed	Enter Current Password Enter New Password Re-enter New Password Password changed **or** INVALID; password not changed	old password; new password; new password

Table 12–3: ASCII COMMAND LIST (Sheet 2 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
VALues	Display the present values of voltages, currents, watts, Vars, etc., including Breaker Health in the second screen. Press ENTER to see the second screen	VIEW	**Present Values** VA rms: V IA rms: A VB rms: V IB rms: A VC rms: V IC rms: A In rms: A VA: V degs IA: A degs VB: V degs IB: A degs VC: V degs IC: A degs In: A degs Watts: KW Vars: kVar Power Factor Frequency: Hz Setting Group Number:1 No. of Breakers: 2 Breaker 1: Closed Breaker 2: N/A **Breaker Health** Phase A accumulated Amps: 45.2 A Phase B accumulated Amps: 11.1 A Phase C accumulated Amps: 25.7A Breaker Operations: 129	None
READings	Display the present values of voltages, currents, watts, Vars, etc., and update them once per second. The ESC key stops the update. No Breaker Health is displayed.			
FAUlts	Display fault reports. The list of available faults is displayed first then a number is chosen to view a particular fault	VIEW	FLTNO DATE TIME TRIP TYPE FAULT TYPE DISTANCE 1 07/09/98 15:32:23.6833 EXT AG 0.2mi Enter Fault Number (press ESC to quit): 1 Report for Fault No: 1 TRIP DATE: 07/03/98 TRIP TIME: 16.32.23.6833 Trip Type(s): Z1 Fault Type: ABG Relay Operating Time: 488 ms Breaker Operating Time: 1152 ms Distance: 9999 miles ITEM A B C D Prefault Current (A) 0.00 0.00 0.00 0.00 Fault Current (A) 0.00 0.00 0.00 0.00 Fault Voltage (kV) 0.00 0.00 0.00 0.00 Press ENTER to Continue List of Fault Events: TIME EVENT 16:32:23.7025 Oscillography Capture 16:32:23.7041 RMS Oscillography Data Press Y to get oscillography data Press ESC to quit Press Any Key to continue	Press E for expanded mode, ESC to end Two digit number, 1 to 16

Table 12–3: ASCII COMMAND LIST (Sheet 3 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
EVEnts	Display events	VIEW	List of events with date and time. Example: 06/30/98 16:26:29.7562 Host Logoff on MMI 06/30/98 16:24:37.5944 Host Logon OK on Port 2 06/30/98 16:10:45.6505 Recloser in RESET state 06/30/98 16:10:40.0000 Settings File 0 in Use 06/30/98 16:10:40.0000 System booted Press ENTER to continue, B to go back a screen, or ESC to quit	None
TRIP	Open Breaker command; issues the command to open breaker; breaker will be determined by settings NUM_BRKR and NUM_TC	CONTROL	Enter Breaker No. (1 / 2 / BOTH) TRIP BREAKER 1, ! Are you sure? (Y/N) Breaker open command sent	1, 2, or BOTH; Y to trip, N to cancel
CLOSe	Close Breaker command; issues the command to close breaker; breaker will be determined by settings NUM_BRKR and NUM_TC	CONTROL	Enter Breaker No. (1 / 2 / BOTH) CLOSE BREAKER 1,! Are you sure? (Y/N) Breaker close command sent	1, 2, or BOTH; Y to trip, N to cancel
ENOUT	Enable outputs	CONTROL	Enable Outputs, Are you sure? (Y/N) Outputs are disabled **or** Outputs cannot be disabled	Y for OK, N to cancel; command
DISABle outputs	Disable outputs	CONTROL	Disable Outputs, Are you sure? (Y/N) Outputs are disabled **or** Outputs cannot be disabled	Y for OK, N to cancel; command
STATUs	Display status of the relay	VIEW	RELAY STATUS Refer to the servicing section for status messages for the LPS-D Press ENTER to continue	None
DATAReset	Clear various data logs maintained in the relay	SETTING	To clear FAULT REPORT and OSCILLOGRAPHY enter F To clear OST REPORT enter S To clear EVENT DATA enter E To reset target LED and clear warn, failure, and trip messages enter L To clear BREAKER HEALTH enter B To quit press ESC Enter your choice:	Enter letter, press ENTER
DIGTest	Perform Digital Output tests; the test energizes the selected output until END is chosen or another output is tested	MASTER	Turn Protection off (Y/N): Enter the number of the Digital Output to be tested (1 to 18) Enter END to end test To see list of Digital Outputs enter H To quit press ESC Enter your choice: 4 Digital Output #4 is Activated Turn Protection on? (Y/N):	Enter letter; Enter digit form 1 to 18; enter letter

Table 12–3: ASCII COMMAND LIST (Sheet 4 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
GROUP		SETTING	The active Protectioning Setting Group number is 1 To select a Setting Group enter Setting Group Number ('1' - '4') To select active setting group through Contact Converter Inputs enter '0' To quit press ESC Enter your choice: Are you sure (Y/N):? y New Active Group = 3	Enter digit from 0 to 4; enter letter
INPuts	Request contact converter status	VIEW	Contact Converter #0=0 (SETTING GROUP BIT 0) Contact Converter #1=1 (SETTING GROUP BIT 1) Contact Converter #2=1 (not assigned) Contact Converter #3=0 (not assigned) Contact Converter #4=0 (not assigned) Contact Converter #5=1 (not assigned) Contact Converter #6=0 (not assigned) Contact Converter #7=1 (not assigned)	None
MODEL	Retrieve the model number, serial number, and version of the relay	VIEW	MODEL: LPSDA35U143VE3S VERSION: V0001.11	None
CRCcalc	Recalculates the CRC of various settings groups (this is primarily a troubleshooting command - it is used only where a relay may have gone through a loss power during a settings change, and the settings are corrupted beyond the ability of the relay to correct).	SETTINGS	CRCs are recalculated	None
STLINID	Allows the station and line IDs to be changed	SETTINGS	Station ID: Current Station ID Line ID: Current Line ID Do you want to change Station and/or Line ID? (Y/N): y Enter new Station ID (max. 32 characters): NEW STATION ID Enter new Line ID (max. 32 characters): NEW FEEDER ID Are you sure? (Y/N): y	Y to change, N to exit; NEW STATION ID or ENTER to keep current ID; NEW FEEDER ID or ENTER to keep current ID; enter letter

Table 12–3: ASCII COMMAND LIST (Sheet 5 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
RELTest	Selects and runs a given relay test. Puts the relay in test mode (Contact A! Reports test function operation).	MASTER	Disable Outputs? (Y/N): Select the function to be tested (2 to 49) To stop the test in progress enter I To see the list of functions enter H To quit without suspending the test enter Q To quit press ESC Enter your choice: 2 Z1 AG test function is routed to contact A!	Enter letter Y or N; one to two digit number, 1 to 49; enter letter H or Q
ACCESS	Allows the user to change privilege level	VIEW	Enter Password:?	User-defined password
OSCtrg	Start oscillography recording	VIEW	Are you sure? (Y/N): y Oscillography is triggered	Enter letter Y or N
CHNLtest	Test PLC channel. The test starts when a B is entered and ends only when an E is entered.	MASTER	To begin Channel Test enter B, To end Channel Test enter E	Enter letter B or E
PLAYBack	Re-run a fault produced earlier or test case for relay. There are three choices for running a fault: 1) re-run a fault saved in the relay; 2) with factory test data; 3) download oscillography into relay and run fault	ACTION	To run the relay on Fault Data enter Fault Number To run the relay on factory test case enter F To run the relay on downloaded test data enter D To quit press ESC Enter your choice: 5 The fault is absent There is no factory test data in the relay There is no downloaded data in the relay	Fault number, F, D, or ESC
LUIPass	Display coded LUI passwords. See decoding table in Chapter 8	VIEW	MMI PASSWORDS Settings Password: [DHLPPPPPPPPPPP Control Password: [AEIPPPPPPPPPPP Master Password: [MBFPPPPPPPPPPP	None
HELP	Displays the ASCII command mnemonics as well as descriptions of each command	VIEW		None
OUTPuts	Displays the current state of the digital outputs	VIEW	Output Contact #1, T1=0 Output Contact #2, T2=0 Output Contact #3, T3=0 Output Contact #4, T4=0 Output Contact #5, A1=0 Output Contact #6, A2=0 Output Contact #7, A3=0 Output Contact #8, A4=0 Output Contact #9, A5=0 Output Contact #10, A6=0 Output Contact #11, A7=0 Output Contact #12, A8=0 Output Contact #13, KT1=0 Output Contact #14, KT2=0 Output Contact #15, KT3=0 Output Contact #16, KT4=0 Output Contact #17, C1=0 Output Contact #18, C2=0	None
DATE	Displays the current LPS-D date	SETTINGS	Do you want to change date? (Y/N): Enter new date (mm/dd/yy): Command is executed	Enter letter Y or N; 6 digit date code

Table 12–3: ASCII COMMAND LIST (Sheet 6 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
TIMe	Displays the current LPS-D time	SETTINGS	Do you want to change time? (Y/N): Enter new time (hh:mm:ss): Command is executed	Enter letter Y or N; 6 digit time code
LINEs	Changes the number of lines the relay will display before pausing for the user to read	VIEW	Enter the number of LINES PER PAGE (24/25/48/50):	Enter 24, 25, 48, or 50
GEModem	Changes communications type to GE-Modem after user has logged out	SETTINGS		None
ECHo	Toggles the echo state and reports its status	VIEW	Echo is turned ON (OFF)	None
PORTparam	Changes and displays the current port parameters for the LPS-D serial communications port	SETTINGS	Do you want to change communication port parameters? (Y/N): Interface is (0 - RS232, 1 - RS485): 0 Enter Interface Type (0 - RS232, 1 - RS485): Baud rate is 9600 Enter baud rate (19200, 9600, 4800, 2400, 1200, 300): Parity check type is (0 -none, 1 - odd, 2 - even): 0 Enter parity check type (0 -none, 1 - odd, 2 - even): Number of stop bits is 1 Enter number of stop bits (1 or 2): Save changes? (Y/N):	Y displays parameter to be changed, N exits; 0 for RS233, 1 for RS485; press ENTER for no change; choose baud rate matching PC port; Enter 0, 1, or 2; Enter 0, 1, or 2; Enter Y or N
END	Ends the session	VIEW		None

Table 12–3: ASCII COMMAND LIST (Sheet 7 of 7)

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
SHOWSET	Displays the current values of selected settings	VIEW	To see PROTECTION GROUP Settings press Setting Group no 1 to 4 To see GENERAL Settings press G To quit press ESC Enter your choice:2 To view Category of Settings press C To view ALL Settings press A To go back to previous menu press B To quit press ESC Enter your choice: C To view protection SETTINGS in a category enter category number 1 to 20 To view protection settings CATEGORY names enter C To go back to previous menu press B To quit press ESC Enter your choice: 5 Press ENTER to continue or ESC to quit	Enter 1, 2, 3, 4, G, or press ESC Enter C, A, B, or press ESC Enter numbers between 1 to 20, the letters C and B, or press ESC Press ENTER or ESC
SET	Allows the user to change settings	SETTINGS	To view/change PROTECTION GROUP Settings press Setting Group no 1 to 4 To view/change GENERAL Settings press G To quit press ESC Enter your choice:2 To view/change Category of Settings press C To view/change ALL Settings press A To go back to previous menu press B To quit press ESC Enter your choice: C To view/change protection SETTINGS in a category enter category number 1 to 20 To view/change protection settings CATEGORY names enter C To go back to previous menu press B To quit press ESC Enter your choice: 1 Press ENTER to continue or ESC to quit	Enter 1, 2, 3, 4, G, or press ESC Enter C, A, B, or press ESC Enter numbers between 1 to 20, the letters C and B, or press ESC Press ENTER or ESC

13.1.1 OVERVIEW

The LPS-D relay has been designed to allow flexibility in the operation of contact converter inputs and contact outputs. The inputs and outputs are not hard-wired to any function; the functions of each input and output are defined by a software file which is downloaded to the relay as a part of each setting group.

The software file represents the linkage between the contact converters, internally generated protection flags, and contact outputs; it contains information regarding the logical relationships among each entity. This file is built using a windows based application called Xpression Builder.

Xpression Builder allows the utility engineer to design the interconnection of the inputs and outputs with Boolean operators, latches, timers, and counters in a graphical environment. The application performs the task of compiling the design from a graphical format, and allows the engineer to download the file to a relay setting group with ALPS-Link. Each setting group can contain different Xpression Builder logic. The LPS-D comes with a default Configurable Logic implementation.

13.1.2 INSTALLATION

If the LPS-D software suite has been installed from the Products CD or GE Power Management website, Xpression Builder is probably already installed. To install Xpression Builder by itself from the Products CD or website, consult the procedure in Section 11.2.4 SOFTWARE INSTALLATION on page 11–4, and choose Xpression Builder from the LPS-D software menu.

To install the software from the GE Power Management web site enter the following URL in your Web browser:

www.GEindustrial.com/pm

The home page is the same as that shown in Figure 11–2: GE POWER MANAGEMENT WELCOME SCREEN on page 11–4. Follow the procedure in Section 11.2.4 SOFTWARE INSTALLATION on page 11–4 to continue the installation.

13.2.1 OVERVIEW

Xpression Builder logic is processed every other millisecond. This should be considered when designing logic to implement in the relay. The more gates connected in series, the longer the time delay from the initial logic input to the final logic output (roughly 2 ms per gate) of the expected result. This delay applies to the Xpression Builder logic only. The scheme logic outputs of the relay will not be delayed with the use of configurable logic.

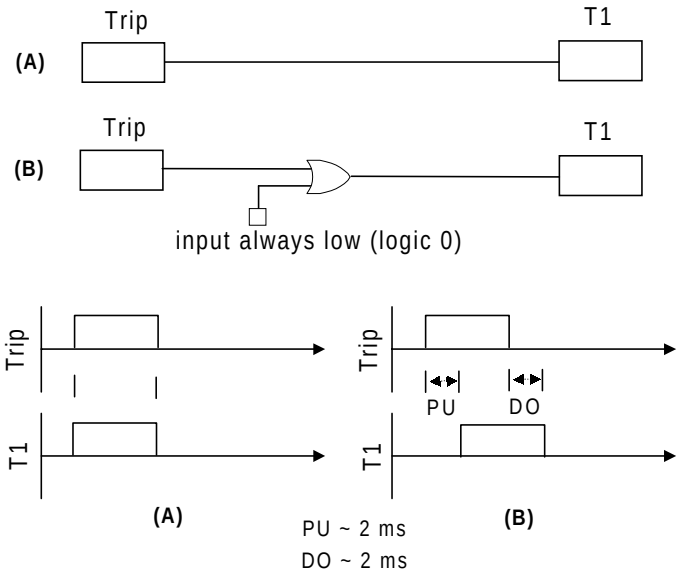


Figure 13–1: LOGIC PROCESSING DELAY

For example, the TRIP (flag #33) output of the scheme logic, when directly connected to an output contact, will close that contact when it becomes high (logic 1) with no additional processing delay as shown in part A of the figure above. If the TRIP flag is connected to a Boolean gate before it reaches an output contact, a gate processing delay of 2 ms should be added to the expected function operating time as shown in part B above. This should be taken into consideration in the design of the relay configurable logic. This is why it is recommended all user defined logic be tested in a laboratory environment before installation in the field. This will ensure user confidence and expected performance of the configurable logic developed with the relay internal flags.

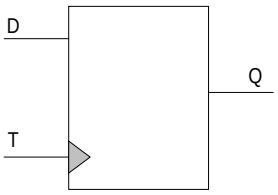
13.2.2 BOOLEAN OPERATORS, LATCHES, TIMERS, & COUNTERS

a) BOOLEAN OPERATORS

The operation of the Boolean operators (AND, OR, and NOT) are self explanatory. Each gate may have up to four (4) inputs. Each of the inputs may be logically inverted by clicking the right mouse button when the cursor is at the input of the gate. A small circle at the gate input will indicate the inversion of the input signal. The output can also be inverted by clicking the right mouse button when the cursor is at the output of the gate. A small circle at the gate output will indicate the inversion of the output signal.

b) LATCHES

A “D” flip-flop is used in the Xpression Builder logic as shown in Figure 13–2: LATCH AND TRUTH TABLE. The D input is where the data bit to be stored is applied. The T or clock input controls the flip-flop. It determines whether the data on the D input line is recognized (clocked) or ignored. If the T input line is high (binary 1), the data on the D input line is stored in the flip-flop. If the T input line is low (binary 0), the D input line is not recognized. The Q output line directly reflects the state of the flip-flop. If the flip-flop is set, then Q equals a high (binary 1). If Q equals a low (binary 0), then the flip-flop is reset.



T	D	Q
L	X	Q_0
H	L	L
H	H	H

Figure 13–2: LATCH AND TRUTH TABLE

c) TIMERS

There are two types of timers used in the Xpression Builder program, the Pickup/Dropout Timer and the Pickup Relay Timer.

The simplest type is the Pickup/Dropout timer shown in the figure below. The PU = 300 indicates the pickup delay in milliseconds and DO = 250 indicates the dropout delay in milliseconds. In both parts A and B, the IN/OUT time charts describe how the timer functions. If the input is high (binary 1) for a time equal to the pickup delay, the output becomes high (binary 1). Any reset of the input (high to low) causes the accumulated pickup time to reset immediately to zero. Once the output occurs, it remains high as long as the input remains high, and when the input subsequently goes low the output stays high for a time equal to the dropout delay. Once the dropout timer has started, it will continue to time out even if the input goes high during the reset time. Time chart A shows a second input pulse occurring after the output goes low. Since this pulse length is less than the 300 ms pickup delay, the output stays low. Time chart B shows a second input pulse occurring 100 ms after the first input pulse goes low. The output goes low as shown in time chart B, but the output then goes high 300 ms after the leading edge of the second input pulse or 150 ms after the trailing edge of the first output pulse. The pickup and dropout timers are independent of each other.

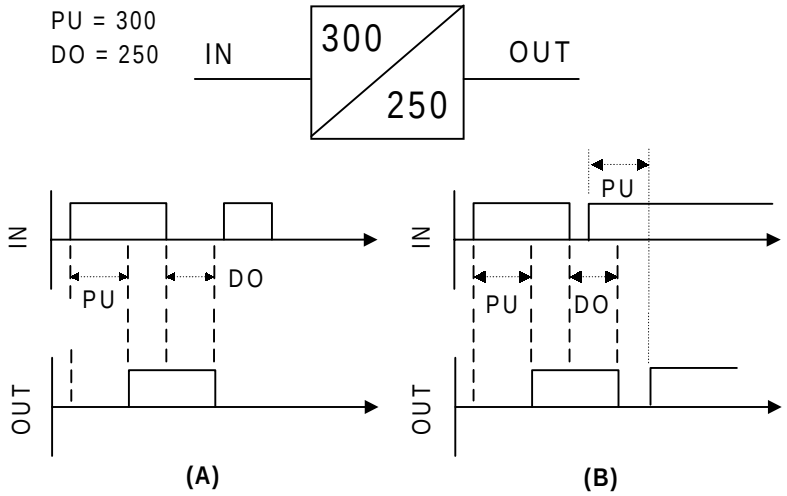


Figure 13–3: PICKUP/DROPOUT TIMER

The second type of timer is basically a pickup delay timer with a reset input/output feature. As shown in Figure 13–4: PICKUP DELAY TIMER, there are two inputs, two outputs, and a user selected pickup delay (in milliseconds). In its “initial” state with no inputs applied, both R and S are low (binary 0), the timer outputs RO and SO are both low (binary 0). The timer starts counting when the S input is high (binary 1). When the count becomes equal to the set time delay (1000 ms for our example), the SO output is set high (binary 1) and the RO output is set low (binary 0). If the R input becomes high (binary 1) while the timer IS NOT counting, then both outputs RO and SO are set low (binary 0) which returns the timer to its “initial state”. See Table 13–1: PICKUP DELAY TIMER TRUTH TABLE for a summary of the pickup delay timer function.

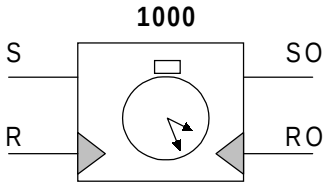


Figure 13–4: PICKUP DELAY TIMER

Table 13–1: PICKUP DELAY TIMER TRUTH TABLE

S	R	Previous Timer State	Current Timer State	RO	SO
L	L	NOT TIMING	NOT TIMING	RO_{n-1}	L
↑	L	NOT TIMING	TIMING DOWN	L	L
X	L	TIMING DOWN	TIMER EXPIRED	L	H
X	H	TIMING DOWN	TIMER RESET	H	L
X	↑	NOT TIMING	NOT TIMING	L	L

d) COUNTERS

The counter has two input line, one output line, and a user selected count threshold (in milliseconds) as shown in Figure 13–5: COUNTER. A transition from low (binary 0) to high (binary 1) on the S input line increments the counter by a value of one. The O output line is high (binary 1) when the accumulated count is equal to or greater than the count threshold. If the O output line is low (binary 0), then the accumulated count is less than the set value. A transition from low (binary 0) to high (binary 1) on the R input line resets the counter to zero.

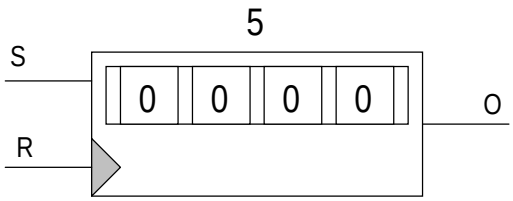


Figure 13–5: COUNTER

Table 13–2: CONTACT CONVERTER INPUT FLAGS

Index	Description	Mnemonic
0	No Assignment to Input	NONE
1	Breaker #1 52b Contact Input	52B_1
4	Breaker #2 52b Contact Input	52B_2
8	Change Setting Group Input Bit 0	CGST1
9	Change Setting Group Input Bit 1	CGST2
10	External Contact Input to Stop Carrier	STCR
11	External Contact Input to Block Pilot Tripping	BPLTRP
12	Receiver 1 Input	RCVR1
13	Receiver 2 Input	RCVR2
15	External Reclose Initiate 3-Pole	EXRI3P
16	External Reclose Inhibit	EXRINH
17	External Reclose Cancel	EXRCNL
18	Reclose Reset	RCLRST
19	External Manual Close	EMNCLS
22	External Contact Input to Disable Outputs	DISOUT
23	External Contact to Trigger Oscillography	OSCTRG
24	Manual Lock-Out	MANLKT
25	Configurable Input 1	CNFDI1
26	Configurable Input 2	CNFDI2
27	Configurable Input 3	CNFDI3
28	Configurable Input 4	CNFDI4
29	Configurable Input 5	CNFDI5
30	Configurable Input 6	CNFDI6
31	Configurable Input 7	CNFDI7
32	Configurable Input 8	CNFDI8

13.3.2 INPUT/OUTPUT FLAGS

The input flags available for assignment to user defined logic are as follows:

Table 13–3: CONFIGURABLE INPUTS

Index	Description	Mnemonic
25	Configurable Input 1	CNFDI1
26	Configurable Input 2	CNFDI2
27	Configurable Input 3	CNFDI3
28	Configurable Input 4	CNFDI4
29	Configurable Input 5	CNFDI5
30	Configurable Input 6	CNFDI6
31	Configurable Input 7	CNFDI7
32	Configurable Input 8	CNFDI8

Table 13–4: SCHEME LOGIC INPUTS

Index	Description	Mnemonic
1	Breaker #1 52b Contact Input	52B_1
4	Breaker #2 52b Contact Input	52B_2
8	Change Setting Group Input Bit 0	CGST1
9	Change Setting Group Input Bit 1	CGST2
10	External Contact Input to Stop Carrier	STCR
11	External Contact Input to Block Pilot Tripping	BPLTRP
12	Receiver 1 Input	RCVR1
13	Receiver 2 Input	RCVR2
15	External Reclose Initiate 3-Pole	EXRI3P
16	External Reclose Inhibit	EXRINH
17	External Reclose Cancel	EXRCNL
18	Reclose Reset	RCLRST
19	External Manual Close	EMNCLS
20	External Contact to Reset Trip Target Display	RESET
21	External Contact Input to Disable Protection	DISPRT
22	External Contact Input to Disable Outputs	DISOUT
23	External Contact to Trigger Oscillography	OSCTRG
24	Manual Lock-Out	MANLKT

Table 13–5: SCHEME LOGIC AND RECLOSER OUTPUTS

Index	Description	Mnemonic
33	Trip	TRIP
37	Reclose Initiate	RI
38	Reclose Cancel Output from Scheme Output	CANCL
39	Key Xmtr 1 (Carrier Start from Scheme Logic)	KEY1
40	Key Xmtr 2 (Carrier Stop from Scheme Logic)	KEY2
43	Warm Restart	WARMST
44	Reclose in Progress	RIP
45	Line Overload Alarm Output	LNOVLD
46	Critical Alarm Output	CRTALM
47	Recloser Lockout	LORCL
48	Trip Circuit Monitor Alarm	TCMALM
49	Zone Flags On Alarm	ZNALM
50	Overcurrent Alarm	OVRALM
51	Unbalanced Current Detector Alarm Output	UNBAL
52	Non-Critical Alarm Output	NCALM
56	Manual Open Breaker # 1	MNOPN1
57	Manual Open Breaker # 2	MNOPN2
58	Manual Close Breaker # 1	MNCLS1
59	Manual Close Breaker # 2	MNCLS2
100	All Phases Open	OPEN
114	Line Pick-Up	LPU
115	Fuse Failure Alarm	FF
120	Out-of-Step Blocking	OSB
121	Out-of-Step Tripping	OST
122	Configurable Trip Bus	CNFTRP
123	Configurable Oscillography Trigger	CNFOSC
135	Any Trip Bus	TRPBUS
136	Weak Infeed Trip	WITRIP
140	Any Phase Overvoltage Pickup	OVRVPU
141	Positive Sequence Overvoltage Pickup	V1TPU
142	Compensated Positive Sequence Overvoltage Pickup	V1CPU
144	Block Reclose Initiate	BLK-RI
145	Manual Close In Progress	CLS IP
146	Breaker Close	BKRCLS
153	Phase A Overvoltage	AVOVR
154	Phase B Overvoltage	BVOVR
155	Phase C Overvoltage	CVOVR
156	Instantaneous Positive Sequence Overvoltage	V1IOVR
157	Time Delayed Positive Sequence Overvoltage	V1TOVR
158	Instantaneous Compensated Positive Sequence Overvoltage	V1CIOV
159	Time Delayed Compensated Positive Sequence Overvoltage	V1CTOV
160	Any Phase Overvoltage	OVRVLT

Table 13–6: DISTANCE UNITS

INDEX	DESCRIPTION	MNEMONIC
65	Zone 1 AB Distance Function	Z1AB
66	Zone 1 BC Distance Function	Z1BC
67	Zone 1 CA Distance Function	Z1CA
68	Zone 2 AB Distance Function	Z2AB
69	Zone 2 BC Distance Function	Z2BC
70	Zone 2 CA Distance Function	Z2CA
71	Zone 3 AB Distance Function	Z3AB
72	Zone 3 BC Distance Function	Z3BC
73	Zone 3 CA Distance Function	Z3CA
74	Zone 4 AB Distance Function	Z4AB
75	Zone 4 BC Distance Function	Z4BC
76	Zone 4 CA Distance Function	Z4CA
77	Any Zone 1 Phase Distance Function	Z1PH
78	Any Zone 2 Phase Distance Function	Z2PH
79	Any Zone 3 Phase Distance Function	Z3PH
80	Any Zone 4 Phase Distance Function	Z4PH
81	Zone 1 AG Distance Function	Z1AG
82	Zone 1 BG Distance Function	Z1BG
83	Zone 1 CG Distance Function	Z1CG
84	Zone 2 AG Distance Function	Z2AG
85	Zone 2 BG Distance Function	Z2BG
86	Zone 2 CG Distance Function	Z2CG
87	Zone 3 AG Distance Function	Z3AG
88	Zone 3 BG Distance Function	Z3BG
89	Zone 3 CG Distance Function	Z3CG
90	Zone 4 AG Distance Function	Z4AG
91	Zone 4 BG Distance Function	Z4BG
92	Zone 4 CG Distance Function	Z4CG
93	Any Zone 1 Ground Distance Function	Z1GRD
94	Any Zone 2 Ground Distance Function	Z2GRD
95	Any Zone 3 Ground Distance Function	Z3GRD
96	Any Zone 4 Ground Distance Function	Z4GRD
129	Zone 2 Ground Timer	Z2GTMR
130	Zone 3 Ground Timer	Z3GTMR
131	Zone 4 Ground Timer	Z4GTMR
132	Zone 2 Phase Timer	Z2PTMR
133	Zone 3 Phase Timer	Z3PTMR
134	Zone 4 Phase Timer	Z4PTMR
106	TL1 Timer Output	TL1
124	TL16 Timer Output	TL16
125	TL24 Timer Output	TL24
128	TL25 Timer Output	TL25
126	Ground Forward Flag (NT)	GRDFWD
127	Ground Reverse Flag (NB)	GRDREV

Table 13–7: CURRENT AND VOLTAGE UNITS

INDEX	DESCRIPTION	MNEMONIC
103	Any Phase Undervoltage	ANYUVT
104	All Voltage High (No Phase Undervoltage)	ALLVLT
105	Fault Detector (FD)	FLTDET
107	IT Detector	IT
108	IB Detector	IB
109	IPT Detector	IPT
110	IPB Detector	IPB
111	Remote Breaker Open Detector	REMOPN
112	Ground Directional Trip (NT AND IPT)	GRDTRP
113	Ground Directional Block (NB AND IPB)	GRDBLK
116	Instantaneous Phase Overcurrent (50P/PH4)	50
117	Instantaneous Ground Overcurrent (50G/IDT)	50G
118	Ground Time Overcurrent Pick-Up	TOCACT
119	Ground Time Overcurrent Trip (51G/TOC)	TOCTRP

Table 13–8: MISCELLANEOUS

INDEX	DESCRIPTION	MNEMONIC
137	Sync Check	SYNC
138	Number of Breaker Operation Alarm	BRMNOP
139	Breaker Equipment Duty Alarm	BRMNDT
60	Fault ID: Phase A Involved	DAFLTA
61	Fault ID: Phase B Involved	DAFLTB
62	Fault ID: Phase C Involved	DAFLTC
63	Fault ID: Neutral Involved	DAFLTN
64	DMA Overrun	DMAOVR
147	Trip Circuit #1 Voltage Monitor Status	T1TC
148	Trip Circuit #2 Voltage Monitor Status	T2TC
149	Trip Circuit #3 Voltage Monitor Status	T3TC
150	Trip Circuit #4 Voltage Monitor Status	T4TC

Table 13–9: USER DEFINABLE OUTPUT FLAGS

INDEX	DESCRIPTION	MNEMONIC
-	Trip Contacts	T1 to T6
-	Auxiliary Contacts	A1 to A12
-	Control Contacts	C1 to C2
-	High Speed Channel Contacts	KT1 to KT4
-	User Defined Trip	CONFTRIP
-	User Defined Oscillography Capture	CONFOSC
-	User Defined Non-Critical Alarm	NC Alarm

13.4.1 DESCRIPTION

In the Xpression Builder program, Select **File** followed by **New**. A menu window for ALPS / LPS / DFP200 options will be displayed as shown in Figure 13–6: CREATING A NEW FILE. For examination purposes, select **LPS 3-Pole Configurable Logic**. A working screen will be displayed for an LPS-D Three Phase Tripping unit.

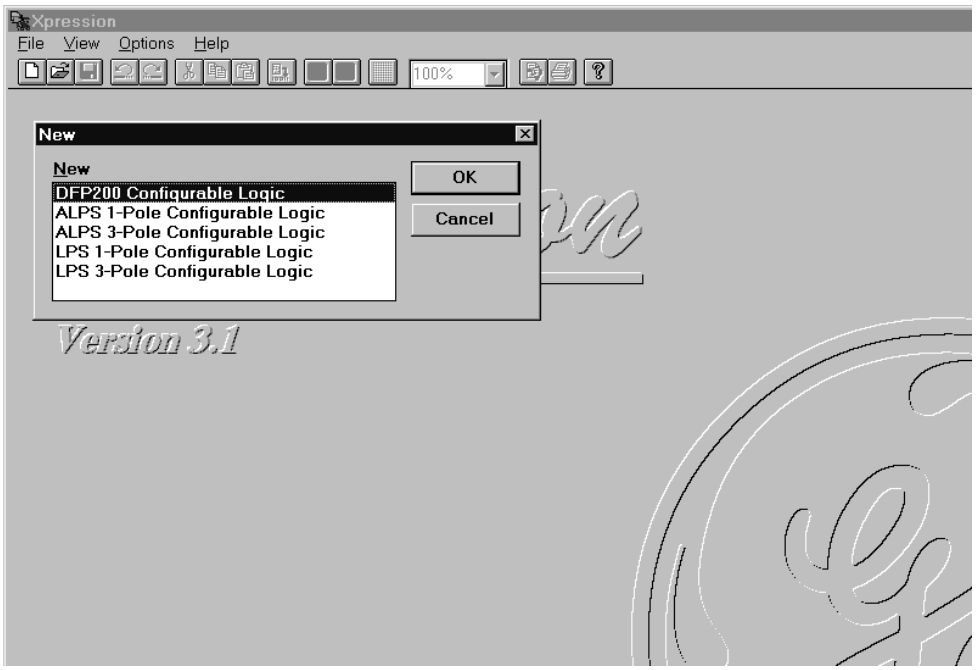


Figure 13–6: CREATING A NEW FILE

The next step in the design of configurable logic is to determine the need for digital inputs. Typical inputs assigned to contact converters are channel receivers and 52_b contacts. Other inputs can come from external contacts, other relay outputs, or the feedback of one of the LPS-D outputs to an input. The list of available contact converter input assignments can be found in Table 13–2: CONTACT CONVERTER INPUT FLAGS. In effect, this process does nothing more than associate a given digital input with a name that Xpression Builder can use. Selection of the contact converter (CC) box, for example CC1, with the left mouse button will activate a pull down menu from where flags can be assigned to the respective input as shown in Figure 13–7: CONTACT CONVERTER INPUTS (CC). Double clicking on the CC box near the input bar with the right mouse button will give the input an inverted sense and a NOT logical gate will appear on the input bar as shown in Figure 13–8: INVERTED CC INPUTS. A straight input will require a pickup voltage presence to be considered a high input (logic 1). An inverted input will require a pickup voltage presence to be considered a low input (logic 0).

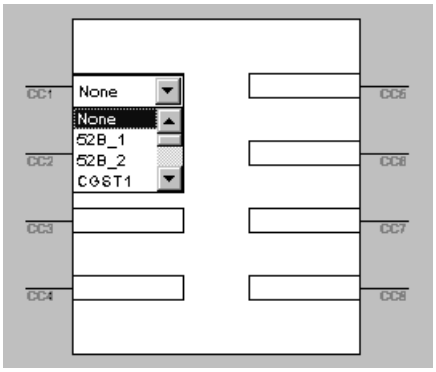


Figure 13–7: CONTACT CONVERTER INPUTS (CC)

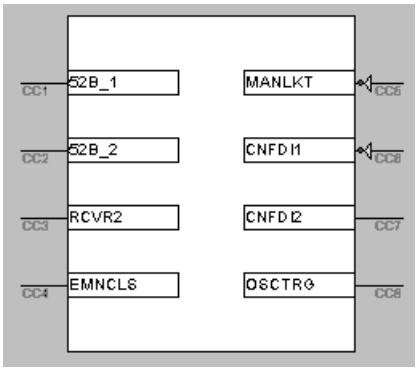


Figure 13–8: INVERTED CC INPUTS

The next step is to take advantage of the internal protection flags in the relay, and put them to work in logical combinations necessary to your specific application. Select the **Input** flags icon as shown below. The input flags are listed by group beginning with Table 13–3: CONFIGURABLE INPUTS. You can move between groups by using the mouse to scroll through the pull-down menu. Simply select the flag by clicking the left mouse button. Move the cursor to the location where the flag is going to be used and click the left mouse button again. This action will place the flag at the desired location.

Figure 13–9: INPUT, OPERATOR, AND OUTPUT ICONS

Select the **Operator** icon as shown above. The available operators are AND, OR, NOT, Latches, Counters, PD Timers, and Timers. Simply select the operator by clicking the left mouse button. Move the cursor to the location where the operator is going to be used and click the left mouse button again. This action will place the operator at the desired location.

The next step is selecting the output contacts which will be used in the relay application. Select the **Output** flag icon as shown above. The output contacts are listed in Table 13–9: USER DEFINABLE OUTPUT FLAGS. Select the output flag by clicking the left mouse button. Move the cursor to the location where the flag is going to be used and click the left mouse button again. This action will place the flag at the desired location.

Start connecting the inputs to the Boolean operators and to the output gates. To use straight line connections, select the **Connection** icon as shown below. To use orthogonal line connections, select the **Orthoconnection** icon as shown in below. Once the type of connection is selected, click the left mouse button on an input or Boolean operator output connection stud. Move the mouse and click the left button on the connection stud of an output or the input of a Boolean operator.

If all the inputs are connected to logic gates and/or output contacts, the logic is ready for compilation.

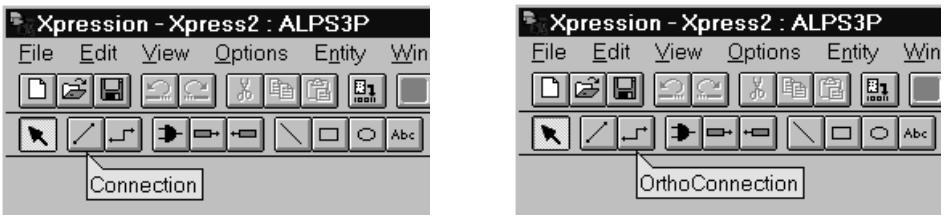


Figure 13–10: STRAIGHT AND ORTHO-CONNECTION ICONS

13.4.2 COMPILING AND DOWNLOADING XPRESSION BUILDER LOGIC

Once the logic has been created you are ready to compile. Under the **File** header, select **Compile**. If you are connected to the relay at the time you can download the logic to the relay by selecting the **Download** command under the **File** header. After you compile the logic, under the **File** header, select **Save_As** and give the file a name with a .BIN extension. The BIN file is a binary formatted file which is downloaded to the relay. A user should also save the logic with an .EXP extension. The EXP file saves the graphical layout of the logic. When both formats are saved, the logic uploaded from the relay can be matched to the graphical layout saved for the configurable logic file (Note: when Xpression Builder is launched, it prompts the user for the location of the EXP file; if the EXP file was not created, select **Cancel** and Xpression Builder will give the relay logic a graphical layout which is logically correct, but may have a poor layout).

13.4.3 BREAKER FAILURE EXAMPLE

The figure below is an example of a simple breaker failure scheme which can be implemented in the relay using Xpression Builder logic. Use the description in the previous sections to select the external contact input to block pilot tripping (BPLTRIP), the external configurable input (CNFDI1), the internal block supervision current flag (IB), the Boolean operators (OR, AND, and P/D Timer), and the output contact (A1).

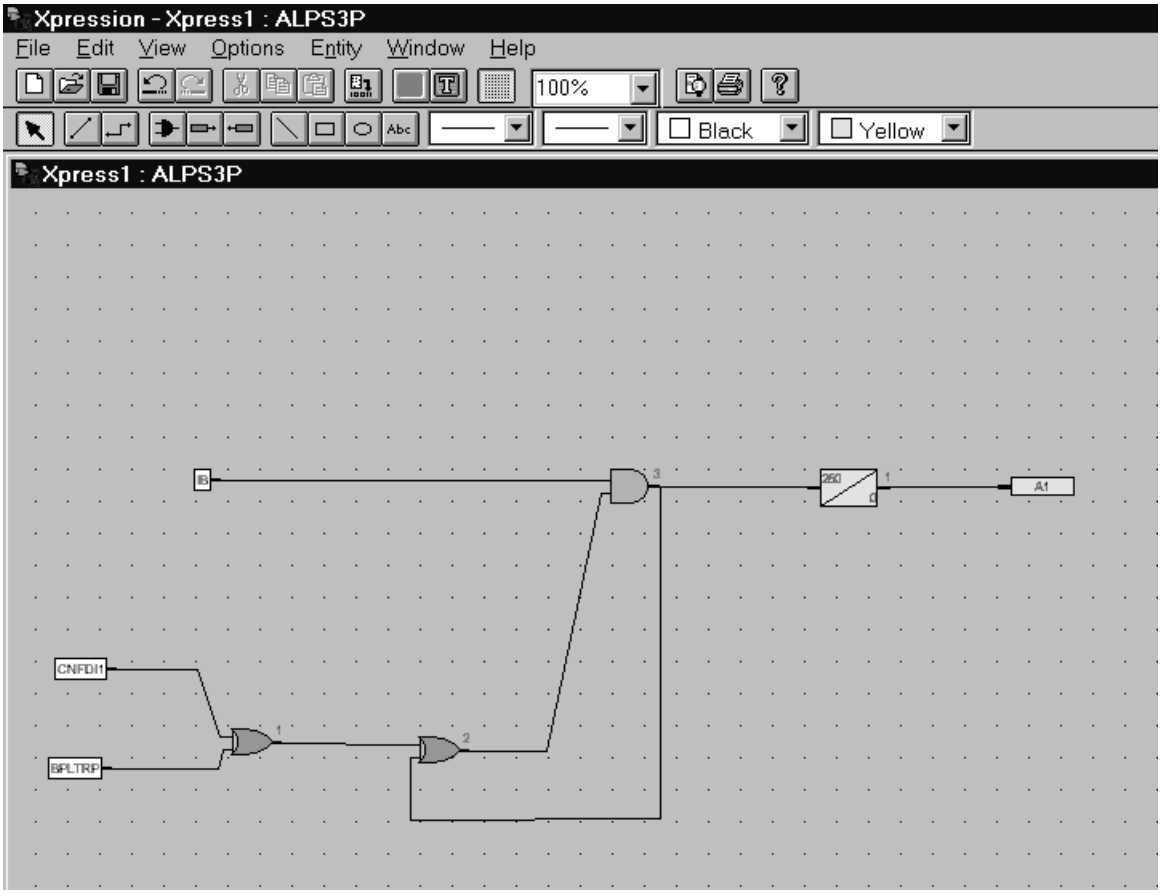


Figure 13–11: SAMPLE BREAKER FAILURE LOGIC

14.1.1 INSTALLATION

The ALPS-SET program can be installed from the GE Products CD or downloaded from the GE Power Management website at www.GEindustrial.com/pm. See Section 11.2.4 SOFTWARE INSTALLATION on page 11–4 for installation instructions.

14.1.2 STARTING THE PROGRAM

- Open the LPS-D PC Programs Software Folder
- Click on ALPS-SET
- After reading the Disclaimer, click on the OK button. The following dialog box is displayed:

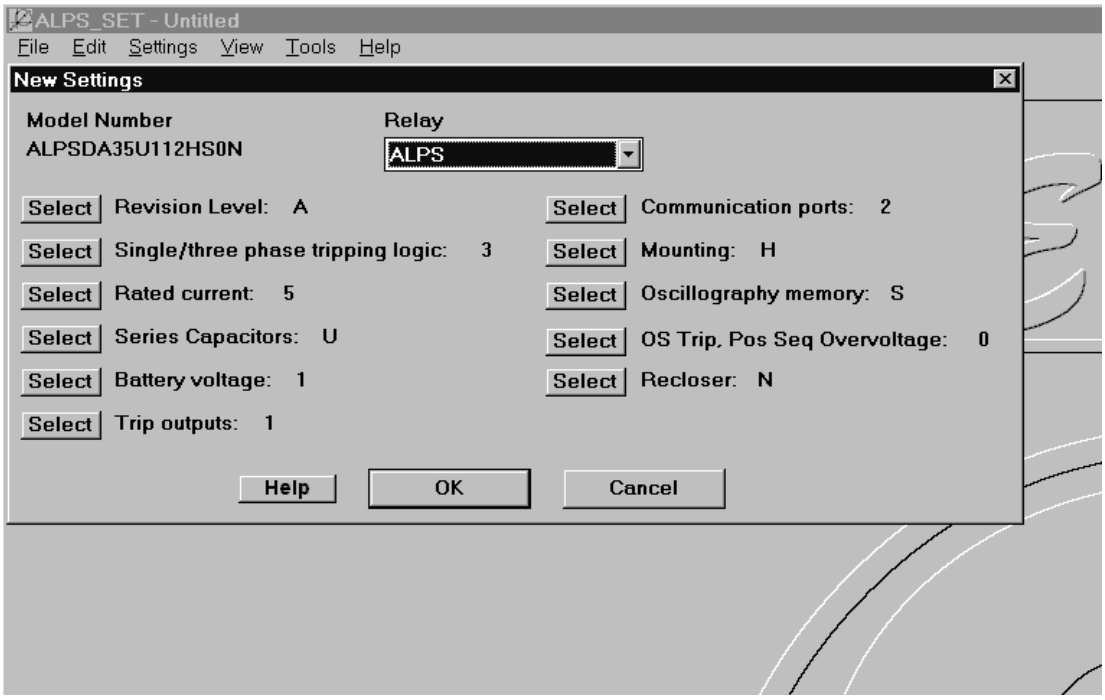


Figure 14–1: NEW SETTINGS DIALOG BOX

The **Select** button for the Revision Level displays the following dialog box (the list of items to select from will be different for different **Select** buttons).

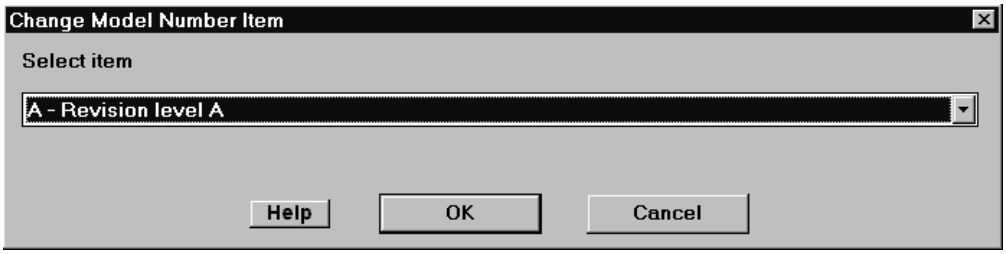


Figure 14–2: CHANGE MODEL NUMBER ITEM DIALOG BOX

For each **Select** button in the **New Settings** dialog box, select an item that is different from the currently selected item in the drop down list box and select **OK**. Verify that:

- The model number changes
- The new selection is displayed to the right of the **Select** button.

For one **Select** button, select an item that is different from the currently selected one in the drop down list box and select **Cancel**. Verify that:

- The model number does not change
- The new selection that is displayed to the right of the **Select** button does not change.

Select **OK** to create settings for the model number. Verify that the **Select Protection Scheme** dialog box is displayed as follows:

Figure 14–3: SELECT PROTECTION SCHEME DIALOG BOX

Note that there is no **Cancel** button. For new settings, the user must make a scheme selection. Click on the **Help** button. This displays the help text for the **Select Protection Scheme** dialog box.

Select a scheme and click **OK**. An instruction box provides instructions on changing the selected scheme. For the STEPDST scheme, choose the **Settings > Protection Settings** menu item. The **Change Settings – Protection** dialog box is displayed. Individual settings for the scheme selected may now be changed.

- Note that only the protection settings that apply to the model number and the firmware version are displayed in the list box.

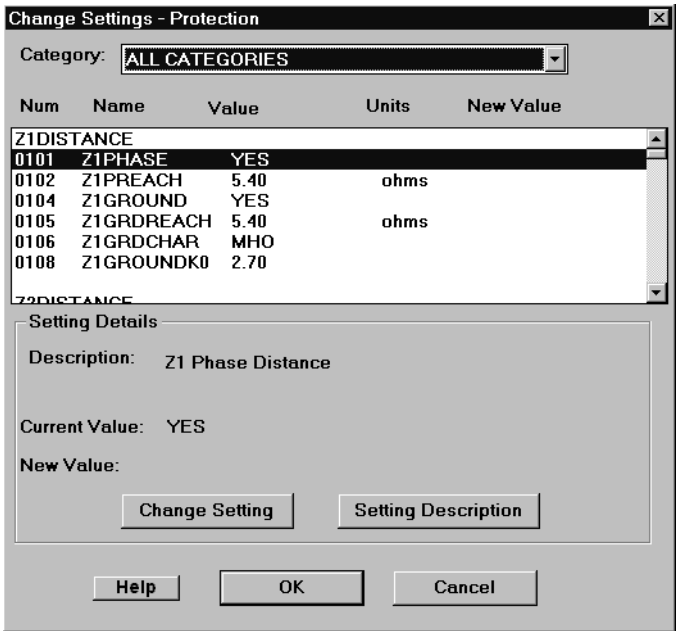


Figure 14–4: CHANGE SETTINGS – PROTECTION DIALOG BOX

Click on the **Change Setting** button in the **Change Settings – Protection** dialog box. This displays the **Change Setting Value** dialog box:

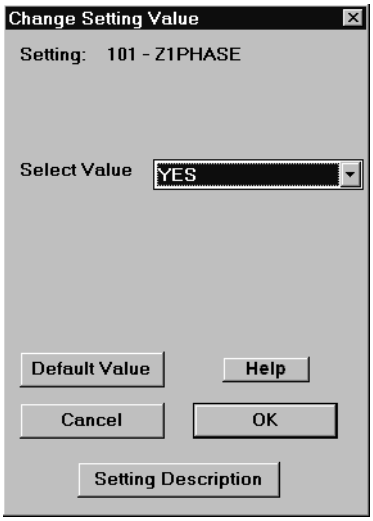


Figure 14–5: CHANGE SETTING VALUE DIALOG BOX

- Each setting may be individually changed by selecting the setting and entering the required value. The range of the setting is displayed.
- The help command will give you detailed information about the setting to be changed.
- If a setting is selected that has specific values, the following dialog box is displayed.

Select **Cancel** to close the **Change Settings – Protection** dialog box.

Select **Save Settings** from the **File** menu. The **Save Settings As** dialog box is displayed since this is a new settings file and has not yet been given a name. Select **Cancel**.

14.1.3 PRINT SETTINGS REPORT

Select **Print Settings Report** from the **File** menu. The **Select Categories** dialog box is displayed as follows.

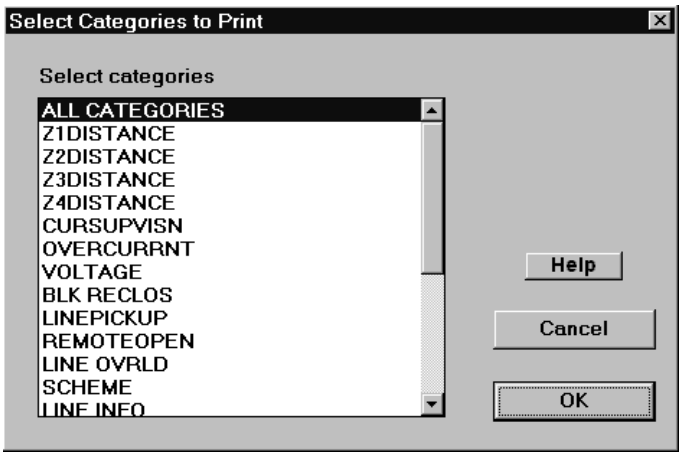


Figure 14–6: SELECT CATEGORIES TO PRINT DIALOG BOX

Select the desired categories and click on the **OK** button.

14.1.4 EDIT MENU – COPY SETTINGS REPORT

Select **Copy Settings Report** from the **Edit** menu. The **Select Categories** dialog box is displayed as shown in Section 14.1.3: PRINT SETTINGS REPORT.

The dialog box title is now titled **Select Categories to Copy**. Select **ALL CATEGORIES** from the **Select Categories** list box to copy all categories.

14.1.5 TOOLS MENU

There is one menu item – **Setup**. Click on **Setup** and the following dialog box is displayed.

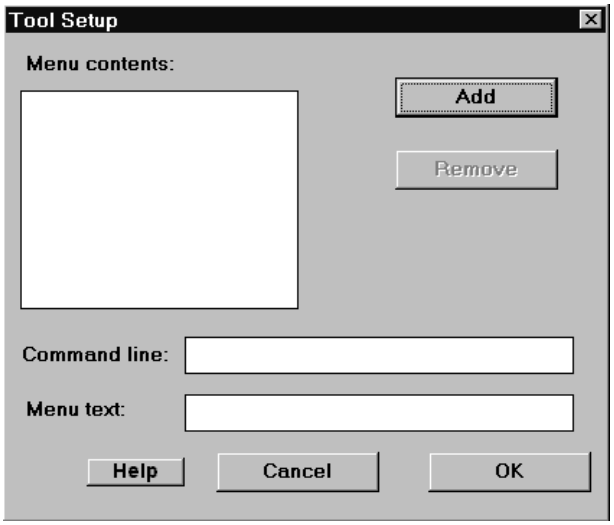


Figure 14–7: TOOL SETUP DIALOG BOX

Any Microsoft compatible tool can be added to the toolbar by selecting **Add** and browsing for the tool.

14.1.6 HELP MENU

Select **Contents** from the **Help** menu. A help screen is displayed that lists the contents of the help system. Any item that is green can be clicked on to view that topic. Verify that each topic has the appropriate explanation.

The **Using Help** menu item aids in calculating the settings. By selecting the setting you need help on, the instruction book text is displayed to inform the user how to calculate the setting.

Select **About ALPS_SET** from the **Help** menu. The following dialog box is displayed:

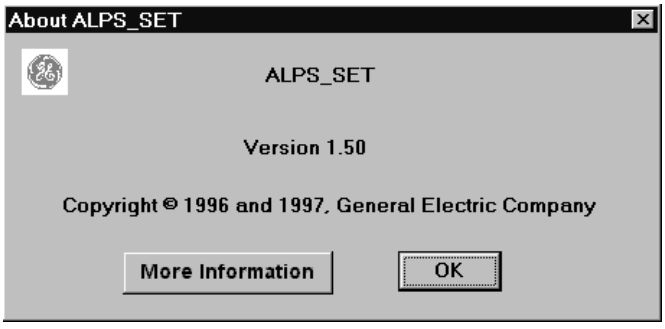


Figure 14–8: ABOUT ALPS-SET DIALOG BOX

The version number and dates may be different than shown above.

Why doesn't the relay accept the default LUI passwords?

A new relay comes with LUI (Local User Interface) and remote factory setting passwords. The master factory setting password must be changed in order to login and perform actions with the relay through the keypad. To change a factory setting password, perform the following steps:

1. Press the action key [ACT]
2. Press the enter key [ENT]; no password is required
3. Scroll down the menu to item **10. CHANGE PASSWORD**
4. Press the [ENT] key
5. Select the password to be changed
6. Enter the factory password
7. Enter your new password
8. Re-enter your new password
9. Logout by pressing the [END] key followed by the [ENT] key
10. The factory setting password has now been successfully changed

What are the LUI and remote factory setting passwords?

The LUI factory passwords for the different privilege levels are:

- **789.** (master)
- **456.** (actions)
- **123.** (settings)

Note: the period is part of the password!

The LUI passwords stored in the relay may be viewed, in encoded format, via remote communications. The remote factory passwords for the different privilege levels are

- **master!** (master)
- **actions!** (actions)
- **setting!** (setting)
- **view!** (view)

The remote passwords stored in the relay may be viewed, in encoded format, via the LUI.

Why can't I communicate with the relay using ALPS-Link?

If you are unable to communicate with the LPS-D relay using ALPS-Link, perform the following checks:

- Verify the ALPS-Link program is selected for the comm port you are using on your PC or laptop
- Verify the cable you are using is a null modem cable
- Verify the protocol of the relay comm port you are using is set for GE-Modem. Note: rear port PL2A is factory set for ASCII.
- Verify the unit ID, baud rate, stop bits, and parity settings of the relay comm port you are using to match with the settings in the device setup for the ALPS-Link session.

What would I do if the LPS-D gives a red LED status indication?

If the LPS-D relay displays a red LED status, prompt the relay for failure messages. Press the information key (INF) and select Status. Scroll down the list and write the failure messages of the relay. Protection is not active when the Status LED is red. This condition could indicate a critical failure: contact GE.

In which format should I save Xpression Builder configurable logic?

When configurable logic is created with Xpression Builder, it must be saved with a .BIN extension. The BIN file is a binary formatted file which is downloaded to the relay. The user should *also* save the logic with an .EXP extension. The EXP file saves the graphical layout of the logic. When both formats are saved, the logic uploaded from the relay can be matched to the graphical layout saved for the configurable logic file. If an EXP file is not created, Xpression Builder will give the relay logic a graphical layout which is logically correct, but may have a poor layout.

Which do I download first: Xpression Builder configurable logic or relay settings?

First, download protection and general settings using the ALPS-Link program. Secondly, download the configurable logic into the relay. The order of these two steps is important because downloading configurable logic or settings change the inputs and outputs of the relay. The last settings downloaded are saved in the relay.

Does ALPS-Link work with Windows NT?

Yes. ALPS-Link versions 3.30304 and later work on Windows 3.1, Windows 95, and Windows NT platforms. The install program will look to see what operating system the user is running and will install the correct executable.

Are the Trip Output Contacts (T1 to T4/T6) polarity sensitive?

Yes. The Trip Output Contacts are polarity sensitive even if the user does not have an SCR model. The internal circuitry requires the correct polarity for the trip circuit monitor function to operate properly. The contact polarities are shown in Figures 1–22: ELEMENTARY DIAGRAM WITH DEFAULT I/O ASSIGNMENTS and 1–23: ELEMENTARY DIAGRAM.

Can I create a settings file without having a relay?

Yes. The LPS-D PC software package includes a program called ALPS-SET which allows you to create a settings file based upon your relay model number. See Chapter 14: ALPS-SET PC SOFTWARE.

Can I plot the phase and ground characteristics of my settings for the relay?

Yes. The LPS-D PC software package includes a program called ALPS-Test which allows you to plot the phase and ground characteristics from your settings file. See Chapter 10: ALPS TEST PROGRAM.

What format should I choose when saving oscillography data?

If you use the GE-DATA program to view oscillography, save the data in DAFF format. For other comtrade compatible viewers, save the data in the COMTRADE format. Note: a readme file in the LPS/UTIL directory describes the procedure to convert LPS-D oscillography for use with the DL-DATA program.

Why are so many files created when I save oscillography data?

Several files are created when oscillography data is retrieved from the relay because they each serve different purposes.

Saving data in the DAFF format creates an OSC, DAF, and REP file. The OSC file is used to playback a waveform to the relay. The DAF file is used by the GE-DATA program to view the waveforms and flags within the relay. The REP file contains the fault report and settings in the relay at the time of the fault.

Saving data in the COMTRADE format creates an OSC, HDR, CFG, DAT, ASC, and REP file. The OSC file is used to playback a waveform to the relay. The HDR file contains the fault report and the settings in the relay at the time of the fault. The CFG file contains the configuration of the data such as sample rate and description of channels. The DAT file contains the actual oscillography data in a binary format. The ASC file contains the oscillography data in an ASCII format. The REP file contains instructions on saving the oscillography data.

To view the latest version of this FAQ and other documents, visit the GE Power Management Home page at www.ge.com/indsys/pm.

A

B.1.1 FIXED VALUES

Table B–1: MODBUS MEMORY MAP: FIXED VALUES

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R40000	COMMAND_FW_REV	CommCard firmware revision		RO	2 hex bytes with period implied between higher and lower bytes
R40001	REPORT_PKT_SIZE	Oscillography Report Packet Size	192 bytes	RO	unsigned unit
R40002S16	MODEL_NUMBER	Model Number	16 bytes	R0	S16
R40010S12	PROM_VERSION	PROM Version	12 bytes	RO	S12
R40016S16	SERIAL_NUMBER	Serial Number	16 bytes	RO	S16

B.1.2 COMMAND COILS

Table B–2: MODBUS MEMORY MAP: COMMAND COILS

Register Address	DDE Item Name (Mnemonic)	Contents	R/W	Modbus Usage
R00500	OP_BKR_1	Operate Breaker 1	WO	Force ON Value to close breaker: 0xFF00 Force OFF Value to trip breaker: 0x0000
R00501	OP_BKR_2	Operate Breaker 2	WO	Force ON Value to close breaker: 0xFF00 Force OFF Value to trip breaker: 0x0000
R00502	ENABLE_OUTPUT	Enable/Disable Outputs	WO	Force ON – F26 Value to close breaker: 0xFF00 Force OFF – F26 Value to trip breaker: 0x0000
R00503	TRIGGER_OSC	OSC Trigger	WO	Value to trigger oscillography: 0xFF00
R00504	CANCEL_REPORT	Cancel Report	WO	Value to cancel active report: 0xFF00
R00505	CHANNEL_TEST	Channel Test	WO	Value to start test: 0xFF00 Value to stop test: 0x0000

B

Table B–3: MODBUS MEMORY MAP: DYNAMIC VALUES (Sheet 1 of 3)

Register Address	DDE Item Name (Mnemonic)	Contents	Range	Units	R/W	Format Code
R31000L	DATE_DYN	Date			RO	F1
R31002L	TIME_DYN	Time			RO	F2
R31004F	VA_RMS	Va RMS	0 to 9999x10^6	KiloVolts *	R0	Float
R31006F	VB_RMS	Vb RMS	0 to 9999x10^6	KiloVolts *	RO	Float
R31008F	VC_RMS	Vc RMS	0 to 99999x10^6	KiloVolts *	RO	Float
R31010F	IA_RMS	Ia RMS	0 to 99999x10^6	Amps	RO	Float
R31012F	IB_RMS	Ib RMS	0 to 99999x10^6	Amps	RO	Float
R31014F	IC_RMS	Ic RMS	0 to 99999x10^6	Amps	RO	Float
R31016F	IN_RMS	In RMS	0 to 99999x10^6	Amps	RO	Float
R31018F	VA_DYN	Va	0 to 9999x10^6	KiloVolts *	RO	Float
R31020I	ANGLE_VA	Angle Va	-999 to 999	Degrees	RO	INT
R31021F	VB_DYN	Vb	0 to 99999x10^6	KiloVolts *	RO	Float
R31023I	ANGLE_VB	Angle Vb	-999 to 999	Degrees	RO	INT
R31024F	VC_DYN	Vc	0 to 99999x10^6	KiloVolts *	RO	Float
R31026I	ANGLE_VC	Angle Vc	-999 to 999	Degrees	RO	INT
R31027F	IA_DYN	Ia	0 to 99999x10^6	Amps	RO	Float
R31029I	ANGLE_IA	Angle Ia	-999 to 999	Degrees	RO	INT
R31030F	IB_DYN	Ib	0 to 99999x10^6	Amps	RO	Float
R31032I	ANGLE_IB	Angle Ib	-999 to 999	Degrees	RO	INT
R31033F	IC_DYN	Ic	0 to 99999x10^6	Amps	RO	Float
R31035I	ANGLE_IC	Angle Ic	-999 to 999	Degrees	RO	INT
R31036F	IN_DYN	In	0 to 99999x10^6	Amps	RO	Float
R31038I	ANGLE_IN	Angle In	-999 to 999	Degrees	RO	INT
R31039F	WATTS	Watts Real Power	–99999x10^6 to 99999x10^6	Watts	RO	Float
R31041F	VARS	Vars	–99999x10^6 to 99999x10^6	Vars	RO	Float
R31043F	PF	pf	-1 to 1		RO	Float
R31045F	FREQ	Frequency	0 to 60	Hertz	RO	Float
R31047I	ACT_PROT_GRP_ NUMBER	Active Setting Group	1 to 4		RO	INT
R31048I	NO_BRKRS	Number of Breakers	1 to 2		RO	INT
R31049I	BKR_1A	Brk1/1A			RO	F3
R31050I	BKR1B	Brk1B			RO	F3
R31051I	BKR1C	Bkr1C			RO	F3

Table B–3: MODBUS MEMORY MAP: DYNAMIC VALUES (Sheet 2 of 3)

Register Address	DDE Item Name (Mnemonic)	Contents	Range	Units	R/W	Format Code
R31052I	BKR2_2A	Bkr2/2A			R0	F3
R31053I	BKR2B	Bkr2B			R0	F3
R31054I	BKR2C	Bkr2C			R0	F3
R31055F	PHA_EQP_DTY	PhA Eqp Duty			R0	Float
R31057	PHA_MULTIPLIER	PhA Multiplier			R0	F49
R31058F	PHB_EQP_DTY	PhB Eqp Duty			R0	Float
R31060	PHB_MULTIPLIER	PhB Multiplier			R0	F49
R31061F	PHC_EQP_DUTY	PhC Eqp Duty			R0	Float
R31063	PHC_MULTIPLIER	PhC Multiplier			R0	F49
R31064I	PHA_NUM_BKR_OP	PhANumBkrOp			R0	INT
R31065I	PHB_NUM_BKR_OP	PhBNumBkrOp			R0	INT
R31066I	PHC_NUM_BKR_OP	PhCNumBkrOp			R0	INT
R31067	STOP_CARRIER	Stop Carrier			R0	F4
R31068	BLK_PLT_TRP	Blk plt trp			R0	F4
R31069	RECLS_STATE	Recls State			R0	F5
R31070	EVN_FLT_FLG	Evn/Flt flg			R0	F50
R31071	EEP_960STAT1	EEP_960STAT1			R0	F6
R31072	EEP_960STAT2	EEP_960STAT2			R0	F7
R31073	EEP_ANISTAT	EEP_ANISTAT			R0	F8
R31074	EEP_DSPSTAT	EEP_DSPSTAT			R0	F9
R31075	EEP_MISCSTAT1	EEP_MISCSTAT1			R0	F10
R31076	EEP_MISCSTAT2	EEP_MISCSTAT2			R0	F11
R31077	OUTPUT_STATUS	STATUS BITS for Output			R0	F28
R31079	CC_STATUS	STATUS BITS for Contact Converters			R0	F27
R31080	DOWNLOAD_STATUS	Download Status			R0	F20
R31081	PRIM_SEC_FLAG	Primary / Secondary Flag			R0	F60
R31131A3	CONTROL_ITEM				R0	A3
R31131	NUM_FIFO_REG_ AVAIL	Number of FIFO registers available			R0	
R31132A2	MONITOR_ITEM	Monitor Item			R0	A2
R31132	ACT_REPORT_TYPE	Active Report Type			R0	
R31133	REPORT_STATUS	Report Status Register			R0	
R31134		OST Report Available	0 – not available 1 – available		R0	
R31501A7	OSC_STATUS_DATA	Waveform Server Fault Data			R0	A7
R31501L	FAULT_1_DATE	Fault Date			R0	F1
R31503L	FAULT_1_TIME	Fault Time			R0	F2
R31505	FAULT_1_DATA	Fault Data			R0	F14

Table B–3: MODBUS MEMORY MAP: DYNAMIC VALUES (Sheet 3 of 3)

Register Address	DDE Item Name (Mnemonic)	Contents	Range	Units	R/W	Format Code
R31506F	FAULT_1_DIST	Fault Distance		†	RO	Float
R32001		Date (Event 1)		MM/DD/YY	RO	F1
R32003		Time (Event 1)		HH:MM:sec.ms	RO	F2
R32005		Event Code (Event 1)			RO	F61

† See the Line Units Setpoint Register for the units of Fault Distance

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 1 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43000L	DATE_SET	Date		R/W	F1
R43002L	TIME_SET	Time		R/W	F2
R43026I	SYS_FREQUENCY	SYSFREQ	Hertz; 50 or 60	R/W	INT
R43027I	PH_ROTATE	PHASEROTATE	0 = ABC; 1 = ACB	R/W	INT
R43028I	TIME_SYNCH	TIMESYNCH	0 = internal; 1 = external	R/W	INT
R43029I	NUM_BKR	NUM_BKR	1, 2	R/W	INT
R43030I	NUM_TC	NUM_TC	1, 2	R/W	INT
R43031I	NUM_MON	NUM_MON		R/W	INT
R43032I	DISP_VAL	DISPLAYVAL		R/W	F60
R43033I	LANGUAGE	Language	0 = English; 1 = Spanish	R/W	INT
R43034I	COM_PORT1	COMPORT1		R/W	F12
R43035I	COM_PORT2	COMPORT2		R/W	F13
R43036I	COM_PORT3	COMPORT3		R/W	F13
R43037I	NUM_FAULTS	NUMFAULTS	7, 14, 28, 40	R/W	INT
R43038I	SET_PREFAULT	PREFAULT	1 to 8	R/W	INT
R43039I	SPLIT_REC	SPLITREC	0 to 100%	R/W	INT
R43040F	EXPONENT	EXPONENT	1.0 to 2.0	R/W	Float
R43042I	MAX_OP	MAX_OP	0 to 9999	R/W	INT
R43043F	MAX_IXT	MAX_IXT	0 to 999.9M	R/W	Float
R43045F	IXT_PH_A	IXTPHASEA	0 to 999.9M	R/W	Float
R43047F	IXT_PH_B	IXTPHASEB	0 to 999.9M	R/W	Float
R43049F	IXT_PH_C	IXTPHASEC	0 to 999.9M	R/W	Float
R43051I	NUM_OP	NUM_OP	0 to 9999	R/W	INT
R43052I	NUM_OP_A	NUM_OP_A	0 to 9999	R/W	INT
R43053I	NUM_OP_B	NUM_OP_B	0 to 9999	R/W	INT
R43054I	NUM_OP_C	NUM_OP_C	0 to 9999	R/W	INT
R43055I	CC_1	CC_1	0 to 32	R/W	INT
R43056I	CC_2	CC_2	0 to 32	R/W	INT
R43057I	CC_3	CC_3	0 to 32	R/W	INT
R43058I	CC_4	CC_4	0 to 32	R/W	INT
R43059I	CC_5	CC_5	0 to 32	R/W	INT
R43060I	CC_6	CC_6	0 to 32	R/W	INT
R43061I	CC_7	CC_7	0 to 32	R/W	INT
R43062I	CC_8	CC_8	0 to 32	R/W	INT
R43063I	CC_9	CC_9	0 to 32	R/W	INT
R43064I	CC_10	CC_10	0 to 32	R/W	INT
R43065I	CC_11	CC_11	0 to 32	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 2 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43066I	CC_12	CC_12	0 to 32	R/W	INT
R43070I	ACT_SET_GRP	Active Settings Group	1 to 4	R/W	INT
R43071I	RESET_TYPE	Reset Type		R/W	F43
R43079S32	STATION_ID	Station ID		R/W	ASCII
R43095S32	LINE_ID	Line ID		R/W	ASCII
R43120I	G1_Z1PHASE	Z1PHASE	0 = No; 1 = Yes	R/W	INT
R43121F	G1_Z1PHREACH	Z1PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43123F	G1_Z1PLEVDET	Z1PLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R43125I	G1_Z1GROUND	Z1GROUND	0 = No; 1 = Yes	R/W	INT
R43126F	G1_Z1GRDREACH	Z1GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43128I	G1_Z1GRDCHAR	Z1GRDCHAR	0 = Mho; 1 = React	R/W	INT
R43129F	G1_Z1SUREACH	Z1SUREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43131F	G1_Z1GROUNDK0	Z1GROUNDK0	1.0 to 7.0 step 0.1	R/W	Float
R43133F	G1_Z1GLEVDET	ZIGLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R43135I	G1_Z1BLOCK	Z1BLOCK	0 = No; 1 = Yes	R/W	INT
R43136I	G1_Z2PHASE	Z2PHASE	0 = No; 1 = Yes	R/W	INT
R43137F	G1_Z2PHREACH	Z2PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43139I	G1_Z2PCHARANG	Z2PCHARANG	90 to 120° step 5	R/W	INT
R43140I	G1_Z2GROUND	Z2GROUND	0 = No; 1 = Yes	R/W	INT
R43141I	G1_Z2GRDCHAR	Z2GRDCHAR	0 = MHO; 1 = GDOC; 2 = MHOGDOC	R/W	INT
R43142F	G1_Z2GRDREACH	Z2GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43144I	G1_Z2GCHARANG	Z2GCHARANG	90 to 120° step 5	R/W	INT
R43145I	G1_Z2TIMERS	Z2TIMERS	0 = No; 1 = Yes	R/W	INT
R43146F	G1_Z2P_TIME	Z2P_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R43148F	G1_Z2G_TIME	Z2G_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R43150I	G1_Z3PHASE	Z3PHASE	0 = No; 1 = Yes	R/W	INT
R43151F	G1_Z3PHREACH	Z3PHREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43153I	G1_Z3PCHARANG	Z3PCHARANG	90 to 120° step 5	R/W	INT
R43154I	G1_Z3GRND	Z3GRND	0 = No; 1 = Yes	R/W	INT
R43155F	G1_Z3GRDREACH	Z3GRDREACH	0.01 to 50.0 W step 0.1 (5A) 0.05 to 250.0 W step 0.05 (1A)	R/W	Float
R43157I	G1_Z3GCHARACHAG	Z3CHARCHAG	90 to 120° step 5	R/W	INT
R43158F	G1_Z3P_TIME	Z3P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 3 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43160F	G1_Z3G_TIME	Z3G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43162I	G1_Z4PHASE	Z4PHASE	0 = No; 1 = Yes	R/W	INT
R43163F	G1_Z4PHREACH	Z4PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43165I	G1_Z4PCHRANG	Z4PCHRANG	80 to 120° step 5	R/W	INT
R43166I	G1_Z4GRND	Z4GRND	0 = No; 1 = Yes	R/W	INT
R43167F	G1_Z4GRDREACH	Z4GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43169I	G1_Z4GCHARANG	Z4GCHARANG	80 to 120° step 5	R/W	INT
R43170I	G1_Z4DIRECTN	Z4DIRECTN	0 = Forward; 1 = Reverse	R/W	INT
R43171I	G1_Z4TIMERS	Z4TIMERS	0 = No; 1 = Yes	R/W	INT
R43172F	G1_Z4P_TIME	Z4P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43174F	G1_Z4G_TIME	Z4G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43176F	G1_IT_PICKUP	IT_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R43178F	G1_IB_PICKUP	IB_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R43180F	G1_IPT_PICKUP	IPT_PICKUP	0.50 to 5.0 A step 0.01 (5A) 0.1 to 1.0 A step 0.01 (1A)	R/W	Float
R43182F	G1_IPB_PICKUP	IPB_PICKUP	0.25 to 3.75 A step 0.01 (5A) 0.05 to 0.75 A step 0.01 (1A)	R/W	Float
R43184F	G1_IPBKFACTOR	IPBKFACTOR	0.0, 0.066	R/W	Float
R43186F	G1_NT_OFFSET	NT_OFFSET	0.0 to 20.0 W step 0.01 0.0 to 100 W step 0.01	R/W	Float
R43188I	G1_UNBALALARM	UNBALALARM	0 = No; 1 = Yes	R/W	INT
R43189I	G1_50	50	0 = No; 1 = Yes	R/W	INT
R43190I	G1_50_DIRCNL	50_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43191F	G1_50PICKUP	50PICKUP	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R43193F	G1_50PICKUPFF	50PICKUPFF	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R43195I	G1_50G	50G	0 = No; 1 = Yes	R/W	INT
R43196I	G1_50G_DIRCNL	50G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43197F	G1_50GPICKUP	50GPICKUP	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R43199F	G1_50GPICKUPFF	50GPICKUPFF	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R43201F	G1_50GRESTNT	50GRESTNT	0.0, 0.3	R/W	INT
R43203I	G1_51G	51G	0 = No; 1 = Yes	R/W	INT
R43204I	G1_51G_DIRCNL	51G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43205F	G1_51GPICKUP	51GPICKUP	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 4 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43207F	G1_51GPICKUPFF	51GPICKUPFF	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R43209I	G1_51GCURVE	51GCURVE	0 = INV; 1 = V-INV; 2 = EINV; 3 = CUSTOM; 4 = DEFT	R/W	INT
R43210F	G1_51GTIMDIAL	51GTIMDIAL	0.5 to 10.0 step 0.1	R/W	Float
R43212F	G1_51GDEFTIMDELY	51GDEFTIMDELY	0.5 to 30 sec. step 0.1	R/W	Float
R43214I	G1_51G_RESET	51G_RESET	0 = FAST; 1 = EM	R/W	INT
R43215I	G1_RATEDVOLTS	RATEDVOLTS	1.00105E+14 V	R/W	INT
R43216I	G1_PHASEOVER	PHASEOVER	0 = No; 1 = Yes	R/W	INT
R43217F	G1_PHOVPICKUP	PHOVPICKUP	0.0 to 1.4 p.u. V step 0.01	R/W	Float
R43219F	G1_PHOVTMDLY	PHOVTMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43221I	G1_V1OVER	V1OVER	0 = No; 1 = Yes	R/W	INT
R43222F	G1_V1OVINSTPU	V1OVINSTPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43224F	G1_V1OVTIMPU	V1OVTIMPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43226F	G1_V1OVTIMDLY	V1OVTIMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43228I	G1_V1COMP	V1COMP	0 = No; 1 = Yes	R/W	INT
R43229F	G1_V1COMRCH	V1COMRCH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43231F	G1_VICOMPINPU	V1COMPINPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43233F	G1_V1COMPTDPU	V1COMPTDPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43235F	G1_V1COMPDLY	V1COMPDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43237I	G1_FUSEFAIL	FUSEFAIL	0 = No; 1 = Yes	R/W	INT
R43238I	G1_ALL_BELOW	ALL_BELOW	0 = No; 1 = Yes	R/W	INT
R43239I	G1_OUTOFSTEP	OUTOFSTEP	0 = No; 1 = Yes	R/W	INT
R43240I	G1_ALL_3_Z2PH	ALL_3_Z2PH	0 = No; 1 = Yes	R/W	INT
R43241I	G1_50G_BLOCK	50G_BLOCK	0 = No; 1 = Yes	R/W	INT
R43242I	G1_Z2TIMETRIP	Z2TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43243I	G1_Z3TIMETRIP	Z3TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43244I	G1_Z4TIMETRIP	Z4TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43245I	G1_Z1PHASTRIP	Z1PHASTRIP	0 = No; 1 = Yes	R/W	INT
R43246I	G1_ANYZ2PHASE	ANYZ2PHASE	0 = No; 1 = Yes	R/W	INT
R43247I	G1_CONFGTRIP	CONFGTRIP	0 = No; 1 = Yes	R/W	INT
R43248I	G1_LINEPICKUP	LINEPICKUP	0 = No; 1 = Yes	R/W	INT
R43249I	G1_BYPASSTL3	BYPASSTL3	0 = No; 1 = Yes	R/W	INT
R43250F	G1_I1PICKPU	I1PICKUP	1.0 to 15.0 A step 0.1 0.2 to 3.0 A step 0.1	R/W	Float
R43252I	G1_REMOTEOPEN	REMOTEOPEN	0 = No; 1 = Yes	R/W	INT
R43253I	G1_TL20PICKUP	TL20PICKUP	10 to 100 msec. step 1	R/W	INT
R43254I	G1_LINEOVERLD	LINEOVERLD	0 = No; 1 = Yes	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 5 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43255F	G1_LEVEL1PU	LEVEL1PU	2.5 to 20.0 A step 0.1 (5A) 0.5 to 4.0 A step 0.1 (1A)	R/W	Float
R43257F	G1_LEVEL2PU	LEVEL2PU	5.0 to 40.0 A step 0.1 (5A) 1.0 to 8.0 A step 0.1 (1A)	R/W	Float
R43259F	G1_LEVEL1TDLY	LEVEL1TDLY	10 to 200 sec. step 1	R/W	Float
R43261F	G1_LEVEL2TDLY	LEVEL2TDLY	10 to 99 sec. step 1	R/W	Float
R43263I	G1_PICKSCHEME	PICKSCHEME	0 = STEPDST; 1 = PUTT; 2 = POTT1; 3 = POTT2; 4 = HYBRID	R/W	INT
R43264I	G1_NUMRCVR	NUMRCVR	0, 1, 2	R/W	INT
R43265I	G1_TRIPMODE	TRIPMODE	0 = 3POLE; 1 = 1POLE; 2 = 1POLEZ2	R/W	INT
R43266I	G1_CARRSTART	CARRSTART	0 = DIR; 1 = IPB; 2 = FD	R/W	INT
R43267I	G1_WKINFTRIP	WKINFTRIP	0 = No; 1= Yes	R/W	INT
R43268I	G1_TL1PICKUP	TL1PICKUP	1 to 200 msec. step 1	R/W	INT
R43269I	G1_TL4PICKUP	TL4PICKUP	0 to 50 msec. step 1	R/W	INT
R43270I	G1_TL4DROPOUT	TL4DROPOUT	0 to 50 msec. step 1	R/W	INT
R43271I	G1_TL5PICKUP	TL5PICKUP	0 to 200 msec. step 1	R/W	INT
R43272I	G1_TL5DROPOUT	TL5DROPOUT	0 to 200 msec. step 1	R/W	INT
R43273I	G1_TL6PICKUP	TL6PICKUP	0 to 200 msec. step 1	R/W	INT
R43274I	G1_TL6DROPOUT	TL6DROPOUT	0 to 200 msec. step 1	R/W	INT
R43275I	G1_TL16PICKUP	TL16PICKUP	8 to 99 msec. step 1	R/W	INT
R43276I	G1_TL24DROPOUT	TL24DROPOUT	30 to 500 msec. step 1	R/W	INT
R43277I	G1_TL25DROPOUT	TL25DROPOUT	30 to 500 msec. step 1	R/W	INT
R43278I	G1_TL26PICKUP	TL26PICKUP	0 to 50 msec. step 1	R/W	INT
R43279I	G1_POSSEQANG	POSSEQANG	25 to 90° step 1	R/W	INT
R43280I	G1_ZERSEQANG	ZERSEQANG	25 to 90° step 1	R/W	INT
R43281F	G1_ZLINE	ZLINE	0.01 to 50 Ω step 0.01 0.05 to 250 Ω step 0.05	R/W	Float
R43283F	G1_ZEROSEQK0	G1_ZEROSEQK0	1.0 to 7.0 step 0.1	R/W	Float
R43285F	G1_LINELENGTH	LINELENGTH	0.0 to 500.0 step 0.1	R/W	Float
R43287I	G1_LINEUNIT	LINEUNIT	0 = Miles, 1 = Km	R/W	INT
R43288I	G1_CTRATIO	CTRATIO	1 to 5000 step 1	R/W	INT
R43289I	G1_PTRATIO	PTRATIO	1 to 7000 step 1	R/W	INT
R43290F	G1_FLTLOCK	FLTLOCK	0 to 99.9 sec. step 0.1	R/W	Float
R43292I	G1_FLTRESET	FLTRESET	0 to 999 minutes step 1	R/W	INT
R43293I	G1_MOBZONE	MOBZONE	0 = Zone 2; 1 = Zone 3; 2 = Zone 4	R/W	INT
R43294I	G1_MOBCHARANG	MOBCHARANG	30 to 130° step 1	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 6 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43295I	G1_BLOCKWHAT	BLOCKWHAT	0 = BLKALL; 1 = BLKDIST; 2 = BLKPHAS; 3 = BLKNONE	R/W	INT
R43296I	G1_BLOCKZ1	BLOCKZ1	0 = No; 1 = Yes	R/W	INT
R43297I	G1_BLOCKZ2	BLOCKZ2	0 = No; 1 = Yes	R/W	INT
R43298I	G1_BLOCKZ3	BLOCKZ3	0 = No; 1 = Yes	R/W	INT
R43299I	G1_BLOCKZ4	BLOCKZ4	0 = No; 1 = Yes	R/W	INT
R43300I	G1_USE_OST	USE_OST	0 = No; 1 = Yes	R/W	INT
R43301I	G1_NUMBRCHAR	NUMBRCHAR	2, 3	R/W	INT
R43302I	G1_TRIPIN_OUT	TRIPIN_OUT	0 = IN; 1 = OUT	R/W	INT
R43303F	G1_FWDREACH	FWDREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R43305F	G1_REVREACH	REVREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R43307I	G1_OUTER	OUTER	40 to 165° step 1	R/W	INT
R43308I	G1_MIDDLE	MIDDLE	40 to 165° step 1	R/W	INT
R43309I	G1_INNER	INNER	40 to 165° step 1	R/W	INT
R43310I	G1_TLOS1PU	TLOS1PU	1 to 100 msec. step 1	R/W	INT
R43311I	G1_TLOS1DO	TLOS1DO	1 to 100 msec. step 1	R/W	INT
R43312I	G1_TLOS2PU	TLOS2PU	1 to 100 msec. step 1	R/W	INT
R43313I	G1_TLOS3PU	TLOS3PU	1 to 100 msec. step 1	R/W	INT
R43314I	G1_TLOS4PU	TLOS4PU	1 to 100 msec. step 1	R/W	INT
R43315I	G1_RECLMODE	RECLMODE	0 = Off; 1 = None; 2 = Internal; 3 = External; 4 = Both	R/W	INT
R43316I	G1_RECLOSETYPE	RECLOSETYPE	0 = 1POLE; 1 = 3 POLE; 2 = 1POLE3POLE	R/W	INT
R43317I	G1_NUM_1P_AT	NUM_1P_AT	1, 2, 3, 4	R/W	INT
R43318F	G1_1PDELAY1	1PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R43320F	G1_1PDELAY2	1PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R43322F	G1_1PDELAY3	1PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R43324F	G1_1PDELAY4	1PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R43326I	G1_NUM_3P_AT	NUM_3P_AT	1, 2, 3, 4	R/W	INT
R43327F	G1_3PDELAY1	3PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R43329F	G1_3PDELAY2	3PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R43331F	G1_3PDELAY3	3PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R43333F	G1_3PDELAY4	3PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R43335F	G1_RESETTIME	RESETTIME	0.1 to 300.0 sec. step 0.1	R/W	Float
R43337F	G1_DWELLTIME	DWELLTIME	0.1 to 2.0 sec. step 0.1	R/W	Float
R43339I	G1_HOLD	HOLD	0 = No; 1 = Yes	R/W	INT
R43340I	G1_HOLDTIME	HOLDTIME	1 to 1000 sec. step 1	R/W	INT
R43341I	G1_HOLDSENSE	HOLDSENSE	0 = CC; 1 = CO	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 7 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43342I	G1_SYNCHCHECK	SYNCHCHECK	0 = No, 1 = Yes	R/W	INT
R43343F	G1_CLOSEANG	CLOSEANG	0 to 75° step 1	R/W	INT
R43345F	G1_SLIPFREQ	SLIPFREQ	0.1 to 5.0 Hz step 0.1	R/W	Float
R43347I	G1_BUSLINE	BUSLINE	0 = BUS; 1 = LINE	R/W	INT
R43348I	G1_SYNCHPHASE	SYNCHPHASE	0 = VA; 1 = VB; 2 = VC 3 = VAB; 4 = VBC; 5 = VCA	R/W	INT
R43349I	G1_SYNCHHOLD	SYNCHHOLD	1 to 100 sec. step 1	R/W	INT
R43350I	G1_SP1DELAY2	SP1DELAY2	0 = No; 1 = Yes	R/W	INT
R43351I	G1_SP1DELAY3	SP1DELAY3	0 = No; 1 = Yes	R/W	INT
R43352I	G1_SP1DELAY4	SP1DELAYR	0 = No; 1 = Yes	R/W	INT
R43353I	G1_SP3DELAY1	SP3DELAY1	0 = No; 1 = Yes	R/W	INT
R43354I	G1_SP3DELAY2	SP3DELAY2	0 = No; 1 = Yes	R/W	INT
R43355I	G1_SP3DELAY3	SP3DELAY3	0 = No; 1 = Yes	R/W	INT
R43356I	G1_SP3DELAY4	SP3DELAY4	0 = No; 1 = Yes	R/W	INT
R43357I	G1_SYNCMANCLS	SYNCMANCLS	0 = No; 1 = Yes	R/W	INT
R43358F	G1_VBUSLIVE	VBUSLIVE	0.1 to 130 V step 0.1	R/W	Float
R43360F	G1_VBUSDEAD	VBUSDEAD	0.1 to 130 V step 0.1	R/W	Float
R43362F	G1_VLINELIVE	VLINELIVE	0.1 to 130 V step 0.1	R/W	Float
R43364F	G1_VLINEDEAD	VLINEDEAD	0.1 to 130 V step 0.1	R/W	Float
R43366I	G1_LBUSDLINE	LBUSDLINE	0 = No; 1 = Yes	R/W	INT
R43367I	G1_DBUSLLINE	DBUSLLINE	0 = No; 1 = Yes	R/W	INT
R43368I	G1_DBUSDLINE	DBUSDLINE	0 = No; 1 = Yes	R/W	INT
R43369F	G1_DELTAV	DELTAV	0.1 to 130 V step 0.1	R/W	Float
R43371I	G1_DELTAVBLK	DELTAVBLK	0 = No; 1 = Yes	R/W	INT
R43372I	G1_NCAIN1	NCAIN1	0 to 256 step 1 (depending on choice of input assignment)	R/W	INT
R43373I	G1_NCAIN2	NCAIN2	0 to 256 step 1	R/W	INT
R43374I	G1_NCAIN3	NCAIN3	0 to 256 step 1	R/W	INT
R43375I	G1_NCAIN4	NCAIN4	0 to 256 step 1	R/W	INT
R43376I	G1_NCAIN5	NCAIN5	0 to 256 step 1	R/W	INT
R43377I	G1_NCAIN6	NCAIN6	0 to 256 step 1	R/W	INT
R43378I	G1_NCAIN7	NCAIN7	0 to 256 step 1	R/W	INT
R43379I	G1_NCAIN8	NCAIN8	0 to 256 step 1	R/W	INT
R43380I	G1_T1	T1	0 to 256 step 1	R/W	INT
R43381I	G1_T2	T2	0 to 256 step 1	R/W	INT
R43382I	G1_T3	T3	0 to 256 step 1	R/W	INT
R43383I	G1_T4	T4	0 to 256 step 1	R/W	INT
R43384I	G1_T5	T5	0 to 256 step 1	R/W	INT
R43385I	G1_T6	T6	0 to 256 step 1	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 8 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43386I	G1_A1	A1	0 to 256 step 1	R/W	INT
R43387I	G1_A2	A2	0 to 256 step 1	R/W	INT
R43388I	G1_A3	A3	0 to 256 step 1	R/W	INT
R43389I	G1_A4	A4	0 to 256 step 1	R/W	INT
R43390I	G1_A5	A5	0 to 256 step 1	R/W	INT
R43391I	G1_A6	A6	0 to 256 step 1	R/W	INT
R43392I	G1_A7	A7	0 to 256 step 1	R/W	INT
R43393I	G1_A8	A8	0 to 256 step 1	R/W	INT
R43394I	G1_A9	A9	0 to 256 step 1	R/W	INT
R43395I	G1_A10	A10	0 to 256 step 1	R/W	INT
R43396I	G1_A11	A11	0 to 256 step 1	R/W	INT
R43397I	G1_A12	A12	0 to 256 step 1	R/W	INT
R43398I	G1_C1	C1	0 to 256 step 1	R/W	INT
R43399I	G1_C2	C2	0 to 256 step 1	R/W	INT
R43400I	G1_KT1	KT1	0 to 256 step 1	R/W	INT
R43401I	G1_KT2	KT2	0 to 256 step 1	R/W	INT
R43402I	G1_KT3	KT3	0 to 256 step 1	R/W	INT
R43403I	G1_KT4	KT4	0 to 256 step 1	R/W	INT
R43404I	G1_CONFTRIP	CONFTRIP	0 to 256 step 1	R/W	INT
R43405I	G1_CONFOSC	CONFOSC	0 to 256 step 1	R/W	INT
R43500I	G2_Z1PHASE	Z1PHASE	0 = No; 1 = Yes	R/W	INT
R43501F	G2_Z1PHREACH	Z1PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43503F	G2_Z1PLEVDET	Z1PLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R43505I	G2_Z1GROUND	Z1GROUND	0 = No; 1 = Yes	R/W	INT
R43506F	G2_Z1GRDREACH	Z1GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43508I	G2_Z1GRDCHAR	Z1GRDCHAR	0 = Mho; 1 = React	R/W	INT
R43509F	G2_Z1SUREACH	Z1SUREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43511F	G2_Z1GROUNDK0	Z1GROUNDK0	1.0 to 7.0 step 0.1	R/W	Float
R43513F	G2_Z1GLEVDET	ZIGLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R43515I	G2_Z1BLOCK	Z1BLOCK	0 = No; 1 = Yes	R/W	INT
R43516I	G2_Z2PHASE	Z2PHASE	0 = No; 1 = Yes	R/W	INT
R43517F	G2_Z2PHREACH	Z2PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43519I	G2_Z2PCHARANG	Z2PCHARANG	90 to 120° step 5	R/W	INT
R43520I	G2_Z2GROUND	Z2GROUND	0 = No; 1 = Yes	R/W	INT
R43521I	G2_Z2GRDCHAR	Z2GRDCHAR	0 = MHO; 1 = GDOC; 2 = MHOGDOC	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 9 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43522F	G2_Z2GRDREACH	Z2GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43524I	G2_Z2GCHARANG	Z2GCHARANG	90 to 120° step 5	R/W	INT
R43525I	G2_Z2TIMERS	Z2TIMERS	0 = No; 1 = Yes	R/W	INT
R43526F	G2_Z2P_TIME	Z2P_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R43528F	G2_Z2G_TIME	Z2G_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R43530I	G2_Z3PHASE	Z3PHASE	0 = No; 1 = Yes	R/W	INT
R43531F	G2_Z3PHREACH	Z3PHREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43533I	G2_Z3PCHARANG	Z3PCHARANG	90 to 120° step 5	R/W	INT
R43534I	G2_Z3GRND	Z3GRND	0 = No; 1 = Yes	R/W	INT
R43535F	G2_Z3GRDREACH	Z3GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43537I	G2_Z3GCHARACHAG	Z3CHARCHAG	90 to 120° step 5	R/W	INT
R45538F	G2_Z3P_TIME	Z3P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43540F	G2_Z3G_TIME	Z3G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43542I	G2_Z4PHASE	Z4PHASE	0 = No; 1 = Yes	R/W	INT
R43543F	G2_Z4PHREACH	Z4PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43545I	G2_Z4PCHRANG	Z4PCHRANG	80 to 120° step 5	R/W	INT
R43546I	G2_Z4GRND	Z4GRND	0 = No; 1 = Yes	R/W	INT
R43547F	G2_Z4GRDREACH	Z4GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43549I	G2_Z4GCHARANG	Z4GCHARANG	80 to 120° step 5	R/W	INT
R43550I	G2_Z4DIRECTN	Z4DIRECTN	0 = Forward; 1 = Reverse	R/W	INT
R43551I	G2_Z4TIMERS	Z4TIMERS	0 = No; 1 = Yes	R/W	INT
R43552F	G2_Z4P_TIME	Z4P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43554F	G2_Z4G_TIME	Z4G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43556F	G2_IT_PICKUP	IT_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R43558F	G2_IB_PICKUP	IB_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R43560F	G2_IPT_PICKUP	IPT_PICKUP	0.50 to 5.0 A step 0.01 (5A) 0.1 to 1.0 A step 0.01 (1A)	R/W	Float
R43562F	G2_IPB_PICKUP	IPB_PICKUP	0.25 to 3.75 A step 0.01 (5A) 0.05 to 0.75 A step 0.01 (1A)	R/W	Float
R43564F	G2_IPBKFACTOR	IPBKFACTOR	0.0, 0.066	R/W	Float
R43566F	G2_NT_OFFSET	NT_OFFSET	0.0 to 20.0 Ω step 0.01 0.0 to 100 Ω step 0.01	R/W	Float
R43568I	G2_UNBALALARM	UNBALALARM	0 = No; 1 = Yes	R/W	INT
R43569I	G2_50	50	0 = No; 1 = Yes	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 10 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43570I	G2_50_DIRCNL	50_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43571F	G2_50PICKUP	50PICKUP	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R43573F	G2_50PICKUPFF	50PICKUPFF	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R43575I	G2_50G	50G	0 = No; 1 = Yes	R/W	INT
R43576I	G2_50G_DIRCNL	50G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43577F	G2_50GPICKUP	50GPICKUP	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R43579F	G2_50GPICKUPFF	50GPICKUPFF	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R43581F	G2_50GRESTNT	50GRESTNT	0.0, 0.3	R/W	INT
R43583I	G2_51G	51G	0 = No; 1 = Yes	R/W	INT
R43584I	G2_51G_DIRCNL	51G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43585F	G2_51GPICKUP	51GPICKUP	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R43587F	G2_51GPICKUPFF	51GPICKUPFF	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R43589I	G2_51GCURVE	51GCURVE	0 = INV; 1 = V-INV; 2 = EINV; 3 = CUSTOM; 4 = DEFT	R/W	INT
R43590F	G2_51GTIMDIAL	51GTIMDIAL	0.5 to 10.0 step 0.1	R/W	Float
R43592F	G2_51GDEFTIMDELY	51GDEFTIMDELY	0.5 to 30 sec. step 0.1	R/W	Float
R43594I	G2_51G_RESET	51G_RESET	0 = FAST; 1 = EM	R/W	INT
R43595I	G2_RATEDVOLTS	RATEDVOLTS	1.00105E+14 V	R/W	INT
R43596I	G2_PHASEOVER	PHASEOVER	0 = No; 1 = Yes	R/W	INT
R43597F	G2_PHOVPICKUP	PHOVPICKUP	0.0 to 1.4 p.u. V step 0.01	R/W	Float
R43599F	G2_PHOVTMDLY	PHOVTMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43601I	G2_V1OVER	V1OVER	0 = No; 1 = Yes	R/W	INT
R43602F	G2_V1OVINSTPU	V1OVINSTPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43604F	G2_V1OVTIMPU	V1OVTIMPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43606F	G2_V1OVTIMDLY	V1OVTIMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43608I	G2_V1COMP	V1COMP	0 = No; 1 = Yes	R/W	INT
R43609F	G2_V1COMRCH	V1COMRCH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43611F	G2_VICOMPINPU	V1COMPINPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43613F	G2_V1COMPTDPU	V1COMPTDPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43615F	G2_V1COMPDLY	V1COMPDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43617I	G2_FUSEFAIL	FUSEFAIL	0 = No; 1 = Yes	R/W	INT
R43618I	G2_ALL_BELOW	ALL_BELOW	0 = No; 1 = Yes	R/W	INT
R43619I	G2_OUTOFSTEP	OUTOFSTEP	0 = No; 1 = Yes	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 11 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43620I	G2_ALL_3_Z2PH	ALL_3_Z2PH	0 = No; 1 = Yes	R/W	INT
R43621I	G2_50G_BLOCK	50G_BLOCK	0 = No; 1 = Yes	R/W	INT
R43622I	G2_Z2TIMETRIP	Z2TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43623I	G2_Z3TIMETRIP	Z3TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43624I	G2_Z4TIMETRIP	Z4TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43625I	G2_Z1PHASTRIP	Z1PHASTRIP	0 = No; 1 = Yes	R/W	INT
R43626I	G2_ANYZ2PHASE	ANYZ2PHASE	0 = No; 1 = Yes	R/W	INT
R43627I	G2_CONFGTRIP	CONFGTRIP	0 = No; 1 = Yes	R/W	INT
R43628I	G2_LINEPICKUP	LINEPICKUP	0 = No; 1 = Yes	R/W	INT
R43629I	G2_BYPASSTL3	BYPASSTL3	0 = No; 1 = Yes	R/W	INT
R43630F	G2_I1PICKPU	I1PICKUP	1.0 to 15.0 A step 0.1 0.2 to 3.0 A step 0.1	R/W	Float
R43632I	G2_REMOTEOPEN	REMOTEOPEN	0 = No; 1 = Yes	R/W	INT
R43633I	G2_TL20PICKUP	TL20PICKUP	10 to 100 msec. step 1	R/W	INT
R43634I	G2_LINEOVERLD	LINEOVERLD	0 = No; 1 = Yes	R/W	INT
R43635F	G2_LEVEL1PU	LEVEL1PU	2.5 to 20.0 A step 0.1 (5A) 0.5 to 4.0 A step 0.1 (1A)	R/W	Float
R43637F	G2_LEVEL2PU	LEVEL2PU	5.0 to 40.0 A step 0.1 (5A) 1.0 to 8.0 A step 0.1 (1A)	R/W	Float
R43639F	G2_LEVEL1TDLY	LEVEL1TDLY	10 to 200 sec. step 1	R/W	Float
R43641F	G2_LEVEL2TDLY	LEVEL2TDLY	10 to 99 sec. step 1	R/W	Float
R43643I	G2_PICKSCHEME	PICKSCHEME	0 = STEPDST; 1 = PUTT; 2 = POTT1; 3 = POTT2; 4 = HYBRID	R/W	INT
R43644I	G2_NUMRCVR	NUMRCVR	0, 1, 2	R/W	INT
R43645I	G2_TRIPMODE	TRIPMODE	0 = 3POLE; 1 = 1POLE; 2 = 1POLEZ2	R/W	INT
R43646I	G2_CARRSTART	CARRSTART	0 = DIR; 1 = IPB; 2 = FD	R/W	INT
R43647I	G2_WKINFTRIP	WKINFTRIP	0 = No; 1= Yes	R/W	INT
R43648I	G2_TL1PICKUP	TL1PICKUP	1 to 200 msec. step 1	R/W	INT
R43649I	G2_TL4PICKUP	TL4PICKUP	0 to 50 msec. step 1	R/W	INT
R43650I	G2_TL4DROPOUT	TL4DROPOUT	0 to 50 msec. step 1	R/W	INT
R43651I	G2_TL5PICKUP	TL5PICKUP	0 to 200 msec. step 1	R/W	INT
R43652I	G2_TL5DROPOUT	TL5DROPOUT	0 to 200 msec. step 1	R/W	INT
R43653I	G2_TL6PICKUP	TL6PICKUP	0 to 200 msec. step 1	R/W	INT
R43654I	G2_TL6DROPOUT	TL6DROPOUT	0 to 200 msec. step 1	R/W	INT
R43655I	G2_TL16PICKUP	TL16PICKUP	8 to 99 msec. step 1	R/W	INT
R43656I	G2_TL24DROPOUT	TL24DROPOUT	30 to 500 msec. step 1	R/W	INT
R43657I	G2_TL25DROPOUT	TL25DROPOUT	30 to 500 msec. step 1	R/W	INT
R43658I	G2_TL26PICKUP	TL26PICKUP	0 to 50 msec. step 1	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 12 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43659I	G2_POSSEQANG	POSSEQANG	25 to 90° step 1	R/W	INT
R43660I	G2_ZERSEQANG	ZERSEQANG	25 to 90° step 1	R/W	INT
R43661F	G2_ZLINE	ZLINE	0.01 to 50 W step 0.01 0.05 to 250 W step 0.05	R/W	Float
R43663F	G2_ZEROSEQK0	G2_ZEROSEQK0	1.0 to 7.0 step 0.1	R/W	Float
R43665F	G2_LINELENGTH	LINELENGTH	0.0 to 500.0 step 0.1	R/W	Float
R43667I	G2_LINEUNIT	LINEUNIT	0 = Miles, 1 = Km	R/W	INT
R43668I	G2_CTRATIO	CTRATIO	1 to 5000 step 1	R/W	INT
R43669I	G2_PTRATIO	PTRATIO	1 to 7000 step 1	R/W	INT
R43670F	G2_FLTLOCK	FLTLOCK	0 to 99.9 sec. step 0.1	R/W	Float
R43672I	G2_FLTRESET	FLTRESET	0 to 999 minutes step 1	R/W	INT
R43673I	G2_MOBZONE	MOBZONE	0 = Zone 2; 1 = Zone 3; 2 = Zone 4	R/W	INT
R43674I	G2_MOBCHARANG	MOBCHARANG	30 to 130° step 1	R/W	INT
R43675I	G2_BLOCKWHAT	BLOCKWHAT	0 = BLKALL; 1 = BLKDIST; 2 = BLKPHAS; 3 = BLKNONE	R/W	INT
R43676I	G2_BLOCKZ1	BLOCKZ1	0 = No; 1 = Yes	R/W	INT
R43677I	G2_BLOCKZ2	BLOCKZ2	0 = No; 1 = Yes	R/W	INT
R43678I	G2_BLOCKZ3	BLOCKZ3	0 = No; 1 = Yes	R/W	INT
R43679I	G2_BLOCKZ4	BLOCKZ4	0 = No; 1 = Yes	R/W	INT
R43680I	G2_USE_OST	USE_OST	0 = No; 1 = Yes	R/W	INT
R43681I	G2_NUMBRCHAR	NUMBRCHAR	2, 3	R/W	INT
R43682I	G2_TRIPIN_OUT	TRIPIN_OUT	0 = IN; 1 = OUT	R/W	INT
R43683F	G2_FWDREACH	FWDREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R43685F	G2_REVREACH	REVREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R43687I	G2_OUTER	OUTER	40 to 165° step 1	R/W	INT
R43688I	G2_MIDDLE	MIDDLE	40 to 165° step 1	R/W	INT
R43689I	G2_INNER	INNER	40 to 165° step 1	R/W	INT
R43690I	G2_TLOS1PU	TLOS1PU	1 to 100 msec. step 1	R/W	INT
R43691I	G2_TLOS1DO	TLOS1DO	1 to 100 msec. step 1	R/W	INT
R43692I	G2_TLOS2PU	TLOS2PU	1 to 100 msec. step 1	R/W	INT
R43693I	G2_TLOS3PU	TLOS3PU	1 to 100 msec. step 1	R/W	INT
R43694I	G2_TLOS4PU	TLOS4PU	1 to 100 msec. step 1	R/W	INT
R43695I	G2_RECLMODE	RECLMODE	0 = Off; 1 = None; 2 = Internal; 3 = External; 4 = Both	R/W	INT
R43696I	G2_RECLOSETYPE	RECLOSETYPE	0 = 1POLE; 1 = 3 POLE; 2 = 1POLE3POLE	R/W	INT
R43697I	G2_NUM_1P_AT	NUM_1P_AT	1, 2, 3, 4	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 13 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43698F	G2_1PDELAY1	1PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R43700F	G2_1PDELAY2	1PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R43702F	G2_1PDELAY3	1PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R43704F	G2_1PDELAY4	1PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R43706I	G2_NUM_3P_AT	NUM_3P_AT	1, 2, 3, 4	R/W	INT
R43707F	G2_3PDELAY1	3PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R43709F	G2_3PDELAY2	3PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R43711F	G2_3PDELAY3	3PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R43713F	G2_3PDELAY4	3PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R43715F	G2_RESETTIME	RESETTIME	0.1 to 300.0 sec. step 0.1	R/W	Float
R43717F	G2_DWELLTIME	DWELLTIME	0.1 to 2.0 sec. step 0.1	R/W	Float
R43719I	G2_HOLD	HOLD	0 = No; 1 = Yes	R/W	INT
R43720I	G2_HOLDTIME	HOLDTIME	1 to 1000 sec. step 1	R/W	INT
R43721I	G2_HOLDSENSE	HOLDSENSE	0 = CC; 1 = CO	R/W	INT
R43722I	G2_SYNCHCHECK	SYNCHCHECK	0 = No, 1 = Yes	R/W	INT
R43723F	G2_CLOSEANG	CLOSEANG	0 to 75° step 1	R/W	INT
R43725F	G2_SLIPFREQ	SLIPFREQ	0.1 to 5.0 Hz step 0.1	R/W	Float
R43727I	G2_BUSLINE	BUSLINE	0 = BUS; 1 = LINE	R/W	INT
R43728I	G2_SYNCHPHASE	SYNCHPHASE	0 = VA; 1 = VB; 2 = VC 3 = VAB; 4 = VBC; 5 = VCA	R/W	INT
R43729I	G2_SYNCHHOLD	SYNCHHOLD	1 to 100 sec. step 1	R/W	INT
R43730I	G2_SP1DELAY2	SP1DELAY2	0 = No; 1 = Yes	R/W	INT
R43731I	G2_SP1DELAY3	SP1DELAY3	0 = No; 1 = Yes	R/W	INT
R43732I	G2_SP1DELAY4	SP1DELAYR	0 = No; 1 = Yes	R/W	INT
R43733I	G2_SP3DELAY1	SP3DELAY1	0 = No; 1 = Yes	R/W	INT
R43734I	G2_SP3DELAY2	SP3DELAY2	0 = No; 1 = Yes	R/W	INT
R43735I	G2_SP3DELAY3	SP3DELAY3	0 = No; 1 = Yes	R/W	INT
R43736I	G2_SP3DELAY4	SP3DELAY4	0 = No; 1 = Yes	R/W	INT
R43737I	G2_SYNCMANCLS	SYNCMANCLS	0 = No; 1 = Yes	R/W	INT
R43738F	G2_VBUSLIVE	VBUSLIVE	0.1 to 130 V step 0.1	R/W	Float
R43740F	G2_VBUSDEAD	VBUSDEAD	0.1 to 130 V step 0.1	R/W	Float
R43742F	G2_VLINELIVE	VLINELIVE	0.1 to 130 V step 0.1	R/W	Float
R43744F	G2_VLINEDEAD	VLINEDEAD	0.1 to 130 V step 0.1	R/W	Float
R43746I	G2_LBUSDLINE	LBUSDLINE	0 = No; 1 = Yes	R/W	INT
R43747I	G2_DBUSLLINE	DBUSLLINE	0 = No; 1 = Yes	R/W	INT
R43748I	G2_DBUSDLINE	DBUSDLINE	0 = No; 1 = Yes	R/W	INT
R43749F	G2_DELTAV	DELTAV	0.1 to 130 V step 0.1	R/W	Float
R43751I	G2_DELTAVBLK	DELTAVBLK	0 = No; 1 = Yes	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 14 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43752I	G2_NCAIN1	NCAIN1	0 to 256 step 1 (depending on choice of input assignment)	R/W	INT
R43753I	G2_NCAIN2	NCAIN2	0 to 256 step 1	R/W	INT
R43754I	G2_NCAIN3	NCAIN3	0 to 256 step 1	R/W	INT
R43755I	G2_NCAIN4	NCAIN4	0 to 256 step 1	R/W	INT
R43756I	G2_NCAIN5	NCAIN5	0 to 256 step 1	R/W	INT
R43757I	G2_NCAIN6	NCAIN6	0 to 256 step 1	R/W	INT
R43758I	G2_NCAIN7	NCAIN7	0 to 256 step 1	R/W	INT
R43759I	G2_NCAIN8	NCAIN8	0 to 256 step 1	R/W	INT
R43760I	G2_T1	T1	0 to 256 step 1	R/W	INT
R43761I	G2_T2	T2	0 to 256 step 1	R/W	INT
R43762I	G2_T3	T3	0 to 256 step 1	R/W	INT
R43763I	G2_T4	T4	0 to 256 step 1	R/W	INT
R43764I	G2_T5	T5	0 to 256 step 1	R/W	INT
R43765I	G2_T6	T6	0 to 256 step 1	R/W	INT
R43766I	G2_A1	A1	0 to 256 step 1	R/W	INT
R43767I	G2_A2	A2	0 to 256 step 1	R/W	INT
R43768I	G2_A3	A3	0 to 256 step 1	R/W	INT
R43769I	G2_A4	A4	0 to 256 step 1	R/W	INT
R43770I	G2_A5	A5	0 to 256 step 1	R/W	INT
R43771I	G2_A6	A6	0 to 256 step 1	R/W	INT
R43772I	G2_A7	A7	0 to 256 step 1	R/W	INT
R43773I	G2_A8	A8	0 to 256 step 1	R/W	INT
R43774I	G2_A9	A9	0 to 256 step 1	R/W	INT
R43775I	G2_A10	A10	0 to 256 step 1	R/W	INT
R43776I	G2_A11	A11	0 to 256 step 1	R/W	INT
R43777I	G2_A12	A12	0 to 256 step 1	R/W	INT
R43778I	G2_C1	C1	0 to 256 step 1	R/W	INT
R43779I	G2_C2	C2	0 to 256 step 1	R/W	INT
R43780I	G2_KT1	KT1	0 to 256 step 1	R/W	INT
R43781I	G2_KT2	KT2	0 to 256 step 1	R/W	INT
R43782I	G2_KT3	KT3	0 to 256 step 1	R/W	INT
R43783I	G2_KT4	KT4	0 to 256 step 1	R/W	INT
R43784I	G2_CONFTRIP	CONFTRIP	0 to 256 step 1	R/W	INT
R43785I	G2_CONFOSC	CONFOSC	0 to 256 step 1	R/W	INT
R43800I	G3_Z1PHASE	Z1PHASE	0 = No; 1 = Yes	R/W	INT
R43801F	G3_Z1PHREACH	Z1PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43803F	G3_Z1PLEVDET	Z1PLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 15 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43805I	G3_Z1GROUND	Z1GROUND	0 = No; 1 = Yes	R/W	INT
R43806F	G3_Z1GRDREACH	Z1GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43808I	G3_Z1GRDCHAR	Z1GRDCHAR	0 = Mho; 1 = React	R/W	INT
R43809F	G3_Z1SUREACH	Z1SUREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43811F	G3_Z1GROUNDK0	Z1GROUNDK0	1.0 to 7.0 step 0.1	R/W	Float
R43813F	G3_Z1GLEVDET	ZIGLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R43815I	G3_Z1BLOCK	Z1BLOCK	0 = No; 1 = Yes	R/W	INT
R43816I	G3_Z2PHASE	Z2PHASE	0 = No; 1 = Yes	R/W	INT
R43817F	G3_Z2PHREACH	Z2PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43819I	G3_Z2PCHARANG	Z2PCHARANG	90 to 120° step 5	R/W	INT
R43820I	G3_Z2GROUND	Z2GROUND	0 = No; 1 = Yes	R/W	INT
R43821I	G3_Z2GRDCHAR	Z2GRDCHAR	0 = MHO; 1 = GDOC; 2 = MHOGDOC	R/W	INT
R43822F	G3_Z2GRDREACH	Z2GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43824I	G3_Z2GCHARANG	Z2GCHARANG	90 to 120° step 5	R/W	INT
R43825I	G3_Z2TIMERS	Z2TIMERS	0 = No; 1 = Yes	R/W	INT
R43826F	G3_Z2P_TIME	Z2P_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R43828F	G3_Z2G_TIME	Z2G_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R43830I	G3_Z3PHASE	Z3PHASE	0 = No; 1 = Yes	R/W	INT
R43831F	G3_Z3PHREACH	Z3PHREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43833I	G3_Z3PCHARANG	Z3PCHARANG	90 to 120° step 5	R/W	INT
R43834I	G3_Z3GRND	Z3GRND	0 = No; 1 = Yes	R/W	INT
R43835F	G3_Z3GRDREACH	Z3GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43837I	G3_Z3GCHARACHAG	Z3CHARCHAG	90 to 120° step 5	R/W	INT
R43838F	G3_Z3P_TIME	Z3P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43840F	G3_Z3G_TIME	Z3G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43842I	G3_Z4PHASE	Z4PHASE	0 = No; 1 = Yes	R/W	INT
R43843F	G3_Z4PHREACH	Z4PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43845I	G3_Z4PCHRANG	Z4PCHRANG	80 to 120° step 5	R/W	INT
R43846I	G3_Z4GRND	Z4GRND	0 = No; 1 = Yes	R/W	INT
R43847F	G3_Z4GRDREACH	Z4GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R43849I	G3_Z4GCHARANG	Z4GCHARANG	80 to 120° step 5	R/W	INT
R43850I	G3_Z4DIRECTN	Z4DIRECTN	0 = Forward; 1 = Reverse	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 16 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43851I	G3_Z4TIMERS	Z4TIMERS	0 = No; 1 = Yes	R/W	INT
R43852F	G3_Z4P_TIME	Z4P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43854F	G3_Z4G_TIME	Z4G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R43856F	G3_IT_PICKUP	IT_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R43858F	G3_IB_PICKUP	IB_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R43860F	G3_IPT_PICKUP	IPT_PICKUP	0.50 to 5.0 A step 0.01 (5A) 0.1 to 1.0 A step 0.01 (1A)	R/W	Float
R43862F	G3_IPB_PICKUP	IPB_PICKUP	0.25 to 3.75 A step 0.01 (5A) 0.05 to 0.75 A step 0.01 (1A)	R/W	Float
R43864F	G3_IPBKFACTOR	IPBKFACTOR	0.0, 0.066	R/W	Float
R43866F	G3_NT_OFFSET	NT_OFFSET	0.0 to 20.0 W step 0.01 0.0 to 100 W step 0.01	R/W	Float
R43868I	G3_UNBALALARM	UNBALALARM	0 = No; 1 = Yes	R/W	INT
R43869I	G3_50	50	0 = No; 1 = Yes	R/W	INT
R43870I	G3_50_DIRCNL	50_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43871F	G3_50PICKUP	50PICKUP	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R43873F	G3_50PICKUPFF	50PICKUPFF	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R43875I	G3_50G	50G	0 = No; 1 = Yes	R/W	INT
R43876I	G3_50G_DIRCNL	50G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43877F	G3_50GPICKUP	50GPICKUP	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R43879F	G3_50GPICKUPFF	50GPICKUPFF	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R43881F	G3_50GRESTNT	50GRESTNT	0.0, 0.3	R/W	INT
R43883I	G3_51G	51G	0 = No; 1 = Yes	R/W	INT
R43884I	G3_51G_DIRCNL	51G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R43885F	G3_51GPICKUP	51GPICKUP	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R43887F	G3_51GPICKUPFF	51GPICKUPFF	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R43889I	G3_51GCURVE	51GCURVE	0 = INV; 1 = V-INV; 2 = EINV; 3 = CUSTOM; 4 = DEFT	R/W	INT
R43890F	G3_51GTIMDIAL	51GTIMDIAL	0.5 to 10.0 step 0.1	R/W	Float
R43892F	G3_51GDEFTIMDELY	51GDEFTIMDELY	0.5 to 30 sec. step 0.1	R/W	Float
R43894I	G3_51G_RESET	51G_RESET	0 = FAST; 1 = EM	R/W	INT
R43895I	G3_RATEDVOLTS	RATEDVOLTS	1.00105E+14 V	R/W	INT
R43896I	G3_PHASEOVER	PHASEOVER	0 = No; 1 = Yes	R/W	INT
R43897F	G3_PHOVPICKUP	PHOVPICKUP	0.0 to 1.4 p.u. V step 0.01	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 17 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43899F	G3_PHOVTMDLY	PHOVTMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43901I	G3_V1OVER	V1OVER	0 = No; 1 = Yes	R/W	INT
R43902F	G3_V1OVINSTPU	V1OVINSTPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43904F	G3_V1OVTIMPU	V1OVTIMPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43906F	G3_V1OVTIMDLY	V1OVTIMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43908I	G3_V1COMP	V1COMP	0 = No; 1 = Yes	R/W	INT
R43909F	G3_V1COMRCH	V1COMRCH	0.01 to 50.0 W step 0.01 (5A) 0.05 to 250.0 W step 0.05 (1A)	R/W	Float
R43911F	G3_VICOMPINPU	V1COMPINPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43913F	G3_V1COMPTDPU	V1COMPTDPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R43915F	G3_V1COMPDLY	V1COMPDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R43917I	G3_FUSEFAIL	FUSEFAIL	0 = No; 1 = Yes	R/W	INT
R43918I	G3_ALL_BELOW	ALL_BELOW	0 = No; 1 = Yes	R/W	INT
R43919I	G3_OUTOFSTEP	OUTOFSTEP	0 = No; 1 = Yes	R/W	INT
R43920I	G3_ALL_3_Z2PH	ALL_3_Z2PH	0 = No; 1 = Yes	R/W	INT
R43921I	G3_50G_BLOCK	50G_BLOCK	0 = No; 1 = Yes	R/W	INT
R43922I	G3_Z2TIMETRIP	Z2TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43923I	G3_Z3TIMETRIP	Z3TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43924I	G3_Z4TIMETRIP	Z4TIMETRIP	0 = No; 1 = Yes	R/W	INT
R43925I	G3_Z1PHASTRIP	Z1PHASTRIP	0 = No; 1 = Yes	R/W	INT
R43926I	G3_ANYZ2PHASE	ANYZ2PHASE	0 = No; 1 = Yes	R/W	INT
R43927I	G3_CONFGTRIP	CONFGTRIP	0 = No; 1 = Yes	R/W	INT
R43928I	G3_LINEPICKUP	LINEPICKUP	0 = No; 1 = Yes	R/W	INT
R43929I	G3_BYPASSTL3	BYPASSTL3	0 = No; 1 = Yes	R/W	INT
R43930F	G3_I1PICKPU	I1PICKUP	1.0 to 15.0 A step 0.1 0.2 to 3.0 A step 0.1	R/W	Float
R43932I	G3_REMOTEOPEN	REMOTEOPEN	0 = No; 1 = Yes	R/W	INT
R43933I	G3_TL20PICKUP	TL20PICKUP	10 to 100 msec. step 1	R/W	INT
R43934I	G3_LINEOVERLD	LINEOVERLD	0 = No; 1 = Yes	R/W	INT
R43935F	G3_LEVEL1PU	LEVEL1PU	2.5 to 20.0 A step 0.1 (5A) 0.5 to 4.0 A step 0.1 (1A)	R/W	Float
R43937F	G3_LEVEL2PU	LEVEL2PU	5.0 to 40.0 A step 0.1 (5A) 1.0 to 8.0 A step 0.1 (1A)	R/W	Float
R43939F	G3_LEVEL1TDLY	LEVEL1TDLY	10 to 200 sec. step 1	R/W	Float
R43941F	G3_LEVEL2TDLY	LEVEL2TDLY	10 to 99 sec. step 1	R/W	Float
R43943I	G3_PICKSCHEME	PICKSCHEME	0 = STEPDST; 1 = PUTT; 2 = POTT1; 3 = POTT2; 4 = HYBRID	R/W	INT
R43944I	G3_NUMRCVR	NUMRCVR	0, 1, 2	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 18 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43945I	G3_TRIPMODE	TRIPMODE	0 = 3POLE; 1 = 1POLE; 2 = 1POLEZ2	R/W	INT
R43946I	G3_CARRSTART	CARRSTART	0 = DIR; 1 = IPB; 2 = FD	R/W	INT
R43947I	G3_WKINFTRIP	WKINFTRIP	0 = No; 1= Yes	R/W	INT
R43948I	G3_TL1PICKUP	TL1PICKUP	1 to 200 msec. step 1	R/W	INT
R43949I	G3_TL4PICKUP	TL4PICKUP	0 to 50 msec. step 1	R/W	INT
R43950I	G3_TL4DROPOUT	TL4DROPOUT	0 to 50 msec. step 1	R/W	INT
R43951I	G3_TL5PICKUP	TL5PICKUP	0 to 200 msec. step 1	R/W	INT
R43952I	G3_TL5DROPOUT	TL5DROPOUT	0 to 200 msec. step 1	R/W	INT
R43953I	G3_TL6PICKUP	TL6PICKUP	0 to 200 msec. step 1	R/W	INT
R43954I	G3_TL6DROPOUT	TL6DROPOUT	0 to 200 msec. step 1	R/W	INT
R43955I	G3_TL16PICKUP	TL16PICKUP	8 to 99 msec. step 1	R/W	INT
R43956I	G3_TL24DROPOUT	TL24DROPOUT	30 to 500 msec. step 1	R/W	INT
R43957I	G3_TL25DROPOUT	TL25DROPOUT	30 to 500 msec. step 1	R/W	INT
R43958I	G3_TL26PICKUP	TL26PICKUP	0 to 50 msec. step 1	R/W	INT
R43959I	G3_POSSEQANG	POSSEQANG	25 to 90° step 1	R/W	INT
R43960I	G3_ZERSEQANG	ZERSEQANG	25 to 90° step 1	R/W	INT
R43961F	G3_ZLINE	ZLINE	0.01 to 50 Ω step 0.01 0.05 to 250 Ω step 0.05	R/W	Float
R43963F	G3_ZEROSEQK0	G3_ZEROSEQK0	1.0 to 7.0 step 0.1	R/W	Float
R43965F	G3_LINELENGTH	LINELENGTH	0.0 to 500.0 step 0.1	R/W	Float
R43967I	G3_LINEUNIT	LINEUNIT	0 = Miles, 1 = Km	R/W	INT
R43968I	G3_CTRATIO	CTRATIO	1 to 5000 step 1	R/W	INT
R43969I	G3_PTRATIO	PTRATIO	1 to 7000 step 1	R/W	INT
R43970F	G3_FLTLOCK	FLTLOCK	0 to 99.9 sec. step 0.1	R/W	Float
R43972I	G3_FLTRESET	FLTRESET	0 to 999 minutes step 1	R/W	INT
R43973I	G3_MOBZONE	MOBZONE	0 = Zone 2; 1 = Zone 3; 2 = Zone 4	R/W	INT
R43974I	G3_MOBCHARANG	MOBCHARANG	30 to 130° step 1	R/W	INT
R43975I	G3_BLOCKWHAT	BLOCKWHAT	0 = BLKALL; 1 = BLKDIST; 2 = BLKPHAS; 3 = BLKNONE	R/W	INT
R43976I	G3_BLOCKZ1	BLOCKZ1	0 = No; 1 = Yes	R/W	INT
R43977I	G3_BLOCKZ2	BLOCKZ2	0 = No; 1 = Yes	R/W	INT
R43978I	G3_BLOCKZ3	BLOCKZ3	0 = No; 1 = Yes	R/W	INT
R43979I	G3_BLOCKZ4	BLOCKZ4	0 = No; 1 = Yes	R/W	INT
R43980I	G3_USE_OST	USE_OST	0 = No; 1 = Yes	R/W	INT
R43981I	G3_NUMBRCHAR	NUMBRCHAR	2, 3	R/W	INT
R43982I	G3_TRIPIN_OUT	TRIPIN_OUT	0 = IN; 1 = OUT	R/W	INT
R43983F	G3_FWDREACH	FWDREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 19 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R43985F	G3_REVREACH	REVREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R43987I	G3_OUTER	OUTER	40 to 165° step 1	R/W	INT
R43988I	G3_MIDDLE	MIDDLE	40 to 165° step 1	R/W	INT
R43989I	G3_INNER	INNER	40 to 165° step 1	R/W	INT
R43990I	G3_TLOS1PU	TLOS1PU	1 to 100 msec. step 1	R/W	INT
R43991I	G3_TLOS1DO	TLOS1DO	1 to 100 msec. step 1	R/W	INT
R43992I	G3_TLOS2PU	TLOS2PU	1 to 100 msec. step 1	R/W	INT
R43993I	G3_TLOS3PU	TLOS3PU	1 to 100 msec. step 1	R/W	INT
R43994I	G3_TLOS4PU	TLOS4PU	1 to 100 msec. step 1	R/W	INT
R43995I	G3_RECLMODE	RECLMODE	0 = Off; 1 = None; 2 = Internal; 3 = External; 4 = Both	R/W	INT
R43996I	G3_RECLOSETYPE	RECLOSETYPE	0 = 1POLE; 1 = 3 POLE; 2 = 1POLE3POLE	R/W	INT
R43997I	G3_NUM_1P_AT	NUM_1P_AT	1, 2, 3, 4	R/W	INT
R43998F	G3_1PDELAY1	1PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R44000F	G3_1PDELAY2	1PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R44002F	G3_1PDELAY3	1PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R44004F	G3_1PDELAY4	1PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R44006I	G3_NUM_3P_AT	NUM_3P_AT	1, 2, 3, 4	R/W	INT
R44007F	G3_3PDELAY1	3PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R44009F	G3_3PDELAY2	3PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R44011F	G3_3PDELAY3	3PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R44013F	G3_3PDELAY4	3PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R44015F	G3_RESETTIME	RESETTIME	0.1 to 300.0 sec. step 0.1	R/W	Float
R44017F	G3_DWELLTIME	DWELLTIME	0.1 to 2.0 sec. step 0.1	R/W	Float
R44019I	G3_HOLD	HOLD	0 = No; 1 = Yes	R/W	INT
R44020I	G3_HOLDTIME	HOLDTIME	1 to 1000 sec. step 1	R/W	INT
R44021I	G3_HOLDSENSE	HOLDSENSE	0 = CC; 1 = CO	R/W	INT
R44022I	G3_SYNCHCHECK	SYNCHCHECK	0 = No, 1 = Yes	R/W	INT
R44023F	G3_CLOSEANG	CLOSEANG	0 to 75° step 1	R/W	INT
R44025F	G3_SLIPFREQ	SLIPFREQ	0.1 to 5.0 Hz step 0.1	R/W	Float
R44027I	G3_BUSLINE	BUSLINE	0 = BUS; 1 = LINE	R/W	INT
R44028I	G3_SYNCHPHASE	SYNCHPHASE	0 = VA; 1 = VB; 2 = VC 3 = VAB; 4 = VBC; 5 = VCA	R/W	INT
R44029I	G3_SYNCHHOLD	SYNCHHOLD	1 to 100 sec. step 1	R/W	INT
R44030I	G3_SP1DELAY2	SP1DELAY2	1	R/W	INT
R44031I	G3_SP1DELAY3	SP1DELAY3	0 = No; 1 = Yes	R/W	INT
R44032I	G3_SP1DELAY4	SP1DELAYR	0 = No; 1 = Yes	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 20 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44033I	G3_SP3DELAY1	SP3DELAY1	0 = No; 1 = Yes	R/W	INT
R44034I	G3_SP3DELAY2	SP3DELAY2	0 = No; 1 = Yes	R/W	INT
R44035I	G3_SP3DELAY3	SP3DELAY3	0 = No; 1 = Yes	R/W	INT
R44036I	G3_SP3DELAY4	SP3DELAY4	0 = No; 1 = Yes	R/W	INT
R44037I	G3_SYNCMANCLS	SYNCMANCLS	0 = No; 1 = Yes	R/W	INT
R44038F	G3_VBUSLIVE	VBUSLIVE	0.1 to 130 V step 0.1	R/W	Float
R44030F	G3_VBUSDEAD	VBUSDEAD	0.1 to 130 V step 0.1	R/W	Float
R44042F	G3_VLINELIVE	VLINELIVE	0.1 to 130 V step 0.1	R/W	Float
R44044F	G3_VLINEDEAD	VLINEDEAD	0.1 to 130 V step 0.1	R/W	Float
R44046I	G3_LBUSDLINE	LBUSDLINE	0 = No; 1 = Yes	R/W	INT
R44047I	G3_DBUSLLINE	DBUSLLINE	0 = No; 1 = Yes	R/W	INT
R44048I	G3_DBUSDLINE	DBUSDLINE	0 = No; 1 = Yes	R/W	INT
R44049F	G3_DELTAV	DELTAV	0.1 to 130 V step 0.1	R/W	Float
R44051I	G3_DELTAVBLK	DELTAVBLK	0 = No; 1 = Yes	R/W	INT
R44052I	G3_NCAIN1	NCAIN1	0 to 256 step 1 (depending on choice of input assignment)	R/W	INT
R44053I	G3_NCAIN2	NCAIN2	0 to 256 step 1	R/W	INT
R44054I	G3_NCAIN3	NCAIN3	0 to 256 step 1	R/W	INT
R47055I	G3_NCAIN4	NCAIN4	0 to 256 step 1	R/W	INT
R44056I	G3_NCAIN5	NCAIN5	0 to 256 step 1	R/W	INT
R44057I	G3_NCAIN6	NCAIN6	0 to 256 step 1	R/W	INT
R44058I	G3_NCAIN7	NCAIN7	0 to 256 step 1	R/W	INT
R44059I	G3_NCAIN8	NCAIN8	0 to 256 step 1	R/W	INT
R44060I	G3_T1	T1	0 to 256 step 1	R/W	INT
R44061I	G3_T2	T2	0 to 256 step 1	R/W	INT
R44062I	G3_T3	T3	0 to 256 step 1	R/W	INT
R44063I	G3_T4	T4	0 to 256 step 1	R/W	INT
R44064I	G3_T5	T5	0 to 256 step 1	R/W	INT
R44065I	G3_T6	T6	0 to 256 step 1	R/W	INT
R44066I	G3_A1	A1	0 to 256 step 1	R/W	INT
R44067I	G3_A2	A2	0 to 256 step 1	R/W	INT
R44068I	G3_A3	A3	0 to 256 step 1	R/W	INT
R44069I	G3_A4	A4	0 to 256 step 1	R/W	INT
R44070I	G3_A5	A5	0 to 256 step 1	R/W	INT
R44071I	G3_A6	A6	0 to 256 step 1	R/W	INT
R44072I	G3_A7	A7	0 to 256 step 1	R/W	INT
R44073I	G3_A8	A8	0 to 256 step 1	R/W	INT
R44074I	G3_A9	A9	0 to 256 step 1	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 21 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44075I	G3_A10	A10	0 to 256 step 1	R/W	INT
R44076I	G3_A11	A11	0 to 256 step 1	R/W	INT
R44077I	G3_A12	A12	0 to 256 step 1	R/W	INT
R44078I	G3_C1	C1	0 to 256 step 1	R/W	INT
R44079I	G3_C2	C2	0 to 256 step 1	R/W	INT
R44080I	G3_KT1	KT1	0 to 256 step 1	R/W	INT
R44081I	G3_KT2	KT2	0 to 256 step 1	R/W	INT
R44082I	G3_KT3	KT3	0 to 256 step 1	R/W	INT
R44083I	G3_KT4	KT4	0 to 256 step 1	R/W	INT
R44084I	G3_CONFTRIP	CONFTRIP	0 to 256 step 1	R/W	INT
R44085I	G3_CONFOSC	CONFOSC	0 to 256 step 1	R/W	INT
R44100I	G4_Z1PHASE	Z1PHASE	0 = No; 1 = Yes	R/W	INT
R44101F	G4_Z1PHREACH	Z1PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44103F	G4_Z1PLEVDET	Z1PLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R44105I	G4_Z1GROUND	Z1GROUND	0 = No; 1 = Yes	R/W	INT
R44106F	G4_Z1GRDREACH	Z1GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44108I	G4_Z1GRDCHAR	Z1GRDCHAR	0 = Mho; 1 = React	R/W	INT
R44109F	G4_Z1SUREACH	Z1SUREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44111F	G4_Z1GROUNDK0	Z1GROUNDK0	1.0 to 7.0 step 0.1	R/W	Float
R44113F	G4_Z1GLEVDET	ZIGLEVDET	0.0 to 9.9 p.u. V step 0.1	R/W	Float
R44115I	G4_Z1BLOCK	Z1BLOCK	0 = No; 1 = Yes	R/W	INT
R44116I	G4_Z2PHASE	Z2PHASE	0 = No; 1 = Yes	R/W	INT
R44117F	G4_Z2PHREACH	Z2PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44119I	G4_Z2PCHARANG	Z2PCHARANG	90 to 120° step 5	R/W	INT
R44120I	G4_Z2GROUND	Z2GROUND	0 = No; 1 = Yes	R/W	INT
R44121I	G4_Z2GRDCHAR	Z2GRDCHAR	0 = MHO; 1 = GDOC; 2 = MHOGDOC	R/W	INT
R44122F	G4_Z2GRDREACH	Z2GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44124I	G4_Z2GCHARANG	Z2GCHARANG	90 to 120° step 5	R/W	INT
R44125I	G4_Z2TIMERS	Z2TIMERS	0 = No; 1 = Yes	R/W	INT
R44126F	G4_Z2P_TIME	Z2P_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R44128F	G4_Z2G_TIME	Z2G_TIME	0.10 to 3.0 sec. step 0.01	R/W	Float
R44130I	G4_Z3PHASE	Z3PHASE	0 = No; 1 = Yes	R/W	INT
R44131F	G4_Z3PHREACH	Z3PHREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 22 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44133I	G4_Z3PCHARANG	Z3PCHARANG	90 to 120° step 5	R/W	INT
R44134I	G4_Z3GRND	Z3GRND	0 = No; 1 = Yes	R/W	INT
R44135F	G4_Z3GRDREACH	Z3GRDREACH	0.01 to 50.0 Ω step 0.1 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44137I	G4_Z3GCHARACHAG	Z3CHARCHAG	90 to 120° step 5	R/W	INT
R44138F	G4_Z3P_TIME	Z3P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R44140F	G4_Z3G_TIME	Z3G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R44142I	G4_Z4PHASE	Z4PHASE	0 = No; 1 = Yes	R/W	INT
R44143F	G4_Z4PHREACH	Z4PHREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44145I	G4_Z4PCHRANG	Z4PCHRANG	80 to 120° step 5	R/W	INT
R44146I	G4_Z4GRND	Z4GRND	0 = No; 1 = Yes	R/W	INT
R44147F	G4_Z4GRDREACH	Z4GRDREACH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44149I	G4_Z4GCHARANG	Z4GCHARANG	80 to 120° step 5	R/W	INT
R44150I	G4_Z4DIRECTN	Z4DIRECTN	0 = Forward; 1 = Reverse	R/W	INT
R44151I	G4_Z4TIMERS	Z4TIMERS	0 = No; 1 = Yes	R/W	INT
R44152F	G4_Z4P_TIME	Z4P_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R44154F	G4_Z4G_TIME	Z4G_TIME	0.10 to 10.0 sec. step 0.01	R/W	Float
R44156F	G4_IT_PICKUP	IT_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R44158F	G4_IB_PICKUP	IB_PICKUP	0.20 to 4.0 A step 0.01 (5A) 0.04 to 0.8 A step 0.01 (1A)	R/W	Float
R44160F	G4_IPT_PICKUP	IPT_PICKUP	0.50 to 5.0 A step 0.01 (5A) 0.1 to 1.0 A step 0.01 (1A)	R/W	Float
R44162F	G4_IPB_PICKUP	IPB_PICKUP	0.25 to 3.75 A step 0.01 (5A) 0.05 to 0.75 A step 0.01 (1A)	R/W	Float
R44164F	G4_IPBKFACTOR	IPBKFACTOR	0.0, 0.066	R/W	Float
R44166F	G4_NT_OFFSET	NT_OFFSET	0.0 to 20.0 Ω step 0.01 0.0 to 100 Ω step 0.01	R/W	Float
R44168I	G4_UNBALALARM	UNBALALARM	0 = No; 1 = Yes	R/W	INT
R44169I	G4_50	50	0 = No; 1 = Yes	R/W	INT
R44170I	G4_50_DIRCNL	50_DIRCNL	0 = No; 1 = Yes	R/W	INT
R44171F	G4_50PICKUP	50PICKUP	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R44173F	G4_50PICKUPFF	50PICKUPFF	2.0 to 160.0 A step 0.1 (5A) 0.4 to 32.0 A step 0.1 (1A)	R/W	Float
R44175I	G4_50G	50G	0 = No; 1 = Yes	R/W	INT
R44176I	G4_50G_DIRCNL	50G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R44177F	G4_50GPICKUP	50GPICKUP	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 23 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44179F	G4_50GPICKUPFF	50GPICKUPFF	0.5 to 80.0 A step 0.1 (5A) 0.1 to 16.0 A step 0.1 (1A)	R/W	Float
R44181F	G4_50GRESTNT	50GRESTNT	0.0, 0.3	R/W	INT
R44183I	G4_51G	51G	0 = No; 1 = Yes	R/W	INT
R44184I	G4_51G_DIRCNL	51G_DIRCNL	0 = No; 1 = Yes	R/W	INT
R44185F	G4_51GPICKUP	51GPICKUP	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R44187F	G4_51GPICKUPFF	51GPICKUPFF	0.20 to 15.0 A step 0.01 (5A) 0.04 to 3.0 A step 0.01 (1A)	R/W	Float
R44189I	G4_51GCURVE	51GCURVE	0 = INV; 1 = V-INV; 2 = EINV; 3 = CUSTOM; 4 = DEFT	R/W	INT
R44190F	G4_51GTIMDIAL	51GTIMDIAL	0.5 to 10.0 step 0.1	R/W	Float
R44192F	G4_51GDEFTIMDELY	51GDEFTIMDELY	0.5 to 30 sec. step 0.1	R/W	Float
R44194I	G4_51G_RESET	51G_RESET	0 = FAST; 1 = EM	R/W	INT
R44195I	G4_RATEDVOLTS	RATEDVOLTS	1.00105E+14 V	R/W	INT
R44196I	G4_PHASEOVER	PHASEOVER	0 = No; 1 = Yes	R/W	INT
R44197F	G4_PHOVPICKUP	PHOVPICKUP	0.0 to 1.4 p.u. V step 0.01	R/W	Float
R44199F	G4_PHOVTMDLY	PHOVTMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R44201I	G4_V1OVER	V1OVER	0 = No; 1 = Yes	R/W	INT
R44202F	G4_V1OVINSTPU	V1OVINSTPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R44204F	G4_V1OVTIMPU	V1OVTIMPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R44206F	G4_V1OVTIMDLY	V1OVTIMDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R44208I	G4_V1COMP	V1COMP	0 = No; 1 = Yes	R/W	INT
R44209F	G4_V1COMRCH	V1COMRCH	0.01 to 50.0 Ω step 0.01 (5A) 0.05 to 250.0 Ω step 0.05 (1A)	R/W	Float
R44211F	G4_VICOMPINPU	V1COMPINPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R44213F	G4_V1COMPTDPU	V1COMPTDPU	1.0 to 1.4 p.u. V step 0.01	R/W	Float
R44215F	G4_V1COMPDLY	V1COMPDLY	0.0 to 10.0 sec. step 0.01	R/W	Float
R44217I	G4_FUSEFAIL	FUSEFAIL	0 = No; 1 = Yes	R/W	INT
R44218I	G4_ALL_BELOW	ALL_BELOW	0 = No; 1 = Yes	R/W	INT
R44219I	G4_OUTOFSTEP	OUTOFSTEP	0 = No; 1 = Yes	R/W	INT
R44220I	G4_ALL_3_Z2PH	ALL_3_Z2PH	0 = No; 1 = Yes	R/W	INT
R44221I	G4_50G_BLOCK	50G_BLOCK	0 = No; 1 = Yes	R/W	INT
R44222I	G4_Z2TIMETRIP	Z2TIMETRIP	0 = No; 1 = Yes	R/W	INT
R44223I	G4_Z3TIMETRIP	Z3TIMETRIP	0 = No; 1 = Yes	R/W	INT
R44224I	G4_Z4TIMETRIP	Z4TIMETRIP	0 = No; 1 = Yes	R/W	INT
R44225I	G4_Z1PHASTRIP	Z1PHASTRIP	0 = No; 1 = Yes	R/W	INT
R44226I	G4_ANYZ2PHASE	ANYZ2PHASE	0 = No; 1 = Yes	R/W	INT
R44227I	G4_CONFGTRIP	CONFGTRIP	0 = No; 1 = Yes	R/W	INT
R44228I	G4_LINEPICKUP	LINEPICKUP	0 = No; 1 = Yes	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 24 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44229I	G4_BYPASSTL3	BYPASSTL3	0 = No; 1 = Yes	R/W	INT
R44230F	G4_I1PICKPU	I1PICKUP	1.0 to 15.0 A step 0.1 0.2 to 3.0 A step 0.1	R/W	Float
R44232I	G4_REMOTEOPEN	REMOTEOPEN	0 = No; 1 = Yes	R/W	INT
R44233I	G4_TL20PICKUP	TL20PICKUP	10 to 100 msec. step 1	R/W	INT
R44234I	G4_LINEOVERLD	LINEOVERLD	0 = No; 1 = Yes	R/W	INT
R44235F	G4_LEVEL1PU	LEVEL1PU	2.5 to 20.0 A step 0.1 (5A) 0.5 to 4.0 A step 0.1 (1A)	R/W	Float
R44237F	G4_LEVEL2PU	LEVEL2PU	5.0 to 40.0 A step 0.1 (5A) 1.0 to 8.0 A step 0.1 (1A)	R/W	Float
R44239F	G4_LEVEL1TDLY	LEVEL1TDLY	10 to 200 sec. step 1	R/W	Float
R44241F	G4_LEVEL2TDLY	LEVEL2TDLY	10 to 99 sec. step 1	R/W	Float
R44243I	G4_PICKSCHEME	PICKSCHEME	0 = STEPDST; 1 = PUTT; 2 = POTT1; 3 = POTT2; 4 = HYBRID	R/W	INT
R44244I	G4_NUMRCVR	NUMRCVR	0, 1, 2	R/W	INT
R44245I	G4_TRIPMODE	TRIPMODE	0 = 3POLE; 1 = 1POLE; 2 = 1POLEZ2	R/W	INT
R44246I	G4_CARRSTART	CARRSTART	0 = DIR; 1 = IPB; 2 = FD	R/W	INT
R44247I	G4_WKINFTRIP	WKINFTRIP	0 = No; 1= Yes	R/W	INT
R44248I	G4_TL1PICKUP	TL1PICKUP	1 to 200 msec. step 1	R/W	INT
R44249I	G4_TL4PICKUP	TL4PICKUP	0 to 50 msec. step 1	R/W	INT
R44250I	G4_TL4DROPOUT	TL4DROPOUT	0 to 50 msec. step 1	R/W	INT
R44251I	G4_TL5PICKUP	TL5PICKUP	0 to 200 msec. step 1	R/W	INT
R44252I	G4_TL5DROPOUT	TL5DROPOUT	0 to 200 msec. step 1	R/W	INT
R44253I	G4_TL6PICKUP	TL6PICKUP	0 to 200 msec. step 1	R/W	INT
R44254I	G4_TL6DROPOUT	TL6DROPOUT	0 to 200 msec. step 1	R/W	INT
R44255I	G4_TL16PICKUP	TL16PICKUP	8 to 99 msec. step 1	R/W	INT
R44256I	G4_TL24DROPOUT	TL24DROPOUT	30 to 500 msec. step 1	R/W	INT
R44257I	G4_TL25DROPOUT	TL25DROPOUT	30 to 500 msec. step 1	R/W	INT
R44258I	G4_TL26PICKUP	TL26PICKUP	0 to 50 msec. step 1	R/W	INT
R44259I	G4_POSSEQANG	POSSEQANG	25 to 90° step 1	R/W	INT
R44260I	G4_ZERSEQANG	ZERSEQANG	25 to 90° step 1	R/W	INT
R44261F	G4_ZLINE	ZLINE	0.01 to 50 Ω step 0.01 0.05 to 250 Ω step 0.05	R/W	Float
R44263F	G4_ZEROSEQK0	G4_ZEROSEQK0	1.0 to 7.0 step 0.1	R/W	Float
R44265F	G4_LINELENGTH	LINELENGTH	0.0 to 500.0 step 0.1	R/W	Float
R44267I	G4_LINEUNIT	LINEUNIT	0 = Miles, 1 = Km	R/W	INT
R44268I	G4_CTRATIO	CTRATIO	1 to 5000 step 1	R/W	INT
R44269I	G4_PTRATIO	PTRATIO	1 to 7000 step 1	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 25 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44270F	G4_FLTLOCK	FLTLOCK	0 to 99.9 sec. step 0.1	R/W	Float
R44272I	G4_FLTRESET	FLTRESET	0 to 999 minutes step 1	R/W	INT
R44273I	G4_MOBZONE	MOBZONE	0 = Zone 2; 1 = Zone 3; 2 = Zone 4	R/W	INT
R44274I	G4_MOBCHARANG	MOBCHARANG	30 to 130° step 1	R/W	INT
R44275I	G4_BLOCKWHAT	BLOCKWHAT	0 = BLKALL; 1 = BLKDIST; 2 = BLKPHAS; 3 = BLKNONE	R/W	INT
R44276I	G4_BLOCKZ1	BLOCKZ1	0 = No; 1 = Yes	R/W	INT
R44277I	G4_BLOCKZ2	BLOCKZ2	0 = No; 1 = Yes	R/W	INT
R44278I	G4_BLOCKZ3	BLOCKZ3	0 = No; 1 = Yes	R/W	INT
R44279I	G4_BLOCKZ4	BLOCKZ4	0 = No; 1 = Yes	R/W	INT
R44280I	G4_USE_OST	USE_OST	0 = No; 1 = Yes	R/W	INT
R44281I	G4_NUMBRCHAR	NUMBRCHAR	2, 3	R/W	INT
R44282I	G4_TRIPIN_OUT	TRIPIN_OUT	0 = IN; 1 = OUT	R/W	INT
R44283F	G4_FWDREACH	FWDREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R44285F	G4_REVREACH	REVREACH	0.1 to 75.0 Ω step 0.1 (5A) 0.5 to 375.0 Ω step 0.5 (1A)	R/W	Float
R44287I	G4_OUTER	OUTER	40 to 165° step 1	R/W	INT
R44288I	G4_MIDDLE	MIDDLE	40 to 165° step 1	R/W	INT
R44289I	G4_INNER	INNER	40 to 165° step 1	R/W	INT
R44290I	G4_TLOS1PU	TLOS1PU	1 to 100 msec. step 1	R/W	INT
R44291I	G4_TLOS1DO	TLOS1DO	1 to 100 msec. step 1	R/W	INT
R44292I	G4_TLOS2PU	TLOS2PU	1 to 100 msec. step 1	R/W	INT
R44293I	G4_TLOS3PU	TLOS3PU	1 to 100 msec. step 1	R/W	INT
R44294I	G4_TLOS4PU	TLOS4PU	1 to 100 msec. step 1	R/W	INT
R44295I	G4_RECLMODE	RECLMODE	0 = Off; 1 = None; 2 = Internal; 3 = External; 4 = Both	R/W	INT
R44296I	G4_RECLOSETYPE	RECLOSETYPE	0 = 1POLE; 1 = 3 POLE; 2 = 1POLE3POLE	R/W	INT
R44297I	G4_NUM_1P_AT	NUM_1P_AT	1, 2, 3, 4	R/W	INT
R44298F	G4_1PDELAY1	1PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R44300F	G4_1PDELAY2	1PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R44302F	G4_1PDELAY3	1PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R44304F	G4_1PDELAY4	1PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float
R44306I	G4_NUM_3P_AT	NUM_3P_AT	1, 2, 3, 4	R/W	INT
R44307F	G4_3PDELAY1	3PDELAY1	0.1 to 300.0 sec. step 0.1	R/W	Float
R44309F	G4_3PDELAY2	3PDELAY2	0.1 to 300.0 sec. step 0.1	R/W	Float
R44311F	G4_3PDELAY3	3PDELAY3	0.1 to 300.0 sec. step 0.1	R/W	Float
R44313F	G4_3PDELAY4	3PDELAY4	0.1 to 300.0 sec. step 0.1	R/W	Float

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 26 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44315F	G4_RESETTIME	RESETTIME	0.1 to 300.0 sec. step 0.1	R/W	Float
R44317F	G4_DWELLTIME	DWELLTIME	0.1 to 2.0 sec. step 0.1	R/W	Float
R44319I	G4_HOLD	HOLD	0 = No; 1 = Yes	R/W	INT
R44320I	G4_HOLDTIME	HOLDTIME	1 to 1000 sec. step 1	R/W	INT
R44321I	G4_HOLDSENSE	HOLDSENSE	0 = CC; 1 = CO	R/W	INT
R44322I	G4_SYNCHCHECK	SYNCHCHECK	0 = No, 1 = Yes	R/W	INT
R44323F	G4_CLOSEANG	CLOSEANG	0 to 75° step 1	R/W	INT
R44325F	G4_SLIPFREQ	SLIPFREQ	0.1 to 5.0 Hz step 0.1	R/W	Float
R44327I	G4_BUSLINE	BUSLINE	0 = BUS; 1 = LINE	R/W	INT
R44328I	G4_SYNCHPHASE	SYNCHPHASE	0 = VA; 1 = VB; 2 = VC 3 = VAB; 4 = VBC; 5 = VCA	R/W	INT
R44329I	G4_SYNCHHOLD	SYNCHHOLD	1 to 100 sec. step 1	R/W	INT
R44330I	G4_SP1DELAY2	SP1DELAY2	1	R/W	INT
R44331I	G4_SP1DELAY3	SP1DELAY3	0 = No; 1 = Yes	R/W	INT
R44332I	G4_SP1DELAY4	SP1DELAYR	0 = No; 1 = Yes	R/W	INT
R44333I	G4_SP3DELAY1	SP3DELAY1	0 = No; 1 = Yes	R/W	INT
R44334I	G4_SP3DELAY2	SP3DELAY2	0 = No; 1 = Yes	R/W	INT
R44335I	G4_SP3DELAY3	SP3DELAY3	0 = No; 1 = Yes	R/W	INT
R44336I	G4_SP3DELAY4	SP3DELAY4	0 = No; 1 = Yes	R/W	INT
R44337I	G4_SYNCMANCLS	SYNCMANCLS	0 = No; 1 = Yes	R/W	INT
R44338F	G4_VBUSLIVE	VBUSLIVE	0.1 to 130 V step 0.1	R/W	Float
R44340F	G4_VBUSDEAD	VBUSDEAD	0.1 to 130 V step 0.1	R/W	Float
R44342F	G4_VLINELIVE	VLINELIVE	0.1 to 130 V step 0.1	R/W	Float
R44344F	G4_VLINEDEAD	VLINEDEAD	0.1 to 130 V step 0.1	R/W	Float
R44346I	G4_LBUSDLINE	LBUSDLINE	0 = No; 1 = Yes	R/W	INT
R44347I	G4_DBUSLLINE	DBUSLLINE	0 = No; 1 = Yes	R/W	INT
R44348I	G4_DBUSDLINE	DBUSDLINE	0 = No; 1 = Yes	R/W	INT
R44349F	G4_DELTAV	DELTAV	0.1 to 130 V step 0.1	R/W	Float
R44351I	G4_DELTAVBLK	DELTAVBLK	0 = No; 1 = Yes	R/W	INT
R44352I	G4_NCAIN1	NCAIN1	0 to 256 step 1 (depending on choice of input assignment)	R/W	INT
R44353I	G4_NCAIN2	NCAIN2	0 to 256 step 1	R/W	INT
R44354I	G4_NCAIN3	NCAIN3	0 to 256 step 1	R/W	INT
R47355I	G4_NCAIN4	NCAIN4	0 to 256 step 1	R/W	INT
R44356I	G4_NCAIN5	NCAIN5	0 to 256 step 1	R/W	INT
R44357I	G4_NCAIN6	NCAIN6	0 to 256 step 1	R/W	INT
R44358I	G4_NCAIN7	NCAIN7	0 to 256 step 1	R/W	INT
R44359I	G4_NCAIN8	NCAIN8	0 to 256 step 1	R/W	INT
R44360I	G4_T1	T1	0 to 256 step 1	R/W	INT

Table B–4: MODBUS MEMORY MAP: SETPOINTS (Sheet 27 of 27)

Register Address	DDE Item Name (Mnemonic)	Contents	Units/Value/Range	R/W	Format Code
R44361I	G4_T2	T2	0 to 256 step 1	R/W	INT
R44362I	G4_T3	T3	0 to 256 step 1	R/W	INT
R44363I	G4_T4	T4	0 to 256 step 1	R/W	INT
R44364I	G4_T5	T5	0 to 256 step 1	R/W	INT
R44365I	G4_T6	T6	0 to 256 step 1	R/W	INT
R44366I	G4_A1	A1	0 to 256 step 1	R/W	INT
R44367I	G4_A2	A2	0 to 256 step 1	R/W	INT
R44368I	G4_A3	A3	0 to 256 step 1	R/W	INT
R44369I	G4_A4	A4	0 to 256 step 1	R/W	INT
R44370I	G4_A5	A5	0 to 256 step 1	R/W	INT
R44371I	G4_A6	A6	0 to 256 step 1	R/W	INT
R44372I	G4_A7	A7	0 to 256 step 1	R/W	INT
R44373I	G4_A8	A8	0 to 256 step 1	R/W	INT
R44374I	G4_A9	A9	0 to 256 step 1	R/W	INT
R44375I	G4_A10	A10	0 to 256 step 1	R/W	INT
R44376I	G4_A11	A11	0 to 256 step 1	R/W	INT
R44377I	G4_A12	A12	0 to 256 step 1	R/W	INT
R44378I	G4_C1	C1	0 to 256 step 1	R/W	INT
R44379I	G4_C2	C2	0 to 256 step 1	R/W	INT
R44380I	G4_KT1	KT1	0 to 256 step 1	R/W	INT
R44381I	G4_KT2	KT2	0 to 256 step 1	R/W	INT
R44382I	G4_KT3	KT3	0 to 256 step 1	R/W	INT
R44383I	G4_KT4	KT4	0 to 256 step 1	R/W	INT
R44384I	G4_CONFTRIP	CONFTRIP	0 to 256 step 1	R/W	INT
R44385I	G4_CONFOSC	CONFOSC	0 to 256 step 1	R/W	INT

Table B–5: FORMAT CODES (Sheet 1 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
F1		**DATE (32 bits): MM/DD/YY**
		Month (8 bits): 1 = Jan.; 2 = Feb.; 3 = Mar, etc.
		Day (8 bits): 1 to 31
		Year (16 bits)
F2		**TIME (32 bits): HH:MM:SS.sss**
		Hours (8 bits): 0 = 12 am; 1 = am; 2 = 2 am; etc.
		Minutes (8 bits): 0 to 59
		Seconds (16 bits): 0 = 00.000 sec.; 1 = 00.001 sec.; ...; 59999 = 59.999 sec.
F3		**BREAKER (2 bytes)**
	0	Open
	1	Close
	2	Not applicable
F4		
	0	On
	1	Off
	2	Not applicable
F5		**RECLS STATE**
	0	None
	1	Reclose
	2	Process
	3	Lockout
	4	Manual lockout
	5	Off
F6		**SYS_960STAT1 (16 bits)**
	bit 0	FLASH self-test error in 960 card
	bit 1	Startup RAM self-test error in 960 card
	bit 2	CRC RAM self-test error
	bit 3	DPRAM self-test error
	bit 4	Interrupt self-test error
	bit 5	Timer self-test error
	bit 6	EEPROM self-test error
	bit 7	CAPACITOR RAM self-test error
	bit 8	RTC failure
	bit 9	Watchdog timer failure
	bits 10 & 11	
	bit 12	Version error
	bit 13	SYSTEM processor (i960) in RESET

Table B–5: FORMAT CODES (Sheet 2 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	bit 14	DO h/w disable flag
	bit 15	
F7		**SYS_960STAT2 (16 bits)**
	bit 0	
	bit 1	Digital output self-test error
	bit 2	LCD display self-test error
	bit 3	IRIG-B self-test error
	bit 4	Rear port 1 present/absent
	bit 5	Rear port 2 present/absent
	bit 6	Voltage ckt #1 continuity error
	bit 7	Voltage ckt #2 continuity error
	bit 8	Voltage ckt #3 continuity error
	bit 9	Voltage ckt #4 continuity error
	bit 10	Voltage ckt #5 continuity error
	bit 11	Voltage ckt #6 continuity error
	bits 12 to 14	
	bit 15	Hardware Configuration Mismatch
F8		**SYS_ANISTAT (16 bits)**
	bit 0	A/D controller self-test error
	bit 1	A/D serial NVM self-test error
	bit 2	A/D reference self-test error
	bit 3	Zero crossing self-test error
	bit 4	A/D reference self-test error has been corrected
	bit 5	No ANI/DMA interrupt self-test error
	bit 6	Digital input error
	bit 7	Digital input error corrects
	bit 8	
	bit 9	MAG serial NVM self-test error
	bit 10	Serial port #1 error
	bit 11	Serial port #2 error
	bit 12	Serial port #3 error
	bit 13	Parallel port error
	bit 14	
	bit 15	Power frequency error
F9		**SYS_DSPSTAT (16 bits)**
	bit 0	PROM self-test error in DSP card
	bit 1	Startup RAM self-test error in DSP card
	bit 2	CRC RAM self-test error in DSP card
	bit 3	Shared RAM self-test error (reported by DSP)

Table B–5: FORMAT CODES (Sheet 3 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	bit 4	Interrupt self-test error
	bit 5	Shared RAM checksum error
	bits 6 to 12	
	bit 13	DSP processor in RESET
	bit 14	DSP version error
	bit 15	DSP processor in SHUTDOWN
F10		**SYS_MISCSTAT1 (16 bits)**
	bit 0	Protection disabled flag
	bit 1	
	bit 2	Continuous monitor alarm error
	bit 3	Unbalanced system detection error
	bit 4	Fuse failure error
	bit 5	Trip bus check error
	bits 6 to 11	
	bit 12	Time strobe fail **(tentative)
	bit 13	H/W jumper (remote manual trip/close)
	bit 14	H/W jumper (remote change sett / Soft DO enable/disable)
	bit 15	H/W jumper (MMI keypad enabled/disabled)
F11		**SYS_MISCSTAT2 (16 bits)**
	bit 0	Group selection through contact converters
	bit 1	Relay test
	bit 2	Digital output test
	bit 3	Channel test
	bit 4	Playback
	bit 5	MMI passwords enabled/disabled
	bit 6	Logon failure through front port
	bit 7	Logon failure through rear port #1
	bit 8	Logon failure through rear port #2
	bit 9	D.O. software disable flag
	bit 10	Communication access level – low bit
	bit 11	Communication access level – high bit
	bit 12	Factory settings access level
	bit 13	Active setting group – low bit
	bit 14	Active setting group – high bit
	bit 15	
F12		**PORT 1 (Integer): XXYZ**
	F56	Baud Rate (XX): 12 = 1200 baud; 24 = 2400 baud; etc.
	F57	Parity (Y): 0 = no parity; 1 = parity
	F58	Stop bits (Z): 0 = no stop bits; 1 = one stop bit; etc.

Table B–5: FORMAT CODES (Sheet 4 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
F13		**PORT 2 (Integer): IXXYZ**
	F59	Interface (I)
	F56	Baud Rate (XX): 12 = 1200 baud; 24 = 2400 baud; etc.
	F57	Parity (Y): 0 = no parity; 1 = parity
	F58	Stop bits (Z): 0 = no stop bits; 1 = one stop bit; etc.
F17		**TRIP TYPES**
	0	No trip available
	1	Z1
	2	Z2
	3	Z3
	4	Z4
	5	PLT
	6	50G
	7	50P
	8	51G
	9	LPU
	10	REM
	11	WI
	12	OSC
	13	SZ1
	14	SZ2
	15	SP1
	16	SW1
	17	CTB
	255	Undefined
F18		**FAULT TYPES**
	1	AG_: phase A to ground
	2	BG_: phase B to ground
	3	CG_: phase C to ground
	4	ABG_: phase A to phase B to ground
	5	BCG_: phase B to phase C to ground
	6	CAG_: phase C to phase A to ground
	7	AB_: phase A to phase B
	8	BC_: phase B to phase C
	9	CA_: phase C to phase A
	10	3PH: phase A to phase B to phase C
	255	Undefined
F20		**DOWNLOAD STATUS**
	0	OK

Table B–5: FORMAT CODES (Sheet 5 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	1	Erasing Flash RAM
	2	Communication error
	3	Code CRC error
	4	Flash write error
	5	Flash erase error
	6	Incorrect application error
	7	Incorrect size
	8	Computing the application code CRC
F22		**DIGITAL TEST NUMBER**
for three	0	End of test
phase	1	T1
systems	2	T2
	3	T3
	4	T4
	5 to 6	
	7	A1
	8	A2
	9	A3
	10	A4
	11	A5
	12	A6
	13	A7
	14	A8
	15 to 18	
	19	KT1
	20	KT2
	21	KT3
	22	KT4
	23	C1A / C1B
	24	C2A / C2B
	25	CA – A/B (critical alarm)
F22		**DIGITAL TEST NUMBER**
for single	0	End of test
phase	1	T1
systems	2	T2
	3	T3
	4	T4
	5	T5
	6	T6

Table B–5: FORMAT CODES (Sheet 6 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	7	A1
	8	A2
	9	A3
	10	A4
	11	A5
	12	A6
	13	A7
	14	A8
	15	A9
	16	A10
	17	A11
	18	A12
	19	KT1
	20	KT2
	21	KT3
	22	KT4
	23	C1A / C1B
	24	C2A / C2B
	25	CA – A/B (critical alarm)
F26		**OUTPUT MODE**
	0	Output enabled
	1	Output disabled
F27		**STATUS BITS for Contact Converters (0 = not activated; 1 = activated)**
	bit 0	Status for CC1
	bit 1	Status for CC2
	bit 2	Status for CC3
	bit 3	Status for CC4
	bit 4	Status for CC5
	bit 5	Status for CC6
	bit 6	Status for CC7
	bit 7	Status for CC8
	bit 8	Status for CC9
	bit 9	Status for CC10
	bit 10	Status for CC11
	bit 11	Status for CC12

Table B–5: FORMAT CODES (Sheet 7 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
F28		**STATUS BITS for Output Contacts (0 = not activated; 1 = activated)**
single	bit 0	Status for T1
phase	bit 1	Status for T2
tripping	bit 2	Status for T3
model	bit 3	Status for T4
	bit 4	Status for T5
	bit 5	Status for T6
	bit 6	Status for A1
	bit 7	Status for A2
	bit 8	Status for A3
	bit 9	Status for A4
	bit 10	Status for A5
	bit 11	Status for A6
	bit 12	Status for A7
	bit 13	Status for A8
	bit 14	Status for A9
	bit 15	Status for A10
	bit 16	Status for A11
	bit 17	Status for A12
	bit 18	Status for KT1
	bit 19	Status for KT2
	bit 20	Status for KT3
	bit 21	Status for KT4
	bit 22	Status for C1
	bit 23	Status for C2
	bit 24	Status for CA – A/B (critical alarm)
F28		**STATUS BITS for Output Contacts (0 = not activated; 1 = activated)**
three	bit 0	Status for T1
phase	bit 1	Status for T2
tripping	bit 2	Status for T3
model	bit 3	Status for T4
	bits 4 to 5	
	bit 6	Status for A1
	bit 7	Status for A2
	bit 8	Status for A3
	bit 9	Status for A4
	bit 10	Status for A5
	bit 11	Status for A6
	bit 12	Status for A7

Table B–5: FORMAT CODES (Sheet 8 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	bit 13	Status for A8
	bits 14 to 17	
	bit 18	Status for KT1
	bit 19	Status for KT2
	bit 20	Status for KT3
	bit 21	Status for KT4
	bit 22	Status for C1
	bit 23	Status for C2
	bit 24	Status for CA – A/B (critical alarm)
F43		**RESET TYPE**
	0	Fault report and oscillography data
	1	Event data
	2	OST data
	3	Breaker Health
	4	Reset target LEDs, clear warn and fail and trip message from display and EEPROM
F49		**MULTIPLIER**
	0	M: millions
	1	K: thousands
	2	Actual value
F52		**PHASEROTATE**
	0	ABC
	1	ACB
F56		**BAUD RATE**
	03	300
	12	1200
	24	2400
	48	4800
	96	9600
	19	19200
F57		**PARITY**
	0	no parity
	1	odd parity
	2	even parity
F58		**STOP BITS**
	1	1
	2	2
F59		**INTERFACE**
	0	RS232
	1	RS485

Table B–5: FORMAT CODES (Sheet 9 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
F60		**DISPLAYVAL**
	0	Primary
	1	Secondary
F61		**EVENT CODES**
	000	“FAIL– CPU BOARD SRAM”
	001	“FAIL– 960 ACCESS TO DPRAM”
	002	“FAIL– EEPROM”
	003	“FAIL– DIGITAL OUTPUT TEST”
	004	“FAIL– INTERRUPT TEST”
	005	“FAIL– ANI ADC CONTROL LOGIC”
	006	“FAIL– ANI REFERENCE CHANNEL TEST”
	007	“FAIL– DMA INTERRUPT”
	008	“FAIL– ANI BOARD TIMER”
	009	“FAIL– ANI BOARD SERIAL EEPROM TEST”
	010	“FAIL– MAG MODULE SERIAL EEPROM TEST”
	011	“FAIL– DIG OUTPUT SERIAL EEPROM TEST”
	012	“FAIL– DTA SERIAL EEPROM TEST”
	013	“FAIL– DSP PROM”
	014	“FAIL– DSP INTERNAL RAM”
	015	“FAIL– DSP INTERNAL RAM CHECKSUM ERROR”
	016	“FAIL– DSP ACCESS TO DPRAM”
	017	“FAIL– DSP INTERRUPT”
	018	“FAIL– DIGITAL INPUT TEST”
	019	“FAIL– MODEL NUMBER”
	020	“FAIL– MAG MODULE CONFIG MISMATCH”
	021	“FAIL– ANI MODULE CONFIG MISMATCH”
	022	“FAIL– DIG INPUT MODULE CONFIG MISMATCH”
	023	“FAIL– DIG OUTPUT MODULE CONFIG MISMATCH”
	024	“FAIL– TRIP CIRCUIT #1 CONTINUITY MONITOR”
	025	“FAIL– TRIP CIRCUIT #2 CONTINUITY MONITOR”
	026	“FAIL– TRIP CIRCUIT #3 CONTINUITY MONITOR”
	027	“FAIL– TRIP CIRCUIT #4 CONTINUITY MONITOR”
	028	“FAIL– TRIP CIRCUIT #5 CONTINUITY MONITOR”
	029	“FAIL– TRIP CIRCUIT #6 CONTINUITY MONITOR”
	030	“FAIL– SOFTWARE VERSION ERROR”
	031	“FAIL– DSP SOFTWARE VERSION ERROR”
	032	“FAIL– FIVE RESTARTS IN AN HOUR”
	033	“FAIL– i960-DSP INTERFACE (DPRAM)”
	034	“RUNTIME FLASH TEST CRC CHECK FAIL”

Table B–5: FORMAT CODES (Sheet 10 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	035	“i960 INSTRUCTION FAULT OCCURED”
	036	“i960 ARITHMETIC INSTRUCTION FAULT”
	037	“TOO MANY BOGUS INTERRUPTS”
	038	“FAIL– DSP DPRAM CHECKSUM”
	039 to 042	
	043	“WARN – CPU BOARD TIMER TEST”
	044	“WARN – ZERO CROSSING LOGIC”
	045	“WARN – CAPRAM FAILURE”
	046	“WARN – RTC TEST FAILURE”
	047	“WARN – COMM FRONT PORT FAILURE”
	048	“WARN – COMM REAR PORT 1 FAILURE”
	049	“WARN – COMM REAR PORT 2 FAILURE”
	050	“WARN – WATCHDOG TIMER FAILED”
	051	“WARN – LCD DISPLAY FAILURE”
	052	“WARN – IRIGB FAILED”
	053	“WARN – H/W MISMATCH - REAR PORT 2 ABSENT”
	054	“WARN – NON CRIT FIELD IN MODEL NUM ERROR”
	055	“WARN – CAPRAM SIZE MISMATCH”
	056	“WARN – FREQUENCY OUT OF RANGE”
	057	“WARN – WARM RESTART”
	058 to 061	
	062	“ANI REFERENCE CORRECTED”
	063	“DIGITAL INPUT ERROR CORRECTED”
	064	“MAG MODULE ERROR CORRECTED”
	065	“ANI MODULE ERROR CORRECTED”
	066	“LCD DISPLAY ERROR CORRECTED”
	067 to 076	
	077	“LOGIN FAILED”
	078	“PASSWORD CHANGE”
	079	“ENABLE OUTPUTS”
	080	“DISABLE OUTPUTS”
	081	“MANUAL TRIP”
	082	“MANUAL CLOSE”
	083	“ATTEMPTED MANUAL TRIP FAILED”
	084	“ATTEMPTED MANUAL CLOSE FAILED”
	085	“MANUAL RECLOSER RESET”
	086	“SETTINGS CHANGE STARTED”
	087	“SETTINGS CHANGE DONE”
	088	“PROTECTION TURNED OFF”

Table B–5: FORMAT CODES (Sheet 11 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	089	“PROTECTION TURNED ON”
	090	“FAULTS RESET”
	091	“EVENTS RESET”
	092	“OST OSCILLOGRAPHY RESET”
	093	“EQUIPMENT DUTY RESET”
	094	“ACTIVE SETTING GROUP CHANGED”
	095	“PROTECTION REINITIALIZATION SERVICED”
	096	“PROTECTION REINIT NOT SERVICED”
	097	“FACTORY SETTING DONE”
	098	“ERR – CONTANTS USED FOR PROT”
	099	“ERR – CONFIG LOGIC CODE AREA”
	100	“INITIALIZED, LPS INITIALIZED”
	101 to 104	
	105	“TRIP SIGNALS ON”
	106	“TRIP SIGNALS RESET”
	107	“TRIP A SIGNAL ON”
	108	“TRIP A SIGNAL RESET”
	109	“TRIP B SIGNAL ON”
	110	“TRIP B SIGNAL RESET”
	111	“TRIP C SIGNAL ON”
	112	“TRIP C SIGNAL RESET”
	113	“OUT OF STEP BLOCK ON”
	114	“OUT OF STEP BLOCK OFF”
	115	“BREAKER #1 OPEN”
	116	“BREAKER #1 CLOSED”
	117	“BREAKER #2 OPEN”
	118	“BREAKER #2 CLOSED”
	119	“FUSE FAILURE ALARM ON”
	120	“FUSE FAILURE ALARM OFF”
	121	“RECEIVE CARRIER ON”
	122	“RECEIVE CARRIER OFF”
	123	“KEY TRANSMITTER ON”
	124	“KEY TRANSMITTER OFF”
	125	“TRIP CIRCUIT #1 ENERGIZED”
	126	“TRIP CIRCUIT #2 ENERGIZED”
	127	“TRIP CIRCUIT #3 ENERGIZED”
	128	“TRIP CIRCUIT #4 ENERGIZED”
	129	“TRIP CIRCUIT #5 ENERGIZED”
	130	“TRIP CIRCUIT #6 ENERGIZED”

Table B–5: FORMAT CODES (Sheet 12 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
	131	“LINE OVERLOAD ALARM OFF”
	132	“LINE OVERLOAD ALARM ON”
	133	“TRIP CIRCUIT #1 MONITOR ALARM ON”
	134	“TRIP CIRCUIT #1 MONITOR ALARM OFF”
	135	“TRIP CIRCUIT #2 MONITOR ALARM ON”
	136	“TRIP CIRCUIT #2 MONITOR ALARM OFF”
	137	“TRIP CIRCUIT #3 MONITOR ALARM ON”
	138	“TRIP CIRCUIT #3 MONITOR ALARM OFF”
	139	“TRIP CIRCUIT #4 MONITOR ALARM ON”
	140	“TRIP CIRCUIT #4 MONITOR ALARM OFF”
	141	“TRIP CIRCUIT #5 MONITOR ALARM ON”
	142	“TRIP CIRCUIT #5 MONITOR ALARM OFF”
	143	“TRIP CIRCUIT #6 MONITOR ALARM ON”
	144	“TRIP CIRCUIT #6 MONITOR ALARM OFF”
	145	“PILOT PROTECTION ON”
	146	“PILOT PROTECTION OFF”
	147	“OSCILLOGRAPHY TRIGGERED”
	148	“FAIL – TRIP BUS CHECK”
	149	“UNBALANCED SYSTEM DETECTION ALARM ON”
	150	“UNBALANCED SYSTEM DETECTION ALARM OFF”
	151	“ZONE MEASUREMENT UNITS ALARM ON”
	152	“ZONE MEASUREMENT UNITS ALARM OFF”
	153	“OVERCURRENT MONITOR ALARM ON”
	154	“OVERCURRENT MONITOR ALARM OFF”
	155	“TRIP CIRCUIT #1 NOT ENERGIZED”
	156	“TRIP CIRCUIT #2 NOT ENERGIZED”
	157	“TRIP CIRCUIT #3 NOT ENERGIZED”
	158	“TRIP CIRCUIT #4 NOT ENERGIZED”
	159	“TRIP CIRCUIT #5 NOT ENERGIZED”
	160	“TRIP CIRCUIT #6 NOT ENERGIZED”
	161	“RECLOSER IN RESET”
	162	“RECLOSE IN PROGRESS – START”
	163	“RECLOSE IN PROGRESS – END”
	164	“SINGLE POLE RECLOSE – SHOT1”
	165	“SINGLE POLE RECLOSE – SHOT2”
	166	“SINGLE POLE RECLOSE – SHOT3”
		“SINGLE POLE RECLOSE – SHOT4”
		“THREE POLE RECLOSE – SHOT1”
		“THREE POLE RECLOSE – SHOT2”

Table B–5: FORMAT CODES (Sheet 13 of 13)

TYPE	VALUE / BIT MASK	DESCRIPTION
		“THREE POLE RECLOSE – SHOT3”
		“THREE POLE RECLOSE – SHOT4”
		“OUT OF STEP TRIP ON”
		“OUT OF STEP TRIP OFF”
		“RUNTIME ANI CONTROL ERROR”
		“RUNTIME ANI REFERENCE ERROR”
		“TOC CURVE CHANGED”
		“RUN TIME DSP HANDSHAKE”
		“RUN TIME DSP PROGRAM ROM”
		“RUN TIME DSP CRC STATIC RAM”
		“RUN TIME DSP DPRAM”
		“RUN TIME DSP DPRAM CHECKSUM”
		“RUN TIME NO DMA INTERRUPT”
		“EEPROM CRC RECALCULATED”
		“MAX BREAKER OPERATIONS EXCEEDED”
		“MAX I2T EXCEEDED”
		“NO SYNC CHECK”
		“RECLOSER IN LOCKOUT – NO INHIBIT INPUT”
		“RECLOSER IN LOCKOUT – BREAKER OPEN”
		“RECLOSER IN LOCKOUT – RECLOSE UNSUCCESSFUL”
		“RECLOSER IN LOCKOUT – RECLOSE CANCEL”
		“RECLOSER IN LOCKOUT – BREAKER FAIL TO OPEN”
		“RECLOSER IN LOCKOUT – MAXIMUM SHOTS”
		“RECLOSER IN LOCKOUT – INVALID REC TYPE”
		“RECLOSE – OUTPUT ISSUED”
		“RECLOSER IN LOCKOUT – MANUAL LOCKOUT”
F69		**EVENT SOURCE**
	0	Port PL1
	1	Port PL2
	2	Port PL3
	3	LUI
	4	Protection
	5	Self-test
	6	Startup

C.1.1 DESCRIPTION

NOTE

The DNP Protocol is only available on LPS-D Rev. A versions V0004.04AA23 or higher and Rev. B. versions V0005.01AA02 or higher.

This appendix contains information for using DNP with the LPS-D for users familiar with the DNP protocol. Since DNP is a complex protocol, it is not within the scope of this manual to provide a complete description of its operation in the detail required for communication with the LPS-D. It is strongly recommended that interested users contact the DNP Users Group at www.dnp.org to obtain further information. Members of the DNP Users group are eligible to receive complete descriptions of all aspects of the protocol.

C.1.2 MODIFYING SETTINGS USING DNP

LPS-D settings can be read using Function Code 1 to read the Analog Output Object Points. Settings can only be modified using Function Codes 5 or 6 to Direct Operate the Analog Output Object Points. Since there are eight groups of settings for most of the Settings categories, the Settings group of interest must be selected before reading or writing any of the Analog Output Points. Analog Output Point #0 gives the currently active settings group being used by the DNP application in the device. Note that this is not necessarily same as the currently active settings group of the device. On power-up or any device restart, this point is set to the active settings group of the device, but this can later be changed using DNP functions and can be different from the active settings group in the device.

Binary Output #13, Start Settings Change must be activated before starting any settings changes using function codes 5 or 6 to Analog Output points. Any changes to the Analog output points are only done in the local copy of the DNP application and are not written to the Non-Volatile memory section of the device where settings are stored till Binary Output #14, End Settings Change is activated. This procedure is summarized in the following steps.

1. Start Settings change by activating Binary Output #13 (using function code 5 or 6)
2. Select the settings group by writing the appropriate value in Analog Output point #0 (using function code 5 or 6).
3. Modify the required settings by writing to the corresponding Analog Output points (using function code 5 or 6).
4. End Settings change by activating Binary Output #14 (using function code 5 or 6). When this is done, the new settings are saved in Non-Volatile memory and the device is restarted if any of the critical settings are modified. Refer to the Instruction Book for details on the Critical settings.

C

DNP 3.0
DEVICE PROFILE DOCUMENT

Vendor Name: General Electric Power Management Inc.

Device Name: LPS-D Line Protection System

Highest DNP Level Supported:	Device Function:
For Requests: Level 2 For Responses: Level 2	☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table):
- Binary Input (Object 1, Variations 1 and 2)
- Binary Output (Object 10, Variation 2)
- Binary Counter (Object 20, Variations 5 and 6)
- Frozen Counter (Object 21, Variations 5 and 6)
- Analog Input (Object 30, Variations 1, 2, 3 and 4)
- Analog Input Change (Object 32, Variations 1, 2, 3 and 4)
- Analog Output (Object 40, Variations 1 and 2)
- Analog Output Block (Object 41, Variation 1)
- Warm Restart (Function code 14)

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted: 292 Received: 292	Transmitted: 2048 Received: 2048

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
☒ None ☐ Fixed ☐ Configurable	☒ None ☐ Configurable

Requires Data Link Layer Confirmation:
- ☒ Never
- ☐ Always
- ☐ Sometimes
- ☐ Configurable

Requires Application Layer Confirmation:
- ☐ Never
- ☐ Always
- ☐ When reporting Event Data
- ☒ When sending multi-fragment responses
- ☐ Sometimes
- ☐ Configurable

Timeouts while waiting for:

Data Link Confirm	☒ None	☐ Fixed	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed	☐ Variable	☐ Configurable
Application Confirm	☐ None	☒ Fixed at 5000 ms	☐ Variable	☐ Configurable
Complete Appl. Response	☒ None	☐ Fixed	☐ Variable	☐ Configurable
Others:	(None)			

DNP 3.0
DEVICE PROFILE DOCUMENT (Continued)

Sends/Executes Control Operations:

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☐ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Count > 1	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Pulse Off	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch Off	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

(For an explanation of the above, refer to the discussion accompanying the point list for the Binary Output/ Control Relay Output Block objects)

Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Reports Binary Input Change Events when no specific variations requested:
- ☐ Never
- ☒ Only time-tagged
- ☐ Only non-time-tagged
- ☐ Configurable to send both, one or the other

Reports time-tagged Binary Input Change Events when no specific variation requested:
- ☐ Never
- ☒ Binary Input Change With Time
- ☐ Binary Input Change With Relative Time
- ☐ Configurable

Sends Unsolicited Responses:
- ☒ Never
- ☐ Configurable
- ☐ Only certain objects
- ☐ Sometimes
- ☐ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses:
- ☒ Never
- ☐ When Device Restarts
- ☐ When Status Flags Change

Default Counter Object/Variation:
- ☐ No Counters Reported
- ☐ Configurable
- ☒ Default Object: 20
  Default Variation: 6
- ☐ Point-by-point list attached

Counters Roll Over at:
- ☐ No Counters Reported
- ☐ Configurable
- ☐ 16 Bits
- ☐ 32 Bits
- ☐ Other Value
- ☒ Point-by-point list attached

Sends Multi-Fragment Responses: ☐ Yes ☒ No

C.2.2 IMPLEMENTATION TABLE

The implementation table gives a list of all objects recognized and returned by the LPS-D device. Additional information detailing a list of default variations returned for each object and lists of defined point numbers for each object is provided on the following pages.

Table C–1: IMPLEMENTATION TABLE (Sheet 1 of 2)

IMPLEMENTATION TABLE						
OBJECT			REQUEST		RESPONSE	
OBJ	VAR	DESCRIPTION	FUNC CODES (DEC)	QUAL CODES (HEX)	FUNC CODES (DEC)	QUAL CODES (HEX)
1	0	Binary Input – All Variations	1	06		
1	1	Binary Input	1	00, 01, 06	129	00, 01
1	2	Binary Input With Status	1	00, 01, 06	129	00, 01
2	0	Binary Input Change – All Variations	1	06, 07, 08		
2	1	Binary Input Change Without Time	1	06, 07, 08	129	17, 28
2	2	Binary Input Change With Time	1	06, 07, 08	129	17, 28
10	0	Binary Output – All Variations	1	06		
10	2	Binary Output Status	1	00, 01, 06	129	00, 01
12	1	Control Relay Output Block	5, 6	17, 28	129	17, 28
20	0	Binary Counter – All Variations	1, 7, 8, 9, 10	06	129	00, 01
20	5	32-Bit Binary Counter without Flag	1, 7, 8, 9, 10	06	129	00, 01
20	6	16-Bit Binary Counter without Flag	1, 7, 8, 9, 10	06	129	00, 01
21	0	Frozen Counter – All Variations	1	06	129	00, 01
21	9	32-Bit Frozen Counter without Flag	1	06	129	00, 01
21	10	16-Bit Frozen Counter without Flag	1	06	129	00, 01
30	0	Analog Input – All Variations	1	06		
30	1	32-Bit Analog Input with Flag	1	00, 01, 06	129	00, 01
30	2	16-Bit Analog Input with Flag	1	00, 01, 06	129	00, 01
30	3	32-Bit Analog Input without Flag	1	00, 01, 06	129	00, 01
30	4	16-Bit Analog Input without Flag	1	00, 01, 06	129	00, 01
32	0	Analog Change Event – All Variations	1	06, 07, 08		
32	1	32-Bit Analog Change Event without Time	1	06, 07, 08	129	17, 28
32	2	16-Bit Analog Change Event without Time	1	06, 07, 08	129	17, 28
32	3	32-Bit Analog Change Event with Time	1	06, 07, 08	129	17, 28
32	4	16-Bit Analog Change Event with Time	1	06, 07, 08	129	17, 28

[1], [2], [3], [4], [5], [6] See Table Notes following the Implementation Table

Table C–1: IMPLEMENTATION TABLE (Sheet 2 of 2)

IMPLEMENTATION TABLE						
OBJECT			REQUEST		RESPONSE	
OBJ	VAR	DESCRIPTION	FUNC CODES (DEC)	QUAL CODES (HEX)	FUNC CODES (DEC)	QUAL CODES (HEX)
40	0	Analog Output Status – All Variations	1	06		
40	1	32-Bit Analog Output Status	1	00, 01, 06	129	00, 01
40	2	16-Bit Analog Output Status	1	00, 01, 06	129	00, 01
41	1	32-Bit Analog Output Block	5, 6	17, 28	129	17, 28
41	2	16-Bit Analog Output Block	5, 6	17, 28	129	17, 28
50	1	Time And Date	1, 2	07 [1]	129	07
60	1	Class 0 Data [2]	1	06		
60	2	Class 1 Data [3]	1	06, 07,. 08	129	
60	3	Class 2 Data [3]	1	06, 07, 08	129	
60	4	Class 3 Data [3]	1	06, 07, 08	129	
80	1	Internal Indications	2	00 [4]	129	
No Object (Cold Start Command)			13			
No Object (Warm Start Command) [5]			14			
No Object (Delay Measurement Command) [6]			23			

[1], [2], [3], [4], [5], [6] See Table Notes following the Implementation Table

TABLE NOTES:

1 For this object, the quantity specified in the request must be exactly ‘1’ as there is only one instance of this object defined in the relay.

2 All Static Data known to the relay is returned in response to a request for Class 0. This includes all objects of type 1 (Binary Input), type 10 (Binary Output), type 30 (Analog Input) and type 40 (Analog Output).

3 The point tables for Binary Input and Analog Input objects contain a field that defines to which event class the corresponding static data has been assigned.

4 For this object, the qualifier code must specify an index of 7 only.

5 Warm Restart (Function Code 14) is supported although it is not required by the DNP L2 specification.

6 Delay Measurement (Function Code 23) is supported although it should be noted that the relay would never set the “Time Synchronization Required” Internal Indication bit.

C.2.3 DEFAULT VARIATIONS

The following table specifies the default variation for all objects returned by the relay. These variations will be returned for the object in a response when no specific variation is specified in a request.

Table C–2: DEFAULT VARIATIONS

DEFAULT VARIATIONS		
OBJECT	**DESCRIPTION**	**DEFAULT VARIATION**
1	Binary Input	1
2	Binary Input Change with Time	2
10	Binary Output Status	2
20	16-Bit Binary Counter without Flag	6
21	16-Bit Frozen Counter without Flag	10
30	16-Bit Analog Input without Flag	4
32	16-Bit Analog Input Change without Time	2
40	16-Bit Analog Output Status	2

C.3.1 DESCRIPTION

The following tables give a list of data points defined for each object in the relay.

C.3.2 BINARY INPUT, BINARY INPUT CHANGE

Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 1 of 6)

BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02)			
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**REMARKS**
0	Relay In Service	Class 1	
1	Critical Failure	Class 1	
2	Non-Critical Failure	Class 1	
3	Warm Restart	Class 1	
4	Settings Group 1 Active	Class 1	
5	Settings Group 2 Active	Class 1	
6	Settings Group 3 Active	Class 1	
7	Settings Group 4 Active	Class 1	
8	Recloser Disabled	Class 1	
9	Recloser in Reset	Class 1	
10	Recloser in Progress	Class 1	
11	Recloser in Lockout	Class 1	
12	Breaker #1 / Breaker #1 Phase A is Open	Class 1	
13	Breaker #1 Phase B is Open	Class 1	
14	Breaker #1 Phase C is Open	Class 1	
15	Breaker #1 / Breaker #1 Phase A is Closed	Class 1	
16	Breaker #1 Phase B is Closed	Class 1	
17	Breaker #1 Phase C is Closed	Class 1	
18	Breaker #2 / Breaker #2 Phase A is Open	Class 1	
19	Breaker #2 Phase B is Open	Class 1	
20	Breaker #2 Phase C is Open	Class 1	
21	Breaker #2 / Breaker #2 Phase A is Closed	Class 1	
22	Breaker #2 Phase B is Closed	Class 1	
23	Breaker #2 Phase C is Closed	Class 1	
24	DO – Phase A Trip Bus	Class 1	
25	DO – Phase B Trip Bus	Class 1	
26	DO – Phase C Trip Bus	Class 1	
27	DO – Single Pole Reclose Initiate	Class 1	
28	DO – Three Pole Reclose Initiate	Class 1	
29	DO – Reclose Cancel	Class 1	
30	DO – Key Transmitter 1/Carrier Start	Class 1	

Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 2 of 6)

BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02)			
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**REMARKS**
31	DO – Key Transmitter 2/Carrier Stop	Class 1	
32	DO – Three Phase Trip Enable	Class 1	
33	…Reserved…		
34	…Reserved…		
35	DO – Reclose In Progress	Class 1	
36	DO – Line Overload Alarm	Class 1	
37	DO – Recloser in Lockout Alarm	Class 1	
38	DO – Trip Circuit Alarm	Class 1	
39	DO – Zone Flags ON Alarm	Class 1	
40	DO – Over Current Alarm	Class 1	
41	DO – Unbalanced Alarm	Class 1	
42	DO – Key Transmitter 3	Class 1	
43	DO – Key Transmitter 4	Class 1	
44	DO – Manual Open Breaker 1	Class 1	
45	DO – Manual Open Breaker 2	Class 1	
46	DO – Manual Close Breaker 1	Class 1	
47	DO – Manual Close Breaker 2	Class 1	
48	DO – Fault ID Phase A	Class 1	
49	DO – Fault ID Phase B	Class 1	
50	DO – Fault ID Phase C	Class 1	
51	DO – Fault ID Neutral	Class 1	
52	Zone 1 AB Distance Function	Class 1	
53	Zone 1 BC Distance Function	Class1	
54	Zone 1 CA Distance Function	Class1	
55	Zone 2 AB Distance Function	Class 1	
56	Zone 2 BC Distance Function	Class1	
57	Zone 2 CA Distance Function	Class1	
58	Zone 3 AB Distance Function	Class 1	
59	Zone 3 BC Distance Function	Class1	
60	Zone 3 CA Distance Function	Class1	
61	Zone 4 AB Distance Function	Class 1	
62	Zone 4 BC Distance Function	Class1	
63	Zone 4 CA Distance Function	Class1	
64	Any Z1 Phase Distance Function	Class 1	
65	Any Z2 Phase Distance Function	Class 1	
66	Any Z3 Phase Distance Function	Class 1	

Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 3 of 6)

BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02)			
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**REMARKS**
67	Any Z4 Phase Distance Function	Class 1	
68	Zone 1 AG Distance Function	Class 1	
69	Zone 1 BG Distance Function	Class 1	
70	Zone 1 CG Distance Function	Class 1	
71	Zone 2 AG Distance Function	Class 1	
72	Zone 2 BG Distance Function	Class 1	
73	Zone 2 CG Distance Function	Class 1	
74	Zone 3 AG Distance Function	Class 1	
75	Zone 3 BG Distance Function	Class 1	
76	Zone 3 CG Distance Function	Class 1	
77	Zone 4 AG Distance Function	Class 1	
78	Zone 4 BG Distance Function	Class 1	
79	Zone 4 CG Distance Function	Class 1	
80	Any Z1 Ground Distance Function	Class 1	
81	Any Z2 Ground Distance Function	Class 1	
82	Any Z3 Ground Distance Function	Class 1	
83	Any Z4 Ground Distance Function	Class 1	
84	Any Phase Under Voltage	Class 1	
85	All Voltages High	Class 1	
86	Fault Detector	Class 1	
87	TL1 Timer Output	Class 1	
88	IT Detector	Class 1	
89	IB Detector	Class 1	
90	IPT Detector	Class 1	
91	IPB Detector	Class 1	
92	Remote Breaker Open Detector	Class 1	
93	Ground Directional Trip	Class 1	
94	Ground Directional Block	Class 1	
95	Line Pickup	Class 1	
96	Fuse Failure	Class 1	
97	Instantaneous Phase Over Current	Class 1	
98	Instantaneous Ground Over Current	Class 1	
99	Ground Time Over Current Pickup	Class 1	
100	Ground Time Over Current Trip	Class 1	
101	Out of Step Blocking	Class 1	
102	Out of Step Trip	Class 1	

Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 4 of 6)

BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02)			
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**REMARKS**
103	Configurable Trip Bus Input	Class 1	
104	Configurable Oscillography Trigger	Class 1	
105	TL16 Timer Output	Class 1	
106	TL24 Timer Output	Class 1	
107	Ground Forward Flag	Class 1	
108	Ground Reverse Flag	Class 1	
109	TL25 Timer Output	Class 1	
110	Z2 Ground Timer	Class 1	
111	Z3 Ground Timer	Class 1	
112	Z4 Ground Timer	Class 1	
113	Z2 Phase Timer	Class 1	
114	Z3 Phase Timer	Class 1	
115	Z4 Phase Timer	Class 1	
116	Any Trip Bus	Class 1	
117	Weak Infeed Trip	Class 1	
118	Synch Check Output	Class 1	
119	Any Phase Over Voltage Pickup	Class 1	
120	Positive Sequence Over Voltage Pickup	Class 1	
121	Compensated Positive Sequence Overvoltage Pickup	Class 1	
122	Phase A Over Voltage	Class 1	
123	Phase B Over Voltage	Class 1	
124	Phase C Over Voltage	Class 1	
125	Instantaneous Positive Sequence Over Voltage	Class 1	
126	Time Delayed Positive Sequence Over Voltage	Class 1	
127	Instantaneous Compensated Positive Sequence Overvoltage	Class 1	
128	Time Delayed Compensated Positive Sequence Overvoltage	Class 1	
129	Any Phase Overvoltage	Class 1	
130	I1 Line Pickup	Class 1	
131	Manual Close Requested	Class 1	
132	CC Input – 52b Breaker #1 Phase A	Class 1	
133	CC Input – 52b Breaker #1 Phase B	Class 1	
134	CC Input – 52b Breaker #1 Phase C	Class 1	
135	CC Input – 52b Breaker #2 Phase A	Class 1	
136	CC Input – 52b Breaker #2 Phase B	Class 1	
137	CC Input – 52b Breaker #2 Phase C	Class 1	
138	CC Input – Enable 3-Phase Tripping	Class 1	

Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 5 of 6)

BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02)			
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**REMARKS**
139	CC Input – Change Setting Group Input Bit 0	Class 1	
140	CC Input – Change Setting Group Input Bit 1	Class 1	
141	CC Input – Stop Carrier / Receiver 3	Class 1	
142	CC Input – Block Pilot Tripping /Receiver 4	Class 1	
143	CC Input – Receiver 1	Class 1	
144	CC Input – Receiver 2	Class 1	
145	CC Input – Single Pole Reclose Initiate	Class 1	
146	CC Input – Three Pole Reclose Initiate	Class 1	
147	CC Input – Reclose Inhibit	Class 1	
148	CC Input – Reclose Cancel	Class 1	
149	CC Input – Reclose Reset	Class 1	
150	CC Input – Manual Close	Class 1	
151	CC Input – Target Reset	Class 1	
152	CC Input – Disable Protection	Class 1	
153	CC Input – Disable Outputs	Class 1	
154	CC Input – Oscillography Trigger	Class 1	
155	CC Input – Manual Lockout	Class 1	
156	CC Input – Configurable Input 1	Class 1	
157	CC Input – Configurable Input 2	Class 1	
158	CC Input – Configurable Input 3	Class 1	
159	CC Input – Configurable Input 4	Class 1	
160	CC Input – Configurable Input 5	Class 1	
161	CC Input – Configurable Input 6	Class 1	
162	CC Input – Configurable Input 7	Class 1	
163	CC Input – Configurable Input 8	Class 1	
164	CC Input #1 Closed	Class 1	
165	CC Input #2 Closed	Class 1	
166	CC Input #3 Closed	Class 1	
167	CC Input #4 Closed	Class 1	
168	CC Input #5 Closed	Class 1	
169	CC Input #6 Closed	Class 1	
170	CC Input #7 Closed	Class 1	
171	CC Input #8 Closed	Class 1	
172	CC Input #9 Closed	Class 1	
173	CC Input #10 Closed	Class 1	
174	CC Input #11 Closed	Class 1	

Table C–3: POINT LIST: OBJECTS 01 & 02 (Sheet 6 of 6)

BINARY INPUT (OBJECT 01) BINARY INPUT CHANGE (OBJECT 02)			
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**REMARKS**
175	CC Input #12 Closed	Class 1	
176	Output T1 Closed	Class 1	
177	Output T2 Closed	Class 1	
178	Output T3 Closed	Class 1	
179	Output T4 Closed	Class 1	
180	Output T5 Closed	Class 1	
181	Output T6 Closed	Class 1	
182	Output A1 Closed	Class 1	
183	Output A2 Closed	Class 1	
184	Output A3 Closed	Class 1	
185	Output A4 Closed	Class 1	
186	Output A5 Closed	Class 1	
187	Output A6 Closed	Class 1	
188	Output A7 Closed	Class 1	
189	Output A8 Closed	Class 1	
190	Output A9 Closed	Class 1	
191	Output A10 Closed	Class 1	
192	Output A11 Closed	Class 1	
193	Output A12 Closed	Class 1	
194	Output KT1 Closed	Class 1	
195	Output KT2 Closed	Class 1	
196	Output KT3 Closed	Class 1	
197	Output KT4 Closed	Class 1	
198	Output C1 Closed	Class 1	
199	Output C2 Closed	Class 1	
200	Fault Target - Phase A	Class 1	
201	Fault Target - Phase B	Class 1	
202	Fault Target - Phase C	Class 1	
203	Fault Target - Ground	Class 1	
204			

Table C–4: POINT LIST: OBJECTS 10 & 12

BINARY OUTPUT (OBJECT 10) CONTROL RELAY OUTPUT BLOCK (OBJECT 12)	
INDEX	**DESCRIPTION**
0	Open Breaker #1
1	Close Breaker #1
2	Open Breaker #2
3	Close Breaker #2
4	Enable Outputs
5	Disable Outputs
6	Trigger Oscillography
7	Reset Recloser
8	Lockout Recloser
9	Reset Event Data
10	Reset Fault Data
11	Reset OST Data
12	Reset Breaker Duty
13	Reset Latched Alarms
14	Start Settings Change
15	End Settings Change
16	

The LPS-D uses the following rules when parsing requests for control of Binary Output points using Object 12.

1. The Count field is checked first. If it is zero, the command will be accepted but no action will be taken. If this field is non-zero, the command will be executed once.
2. The Control Code field of Object 12 is then checked:
   - The Queue and Clear sub-field are ignored.
   - For all points, the only valid control is “Close – Pulse On” (0x41). This is used to initiate the function associated with the point.
   - Any value in the Control Code field not specified above is invalid and will be rejected.
3. The On Time and Off Time fields are ignored. A “Pulse On” control takes effect immediately when received. Thus, the timing is irrelevant.
4. The Status field in the response will reflect the success or failure of the control attempt as below:
   - A Status of “Request Accepted” (0) will be returned if the command was accepted.
   - A Status of “Request Not Accepted due to Formatting Errors” (3) will be returned if the Control Code field was incorrectly formatted or an invalid code was present in the command.
   - A Status of “Control Operation not Supported for this Point” (4) will be returned if an attempt was made to operate the point and the device, owing to its configuration, does not allow the point to perform its function.

An operate of an Output point may fail even if the command is accepted due to other inputs or conditions existing at the time. To verify the success or failure of an “OPERATE” of an output point, the associated Binary or Analog Input(s) may be examined after the control operation is performed.

When using Object 10 to read the status of any Binary Output, a value of zero will always be returned. This is because all points are “Pulse On” and are deemed normally off.

C.3.4 BINARY COUNTER, FROZEN COUNTER

Table C–5: POINT LIST: OBJECTS 20 & 21

BINARY COUNTER (OBJECT 20) FROZEN COUNTER (OBJECT 21)		
INDEX	**DESCRIPTION**	**ROLLOVER POINT**
0	Breaker Health Accumulator – Phase A	4294967295
1	Breaker Health Accumulator – Phase B	4294967295
2	Breaker Health Accumulator – Phase C	4294967295
3	Number Of Trips – Phase A	65535
4	Number Of Trips – Phase B	65535
5	Number Of Trips – Phase C	65535

None of the above counters can be cleared with the Freeze/Clear (function code 9) operation. Instead, the control relay output block points can be used to clear groups of counters. There is only one copy of each counter, so clearing a counter from other serial ports or MMI causes the corresponding DNP counter point to be cleared and vice-versa. However, note that counters 2 to 5 cannot be cleared using DNP protocol. The Breaker Health can be set via MMI or from other serial ports using GE_MODEM, MODBUS or ASCII protocols.

C.3.5 ANALOG INPUT, ANALOG INPUT CHANGE

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 1 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
0	Phase A RMS Current	Class 2	F1	Amp	Note 2
1	Phase B RMS Current	Class 2	F1	Amp	Note 2
2	Phase C RMS Current	Class 2	F1	Amp	Note 2
3	Neutral RMS Current	Class 2	F1	Amp	Note 2
4	Phase A RMS Voltage	Class 2	F2	Amp	Note 2
5	Phase B RMS Voltage	Class 2	F2	Volt	Note 2
6	Phase C RMS Voltage	Class 2	F2	Volt	Note 2
7	Phase A Current Amplitude	Class 2	F1	Amp	Note 2
8	Phase A Current Angle	Class 2	F4	Deg.	Note 2
9	Phase B Current Amplitude	Class 2	F1	Amp	Note 2
10	Phase B Current Angle	Class 2	F4	Deg.	Note 2
11	Phase C Current Amplitude	Class 2	F1	Amp	Note 2
12	Phase C Current Angle	Class 2	F4	Deg.	Note 2
13	Neutral Current Amplitude	Class 2	F1	Amp	Note 2
14	Neutral Current Angle	Class 2	F4	Deg.	Note 2
15	Phase A Voltage Amplitude	Class 2	F2	Amp	Note 2
16	Phase A Voltage Angle	Class 2	F4	Deg.	Note 2
17	Phase B Voltage Amplitude	Class 2	F2	Amp	Note 2
18	Phase B Voltage Angle	Class 2	F4	Deg.	Note 2
19	Phase C Voltage Amplitude	Class 2	F2	Amp	Note 2
20	Phase C Voltage Angle	Class 2	F4	Deg.	Note 2
21	Watts	Class 2	F3	Watts	Note 2
22	Vars	Class 2	F3	Vars	Note 2
23	Power Factor	Class 2	F1		Note 2
24	Frequency	Class 2	F1		
25	Status – CPU Status Word 1	Class 2	F9		
26	Status – CPU Status Word 2	Class 2	F9		
27	Status – ANI Status	Class 2	F10		
28	Status – DSP Status	Class 2	F11		
29	Status – Misc. Status Word 1	Class 2	F12		
30	Status – Misc. Status Word 2	Class 2	F12		
31	Fault 1 Date (Lower 16-Bits)	Class 2			
32	Fault 1 Date (Middle 16-Bits)	Class 2			
33	Fault 1 Date (Upper 16-Bits)	Class 2			

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 2 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
34	Fault 1 Type	Class 2	F5		
35	Fault 1 Trip Type		F6		
36	Fault 1 Distance		F2		
37	Fault 1 Relay Operating Time	Class 2	F4		
38	Fault1 Breaker Operating Time	Class 2	F4		
39	Fault1 – Phase A Prefault Current	Class 2	F1		
40	Fault1 – Phase B Prefault Current		F1		
41	Fault1 – Phase C Prefault Current		F1		
42	Fault1 – Neutral Prefault Current		F1		
43	Fault1 – Phase A Fault Current		F1		
44	Fault1 – Phase B Fault Current		F1		
45	Fault1 – Phase C Fault Current		F1		
46	Fault1 – Neutral Fault Current		F1		
47	Fault1 – Phase A Fault Voltage		F2		
48	Fault1 – Phase B Fault Voltage		F2		
49	Fault1 – Phase C Fault Voltage		F2		
50	Fault 2 Date (Lower 16-Bits)				
51	Fault 2 Date (Middle 16-Bits)				
52	Fault 2 Date (Upper 16-Bits)				
53	Fault 2 Type				
54	Fault 2 Trip Type				
55	Fault 2 Distance				
56	Fault 3 Date (Lower 16-Bits)				
57	Fault 3 Date (Middle 16-Bits)				
58	Fault 3 Date (Upper 16-Bits)				
59	Fault 3 Type				
60	Fault 3 Trip Type				
61	Fault 3 Distance				
62	Fault 4 Date (Lower 16-Bits)				
63	Fault 4 Date (Middle 16-Bits)				
64	Fault 4 Date (Upper 16-Bits)				
65	Fault 4 Type				
66	Fault 4 Trip Type				
67	Fault 4 Distance				
68	Fault 5 Date (Lower 16-Bits)				

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 3 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
69	Fault 5 Date (Middle 16-Bits)				
70	Fault 5 Date (Upper 16-Bits)				
71	Fault 5 Type				
72	Fault 5 Trip Type				
73	Fault 5 Distance				
74	Fault 6 Date (Lower 16-Bits)				
75	Fault 6 Date (Middle 16-Bits)				
76	Fault 6 Date (Upper 16-Bits)				
77	Fault 6 Type				
78	Fault 6 Trip Type				
79	Fault 6 Distance				
80	Fault 7 Date (Lower 16-Bits)				
81	Fault 7 Date (Middle 16-Bits)				
82	Fault 7 Date (Upper 16-Bits)				
83	Fault 7 Type				
84	Fault 7 Trip Type				
85	Fault 7 Distance				
86	Fault 8 Date (Lower 16-Bits)				
87	Fault 8 Date (Middle 16-Bits)				
88	Fault 8 Date (Upper 16-Bits)				
89	Fault 8 Type				
90	Fault 8 Trip Type				
91	Fault 8 Distance				
92	Fault 9 Date (Lower 16-Bits)				
93	Fault 9 Date (Middle 16-Bits)				
94	Fault 9 Date (Upper 16-Bits)				
95	Fault 9 Type				
96	Fault 9 Trip Type				
97	Fault 9 Distance				
98	Fault 10 Date (Lower 16-Bits)				
99	Fault 10 Date (Middle 16-Bits)				
100	Fault 10 Date (Upper 16-Bits)				
101	Fault 10 Type				
102	Fault 10 Trip Type				
103	Fault 10 Distance				

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 4 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
104	Fault 11 Date (Lower 16-Bits)				
105	Fault 11 Date (Middle 16-Bits)				
106	Fault 11 Date (Upper 16-Bits)				
107	Fault 11 Type				
108	Fault 11 Trip Type				
109	Fault 11 Distance				
110	Fault 12 Date (Lower 16-Bits)				
111	Fault 12 Date (Middle 16-Bits)				
112	Fault 12 Date (Upper 16-Bits)				
113	Fault 12 Type				
114	Fault 12 Trip Type				
115	Fault 12 Distance				
116	Fault 13 Date (Lower 16-Bits)				
117	Fault 13 Date (Middle 16-Bits)				
118	Fault 13 Date (Upper 16-Bits)				
119	Fault 13 Type				
120	Fault 13 Trip Type				
121	Fault 13 Distance				
122	Fault 14 Date (Lower 16-Bits)				
123	Fault 14 Date (Middle 16-Bits)				
124	Fault 14 Date (Upper 16-Bits)				
125	Fault 14 Type				
126	Fault 14 Trip Type				
127	Fault 14 Distance				
128	Fault 15 Date (Lower 16-Bits)				
129	Fault 15 Date (Middle 16-Bits)				
130	Fault 15 Date (Upper 16-Bits)				
131	Fault 15 Type				
132	Fault 15 Trip Type				
133	Fault 15 Distance				
134	Fault 16 Date (Lower 16-Bits)				
135	Fault 16 Date (Middle 16-Bits)				
136	Fault 16 Date (Upper 16-Bits)				
137	Fault 16 Type				
138	Fault 16 Trip Type				

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 5 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
139	Fault 16 Distance				
140	Fault 17 Date (Lower 16-Bits)				
141	Fault 17 Date (Middle 16-Bits)				
142	Fault 17 Date (Upper 16-Bits)				
143	Fault 17 Type				
144	Fault 17 Trip Type				
145	Fault 17 Distance				
146	Fault 18 Date (Lower 16-Bits)				
147	Fault 18 Date (Middle 16-Bits)				
148	Fault 18 Date (Upper 16-Bits)				
149	Fault 18 Type				
150	Fault 18 Trip Type				
151	Fault 18 Distance				
152	Fault 19 Date (Lower 16-Bits)				
153	Fault 19 Date (Middle 16-Bits)				
154	Fault 19 Date (Upper 16-Bits)				
155	Fault 19 Type				
156	Fault 19 Trip Type				
157	Fault 19 Distance				
158	Fault 20 Date (Lower 16-Bits)				
159	Fault 20 Date (Middle 16-Bits)				
160	Fault 20 Date (Upper 16-Bits)				
161	Fault 20 Type				
162	Fault 20 Trip Type				
163	Fault 20 Distance				
164	Fault 21 Date (Lower 16-Bits)				
165	Fault 21 Date (Middle 16-Bits)				
166	Fault 21 Date (Upper 16-Bits)				
167	Fault 21 Type				
168	Fault 21 Trip Type				
169	Fault 21 Distance				
170	Fault 22 Date (Lower 16-Bits)				
171	Fault 22 Date (Middle 16-Bits)				
172	Fault 22 Date (Upper 16-Bits)				
173	Fault 22 Type				

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 6 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
174	Fault 22 Trip Type				
175	Fault 22 Distance				
176	Fault 23 Date (Lower 16-Bits)				
177	Fault 23 Date (Middle 16-Bits)				
178	Fault 23 Date (Upper 16-Bits)				
179	Fault 23 Type				
180	Fault 23 Trip Type				
181	Fault 23 Distance				
182	Fault 24 Date (Lower 16-Bits)				
183	Fault 24 Date (Middle 16-Bits)				
184	Fault 24 Date (Upper 16-Bits)				
185	Fault 24 Type				
186	Fault 24 Trip Type				
187	Fault 24 Distance				
188	Fault 25 Date (Lower 16-Bits)				
189	Fault 25 Date (Middle 16-Bits)				
190	Fault 25 Date (Upper 16-Bits)				
191	Fault 25 Type				
192	Fault 25 Trip Type				
193	Fault 25 Distance				
194	Fault 26 Date (Lower 16-Bits)				
195	Fault 26 Date (Middle 16-Bits)				
196	Fault 26 Date (Upper 16-Bits)				
197	Fault 26 Type				
198	Fault 26 Trip Type				
199	Fault 26 Distance				
200	Fault 27 Date (Lower 16-Bits)				
201	Fault 27 Date (Middle 16-Bits)				
202	Fault 27 Date (Upper 16-Bits)				
203	Fault 27 Type				
204	Fault 27 Trip Type				
205	Fault 27 Distance				
206	Fault 28 Date (Lower 16-Bits)				
207	Fault 28 Date (Middle 16-Bits)				
208	Fault 28 Date (Upper 16-Bits)				

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 7 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
209	Fault 28 Type				
210	Fault 28 Trip Type				
211	Fault 28 Distance				
212	Fault 29 Date (Lower 16-Bits)				
213	Fault 29 Date (Middle 16-Bits)				
214	Fault 29 Date (Upper 16-Bits)				
215	Fault 29 Type				
216	Fault 29 Trip Type				
217	Fault 29 Distance				
218	Fault 30 Date (Lower 16-Bits)				
219	Fault 30 Date (Middle 16-Bits)				
220	Fault 30 Date (Upper 16-Bits)				
221	Fault 30 Type				
222	Fault 30 Trip Type				
223	Fault 30 Distance				
224	Fault 31 Date (Lower 16-Bits)				
225	Fault 31 Date (Middle 16-Bits)				
226	Fault 31 Date (Upper 16-Bits)				
227	Fault 31 Type				
228	Fault 31 Trip Type				
229	Fault 31 Distance				
230	Fault 32 Date (Lower 16-Bits)				
231	Fault 32 Date (Middle 16-Bits)				
232	Fault 32 Date (Upper 16-Bits)				
233	Fault 32 Type				
234	Fault 32 Trip Type				
235	Fault 32 Distance				
236	Fault 33 Date (Lower 16-Bits)				
237	Fault 33 Date (Middle 16-Bits)				
238	Fault 33 Date (Upper 16-Bits)				
239	Fault 33 Type				
240	Fault 33 Trip Type				
241	Fault 33 Distance				
242	Fault 34 Date (Lower 16-Bits)				
243	Fault 34 Date (Middle 16-Bits)				

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

Table C–6: POINT LIST: OBJECTS 30 & 32 (Sheet 8 of 8)

ANALOG INPUT (OBJECT 30) ANALOG INPUT CHANGE (OBJECT 32)					
INDEX	**DESCRIPTION**	**EVENT CLASS ASSIGNED TO**	**FORMAT/ UNITS**		**REMARKS**
244	Fault 34 Date (Upper 16-Bits)				
245	Fault 34 Type				
246	Fault 34 Trip Type				
247	Fault 34 Distance				
248	Fault 35 Date (Lower 16-Bits)				
249	Fault 35 Date (Middle 16-Bits)				
250	Fault 35 Date (Upper 16-Bits)				
251	Fault 35 Type				
252	Fault 35 Trip Type				
253	Fault 35 Distance				
254	Fault 36 Date (Lower 16-Bits)				
255	Fault 36 Date (Middle 16-Bits)				
256	Fault 36 Date (Upper 16-Bits)				
257	Fault 36 Type				
258	Fault 36 Trip Type				
259	Fault 36 Distance				
260					

[1], [2], [3], [4], [5], [6] See Table Notes following the Table

TABLE NOTES:

1. The upper and lower 16-bit portions of all the 32-bit values reported by LPS-D are assigned to two separate points. To read a 32-bit value, it is necessary to read both the upper and lower 16-bit portions and concatenate these two values to form a 32-bit value and interpret the result according to the format associated with the value.
2. An event object will be generated for this point if the current value of the point changes by an amount greater than or equal to two percent of its previous value.
3. An event object will be generated if the frequency changes by 0.05 Hz or more from its previous value.
4. An event object will be generated if the current value of a point is in any way changed from its previous value.
5. The Time-Stamp of various Analog Inputs is reported in DNP Time Object format. The 48-bit absolute time is allocated to three separate points that need to be concatenated and interpreted as a DNP Time Object (Variation 1).
6. The units for Fault Location are determined by the value read at the Point corresponding to Fault Location Units. The Fault Location units can be either Miles or Km as per the Fault Location Unit value.

C.3.6 ANALOG OUTPUT, ANALOG OUTPUT BLOCK

Refer to Chapter 2 for a detailed description of the setpoints listed in the table below. The formats, ranges and units for various setpoints are as described in the Instruction Book but for the following exceptions in these notes. Refer to Appendix B, for a description of the procedure to View/Change the LPS-D setpoints.

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 1 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
0	Edit Settings Group Number			Note 1
1	Z1 Phase Distance			
2	Z1 Phase Reach			
3	Z1 Phase Level Detector			
4	Z1 Ground Distance			
5	Z1 Ground Reach			
6	Z1 Ground Characteristic			
7	Z1 Ground React. Mho Supervision Reach			
8	Z1 Ground K0			
9	Z1 Ground Level Detector			
10	Z1 Blocking Supervision			
11	Z1 Ground Characteristic Angle (LPSQUAD) …Reserved…(ALPS/LPS)			
12	Z1 Right Resistive Ground Blinder (LPSQUAD) …Reserved….(ALPS/LPS)			
13	Z2 Phase Distance			
14	Z2 Phase Reach			
15	Z2 Phase Characteristic Angle			
16	Z2 Ground Distance			
17	Z2 Ground Characteristic			
18	Z2 Ground Reach			
19	Z2 Ground Characteristic Angle			
20	Z2 Timers			
21	Z2 Phase Timer			
22	Z2 Ground Timer			
23	Z2 Right Resistive Ground Blinder (LPSQUAD) …Reserved…(ALPS/LPS)			
24	Z3 Phase Distance			
25	Z3 Phase Reach			
26	Z3 Phase Characteristic Angle			
27	Z3 Ground Distance			
28	Z3 Ground Reach			
29	Z3 Ground Characteristic Angle			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 2 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
30	Z3 Phase Timer			
31	Z3 Ground Timer			
32	Z3 Ground Characteristic (LPSQUAD) …Reserved…(ALPS/LPS)			
33	Z3 Right Resistive Ground Blinder (LPSQUAD) …Reserved…(ALPS/LPS)			
34	Z4 Phase Distance			
35	Z4 Phase Reach			
36	Z4 Phase Characteristic Angle			
37	…Reserved…			
38	Z4 Ground Distance			
39	Z4 Ground Reach			
40	Z4 Ground Characteristic Angle			
41	Z4 Direction			
42	Z4 Timers			
43	Z4 Phase Timer			
44	Z4 Ground Timer			
45	Z4 Ground Characteristic (LPSQUAD) …Reserved…(ALPS/LPS)			
46	Z4 Right Resistive Ground Blinder (LPSQUAD) …Reserved…(ALPS/LPS)			
47	Trip Supervision Current			
48	Block Supervision Current			
49	GDOC Trip Current			
50	GDOC Block Current			
51	IPB I1 Restraint			
52	NT/NB Offset			
53	Unbalanced Current Alarm			
54	Phase Instantaneous Overcurrent			
55	Directional Control 50			
56	50 Pickup Setting			
57	50 Pickup during Fuse Failure			
58	Ground Instantaneous Overcurrent			
59	Directional Control 50G			
60	50G Pickup Settings			
61	50G Pickup during Fuse Failure			
62	50G Restraint Setting			
63	Ground Time Overcurrent			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 3 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
64	Directional Control 51G			
65	51G Pickup Setting			
66	51G Pickup during Fuse Failure			
67	51G Curve			
68	51G Time Dial			
69	Definite Time Delay			
70	51G Reset Characteristic			
71	Rated Per Unit Voltage			
72	Select Phase Overvoltage			
73	Phase Overvoltage Pickup			
74	Phase Overvoltage Time Delay			
75	Select Pos. Sequence Overvoltage			
76	Inst. Pos. Sequence Overvoltage Pickup			
77	TOV Pos. Seq. Overvoltage Pickup			
78	Pos. Seq. Overvoltage Time Delay			
79	Compensated Pos. Seq. OV			
80	Compensated Pos. Seq. OV Impedance			
81	Inst. Compensated Pos. Seq. OV Pickup			
82	TOV Compensated Pos. Seq. OV Pickup			
83	Compensated Pos. Seq. OV Time Delay			
84	PTFF Blocking			
85	Block Reclosing for any function			
86	Block for Out of Step			
87	Block for 3-Phase Faults			
88	Block for 50G Trip			
89	Block for Z2 Time Delayed Trip			
90	Block for Z3 Time Delayed Trip			
91	Block for Z4 Time Delayed Trip			
92	Block for any Z1 Phase Fault			
93	Block for any Z2 Phase Fault			
94	Block for Configurable Trip Logic			
95	Select Line Pickup			
96	Bypass Line pickup time delay			
97	I1 Pickup			
98	Select Remote Open Detector			
99	Remote Open Detector Time Delay			
100	Select Line Overload protection			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 4 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
101	Level 1 Pickup Current			
102	Level 2 Pickup Current			
103	Level 1 Time Delay			
104	Level 2 Time Delay			
105	Select Scheme Logic			
106	Select Number of Receivers			
107	1-Phase/3-Phase Trip Mode			
108	Select function to use to start carrier in Blocking scheme			
109	Select Weak Infeed tripping for Hybrid Scheme			
110	Trip Integrator			
111	POTT Coord Timer PU			
112	POTT Coord Timer DO			
113	BKR1 b Switch Coord Timer PU			
114	BKR1 b Switch Coord Timer DO			
115	BKR2 b Switch Coord Timer PU			
116	BKR2 b Switch Coord Timer DO			
117	Weak Infeed Trip Timer			
118	GDOC Blocking Timer			
119	Distance Blocking Timer			
120	Repeat Delay Timer			
121	Pos. Seq. Impedance Angle			
122	Zero Seq. Impedance Angle			
123	Pos. Seq. Line Impedance in sec. ohms			
124	Z0/Z1 Ratio			
125	Line Length			
126	Units of Length			
127	CT Ratio			
128	PT Ratio			
129	Hold Time			
130	Fault Location Reset Time			
131	Coordinating Zone			
132	MOB Characteristic Angle			
133	Block during OS			
134	Block all Zone 1 Functions			
135	Block all Zone 2 Functions			
136	Block all Zone 3 Functions			
137	Block all Zone 4 Functions			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 5 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
138	Select OST			
139	Select Number of Characteristics			
140	Trip Entering or Leaving Inner			
141	OST Forward Reach			
142	OST Reverse Reach			
143	Outer Characteristic Angle			
144	Middle Characteristic Angle			
145	Inner Characteristic Angle			
146	Coordinating Timer 1 Pickup			
147	Coordinating Timer 1 Dropout			
148	Coordinating Timer 2 Pickup			
149	Coordinating Timer 3 Pickup			
150	Coordinating Timer 4 Pickup			
151	Select Reclosing Option			
152	Select Reclosing Type			
153	Number of attempts following 1P Trip			
154	1-Pole First Delay			
155	1-Pole Second Delay			
156	1-Pole Third Delay			
157	1-Pole Fourth Delay			
158	Number of attempts following 3P Trip			
159	3-Pole First Delay			
160	3-Pole Second Delay			
161	3-Pole Third Delay			
162	3-Pole Fourth Delay			
163	Reset Time			
164	Contact Dwell Time			
165	Inhibit Hold Select			
166	Inhibit Hold Time			
167	Inhibit Contact Input Sense			
168	Synch. Check Supervision			
169	Closing Angle			
170	Slip Frequency			
171	Bus or Line Voltage			
172	Voltage used by SYNCCHECK			
173	SYNCCHECK Hold Time			
174	Supervise 2nd 3P Reclose after 1P Trip			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 6 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
175	Supervise 3rd 3P Reclose after 1P Trip			
176	Supervise 4th 3P Reclose after 1P Trip			
177	Supervise 1st 3P Reclose after 3P Trip			
178	Supervise 2nd 3P Reclose after 3P Trip			
179	Supervise 3rd 3P Reclose after 3P Trip			
180	Supervise 4th 3P Reclose after 3P Trip			
181	Supervise Manual Close			
182	Live Bus Voltage			
183	Dead Bus Voltage			
184	Live Line Voltage			
185	Dead Line Voltage			
186	Live Bus Dead Line			
187	Dead Bus Live Line			
188	Dead Bus Dead Line			
189	Voltage Difference			
190	Block Sync. Check by DELTAV			
191	Non-Critical Alarm Input #1			
192	Non-Critical Alarm Input #2			
193	Non-Critical Alarm Input #3			
194	Non-Critical Alarm Input #4			
195	Non-Critical Alarm Input #5			
196	Non-Critical Alarm Input #6			
197	Non-Critical Alarm Input #7			
198	Non-Critical Alarm Input #8			
199	T1 Contact			
200	T2 Contact			
201	T3 Contact			
202	T4 Contact			
203	T5 Contact			
204	T6 Contact			
205	A1 Contact			
206	A2 Contact			
207	A3 Contact			
208	A4 Contact			
209	A5 Contact			
210	A6 Contact			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 7 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
211	A7 Contact			
212	A8 Contact			
213	A9 Contact			
214	A10 Contact			
215	A11 Contact			
216	A12 Contact			
217	C1 Contact			
218	C2 Contact			
219	KT1 Contact			
220	KT2 Contact			
221	KT3 Contact			
222	KT4 Contact			
223	Configurable 3P Trip			
224	Configurable Oscillography Capture			
225	…Reserved…			
226	System Frequency			
227	Phase Rotation			
228	Time Synch Source			
229	Number of Breakers			
230	Number of Trip Circuits			
231	Number of Trip Circuits Monitors			
232	Value Display Mode			
233	Language Option			
234	System Inputs 1 to 4 (LPSQUAD) …Reserved…(ALPS/LPS)			
235	Comm. Port #1 Baud Rate			
236	Comm. Port #1 Parity			
237	Comm. Port #1 Stop Bits			
238	Comm. Port #2 Baud Rate			
239	Comm. Port #2 Parity			
240	Comm. Port #2 Stop Bits			
241	Comm. Port #3 Baud Rate			
242	Comm. Port #3 Parity			
243	Comm. Port #3 Stop Bits			
244	Comm. Port #1 Protocol			
245	Comm. Port #2 Protocol			
246	Comm. Port #3 Protocol			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 8 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
247	Number of Fault Records			
248	Number of Prefault Cycles			
249	Split Fault Record			
250	Exponent in I^*t calculation			
251	Maximum number of Breaker Operations			
252	Maximum Breaker Equipment Duty			
253	Accumulated Breaker Duty – Phase A			
254	Accumulated Breaker Duty – Phase B			
255	Accumulated Breaker Duty – Phase C			
256	Present Number of Breaker Operations – Phase A (1 Pole)			
257	Present Number of Breaker Operations – Phase B (1 Pole)			
258	Present Number of Breaker Operations – Phase C (1 Pole)			
259	Present Number of Breaker Operations (3 Pole)			
260	Contact Converter #1 Configuration			
261	Contact Converter #2 Configuration			
262	Contact Converter #3 Configuration			
263	Contact Converter #4 Configuration			
264	Contact Converter #5 Configuration			
265	Contact Converter #6 Configuration			
266	Contact Converter #7 Configuration			
267	Contact Converter #8 Configuration			
268	Contact Converter #9 Configuration			
269	Contact Converter #10 Configuration			
270	Contact Converter #11 Configuration			
271	Contact Converter #12 Configuration			
272	…Reserved…			
273	…Reserved…			
274	…Reserved…			
275	…Reserved…			
276	…Reserved…			
277	…Reserved…			
278	…Reserved…			
279	…Reserved…			
280	…Reserved…			
281	…Reserved…			
282	…Reserved…			
283	…Reserved…			

Table C–7: POINT LIST: OBJECTS 40 & 42 (Sheet 9 of 9)

ANALOG OUTPUT (OBJECT 40) ANALOG OUTPUT BLOCK (OBJECT 41)				
INDEX	**DESCRIPTION**	**FORMAT / UNITS**		**REMARKS**
284	…Reserved…			
285	…Reserved…			
286	…Reserved…			
287	…Reserved…			
288	…Reserved…			
289	…Reserved…			
290	…Reserved…			
291	…Reserved…			
292	…Reserved…			
293	…Reserved…			
294	…Reserved…			
295	…Reserved…			
296	…Reserved…			
297	…Reserved…			
298	…Reserved…			
299	…Reserved…			
300	…Reserved…			
301	…Reserved…			
302	…Reserved…			
303	…Reserved…			

TABLE NOTES:

There are four settings groups in LPS-D. However, there is only one group of General Settings categories, CONFIGURE, COMMPORTS, OSC_GRAPHY, BRKR_DUTY, and INPUTS, which are represented by Analog Output Points 218 to 261. The other points report the settings from the group selected by the setpoint at Point 0. Note that this only a DNP setpoint, not part of device settings, and is not stored in non-volatile memory. This setpoint points to the active settings group on device boot-up or a warm or cold restart. This can be set to point to any other group desired. The setpoint value ranges from 0 to 3, selecting Settings groups 1 to 4 respectively.

The port settings are not reported as a single Multi-Field number as with other LPS-D protocols but are reported as separate setpoints for each of the port parameters. Each port's baud rate, stop bits and parity are assigned to separate points.

The upper and lower 16-bit portions of all 32-bit values reported by LPS-D are assigned to two separate points. To read a 32-bit value, it is necessary to read both the upper and lower 16-bit portions and concatenate these two values to form a 32-bit value and interpret the result according to the format associated with the value.

These setpoints are Multi-field value in other communication protocols of LPS-D with each bit corresponding to an option/field. However, in DNP, each of the bits is assigned to a separate point. Note that the interpretation of the bit remains same as in other protocols. If a bit has a value of '0' then the corresponding option is OFF and if that bit has a value of '1', the corresponding option is ON.

Note that there is an overlap of Point Numbers here. The setpoints from 307 are different in LPS-D and ALPS. The remaining setpoints are same. The ALPS has a total of 334 setpoints.

C.3.7 DATA FORMATS – ANALOG INPUT AND OUTPUT POINTS

Data formats for Analog Input and Analog Output Points.

F1 – Signed 16-bit integer, 1 decimal place.

e.g. 123.4 is reported as 1234.

F2 – Signed 16-bit integer, 2 decimal places.

e.g. 12.34 is reported as 1234.

F3 – Signed 16-bit integer, 3 decimal places.

e.g. 1.234 is reported as 1234.

F4 - Signed 16-bit integer, no decimal places

F5 - Signed 8-bit integer, No decimal places. Encoded Fault Type.

There are 16 valid fault type codes as given below:

Table C–8: FAULT TYPE CODES

FAULT TYPE CODE	FAULT TYPE
0	Undetermined
1	AG
2	BG
3	CG
4	ABG
5	BCG
6	CAG
7	AB
8	BC
9	CA
10	3PH
11	A
12	B
13	C
14	G
15	TRG

F6 – Unsigned 16-bit integer, No decimal places. Encoded Fault Trip Type. The lower and upper 16-bits of the 32-bit value are assigned to two separate points. To read the trip type the two points need to be read and concatenated to form a 32-bit word.

Each bit of Trip Type indicates a Trip flag that is picked up. The following table lists the mnemonic for each of the bits of Trip Type.

F7 – Unsigned 8-bit integer, No decimal places. Encoded Trip Phase information.

Trip phases is a single byte value with the least significant four bits indicating which of the four phases have a trip fault as shown below:

Trip Phases: xxxxGCBA (binary)
A = '1' then Phase A has a Trip Fault
B = '1' then Phase B has a Trip Fault
C = '1' then Phase C has a Trip Fault
G = '1' then Phase G has a Trip Fault

F8 – Unsigned 16-bit integer, No decimal places. Part of 48-bit DNP Time. This has the same format as the DNP Time object (50), Variation 1, except that it has been assigned to three separate points as shown in the table. After reading the three points they should be concatenated to form a 48-bit value and interpreted as DNP Time Object.

F9 – Unsigned 16-bit integer. No decimal places. Encoded CPU Status information.

F10 – Unsigned 16-bit integer. No decimal places. Encoded ANI Status information.

F11 – Unsigned 16-bit integer. No decimal places. Encoded DSP Status information.

F12 – Unsigned 16-bit integer. No decimal places. Encoded Miscellaneous Status information.

F13 – Unsigned 8-bit integer, No decimal places. Encoded RMS/HiZ Fault Type. There are four valid RMS/HiZ fault type codes as give below.

Table C–9: RMS / HiZ FAULT TYPE CODES

FAULT TYPE CODE	RMS / HiZ FAULT TYPE
0	Undetermined
1	HiZ (Downed Conductor)
2	RC (Arcing)
3	2COC”

F12 – Unsigned 8-bit integer, No decimal places. RMS Pickup phases.

RMS Pickup phases is a single byte value with the least significant four bits indicating which of the four phases have an RMS type fault as shown below:

Trip Phases: xxxxGCBA (binary)

A = '1' then Phase A has an RMS Fault
B = '1' then Phase B has an RMS Fault
C = '1' then Phase C has an RMS Fault
G = '1' then Phase G has an RMS Fault

C

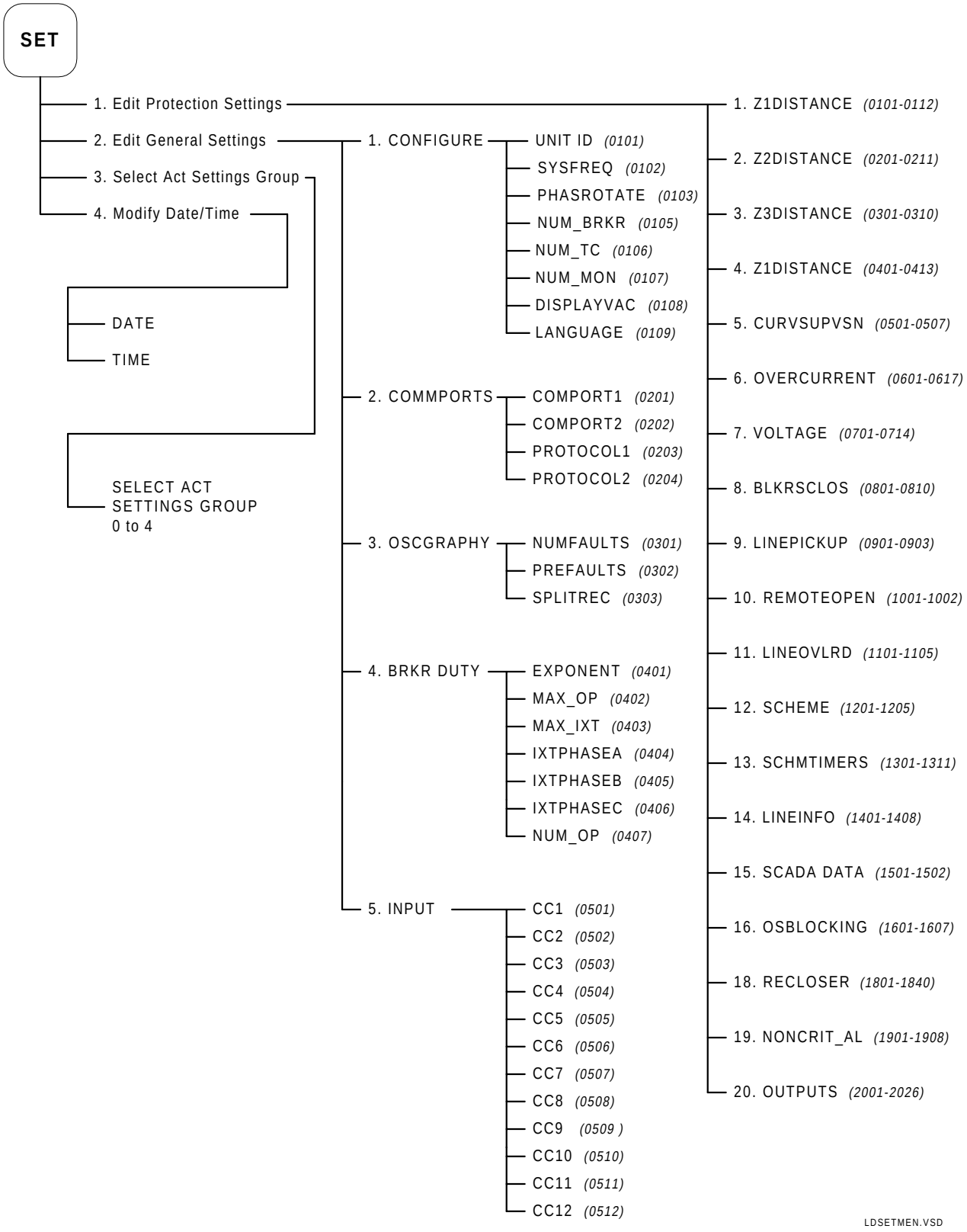


Figure D–1: SET KEYPAD MENU

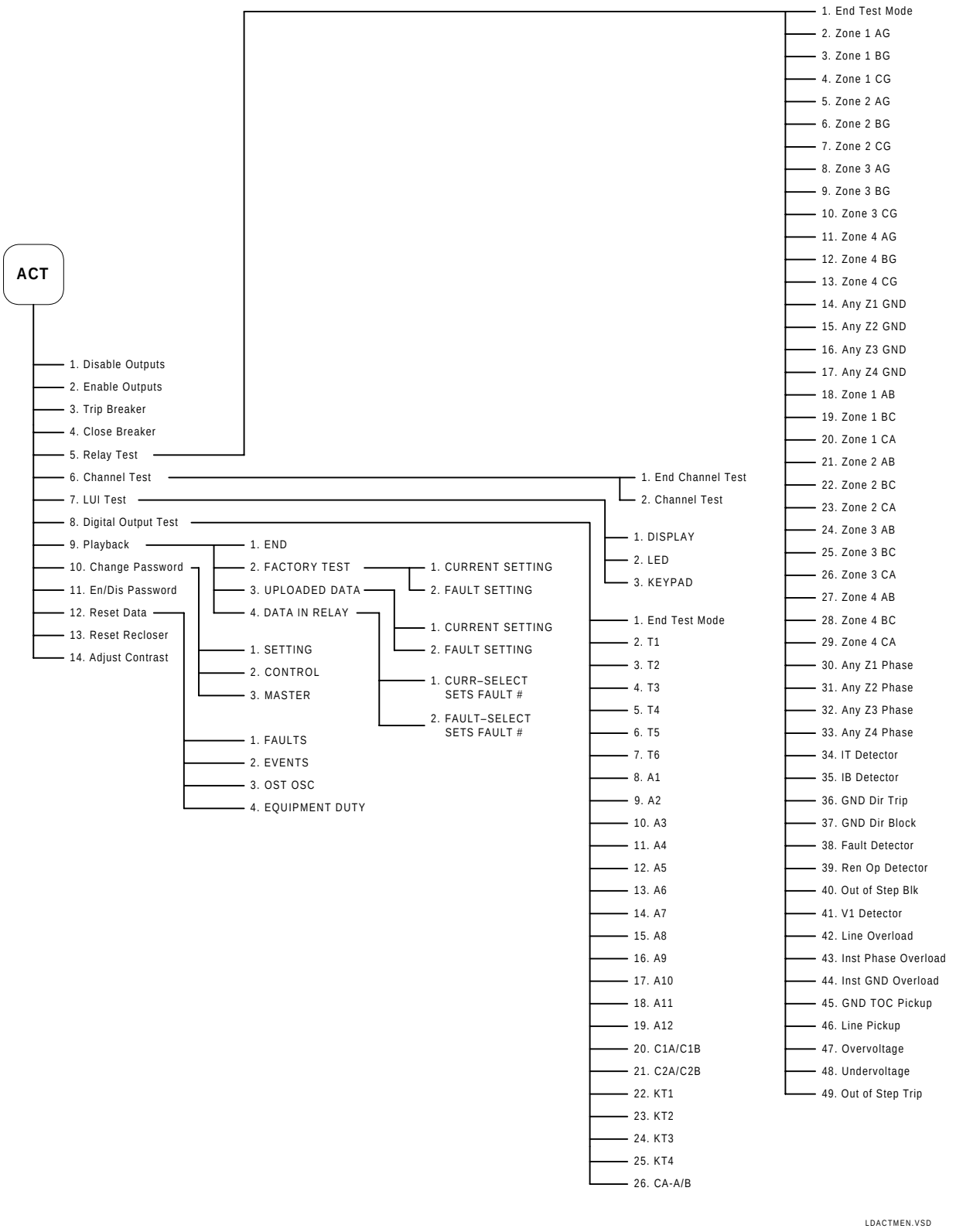


Figure D–2: ACT KEYPAD MENU

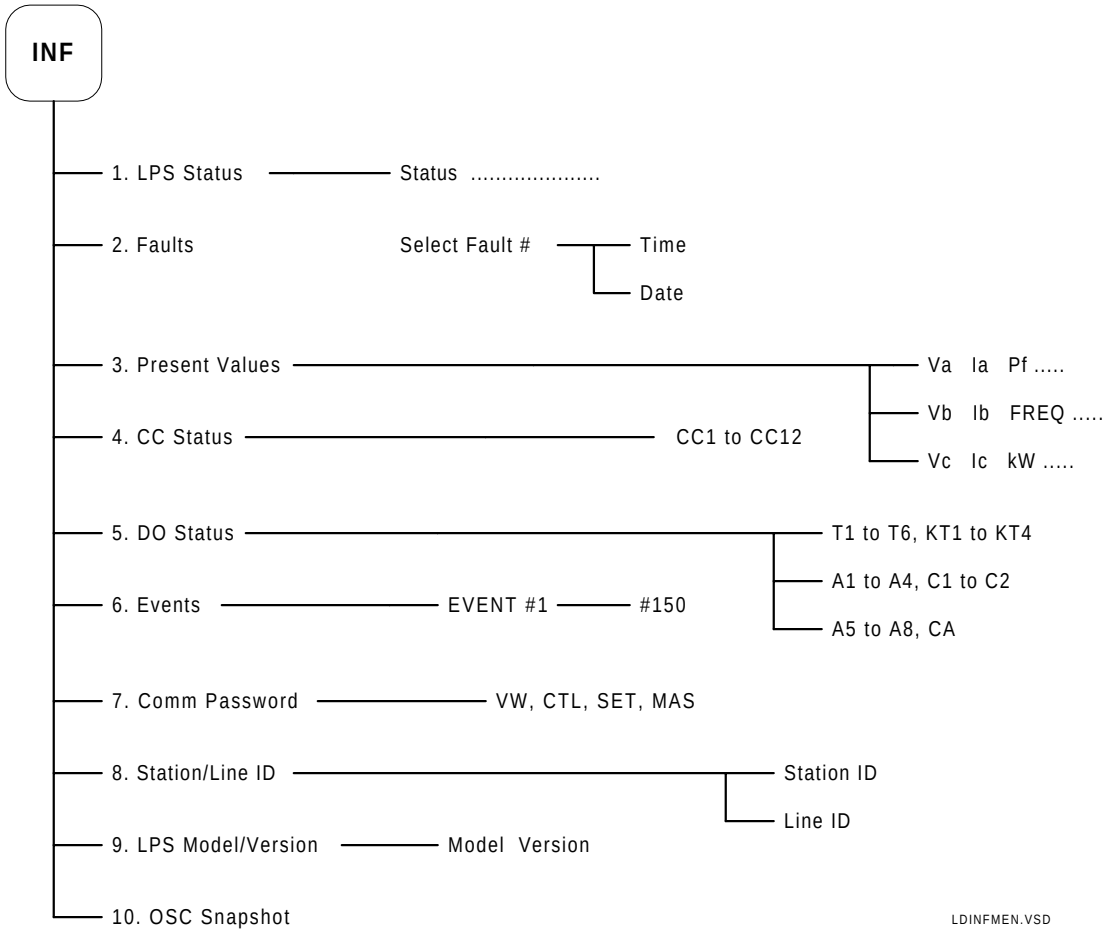


Figure D–3: INF KEYPAD MENU

D

E.1.1 LIST OF FIGURES

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General Electric Power Management Inc. (GE Power Management) warrants each relay it manufactures to be free from defects in material and workmanship under normal use and service for a period of 24 months from date of shipment from factory.

In the event of a failure covered by warranty, GE Power Management will undertake to repair or replace the relay providing the warrantor determined that it is defective and it is returned with all transportation charges prepaid to an authorized service centre or the factory. Repairs or replacement under warranty will be made without charge.

Warranty shall not apply to any relay which has been subject to misuse, negligence, accident, incorrect installation or use not in accordance with instructions nor any unit that has been altered outside a GE Power Management authorized factory outlet.

GE Power Management is not liable for special, indirect or consequential damages or for loss of profit or for expenses sustained as a result of a relay malfunction, incorrect application or adjustment.

For complete text of Warranty (including limitations and disclaimers), refer to GE Power Management Standard Conditions of Sale.

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