



GE Power Management

DLP-C Digital Line Protection Instruction Manual

Digital Transmission Line Relaying System with Three-Pole Tripping

DLP-C Revision: V002.740C

Manual P/N: GEK-100680C

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Manufactured under an
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1.1.1 UNPACKING THE RELAY

**NOTE**

This instruction book covers the following models:

DLP3***KC
DLP3***LC
DLP3***NC

All of these models are three-pole tripping units, with recloser. The models ending LC and NC do not include test plugs. These units are powered on and off with a power switch located on the MGM module. All references to test plugs do not pertain to these models. The models ending in NC do not include either test plugs or the local MMI keypad interface, except for a single Clear (CLR) key. All references to test plugs or a keypad do not pertain to these models.

1. Unpack and examine the relay according to the instructions Chapter 3: HARWARE DESCRIPTION of this manual.
2. Prior to applying power, make sure each module is properly seated in the relay. Then apply rated DC power to the relay at the power supply input terminals. Refer to Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44 for the location of these terminals.
3. The rated DC value for the relay is found on the nameplate located inside the front cover on the right side.

1.1.2 LOCAL COMMUNICATIONS VIA KEYPAD

Instructions on how to use the keypad to change settings and put the relay into test mode, can be found in Section 5.2.2: SETTING CHANGES on page 5–5 Complete instructions on how to operate the keypad are found in Section 9.2: KEYBOARD on page 9–2. The following is intended as a “Quick Reference” to the DLP MMI

This DLP 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 MMI passwords:

SETTINGS: 1234.

MASTER: 5678.

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

In order to change the password, the user must first enter the factory password under the ACTION key (ENTER PASSWORD), and then change the password under the ACTION key, (CHANGE PASWORD).

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

1.1.3 REMOTE COMMUNICATIONS VIA LOCAL PC

To communicate with the relay from a 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 (PL-1), or the 9 pin D-connector on the front (COM). Cable diagrams can be found in Section 9.8: REMOTE COMMUNICATIONS INTERFACE on page 9–40.

The communications software, DLP-LINK, required to access the relay from a PC is included on the diskette in the plastic pocket at the back of this manual. Follow instructions in Chapter 10: SOFTWARE to load DLP-LINK onto the PC.

The following information is intended to provide a "Quick Reference" to the DLP-LINK program.

1

This DLP relay 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: SETT!
- MASTER: CTRL!

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 can be changed under the ACTION menu, (CHANGE PASSWORD). Before the user can change another password, he must LOGOUT from the DLP. The user can then change the remaining passwords by first logging into the DLP using another default password.

The communications passwords may be viewed, in an encoded format, via the keypad, under the INF (Information) key.

To log into the relay, follow the instructions in the ACCEPTANCE TEST section under "USING DLP-LINK." Any one of the factory passwords can be used to log on to the relay. The relay UNIT ID (setting 1501) is factory set to 0 and the baud rate (setting 1509) is factory set to 2400 baud.

1.1.4 ORDER CODES & SELECTION GUIDE

Table 1–1: ORDER CODES

	DLP * * * * *						
Base Unit	DLP						Base Unit
Tripping Logic	1						Single Pole Tripping Logic
	3						Three Pole Tripping Logic
Current Rating	1						1 Ampere Rated Current
	5						5 Ampere Rated Current
Battery Voltage	0						48V DC battery voltage
	1						110/125 V DC battery voltage
	2						220/250 V DC battery voltage
Tripping	1						SCR Tripping Output
	2						Relays – Tripping Output
Functions and Features				A			Functions and Features – see DLP-C selection guide below.
				B			
				C			
				D			
				E			
				F			
				G			
				H			
				J			
				K			
				L			
			M				
			N				
			P				
			R				
			S				
Firmware				C			DLP Revision C Firmware

Table 1–2: FUNCTIONS AND FEATURES GUIDE

FUNCTION CODE	APPLICABLE MODELS	KEYPAD	RECLOSER	TEST PLUGS	SCADA DTA	NUMBER OF ZONES
A	DLP3****AC	✓		✓		4
B	DLP1****BC DLP3****BC					4
C	DLP3****CC	✓		✓	✓	4
D	DLP3****DC				✓	4
E	DLP3****EC					2
F	DLP3****FC				✓	2
G	DLP1****GC	✓		✓		4
H	DLP1****HC	✓	✓	✓		4
J	DLP1****JC	✓		✓	✓	4
K	DLP1****KC DLP3****KC	✓	✓	✓	✓	4
L	DLP3****LC	✓	✓			4
M	DLP3****MC	✓				4
N	DLP3****NC		✓			4
P	DLP1****PC DLP3****PC			✓		4
R	DLP3****RC			✓	✓	4
S	DLP1****SC		✓		✓	4

For example, the order code

DLP3512CC

refers to a DLP rated 5 amperes, 50/60 Hz, 110/125 V DC, with relay contact outputs for three pole tripping, keypad, and RS232 communications, with SCADA, test plugs, no recloser, revision C firmware.

The DLP3 is a microprocessor-based digital relay system that uses wave-form sampling together with appropriate algorithms to provide three-phase-tripping schemes for transmission line protection, fault location, and related features that enhance the interface between the user and the DLP3.

The DLP3 system is designed to be used on transmission lines of any voltage level that do not incorporate series capacitor compensation. It should be determined that the DLP3's operating time range (typically 0.75 - 1.5 cycles) is consistent with the requirements of the application. More detailed application considerations are contained in this section and in Chapter 2: CALCULATION OF SETTINGS.

1.2.2 LINE PROTECTION SCHEMES AND FEATURES

The DLP3 incorporates four zones of distance protection to implement six different protection schemes. These schemes are:

- Step Distance
- Zone 1 Extension
- Permissive Overreach Transfer Trip (POTT)
- Permissive Underreach Transfer Trip (PUTT)
- Blocking

Hybrid Ground-reactance distance functions can be selected to replace the ground Zone 1 variable-mho distance functions. A unique "adaptive reach" for the supervising mho characteristic is used when ground-reactance functions are selected. Ground directional overcurrent functions can be selected to replace or supplement the overreaching zone (Zone 2) ground-distance functions. An instantaneous non-directional phase-overcurrent function (PH4), an instantaneous ground-overcurrent function (IDT), with optional directional control, and a ground time-overcurrent function (TOC), with optional directional control, are available for backup tripping.

The Zone 4 variable-mho distance functions can be reversed in direction. This feature is used when a "reversed" or "blocking" function is required. When the Blocking or Hybrid schemes are selected, Zone 4 must be set to the reverse direction, since these schemes require a reverse-looking blocking function.

When phase and ground-distance functions are used for a zone of protection, six individual measuring functions are present: 3 for phase distance and 3 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 relay systems which have accumulated decades of dependable and secure in-service experience.

The *measurement functions* included are:

- 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
- Zone 2: (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

Zone 3: (3) variable-mho phase-distance functions
(3) variable-mho ground-distance functions

Zone 4: (3) reversible variable-mho phase-distance functions with offset
(3) reversible variable-mho ground-distance functions

Overcurrent Backup: PH4 - non-directional phase-overcurrent direct trip
IDT - ground-overcurrent direct trip (directional or non-directional)
TOC - ground time-overcurrent direct trip (directional or non-directional)

Overcurrent Supervision: IT - trip supervision overcurrent
IB - block supervision overcurrent

Fault Detector: FD

Line Pickup Overcurrent: I1

Remote-Open Detector: ROD

Line-Overload Detectors: Level 1 Overcurrent
Level 2 Overcurrent

Positive-Sequence Voltage Detector: V1

1.3.1 DESCRIPTION

1

The six available protection schemes are described below. Five functional logic diagrams, Figures 1–3: STEP DISTANCE LOGIC DIAGRAM through 1–10: HYBRID LOGIC DIAGRAM show the scheme logic for the six protection schemes using conventional AND/OR combinational logic. Each functional logic diagram is presented as an aid in describing the scheme operation. The elementary diagram of Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44 shows the external connections to the DLP3 relay system. The two figures below define the symbols used in the protection scheme logic diagrams. Typical interconnections diagrams between the DLP3 and an appropriate carrier/tone equipment for three pilot schemes are also included as follows:

- BLOCKING with CS28A (Figure 1–8: BLOCKING SCHEME INTERCONNECTIONS on page 1–17)
- POTT with NS40A (Figure 1–6: POTT SCHEME INTERCONNECTIONS on page 1–14)
- HYBRID with Unblocking CS61C (Figure 1–11: HYBRID SCHEME INTERCONNECTIONS on page 1–22)

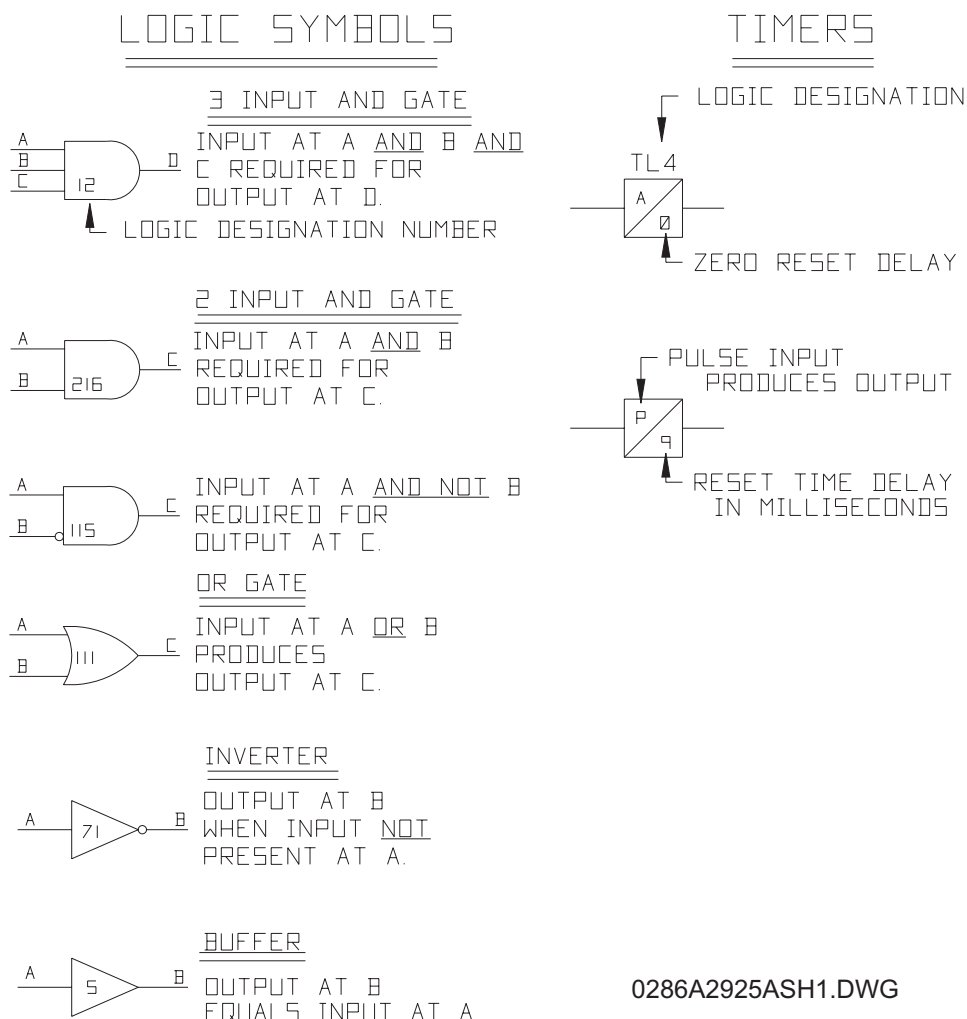
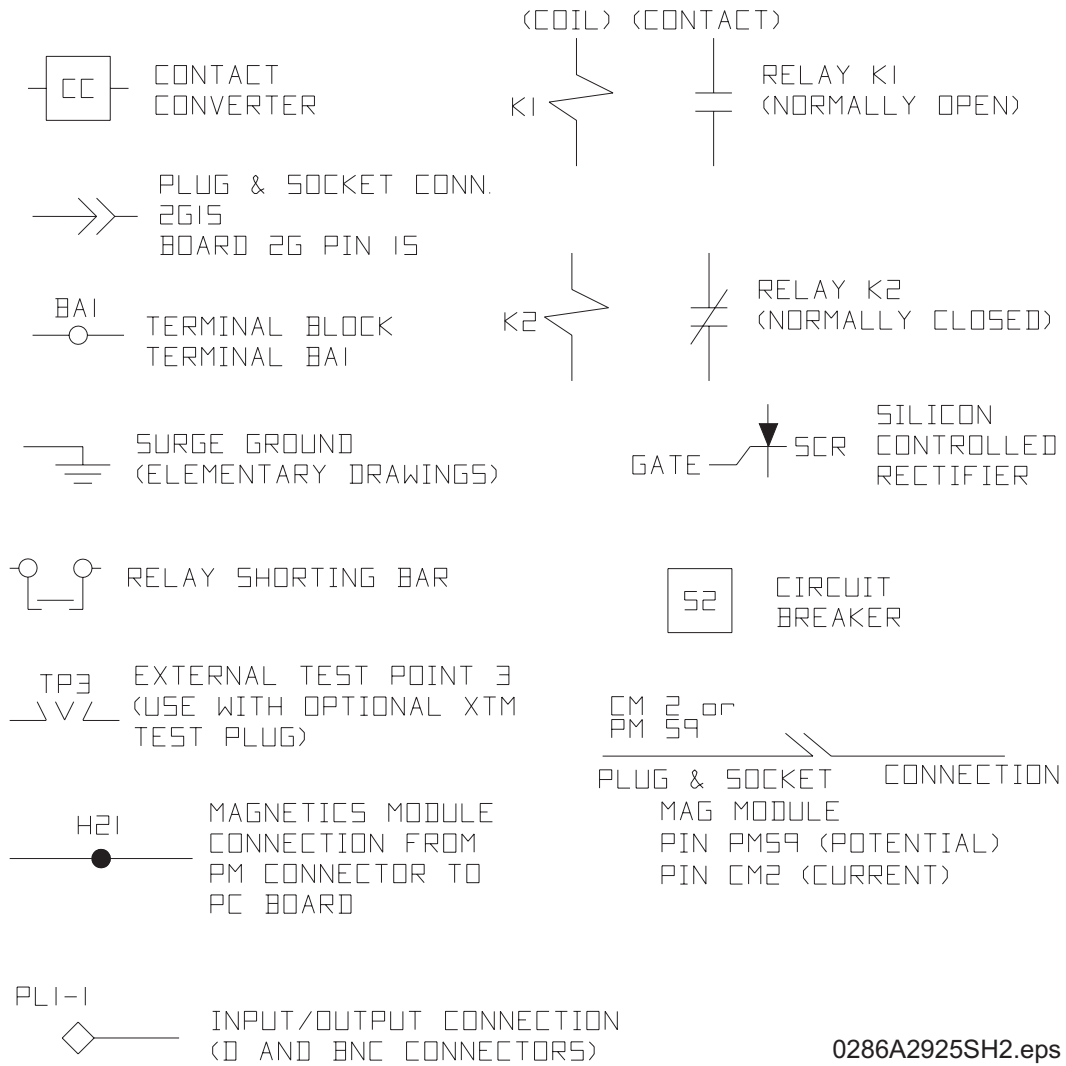


Figure 1–1: DIGITAL RELAY SYMBOL LEGEND (1 OF 2)



0286A2925SH2.eps

Figure 1-2: DIGITAL RELAY SYMBOL LEGEND (2 OF 2)

1.3.2 STEP DISTANCE

The logic diagram for the Step Distance scheme is shown on the following page. Since the step distance scheme overlays the other schemes available in the DLP3, this non-pilot scheme is in essence a part of all the schemes. 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 virtually 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 Chapter 2: CALCULATION OF SETTINGS.

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% or more 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 in direction. For some applications it may prove feasible and desirable to implement both a forward-looking Zone 3 and a forward-looking Zone 4.

By a separate setting for each zone of protection, the phase-distance functions can be placed in service or taken out of service. 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, and the other timer is associated with the ground functions.

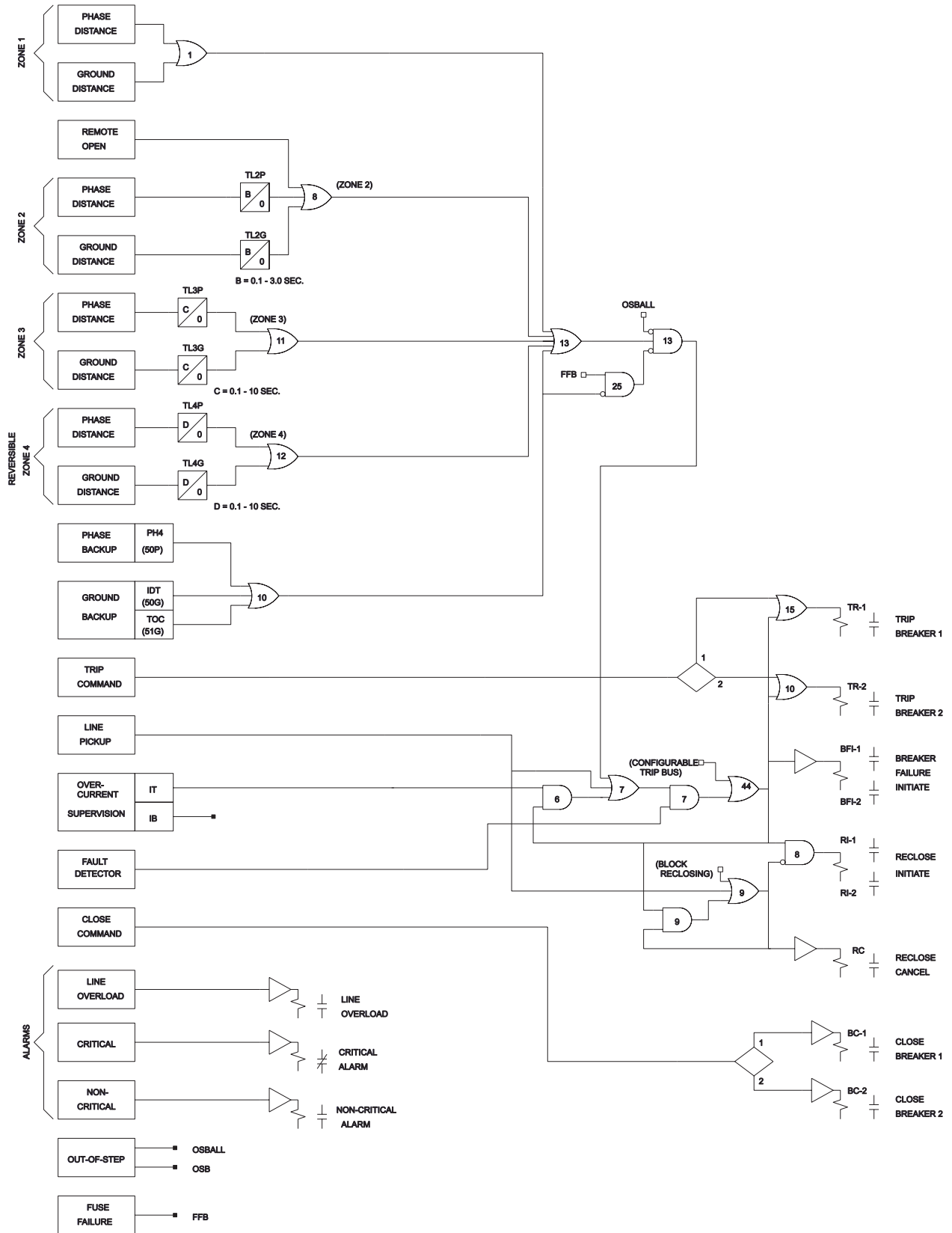


Figure 1-3: STEP DISTANCE LOGIC DIAGRAM

1.3.3 ZONE 1 EXTENSION

The logic diagram for the Zone 1 Extension scheme is shown on the following page. Like the Step Distance scheme, Zone 1 Extension does not utilize a communication channel. The intent of this scheme is to provide high-speed tripping at each terminal for 100% of the protected line section without the addition of a communication channel. This is accomplished by letting the Zone 2 overreaching function trip without any intentional time delay (i.e., Zone 2 initially acts as the Zone 1 function via OR102) for the initial fault occurrence. Opening of the breaker starts the associated automatic-reclose function; an internal or external recloser is a necessary part of this scheme. As soon as the recloser begins its programmed cycle, the actual Zone 1 function is placed back in service via OR102, restoring Zone 1 reach to 90% or less of the protected line section. This condition stays in effect until the recloser resets.

If the recloser is active in the DLP3, the internal Zone 1 Reach Reset flag (a software indicator that signals the occurrence of a certain condition) is used via OR101 to select either the Zone 2 or Zone 1 functions to trip via OR102, and it is not necessary to wire an external contact to CC3. The Zone 1 Reach Reset flag is set in the recloser function software when the recloser is initiated and is reset only when the recloser function goes to the RESET state. Should the recloser function end up at the LOCKOUT state, the Zone 1 Reach Reset flag will remain hesitant; the breaker is closed manually and the recloser function times out to the RESET state. A Z1RR output contact that is closed when the Zone 1 Reach Reset flag is set is provided when it is desired to control an external Zone 1 Extension scheme from the DLP3 recloser function.

If the optional recloser function is not present in the DLP3, then an external recloser contact must be wired to CC3. Timer TL20 is used if the external recloser cannot supply a contact that mimics the operation of the Z1RR contact associated with the optional DLP3 recloser function. For instance, if the external recloser contact wired to CC3 closes momentarily at the beginning of each recloser step but does not stay closed until the recloser goes to RESET, then the "D" dropout time of TL20 should be set to a value equal to the reset or reclaim time setting of the external recloser. If the external recloser contact wired to CC3 can mimic the operation of the Z1RR contact, then the "D" dropout time of TL20 should be set to 0.

For a transient internal fault, the breaker will reclose successfully. For a permanent internal fault, further tripping during the reset or reclaim time of the recloser will be exactly the same as for the Step Distance scheme described above. A fault in an adjacent line section can cause the Zone 1 Extension scheme to trip the breaker, but this lack of selectivity and increase in the number of breaker operations may be offset by the fact that no communication channel is required. Use of one of the pilot schemes described below is a more elegant solution to providing high-speed tripping at all ends of the protected line for internal faults along the entire line length.

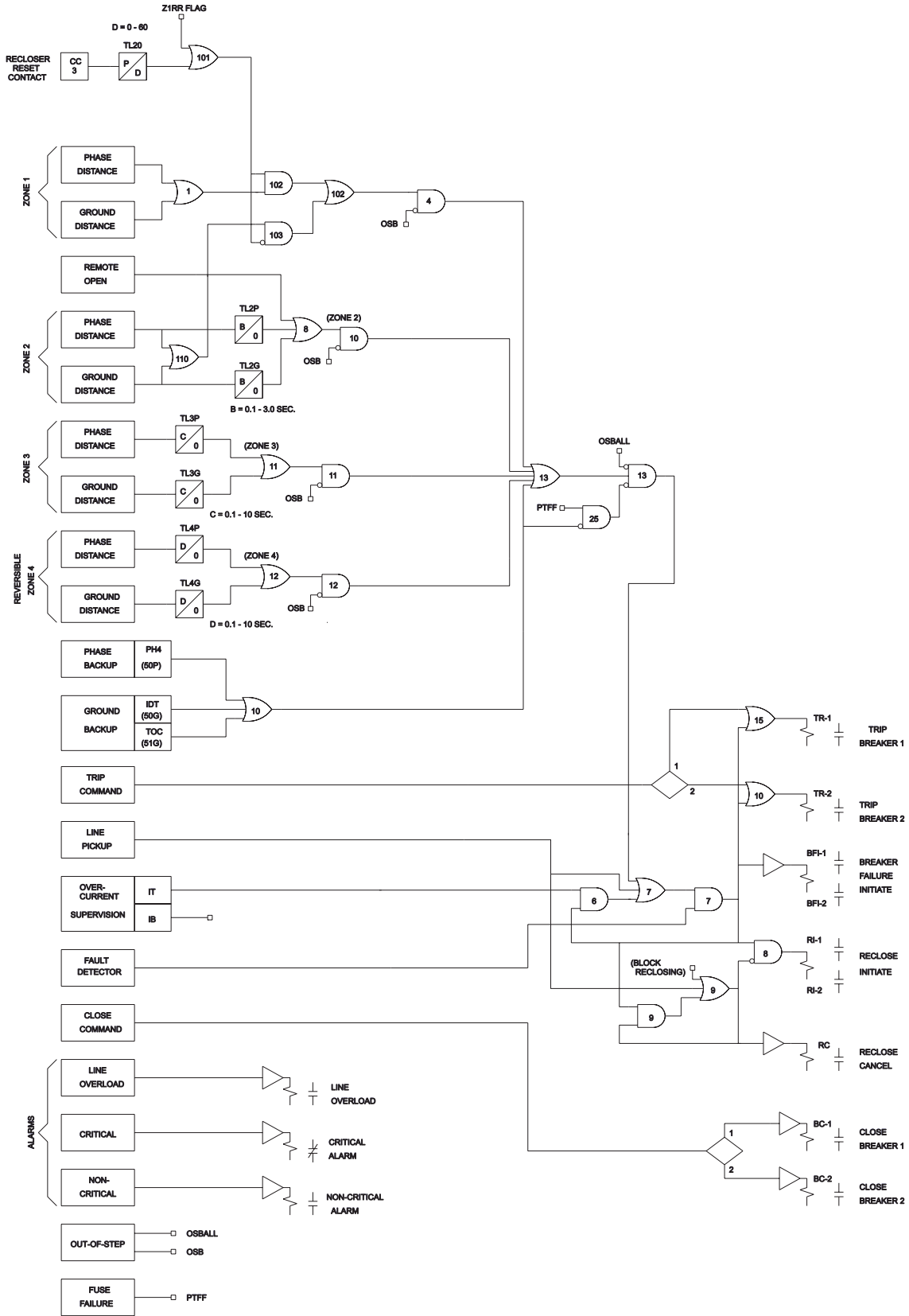


Figure 1-4: ZONE 1 EXTENSION LOGIC DIAGRAM

1.3.4 PERMISSIVE OVERREACH TRANSFER TRIP (POTT)**1**

The logic diagram for the POTT scheme is shown on the following page. Note that this logic diagram applies to both a POTT scheme and a Permissive Underreach Transfer Trip (PUTT) scheme. Both the POTT and PUTT schemes require receipt of a tripping signal from the remote end(s) to permit tripping at the local end. The channel equipment used is generally a frequency-shift-keying (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 multi-phase fault on the protected line, one or more of the overreaching zone variable-mho functions will operate at each terminal of the line and apply one of the inputs to the comparator, AND1, via OR2 and TL4. The output from OR2 will also key the transmitter to the trip frequency via OR5. At each terminal of a two-terminal line, the receiver will produce a trip output, which is recognized by the relay as an output from contact converter 3 (CC3). Assuming that the out-of-step blocking function has not operated, an AND1 output will be present, resulting in a trip output via OR3, TL1, OR4, AND3, OR13, AND13, OR7, and AND7. The same sequence of operation 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 located there, then neither end can trip via the POTT logic. For such a weak or zero-infeed condition, a Hybrid scheme is preferable.

Timer TL1 is provided to allow 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 is used in conjunction with timer TL1 to prevent 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 will only occur when a fault has occurred on the power system. The above description assumes a two-terminal line. When a POTT 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 permissive trip signal must be received from each of the two remote terminals, as indicated by an output from AND2.

On a line protected by a POTT 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. Contact converters CC1 and CC2 are used for this purpose. If a single breaker is involved, then only CC1 is required. If two breakers are involved, as in a ring bus or breaker-and-a-half bus arrangement, then CC1 and CC2 are combined at AND5 to indicate that the line is open.

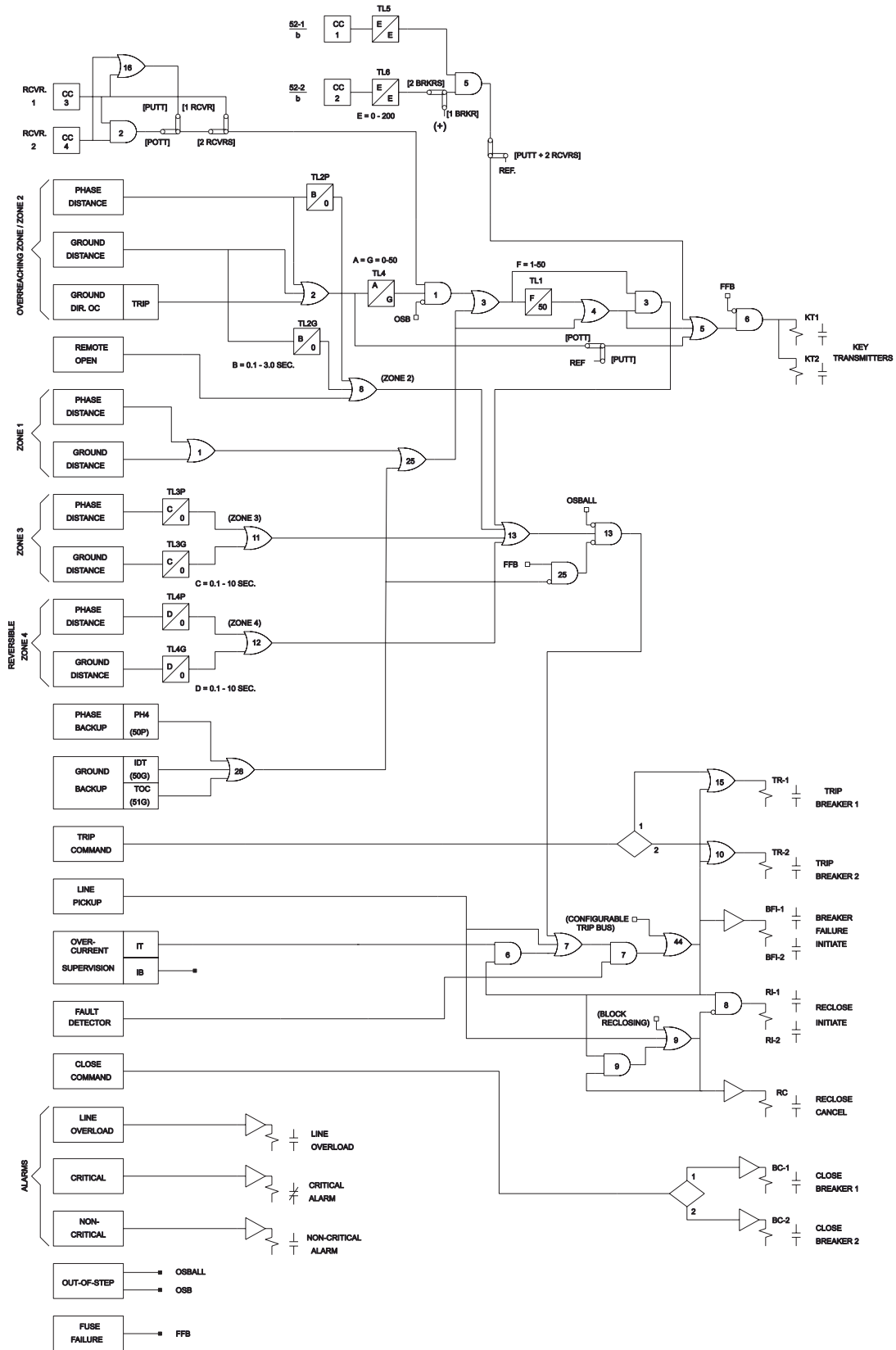


Figure 1-5: POTT/PUTT LOGIC DIAGRAM

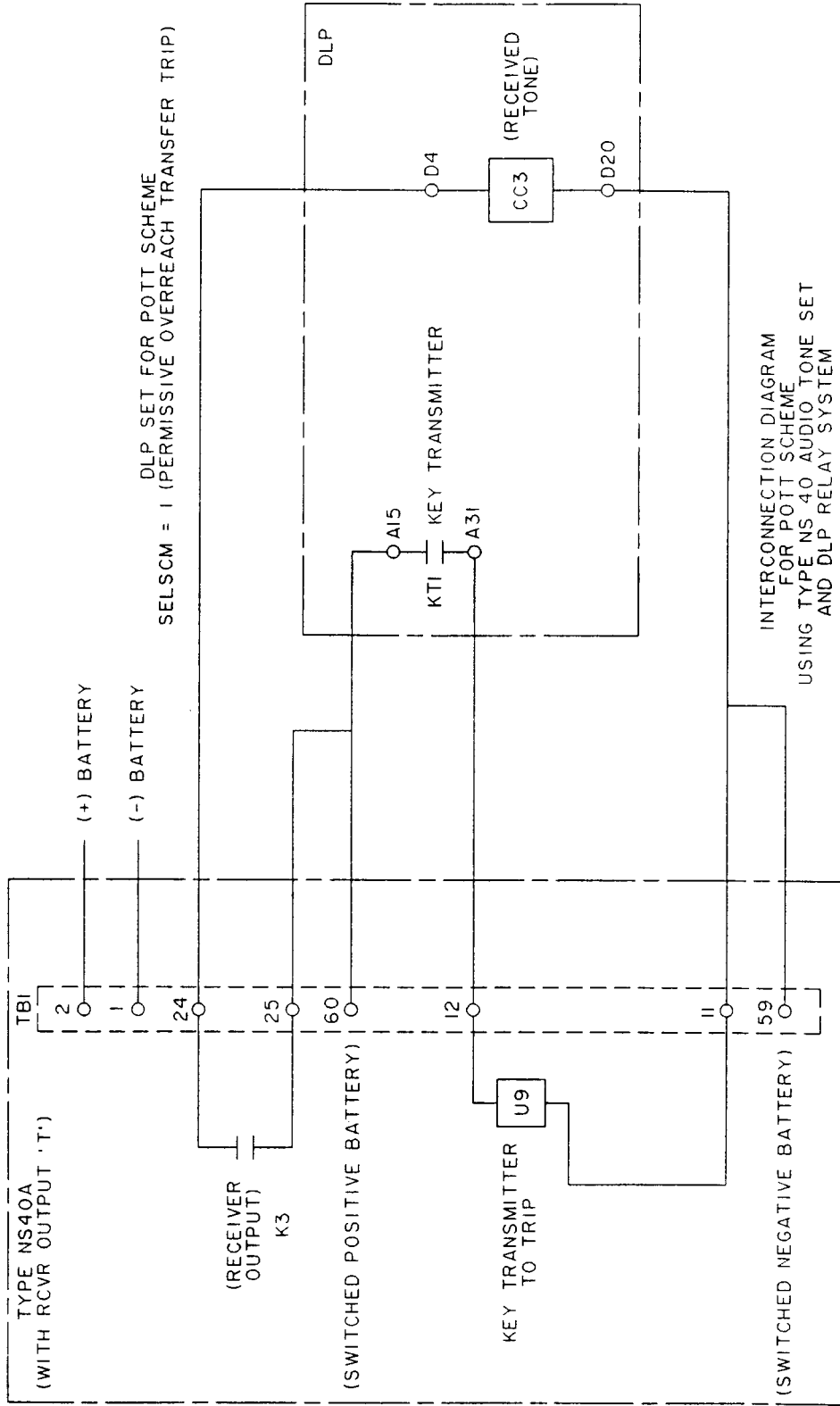


Figure 1-6: POTT SCHEME INTERCONNECTIONS

1.3.5 PERMISSIVE UNDERREACH TRANSFER TRIP (PUTT)

The logic diagram for the PUTT scheme is shown on the previous page. 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, OR7, and AND7 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) produces an output, satisfying the input conditions of the comparator, AND1.

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 OR16, 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, 52/b contact keying of the transmitter should not be used. Because the two receivers are ORed together, a continuous trip signal sent from the open end, when only one end is open, would result 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 DLP3, 52/b contact keying of the transmitter is automatically prevented if SELSCM=2 [PUTT] and NUMRCVR=2 [2 RCVRS] as indicated in the logic diagram by the link located between AND5 and OR5. For a two-terminal PUTT application 52/b contact keying of the transmitter should be used.

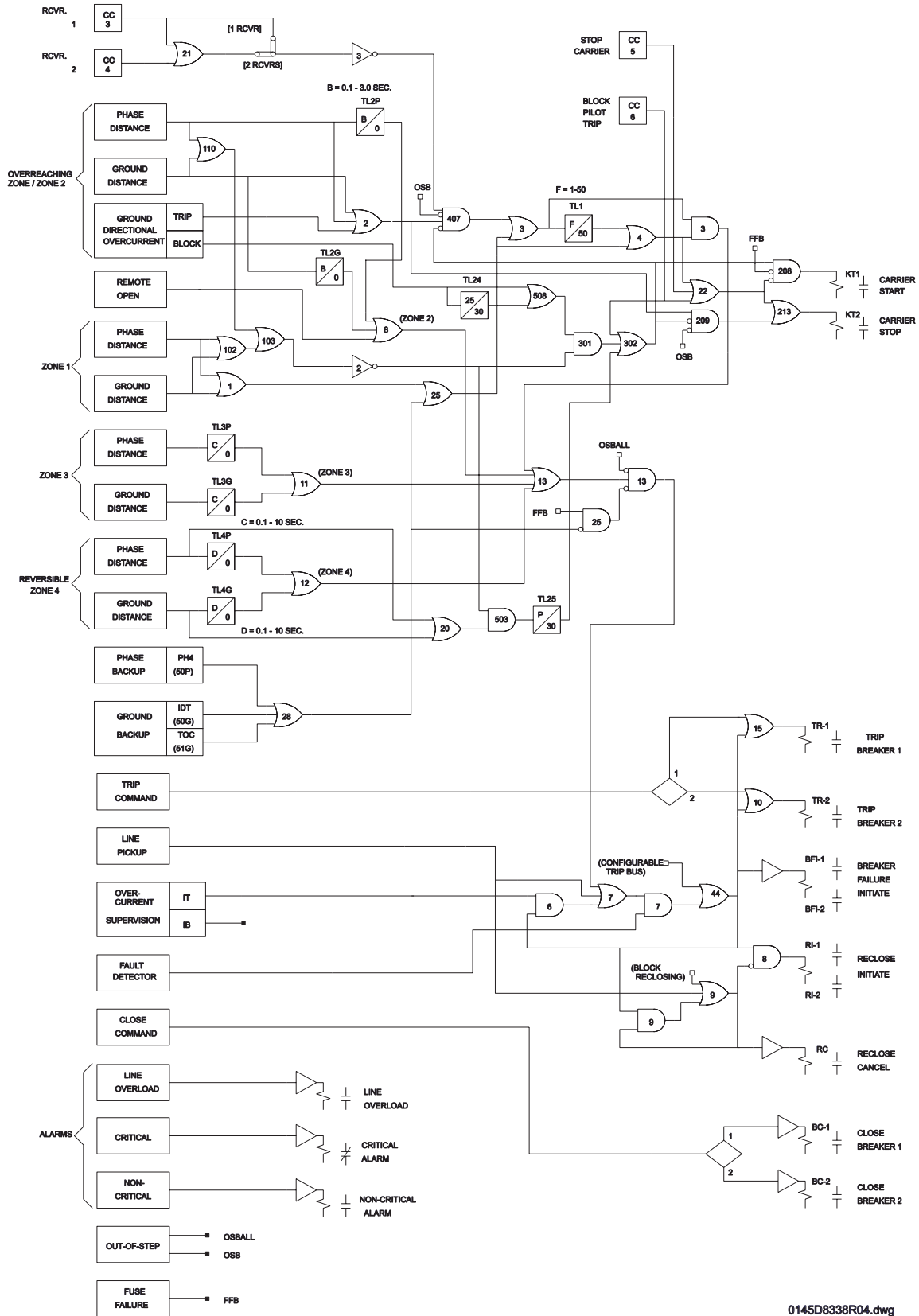
1.3.6 BLOCKING SCHEME

The logic diagram for the three available Blocking schemes is shown on the following page. Figure 1–9: GROUND CARRIER START OPTIONS shows the ground carrier start options for the three available Blocking schemes. Since a reverse-looking blocking function is required in this scheme, the Zone 4 distance functions must be set for reversed reach. As far as channel operation is concerned, a blocking scheme has virtually opposite sense from a POTT or PUTT scheme. For a remote external fault, the blocking functions at the remote end key the transmitter, and the receipt of this "blocking signal" at the local end 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 type, rather than an FSK type. Note that both Carrier Start and Carrier Stop contact outputs are provided to control the transmitter in the GE CS28A ON-OFF carrier set.

For any multi-phase fault on the protected line, one or more of the overreaching zone variable-mho functions will operate at each end of the line and apply one of the inputs to the comparator AND407 via OR2. An output from OR110 will inhibit the blocking functions at AND503 via OR103 and NOT2, and any carrier that may have been started will be stopped via OR2, AND209, and OR213. Consequently, carrier will be stopped or will not be started at any terminal of the line; there will be no receiver output and no blocking input applied to comparator AND407 via CC3 and NOT3. Assuming that the out-of-step blocking function has not operated, AND407 will produce an output to initiate tripping following the coordination-time-delay pickup set on timer TL1. The coordinating time is required to allow time for a blocking signal to be received from the remote terminal(s) to prevent misoperation on external faults. The required setting is described in the Chapter 2. Note that tripping, as in all the schemes, is supervised by the Fault Detector at AND7, thus confirming that a trip will only occur when a fault is present on the power system.

The sequence of operations is similar for an internal ground fault; however, the three blocking schemes each use a different logic for starting carrier for ground faults. Ground-distance, ground directional overcurrent, or both acting in parallel may be selected for ground-fault protection. Ground-distance and ground-directional overcurrent have separate trip and block functions as well as separate transient-blocking circuits.

1



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Figure 1-7: BLOCKING LOGIC DIAGRAM

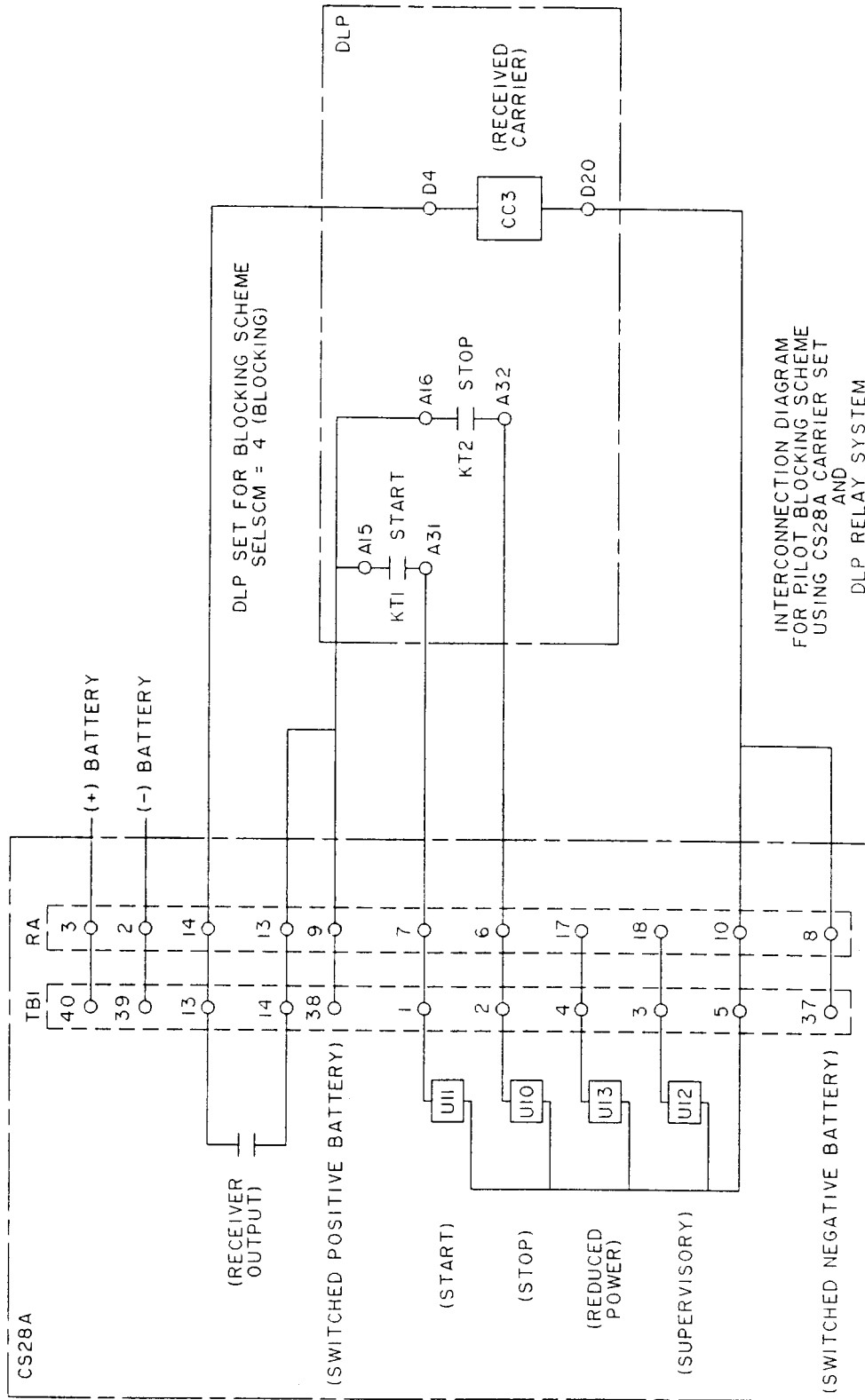


Figure 1-8: BLOCKING SCHEME INTERCONNECTIONS

1

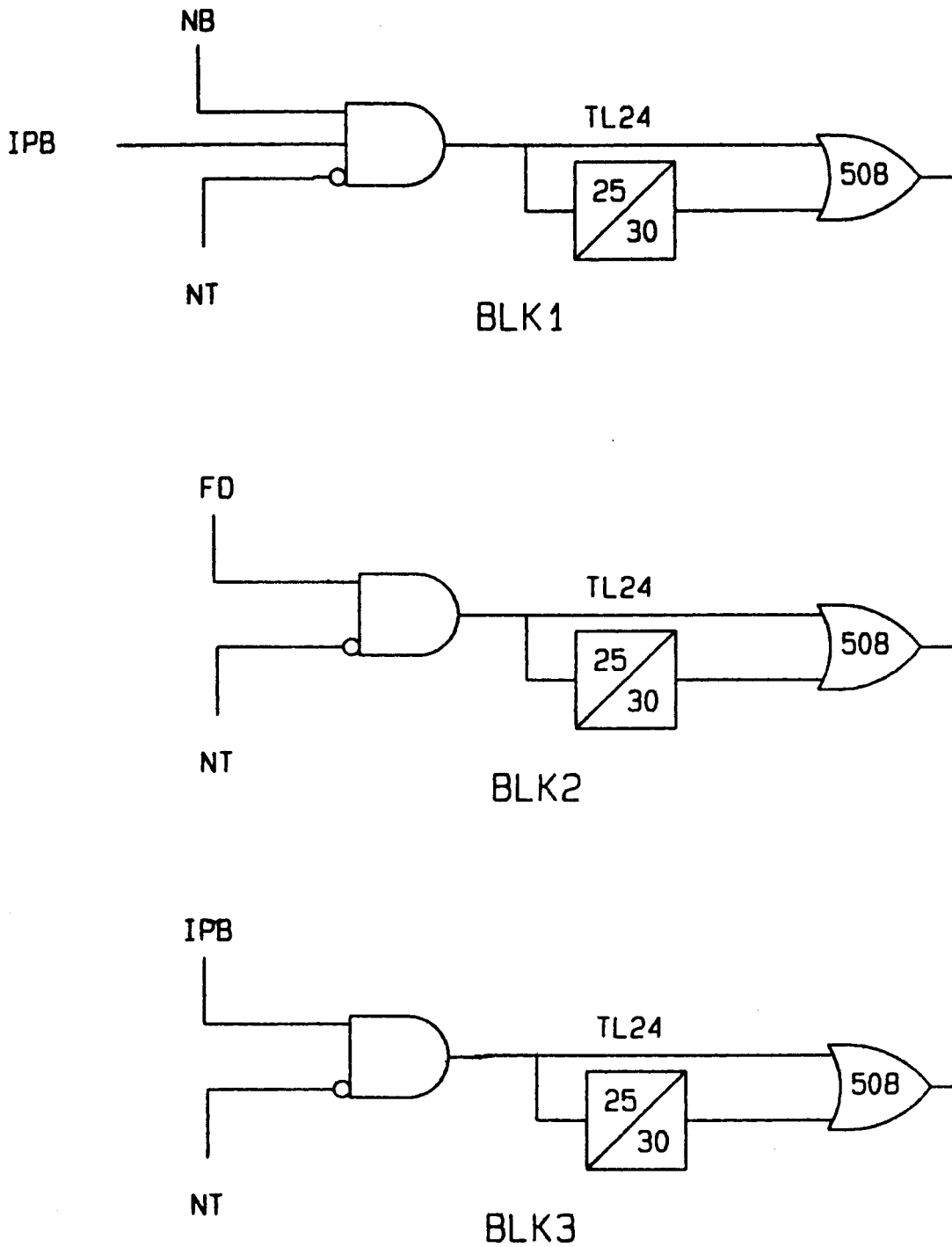


Figure 1-9: GROUND CARRIER START OPTIONS

The BLK1 scheme uses the IPB function ANDed with the NB function to start carrier in the GDOC or MDOC schemes. The BLK2 and BLK3 schemes use a non-directional carrier start function. BLK2 uses the fault detector (FD) function; BLK3 uses the IPB function. In the BLK3 scheme, the IPB function operates on the zero-sequence current without positive-sequence current restraint; in the BLK1 scheme, the IPB function operates on zero-sequence current with positive-sequence current restraint.

For remote external faults within the reach of the local overreaching zone tripping functions, one of the remote blocking functions will operate to key the transmitter ON, sending a blocking signal to the local end. The receiver output blocks tripping at the local end by removing the upper input to AND407 via CC3 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 used to block tripping when clearing external faults or during current reversals that might occur when clearing faults on a parallel line.

The ground-directional overcurrent (GDOC) transient-blocking logic consists of TL24, OR508, AND301, and OR302. When an external fault occurs, the GDOC blocking function operates to start carrier and to apply a blocking input to the comparator. If the external fault persists for 25 ms., TL24 will produce an output. At this point the GDOC blocking function is set up with an extended dropout time so that carrier will be maintained and tripping will be 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 were to operate as a result of a current reversal or a fault-clearing transient, tripping would not be initiated because of the blocking output maintained by the blocking function(s). For internal ground faults, TL24 would never pick up. For 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 were to occur following an initial external fault.

In a typical application utilizing ON-OFF carrier sets, only one receiver is used at each terminal of the line regardless of the number of line terminals, and CC3 (RCVR 1 in the logic diagram) is used to convert the receiver output into a blocking signal usable by the DLP3. Some blocking schemes use frequency-shift tone channels such as the GE type NS40. For a three-terminal application employing FSK tones, each terminal would have two receivers, and CC4 is used in conjunction with CC3. CC5 and CC6 are provided for additional transmitter and scheme control. CC5 is used to turn 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 CC5, which turns OFF the transmitter, permitting the remote end to trip. CC6 output is used to disable the pilot-scheme logic while allowing the backup Zone 1, Zone 2, etc. to function. Typically an external contact wired to CC6 is closed when the associated carrier set is removed from service to prevent over-tripping for external faults.

1.3.7 HYBRID SCHEME

The logic diagram for the Hybrid scheme is shown on the following page. A Hybrid scheme combines aspects of a tripping scheme with aspects of a blocking scheme, but it is perhaps easiest to explain as being an enhanced POTT scheme. As explained under the POTT scheme description, 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 infeed end(s) to trip. Also present is a "weak infeed trip" circuit that permits the weak-infeed end to trip virtually simultaneously with the strong in-feed end. A Hybrid scheme requires reverse-looking blocking functions to implement these enhancements, and the same transient- blocking logics that are used in a Blocking scheme are used in a Hybrid 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 POTT scheme described under the previous heading. When a weak or zero-in-feed condition exists at one terminal, then the echo keying is used to permit the strong in-feed terminal to trip. The weak in-feed tripping circuit may be used to trip the weak in-feed terminal. If weak in-feed tripping is not desired, then this feature may be disable.

Assume that an internal fault on the protected line is not detected at a weak-infeed terminal. At the strong in-feed terminal(s), the transmitter will be keyed to the trip frequency. At the weak- infeed terminal the blocking functions will not have operated and the receiver will produce an output when it receives the trip frequency. This output will be applied to timer TL11 and AND102 via OR101. AND102 will produce 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 will then allow the strong terminal(s) to trip.

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 setting 1202, Number of Receivers (NUMRCVR) is set at 2, provided that setting 1201, Select Scheme (SELSCM), is set at 3 (HYBRID).

The echo circuit with the addition of OR305, AND405 and timer TL16, comprises the weak- infeed tripping circuit. For the same internal fault condition outlined in the previous paragraph, AND405 will produce an output since:

1. the NOT input to AND405 is satisfied because there is no output from the blocking functions
2. there is an output from OR305, since either FD has operated or V1 has dropped out
3. 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.

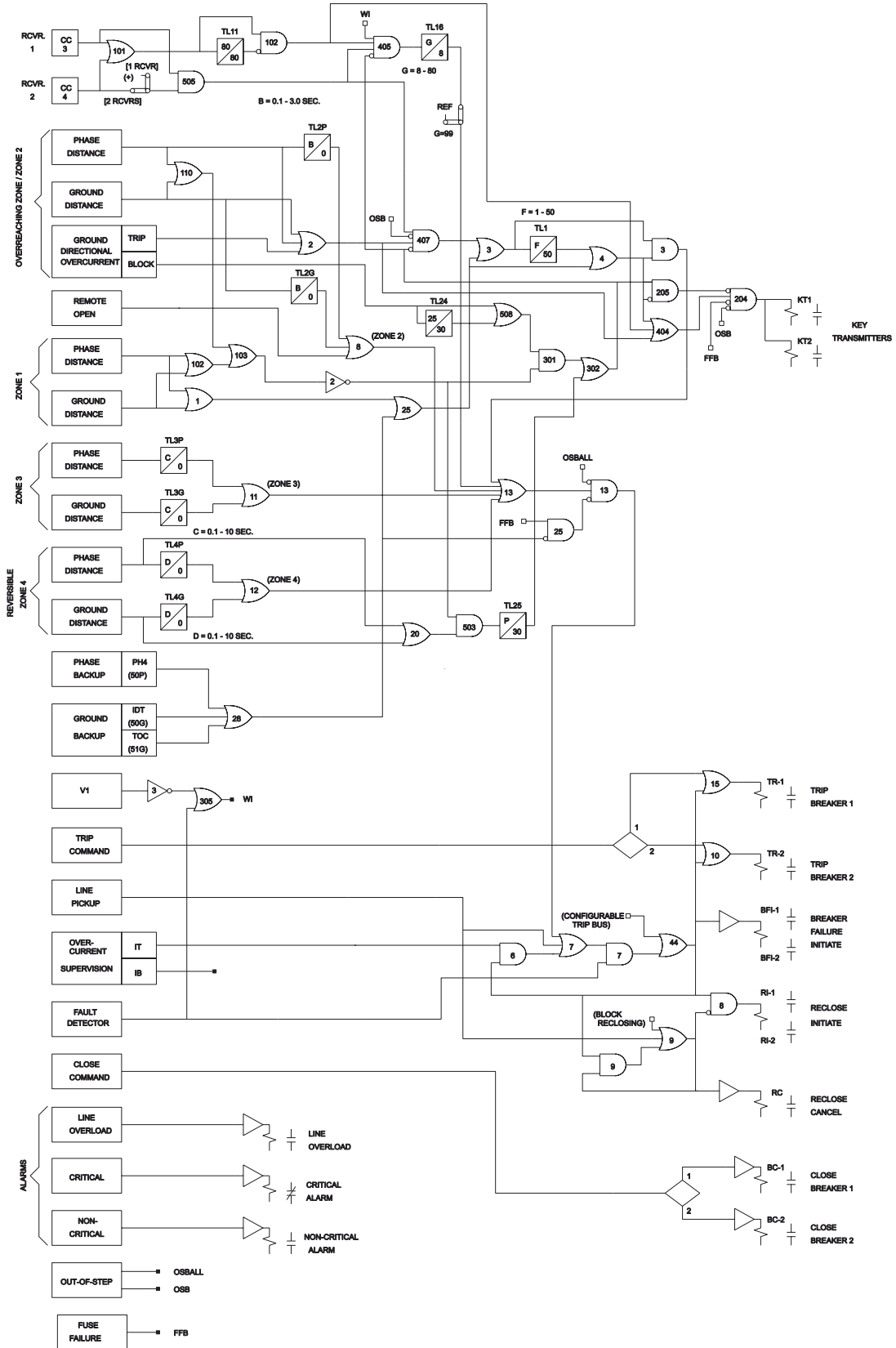


Figure 1-10: HYBRID LOGIC DIAGRAM

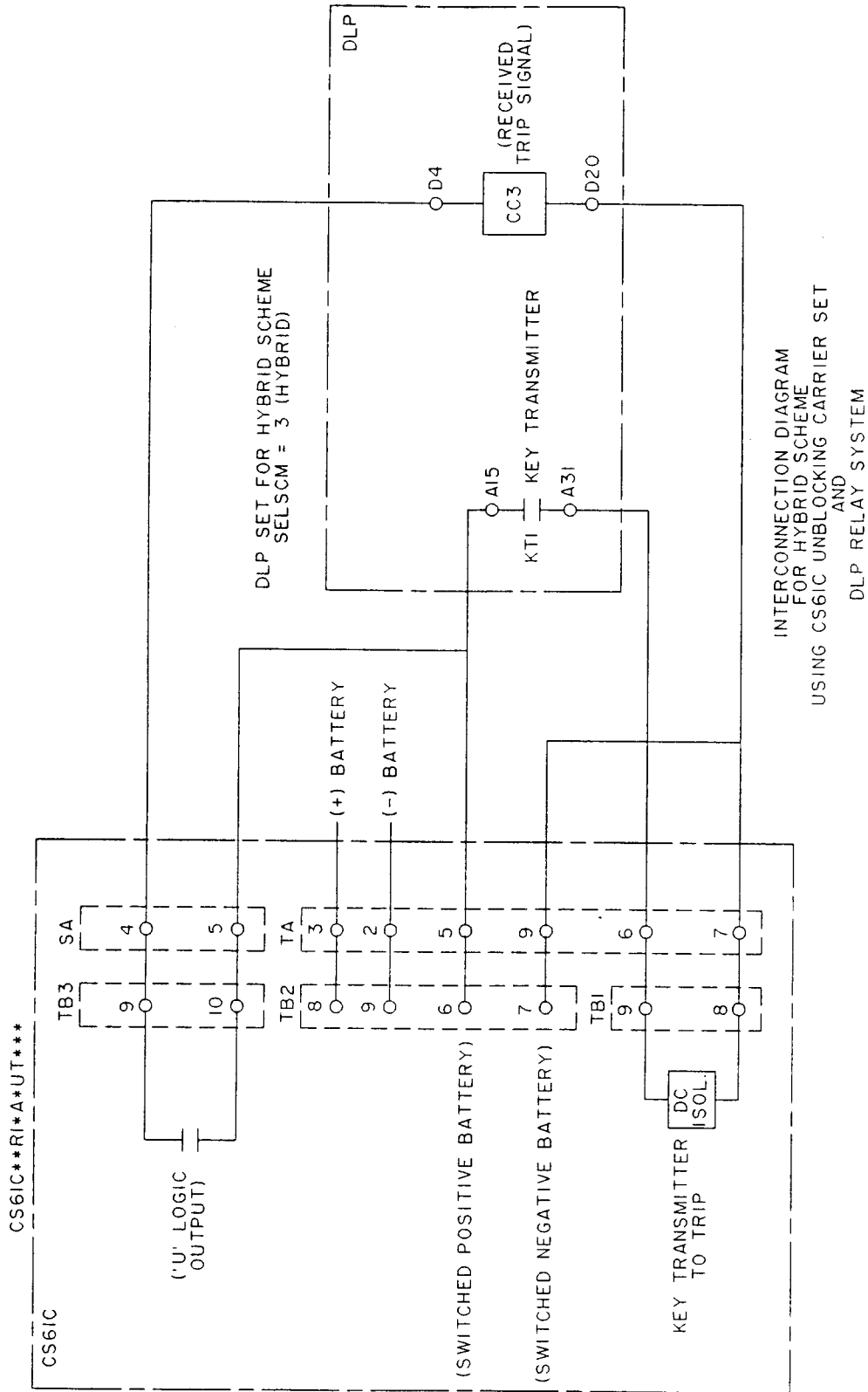


Figure 1-11: HYBRID SCHEME INTERCONNECTIONS

1.3.8 RECLOSER

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The optional reclosing function (recloser) can be set to provide one or two reclose attempts. The setting Select Recloser Scheme, SELRCLR, allows for the selection of four different modes of operation as listed below:

- SELRCLR = 0 The recloser is completely disabled with all the outputs OFF (contacts open); an external recloser may be used.
- SELRCLR = 1 The recloser is turned off. This is similar to mode 0 above except that the Z1RR output is ON (contact closed).
- SELRCLR = 3 One reclosing attempt is allowed.
- SELRCLR = 6 Two reclosing attempts are allowed.

The reclose-time-delay setting for the first reclose is different from that for the second reclose. The recloser may be operated from an external protective relay system by using the digital inputs (contact converters, CC1, etc.) and output contacts shown in the figure below. The recloser does not distinguish between internally generated input signals (software flags from the DLP3 protection module) and externally generated input signals (digital inputs from the external relay system). All digital inputs are logically ORed with corresponding flags from the DLP3. Likewise, output signals simultaneously cause the appropriate output relay to operate and are sent to the DLP3 protection module as software flags.

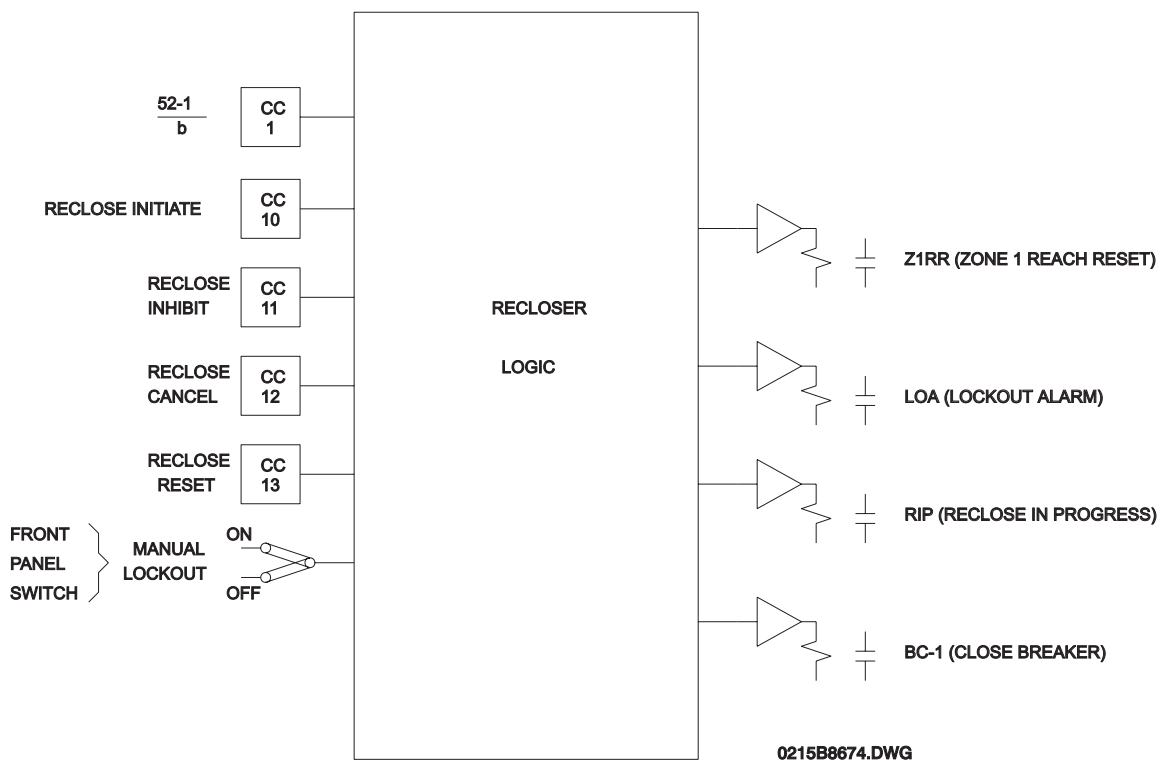


Figure 1-12: RECLOSER INPUT/OUTPUT DIAGRAM

The digital inputs are:

- MANUAL LOCKOUT is a switch on the front panel of the DLP3. When this switch is set to ON, the recloser will go to LOCKOUT from any position in the reclosing cycle except DWELL TIME. This is to ensure that the CLOSE CONTACT stays closed for a sufficient time. When DWELL TIME ends, the recloser will then go to LOCKOUT. The recloser will stay at LOCKOUT as long as the switch remains ON.

- RECLOSE INITIATE, informs the recloser that a trip has occurred.
- RECLOSE INHIBIT is used to keep the recloser from issuing the CLOSE BREAKER signal. If this signal is ON when the RECLOSE TIMER times out, the recloser will either start counting the Hold Time Delay (HOLDDLY) (if the setting HOLD = YES) or go to LOCKOUT (if the setting HOLD = NO). During the HOLDDLY, the CLOSE BREAKER signal will be issued as soon as RECLOSE INHIBIT goes OFF. If RECLOSE INHIBIT is still ON when the HOLD TIMER times out, the recloser will go to LOCKOUT.
- RECLOSE CANCEL, RC, produces different effects depending on the recloser's state when this signal goes ON. In RESET, the recloser will disregard any RECLOSE INITIATE received while RECLOSE CANCEL is ON, and the recloser will stay in RESET. During a reclose cycle, RECLOSE CANCEL will send the recloser to LOCKOUT. During the DWELL TIME, RECLOSE CANCEL will remove the CLOSE BREAKER signal and then send the recloser to LOCKOUT. In LOCKOUT, RECLOSE CANCEL has no effect.
- RECLOSE RESET is used to send the recloser from LOCKOUT to RESET without counting the RESET TIME. It will attempt to take the recloser out of LOCKOUT regardless of the breaker status or the presence of RECLOSE INITIATE signals, but if the breaker is open the recloser will return immediately to LOCKOUT. It has no effect if MANUAL LOCKOUT is ON. The same effect is achieved by the RESET RECLOSER command issued from the MMI.

The digital outputs are:

- ZONE 1 REACH RESET, Z1RR, controls the reach of the Zone 1 distance functions in a Zone 1 Extension protection scheme. When this signal is OFF (contact open) the distance functions are set to "extended Zone 1 reach", which is an overreaching setting. When this signal is ON (contact closed) the distance functions are set to the normal underreaching Zone 1 setting. Z1RR is ON when the recloser is in LOCKOUT and OFF when the recloser is in RESET. During a reclose cycle, Z1RR will go ON as soon as the first CLOSE BREAKER signal is issued, and it will remain ON until the recloser goes back to RESET. If the setting SELRCLR = 1, then Z1RR will be ON permanently.
- RECLOSE IN PROGRESS, RIP, is set when a reclosing cycle begins following detection of RI. RIP will be cleared when the recloser goes to LOCKOUT or to RESET.
- LOCKOUT ALARM, LOA, is ON for as long as the recloser is in LOCKOUT, and it is OFF for all other recloser states.

The following settings are associated with the recloser:

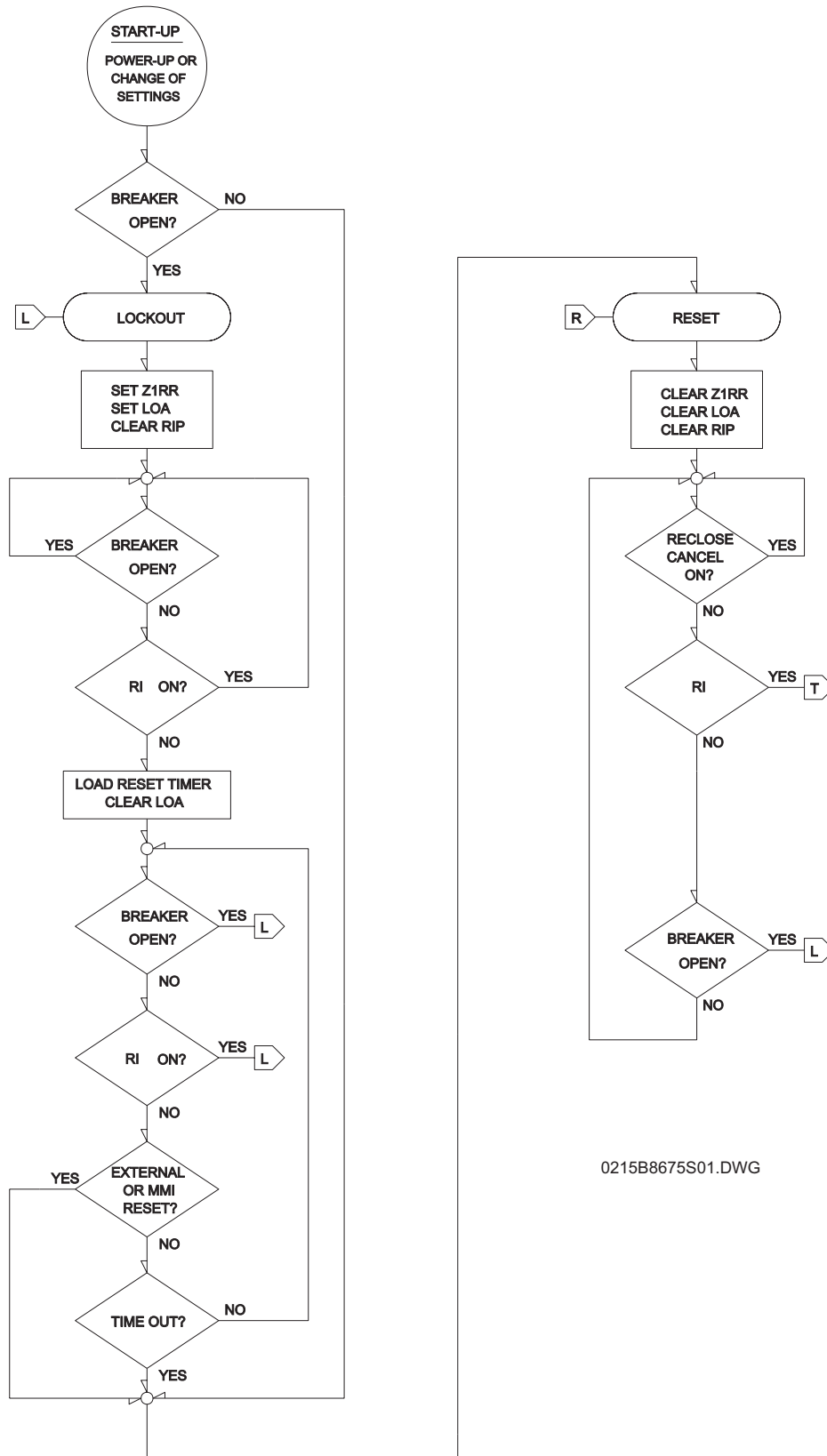
- SELRCLR - Select Recloser Scheme allows selection of one of four modes of operation as previously explained above.
- TPRDLY1 - Reclose Delay First Attempt determines the time between an initial trip and the reclosure of the breaker.
- RDLY2 - Reclose Delay Second Attempt determines the time between the second trip and the reclosure of the breaker.
- HOLD - Hold is either YES or NO and determines the action taken by the recloser just prior to issuing a CLOSE BREAKER signal. At this point the recloser checks the status of the RECLOSE INHIBIT digital input, and the next step is determined by HOLD as explained under the heading RECLOSE INHIBIT above.
- HOLDDLY - Hold Delay determines the duration of the HOLD timer.
- DWELLTM - Dwell Time Delay determines the time the CLOSE BREAKER signal will stay on once it has been issued.
- RSTDLY - Reset Time Delay determines the time delay of the RESET TIMER. Events associated with the recloser are part of the Sequence-of-Events function.

The recloser events are:

- Lockout - Reclose Inhibit: This event is stored when the recloser is sent to LOCKOUT after RECLOSE INHIBIT is detected when 1) with HOLD = NO, RECLOSE INHIBIT is ON after the RECLOSE TIMER times out, or 2) with HOLD = YES, RECLOSE INHIBIT stays ON for the duration of the HOLD TIMER count down.
- Lockout - Reclose Cancel: This event is stored when a reclosing cycle is aborted by RECLOSE CANCEL.
- Lockout - Permanent Fault: This event is stored when 1) a second RI is detected in one-attempt schemes or a third RI is detected in two-attempt schemes or 2) any RI is detected during the reset time when going from LOCKOUT to RESET.
- Lockout - Failure to Open: This event is stored if the breaker is closed at the time that the CLOSE BREAKER signal is issued.
- External Three-pole RI: This event is stored when an external RI is detected, provided that the RI affects the operation of the recloser.
- External Reset: This event is stored when the RECLOSER RESET digital input or RESET RECLOSER command causes the recloser to RESET.
- Breaker Reclosed: This event is stored when the recloser issues a CLOSE BREAKER signal.
- Manual Lockout ON: This event is stored when the MANUAL LOCKOUT switch is toggled from OFF to ON.
- Manual Lockout OFF: This event is stored when the MANUAL LOCKOUT switch is toggled from ON to OFF.

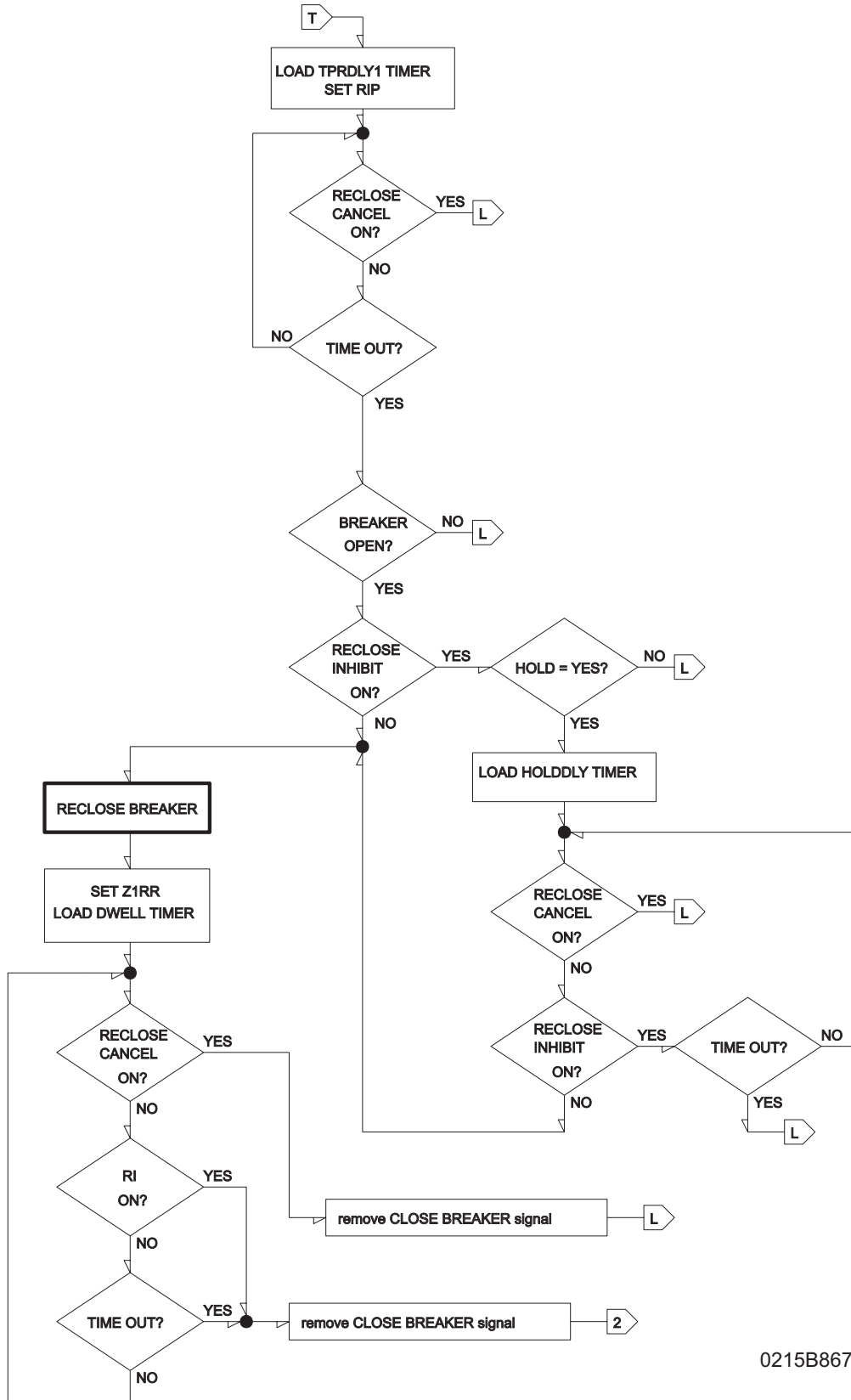
The figures below show the flow charts for the recloser operating in mode 6, SELRCLR = 6. Recloser operation will be described using this mode, since it encompasses the full capability of the recloser.

1



0215B8675S01.DWG

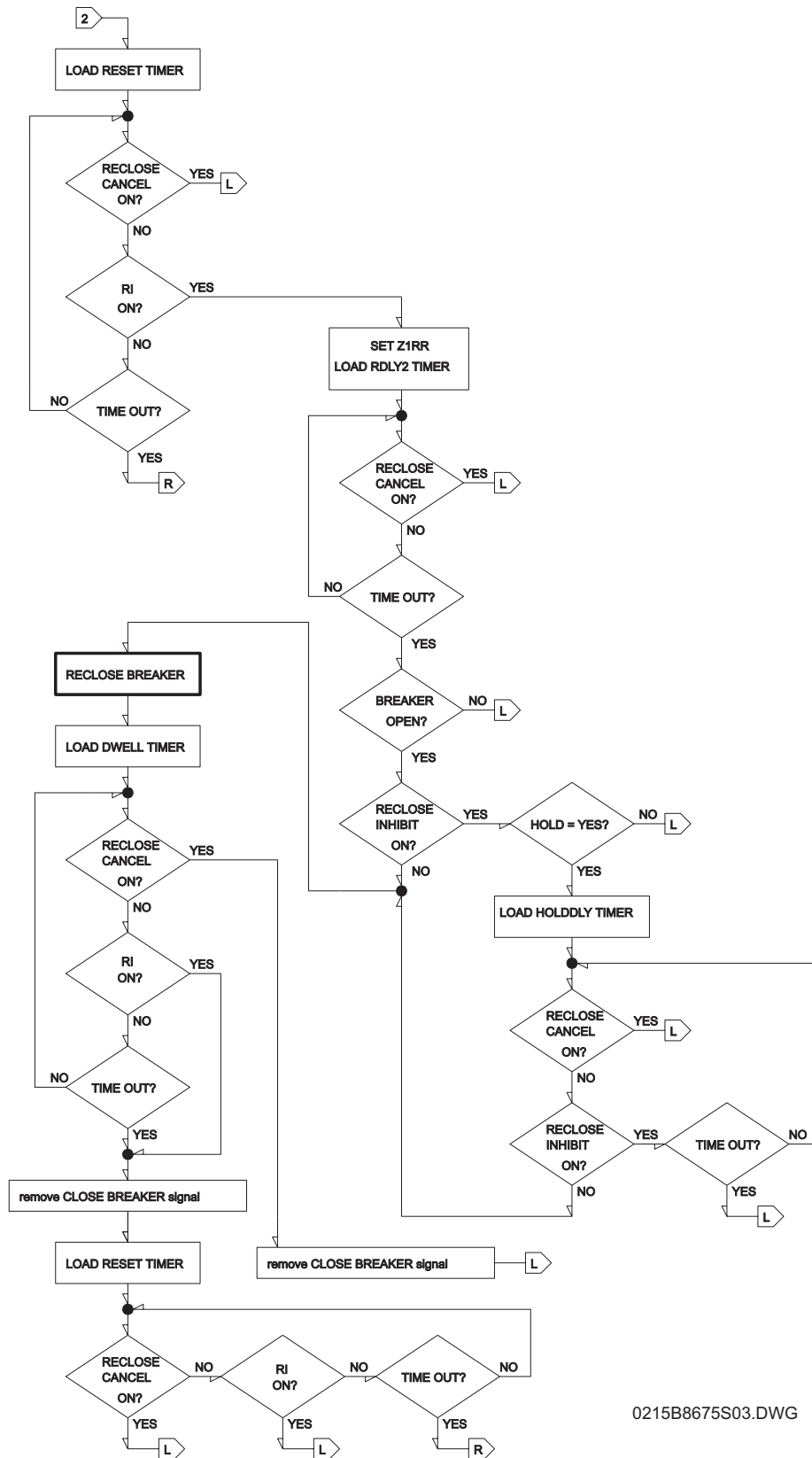
Figure 1–13: RECLOSER FLOWCHART (1 OF 3)



0215B8675S02.DWG

Figure 1-14: RECLOSER FLOWCHART (2 OF 3)

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0215B8675S03.DWG

Figure 1-15: RECLOSER FLOWCHART (3 OF 3)

Following power-up of the DLP3 or a change in settings, the recloser first checks to see whether MANUAL LOCKOUT is ON. If it is, the recloser will go to LOCKOUT, but the "Manual Lockout ON" event is not recorded. If it is not, the recloser will check whether the breaker is open. An open breaker will cause the recloser to go to LOCKOUT, and a closed breaker will cause the recloser to go to RESET.

Once at LOCKOUT, the recloser will set Z1RR and LOA and clear RIP, and it will enter a loop checking for conditions that permit a return to RESET. If any pole is open or any RI is ON the recloser will stay in LOCKOUT. Otherwise the RESET TIMER is loaded with the value RSTDLY, LOA is cleared, and the RESET TIMER begins counting down. During the RESET TIME count down, three conditions are checked. If an open pole is detected, then the recloser goes to LOCKOUT without an event message being stored. Any RI signal going ON causes a "Lockout - Permanent Fault" event to be stored and the recloser goes to LOCKOUT. Finally, either the RECLOSE RESET signal or the RESET RECLOSER command will send the recloser to RESET immediately.

After reaching RESET, the recloser clears Z1RR, LOA, and RIP, and it enters a loop that checks RI and BREAKER OPEN unless RECLOSE CANCEL is ON. If an open breaker is detected, then the recloser goes to LOCKOUT.

If RI goes ON, RIP is set and the RECLOSE TIMER is loaded with the value TPRDLY1. While this timer is counting down, RECLOSE CANCEL is checked. If it is ON, a "Lockout - Reclose Cancel" event is stored and the recloser goes to LOCKOUT. After the RECLOSE TIMER times out, the closing procedure begins.

Before closing the breaker, the recloser checks the 52/b digital inputs to make sure that the breaker is open. If the breaker is closed, a "Lockout - Failure to Open" event is stored and the recloser goes to LOCKOUT. If the breaker did open, the recloser will check the state of RECLOSE INHIBIT. If it is OFF (external contact open) the breaker is closed. If it is ON (external contact closed), the recloser will read the value of HOLD. If HOLD = NO, a "Lockout - Reclose Inhibit" event is stored and the recloser goes to LOCKOUT. If HOLD = YES, the HOLD TIMER is loaded with the value HOLDDLY. While this timer is counting down, the recloser checks RECLOSE CANCEL and RECLOSE INHIBIT. If RECLOSE CANCEL goes ON, a "Lockout - Reclose Cancel" event is stored and the recloser goes to LOCKOUT. If RECLOSE INHIBIT goes OFF, the breaker is closed. If the HOLD TIMER times out before RECLOSE INHIBIT goes OFF, a "Lockout - Reclose Inhibit" event is stored and the recloser goes to LOCKOUT.

Once the recloser decides to close the breaker, a CLOSE BREAKER signal is issued, Z1RR is set, and a "Breaker Reclosed" event is stored. The DWELL TIMER is now loaded with the value DWELLTM and this timer starts counting down. During the countdown, RECLOSE CANCEL and RI is checked. If RECLOSE CANCEL goes ON, then the CLOSE SIGNAL is removed and the recloser goes to LOCKOUT. If RI goes ON, then the CLOSE SIGNAL is removed and the recloser moves to the second reclose attempt.

At this point, following the first reclose attempt, the RESET TIMER is loaded with the value RSTDLY and this timer starts counting down. During this time the recloser checks RECLOSE CANCEL and RI. If RECLOSE CANCEL goes ON, a "Lockout - Reclose Cancel" event is stored and the recloser goes to LOCKOUT. If RI goes ON, it is assumed that the first reclosing attempt was unsuccessful and the RECLOSE TIMER is loaded with the value RDLY2 to begin the second reclosing attempt. If the RECLOSE TIMER times out, the first attempt is considered successful and the recloser goes to RESET.

Assuming that the first reclosing attempt was unsuccessful, the RECLOSE TIMER loaded with the value RDLY2 is counting down. While this timer is counting, the recloser checks RECLOSE CANCEL, and if it goes ON, a "Lockout - Reclose Cancel" event is stored and the recloser goes to LOCKOUT. After the RECLOSE TIMER times out, the same closing procedure previously described begins.

After the DWELL TIMER times out, the RESET TIMER is loaded with the value RSTDLY and starts counting down. While this timer is counting, the recloser checks RECLOSE CANCEL and RI. If RECLOSE CANCEL goes ON, a "Lockout - Reclose Cancel" event is stored and the recloser goes to LOCKOUT. If RI goes ON, it is assumed that the second reclosing attempt was unsuccessful. A "Lockout - Permanent Fault" event is stored and the recloser goes to LOCKOUT. If the RECLOSE TIMER times out, the second attempt is assumed successful and the recloser goes to RESET.

1.3.9 OUT-OF-STEP BLOCKING

The figures below show a functional diagram of the out-of-step blocking logic plus 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 and then some time later it will enter the phase trip function. When MOB picks up during the power swing it will apply the upper input to AND201, and the lower input will be present from the NOT via OR203, since the phase trip function has not operated yet. AND201 will then produce an output to energize timer TL1 via OR207. If the impedance stays between the MOB and phase trip function characteristic for the pickup time of TL1, an OSB output will result. The OSB output is routed back to the lower input of AND201 via OR201 to seal-in the OSB output for as long as the MOB is picked up. The OSB output will reset 50 ms after the swing-impedance locus leaves the MOB characteristic. OSB is always routed to block reclosing.

OSB can be selected to block tripping of:

1. All functions
2. All functions except the direct trip overcurrent functions
3. Only the phase distance functions
4. No functions

For 2 and 3, each of the four distance zones (Zone 1, 2, 3, or 4) may be individually selected to be blocked or not.

Timer TL1 has an adaptive pickup feature that has 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 will typically be encountered after the first slip cycle.

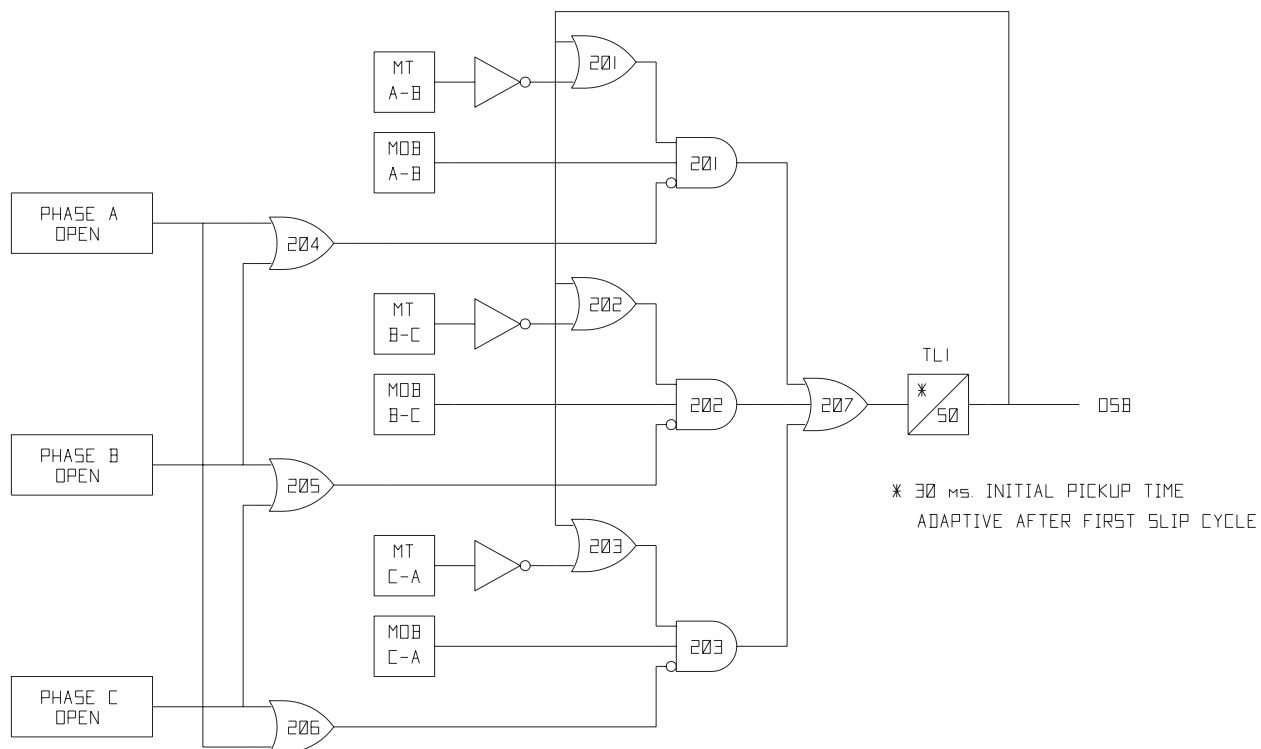


Figure 1–16: OUT-OF-STEP BLOCKING LOGIC

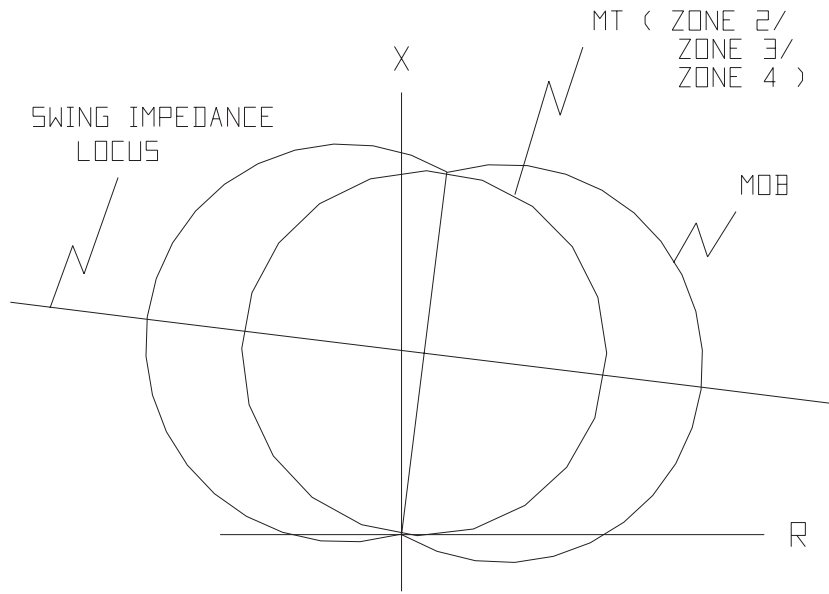


Figure 1-17: OSB R-X DIAGRAM

1.3.10 REMOTE OPEN DETECTOR

The Remote-Open Detector (ROD) function operates and issues a trip signal when the remote breaker opens during an unbalanced internal fault. The principle of operation used to detect that the remote breaker has opened is to recognize charging current on one or more phases following opening of the remote breaker. As shown in the functional logic diagrams for the five protection schemes, the ROD output trips via OR8, AND10, OR13, AND13, OR35, and AND35. The Remote-Open Detector will not operate when a balanced three-phase fault is present.

ROD tripping, when used, can speed up tripping at the end of the line that otherwise would be the slowest to respond for a sequential tripping condition. In a Step Distance scheme, ROD tripping would be of benefit for any unbalanced internal fault not detected by Zone 1. In a Blocking scheme, ROD tripping would be of benefit 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.

The functional logic diagram of the ROD function that will be used as an aid in describing ROD operation is shown below. The sequence of events that results in an ROD output is (1) no charging current detected prior to the fault - logic 0 output from AND2, (2) fault detected - logic 1 output from OR3, (3) remote breaker opens - logic 1 output from AND3, and (4) fault still present so that the two inputs to AND4 persist for the time-delay setting of timer TL20.

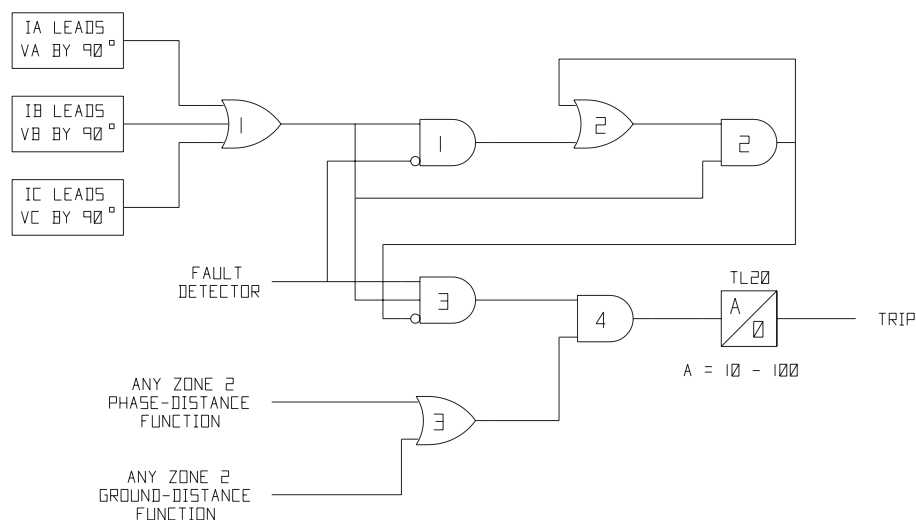


Figure 1-18: REMOTE-OPEN DETECTOR LOGIC

If initially charging current is detected but the fault detector (FD) is not picked up - indicating no fault on the power system, then OR1 and consequently AND1 will produce an output. AND2 will produce an output and seal 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. Should a subsequent fault occur and the remote breaker open, ROD is prevented from producing an output. If sufficient load current is flowing prior to the fault, there will be no output from OR1 - no charging current detected - and AND3 will not be blocked, since there is no output from AND2. If subsequently an unbalanced fault occurs, FD will block 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. Provided the fault is still present as evidenced by an output from OR3, an ROD trip will result following the expiration of the TL20 security time delay.

1.3.11 LINE PICKUP

1

Line Pickup provides tripping in the event that the breaker is closed into a zero-voltage bolted fault, such as would occur if the grounding chains were left on the line following maintenance. The functional logic for Line Pickup.

When the line is de-energized, the open breaker detector, IB, and the positive-sequence voltage detector, V1, will be reset, indicating that the line is dead. The resulting output from AND4 will cause timer TL2 to operate 150 ms. later. Consequently, when the line is energized and a fault exists, current detector I1 will pick up and AND2 will produce an output. If the link connected to the bottom input of AND3 is connected to (+), then AND3 will produce an output immediately to initiate tripping of the breaker. If the link is connected to reference (REF.), then tripping will occur after the 45 ms. pickup delay of timer TL3. The bypass of timer TL3, which is shown functionally as AND3 and the associated link, is in reality simply a setting, SELTBP (0902), and the setting that corresponds to a specific link position is shown in the logic diagram below. If the DLP3 detects an open pole (pole disagreement), Line Pickup is disabled at AND5. If the line is energized and no fault exists, V1 will pick up and timer TL1 will begin timing; 25 ms. later the output of TL1 will reset timer TL2 via the fast reset input. AND2 will have its lower input removed at that time to take Line Pickup out of service.

Timer TL3 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. In those cases, TL3 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.

While 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, it can also be used to trip for any type of permanent fault along the entire line length, regardless of the I1 pickup setting, that produces voltage at the relay location that is sufficient to operate a Zone 2 distance function but not so high as to operate the V1 voltage detector. This is accomplished by routing Zone 2 phase-distance or ground-distance function outputs to AND1. The other input to AND1 is the normal Line-Pickup-enable output from timer TL2, 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, for a Step Distance scheme this feature will still result in faster tripping for permanent faults located at the remote bus (or anywhere past the local Zone 1 reach).

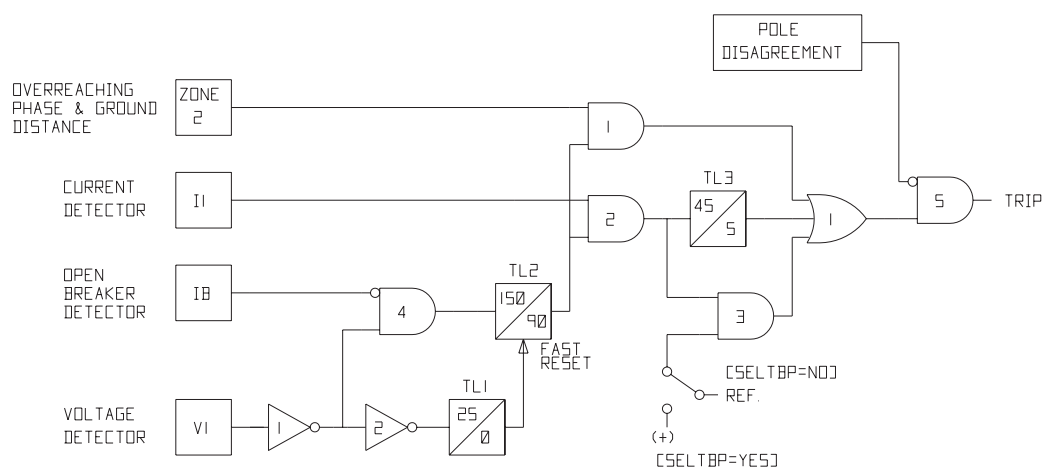


Figure 1-19: LINE PICKUP LOGIC

1.3.12 POTENTIAL TRANSFORMER FUSE FAILURE (PTFF)

1

Since 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. The backup overcurrent functions PH4, non-directional IDT, and non-directional TOC are allowed to trip. If IDT or TOC is directionally supervised by NT, then that function is not allowed to trip. The functional logic for the PTFF function is shown below.

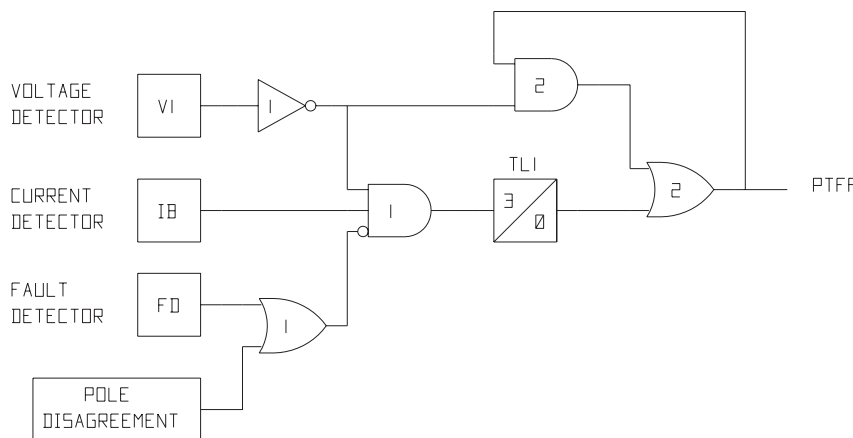


Figure 1–20: PTFF LOGIC

If AC potential is lost, as indicated by the positive-sequence voltage detector V1 dropping out and NOT1 producing a logic 1 output, the upper input will be present at AND1. The V1 pickup setting is fixed at 75% of nominal - 50 volts secondary - and the pickup-to-dropout ratio is virtually 100%. The middle input to AND1 is present if load current is sufficient to operate the current detector IB, and the bottom input is dependent upon whether or not the fault detector FD has operated, or whether one or more poles are open. When the POLE DISAGREEMENT logic detects that one or more poles of the circuit breaker(s) are open, PTFF 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 will produce an output that will cause 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 output of V1, so that PTFF output will be maintained as long as the potential is below normal. Setting 1003, SELFFB, determines whether PTFF operation issues a critical alarm and blocks distance/directional tripping (SELFFB=YES) or merely issues a critical alarm (SELFFB=NO). When the potential returns to normal, V1 and NOT1 will reset to remove the seal-in, allowing the PTFF output to reset.

When a fault occurs with an attendant drop in potential, the V1 function will reset, but the fault detector will operate to prevent an output from AND1. For fault conditions, PTFF will not operate.

1.3.13 OVERCURRENT BACKUP

An instantaneous non-directional phase-overcurrent tripping function (PH4) is included to provide direct tripping for three-phase and phase-to-phase faults. Since PH4 is non-directional, Power system conditions will determine whether or not this function can be set to distinguish between internal and external faults. An instantaneous overcurrent tripping function (IDT) is included in the scheme to provide direct tripping for severe phase-to-ground faults. Also included is a time-overcurrent tripping function (TOC) that 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 user's discretion.

1.3.14 LINE OVERLOAD

The Line Overload function provides an 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.

1.4.1 ALARMS

1

Two separate self-test alarms are provided. The non-critical alarm indicates that self-test has detected a problem that does not warrant taking the relay system out of service. This is a normally open contact, which closes when a non-critical alarm occurs. Three consecutive remote login failures, a loss of potential detected by the Fuse Failure function, or detection of a sustained unbalanced-current condition will also activate the non-critical alarm.

The critical alarm indicates that self-test has detected a problem that warrants taking the relay system out of service. This is a normally closed contact, which is held open for normal conditions but which closes when a critical alarm occurs.

A separate alarm contact is located on the power supply. This is a normally closed contact that is held open when the power supply is normal but that closes when the power supply fails or is turned off. The self-test critical alarm contact and the power supply alarm contact are paralleled to create one combined critical alarm output. The output contact associated with the Line Overload function is also classified as an alarm output.

1.4.2 BREAKER CONTROL

By using the local MMI or a remote PC connected to the RS232 port, it is possible selectively to trip and close two different breakers. Two distinct breaker-trip commands can be issued; trip breaker 1 and trip breaker 2. The breaker-trip command uses the same output contacts or SCRs used when a fault trip command is issued. Two distinct breaker-close commands can be issued; close breaker 1 and close breaker 2. Separate auxiliary relays are associated with the close command. The contact of each auxiliary relay must be wired to the appropriate breaker's close circuit. The breaker tripping and closing described above can be enabled or disabled by a hard-wired jumper located on the MMI module. As shipped from the factory, this jumper is physically present and Breaker Control is disabled. To enable Breaker Control, the jumper must be removed.

1.4.3 CONFIGURABLE INPUTS

Three of the digital inputs, contact converters CC4, CC5, and CC6, are user configurable. The user can select from nine possible combinations how these digital inputs are used via setting 1701, CONCCI. For further explanation refer to Chapter 2: CALCULATION OF SETTINGS.

1.4.4 CONFIGURABLE OUTPUTS

To provide greater flexibility in utilization of the output contacts, six digital outputs are designated as configurable. These are shown in the table below:

Table 1–3: CONFIGURABLE OUTPUTS

DIGITAL OUTPUT	SETTINGS CATEGORY
1. CLOSE CONTACT, BC-1	18: BKR1CLSOUT
2. CLOSE CONTACT, BC-2	19: BKR2CLSOUT
3. RECLOSE CANCEL, RC	20: RCANCLOUT
4. LINE OVERLOAD	21: LNOVLDOUT
5. NON-CRITICAL ALARM	22: NONCRITOUT
6. RECLOSE INITIATE, RI (two contacts)	23. RINITOUT

The names listed above in the left-hand column are the "default" utilizations of these contacts as marked on the protection scheme logic diagrams. Each of the above digital outputs is associated with a unique settings category comprised of nine distinct settings. For instance, settings category 18, BKR1CLSOUT, controls the use of configurable digital output #1 as indicated in the above listing. For all of the above settings, except Line Overload, the first setting in this category, CONOUT_x (where x = 1, 2, 3, 4, 5, or 6), may be either 0, 1, or 2 as tabulated below:

CONOUT1 = 0 (used as BC-1, the default setting)

CONOUT1 = 1 (energized by an 8-input logical OR)

CONOUT1 = 2 (energized by an 8-input logical AND)

For the Line Overload digital output, the setting CONOUT4 may be either 0, 1, 2, 3, or 4 as tabulated below:

CONOUT4 = 0 (used as Line Overload, the default setting)

CONOUT4 = 1 (energized by an 8-input logical OR)

CONOUT4 = 2 (energized by an 8-input logical AND)

CONOUT4 = 3 (energized by an 8-input logical OR and activates the trip bus)

CONOUT4 = 4 (energized by an 8-input logical AND and activates the trip bus)

For a setting value of 3 or 4, an OR or AND function output produces a DLP trip as well as closing the Line Overload contact. A "CTB" trip type will be displayed. A timer function with settable pickup and dropout times (see settings 1309 - CFG Pickup Time and 1310 - CFG Dropout Time) is located between the OR and AND function and the Line Overload relay coil (and DLP trip bus) when CONOUT4 = 1, 2, 3, or 4. When CONOUT4 = 3 or 4, the dropout time is automatically fixed at 25 ms regardless of the setting of CFG Dropout Time (1310).

The 8 inputs to the logical AND or OR are determined by the remaining eight settings in this category, CO1IN1 through CO1IN8, termed "input numbers." Each "input number" setting can be set over the range from 0 to 64. A "0" indicates that the input is not used. Settings 1 to 64 are selected from a table of predetermined signals from within the DLP3 relay. For further explanation refer to Chapter 2: CALCULATION OF SETTINGS.

1.4.5 CONFIGURABLE TRIP BUS

The DLP can be programmed to trip for a selected condition by using the LNOVLDOUT settings category. If CONOUT4 = 3 or 4, the OR or AND output produces a DLP trip through the DLP trip output contacts or SCRs and closes the Line Overload contact. If the programmed condition is the primary cause of the trip, the trip type displayed will be CTB (Configurable Trip Bus). To enable the Line Overload category to cause a trip, CONOUT4 must be set to either 3 or 4. If CONOUT4 = 0, 1, or 2, then only the Line Overload contact will operate.

1.4.6 FAULT LOCATION

A separate and distinct algorithm from the algorithms used to implement the relay measuring functions is present to provide fault location information, which is presented as miles (or kilometers) from the relay location to the fault. The distance to the fault is based on a line length (miles or kilometers) provided by the user as a setting. Fault location output is displayed on the local MMI as part of the target information following a relay trip, and it is also contained in the Fault Report described below.

1.4.7 FAULT REPORT

When a fault occurs, pertinent information, consisting of unit ID, date and time, operating time, pre-fault currents, fault currents and voltages, fault type, trip type, distance to fault, and selected events, is stored in memory. The five most recent fault events are stored. A full description of this function is contained in Chapter 9: INTERFACE.

1.4.8 CURRENT UNBALANCE DETECTION

If the Fault Detector, FD, remains picked up for 60 seconds, a non-critical alarm is issued and an event message is stored under Sequence of Events. This function is intended to indicate sustained unbalanced-current conditions that may be caused by such things as a shorted or open transformer.

1.4.9 CONTINUOUS MONITOR

The DLP relay includes a Continuous Monitor feature in addition to its self-test features. The Continuous Monitor is intended to detect any DLP tripping units (Zone 2 or Zone 3 distance functions, IDT or PH4 overcurrent functions) that are in the picked up condition with a corresponding operation of the Fault Detector. If such a condition occurs and persists for 1 second, the DLP relay will issue a non-critical alarm and log a continuous monitor event.

1.4.10 LOCAL MAN-MACHINE INTERFACE

A local MMI, incorporating a keypad and light-emitting-diode (LED) display, is provided to allow the user to enter settings, display present values, view fault target information, and access stored data. The use and functioning of the MMI is fully described in Chapter 9: INTERFACE. Models ending with NC have no keypad; see Chapter 10: SOFTWARE for use and functioning of the communication software.

1.4.11 LOCAL PRINTER

A serial port (PL-2) on the rear of the DLP3's case permits the use of a local printer. When a local printer is connected, all events (see Sequence of Events below) are automatically printed at the time of occurrence. In addition, other information stored in the DLP3's memory can be printed when requested via the local MMI as described in Chapter 9: INTERFACE.

1.4.12 OSCILLOGRAPHY

A set of oscillography data is stored in memory each time the DLP3 issues a trip, and optionally (via settings) when an internal oscillography trigger flag is set or an external contact is closed. Setting 1515, OSCTRIG, allows a choice of five internal signals to trigger oscillography storage. Setting 1701, CONCCI, determines the use of the configurable inputs (contact converters), and if CONCCI = 1, 4, or 7, then contact converter 4 (CC4) is used to trigger oscillography storage. When used as an oscillography trigger, CC4 is logically ORed with the internal oscillography trigger flag. The output of this logical OR is referred to as "OSC Trigger" below.

It is important to note that OSC Trigger acts to cause oscillography storage but does not necessarily set t=0, the time sample that delineates between "pre-fault" and "post-fault" oscillography cycles. For discussion purposes, the term "disturbance period" is defined as the number of cycles of oscillography data (pre-fault plus post-fault) as determined by the setting 1513, NUMFLTS. If the internal Fault Detector, FD, comes up initially and OSC Trigger follows any time within the disturbance period, oscillography data is stored whether or not the DLP3 issues a trip. If the DLP3 issues a trip, then a normal fault report is stored as part of the oscillography data. If the DLP3 does not issue a trip, a pseudo fault report is created where the trip type is listed as OSC, the trip time is the time at which 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 MMI LED display will not show "target" information, but an event message and fault report will be 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 any time within the disturbance period, the same actions occur as described above, and FD determines $t=0$. If only OSC Trigger occurs, then a pseudo fault report is created and OSC Trigger determines $t=0$. This arrangement assures that the oscillography function will always capture a DLP3 trip with FD determining $t=0$ regardless of whether an optional internal or external trigger is used.

Oscillography data includes station and line identification, a complete list of settings, the fault report, internal flags, and a selectable number of pre-fault and post-fault data samples. Further description of this function is contained in the DL-DATA section of Chapter 10: SOFTWARE.

This version of the DLP (firmware versions V002.430C and higher) differs from previous versions as to which internal flags are stored as part of Oscillography data. Now, when a function is disabled, the associated flags are not stored. For example, if SELZ1G = NO and SELZ1P = NO, the Zone 1 flags (indicating Zone 1 operation or non-operation) are not stored. Previously, if SELZ1G = NO and SELZ1P = NO, the Zone 1 flags were stored, even though the Zone 1 functions were disabled – this feature caused some confusion, especially when appropriate reach or pickup settings were not used.

1.4.13 PASSWORD PROTECTION

Passwords provide security when using the local man-machine interface (MMI) or during remote communications while running the DLP-LINK program. Two different passwords provide local MMI security for

- Control operations (trip and close the breakers) and settings changes
- Settings changes.

Three different passwords provide remote DLP-LINK communications security for:

- Viewing and uploading information
- Control operations and settings changes
- Settings changes.

A single view only password provides ASCII port security.

Refer to the INTERFACE chapter for a description of MMI password usage (not applicable to models without keypad), and refer to the SOFTWARE chapter for a description of DLP-LINK password usage.

1.4.14 REMOTE COMMUNICATIONS

Three RS232 serial ports are provided. A DB-25 plug (PL-1) located on the rear of the case is provided for the following:

- Communication with the DLP3 using DLP-Link software from an IBM-compatible computer

A second DB-25 plug (PL-2) located on the rear of the case is provided for the following:

- Connecting the DLP3 to an IBM-compatible PC using an ASCII protocol interface

When communication via a PC is desired, the PC may be connected via the proper null-modem cable, provided the cable length does not exceed 50 feet, or the PC may be connected via interposing modems when physically remote from the DLP3. Unique PC software, DLP-LINK, is required to communicate with the relay system. The capabilities and use of DLP-LINK are described in the SOFTWARE chapter. Refer to the INTERFACE chapter for details regarding the required cables.

When connection to the G-NET host computer is desired, two different physical connections are possible. Standard hard-wire cables may be used for distances up to 50 feet. For longer distances it is possible to add an optional external adapter that plugs into PL-1 to provide a fiber optic link between the DLP3 and the G-NET host computer. An isolated 5 volt DC supply is internally connected to pin 11 of PL-1 to power this external adapter. When connected to the G-NET host computer, the DLP3 receives a time-synchronization pulse via pin 25 of PL-1. This pulse sets the internal clock of the DLP3 to permit time synchronization to an external time standard connected to the G-NET host computer.

The two RS232 serial ports, PL-1 and the front port, are implemented with separate UARTs (universal asynchronous receiver transmitters), but when one is active the other is effectively disabled. For instance, when PL-1 is connected to the G-NET host computer and the G-NET system is active, it is not possible to log into the DLP3 from the front port. If PL-1 is connected to a modem and the front port is connected to a PC using a null-modem cable, then the first port that becomes active is given preference and the other port is disabled. However, it is permissible to have cables and associated equipment connected to each port simultaneously.

1.4.15 SCADA DIGITAL-TO-ANALOG INTERFACE (OPTIONAL)

An optional DTA module is available that provides 1) an analog output proportional to the distance from the relay to the fault as calculated by the fault location algorithm and 2) 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 will close.

The DTA module provides either a nominal 0 to 1 ma DC output or a nominal 0 to 5 volt DC output. The choice of output range is selected by a switch located on the DTA module. The DTA module must be removed from the DLP3 chassis to access this switch. The proper sequence for selecting the output range is:

- remove DC power from the DLP3
- remove the DTA module, make the desired switch setting, and reinsert the DTA module
- restore DC power to the DLP3

When the fault location is calculated to be 100% of the line length, the DTA module output will be either 0.8 ma DC or 4.0 volts DC. The DTA module output goes to full scale (either 1 ma DC or 5 volts 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 volts 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 module reset.

There are two settings associated with the SCADA DTA Interface. FLTLOCK is used to specify a time period after a fault during which fault location calculations resulting from subsequent faults will be prevented from updating the fault location information stored in the DTA module. FLTRESET is used to specify a time period after a fault at the expiration of which 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. Note when either the DLP3's date or time is changed the timers associated with FLTLOCK and FLTRESET are reset and the DTA module is reset.

1.4.16 SEQUENCE OF EVENTS

This function time tags and stores in memory the last 100 events. The resolution of the time-tagging is 1 millisecond. The event list contains power system events, operator actions, recloser actions, and self-test alarms. Sequence of Events can be accessed remotely via the RS232 port and a PC. A full description of this function is contained in Chapter 9: INTERFACE.

1.4.17 SELECTABLE GROUPS OF SETTINGS

Four separate groups of settings may be stored in non-volatile memory. Only one group can be active at a given time, but the active group may be selected via external switch contacts or via a command issued from the local MMI or DLP-LINK communication software. If the selection is to be made via 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 the following diagram.

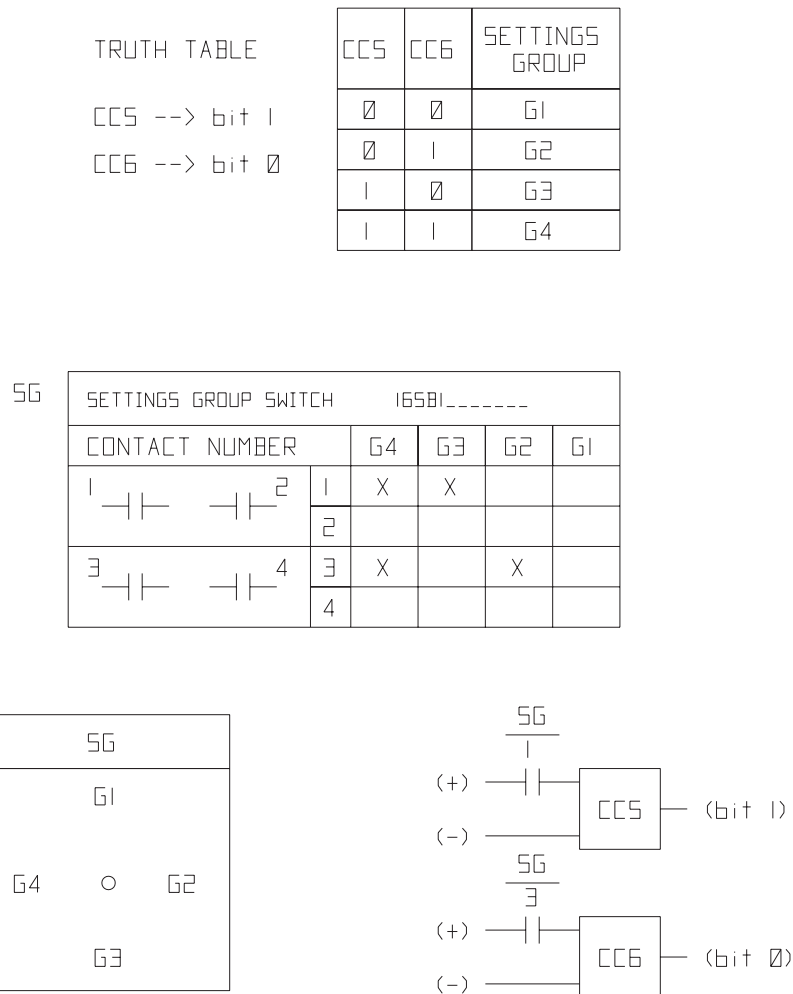


Figure 1–21: SELECTABLE GROUPS OF SETTINGS

1.4.18 TIME SYNCHRONIZATION

The DLP3 includes a clock that can run freely from the internal oscillator, or be synchronized from an external signal. Two different external time-synch signals are possible. If the DLP3 is connected to the host computer of a G-NET substation information and control system, then the DLP3 receives a time-synch pulse via pin 25 of PL-1. If the DLP3 is not connected to a G-NET host computer, then an unmodulated IRIG-B signal connected to PL-4 may be used to synchronize the clock. In both cases, the clock in a given DLP3 is synchronized to within 1 millisecond of any other DLP3 clock, provided the two relays are wired to the same synchronizing signal.

1.4.19 TRIP BUS CHECK

After a settings change is made in the active settings group, the DLP3 will automatically return to its normal protection-on mode following 1) storage of the new setting values in non-volatile memory and 2) a Trip Bus Check to determine that the changed settings have not caused any of the trip functions to operate for system conditions (i.e., 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.

1.4.20 TRIP CIRCUIT MONITOR

Within the DLP3 relay system the DC battery voltage across each of the open trip contacts (or SCRs) may be continuously monitored to indicate whether the associated trip circuit is intact. If the monitored DC voltage becomes virtually zero, then the trip circuit has failed 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 three trip contacts (or SCRs) - one per phase - associated with each breaker in the DLP3. The voltage across each contact (or SCR) is monitored separately, but when the Trip Circuit Monitor function is disabled for a particular breaker all three associated contacts (or SCRs) have this function disabled.

Operation of the Trip Circuit Monitor causes the non-critical alarm contact to close. If one or more poles of the breaker is opened in some manner other than by a trip issued by the DLP3, then the 52/a contact normally wired in series with the trip coil would open and cause the voltage across the open contact to become zero. To avoid a non-critical alarm for this condition, the associated 52/b contact is monitored. Closure of the 52/b contact disables the Trip Circuit Monitor function for the involved pole.

1.4.21 TRIP CURRENT MONITOR

A current sensor is wired in series with each trip output contact or SCR to monitor the DC current in the external trip circuit after the DLP3 issues a trip signal. An event message that reads TRIP CIRCUIT #XY ENERGIZED or TRIP CIRCUIT #XY NOT ENERGIZED is issued depending upon whether or not DC current is detected. X is either 1 or 2, signifying breaker 1 or breaker 2. Y is A, B, or C, signifying the phase that was tripped.

1.4.22 START-UP SELF-TESTS

The most comprehensive testing of the DLP3 is performed during a power-up. Since the DLP3 is not performing any protection activities at that time, tests (such as RAM tests) that would be disruptive to run-time processing may be performed during the start-up.

All three processors participate in the start-up self-testing. The processors communicate their results to each other so that any failures found can be reported to the user, and so that each processor successfully completes its assigned self-tests before the DLP3 begins protection activity.

During power-up, each of the three microprocessors performs start-up self-tests on its associated hardware (PROM, local RAM, shared RAM, interrupt controller, timer chip, serial and parallel I/O ports, non-volatile memory, analog and digital I/O circuitry, MMI hardware, etc.). In addition, the DLP3 verifies that the PROM version numbers in all three processor boards are compatible, and that the Model Number stored in non-volatile memory agrees with the unit's configuration. The components tested at start-up are listed in the Start-Up Self Tests Table in the SERVICING section.

In most cases, if any critical self-test failure is detected, the DLP3 will not continue its start-up, nor will it cause a reset. An attempt will be made to store the DLP3 status, to initialize the MMI and remote communications hardware/software for communicating status, and to print a diagnostic message. The critical alarm output will be energized.

If no failures are detected, the DLP3 completes initialization of its hardware and software; this includes reading information from the serial Non-Volatile RAM (NVRAM) in the magnetics module, stored during the manufacturing process, to determine the current rating of the magnetics in the unit (1A or 5A). Next, each processor board (DAP and SSP) will enable the outputs. As the final step, the DLP3 checks the results of all the tests to determine whether to turn on the green LED lamp on the front panel.

The start-up procedure will take approximately one minute. As soon as the SSP successfully completes its PROM test and initializes the display hardware, the message "INITIALIZING" will appear on the display. When all DLP3 initialization is completed satisfactorily, the display will be blanked and the DLP3 begins acquiring and processing data.

1.4.23 RUN-TIME SELF-TESTS

Each of the three processors will have "idle time" when the system is in a quiescent state; i.e., when the DLP3 is not performing fault or post-fault processing. During this idle time, each processor will perform "background" self-tests that are not disruptive to the foreground processing; that is, tests that do not interfere with the foreground tasks' use of serial and parallel ports, and tests that do not inhibit interrupts to any processor. If any background self-test fails, the test is repeated. To declare a component "failed", the test must fail three consecutive times. In the case of most critical failures, the DLP3 will force a reset to attempt to get the failed component working again.

The DLP3 is able to distinguish between a start-up (power-up) and a reset caused automatically by a DLP3 malfunction. The reset is a fault tolerant feature of the DLP3; it is performed as an attempt to resume operation again 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 to the user by the DLP3. If the reset is successful, no message is printed, no failure status is recorded, and the critical alarm output is not energized; however, during the reset procedure, the red LED on the MMI panel will light and a failure code may appear on the MMI display. Therefore, if the reset is not successful, the processor board will be shut down, leaving the MMI panel displaying the above error information. Refer to the SERVICING chapter for error codes. To prevent continual resets in the case of a solid failure, both hardware and software will permit only four resets in a one-hour period. On the fifth reset, the DLP3 will not perform initialization, but will attempt to initialize MMI, 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 the Run Time Background Self Tests Table in the SERVICING section. The 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 the Run Time Foreground Self Tests Table in the SERVICING chapter. Some foreground tests are performed every sample period, while others are performed less frequently. As with background self-tests, any failed 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 the Trip Circuit Monitor portion of this section.

In addition to regularly scheduled self-tests, the operator may initiate a visual-response test of the MMI components. Refer to the MMI Display Test in the ACCEPTANCE TESTS chapter of this manual.

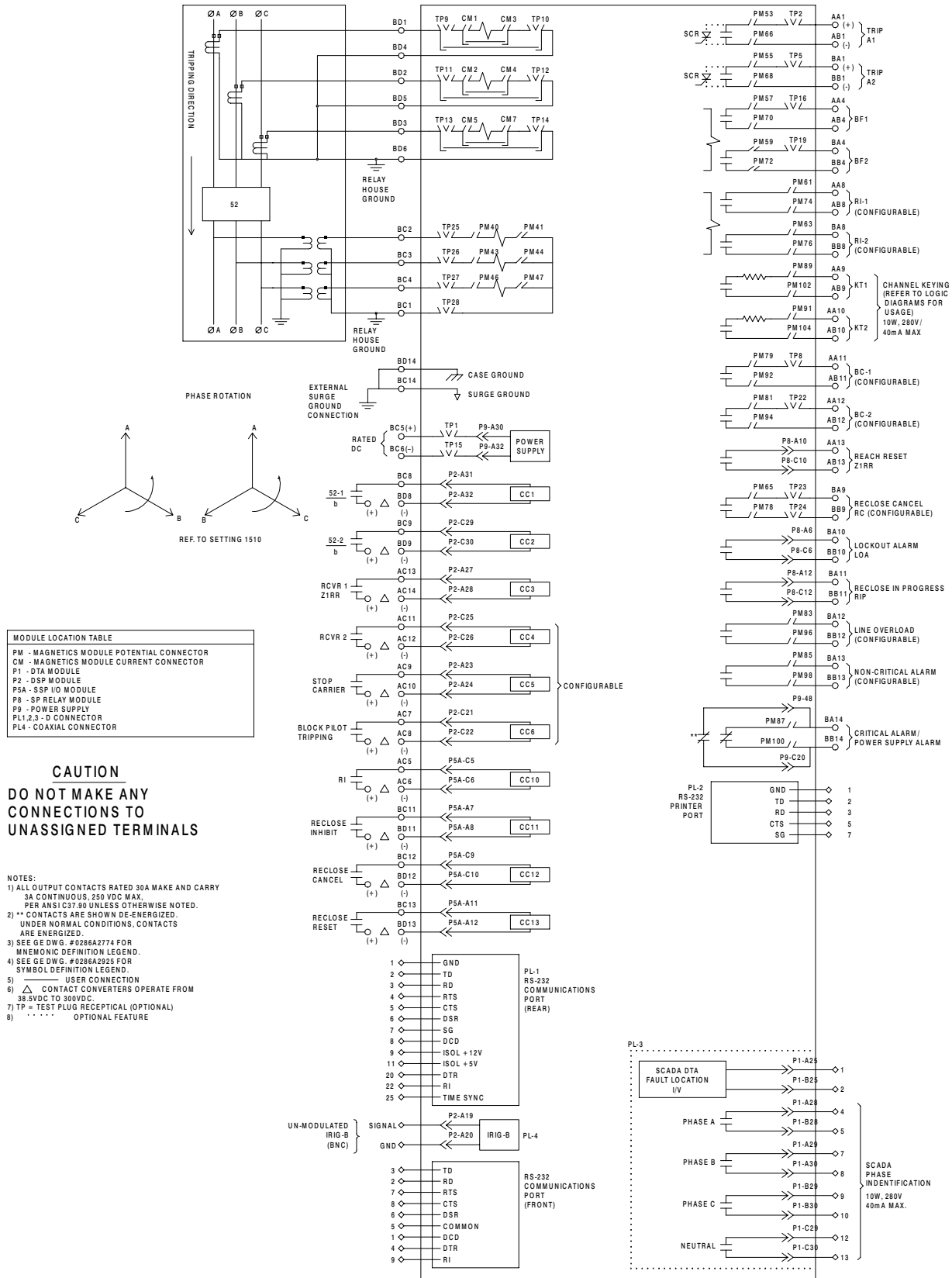


Figure 1-22: DLPC-3 ELEMENTARY DIAGRAM

2.1.1 DESCRIPTION

This section provides information to assist the user in determining the required settings for the DLP3 relay system. Some settings are a function of what protection scheme is selected, while other settings are the same, REGARDLESS of the scheme. Certain settings will be determined by user preference. As an example, the Zone 1 direct trip functions may or may not be used with a pilot BLOCKING scheme.

Those settings that are independent of the selected scheme will be presented first, followed by scheme-dependent settings. For scheme-dependent settings, six separate sections, corresponding to the six possible schemes, are included. At the end of this tab is a blank settings form, which may be copied and used to record the required settings for a particular application.

Table 2–1: SETTINGS AND RANGES on page 2–3 lists all the settings and the corresponding ranges and units. The column labeled DEFAULT in 1 indicates the DLP3 settings stored in memory as shipped from the factory. The settings described in the subsequent text are arranged by category of settings, which correspond to the category-of-settings headings displayed on the light-emitting-diode (LED) display of the local man-machine interface (MMI). A category of settings is identified by all capitals, e.g., CONFIGURATION SETTINGS, CONFIG. Individual settings or category-of-settings headings are listed by the descriptive name followed by its mnemonic. The mnemonic is what is displayed on the local MMI to identify the particular setting or category-of-settings heading.

Setting ranges for distance and overcurrent functions are different, depending upon whether the DLP3 model is designed for use with current transformers having a nominal 1 ampere secondary rating or a nominal 5 amp secondary rating. Table 2–1: SETTINGS AND RANGES on page 2–3 lists these different ranges (where applicable) under the columns labelled "5 AMP" and "1 AMP."

The sample transmission system shown on the following page will be used to determine example settings for a DLP3 relay system located at bus Able on protected line section A-B. The current transformers are assumed to have a 5-amp-rated secondary, and the DLP3 has a 5 amp secondary rating. Only "5 AMP" ranges for distance and overcurrent functions are mentioned in the text and example calculations that follow. All reach settings are in secondary values.

Figure 2–1: SAMPLE 345 KV SYSTEM

2.1.2 SETTINGS TABLE

Table 2–1: SETTINGS AND RANGES (Sheet 1 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
Z1DIST						
0101	SELZ1G	YES, NO		N/A	YES	
0102	SELZ1P	YES, NO		N/A	YES	
0103	Z1R	0.01–50.00	0.01–250.00	ohms	5.40	27.00
0104	Z1GR	0.01–50.00	0.01–250.00	ohms	5.40	27.00
0105	SELZ1U	0 (MHO), 1 (REACT)		N/A	0 (MHO)	
0106	Z1SU	0.01–50.00	0.01–250.00	ohms	20.00	100.00
0107	Z1K0	1.0–7.0		N/A	2.7	
0108	Z1ERST	0.0–6.0		sec.	4.0	
Z2DIST						
0201	SELZ2G	YES/NO		N/A	YES	
0202	SELZ2P	YES/NO		N/A	YES	
0203	Z2R	0.01–50.00	0.01–250.00	ohms	9.00	45.00
0204	Z2GR	0.01–50.00	0.01–250.00	ohms	9.00	45.00
0205	SELZ2U	0 (MHO), 1 (GDOC), 2 (MHOGDOC)		N/A	0 (MHO)	
0206	SELZ2T	YES, NO		N/A	YES	
0207	PUTL2P	0.10–3.00		sec.	1.00	
0208	PUTL2G	0.10–3.00		sec.	1.00	
0209	Z2PANG	90, 105, 120		deg	90	
0210	Z2GANG	90, 105, 120		deg	90	
Z3DIST						
0301	SELZ3G	YES/NO		N/A	YES	
0302	SELZ3P	YES/NO		N/A	YES	
0303	Z3R	0.01–50.00	0.01–250.00	ohms	12.00	60.00
0304	Z3GR	0.01–50.00	0.01–250.00	ohms	12.00	60.00
0305	PUTL3P	0.10–10.00		sec.	3.00	
0306	PUTL3G	0.10–10.00		sec.	3.00	

Table 2-1: SETTINGS AND RANGES (Sheet 2 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
0307	Z3PANG	90, 105, 120		deg	90	
0308	Z3GANG	90, 105, 120		deg	90	
Z4DIST						
0401	SELZ4G	YES/NO		N/A	YES	
0402	SELZ4P	YES/NO		N/A	YES	
0403	Z4R	0.01–50.00	0.01–250.00	ohms	18.00	90.00
0404	Z4GR	0.01–50.00	0.01–250.00	ohms	18.00	90.00
0405	Z4OR	0.00–0.40		N/A	0.10	
0406	SELZ4T	YES/NO		N/A	YES	
0407	PUTL4P	0.10–10.00		sec.	5.00	
0408	PUTL4G	0.10–10.00		sec.	5.00	
0409	Z4PANG	80, 90, 95, 105, 110, 120		deg	90	
0410	Z4GANG	80, 90, 95, 105, 110, 120		deg	90	
0411	SELZ4D	0 (FORWRD), 1 (REVERS)		N/A	0 (FORWRD)	
CURVSUPVIS						
0501	PUIPT	0.50–5.00	0.10–1.00	amps	0.50	0.10
0502	PUIPB	0.25–3.75	0.05–0.75	amps	0.25	0.05
0503	PUIT	0.20–4.00	0.04–0.80	amps	0.20	0.04
0504	PUIB	0.20–4.00	0.04–0.80	amps	0.20	0.04
OVERCUR						
0601	SELP4H	YES, NO		N/A	YES	
0602	PUP4H	2.0–100.0	0.4–20.0	amps	20.0	4.0
0603	SELIDT	YES, NO		N/A	YES	
0604	SELDIDT	YES, NO		N/A	YES	
0605	PUIDT	0.5–80.0	0.1–16.0	amps	10.0	2.0
0606	SELTOC	YES, NO		N/A	YES	
0607	SELDTOC	YES, NO		N/A	YES	
0608	PUTOC	0.20–15.00	0.04–3.00	amps	1.00	0.20
0609	TDTOC	0.5–10.0		N/A	5.0	

Table 2–1: SETTINGS AND RANGES (Sheet 3 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
0610	PUTTM	0.5–30.0		sec.	1.0	
0611	SELCURV	0 (INV), 1 (V-INV), 2 (E-INV), 3 (CUSTOM), 4 (DEFT)		N/A	1 (V-INV)	
0612	KDCONST	0.0, 0.3		N/A	0.3	
BLK RECLOS						
0701	SELALL	YES, NO		N/A	YES	
0702	RBOSB	YES, NO		N/A	NO	
0703	RB3PH	YES, NO		N/A	NO	
0704	RBTOC	YES, NO		N/A	NO	
0705	TBZ2T	YES, NO		N/A	NO	
0706	RBZ3T	YES, NO		N/A	NO	
0707	RBZ4T	YES, NO		N/A	NO	
0708	RBZ1PH	YES, NO		N/A	NO	
0709	RBZ2PH	YES, NO		N/A	NO	
0710	RBCTB	YES, NO		N/A	NO	
OUTOFSTEP						
0801	SELPTZ	0 (ZONE2), 1 (ZONE3), 2 (ZONE4)		N/A	0 (ZONE 2)	
0802	MOBANG	30–130		deg	70	
0803	SELOSB	0 (BLKALL), 1 (BLKDIST), 2 (BLKPHAS), 3 (BLKNONE)		N/A	0 (BLKALL)	
0804	OSBLKZ1	YES, NO		N/A	YES	
0805	OSBLKZ2	YES, NO		N/A	YES	
0806	OSBLKZ3	YES, NO		N/A	YES	
0807	OSBLKZ4	YES, NO		N/A	YES	
LINEPU						
0901	SELLPU	YES, NO		N/A	YES	
0902	SELTPB	YES, NO		N/A	YES	
0903	PUI1	1.0–15.0	0.2–3.0	amps	5.0	1.0

Table 2-1: SETTINGS AND RANGES (Sheet 4 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
REMOTEOPEN						
1001	SELROD	YES, NO		N/A	YES	
1002	PUTLB	10-100		msec	100	
1003	SELFFB	YES, NO		N/A	YES	
LINE OVERLD						
1101	SELOVL	YES, NO		N/A	NO	
1102	PULV1	2.5-20.0	0.5-4.0	amps	10.0	2.0
1103	PULV2	5.0-40.0	1.0-8.0	amps	20.0	4.0
1104	PUTL31	10-990		sec.	200	
1105	PUTL32	10-99		sec.	20	
SCHEMESEL						
1201	SELSCM	0 (STEPDST), 1 (POTT), 2 (PUTT), 3 (HYBRID), 4 (BLK1), 5 (ZNE1EXT) 6 (BLK2), 7 (BLK3)		N/A	0 (STEPDST)	
1202	NUMRCVR	0, 1, 2		N/A	0	
SCHEMETIM						
1301	PUTL1	1-50		msec	1	
1302	PUTL5	0-200		msec	50	
1303	DOTL5	0-200		msec	50	
1304	PUTL6	0-200		msec	50	
1305	DOTL6	0-200		msec	50	
1306	PUTL4	0-50		msec	0	
1307	DOTL4	0-50		msec	0	
1308	PUTL16	8-99		msec	8	
1309	PUTLCFG	0-100		msec	10	
1310	DOTLCFG	0-100		msec	0	
LINE QTY						
1401	POSANG	45-90		deg	85	
1402	ZERANG	45-90		deg	75	

Table 2-1: SETTINGS AND RANGES (Sheet 5 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
1403	ZP	0.01–50.0	0.01–250.0	ohms	6.00	30.00
1404	K0	1.0–7.0		N/A	3.0	
1405	LINELEN	0.0–200.0 0.0–322.0		miles km	100.0 161.0	
CONFIG						
1501	UNITID	0–9999		N/A	0	
1502	SYSFREQ	50, 60		Hz	60	
1503	NUMBKRS	1, 2		N/A	1	
1504	TRIPCIRC	0 (NONE), 1 (BKR1), 2(BKR2), 3 (BOTH)		N/A	0 (NONE)	
1505	SELPRIM	0 (CVTPRI), 1 (CVTSEC), 2 (PTPRI), 3 (PTSEC)		N/A	3 (PTSEC)	
1506	CTRATIO	1–5000		N/A	400	
1507	PTRATIO	1–7000		N/A	2000	
1508	DISTUNIT	0 (MILES), 1 (KM)		N/A	0 (MILES)	
1509	COMMPORT	Baud Rate (xx): 03 (300), 12 (1200), 24 (2400), 48 (4800), 96 (9600) Parity (y): 0 (none), 1 (odd), 2 (even) Stop Bits (z): 1, 2		xxyz	2401 (2400 Baud, No Parity, 1 Stop Bit)	
1510	PHASDESG	0 (A-B-C), 1 (A-C-B)		N/A	0 (A-B-C)	
1511	SELTSYNC	0 (NONE), 1 (IRIG-B) 2 (G-NET)		N/A	0 (NONE)	
1512	NUMFLTS	2, 4, 7, 14		N/A	4	
1513	PREFLT	1–8		N/A	3	
1514	OSCTRIG	0 (UNUSED), 1 (FLTDET), 2 (ANYZ2), 3 (ANYZ3), 4 (ANYZ4) 5 (OUTSTP), 6 (V1DET)		N/A	0 (UNUSED)	
1515	UNBALALM	YES, NO		N/A	YES	
SCADA DTA						
1601	FLTLOCK	0–99.9		sec.	0	
1602	FLTRESET	0–999		min.	0	

Table 2-1: SETTINGS AND RANGES (Sheet 6 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
CNFGINPUTS						
1701	CONCCI	0-8		N/A	3	
1702	SETGRP	0-4		N/A	1	
BKR1CLSOUT						
1801	CONOUT1	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		N/A	0 (DEFAULT)	
1802	CO1IN1	0-64, 101-164		N/A	0	
1803	CO1IN2	0-64, 101-164		N/A	0	
1804	CO1IN3	0-64, 101-164		N/A	0	
1805	CO1IN4	0-64, 101-164		N/A	0	
1806	CO1IN5	0-64, 101-164		N/A	0	
1807	CO1IN6	0-64, 101-164		N/A	0	
1808	CO1IN7	0-64, 101-164		N/A	0	
1809	CO1IN8	0-64, 101-164		N/A	0	
BKR2CLSOUT						
1901	CONOUT2	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		N/A	0 (DEFAULT)	
1902	CO2IN1	0-64, 101-164		N/A	0	
1903	CO2IN2	0-64, 101-164		N/A	0	
1904	CO2IN3	0-64, 101-164		N/A	0	
1905	CO2IN4	0-64, 101-164		N/A	0	
1906	CO2IN5	0-64, 101-164		N/A	0	
1907	CO2IN6	0-64, 101-164		N/A	0	
1908	CO2IN7	0-64, 101-164		N/A	0	
1909	CO2IN8	0-64, 101-164		N/A	0	
RCANCLOUT						
2001	CONOUT3	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		N/A	0 (DEFAULT)	
2002	CO3IN1	0-64, 101-164		N/A	0	
2003	CO3IN2	0-64, 101-164		N/A	0	

Table 2-1: SETTINGS AND RANGES (Sheet 7 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
2004	CO3IN3	0-64, 101-164		N/A	0	
2005	CO3IN4	0-64, 101-164		N/A	0	
2006	CO3IN5	0-64, 101-164		N/A	0	
2007	CO3IN6	0-64, 101-164		N/A	0	
2008	CO3IN7	0-64, 101-164		N/A	0	
2009	CO3IN8	0-64, 101-164		N/A	0	
LNOVLDOUT						
2101	CONOUT4	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE) 3 (OR CTB) 4 (AND CTB)		N/A	0 (DEFAULT)	
2102	CO4IN1	0-64, 101-164		N/A	0	
2103	CO4IN2	0-64, 101-164		N/A	0	
2104	CO4IN3	0-64, 101-164		N/A	0	
2105	CO4IN4	0-64, 101-164		N/A	0	
2106	CO4IN5	0-64, 101-164		N/A	0	
2107	CO4IN6	0-64, 101-164		N/A	0	
2108	CO4IN7	0-64, 101-164		N/A	0	
2109	CO4IN8	0-64, 101-164		N/A	0	
NONCRITOUT						
2201	CONOUT5	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		N/A	0 (DEFAULT)	
2202	CO5IN1	0-64, 101-164		N/A	0	
2203	CO5IN2	0-64, 101-164		N/A	0	
2204	CO5IN3	0-64, 101-164		N/A	0	
2205	CO5IN4	0-64, 101-164		N/A	0	
2206	CO5IN5	0-64, 101-164		N/A	0	
2207	CO5IN6	0-64, 101-164		N/A	0	
2208	CO5IN7	0-64, 101-164		N/A	0	
2209	CO5IN8	0-64, 101-164		N/A	0	

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Table 2-1: SETTINGS AND RANGES (Sheet 8 of 8)

SETTING		RANGE		UNITS	DEFAULT	
NO.	MNEMONIC	5 AMP	1 AMP		5 AMP	1 AMP
RINITOUT						
2301	CONOUT6	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		N/A	0 (DEFAULT)	
2302	CO6IN1	0-64, 101-164		N/A	0	
2303	CO6IN2	0-64, 101-164		N/A	0	
2304	CO6IN3	0-64, 101-164		N/A	0	
2305	CO6IN4	0-64, 101-164		N/A	0	
2306	CO6IN5	0-64, 101-164		N/A	0	
2307	CO6IN6	0-64, 101-164		N/A	0	
2308	CO6IN7	0-64, 101-164		N/A	0	
2309	CO6IN8	0-64, 101-164		N/A	0	
RECLOSER						
2401	SELRCLR	0 (NONE), 1 (OFF), 2 (1-TPOLE) 3 (2-TPOLE)		N/A	0 (NONE)	
2402	SPRDLY1	0.01-2.55		sec.	2.55	
2403	TPRDLY1	0.01-2.55		sec.	2.55	
2404	RDLY2	1-255		sec.	255	
2405	HOLD	YES, NO		N/A	NO	
2406	HOLDDLY	1-255		sec.	1	
2407	DWELLTM	0.1-2.0		sec.	1.0	
2408	RSTDLY	1-255		sec.	255	

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2.2.1 CONFIGURATION SETTINGS

1501: UNITID – UNIT ID NUMBER

The UNITID is a decimal number between 0 and 9999 stored in non-volatile memory, which uniquely identifies a DLP3 relay system. When the DLP3 is accessed via its PL-1 serial port, the UNITID must be known to establish communication, thus providing a measure of security. UNITID can only be changed via the keypad of the local MMI. It is not possible to change UNITID via DLP-LINK communications software; thus, for models ending with NC, the UNITID cannot be changed. The factory-set UNITID can be viewed through the Request Line/station id menu item under Information in the Relay Functions menu of DLP-LINK.

1502: SYSFREQ – SYSTEM FREQUENCY

SYSFREQ can be set to either 50 Hz or 60 Hz. When this setting is changed the DLP3 must be re-initialized by turning the DC power off and then on.

1503: NUMBKRS – NUMBER OF BREAKERS

NUMBKRS can be set to either 1 or 2. When set to 1, the TRIP and CLOSE commands will only activate their respective BREAKER 1 outputs. When set to 2, the TRIP and CLOSE commands will selectively 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.

For a single breaker arrangement, NUMBKRS is set to 1. For breaker-and-a-half or ring bus arrangements, where two breakers are involved, NUMBKRS is set to 2. A relay trip will cause both of the appropriate phase-trip contacts or SCRs to operate, regardless of whether NUMBKRS is set to 1 or 2.

NUMBKRS also affects the optional recloser. If the recloser is present and NUMBKRS=1, then the recloser is used as defined by its settings (2401-08). If the recloser is present and NUMBKRS=2, then setting 2401, SEL-RCLR, is automatically set to 0 (NONE), which disables the recloser.

1504: TRIPCIRC – TRIP CIRCUIT MONITOR

The four possible settings are 0 (NONE), 1 (BKR 1), 2 (BKR 2), or 3 (BOTH). These select the phase-designated trip contacts or SCRs (1 or 2 - see the protection scheme logic diagrams) for which the function is active. For instance, with TRIPCIRC = 1 the trip-circuit-monitor function is active only for the trip contact (or SCR) associated with breaker 1.

1505: SELPRIM – SELECT PRIMARY/SECONDARY UNITS

SELPRIM can be set to either 0 (CVT PRI), 1 (CVT SEC), 2 (PT PRI), or 3 (PT SEC). This one setting determines two different aspects of the DLP3's operation. First, the setting determines how PRESENT VALUES (currents, voltages, watts, and vars) are displayed. With SELPRIM = 0 or 2, the PRESENT VALUES are displayed and stored as primary values. With SELPRIM = 1 or 3, the PRESENT VALUES are displayed and stored as secondary values. All settings are expressed in terms of secondary values, regardless of the SELPRIM present-value-display setting.

Secondly, the setting determines the amount of filtering used in the DLP3's distance functions to overcome transient error signals that may be present in the AC voltages. When magnetic voltage transformers (PTs) are used, SELPRIM = 2 or 3 should be selected, depending upon whether PRESENT VALUES are to be displayed in primary or secondary values. With SELPRIM = 0 or 1, the operating time of the distance functions will be slower at lower values of operating signal (IZ-V) where the transient error signals associated with CVTs become significant. Note that when CVTs are used, a setting of SELPRIM = 2 or 3 may result in Zone 1 overreach for line-end faults. Therefore SELPRIM must be set to 0 or 1 when CVTs are used.

1506: CTRATIO – CURRENT TRANSFORMER RATIO

CTRATIO can be set over the range of 1 - 5000.

1507: PTRATIO – POTENTIAL TRANSFORMER RATIO

PTRATIO can be set over the range of 1 - 7000.

1508: DISTUNIT – UNITS OF DISTANCE

DISTUNIT can be set to either MILES or KM (kilometers). This setting determines the unit of distance used for reporting fault location in the Fault Report.

1509: COMMPORT – COMMUNICATIONS PORT

COMMPORT sets the baud rate, parity, and stop bits of the DLP3's RS232 serial port. The setting format is xyz where:

- Baud Rate = xx = 03, 12, 24, 48, 96
- 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 RS232 serial port (PL-1) of the DLP3 relay system. 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 communication hardware might dictate using 2 stop bits. DLP-LINK communications software can be configured to match this DLP3 settings for baud rate, parity, and stop bits.

COMMPORT can only be changed via the keypad of the local MMI, or, for models ending with NC, via jumpers. It is not possible to change COMMPORT via DLP-LINK communications software. In most instances, it will be desirable to have the COMMPORT values identical in each of the four settings groups to prevent interrupting communications when switching between settings groups.

1510: PHASDESG – PHASE DESIGNATION

PHASDESG can be set to either A-B-C or A-C-B to match the positive-sequence phase rotation for the section of the power system where the DLP3 is installed. This setting permits the DLP3 to report the proper faulted phase or phase pair in the appropriate way.

1511: SELTSYNC – SELECT TIME SYNCHRONIZATION

SELSYNC determines the method of synchronizing the DLP3's internal clock, and it can be set to 0 (INTERNAL), 1 (IRIG-B), or 2 (G-NET). SELSYNC = 0 lets the clock run freely from the internal oscillator. SELSYNC = 1 synchronizes the clock using an IRIG-B signal connected directly to the DLP3 relay via port PL-4. SELSYNC = 2 synchronizes the clock using a signal on pin 25 of RS232 port PL-1, when connected to a G-NET host computer.

1512: NUMFLTS – NUMBER OF FAULTS

NUMFLTS selects the maximum number of oscillography "storage events" (faults) that may be stored in memory without overwriting, and can be set to 2, 4, 7, or 14. When the maximum number have been stored in memory, the oscillography data associated with a subsequent storage event will overwrite the data from the first (oldest). This setting allows the user to apportion a fixed amount of memory into different-sized blocks for oscillography storage. The following tabulation shows the total number of oscillography cycles allowed per storage event as a function of NUMFLTS.

Table 2–2: OSCILLOGRAPHY STORAGE EVENTS

NUMFLTS	STORAGE CYCLES
2	72
4	36
7	18
14	9

1513: PREFLT – PREFault CYCLES

PREFLT selects the number of pre-trigger (or pre-fault) cycles in each oscillography data set, and it can be set over the range from 1 to 8. NUMFLTS determines the total number of cycles per storage event as explained above, and PREFLT determines how many of these are pre-trigger cycles.

1514: OSCTRIG – OSCILLOGRAPHY TRIGGER

OSCTRIG selects from among six internal signals that may be used to trigger oscillography storage in addition to a DLP3 trip, which always causes oscillography to be stored. Refer to OTHER FEATURES - Oscillography in the PRODUCT DESCRIPTION section for further explanation. OSCTRIG may be set to 0 (NONE), 1 (FLT-DET) Fault Detector, 2 (ANY Z2) any Zone 2 phase- or ground-distance function output, 3 (ANY Z3) any Zone 3 phase- or ground- distance function output, 4 (ANY Z4) any Zone 4 phase- or ground-distance function output, 5 (OUTSTP) out-of-step output, or 6 (V1 DET) positive-sequence under-voltage function.

1515: UNBALALM – CURRENT UNBALANCE ALARM

UNBALALM can be set to YES or NO. This setting determines if the Current Unbalance Detection function is in service (YES) or out of service (NO).

2.2.2 EXAMPLE CONFIGURATION SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

```

UNITID = 1
SYSFREQ = 60
NUMBKRS = 1
TRIPCIRC = 1
SELPRIM = 1 (SECNDRY)
CTRATIO = 400 [2000/5]
PTRATIO = 3000 [345,000/115]
DISTUNIT = 0 (MILES)
COMMPORT = 2401
PHASEDESG = 0 (A-B-C)
SELTSYNC = 0 (INTERNAL)
NUMFLTS = 4
PREFLT = 3
OSCTRIG = 0 (UNUSED)
UNBALALM = YES

```

2.2.3 LINE QUANTITIES

1401: POSANG – POSITIVE-SEQUENCE ANGLE OF MAX. REACH

POSANG can be set over the range of 45°- 90°, and is common to all of the distance functions. It should be set to a value that is equal to or just larger than the angle of the positive-sequence impedance of the protected line.

1402: ZERANG – ZERO SEQUENCE ANGLE OF MAXIMUM REACH

ZERANG can be set over the range of 45°- 90°, and is common to all of the ground-distance functions. It should be set to a value that is equal to, or just larger than, the angle of the zero-sequence impedance of the protected line.

1403: ZP – POSITIVE-SEQUENCE IMPEDANCE

ZP can be set over the range of 0.01 - 50.00 ohms. It should be set for the positive-sequence impedance of the protected line.

1404: K0 – ZERO SEQUENCE CURRENT COMPENSATION

K0 can be set over the range of 1.0 - 7.0. This setting determines the amount of zero-sequence current fed back into all 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 to a ground fault. It should be set for:

$$K0 = Z0L / Z1L$$

where: Z0L = zero-sequence impedance of line; Z1L = positive-sequence impedance of line

1405: LINELEN – LINE LENGTH

LINELEN can be set over the range of 0.0 - 200.0 miles or 0.0 - 322.0 kilometers. This setting is the physical length of the protected line, and it is used to permit the fault location to be reported in miles or kilometers from the relay location.

2.2.4 EXAMPLE LINE QUANTITY SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

POSANG = 85
 ZERANG = 74
 ZP = 6.00
 K0 = 3.2
 LINELEN = 75

2.2.5 OVERCURRENT BACKUP

0601: SELPH4 – SELECT PHASE INST. OVERCURRENT

SELPH4 can be set to either YES or NO. This setting determines whether the PH4 function is in service (YES) or out of service (NO).

0602: PUPH4 – PHASE INSTANTANEOUS OVERCURRENT

Since PH4 is a non-directional direct-trip function, it must be set not to operate on the worst-case external fault at either end of the line. Such a safe setting may mean that little or no coverage is provided for internal faults. Whether or not a usable setting can be made will depend on the system impedance values. PH4 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 PH4 to have the same response for all multi-phase faults at the same location. PUPH4 should be set at least 25% greater than the maximum three-phase-fault delta current at either terminal of the protected 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. PUPH4 can be set over the range of 2.0-100.0 amps.

0603: SELIDT – SELECT GROUND INST. OVERCURRENT

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

0604: SELDIDT – DIRECTIONAL CONTROL OF IDT

SELDIDT can be set to either YES or NO. This setting determines whether IDT is directionally controlled (YES) or non-directional (NO).

0605: PUIDT – GROUND INSTANTANEOUS OVERCURRENT

The considerations used to determine the IDT setting depend on whether IDT is non-directional or directionally controlled. If IDT is non-directional, then it must be set not to operate on the worst case external fault at either end of the line. If IDT is controlled by the NT directional function, then it must be set not to operate on the worst-case external fault, only at the remote end. 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. IDT provides direct tripping for single-line-to-ground faults, and its operating quantity is:

$$3x|I_0| - 3xKDx|I_1|$$

where: KD = 0 or 0.3

When KD 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 IDT setting is established by first determining the maximum positive value of the operating quantity listed above. PUIDT is then this maximum operate signal plus a margin of 25% of the $3x|I_0|$ value from this same maximum operate signal.

$$PUIDT = 3x|I_0| - 3xKDx|I_1| + 0.25x3x|I_0|$$

When KD is set to 0, the setting is based on $3x|I_0|$. PUIDT can be set over the range of 0.5-80.0 amps.

0606: SELTOC – SELECT GROUND TIME OVERCURRENT (TOC)

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

0607: SELDTC – SELECT DIRECTIONAL CONTROL OF TOC

SELDTC can be set to either YES or NO. This setting determines whether TOC is directionally controlled (YES) or non-directional (NO).

0608: PUTOC – GROUND TIME OVERCURRENT

The TOC function provides time-delayed backup tripping for single-line-to-ground faults, and its operating quantity is:

$$3x|I_0|$$

The curve shape used for TOC is determined by the SELCURV setting as described below. PUTOC can be set over the range of 0.20-15.00 amps. The pickup and time-dial settings should be selected to provide coordination with similar functions in adjacent line sections.

0609: TDTOC – GROUND TIME OVERCURRENT TIME DIAL

TDTOC selects the time-dial setting for the TOC function. TDTOC can be set over the range of 0.5 - 10.0. The pickup and time-dial settings should be selected to provide coordination with similar functions in adjacent line sections.

0610: PUTTM – DEFINITE TIME DELAY

When the TOC function is selected to have a definite time characteristic, PUTTM determines the associated fixed time delay. PUTTM may be set over the range of 0.5-30.0 seconds.

0611: SELCURV – SELECT TOC CHARACTERISTIC CURVE

SELCURV determines the characteristic curve shape for the TOC function. The choices are:

- 0 (INV) inverse curve - Figure 2–2: TOC INVERSE TIME CURRENT CURVE
- 1 (V-INV) very inverse curve - Figure 2–3: TOC VERY INVERSE TIME CURRENT CURVE
- 2 (E-INV) extremely inverse - Figure 2–4: TOC EXTREMELY INVERSE TIME CURRENT CURVE
- 3 (CUSTOM) user-defined custom curve
- 4 (DEFT) definite time.

The user-defined custom curve is created by running the PC program DLPTOC.EXE. This program may be run from the DOS prompt or called from a menu item in the DLP-LINK communications program. The resultant data file created by DLPTOC is downloaded to the DLP3 using DLP-LINK.

0612: KDCONST – SELECT IDT RESTRAINT CONSTANT

KDCONST can be set to 0.0 or 0.3, and it determines whether or not a portion of the positive-sequence current, $3xKDx|I1|$, is used to restrain the operating quantity, $3x|I0|$.

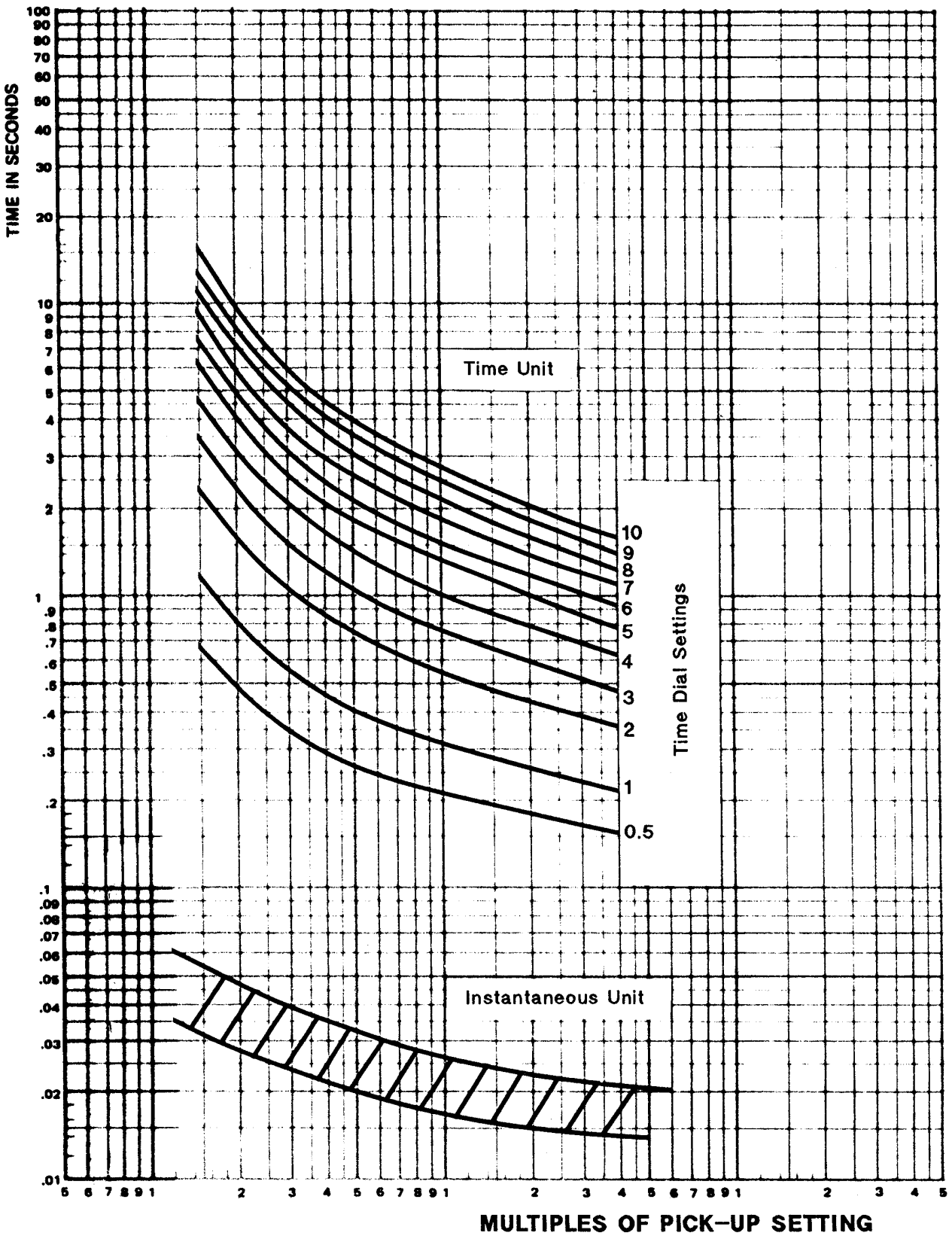


Figure 2-2: TOC INVERSE TIME CURRENT CURVE

2

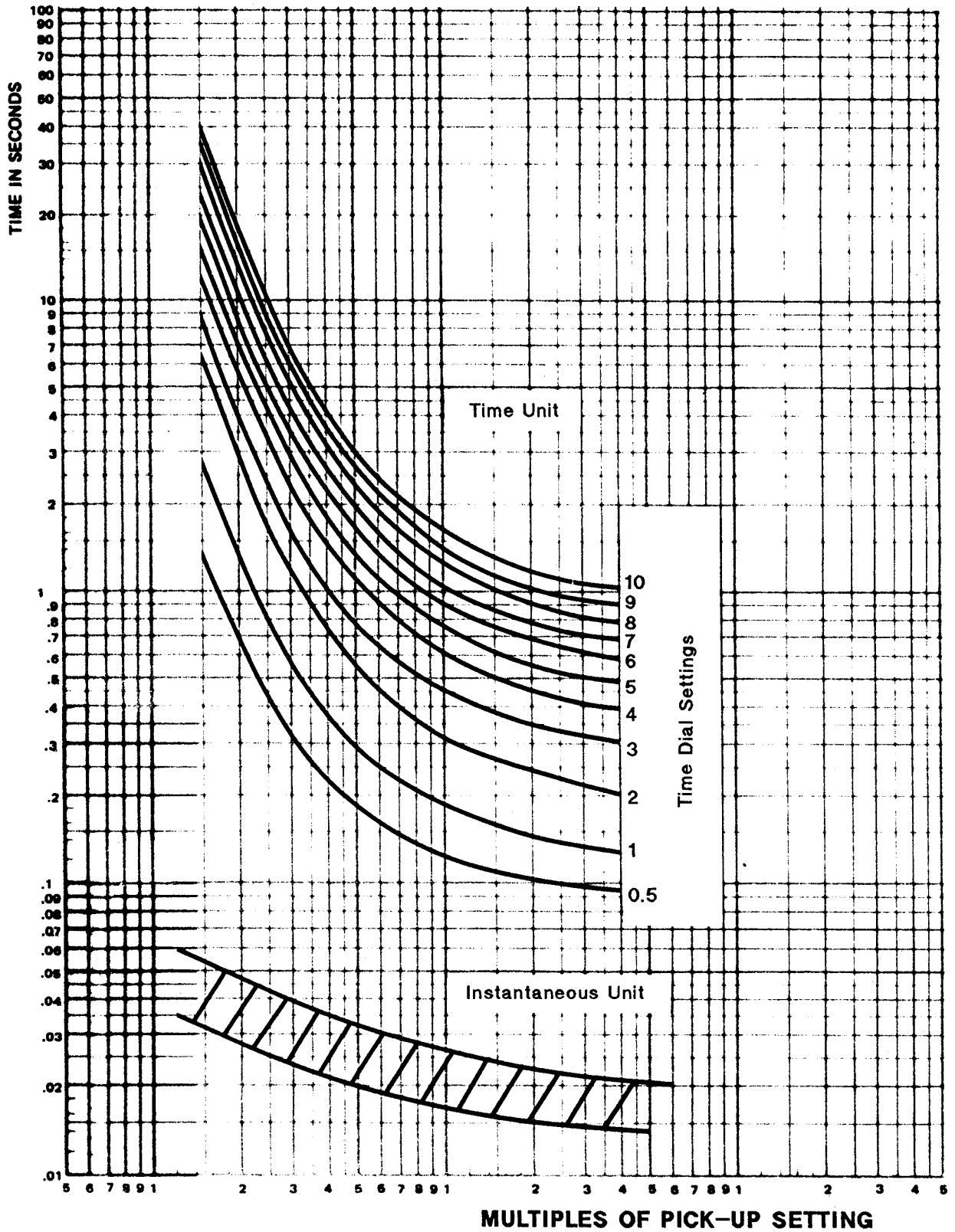


Figure 2-3: TOC VERY INVERSE TIME CURRENT CURVE

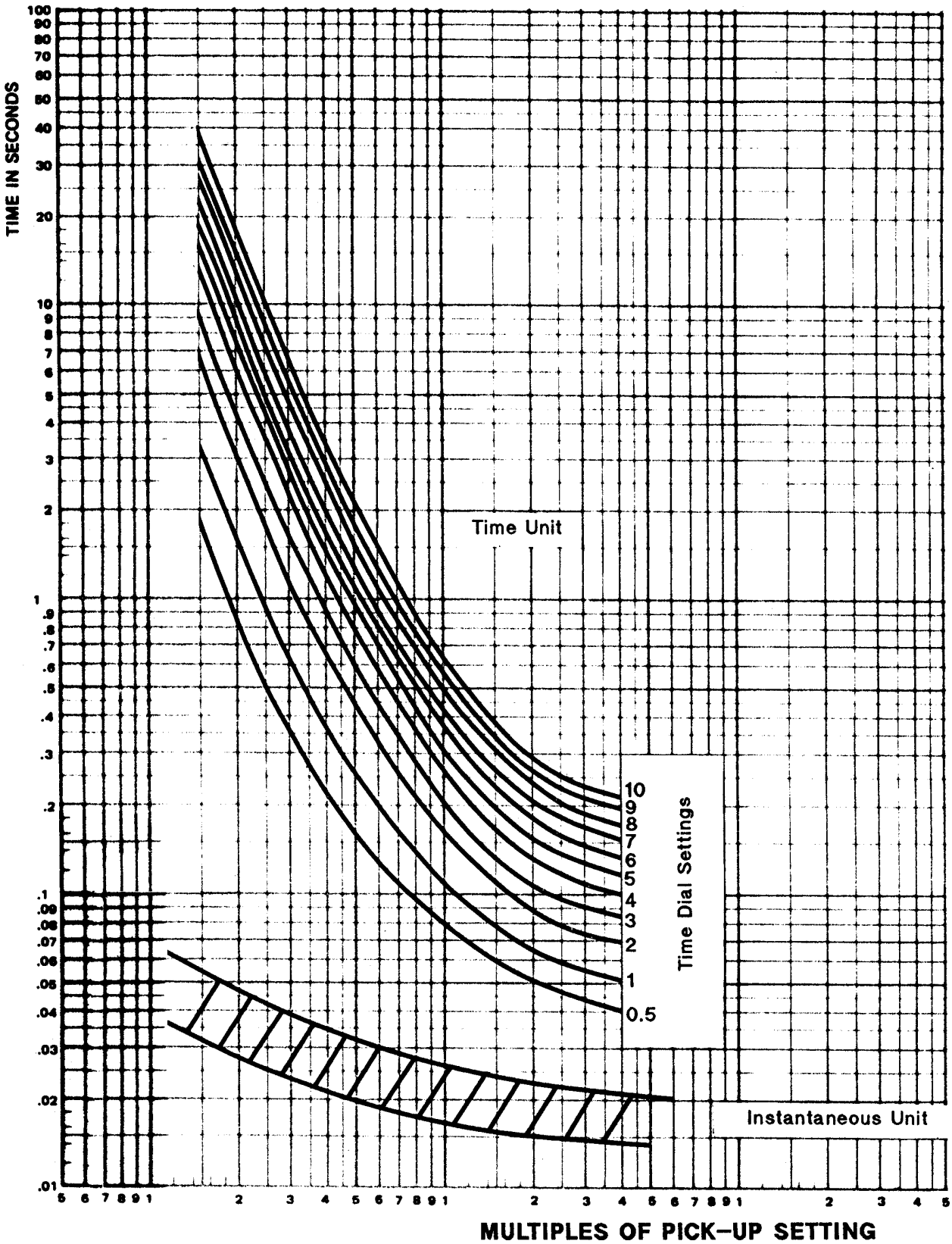


Figure 2-4: TOC EXTREMELY INVERSE TIME CURRENT CURVE

2.2.6 EXAMPLE OVERCURRENT BACKUP SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

SELP4 = YES

The table below lists the three-phase fault currents at the two protected-line busses:

Bus Fault Current Able 7.18 amps Baker 8.3 amps

PUPH4 must be set for 1.25 times the three-phase fault current at bus B.

$PUPH4 = 1.25 \times 1.732 \times 8.3 = 18.0$ amps

SELIDT = YES

The table below lists the results of the evaluation of the IDT operate quantity, $3x|I_0| - 3xKDx|I_1|$ where $KD=0.3$, for phase-A-to-ground faults at the two protected-line busses under the conditions indicated:

Table 2–3: IDT OPERATE QUANTITY EVALUATION

FAULT BUS	BRKR C	BRKR E	LOAD?	$3x I_0 $	OPERATE QUANTITY
Able	closed	closed	Yes	2.44	-0.82
Able	open	closed	Yes	1.85	-0.58
Able	closed	open	Yes	1.87	-0.67
Baker	closed	closed	Yes	5.10	1.76
Baker	open	closed	Yes	5.22	2.46
Baker	closed	open	Yes	4.97	1.95
Able	closed	closed	No	2.50	0.36
Able	open	closed	No	1.88	0.24
Able	closed	open	No	1.91	0.35
Baker	closed	closed	No	5.27	3.59
Baker	open	closed	No	5.39	3.77
Baker	closed	open	No	5.20	3.50
Baker	open	open	No	5.41	3.79
Able**	closed	closed	No	2.25	1.63

** bus Able isolated from equivalent source impedance

SELDIDT = NO

$PUIDT = 3.79 + (0.25 \times 5.41) = 5.14$ amps

SELTOC = YES

SELDTOC = YES

It is assumed that the maximum sensitivity is desired for the TOC function in order to provide protection for high-resistance ground faults.

PUTOC = 0.20 amps
 TDTOC = 2.0
 PUTTM = <NOT APPLICABLE>
 SELCURV = 0 (INV) KDCONST = 0.3

2.2.7 LINE PICKUP

0901: SELLPU – SELECT LINE PICKUP

SELLPU can be set to either YES or NO. This setting determines whether the Line Pickup function is in service (YES) or out of service (NO).

0902: PUI1 – POSITIVE-SEQUENCE OVERCURRENT (I1)

I1 is the overcurrent trip unit within the Line Pickup function, and it operates on the magnitude of the positive-sequence current. PUI1 can be set over the range of 1.0-15.0 amps.

PUI1 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.

0903: SELTBP – SELECT TIME BYPASS

SELTBP can be set to either YES or NO. This setting determines whether the coordinating timer, TL3 in Figure 1–18: REMOTE-OPEN DETECTOR LOGIC on page 1–32, is bypassed (YES) or left in service (NO).

If high-speed simultaneous reclosing is used and I1 is set below the maximum load current, then SELTBP should be set to NO to place timer TL3 in service. This will prevent tripping on load current that might be present immediately after picking up the line.

If I1 can be set with a pickup of at least 110% of the maximum load current, if sequential reclosing is used, or if there is no automatic reclosing, then SELTBP should be set to YES, to bypass coordinating timer TL3 to obtain faster tripping.

2.2.8 EXAMPLE LINE PICKUP SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

SELLPU = NO

The three-phase fault current for a fault just in front of relay at Able is 33.2 amps, and the load current is 3.29 amps. Assume that more sensitive protection is desired than would be obtained with the proposed setting of 2/3 of 33.2 amps. Therefore, a setting of 110% of the load current is used.

PUI1 = 1.1 x 3.29 = 3.6 amps
 SELTBP = YES

2.2.9 LINE OVERLOAD

The Line Overload function consists of two overcurrent units, Level 1 and Level 2, with independent time delays. There is one alarm contact output, which closes when either Level 1 or Level 2 operates. 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: SELOVL – SELECT LINE OVERLOAD

SELOVL can be set to either YES or NO. This setting determines whether the Line Overload function is in service (YES) or out of service (NO).

1102: PULV1 – LEVEL 1 OVERCURRENT

PULV1 can be set over the range of 2.5-20.0 amps.

1103: PULV2 – LEVEL 2 OVERCURRENT

PULV2 can be set over the range of 5.0-40.0 amps.

1104: PUTL31 – LEVEL 1 TIME DELAY

PUTL31 can be set over the range of 10 - 990 seconds.

1105: PUTL32 – LEVEL 2 TIME DELAY

PUTL32 can be set over the range of 10 - 99 seconds.

2.2.10 EXAMPLE LINE OVERLOAD SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

SELOVL = YES
 PULV1 = 6.5 amps
 PULV2 = 15.0 amps
 PUTL31 = 100 seconds
 PUTL32 = 30 seconds

2.2.11 OUT OF STEP BLOCKING**0801: SELPTZ – SELECT PHASE TRIP UNIT TO COORDINATE**

SELPTZ can be set for 0 (ZONE 2), 1 (ZONE 3), or 2 (ZONE 4). This setting establishes with which zone of phase-distance functions the out-of-step characteristic (MOB) coordinates (see Figure 1–17: OSB R-X DIAGRAM on page 1–31). Note that the reach at the angle of maximum reach for the MOB characteristic is equal to that of the selected zone. SELPTZ can only be set to 2 if Zone 4 is set with a forward reach.

0802: MOBANG – CHARACTERISTIC ANGLE

This setting determines the shape of the MOB characteristic on the R-X diagram, and it determines the separation between the MOB and phase trip functions on the R-X diagram. This separation, and the initial pickup delay of timer TL1 in Figure 1–17: OSB R-X DIAGRAM on page 1–31, determines whether or not the OSB function will detect the fastest swing-impedance locus during the first slip cycle. The initial pickup of TL1 is fixed at 30 milliseconds, consequently MOBANG must be adjusted to assure operation on the first slip cycle.

If complete information, consisting of the fastest swing-impedance locus and time rate of change along the locus, is not known, then it is suggested that MOBANG be set for 20° less than the characteristic angle of the associated phase-distance functions. A lower limit on MOBANG is that MOB should not operate for the maximum load (minimum load impedance). MOBANG may be set over the range of 30° - 130°.

0803: SELOSB – SELECT BLOCK TRIP ACTIONS

This setting determines which trip functions are blocked from tripping when the Out-of-Step function operates. SELOSB can be set to:

0 (BLKALL) - Block all tripping

- 1 (BLKDIST) - Block all distance function and channel tripping
- 2 (BLKPHAS) - Block phase distance functions only
- 3 (BLKNONE) - No tripping functions are blocked

When SELOSB = 1, only the instantaneous overcurrent and time-overcurrent functions can produce a trip during an out-of-step condition.

- 0804: OSBLKZ1 – SELECT ZONE 1 BLOCK**
- 0805: OSBLKZ2 – SELECT ZONE 2 BLOCK**
- 0806: OSBLKZ3 – SELECT ZONE 3 BLOCK**
- 0807: OSBLKZ4 – SELECT ZONE 4 BLOCK**

OSBLKZ1, 2, 3, and 4 can be set to either YES or NO. When SELOSB = 1 or 2, each of the four distance zones may be individually selected to be blocked, or not, via these four settings. When set to YES, the appropriate zone will be blocked from operating when an out-of-step condition is detected. When set to NO, the appropriate zone is allowed to trip despite the detection of an out-of-step condition.

2.2.12 EXAMPLE OSB SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

It is assumed that swing-impedance locus information for the out-of-step condition is not available. Zone 2 will be selected as the coordinating function, and Zone 2 will have a 90° circular characteristic.

```
SELPTZ = 0 (ZONE 2)
MOBANG = 90 - 20 = 70
SELOSB = 1 (BLKDIST)
OSBLKZ1 = YES
OSBLKZ2 = YES
OSBLKZ3 = YES
OSBLKZ4 = YES
```

2.2.13 BLOCK RECLOSING

These settings determine which function or logic outputs are used to block the Reclose Initiate (RI) output and to operate the Reclose Cancel (RC) output in addition to Line Pickup. Refer to the OR43 input labeled "BLOCK RECLOSING FLAG" in the protection scheme logic diagrams.

Select All (of the below)	SELALL (0701)
Out-of-Step Block,	RBOSB (0702)
3-Phase Faults,	RB3PH (0703)
Ground Time Overcurrent,	RBTOC (0704)
Zone 2 Timers,	RBZ2T (0705)
Zone 3 Timers,	RBZ3T (0706)
Zone 4 Timers,	RBZ4T (0707)
Any Zone 1 Phase Distance,	RBZ1PH (0708)
Any Zone 2 Phase Distance,	RBZ2PH (0709)
Configurable Trip Bus	RBCTB (0710)

All of the above can be set to either YES or NO. YES means that the signal blocks RI and operates RC. NO means that the signal has no affect on RI or RC operation.

2.2.14 EXAMPLE BLOCK RECLOSING SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

SELALL = YES

With this selection, the other settings may be YES or NO without affecting the result that all the signals block reclosing.

2

2.2.15 SCADA DTA INTERFACE

The following two settings are functional only if the optional DTA module is present. If the DTA module is not present, the settings may be at any value within their range without affecting any other part of the DLP3.

1601: FLTLOCK – SCADA DTA FAULT LOCATION

FLTLOCK can be set over the range of 0 - 99.9 seconds. FLTLOCK is used to specify a time period after a fault during which fault-location calculations resulting from subsequent faults will be prevented from updating the fault-location information stored in the DTA module.

1602: FLTRESET – SCADA DTA FAULT LOCATION RESET

FLTRESET can be set over the range of 0 - 999 minutes. FLTRESET is used to specify a time period after a fault, at the expiration of which 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.

2.2.16 EXAMPLE SCADA SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

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.

2.2.17 CONFIGURABLE INPUTS

1701: CONCCI – CONFIGURABLE INPUT MODE

CONCCI determines how the three configurable digital inputs, contact converters CC4, CC5, and CC6, are used. CONCCI may be set over the range of 0 - 8 where the selected value chooses from nine pre-determined combinations, as shown in the table below.

where:

- **RCVR. 2** indicates that the external contact wired to CC4 is used as receiver number 2 in a pilot scheme.
- **External Trigger** indicates that the external contact wired to CC4 is used as an oscillography trigger.
- **Cnfg. Input 1, 2, or 3** indicates that the external contact wired to CC4, 5, or 6 is used as one of the 64 "input numbers" associated with the Configurable Outputs (refer to the next section for an explanation).
- **Select Grp. bit 0 or 1** indicates that the external contact wired to CC5 or CC6 is used as one of the two bits that determine which settings group (1, 2, 3, or 4) is active. Two bits allow four combinations to select the settings group (refer to PRODUCT DESCRIPTION and Figure 1–20: PTFE LOGIC on page 1–34 for an explanation).

- **Stop Carrier** indicates that the external contact wired to CC5 is used to close the KT2 CARRIER STOP contact and prevent the KT1 CARRIER START contact from closing when a blocking scheme is selected, SELSCM = 4 (BLOCK).
- **Block Pilot Tripping** indicates that the external contact wired to CC6 is used to block pilot tripping and stop carrier (see above) when a blocking scheme is selected, SELSCM = 4 (BLOCK).

Table 2–4: CONCCI SETTING TABLE

CONCCI	CC4	CC5	CC6
0	RCVR. 2	Select Grp. bit 1	Select Grp. bit 0
1	External Trigger	Select Grp. bit 1	Select Grp. bit 0
2	Confg. Input 1	Select Grp. bit 1	Select Grp. bit 0
3	RCVR. 2	Stop Carrier	Block Pilot Trip
4	External Trigger	Stop Carrier	Block Pilot Trip
5	Confg. Input 1	Stop Carrier	Block Pilot Trip
6	RCVR. 2	Confg. Input 2	Confg. Input 3
7	External Trigger	Confg. Input 2	Confg. Input 3
8	Confg. Input 1	Confg. Input 2	Confg. Input 3

CONCCI=3 is the "default" setting. This is the setting as shipped from the factory and the designations shown above for CONCCI=3 appear on the five functional logic diagrams in Chapter 2: PRODUCT DESCRIPTION.

1702: SETGRP – SETTINGS GROUP

SETGRP determines the "active" settings group from the four different groups that are stored in non-volatile memory. SETGRP may be set to 0 (active settings group is determined by outputs from CC5 and CC6), 1 (active group = 1), 2 (active group = 2), 3 (active group = 3), and 4 (active group = 4). When a settings group is changed while the DLP3 is on-line and protecting (green light ON), a "Trip Bus Check" is performed prior to allowing the new settings to become effective. Refer to PRODUCT DESCRIPTION for an explanation of the Trip Bus Check feature.

The considerations for selecting the SETGRP and CONCCI settings are interrelated, and these two settings must be modified as a pair. The correct sequence is to set CONCCI first and then SETGRP. When SETGRP and CONCCI settings are changed within the active settings group, these new values are also stored in the other three settings groups. SETGRP and CONCCI are always the same values in all four settings groups.



CERTAIN COMBINATIONS OF SETGRP and CONCCI ARE MUTUALLY EXCLUSIVE, AND IF THESE SETTINGS ARE NOT SELECTED PROPERLY THE DLP3 WILL NOT FUNCTION AS INTENDED!

NOTE

If CONCCI is set to 0, 1, or 2, then SETGRP must be set to 0. If CONCCI is set to 3, 4, 5, 6, 7, or 8, then SETGRP must be set to 1, 2, 3, or 4.

2.2.18 EXAMPLE CONFIGURABLE INPUT SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

CONCCI = 3
SETGRP = 1

2

2.2.19 CONFIGURABLE OUTPUT #1

a) CONFIGURABLE OUTPUT #1, BKR1CLSOUT

1801: CONOUT1 – CLOSE CONTACT 1

CONOUT1 determines how configurable output #1 is used, and it may be set to 0, 1, or 2 as tabulated below:

- CONOUT1 = 0 (used as BC-1, the default setting)
- CONOUT1 = 1 (energized by an 8-input logical OR)
- CONOUT1 = 2 (energized by an 8-input logical AND)

The figure below is a functional logic diagram for configurable output #1. The link represents the CONOUT1 setting. When CONOUT1=0 the contact closes when a breaker #1 close command, BKCLS1, is received, and the contact is labeled, BC-1, to correspond to this default setting. When CONOUT1=1 the contact closes when any of 8 inputs to OR1 are present. When CONOUT1=2 the contact closes when all of the 8 inputs to AND1 are present. Settings CO1IN1-8 determine what internal DLP3 signals are routed to each of the 8 inputs, as explained below.

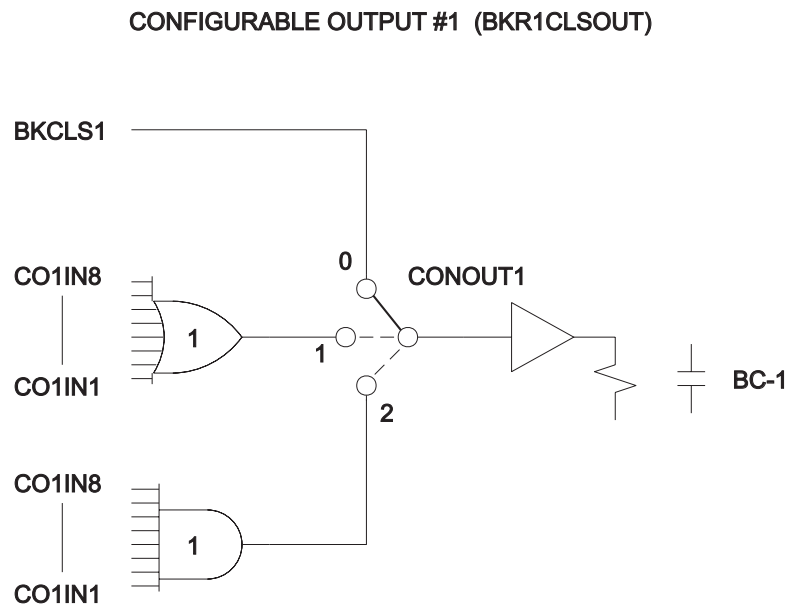


Figure 2–5: CONFIGURABLE OUTPUT #1 LOGIC

1802: CO1IN1 – INPUT NUMBER 1

CO1IN1 may be set over the range from 0 to 64. A "0" indicates that the OR or AND input is not used (i.e., the input is set to be a "logic 0" for an OR or a "logic 1" for an AND). Settings 1 to 64 are selected from the DLP3 internal signals in the following table:

1803: CO1IN2 – INPUT NUMBER 2
 1804: CO1IN3 – INPUT NUMBER 3
 1805: CO1IN4 – INPUT NUMBER 4
 1806: CO1IN5 – INPUT NUMBER 5
 1807: CO1IN6 – INPUT NUMBER 6
 1808: CO1IN7 – INPUT NUMBER 7
 1809: CO1IN8 – INPUT NUMBER 8

See CO1IN1.

Table 2–5: INTERNAL SIGNALS, CO1IN1 TO CO1IN8 (Sheet 1 of 2)

INPUT SIGNAL	INPUT NO.	MMI MNEMONIC
ZONE 1 AG	1	Z1 AG
ZONE 1 BG	2	Z1 BG
ZONE 1 CG	3	Z1 CG
ZONE 2 AG	4	Z2 AG
ZONE 2 BG	5	Z2 BG
ZONE 2 CG	6	Z2 CG
ZONE 3 AG	7	Z3 AG
ZONE 3 BG	8	Z3 BG
ZONE 3 CG	9	Z3 CG
ZONE 4 AG	10	Z4 AG
ZONE 4 BG	11	Z4 BG
ZONE 4 CG	12	Z4 CG
ANY ZONE 1 GND.	13	Z1 GRN
Z2 GND. TIMER, TL2G	14	Z2 GRND TIMER
Z3 GND. TIMER, TL3G	15	Z3 GRND TIMER
Z4 GND. TIMER, TL4G	16	Z4 GRND TIMER
ZONE 1 AB	17	Z1 AB
ZONE 1 BC	18	Z1 BC
ZONE 1 CA	19	Z1 CA
ZONE 2 AB	20	Z2 AB
ZONE 2 BC	21	Z2 BC
ZONE 2 CA	22	Z2 CA
ZONE 3 AB	23	Z3 AB
ZONE 3 BC	24	Z3 BC
ZONE 3 CA	25	Z3 CA
ZONE 4 AB	26	Z4 AB
ZONE 4 BC	27	Z4 BC
ZONE 4 CA	28	Z4 CA
ANY ZONE 1 PHASE	29	Z1 PHS
Z2 PHASE TIMER, TL2P	30	Z2 PHASE TIMER
Z3 PHASE TIMER, TL3P	31	Z3 PHASE TIMER
Z4 PHASE TIMER, TL4P	32	Z4 PHASE TIMER

Table 2-5: INTERNAL SIGNALS, CO1IN1 TO CO1IN8 (Sheet 2 of 2)

INPUT SIGNAL	INPUT NO.	MMI MNEMONIC
IT	33	IT DET
IB	34	IB DET
IPT+NT	35	GRDTRP
IPB+NB	36	GRDBLK
FAULT DETECTOR, FD	37	FLTDET
REMOTE OPEN, ROD	38	REMOPN
OUT OF STEP, OSB	39	OUTSTP
V1 DETECTOR	40	V1 DET
LINE OVERLOAD	41	LNOVLD
PH4 (50P)	42	INPOVR
IDT (50G)	43	INGOVR
TOC (51G)	44	TMGOVR
LINE PICKUP	45	LPCKUP
FUSE FAILURE	46	FUSEFL
NT	47	GR FWR
NB	48	GR RVR
RECLOSE CANCEL, RC	49	RECCAN
CONFIG. INPUT 1	50	CNFIN1
CONFIG. INPUT 2	51	CNFIN2
CONFIG. INPUT 3	52	CNFIN3
NON-CRITICAL ALARM	53	NOCALM
ANY ZONE 2 - PH. OR GND.	54	ANY Z2
ANY ZONE 3 - PH. OR GND.	55	ANY Z3
ANY ZONE 4 - PH. OR GND.	56	ANY Z4
TRIP BUS	57	TRPBF1
MANUAL CLOSE - BRKR. 1	58	BKCLS1
MANUAL CLOSE - BRKR. 2	59	BKCLS2
RI-3P	60	RECIN3
RECLOSER - CLOSE BREAKER	62	BRKCLS
RECOSER - CC10	63	ERCIN3

The logical NOT of any of the above 62 inputs is selected by adding 100 to the Input Number listed above. For example, the logical NOT of FD for input #1 is CO1IN1=137.

2.2.20 CONFIGURABLE OUTPUT #2

1901: CONOUT2 – CLOSE CONTACT 2
 1902: CO2IN2 – INPUT NUMBER 1
 1903: CO2IN2 – INPUT NUMBER 2
 1904: CO2IN3 – INPUT NUMBER 3
 1905: CO2IN4 – INPUT NUMBER 4
 1906: CO2IN5 – INPUT NUMBER 5
 1907: CO2IN6 – INPUT NUMBER 6
 1908: CO2IN7 – INPUT NUMBER 7
 1909: CO2IN8 – INPUT NUMBER 8

see CONFIGURABLE OUTPUT #1

2.2.21 CONFIGURABLE OUTPUT #3

2001: CONOUT3 – CLOSE CONTACT 3
 2002: CO3IN2 – INPUT NUMBER 1
 2003: CO3IN2 – INPUT NUMBER 2
 2004: CO3IN3 – INPUT NUMBER 3
 2005: CO3IN4 – INPUT NUMBER 4
 2006: CO3IN5 – INPUT NUMBER 5
 2007: CO3IN6 – INPUT NUMBER 6
 2008: CO3IN7 – INPUT NUMBER 7
 2009: CO3IN8 – INPUT NUMBER 8

see CONFIGURABLE OUTPUT #1

2.2.22 CONFIGURABLE OUTPUT #4

2101: CONOUT4 – LINE OVERLOAD

CONOUT4 determines how Configurable output #4 is used, and it may be set to 0, 1, 2, 3, or 4 as tabulated below:

CONOUT4 = 0 (used as Line Overload, the default setting)

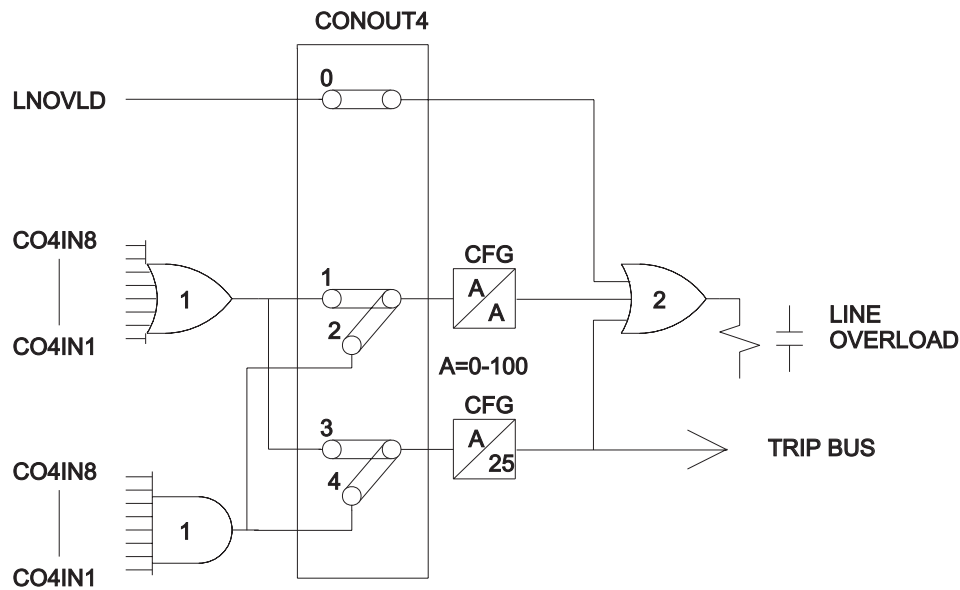
CONOUT4 = 1 (energized by an 8-input logical OR)

CONOUT4 = 2 (energized by an 8-input logical AND)

CONOUT4 = 3 (energized by an 8-input logical OR and activates the trip bus)

CONOUT4 = 4 (energized by an 8-input logical AND and activates the trip bus)

The figure below is a functional logic diagram for configurable output #4. The links in the dotted box represent the CONOUT4 setting. When CONOUT4 = 0, the contact closes when the Line Overload function operates, and the contact is labeled Line Overload, to correspond to this default setting. When CONOUT4 = 1, the contact closes when any of the 8 inputs to OR1 are present. When CONOUT4 = 2, the contact closes when all of the 8 inputs to AND1 are present. When CONOUT4 = 3, the contact closes and a DLP trip is produced when any of the 8 inputs to OR1 are present. When CONOUT4 = 4, the contact closes and a DLP trip is produced when all of the 8 inputs to AND1 are present.



(CFG- REFERENCE SETTINGS 1309 AND 1310)

Figure 2–6: CONFIGURABLE OUTPUT #4 LOGIC

The settings CO4IN1-8 determine what internal DLP signals are routed to the 8 inputs as explained below.

2102: CO4IN1 – INPUT NUMBER 1

CO4IN1 may be set over the range from 0 to 64. A “0” indicates that the OR or AND input is not used (i.e. the input is set to be a ‘logic 0’ for an OR or a ‘logic 1’ for an AND). Settings 1 to 64 are selected from the DLP3 internal signals.

2102: CO4IN2 – INPUT NUMBER 2

2102: CO4IN3 – INPUT NUMBER 3

2102: CO4IN4 – INPUT NUMBER 4

2102: CO4IN5 – INPUT NUMBER 5

2102: CO4IN6 – INPUT NUMBER 6

2102: CO4IN7 – INPUT NUMBER 7

2102: CO4IN8 – INPUT NUMBER 8

see CO4IN1.

2.2.23 CONFIGURABLE OUTPUT #5

2201: CONOUT5 – CLOSE CONTACT 5

2202: CO5IN2 – INPUT NUMBER 1

2203: CO5IN2 – INPUT NUMBER 2

2204: CO5IN3 – INPUT NUMBER 3

2205: CO5IN4 – INPUT NUMBER 4

2206: CO5IN5 – INPUT NUMBER 5

2207: CO5IN6 – INPUT NUMBER 6

2208: CO5IN7 – INPUT NUMBER 7

2209: CO5IN8 – INPUT NUMBER 8

see CONFIGURABLE OUTPUT #1

2.2.24 CONFIGURABLE OUTPUT #6

2301: CONOUT6 – CLOSE CONTACT 6
2302: CO6IN2 – INPUT NUMBER 1
2303: CO6IN2 – INPUT NUMBER 2
2304: CO6IN3 – INPUT NUMBER 3
2305: CO6IN4 – INPUT NUMBER 4
2306: CO6IN5 – INPUT NUMBER 5
2307: CO6IN6 – INPUT NUMBER 6
2308: CO6IN7 – INPUT NUMBER 7
2309: CO6IN8 – INPUT NUMBER 8

see CONFIGURABLE OUTPUT #1

2.2.25 EXAMPLE CONFIGURABLE OUTPUT SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

CONOUT1 = 0
 CO1IN1 = 0
 CO1IN2 = 0
 CO1IN3 = 0
 CO1IN4 = 0
 CO1IN5 = 0
 CO1IN6 = 0
 CO1IN7 = 0
 CO1IN8 = 0

Identical settings for configurable outputs 2 - 6.

2.2.26 RECLOSER

2401: SELRCLR – RECLOSER SCHEME

SELRCLR allows for the selection of four different modes of operation as listed below:

SELRCLR = 0 The recloser is completely disabled with all the outputs OFF (contacts open); an external recloser may be used.

SELRCLR = 1 The recloser is turned off. This is similar to mode 0 above except that the Z1RR output is ON (contact closed).

SELRCLR = 3 One reclosing attempt is allowed.

SELRCLR= 6 Two reclosing attempts are allowed. The reclose-time-delay setting for the first reclose is different from that for the second reclose.

2403: TRPDLY1 – RECLOSE DELAY #1

TRPDLY1 is the time delay for the first reclose, and it can be set over the range of 0.01-2.55 seconds.

2404: RPDLY2 – RECLOSE DELAY #2

RDLY2 is the time delay for the second reclose, and can be set over the range of 1-255 seconds.

2405: HOLD – HOLD MODE

HOLD can be set to YES or NO and affects the action taken by the recloser just prior to issuing a CLOSE BREAKER signal. At this point the recloser checks the status of the RECLOSE INHIBIT digital input (contact converter CC11). If RECLOSE INHIBIT is OFF (external contact open), the CLOSE BREAKER signal is issued. If RECLOSE INHIBIT is ON (external contact closed), then the next step is determined by HOLD. If HOLD=YES the recloser will start counting the Hold Time Delay (HOLDDLY). During this time, the CLOSE BREAKER signal will be issued as soon as RECLOSE INHIBIT goes OFF. If RECLOSE INHIBIT is still ON when HOLDDLY times out, the recloser will go to LOCKOUT. If instead, HOLD=NO the recloser will go immediately to LOCKOUT.

2406: HOLDDLY – HOLD TIME DELAY

HOLDDLY is the time delay used when HOLD=YES, and it can be set over the range of 1-255 seconds.

2407: DWELLTIM – DWELL TIME DELAY

DWELLTM is the time that the CLOSE BREAKER signal will stay on once it has been issued, and it can be set over the range of 0.1-2.0 seconds.

2408: RSTDLY – RESET TIME DLEAY

RSTDLY is the time after the CLOSE BREAKER signal has been removed that the recloser waits before going to RESET. If a trip occurs during RSTDLY, the recloser goes to the next programmed reclose or to LOCKOUT. RSTDLY can be set over the range of 1-255 seconds.

2.2.27 EXAMPLE RECLOSER SETTINGS

Based on Figure 2–1: SAMPLE 345 KV SYSTEM on page 2–2.

```

SELRCLR = 3
TPRDLY1 = 1.0
RDLY2 = 3.00
HOLD = NO
HOLDDLY = <NOT APPLICABLE>
DWELLTM = 0.5
RSTDLY = 30

```

2.2.28 SCHEME SELECTION

The settings that have not been discussed above are directly or indirectly related to the type of scheme selected. Consequently, the remaining setting categories:

```

ZONE 1 DISTANCE FUNCTIONS
ZONE 2 / PILOT ZONE
ZONE 3 DISTANCE FUNCTIONS
ZONE 4 DISTANCE FUNCTIONS
OVERCURRENT SUPERVISION
SCHEME LOGIC TIMERS
REMOTE OPEN DETECTOR

```

will be considered separately for each of the six possible schemes.

2.3.1 SCHEME SELECTION

1201: SELSCM – SELECT SCHEME

SELSCM = 0 (STEPDST)

1202: NUMRCVR – NUMBER OF RECEIVERS

For a Step Distance scheme, set NUMRCVR = 0 since there is no local receiver.

2.3.2 ZONE 1 DISTANCE FUNCTIONS

0101: SELZ1G – SELECT ZONE 1 GROUND

SELZ1G can be set to either YES or NO. This setting determines whether the Zone 1 ground-distance functions are in service (YES) or out of service (NO). For a Step Distance scheme, set SELZ1G=YES.

0102: SELZ1P – SELECT ZONE 1 PHASE

SELZ1P can be set to either YES or NO. This setting determines whether the Zone 1 phase-distance functions are in service (YES) or out of service (NO). For a Step Distance scheme, set SELZ1P=YES.

0103: Z1R – ZONE 1 PHASE (M1)**0104: Z1GR – ZONE 1 GROUND (M1G)**

Z1R and Z1GR can be set over the range of 0.01 - 50.00 ohms. When potential transformers are used, the first zone distance functions should be set to reach no more than 90% of the positive-sequence impedance of the protected line, regardless of the source-to-line ratio. When capacitor voltage transformers (CVTs) are used, refer to Figure 2-7: ZONE 1 REACH WITH CVTS on page 2-34 determine the maximum reach in percent of positive-sequence impedance of the protected line as a function of the source- to-line ratio.

0105: SELZ1U – SELECT ZONE 1 GROUND UNIT

SELZ1U can be set to either 0 (MHO) or 1 (REACT). This setting determines the type of measuring unit used for the Zone 1 ground-distance functions, either a Mho unit or a Reactance unit. Except for very short lines, it is recommended that the Mho unit be used, since its operating time is slightly faster than that of the Reactance unit. 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 unit can be selected for a long line if desired.

2

Zone 1 Reach
When Used With Capacitor Voltage Transformers (CVTs)

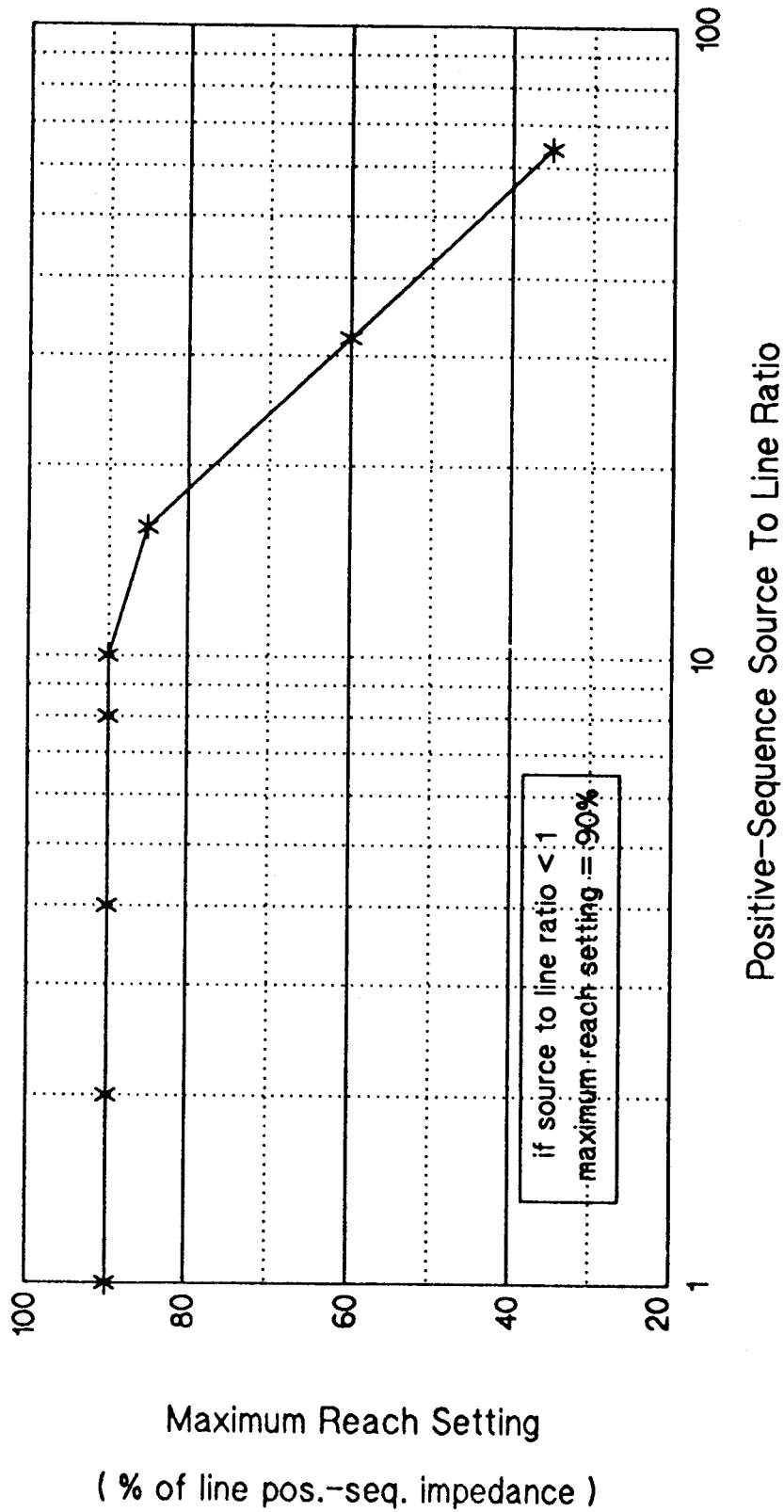


Figure 2-7: ZONE 1 REACH WITH CVTS

0106: Z1SU – REACH SETTING OF MHO UNIT

This setting is not relevant unless the Zone 1 ground-distance functions have been set to be reactance units (see SELZ1U above). Since the reactance unit is non-directional, it is supervised by a Mho unit, as shown in the figure below, to make it directional. Z1SU can be set over the range of 0.01 - 50.00 ohms.

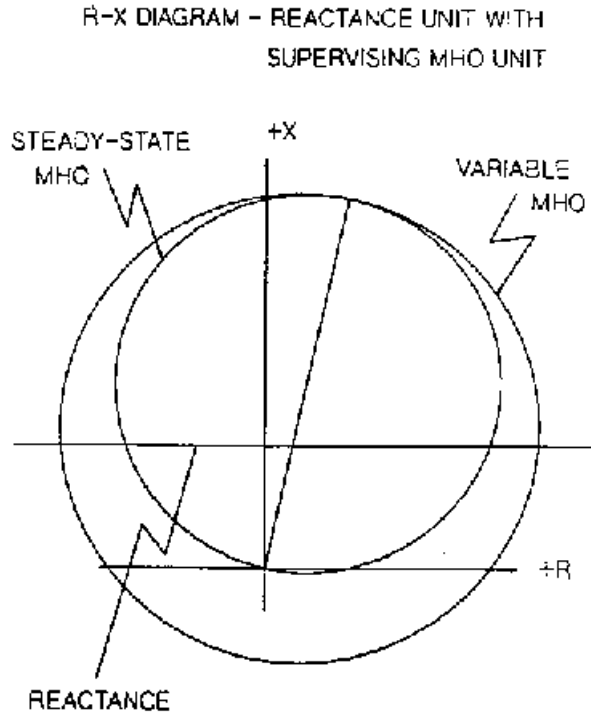


Figure 2-8: MHO UNIT R-X DIAGRAM

Z1SU is the minimum reach for the supervising Mho unit. This setting can be easily calculated if the maximum load flow across the line is known; refer to Figure 2-9: Z1SU SETTING on page 2-36 for details. The criterion used for establishing the minimum reach is based on maintaining a 40° angular margin between angle A and angle B. 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° .

An adaptive feature of the DLP3 is that the reach of the supervising Mho unit is adjusted as the load flow changes. The reach can never be less than Z1SU, but it can be larger. As the load flow decreases, the load impedance becomes larger, and the reach is increased while maintaining the 40° differential between angles A and B. If the load now increases, the reach will be decreased but will never be less than Z1SU. This adaptive-reach feature optimizes the reactance unit coverage for ground-fault impedance.

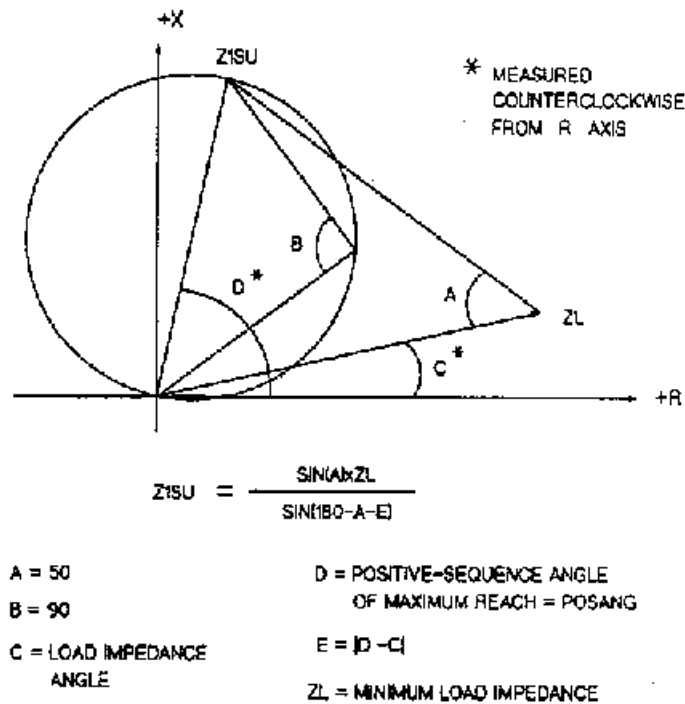


Figure 2-9: Z1SU SETTING

0107: Z1K0 – ZERO-SEQUENCE CURRENT COMPENSATION

Z1K0 can be set over the range of 1.0 - 7.0. This setting determines the amount of zero-sequence current fed back into 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 for:

$$Z1K0 = 0.95 \times (Z0L / Z1L)$$

where: Z0L = zero-sequence impedance of line
 Z1L = positive-sequence impedance of line

0108: Z1ERST – ZONE 1 REACH RESET TIMER

Z1ERST is the pickup time delay of timer TL20 in Figure 1-4: ZONE 1 EXTENSION LOGIC DIAGRAM on page 1-11, the functional logic diagram for the Zone 1 Extension Scheme. Z1ERST can be set over the range of 0.0-60.0 seconds. Refer to the PRODUCT DESCRIPTION section under Zone 1 Extension for an explanation of when the Z1ERST time delay is required. When required, Z1ERST is set to the reset or reclaim time setting of the external recloser. TL20 is used in a Zone 1 Extension scheme only. For any other scheme, Z1ERST may be set to any value within its range without affecting scheme operation.

2.3.3 ZONE 2 / PILOT ZONE**0201: SELZ2G – SELECT ZONE 2 GROUND**

SELZ2G can be set to either YES or NO. For a Step Distance scheme, ground-distance functions are often used for Zone 2 protection. If this is the case, set SELZ2G=YES. In some cases only phase-distance functions are used, and ground faults are detected by the backup ground-overcurrent functions IDT and TOC. Here, SELZ2G=NO would be selected.

0202: SELZ2P – SELECT ZONE 2 PHASE

SELZ2P can be set to either YES or NO. For a Step Distance scheme, Zone 2 phase-distance functions are required, and SELZ2P=YES should be selected.

0203: Z2R – REACH SETTING (MT) ZONE 2 PHASE

Z2R can be set over the range of 0.01 - 50.00 ohms. In a Step Distance scheme Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault-current sources. Typically, on a two-terminal line, Z2R would be set for 125-150% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to: (1) cause the MT functions to pick up on the maximum load flow or (2) cause the MT functions to lose selectivity with the second-zone phase-distance functions on the shortest adjoining line section. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2P with additional time delay.

0204: Z2G – REACH SETTING (MTG) ZONE 2 GROUND

Z2GR can be set over the range of 0.01 - 50.00 ohms. In a Step Distance scheme Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z2GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram or (2) cause the MTG functions to lose selectivity with the second-zone ground-distance functions on the shortest adjoining line section. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2G with additional time delay.

0205: SELZ2U: SELECT ZONE 2 GROUND UNIT

This setting permits choosing either Mho ground distance, ground directional-overcurrent, or both, for the overreaching zone in a pilot scheme. For a Step Distance scheme, this setting has no effect on the scheme logic, and SELZ2U may be set to any value within its range.

0206: SELZ2T – SELECT ZONE 2 TIMERS

SELZ2T can be set to either YES or NO. For a Step Distance scheme, where a Zone 2 time delay is required, SELZ2T = YES must be selected.

0207: PUTL2P – PHASE TIMER

This Zone 2 time delay should be set long enough to coordinate with the operating time of bus- or transformer-differential relays at the remote bus, and Zone 1 phase-distance relays of adjoining line sections, added to the breaker(s) trip time. PUTL2P can be set over the range of 0.10 - 3.00 seconds.

0208: PUTL2G – GROUND TIMER

This Zone 2 time delay should be set long enough to coordinate with the operating time of bus- or transformer-differential relays at the remote bus, and Zone 1 ground-distance relays of adjoining line sections, added to the breaker(s) trip time. PUTL2G can be set over the range of 0.10 - 3.00 seconds.

0209: Z2PANG – PHASE CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the MT phase-distance functions, as shown in Figure 2–10: MT R-X DIAGRAM. Z2PANG can be set to 90°, 105°, or 120°. A 90° setting is recommended. If the desired reach, Z2R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a "lens-shaped" characteristic associated with the 105° or 120° setting may prevent operation on load without having to reduce the reach. The settings of both Z2R and Z2PANG may be evaluated by using the formula associated with the "Maximum Allowable

Reach" method of Figure 2-11: MAXIMUM ALLOWABLE REACH below. The criterion used for establishing the maximum reach given in the figure below is based on maintaining a 40° angular margin between angle A and angle B.

2

CHARACTERISTIC SHAPE
VERSUS
CHARACTERISTIC ANGLE

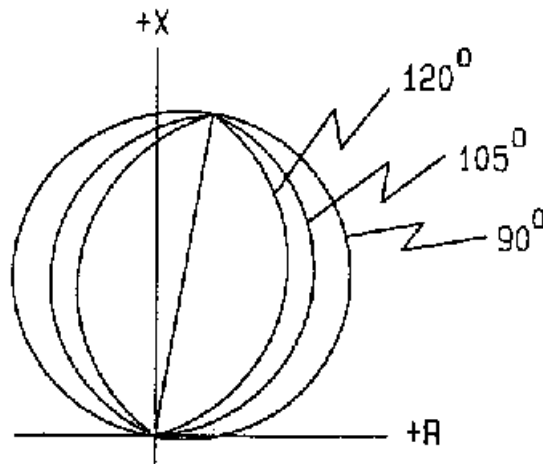
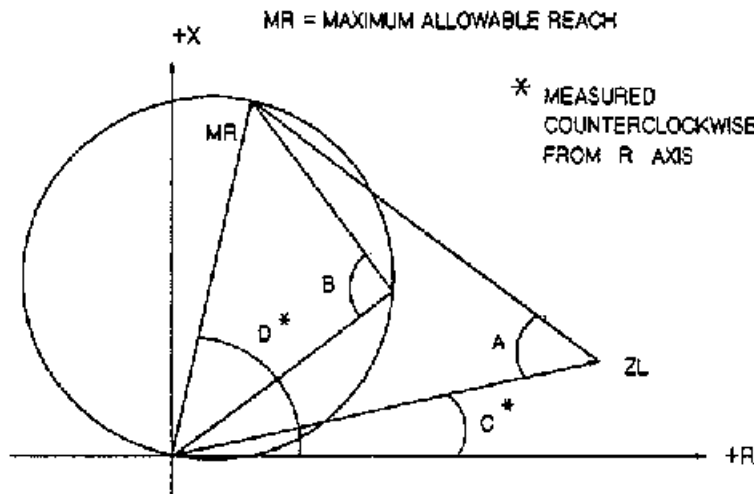


Figure 2-10: MT R-X DIAGRAM



$$MR = \frac{\sin(A) \times ZL}{\sin(180 - A - E)}$$

- A = 50 for circle (B=90)
- A = 65 for lens (B=105)
- A = 80 for lens (B=120)
- C = LOAD IMPEDANCE ANGLE
- D = POSITIVE-SEQUENCE ANGLE OF MAXIMUM REACH = POSANG
- E = |D - C|
- ZL = MINIMUM LOAD IMPEDANCE

Figure 2-11: MAXIMUM ALLOWABLE REACH

0210: Z2GANG – GROUND CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the MTG ground-distance functions. Z2GANG can be set to 90°, 105°, or 120°. A 90° setting should be used unless the desired reach, Z2GR, is such that the impedance point associated with the maximum load flow plots within the MTG steady-state characteristic. The settings of both Z2GR and Z2GANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method shown above. The criterion used for establishing the maximum reach given in Figure 2–11: MAXIMUM ALLOWABLE REACH is based on maintaining a 40° angular margin between angle A and angle B

2.3.4 ZONE 3 DISTANCE FUNCTIONS**0301: SELZ3G – SELECT ZONE 3 GROUND**

SELZ3G can be set to either YES or NO. When Zone 3 is used as part of a Step Distance scheme and ground-distance functions are required, set SELZ3G = YES. If Zone 3 is not used at all, or if only Zone 3 phase-distance functions are required, set SELZ3G = NO.

0302: SELZ3P – SELECT ZONE 3 PHASE

SELZ3P can be set to either YES or NO. When Zone 3 is used as part of a Step Distance scheme, phase-distance functions are required and SELZ3P = YES must be selected. If Zone 3 is not used at all, set SELZ3P = NO.

0303: Z3R – REACH SETTING (M3) ZONE 3 PHASE

Z3R can be set over the range of 0.01 - 50.00 ohms. In a Step Distance scheme, Zone 3 provides backup protection for adjoining line sections out of the remote bus, and Z3R 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. Z3R should never be set so large as to: (1) cause the M3 functions to pick up on the maximum load flow or (2) cause the M3 functions to lose selectivity with the third-zone phase-distance functions on the shortest adjoining line section out of the remote bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

0304: Z3GR – REACH SETTING (M3G) ZONE 3 GROUND

Z3GR can be set over the range of 0.01 - 50.00 ohms. In a Step Distance scheme Zone 3 provides backup protection for adjoining line sections out of the remote bus, and Z3GR should be set to see a ground fault at the end of the longest adjoining line section out of the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z3GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the M3G characteristic on an R-X diagram, or (2) cause the M3G functions to lose selectivity with the third-zone ground-distance functions on the shortest adjoining line section out of the remote bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

0305: PUTL3P – PHASE TIMER

This Zone 3 time delay should be set long enough to coordinate with the time-delayed operation of Zone 2 phase-distance relays of adjoining line sections, added to the breaker(s) trip time. PUTL3P can be set over the range of 0.10 - 10.00 seconds.

0306: PUTL3G – GROUND TIMER

This Zone 3 time delay should be set long enough to coordinate with the time-delayed operation of Zone 2 ground-distance relays of adjoining line sections, added to the breaker(s) trip time. PUTL3G can be set over the range of 0.10 - 10.00 seconds.

0307: Z3PANG – PHASE CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the M3 phase-distance functions, as shown in Figure 2–10: MT R-X DIAGRAM. Z3PANG can be set to 90°, 105°, or 120°. A 90° setting is recommended. If the desired reach, Z3R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a "lens-shaped" characteristic associated with the 105° or 120° setting may prevent operation on load without having to reduce the reach. The settings of both Z3R and Z3PANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method described above. The criterion used for establishing the maximum reach given in Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is based on maintaining a 40° angular margin between angle A and angle B.

0308: Z3GANG – GROUND CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the M3G ground-distance functions. Z3GANG can be set to 90°, 105°, or 120°. A 90° setting should be used unless the desired reach, Z3GR, is such that the impedance point associated with the maximum load flow plots within the M3G steady-state characteristic. The settings of both Z3GR and Z3GANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method described above. The criterion used for establishing the maximum reach given in Figure 2–11: MAXIMUM ALLOWABLE REACH is based on maintaining a 40° angular margin between angle A and angle B.

2.3.5 ZONE 4 DISTANCE FUNCTIONS**0401: SELZ4G – SELECT ZONE 4 GROUND**

SELZ4G can be set to either YES or NO. When Zone 4 is used as part of a Step Distance scheme and ground-distance functions are required, set SELZ4G = YES. If Zone 4 is not used at all, or if only Zone 4 phase-distance functions are required set SELZ4G = NO.

0402: SELZ4P – SELECT ZONE 4 PHASE

SELZ4P can be set to either YES or NO. When Zone 4 is used as part of a Step Distance scheme, phase-distance functions are required and SELZ4P = YES must be selected. If Zone 4 is not used at all, set SELZ4P = NO.

0411: SELZ4D – SELECT DIRECTION

The directional sense of Zone 4 can be reversed. SELZ4D can be set to either 0 (FORWRD) forward or 1 (REVERS) reverse. In a Step Distance scheme, the Zone 4 distance functions may be either forward-looking or reverse-looking. Ideally, a forward-looking Zone 4 would provide backup protection for lines two buses removed from the relay location, however such use will be limited due to maximum-reach constraints. More realistically, a reverse-looking Zone 4 will be used in those cases where a forward-looking Zone 3 cannot be used due to maximum-reach constraints. For such a case, the reverse-looking Zone 4 becomes what is known in the literature as a "reversed third zone" function.

0403: Z4R – REACH SETTING (M4) ZONE 4 PHASE

Z4R can be set over the range of 0.01 - 50.00 ohms. In a Step Distance scheme a reversed-Zone 4 provides backup protection for line sections out of the local bus, and Z4R should be set to see a multi-phase fault at the end of the longest line section, considering such factors as arc resistance and underreach caused by interme-

diate fault-current sources. Z4R should never be set so large as to: (1) cause the M4 functions to pick up on the maximum load flow or (2) cause the M4 functions to lose selectivity with the second-zone phase-distance functions on the shortest line section out of the local bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

0405: Z4OR – PHASE OFFSET REACH

The Zone 4 phase-distance functions can be set with an "offset" reach that is in the opposite direction from that determined by the SELZ4D setting. The Z4OR setting is a multiplier and the actual ohmic offset is equal to $(0.00 - 0.40) \times Z4R$. A reversed-M4 characteristic with offset is shown below. For Step Distance schemes, an offset reach should only be considered when SELZ4D = 1 (REVERS). For the case of a zero-voltage three-phase fault at the relay location, an offset setting keeps the M4 functions and the associated zone timer continuously energized for the duration of the fault, since M4 can now operate on fault current only.

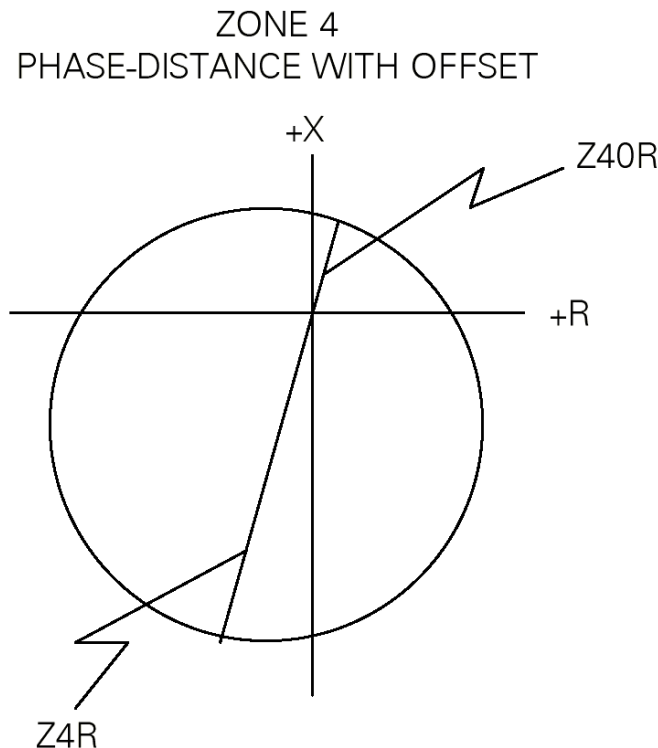


Figure 2-12: ZONE 4 PHASE-DISTANCE R-X DIAGRAM

0404: Z4GR – REACH SETTING (M4G) ZONE 4 GROUND

Z4GR can be set over the range of 0.01 - 50.00 ohms. In a Step Distance scheme a reverse-looking Zone 4 provides backup protection for line sections out of the local bus, and Z4GR should be set to see a ground fault at the end of the longest line section, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z4GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the M4G characteristic on an R-X diagram or (2) cause the M4G functions to lose selectivity with the second-zone ground-distance functions on the shortest line section out of the local bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

0406: SELZ4T – SELECT ZONE 4 TIMERS

SELZ4T can be set to either YES or NO. If Zone 4 backup is required, then SELZ4T=YES must be selected.

0407: PUTL4P – PHASE TIMER

This Zone 4 time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of phase-distance relays, added to the breaker(s) trip time. PUTL4P can be set over the range of 0.10 - 10.00 seconds.

0408: PUTL4G – GROUND TIMER

This Zone 4 time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of ground-distance relays, added to the breaker(s) trip time. PUTL4G can be set over the range of 0.10 - 10.00 seconds.

0409: Z4PANG – PHASE CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the M4 phase-distance functions. Z4PANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. A 90° setting is recommended. If the desired reach, Z4R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a "lens-shaped" characteristic associated with the 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

0410: Z4GANG – GROUND CHARACTERSTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the M4G ground-distance functions. Z4GANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. A 90° setting should be used unless the desired reach, Z4GR, is such that the impedance point associated with the maximum load flow plots within the M4G steady-state characteristic. For such a case, a "lens-shaped" characteristic associated with the 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

2.3.6 OVERCURRENT SUPERVISION**0501: PUIPT – GROUND PILOT TRIP (IPT) OVERCURRENT****0502: PUIPB – GROUND PILOT BLOCK (IPB) OVERCURRENT**

For a Step Distance scheme, the pilot overcurrent functions are not used. IPT and IPB can be set for any value within their range without affecting scheme operation.

0503: PUIT – TRIP SUPERVISION (IT) OVERCURRENT**0504: PUIB – BLOCK SUPERVISION (IB) OVERCURRENT**

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip bus seal-in circuit. For a Step Distance scheme, IT and IB should have the same setting. PUIT and PUIB can be set over the range of 0.20 - 4.00 amps. It is recommended that PUIT and PUIB be set at their minimum value.

2.3.7 SCHEME LOGIC TIMERS**1301: PUTL1 – TRIP INTEGRATOR (TL1) PICKUP****1306: PUTL4 – POTT COORDINATION (TL4) PICKUP****1307: DOTL4 – POTT COORDINATION (TL4) DROPOUT**

PUTL1 can be set over the range of 1 - 50 milliseconds. PUTL4 and DOTL4 can be set over the range of 0 - 50 milliseconds. For a Step Distance scheme, PUTL1, PUTL4, and DOTL4 can be left at any setting within their range without affecting scheme operation.

- 1302: PUTL5 – 52/B CONTACT COORDINATION (TL5) PICKUP**
- 1303: DOTL5 – 52/B CONTACT COORDINATION (TL5) DROPOUT**
- 1304: PUTL5 – 52/B CONTACT COORDINATION (TL6) PICKUP**
- 1305: PUTL5 – 52/B CONTACT COORDINATION (TL6) DROPOUT**

All of these can be set over the range of 0 - 200 milliseconds. Since breaker-position information is not required for the Step Distance scheme logic, these timers are not a part of that logic. However, the DLP3's Sequence of Events function uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in the Elementary Diagram. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

If the recloser is disabled (SELRCLR= 0 or 1), then the output of CC1 provides the input to timer TL5. If the recloser is functional (SELRCLR = 3 or 6), then the output of CC1 is an input to the recloser, and timer TL5 is only used for reporting.

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 time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

1308: PUTLT16 – WEAK INFEED TRIP

PUTLT16 can be set over the range of 8 - 99 milliseconds. Since TL16 is not part of the Step Distance scheme logic, PUTLT16 can be set at any value within its range.

1309: PUTLCFG – CONFIGURABLE TRIP PICKUP

PUTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the pickup delay associated with Configurable Output #4 when CONOUT4 = 1, 2, 3, or 4. Its value depends on how Configurable Output #4 is being used.

1310: DOTLCFG – CONFIGURABLE TRIP DROPOUT

DOTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1 or 2. With CONOUT = 3 or 4, the programmed conditions that cause a DLP trip may not result in a seal-in of the trip bus. In this case, DOTLCFG is fixed at 25 ms to ensure that the trip contacts stay closed long enough to accomplish the desired result.

2.3.8 REMOTE OPEN DETECTOR

1001: SELROD – SELECT REMOTE OPEN DETECTOR

SELROD can be set to either YES or NO. When SELROD = YES, the Remote Open function is in service. When SELROD = NO, the Remote Open function is out of service. For a Step Distance scheme, it is suggested that the Remote Open function be placed in service to obtain faster tripping for faults on the protected line near the remote end that would normally be cleared in Zone 2 time.

1002: PUTLT20 – TIMER (TL20) DELAY

TL20 provides the time delay associated with the Remote Open function. PUTLT20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTLT20 be set at 40.

1003: SELFFB – BLOCK TRIPPING FOR FUSE FAILURE

SELFFB can be set to either YES or NO. When SELFFB = YES, the output of the Potential Transformer Fuse Failure function will block all tripping that is initiated by a distance or directional function. The phase backup overcurrent function, PH4, and the ground backup overcurrent functions, IDT and TOC, are allowed to trip. However, if IDT or TOC is directionally supervised, then that function is not permitted to trip. When SELFFB = NO, the Potential Transformer Fuse Failure function will not block tripping when it operates for a blown potential fuse(s). It is suggested that SELFFB = YES.

2.3.9 EXAMPLE STEP DISTANCE SCHEME SETTINGS**a) SCHEME SELECTION, SCHEMESEL**

SELSCM = 0 (STEPDST)
NUMRCVR = 0

b) ZONE 1 DISTANCE FUNCTIONS, Z1DIST

SELZIG = YES
SELZ1P = YES
Z1R = $0.9 \times 6 = 5.40$
Z1GR = $0.9 \times 6 = 5.40$

Since $Z1(\text{source})/Z1(\text{line}) = 2/6 = 0.33$, the protected line is considered "long" and the Zone 1 ground-distance functions are selected to be Mho units.

SELZ1U = 0 (MHO)
Z1SU = <NOT APPLICABLE>
Z1K0 = $0.95 \times (19.2/6) = 3.0$
Z1ERST = <NOT APPLICABLE>

For purposes of illustration, the Z1SU reach setting will be determined assuming SELZ1U = 1(REACT).

Referring to Figures 2–1: SAMPLE 345 KV SYSTEM and 2–9: Z1SU SETTING:

ZL = $19.7 / 5.6^\circ$
K0 = 3.0
A = 50
C = 5.6
D = 85
E = $85 - 5.6 = 79.4$
Z1SU = $19.7 \times \sin(50^\circ) / \sin(180^\circ - 50^\circ - 79.4^\circ) = 19.53$

c) ZONE 2 / PILOT ZONE, Z2DIST

SELZ2G = YES
SELZ2P = YES
Z2R = $1.25 \times 6 = 7.50$ ohms
Z2GR = $1.25 \times 6 = 7.50$ ohms
SELZ2U = <NOT APPLICABLE>
SELZ2T = YES
PUTL2P = 0.2 seconds
PUTL2G = 0.2 seconds
Z2PANG = 90
Z2GANG = 90

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH is used to check Z2R and Z2PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

$$MR = 19.5 \text{ ohms}$$

Consequently, with $Z2R = 7.50$ and $Z2PANG = 90$, there is no risk of having the MT functions pick up for the maximum load condition. Similarly, with $Z2GR = 7.50$ and $Z2GANG = 90$, the apparent impedance for the maximum load condition will not plot within the MTG characteristic.

d) ZONE 3 DISTANCE FUNCTIONS, Z3DIST

$$SELZ3G = \text{YES}$$

$$SELZ3P = \text{YES}$$

Line section C-D and source E2 provide an intermediate current source that will amplify the apparent impedance seen by the M3 functions at ABLE for a multi-phase fault at the end of the longest adjoining line section, EF. With line section CD switched out, the positive-sequence impedance at ABLE for a three-phase fault at DELTA is $6 + 4.5 = 10.5$ ohms. With line section C-D in service, the positive-sequence impedance at ABLE for a three-phase fault at DELTA is:

$$Z(\text{ABLE}) = Z(\text{AB}) + Z(\text{EF}) + (\text{ICD}/\text{IAB}) \times Z(\text{EF})$$

where: $\text{ICD} = 4.41$ amps
 $\text{IAB} = 5.04$ amps
 $Z(\text{ABLE}) = 6 + 4.5 + (4.41/5.04) \times 4.5 = 14.44$ ohms
 $Z3R = 14.44$ ohms

A similar equation can be derived for the effect of infeed on the M3G ground-distance functions at ABLE with a line-to-ground fault at DELTA. If the simplifying assumption that

$$Z0(\text{AB})/Z1(\text{AB}) = Z0(\text{CD})/Z1(\text{CD}) = Z0(\text{EF})/Z1(\text{EF}) = K0$$

is made, then the equation presented below is valid.

$$Z(\text{ABLE}) = Z(\text{AB}) + Z(\text{EF}) + Z(\text{EF}) \times [I\varnothing + (K0-1)I0] (\text{AB}) / [I\varnothing + (K0-1)I0] (\text{CD})]$$

where: $I\varnothing$ = phase current for faulted phase
 $I0$ = zero-sequence current
 $K0 = 3.2$

For no pre-fault load flow and an A-G fault at DELTA:

$$I\varnothing(\text{AB}) = 2.71 \text{ amps; } I\varnothing(\text{CD}) = 3.29 \text{ amps}$$

$$I0(\text{AB}) = 0.50 \text{ amps; } I0(\text{CD}) = 0.68 \text{ amps}$$

Therefore,

$$Z(\text{ABLE}) = 6 + 4.5 + 4.5 \times [(3.29 + 2.2(0.68)) / (2.71 + 2.2(0.50))]$$

$$Z(\text{ABLE}) = 16.15 \text{ ohms}$$

The angle of the calculated impedance above is assumed to be at $\text{POSANG} = 85^\circ$. A more direct approach to determine the apparent impedance at ABLE for an A-G fault at DELTA would be to take the results of a short-circuit study and calculate the following equation:

$$Z(\text{ABLE}) = V\varnothing G / [I\varnothing + (K0 - 1)I0]$$

where: $I\varnothing = 2.71 \angle -82.0^\circ$
 $I0 = 0.50 \angle -76.9^\circ$
 $V\varnothing G = 61.1 \angle -0.2^\circ$ (phase-to-ground voltage)

$$Z(\text{ABLE}) = 16.00 / 80.3^\circ$$

The difference in the two approaches can be attributed to the simplifying assumptions made for the first approach. The second approach is more exact.

Z3RG = 16.00 ohms
 PUTL3P = 0.5 seconds
 PUTL3G = 0.5 seconds
 Z3PANG = 90
 Z3GANG = 90

2

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is used to check Z3R and Z3PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

MR = 19.5 ohms

Consequently, with Z3R = 14.44 and Z3PANG = 90, there is no risk of having the M3 functions pick up for the maximum load condition. Similarly, with Z3GR = 16.00 and Z3GANG = 90, the apparent impedance for the maximum load condition will not plot within the M3G characteristic.

e) ZONE 4 DISTANCE FUNCTIONS, Z4DIST

SELZ4G = NO
 SELZ4P = NO

With the above two settings, the Zone 4 function is out of service and the other settings associated with Zone 4 can be set at any value within their range.

f) OVERCURRENT SUPERVISION, CURSUPVIS

PUIPT = <NOT APPLICABLE>
 PUIPB = <NOT APPLICABLE>
 PUIT = 0.20 amps
 PUIB = 0.20 amps

g) SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1 = <NOT APPLICABLE>
 PUTL4 = <NOT APPLICABLE>
 DOTL4 = <NOT APPLICABLE>

Since NUMBKRS=1, only TL5 requires settings.

PUTL5 = 80 ms.
 DOTL5 = 100 ms.
 PUTL6 = <NOT APPLICABLE>
 DOTL6 = <NOT APPLICABLE>
 PUTL16 = <NOT APPLICABLE>

h) REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD = YES
 PUTL20 = 40 ms.
 SELFFB = YES

SELPRIM can be set to either 0 (PRIMARY) or 1 (SECNDRY), secondary. This setting determines whether the PRESENT VALUES (currents, voltages, watts, and vars) are displayed and stored as primary or secondary values. **All settings are expressed in terms of secondary values, regardless of whether SELPRIM is set to 0 or 1.**

2.4.1 SCHEME SELECTION

1201: SELSCM – SELECT SCHEME

SELSCM=5 (ZNE1EXT)

1202: NUMRCVR – NUMBER OF RECEIVERS

For a Zone 1 Extension scheme, set NUMRCVR=0, since there is no local receiver.

2.4.2 ZONE 1 DISTANCE FUNCTIONS

0101: SELZ1G – SELECT ZONE 1 GROUND**0102: SELZ1P – SELECT ZONE 1 PHASE**

SELZ1G and SELZ1P can be set to either YES or NO. Both SELZ1G and SELZ1P must be set to YES for a Zone 1 Extension Scheme.

0103: Z1R – REACH SETTING (M1) ZONE 1 PHASE**0104: Z1GR – REACH SETTING (M1G) ZONE 1 GROUND****0105: SELZ1U – SELECT ZONE 1 GROUND UNIT****0106: Z1SU – REACH SETTING OF MHO UNIT****0107: Z1K0 – ZERO-SEQUENCE CURRENT COMPENSATION**

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME" for a description of the considerations for the above settings.

0108: Z1ERST – ZONE 1 REACH RESET TIMER

Z1ERST is the pickup time delay of timer TL20 in Figure 1–4: ZONE 1 EXTENSION LOGIC DIAGRAM on page 1–11, the functional logic diagram for the Zone 1 Extension Scheme. Z1ERST can be set over the range of 0.0-60.0 seconds. Refer to the PRODUCT DESCRIPTION section under Zone 1 Extension for an explanation of when the Z1ERST time delay is required. When required, Z1ERST is set to the reset or reclaim time setting of the external recloser.

2.4.3 ZONE 2 / PILOT ZONE

0201: SELZ2G – SELECT ZONE 2 GROUND

SELZ2G can be set to either YES or NO. For a Zone 1 Extension scheme, set SELZ2G=YES.

0202: SELZ2P – SELECT ZONE 2 PHASE

SELZ2P can be set to either YES or NO. For a Zone 1 Extension scheme, set SELZ2P=YES.

0203: Z2R – REACH SETTING (MTG) ZONE 2 PHASE

Z2R can be set over the range of 0.01 - 50.00 ohms. In a Zone 1 Extension scheme Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault-current sources. Typically, on a two-terminal line, Z2R would be set for 125-150% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to: (1) cause the MT functions to pick up on the maximum load flow, or (2) cause the MT functions to lose selectivity with the second-zone phase-distance functions on the shortest adjoining line section. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2P with additional time delay.

0204: Z4GR – REACH SETTING (MTG) ZONE 2 GROUND

Z2GR can be set over the range of 0.01 - 50.00 ohms. In a Zone 1 Extension scheme Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z2GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram, or (2) cause the MTG functions to lose selectivity with the second-zone ground-distance functions on the shortest adjoining line section. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2G with additional time delay.

0205: SELZ2U – SELECT ZONE 2 GROUND UNIT

This setting permits choosing either Mho ground distance, or ground directional-overcurrent, or both, for the overreaching zone in a pilot scheme. For a Zone 1 Extension scheme, this setting has no effect on the scheme logic, and SELZ2U may be set to any value within its range.

0206: SELZ2T – SELECT ZONE 2 TIMERS

SELZ2T can be set to either YES or NO. For a Zone 1 Extension scheme, set SELZ2T=YES.

0207: PUTL2P – PHASE TIMER**0208: PUTL2G – GROUND TIMER****0209: Z2PANG – PHASE CHARACTERISTIC ANGLE****0210: Z2GANG – GROUND CHARACTERISTIC ANGLE**

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME" for a description of the considerations for the above settings.

2.4.4 ZONE 3 AND 4 DISTANCE FUNCTIONS

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the required settings for these two categories.

2.4.5 OVERCURRENT SUPERVISION**0501: PUIPT – GROUND PILOT TRIP (IPT) OVERCURRENT****0502: PUIPB – GROUND PILOT BLOCK (IPB) OVERCURRENT**

For a Zone 1 Extension scheme, the pilot overcurrent functions are not used. IPT and IPB can be set for any value within their range without affecting scheme operation.

0503: PUIT – TRIP SUPERVISION (IT) OVERCURRENT**0504: PUIB – BLOCK SUPERVISION (IB) OVERCURRENT**

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip bus seal-in circuit. For a Zone 1 Extension scheme, IT and IB should have the same setting. PUIT and PUIB can be set over the range of 0.20 - 4.00 amps. It is recommended that PUIT and PUIB be set at their minimum value.

2.4.6 SCHEME LOGIC TIMERS

- 1301: PUTL1 – TRIP INTEGRATOR (TL1) PICKUP**
1306: PUTL4 – POTT COORDINATION (TL4) PICKUP
1307: DOTL4 – POTT COORDINATION (TL4) DROPOUT

PUTL1 can be set over the range of 1 - 50 milliseconds. PUTL4 and DOTL4 can be set over the range of 0 - 50 milliseconds. For a Zone 1 Extension scheme, PUTL1, PUTL4, and DOTL4 can all be left at any setting within their range without affecting scheme operation.

- 1302: PUTL5 – 52/B CONTACT COORDINATION (TL5) PICKUP**
1303: DOTL5 – 52/B CONTACT COORDINATION (TL5) DROPOUT
1304: PUTL6 – 52/B CONTACT COORDINATION (TL6) PICKUP
1305: DOTL6 – 52/B CONTACT COORDINATION (TL6) DROPOUT

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the Zone 1 Extension scheme logic, these timers are not a part of that logic. However, the DLP3's Sequence of Events function uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in the Elementary Diagram. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

If the recloser is disabled (SELRCLR= 0 or 1), then the output of CC1 provides the input to timer TL5. If the recloser is functional (SELRCLR = 3 or 6), then the output of CC1 is an input to the recloser, and timer TL5 is only used for reporting.

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 time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

1308: PUTLT16 – WEAK INFEEED TRIP

PUTL16 can be set over the range of 8 - 99 milliseconds. Since TL16 is not part of the Step Distance scheme logic, PUTL16 can be set at any value within its range.

1309: PUTLCFG – CONFIGURABLE TRIP PICKUP

PUTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the pickup delay associated with Configurable Output #4 when CONOUT4 = 1, 2, 3, or 4. Its value depends on how Configurable Output #4 is being used.

1310: DOTLCFG – CONFIGURABLE TRIP DROPOUT

DOTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1 or 2. With CONOUT = 3 or 4, the programmed conditions that cause a DLP trip may not result in a seal-in of the trip bus. In this case, DOTLCFG is fixed at 25 ms to ensure that the trip contacts stay closed long enough to accomplish the desired result.

2.4.7 REMOTE OPEN DETECTOR

1001: SELROD – SELECT REMOTE OPEN DETECTOR

SELROD can be set to either YES or NO. When SELROD=YES, the Remote Open function is in service. When SELROD=NO, the Remote Open function is out of service. For a Zone 1 Extension scheme, it is suggested that the Remote Open function be placed in service to obtain faster tripping for faults on the protected line near the remote end that would not normally be cleared until expiration of the Zone 2 timer.

1002: PUTL20 – TIMER (TL20) DELAY

TL20 provides the time delay associated with the Remote Open function. PUTL20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTL20 be set at 40.

1003: SELFFB – BLOCK TRIPPING FOR FUSE FAILURE

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.4.8 EXAMPLE ZONE 1 EXTENSION SCHEME SETTINGS**a) SCHEME SELECTION, SCHEMESEL**

SELSCM=0 (STEPDST)
NUMRCVR=0

b) ZONE 1 DISTANCE FUNCTIONS, Z1DIST

SELZIG=YES
SELZ1P=YES
 $Z1R = 0.9 \times 6 = 5.40$
 $Z1GR = 0.9 \times 6 = 5.40$

Since $Z1(\text{source})/Z1(\text{line}) = 2/6 = 0.33$, the protected line is considered "long" and the Zone 1 ground-distance functions are selected to be Mho units.

SELZ1U=0 (MHO)
Z1SU = <NOT APPLICABLE>
 $Z1K0 = 0.95 \times (19.2/6) = 3.0$
Z1ERST = 0

For purposes of illustration, the Z1SU reach setting will be determined assuming SELZ1U=1(REACT). Referring to Figures 2–1: SAMPLE 345 KV SYSTEM and 2–9: Z1SU SETTING.

$ZL = 19.7 / 5.6^\circ$
K0 = 3.0
A = 50
C = 5.6
D = 85
E = 85 – 5.6 = 79.4
 $Z1SU = 19.7 \times \sin(50^\circ) / \sin(180^\circ - 50^\circ - 79.4^\circ) = 19.53$

c) ZONE 2 / PILOT ZONE, Z2DIST

SELZ2G=YES
SELZ2P=YES
 $Z2R = 1.25 \times 6 = 7.50$ ohms
 $Z2GR = 1.25 \times 6 = 7.50$ ohms
SELZ2U = <NOT APPLICABLE>

SELZ2T=YES PUTL2P = 0.2 seconds
 PUTL2G = 0.2 seconds
 Z2PANG=90 Z2GANG=90

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is used to check Z2R and Z2PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

$$MR = 19.5 \text{ ohms}$$

Consequently, with Z2R=7.50 and Z2PANG=90, there is no risk of having the MT functions pick up for the maximum load condition. Similarly, with Z2GR=7.50 and Z2GANG=90, the apparent impedance for the maximum load condition will not plot within the MTG characteristic.

d) ZONE 3 DISTANCE FUNCTIONS, Z3DIST

SELZ3G=NO
 SELZ3P=NO

e) ZONE 4 DISTANCE FUNCTIONS, Z4DIST

SELZ4G=NO
 SELZ4P=NO

With the above two settings, the Zone 3 and Zone 4 functions are out of service and the other settings associated with Zone 3 and Zone 4 can be set at any value within their range.

f) OVERCURRENT SUPERVISION, CURSUPVIS

PUIPT = <NOT APPLICABLE>
 PUIPB = <NOT APPLICABLE>
 PUIT = 0.20 amps
 PUIB = 0.20 amps

g) SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1 = <NOT APPLICABLE>
 PUTL4 = <NOT APPLICABLE>
 DOTL4 = <NOT APPLICABLE>

Since NUMBKRS=1, only TL5 requires settings.

PUTL5 = 80 ms.
 DOTL5 = 100 ms.
 PUTL6 = <NOT APPLICABLE>
 DOTL6 = <NOT APPLICABLE>
 PUTL16 = <NOT APPLICABLE>

h) REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD=YES
 PUTL20= 40 ms.
 SELFFB=YES

2.5.1 SCHEME SELECTION

1201: SELSCM – SELECT SCHEME

SELSCM=1 (POTT)

1202: NUMRCVR – NUMBER OF RECEIVERS

For a two-terminal POTT scheme using frequency-shift channel equipment, set NUMRCVR=1, and wire the receiver output contact to contact converter 3 (CC3). For a three-terminal line application, set NUMRCVR=2, and wire one receiver to CC3 and the second receiver to CC4.

2.5.2 ZONE 1 DISTANCE FUNCTIONS

0101: SELZ1G – SELECT ZONE 1 GROUND**0102: SELZ1P – SELECT ZONE 1 PHASE**

SELZ1G and SELZ1P can be set to either YES or NO. This setting determines whether the Zone 1 distance functions are in service (YES) or out of service (NO). For a POTT scheme, the Zone 1 functions may be used as a backup zone, but are not required.

0103: Z1R – REACH SETTING (M1) ZONE 1 PHASE**0104: Z1GR – REACH SETTING (M1G) ZONE 1 GROUND****0105: SELZ1U – SELECT ZONE 1 GROUND UNIT****0106: Z1SU – REACH SETTING OF MHO UNIT****0107: Z1K0 – ZERO-SEQUENCE CURRENT COMPENSATION****0108: Z1ERST – ZONE 1 REACH RESET TIMER**

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.5.3 ZONE 2 / PILOT ZONE

0201: SELZ2G – SELECT ZONE 2 GROUND**0202: SELZ2P – SELECT ZONE 2 PHASE**

SELZ2G and SELZ2P can be set to either YES or NO. For a POTT scheme, set SELZ2G and SELZ2P to YES.

In a POTT scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondly, the MT and MTG functions may be used for Zone 2 backup. A Z2R and Z2GR reach setting that satisfies the requirements of both uses simultaneously may be impossible or undesirable. For example, the required Zone 2 backup reach may be less than the desired reach for the pilot overreaching zone. In this case, the Zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the Zone 2 reach, and the M4 and M4G functions can be set for the Zone 3 reach.

The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a discussion of the settings for Zone 2 backup

0203: Z2R – REACH SETTING (MT) ZONE 2 PHASE

Z2R can be set over the range of 0.01 - 50.00 ohms. In a POTT scheme, Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault-current sources. For a two-terminal line, it is suggested that Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to cause the MT functions to pick up on the maximum load flow.

0204: Z2GR – REACH SETTING (MTG) ZONE 2 GROUND

Z2GR can be set over the range of 0.01 - 50.00 ohms. In a POTT scheme, Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. For a two-terminal line with no mutual coupling, it is suggested that Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram.

0205: SELZ2U – SELECT ZONE 2 GROUND UNIT

SELZ2U can be set to 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting chooses either Mho ground-distance, or ground directional-overcurrent, or both, for the pilot overreaching zone. The ground directional-overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U=1 (GDOC), Zone 2 distance backup protection is provided with SELZ2G=YES. With SELZ2U=2 (MHOGDOC), both Mho ground-distance and ground directional-overcurrent functions are operating simultaneously for the pilot overreaching zone, provided SELZ2G=YES.

For a POTT scheme, any one of the three settings is possible.

0206: SELZ2T – SELECT ZONE 2 TIMERS

SELZ2T can be set to either YES or NO. For a POTT scheme where the MT and MTG functions are also used for Zone 2 backup, SELZ2T=YES must be selected. If the MT and MTG functions are used exclusively for the pilot overreaching zone, set SELZ2T=NO

0207: PUTL2P – PHASE TIMER**0208: PUTL2G – GROUND TIMER**

If SELZ2T=YES, refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

0209: Z2PANG – PHASE CHARACTERISTIC ANGLE**0210: Z2GANG – GROUND CHARACTERISTIC ANGLE**

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.5.4 ZONE 3 AND 4 DISTANCE FUNCTIONS

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the required settings for these two categories.

2.5.5 OVERCURRENT SUPERVISION**0501: PUIPT – GROUND PILOT TRIP (IPT) OVERCURRENT**

If SELZ2U=1 (GDOC) or SELZ2U=2 (MHOGDOC), IPT logically ANDed with the negative- sequence directional function (NT), is the pilot directional-overcurrent trip function. The IPT operating quantity is:

$$3x|I_0|$$

PUIPT can be set over the range of 0.50 - 5.00 amps. It is suggested that PUIPT be set to its minimum value of 0.50 amps.

0502: PUIPB – GROUND PILOT BLOCK (IPB) OVERCURRENT

For a POTT scheme, IPB is not used and can be set for any value within its range without affecting scheme operation.

0503: PUIT – TRIP SUPERVISION (IT) OVERCURRENT**0504: PUIB – BLOCK SUPERVISION (IB) OVERCURRENT**

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip-bus seal-in circuit. For a POTT scheme, IT and IB should have the same setting. PUIT and PUIB can be set over the range of 0.20 - 4.00 amps. It is recommended that PUIT and PUIB be set at their minimum value.

2.5.6 SCHEME LOGIC TIMERS**1301: PUTL1 – TRIP INTEGRATOR (TL1) PICKUP**

PUTL1 can be set over the range of 1 - 50 milliseconds. For a POTT scheme, TL1 provides security against spurious channel output during external faults within the reach of the over-reaching trip functions. PUTL1 should be based on the maximum output, if any, expected from the channel under these conditions. If current reversals are possible, see the discussion below for TL4.

1306: PUTL4 – POTT COORDINATION (TL4) PICKUP

PUTL4 can be set over the range of 0 - 50 milliseconds. For a POTT scheme, the pickup time delays of TL4 and TL1 provide transient-blocking coordination to prevent a misoperation for current reversals that can occur when sequentially clearing faults on a parallel line. If there is no parallel line, set PUTL4=0 and set PUTL1 as described above under TL1. If there is a parallel line, then:

$$\text{PUTL1}=8 \text{ ms.}$$

$$\text{PUTL4} = 17 \text{ ms.} - \text{PUTL1} + \text{channel release time (in ms.)}$$

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.

1307: DOTL4 – POTT COORDINATION (TL4) DROPOUT

DOTL4 can be set over the range of 0 - 50 milliseconds. For a POTT scheme, DOTL4 is normally set to 0.

1302: PUTL5 – 52/B CONTACT COORDINATION (TL5) PICKUP**1303: DOTL5 – 52/B CONTACT COORDINATION (TL5) DROPOUT****1304: PUTL6 – 52/B CONTACT COORDINATION (TL6) PICKUP****1305: DOTL6 – 52/B CONTACT COORDINATION (TL6) DROPOUT**

All of these can be set over the range of 0 - 200 milliseconds. For a POTT scheme, the 52/b contacts are required to key the local transmitter to the TRIP frequency when the breaker(s) are open. If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

If the recloser is disabled (SELRCLR= 0 or 1), then the output of CC1 provides the input to timer TL5. If the recloser is functional (SELRCLR = 3 or 6), then the output of CC1 is an input to the recloser, and timer TL5 is only used for reporting.

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 time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

1308: PUTLT16 – WEAK INFEED TRIP

PUTLT16 can be set over the range of 8 - 99 milliseconds. Since TL16 is not part of the Step Distance scheme logic, PUTLT16 can be set at any value within its range.

1309: PUTLCFG – CONFIGURABLE TRIP PICKUP

PUTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the pickup delay associated with Configurable Output #4 when CONOUT4 = 1, 2, 3, or 4. Its value depends on how Configurable Output #4 is being used.

1310: DOTLCFG – CONFIGURABLE TRIP DROPOUT

DOTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1 or 2. With CONOUT = 3 or 4, the programmed conditions that cause a DLP trip may not result in a seal-in of the trip bus. In this case, DOTLCFG is fixed at 25 ms to ensure that the trip contacts stay closed long enough to accomplish the desired result.

2.5.7 REMOTE OPEN DETECTOR**1001: SELROD – SELECT REMOTE OPEN DETECTOR**

SELROD can be set to either YES or NO. When SELROD=YES, the Remote Open function is in service. When SELROD=NO, the Remote Open function is out of service. For a POTT scheme, the Remote Open function will not normally provide faster tripping, and may be placed out of service.

1002: PUTL20 – REMOTE OPEN TIMER (TL20) PICKUP

TL20 provides the time delay associated with the Remote Open function. PUTL20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTL20 be set at 40. If SELROD=NO, this setting has no effect.

1003: SELFFB – SELECT FUSE FAILURE BLOCK

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above setting.

2.5.8 EXAMPLE POTT SETTINGS**a) SCHEME SELECTION, SCHEMESEL**

SELSCM=1 (POTT)
NUMRCVR=1

b) ZONE 1 DISTANCE FUNCTIONS, Z1DIST

SELZIG=YES
SELZ1P=YES
 $Z1R = 0.9 \times 6 = 5.40$
 $Z1GR = 0.9 \times 6 = 5.40$

Since $Z1(\text{source})/Z1(\text{line}) = 2/6 = 0.33$, the protected line is considered "long" and the Zone 1 ground-distance functions are selected to be Mho units.

SELZ1U=0 (MHO)
Z1SU = <NOT APPLICABLE>
 $Z1K0 = 0.95 \times (19.2/6) = 3.0$
Z1ERST = <NOT APPLICABLE>

c) ZONE 2 / PILOT ZONE, Z2DIST

SELZ2G=YES
 SELZ2P= YES
 $Z2R = 2.0 \times 6 = 12.00$ ohms
 $Z2GR = 2.0 \times 6 = 12.00$ ohms
 SELZ2U=2 (MHOGDOC)
 SELZ2T=NO
 PUTL2P = <NOT APPLICABLE>
 PUTL2G = <NOT APPLICABLE>
 Z2PANG=90
 Z2GANG=90

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is used to check Z2R and Z2PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

$$MR = 19.5 \text{ ohms}$$

Consequently, with Z2R=12.00 and Z2PANG=90, there is no risk of having the MT functions pick up for the maximum load condition. Similarly, with Z2GR=12.00 and Z2GANG=90, the apparent impedance for the maximum load condition will not plot within the MTG characteristic.

d) ZONE 3 & 4 DISTANCE FUNCTIONS, Z3DIST & Z4DIST

Refer to the "Example Settings" section under " SETTINGS FOR STEP DISTANCE SCHEME " for an example of how to calculate the settings for these two categories. For this example, SELZ2T=NO, therefore the Z3DIST settings will be based on Zone 2 considerations and Z4DIST settings will be based on Zone 3 considerations.

e) OVERCURRENT SUPERVISION, CURSUPVIS

PUIPT = 0.50 amps
 PUIPB = <NOT APPLICABLE>
 PUIT = 0.20 amps
 PUIB = 0.20 amps

f) SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1=3 ms.

Since there are no parallel lines associated with the protected line, TL4 is set at 0.

PUTL4 = 0
 DOTL4 = 0
 PUTL5 = 80 ms.
 DOTL5 = 100 ms.
 PUTL6 = <NOT APPLICABLE>
 DOTL6 = <NOT APPLICABLE>
 PUTL16 = <NOT APPLICABLE>

g) REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD=NO
 PUTL20 = <NOT APPLICABLE>
 SELFFB=YES

2.6.1 SCHEME SELECTION

1201: SELSCM – SELECT SCHEME

SELSCM=2 (PUTT)

1202: NUMRCVR – NUMBER OF RECEIVERS

For a two-terminal PUTT scheme using frequency-shift-keying channel equipment, set NUMRCVR=1, and wire the receiver output contact to contact converter 3 (CC3). For a three-terminal line application, set NUMRCVR=2, and wire one receiver to CC3 and the second receiver to CC4.

2.6.2 ZONE 1 DISTANCE FUNCTIONS

0101: SELZ1G – SELECT ZONE 1 GROUND**0102: SELZ1P – SELECT ZONE 1 PHASE**

Select Zone 1 Phase, SELZ1P (0102) SELZ1G and SELZ1P can be set to either YES or NO. Both SELZ1G and SELZ1P must be set to YES for a PUTT scheme.

0103: Z1R – REACH SETTING (M1) ZONE 1 PHASE**0104: Z1GR – REACH SETTING (M1G) ZONE 1 GROUND****0105: SELZ1U – SELECT ZONE 1 GROUND UNIT****0106: Z1SU – REACH SETTING OF MHO UNIT****0107: Z1K0 – ZERO-SEQUENCE CURRENT COMPENSATION****0108: Z1ERST – ZONE 1 REACH RESET TIMER**

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.6.3 ZONE 2 / PILOT ZONE

0201: SELZ2G – SELECT ZONE 2 GROUND**0202: SELZ2P – SELECT ZONE 2 PHASE**

SELZ2G and SELZ2P can be set to either YES or NO. For a PUTT scheme, set SELZ2G and SELZ2P to YES.

In a PUTT scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondly, the MT and MTG functions may be used for Zone 2 backup. A Z2R and Z2GR reach setting that satisfies the requirements of both uses simultaneously may be impossible or undesirable. For example, the required Zone 2 backup reach may be less than the desired reach for the pilot overreaching zone. In this case, the Zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the Zone 2 reach, and the M4 and M4G functions can be set for the Zone 3 reach.

The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a discussion of the settings for Zone 2 backup.

0203: Z2R – REACH SETTING (MT) ZONE 2 PHASE**0204: Z2GR – REACH SETTING (MTG) ZONE 2 GROUND**

Refer to the previous section entitled "SETTINGS FOR PERMISSIVE OVERREACH TRANSFER TRIP SCHEME " for a description of the considerations for the above settings.

0205: SELZ2U – SELECT ZONE 2 GROUND UNIT

SELZ2U can be set to 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting chooses either Mho ground-distance, or ground directional-overcurrent, or both, for the pilot overreaching zone. The ground directional-overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U=1 (GDOC), Zone 2 distance backup protection is provided with SELZ2G=YES. With SELZ2U=2 (MHOGDOC), both Mho ground-distance and ground directional-overcurrent functions are operating simultaneously for the pilot overreaching zone, provided SELZ2G=YES.

For a PUTT scheme, any one of the three settings is possible. Since Zone 1 uses only distance functions, there is not much value in using ground directional-overcurrent functions for the overreaching zone, and it is suggested that SELZ2U=0 (MHO).

0206: SELZ2T – SELECT ZONE 2 TIMERS

SELZ2T can be set to either YES or NO. For a PUTT scheme, where the MT and MTG functions are also used for Zone 2 backup, SELZ2T=YES must be selected. If the MT and MTG functions are used exclusively for the pilot overreaching zone, set SELZ2T=NO.

0207: PUTL2P – PHASE TIMER**0208: PUTL2G – GROUND TIMER**

If SELZ2T=YES, refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

0209: Z2PANG – PHASE CHARACTERISTIC ANGLE**0210: Z2GANG – GROUND CHARACTERISTIC ANGLE**

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.6.4 ZONE 3 AND 4 DISTANCE FUNCTIONS

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the required settings for these two categories.

2.6.5 OVERCURRENT SUPERVISION**0501: PUIPT – GROUND PILOT TRIP (IPT) OVERCURRENT**

If the suggested setting SELZ2U=0 (MHO) is used for the PUTT scheme, IPT is not used. Refer to the previous section entitled "SETTINGS FOR PERMISSIVE OVERREACH TRANSFER TRIP SCHEME " if IPT is used.

0502: PUIPB – GROUND PILOT BLOCK (IPB) OVERCURRENT

For a PUTT scheme, IPB is not used and can be set for any value within its range without affecting scheme operation.

0503: PUIT – TRIP SUPERVISION (IT) OVERCURRENT**0504: PUIB – BLOCK SUPERVISION (IB) OVERCURRENT**

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip bus seal-in circuit. For a PUTT scheme, IT and IB should have the same setting. PUIT and PUIB can be set over the range of 0.20 - 4.00 amps. It is recommended that PUIT and PUIB be set at their minimum value.

2.6.6 SCHEME LOGIC TIMERS

1301: PUTL1 – TRIP INTEGRATOR (TL1) PICKUP

PUTL1 can be set over the range of 1 - 50 milliseconds. For a PUTT scheme, TL1 provides security against spurious channel output during external faults within the reach of the overreaching trip functions. PUTL1 should be based on the maximum output, if any, expected from the channel under these conditions.

1306: PUTL4 – POTT COORDINATION (TL4) PICKUP

PUTL4 can be set over the range of 0 - 50 milliseconds. 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. Set PUTL4=0.

1307: DOTL4 – POTT COORDINATION (TL4) DROPOUT

DOTL4 can be set over the range of 0 - 50 milliseconds. For a PUTT scheme, set DOTL4=0.

1302: PUTL5 – 52/B CONTACT COORDINATION (TL5) PICKUP**1303: DOTL5 – 52/B CONTACT COORDINATION (TL5) DROPOUT****1304: PUTL6 – 52/B CONTACT COORDINATION (TL6) PICKUP****1305: DOTL6 – 52/B CONTACT COORDINATION (TL6) DROPOUT**

All of these can be set over the range of 0 - 200 milliseconds. For a PUTT scheme, 52/b contact keying of the local transmitter to the TRIP frequency when the breaker is open is required with a two-terminal line, but, to prevent tripping on external faults with one end open, it should not be used at any end of a three-terminal line. If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

If the recloser is disabled (SELRCLR= 0 or 1), then the output of CC1 provides the input to timer TL5. If the recloser is functional (SELRCLR = 3 or 6), then the output of CC1 is an input to the recloser, and timer TL5 is only used for reporting.

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 time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

1308: PUTLT16 – WEAK INFEED TRIP

PUTL16 can be set over the range of 8 - 99 milliseconds. Since TL16 is not part of the Step Distance scheme logic, PUTL16 can be set at any value within its range.

1309: PUTLCFG – CONFIGURABLE TRIP PICKUP

PUTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the pickup delay associated with Configurable Output #4 when CONOUT4 = 1, 2, 3, or 4. Its value depends on how Configurable Output #4 is being used.

1310: DOTLCFG – CONFIGURABLE TRIP DROPOUT

DOTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1 or 2. With CONOUT = 3 or 4, the programmed conditions that cause a DLP trip may not result in a seal-in of the trip bus. In this case, DOTLCFG is fixed at 25 ms to ensure that the trip contacts stay closed long enough to accomplish the desired result.

2.6.7 REMOTE OPEN DETECTOR**1001: SELROD – SELECT REMOTE OPEN DETECTOR**

SELROD can be set to either YES or NO. When SELROD=YES, the Remote Open function is in service. When SELROD=NO, the Remote Open function is out of service. For a PUTT scheme, the Remote Open function will not normally provide faster tripping, and may be placed out of service.

1002: PUTL20 – REMOTE OPEN TIMER (TL20) PICKUP

TL20 provides the time delay associated with the Remote Open function. PUTL20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTL20 be set at 40. If SELROD=NO, this setting has no effect.

1003: SELFFB – SELECT FUSE FAILURE BLOCK

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above setting.

2.6.8 EXAMPLE PUTT SETTINGS**a) SCHEME SELECTION, SCHEMESEL**

SELSCM=2 (PUTT)
NUMRCVR=1

b) ZONE 1 DISTANCE FUNCTIONS, Z1DIST

SELZIG=YES
SELZ1P=YES
Z1R = $0.9 \times 6 = 5.40$
Z1GR = $0.9 \times 6 = 5.40$

Since $Z1(\text{source})/Z1(\text{line}) = 2/6 = 0.33$, the protected line is considered "long" and the Zone 1 ground-distance functions are selected to be Mho units.

SELZ1U=0 (MHO)
Z1SU = <NOT APPLICABLE>
Z1K0 = $0.95 \times (19.2/6) = 3.0$
Z1ERST = <NOT APPLICABLE>

c) ZONE 2 / PILOT ZONE, Z2DIST

SELZ2G=YES
SELZ2P=YES
Z2R = $2.0 \times 6 = 12.00$ ohms
Z2GR = $2.0 \times 6 = 12.00$ ohms
SELZ2U=0 (MHO)
SELZ2T=NO
PUTL2P = <NOT APPLICABLE>
PUTL2G = <NOT APPLICABLE>
Z2PANG=90
Z2GANG=90

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is used to check Z2R and Z2PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

$$MR = 19.5 \text{ ohms}$$

Consequently, with Z2R=12.00 and Z2PANG=90, there is no risk of having the MT functions pick up for the maximum load condition. Similarly, with Z2GR=12.00 and Z2GANG=90, the apparent impedance for the maximum load condition will not plot within the MTG characteristic.

d) ZONE 3 & 4 DISTANCE FUNCTIONS, Z3DIST & Z4DIST

Refer to the " Example Settings " section under " SETTINGS FOR STEP DISTANCE SCHEME " for an example of how to calculate the settings for these two categories. For this example, SELZ2T=NO, therefore the Z3DIST settings will be based on Zone 2 considerations and Z4DIST settings will be based on Zone 3 considerations.

e) OVERCURRENT SUPERVISION, CURSUPVIS

PUIPT = <NOT APPLICABLE>
 PUIPB = <NOT APPLICABLE>
 PUIT = 0.20 amps
 PUIB = 0.20 amps

f) SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1 = 3 ms.
 PUTL4 = 0
 DOTL4 = 0
 PUTL5 = 80 ms.
 DOTL5 = 100 ms.
 PUTL6 = <NOT APPLICABLE>
 DOTL6 = <NOT APPLICABLE>
 PUTL16 = <NOT APPLICABLE>

g) REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD=NO
 PUTL20 = <NOT APPLICABLE>
 SELFFB=YES

2.7.1 SCHEME SELECTION

1201: SELSCM – SELECT SCHEME

Three Blocking scheme logics are available. The schemes are described in Section 1.3.6: BLOCKING SCHEME on page 1–15.

- SELSCM = 4 (BLK1) – directional carrier start using IPB with positive-sequence current restraint
- SELSCM = 6 (BLK2) – non-directional carrier start using the fault detector
- SELSCM = 7 (BLK3) – non-directional carrier start using IPB without positive-sequence current restraint

The BLK1 scheme is the standard DLP Blocking scheme logic; the BLK2 and BLK3 schemes offer alternative carrier starting options to aid in coordination when the DLP relay is used in a blocking scheme with relays of different designs at other terminals. The BLK2 scheme starts the blocking carrier whenever the DLP Fault Detector operates. Because the DLP Fault Detector responds to all fault types and some changes in load current, carrier may be started for more conditions than desired. The pickup of the Fault Detector is not adjustable and is approximately 0.6 ampere of phase current for a radial single line to ground fault. The BLK3 scheme uses a non-directional zero-sequence current function (IPB) to start carrier. This function is intended to respond only to faults involving ground and is similar to design to the carrier start functions in many existing electromechanical relay schemes. The operating time versus current magnitude for the FD and IPB functions used in the BLK2 and BLK3 schemes is shown below.

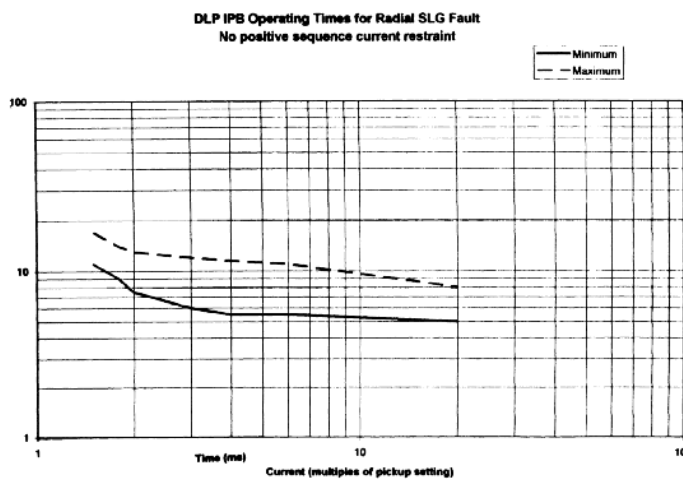
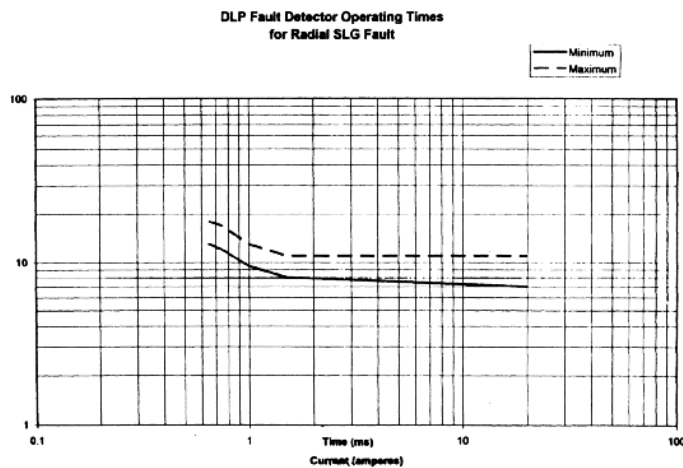


Figure 2–13: FD AND IPB OPERATING TIMES

1202: NUMRCVR – NUMBER OF RECEIVERS

For a BLOCKING scheme using ON-OFF channel equipment, set NUMRCVR=1, and wire the receiver output contact to contact converter 3 (CC3). Since all the ON-OFF receivers operate at the same frequency, regardless of the number of line terminals, this setting is always the same.

2.7.2 ZONE 1 DISTANCE FUNCTIONS**0101: SELZ1G – SELECT ZONE 1 GROUND****0102: SELZ1P – SELECT ZONE 1 PHASE**

SELZ1G and SELZ1P can be set to either YES or NO. This setting determines whether the Zone 1 distance functions are in service (YES) or out of service (NO). For a BLOCKING scheme, the Zone 1 functions may be used as a backup zone, but are not required.

0103: Z1R – REACH SETTING (M1) ZONE 1 PHASE**0104: Z1GR – REACH SETTING (M1G) ZONE 1 GROUND****0105: SELZ1U – SELECT ZONE 1 GROUND UNIT****0106: Z1SU – REACH SETTING OF MHO UNIT****0107: Z1K0 – ZERO-SEQUENCE CURRENT COMPENSATION****0108: Z1ERST – ZONE 1 REACH RESET TIMER**

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.7.3 ZONE 2 / PILOT ZONE**0201: SELZ2G – SELECT ZONE 2 GROUND****0202: SELZ2P – SELECT ZONE 2 PHASE**

SELZ2G and SELZ2P can be set to either YES or NO. For a BLOCKING scheme, set SELZ2G and SELZ2P to YES. In a BLOCKING scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondly, the MT and MTG functions may be used for Zone 2 backup. A Z2R and Z2GR reach setting that satisfies the requirements of both uses simultaneously may be impossible or undesirable. For example, the required Zone 2 backup reach may be less than the desired reach for the pilot overreaching zone. In this case, the Zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the Zone 2 reach, and the M4 and M4G functions can be set for the Zone 3 reach. The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a discussion of the settings for Zone 2 backup.

In a BLOCKING scheme, the pilot-overreaching-zone tripping functions at the local end must coordinate with the blocking functions at the remote end for an external fault behind the remote end. If this reach (or pickup level) coordination is not achieved, a misoperation (over-trip) for an external fault can occur. Simply stated, for an external fault behind the remote terminal, the blocking functions at the remote end must operate for any fault for which the pilot- overreaching-zone tripping functions at the local end operate.

0203: Z2R – REACH SETTING (MT) ZONE 2 PHASE

Z2R can be set over the range of 0.01 - 50.00 ohms. In a BLOCKING scheme, Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault-current sources. For a two-terminal line, it is suggested that Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to cause the MT functions to pick up on the maximum load flow. In addition, the Z2R setting must allow the MT tripping functions to coordinate with the reversed-M4 blocking functions at the remote end(s).

0204: Z2GR – REACH SETTING (MTG) ZONE 2 GROUND

Z2GR can be set over the range of 0.01 - 50.00 ohms. In a BLOCKING scheme, Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero- sequence mutual coupling with a parallel line. For a two-terminal line with no mutual coupling, it is suggested that Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram. In addition, the Z2GR setting must allow the MTG tripping functions to coordinate with the reversed-M4G blocking functions at the remote end(s).

0205: SELZ2U – SELECT ZONE 2 GROUND UNIT

This setting chooses either Mho ground-distance, ground directional-overcurrent, or both, for the pilot overreaching zone. The ground directional-overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U=1 (GDOC), Zone 2 distance backup protection is provided with SELZ2G=YES. With SELZ2U=2 (MHO GDOC), both Mho ground-distance and ground directional-overcurrent functions are operating simultaneously for the pilot overreaching zone, provided SELZ2G=YES.

For a BLOCKING scheme, any one of the three settings is possible.

0206: SELZ2T – SELECT ZONE 2 TIMERS

SELZ2T can be set to either YES or NO. For a BLOCKING scheme, where the MT and MTG functions are also used for Zone 2 backup, SELZ2T=YES must be selected. If the MT and MTG functions are used exclusively for the pilot overreaching zone, set SELZ2T=NO.

0207: PUTL2P – PHASE TIMER**0208: PUTL2G – GROUND TIMER**

If SELZ2T=YES, refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

0209: Z2PANG – PHASE CHARACTERISTIC ANGLE**0210: Z2GANG – GROUND CHARACTERISTIC ANGLE**

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.7.4 ZONE 3 DISTANCE FUNCTIONS

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the required settings for this category.

2.7.5 ZONE 4 DISTANCE FUNCTIONS**0401: SELZ4G – SELECT ZONE 4 GROUND**

SELZ4G can be set to either YES or NO. For a BLOCKING scheme, where SELZ2U=0 (MHO) or SELZ2U=2 (MHO GDOC), the MTG tripping functions are active and SELZ4G=YES must be selected. If SELZ2U=1 (GDOC), then set SELZ4G=NO.

0402: SELZ4P – SELECT ZONE 4 PHASE

SELZ4P can be set to either YES or NO. For a BLOCKING scheme, SELZ4P=YES is required, since the MT tripping functions are always used.

0411: SELZ4D – SELECT DIRECTION

The directional sense of Zone 4 can be reversed. SELZ4D can be set to either 0 (FORWRD) forward or 1 (REVERS) reverse. In a BLOCKING scheme, the Zone 4 distance functions must be reverse-looking. Set SELZ4D=1 (REVERS).

0403: Z4R – REACH SETTING (M4) ZONE 4 PHASE

Z4R can be set over the range of 0.01 - 50.00 ohms. In a BLOCKING scheme the local blocking zone reversed-M4 functions key the local transmitter to send a blocking signal to the remote end to prevent the remote end from tripping on an external multi-phase fault behind the local end. The Z4R setting must be such that the reversed-M4 functions coordinate with the MT tripping functions at the remote end(s). Z4R should never be set so large as to cause the M4 functions to pick up on the maximum load flow.

0405: Z4OR – PHASE OFFSET REACH

The Zone 4 phase-distance functions can be set with an "offset" reach that is in the opposite direction from that determined by the SELZ4D setting. The Z4OR setting is a multiplier and the actual ohmic offset is equal to $(0.00 - 0.40) \times Z4R$. A reversed-M4 characteristic with offset is shown in Figure 2–12: ZONE 4 PHASE-DISTANCE R-X DIAGRAM on page 2–41. For a BLOCKING scheme, an offset reach is required. An offset setting keeps the reversed-M4 functions continuously energized for the duration of an external, bolted, zero-voltage fault at the relay location, since, with offset, M4 can operate on fault current only. This permits continuous keying of the local transmitter to sustain the blocking signal being sent to the remote end.

0404: Z4GR – ZONE 4 GROUND

Z4GR can be set over the range of 0.01 - 50.00 ohms. In a BLOCKING scheme the local blocking zone reversed-M4G functions key the local transmitter to send a blocking signal to the remote end to prevent the remote end from tripping on an external ground fault behind the local end. The Z4GR setting must be such that the reversed-M4G functions coordinate with the MTG tripping functions at the remote end(s). Z4GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the M4G characteristic on an R-X diagram.

If the MT or MTG reach at the remote end is less than twice the positive-sequence impedance of the line, then the proposed settings are:

$$Z4R = 0.85 \times (Z2R \text{ [REMOTE]})$$

$$Z4GR = 0.85 \times (Z2GR \text{ [REMOTE]})$$

If the MT or MTG reach at the remote end is greater than twice the positive-sequence impedance of the line, then the proposed settings are:

$$Z4R = 1.7 \times (Z2R \text{ [REMOTE]} - Z1L)$$

$$Z4GR = 1.7 \times (Z2GR \text{ [REMOTE]} - Z1L)$$

where: Z1L = positive-sequence impedance of the protected line

0406: SELZ4T – SELECT ZONE 4 TIMERS

SELZ4T can be set to either YES or NO. For a BLOCKING scheme, the reversed Zone 4 functions may serve as a backup zone as well as a pilot blocking zone. If this backup feature is desired, set SELZ4T=YES to put TL4P and TL4G in service. Set SELZ4T=NO to place TL4P and TL4G out of service.

0407: PUTL4P – PHASE TIMER SETTING

If SELZ4T=YES and the reversed-M4 functions are to serve as a backup zone as well as a pilot blocking zone, then the TL4P time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of phase-distance relays, added to the breaker(s) trip time. If SELZ4T=NO, then PUTL4P may be set to any value within its range with no effect on scheme operation. PUTL4P can be set over the range of 0.10 - 10.00 seconds.

0408: PUTL4G – GROUND TIMER SETTING

If SELZ4T=YES and the reversed-M4G functions are to serve as a backup zone as well as a pilot blocking zone, then the TL4G time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of ground-distance relays, added to the breaker(s) trip time. If SELZ4T=NO, then PUTL4G may be set to any value within its range with no effect on scheme operation. PUTL4G can be set over the range of 0.10 - 10.00 seconds.

0409: Z4PANG – PHASE CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, by the reversed-M4 phase-distance functions. Z4PANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. An 80° setting is recommended. If the desired reach, Z4R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a characteristic associated with the 90°, 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

0410: Z4GANG – GROUND CHARACTERISITIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the reversed-M4G ground-distance functions. Z4GANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. An 80° setting should be used unless the desired reach, Z4GR, is such that the impedance point associated with the maximum load flow plots within the M4G steady-state characteristic. For such a case, the characteristic associated with the 90°, 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

2.7.6 OVERCURRENT SUPERVISION**0501: PUIPT – GROUND PILOT TRIP (IPT) FUNCTION****0502: PUIPB – GROUND PILOT BLOCK (IPB) FUNCTION**

For a BLOCKING scheme, the pilot overcurrent functions are in service if SELZ2U=1 (GDOC) or SELZ2U=2 (MHOGDOC). IPT, logically ANDed with the forward-looking negative-sequence directional function (NT), is the pilot directional-overcurrent tripping function. The IPT operating quantity is:

$$3x|I_0| - 3xKTx|I_1|$$

where: $KT = 0.1$

Positive-sequence restraint is used to provide secure operation during steady-state unbalance, error currents, and external faults. PUIPT can be set over the range of 0.50 - 5.00 amps.

IPB, logically ANDed with the reverse-looking negative-sequence directional function (NB), is the pilot directional-overcurrent blocking function. The IPB operating quantity is:

$$3x|I_0| - 3xKBx|I_1|$$

where: $KB = 0.066$ for BLK1 and 0.0 for BLK3

PUIPB can be set over the range of 0.25 - 3.75 amps. PUIPB should be set to its minimum setting of 0.25 amps. For two-terminal line applications, PUIPT should be set to its minimum setting of 0.50 amps for lines less than 100 miles long, and 0.75 amps for lines greater than 100 miles in length, to compensate for the increased charging current. PUIPT must be set higher than PUIPB at the remote terminal to assure local-trip remote-block coordination.

For three-terminal line applications, the coordination margins indicated by the suggested PUIPT and PUIPB settings given here may, in the worst case, have to be doubled. For two- or three-terminal applications, such as cable circuits, where the zero-sequence charging current is significant, the magnitude of charging current should be calculated to establish an adequate coordination margin.

In the BLK3 scheme, PUIPB should be set to provide coordination with the ground pilot tripping function used at the remoter terminal(s). In any application, PUIPB should never be more than 50% of the setting of the ground pilot tripping function used at the remote terminal.

0503: PUIT – TRIP SUPERVISION (IT) OVERCURRENT

0504: PUIB – BLOCK SUPERVISION (IB) OVERCURRENT

The IT overcurrent function provides supervision for the tripping-zone distance functions, and IT is used in the trip bus seal-in circuit. The IB overcurrent function provides supervision for the reversed-M4 and reversed-M4G blocking-zone distance functions. For a BLOCKING scheme, the local PUIT and remote PUIB settings must coordinate. PUIT and PUIB can be set over the range of 0.20 - 4.00 amps. PUIB should be set for 0.20 amps. For two-terminal line applications, it is recommended that PUIT be set at 0.40 amps for lines less than 100 miles long, and 0.60 amps for lines greater than 100 miles in length, to compensate for the increased charging current.

For three-terminal line applications, this coordination margin may, in the worst case, have to be doubled. For two- or three-terminal applications, such as cable circuits, where the zero-sequence charging current is significant, the magnitude of charging current should be calculated to establish an adequate coordination margin.

2.7.7 SCHEME LOGIC TIMERS

1301: PUTL1 – TRIP INTEGRATOR (TL1) PICKUP

PUTL1 can be set over the range of 1 - 50 milliseconds. For a BLOCKING scheme, PUTL1 delays tripping at the local end until a blocking signal can be received from the remote end for an external fault behind the remote end. The setting is determined by two factors: (1) the worst- case time coordination between the remote blocking functions and the local pilot tripping functions and (2) the total remote-transmitter-keying to local-receiver-output time delay, which is equal to the back-to-back channel time plus the propagation time.

$$\text{PUTL1} = 8 \text{ ms.} + \text{channel time (ms.)} + \text{propagation time (ms.)}$$

1306: PUTL4 – POTT COORDINATION (TL4) PICKUP

1307: DOTL4 – POTT COORDINATION (TL4) DROPOUT

For a BLOCKING scheme, TL4 is not used. PUTL4 and DOTL4 can be left at any setting within their range without affecting scheme operation.

1302: PUTL5 – 52/B CONTACT COORDINATION (TL5) PICKUP

1303: DOTL5 – 52/B CONTACT COORDINATION (TL5) DROPOUT

1304: PUTL6 – 52/B CONTACT COORDINATION (TL6) PICKUP

1305: DOTL6 – 52/B CONTACT COORDINATION (TL6) DROPOUT

All of these can be set over the range of 0 - 200 milliseconds. Since breaker-position information is not required for the BLOCKING scheme logic, these timers are not a part of that logic. However, the DLP3's Sequence of Events function uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on

page 1–44. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

If the recloser is disabled (SELRCLR= 0 or 1), then the output of CC1 provides the input to timer TL5. If the recloser is functional (SELRCLR = 3 or 6), then the output of CC1 is an input to the recloser, and timer TL5 is only used for reporting.

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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 time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

1308: PUTLT16 – WEAK INFEED TRIP

PUTL16 can be set over the range of 8 - 99 milliseconds. Since TL16 is not part of the Step Distance scheme logic, PUTL16 can be set at any value within its range.

1309: PUTLCFG – CONFIGURABLE TRIP PICKUP

PUTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the pickup delay associated with Configurable Output #4 when CONOUT4 = 1, 2, 3, or 4. Its value depends on how Configurable Output #4 is being used.

1310: DOTLCFG – CONFIGURABLE TRIP DROPOUT

DOTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1 or 2. With CONOUT = 3 or 4, the programmed conditions that cause a DLP trip may not result in a seal-in of the trip bus. In this case, DOTLCFG is fixed at 25 ms to ensure that the trip contacts stay closed long enough to accomplish the desired result.

2.7.8 REMOTE OPEN DETECTOR

1001: SELROD – SELECT REMOTE OPEN DETECTOR

SELROD can be set to either YES or NO. When SELROD=YES, the Remote Open function is in service. When SELROD=NO, the Remote Open function is out of service. For certain applications of a BLOCKING scheme, where some faults can only be cleared sequentially following fault-current redistribution after one end trips, it is suggested that the Remote Open function be placed in service, to obtain possible faster tripping.

1002: PUTL20 – REMOTE OPEN TIMER (TL20) PICKUP

TL20 provides the time delay associated with the Remote Open function. PUTL20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTL20 be set at 40.

1003: SELFFB – SELECT FUSE FAILURE BLOCK

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above setting.

2.7.9 EXAMPLE BLOCKING SCHEME SETTINGS

a) SCHEME SELECTION, SCHEMESEL

SELSCM = 4 (BLK1)
NUMRCVR = 1

b) ZONE 1 DISTANCE FUNCTIONS, Z1DIST

SELZIG=YES
 SELZ1P=YES
 $Z1R = 0.9 \times 6 = 5.40$
 $Z1GR = 0.9 \times 6 = 5.40$

Since $Z1(\text{source})/Z1(\text{line}) = 2/6 = 0.33$, the protected line is considered "long" and the Zone 1 ground-distance functions are selected to be Mho units.

SELZ1U=0 (MHO)
 Z1SU = <NOT APPLICABLE>
 $Z1K0 = 0.95 \times (19.2/6) = 3.0$
 Z1ERST = <NOT APPLICABLE>

c) ZONE 2 / PILOT ZONE, Z2DIST

SELZ2G=YES
 SELZ2P=YES
 $Z2R = 2.0 \times 6 = 12.00$ ohms
 $Z2GR = 2.0 \times 6 = 12.00$ ohms
 SELZ2U=2 (MHOGDOC)
 SELZ2T=NO
 PUTL2P = <NOT APPLICABLE>
 PUTL2G = <NOT APPLICABLE>
 Z2PANG=90
 Z2GANG=90

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is used to check Z2R and Z2PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

$$MR = 19.5 \text{ ohms}$$

Consequently, with $Z2R=12.00$ and $Z2PANG=90$, there is no risk of having the MT functions pick up for the maximum load condition. Similarly, with $Z2GR=12.00$ and $Z2GANG=90$, the apparent impedance for the maximum load condition will not plot within the MTG characteristic.

d) ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the " Example Step Distance Settings " section under " SETTINGS FOR STEP DISTANCE SCHEME " for an example of how to calculate the settings for this category. For this example, SELZ2T= NO, therefore the Z3DIST settings will be based on Zone 2 considerations.

e) ZONE 4 DISTANCE FUNCTIONS, Z4DIST

SELZ4G=YES
 SELZ4P=YES
 SELZ4D=1 (REVERS)

Since Z2R at the remote end is exactly twice the positive-sequence impedance of the protected line:

$$Z4R = 0.85 \times 12.00 = 10.20 \text{ ohms}$$

The proposed offset for the reversed-M4 functions is as close to 0.5 ohms as the Z4OR setting will allow. For this example, with $Z4OR=0.05$:

$$\text{Offset ohms} = Z4OR \times Z4R = 0.05 \times 10.20 = 0.51 \text{ ohms,}$$

which is as close to 0.5 ohms as attainable.

Z4OR = 0.05
 Z4GR = $0.85 \times 12.00 = 10.20$ ohms
 SELZ4T=NO
 PUTL4P = <NOT APPLICABLE>
 PTTL4G = <NOT APPLICABLE>

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The characteristic angle setting for the blocking functions should be set 10° less than the characteristic angle of the pilot overreaching functions at the remote end.

Z4PANG=80
 Z4GANG=80

f) OVERCURRENT SUPERVISION, CURSUPVIS

PUIPT = 0.50 amps
 PUIPB = 0.25 amps
 PUIT = 0.40 amps
 PUIB = 0.20 amps

g) SCHEME LOGIC TIMERS, SCHEMETIM

The channel time of a wide-band CS28 power-line-carrier set is 2 milliseconds. Assuming negligible propagation time, $PUTL1 = 8 + 2 + 0 = 10$ milliseconds.

PUTL1=10 ms.
 PUTL4 = <NOT APPLICABLE>
 DOTL4 = <NOT APPLICABLE>

Since NUMBKRS=1, only TL5 requires settings.

PUTL5 = 80 ms.
 DOTL5 = 100 ms.
 PUTL6 = <NOT APPLICABLE>
 DOTL6 = <NOT APPLICABLE>
 PUTL16 = <NOT APPLICABLE>

h) REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD=NO
 PUTL20 = <NOT APPLICABLE>
 SELFFB=YES

2.8.1 SCHEME SELECTION**1201: SELSCM – SELECT SCHEME**

SELSCM=3 (HYBRID)

1202: NUMRCVR – NUMBER OF RECEIVERS

For a two-terminal HYBRID scheme using frequency-shift-keying channel equipment, set NUMRCVR=1, and wire the receiver output contact to contact converter 3 (CC3). For a three-terminal line application set NUMRCVR=2, and wire one receiver to CC3 and the second receiver to CC4.

2.8.2 ZONE 1 DISTANCE FUNCTIONS**0101: SELZ1G – SELECT ZONE 1 GROUND****0102: SELZ1P – SELECT ZONE 1 PHASE**

SELZ1G and SELZ1P can be set to either YES or NO. This setting determines whether the Zone 1 distance functions are in service (YES) or out of service (NO). For a HYBRID scheme, the Zone 1 functions may be used as a backup zone, but are not required.

0103: Z1R – REACH SETTING (M1) ZONE 1 PHASE**0104: Z1GR – REACH SETTING (M1G) ZONE 1 GROUND****0105: SELZ1U – SELECT ZONE 1 GROUND UNIT****0106: Z1SU – REACH SETTING OF MHO UNIT****0107: Z1K0 – ZERO-SEQUENCE CURRENT COMPENSATION****0108: Z1ERST – ZONE 1 REACH RESET TIMER**

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.8.3 ZONE 2 / PILOT ZONE**0201: SELZ2G – SELECT ZONE 2 GROUND****0202: SELZ2P – SELECT ZONE 2 PHASE**

SELZ2G and SELZ2P can be set to either YES or NO. For a HYBRID scheme, set SELZ2G and SELZ2P to YES.

In a HYBRID scheme, the pilot-overreaching zone consists of the MT and MTG functions.

Secondarily, the MT and MTG functions may be used for Zone 2 backup. A Z2R and Z2GR reach setting that satisfies the requirements of both uses simultaneously may be impossible or undesirable. For example, the required Zone 2 backup reach may be less than the desired reach for the pilot overreaching zone. In this case, the Zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the Zone 2 reach, and the M4 and M4G functions can be set for the Zone 3 reach.

In a HYBRID scheme, the pilot-overreaching-zone tripping functions at the local end must coordinate with the blocking functions at the remote end for an external fault behind the remote end. If this reach (or pickup level) coordination is not achieved, a misoperation (over-trip) for an external fault can occur. Simply stated, for an external fault behind the remote terminal, the blocking functions at the remote end must operate for any fault for which the pilot-overreaching- zone tripping functions at the local end operate.

The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a discussion of the settings for Zone 2 backup.

0203: Z2R – REACH SETTING (MT) ZONE 2 PHASE

Z2R can be set over the range of 0.01 - 50.00 ohms. In a HYBRID scheme, Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault-current sources. For a two-terminal line, it is suggested that Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to cause the MT functions to pick up on the maximum load flow. In addition, the Z2R setting must allow the MT tripping functions to coordinate with the reversed-M4 blocking functions at the remote end(s).

0204: Z2GR – REACH SETTING (MTG) ZONE 2 GROUND

Z2GR can be set over the range of 0.01 - 50.00 ohms. In a HYBRID scheme, Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault-current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. For a two-terminal line with no mutual coupling, it is suggested that Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram. In addition, the Z2GR setting must allow the MTG tripping functions to coordinate with the reversed-M4G blocking functions at the remote end(s).

0205: SELZ2U – SELECT ZONE 2 GROUND UNIT

SELZ2U can be set to 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting chooses either Mho ground-distance, or ground directional-overcurrent, or both, for the pilot overreaching zone. The ground directional-overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U=1 (GDOC), Zone 2 distance backup protection is provided with SELZ2G=YES. With SELZ2U=2 (MHOGDOC), both Mho ground-distance and ground directional-overcurrent functions are operating simultaneously for the pilot overreaching zone, provided SELZ2G=YES.

For a HYBRID scheme, any one of the three settings is possible.

0206: SELZ2T – SELECT ZONE 2 TIMERS

SELZ2T can be set to either YES or NO. For a HYBRID scheme, where the MT and MTG functions are also used for Zone 2 backup, SELZ2T=YES must be selected. If the MT and MTG functions are used exclusively for the pilot-overreaching zone, set SELZ2T=NO.

0207: PUTL2P – PHASE TIMER**0208: PUTL2G – GROUND TIMER**

If SELZ2T=YES, refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

0209: Z2PANG – PHASE CHARACTERISTIC ANGLE**0210: Z2GANG – GROUND CHARACTERISTIC ANGLE**

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above settings.

2.8.4 ZONE 3 DISTANCE FUNCTIONS

Refer to the previous section entitled "SETTINGS FOR STEP DISTANCE SCHEME " for a description of the required settings for this category.

2.8.5 ZONE 4 DISTANCE FUNCTIONS

0401: SELZ4G – SELECT ZONE 4 GROUND

SELZ4G can be set to either YES or NO. For a HYBRID scheme, where SELZ2U=0 (MHO) or SELZ2U=2 (MHOODOC), the MTG tripping functions are active and SELZ4G=YES **must** be selected. If SELZ2U=1 (ODOC), then set SELZ4G=NO.

0402: SELZ4P – SELECT ZONE 4 PHASE

SELZ4P can be set to either YES or NO. For a HYBRID scheme, SELZ4P=YES is required, since the MT tripping functions are always used.

0411: SELZ4D – SELECT DIRECTION

The directional sense of Zone 4 can be reversed. SELZ4D can be set to either 0 (FORWRD) forward or 1 (REVERS) reverse. In a HYBRID scheme, the Zone 4 distance functions **must** be reverse-looking. Set SELZ4D=1 (REVERS).

0403: Z4R – REACH SETTING (M4) ZONE 4 PHASE

Z4R can be set over the range of 0.01 - 50.00 ohms. In a HYBRID scheme the local blocking zone reversed-M4 functions block the echo circuit from keying the local transmitter to prevent the remote end from tripping on an external multi-phase fault behind the local end. The Z4R setting must be such that the reversed-M4 functions coordinate with the MT tripping functions at the remote end(s). Z4R should never be set so large as to cause the M4 functions to pick up on the maximum load flow.

0405: Z4OR – PHASE OFFSET REACH

The Zone 4 phase-distance functions can be set with an "offset" reach, which is in the opposite direction from that determined by the SELZ4D setting. The Z4OR setting is a multiplier and the actual ohmic offset is equal to $(0.00 - 0.40) \times Z4R$ ohms. A reversed-M4 characteristic with offset is shown in Figure 2-12: ZONE 4 PHASE-DISTANCE R-X DIAGRAM on page 2-41. For a HYBRID scheme, an offset reach is required. An offset setting keeps the reversed-M4 functions continuously energized for the duration of an external, bolted, zero-voltage fault at the relay location, since, with offset, M4 can operate on fault current only. This prevents the echo circuit from keying the local transmitter for the duration of the external fault.

0404: Z4GR – REACH SETTING (M4G) ZONE 4 GROUND

Z4GR can be set over the range of 0.01 - 50.00 ohms. In a HYBRID scheme the local blocking zone reversed-M4G functions block the echo circuit from keying the local transmitter to prevent the remote end from tripping on an external ground fault behind the local end. The Z4GR setting must be such that the reversed-M4G functions coordinate with the MTG tripping functions at the remote end(s). Z4GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the M4G characteristic on an R-X diagram.

If the MT or MTG reach at the remote end is less than twice the positive-sequence impedance of the line, then the proposed settings are:

$$Z4R = 0.85 \times (Z2R \text{ [REMOTE]})$$

$$Z4GR = 0.85 \times (Z2GR \text{ [REMOTE]})$$

If the MT or MTG reach at the remote end is greater than twice the positive-sequence impedance of the line, then the proposed settings are:

$$Z4R = 1.7 \times (Z2R \text{ [REMOTE]} - Z1L)$$

$$Z4GR = 1.7 \times (Z2GR \text{ [REMOTE]} - Z1L)$$

where: Z_{1L} = positive-sequence impedance of the protected line

0406: SELZ4T – SELECT ZONE 4 TIMERS

SELZ4T can be set to either YES or NO. For a HYBRID scheme, the reversed Zone 4 functions may serve as a backup zone as well as a pilot blocking zone. If this backup feature is desired, set SELZ4T=YES to put TL4P and TL4G in service. Set SELZ4T=NO to place TL4P and TL4G out of service.

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0407: PUTL4P – PHASE TIMER

If SELZ4T=YES and the reversed-M4 functions are to serve as a backup zone as well as a pilot blocking zone, then the TL4P time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of phase-distance relays, added to the breaker(s) trip time. If SELZ4T=NO, then PUTL4P may be set to any value within its range with no effect on scheme operation. PUTL4P can be set over the range of 0.10 - 10.00 seconds.

0408: PUTL4G – GROUND TIMER

If SELZ4T=YES and the reversed-M4G functions are to serve as a backup zone as well as a pilot blocking zone, then the TL4G time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of ground-distance relays, added to the breaker(s) trip time. If SELZ4T=NO, then PUTL4G may be set to any value within its range with no effect on scheme operation. PUTL4G can be set over the range of 0.10 - 10.00 seconds.

0409: Z4PANG – PHASE CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, by the reversed-M4 phase-distance functions. Z4PANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. An 80° setting is recommended. If the desired reach, Z4R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a characteristic associated with the 90°, 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

0410: Z4GANG – GROUND CHARACTERISTIC ANGLE

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram, of the reverse-M4G ground-distance functions. Z4GANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. An 80° setting should be used unless the desired reach, Z4GR, is such that the impedance point associated with the maximum load flow plots within the M4G steady-state characteristic. For such a case, the characteristic associated with the 90°, 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

2.8.6 OVERCURRENT SUPERVISION

0501: PUIPT – GROUND PILOT TRIP (IPT) OVERCURRENT

0502: PUIPB – GROUND PILOT BLOCK (IPB) OVERCURRENT

For a HYBRID scheme, the pilot overcurrent functions are in service if SELZ2U=1 (GDOC), or SELZ2U=2 (MHOGDOC). IPT, logically ANDed with the forward-looking negative-sequence directional function (NT), is the pilot directional-overcurrent tripping function. The IPT operating quantity is:

$$3x|I_0| - 3xKTx|I_1|$$

where: $KT = 0.1$

Positive-sequence restraint is used to provide secure operation during steady-state unbalance, error currents, and external faults. PUIPT can be set over the range of 0.50 - 5.00 amps.

IPB, logically ANDed with the reverse-looking negative-sequence directional function (NB), is the pilot directional-overcurrent blocking function. The IPB operating quantity is:

$$3x|I_0| - 3xKBx|I_1|$$

where: KB = 0.066

PUIPB can be set over the range of 0.25 - 3.75 amps.

PUIPB should be set to its minimum setting of 0.25 amps. For two-terminal line applications, PUIPT should be set to its minimum setting of 0.50 amps for lines less than 100 miles long, and 0.75 amps for lines greater than 100 miles in length, to compensate for the increased charging current. PUIPT must be set higher than IPB at the remote terminal, to assure local-trip remote-block coordination.

For three-terminal line applications, the coordination margins indicated by the suggested PUIPT and PUIPB settings given here may, in the worst case, have to be doubled. For two- or three-terminal applications, such as cable circuits, where the zero-sequence charging current is significant, the magnitude of charging current should be calculated to establish an adequate coordination margin.

0503: PUIT – TRIP SUPERVISION (IT) OVERCURRENT

0504: PUIB – BLOCK SUPERVISION (IB) OVERCURRENT

The IT overcurrent function provides supervision for the tripping-zone distance functions, and IT is used in the trip-bus seal-in circuit. The IB overcurrent function provides supervision for the reversed-M4 and reversed-M4G blocking-zone distance functions. For a HYBRID scheme, the local PUIT and remote PUIB settings must coordinate. PUIT and PUIB can be set over the range of 0.20 - 4.00 amps. PUIB should be set for 0.20 amps. For two-terminal line applications, it is recommended that PUIT be set at 0.40 amps for lines less than 100 miles long, and 0.60 amps for lines greater than 100 miles in length, to compensate for the increased charging current.

For three-terminal line applications, this coordination margin may, in the worst case, have to be doubled. For two- or three-terminal applications, such as cable circuits, where the zero-sequence charging current is significant, the magnitude of charging current should be calculated to establish an adequate coordination margin.

2.8.7 SCHEME LOGIC TIMERS

1301: PUTL1 – TRIP INTEGRATOR (TL1) PICKUP

PUTL1 can be set over the range of 1 - 50 milliseconds. For a HYBRID scheme, TL1 provides security against spurious channel output during external faults within the reach of the overreaching trip functions. PUTL1 should be based on the maximum output, if any, expected from the channel under these conditions.

1306: PUTL4 – POTT COORDINATION (TL4) PICKUP

1307: DOTL4 – POTT COORDINATION (TL4) DROPOUT

For a HYBRID scheme, TL4 is not used. PUTL4 and DOTL4 can be left at any setting within their range without affecting scheme operation.

1302: PUTL5 – 52/B CONTACT COORDINATION (TL5) PICKUP

1303: DOTL5 – 52/B CONTACT COORDINATION (TL5) DROPOUT

1304: PUTL6 – 52/B CONTACT COORDINATION (TL6) PICKUP

1305: DOTL6 – 52/B CONTACT COORDINATION (TL6) DROPOUT

All of these can be set over the range of 0 - 200 milliseconds. Since breaker-position information is not required for the HYBRID scheme logic, these timers are not a part of that logic. However, the DLP3's Sequence of Events function uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed."

If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

2

If the recloser is disabled (SELRCLR= 0 or 1), then the output of CC1 provides the input to timer TL5. If the recloser is functional (SELRCLR = 3 or 6), then the output of CC1 is an input to the recloser, and timer TL5 is only used for reporting.

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 time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

1308: PUTLT16 – WEAK INFEED TRIP

Note: Timer TL16 is only functional when SELSCM = 3 (HYBRID)!

PUTL16 can be set over the range of 8 - 99 milliseconds. The pickup delay of timer TL16 is used to provide security in the weak infeed tripping logic. It should be set to override any outputs from the receiver during weak infeed fault conditions. Normally, PUTL16 will be set at its minimum value of 8 milliseconds.

When PUTL16 = 99, the pickup delay becomes infinite, effectively disabling the weak infeed tripping logic.

PUTL16 should never be set greater than the pickup delay of timer TL11 in Figure 1–10:: HYBRID LOGIC DIAGRAM on page 1–21 if weak infeed tripping is desired. For a Hybrid scheme (SELSCM = 3), the pickup delay of TL11 is 80 ms for two-terminal applications (NUMRCVR = 1) and 50 ms for three-terminal applications (NUMRCVR = 2).

1309: PUTLCFG – CONFIGURABLE TRIP PICKUP

PUTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the pickup delay associated with Configurable Output #4 when CONOUT4 = 1, 2, 3, or 4. Its value depends on how Configurable Output #4 is being used.

1310: DOTLCFG – CONFIGURABLE TRIP DROPOUT

DOTLCFG can be set over the range of 0 to 100 milliseconds. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1 or 2. With CONOUT = 3 or 4, the programmed conditions that cause a DLP trip may not result in a seal-in of the trip bus. In this case, DOTLCFG is fixed at 25 ms to ensure that the trip contacts stay closed long enough to accomplish the desired result.

2.8.8 REMOTE OPEN DETECTOR

1001: SELROD – SELECT REMOTE OPEN DETECTOR

SELROD can be set to either YES or NO. When SELROD=YES, the Remote Open function is in service. When SELROD=NO, the Remote Open function is out of service. For a HYBRID scheme, the Remote Open Detector function will not normally provide faster tripping, and may be placed out of service.

1002: PUTL20 – REMOTE OPEN TIMER (TL20) PICKUP

TL20 provides the time delay associated with the Remote Open function. PUTL20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTL20 be set at 40. If SELROD=NO, then this setting has no effect.

1003: SELFFB – SELECT FUSE FAILURE BLOCK

Refer to the previous section entitled " SETTINGS FOR STEP DISTANCE SCHEME " for a description of the considerations for the above setting.

2.8.9 EXAMPLE HYBRID SCHEME SETTINGS**a) SCHEME SELECTION, SCHEMESEL**

SELSCM=3 (HYBRID)
NUMRCVR=1

b) ZONE 1 DISTANCE FUNCTIONS, Z1DIST

SELZIG=YES
SELZ1P=YES
Z1R = 0.9 x 6 = 5.40
Z1GR = 0.9 x 6 = 5.40

Since $Z1(\text{source})/Z1(\text{line}) = 2/6 = 0.33$, the protected line is considered "long" and the Zone 1 ground-distance functions are selected to be Mho units.

SELZ1U=0 (MHO)
Z1SU = <NOT APPLICABLE>
Z1K0 = 0.95 x (19.2/6) = 3.0
Z1ERST = <NOT APPLICABLE>

c) ZONE 2 / PILOT ZONE, Z2DIST

SELZ2G=YES
SELZ2P=YES
Z2R = 2.0 x 6 = 12.00 ohms
Z2GR = 2.0 x 6 = 12.00 ohms
SELZ2U=2 (MHOGDOC)
SELZ2T=NO
PUTL2P = <NOT APPLICABLE>
PUTL2G = <NOT APPLICABLE>
Z2PANG=90
Z2GANG=90

The formula from Figure 2–11: MAXIMUM ALLOWABLE REACH on page 2–38 is used to check Z2R and Z2PANG.

$$MR = \sin(50^\circ) \times 19.7 / \sin(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$

$$MR = 19.5 \text{ ohms}$$

Consequently, with Z2R=12.00 and Z2PANG=90, there is no risk of having the MT functions pick up for the maximum load condition. Similarly, with Z2GR=12.00 and Z2GANG=90, the apparent impedance for the maximum load condition will not plot within the MTG characteristic.

d) ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the " Example Step Distance Settings " section under " SETTINGS FOR STEP DISTANCE SCHEME " for an example of how to calculate the settings for this category. For this example, SELZ2T= NO, therefore the Z3DIST settings will be based on Zone 2 considerations.

e) ZONE 4 DISTANCE FUNCTIONS, Z4DIST

SELZ4G=YES
 SELZ4P=YES
 SELZ4D=1 (REVERS)

Since Z2R at the remote end is exactly twice the positive-sequence impedance of the protected line:

$$Z4R = 0.85 \times 12.00 = 10.20 \text{ ohms}$$

The proposed offset for the reversed-M4 functions is as close to 0.5 ohms as the Z4OR setting will allow. For this example, with Z4OR=0.05:

$$\text{Offset ohms} = Z4OR \times Z4R = 0.05 \times 10.20 = 0.51 \text{ ohms,}$$

which is as close to 0.5 ohms as attainable.

Z4OR = 0.05
 Z4GR = 0.85 x 12.00 = 10.20 ohms
 SELZ4T=NO
 PUTL4P = <NOT APPLICABLE>
 PTTL4G = <NOT APPLICABLE>

The characteristic angle setting for the blocking functions should be set 10° less than the characteristic angle of the pilot overreaching functions at the remote end.

Z4PANG=80
 Z4GANG=80

f) OVERCURRENT SUPERVISION, CURSUPVIS

PUIPT = 0.50 amps
 PUIPB = 0.25 amps
 PUIT = 0.40 amps
 PUIB = 0.20 amps

g) SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1=3 ms.
 PUTL4 = <NOT APPLICABLE>
 DOTL4 = <NOT APPLICABLE>

Since NUMBKRS=1, only TL5 requires settings.

PUTL5=80 ms.
 DOTL5=100 ms.
 PUTL6 = <NOT APPLICABLE>
 DOTL6 = <NOT APPLICABLE>
 PUTL16=8 ms.

h) REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD=NO
 PUTL20 = <NOT APPLICABLE>
 SELFFB=YES

2.9.1 DESCRIPTION

The current sensitivity for the phase-distance functions is determined from:

$$I_{\phi\phi} Z_{R1} = 0.294 / (1-X)$$

where: $I_{\phi\phi}$ = phase-phase current at relay (i.e., $I_A - I_B$)

Z_{R1} = positive-sequence relay reach

X = actual reach / nominal reach

The expression $(1-X)$ is referred to as the "pull-back" in reach. For example, if $X = 0.9$, then the pull-back in reach is said to be 0.1 or 10%.

2.9.2 EXAMPLE

For the phase pair A-B and:

$$Z_{R1} = 1 \text{ ohm}$$

$$X = 0.9$$

$$(1-X) = 0.1 \quad (10\% \text{ pull-back})$$

$$I_A - I_B = 0.294 / 0.1 = 2.94 \text{ A}$$

For a phase-phase fault:

$$I_A - I_B = 2(I_A) = 2.94 \text{ amps}$$

$$I_A = 1.47 \text{ amps}$$

For a three-phase fault:

$$I_A - I_B = 1.732(I_A) = 2.94 \text{ amps}$$

$$I_A = 1.7 \text{ amps}$$

The current sensitivity for the ground distance functions is determined from:

$$|(I_{\phi} - I_0) Z_{R1} / \phi_1 + I_0 \times K_0 \times Z_{R1} / \phi_0| = 0.22 / (1-X)$$

To use this formula, the ratio I_0 to I_{ϕ} must be known or assumed, where:

I_{ϕ} = phase current at relay

I_0 = zero-sequence current at relay

Z_{R1} = positive-sequence relay reach

ϕ_1 = positive-sequence relay angle (POSANG)

ϕ_0 = zero-sequence relay angle (ZERANG)

K_0 = zero-sequence current compensation factor

X = actual reach / nominal reach

For phase A and:

$$I_A = 3(I_0)$$

$$\phi_1 = \phi_0$$

$$K_0 = 3$$

$$Z_{R1} = 1 \text{ ohm}$$

$$X = 0.9, \text{ thus } (1-X) = 0.1 \quad (10\% \text{ pull-back})$$

$$5/3 I_A = 0.22 / 0.1 = 2.2 \text{ amps}$$

$$I_A = 1.32 \text{ amps}$$

The minimum current required to operate the distance functions for a zero-voltage fault right in front of the relay can be conservatively estimated by setting $X = 0$ in the above formulas.

For example, for the phase pair A-B with:

$$Z_{R1} = 1 \text{ ohm}$$

$$X = 0; (1-X) = 1 \quad (100\% \text{ pull back})$$

$$I_A - I_B = 0.294/1 = 0.294 \text{ amps}$$

For a phase-phase fault:

$$I_A - I_B = 2(I_A) = 0.294 \text{ amps}$$

$$I_A = 0.147 \text{ amps}$$

For a three-phase fault:

$$I_A - I_B = 1.732(I_A) = 0.294 \text{ amps}$$

$$I_A = 0.17 \text{ amps}$$

Assuming a 5-AMP-rated DLP3, the IT current supervision function will limit the distance- function current sensitivity in the above example, since the minimum IT setting is 0.2 amps. In general, the IT-function setting determines the distance-function current sensitivity when its setting exceeds the value calculated from the above formulas.

Table 2–6: USER SETTINGS TABLE (Sheet 1 of 7)

SET#	DESCRIPTION	USER SETTING
01 Zone 1 Distance Functions (Z1DIST)		
0101	Select Zone 1 Ground (SELZ1G)	
0102	Select Zone 1 Phase (SELZ1P)	
0103	Reach Setting M1, Zone 1 Phase (Z1R)	
0104	Reach Setting M1G, Zone 1 Ground (Z1GR)	
0105	Select Zone 1 Ground Unit (SELZ1U)	
0106	Reach Setting of Mho Unit (Z1SU)	
0107	Zero-Sequence Current Compensation (Z1K0)	
0108	Zone 1 Extension Reach Reset Timer (Z1ERST)	
02 Zone 2 / Pilot Zone (Z2DIST)		
0201	Select Zone 2 Ground (SELZ2G)	
0202	Select Zone 2 Phase (SELZ2P)	
0203	Reach Setting MT, Zone 2 Phase (Z2R)	
0204	Reach Setting MTG, Zone 2 Ground (Z2GR)	
0205	Select Zone 2 Ground Unit (SELZ2T)	
0206	Select Zone 2 Timers (SELZ2T)	
0207	Phase Timer Setting (PUTL2P)	
0208	Ground Timer Setting (PUTL2G)	
0209	Phase Characteristic Angle (Z2PANG)	
0210	Ground Characteristic Angle (Z2GANG)	
03 Zone 3 Distance Functions (Z3DIST)		
0301	Select Zone 3 Ground (SELZ3G)	
0302	Select Zone 3 Phase (SELZ3P)	
0303	Reach Setting M3, Zone 3 Phase (Z3R)	
0304	Reach Setting M3G, Zone 3 Ground (Z3GR)	
0305	Phase Timer Setting (PUTL3P)	
0306	Ground Timer Setting (PUTL3G)	
0307	Phase Characteristic Angle (Z3PANG)	
0308	Ground Characteristic Angle (Z3GANG)	

Table 2–6: USER SETTINGS TABLE (Sheet 2 of 7)

SET#	DESCRIPTION	USER SETTING
04 Zone 1 Distance Functions (Z4DIST)		
0401	Select Zone 4 Ground (SELZ4G)	
0402	Select Zone 4 Phase (SELZ4P)	
0403	Reach Setting M4, Zone 4 Phase (Z4R)	
0404	Reach Setting M4G, Zone 4 Ground (Z4GR)	
0405	Phase Offset Reach (Z4OR)	
0406	Select Zone 4 Timers (SELZ4T)	
0407	Phase Timer Setting (PUTL4P)	
0408	Ground Timer Setting (PUTL4G)	
0409	Phase Characteristic Angle (Z4PANG)	
0410	Ground Characteristic Angle (Z4GANG)	
0411	Select Direction (SELZ4D)	
05 Overcurrent Supervision (CURSUPVIS)		
0501	Ground Pilot Trip IPT Overcurrent (PUIPT)	
0502	Ground Pilot Block IPB Overcurrent (PUIPB)	
0503	Trip Supervision IT Overcurrent (PUIT)	
0504	Block Supervision IB Overcurrent (PUIB)	
06 Overcurrent Backup (OVERCUR)		
0601	Select Phase Instantaneous Overcurrent, PH4 (SELPH4)	
0602	Phase Instantaneous Overcurrent Setting (PUPH4)	
0603	Select Ground Instantaneous Overcurrent, IDT (SELIDT)	
0604	Directional Control of IDT (SELDIDT)	
0605	Ground Instantaneous Overcurrent Setting (PUIDT)	
0606	Select Ground Time Overcurrent, TOC (SELTOC)	
0607	Directional Control of TOC (SELDTOC)	
0608	Ground Time Overcurrent Setting (PUTOC)	
0609	Ground Time Overcurrent Time Dial (TDTOC)	
0610	Definite Time Curve Delay Setting (PUTTM)	
0611	Select TOC Curve (SELCURV)	
0612	Ground Instantaneous Positive-Sequence Restraint (KDCONST)	

Table 2–6: USER SETTINGS TABLE (Sheet 3 of 7)

SET#	DESCRIPTION	USER SETTING
07 Block Reclosing (BLKRECLOS)		
0701	Select All (SELALL)	
0702	Out-of-Step Block (RBOSB)	
0703	All Zone 2 Phase Functions (RB3PH)	
0704	Ground Time Overcurrent (RBTOC)	
0705	Zone 2 Timers (RBZ2T)	
0706	Zone 3 Timers (RBZ3T)	
0707	Zone 4 Timers (RBZ4T)	
0708	Any Zone 1 Phase Function (RBZ1PH)	
0709	Any Zone 2 Phase Function (RBZ2PH)	
0710	Configurable Trip Bus (RBCTB)	
08 Out-of-Step Blocking (OUTOFSTEP)		
0801	Select Phase Unit to Coordinate With (SELPTZ)	
0802	Characteristic Angle (MOBANG)	
0803	Select Block Trip Actions (SELOSB)	
0804	Select Zone 1 Block (OSBLKZ1)	
0805	Select Zone 2 Block (OSBLKZ2)	
0806	Select Zone 3 Block (OSBLKZ3)	
0807	Select Zone 4 Block (OSBLKZ4)	
09 Line Pickup (LINEPU)		
0901	Select Line Pickup (SELLPU)	
0902	Select Timer Bypass (DELTBP)	
0903	Positive-Sequence Overcurrent I1 Setting (PUI1)	
10 Remote Open Detector, ROD (REMOTEOPEN)		
1001	Select Remote Open Detector (SELROD)	
1002	Timer TL20 Delay Setting (PUTL20)	
1003	Block Tripping for Fuse Failure (SELFFB)	
11 Line Overload (LINEOVRD)		
1101	Select Line Overload (SELOVL)	
1102	Level 1 Overcurrent Setting (PULV1)	

Table 2-6: USER SETTINGS TABLE (Sheet 4 of 7)

SET#	DESCRIPTION	USER SETTING
1103	Level 2 Overcurrent Setting (PULV2)	
1104	Level 1 Time Delay (PUTL31)	
1105	Level 2 Time Delay (PUTL32)	
12 Scheme Selection (SCHEMESEL)		
1201	Select Scheme (SELSCM)	
1202	Number of Receivers (NUMRCVR)	
1203	Trip Mode (TRPMODE)	
13 Scheme Logic Timers (SCHEMETIM)		
1301	Trip Integrator TL1 Pickup (PUTL1)	
1302	52/b Contact Coordination TL5 Pickup (PUTL5)	
1303	52/b Contact Coordination TL5 Dropout (DOTL5)	
1304	52/b Contact Coordination TL6 Pickup (PUTL6)	
1305	52/b Contact Coordination TL6 Dropout (DOTL6)	
1306	POTT Coordination TL4 Pickup (PUTL4)	
1307	POTT Coordination TL4 Dropout (DOTL4)	
1308	Weak-Infeed-Trip TL16 Pickup (PUTL16)	
1309	Configurable Pickup Time (PUTLCTB)	
1310	Configurable Dropout Time (DOTLCTB)	
14 Line Quantities (LINEQTY)		
1401	Positive-Sequence Angle of Maximum Reach (POSANG)	
1402	Zero-Sequence Angle of Maximum Reach (ZERANG)	
1403	Positive-Sequence Impedance (ZP)	
1404	Zero-Sequence Current Compensation (K0)	
1405	Line Length (LINELEN)	
15 Configuration Settings (CONFIG)		
1501	Unit ID Number (UNITID)	
1502	System Frequency (SYSFREQ)	
1503	Number of Breakers (NUMBKRS)	
1504	Trip Circuit Monitor (TRIPCIRC)	
1505	Select Primary / Secondary Unit (SELPRIM)	

Table 2–6: USER SETTINGS TABLE (Sheet 5 of 7)

SET#	DESCRIPTION	USER SETTING
1506	Current Transformer Ratio (CTRATIO)	
1507	Potential Transformer Ratio (PTRATIO)	
1508	Unit of Distance (DISTUNIT)	
1509	Communication Port (COMMPORT)	
1510	Phase Designation (PHASDEG)	
1511	Select Time Synchronization (SELTSYNC)	
1512	Number of Faults (NUMFLTS)	
1513	Number of Prefault Cycles (PREFLT)	
1514	Oscillography Trigger (OSCTRIG)	
1515	Current Unbalance Alarm (UNBALALM)	
16 SCADA DTA Interface (SCADADTA)		
1601	SCADA DTA Fault Location Lock (FLTLOCK)	
1602	SCADA DTA Fault Location Reset (FLTRESET)	
17 Configurable Inputs (CNFGINPUTS)		
1701	Configurable Input Mode (CONCCI)	
1702	Settings Group (SETGRP)	
18 Configurable Input #1 (BKR1CLSOUT)		
1801	Close Contact 1 (CONOUT1)	
1802	Input Number 1 (CO1IN1)	
1803	Input Number 2 (CO1IN2)	
1804	Input Number 3 (CO1IN3)	
1805	Input Number 4 (CO1IN4)	
1806	Input Number 5 (CO1IN5)	
1807	Input Number 6 (CO1IN6)	
1808	Input Number 7 (CO1IN7)	
1809	Input Number 8 (CO1IN8)	
19 Configurable Input #2 (BKR2CLSOUT)		
1901	Close Contact 2 (CONOUT2)	
1902	Input Number 1 (CO2IN1)	
1903	Input Number 2 (CO2IN2)	

Table 2–6: USER SETTINGS TABLE (Sheet 6 of 7)

SET#	DESCRIPTION	USER SETTING
1904	Input Number 3 (CO2IN3)	
1905	Input Number 4 (CO2IN4)	
1906	Input Number 5 (CO2IN5)	
1907	Input Number 6 (CO2IN6)	
1908	Input Number 7 (CO2IN7)	
1909	Input Number 8 (CO2IN8)	
20 Configurable Input #3 (RCCANCLOUT)		
2001	Reclose Cancel (CONOUT3)	
2002	Input Number 1 (CO3IN1)	
2003	Input Number 2 (CO3IN2)	
2004	Input Number 3 (CO3IN3)	
2005	Input Number 4 (CO3IN4)	
2006	Input Number 5 (CO3IN5)	
2007	Input Number 6 (CO3IN6)	
2008	Input Number 7 (CO3IN7)	
2009	Input Number 8 (CO3IN8)	
21 Configurable Input #4 (LNOVLDOUT)		
2101	Line Overload (CONOUT4)	
2102	Input Number 1 (CO4IN1)	
2103	Input Number 2 (CO4IN2)	
2104	Input Number 3 (CO4IN3)	
2105	Input Number 4 (CO4IN4)	
2106	Input Number 5 (CO4IN5)	
2107	Input Number 6 (CO4IN6)	
2108	Input Number 7 (CO4IN7)	
2109	Input Number 8 (CO4IN8)	
22 Configurable Input #5 (NONCRITOUT)		
2201	Noncritical Alarm (CONOUT5)	
2202	Input Number 1 (CO5IN1)	
2203	Input Number 2 (CO5IN2)	

Table 2–6: USER SETTINGS TABLE (Sheet 7 of 7)

SET#	DESCRIPTION	USER SETTING
2204	Input Number 3 (CO5IN3)	
2205	Input Number 4 (CO5IN4)	
2206	Input Number 5 (CO5IN5)	
2207	Input Number 6 (CO5IN6)	
2208	Input Number 7 (CO5IN7)	
2209	Input Number 8 (CO5IN8)	
23 Configurable Input #6 (RINITOUT)		
2301	Reclose Initiate (CONOUT6)	
2302	Input Number 1 (CO6IN1)	
2303	Input Number 2 (CO6IN2)	
2304	Input Number 3 (CO6IN3)	
2305	Input Number 4 (CO6IN4)	
2306	Input Number 5 (CO6IN5)	
2307	Input Number 6 (CO6IN6)	
2308	Input Number 7 (CO6IN7)	
2309	Input Number 8 (CO6IN8)	
24 Recloser Settings (RECLOSER)		
2401	Recloser Scheme (SELRCLR)	
2402	Single-Pole Reclose Delay 1 (SPRDLY1)	
2403	Three-Pole Reclose Delay 1 (TPRDLY1)	
2404	Reclose Delay 2 (RDLY2)	
2405	Hold Mode (HOLD)	
2406	Hold Time Delay (HOLDDLY)	
2407	Dwell Time Delay (DWELLTM)	
2408	Reset Time Delay (RSTDLY)	

2

3.1.1 CONSTRUCTION

CAUTION: Power down the relay with the power switch or by removing one of the connection plugs before removing or inserting modules. Failure to do so can permanently damage the relay.

The case that houses the electronic modules is constructed from an aluminum alloy. It consists of a main frame with side mounting brackets, a front cover and a rear cover.

The front cover, comprised of a metal frame with plate glass, is pivoted on the top and is opened from the bottom by way of two spring-loaded latches. The door is constrained from coming off by tabs that require the door to be unlatched and lifted slightly in order to be removed. A pushbutton extender installed into the plate glass makes it possible to clear the display without removing the front cover.

The rear cover supports terminal blocks that are used in making external connections to the case. The modules are mounted vertically inside the case, and they are supported by sockets on the mother board within the case. In addition to providing this mechanical support, the sockets also offer the means of making the electrical connection to the modules. The modules are further restrained inside the case by the front cover.

Proper alignment of the module with respect to the socket is maintained by slotted guides, one guide above and one guide beneath each module, with the exception of the magnetics module, MGM, which requires two guides above and two beneath, and the man-machine interface module, MMI, which requires three pairs of guides.

3.1.2 ELECTRICAL CONNECTIONS & INTERNAL WIRING

As mentioned earlier, electrical connections are made to the case through seven terminal blocks mounted on the rear cover plate. Each block contains 14 terminal points, which consist of a Number 6 screw threaded into a flat contact plate.

Connection to the printed-circuit-board module is made by means of 96-pin Eurocard connectors. Connection to the MGM module is made by means of two connector sockets; an 8-contact current block and a 104-pin signal block. The current block contacts are rated to handle current transformer (CT) secondary currents, and they are shorted upon removal of the MGM module.

3.1.3 IDENTIFICATION

The DLP3 system model number label is located on the outside of the front cover, and on the right-hand side-sheet inside the case. A marking strip indicating the name and position of every module in a case is included on the front bottom of the case. It is placed to be read when the front cover is removed. Figure 4-1: MODULE LOCATION on page 4-1 shows the location of the modules.

The terminal blocks located on the rear cover plate are uniquely identified by a two-letter code that is found directly beneath the outermost edge of each terminal block. Also, the terminal points (1 through 14) are identified by stamped numbers.

Two connectors, PL1 and PL2, are used for serial communication between the DLP3 and the PC/Modem and printer. PL3 is used for the SCADA DTA output and phase identification contacts. PL4 is a BNC connector, used for an unmodulated IRIG B input.

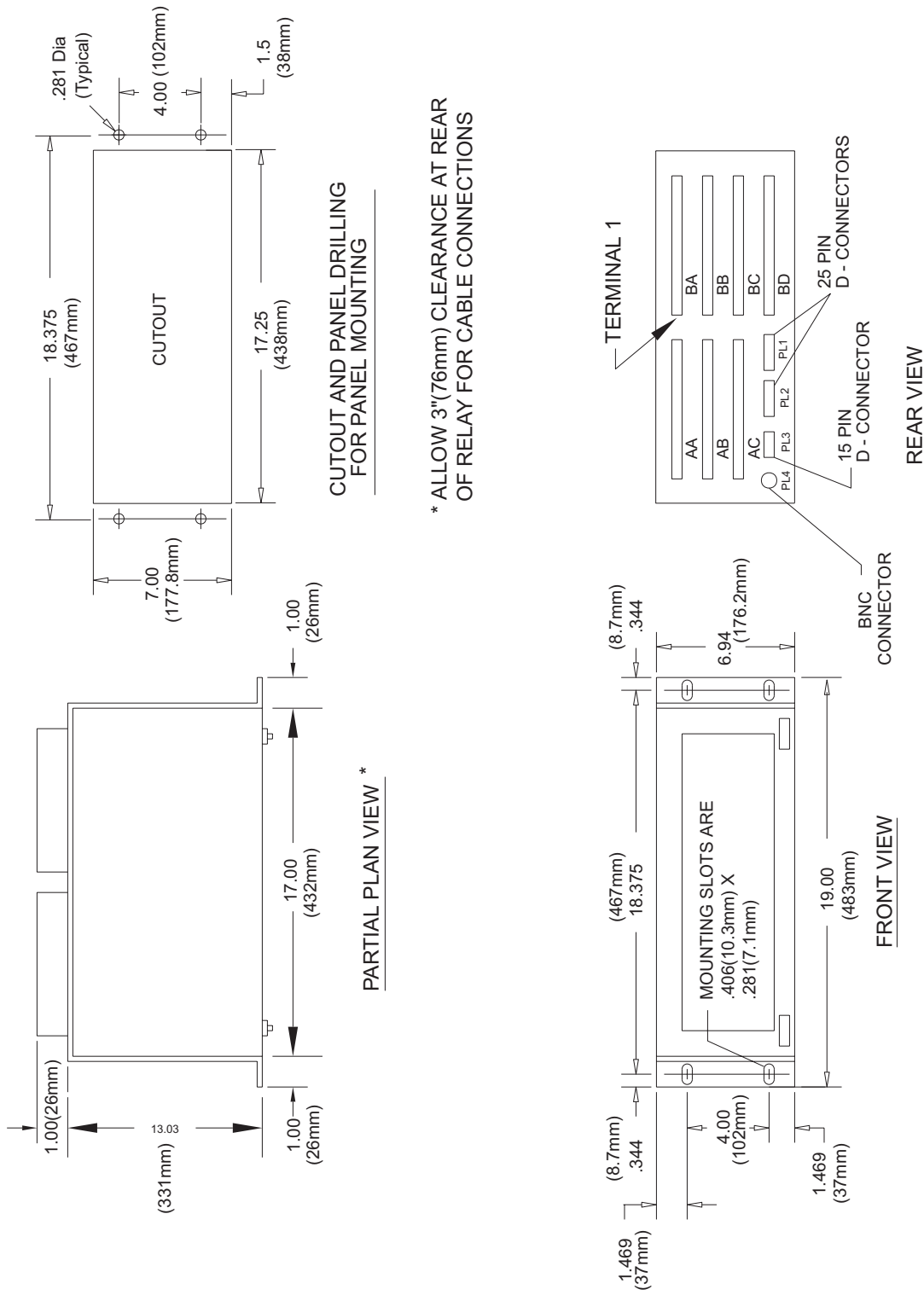
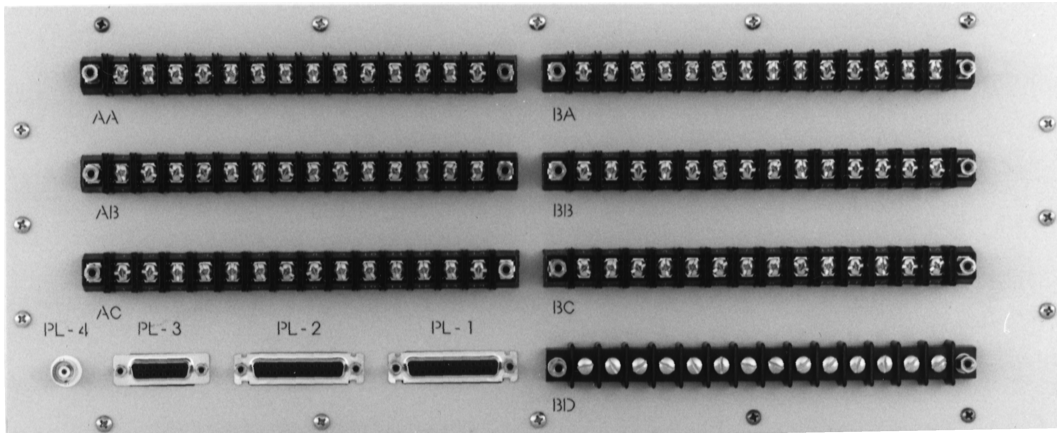


Figure 3-1: OUTLINE DRAWING



FRONT VIEW



REAR VIEW

Figure 3-2: FRONT AND BACK VIEWS (WITH KEYPAD & TEST PLUGS)

3

3.2.1 BASIC CONSTRUCTION

CAUTION: This relay contains electronic components that could be damaged by electrostatic discharge currents if those currents flow through certain terminals of the components. The main source of electrostatic discharge currents is the human body, and the conditions of low humidity, carpeted floors and isolating shoes are conducive to the generation of electrostatic discharge currents. Where these conditions exist, care should be exercised when removing and handling the modules to make settings on the internal switches. The persons handling the modules should make sure that their body charge has been discharged, by touching some surface at ground potential before touching any of the components on the modules.

Each module consists of a printed-circuit board and front panel. Two knobs are provided on the front panel for removing and inserting the module. Electrical connection is made by the 96 pins of the Eurocard connector located at the back of the board.

3.2.2 IDENTIFICATION

Each module has its own identification number, consisting of a three-letter code followed by a three-digit number. These are found at the bottom of each front panel and may be read when the front cover is removed.

3.3.1 DESCRIPTION

The XTM test plugs are designed specifically for post-installation testing of the DLP3 system. There are two plugs; XTM28L1 (left-hand plug) and XTM28R1 (right-hand plug), each providing access to fourteen relay-side and fourteen system-side points. The system-side points are designated "S" and the relay-side points are designated "R". The plugs are keyed by the contact finger arrangement so that there may be no accidental interchange between the left-hand and right-hand plugs.

The plugs are fitted with a sliding handle that swings out to facilitate wiring to the terminals. The terminals consist of number 8 screws threaded into flat contact plates. The handles each have a tab on the outside edge to guide the wire dress of the test leads.

CAUTION: Not all external connections to the DLP3 are wired through the test receptacle.

3.3.2 TERMINAL DESIGNATION

The test receptacle and connection plugs are located to the left of the magnetics module (extreme left-hand position). Their terminals are labeled 1 through 28, with 1 through 14 corresponding to the left-hand side and 15 through 28 corresponding to the right-hand side. These points are designated on the elementary diagram, Figure PD-6 as TP1 through TP28. The left-hand test plug (XTM28L1) terminals are labeled 1R through 14R and 1S through 14S for the relay side and system side, respectively, with the system side labeled in red. Similarly, the right-hand test plug (XTM28R1) terminals are labeled 15R through 28R and 15S through 28S.

3.3.3 XTM TEST-CIRCUIT CONNECTIONS

Test-circuit connections, designated as TP points in the elementary diagrams, should be made to the relay side of the test plug. Where it is desired to use available system quantities for testing, e.g., DC control power, jumpers may be inserted between the corresponding system-side and relay-side test plug terminals. Appropriate precautions should be taken when working with station battery DC.

Connections should be made to the test plugs prior to insertion into the DLP3.

3.3.4 TEST PLUG INSERTION

To insert the test plugs, the two connection plugs must first be removed. In so doing, electrical continuity is broken between the power system and the DLP3 for those signals that are wired through the test receptacle (refer to TP points on the elementary diagram in the PRODUCT DESCRIPTION section). For the terminals connected to the current-transformer secondaries, shorting bars are included on the system side of the test receptacle. These are clearly visible through the transparent plastic face plate on the receptacle. The shorting bars make contact before the connection-plug contacts break during removal, so that the CT secondaries are never open-circuited.

Both test plugs may be inserted at the same time. Otherwise, if using only one test plug, the connection plug may remain in the other half of the receptacle.

When the test plugs are inserted into the receptacle, parts of the power system become isolated from the DLP3. Refer to the elementary diagram for the TP points associated with each of the test plugs.

NOTE: To remove power from the relay, remove at least one of the connection plugs positioned to the left of the MGM module (see Figure 4–1: MODULE LOCATION on page 4–1).

WARNING: IT IS CRITICAL THAT JUMPERS BE INSERTED ON THE SYSTEM-SIDE TEST PLUG TERMINALS THAT ARE CONNECTED TO THE CT SECONDARIES, AS SHOWN IN THE ELEMENTARY DIAGRAM IN CHAPTER 2. IF THESE JUMPERS ARE LEFT OUT, THE RESULTING HIGH VOLTAGES DEVELOPED PRESENT A SERIOUS HAZARD TO PERSONNEL AND MAY SEVERELY DAMAGE EQUIPMENT.

3.4.1 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.

3.4.2 ENVIRONMENT

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

3.4.3 MOUNTING

The DLP3 case has been designed for standard rack mounting. The case measures four rack units (4 RU) in height. Refer to Figure HD-1 for the outline and mounting dimensions.

3.4.4 EXTERNAL CONNECTIONS

External connections are made according to the elementary diagram in the PRODUCT DESCRIPTION section. This is a general diagram incorporating all of the available options. Connection need not be made to those terminals associated with options that will not be used.

3.4.5 EXTERNAL CONNECTIONS TEST (FOR UNITS WITH TEST PLUGS)

An overall check of current transformer polarities, potential transformer polarities, and connections to the DLP3 relay, can be made prior to placing the DLP3 in service, by using the system voltages and load current while monitoring the output of the NB directional function ANDed with the IPB ground pilot block overcurrent function (NB+IPB). It should be noted that this test is a check of the external wiring and not a check of NB or IPB.

WARNING: THE DLP3 SHOULD BE DISABLED TO PREVENT TRIPPING OF THE CIRCUIT BREAKERS UNTIL IT HAS BEEN DETERMINED THAT THE UNIT IS CONNECTED PROPERLY. THIS CAN BE DONE IN TWO WAYS. ONE IS TO DE-ENERGIZE THE TRIP CIRCUIT CONNECTED TO THE RELAY; THE OTHER IS TO DISABLE THE DLP3 OUTPUTS BY SETTING THE "DISABLE OUTPUTS" FUNCTION TO "YES" PRIOR TO INSTALLATION.

It is assumed that the operator is familiar with the use of the DLP3, and that the NB function has been checked for correct directional action per the ACCEPTANCE TESTS section. IPB should be set for its minimum pickup of $0.05x(IN)$, and the load current should be at least twice the pickup setting of IPB. The tests outlined below will be valid only if the direction of watt (KW) and var (KVAR) flow is known for the relay location at the time the tests are performed.

If the direction of KW and KVAR flow is away from the bus and into the protected line section, then use the XTM test-plug connections in Table 3–1: XTM CONNECTIONS, KW AND KVAR AWAY FROM BUS on page 3–7. These connections simulate an internal phase-A-to-ground fault by applying rated voltage to phases B and C and zero voltage to phase A, while applying load current to phase A only. Follow the procedure outlined below:

1. Set IPB at its minimum pickup of $0.05x(IN)$.
2. Insert the two XTM test plugs, connected per Table 3–1: XTM CONNECTIONS, KW AND KVAR AWAY FROM BUS, into the relay.

- Using the ACT key, go to the Relay Test category and select GND DIR BLOCK (NB+IPB). NB+IPB output is now routed to pick up the RC contact. Check for NB+IPB operation by checking that the RC contact is closed. Operation of NB+IPB indicates that the external wiring is correct.

NOTE: If the direction of KVAR flow is into the station bus, the resulting phase angle between load current and system voltage may be such that NB+IPB will not operate.

- Take the relay out of the test mode after the test is completed, by scrolling to END TEST MODE and pressing the ENT key.
- Change the IPB setting back to the value called for by the application.

If the direction of KW and KVAR flow is into the bus from the protected line section, then use the XTM test-plug connections in Table 3–2: XTM CONNECTIONS, KW AND KVAR INTO BUS. These connections reverse the phase A load current in the relay so that the NB function will operate for this condition. Follow the procedure outlined below:

- Set IPB at its minimum pickup of $0.05 \times (IN)$.
- Insert the two XTM test plugs, connected per Table 3–2: XTM CONNECTIONS, KW AND KVAR INTO BUS, into the relay.
- Using the ACT key, go to the Relay Test category and select GND DIR BLOCK (NB+IPB). NB+IPB output is now routed to pick up the RC contact. Check for NB+IPB operation by checking that the RC contact is closed. Operation of NB+IPB indicates that the external wiring is correct.

NOTE: If the direction of KVAR flow is away from the station bus, the resulting phase angle between load current and system voltage may be such that NB+IPB will not operate.

- Take the relay out of the test mode after the test is completed, by scrolling to END TEST MODE and pressing the ENT key.
- Change the IPB setting back to the value called for by the application.

3.4.6 SURGE GROUND CONNECTION

CAUTION: DLP3 Terminals BC14 and BD14 must be tied together, and terminal BD14 must be tied to station ground, as shown in Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44. The connection to the ground bus must be made as short as possible, using No.12 wire or larger.

The XTM connections for the External Connections Test with KW and KVAR away from Bus is shown in the table below:

Table 3–1: XTM CONNECTIONS, KW AND KVAR AWAY FROM BUS

(LEFT) XTM28L1		(RIGHT) XTM28R1	
FROM	TO	FROM	TO
1S	1R	15S	15R
9S	10R	26S	26R
10S	9R	27S	27R
11S	12S	28S	28R
13S	14S		

CAUTION: Connections between points 9 through 14 must be made before inserting the XTM28L1 test plug, to prevent open-circuiting the CT secondaries.

The XTM connections for the External Connections Test with KW and KVAR away into Bus is shown in the table below

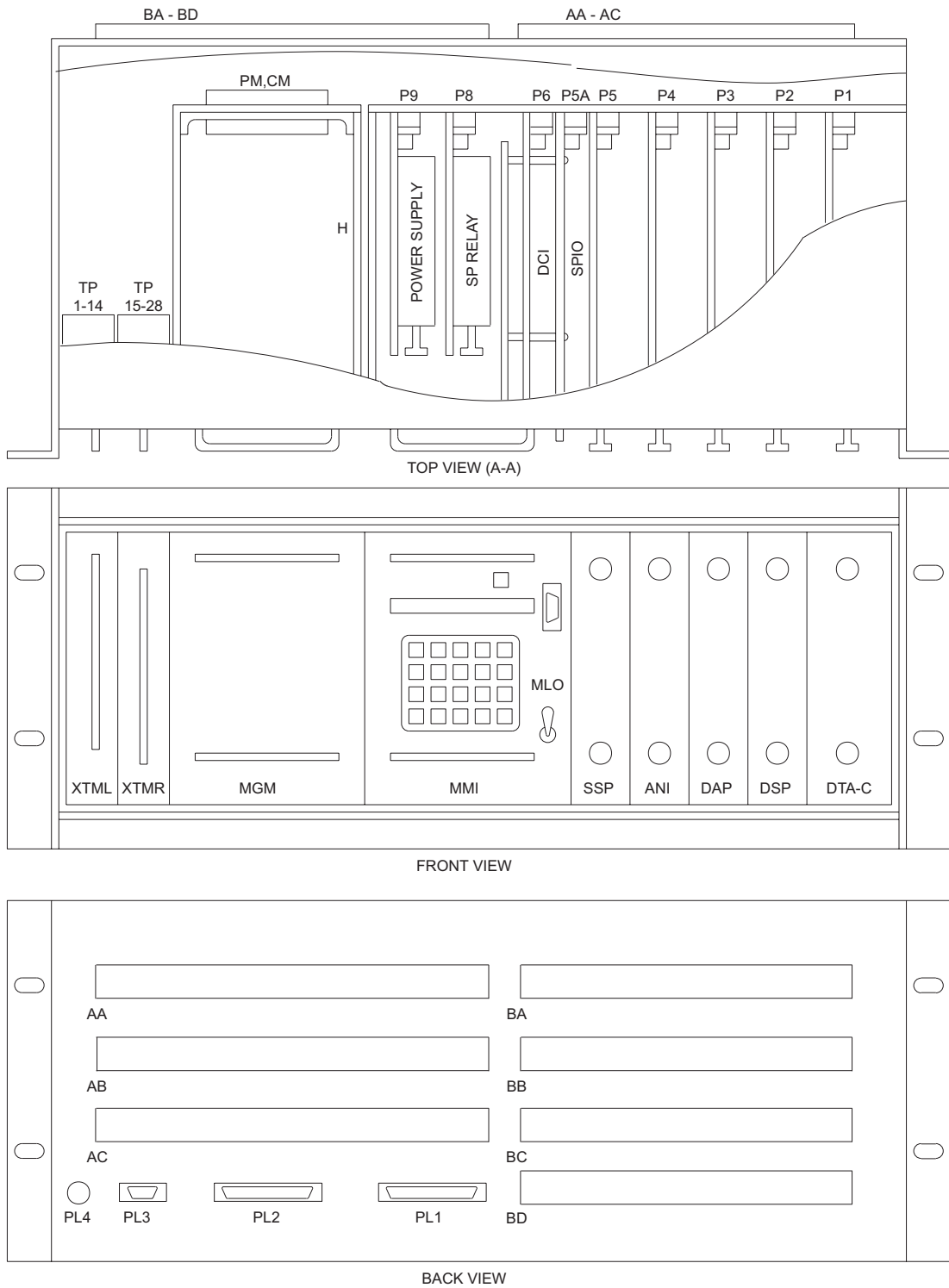
Table 3–2: XTM CONNECTIONS, KW AND KVAR INTO BUS

(LEFT) XTM28L1		(RIGHT) XTM28R1	
FROM	TO	FROM	TO
1S	1R	15S	15R
9S	9R	26S	26R
10S	10R	27S	27R
11S	12S	28S	28R
13S	14S		

CAUTION: Connections between points 9 through 14 must be made before inserting the XTM28L1 test plug, to prevent open-circuiting the CT secondaries.

4.1.1 DESCRIPTION

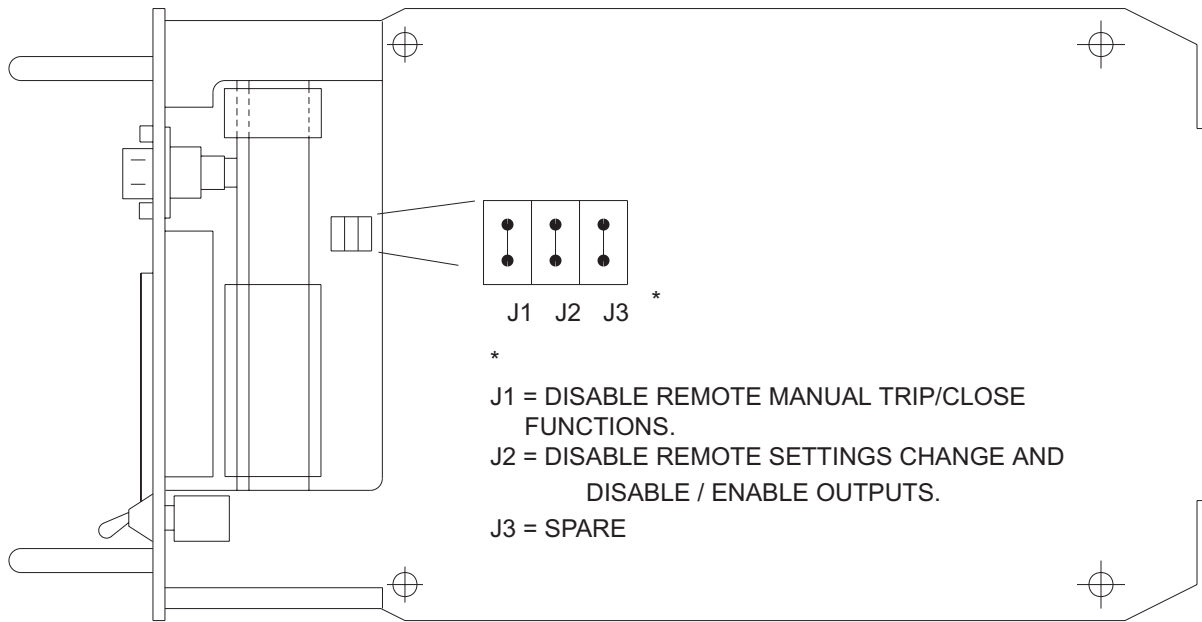
CAUTION: Power Down the relay with the power switch or by removing a connection plug before removing or inserting modules. Failure to do so can permanently damage the relay.



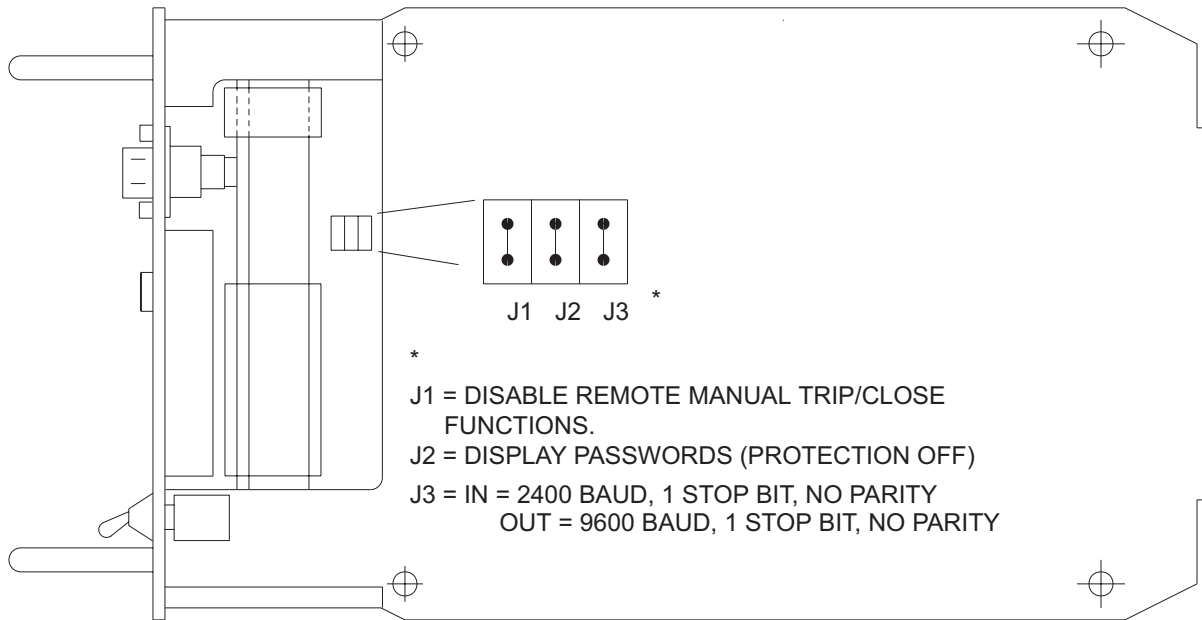
4

Figure 4-1: MODULE LOCATION

4



A) MMI WITH KEYPAD



B) MMI WITHOUT KEYPAD

Figure 4–2: MMI MODULE

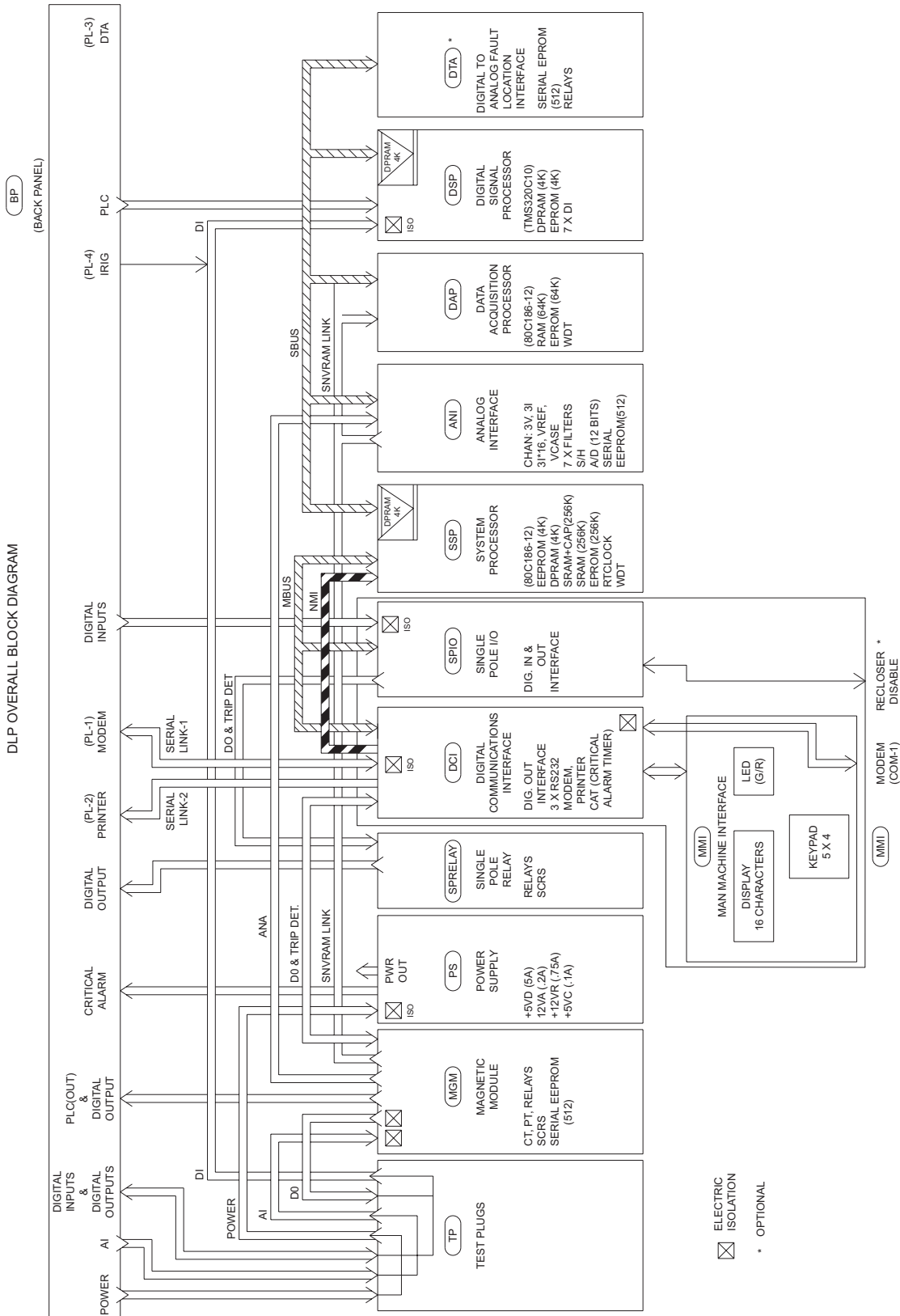


Figure 4-3: DLP3 OVERALL BLOCK DIAGRAM

4.2.1 DESCRIPTION

The Magnetics Module (MGM) contains the input current transformers, voltage transformers and a Relay Driver circuit board. The Relay Driver circuit board contains the alarm, BFI, RI, RC, breaker close, key transmitter, and tripping contacts (or SCRs). In addition, the MGM contains an EEPROM with factory-stored DLP model information (DC voltage rating, AC current rating) and gain-calibration information for the analog channels.

4

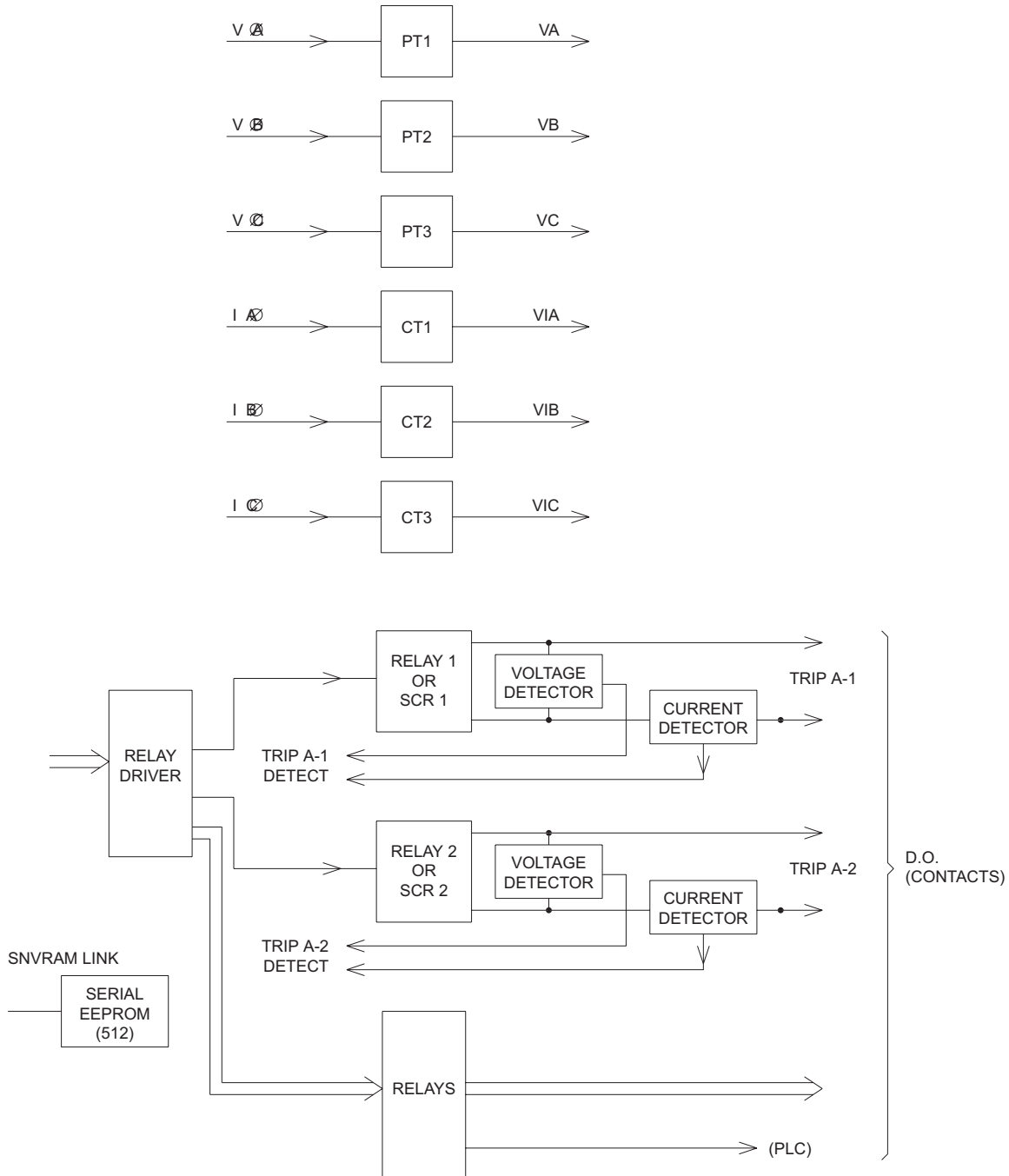
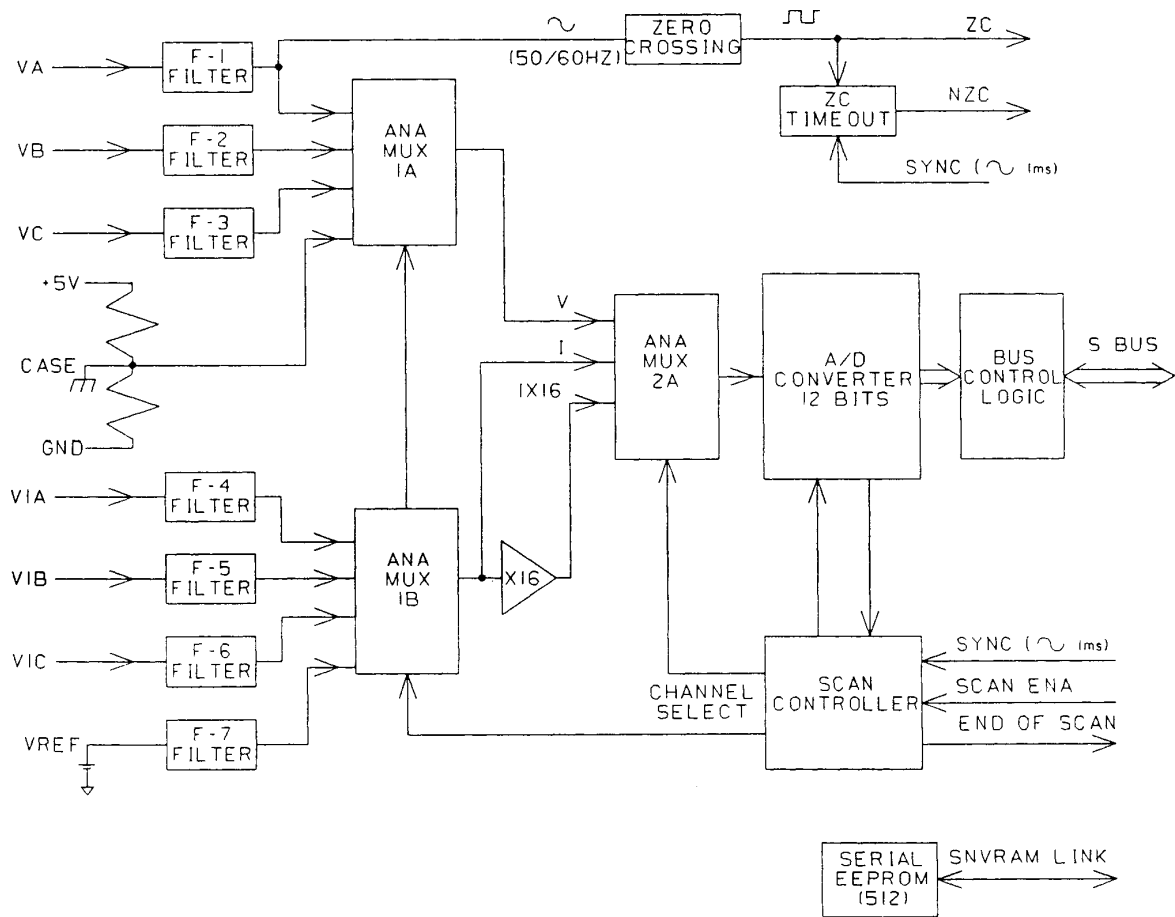


Figure 4-4: MGM BLOCK DIAGRAM

4.3.1 DESCRIPTION

The Analog Interface Module (ANI) contains the anti-aliasing filters, the multiplexing and control logic for the analog-to-digital converter, and an EEPROM to store factory-set channel gains and offsets.



4

Figure 4-5: ANI BLOCK DIAGRAM

4.4.1 DESCRIPTION

The Data Acquisition Processor Module (DAP) contains one of the two 80C186 processors used in the DLP, and the associated memory. The functions performed by the DAP include:

- | | |
|-------------------------------------|---------------------|
| Zone Determination | Digital Input Logic |
| Out-of-Step Logic | Frequency Tracking |
| Analog-to-Digital Interface | IRIG-B Interface |
| Coincidence Logic for Zones 3 and 4 | SCADA Output |

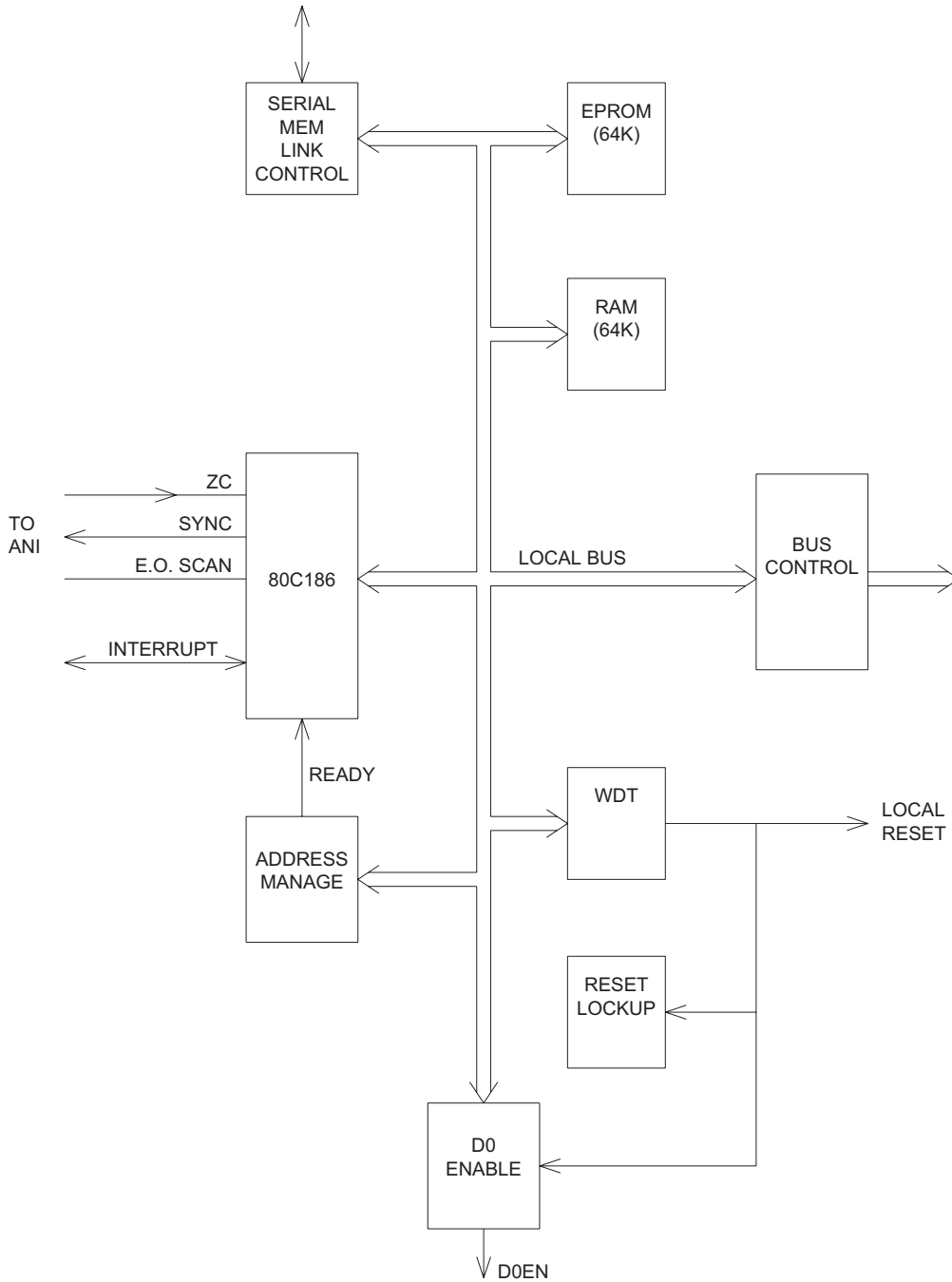


Figure 4-6: DAP BLOCK DIAGRAM

4

4.5.1 DESCRIPTION

The Digital Signal Processor Module (DSP) contains the TMS320C10 digital-signal-processor chip and its required memory. The DSP is responsible for most of the numerical calculations in the DLP. It performs a recursive Fourier Transform calculation to transform the digitized waveforms into phasor quantities. It also handles the coincidence logic for Zones 1 and 2. In addition, the DSP includes the isolated contact converters (Digital Inputs) and IRIG-B time synch input.

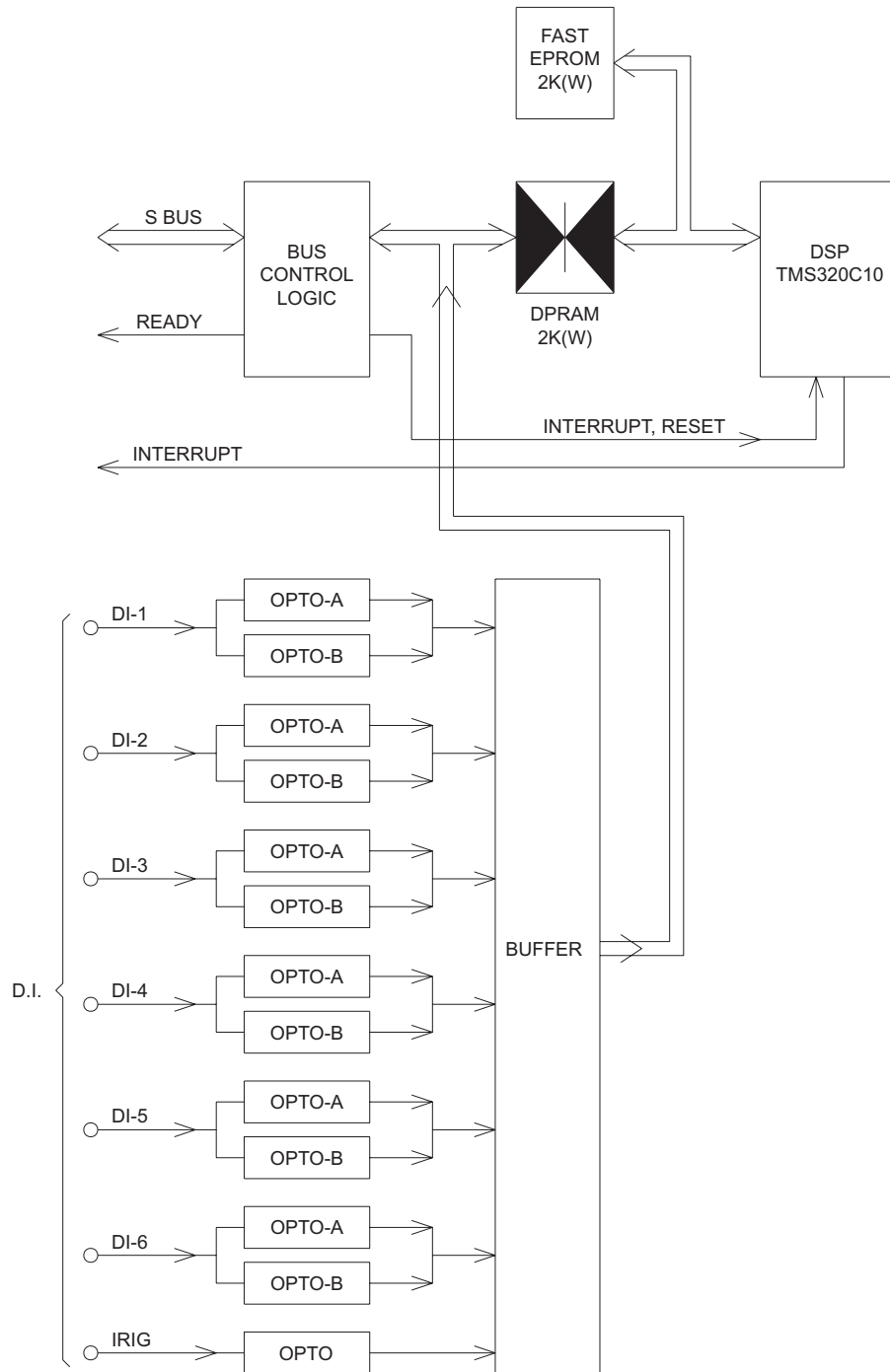


Figure 4-7: DSP BLOCK DIAGRAM

4.6.1 DESCRIPTION

The System Processor Module (SSP) contains one of the two 80C186 processors used in the DLP, EEPROM for storage of user settings, CAPRAM for storage of fault data and oscillography, and shared memory used for data transfer to other modules. The functions performed by the SSP include: Scheme Logic, Test Mode, Peripheral-Protection-Trip Logic, Digital Output Logic, Fault Reporting, MMI Control, Power-System Alarming, Communications, and Printer Control

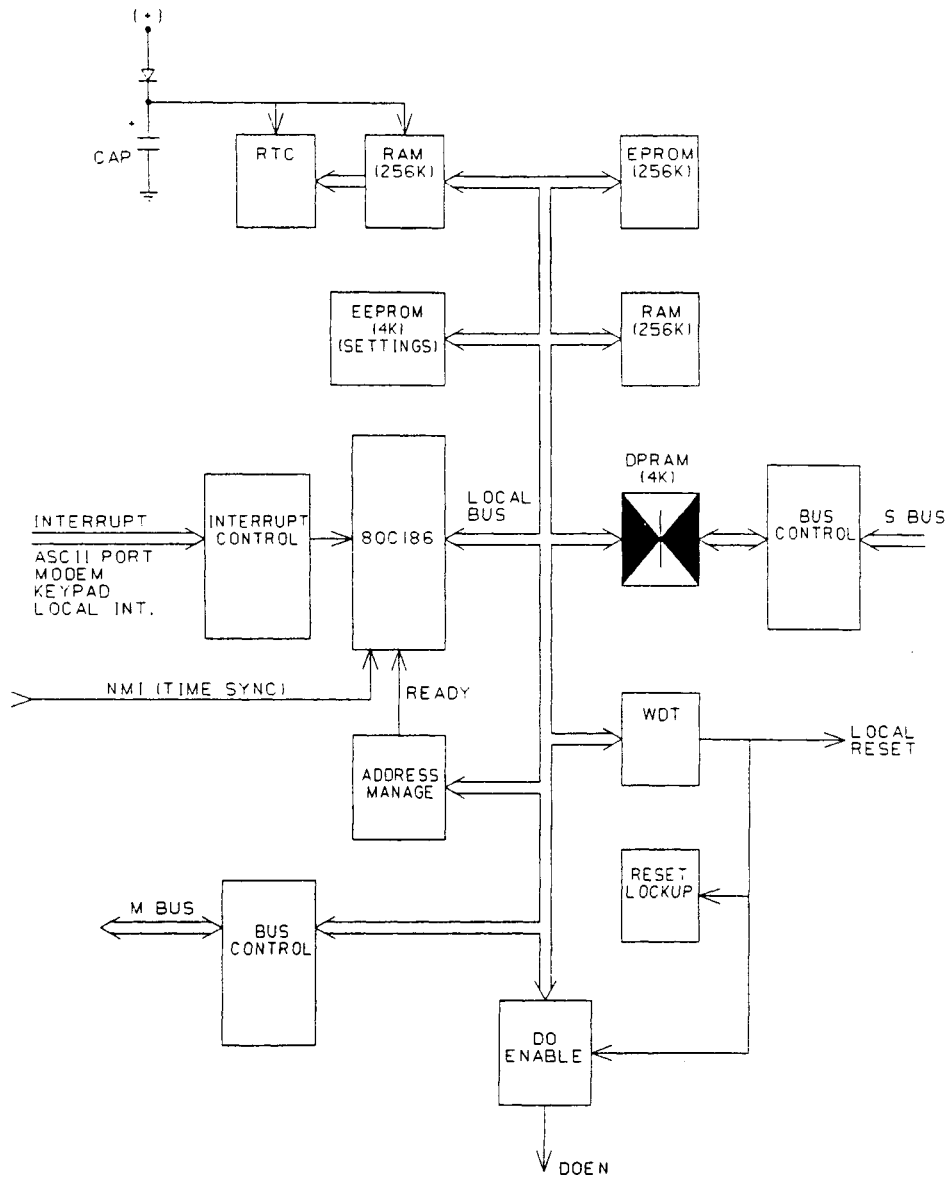


Figure 4-8: SSP BLOCK DIAGM

4

4.7.1 DESCRIPTION

The Man Machine Interface Module (MMI) of models ending with KC or LC contains the 16 character LED display, the green/red status LED, a 9-pin RS-232 port, and the 20 character keypad. (Models ending with NC contain the Clear key, 16-character LED display, green/red status LED, and RS-232 port.) The module includes three circuit boards: the MMI, DCI, and SPIO. The MMI board contains all of the items listed above. The DCI contains the DLP communications interface (two RS-232 ports and a printer port), Critical Alarm Timer, and various output relay drivers. In addition, the DCI contains user-selectable jumpers to enable remote functions (refer to Figure 4-2: MMI MODULE on page 4-2).

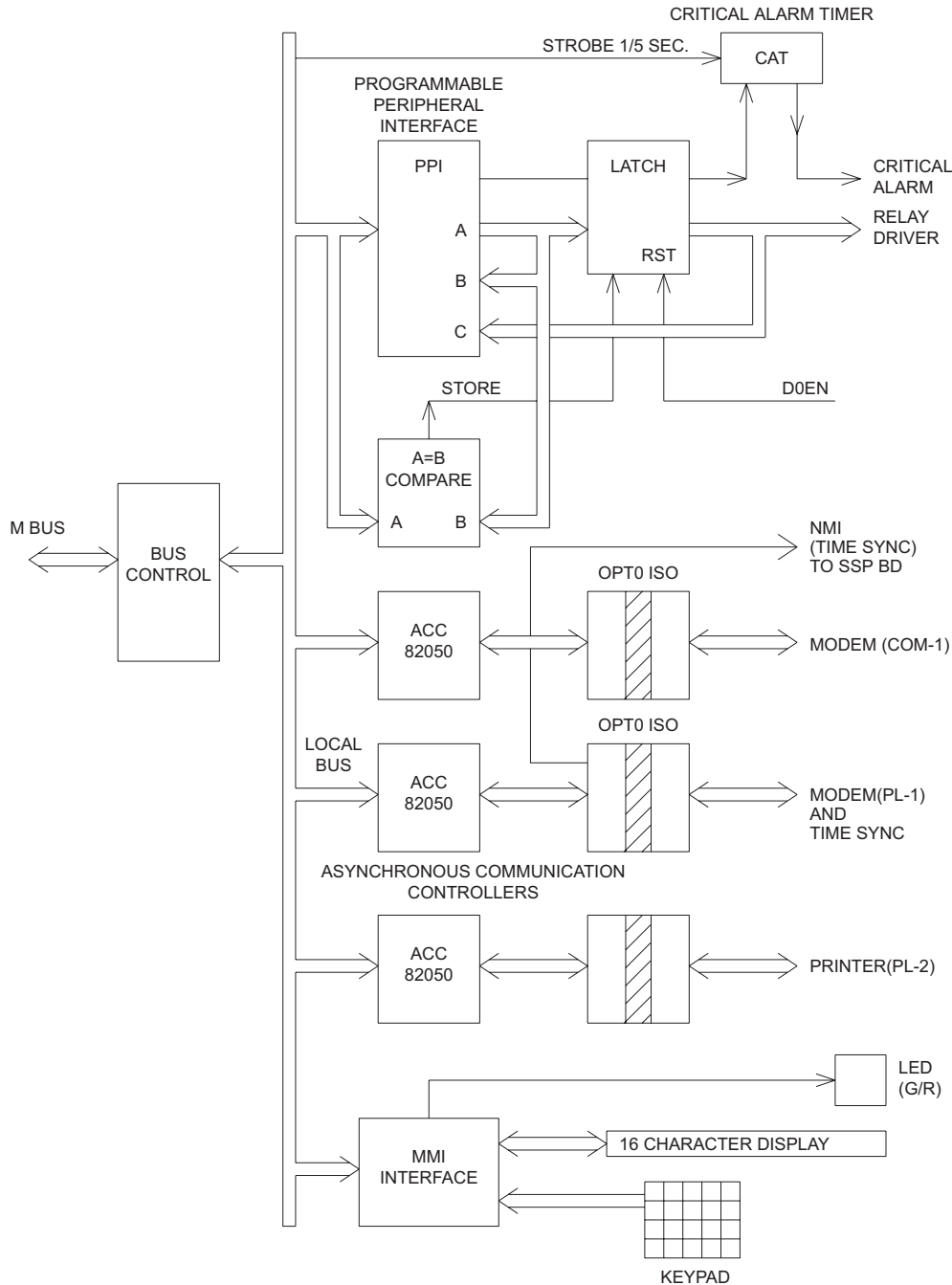


Figure 4-9: DCI & MMI BLOCK DIAGRAM

4.8.1 DESCRIPTION

The SPIO (Single-Pole Input/Output) board contains the additional relay driver outputs and isolated contact converter inputs to allow for reclosing functions.

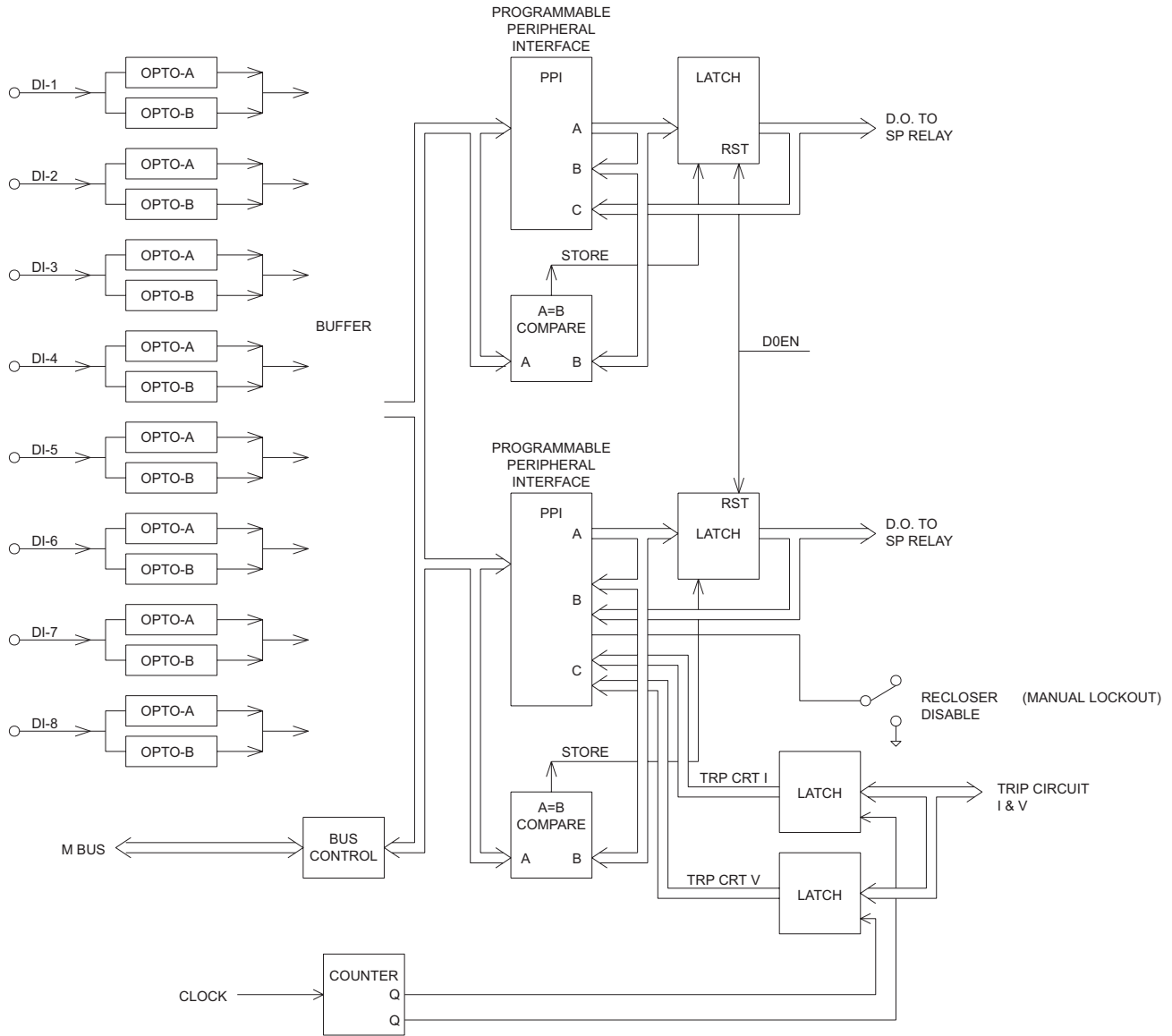
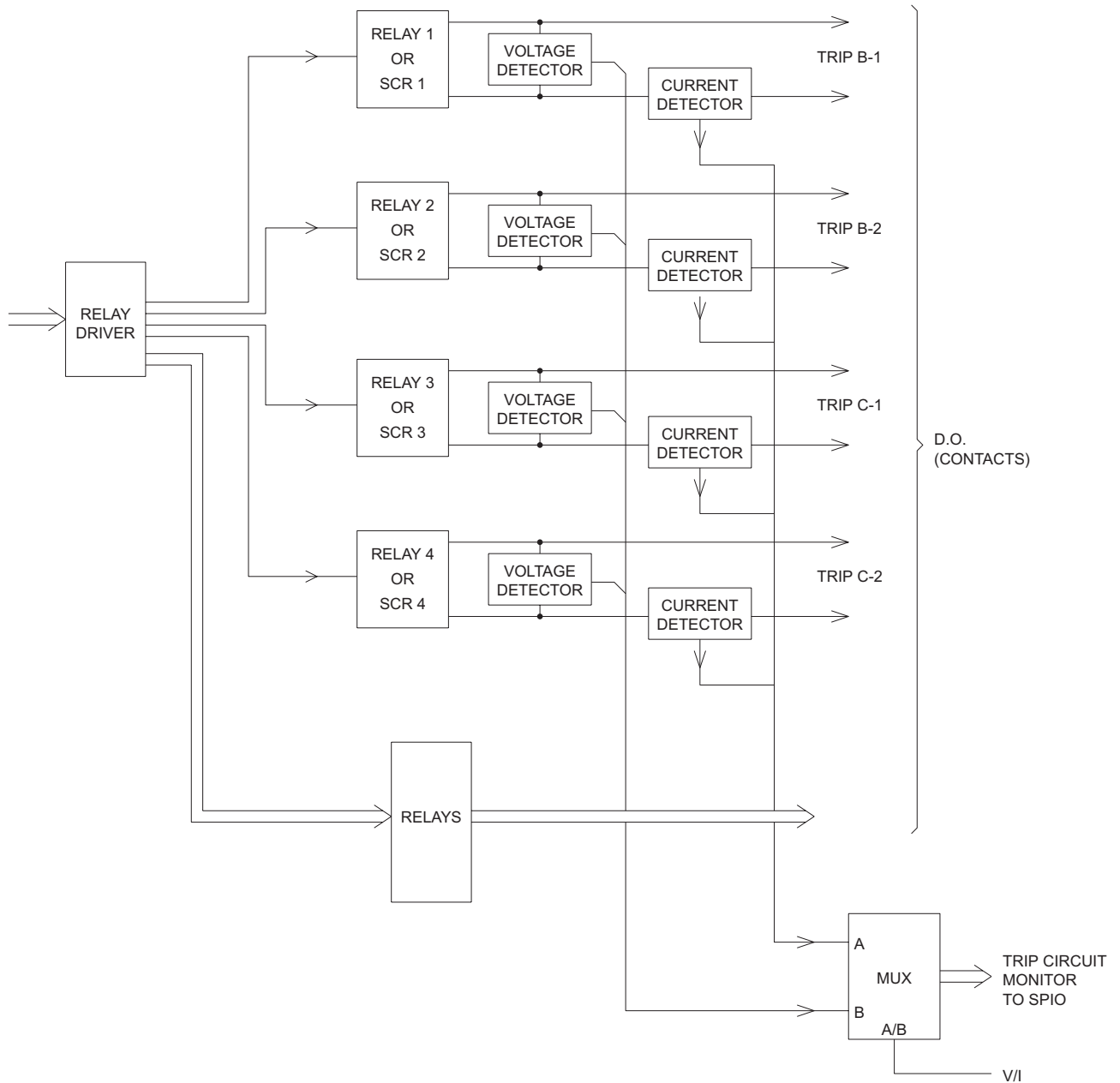


Figure 4-10: SPIO BLOCK DIAGRAM

4.9.1 DESCRIPTION

The Single-Pole Relay Module (SPRELAY) is located behind the MMI module front plate. This module contains the additional relays used by the recloser.



4

Figure 4-11: SPIO BLOCK DIAGRAM

4.10.1 DESCRIPTION

The Digital to Analog Module (DTA) contains the circuits to produce an isolated analog output, either voltage or current, proportional to the distance to the fault. It also contains four dry contacts that close to indicate the faulted phases.

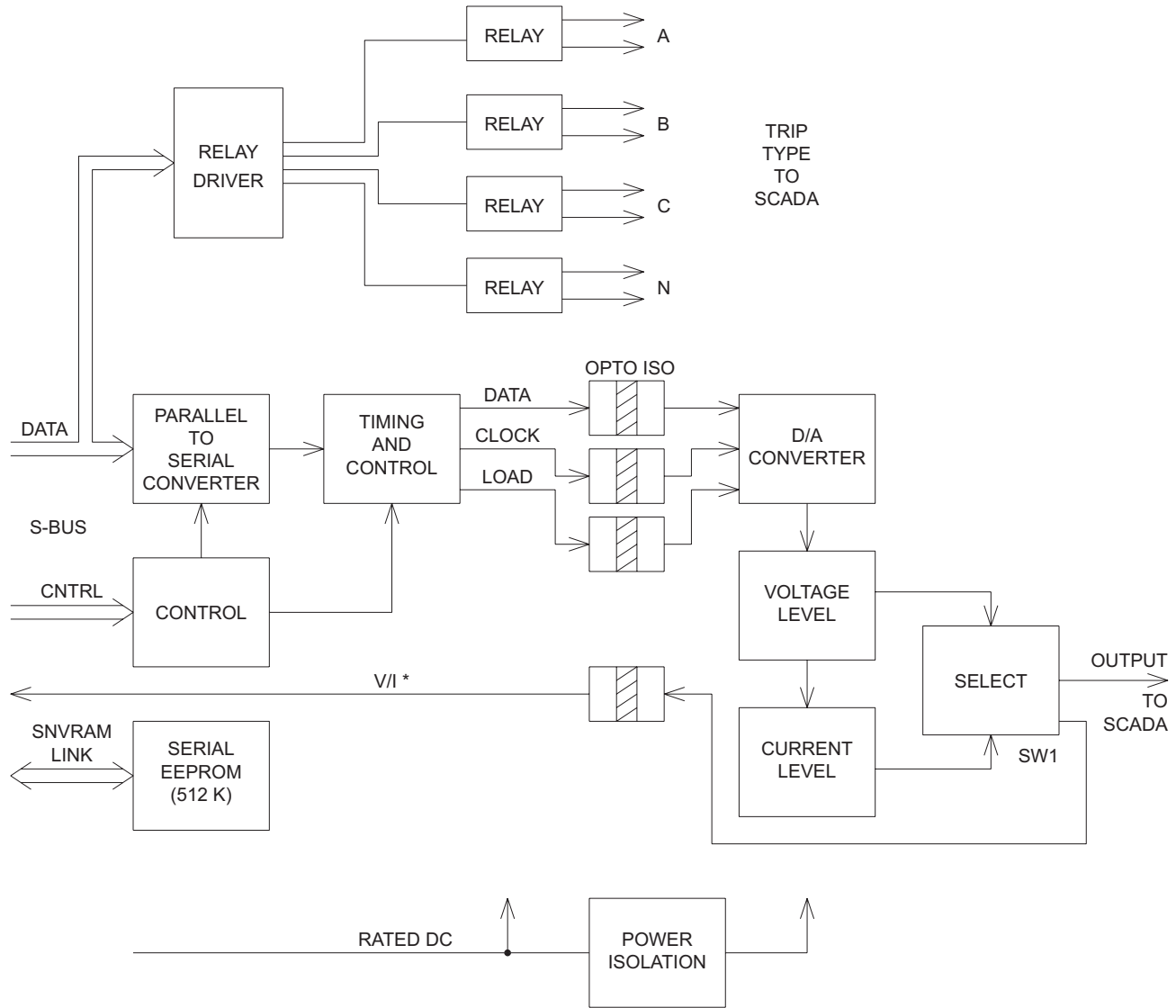
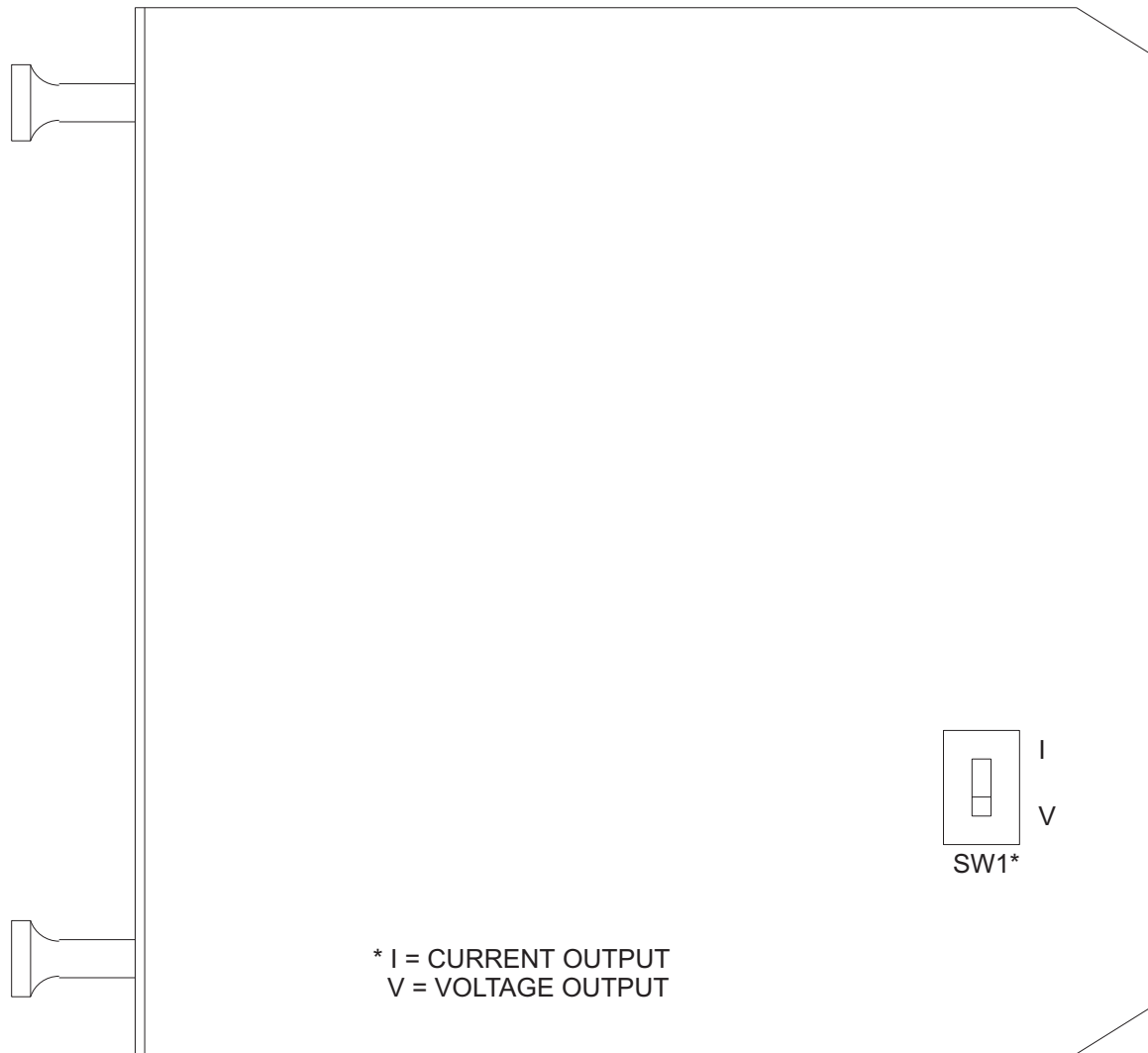


Figure 4-12: DTA BLOCK DIAGRAM



4

SIDE VIEW

Figure 4-13: DTA MODULE

CAUTION: Power Down the relay, with the power switch or by removing a connecting plug, before removing or inserting modules. Failure to do so can permanently damage the relay.

This section is a guide for testing the relay. It is not necessary that the tests be performed for incoming inspection. The relay has been tested at the factory with automated test equipment. The DLP3 is a digital relay controlled by "self checking" software. If a system failure is detected it will be reported through the MMI.

The following tests include: Relay-status self test and display and MMI self test. Tests of backup protection functions, measuring units, and Zone timers are also included, and can be performed at the user's discretion.

a) GENERAL TESTS

- T1 MMI Status and Display Tests (Self Tests)
- T2 Digital Output Tests
- T3 Configurable Input and Output Tests
- T4 AC System Input Test

b) MEASURING UNIT TESTS

- T5 FD Fault Detector
- T6 IT Trip Supervision Test
- T7 IB Blocking Supervision Test
- T8 Ground Directional Trip Test, IPT + NT
- T9 Ground Directional Block Test, IPB + NB

c) BACKUP PROTECTION TESTS

- T10 Phase Instantaneous Overcurrent PH4
- T11 Ground Instantaneous Over-current IDT
- T12 Ground Time Over-current TOC

d) ZONE GROUND/PHASE REACH & TIMERS TEST

- T13 Zone 1 Ground Reach M1G
- T14 Zone 2 Ground Reach MTG
- T15 Zone 3 Ground Reach M3G
- T16 Zone 4 Ground Reach M4G
- T17 Zone Ground Timer Tests
- T18 Zone 1 Phase Reach M1
- T19 Zone 2 Phase Reach MT
- T20 Zone 3 Phase Reach M3
- T21 Zone 4 Phase Reach M4
- T22 Zone Phase Timer Tests
- T23 Out of Step MOB

e) RECLOSER TESTS

- T24 Recloser

5.1.2 TEST EQUIPMENT

1. Three-phase source of voltage and current at rated frequency
2. DC Control voltage source
3. Three AC voltmeters
4. Three AC ammeters
5. A continuity tester or Ohm meter
6. An IBM-compatible computer with a serial port and mouse
7. An RS232 null modem cable to connect the PC to the DLP3
8. A Precision Timer for testing timed events.

The specific requirements of the equipment are given in the text of this section, and in the 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 one that is within the voltage range shown in the SPECIFICATIONS section.

As an alternative, a three-phase electronic test source may be used. In many cases, these devices enable the test circuits to be simplified greatly.

5.1.3 DRAWINGS AND REFERENCES

The following drawings should be used for reference during testing. They are located in the PRODUCT DESCRIPTION and CALCULATION OF SETTINGS sections.

a) DRAWINGS

- Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44
- Figure 1–3: STEP DISTANCE LOGIC DIAGRAM on page 1–9
- Figure 1–4: ZONE 1 EXTENSION LOGIC DIAGRAM on page 1–11
- Figure 1–5: POTT/PUTT LOGIC DIAGRAM on page 1–13
- Figure 1–7: BLOCKING LOGIC DIAGRAM on page 1–16
- Figure 1–10: HYBRID LOGIC DIAGRAM on page 1–21
- Figure 2–2: TOC INVERSE TIME CURRENT CURVE on page 2–17
- Figure 2–3: TOC VERY INVERSE TIME CURRENT CURVE on page 2–18
- Figure 2–4: TOC EXTREMELY INVERSE TIME CURRENT CURVE on page 2–19

b) REFERENCES

- Chapter 10: SOFTWARE
- Default Relay Settings

5.1.4 EQUIPMENT GROUNDING

All equipment used in testing the DLP3 relay should be connected to a common grounding point, to provide noise immunity. This includes the voltage and current sources, as well as the DLP3 itself.

The ground connection on the DLP3 is terminal BD14. The common for surge protection is terminal BC14. NOTE: BC14 should be connected to BD14 with #12 wire or larger during test as well as operation. (The separate surge ground is for High Pot testing purposes.)

5.1.5 REQUIRED SETTINGS

Most tests will utilize the Default Settings. If setting changes are required, they will be listed prior to the test procedure.

For periodic testing purposes, see the following section. It provides details on doing the relay test with user-specific settings.

5.2.1 DESCRIPTION

1. The DLP3 is tested in the "test mode" of operation. This mode allows the internal measuring units and functions to be brought out and viewed. 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, and routes their status to the RC "reclose cancel" contact. When the particular function under test has picked up, the RC contact will close. Target information will be displayed for tests that cause tripping. Testing can be performed with outputs disabled, in which case RC is the only contact that will operate. Outputs can be disabled from the Actions menu.

CAUTION: The RC contact will chatter when the unit under test is near its threshold. DO NOT let it continue. Remove the test current. A single contact closure is enough to determine that the unit picked up.

Before each zone reach test, backup protection functions and zones not under test should be disabled, using the settings. This is not strictly necessary when using the test mode, but if it is not done, 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 keep that in mind during the tests.

A continuity tester with high-input impedance, such as a Digital Ohmmeter, should be used to monitor the RC contact during the testing of the relay.

WARNING: TRIPPING CONTACTS WILL OPERATE IN THE TEST MODE UNLESS OUTPUTS ARE DISABLED BY THE USER.

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. During the test, one or possibly more of the electronic current sources may not be used. If the source is not used, it must be set to zero (0) zero in addition to being disabled. Also, the currents should always be set at or near zero (0) 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 refers to the referenced quantity leading phase A voltage. A negative (-) phase angle refers to the referenced quantity lagging phase A voltage.
5. All test voltages are phase-to-ground measurements unless otherwise specified.
6. Typing an entry on the keypad will be shown as ["key"] where "key" is the alpha numeric label of the key to be pressed.

For tests that require a setting change, the setting number will be shown in parentheses next to the setting, to facilitate direct access to the setting. This is performed by pressing the [SET] key, the setting number (nnnn), and [ENT]. The new setting may then be entered.

7. When testing the relay using the DLP-LINK software, the only time that information will normally appear on the MMI display is after the relay has tripped. Relay status and test mode information will not appear. Exceptions include any error codes the relay may report such as "742" after three unsuccessful login attempts.
8. NOTE: Operation of the Potential Transformer Fuse Failure (PTFF) will cause the Critical Alarm to operate.

At the end of testing, make sure that all settings are returned to initial values. Print them out, and verify them, before placing the relay in service. If a printer is not available, scroll through all settings with the MMI Display and verify each one.

5.2.2 SETTING CHANGES

Setting changes required for a particular test will be listed before the test. A sample setting change using the MMI keypad is shown below. (For models ending with NC, see USING DLP-LINK below.) Refer to the INTERFACE section for further details on making setting changes.

a) SETTING CHANGE

Changing the reach of the ZONE 1 Ground Unit to 5.6 Ohms.

1. Apply rated DC and wait for relay initialization to complete, as indicated by the green LED on the MMI.
2. Press the [ACT] "action" key. Scroll with the arrow key until "ACT: ENTER PASSWORD" is displayed, then press the [ENT] "enter" key.

If this is the first time the Settings Level functions are used, the password has the factory value "1234.". The factory value of the Master Level password is "5678.". These passwords must be changed before any Setting functions can be accessed. See the INTERFACE section for information on how to change the password.

3. Enter the current Settings or Master Level password. If the password is not known, see the INTERFACE section for information on how it can be viewed.

When the correct password is entered, "SELECTED" is displayed.

4. Press the [SET] "settings" key. Press the [1/Y] and [ENT] "enter" key to select settings group 1.
5. Scroll with the arrow key until "SET: Z1DIST" is displayed, then press the [ENT] "enter" key.
6. Scroll through the Z1DIST settings until you get to "Z1GR = #.#".
7. Type "5.6" on the keypad. The typed inputs will be shown on the MMI display at half intensity. This represents that a change is made but not yet entered.
8. When the correct reach is entered, press the [ENT] "enter" key. The typed inputs will now be shown on the MMI display at full intensity. This represents that the change is entered into the settings buffer, but not permanently changed in the relay.
9. To finalize the setting change, press the [END] "end" key followed by the [ENT] "enter" key.
If the "end" and the "enter" keys are not pressed after setting changes, the settings will not be stored into memory.
10. Restore the Z1GR setting back to its original value before beginning the test. It will be necessary to enter the Settings Level password again.

b) ENTERING THE TEST MODE

Before each test it is necessary to set the relay in the 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, as indicated by the green LED on the MMI.
2. Press the [ACT] "action" key. Scroll with the arrow key until "ACT: ENTER PASSWORD" is displayed, then press the [ENT] "enter" key.

If this is the first time the Master Level functions are used, the password has the factory value "25678.". This password must be changed before any Control functions can be accessed. See the INTERFACE section for information on how to change the password.

3. Enter the current Master Level password. If the password is not known, see the INTERFACE section for information on how it can be viewed.

When the correct password is entered, "SELECTED" will be displayed.

4. Press the [ACT] "action" key. Scroll with the arrow key until "ACT: RELAY TEST" is displayed, then press the [ENT] "enter" key.
5. Scroll through the different test mode functions or enter the number of the desired test, such as "38" for the FAULT DETECTOR. Then press [ENT] and the display will indicate

FAULT DETECTOR ON

and the MMI LED will turn red, indicating that the relay is in the test mode. When the relay picks up for the selected function it will close the RC "reclose cancel" contact.

c) EXITING THE TEST MODE

While in the "TEST MODE", press the [ACT] "Action" key. Scroll with the arrow key until

ACT: Relay Test

is displayed, then press the [ENT] "Enter" key. Scroll until the display shows

END TST MODE?

or enter "1". Then press the [ENT] key. The MMI LED should return to green, indicating that normal operation has resumed.

5.3.1 DESCRIPTION

To test the relay without using the DLP3 Keypad, communication with the relay is accomplished via a PC with the program DLP-LINK. DLP-LINK is required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Once in test mode, current and voltages are applied to the relay to simulate the desired system conditions.

The following section is intended to give a step by step procedure to test the relay, from setting up communications to the application of the voltages and current inputs. It will be necessary to be familiar with the DLP-LINK software. Refer to the SOFTWARE section of this manual for information on how to use DLP-LINK.

5.3.2 HARDWARE SETUP

The hardware, specifically the cable to connect your PC to the relay, depends on the connection the PC requires and that of the DLP3. The DLP3 port PL-1 accepts a 25 pin male D-connector. Port COMM accepts a 9 pin male D-connector. The PC used may require a 9 or a 25 pin connector. Null modem cables are shown in the INTERFACE section for connecting to the DLP3 with a 9-pin-to-25-pin and a 25-pin-to-25-pin setup.

Connect the PC to the DLP3 with the appropriate null modem connector. See INTERFACE section for Cable diagrams.

5.3.3 SOFTWARE SETUP

The Software set up consists of loading the software on to the PC, starting the program, and configuring the program to the PORT and BAUD RATE of the PC and DLP3.

a) LOAD AND START DLP-LINK

Use the INSTALLATION guide in the SOFTWARE section of this manual for directions to load DLP-LINK onto your PC.

1. Change directories to the location of the DLP-LINK program.
2. Start the program by typing "DLP-LINK" at the DOS prompt.

b) SET LOCAL PC CONFIGURATION

When you start DLP-LINK the MAIN MENU is displayed.

3. Select the SETUP heading. Refer to the SOFTWARE section for information on how to select items using the keyboard or a mouse.

The SETUP menu will now be displayed.

4. Select COMMUNICATION PORT NUMBER.

The default communications port will be displayed.

5. Type in the port number that matches the PC port connected to the DLP3.
6. If port 3 or 4 is selected, the IRQ number must also be selected.
7. Select "OK" when the port is configured.

c) SET UP A TEST UNIT DESCRIPTION

The next step is to create a new "Unit Description" that matches the DLP3's baud rate, phone number, and switch code. The DLP3 is accessed locally during testing, therefore the PHONE NUMBER and the SWITCH CODE will be set to zeros. The BAUD RATE will be set to the factory setting of 2400 with one stop bit and no parity.

8. Select the ADD RELAY TO LIST heading from the SETUP menu.
9. When prompted for the UNIT DESCRIPTION, type "TEST" and select "OK".
A new unit description called "TEST" is created and must now have parameters set for it. The RELAY PARAMETERS menu appears, with spaces for PHONE NUMBER, SWITCH CODE, BAUD RATE, STOP BITS, and PARITY.
10. At the PHONE NUMBER prompt, press [TAB]. (This is the default used when there is no phone.)
11. At the SWITCH CODE prompt, press [TAB]. (This is the default value for no switch.)
12. At the BAUD RATE prompt, select "2400" and press [TAB].
13. At the STOP BITS prompt, select "1" and press [TAB].
14. At the PARITY prompt, select "None" and press [TAB].
The Unit Description for "TEST" is complete.
15. Enter "OK" to return to the SETUP MENU.

5.3.4 RELAY SETUP

Before shipment, the relay is set with factory default settings. These include the UnitID, the Baud Rate, and the Factory Passwords. The default communications parameters are:

Table 5-1: DEFAULT COMMUNICATIONS PARAMETERS

SETTING	VALUE	DEFAULT (FROM FACTORY)
UNIT ID	0	(CONFIG setting)
VIEW PASSWORD	VIEW!	(Local Communication ACTION)
MASTER PASSWORD	CTRL!	(Local Communication ACTION)
SETTINGS PASSWORD	SETT!	(Local Communication ACTION)
BAUD RATE	2400	(CONFIG setting)

If this is the first login to the relay, these parameters will need to be changed. The remote passwords must be changed before any functions except CHANGE PASSWORD or LOGOUT can be used. Refer to the SOFTWARE section of this manual.

a) LOGGING INTO THE RELAY

1. Select LOGIN from the RELAY FUNCTIONS menu.
2. Select the relay login data for "TEST" just created.

DLP-LINK will prompt for a password. If this is the first login to the relay, the passwords are those listed in the table above, and must be changed before any of the relay functions except CHANGE PASSWORD and LOGOUT will operate. See the SOFTWARE section of this manual for information on how to change a password.

3. Type in the current password and press [TAB].

If the password is not known, refer to the INTERFACE section of this manual for information on how to display the current password.

DLP-LINK will prompt for the unit ID.

4. Type in "0" and press [TAB].
5. Select "OK".

DLP-LINK will respond with a "SUCCESSFUL LOGIN" message.

b) SETTING CHANGES

Setting changes required for a particular test will be listed before the test. A setting can be changed in two ways, by category or individually, by selecting either VIEW/CHANGE CATEGORY OF SETTINGS or VIEW/CHANGE INDIVIDUAL SETTINGS from the DLP SETTINGS menu. A procedure for and example of how to change settings is provided in the SOFTWARE section of this manual.

It is important to remember to select END SETTING CHANGES from the DLP SETTINGS menu after all settings changes for a particular test are completed. This is necessary because settings are stored in a buffer so that they can all be downloaded at once. Selecting END SETTINGS CHANGES changes the settings in the relay itself.

c) ENTERING THE TEST MODE

Before most tests it is necessary to set the relay in the test mode according to the function to be tested. The test mode is set as follows:

1. If logged in under the Settings access level, select CHANGE ACCESS LEVEL from the RELAY FUNCTIONS menu.
2. Enter the Master Level password. If the password is not known, see the INTERFACE chapter for information on how it can be viewed.
3. When the password is accepted, "MASTER LEVEL" will appear at the bottom of the screen.

Steps 1 to 3 need not be performed if the user is already logged in under the Master Access Level.

4. Select RELAY TEST MODE from the DLP ACTIONS menu.
The RELAY TEST list box appears.
5. Select the test you wish to enter from the menu and then select "OK".

The MMI LED will change from green to red when the DLP3 is in the test mode.

d) EXITING THE TEST MODE

The test mode is ended, and the relay protection turned on, by selecting END TEST MODE from the RELAY TEST list box and then selecting "OK". The MMI LED changes from red to green, indicating that normal operation has resumed.

5.4.1 DESCRIPTION

Before beginning the test, the relay settings should be printed for reference and verification. The factory settings are listed in the CALCULATION OF SETTINGS section. If no printer is available, scroll through each setting and make sure they all match the default settings listed.

If testing with DLP-LINK, the relay settings should be uploaded from the DLP3 and printed for reference and verification.

Verify that each DLP3 setting matches the default setting listed. If no printer is available, use the VIEW/CHANGE CATEGORY OF SETTINGS command for verification. Once uploaded, the current DLP3 settings can be saved to a disk file so that they can be reloaded back into the DLP3 when testing is completed. Use the SAVE DLP SETTINGS TO FILE command in the DLP SETTINGS menu. DLP-LINK will prompt you 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 the SOFTWARE section of this manual.

5.5.1 T1 – MMI STATUS AND DISPLAY TESTING

The Relay's Status is reported through the MMI, the non-critical alarm contact, and the critical alarm contact. If a system error caused relaying functions to cease, the LED on the MMI would turn "red" and the critical alarm contact would close. A failure that did not interrupt relaying would be indicated by the non-critical alarm closing, and by a "WARN" message on the MMI display.

a) STATUS CHECK

This test will demonstrate the use of the MMI to check relay status. See the FSERVICING section for further information.

Setting Change: CONFIG (1504) TRIPCIRC = 0 (NONE)

1. The AC inputs are not required for this test, only the DC-power-supply voltage. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.
2. Press the [INF] "information" key. Then scroll with the arrow keys until the heading "INF: STATUS" is displayed.
3. Press the [ENT] "enter" key.

The display should be "STATUS OK". "OK" represents that the relay is operational and there are no errors.

b) FAILURE STATUS

4. Change the setting of the trip circuit monitor: (1504) TRIPCIRC = 1 (BKR1). When this is done, the relay expects wetting voltage across the trip contacts.

NOTE: Press "END" "ENTER" after each setting change.

5. Press the [INF] "information" key. Then scroll with the arrow keys until the heading "INF: STATUS" is displayed.
6. Press the [ENT] "enter" key.

The display should be "STATUS: WARN".

7. Scroll with the arrow keys until the heading "WARN: BKR1 TRP CIR OPN " is displayed. This verifies that the relay detected the absence of wetting voltage across the trip contact.
8. Change the setting of the trip circuit monitor back to: (1504) TRIPCIRC = 0 (NONE), before proceeding with the next test.

c) DISPLAY TESTS (FOR DLP WITH KEYPAD ONLY)

The MMI test is built into the software. It allows the user to test the keypad, the printer, and the display. If no printer is to be used with your relay, then skip the printer port testing.

1. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.
2. Press the [ACT] "action" key. Then scroll with the arrow keys until the heading "ACT: MMI TEST" is displayed.
3. Press the [ENT] "enter" key.

The display should be eight fully lit rectangles followed by the word "NEXT?".

4. Press the [1/Y] followed by the [ENT] key.

The display will change to eight fully lit rectangles on the right of the display preceded by the word "LED TST?".

5. Press the [1/Y] followed by the [ENT] key.

The green LED will momentarily turn red.

6. Next, the display will prompt you for the keyboard test with "KEYBRD TST?".
7. Press the [1/Y] key followed by the [ENT] key.
8. At this point the MMI is in the keyboard test. Press every key on the keypad, except for the [CLR] "clear" key. As you press each key, verify that the display indicates the key that was pressed. Example: pressing the up arrow would be displayed by the word "UP". The other keys will match the description that is on the key itself.
9. When all the keys have been checked, press the [CLR] key.

d) PRINTER TEST (SKIP IF YOU ARE WITHOUT A KEYPAD OR PRINTER)

10. The display prompt will be "PRINTER TST?". If you do not have a printer, then press the [3/N] followed by the [ENT] key. If you have a printer, press the [1/Y] followed by the [ENT] key.

The printout will be 40 characters that include the alphabet, the numbers 0 through 9, and the ;, =, /, and "." characters. Forty lines will be printed.

11. When the printout is completed, press the [END] followed by the [ENT] key. This will end the MMI test mode.

5.5.2 T2 – DIGITAL OUTPUT TEST

5

This test is used to check 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.

NOTE: If using DLP-Link to run this test, none of the outputs will operate unless Jumper J1 on the MMI module is removed. Refer to Figure 4–2: MMI MODULE on page 4–2.

Protection can be enabled or disabled, as deemed necessary by the user.

1. Connect the relay as shown in Figure 5–1: DIGITAL OUTPUT TEST CONNECTIONS below.
2. Enter the "Control Level" password.
3. Press the [ACT] key and then select "DIG OUT TEST". Press the [ENT] key.
4. Select the output to test by using the arrow keys to scroll to the desired output, such as TRIP1, and press the [ENT] key.

Before the contact is allowed to close, you will be prompted to turn protection off during the test. The prompt is: "PROTECT OFF?". Press the [1/Y] key followed by the [ENT] key to turn protection off. Protection will remain off until the test mode is ended. (If desired, protection can be left enabled during the test.)

Once the protection choice is made, the "relay output" selected will close.

Verify that the output under test has closed, using an ohmmeter or other suitable device.

5. After the output is tested, scroll to the next output to test, then press the [ENT] key. This output will close and the previously selected output will open. Continue in this fashion until all outputs are tested.
6. End the test mode by scrolling to the "END TEST MODE" selection, then press the [ENT] key. Alternatively, [END] followed by the [ENT] can be pressed to end the test and re-enable protection.

DIGITAL OUTPUT	X	Y
TRIP-1	AA1	AB1
TRIP-2	BA1	BB1
BFI	AA4	AB4
	BA4	BB4
RI	AA8	AB8
	BA8	BB8
BC-1	AA11	AB11
BC-2	AA12	AB12
RC	BA9	BB9
NCA	BA13	BB13
CA	BA14	BB14
KT-1	AA9	AB9
KT-2	AA10	AB10
LN OVRLD	BA12	BB12
RIP	BA11	BB11
LOA	BA10	BB10
Z1RR	AA13	AB13

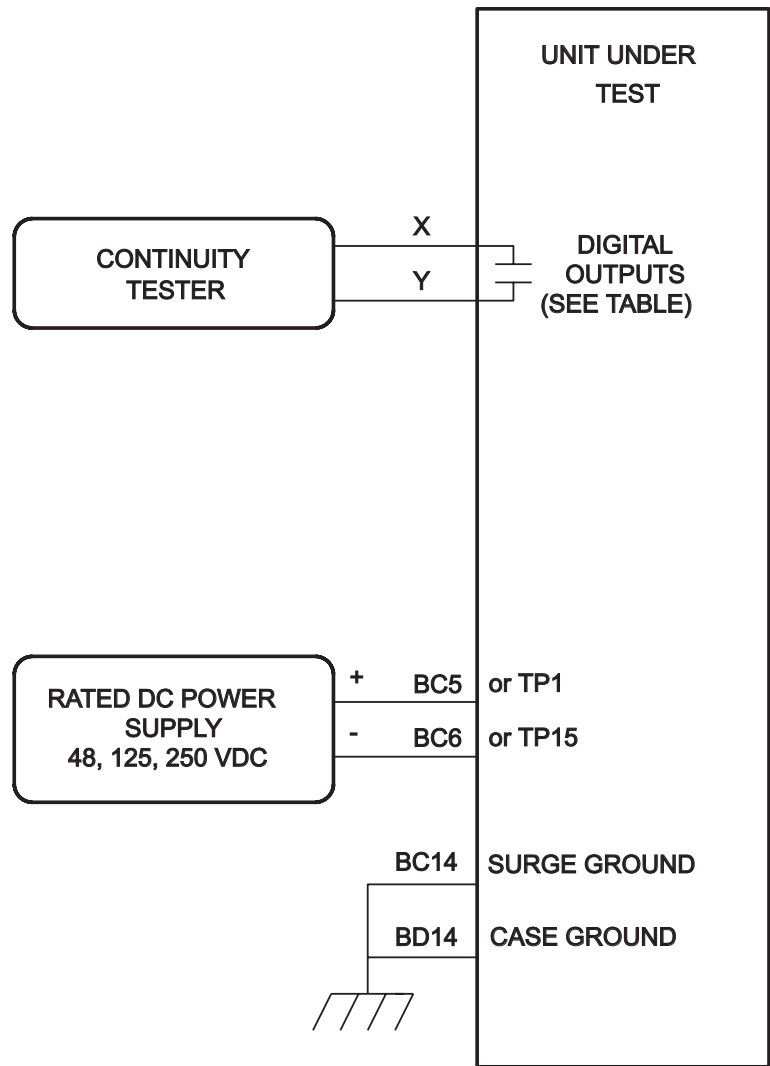


Figure 5–1: DIGITAL OUTPUT TEST CONNECTIONS

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5.5.3 T3 – CONFIGURABLE INPUT & OUTPUT TESTS

The DLP3 includes three configurable inputs and six configurable outputs, which provide great flexibility in applying and testing the relay.

The configurable inputs are set in "modes of operation" that determine how the inputs will be used. In one mode, the input could be used to trigger oscillography, and in another it could be used to control a configurable output.

The configurable outputs are set in a different manner. Each output can be set as a logical 'AND' or a logical 'OR' of up to eight of the 64 measuring units of the relay. In the test case used below, the digital inputs will be used as "logic" inputs to the configurable output. When the input is energized, the configurable output contacts will close.

Change the following settings for MODE0 operation. In MODE0, CC4 will be RCVR2 input and CC5 and CC6 will select the settings group used by the relay.

Settings:

CURSUPVIS

(1701) CONCCI = 0 (MODE0)

(1702) SETGRP = 0 (ADAPTIVE SETTINGS GROUP)

SCHEMESEL

G1 (1201) SELSCM = 1 (POTT)

G1 (1202) NUMRCVR = 2

CONFIG

G1 (1503) NUMBKRS = 2

1. Connect the relay as shown in Figure 5–2: CONFIGURABLE INPUT & OUTPUT TEST CONNECTIONS on page 5–16.
2. Apply rated DC across CC4 (AC11-AC12). Using the MMI and the INFORMATION - STATUS command, (or DLP-LINK, Relay Functions, Information, request DLP Status) verify that PLT #2 is ON.
3. Remove DC from CC4. Using the MMI and the INFORMATION - STATUS command, verify that PLT #2 is OFF.

a) SETTINGS GROUP SELECTION

In MODE0, CC5 and CC6 are used to select the settings group to be used by the relay.

4. Remove any input to CC5 (AC9-AC10), and CC6 (AC7-AC8). Using the MMI and the INFORMATION - STATUS command, verify that settings group 1 is selected.
5. Apply rated DC across CC5. Using the MMI and the INFORMATION - VALUES command, verify that settings group 3 is selected.
6. Apply rated DC across CC5, and across CC6. Using the MMI and the INFORMATION - VALUES command, verify that SETTINGS GROUP 4 is selected.
7. Remove any input to CC5, and apply rated DC across CC6. Using the MMI and the INFORMATION - VALUES command, verify that settings group 2 is selected.
8. Change the following settings to place the inputs into MODE8 and configure the outputs. In MODE8 CC4, CC5, and CC6 are used as inputs to the configurable outputs.

CNFGINPUTS

(1701) CONCCI = 8 (MODE8)

(1702) SETGRP = 1 (SETTINGS GROUP 1)

SCHEMESEL

G1 (1201) SELSCM = 1 (POTT)

G1 (1202) NUMRCVR = 1

CONFIG

G1 (1503) NUMBKRS = 2

BKR1CLSOUT

G1 (1801) CONOUT1 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)

G1 (1802) CO1IN1 = 52 (CONFIGURABLE INPUT 3, CC6)

G1 (1803-1809) = 0 (NOT ASSIGNED)

BKR21CLSOUT

G1 (1901) CONOUT2 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)

G1 (1902) CO2IN1 = 52 (CONFIGURABLE INPUT 3, CC6)

G1 (1903-1909) = 0 (NOT ASSIGNED)

RCANCLSOUT

- G1 (2001) CONOUT3 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
- G1 (2002) CO3IN1 = 51 (CONFIGURABLE INPUT 2, CC5)
- G1 (2003-2009) = 0 (NOT ASSIGNED)

LNOVLDOU

- G1 (2101) CONOUT4 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
- G1 (2102) CO4IN1 = 51 (CONFIGURABLE INPUT 2, CC5)
- G1 (2103-2109) = 0 (NOT ASSIGNED)

NONCRITOUT

- G1 (2201) CONOUT5 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
- G1 (2202) CO5IN1 = 50 (CONFIGURABLE INPUT 1, CC4)
- G1 (2203-2209) = 0 (NOT ASSIGNED)

RINITOUT

- G1 (2301) CONOUT6 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
- G1 (2302) CO6IN1 = 50 (CONFIGURABLE INPUT 1, CC4)
- G1 (2302-2309) = 0 (NOT ASSIGNED)

9. Apply rated DC across CC4, AC11-AC12.

10. Verify that the following contacts close:

Output	Contacts
CONOUT5	AC8-AD8
CONOUT6	AA5-AB5 and AA6-AB6

11. Remove DC from CC4.

12. Verify that the contacts are now open.

13. Apply rated DC across CC5 (AC9-AC10).

14. Verify that the following contacts close:

Output	Contacts
CONOUT3	AC7-AD7
CONOUT4	AC12-AD12

15. Remove DC from CC5.

16. Verify that these contacts are now open.

17. Apply rated DC across CC6, (AC7-AC8).

18. Verify that the following contacts close:

Output	Contacts
CONOUT1	AA7-AB7
CONOUT2	AA8-AB8

19. Remove DC from CC6.

20. Verify that these contacts are now open.

5

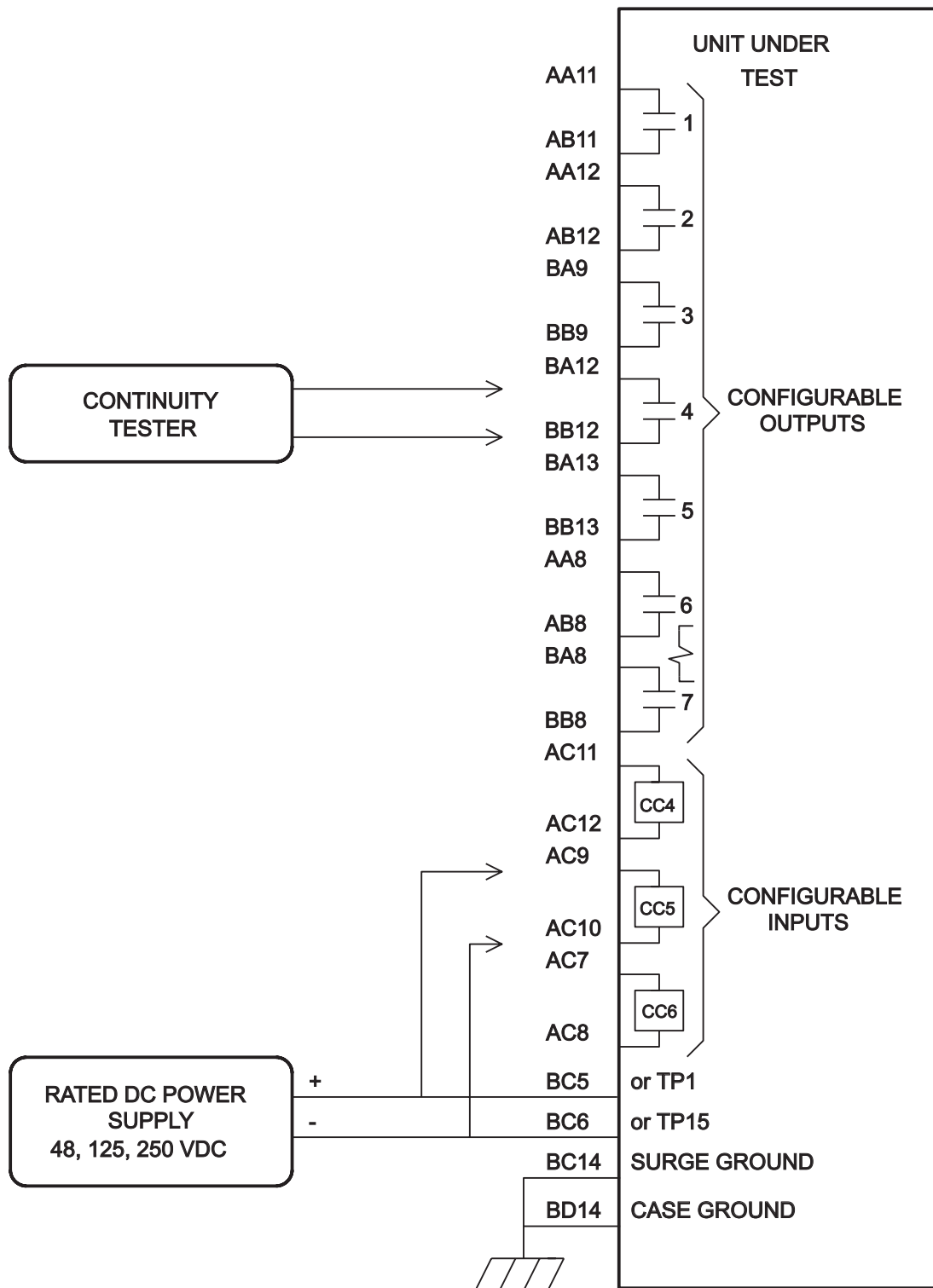


Figure 5-2: CONFIGURABLE INPUT & OUTPUT TEST CONNECTIONS

5.5.4 T4 – AC SYSTEM INPUT TEST

This initial test uses the "VALUES" function of the MMI to determine that the voltages and currents are applied to the proper connections on the terminal strip. The "VALUES" function can be used at any time during the test, to verify that the relay has the correct voltages and currents applied.

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS below.
2. Set $V_A = 67$ volts rms 0° , $V_B = 57$ volts rms -120° , and $V_C = 47$ volts rms $+120^\circ$.
3. Press the [INF] "information" key on the MMI. Scroll with arrow keys to the "INF: VALUES" heading, then press the [ENT] key. The present values are now selected.
4. With the arrow keys, scroll through the values of V_A , V_B , and V_C and verify that the voltages are within +2 volts of the voltage source setting. This verifies the connections of the voltage sources. If a printer is available, press the [PRT] key while in the VALUES category and all present values will be printed.
5. Set $I_{op} = 1.0$ amp rms for phases IA, IB, or IC, as shown by the "Y" connection point in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS.
6. With the arrow keys, scroll to the value of IA, IB, or IC depending on the "Y" connection. Verify that the current reading is between 0.9 and 1.1 amps rms.

Alternatively, whenever the MMI display is blank, pressing the [CLR] key will automatically scroll through all of the present values.

Reduce the test current to zero (0) amps.

5

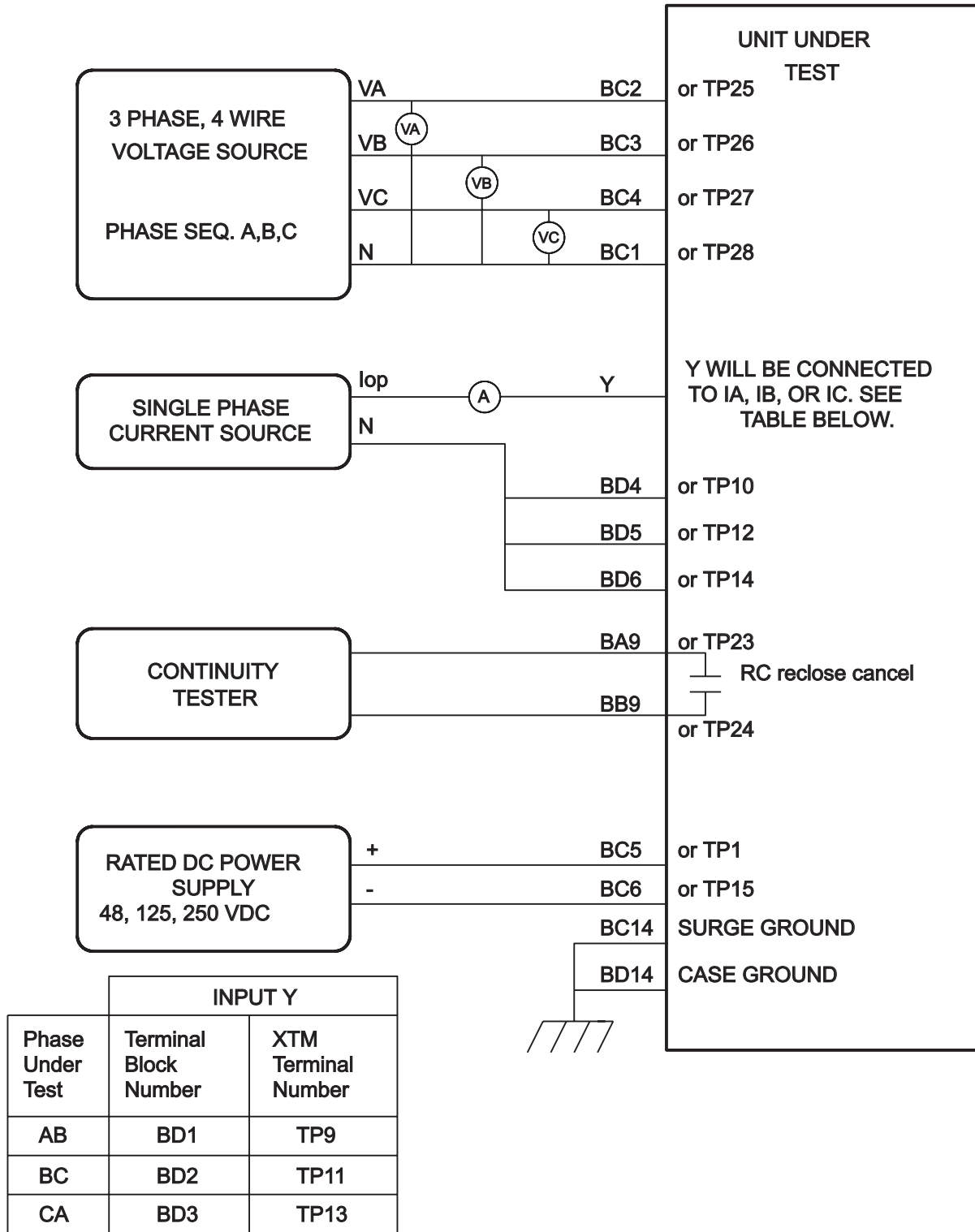


Figure 5-3: PHASE-TO-GROUND TEST CONNECTIONS

5.6.1 WARNING

CAUTION: The RC contact will chatter when the unit under test is near its threshold. DO NOT let it continue. Remove the test current. A single contact closure is enough to determine that the unit picked up.

5.6.2 T5 – FAULT DETECTOR TEST

The Fault Detector responds to sudden changes in current levels. Slow changes will not be picked up.

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into test mode 38 (the fault detector). "FAULT DETECTOR ON" will be displayed at the MMI. Set VA = 67 volts rms 0°; VB = 67 volts rms –120°; VC = 67 volts rms +120°.
3. Slowly increase Iop to 1.2(0.4) amps rms, approximately 0.1(0.01) amp per second. Slowly decrease the current to zero (0) amp. The RC contact should not close.
4. Suddenly increase the current of Iop to 1.5(0.3) amps rms. The RC contact will close momentarily.
5. Suddenly increase the current of Iop to 2.5(0.5) amperes rms. The RC contact will close until current is removed.
6. Reduce Iop to Zero (0).

5.6.3 T6 – IT TRIP SUPERVISION TEST

Settings:

CURSUPVIS

(503) PUIT = 0.25(.05) AMP

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into test mode 34 (IT Detector). "IT DETECTOR ON" will be displayed at the MMI.
3. Set the current of Iop to 0.40(.08) amp rms and apply to the relay. The RC contact should close. Lower Iop to .15(.03) amp rms, and the RC contact should open.
4. Reduce Iop to zero (0).

5.6.4 T7 – IB BLOCKING SUPERVISION TEST

Settings:

CURSUPVIS

(504) PUIB = 0.2 (.04) AMP

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into test mode 35 (IB Detector). "IB DETECTOR ON" will be displayed at the MMI.
3. Set the current of Iop to .30(.06) amp rms and apply to the relay. The RC contact should close. Lower Iop to .10(.02) amp rms, and the RC contact should open.
4. Reduce Iop to zero (0).

5.6.5 T8 – GROUND DIRECTIONAL TRIP TEST (IPT + NT)

Settings:

CURSUPVIS

(501) PUIPT = 0.5(0.1) AMP

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18 for an AG test.
2. Set VA = 57 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms +120°.
3. Set the relay into test mode 36 (Ground Directional Trip). "GRD DIR TRIP ON" will be displayed at the MMI.
4. Set IA, the current of lop, to .70(.14) amp rms –85°, and apply to the relay. The RC contact should close. Lower lop to .40(.08) amp rms, and the RC contact should open.
5. Reduce lop to zero (0).

5.6.6 T9 – GROUND DIRECTIONAL BLOCK TEST (IPB + NB)

Settings:

CURSUPVIS

(502) PUIPB = 0.25(.05) AMP

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18 for an AG test.
2. Set VA = 55 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms +120°.
3. Set the relay into test mode 37 (Ground Directional Block). "GRD DIR BLK ON" will be displayed at the MMI.
4. Set IA, the current of lop, to .40(.08) amp rms –265°, and apply to the relay. The RC contact should close. Lower lop to .15(.03) amp rms, and the RC contact should open.
5. Reduce lop to zero (0).

5.6.7 T10 – PHASE INSTANTANEOUS OVERCURRENT (PH4)

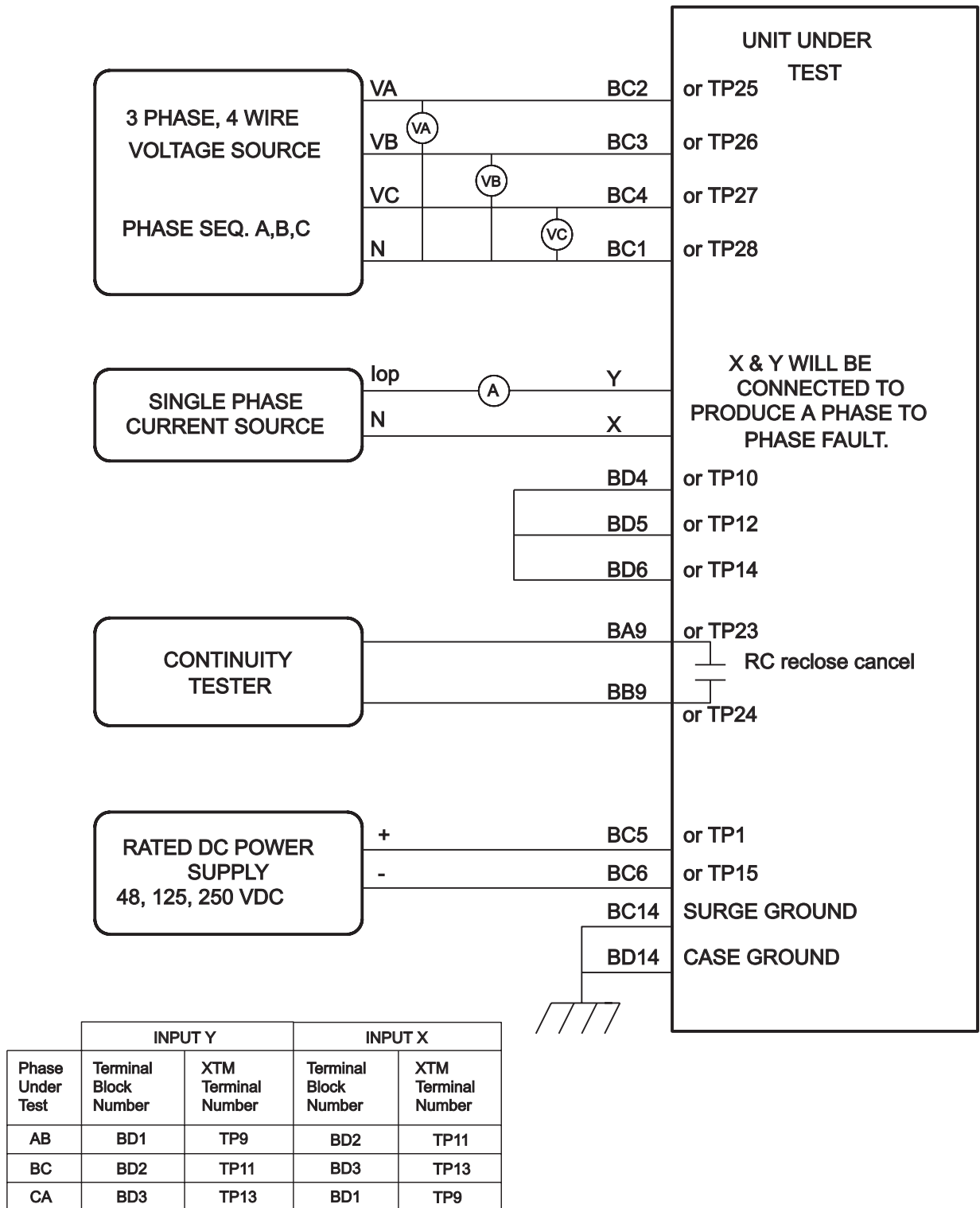
Settings Changes:

OVERCUR

(601) SELPH4 = YES

(602) PUPH4 = 5.0(1.0) AMPS

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS below, for a phase AB, BC or CA fault.
2. Set the relay into test mode 43 (Phase Overcurrent). " INST PHS OVRC ON" will be displayed at the MMI.
3. Set the current of lop to 2.8(.6) amps rms and apply to the relay. The RC contact should close. Lower lop to 2.0(.4) amps rms, and the RC contact should open.
4. Reduce lop to zero (0).
5. Change (602) PUPH4 back to pretest setting of 20 amps.



5

Figure 5-4: PHASE-TO-PHASE TEST CONNECTIONS

5.6.8 GROUND INSTANTANEOUS OVERCURRENT (IDT)

Settings Changes:

OVERCUR

- (603) SELIDT = YES
- (605) PUIDT = 2.5(0.5) AMPS
- (604) SELDIDT = NO (directional control off)

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into test mode 44 (Ground Overcurrent). " INST GND OVRC ON" will be displayed at the MMI.
3. Set the current of Iop to 4.0(.80) amps rms and apply to the relay. The RC contact should close. Lower Iop to 2.4(.40) amps rms, and the RC contact should open.
4. Reduce Iop to zero (0).
5. Change the setting of (604) SELDIDT back to "YES" to restore directional control, and change (605) PUIDT back to pretest setting. (10A Default)

5.6.9 T12 – GROUND TIME OVERCURRENT (TOC)

Settings Changes:

OVERCUR

- (606) SELTOC = YES
- (607) SELDTC = NO (directional control off)
- (608) PUTOC = 1.0(0.2)
- (609) TDTC = 5

1. Connect the relay as shown in Figure 5–5: GROUND REACH TIMER TEST CONNECTIONS below.
NOTE: Start the timer when Iop is applied, and stop the timer when the RC closes (the relay trips).
2. Set the relay into test mode 45 (TOC). " TIM DLY GD OC ON" will be displayed at the MMI.
3. Apply Iop at 3.0(0.6) amps rms and start the timer. Leave the current "on" until the RC contact closes, and stop the timer. The TOC will time out in 2.8 to 3.2 seconds.
4. Reduce Iop to zero (0).
5. Repeat steps 3 and 4, using the values for Iop below. Verify that the TOC times out within the time specified.

Current RMS	Time in Seconds
3 A	2.5 - 3.5
6 A	1.0 - 1.2
10 A	0.7 - 0.8

6. Change the setting of (607) SELDTC to "YES"; change (608) PUTOC to pretest setting.

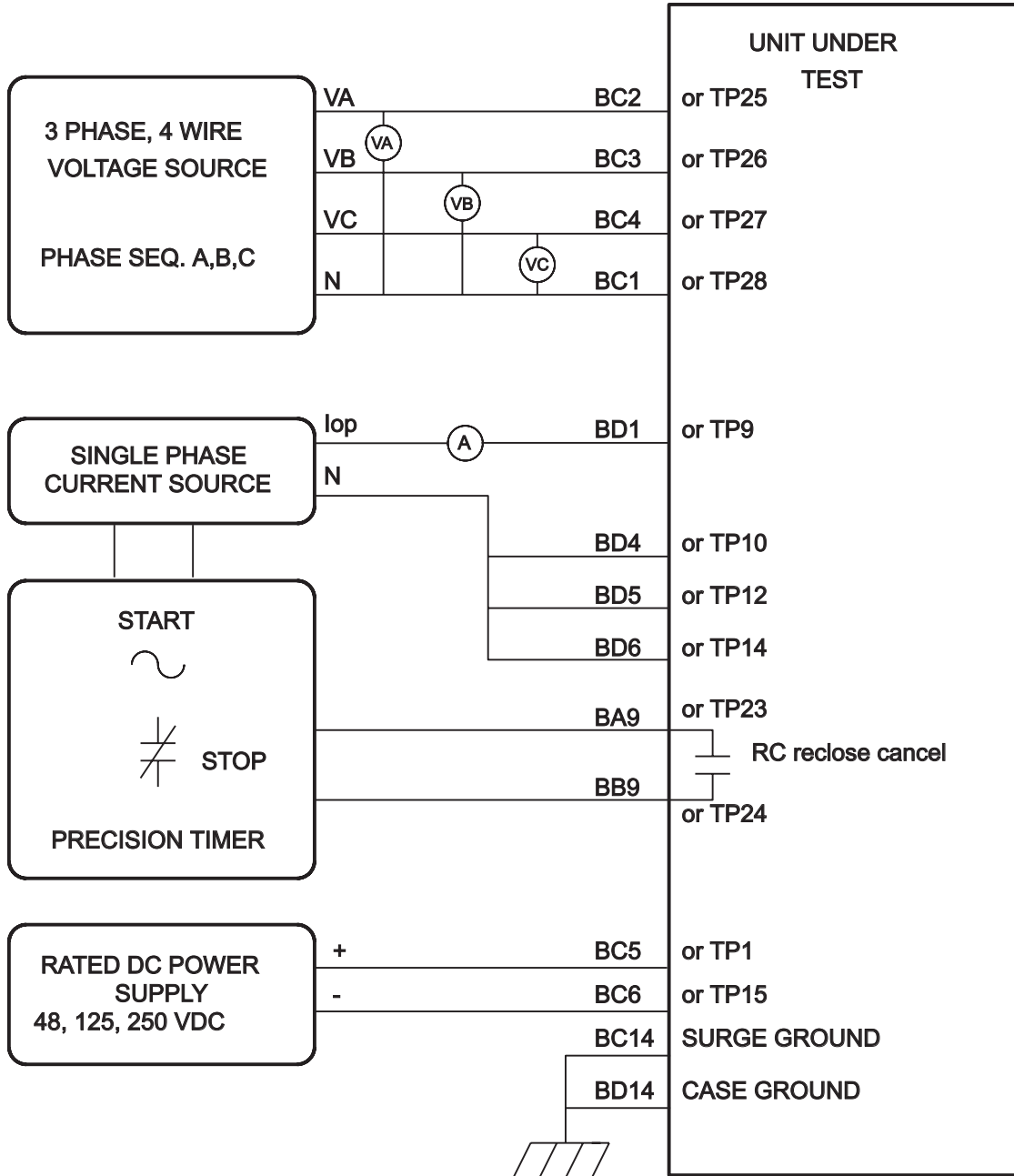


Figure 5-5: GROUND REACH TIMER TEST CONNECTIONS

5.7.1 ZONE REACH TESTING CONSIDERATIONS

1. The Zone measuring units are tested in the "test mode" of operation. The RC "reclose cancel" contact indicates when the unit has operated. It is the only measure of whether the test passes or fails. The MMI target information is used for reference only. This is due to the fact that the relay may trip for a different function from the one that is under test.
2. When testing a particular zone, the other protection zones will be disabled by the settings listed prior to the test. This is not strictly necessary when using the test mode, but if it is not done, the trip target type may not match the unit currently being tested. The backup protection functions will cause the relay to trip during zone testing. If this is not desired, disable the backup functions by changing the following settings.

OVERCUR

- (601) SELPH4 = NO
- (603) SELIDT = NO
- (606) SELTOC = NO

OUTOFSTEP

- (803) SELOSB = 2 (BLKNONE)

NOTE: AFTER THE ZONE REACH TESTING IS COMPLETED, RESTORE THE ABOVE SETTINGS TO THE PRETEST VALUES.

5.7.2 T13 – ZONE 1 GROUND REACH TEST

5

Setting Changes:

Z1DIST

- (101) SELZ1G = YES
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = NO

Ground Faults (AG, BG, and CG) M1G

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
2. Set the relay into test mode 14 (ANY Zone 1 Ground). "ANY Z1 GRND ON" will be displayed at the MMI.
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle listed below. (Increase VA, VB, VC to 75V when Iop = –79°)

I Degrees	Volts RMS	DIST **
–49	56 - 63	-
–79	65 - 73	82-88
–109	56 - 63	-

4. Set the fault current, "Iop", to 8.2(1.6) amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown above.

- Reduce the fault current to zero (0).

If the backup protection functions and the zones not under test have been disabled, note that the trip target indication concurs with the fault. An AG fault will be displayed as: TRIP: AG Z1 "DIST" **.

- Repeat the test for phase BG and CG faults.

** Reference only

5.7.3 T14 – ZONE 2 GROUND REACH TEST

Setting Changes:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = YES
- (202) SELZ2P = NO
- (207) PUTL2P = 0.1
- (208) PUTL2G = 0.1

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = NO

Ground Faults (AG, BG, and CG), MTG

- Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
- Set the relay into the ZONE 2 ground test mode for the appropriate phase under test: e.g., "ZONE 2 AG ON".
- Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed below. (Increase VA, VB, VC to 75V when Iop = –79°)

I Degrees	Volts RMS	DIST **
–49	56 - 63	-
–79	65 - 73	146-154
–109	56 - 63	-

- Set the fault current to 4.6(0.9) amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown above.
- Reduce the fault current to zero (0).

If the backup protection functions and the zones not under test have been disabled, note that the trip target indication concurs with the fault. An AG fault will be displayed as: TRIP: AG Z2 "DIST"**.

- Repeat the test for phase BG and CG faults.

** Reference only

5.7.4 T15 – ZONE 3 GROUND REACH TEST

Setting Changes:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

Z3DIST

- (301) SELZ3G = YES
- (302) SELZ3P = NO
- (305) PUTL3P = 0.1
- (306) PUTL3G = 0.1

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = NO

Ground Faults (AG, BG, and CG)

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
2. Set the relay into the ZONE 3 ground test mode for the appropriate phase under test: e.g., "ZONE 3 AG ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed below. (Increase VA, VB, VC to 75V when Iop = –79°)

I Degrees	Volts RMS	DIST **
–49	57 - 64	-
–79	66 - 73	195-205
–109	57 - 64	-

4. Set the fault current to 3.5(0.7) amperes rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown above.
5. Reduce the fault current to zero (0).

If the backup protection functions and the zones not under test have been disabled, note that the trip target indication concurs with the fault. An AG fault will be displayed as: TRIP: AG Z3 "DIST"**.

6. Repeat the test for phase BG and CG faults.

** Reference only

5.7.5 T16 – ZONE 4 GROUND REACH TEST

Setting Changes:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

Z4DIST

- (401) SELZ4G = YES
- (402) SELZ4P = NO
- (407) PUTL4P = 0.1
- (408) PUTL4G = 0.1

Z4 Ground Faults (AG, BG, and CG)

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
2. Set the relay into the ZONE 4 ground test mode for the appropriate phase under test: e.g., "ZONE 4 AG ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed below. (Increase VA, VB, VC to 75V when Iop = –79°)

I Degrees	Volts RMS	DIST **
–49	56 - 63	-
–79	62 - 72	290-310
–109	56 - 63	-

4. Set the fault current to 2.3(0.5) amperes rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown above.
5. Reduce the fault current to zero (0).
6. Repeat the test for phase BG and CG faults.

** Reference only

5.7.6 T17 – GROUND (ZONE BACKUP) TIMER TESTS

Settings:

LINEPU

(901) SELLPU = NO

Z1DIST

(101) SELZ1G = NO

(102) SELZ1P = NO

Z2DIST

(201) SELZ2G = YES

(202) SELZ2P = NO

(207) PUTL2P = 1.0

(208) PUTL2G = 1.0

Z3DIST

(301) SELZ3G = YES

(302) SELZ3P = NO

(305) PUTL3P = 3.0

(306) PUTL3G = 3.0

Z4DIST

(401) SELZ4G = YES

(402) SELZ4P = NO

(407) PUTL4G = 5.0

(408) PUTL4P = 5.0

a) ZONE 2 TIMER**Z2 timer default value of 1.0 sec.**

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phase under test.
2. Set the relay into test mode 15 (Zone 2 Timer). "Z2 GRND TIMER ON" will be displayed at the MMI.
3. Set the voltage inputs to: VA = 55 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to –55°.
4. 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 to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.
5. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). If the backup protection functions and the zones not under test have been disabled, verify that the trip target indication shows a ZONE 2 trip, such as: AG Z2. This verifies that the second zone tripped.

The time for the trip should be in the range of 0.9 to 1.1 seconds.

6. Leave the voltages at the values in step 3.

b) ZONE 3 TIME OUT**Z3 timer default value of 3.0 sec.**

Setting Change:

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

7. Set the relay into test mode 16 (Zone 3 Timer). "Z3 GRND TIMER ON" will be displayed at the MMI.
8. 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 to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.
9. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a ZONE 3 trip, such as: AG Z3. This verifies that the third zone tripped.

The time for the trip should be in the range of 2.9 to 3.1 seconds.

10. Leave the voltages at the values in step 3.

c) ZONE 4 TIME OUT**Z4 timer default value of 5.0 sec.**

Setting Change:

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

11. Set the relay into test mode 17 (Zone 4 Timer). "Z4 GRND TIMER ON" will be displayed at the MMI.
12. 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 to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.
13. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). If the backup protection functions and the zones not under test have been disabled, verify that the trip target indication shows a ZONE 4 trip, such as: AG Z4. This verifies that the fourth zone tripped.

The time for the trip should be in the range of 4.8 to 5.2 seconds.

14. If not continuing with Phase Reach testing, return all settings, including OVERCURR (601, 603, 606) and OTOFSTEP (803), to pretest values:

Settings:

Z1DIST

- (101) SELZ1G = YES
- (102) SELZ1P = YES

Z2DIST

- (201) SELZ2G = YES
- (202) SELZ2P = YES

Z3DIST

- (301) SELZ3G = YES
- (302) SELZ3P = YES

Z4DIST

- (401) SELZ4G = YES
- (402) SELZ4P = YES

5.8.1 SETTINGS FOR PHASE-TO-PHASE TESTS

Setting Changes for *all* Phase-to-Phase tests:

OVERCUR

- (601) SELPH4 = NO
- (603) SELIDT = NO
- (606) SELTOC = NO

OUTOFSTEP

- (803) SELOSB = 2 (BLKNONE)

5.8.2 T18 – ZONE 1 PHASE REACH

Setting Changes:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = YES

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = NO

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phases under test. Set the relay into test mode 30 (ANY ZONE 1 Phase). "ANY Z1 PHASE ON" will be displayed at the MMI.
2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed below. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.
3. Set the fault current to 10.0(2.0) amps rms. Simultaneously reduce the voltage of the faulted phases and check that the RC contact closes when the voltages are within the limits shown below.

I Degrees	Volts RMS	DIST **
–25	51 - 57	-
–55	59 - 66	82-88
–85	51 - 57	-

4. Reduce the fault current to zero (0). If the backup protection functions and the zones not under test have been disabled, note that the trip target indication concurs with the fault. An AB fault will be displayed as: TRIP: AB Z1 "DIST"***.
5. Repeat the test for phase BC and CA faults.

** Reference only

Setting Changes:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = YES
- (207) PUTL2P = 0.1
- (208) PUTL2G = 0.1

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = NO

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure AT-5, for the appropriate phases under test. Set the relay into the ZONE 2 Phase test mode for the appropriate phase under test: e.g., "ZONE 2 AB ON".
2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-7. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.
3. Set the fault current to 6.7(1.4) amps rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table AT-7.

I Degrees	Volts RMS	DIST **
–25	57 - 64	-
–55	65 - 73	146-154
–85	57 - 64	-

4. Reduce Iop of the faulted phase to zero (0).

If the backup protection functions and the zones not under test have been disabled, note that the trip target indication concurs with the fault. An AB fault will be displayed as: TRIP: AB Z2 "DIST"***.

5. Repeat the test for phase BC and CA faults.

** Reference only

5.8.4 T20 – ZONE 3 PHASE REACH

Setting Changes:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = YES
- (306) PUTL3G = 0.1
- (305) PUTL3P = 0.1

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = NO

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phase under test. Set the relay into the ZONE 3 Phase test mode for the appropriate phase under test: e.g., "ZONE 3 AB ON".
2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed below. Note: The leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, VC to 75V when Iop = –55°)
3. Set the fault current to 5.0(1.0) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown below.

I Degrees	Volts RMS	DIST **
–25	56 - 63	-
–55	65 - 73	195-205
–85	56 - 63	-

4. Reduce the fault current to zero (0). If the backup protection functions and the zones not under test have been disabled, note that the trip target indication concurs with the fault. An AB fault will be displayed as: TRIP: AB Z3 "DIST"***.
5. Repeat the test for phase BC and CA faults.

** Reference only

Setting Changes:

Z1DIST

(101) SELZ1G = NO
(102) SELZ1P = NO

Z2DIST

(201) SELZ2G = NO
(202) SELZ2P = NO

Z3DIST

(301) SELZ3G = NO
(302) SELZ3P = NO

Z4DIST

(401) SELZ4G = NO
(402) SELZ4P = YES
(407) PUTL4P = 0.1
(408) PUTL4G = 0.1

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phase under test. Set the relay into the ZONE 4 Phase test mode for the appropriate phase under test: e.g., "ZONE 4 AB ON".
2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "I_{op}", to the phase-angle value listed below. Note: The leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, VC to 75V when I_{op} = –55°)
3. Set the fault current to 3.3(0.7) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown below.

I Degrees	Volts RMS	DIST **
–25	56 - 63	-
–55	54 - 72	82-88
–85	56 - 63	-

4. Reduce the fault current to zero (0).
5. Repeat the test for phase BC and CA faults.

** Reference only

5.8.6 T22 – PHASE (ZONE BACKUP) TIMER TESTS

Settings:

Z1DIST

- (101) SELZ1G = NO
- (102) SELZ1P = NO

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = YES
- (207) PUTL2P = 1.0
- (208) PUTL2G = 1.0

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = YES
- (305) PUTL3P = 3.0
- (306) PUTL3G = 3.0

Z4DIST

- (401) SELZ4G = NO
- (402) SELZ4P = YES
- (407) PUTL4P = 5.0
- (408) PUTL4G = 5.0

5

a) ZONE 2 TIMER

Z2 timer default value of 1.0 sec.

1. Connect the relay as shown in Figure 5–6: PHASE REACH TIMER TEST CONNECTIONS on page 5–36, for an AB fault.
2. Set the relay into test mode 31 (Zone 2 Phase Timer). "Z2 PHASE TIMER ON" will be displayed at the MMI.
3. Set the voltage inputs to: VA = 55 volts rms 0°, VB = 55 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to –55°.
4. Apply the fault current at 10.0(2.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps. It should be applied at that level.) This is an AB fault that is within pickup of all four zones.
5. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a ZONE 2 trip, such as: AB Z2. This verifies that the second zone tripped.

The time for the trip should be in the range of 0.9 to 1.1 seconds.

6. Leave the voltages at the values in step 3.

b) ZONE 3 TIME OUT

Z3 timer default value of 3.0 sec.

Setting Change:

Z2DIST

- (201) SELZ2G = NO
- (202) SELZ2P = NO

7. Set the relay into test mode 32 (Zone 3 Phase Timer). "Z3 PHASE TIMER ON" will be displayed at the MMI.

8. Apply the fault current at 10.0(2.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps. It should be applied at that level.) This is an AB fault that is within pickup of all four zones.
9. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a ZONE 3 trip, such as: AB Z3. This verifies that the third zone tripped.

The time for the trip should be in the range of 2.9 to 3.1 seconds.

10. Leave the voltages at the values in step 3.

c) ZONE 4 TIME OUT

Z4 timer default value of 5.0 sec.

Setting Change:

Z3DIST

- (301) SELZ3G = NO
- (302) SELZ3P = NO

11. Set the relay into test mode 33 (Zone 4 Phase Timer). "Z4 PHASE TIMER ON" will be displayed at the MMI.
12. Apply a fault current of 10.0(2.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps. It should be applied at that level.) This is an AG fault within pickup of all four zones.
13. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a ZONE 4 trip, such as: AB Z4. This verifies that the fourth zone tripped.

The time for the trip should be in the range of 4.8 to 5.2 seconds.

14. If not continuing with MOB testing, return all settings, including OVERCURRE (601, 603, 606) and OUTOFSTEP (803), to pretest values:

Settings:

Z1DIST

- (101) SELZ1G = YES
- (102) SELZ1P = YES

Z2DIST

- (201) SELZ2G = YES
- (202) SELZ2P = YES

Z3DIST

- (301) SELZ3G = YES
- (302) SELZ3P = YES

Z4DIST

- (401) SELZ4G = YES
- (402) SELZ4P = YES

5

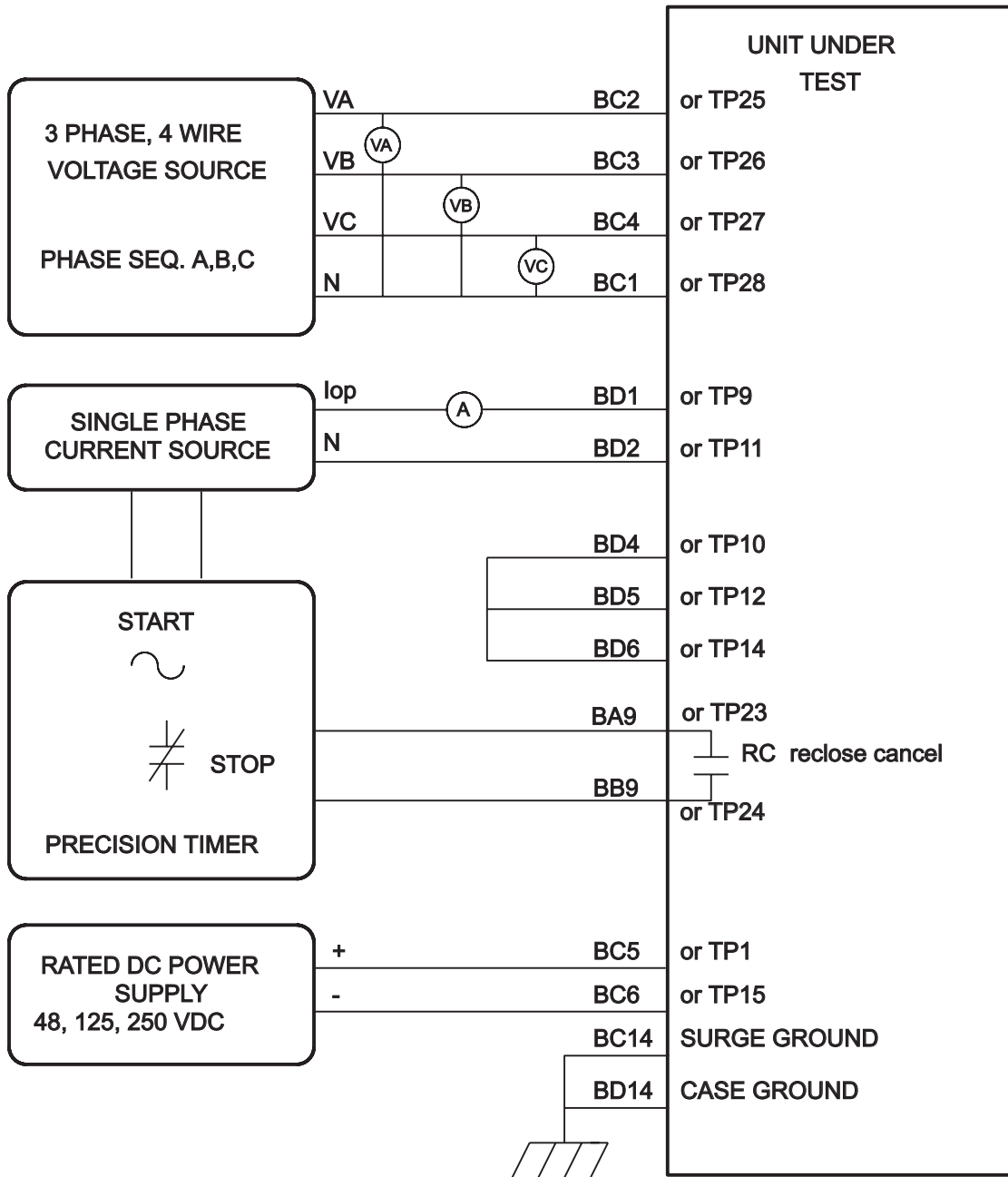


Figure 5-6: PHASE REACH TIMER TEST CONNECTIONS

5.9.1 T23 – OUT-OF-STEP REACH

Setting Changes:

OUTOFSTEP

(803) SELOSB = 0 (BLKALL)
(801) SELPTZ = 0 (ZONE 2)

Z1DIST

(101) SELZ1G = NO
(102) SELZ1P = NO

Z2DIST

(201) SELZ2G = NO
(202) SELZ2P = YES

Z3DIST

(301) SELZ3G = NO
(302) SELZ3P = NO

Z4DIST

(401) SELZ4G = NO
(402) SELZ4P = NO

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phase under test.
2. Set the relay into the test mode 40 (OUT OF STEP). "OUT OF STEP ON" will be displayed at the MMI.
3. Set the voltage inputs to: VA = 75 volts rms 0°, VB = 75 volts rms –120°, and VC = 75 volts rms –240°. Set the fault current, "Iop", to the phase-angle value listed below. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.

I Degrees	Volts RMS
–85	62 - 72
–25	62 - 72

4. Set the currents in the faulted phases to 6.3(1.3) amperes rms. Reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in below.
5. Reduce the current in the faulted phase to zero (0).
6. Repeat the test for phases BC and CA. Return Settings to pretest values:

LINEPU

(901) SELLPU = YES

Z1DIST

(101) SELZ1G = YES
(102) SELZ1P = YES

Z2DIST

(201) SELZ2G = YES
(202) SELZ2P = YES

Z3DIST

(301) SELZ3G = YES
(302) SELZ3P = YES

Z4DIST

(401) SELZ4G = YES
(402) SELZ4P = YES

5.10.1 T24 – RECLOSER

NOTE: The following tests are not intended to demonstrate all functions of the recloser but to show that all inputs and outputs are operational.

Setting Changes to be done in Step 2 of this test:

RECLOSER

(2401) SELRCLR = 3 (TWO SHOT RECLOSING)

(2402) TPRDLY1 = 2.55 SECONDS

(2408) RSTDLY = 255 SECONDS

1. Connect the relay as shown in Figure 5–7: RECLOSER TEST CONNECTIONS on page 5–39. Rated DC voltage is applied to both 52b inputs so that the DLP3 detects open breakers.

Set the Manual Lockout Switch to the OFF position.

2. Change the settings of the relay to the ones above. If the settings are already at the above settings, enter them again. The test sequence is based on starting from power up or settings initialization.
3. After the settings change, the relay will go into LOCKOUT, since the relay detects open breakers. Verify the state of the following contacts:

Contact	Terminals	State
Z1RR	AA13 - AB13	closed
LOA	BA10 - BB10	closed
RIP	BA11 - BB11	open

4. Remove voltage from the 52b inputs so that the DLP3 detects closed breakers. Momentarily apply rated DC voltage across the RECLOSE RESET input (BC13-BD13) then release. Operating the RECLOSE RESET will bypass the reset delay timer; RSTDLY

Verify that the above contacts (Z1RR, LOA, RIP) are all open.

5. This test will verify that a Reclose Cancel will prevent a reclose from a reclose initiate.

Apply rated DC voltage across the RECLOSE CANCEL input (BC12-BD12). While keeping the RC input energized, momentarily apply rated DC voltage across the RI input (AC5-AC6) then release.

Verify that the recloser output contacts remain open. Remove the voltage from the RC input.

6. In this test a Reclose Initiate will be issued followed by a Reclose Cancel before the Reclose Delay can time out.

Apply rated DC voltage across the RI input then release. RIP will close.

Before TPRDLY1 times out (2.55 seconds), apply rated DC voltage across the RECLOSE CANCEL input. RIP will open and Z1RR and LOA will close. The recloser will have been sent immediately to LOCKOUT by the RC.

7. Momentarily apply rated DC voltage across the RECLOSE RESET input then, release. All recloser output signals will open.

8. This test will verify that Reclose Inhibit will prevent a reclose. Apply rated DC voltage across the RECLOSE INHIBIT input (BC11-BD11). While keeping the RINH input energized, momentarily apply rated DC voltage across the RI input, then release. Verify the state of the following contacts:

Contact	Terminals	State
Z1RR	AA13 - AB13	closes after 2.55 seconds
LOA	BA10 - BB10	closes after 2.55 seconds
RIP	BA11 - BB11	closes for 2.55 seconds
BC-1	AA11 - AB11	open

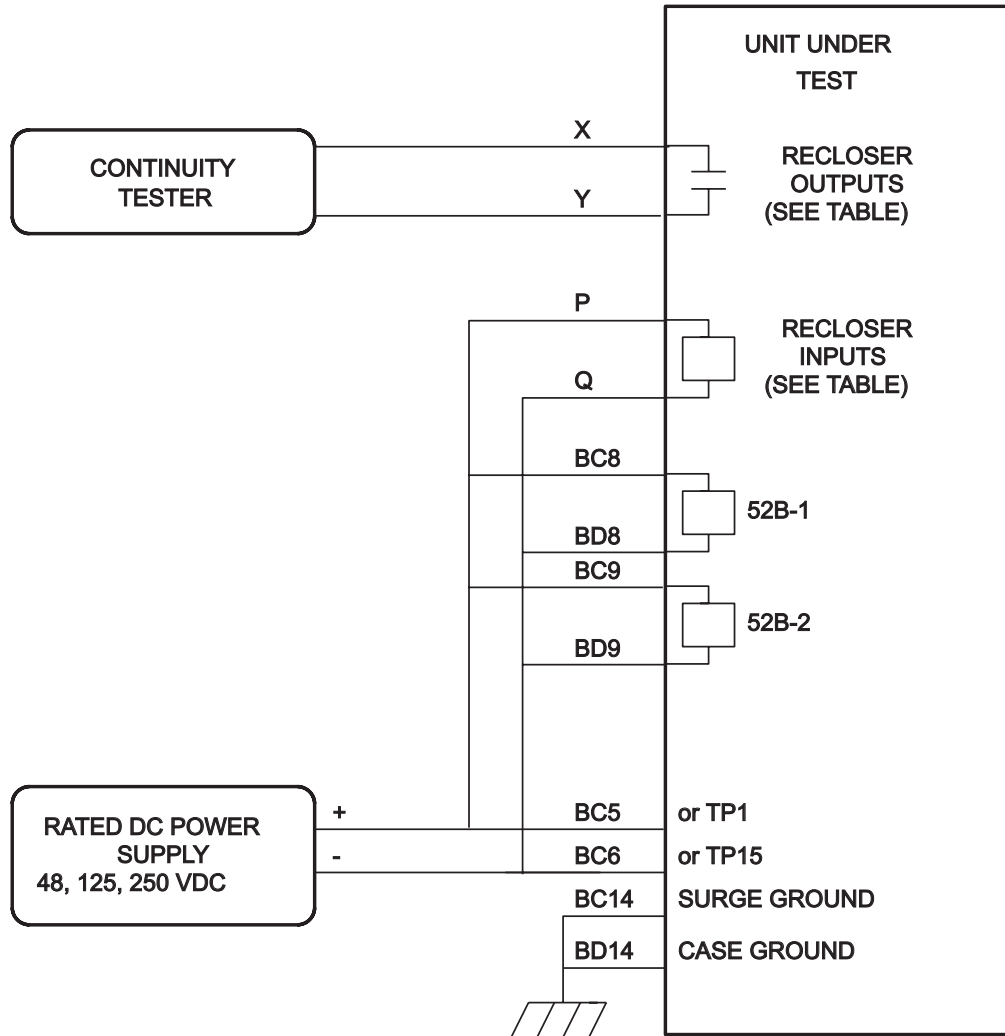
The recloser has returned to LOCKOUT due to the RINH.

- Remove the rated DC voltage from the RINH input. Momentarily apply rated DC voltage across the RECLOSE RESET input, then release.

All recloser output contacts will open.

- Momentarily apply rated DC voltage across the RI input, then release. Then apply rated DC voltage across the 52b inputs. RIP will close.

After 5 seconds the BREAKER CLOSE contact (AA11-AB11) will close, and stay closed for 1 second. (Dwell Time delay, DWELLTM). The recloser will then return to LOCKOUT.



RECLOSER INPUTS	P	Q
RECL RST	BC13	BD13
RECL CAN	BC12	BD12
RI	AC5	AC6
RECL INH	BC11	BD11

RECLOSER OUTPUTS	X	Y
Z1RR	AA13	AB13
LOA	BA10	BB10
RIP	BA11	BB11
BC-1	AA11	AB11

Figure 5–7: RECLOSER TEST CONNECTIONS

5.11.1 ENDING ACCEPTANCE TESTING

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 before testing using DLP-LINK, download the file to the relay.

6.1.1 DESCRIPTION

CAUTION: Power Down the relay, with the power switch or by removing a connection plug, before removing or inserting modules. Failure to do so can permanently damage the relay.

The formulas below will permit the calculation of pickup currents and voltages for testing the DLP3 with settings specific to a particular application. The test circuits and procedures are the same as used and illustrated in the ACCEPTANCE TESTS section of this book.

It is up to the user to determine the extent of the testing to be performed. The tests shown are guides for performing the test; they are not strictly required to be done at every periodic test of the relay. The desired test procedures can be incorporated into the user's standard test procedures.

However, it is suggested that at least the relay's built-in "Self Tests" be incorporated into the user's test procedures. They will give the operational status of the unit.

It is assumed that the user is familiar with testing the DLP3. If not, refer to the ACCEPTANCE TEST section for details.

a) GENERAL TESTS

- T1 MMI Status Test (Built-In Self Tests)
- T2 MMI Display Test (Built-In Self Tests)
- T3 Digital Output Test
- T4 AC System Input Test

b) MEASURING UNIT TESTS

- T5 IT Trip Supervision Test
- T6 IB Blocking Supervision Test
- T7 Ground Directional Trip Test, IPT + NT
- T8 Ground Directional Block Test, IPB + NB

c) BACKUP PROTECTION TESTS

- T9 Phase Instantaneous Overcurrent PH4
- T10 Ground Instantaneous Over-current IDT
- T11 Ground Time Over-current TOC

d) ZONE GROUND/PHASE REACH MEASURING UNITS

- T12 Zone 1 Ground Reach M1G
- T13 Zone 2 Ground Reach MTG
- T14 Zone 3 Ground Reach M3G
- T15 Zone 4 Ground Reach M4G
- T16 Zone 1 Phase Reach M1
- T17 Zone 2 Phase Reach MT
- T18 Zone 3 Phase Reach M3
- T19 Zone 4 Phase Reach M4

6.1.2 DRAWINGS & REFERENCES

The following drawings should be used for reference during testing. They are located in the PRODUCT DESCRIPTION, and the CALCULATION OF SETTINGS sections.

a) DRAWINGS

- Figure 1–22: DLPC-3 ELEMENTARY DIAGRAM on page 1–44
- Figure 1–3: STEP DISTANCE LOGIC DIAGRAM on page 1–9
- Figure 1–4: ZONE 1 EXTENSION LOGIC DIAGRAM on page 1–11
- Figure 1–5: POTT/PUTT LOGIC DIAGRAM on page 1–13
- Figure 1–7: BLOCKING LOGIC DIAGRAM on page 1–16
- Figure 1–10: HYBRID LOGIC DIAGRAM on page 1–21
- Figure 2–2: TOC INVERSE TIME CURRENT CURVE on page 2–17
- Figure 2–3: TOC VERY INVERSE TIME CURRENT CURVE on page 2–18
- Figure 2–4: TOC EXTREMELY INVERSE TIME CURRENT CURVE on page 2–19

b) REFERENCES

- Chapter 5: ACCEPTANCE TESTS
- Chapter 10: SOFTWARE

6.2.1 DESCRIPTION

The DLP3 is tested in the "test mode" of operation. This mode allows the internal measuring units and functions to be brought out and viewed. 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, and routes their status to the RC "reclose cancel" contact. When the particular function under test has picked up, the RC contact will close, and target information will be displayed for tests that cause tripping. Testing can be performed with outputs disabled, in which case RC is the only contact that will operate. Outputs can be disabled from the Actions menu.

CAUTION: The RC contact will chatter when the unit under test is near its threshold. DO NOT LET IT CONTINUE. REMOVE THE TEST CURRENT. A single contact closure is enough to determine that the unit picked up.

Before each zone reach test, backup protection functions and zones not under test should be disabled, using the settings. This is not strictly necessary when using the test mode, but if it is not done, 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 keep that in mind during the tests.

A continuity tester with high-input impedance, such as a Digital Ohmmeter, should be used to monitor the RC contact during the testing of the relay.

NOTE: TRIPPING CONTACTS WILL OPERATE IN THE TEST MODE UNLESS OUTPUTS ARE DISABLED BY THE USER.

6.2.2 ENTERING THE TEST MODE

Before each test it is necessary to set the relay in the 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, as indicated by the green LED on the MMI.
2. Press the [ACT] "action" key. Scroll with the arrow key until "ACT: ENTER PASSWORD" is displayed, then press the [ENT] "enter" key.
3. Enter the Control Level password (see the INTERFACE section for a description of MMI passwords).
When the correct password is entered, "SELECTED" will be displayed.
4. Press the [ACT] "action" key. Scroll with the arrow key until "ACT: RELAY TEST" is displayed, then press the [ENT] "enter" key.
5. Scroll through the different test mode functions or enter the number of the desired test, such as "38" for the FAULT DETECTOR. Then press [ENT] and the display will indicate "FAULT DETECTOR ON", and the MMI LED will turn red, indicating that the relay is in the test mode. When the relay picks up for the selected function it will close the RC "reclose cancel" contact.

6.2.3 EXITING THE TEST MODE

While in the "TEST MODE", press the [ACT] key. Scroll with the arrow key until "ACT:RELAY TEST" is displayed, then press the [ENT] key. Scroll until the display shows "END TST MODE?" or enter "1". Then press the [ENT] key. The MMI LED should return to green, indicating that normal operation has resumed.

6.2.4 INITIAL TEST SETUP

Before beginning the test, the relay settings should be printed for reference and verification. If no printer is available, scroll through each setting and make sure they match the required settings of the relay.

At the beginning of each test there is space provided to record the user-specific setting for the function under test.

6.2.5 USING DLP-LINK

To test the relay without the DLP3 Keypad, communication with the relay is accomplished via a PC with the program DLP-LINK. DLP-LINK is required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Once in test mode, current and voltages are applied to the relay to simulate the desired system conditions.

Follow the procedure specified in the ACCEPTANCE TEST section to test the relay with DLP-LINK.

6.3.1 T1 – MMI RELAY STATUS

The Relay's Status is reported through the MMI, the non-critical alarm contact and the critical alarm contact. If a system error caused relaying functions to cease, the LED on the MMI would turn "red" and the critical alarm contact would close. A failure that did not interrupt relaying would be indicated by the non-critical alarm closing, and by a "WARN" message on the MMI display.

If a STATUS error is detected, see the SERVICING section for further information.

1. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.
2. Press the [INF] "information" key. Then scroll with the arrow keys until the heading "INF: STATUS" is displayed.
3. Press the [ENT] "enter" key.

The display should be "STATUS OK". "OK" represents that the relay is operational and there are no internal errors

6.3.2 T2 – MMI DISPLAY TEST**(Skip this test for models ending with NC.)**

The MMI test is built into the software. It allows the user to test the keypad, the printer, and the display. If no printer is to be used with your relay, then skip the printer port testing.

1. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.
2. Press the [ACT] "action" key. Then scroll with the arrow keys until the heading "ACT: MMI TEST" is displayed.
3. Press the [ENT] "enter" key.

The display should be eight fully lit rectangles followed by the word "NEXT?".

4. Press the [1/Y] followed by the [ENT] key.

The display will change to eight fully lit rectangles on the right of the display, preceded by the word "LED TST?".

5. Press the [1/Y] followed by the [ENT] key.

The green LED will momentarily turn red.

6. Next, the display will prompt you for the keyboard test with "KEYBRD TST?".

7. Press the [1/Y] key followed by the [ENT] key.

8. At this point the MMI is in the keyboard test. Press every key on the keypad, except for the [CLR] "clear" key. As you press each key, verify that the display indicates the key that was pressed. Example: pressing the up arrow would be displayed by the word "UP". The other keys will match the description that is on the key itself.

9. When all the keys have been checked, press the [CLR] key.

PRINTER TEST (skip this if you do not have a keypad or printer)

10. The display prompt will be "PRINTER TST?". If you do not have a printer the press the [3/N] followed by the [ENT] key. If you have a printer, press the [1/Y] followed by the [ENT] key.

The printout will be 40 characters, which include the alphabet, the numbers 0 through 9, and the " : = / ." characters. Eight lines will be printed.

- When the printout is completed, press the [END] followed by the [ENT] key. This will end the MMI test mode.

6.3.3 T3 – DIGITAL OUTPUT TEST

This test is used to check 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.

NOTE: If using DLP-Link to run this test, none of the outputs will operate unless Jumper J1 on the MMI module is removed. Refer to Figure 4–2: MMI MODULE on page 4–2.

Protection can be enabled or disabled, as deemed necessary by the user.

- Connect the relay as shown in Figure 5–1: DIGITAL OUTPUT TEST CONNECTIONS on page 5–13.
- Enter the "Control Level" password.
- Press the [ACT] key and then select "DIG OUT TEST". Press the [ENT] key.
- Select the output to test. Use the arrow keys to scroll to the desired output, such as TRIP1A, and press the [ENT] key.

Before the contact is allowed to close, you will be prompted to turn protection off during the test. The prompt is: "PROTECT OFF?". Press the [1/Y] key followed by the [ENT] key to turn protection off. Protection will remain off until the test mode is ended. (If desired, protection can be left enabled during the test.)

Once the protection choice is made, the selected "relay output" will close.

Verify that the output under test has closed, using an ohmmeter or other suitable device.

- After the output is tested, scroll to the next output to test, then press the [ENT] key. This output will close and the previously selected output will open. Continue in this fashion until all outputs are tested.
- End the test mode by scrolling to the "END TEST MODE" selection, then press the [ENT] key. Alternatively, [END] followed by the [ENT] can be pressed to end the test and re-enable protection.

6.3.4 T4 – AC SYSTEM INPUT TEST

This test uses the "VALUES" function of the MMI to observe the voltage and current levels applied to the relay.

- Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
- Set VA = 67 volts rms 0°, VB = 57 volts rms –120° and VC = 47 volts rms +120°
- Press the [INF] "information" key on the MMI. Scroll with arrow keys to the "INF: VALUES" heading, then press the [ENT] key. The present values are now selected.
- With the arrow keys, scroll through the values of VA, VB, and VC and verify that the voltages are within ±2 volts of the voltage input to the relay.
- Apply Iop at 1.0 amps rms to the "Y" test point for the current under test.
- With the arrow keys, scroll to the value of IA, IB, or IC. Verify that the current reading is within 5% of the input current.
- Reduce the test current to zero (0) amps.

6.4.1 WARNING

CAUTION: The RC contact will chatter when the unit under test is near its threshold. **DO NOT LET IT CONTINUE. REMOVE THE TEST CURRENT.** A single contact closure is enough to determine that the unit has picked up.

Prior to each test there is space provided to record the user-specific setting for the function under test.

6.4.2 T5 – IT TRIP SUPERVISION TEST

Settings:

CURSUPVIS

(503)PUIT = [_____] amps

IT is calculated with the following equation:

$$IT = IA, IB, \text{ or } IC \quad (1)$$

The test current, "Iop", is single-phase current applied to phase IA.

Thus the unit should pick up when Iop = IT.

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into the test mode 34 (IT Detector). "IT DETECTOR ON" will be displayed at the MMI.
3. Set the current of Iop to $[IT+0.10 = \text{_____}]$ amps rms and apply to the relay. The RC contact should close. Lower Iop to $[IT-0.1 = \text{_____}]$ amps rms and the RC contact should open.
4. Reduce Iop to zero (0).

6.4.3 T6 – IB BLOCKING SUPERVISION TEST

Settings:

CURSUPVIS

(504)PUIB = [_____] amps

IB is calculated with the following equation:

$$IB = IA, IB, \text{ or } IC \quad (2)$$

The test current, "Iop", is single-phase current equal to IA.

Thus the unit should pick up when Iop = IB.

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into test mode 35 (IB Detector). "IB DETECTOR ON" will be displayed at the MMI.
3. Set the current of Iop to $[IB+0.1 = \text{_____}]$ amps rms and apply to the relay. The RC contact should close. Lower Iop to $[IB-0.1 = \text{_____}]$ amps rms and the RC contact should open.
4. Reduce Iop to zero (0).

6.4.4 T7 – GROUND DIRECTIONAL TRIP TEST

Settings:

CURSUPVIS

(501)PUIPT = [] amps

The IPT operating quantity is:

$$3*|I0| - 3*KT*|I1| \quad (3)$$

I0 is equal to Zero-Sequence Current.

I1 is equal to Positive-Sequence Current.

KT is equal to 0.3 for Blocking and Hybrid schemes, and equal to 0 for POTT and PUTT schemes.

Since the test current, "Iop", is single-phase current:

$$I0 = Iop/3 \quad \text{and} \quad I1 = Iop/3.$$

Substituting Iop/3 for I1 and I0 into equation (3), and assuming a Blocking or Hybrid scheme, yields:

$$PUIPT = Iop - 0.1*Iop = 0.9*Iop.$$

Therefore IPT will pick up when: $Iop \geq PUIPT/0.9$

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18 for an AG test.
2. Set VA = 57 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms +120°.
3. Set the relay into test mode 36 (Ground Directional Trip). "GND DIR TRIP ON" will be displayed on the MMI.
4. Set the current of Iop to $[(PUIPT/0.9)+0.10 =]$ amps rms at /POSANG and apply to the relay. The RC contact should close. Lower Iop to $[(PUIPT/0.9) - 0.1 =]$ amps rms and the RC contact should open.
5. Reduce Iop to zero (0).

6

6.4.5 T8 – GROUND DIRECTIONAL BLOCK TEST

Settings:

CURSUPVIS

(502)PUIPB = [] amps

The IPB operating quantity is:

$$3*|I0| - 3*KB*|I1| \quad (4)$$

I0 is equal to Zero-Sequence Current.

I1 is equal to Positive-Sequence Current.

KB is equal to .066 for Blocking and Hybrid schemes and equal to 0 for POTT and PUTT schemes.

Since the test current, "Iop", is single-phase current:

$$I0 = Iop/3 \quad \text{and} \quad I1 = Iop/3.$$

Substituting Iop/3 for I1 and I0 into equation (4), and assuming a Blocking or Hybrid scheme, yields:

$$PUIPB = Iop - 0.066*Iop = 0.934*Iop.$$

Therefore IPB will pick up when: $Iop \geq PUIPB/0.934$.

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18 for an AG test.

2. Set $V_A = 57$ volts rms 0° , $V_B = 67$ volts rms -120° , and $V_C = 67$ volts rms $+120^\circ$.
3. Set the relay into test mode 37 (Ground Directional Block). "GND DIR BLOCK ON" will be displayed on the MMI.
4. Set the current of I_{op} to $[(PUIPB/0.934)+0.1 = \quad]$ amps rms at $\angle POSANG +180^\circ$ and apply to the relay. The RC contact should close. Lower I_{op} to $[(PUIPB/0.934) - 0.1 = \quad]$ amps rms and the RC contact should open.
5. Reduce I_{op} to zero (0).

6.4.6 T9 – PHASE INSTANTANEOUS OVERCURRENT

Settings Changes:

OVERCUR

(601)SELPH4 = YES
 (602)PUPH4 = [] amps

PH4 is calculated with the following equation:

$$PH4 = (IA - IB), (IB - IC), \text{ or } (IC - IA) \quad (3)$$

PH4 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 $(IA - IB)$ equals $(I_{op} - I_{op})$, or $2 \cdot I_{op}$.

Therefore PH4 will pick up when: $I_{op} = .5 \cdot PH4$

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for a phase AB, BC or CA fault.
2. Set the relay into test mode 43 (Phase Overcurrent). "INST PHS OVRC ON" will be displayed at the MMI.
3. Set the current of I_{op} to $[.5 \cdot PH4 + (0.05 \cdot PH4) = \quad]$ amps rms and apply to the relay. The RC contact should close. Lower I_{op} to $[.5 \cdot PH4 - (0.05 \cdot PH4) = \quad]$ amps rms and the RC contact should open.
4. Reduce I_{op} to zero (0).

6.4.7 T10 – GROUND INSTANTANEOUS OVERCURRENT

Settings Changes:

OVERCUR

(603)SELIDT = YES
 (604)SELIDT = NO (directional unit off)
 (605)PUIDT = [] amps

IDT is internally calculated with the following equation:

$$IDT = 3 \cdot [I_0] - 0.9 \cdot [I_1] \quad (4)$$

I_0 is equal to Zero-Sequence Current.

I_1 is equal to Positive-Sequence Current.

Since the test current, " I_{op} ", is single-phase current:

$$I_{op}/3 = I_0 \quad \text{and} \quad I_{op}/3 = I_1.$$

Substituting $I_{op}/3$ for I_1 and I_0 into equation (4) yields:

$$IDT = I_{op} - 0.3 \cdot I_{op}, \text{ or} \\ IDT = 0.7 \cdot I_{op}.$$

Therefore IDT will pick up when: $I_{op} = IDT/0.7$

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18.
2. Set the relay into test mode 44 (Ground Overcurrent). "INST GND OVRC ON" will be displayed at the MMI.
3. Set the current of I_{op} to $[(IDT/0.7) + 0.5 = \text{_____}]$ amps rms and apply to the relay. The RC contact should close. Lower I_{op} to $[(IDT/0.7) - 0.5 = \text{_____}]$ amps rms and the RC contact should open.
4. Reduce I_{op} to zero (0).
5. Change the setting of (604)SELDIDT back to "YES" to restore directional control, if required.

6.4.8 T11 – GROUND TIME OVERCURRENT

Settings Changes:

OVERCUR

- (606)SELTOC = YES
- (607)SELDTOC = NO (directional control off)
- (608)PUTOC = [_____] amps, TOC pick up current
- (609)TDTOC = [_____] Time-dial setting
- (611)SELCURV = [_____] (curve in use)

TOC is calculated with the following equation:

$$TOC = 3 \cdot I_0 \quad (5)$$

I_0 is equal to zero-sequence current.

Since " I_{op} " is single-phase current, $I_{op}/3 = I_0$.

Substituting $I_{op}/3$ for I_0 in equation (5) yields:

$$TOC = I_{op}$$

Therefore TOC will pick up when: $I_{op} \geq TOC$.

The time it takes for TOC to pick up is determined by the Time-dial curve in the CALCULATION OF SETTINGS section.

CAUTION: If the test current exceeds $2 \cdot I_n$ (I_n = 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 re-applying current.

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21.

NOTE: Start the timer when I_{op} is applied, and stop the timer when the RC closes (the relay trips).

2. Set the relay into test mode 45 (TOC). "TIM DLY GD OC ON" will be displayed at the MMI.
3. Apply I_{op} at $[2 \cdot TOC = \text{_____}]$ amps rms and start the timer. Leave the current "on" until the RC contact close, and stop the timer. The time should be within $\pm 7\%$ of the value found on the DLP3 Time-Dial Curve in use.
4. Reduce I_{op} to zero (0).
5. Repeat steps 3 and 4 for I_{op} at $[6 \cdot TOC = \text{_____}]$ and $[10 \cdot TOC = \text{_____}]$.
6. Change the setting of (607)SELDTOC back to "Yes" if directional control of TOC is required.

6.5.1 GENERAL CONSIDERATIONS

Testing the reach of the relay requires a few organized steps. They are: choosing a test current (IT) for the impedance of the reach, calculating the voltage range in which the unit will pick up, and applying the test voltage and currents in accordance with the test procedure.

The equations shown will be used to calculate the voltage of pickup for a chosen magnitude and phase of current. If you wish to test the complete characteristic, the software program, DLPTTEST, can be used to generate test currents and voltage pickups for the complete characteristic. The software is included on the GE Power Management Products CD and the GE Power Management website at www.ge.com/indsys/pm. It can also be ordered on diskette from the factory.

6.5.2 ZONE 1 TO 4 PHASE-TO-GROUND CALCULATIONS

The following section provides a means for determining 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 consist of: choosing a test current, calculating the impedance of the zone, and then calculating the operate voltage at the test current and impedance.

The test current, "IT", is determined from the table in step 2 below. The value of "IT " is chosen according to the value of the reach of the zone. The nominal pickup voltage, "VNOM", is calculated with respect to "IT " and to several settings of the relay.

NOTE: The pickup voltage calculations at a particular magnitude and phase of "IT " are referenced to the faulted phase under test. If a BG Fault was applied, the current angles would be with respect to the phase angle of VB.

$$VNOM = [(Z)*(ZR)*(IT)/\cos(90 - \theta T)]*(\cos(\theta I - \theta Z - \theta T + 90)) \quad (8)$$

for $(\theta Z + \theta T - 180) < \theta I < \theta Z$

$$VNOM = [(Z)*(ZR)*(IT)/\cos(90 - \theta T)]*(\cos(\theta I - \theta Z + \theta T - 90))$$

for $\theta Z < \theta I < (\theta Z - \theta T + 180)$

where:

Z = Impedance correction factor

ZR = Relay reach for Z1G, Z2G, Z3G, or Z4G

θZ = Angle of maximum reach

IT = Test current for Iop, chosen for the zone

θT = The Characteristic Timer of the zone.

θI = Test current angle with respect to the faulted phase

K0 = Zero-Sequence compensation Factor, of the zone

POSANG = Positive-Sequence Angle of Maximum Reach

ZERANG = Zero-Sequence Angle of Maximum Reach

1. Record the following Relay Settings:

LINE QTY

(1401)POSANG = []

(1402)ZERANG = []

ZR

(104)Z1GR = [] Zone 1

(204)Z2GR = [] Zone 2

(304)Z3GR = [] Zone 3

(404)Z4GR = [] Zone 4

ϕT

Z1GANG = 90 fixed for Zone 1
 (210)Z2GANG = [] Zone 2
 (308)Z3GANG = [] Zone 3
 (410)Z4GANG = [] Zone 4

K0

(107)Z1K0 = [] Zone 1 only
 (1404)K0 = [] Zone 2, Zone 3, and Zone 4

2. Determine the Test Current IT for Zone 1, Zone 2, Zone 3, and Zone 4 from the table below:

In=5 AMPS ZR Reach	IT AMPS Test	In=1 AMPS ZR Reach	IT AMPS Test
0.1 - 2.5	10	0.5 - 12.5	2
2.5 - 6.0	7	12.5 - 30.0	1.4
6.0 - 12.0	3.5	30.0 - 60.0	0.7
12.0 - 20.0	2.1	60.0 - 100.0	0.4
20.0 - 30.0	1.4	100.0 - 150.0	0.3
30.0 - 40.0	1.0	150.0 - 200.0	0.2
40.0 - 50.0	0.8	200.0 - 250.0	0.2

IT (Z1GR) = [] Amps rms
 IT (Z2GR) = [] Amps rms
 IT (Z3GR) = [] Amps rms
 IT (Z4GR) = [] Amps rms

3. Calculate the impedance "Z" for each zone.

Z equals the magnitude of the equation: $(2/3)/(\text{POSANG}) + (K0/3)/(\text{ZERANG})$, and is calculated as shown below:

$z(\text{real}) = (2/3)\cos(\text{POSANG}) + (K0/3)\cos(\text{ZERANG})$
 $z(\text{real}) = []$ ohms real component of Z

$z(\text{imag}) = (2/3)\sin(\text{POSANG}) + (K0/3)\sin(\text{ZERANG})$
 $z(\text{imag}) = []$ ohms imaginary component of Z

$$Z = \sqrt{[z(\text{real})]^2 + [z(\text{imag})]^2}$$

Z1 = [] ohms = magnitude of Zone 1
 Zn = [] ohms = magnitude of Zone 2, 3, and 4

4. Calculate the impedance angle, " ϕZ " for each zone.

ϕZ equals the angle of the equation: $(2/3)/\text{POSANG} + (K0/3)/\text{ZERANG}$, and is calculated as shown below:

$$\phi Z = \text{arcTAN}[z(\text{imag}) / z(\text{real})]$$

$\phi Z1 = []^\circ$ impedance angle, Zone 1
 $\phi Zn = []^\circ$ impedance angle, Zone 2, 3, and 4

5. Choose the IT test angle (ϕI) for the zone.

$\phi I1 = []^\circ$, Zone 1
 $\phi I2 = []^\circ$, Zone 2
 $\phi I3 = []^\circ$, Zone 3
 $\phi I4 = []^\circ$, Zone 4

6. Calculate VNOM for each zone by substituting the values of ZR, Z, ϕZ , and ϕI into equation (8).

VNOM1 = [] Volts rms nominal test voltage Zone 1
 VNOM2 = [] Volts rms nominal test voltage Zone 2
 VNOM3 = [] Volts rms nominal test voltage Zone 3
 VNOM4 = [] Volts rms nominal test voltage Zone 4

NOTE: If Zone 4 is reversed, (411)SEL4ZD=1, remember to add 180° to both the test angle, $\phi I4$, and impedance angle, $\phi Z4$.

6.5.3 T12 – ZONE 1 GROUND REACH TEST

Setting Changes:

Z1DIST

(101)SELZ1G = YES
 (102)SELZ1P = NO

Ground Faults (AG, BG, and CG) M1G

Z1GR = [] OHMS
 VNOM1 = [] VOLTS
 IT = [] AMPS
 $\phi I1$ = [] DEG

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
2. Set the relay into test mode 14 (Any Zone 1 Ground). "ANY Z1 GRND ON" will be displayed at the MMI.
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle of ϕI [], lagging.
4. Set the fault current, "Iop", to [IT =] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
5. Reduce the fault current to zero (0).
6. Return the ZONE 1 phase "SELZ1P" to your specific setting.

6.5.4 T13 – ZONE 2 GROUND REACH TEST

Setting Changes:

Z2DIST

(201)SELZ2G = YES
 (202)SELZ2P = NO

Ground Faults (AG, BG, and CG)

Z2GR = [] OHMS
 VNOM2 = [] VOLTS
 IT = [] AMPS
 $\phi I2$ = [] DEG

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
2. Set the relay into the ZONE 2 Ground test mode for the appropriate phase under test: e.g., "ZONE 2 AG ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle ϕI [] lagging.

4. Set the fault current to [IT = _____] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
5. Reduce the fault current to zero (0).
6. Return ZONE 2 phase "SELZ2P" to your specific setting.

6.5.5 T14 – ZONE 3 GROUND REACH TEST

Setting Changes:

Z3DIST

(301)SELZ3G = YES

(302)SELZ3P = NO

Ground Faults (AG, BG, and CG)

Z3GR = [_____] OHMS

VNOM3 = [_____] VOLTS

IT = [_____] AMPS

∅I3 = [_____] DEG

1. Connect the relay as shown in Figure 5–3: PHASE-TO-GROUND TEST CONNECTIONS on page 5–18, for the appropriate phase under test.
2. Set the relay into the ZONE 3 Ground test mode for the appropriate phase under test: e.g., "ZONE 3 AG ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle value of ∅I [_____] , lagging.
4. Set the fault current to [IT = _____] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
5. Reduce the fault current to zero (0).
6. Return ZONE 3 phase "SELZ3P" to your specific setting.

6

6.5.6 T15 – ZONE 4 GROUND REACH TEST

Setting Changes:

Z4DIST

(401)SELZ4G = YES

(402)SELZ4P = NO

Ground Faults (AG, BG, and CG)

Z4GR = [_____] OHMS

VNOM4 = [_____] VOLTS

IT = [_____] AMPS

∅I4 = [_____] DEG

1. Connect the relay as shown in Figure 5–5: GROUND REACH TIMER TEST CONNECTIONS on page 5–23, for the appropriate phase under test.
2. Set the relay into the ZONE 4 Ground test mode for the appropriate phase under test: e.g., "ZONE 4 AG ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle value of ∅I [_____] , lagging.

4. Set the fault current to [IT = _____] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
5. Reduce the fault current to zero (0).
6. Return ZONE 4 phase "SELZ4P" to your specific setting.

6.5.7 ZONE 1 TO 4 PHASE-TO-PHASE REACH CALCULATIONS

The following section provides a means for determining the test currents and voltages for Z1P, Z2P, Z3P and Z4P. The same procedure is used for each zone to determine the test current "IT " and the voltage of pickup "VNOM".

The test current, "IT ", is determined from table PT-1. The value of "IT " is chosen according to the reach of the zone. The nominal pickup voltage, "VNOM", is calculated with respect to IT and to several relay settings.

VNOM 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° is included in the equation below.

$$VNOM = [(2/1.732)*(ZR)*(IT)/\cos(90-\theta T)]*(\cos((\theta I+30)-\theta Z-\theta T+90)) \quad (9)$$

for $(\theta Z + \theta T - 180) < \theta I < \theta Z$

$$VNOM = [(2/1.732)*(ZR)*(IT)/\cos(90-\theta T)]*(\cos((\theta I+30)-\theta Z+\theta T-90))$$

for $\theta Z < \theta I < (\theta Z - \theta T + 180)$

Definitions:

ZR = Relay reach for Z1P, Z2P, Z3P, or Z4P

IT = Test current for Iop chosen for the zone

θZ = Angle of maximum reach = POSANG

θT = The Characteristic Timer setting of the zone

θI = Test current angle with respect to the faulted phase

POSANG = Positive-Sequence Angle of Maximum Reach

1. Record the Relay Settings:

θZ

$$(1401)POSANG = [\quad]$$

ZR

$$(103)Z1R = [\quad] \text{ Zone 1}$$

$$(203)Z2R = [\quad] \text{ Zone 2}$$

$$(303)Z3R = [\quad] \text{ Zone 3}$$

$$(403)Z4R = [\quad] \text{ Zone 4}$$

In=5 AMPS <u>ZG Reach</u>	IT AMPS <u>Test</u>	In=1 AMPS <u>ZG Reach</u>	IT AMPS <u>Test</u>
0.1 - 2.5	10	0.5 - 12.5	2
2.5 - 6.0	8	12.5 - 30.0	2
6.0 - 12.0	5	30.0 - 60.0	1
12.0 - 20.0	3	60.0 - 100.0	0.6
20.0 - 30.0	2	100.0 - 150.0	0.4
30.0 - 40.0	1.5	150.0 - 200.0	0.3
40.0 - 50.0	1.0	200.0 - 250.0	0.2

øT

Z1PANG = 90 fixed for Zone 1
 (209)Z2PANG = [] Zone 2
 (307)Z3PANG = [] Zone 3
 (409)Z4PANG = [] Zone 4

2. Determine the Test Current "IT " for Zone 1, Zone 2, Zone 3 and Zone 4 from the table in step 1 above:

IT (Z1R) = [] Amps rms
 IT (Z2R) = [] Amps rms
 IT (Z3R) = [] Amps rms
 IT (Z4R) = [] Amps rms

3. Choose øl (the IT angle). VNOM will be at maximum when øl = øZ–30

øl1 = []° for Zone 1 |
 øl2 = []° for Zone 2
 øl3 = []° for Zone 3
 øl4 = []° for Zone 4

4. Calculate "VNOM" for each zone by substituting the values of ZR, øZ (POSANG), IT, and øl into equation (9) for "VNOM" according to zone.

VNOM 1 = [] Volts rms Nominal test voltage for Z1P
 VNOM 2 = [] Volts rms Nominal test voltage for Z2P
 VNOM 3 = [] Volts rms Nominal test voltage for Z3P
 VNOM 4 = [] Volts rms Nominal test voltage for Z4P

NOTE: If Zone 4 is reversed, (411)SEL4ZD=1, remember to add 180° to both the test current angle, øl4, and impedance angle, øZ4. If Zone 4 has a non-zero offset, use the DLPTEST software to calculate VNOM4.

5. Record VNOMn, IT and øln in the space provided in the appropriate Zone reach test.

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6.5.8 T16 – ZONE 1 PHASE REACH

Setting Changes:

Z1DIST

(101)SELZ1G = NO
 (102)SELZ1P = YES

Faults (AB, BC, and CA)

Z1R = [] OHMS
 VNOM1 = [] VOLTS
 IT = [] AMPS
 øl1 = [] DEG

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phases under test.
2. Set the relay into test mode 30 (Any Zone 1 Phase). "ANY Z1 PHASE ON" will be displayed at the MMI.
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle of øl [], lagging. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.
4. Set the fault current to [IT =] amps rms. Simultaneously reduce the voltage of the faulted phases, and check that the RC contact closes when the voltages are within 7% of VNOM.

5. Reduce the fault current to zero (0).
6. Return ZONE 1 ground "SELZ1G" to your specific setting.

6.5.9 T17 – ZONE 2 PHASE REACH

Setting Changes:

Z2DIST

(201)SELZ2G = NO
(202)SELZ2P = YES

3Faults (AB, BC, and CA)

Z2R = [_____] OHMS
VNOM2 = [_____] VOLTS
IT = [_____] AMPS
 $\phi I2$ = [_____] DEG

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phases under test.
2. Set the relay into the Zone 2 Phase test mode for the appropriate phases under test: e.g., "ZONE 2 AB ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle of ϕI [_____] , lagging. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.
4. Set the fault current to [IT = _____] amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the RC contact closes when the voltages are within 7% of VNOM.
5. Reduce the current in the faulted phase to zero (0).
6. Return ZONE 2 ground "SELZ2G" to your specific setting.

6.5.10 T18 – ZONE 3 PHASE REACH

Setting Changes:

Z3DIST

(301)SELZ3G = NO
(302)SELZ3P = YES

Faults (AB, BC, and CA)

Z3R = [_____] OHMS
VNOM3 = [_____] VOLTS
IT = [_____] AMPS
 $\phi I3$ = [_____] DEG

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phase under test.
2. Set the relay into the Zone 3 Phase test mode for the appropriate phases under test: e.g., "ZONE 3 AB ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle of ϕI [_____] , lagging. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.

4. Set the fault current to [IT = _____] amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the RC contact closes when the voltages are within 7% of VNOM.
5. Reduce the fault current to zero (0).
6. Return ZONE 3 ground "SELZ3G" to your specific setting.

6.5.11 T19 – ZONE 4 PHASE REACH

Setting Changes:

Z4DIST

(401)SELZ4G = NO

(402)SELZ4P = YES

Faults (AB, BC, and CA)

Z4R = [_____] OHMS

VNOM4 = [_____] VOLTS

IT = [_____] AMPS

∅I4 = [_____] DEG

1. Connect the relay as shown in Figure 5–4: PHASE-TO-PHASE TEST CONNECTIONS on page 5–21, for the appropriate phase under test.
2. Set the relay into the Zone 4 Phase test mode for the appropriate phases under test: e.g., "ZONE 4 AB ON".
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms –120°, and VC = 67 volts rms –240°. Set the fault current, "Iop", to the phase angle of ∅I [_____] , lagging. Note: The leading phase angle is 180° out of phase with the line to which it is shorted
4. Set the fault current to [IT = _____] amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the RC contact closes when the voltages are within 7% of VNOM.
5. Reduce the fault current to zero (0).
6. Return ZONE 4 ground "SELZ4G" to your specific setting.

CAUTION: When testing is completed, verify that all settings are returned to your specified values. It is helpful to print out the settings and check them one by one.

7.1.1 SPARES

There are two possible servicing methods for the DLP3. They are: spare module replacement and component-level repair. The preferred method is module replacement using the DLP3's automatic self-tests to isolate failed modules. When the defective module is found, it can be replaced with a spare, and the system can be returned to service. This method typically yields the shortest "down time" of the system. To further reduce "down time" it is recommended that a complete set of spare modules be kept at the maintenance center.

It is not recommended that the relay be serviced at the component level. This requires a substantial investment in test/repair equipment, and in technical expertise, and usually results in longer "down times" than module replacement. For those who do wish to trouble-shoot to the component level, drawings can be obtained by requesting them from the factory. When requesting drawings, the following information must be supplied to the factory:

1. The model number of the module. This is found on the lower part of the front nameplate of each module, e.g. MGM703.
2. The assembly number of the module. This is found on the component side of the printed-circuit board. It is an eight-digit number with a letter inserted between the fourth and fifth digit and suffixed with a group identification, e.g. 0215B8011G001.
3. The revision number. This is found on the printed-circuit board adjacent to the assembly number of the board.

CAUTION: Power down the relay, with the power switch or by removing a connection plug, before removing or inserting modules. Failure to do so can permanently damage the relay.

7.1.2 SERVICING WITH RELAY SELF-TEST

The DLP3 automatically performs tests of major functions and critical hardware components and reports their status via the MMI Display/LED and the non-critical and critical alarm contacts. The failure report is dependent on the type or level of the failure. Some failures will operate the critical alarm contact and the MMI LED, while others will only operate the non-critical alarm contact.

There are three levels of self-test performed by the relay. The first level indicates severe relaying failures. They are indicated by a "FAIL" message on the MMI, an opening of the "critical alarm" contact, and by the MMI LED turning red. These failures are the most critical because they indicate that the relay is not providing protection.

The second level of self-test displays warning messages. They are indicated by a "WARN" message on the MMI, and closure of the "non-critical alarm" contact. These failures are a less critical condition whereby the relay is still providing some degree of protection.

The third level of tests indicate "System Status" errors that are due to power-system errors (Trip Circuit Open), or caused by the use of a DLP3 command that disables the relay (Disable Outputs). They are indicated by the "non-critical alarm" contact closing, a red LED, or by the "critical alarm" contact closing. However, no MMI display is provided until the "Information Status" command is used.

The types of self-tests performed are described in the PRODUCT DESCRIPTION section of this manual. The components tested during the start-up self-tests are listed in Table 7-1: START-UP SELF-TESTS. The components tested during run-time background and foreground self-tests are listed in Table 7-2: RUN-TIME BACKGROUND SELF-TESTS and Table 7-3: RUN-TIME FOREGROUND SELF-TESTS, respectively.

Table 7–1: START-UP SELF-TESTS

COMPONENT	METHOD	PROCESSOR	NATURE
PROM	CRC-type check on DAP and SSP; checksum on DSP	All	Critical
Local RAM	Patterns to check for stuck bits, stuck address lines, cross-talk between adjacent bits	All	Critical
Shared RAM	Same as Local RAM	All	Critical
Non-volatile RAM	CRC-type check on settings area; checksum on fault storage area; duplicate locations on serial NVRAM	SSP	Critical if settings area or Serial NVRAM
Timer Chip	Test all processor timers and their interrupts	DAP, SSP	Critical if DAP, Non-Critical if SSP
Interrupt Chips	Test all processor and external Interrupt Controllers	DAP, SSP	Critical
Serial Chips	Wrap around and Interrupt tests for serial interface	SSP	Non-Critical
A/D Controller	DMA Interface	DAP	Critical, DLP will restart
Digital Output Circuitry	Loop-back via parallel port	SSP	Critical, DLP will restart
Digital Input Circuitry	Comparison of bits read via 2 separate optocouplers	DAP	Non-Critical, turn off Pilot protection
Real Time Clock	Test of real time clock Operation and Interrupts	SSP	Non-Critical
LED display	Self-test built in by manufacturer	SSP	Non-critical

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Table 7–2: RUN-TIME BACKGROUND SELF-TESTS

COMPONENT	METHOD	PROCESSOR	NATURE
PROM	CRC-type check on DAP and SSP, checksum on DSP	All	Critical, Restart
RAM	CRC-type check on areas holding settings	All	Critical, Restart
Non-volatile RAM	CRC-type check on settings area; checksum on fault storage area	SSP	Critical if settings area
Timer Chip	Test that all timers are counting	DAP, SSP	Critical if DAP, Non-critical if SSP; Restart

Table 7-3: RUN-TIME FOREGROUND SELF-TESTS

COMPONENT	METHOD	PROCESSOR	NATURE
A/D Controller	DMA Interface	DAP	Critical
Digital Input Circuitry	Comparison of bits read via 2 separate optocouplers	DAP	Non-Critical, Turn off Pilot protection
Digital Output Circuitry	Loop-back via parallel port	SSP	Critical, Restart
Trip Circuit Circuitry	Bit read via parallel port	SSP	Critical
MMI	Operator-initiated, visual feedback	SSP	Non-Critical

7.2.1 DESCRIPTION

Trouble shooting the relay requires three steps. The first step is to determine the type of failure. The type is either a critical, non-critical, or a system-status failure. Next, the list of failure codes and warning codes, or the "Information Status" command, is used to determine what module is defective. Lastly, the defective module is replaced in accordance with safety and static-discharge precautions. The trouble shooting sections are as follows:

1. Servicing a Critical Failure "FAIL"
2. Servicing a Non-Critical Failure "WARN"
3. Servicing a System Status Failure

NOTE: Refer to the ACCEPTANCE TEST section for test of the measuring units, keypad, MMI display, and printer port. The display and printer of models without keypad cannot be tested (other than by observing them in use)

7.2.2 USING THE INFORMATION STATUS COMMAND

Tables have been provided in the SERVICING A CRITICAL FAILURE "FAIL" and SERVICING A NON-CRITICAL FAILURE "WARN" sections below. They can be used to decode "Fail xxx" and "Warn xxx" codes. The "Information Status" command can also be used to extract the same data from the MMI display without looking up the code on the table. The "Information Status" command can be used at the relay site, or remotely over a modem link.

The INFORMATION STATUS command is invoked from the Keypad as follows:

1. Apply rated DC power to the relay and wait for initialization to complete.
2. Press the "Information" key. Then scroll with the arrow keys until the heading "INF: STATUS" is displayed. (If you have a printer press the [PRT] "print" key.)
3. Press the [ENT] "enter" key.

The display will indicate that there is a failure with the words "STATUS: FAIL".

4. Press the "Up Arrow" key to get a detailed report of the failure. A complete list of the possible errors is shown in the next three tables below.

The "FAIL" and "WARN" messages are also included. Their descriptions can also be displayed on the MMI, by using the "Information Status" command.

NOTE: After initial power up or loss of power exceeding 24 hours, the time and date will reset to 00:00:00 01/01/90. All event and fault data will be reset.

Table 7-4: SYSTEM STATUS ERROR MESSAGES

SYSTEM STATUS ERROR	INDICATION	DESCRIPTION
WARN	NCA	WARN condition, press up arrow
FAIL	CA/LED	FAIL condition, press up arrow
MISC	LED	Miscellaneous condition, press up arrow

NOTE: LED = A red LED on the MMI, NCA = the non-critical-alarm contact closing, CA = the critical-alarm contact closing

7.3.1 DESCRIPTION

A critical failure indicates total interruption of the protection function. When a failure occurs on one of the modules (excluding the power supply) the critical alarm contact will open, and the MMI LED will turn red. Remove and re-apply the DC power to bring up the fail message on the display. If the DLP3 successfully restarts the LED will turn green.

The Fail message has the format "FAIL xxx". The "xxx" field following the word "FAIL" is the numeric code that indicates the nature of the critical failure. The Fail message remains on the display until a key is pressed or until the DLP3 restarts successfully (with no self-test failures). See Table SE-5 for the list of Failure codes and their meanings.

NOTE: As an alternative, the "Information Status" command can be used to display the failure type directly on the MMI.

7.3.2 LOCATING THE DEFECTIVE MODULE

Use the table below, or the "Information Status" command, to isolate the cause of the failure. When the suspected module is found, power down the unit and replace it. Re-apply power. If the "FAIL" message is gone then the unit has been successfully repaired. If the message has changed it is possible that an additional module requires replacement.

Table 7-5: FAILURE MESSAGES

CODE	DESCRIPTION	CODE	DESCRIPTION
DAP BOARD		ANI BOARD	
100	PROM: PROM Failure	311	CONTROLLER: Controller Failure
101	LOCAL RAM: Local RAM Failure	312	SERIAL MEM: Serial NVM Failure
102	SYSRAM CRC: DSPRAM CRC Failure	313	REFERENCE: Reference Failure
103	SYSRAM: DSPRAM Failure	---	NO DMA INT: No DMA interrupt
104	INTERRUPT: SYSRAM Failure	MGM Module	
105	EEPROM: Interrupt Failure	414	SERIAL MEM: Serial NVM Failure
106	TIMER: Timer Failure	422	MODEL NUMBER: Model No.
124	VERSION NUM: Version no. Failure	SSP BOARD	
---	NO SSP INT:	515	PROM: PROM Failure
---	No SSP interrupt	516	LOCAL RAM: Local RAM Failure
DSP BOARD		517	SYSRAM CRC: SYSRAM CRC Failure
207	PROM: PROM Failure	518	SYSRAM: SYSRAM Failure
208	LOCAL RAM: Local RAM Failure	519	INTERRUPT: Interrupt Failure
209	DSPRAM: DSP RAM Failure	520	EEPROM: EEPROM Failure
210	INTERRUPT: Interrupt Failure	523	VERSION NUM: Version Number
225	VERSION NUM: Version no. Failure	---	NO DAP INT: No DAP Interrupt
---	FUSE FAILURE: Fuse Failure	MMI BOARD	
---	TRIP BUS CHK FAIL: Auto Trip Bus check failure	621	DIG OUT: Digital Output Failure
---	BKR1 TRP CIR OPN: BKR1 Trip Circuit Open		
---	BKR 2 TRP CIR OPN: BKR2 Trip Circuit Open		

7.4.1 DESCRIPTION

A non-critical failure indicates an interruption in the relay's protection, but not a total loss. When a "WARN" condition occurs, the DLP3's non-critical alarm contact will close. The LED will remain green. Turn off the DC input power, then re-apply. The "WARN XXX" message should appear if the failure still exists.

The Warn message has the format "WARN xxx". The "xxx" field following the word "WARN" 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 DLP3 restarts successfully (with no self-test failures). See Table SE-6 for the list of Warning codes and their meanings.

NOTE: As an alternative to using the table of warnings, the "Information Status" command can be used to display the warning type directly on the MMI.

7.4.2 LOCATING THE DEFECTIVE MODULE

Use the table below, or the "Information Status" command, to isolate the cause of the failure. Power down the unit and replace the suspected module if appropriate. Re-apply power and the WARN message should clear. If the "WARN" message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that an additional module requires replacement.

Table 7-6: WARNING MESSAGES

NUMBER	DESCRIPTION
DSP	
235	DIG INP: Digital Input fail on
SSP	
537	TIMER: Timer Failure
538	CAPRAM: CAPRAM Failure
539	CLOCK: Real Time Clock Failure
742	LOGON FAILURE: Login failed
MMI	
640	SERIAL CHP 1: ASCII serial Port failure
641	DISPLAY: LED display failure
643	TIME STROBE FAIL: Time strobe failure
645	SERIAL CHP 2: Rear com port failure
646	SERIAL CHP 3: Front com port failure
DTA	
844	SERIAL MEMRY: Serial memory failure

Table 7-7: MISCELLANEOUS MESSAGES

MISCELLANEOUS MESSAGE	DESCRIPTION	INDICATION
PROT OFF	Protection off	LED
DIS OUTS	Outputs Disabled	LED
RELAY TEST	Relay in Test Mode	LED
D O TEST	Digital Output test	LED
CHANNEL TEST	Channel Test	None

7.5.1 DESCRIPTION

A system failure is one that indicates a failure of a power system input, or indicates that the relay has been disabled by a user command. They are indicated by the "non-critical alarm" contact closing, by a red LED, or by the "critical alarm" contact closing. However, no MMI display is provided until the "Information Status" command is used. Turn off the DC input power, then re-apply. The non-critical alarm contact will be closed if the failure still exists. Use the "Information Status" to determine the cause of the trouble.

8.1.1 DESCRIPTION

ELECTRICAL RATINGS

Rated Frequency: 50 to 60 Hz
 Rated Voltage: 100 to 120 V AC (phase-to-phase)
 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 2 x rated
 1 minute (one per hr.) 3.5 x rated
 Maximum Permissible current:
 Continuous 2 x I_n
 3 seconds 50 x I_n
 1 second 100 x I_n
 Insulation Test Voltage 2 kV @ 50/60 Hz, one minute
 Impulse Voltage Withstand Fast Transient: 5 kV peak, 1.2/50 ms, 0.5 J
 Radio Frequency Interference Withstand: SWC, per ANSI C37.90.1
 Humidity: 95% without condensation
 Ambient Temperature Range
 Storage: -30°C to 75°C
 Operation: -20°C to 55°C

BURDEN RATINGS

Current Circuit: $I_n = 1$ A: 0.12 Ω
 $I_n = 5$ A: 0.022 Ω
 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

CONTACT RATINGS

Digital to Analog Output 0 to 1 mA, 10V load or 0 to 5 V output (4 V = full scale; 5 V = error)
 Trip Outputs
 Continuous Rating: 3 A
 Make and Carry: 30 A (per ANSI C 37.90)
 SCR Outputs: same as Trip Outputs
 Auxiliary Outputs (including alarms & configurable outputs)
 Continuous Rating: 3 A
 Make and Carry: 30 A (per ANSI C 37.90)
 Channel Control and SCADA DTA Phase Identification
 Contacts 10 W: max. voltage 280 V DC
 max. current 40 mA DC

Trip Circuit Monitor, Contact Converters, & Configurable Inputs: 38.5 to 300 V DC input (150 mA min. for Trip Circuit Monitor)

SCHEME SELECTION

Protection Schemes: Step Distance
 POTT
 PUTT
 Blocking
 Hybrid
 Zone 1 Extension
 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°

CURRENT SUPERVISION FUNCTION

Function	Range A		Resolution A	
	$I_n = 5$ A	$I_n = 1$ A	$I_n = 5$ A	$I_n = 1$ A
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	0.04 to 0.80	0.01	0.01
IB	0.20 to 4.00	0.04 to 0.40	0.01	0.01

OVERCURRENT BACKUP

Function	Range A		Resolution A	
	$I_n = 5$ A	$I_n = 1$ A	$I_n = 5$ A	$I_n = 1$ A
PH4	2.0 to 100.0	0.4 to 20.0	0.1	0.1
IDT	0.5 to 80.0	0.1 to 16.0	0.1	0.1
TOC	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
 Resolution: 0.1

LINE PICKUP

Function	Range A		Resolution A	
	$I_n = 5$ A	$I_n = 1$ A	$I_n = 5$ A	$I_n = 1$ A
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	
	$I_n = 5 A$	$I_n = 1 A$	$I_n = 5 A$	$I_n = 1 A$
Level 1 OC	5.0 to 20.0	1.0 to 4.0	0.1	0.1
Level 2 OC	10.0 to 40.0	2.0 to 8.0	0.1	0.1

Overload Settings

LV1 timer TL31

Range: 10 to 990 seconds

Resolution: 0.01 sec.

LV2 timer TL32

Range: 10 to 99 seconds

Resolution: 0.01 sec.

COMPENSATION FACTOR

Range: 1.0 to 7.0

Resolution: 0.01

SCHEME LOGIC TIMERS

Timer	Description	Range	Resolution
TL1	Trip integrator pickup	1 to 50 ms	1 ms
TL2	Zone 2 timer	0.1 to 3.0 s	0.01 s
TL3	Zone 3 timer	0.1 to 10.0 s	0.01 s
PUTL4P, G	Zone 4 timer	0.1 to 10.0 s	0.01 s
TL4	POTT/PUTT coordination	0.1 to 50 ms	0.1 ms
TL5	b contact coordination for Breaker 1 (pickup & dropout timers)	0 to 200 ms	1 ms
TL6	b contact coordination for Breaker 2 (pickup & dropout timers)	0 to 200 ms	1 ms
TL16	Weak infeed trip pickup	8 to 80 ms	1 ms

SYSTEM CONFIGURATION

Communications baud rate: 300, 1200, 2400, 4800, 9600

Number of breakers: 0 to 2

CT Ratios: 1 to 5000

PT Ratios: 1 to 7000

Distance Units: Miles or Kilometers

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: $I_n = 1 A$: 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: $I_n = 1 A$: 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: $I_n = 1 A$: 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: $I_n = 1 A$: 0.01 Ω $I_n = 5 A$: 0.01 Ω **ACCURACIES**Distance measuring units: Reach: $\pm 5\%$ of setting at angle of maximum reach and rated currentZone Timers: $\pm 3\%$ of settingFault Locator: $\pm 3\%$ (typical)

Data Sample time tag

resolution: ± 1 ms**DIMENSIONS AND WEIGHT**

Height: 6.945" (176 mm)

4 standard rack-units

Width: 19.00" (3 standard rack-units)

Depth: 16" (406 mm)

Weight: The standard rack-mounted unit weighs 26 pounds (11.8 kg)

SPECIFICATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE

The display consists of 16 LED alphanumeric character positions arranged side-by-side horizontally.

Every keystroke at the MMI produces some feedback on the display: numeric keys are echoed as they are pressed, function keys produce an abbreviated word when they are pressed, the ENT key always causes some change in what is being displayed, etc.

All messages on the display are the result of some keyboard action, with four exceptions: the Trip message when the DLP3 has caused a protective trip, the Fail message when the DLP3 has discovered a critical self-test failure, the Warning message when the DLP3 has discovered a non-critical self-test failure, and the Initialization message when the DLP3 is initializing during a power up.

All messages other than the Trip message are displayed at the same intensity, about half of full-intensity. User input for setting changes is echoed at a lower intensity to help distinguish the stored setting value from one that has not yet been entered into the DLP3.

The Trip message is displayed at highest intensity and has the following format: "TRIP x-xxx xxx xxx". The word "TRIP" blinks to indicate that the DLP3 has caused a protective trip. The three fields of information following the word "TRIP" are non-blinking and contain the following information: a three-character fault type (e.g. ABG), a three-character trip type (see 2, Request Fault Information under INFORMATION Key for a list of the trip types), and a three-digit distance to the fault (in the units specified by the user). The message will remain on the display permanently until removed by a keyboard operation. If the DLP3 restarts or is powered down and up, the trip indicator is remembered and re-displayed. As soon as any key is pressed, the Trip message is removed and no longer remembered.

The Fail message has the format "FAIL xxx". The field following the word "FAIL" is a numeric code that indicates the nature of the critical self-test failure. The Fail message remains on the display until a key is pressed or until the DLP3 restarts successfully (with no self-test failures). A list of the failure numbers and their meanings can be found in the SERVICING section.

The Warning message has the format "WARN xxx". The field following the word "WARN" is a numeric code that indicates the nature of the non-critical self-test failure. The Warning message remains on the display until a key is pressed or until the DLP3 restarts successfully (with no self-test failures). A list of the warning numbers and their meanings can be found in the SERVICING section.

The Initialization message has the format "INITIALIZING" and is displayed while the DLP3 is initializing itself during a power-up sequence. The display is blanked as soon as initialization is complete.

All other messages, which are the result of keyboard operations, remain on the display until another key is pressed, or until no keys have been pressed for a period of 15 minutes; at the end of this time-out interval, the display is blanked.

9.2.1 DESCRIPTION

The keyboard is comprised of twenty keys; a 10-key numeric pad, a decimal point, and nine function keys (see the figure below). (Some models of the DLP3 [ending with NC] do not include a keypad but will include only the CLR key. For these, see the SOFTWARE section to learn how to perform these functions.)



Figure 9–1: DLP-C MMI KEYBOARD

9.2.2 CLEAR KEY [CLR]

The CLR key is used to abort a keyboard sequence in progress (for example, when the user sees he has made an error). When the CLR key is pressed, all or part of the display will be blanked.

If there is user-entered information on the display, only that information will be blanked. For example, if the user is entering a Setting value when the CLR key is pressed, only the user's input will be blanked; the name of the setting will remain on the display. As another example, if the user is responding to an Action prompt, only the user's input will be blanked; the prompt question will remain on the display. If there is no user-entered information on the display, the entire display will be blanked and the DLP3 will expect a Command key to be pressed.

If the user presses the CLR key after pressing the PRT key (with no other intervening key presses), printing will be terminated. By this means, the user can halt a long printout if the PRT key was unintentionally pressed.

If a Trip, Fail, or Warn message is being displayed, the user must press the CLR key to blank the error message (all other keys will be ignored). When the error message is blanked, the last message will be displayed, allowing the user to re-enter the correct response.

If the CLR key is pressed when the display is blank, the DLP3 will automatically scroll through all present values once.

9.2.3 PRINT KEY [PRT]

The PRT key has no effect when pressed.

9.2.4 ARROW KEYS

The ARROW keys are used to "scroll" through the list of categories within a Command key or to scroll through the list of items within a category. For example, pressing the INF key will produce the name of the first category (e.g., "STATUS") on the display. Pressing the UP-ARROW key will then produce the name of the second category (e.g., "FAULT") on the display. When the user reaches the desired category, pressing the ENT key will then produce the first item of that category on the display. From that point on, pressing the UP-ARROW key will produce each subsequent item in the category on the display.

While the UP-ARROW key scrolls in a "forward" direction through a list of categories or items, the DOWN-ARROW key can be used to scroll "backward" through a list; i.e., the user may return to the previously displayed item by pressing the DOWN-ARROW key.

When the user is scrolling through a list of categories or items with the UP-ARROW key and gets to the last entity in the list, pressing the UP-ARROW key again will produce the first category or item on the display (wrap-around). Using the DOWN-ARROW key will likewise wrap around from the first category or item to the last. If the user is scrolling through items within a category and wants to get out of that category, pressing the Command key again will display the current category name. The user may then use the ARROW keys to scroll through the categories.

9.2.5 ENTER KEY [ENT]

The ENT key is used to enter data or to enter a choice. When a category name is shown on the display (as the result of pressing a Command key followed by zero or more ARROW key presses) and the user presses the ENT key, he is "choosing" that category to begin scrolling through. When the user is establishing or changing a setting, he uses the numeric keys and decimal point to indicate the value; after the last digit, he presses the ENT key to indicate "this is the value to use". When the display prompts the user to enter a number (e.g., for Fault Information, that selecting which of the stored faults to display), the user enters the number that represents his choice, followed by the ENT key.

9.2.6 DATA ENTRY KEYS

The Data Entry keys consist of the numeric keys and the decimal point. These keys are used to enter data into the DLP3 or to make choices in response to prompts. The numeric keys 1/Y and 3/N have two meanings.

If the user is entering numeric values, the 1/Y and 3/N keys are processed and echoed as 1 and 3. If the user is responding to a YES/NO prompt, the 1/Y key is processed and echoed as a YES and the 3/N key is processed and echoed as a NO.

9.2.7 END KEY

The END key causes two actions. First it is used to indicate that no more setting changes will be made. Protection processing is halted as soon as any setting change is made, and will not be resumed until the user indicates that all setting changes are complete. Second it is used to end a session. That is, when the user presses the END key, the MMI becomes idle (without the 15 minute time-out) and remote communication actions and settings are enabled, if they were previously locked by the MMI.

The key sequence for indicating the end of setting changes and/or the end of a session is:

END ENT

When the user presses the END key, the display shows "HIT ENT TO END". When the user presses the ENT key, the display shows "ENDED".

1. If no setting values have been entered (i.e., the DLP3 has not stopped its protection activities), the DLP3 takes no action in response to the END/ENT key sequence other than to enable action items locked previously by the MMI, to allow action commands from remote communications to be executed.
2. If protection activities had been stopped, the DLP3 now re-initializes itself to use the new setting values and the Event message "SETTING CHANGE DONE" is printed. The DLP3 then checks whether or not outputs have been disabled by the user. If outputs have been disabled, the MMI LED (LED on the MMI panel) will remain red. If outputs are enabled, and there are no critical self-test failures of the DLP3, the MMI LED will turn green. The DLP3 protection software re-initializes itself to use the new setting values. The displayed message changes to "ENDED". The MMI unlocks the settings lock to allow remote communication to display and change settings from a PC. The session is not ended – this allows the user to edit another group of settings (Settings or Master access), or perform actions (Master access) in the same session. To end the session after settings changes have been made, the END-ENT sequence must be completed a second time.

If the END-ENT sequence has been pressed to end the session, the "ENDED" message is blanked from the display when another key is pressed or after a 10 second delay. In the latter case, the display remains blank until another key is pressed.

a) PASSWORDS

There are two sets of passwords, MMI and Communications. Passwords are needed to perform certain operations with the DLP3. A password for actions and settings is entered by selecting the first entry in the list of actions and entering the password after the prompt (See the ACTIONS Key section above). If an action or setting change is not performed for a period of 15 minutes, the password becomes inactive. For settings, after the key sequence END ENT is pressed, the password privileges become inactive. The settings and actions may be viewed at any time but may only be changed if the password for that function is active. Refer to Enter Password in the ACTIONS Key section.

There are two MMI passwords, one for Actions and one for Settings access at the keypad. These passwords are limited to the numeric digits on the keypad. The MMI passwords are different from the Communications passwords, which are for logging into the relay, remote settings changes, and performing remote actions. The Communications passwords can contain any of the allowable alpha-numeric characters in Table IN-7. All 5 types of password are listed below:

Table 9–1: PASSWORD CATEGORIES

MMI PASSWORDS	COMMUNICATIONS PASSWORDS
Master	Master
Settings	Settings
	Viewing

The Communications passwords can only be viewed at the MMI, using the Information key, and the MMI passwords can only be viewed from the Information Menu, under Relay Functions in DLP-LINK. All passwords are displayed in encoded form. Use Table IN-7 to decode the passwords.

9.2.8 SETTINGS KEY [SET]

The SET key is used to display, change, or print settings. There are four groups of settings. Each group contains the same list of settings but they may have different values. Settings are divided into categories; the categories are defined in the CALCULATION OF SETTINGS section. For example, one category is Configuration Settings, which includes items such as user-assigned Unit ID Number, number of breakers, etc. For convenience, each setting within a category will be assigned a number so that the user may go directly to the setting to be viewed or changed. If the Settings or Master password is not active, the setting may only be viewed.

The key sequence for selecting a settings group is

SET {n} {ENTER or PRINT}

where n is the optional setting group number. When the user presses the SET key, the display shows:

SET:GRP 1,2,3,4

listing the four setting groups. If a group was previously selected, but not saved using the END ENT key sequence, then its number will be highlighted. If now the user presses a digit, the display is blanked except for "SET:" and the digit is displayed in position 5. When the user presses the ENTER key, one of two things can happen. If the digit re-selects the currently highlighted group or if no group is currently selected, then the group for which the number was entered becomes selected. If, on the other hand, the entered digit indicates a group different from the one that is currently highlighted, then the following is displayed:

OVRWRT GRP n?

where n is the setting group that was modified but not saved. The user presses 1 for YES to indicate that changes to previously selected group should be overwritten by the newly selected group, or 3 for NO to prevent the overwrite. It is also possible to re-select a group that is highlighted, by just pressing the ENTER key without any preceding digit.

When a group is finally selected, the display shows "SET:" in the first 4 positions and the name of the first category starting in position 5. While in the category display, the user can press the SET key. This will cause "SET: GRP 1,2,3,4" to be displayed again, allowing the user to select another group.

SET {n} {ENTER or PRINT}

where n is the optional 1- to 4-digit setting number. When the user presses the SET key, the display shows "SET:" followed by the name of the first category. If the user wants the first category, he presses the ENT key to display the first item; otherwise, the ARROW keys are used to get to the desired category.

When the user presses the ENT key following the displayed name of a category, the first item in the category is displayed as an 8-character abbreviated name of the setting and its value. Some examples are:

UNITID = 1234
LINELEN = 100.0
SELZ2U = YES

When the user presses one or more digits following the SET key, the name of the category is blanked and the digits are displayed. When the user presses the ENT key following the last digit, the setting corresponding to the entered setting number is displayed as described above. If the setting number is invalid, an error message is displayed.

When the user presses the PRT key, the display says "PRT" in the right-most positions. All settings will be printed, regardless of whether a setting number was entered. The printout will be arranged by categories.

The user may scroll through all of the settings in a category using the ARROW keys. If the user wishes to leave that category, pressing the SET key will cause the current category name to be displayed. Then the user may go to another category by using an ARROW key or may enter a setting number followed by the ENT key to go to another setting.

If the user wants to change a setting, he must first display that setting (item) as described above. With the present value of the setting displayed, he then uses the Data Entry keys to enter the new value. When the first Data Entry key is pressed, the abbreviated name remains on the display but the value is blanked and a blinking ":" symbol appears at the end of the name in place of the "=" symbol; each Data Entry key is displayed as it is pressed, in a lower than normal intensity, and the ":" symbol continues to blink. Note that there are some settings that logically represent a state rather than a number (i.e., YES/NO). For these settings, the 1/Y and 3/N keys are used to indicate the state (1/Y = YES and 3/N = NO) and the words "YES" or "NO" are displayed. After the last digit of the new value is pushed, the user presses the ENT key; at this point the blinking ":" symbol is replaced by an "=" symbol, the value is displayed at normal intensity, and the DLP3 stores the new value as the value of the setting. If the user presses any Command key, the PRT key, either ARROW key or the CLR key instead of the ENT key, the new value will not be stored, and the old value will be retained.

When a setting value is entered, the value is checked against the allowable range of values for that setting. If the value does not fall within the range of values, an error message is displayed. If the setting is a YES/NO type, its value is checked to make sure it is set to either a YES or NO. If the user enters any other digit for this type setting, an error message is displayed. If an error message is displayed, the setting name and unchanged value will be displayed again when the CLR key is pressed. The first time a setting is successfully changed, remote communications is inhibited from reading and changing settings in the DLP3. Also, the first time a setting is successfully changed, it will be reported on the printer as follows:

```
DATE/TIME
LOCAL - SETTINGS CHANGE STARTED
```

After changing the value of a setting, the setting name and the new value remain on the display. The user may press one of the ARROW keys to move to the next setting in the category. He may also press any Command key to begin performing other operations. If the user presses the SET key, the current category will be displayed and the user may then use the ARROW keys to go to another category. If the user presses the SET key again, the first setting category will be displayed. If the user presses any of the other Command keys, the first category associated with that Command key will be displayed.

It is important to note that while values are being entered for any setting, the DLP3 will not stop Protection activities. The new settings are stored in a temporary buffer until the user presses the END/ENT sequence. This will cause a transfer of the new settings from the buffer to permanent storage, and protection will be re-initialized with the new settings. **If the END/ENT sequence is not performed and the DLP is allowed to time out, all of the settings in the temporary buffer will be lost.**

9.2.9 ACTIONS KEY [ACT]

The ACT key is used to perform actions. The categories can be scrolled through, using the ARROW keys. The 12 possible categories are listed below. The names of the categories displayed at the MMI are in parentheses. For convenience, each category has also been assigned a number so that the user may go directly to the desired category. The key sequence for selecting actions is: ACT n [ENT], where n is defined in the following table:

Table 9–2: ACTION KEY SEQUENCE

DISPLAY (N=)	FUNCTION
1: Enter Password	(ENTER PASSWORD)
2: Disable Outputs	(DISABLE)
3: Enable Outputs	(ENABLE)
4: Trip	(TRIP)
5: Close	(CLOSE)
6: Enter Date and Time	(DATE/TIME)
7: Relay Test	(RELAY TEST)
8: Channel Test	(CHANNEL TEST)
9: MMI Test	(MMI TEST)
10: Digital Output Test	(DIG OUTPUT TEST)
11: Fix Up Settings CRC	(COMPUTE CRC)
12: Change Password	(CHANGE PASSWORD)

"n" is the optional category number; if omitted, category 1 is assumed. When the user presses the ACT key, the display shows "ACT:", followed by the abbreviated name of the first category. If the user wants the first category, he presses the ENT key to display the first item; otherwise, he can use the ARROW keys to get to the desired category. If the user presses a digit, the category name is blanked and the digit is displayed. Then when the user presses the ENT key, the abbreviated name of the category corresponding to that number is displayed. If the user enters an invalid category number, an error message is displayed.

When the user presses the ENT key following the displayed name of a category, the first item or prompt in that category is displayed. If the item selected was disable, enable, trip or close, the MMI will attempt to acquire the action lock. The action lock will lock remote communications from performing those functions. If remote communications already has the action lock, the MMI will display the "remote link active" message. If the category contains a list of items, the user may scroll through the items using the ARROW keys, in the same manner as described above for Settings; he may go to the next or previous category by pressing the ACT key followed by one of the ARROW keys. If the category contains prompts, the user must respond to each prompt, or press any Command key or the END key to get out of the sequence of prompts. After the user responds to the prompt and presses the ENT key, the next prompt (if any) will be automatically displayed. The DLP3 performs the appropriate action after the last prompt has been satisfied. As soon as the action is complete, the user will be taken back to the beginning of the category (where the category name is displayed, and the DLP3 is expecting the ENT key to produce the first prompt, an ARROW key to move to another category, or a Command key).

1. ENTER PASSWORD

This category is used to enter the MMI password that activates a privilege level for access through the keypad.

After the ENTER key is pressed, the display prompts the user with the message "ENTER PASSWORD". The user responds by pressing digit keys that represent the password. The digits are echoed with "*". The user then presses the ENTER key, which displays "SELECTED" if the password was valid (or "NOT SELECTED" if it was not). MMI privilege is set to the level associated with the selected password.

NOTE: When a DLP3 is first shipped, special Actions and Setting passwords are provided. Selecting these passwords doesn't increase your privilege level, but only allows you to change the password by using Change Password from the ACTIONS categories, and thereby obtain the higher levels.

2. DISABLE OUPUTS

This category is used to inhibit the DLP3 from energizing any of the Digital Output channels except for the four alarm outputs. After the ENT key is pressed, the display prompts the user with the message "DIS OUTPUTS?". The user presses the 3/N key for NO or the 1/Y key for YES and then presses the ENT key (The response is echoed on the display as "NO" or "YES"). If the user responds with a NO, the message "CANCELLED" appears on the display, and no DLP3 action occurs. If the user responds with YES, the action is performed, the message "OUTPUTS DISABLED" appears on the display, the MMI LED (LED on the MMI panel) turns red, and the printer reports:

TIME/DATE
LOCAL - DISABLE OUTPUTS

If the user responds with a Data Entry key other than the 3/N or 1/Y keys, an error message is displayed and outputs are not disabled.

3. ENABLE OUTPUTS

This category is used to permit the DLP3 to energize all of the Digital Output channels. After the ENT key is pressed, the display prompts the user with the message "EN OUTPUTS?". The user presses the 3/N key for NO or the 1/Y key for YES and then presses the ENT key (The response is echoed on the display as "NO" or "YES"). If the user responds with a NO, the message "CANCELLED" appears on the display, and no DLP3 action occurs. If the user responds with a YES, the action is performed, the message "OUTPUTS ENABLED" appears on the display, the MMI LED (LED on the MMI panel) turns green, and the printer reports:

TIME/DATE
LOCAL - ENABLE OUTPUTS

If the user responds with a Data Entry key other than the 3/N or 1/Y keys, an error message is displayed and outputs are not enabled.

4. TRIP

This category is used to trip the breaker manually; if two breakers are being controlled by the DLP3, each must be tripped individually.

When the ENT key is pressed, the display prompts the user with the message "TRIP BKR 1/2?" if the DLP3 is controlling two breakers (this prompt is not displayed if the DLP3 is controlling one breaker). The user presses a 1 or 2 (any other Data Entry key will cause an error message to be displayed) to indicate which breaker, and then presses the ENT key. The display then prompts the user with the message "TRIP BKR x?". The user presses the 3/N for NO or the 1/Y for YES and then presses the ENT key. (The response is echoed on the display as "NO" and "YES".) If the user responds with a NO, the message "CANCELLED" appears on the display, and no DLP3 action occurs. If the user responds with a YES, the action is performed and the 52/b contact for that breaker is monitored. If the 52/b contact reports that the breaker is open, then the message "BKR x TRIPPED" appears on the display, and the printer reports: TIME/DATE LOCAL - MANUAL TRIP If the 52/b contact reports that the breaker is not open then the message "NOT TRIPPED" appears on the display, and the printer reports

TIME/DATE
LOCAL - MANUAL TRIP ATTEMPTED

If the user responds with a Data Entry key other than the 3/N or 1/Y keys, an error message is displayed and the breaker is not tripped. The trip command is issued for approximately 0.5 to 1 second.

5. CLOSE

This category is used to close a breaker manually. If two breakers are being controlled by the DLP3, each must be closed individually.

When the ENT key is pressed, the display prompts the user with the message "CLSE BKR 1/2?" if the DLP3 is controlling two breakers (this prompt is not displayed if the DLP3 is controlling one breaker). The user presses a 1 or 2 (any other Data Entry key will cause an error message to be displayed) to indicate which breaker, and then presses the ENT key. The display then prompts the user with the message "CLOSE BKR x?". The user presses the 3/N for NO or the 1/Y for YES and then presses the ENT key. (The response is echoed on the display as "NO" and "YES".) If the user responds with a NO, the message "CANCELLED" appears on the display, and no DLP3 action occurs. If the user responds with a YES, the action is performed and the 52/b contact for that breaker is monitored. If the 52/b contact reports that breaker is closed then the message "BKR x CLOSED" appears on the display, and the printer reports: TIME/DATE LOCAL - MANUAL CLOSE If the 52/b contact reports that the breaker is not closed then the message "NOT CLOSED" appears on the display, and the printer reports

```
TIME/DATE
LOCAL - MANUAL CLOSE ATTEMPTED
```

If the user responds with a Data Entry key other than the 3/N or 1/Y keys, an error message is displayed and the breaker is not closed. The Close command is issued for approximately 0.5 to 1 second.

6. DATE/TIME

This category is used to display or change the current date and/or time stored in the DLP3. When the ENT key is pressed, the display shows "DATE: xx/xx/xx", giving the current date in the format mm/dd/yy. If the user wishes to change the date, he enters 6 digits from the numeric keypad, then presses the ENT key. If the user presses any key other than ENT, or the digits entered do not comprise a valid date, the old date is retained (new date is not stored) and an error message is displayed. As soon as the user begins entering digits, the 6 digits on the display are blanked, and the numeric keys pressed by the user are echoed in place of the displayed digits.

NOTE: After initial power up or loss of power exceeding 24 hours, the time and date will reset to 00:00:00 01/01/90. All event and fault data will be reset.

If the user presses the UP-ARROW key after viewing or changing the date, the display shows "TIME: xx:xx:xx", giving the current time in the format hh:mm:ss. If the user wishes to change the time, he enters 6 digits, then presses the ENT key. If the user presses any key other than ENT, or the digits entered do not comprise a valid time, the old time is retained (new time is not stored) and an error message is displayed. As soon as the user begins entering digits, the 6 digits on the display are blanked, and the numeric keys are echoed in place of the displayed digits.

7. RELAY TEST

This category is used to test the relay functions of the DLP3. After the ENT key is pressed, if the DLP3 is already in Test Mode, the display will show the current Test Mode selection. When not in Test Mode the display will show the first item, "END TEST MODE", in the list below. The user may then select a test or cancel a test either by using the UP-ARROW and DOWN-ARROW keys or entering the number corresponding to the test followed by the ENT key. The test that is being displayed is selected for execution by pressing the ENT key. When the test has been selected, the word "ON" will be displayed in the rightmost two characters of the display. When Test Mode has been selected (see ACCEPTANCE TESTS section) the pickup of the selected function will result in the output of a signal on the Reclose Cancel digital output. The user will be able to monitor only one signal at a time. That is, if a user selects a function to monitor, any previously selected function will no longer be monitored. To remove the DLP3 from test mode, the user can either press the ARROW keys until "END TEST MODE" is displayed, then press the ENT key, or press the 1/Y key followed by the ENT key twice;

the currently selected function will stop being monitored. The reclose-cancel digital output will revert to its normal use. Each test function may be selected by scrolling through the Menu, or entering the test number and pressing ENT.

The available tests and their corresponding numbers are shown in the following table:

Table 9–3: TEST MODES

1: END TEST MODE	13: ZONE 4 CG	25: ZONE 3 BC	36: GRD DIR TRIP
2: ZONE 1 AG	14: ANY Z1 GRND	26: ZONE 3 CA	37: GRD DIR BLOCK
3: ZONE 1 BG	15: Z2 GRND TIMER	27: ZONE 4 AB	38: FAULT DETECTOR
4: ZONE 1 CG	16: Z3 GRND TIMER	28: ZONE 4 BC	39: REM OP DETCT
5: ZONE 2 AG	17: Z4 GRND TIMER	29: ZONE 4 CA	40: OUT OF STEP
6: ZONE 2 BG	18: ZONE 1 AB	30: ANY Z1 PHASE	41: V1 DETECTOR
7: ZONE 2 CG	19: ZONE 1 BC	31: Z2 PHASE TIMER	42: LINE OVERLOAD
8: ZONE 3 AG	20: ZONE 1 CA	32: Z3 PHASE TIMER	43: INST PHS OVRC
9: ZONE 3 BG	21: ZONE 2 AB	33: Z4 PHASE TIMER	44: INST GND OVRC
10: ZONE 3 CG	22: ZONE 2 BC	34: IT DETECTOR	45: TIM DLY GD OC
11: ZONE 4 AG	23: ZONE 2 CA	35: IB DETECTOR	46: LINE PICKUP
12: ZONE 4 BG	24: ZONE 3 AB		

8. CHANNEL TEST

This category is used to allow the user to key (turn on) the local transmitter when a channel scheme (POTT, PUTT, BLOCKING, or HYBRID) is used.

After the ENTER key is pressed, the display will show the first of the two items: "END CHNL TEST" or "CHNL TEST". The user may then display the other item by using the ARROW keys. The item that is being displayed is selected for execution by pressing the ENTER key. At this point two checks are performed: privilege level must be Control level and Communication must not be in the process of performing an action. If the checks fail, then an error message is displayed and the test is not performed. When the item is selected, the word "ON" will be displayed in the rightmost two characters of the display.

9. MMI TEST

This is used to test the display, keyboard, MMI LED (LED on the MMI panel), and printer.

If the user presses the PRT key, an error message is displayed, since this category does not have an option of printing.

If the user presses the ENT key, the entire left 8-character display is lit, enabling the user to verify that all those display LED segments are working. The right 8-character display prompts with "NEXT?". If the user presses the 3/N key followed by the ENT key, the next test (testing the right 8-character display) is skipped. If the user presses 1/Y key followed by the ENT key, the right 8-character display is lit, enabling the user to verify that all those display LED segments are working.

The left 8-character display prompts with "LED TST?". If the user presses the 3/N key followed by the ENT key, the MMI LED test is skipped. If the user presses the 1/Y key followed by the ENT key, the MMI LED will be tested. If the MMI LED is green, it will turn red for 5 seconds and return to green. If the MMI LED is red, it will turn green for 5 seconds and return to red.

The display then prompts with "KEYBRD TEST?". If the user presses the 3/N key followed by the ENT key, the keyboard test is skipped. If the user presses the 1/Y key followed by the ENT key, the keyboard test is initiated. First the display is blanked and the user is expected to press keys on the keyboard. The keys' mnemonics are echoed on the display, enabling the user to verify that each key is being sensed correctly. The CLR key terminates the keyboard test.

When the keyboard test is complete (or the user has skipped the keyboard test), the display prompts with "PRINTER TEST?". If the user presses the 3/N key followed by the ENT key, the printer test is skipped and the MMI test is terminated. If the user presses the 1/Y key followed by the ENT key, the printer is tested. Patterns containing all printable characters (upper and lower case, and punctuation) will be printed in all possible columns.

If, during the above sequence, the user presses any Command key or Control key other than the ENT key, the test will be terminated. If the user presses any Data Entry key other than 1/Y or 3/N, an error message will be displayed.

10. FIX UP SETTINGS

This category may be used after the DLP3 has reported an EEPROM failure, indicating that the stored settings do not match their CRC (Cyclic Redundancy Check) code. When using this command, it is imperative that the user EXAMINE EVERY SETTING IN THE DLP3 to assure that each setting is still correct, before performing the END/ENT key sequence to resume Protection (see SERVICING section). Otherwise there is a risk of placing the DLP3 in service with unintended or inconsistent settings.

After the ENT key is pressed, the display prompts the user with the message "FIXUP SETTS?". If the user presses the 3/N key, the message "CANCELLED" appears on the display and no action is taken. If the user presses the 1/Y key, the setting's CRC code is recalculated, the message "CHECK SETTINGS" appears on the display, and the printer reports:

```
TIME/DATE
LOCAL - FIXUP SETTINGS
```

Once the setting's CRC code has been calculated and EVERY DLP3 SETTING HAS BEEN EXAMINED, then the user must press the END key followed by the ENT key to resume Protection. If the user responds with a Data Entry key other than the 3/N or the 1/Y keys, an error message is displayed and the setting's CRC code is not recalculated.

11. CHANGE PASSWORD

This category is used to change the MMI password that is currently in effect. A password becomes effective through selection of Enter Password in this category.

After ENTER is pressed, the display prompts the user with the message "NEW PASSWORD". The user presses digit keys that represent the new password. The digits are echoed with "*". The user then presses the ENTER key and he is prompted with the message "REPEAT". The user must enter the new password again, then press the ENTER key. If the two entered passwords are exactly the same, then the message "CHANGED" is displayed. If they are not the same then "NOT CHANGED" message is displayed and the old password remains selected.

12. DIGITAL OUTPUT TEST

This category is used to test digital outputs of the DLP3.

After the ENTER key is pressed, the display will show the first item, "END DIG TEST", in Table IN-2. The user may then display a test name either by using the ARROW keys or entering the number corresponding to the test, followed by the ENTER key. The test that is being displayed is selected for execution by pressing the ENTER key again.

Note: At this point the privilege level must be Control level. If the privilege level is wrong, then an error message is displayed and the test is not performed. With this action the Communication interference is not checked.

Next, the digital outputs are checked to verify that they are enabled. If they are not, then the message: ENABLE OUTPUTS is displayed and test selection is canceled.

If outputs are enabled then the user must indicate if he wants to disable protection. The message PROTECT OFF? is displayed. The user presses 1 for YES or 3 for NO, followed by ENTER. If the user indicated NO, then the message CANCELLED is displayed and test selection is stopped. If the user indicated YES, then the test name will be redisplayed. Word "ON" will also be shown in the rightmost two characters of the display and the test will be performed.

The user will be able to monitor only one signal at a time. That is, if a user selects a signal to monitor, then any previously selected signal will no longer be monitored.

To stop the digital output test, and re-enable protection, the user presses the ARROW keys until "END TEST MODE" is displayed, or enters "1" followed by the ENTER key. He then presses ENTER.

The user can also stop the test by pressing END ENT key sequence, which ends the DLP3 session.

The available digital-output tests and their corresponding numbers are shown in the table below.

Table 9–4: DIGITAL OUTPUT TESTS

1	End test mode
2	Trip-1
3	Trip-2
4	BFI
5	Reclose Initiate - RI
6	Breaker Close 1
7	Breaker Close 2
8	Reclose Cancel
9	Non-Critical Alarm
10	Critical Alarm
11	Key Transmitter 1
12:	Key Transmitter 2
13:	Line Overload

9.2.10 INFORMATION KEY

9

The INF key is used to request information. The 8 categories are listed below. The names displayed at the MMI are in parentheses. The categories can be scrolled through, using the ARROW keys. For convenience, however, each category is also assigned a number so that the user may go directly to the category he wants.

The key sequence for requesting information is: INF n [ENT or PRT]

Table 9–5: INFORMATION KEY SEQUENCE

1: Status Info	(STATUS)
2: Fault Info	(FAULT)
3: Present Values	(VALUES)
4: Events	(EVENTS)
5: Password	(PASSWORD)
6: Model	(MODEL)
7: Station Id	(STATION ID)
8: Line Id	(LINE ID)

"n" is the optional category number; if omitted, category 1 is assumed.

When the user presses the INF key, the display shows "INF:" followed by the abbreviated name of the first category. If the user wants the first category, he presses the ENT key to display the first item; otherwise, he uses the ARROW keys to get to the desired category. If the user presses a digit, the category name is blanked and the digit is displayed. Then when the user presses the ENT key, the abbreviated name of the category corresponding to the number is displayed. If the user enters an invalid category number, an error message is displayed.

When the user presses the PRT key, the resultant display and DLP3 action are dependent upon the category displayed (see below).

When the user presses the ENT key following the displayed name of a category, the first item or prompt in that category is displayed. If the category contains a list of items, the user may scroll through the items using the ARROW keys, in the same manner as described above for Settings; he may go to the next or previous category by pressing the INF key followed by one of the ARROW keys. If the category contains prompts, the user must respond to each prompt, or press any Command key or the END key to get out of the sequence of prompts. After the user responds to the prompt and presses either the ENT or the PRT key, the next prompt (if any) will be automatically displayed. The DLP3 displays or prints the appropriate information after the last prompt has been satisfied. Pressing the Command key at this point will take the user back to the beginning of the category (where the category name is displayed, and the DLP3 is expecting the ENT key to produce the first prompt, an ARROW key to move to another category, or a Command key).

1. REQUEST DLP3 STATUS INFORMATION

This category is used to display or print the present status of the DLP3 (see SERVICING section).

If the user presses the ENT key, the first item displayed is the overall status of the DLP3. If the DLP3 is working properly and protecting the line, the display will be "STATUS: OK". If there is a critical failure, the display will be "STATUS: FAIL". If there is a non-critical failure, the display will be "STATUS: WARN". If the DLP3 is working properly but not protecting the line, the display will be "STATUS: PROT OFF". If the DLP3 is working properly but outputs have been disabled, the display will be "STATUS: DIS OUTS". The above order is the order in which the overall status will be displayed. For example, if there is a critical alarm and a non-critical alarm the display will be "STATUS: FAIL", indicating the critical alarm.

The user may use the arrow keys for further information if the status is a critical failure, a non-critical failure, or not protecting the line. If the DLP3 is working properly and protecting the line, however, the use of the arrow keys will result in an error message being displayed. If the status indicates a critical failure, boards containing critical failures will be reported in the following order: SSP processor board (displayed as SSP), DAP processor

board (displayed as DAP), DSP processor board (displayed as DSP), analog interface board (displayed as ANI), digital communications interface board and the MMI board (both displayed as MMI), and the magnetics module (displayed as MGM). The last group of critical failures to be displayed are those that are not related to a board. If the user presses the UP-ARROW key, the first critical failure will be displayed, based on the above board order. Successive presses of the UP-ARROW key will display additional critical failures until there are no more critical failures. If the user continues to press the UP-ARROW key, any non-critical failures will be displayed, based on the above board order. When all critical and non-critical failures have been displayed and the user presses the UP-ARROW key again, the overall DLP3 status will be displayed again. Then the user can scroll through the failures again with the UP-ARROW key. In a similar manner the user can use the DOWN-ARROW key to scroll backwards through the failures.

If the status indicates a non-critical failure, the same method as above is used to scroll through the non-critical failures. In this case, there will be no critical failures.

If the status indicates that protection is off, the user will be able to display only the "protection off" status message. If the status indicates that protection is on and outputs are disabled, the user will be able to display only the "outputs disabled" status message. In this case there are no critical or non-critical failures.

If the user presses the PRT key (rather than the ENT key, as above), the following lines are printed first:

```
UNIT ID: 1234
DATE: 07/12/90
TIME: 10:23:44
```

If the DLP3 is working properly and protecting the line, the DLP3 will print the following line:

```
DLP STATUS: OK
```

If there is a critical failure, the DLP3 will print the following line:

```
DLP STATUS: FAILURE
```

If there is a non-critical failure, the DLP3 will print the following line:

```
DLP STATUS: WARNING
```

For critical failures and non-critical failures, any additional status messages will be printed in the same order as they are displayed.

If the DLP3 is working properly and not protecting the line, the DLP3 will print the following line.

```
DLP STATUS: PROTECTION OFF
```

If the DLP3 is working properly and protecting the line but outputs are disabled, the DLP3 will print the following line.

```
DLP STATUS: DISABLED OUTPUTS
```

If the DLP3 hardware is working properly but miscellaneous status information is present, then the DLP3 will print the following line.

```
DLP STATUS: MISC
```

Critical failures, non-critical failures and miscellaneous status messages will be printed in the same order as they are displayed.

2. REQUEST FAULT INFORMATION

This category is used to display or print information associated with up to the last 14 faults that the DLP3 has stored, depending on setting 1512.

When either the ENT key or the PRT key is pressed, the display will prompt by adding the characters "#?" after the message on the display. The user presses a digit (1 to 14), then presses the ENT key. (NOTE: 1 = most recent fault, 2 = second most recent fault, etc.). If there is no valid fault information available for that fault, the message "NO FAULT DATA" will be displayed. If the user presses any number not between 1 and 14, an error message is displayed.

If the user enters the fault number followed by the PRT key, the message "INF: FAULT PRT" is shown on the display. The printed output for the fault occurrence chosen is described in Section 9.5: FAULT REPORT on page 9–23.

If the user enters the fault number followed by the ENT key to display the fault information, the first item of the fault occurrence chosen is displayed as "DATE: xx/xx/xx". Repeatedly pressing the UP-ARROW key will invoke the following displays:

```

TIME: xx:xx:xx
FAULT TYPE: xxx (examples: AG,ABG,CA,3PH)
TRIP TYPE: xxx (see the list below)
DIST: xxx MI (in user-selected units)

```

Pressing the UP-ARROW key after the last quantity will return to the top of the list (DATE). The DOWN-ARROW key can be used to scroll backwards through the list.

The abbreviations for the trip types are as follows:

```

Z1 (Zone 1)
Z2 (Zone 2)
Z3 (Zone 3)
Z4 (Zone 4)
PLT (Pilot)
50G (Ground instantaneous overcurrent)
50P (Phase instantaneous overcurrent)
51G (Ground time-delayed overcurrent)
LPU (Line pickup)
REM (Remote open)
WI (Weak Infeed)
OSC (Oscillography Trigger)
CTB (Configurable Trip Bus)

```

3. REQUEST PRESENT VALUES

This category is used to display or print the present analog values and the status of the contact inputs that the DLP3 is monitoring.

If the user presses the PRT key, the characters "PRT" are displayed in the rightmost positions, and the following is printed:

```

UNIT ID: 1234
DATE: 07/12/90
TIME: 10:23:22

IA = xxx.xx A
ANGLE IA = xxx.xx
IB = xxx.xx A
ANGLE IB = xxx.xx
IC = xxx.xx
ANGLE IC = xxx.xx
IN = xxx.xx A
ANGLE IN = xxx.xx
VA = xxx.x V

```

ANGLE VA = xxx.x
 VB = xxx.x V
 ANGLE VB = xxx.x
 VC = xxx.x V
 ANGLE VC = xxx.xx
 Watts = xxxxxx
 Vars = xxxxxx
 BKR1 = OPEN
 BKR2 = CLOSED
 PLC 1 SIG = ON|
 PLC 2 SIG = ON
 PLC 1 STS = OFF
 PLC 2 STS = OFF

NOTE: Currents and voltages are RMS values and are either primary or secondary as the user selected. Phase angles go from 0° to 180° or –1° to –179° referenced to phase A voltage. VA must be present for this function to operate. Watts and Vars are primary or secondary. Signals are reported only for the number of breakers and carrier sets present in the configuration.

The above PLC and BKR mnemonics refer to contact converters 3-6, and 8-13 (CC3-CC6, CC8-CC13) defined by the Elementary Diagram in the PRODUCT DESCRIPTION section. The PLC signals, PLC SIG and PLC STS, are present for all the pilot schemes except the blocking scheme. For a blocking scheme, the following mnemonics replace PLC STS, which is included with the PLC signals:

STOP CAR = OFF
 BLK PILOT = OFF

The PLC STS signals report the state of STOP CAR and BLK PILOT when the scheme selected is NOT the Blocking scheme.

No action is taken for these signals outside the Blocking scheme. If the user presses the ENT key, the first item is displayed as "IA = xxx.xx". Pressing the UP-ARROW key will produce "ANGLE IA = xxx.xx" on the display, etc. Continuing to press the UP-ARROW key will display each of the quantities shown in the description of PRINT VALUES in turn. Pressing the UP-ARROW key after the last value will return to the first quantity in the list (IA). The DOWN-ARROW key can be used to scroll backwards through the items.

The values are periodically updated while on display.

4. REQUEST EVENTS

This category is used to print Sequence-of-Events information.

If the user presses the PRT key, the characters "PRT" are displayed in the rightmost positions, and the following kinds of messages are printed:

```

EVENTS
UNIT ID: 1
DATE: 08/16/90
TIME: 04:40:19

08/14/90          00:57:49.783
TRIP SIGNALS RESET

08/14/90          00:57:11.072
TRIP CIRCUIT #1 ENERGIZED

08/14/90          00:57:11.069
TRIP SIGNALS ON
  
```

```

08/13/90          22:07:48.119
TRIP SIGNALS RESET

08/13/90          22:07:47.574
TRIP CIRCUIT #1 ENERGIZED

08/13/90          22:07:47/571
TRIP SIGNALS ON

```

(If the user presses the ENT key, an error message is displayed, since Events can only be printed.)

5. VIEW PASSWORD

This category is used to view the communication passwords in encrypted form.

If the user presses the ENTER key, a check is made to verify that Communication is not in the process of changing the passwords. If the checks fail, then an error message is displayed and the action is not performed. If the check passes, then the word VIEW is displayed. Pressing the UP ARROW key displays the View level password. Pressing the UP-ARROW repeatedly displays the word CONTROL, then the Control level password; finally the word SETTING, followed by the Setting level password, and back to the word VIEW. All passwords are displayed in encrypted form (see Table IN-9).

(If the user presses the PRINT key, an error message is displayed, since the communication password can only be displayed.)

6. REQUEST DLP3 MODEL/VERSION

This category is used to display or print the DLP3 model number and the PROM version number.

If the user presses the PRT key, the characters "PRT" are displayed in the rightmost positions, and the following is printed:

```

Station Id
Line ID
UNIT ID #
DATE/TIME (Hr:Min:Sec)
MODEL NUMBER = AAAAAAAAAA
PROM VERSION = AAAAAAAAAA

```

If the user presses the ENT key, the model number will be displayed as "MD:AAAAAAAAAAAA". Pressing the UP-ARROW key will display the PROM version number as "VER:AAAAAAAAAAAA". Pressing the UP-ARROW key again will return to the model number. The DOWN-ARROW key can be used to scroll backwards through the items.

7. STATION ID

This category is used to view the 32-character Station Id string that was downloaded by the Remote Comm. Station Id is printed out with all MMI reports.

If the user presses the ENTER key, a check is made to verify that Communication is not in the process of changing the Station Id. If the checks fail, then an error message is displayed and the action is not performed.

If the check passes, then the first 16 characters of the Station Id are displayed.

Pressing the UP- or DOWN-ARROW displays the next 16 characters of the Station Id. If the user presses the PRINT key, an error message is displayed. It is possible to have Station Id printed out, however, by requesting any of the DLP3 reports.

8. LINE ID

This category is used to view the 32-character Line Id string that was downloaded by the Remote Comm. The Line Id is printed out with all MMI reports.

If the user presses the ENTER key, a check is made to verify that Communication is not in the process of changing the Line Id. If the checks fail, then an error message is displayed and the action is not performed.

If the check passes, then the first 16-characters of the Line Id are displayed. Pressing the UP- or DOWN-ARROW displays the next 16 characters of the Id.

If the user presses the PRINT key, an error message is displayed. It is possible to have the Line Id printed out, however, by requesting any of the DLP3 reports.

9.2.11 ERRORS

If the user enters a wrong response (either data or a choice), an error message will be displayed. See Table IN-2 for a list of the error messages.

If a wrong response is entered, the display is blanked and an error message is displayed. The user must then press the CLR key to blank the error message (all other keys will be ignored). When the error message is blanked, the last message will be re-displayed, allowing the user to re-enter the correct response.

If the setting's CRC code has become corrupted, certain MMI functions will become unavailable. Whenever the error occurs, the user will not be able to change any settings (although the settings can still be viewed). If the error occurs during startup, the user will not be able to perform any of the Action commands except Fixup Settings. Once the setting's CRC has been recalculated by issuing the FIXUP SETTINGS command, the user will be able to perform the Action commands and change settings.

The CRC code is a Cyclic Redundancy Check value stored in memory that is automatically set up whenever a setting is changed. This CRC code enables the EEPROM Self Test to verify the integrity of the settings area in EEPROM.

9.3.1 DESCRIPTION

This key sequence shows how a setting is changed by accessing the setting directly.

Table 9–6: SAMPLE KEY SEQUENCES – SETTING CHANGE

ACCESSING THE SETTING DIRECTLY		USING THE ARROW KEYS	
KEY	DISPLAY	KEY	DISPLAY
SET	SET:Z1DIST	SET	SET:Z1DIST
1	SET:1	ENT	SELZ1G = YES
2	SET:12	UP-ARROW	SELZ1P = YES
0	SET:120	UP-ARROW	Z1R = 9.00
1	SET:1201	8	Z1R :8
ENT	SELSCM = STEP DST	.	Z1R :8.
1	SELSCM: POTT	4	Z1R :8.4
ENT	SELSCM = POTT	5	Z1R :8.45
		ENT	Z1R = 8.45

The following key sequences show how each action is accomplished.

Table 9–7: SAMPLE KEY SEQUENCE – ACTIONS (Sheet 1 of 2)

ACTION	KEY	DISPLAY
DISABLE OUTPUTS:	ACT	ACT:DISABLE
	ENT	DIS OUTPUTS?
	1/Y	DIS OUTPUTS? YES
	ENT	OUTPUTS DISABLED
ENABLE OUTPUTS:	ACT	ACT:DISABLE
	2	ACT:2
	ENT	EN OUTPUTS?
	1/Y	EN OUTPUTS? YES
	ENT	OUTPUTS ENABLED
TRIP: (2 breakers)	ACT	ACT:DISABLE
	3	ACT: 3
	ENT	TRIP BKR 1/2?
	2	TRIP BKR 1/2? 2
	ENT	TRIP BKR 2?
	1/Y	TRIP BKR 2? YES
	ENT	BKR 2 TRIPPED
CLOSE: (1 breaker)	ACT	ACT:DISABLE
	4	ACT:4
	ENT	CLOSE BKR?
	1/Y	CLOSE BKR? YES
	ENT	BKR CLOSED

Table 9-7: SAMPLE KEY SEQUENCE – ACTIONS (Sheet 2 of 2)

ACTION	KEY	DISPLAY
DATE/TIME:	ACT	ACT:DISABLE
	5	ACT:5
	ENT	DATE: 08/29/88
	0	DATE: 0 / /
	7	DATE: 07/ /
	0	DATE: 07/0 /
	1	DATE: 07/01/
	9	DATE: 07/01/9
	0	DATE: 07/01/90
	ENT	DATE= 07/01/90
	UP-ARROW	TIME: 12:34:55
	0	TIME: 0 : :
	1	TIME: 01: :
	2	TIME: 01:2 :
	4	TIME: 01:24:
	1	TIME: 01:24:1
	6	TIME: 01:24:16
ENT	TIME= 01:24:16	
MMI TEST:	ACT	ACT:DISABLE
	7	ACT:7
	ENT	#####NEXT?
	1/Y	#####NEXT?YES
	ENT	LED TST?
	3/N	LED TST?NO
	ENT	KEYBRD TEST?
	3/N	KEYBRD TEST?NO
	ENT	ACT:MMI TEST
FIXUP SETTINGS:	ACT	ACT:DISABLE
	8	ACT:8
	ENT	FIXUP SETTS?
	1/Y	FIXUP SETTS? YES
	ENT	CHECK SETTINGS
RELAY TEST:	ACT	ACT:RELAY TEST
	6	ACT:6
	ENT	END TEST MODE
	UP-ARROW	ZONE 1
	UP-ARROW	ZONE 2
	ENT	ZONE 2 ON

The following key sequence shows how information is retrieved.

Table 9–8: SAMPLE KEY SEQUENCE – INFORMATION

ACTION	KEY	DISPLAY
STATUS:	INF	INF:STATUS
	ENT	STATUS: WARN
	UP-ARROW	LOGIN FAILURE
FAULT:	INF	INF:STATUS
	UP-ARROW	INF:FAULT
	ENT	FAULT #?
	1	FAULT #? 1
	ENT	DATE: MM/DD/YY
	UP-ARROW	TIME: HH:MM:SS
	UP-ARROW	FAULT TYPE: AG
	UP-ARROW	TRIP TYPE : Z1
	UP-ARROW	DIST : 0.0MI
PRESENT VALUES:	INF	INF:STATUS
	UP-ARROW	INF:FAULT
	UP-ARROW	INF:VALUES
	ENT	IA = 5.00 A
	UP-ARROW	ANGLE IA = -50
	UP-ARROW	IB = 5.00 A
	UP-ARROW	ANGLE IB = -120
EVENTS:	INF	INF:STATUS
	UP-ARROW	INF:FAULT
	UP-ARROW	INF:VALUES
	UP-ARROW	INF:EVENTS
PASSWORD:	INF	INF:STATUS
	UP-ARROW	INF:FAULT
	UP-ARROW	INF:VALUES
	UP-ARROW	INF:EVENTS
	UP-ARROW	INF:PASSWORD
	ENT	!A@1#\$\$45%*T()
MODEL/VERSION:	INF	INF:STATUS
	UP-ARROW	INF:FAULT
	UP-ARROW	INF:VALUES
	UP-ARROW	INF:EVENTS
	UP-ARROW	INF:PASSWORD
	UP-ARROW	INF:MODEL
	ENT	MD:DLP3521AA
	UP-ARROW	VER:V001.111A

9.4.1 ERROR MESSAGES TABLE

The following table lists the MMI error messages.

Table 9–9: MMI ERROR MESSAGES

ERROR MESSAGE	CAUSE OF ERROR
VAL OUT OF RANGE	Setting value either greater than upper limit or less than lower limit.
SETT NUM INVALID	Setting number is not valid.
Y/N NOT ENTERED	Setting value or response to a prompt had to be a YES or NO but a 1/Y or 3/N key was not entered.
REQUEST INVALID	Any key that is invalid during a key sequence. Some example are: The PRT key is pressed for an action item. The ENT key is pressed to view events. The UP-ARROW key is pressed while entering a setting value.
CATEGORY INVALID	A wrong category number was entered for either an action or information item.
BKR NUM INVALID	A breaker number greater than 2, or 0, was entered.
DATE INVALID	The day, month, and/or year are not valid.
TIME INVALID	The hour, minute, and/or second are not valid.
FAULT # INVALID	A fault number greater than 5, or 0, was entered.
REMOTE LINK ACT	The remote communications link is in use for actions or settings, local settings changes and action cannot be performed.
MMI KEY ERROR	MMI received an invalid key code from keyboard. (Hardware error)
ACT INVALID NOW	The current action that the user is attempting to perform is invalid because the setting's CRC code is in error.

9.5.1 FAULT REPORT TABLE

 FAULT REPORT

UNIT ID: 1234
 TRIP DATE: 07/20/90
 TRIP TIME: 13:01:23.205
 OPERATING TIME: 10 MS

FAULT TYPE: AG
 TRIP TYPE: Z1
 DISTANCE: 34.3 MI

PREFault IA: 5.61 A
 PREFault IB: 5.23 A
 PREFault IC: 5.30 A
 PREFault IN: 0.51 A

FAULT VA: 51.2 V
 FAULT VB: 66.2 V
 FAULT VC: 67.3 V

FAULT IA: 15.34 A
 FAULT IB: 5.12 A
 FAULT IC: 4.96 A
 FAULT IN: 12.13 A

07/20/90 13:01:23.205
 TRIP SIGNALS ON

07/20/90 13:01:23.210
 TRIP CIRCUIT #1 ENERGIZED

07/20/90 13:01:23.210
 TRIP CIRCUIT #2 ENERGIZED

07/20/90 13:01:23.249
 TRIP SIGNALS RESET

07/20/90 13:01:23.261
 BREAKER #1 OPEN

07/20/90 13:01:23.261
 BREAKER #2 OPEN

9.6.1 EVENTS

The following is the list of events printed by the DLP3:

TRIP SIGNALS ON	LOCAL - SETTINGS CHANGE STARTED
TRIP SIGNALS RESET	LOCAL - SETTINGS CHANGE DONE
TRIP CIRCUIT #1 ENERGIZED	LOCAL - MANUAL TRIP ATTEMPTED
TRIP CIRCUIT #2 ENERGIZED	LOCAL - MANUAL CLOSE ATTEMPTED
TRIP CIRCUIT #1 NOT ENERGIZED	DAP BOARD: PROCESSOR FAILURE CLEARED
TRIP CIRCUIT #2 NOT ENERGIZED	DSP BOARD: CO-PROCESSOR FAILURE CLEARED
OUT OF STEP CONDITION ON	SSP BOARD: FAILURE CLEARED
OUT OF STEP CONDITION OFF	SSP BOARD: QUEUES REINITIALIZED
BREAKER #1 OPEN	MGM BOARD: FAILURE CLEARED
BREAKER #1 CLOSED	ANI BOARD: FAILURE CLEARED
BREAKER #2 OPEN	MMI BOARD: FAILURE CLEARED
BREAKER #2 CLOSED	FAIL - DAP BOARD: PROM
FUSE FAILURE ALARM ON	FAIL - DAP BOARD: LOCAL RAM
FUSE FAILURE ALARM OFF	FAIL - DAP BOARD: DSPRAM CRC
RECEIVE CARRIER ON	FAIL - DAP BOARD: DSPRAM
RECEIVE CARRIER OFF	FAIL - DAP BOARD: SYSRAM
KEY TRANSMITTER ON	FAIL - DAP BOARD: INTERRUPT
LINE OVERLOAD ALARM ON	FAIL - DAP BOARD: TIMER
LINE OVERLOAD ALARM OFF	FAIL - DAP BOARD: VERSION NUMBER
TRIP CIRCUIT #1 MONITOR ALARM ON	FAIL - DSP BOARD: PROM
TRIP CIRCUIT #1 MONITOR ALARM OFF	FAIL - DSP BOARD: LOCAL RAM
TRIP CIRCUIT #2 MONITOR ALARM ON	FAIL - DSP BOARD: DSPRAM
TRIP CIRCUIT #2 MONITOR ALARM OFF	FAIL - DSP BOARD: INTERRUPT
PILOT PROTECTION ON	FAIL - DSP BOARD: VERSION NUMBER
PILOT PROTECTION OFF	FAIL - ANI BOARD: CONTROLLER
REMOTE COMM - PASSWORD CHANGED	FAIL - ANI BOARD: SERIAL MEMORY
REMOTE COMM - MANUAL TRIP	FAIL - ANI BOARD: REFERENCE
REMOTE COMM - MANUAL CLOSE	ANI BOARD: REFERENCE CORRECTED
REMOTE COMM - ENABLE OUTPUTS	FAIL - MGM BOARD: SERIAL MEMORY
REMOTE COMM - DISABLE OUTPUTS	FAIL - MGM BOARD: MODEL NUMBER
REMOTE COMM - SETTINGS CHANGE STARTED	FAIL - SSP BOARD: PROM
REMOTE COMM - SETTINGS CHANGE DONE	FAIL - SSP BOARD: LOCAL RAM
REMOTE COMM - MANUAL TRIP ATTEMPTED	FAIL - SSP BOARD: SYSRAM CRC
REMOTE COMM - MANUAL CLOSE ATTEMPTED	FAIL - SSP BOARD: SYSRAM
LOCAL - MANUAL TRIP	FAIL - SSP BOARD: INTERRUPT
LOCAL - MANUAL CLOSE	FAIL - SSP BOARD: EEPROM
LOCAL - ENABLE OUTPUTS	FAIL - SSP BOARD: VERSION NUMBER
LOCAL - DISABLE OUTPUTS	FAIL - MMI BOARD: DIGITAL OUTPUT

WARN - DSP BOARD: DIGITAL INPUT
 DSP BOARD: DIGITAL INPUT CORRECTED
 WARN - ANI BOARD: ZERO CROSSING
 WARN - SSP BOARD: TIMER
 WARN - SSP BOARD: CAPRAM
 WARN - SSP BOARD: REAL TIME CLOCK
 WARN - MMI BOARD: SERIAL CHIP
 WARN - MMI BOARD: LED DISPLAY

WARN - REMOTE COMM LOGIN FAILED
 Note: If the 3rd login attempt fails this message will be evented
 WARN - DTA BOARD: SERIAL MEMORY
 WARN - SPURIOUS TIME STROBES
 UNBALANCED SYSTEM DETECTION ALARM OFF
 UNBALANCED SYSTEM DETECTION ALARM ON
 CONTINUOUS MONITOR ALARM OFF
 CONTINUOUS MONITOR ALARM ON

9.6.2 MESSAGES

The list of messages displayed on the MMI is as follows:

DAP:PROM ERROR	SSP:INT ERROR
DAP:RAM ERROR	SSP:TIMER ERROR
DAP:CRC RAM ERR	SSP:EEPROM ERROR
DAP:DSPRAM ERROR	SSP:CAPRAM ERROR
DAP:SYSRAM ERROR	SSP:RTC ERROR
DAP:INT ERROR	SSP:D O HW ENA
DAP:TIMER ERROR	SSP:PROCSR SHTDN
DAP:D O HW ENA	MMI:SER CHIP ERR
DAP:PROCSR SHTDN	MMI:D O ERROR
DSP:PROM ERROR	MMI:LED DISP ERR
DSP:RAM ERROR	MGM:MAG S NVM ER
DSP:DSPRAM ERROR	BK1 TRP CIR OPEN
DSP:INT ERROR	BK2 TRP CIR OPEN
DSP:D I ERROR	FUSE FAILURE
DSP:D I ERR COR	LOGON FAILURE
DSP:PROCSR SHTDN	RELAY TEST
ANI:A/D CNTRL ER	D O TEST
ANI:A/D S NVM ER	PROT OFF
ANI:A/D REF ERR	DIS OUTS
ANI:A/D REF COR	UNBALANCED SYSTEM DETECTION ALARM ON
ANI:ZERO CRSS ER	UNBALANCED SYSTEM DETECTION ALARM OFF
SSP:PROM ERROR	CONTINUOUS MONITOR ALARM ON
SSP:RAM ERROR	CONTINUOUS MONITOR ALARM OFF
SSP:CRC RAM ERR	UNBALANCED SYSTEM DETECTED
SSP:SYSRAM ERROR	CONTINUOUS MONITOR ALARM

9.6.3 DLP SETTINGS

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 1 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
Z1DIST – ZONE 1 DISTANCE					
0101	SELZ1G	Select Zone 1 Ground	NO, YES		YES
0102	SELZ1P	Select Zone 1 Phase	NO, YES		YES
0103	Z1R	Zone 1 Phase Reach (M1/M1G)	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	5.40Ω at 5A 27.0Ω at 1A
0104	Z1GR	Zone 1 Ground Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	5.40Ω at 5A 27.0Ω at 1A
0105	SELZ1U	Select Zone 1 Ground Unit	0 (MHO), 1 (REACT)		0 (MHO)
0106	Z1SU	Z1 Ground Reaction Mho Supervision Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250 ohms step 0.05	20.0Ω at 5A 100Ω at 1A
0107	Z1K0	Zone 1 Zero Sequence Compensation Current K0	1.0 to 7.0 step 0.01		2.7
0108	Z1ERST	Zone 1 Extension Reset	0.0 to 60.0 seconds, step 0.1		4.0 sec.
Z2DIST – ZONE 2 DISTANCE					
0201	SELZ2G	Select Zone 2 Ground	NO, YES		YES
0202	SELZ2P	Select Zone 2 Phase	NO, YES		YES
0203	Z2R	Zone 2 Phase Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	9.00Ω at 5A 45.0Ω at 1A
0204	Z2GR	Zone 2 Ground Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	9.00Ω at 5A 45.0Ω at 1A
0205	SELZ2U	Select Zone 2 Ground Unit	0 (MHO), 1 (GDOC), 2 (MHOGDOC)		0 (MHO)
0206	SELZ2T	Select Zone 2 Timers	YES, NO		YES
0207	PUTL2P	Zone 2 Phase Timer	0.10 to 3.0 sec., step 0.01		1.0 sec.
0208	PUTL2G	Zone 2 Ground Timer	0.10 to 3.0 sec., step 0.01		1.0 sec.
0209	Z2PANG	Zone 2 Phase Characteristic Angle	90°, 105°, 120°		90°
0210	Z2GANG	Zone 2 Ground Characteristic Angle	90°, 105°, 120°		90°
Z3DIST – ZONE 3 DISTANCE					
0301	SELZ3G	Select Zone 3 Ground	NO, YES		YES
0302	SELZ3P	Select Zone 3 Phase	NO, YES		YES

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 2 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
0303	Z3R	Zone 3 Phase Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	12.0Ω at 5A 60.0Ω at 1A
0304	Z3GR	Zone 3 Ground Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	12.0Ω at 5A 60.0Ω at 1A
0305	PUTL3P	Zone 3 Phase Timer	0.10 to 10.0 sec., step 0.01		3.0 sec.
0306	PUTL3G	Zone 3 Ground Timer	0.10 to 10.0 sec., step 0.01		3.0 sec.
0307	Z3PANG	Zone 3 Phase Characteristic Angle	90°, 105°, 120°		90°
0308	Z3GANG	Zone 3 Ground Characteristic Angle	90°, 105°, 120°		90°
Z4DISTANCE					
0401	SELZ4G	Select Zone 4 Ground	NO, YES		YES
0402	SELZ4P	Select Zone 4 Phase	NO, YES		YES
0403	Z4R	Zone 4 Phase Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	18.0Ω at 5A 90.0Ω at 1A
0404	Z4GR	Zone 4 Ground Reach	0.01 to 50.0 ohms step 0.01	0.05 to 250.0 ohms step 0.05	18.0Ω at 5A 90.0Ω at 1A
0405	Z4OR	Zone 4 Phase Offset Reach	0.00 to 0.40 step 0.01		0.10
0406	SELZ4T	Zone 4 Timer	YES, NO		YES
0407	PUTL4P	Zone 4Phase Timer	0.10 to 10.0 sec., step 0.01		5.0 sec.
0408	PUTL4G	Zone 4 Ground Timer	0.10 to 10.0 sec., step 0.01		5.0 sec.
0409	Z4PANG	Zone 4 Phase Characteristic Angle	80°, 90°, 95°, 105°, 110°, 120°		90°
0410	Z4GANG	Zone 4 Ground Characteristic Angle	80°, 90°, 95°, 105°, 110°, 120°		90°
0411	SELZ4D	Select Zone 4 Direction	0 (FORWARD), 1 (REVERSE)		0 (FWD)
CURVSUPVIS – OVERCURRENT PILOT/SUPERVISION					
0501	PUIPT	Ground Pilot Trip Overcurrent (IPT)	0.50 to 5.00 amps step 0.01	0.10 to 1.00 amps step 0.01	0.50 A at 5A 0.10 A at 1A
0502	PUIPB	Ground Pilot Block Overcurrent (IPB)	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
0503	PUIT	Trip Supervision Overcurrent (IT)	0.20 to 4.0 amps step 0.01	0.04 to 0.80 amps step 0.01	0.20 A at 5A 0.04 A at 1A
0504	PUIB	Block Supervision Overcurrent (IB)	0.20 to 4.0 amps step 0.01	0.04 to 0.80 amps step 0.01	0.20 A at 5A 0.04 A at 1A

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 3 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
OVERCUR – OVERCURRENT BACKUP					
0601	SELPH4	Select Phase Instantaneous Overcurrent (PH4)	NO, YES		YES
0602	PUPH4	Phase Instantaneous Overcurrent	2.0 to 100.0 amps step 0.1	0.4 to 20.0 amps step 0.1	20.0 A at 5A 4.0A at 1A
0603	SELIDT	Select Ground Instantaneous Overcurrent (IDT)	NO, YES		YES
0604	SELIDIT	Directional Control of IDT	NO, YES		YES
0605	PUIDT	Ground Instantaneous Overcurrent	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
0606	SELTOC	Select Ground Time Overcurrent (TOC)	NO, YES		YES
0607	SELDTOC	Directional Control of TOC	NO, YES		YES
0608	PUTOC	Ground Time Overcurrent	0.20 to 15.00 amps step 0.01	0.04 to 3.00 amps step 0.01	1.00 A at 5A 0.20A at 1A
0609	TDTOC	Ground Time Overcurrent Time Dial	0.5 to 10.0 step 0.1		5.0
0610	PUTTM	Ground Time Overcurrent Pickup Time	0.5 to 30.0 sec., step 0.1		1.0 sec.
0611	SELCURV	Select Ground Time Overcurrent Curve	0 (INV), 1 (V-INV), 2 (E-INV), 3 (CUSTOM), 4(DEFT)		1 (V-INV)
0612	KDCONST	KD Constant	0.0, 0.3		0.3
BLK RECLOS – RECLOSING					
0701	SELALL	All of the Above	NO, YES		YES
0702	RBSOB	Out-of-step Block	NO, YES		NO
0703	RB3PH	All Zone 2 Phase Units	NO, YES		NO
0704	RBTOC	Ground Time Overcurrent (TOC)	NO, YES		NO
0705	RBZ2T	Zone 2 Timers	NO, YES		NO
0706	RBZ3T	Zone 3 Timers	NO, YES		NO
0707	RBZ4T	Zone 4 Timers	NO, YES		NO
0708	RBZ1PH	All Zone 1 Phase Units	NO, YES		NO
0709	RBZ2PH	All Zone 2 Phase Units	NO, YES		NO
0710	RBCTB	Configurable Trip Bus	NO, YES		NO

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 4 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
OUTOFSTEP – OUT-OF-STEP BLOCKING					
0801	SELPTZ	Select Phase Trip Unit to Coordinate with	0 (ZONE2), 1 (ZONE3), 2 (ZONE4)		0 (ZONE2)
0802	MOBANG	Characteristic Angle	30° to 130°, step 1°		70°
0803	SELOSB	Select Block Trip Actions	0 (BLKALL), 1 (BLKDIST), 2 (BLKPHAS), 3 (BLKNONE)		0 (BLKALL)
0804	OSBBLK1	Select Zone 1 Block	NO, YES		YES
0805	OSBBLK2	Select Zone 2 Block	NO, YES		YES
0806	OSBBLK3	Select Zone 3 Block	NO, YES		YES
0807	OSBBLK4	Select Zone 4 Block	NO, YES		YES
LINEPU – LINE PICKUP					
0901	SELLPU	Select Line Pickup	NO, YES		YES
0902	SELTBP	Select Timer Bypass	NO, YES		YES
0903	PUI1	Positive-Sequence Overcurrent	1.0 to 15.0 amps step 0.1	0.2 to 3.0 amps step 0.1	5.0 A at 5A 1.0 A at 1A
REMOTEOPEN – REMOTE OPEN DETECTOR					
1001	SELROD	Select Remote Open Detector	NO, YES		YES
1002	PUTL20	Remote Open Detector Time Delay (TL20)	10 to 100 msec., step 1		100 msec.
1003	SELFFB	Fuse Failure Block	NO, YES		YES
LINE OVERLD – LINE OVERLOAD					
1101	LINEOVERLD	Select Line Overload Protection	NO, YES		NO
1102	PULV1	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	PULV2	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	PUTL31	Level 1 time delay (TL31)	10 to 990 sec., step 1		200 sec.
1105	PUTL32	Level 2 time delay (TL32)	10 to 99 sec., step 1		20 sec.
SCHEMESEL – SCHEME SELECTION					
1201	SELSCM	Select a scheme logic	0 (STEPDST), 1(POTT), 2(PUTT), 3 (HYBRID), 4 (BLK1), 5 (ZNE1EXT), 6 (BLK2), 7 (BLK3)		0 (STEPDST)

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 5 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
1202	NUMRCVR	Select a number of receivers	0, 1, 2		0
SCHEMETIME – SCHEME LOGIC TIMERS					
1301	PUTL1	Trip Integrator	1 to 50 msec., step 1		1 msec.
1302	PUTL5	'b' Contact Coordination Pickup (TL5) Breaker 1	0 to 200 msec., step 1		50 msec.
1303	DOTL5	'b' Contact Coordination Dropout (TL5) Breaker 1	0 to 200 msec., step 1		50 msec.
1304	PUTL6	'b' Contact Coordination Pickup (TL6) Breaker 2	0 to 200 msec., step 1		50 msec.
1305	DOTL6	'b' Contact Coordination Dropout (TL6) Breaker 2	0 to 200 msec., step 1		50 msec.
1306	PUTL4	POTT/PUTT Coordination Pickup (TL4)	0 to 50 msec., step 1		0 msec.
1307	DOTL4	POTT/PUTT Coordination Dropout (TL4)	0 to 50 msec., step 1		0 msec.
1308	PUTL16	Weak Infeed Trip Pickup (TL16)	8 to 80 msec., step 1		8 msec.
1309	PUTLCFG	Configurable Pickup Time	0 to 100 msec., step 1		10 msec.
1310	DOTLCFG	Configurable Dropout Time	0 to 100 msec., step 1		0 msec.
LINE QTY – LINE QUANTITIES					
1401	POSANG	Positive Sequence Impedance Angle	45 to 90 deg., step 1		85 deg.
1402	ZERANG	Zero Sequence Impedance Angle	45 to 90 deg., step 1		75 deg.
1403	ZP	Positive Sequence Line Impedance in sec.ohms	0.01 to 50.0 ohms step 0.01	0.01 to 250.0 ohms step 0.01	6Ω at 5A 30Ω at 1A
1404	K0	Zero-Sequence Current Compensation	1.0 to 7.0, step 0.01		3.0
1405	LINELEN	Line Length	0.0 to 200.0 miles, 0.0 to 322.0 km		100.0 miles / 161.0 km
CONFIG – CONFIGURATION SETTINGS					
1501	UNITD	Unit ID Number	0 to 9999, step 1		0
1502	SYSFREQ	System Frequency	50 Hz, 60 Hz		60 Hz
1503	NUMBKRS	Number of Breakers	1,2		1
1504	TRIPCIRC	Trip Circuit Continuity	0 (NONE), 1 (BKR1), 2 (BKR2), 3 (BOTH)		0 (NONE)

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 6 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
1505	SELPRIM	Select Primary/Secondary Units for Reports	0 (CVTPRI), 1 (CVTSEC), 2 (PTPRI), 3 (PTSEC)		3 (PTSEC)
1506	CTRATIO	CT Ratio	1 to 5000 step 1		400
1507	PTRATIO	PT Ratio	1 to 7000 step 1		2000
1508	DISTUNIT	Units of Distance	0 (MILES), 1 (KM)		0 (MILES)
1509	COMMPORT	Communications Configuration (determined by jumper for DLP models DLP3***NC)	xyz, where Baud Rate (xx): 30 (300), 12 (1200), 24 (2400), 48 (4800), 96 (9600); Parity (y): 0 (none), 1 (odd), 2 (even); Stop Bits (z): 1, 2		2401 (2400 baud, no parity, 1 stop bit)
1510	PHASDESG	Phase Designation	0 (A-B-C), 1 (A-C-B)		0 (A-B-C)
1511	SELTSYNC	Select Time Synch	0 (NONE), 1 (IRIG-B), 2 (G-NET)		0 (NONE)
1512	NUMFLTS	Select Number of Faults	2, 4, 7, 14		4
1513	PREFLT	Number of Prefault Cycles stored for Faults	1 to 8 step 1		3
1514	OSCTRIG	Select Trigger to Store Oscillography Data	0 (UNUSED), 1 (FLTDET), 2 (ANYZ2), 3 (ANYZ3), 4 (ANYZ4), 5 (OUTSTP), 6 (V1DET)		0 (UNUSED)
1515	UNBALALM	Unbalance Detection Alarm	NO, YES		YES
SCADA DTA – SCADA DTA INTERFACE					
1601	FLTLOCK	Fault Location Lock	0, 1.0 to 99.9 seconds, step 0.1		0 sec.
1602	FLTRESET	Fault Location Reset	0 to 999 minutes, step 1		0 min.
CNFGINPUTS – CONFIGURABLE INPUTS					
1701	CONCCI	Configurable Input Mode	0 to 8 step 1		3
1702	SETGRP	Settings Group	0 to 4 step 1		1
BKR1CLSOUT – BREAKER 1 CLOSE / CONFIGURABLE OUTPUT 1 *					
1801	CONOUT1	Contact Output	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		0 (DEFAULT)
1802	CO1IN1	Configurable Output 1, Input 1	0 to 64, 101 to 164, step 1		0
1803	CO1IN2	Configurable Output 1, Input 2	0 to 64, 101 to 164, step 1		0
1804	CO1IN3	Configurable Output 1, Input 3	0 to 64, 101 to 164, step 1		0
1805	CO1IN4	Configurable Output 1, Input 4	0 to 64, 101 to 164, step 1		0

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 7 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
1806	CO1IN5	Configurable Output 1, Input 5	0 to 64, 101 to 164, step 1		0
1807	CO1IN6	Configurable Output 1, Input 6	0 to 64, 101 to 164, step 1		0
1808	CO1IN7	Configurable Output 1, Input 7	0 to 64, 101 to 164, step 1		0
1809	CO1IN8	Configurable Output 1, Input 8	0 to 64, 101 to 164, step 1		0
BKR2CLSOUT – BREAKER 2 CLOSE / CONFIGURABLE OUTPUT 2 *					
1901	CONOUT2	Contact Output	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		0 (DEFAULT)
1902	CO2IN1	Configurable Output 2, Input 1	0 to 64, 101 to 164, step 1		0
1903	CO2IN2	Configurable Output 2, Input 2	0 to 64, 101 to 164, step 1		0
1904	CO2IN3	Configurable Output 2, Input 3	0 to 64, 101 to 164, step 1		0
1905	CO2IN4	Configurable Output 2, Input 4	0 to 64, 101 to 164, step 1		0
1906	CO2IN5	Configurable Output 2, Input 5	0 to 64, 101 to 164, step 1		0
1907	CO2IN6	Configurable Output 2, Input 6	0 to 64, 101 to 164, step 1		0
1908	CO2IN7	Configurable Output 2, Input 7	0 to 64, 101 to 164, step 1		0
1909	CO2IN8	Configurable Output 2, Input 8	0 to 64, 101 to 164, step 1		0
RCANCLOUT – RECLOSE CANCEL / CONFIGURABLE OUTPUT 3 *					
2001	CONOUT3	Contact Output (default is Reclose Cancel)	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		0 (DEFAULT)
2002	CO3IN1	Configurable Output 3, Input 1	0 to 64, 101 to 164, step 1		0
2003	CO3IN2	Configurable Output 3, Input 2	0 to 64, 101 to 164, step 1		0
2004	CO3IN3	Configurable Output 3, Input 3	0 to 64, 101 to 164, step 1		0

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 8 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
2005	CO3IN4	Configurable Output 3, Input 4	0 to 64, 101 to 164, step 1		0
2006	CO3IN5	Configurable Output 3, Input 5	0 to 64, 101 to 164, step 1		0
2007	CO3IN6	Configurable Output 3, Input 6	0 to 64, 101 to 164, step 1		0
2008	CO3IN7	Configurable Output 3, Input 7	0 to 64, 101 to 164, step 1		0
2009	CO3IN8	Configurable Output 3, Input 8	0 to 64, 101 to 164, step 1		0
LNOVLDOU – LINE OVERLOAD / CONFIGURABLE OUTPUT 4 *					
2101	CONOUT4	Contact Output (default is Line Overload)	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE), 3 (ORCTB), 4 (ANDCTB)		0 (DEFAULT)
<p>Note: a value of 1 or 2 for Setting 2101 will use settings 1309 and 1310 for the pickup and dropout times of the contact. For a value of 3 or 4, the trip type will be CTB if the relay trips for the set condition. In addition, setting 1309 will be used as the contact pickup time and the output will remain active until the condition is false for a fixed value of 25 ms. Setting 1310 is not used.</p>					
2102	CO4IN1	Configurable Output 4, Input 1	0 to 64, 101 to 164, step 1		0
2103	CO4IN2	Configurable Output 4, Input 2	0 to 64, 101 to 164, step 1		0
2104	CO4IN3	Configurable Output 4, Input 3	0 to 64, 101 to 164, step 1		0
2105	CO4IN4	Configurable Output 4, Input 4	0 to 64, 101 to 164, step 1		0
2106	CO4IN5	Configurable Output 4, Input 5	0 to 64, 101 to 164, step 1		0
2107	CO4IN6	Configurable Output 4, Input 6	0 to 64, 101 to 164, step 1		0
2108	CO4IN7	Configurable Output 4, Input 7	0 to 64, 101 to 164, step 1		0
2109	CO4IN8	Configurable Output 4, Input 8	0 to 64, 101 to 164, step 1		0
NONCRITOUT – NON-CRITICAL ALARM / CONFIGURABLE OUTPUT 5 *					
2201	CONOUT5	Contact Output (default is Non-critical Alarm)	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		0 (DEFAULT)
2202	CO5IN1	Configurable Output 5, Input 1	0 to 64, 101 to 164, step 1		0

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 9 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
2203	CO5IN2	Configurable Output 5, Input 2	0 to 64, 101 to 164, step 1		0
2204	CO5IN3	Configurable Output 5, Input 3	0 to 64, 101 to 164, step 1		0
2205	CO5IN4	Configurable Output 5, Input 4	0 to 64, 101 to 164, step 1		0
2206	CO5IN5	Configurable Output 5, Input 5	0 to 64, 101 to 164, step 1		0
2207	CO5IN6	Configurable Output 5, Input 6	0 to 64, 101 to 164, step 1		0
2208	CO5IN7	Configurable Output 5, Input 7	0 to 64, 101 to 164, step 1		0
2209	CO5IN8	Configurable Output 5, Input 8	0 to 64, 101 to 164, step 1		0
RINITOUT – RECLOSE INITIATE / CONFIGURABLE OUTPUT 6 *					
2301	CONOUT6	Contact Output (default is Reclose Initiate)	0 (DEFAULT), 1 (ORGATE), 2 (ANDGATE)		0 (DEFAULT)
2302	CO6IN1	Configurable Output 6, Input 1	0 to 64, 101 to 164, step 1		0
2303	CO6IN2	Configurable Output 6, Input 2	0 to 64, 101 to 164, step 1		0
2304	CO6IN3	Configurable Output 6, Input 3	0 to 64, 101 to 164, step 1		0
2305	CO6IN4	Configurable Output 6, Input 4	0 to 64, 101 to 164, step 1		0
2306	CO6IN5	Configurable Output 6, Input 5	0 to 64, 101 to 164, step 1		0
2307	CO6IN6	Configurable Output 6, Input 6	0 to 64, 101 to 164, step 1		0
2308	CO6IN7	Configurable Output 6, Input 7	0 to 64, 101 to 164, step 1		0
2309	CO6IN8	Configurable Output 6, Input 8	0 to 64, 101 to 164, step 1		0
RECLOSER – RECLOSER SETTINGS					
2401	SELRCLR	Select Recloser Scheme	0 (DEFAULT), 1 (OFF), 2 (1-TPOLE), 3 (2-TPOLE)		0 (NONE)
2402	NOT USED				

* See Table 9–11 for Index assignment.

Table 9–10: DLP-C SETTINGS GUIDE (Sheet 10 of 10)

SETTING		DESCRIPTION	RANGE		DEFAULT
NO.	MNEMONIC		5 A RATED UNIT	1 A RATED UNIT	
2403	TRPDLY1	Reclose Delay 1	0.01 to 2.55 seconds, step 0.01		2.55 sec.
2404	RDLY2	Reclose Delay 2	0.01 to 2.55 seconds, step 0.01		2.55 sec.
2405	HOLD	Hold Mode	YES, NO		NO
2406	HOLDDLY	Hold Time Delay	1 to 255 sec., step 1		1 sec.
2407	DWELLTM	Dwell Time Delay	0.1 to 2.0 sec., step 0.1		1.0 sec.
2408	RSTDLY	Reset Time Delay	1 to 255 sec., step 1		255 sec.

* See Table 9–11 for Index assignment.

Table 9–11: INPUT CONDITION CODE TABLE (Sheet 1 of 2)

INPUT CONDITION	RELAY TEST NO.	CONFIGURATION INPUT NO.	CONDITION DESCRIPTION CODE
ZONE 1 AG	2	1	Z1 AG
ZONE 1 BG	3	2	Z1 BG
ZONE 1 CG	4	3	Z1 CG
ZONE 2 AG	5	4	Z2 AG
ZONE 2 BG	6	5	Z2 BG
ZONE 2 CG	7	6	Z2 CG
ZONE 3 AG	8	7	Z3 AG
ZONE 3 BG	9	8	Z3 BG
ZONE 3 CG	10	9	Z3 CG
ZONE 4 AG	11	10	Z4 AG
ZONE 4 BG	12	11	Z4 BG
ZONE 4 CG	13	12	Z4 CG
ANY ZONE 1 GRND	14	13	Z1 GRN
Z2 GND.TIMR,TL2G	15	14	Z2GTMR
Z3 GND.TIMR,TL3G	16	15	Z3GTMR
Z4 GND.TIMR,TL4G	17	16	Z4GTMR
ZONE 1 AB	18	17	Z1 AB
ZONE 1 BC	19	18	Z1 BC
ZONE 1 CA	20	19	Z1 CA
ZONE 2 AB	21	20	Z2 AB
ZONE 2 BC	22	21	Z2 BC
ZONE 2 CA	23	22	Z2 CA
ZONE 3 AB	24	23	Z3 AB
ZONE 3 BC	25	24	Z3 BC
ZONE 3 CA	26	25	Z3 CA
ZONE 4 AB	27	26	Z4 AB
ZONE 4 BC	28	27	Z4 BC
ZONE 4 CA	29	28	Z4 CA
ANY ZONE 1 PHASE	30	29	Z1 PHS
Z2 PHASE TIMER (TL2P)	31	30	Z2PTMR

NOTE: Add 100 to the configurable input number to use as a NOT input.

Table 9–11: INPUT CONDITION CODE TABLE (Sheet 2 of 2)

INPUT CONDITION	RELAY TEST NO.	CONFIGURATION INPUT NO.	CONDITION DESCRIPTION CODE
Z3 PHASE TIMER (TL3P)	32	31	Z3PTMR
Z4 PHASE TIMER (TL3P)	33	32	Z4PTMR
IT DETECTOR	34	33	IT DET
IB DETECTOR	35	34	IB DET
GRD DIR TRIP (IPT+NT)	36	35	GRDTRP
GRD DIR BLOCK(IPB+NB)	37	36	GRDBLK
FAULT DETECTOR (FD)	38	37	FLTDET
REM OP DETCT (ROD)	39	38	REMOPN
OUT OF STEP (OSB)	40	39	OUTSTP
V1 DETECTOR	41	40	V1 DET
LINE OVERLOAD	42	41	LNOVLD
INST PHS OVRC, PH4 (50P)	43	42	INPOVR
INST GND OVRC (IDT)	44	43	INGOVR
TIM DLY GD OC (TOC)	45	44	TMGOVR
LINE PICKUP	46	45	LPCUP
FUSE FAILURE		46	FUSEFL
GRND FORWARD (NT)		47	GR FWR
GRND REVERSE (NB)		48	GR RVR
RCLOSE CANCL (RC)		49	RECCAN
CONFIG INPUT 1		50	CNFIN1
CONFIG INPUT 2		51	CNFIN2
CONFIG INPUT 3		52	CNFIN3
NON-CRITICAL ALARM		53	NOCALM
ANY Z2 PH.OR GND.		54	ANY Z2
ANY Z3 PH.OR GND.		55	ANY Z3
ANY Z4 PH.OR GND.		56	ANY Z4
TRIP BUS/BFI		57	TRPBFI
MAN CLOSE (BRKR.1)		58	BKCLS1
MAN CLOSE (BRKR.2)		59	BKCLS2

NOTE: Add 100 to the configurable input number to use as a NOT input.

Table 9–12: PASSWORD ENCRYPTION KEY

MMI	DECODED	MMI	DECODED	MMI	DECODED
(up)	P	:	J	Q	\$
!	T	;	N	R	(
"	X	<	C	S	,
\$	Q	=	G	T	!
%	U	>	K	U	%
&	Y	?	O	V)
(R	@	0	W	-
)	V			X	"
*	Z	A	4	Y	&
,	S	B	8	Z	*
-	W	D	1	[.
		E	5	\	#
1	D	F	9]	'
2	H	H	2	^	+
3	L	I	6	_	/
4	A	L	3		
5	E	M	7		
6	I	P	(up)		
7	M				
8	B				
9	F				

NOTE: The third column is for factory use only.

9.7.1 DESCRIPTION

The required pin-to-pin connections for the cable that connects the printer to plug PL2 on the back of the DLP3 is shown in Figure IN-2A. Virtually any ASCII character printer may be used provided it contains a serial interface. In addition, the printer's serial interface must be programmable to 1200 baud, 8 character bits, 1 stop bit, and no parity. The printer's handshaking mode must be set to either XON/XOFF or DTR Ready. **The DLP3 printer port (plug PL2) is fixed at 1200 baud.** The DLP3 setting COMMPORT affects the baud rate of the RS232 port (plug PL1) but not the printer port.

9.7.2 RECOMMENDED PRINTER

If the printer is to be installed permanently at the DLP3 location, then the following RADIX thermal printer is recommended because of its temperature range specification.

a) RADIX PRINTER ORDER INFORMATION**Table 9–13: RECOMMENDED PRINTER DATA**

PART NO.	DESCRIPTION	VENDOR
100700.001	FP40 Printer	RADIX
100890.001	FC401 Single unit battery charger	RADIX
105050.000	FC405 Multi-unit battery charger (optional)	RADIX
0246A9866 P2	GE PRINTER CABLE	GE
Printer Paper	8" paper for Radix FP40	Lord Label

ADDRESS: RADIX Corporation (Printer)
4855 Wiley Post Way
Salt Lake City, UT
84116

PHONE #: 800-453-5195

ADDRESS: Lord Label & MFG. (Paper)
3435 W. Madison
Skokie, IL
60076

PHONE #: 800-621-9301

9.8.1 HARDWARE JUMPERS

There are two factory-installed hardware jumpers in the MMI module (see MODULES section) set to inhibit the ability to perform the Remote Manual Trip function, the Remote Manual Close function, the Remote Change DLP3 Settings function, the Remote Disable Outputs function, and the Remote Enable Outputs function.

These hardware jumpers will need to be removed to perform the above functions.

CAUTION: Power Down the relay, with the power switch or by removing a connection plug, before removing or inserting modules. Failure to do so can permanently damage the relay.

The hardware jumpers for DLP with keypad are defined as follows:

Hardware Jumper J1 = Manual Trip and Manual Close functions.

Hardware Jumper J2 = Change DLP Settings, Disable Outputs and Enable Outputs functions.

Hardware Jumper J3 = Spare (not used)

The hardware jumpers for DLP without keypad are defined as follows:

Hardware Jumper J1 = Manual Trip and Manual Close functions.

Hardware Jumper J2 = Display Passwords.

Hardware Jumper J3 = Baud Rate.

9.8.2 MODEM CONNECTIONS & SETTINGS

When establishing communication between the DLP3 and a remote PC, two modems connected via a phone line are required; one modem is located at the DLP3 and the other modem is located at the PC. The cable that connects the modem with either the DLP3 or the PC is shown in Figure 9–3: DLP3 COMMUNICATIONS (2 OF 2). Each of these modems must be "Hayes-compatible", meaning that they must accept configuration commands first developed by Hayes. This is necessary since the DLP-LINK communications software that runs on the PC sends a Hayes-compatible command string to the modem located at the PC. The DLP3 does not send any configuration commands to its modem. **Both the DLP3 modem and the PC modem must be uniquely configured to permit the user to log into and communicate with the DLP3 using DLP-LINK software.**

The required configuration settings are presented as changes to the factory-default configuration settings for a Hayes V-Series 2400 SmartModem. These default settings are:

B1	&C0	S0=0	S37=0	E1	&D0	S6=2	S38=20	L2
&G0	S7=30	M1	&J0	S8=2	N1	&K3	S9=6	&L0
S10=14	Q0	P	&P0	S11=95	V1	&Q5	S12=50	W0
&R0	S18=0	X4	&S0	S25=5	Y0	&T4	S26=1	&X0
S36=1								

Other "Hayes-compatible" modems may implement a subset of the full Hayes command set. **It is the responsibility of the user to ascertain 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 manual of your modem for an explanation of this syntax.

a) PC MODEM

The PC modem must be configured for "intelligent" operation (i.e., command recognition enabled). For the Hayes V-Series 2400 SmartModem, this setting is made via an internal jumper. The default settings listed above are valid for DLP-LINK. Those configuration settings critical to the operation of DLP-LINK are changed by DLP-LINK. The configuration commands sent to the modem from DLP-LINK are:

```
+++ (set modem to command mode)
(delay 2 seconds)
ATE0L0Q0S7=60V0X4Y0 (see explanation following)
```

Command explanation:

- 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 features represented by result codes
- Y0 - disable long space disconnect
- S7=60 - allows modem to hang up if connection is not made within 60 sec.

The command S7=60 is present starting in version 1.05 of DLP-LINK. Earlier versions of DLP-LINK do not execute this command, leaving the time out at the default value, which is typically 30 seconds.

If any of the above commands are not programmable, then the modem will not operate properly. In addition to the required configuration settings listed above, it is suggested that two other settings be made by the user. These are:

- &D3 - causes the modem to reset on the ON-to-OFF transition of DTR (Data Terminal Ready)
- &C1 - causes DCD (Data Carrier Detect) to track the received carrier signal

The modem will operate properly without making these two settings but the modem will not hang up if the appropriate handshaking signal is lost.

A DLP-LINK setting establishes the baud rate, which must match the baud-rate setting of the DLP3. DLP-LINK will then set the specified PC serial port (i.e., 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.

b) DLP3 MODEM

The DLP3 modem must be configured for "dumb" operation (i.e., command recognition disabled). For the Hayes V-Series 2400 SmartModem, this setting is made via an internal jumper. Since the DLP3 does not send any configuration commands to its modem, the required configuration settings must be made prior to connecting the modem to the DLP3. **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 by making all the required settings via switches or saving the settings in non-volatile memory.

The required configuration settings are:

- E0 - disable command state echo
- L0 - low speaker volume (advisable - not necessary)
- Q1 - disable result code display
- &C1 - causes DCD (Data Carrier Detect) to track the received carrier signal
- &D3 - causes the modem to reset on the ON-to-OFF transition of DTR (Data Terminal Ready)
- &Q0 - asynchronous mode
- S0=1 - enable auto-answer

If any of the above settings cannot be implemented, the modem may not answer, the DLP3 may not connect properly, or the user may not be able to log into the DLP3.

With a Hayes V-Series 2400 SmartModem or equivalent, the DLP3 modem will perform a modulation handshake with the PC modem to set the baud rate of the DLP3 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 preferable to use identical modems at each end.

Note that auto-answering is controlled with register S0. S0=0 disables auto-answer. S0=1 will cause the DLP3 modem to answer the incoming call after one ring. S0 can be set for any value between 1 and 255, for the Hayes modem assumed here, if it is desirable to delay modem answering. Note that DLP-LINK (version 1.05 or

higher) configures the PC modem to wait 60 seconds for the DLP3 modem to answer. If the DLP3 modem register S0 is set higher than 12, the PC modem may time out and hang up before the DLP3 modem can answer. S0=12 means that the DLP3 modem will answer after twelve rings and corresponds approximately to the 60 second delay (S7=60) at the PC modem, however the user should verify the number of rings that correspond to 60 seconds for a particular application.

The table below is a listing of the modem command set required to communicate to the DLP3 from a remote PC.

Table 9–14: MODEM SETUP CRITERIA (HAYES COMPATIBLE)

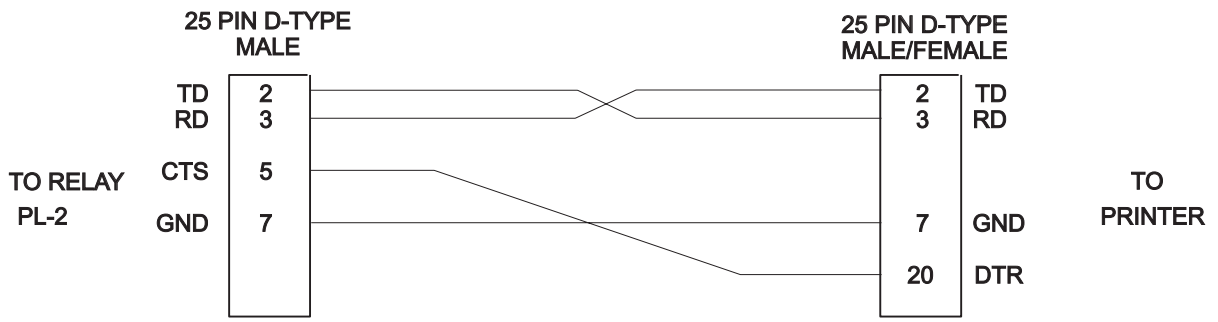
FUNCTION	DLP3 MODEM (REMOTE)	PC MODEM (LOCAL)
DTR Status	Follow DTR (&D3)	Follow DTR (&D3)
Result Code Format	Numeric (V0)	Numeric (V0)
Result Code Display	Disable (Q1)	Disable (Q1)
Command State Echo	Disable (E0)	Disable (E0)
Auto-answer	Enable (S0=1)	Disable (S0=0)
Carrier Detect	Follow CD (&C1)	Follow 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	Modem Reset (&D3)	Modem Reset (&D3)
Pulse Dial Ratio	39%Mk/61%Bk (&P0)	39%Mk/61%Bk (&P0)

9.8.3 CONNECTION TO GNET (OPTIONAL)

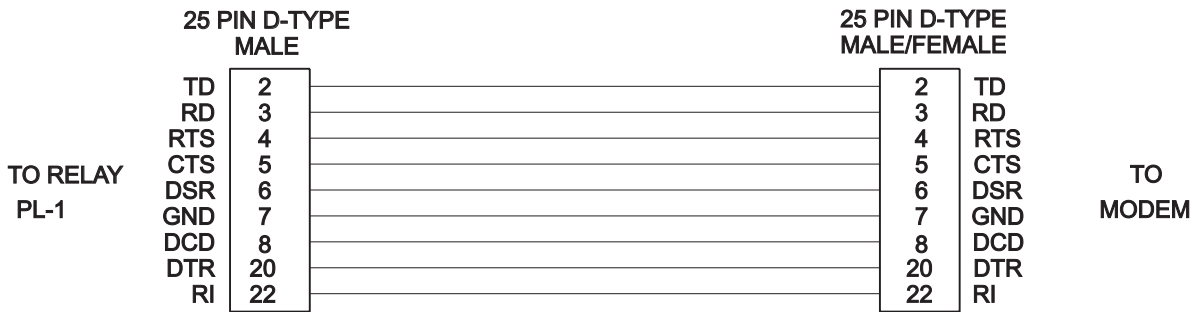
The GNET host computer provides a complete communication package to send and retrieve information automatically from the DLP3. The pin-to-pin connections to the GNET host are shown in Figure IN-2E). Refer to the GNET Instruction Book (GEK-100642) for complete information on GNET Host Computer cable connections and operation.

9.8.4 NULL MODEM CONNECTIONS

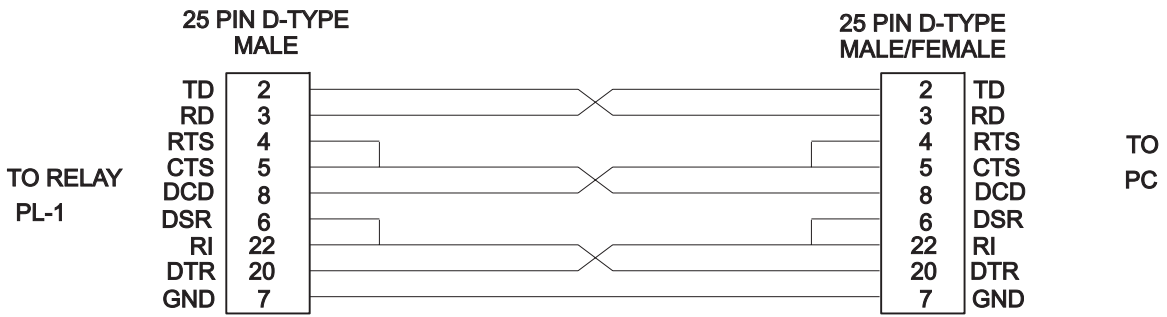
A PC can be connected to a DLP3 without the intervening modems and phone line by using a special cable called a "null modem" cable. The required pin-to-pin connections for the 25-pin-terminal null modem cable to the relay PL1 connection are shown in Figure IN-2C). The pin-to-pin connections for a 9-pin-terminal null modem cable to connector Comm on the MMI are shown in Figure IN-2D). Neither null modem cable should exceed 50 feet in length.



A) PRINTER CONNECTIONS

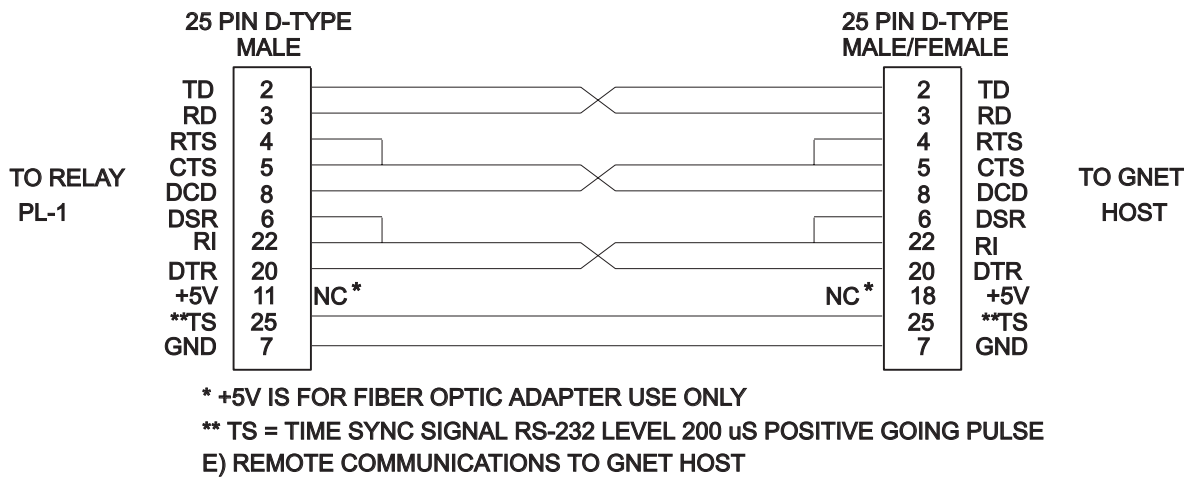
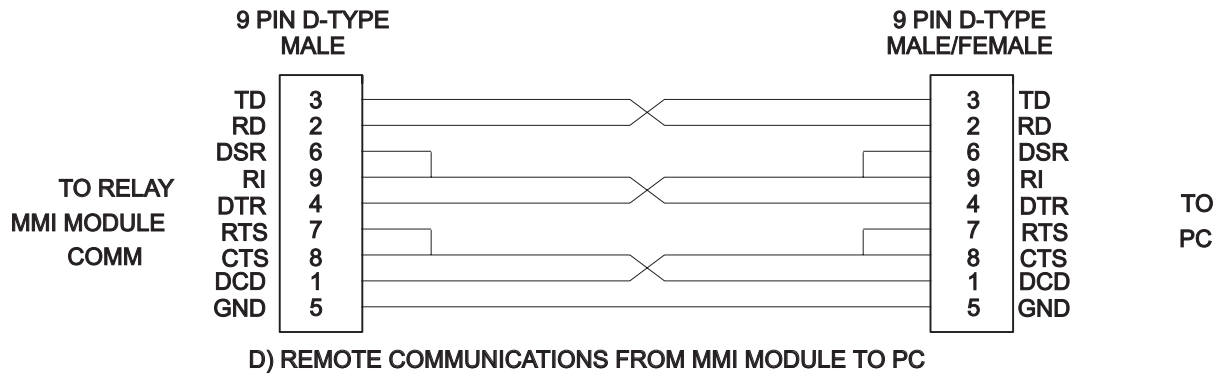


B) REMOTE COMMUNICATIONS VIA MODEM CABLE



C) REMOTE COMMUNICATIONS TO PC DIRECTLY

Figure 9-2: DLP3 COMMUNICATIONS (1 OF 2)



CABLES AVAILABLE UNDER GE PART NO. 0246A9866. SPECIFY CABLE TYPE AND CONNECTOR GENDER.

Figure 9-3: DLP3 COMMUNICATIONS (2 OF 2)

9.9.1 DESCRIPTION

The pin-to-pin connections for the cable connecting the ASCII port to plug PL-2 on the back of the DLP3 are shown in Fig 8-6A. 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 DLP3 COM-MPORT setting affects both the baudrate of the RS232 ports and the ASCII port PL-2.

9.9.2 RECOMMENDED COMMUNICATIONS PACKAGES

The following programs have been tested and known to support the the ASCII interface on the DLP3. Note that almost any communications package that emulates a TTY type terminal should communicate successfully.

Description	Vendor
Procomm Plus	Datastorm
Windows Terminal Program	Microsoft

9.10.1 DESCRIPTION

In the lower right-hand corner of the MMI module there is a toggle switch labelled MLO to put the recloser into manual lockout. With that switch in the ON position, the recloser will go into manual lockout and stay there until the switch is placed in the OFF position. While it is in the OFF position, the recloser will operate according to the 52B switch received from the breaker.

10.1.1 OVERVIEW

A personal computer (PC) provides a remote man-machine interface to the DLP3 for operating personnel.

10.1.2 SYSTEM REQUIREMENTS**a) HARDWARE**

The minimum PC hardware requirements consists of the following components. An IBM-AT or compatible with one parallel port, a minimum of 400 kbytes of free memory (RAM) for running the program, 40 MB hard drive, low density 3¹/₂-inch floppy drive, EGA monitor, and one of the printers described below for plotting oscillography data.

b) SOFTWARE

MSDOS (PCDOS) 3.1 or higher is required for the PC operating system.

10.1.3 INSTALLATION

View the file README.TXT for updated information and installation instructions for this program. This file is found on the 3¹/₂-inch floppy disk located at the end of this manual.

10.1.4 PROGRAM STARTUP

Start the program using the DLP-Link INSTALL.BAT file. Do not use the DLP-Link .EXE file.

10.2.1 MOUSE/KEYBOARD

Either the mouse or the keyboard can be used to access all items in menus, dialog boxes, and list boxes, as described below. Note that a mouse is required for full manipulation of graphical data. A mouse is used to access items in menus and dialog boxes by moving the cursor to the item, followed by pressing and then releasing the left mouse button (clicking).

10.2.2 MAIN HORIZONTAL MENU BAR

Items in the main horizontal menu are selected in one of three ways:

1. Position the mouse cursor on top of the menu item and click the left button.
2. Use a hot key. The hot key is the combination of the ALT key and the letter that is highlighted in the item description (blue).
3. After either of the above methods has been used to select an item on the menu, indicated by one item being highlighted, the ← and → keys can be used to move to adjacent menu items. If the menu is not visible just below the highlighted item on the menu bar use the ↓ key to display the menu.

10.2.3 PULL-DOWN MENUS

Pull-down menu items are selected with either the mouse or keyboard.

- *Mouse* – Position the mouse cursor on the menu item, then click the left button once to display the pull-down menu. To select an item in the pull-down menu, position the cursor on the desired item and click on the left mouse button. Both may be done at once by positioning the cursor over the menu item on the menu bar and holding the left mouse button down, moving the mouse cursor to the desired entry and then releasing the mouse button.
- *Keyboard* – To activate a hot key and activate the associated menu or dialog box, hold the ALT key and strike the highlighted key. If there is no hot key for a desired menu item, use the ↑ and ↓ keys to highlight the desired item, then press the ENTER key, which activates the associated menu or dialog box.

10.2.4 DIALOG BOXES

Dialog boxes are generally characterized by a title bar, a grey box, and OK and CANCEL buttons. The dialog box cannot be moved, resized, or converted to an icon. In addition, only items in the dialog box can be accessed, not any other items on the screen.

If an item in the dialog box has a title with a highlighted character (blue in the default color scheme), this item is accessed from the keyboard by holding the ALT key and pressing the highlighted character (the hot key). Items in a dialog box can also be accessed from the keyboard by using the cursor keys: ↑, ↓, ←, →, PAGE UP, PAGE DOWN, TAB, and SHIFT-TAB keys. In any dialog box the TAB key moves the highlighted item sequentially in one direction and the SHIFT TAB key in the opposite direction. The other cursor keys generally move within a selected item.

Buttons in the dialog box can be accessed from the keyboard with the ↑, ↓, TAB, and SHIFT-TAB keys, or if the button has a highlighted character, the hot key. If a selection is required, it is made with the ENTER key.

To exit from the dialog box and clear it from the screen, select either the OK or CANCEL button.

- *Mouse* – Move the cursor over the screen button and click the left mouse button.
- *Keyboard* – Use the hot keys: ALT-O for OK and ALT-C for CANCEL.

The mouse can be used to select any item in a dialog box by moving the cursor to the desired item and clicking the left mouse button.

The OK button accepts selection(s) made in the dialog box and allows the program to use these selections. The CANCEL button reverts the program to the previous selections. Any highlighted button can be selected by striking the ENTER key.

10.2.5 LIST BOXES

A list box contains all choices for an item in a dialog box (for example, a list of file names). If the list of available entries is longer than the displayed list box, the list box has a vertical scroll bar, on the right side of the list box, for scrolling through the list.

To operate a scroll bar with the mouse, place the tip of the arrow cursor in the gray hatched area or on the arrows at the top and bottom of the scroll bar and click on the left mouse button. If the arrow cursor is in the grey hatched area, then the contents of the list box move a section at a time. If the mouse cursor is on one of the arrows at the top or bottom, the contents of the list box move one line at a time. Holding down the mouse button repeats movement until the mouse button is released or the end of the list is reached. When the desired item can be seen, click on the item with the left mouse button to select and highlight the item.

To operate the scrolling of the list box with the keyboard, use the PAGE UP and PAGE DOWN keys to move the contents of the list box a section at a time and the ↑ and ↓ keys to move the contents one line at a time. Holding keys down repeats the movement in the list box until the key is released. When the desired item can be seen, use the ↑ and ↓ keys to select and highlight it.

Following are the valid keys and their functions for list boxes:

↑ – Move up one selection.

↓ – Move down one selection.

PAGE UP – Move up one page of selections.

PAGE DOWN – Move down one page of selections.

HOME – Move to the first selection.

END – Move to the last selection.

RETURN – Accept the current selection and exit the list box.

ALT-X – Exit the list box without making a selection.

10.2.6 ENTERING TEXT & NUMBERS

The following keys are used when entering and editing text and numbers.

← – Move the cursor one character to the left.

→ – Move the cursor one character to the right.

DELETE – Delete the character at the cursor.

BACKSPACE – Delete the character to the left of the cursor.

INSERT – Toggle between the insert and overwrite mode.

- Overwrite mode is indicated by an underscore-character cursor.
- Insert mode is indicated by a block-character cursor.

ENTER – Accept the text or number in the field or box

ESCAPE – Clear the text or number in the field or box.

The first keystroke other than the arrow keys clears the field or box; thus the box does not have to be cleared before a new entry. If a minor change is desired and you do not wish to clear the field or box, move the cursor first and then do the editing to the entry.

10.3.1 MAIN MENU

The main horizontal menu has the following items and hot keys:

- Relay Functions – ALT-R
- Local Functions – ALT-L
- Setup – ALT-S
- Help – ALT-H

Each item in the main horizontal menu has a pull-down menu associated with it.

10.3.2 RELAY FUNCTIONS

Relay functions includes the menu items listed below with their associated hot key combinations.

Menu Item	Hot Key
<u>L</u> ogin	ALT-L
<u>L</u> ogout	ALT-O
<u>C</u> hange access level	ALT-C
<u>H</u> ang up phone	ALT-H
<u>A</u> ctions...	ALT-A
<u>I</u> nformation...	ALT-I
<u>S</u> ettings...	ALT-S
<u>T</u> OC...	ALT-T

a) LOGIN

Login provides access to the relay. When logging into a DLP3 for the first time, you must use the factory password. In this case, the only commands available at the PC are to change the password and to logout. Change from the factory password to a new password by selecting **change Password** from the **Actions...** menu item in the **Relay functions** pull-down menu. The encoded Communications password can *only* be viewed locally, on the MMI.

The **Login** dialog box contains a list of the currently configured DLP3s, a place to enter the password, a place to enter the unit ID, a button for adding a new DLP3 to the configured DLP3 list, an OK button, and a CANCEL button.

The list of currently configured DLP3s contains the unit description, phone number, baud rate, and multiplexor switch code for each DLP3.

The NEW RELAY button in the dialog box is for adding a relay to the list of configured relays. Enter the unit description, the phone number, the multiplexor switch code, and the phone number for the new relay.

When a relay is selected from the list of relays, the software asks for the password and the unit ID. Neither of these is echoed on the screen. Enter this information, then select **OK** to log in to the relay. Any of the three passwords for Communications can be used to log in to the relay. (See Chapter 9: INTERFACE.) The password entered determines the access level available. For example, if settings changes will be performed, then

the password should be the Settings access password. Another method is to use the View access password to log into the DLP3, then change the access level when settings changes are needed. See the description of **Change access level** below.

b) LOGOUT

Logout disables access to the relay. A check is made to determine the status of protection at the DLP3 (**ON** or **OFF**), which is displayed in the dialog box. Select **OK** to complete logging out or **CANCEL** to remain logged in to the relay. If the status of protection is **OFF** due to a setting change that was not ended, select **CANCEL** and choose **End settings change** under **Settings** in the **Relay Functions** menu.

c) CHANGE ACCESS LEVEL

Select **Change access level** to enter another password so that the settings can be changed, actions can be performed, or to restrict access to viewing only. The access level is displayed on the bottom line of the display.

To choose **Change access level**, move the mouse cursor to the item and click on it or press the hot key ALT-C. A dialog box appears with space to enter a password. Change the access level by entering a password for one of the other levels, then selecting **OK** by clicking on it or with the ALT-O hot key. The new level is displayed at the bottom of the screen. Select **CANCEL** to exit **Change access level** without changing the level.

The table below contains operations performed by DLP-LINK and the associated password level required to perform the operation. All items can be viewed at any level, but can only be changed with the proper access level displayed.

DLP-LINK Operation	Access Level
Change Password	Any
Trip Breaker	Master
Close Breaker	Master
Enable Outputs	Master
Disable Outputs	Master
Change Time and Date	Settings, Master
Change Station/Line ID	Settings, Master
Calculate CRC	Any
Relay Test	Master
Digital Output Test	Master
Channel Test	Master
Perform Settings Changes	Settings, Master

d) HANG UP PHONE

Hang up phone disconnects the phone line at the modem. If you are logged into the relay, the logout procedure is completed before the phone is hung up. To pick this selection, click on the menu item or press the hot key ALT-H.

The **Actions...** menu item displays the additional choices listed below

Action Item	Hot Key
change <u>P</u> assword	ALT-P
<u>M</u> anual trip	ALT-M
manu <u>a</u> l <u>C</u> lose	ALT-C
<u>E</u> nable outputs	ALT-E
<u>D</u> isable outputs	ALT-D
change <u>T</u> ime and date	ALT-T
change <u>S</u> tation/line ID	ALT-S
c <u>A</u> lculate CRC	ALT-A
<u>R</u> elay test mode	ALT-R
digital <u>O</u> utput test	ALT-O
cha <u>N</u> nel test	ALT-N

- **change Password** – Select this item to change the password in the DLP3. The valid password characters are A to Z, 0 to 9, and space. The factory password contains one or more characters that are not valid for subsequent password use. The Communications password can only be viewed on the MMI, in encrypted form, therefore it is *important* to keep a record of the password in a safe place.

First enter the present password. If this password is valid, next enter the new password. If the new password is valid, enter the identical new password again as confirmation. Select **OK**, after which you are asked to confirm the change. Select **OK** again to change the password.

- **Manual trip** – Select this item to trip the breakers manually. If two breakers are controlled by the DLP3, each must be tripped individually. Note that the breakers cannot be tripped if the appropriate jumper is installed (see Chapter 4 for a description of the jumpers). To select **Manual trip**, click on the menu item or press the hot key ALT-M.

Select the breaker to trip with the ↑ and ↓ keys or by clicking on the breaker selection. Select **OK**, after which you are asked to confirm the action. Select **OK** again to trip the breaker and return to the previous screen. Select **CANCEL** to return to the breaker-selection dialog box without tripping the selected breaker. Select **CANCEL** in the breaker-selection dialog box to return to the **Actions...** menu.

- **manual Close** – Select this item to close the breakers manually. If two breakers are controlled by the DLP3, each must be closed individually. Note that the breakers cannot be closed if the appropriate jumper is installed (see Chapter 4 for a description of the jumpers). To select **manual Close**, click on the menu item or press the hot key ALT-C.

Select the breaker to close with the ↑ and ↓ keys or by clicking on the breaker selection. Select **OK**, after which you are asked to confirm the action. Select **OK** again to trip the breaker and return to the previous screen. Select **CANCEL** from the confirmation dialog box to return to the breaker-selection dialog box without closing the selected breaker. Select **CANCEL** from the breaker-selection dialog box to return to the **Actions...** menu.

- **Enable outputs** – Select this item to energize the DLP3 outputs. Note that the digital outputs cannot be enabled remotely if the appropriate jumper is installed (see Chapter 4 for a description of the jumpers on the MMI board). To select **Enable outputs**, click on the menu item or press the hot key ALT-E.

Select the **CANCEL** button to return to the **Actions...** menu. Select **OK** to display another dialog box to confirm the action. Select **OK** again to enable the outputs. If **CANCEL** is selected, there is no change in the status of the digital outputs and the `_previous` menu is redisplayed.

- **Disable outputs** – Select this item to inhibit the DLP3 from energizing any of the relay outputs except the four Alarm Outputs. Note that the digital outputs cannot be disabled if the appropriate jumper is installed (see Chapter 4 for a description of the jumpers on the MMI board). To select **Disable outputs**, click on the menu item or press the hot key ALT-D.

Select **CANCEL** to return to the **Actions...** menu. Select **OK** to display another dialog box to confirm the action. Select **OK** again to disable the outputs. If **CANCEL** is selected, there is no change in the status of the digital outputs, and the previous menu is redisplayed.

- **change Time and date** – Select this item to set the time and date in the DLP3. Changing the time and date through this menu does not affect the time and date in the PC.

First the DLP3's current time and date is displayed. The time is displayed in the format HH:MM:SS (for example: 10:55:09). The date is displayed in the format MM/DD/YY (for example: 07/16/90). You may then edit the time and date. Select **OK** to confirm the action and change the time and date in the DLP3.

- **change Station/line id** – This dialog box displays the station and line ID for the relay. The IDs can be up to 32 characters long and must be all printable characters. To change an ID, select the desired ID with the TAB key or by clicking on it. When the correct ID has been selected, use the insert, delete, and backspace keys to edit and enter data. After the correct ID has been entered, select **OK**, after which you are asked to confirm the IDs. Select **OK** again to send the IDs to the DLP3.

Select **CANCEL** in the confirmation dialog box to return to the dialog box with the Station and Line IDs. Select **CANCEL** in the Station/Line ID dialog box before sending the IDs to the relay to exit the dialog box without sending the IDs to the DLP3. Select **CANCEL** after sending the IDs to the relay to simply return to the **Actions...** menu.

- **calculate CRC** – Select this item to recalculate the settings CRC code in nonvolatile RAM. Select **calculate CRC** by clicking on the menu item or by pressing the ALT-A hot key. A dialog box is displayed that contains only **OK** and **CANCEL** buttons. Select **CANCEL** at any time to return to the **Actions...** menu. For further information see SERVICING.

Select **OK** to display another dialog box to confirm the action. Again select **OK** to recalculate the settings CRC code and send all the settings back to the PC. In addition, a message is displayed to verify all settings.

NOTE: If settings have been uploaded previous to executing this command and have not been saved to a disk file or downloaded, they will be lost.

If **CANCEL** is selected, the CRC value is not recalculated and the previous dialog box is redisplayed.

- **Relay test mode** – Select this item to test the relay functions of the DLP3. Select **Relay test mode** by clicking on the menu item or by pressing the ALT-R hot key. The test functions are displayed in a list box. Since there are 46 test entries in the list box, only a few will be seen at one time. To find the desired test, use the PAGE UP and PAGE DOWN and the ↑ and ↓ keys or use the mouse on the scroll bar.

Select the desired test function by clicking on it or pressing the ENTER key when the correct test has been highlighted. Select **OK** to display another dialog box to confirm the test. Select **OK** again to put the relay in test mode for the selected test. Select **CANCEL** to stop the test and return to the previous dialog box.

Select **CANCEL** in the dialog box with the list of tests to return to the **Actions...** menu box. To put the relay back in operating mode, select **End test mode** from the list of tests.

- **digital Output test** – Select this item to perform digital output tests in the relay. The tests are displayed in a list box. To perform this test, jumper J1 on the microprocessor board must be removed. See Chapter 4 for information on removing the jumper.

Select the test to perform, then select **OK**. A dialog box appears to confirm the test. Again select **OK** to put the relay in test mode with protection **OFF** and perform the test. To put the relay back in operating mode, select **End test mode**.

- **chaNnel test** – Select this item to key (turn on) the local transmitter when a channel scheme is used. To select **chaNnel test**, either click on it or press the ALT-N hot key.

A dialog box is displayed with the choice of starting or stopping the test with the **START** or **STOP** radio buttons. Use the TAB key until the selected radio button is highlighted or click directly on the desired button. Once the Start/Stop choice is made, select **OK** to display another dialog box to confirm that the channel test is to be performed. Select **CANCEL** to return to the **Actions...** menu box.

Select **OK** to display another dialog box to confirm the channel test. Select **OK** again to either start or stop the channel test, depending on which radio button was selected from the previous dialog box. Select **CANCEL** to stop the action and return to the previous dialog box. Select **CANCEL** from the **chaNnel test** dialog box to return to the **Actions...** menu.

10.3.4 INFORMATION

The **Information...** menu item displays the additional choices listed below

Information Item	Hot Key
request <u>P</u> resent values	ALT-P
request fault report <u>I</u> dentification	ALT-I
request <u>F</u> ault report	ALT-F
request <u>E</u> vents	ALT-E
request <u>O</u> scillography data	ALT-O
request dlp <u>S</u> tatus	ALT-S
request dlp <u>M</u> odel	ALT-M
request <u>L</u> ine/station id	ALT-L
request MMI p <u>A</u> ssword	ALT-A

- **request Present values** – Select this item to display, print, or file the present values. To select this menu item, either click on it or press the ALT-P hot key. A dialog box appears with three independent choices for displaying, printing, and filing the present values. To change any of the three choices, either click on it or press the TAB key to highlight the selection and the space bar to change it. An X in the brackets indicates that choice has been selected. One must be chosen for the present values to be retrieved from the relay.

To save the report in a file, enter a file name in the box that is displayed. Either move the mouse cursor to the box and click on it or press the TAB key to highlight the box, then enter the filename and press the ENTER key.

After all the choices have been made, click on **OK** or use the ALT-O hot key to retrieve the report from the relay. Select **CANCEL** to return to the **I**nformation menu without any further action.

If the report is displayed, when finished either click on the small box in the upper left corner or use the ALT-F4 hot key (F4 refers to the Function key F4, not the F key followed by the 4 key.). When the present values have been cleared from the screen, the **Present values** dialog box is redisplayed. Use the ALT-C hot key or click on **CANCEL** to exit **Present values**.

NOTE: Phase angles go from 0° to 180° or –1° to –179°, and are referenced to Phase A voltage (VA). VA must be present for this function to operate. Currents and voltages are RMS values and are either primary or secondary, as selected with setting 1505. Status is reported only for the number of breakers and carrier sets present in the configuration.

- **request fault report Identification** – Select this item to display and/or print the identification of each fault report, including the time, date, and trip type for each fault.

To select this menu item, either click on it or press the ALT-I hot key. A dialog box appears with three independent choices for displaying, printing, and filing the present values. To change any of the three choices, either click on it or use the TAB key to highlight the selection and the space bar to change it. An X in the brackets indicates that choice has been selected. One must be chosen for the fault report identifications to be retrieved from the relay.

To save the report in a file, enter a file name in the dialog box. Either click on the box with the mouse or use the TAB key to highlight the box, then enter the file name and press the ENTER key.

After all the choices have been made, click on **OK** or press the ALT-O hot key to retrieve the identifications from the relay. Select **CANCEL** to return to the Information menu without any further action.

If the identifications are displayed, when finished either click on the small box in the upper left corner or use the ALT-F4 hot key (F4 refers to the Function key F4, not the F key followed by the 4 key). When the identifications have been cleared from the screen, the **fault report Identification** dialog box is redisplayed. Use the ALT-C hot key or click on **CANCEL** to exit.

- **request Fault report** – Select this item to display, print, and/or file a fault report and its associated events. To select this menu item, either click on it or use the ALT-F hot key. A dialog box appears with three independent choices for displaying, printing, and filing the present values. To change any of the three choices, either click on it or press the TAB key to highlight one of the selections and the ↑ and ↓ keys to choose one of the three choices. An X in the brackets indicates that choice has been selected. Press the space bar to change any of the choices. At least one must be chosen for the fault report to be retrieved from the relay. Enter the fault report number (from 1 to 14) in the box supplied on the first line of the **Fault report** dialog box.

To save the report in a file, enter a file name in the dialog box. Either click on the box with the mouse or use the TAB key to highlight the box, then enter the file name and press the ENTER key.

After all the choices have been made, click on **OK** or use the ALT-O hot key to retrieve the fault report from the relay. Select **CANCEL** to return to the Information menu without any further action. To clear the fault report from the screen, if it has been displayed, either click on the small box in the upper left corner or use the ALT-F4 hot key (F4 refers to the Function key F4, not the F key followed by the 4 key). When the fault report has been cleared from the screen, the **Fault report** dialog box is redisplayed. Use the ALT-C hot key or click on **CANCEL** to exit.

The voltages are displayed with units of V if they are secondary or kV if the voltages are primary. You may scroll the screen to view the events associated with the fault. To scroll through the report, press the PAGE UP and PAGE DOWN keys or place the mouse on the ↑ or ↓ on the scroll bar and press the left mouse button. Click the left mouse button to move one line in that direction or hold the button down to scroll continuously. The events are displayed with the most recent event last.

- **request Events** – Select this item to display, print, and/or file the events stored in the relay. To select this menu item, either click on it or use the ALT-E hot key. When this item is selected, a dialog box appears with three independent choices for displaying, printing, and filing the present values. To change any of the three choices, either click on it or press the TAB key to highlight one of the selections and the ↑ and ↓ keys to

choose one of the three choices. An X in the brackets indicates that choice has been selected. Use the space bar to change any of the choices. At least one must be selected for the events to be retrieved from the relay.

To save the report in a file, enter a file name in the dialog box. Either click on the box with the mouse or use the TAB key to highlight the box, then enter the file name and press ENTER.

After all the choices have been made, click on **OK** or use the ALT-O hot key to retrieve the events from the relay. Select **CANCEL** to return to the Information menu without any further action.

Events are displayed chronologically, starting with the most recent event. If there are more events than can be displayed on one screen, a scroll bar appears on the left side of the box. Press the PAGE UP and PAGE DOWN keys or use the mouse on the scroll bar to see the other events.

To clear the events from the screen, if they have been displayed, either click on the small box in the upper left corner or press the ALT-F4 hot key (F4 refers to the Function key F4, not the F key followed by the 4 key). When the events have been cleared from the screen the Events dialog box will be redisplayed. Press the ALT-C hot key or click on **CANCEL** to exit.

NOTE: If dc power is removed for more than 24 hours, all event information will be lost.

- **request Oscillography data** – Select this item to save the oscillography data for a particular fault on disk. To select this menu item either click on it or press the ALT-O hot key. A dialog box appears with spaces to enter the fault number and file name. To change one of the entries, click on it or press the TAB key to highlight one of the selections. Then use the editing keys to enter and/or change the information in the selected box or field. The fault number associated with the oscillography data (1 to 14) and the file name for the data must be supplied before the oscillography data is retrieved from the relay.

After the file name and fault number have been entered, click on **OK** or press the ALT-O hot key to retrieve the oscillography data from the relay. The fault report, the events associated with the fault report, the settings in effect at the time of the fault, and the data are saved to the specified file.

The oscillography data is an ASCII text file consisting of the fault report, the events associated with the fault report, the settings, the currents, the voltages, the digital inputs, digital outputs, and protection flags. This file can be read directly by Lotus 1-2-3, without any modification, by importing the data as numbers rather than text.

NOTE: If dc power is removed for more than 24 hours, the oscillography data will be lost.

- **request dlp Status** – Select this item to display, print, and/or file the DLP3 status. To select this menu item either click on it or press the ALT-S hot key. A dialog box appears with three independent choices for displaying, printing, and filing the present values. To change any of the three choices, either click on it or press the TAB key to highlight one of the selections and the ↑ and ↓ keys to select one of the three choices. An X in the brackets indicates that choice has been selected. Use the space bar to make any changes. At least one must be selected for the status to be retrieved from the relay.

To save the report in a file, a file name must be entered in the box supplied. To enter the file name, click on the box or press the TAB key to highlight the box. Then enter the filename and press ENTER.

After all the choices have been made, click on **OK** or press the ALT-O hot key to retrieve the status from the relay. Select **CANCEL** to return to the Information menu without any further action. To clear the status from the screen, if it has been displayed, either click on the small box in the upper left corner or press the ALT-F4 hot key (F4 refers the Function key F4, not the F key followed by the 4 key). When the status has been cleared from the screen, the **Status** dialog box is redisplayed. Press the ALT-C hot key or click on **CANCEL** to exit.

Status messages are displayed in the same order as those at the DLP3 (described in SERVICING).

- **request dlp Model** – Select this item to display, print, and/or file the DLP3 model and PROM version number. To select this menu item, either click on it or use the ALT-M hot key. A dialog box appears with three independent choices for displaying, printing, and filing the present values. To change any of the three

choices, either click on it or press the TAB key to highlight one of the selections and the ↑ and ↓ keys to choose one of the three choices. An X in the brackets indicates that choice has been selected. Press the space bar to change any of the choices. At least one must be selected for the data to be retrieved from the relay.

To save the report in a file, a file name must be entered in the box supplied. To enter the file name, click on the box or press the TAB key to highlight the box. Then enter the filename and press ENTER.

After all the choices have been made, click on **OK** or use the ALT-O hot key to retrieve the model and PROM version from the relay. Select **CANCEL** to return to the Information menu without any further action. To clear the model and version from the screen, if they have been displayed, either click on the small box in the upper left corner or press the ALT-F4 hot key (F4 refers the Function key F4, not the F key followed by the 4 key). When the model and version have been cleared from the screen, the **Model** dialog box is redisplayed. Use the ALT-C hot key or click on **CANCEL** to exit.

- **request Line/station id** – To select this menu item, either click on or press the ALT-L hot key. A dialog box displays the station and line ID of the relay from which information is being uploaded. Both the station ID and line ID can only be viewed with this item. To change the station ID and line ID select **Change station/line id** from the **Actions...** menu. When finished viewing the IDs, select **OK**.
- **request mmi pAssword** – To select this menu item, either click on it or press the ALT-A hot key. The dialog box displays the MMI passwords in encrypted form. These are the passwords to be used at the MMI, not the Communications password used with DLP-LINK. The MMI passwords can only be viewed from this item and can only be changed at the MMI keypad. For more information see Chapter 9: INTERFACE. When finished viewing the passwords, select **OK**.

10.3.5 SETTINGS

The **Settings...** menu displays the additional choices listed below.

Settings Item	Hot Key
U <p>pload dlp settings</p>	ALT-U
P <p>rint dlp settings</p>	ALT-P
v <u>iew/change C</u> ategory of settings	ALT-C
v <u>iew/change I</u> ndividual settings	ALT-I
D <u>ownload</u> changed settings to dlp	ALT-D
E <u>nd</u> settings change	ALT-E
S <u>ave</u> settings to file	ALT-S

- **Upload dlp settings** – This menu item uploads the settings from the DLP3. To select this menu item, click on it or press the ALT-U hot key. a dialog box asks for the desired group of settings. Enter the group and select **OK**. Select **CANCEL** to return to the **Settings** menu.

When a group has been selected, all the settings for the group are uploaded and the functions that can be performed in the **Settings** menu are displayed.

If the access level is not Settings, the option to **Download changed settings to the DLP** is not available.

- **view/change Category of settings** – Select this item to change or view one or all of the settings in a category. To select this menu item, click on it or press the ALT-C hot key. A list box of category names is displayed. Select a category to view or change with the mouse or the ↑ and ↓ keys followed by ENTER. When

a category has been chosen, select **OK** to display a dialog box with the settings in the category. Select **CANCEL** to return to the **Settings...** menu.

The dialog box for this category consists of a list box containing the settings, the usual **OK** and **CANCEL** buttons, a box for a setting number to be entered, and a box for the setting value to be changed. The TAB key selects any of the above items in the list box. The ↑ and ↓ keys and PAGE UP and PAGE DOWN keys display any unseen settings. A setting can be selected by clicking on it or by highlighting it with the cursor keys and pressing ENTER. After the setting has been selected, it can be changed in the box marked **Setting Value**.

After all the settings changes have been completed, select **OK** to save the settings changes and return to the **Settings** menu. Select **CANCEL** at any time to return to the **Settings** menu without any further action.

If the access level is not Settings, the option to **Download changed settings to the DLP** is not available.

- **view/change Individual settings** – Select this item to change or view one setting at a time. To select this item, either click on it or press the ALT-I hot key. A dialog box appears containing a field to enter a setting number, a list box containing all the settings for the DLP3, a field to enter a new setting value for a selected setting, and an informational field with the valid range for the setting value. Each of the different items can be selected with the TAB key or by clicking on it.

Select a setting to change with the field labeled **Enter setting number**. Use the editing keys to enter and/or change the contents of the field. When a setting number has been entered, followed by ENTER, the list box scrolls to the setting and the cursor appears in the setting value box. Enter a setting value and press ENTER.

The list box labeled **Setting list** contains a list of all the settings. To scroll to a setting that is not displayed, use the PAGE UP and PAGE DOWN keys or the ↑ and ↓ keys or click on the scroll bar on the far-right side of the list box.

The field labeled **Enter setting value** is used to enter a new value for the selected setting. The value is checked to ensure that it is in the allowed range. The allowed range is specified in the field labeled **Setting range**. When a setting value is changed, the word **Changed** is displayed in the list box next to the setting.

Select **OK** to save the setting changes. Select **CANCEL** to return to the **Settings** menu without any further action.

If the access level is not Settings, the option to **Download changed settings to the DLP** is not available.

- **Download changed settings to dlp** – Select this item to transmit all the changed settings to the DLP3. Note that if the appropriate jumper is installed, the DLP3 will not allow setting changes from the PC. See *Chapter 8* for more information on the jumpers.

Select **Download** by clicking on it or by pressing the ALT-D hot key to display a dialog box with the changed settings. To end the settings change automatically, either click on the box or press the TAB key to highlight the selection and press the SPACE BAR to select it. Press the SPACE BAR or click the left mouse button again to deselect the option.

The group number must be set correctly to ensure the desired group of settings is changed. The default is the group that was uploaded from the relay. If another group is to be selected, the item can be chosen by pressing the TAB key or by clicking on the box that contains the group number. The cursor moves to that box. Use the normal editing keys to change the group number. The acceptable group numbers are 1, 2, 3 and 4.

Select **CANCEL** to redisplay the **Settings** menu with no further action. Select **OK** to display another dialog box to confirm that the settings are to be downloaded. Select **OK** again to send the changed settings; the changes are ended if the automatic end settings option was chosen. Select **CANCEL** so that no settings are sent and to redisplay the **Download settings** dialog box.

- **End setting changes** – Select this item after downloading settings to tell the DLP3 that settings changes are complete and protection should use the new settings. (If the option to end settings changes automati-

cally was picked when downloading settings to the DLP3, this menu item need not be selected again.) To select this menu item, click on it or press the ALT-E hot key. A dialog box is displayed containing only the **OK** and **CANCEL** buttons. To end the settings changes, select **OK**. Select **CANCEL** to return to the **Settings** menu. If **CANCEL** is selected before the settings changes are ended, then the new settings are not used.

Select **OK** to display another dialog box to confirm the choice to end the settings changes, since protection will be enabled with the new settings. Select **OK** to end the setting changes. Select **CANCEL** in the confirmation dialog box to reactivate the previous dialog box.

- **Save dlp settings to file** – Select this item to write the settings to a disk file. To select this item, click on it or press the ALT-S hot key. Enter a file name (which may also include a path) in the field labeled **Enter file name**. Select **OK** to save the settings in the specified file. Select **CANCEL** to return to the **Settings** menu without saving the settings.

The contents of the settings file are raw numbers; there is no description of the contents in the file because it is used for input to the program. Use **Print dlp settings** in the **Settings** menu under **Local functions** for a description of the settings.

10.3.6 TOC MENU

The **TOC...** menu displays two additional choices.

- **Download TOC curve** – Select this item to download a TOC curve to the relay from a disk file. A dialog box appears containing several fields, including a list of files in the current directory and a list of disk drives and subdirectories. A file may be selected either by entering a file name in the field labeled **File name** or from the list box labeled **Files**.

The **File name** field contains the file that is currently selected. Select it to specify a file containing TOC values (a file previously created by the **Upload TOC curve** menu item discussed below or by the program DLPTOC) or enter a partial file name using the standard DOS wild card characters * and ?. The field labeled **Directory** indicates the current drive and directory from which the list of files is obtained. This field cannot be edited.

The list box labeled **Files** contains a list of files in the current directory from which a file can be selected. The list box labeled **Directories** contains a list of subdirectories and drives containing additional lists of files.

Select **OK** to download a TOC curve to the relay from the selected file.

- **Upload TOC curve** – Select this item to upload, into DLP-LINK, the TOC curve from the relay and write the values to a disk file. Enter a file name (which may include a path) in the field labeled **Enter file name**. Select **OK** to upload the TOC curve and save the values in the specified file.

The field marked **File name** contains the file that is currently selected. This field may be selected to specify a file containing TOC values (a file previously created by the **Upload TOC curve** menu item or by the DLP-TOC program) or enter a partial file name using the standard DOS wild card characters * and ?. The field labeled **Directory** indicates the current drive and directory where the list of files is obtained. This field cannot be edited.

The list box labeled **Files** contains a list of files in the current directory from which a file can be selected. The list box labeled **Directories** contains a list of subdirectories and drives where additional lists of files can be found.

Select **OK** to upload a TOC curve from the relay to the selected file.

10.3.7 LOCAL FUNCTIONS

Local functions includes the menu items listed in below with their associated hot key combinations.

Menu Item	Hot Key
S <u>ettings...</u>	ALT-S
G <u>raph oscillography data</u>	ALT-G
C <u>ustom TOC curves</u>	ALT-C
go to <u>D</u> OS	ALT-D

a) SETTINGS

The **Settings...** menu under **Local functions** displays the additional choices listed below.

Settings Items	Hot Keys
L <u>oad settings from file</u>	ALT-L
P <u>rint local settings</u>	ALT-P
view/change <u>C</u> ategory of local settings	ALT-C
view/change <u>I</u> ndividual local setting	ALT-I
S <u>ave local settings to file</u>	ALT-S
<u>M</u> odel/version number	ALT-M
station/ <u>L</u> ine id	ALT-L
<u>D</u> ownload local settings to dlp	ALT-D
<u>E</u> nd setting changes	ALT-E

- **Load settings from file** – Select this item to read settings from a disk file into the program as local settings. To select this item, either click on it or press the ALT-L hot key. Selecting this item displays a dialog box containing several fields, including a list of files in the current directory and a list of disk drives and sub-directories. Either enter a file name in the field labeled **File name** or select a file from the list box labeled **Files**.

If a set of local settings is loaded, the previous set of local settings is overwritten and lost, unless they were as saved with the **Save local settings to file** menu item from the **Settings...** menu.

The **File name** field contains the file that is currently selected. This field may be selected to specify a file containing settings (a file previously created by the **Save local settings to file** menu item or the **Save dlp settings to file** menu item) or enter a partial file name using the standard wildcard characters * and ?.

The field labeled **Directory** indicates the current drive and directory from which the list of files is obtained. This field cannot be edited.

The list box labeled **Files** contains a list of files in the current directory from which a file may be selected. The list box labeled **Directories** contains a list of subdirectories and drives containing additional lists of files.

Select **OK** to read the local settings from the selected file.

- **Print local settings** – Select this item to print all settings or categories of settings. To select this item, click on it or press the ALT-P hot key. A list box is displayed with the category names, plus one additional item for printing all categories.

Select the desired category of settings to print. To select a category that is not displayed, press the PAGE UP and PAGE DOWN and ↑ and ↓ keys or use the mouse in the scroll bar or on the arrows at each end. The highlighted item in the list box is the one that is selected. Select **OK** to print the settings.

The settings are printed by category, with one setting name and value per line.

- **view/change Category of local settings** – Select this item to change or view one or all of the settings in a category. To select this menu item, click on it or press the ALT-C hot key. A list box of category names is displayed. Select a category to view with the mouse or the ↑ and ↓ keys followed by the ENTER key. After a category has been chosen, select **OK** to display a dialog box with the settings in the category. Select **CANCEL** to return to the **Settings** menu.

The dialog box for the category contains a list box with the settings, the **OK** and **CANCEL** buttons, a box for entering a setting number, and a box for changing the setting value. The TAB key selects any of the items in the list box. The ↑ and ↓ keys and the PAGE UP and PAGE DOWN keys move the contents to display the settings outside the view window. A setting can be chosen to be changed by highlighting it with the cursor keys and then pressing ENTER or by clicking on it. After the setting has been selected it can be changed in the box marked **Setting Value**.

After all the settings changes have been completed, select **OK** to save the settings changes and return to the **Settings** menu. Select **CANCEL** at any time to return to the category names dialog box without any further action.

- view/change Individual local setting – Select this item to change or view one setting at a time. To select this item, either click on it or press the ALT-I hot key. A dialog box is displayed containing a field to enter a setting number, a list box containing all the settings for the DLP3 from the saved-settings file, a field to enter a new setting value for a selected setting, and an informational field with the valid range for the setting value. Each of the different items can be selected with the TAB key or by clicking on it.

Select a setting to change in the field labeled **Enter setting number**. Use the editing keys to enter and/or change the contents of the field. When a setting number has been entered, press ENTER, then the list box scrolls to the setting and places the cursor in the setting value box. Press ENTER after entering a setting value.

The **Setting list** list box contains a list of all the settings. To scroll to a setting that is not displayed, use the PAGE UP and PAGEDOWN keys and the ↑ and ↓ keys or use the mouse cursor in the scroll bar on the far right side of the list box.

Enter a new value for the selected setting in the field labeled **Enter setting value**. The value is checked to ensure it is in the allowed range; the allowed range is specified in the field labeled **Setting range**. When a setting is changed, the word **Changed** is displayed in the list box next to the setting.

Select **OK** to save the setting changes. Select **CANCEL** to return to the **Settings** menu without any further action.

- **Save local settings to file** – Select this item to write the settings to a disk file. To select this item either click on it or press the ALT-S hot key. Enter a file name (it may include a path) in the field labeled Enter file name. Select **OK** to save the settings in the specified file. Select **CANCEL** to return to the **Settings** menu without any further action. Select **CANCEL** after saving the settings to a file to return to the **Settings** menu.
- **Model/version number** – Select this entry to display the model number and PROM firmware revision that match the settings. To select this item, either click on it or press the ALT-M hot key. These numbers must match any relay to which you wish to send the local settings. If they do not match, the local settings download will fail.

- **station/Line ID** – Select this entry to display the station and line IDs of the relay from which the settings were retrieved. These IDs can be used to identify the relay matching the settings in the file. This menu item is selected by clicking on it or by pressing the ALT-L hot key.
- **Download local settings to DLP3** – This item appears on the menu only if the Communications access level is Settings. Select this item to transmit all the local settings to the DLP3. To select this item, either click on it or press the ALT-D hot key. You must be logged in to a DLP3 in order to use this menu item. Note that if the appropriate jumper is installed, the DLP3 will not allow setting changes from the PC (see MODULES for more information on the jumpers). The local settings file firmware revision must match the PROM version number in the relay or the settings download will fail.

A dialog box is displayed with a list box of all the settings being downloaded and a selection in the lower right corner to end the settings changes automatically. To select the automatic end of settings change, either click on it or press the TAB key to highlight it and the space bar to change it. If an X appears in the brackets it has been selected.

To download the settings to the relay, select **OK** with the mouse or the ALT-O hot key. To exit download at any time select **CANCEL**. Select **OK** to display another dialog box to confirm the download. To continue the download process select **OK** again. If the settings are not to be downloaded, select **CANCEL**. Select **CANCEL** in the **Download** dialog box to exit.

- **End setting changes** – Select this item to tell the DLP3 that settings changes are complete and protection should be re-enabled. This item is not necessary if the option to automatically end settings changes was selected when the settings were downloaded. To select this item either click on it or use the ALT-E hot key.

A dialog box containing the **OK** and **CANCEL** buttons is displayed. Select **OK** to end setting changes or **CANCEL** to exit **End setting changes** without any further action. If **OK** was selected, another dialog box is displayed to confirm the ending of setting changes. Select **CANCEL** to return to the previous dialog box without ending the setting changes. Select **OK** to end the settings changes. Select **CANCEL** to exit.

b) GRAPH OSCILLOGRAPHY DATA

- **Graph Oscillography Data** starts the optional program DL-DATA (if present). This enables graphing of oscillography data without leaving DLP-LINK. Enter the DOS path for the DL-DATA program. The path is entered from the **Setup** menu (see below) and is stored for later use.

c) CUSTOM TOC CURVES

- **Custom TOC curves** starts the program DLPTOC. This enables customizing overcurrent-time curve data without leaving DLP-LINK. The data can then be downloaded to the relay. Enter the DOS path for the DLP-TOC.exe program. The path is entered via the **Setup** menu, and is stored for use here.

d) GO TO DOS

- Select **go to DOS** to temporarily leave DLP-LINK and go to the DOS prompt to execute DOS commands. Any program or command that can run in the available memory can be executed. To return to the program, type EXIT at the DOS prompt.

The **Setup** menu has the items listed in below with their associated hot keys.

Menu Item	Hot Key
<u>C</u> ommunication port number	ALT-C
<u>D</u> ial Type	ALT-D
<u>M</u> odem connection time	ALT-M
<u>R</u> elay parameters	ALT-R
<u>A</u> dd relay to list	ALT-A
<u>dE</u> lete relay from list	ALT-E
Set path for <u>D</u> L- <u>D</u> ATA	ALT-L
Set path for <u>I</u> OC curves	ALT-T
Memory available	N/A

a) COMMUNICATION PORT NUMBER

The communication port for the PC is chosen with this selection. To select this item, either click on it or press the ALT-C hot key. A dialog box containing the port number and IRQ number are displayed. The serial port that is connected to the DLP3, or the modem communicating with the DLP3, must be entered before logging into the relay. If the port chosen is not COM1 or COM2, the IRQ number for the port chosen must be entered. Use the TAB key to move between the port and IRQ fields and the buttons, or click on the desired field.

After a field has been selected, use the editing keys to change and/or enter data. When the port and IRQ numbers are correct, select **OK** to save the numbers. Select **CANCEL** to redisplay the **Setup** menu without any further action.

b) DIAL TYPE

To select this item, either click on it or use the ALT-D hot key. A dialog box containing the dialing type, either tone or pulse, is displayed. The ↑ and ↓ keys toggle between the tone and pulse choices. The TAB key moves between the selected dialing type and the **OK** and **CANCEL** buttons. Select **OK** to store the change. Select **CANCEL** to exit **Dial type** without any further action.

c) MODEM CONNECTION TIME

This item changes the time-out period that DLP-LINK waits for the modem to make a connection. To select this item, either click on it or press the ALT-M hot key. The modem connection time can be set for any time up to 999 seconds, as long as the modem accommodates that long a time-out period. This setting is useful for applications in which the modem is set to pick up after a large number of rings or if the phone system has a long delay in making the initial connection. Select **OK** to store the new time-out period. Select **CANCEL** to exit this item without any further action.

d) RELAY PARAMETERS

Select **Relay parameters** to change or view the communication parameters for a specific relay unit description. Select an entry in the list by clicking on it or by using the ↑ and ↓ keys to highlight the selection, then press ENTER.

After a relay unit description has been picked, another window appears with the phone number, switch code, baud rate, number of stop bits, and the parity for the selected relay unit description. Any of the entry values may be selected by clicking on it or using the TAB key to move between the items, and then using the ↑ and ↓ keys to select the value for that item. Select **OK** to accept the values in the dialog box and store them. Select **CANCEL** to exit the dialog box and use the previous values for the unit description.

Note that once a unit description has been picked, there are no more hot keys available to select items. The TAB key may be used to move from item to item, or the mouse may be used to select a specific item at any time.

To enter or change the phone number, select it by clicking on it or press the TAB key to move the cursor to the phone number box. The normal text-editing keys may be used to enter or modify the phone number. This is an optional item, and should only be filled in if DLP-LINK is using a modem for the unit being described.

To enter or change the switch code, select it by clicking on it or press the TAB key to move the cursor to the switch code box. The normal text-editing keys may be used to enter or modify the phone number. This is an optional item, and should only be filled in if a code-operated switch is in use.

Baud rate must have a value selected. Select it by clicking on it or using the TAB key until it is highlighted. The ↑ and ↓ keys select the desired value, or a specific value can be selected by clicking on it directly.

A choice of one or two stop bits must be made for communications to work properly. Select the stop bits item can by clicking on it or by pressing the TAB key until it is highlighted. The ↑ and ↓ keys select the desired value, or a specific value can be selected by clicking on it directly.

Parity must have a value selected for communications to work properly. Select the parity item can by clicking on it or by pressing the TAB key until it is highlighted. The ↑ and ↓ keys select the desired value, or a specific value can be selected by clicking on it directly.

e) ADD RELAY TO LIST

Select this item to add a unit description and related values to the list of stored relay unit descriptions. Either select the entry in the menu with the mouse or use the hot key ALT-A. A prompt for a unit description then appears. The description is limited to 20 characters. After the description has been entered, select **OK** to accept it. Select **CANCEL** to from the menu entry with no further action.

After the new unit description has been accepted, a dialog box appears with the phone number, switch code, baud rate, stop bits and parity items. Each item can be selected with the TAB or SHIFT TAB key and a value chosen with the ↑ and ↓ keys, or a value can be chosen by clicking on it.

f) DELETE RELAY FROM LIST

This item deletes a relay unit description from the configuration file. To select this item, either click on it or use the ALT-E hot key. A dialog box is displayed containing a list box of all the relay unit descriptions and the **OK** and **CANCEL** buttons.

Select the desired relay from the list box displaying the unit descriptions with the ↑ and ↓ keys to highlight the desired relay and then pressing ENTER, or by clicking on the desired relay. Select **OK** to mark the unit description for deletion. Select **CANCEL** to exit without deleting any relay unit descriptions. If **OK** is selected, you are asked to confirm the deletion of the unit description. Select **OK** to delete the relay unit description. Select **CANCEL** to return to the list box without deleting any relay unit description. Select **CANCEL** in the dialog box to exit from the menu entry.

g) SET PATH FOR DL-DATA

DL-DATA (optional) can be started from DLP-LINK from the **Local functions** menu. The DOS path must first be set so DLP-LINK knows where to find the program. To set the path, select this menu item by clicking on it or by pressing the hot key ALT-L. A dialog box appears with space to enter a path. Select **OK** to accept the new path or **CANCEL** to exit without changing the previous path.

h) SET PATH FOR TOC CURVES

CUSTTOC (optional) can be started from DLP-LINK from the **Local functions** menu. The DOS path must first be set so DLP-LINK knows where to find the program. To set the path, select this menu item by clicking on it or by pressing the hot key ALT-T. A dialog box appears with space to enter a path. Select **OK** to accept the new path or **CANCEL** to exit without changing the previous path.

i) MEMORY AVAILABLE

Select this item to display the amount of available memory while DLP-LINK is running. Either click on it or use the ↑ or ↓ keys to highlight the menu item and press ENTER. There is no hot key for this item.

10.3.9 EXITING DLP-LINK

There are two ways to exit DLP-LINK, as follows:

- ALT-F4 displays a dialog box with the exit message. Select **OK** to exit DLP-LINK. Select **CANCEL** to return to the program.
- The ALT key combined with the space bar displays the System Menu after all menus have been cleared from the screen. Choose the **CLOSE** entry, with the mouse or the hot key ALT-C, to display a dialog box with the exit message. Select **OK** to exit DLP-LINK. Select **CANCEL** to return to the program without exiting.

NOTE: Before exiting DLP-LINK, all dialog boxes and list boxes must be cleared from the screen. It is not necessary to clear all the menus from the screen.

10.3.10 HELP

This item displays a pull-down menu with a selection of topics for which help exists. This menu is different in that the items do not have hot keys associated with them. Items are selected either by clicking on them or by pressing the ↑ and ↓ keys followed by the ENTER key.

10.4.1 OVERVIEW

This program plots oscillography data obtained during a fault and displays fault reports and fault events. The data displayed include currents, voltages, digital inputs, digital outputs, and protection flags.

The program obtains the oscillography data from a disk file in the PC that is created by the DLP-LINK program. Refer to the previous section for a description of how to retrieve oscillography data from the DLP3.

The updated version (V002.110B and later) of the DLP3 differs from previous versions as to which internal flags are stored as part of Oscillography data. Now, when a function is disabled, the associated flags are NOT stored. For example, if (101)SELZ1G = NO and (102)SELZ1P = NO, the zone 1 flags (indicating zone 1 operation or non-operation) are not stored. Previously, if these settings were both set to NO, the zone 1 flags were stored even though the zone 1 functions were disabled, and this feature caused some confusion, especially when appropriate reach or pickup settings were not used

The disk file containing the oscillography data is in ASCII format and is formatted in the following order:

1. The fault report (in the format that is displayed on the screen in the DLP-LINK program).
2. The events associated with the fault report (again, in the format that is displayed on the screen by DLP-LINK).
3. The title columns for a spread sheet.
4. The oscillography data. Each line in the file consists of one sample of data. Each sample has four currents (phase A, B, C and ground), three voltages (phase A, B, and C), and six flags. The flags contain the data listed in the following table.

NOTE: The updated version (V002.430C and later) of the DLP differ form previous versions as to which internal flags are stored as part of oscillography data. Now, when a function is disabled, the associated flags are NOT stored. For example, if (101) SELZ1G = NO and (102) SELZ1P = NO, the Zone 1 flags (indicating Zone 1 operation or non-operation) are not stored. Previously, if these settings were both set to NO, the Zone 1 flags were stored even though the Zone 1 functions were disabled – this feature caused some confusion, especially when appropriate reach or pickup settings were not used.

Table 10–1: OSCILLOGRAPHY FLAGS

FLAG	DESCRIPTION
1	DIGITAL INPUTS, SIX (CONTACT CONVERTERS)
2	DIGITAL OUTPUTS Breaker 1 trip, Breaker 2 trip Breaker failure initiate, Reclose initiate Reclose cancel, Start carrier, Stop carrier Breaker 1 close, Breaker 2 close Line overload, Non-critical alarm Critical alarm
3	PHASE ZONE FLAGS Zone 1 AB, Zone 1 BC, Zone 1 CA Zone 2 AB, Zone 2 BC, Zone 2 CA Zone 3 AB, Zone 3 BC, Zone 3 CA Zone 4 AB, Zone 4 BC, Zone 4 CA
4	BREAKER STATUS AND GROUND ZONE FLAGS Zone 1 AG, Zone 1 BG, Zone 1 CG Zone 2 AG, Zone 2 BG, Zone 2 CG Zone 3 AG, Zone 3 BG, Zone 3 CG Zone 4 AG, Zone 4 BG, Zone 4 CG Breaker trip, Reclose initiate Reclose cancel, Start carrier
5	PROTECTION LOGICAL INPUT FLAGS Overcurrent supervision for trip Overcurrent supervision for blocking Ground direction overcurrent trip Ground direction overcurrent block Out-of-step blocking Fuse failure Remote open detector Line overload Line pickup Ground instantaneous overcurrent Phase instantaneous overcurrent Ground time delay overcurrent Negative-sequence direction forward Negative-sequence direction reverse Fault detector
6	OUTPUT STATUS OF PROTECTION TIMERS POTT/PUTT coordination timer (TL4) Zone 2 phase timer (TL2P) Zone 2 ground timer (TL2G) Zone 3 phase timer (TL3P) Zone 3 ground timer (TL3G) Zone 4 phase timer (TL4P) Zone 4 ground timer (TL4G) Trip integrator timer (TL1) 'b' contact coordination timer, breaker 1 (TL5) 'b' contact coordination timer, breaker 2 (TL6) Timer (TL24), refer to logic diagrams Timer (TL101), refer to logic diagrams Timer (TL25), refer to logic diagrams Weak-infeed-trip timer (TL16)

10.4.2 SYSTEM REQUIREMENTS

a) HARDWARE

The minimum PC hardware requirements consists of the following components:

- An IBM-AT or compatible with one parallel port.
- Minimum of 450K of RAM in which to run the program.
- 40MB hard drive.
- Low-density 3¹/₂-inch floppy drive.
- EGA/VGA or better monitor
- A printer for plotting oscillography data.

b) SOFTWARE

- MSDOS (PCDOS) 3.1 or above is required as the PC operating system.

10.4.3 INSTALLATION

Copy all files from the distribution diskette to your hard drive using the DOS copy command.

10.4.4 GENERAL OPERATION

a) MOUSE AND KEYBOARD

Either a mouse or the keyboard can be used to access all items in menus and dialog boxes. However, a mouse is required for full manipulation of graphical data,.

A mouse is used to access items in menus and dialog boxes by pressing, then releasing the left mouse button (clicking).

b) MAIN HORIZONTAL MENU BARS

Items in the main horizontal menu are selected in one of three ways:

- Position the mouse cursor on top of the menu item and click the left button.
- Use a hot key. A hot key is the combination of the ALT key and the letter that is highlighted in the item description (yellow in the default colors).
- When an item on the menu has been selected, the → and ← keys can be used to move to adjacent menu items.

c) PULL-DOWN MENUS

Pull-down menus can be selected in the following ways:

- Position the mouse cursor on top of the menu item and click the left button.
- Position the mouse cursor on top of the menu item and press the left button. While holding the left button down, move the cursor to the desired menu item and release the button.
- Use a hot key. The hot key is the combination of the ALT key and the key highlighted (yellow in the default colors). This method is not available in the HELP pull-down menu.
- Use the ↑ and ↓ keys to highlight the desired menu item, then press ENTER.

10.4.5 WINDOWS

Windows have various parts of interest to the user. The title bar, which is displayed across the top of the window and has a small solid rectangle on the left side, contains the oscillography data file name and the date and time of the fault. The quit button is just below the title bar. Other parts are specific to the data being viewed.

Windows containing data plots (currents, voltages, flags) and reports can in general be resized and moved anywhere on the screen. When the mouse cursor is moved into the title bar, the cursor changes shape into a crosshair. To resize the window, hold the right mouse button down and drag the mouse until the window is the desired size, then release the button. To move the window, hold the left mouse button down and drag the mouse until the window is in the desired position, then release the button.

Windows can also be made into an icon (a small window just large enough to contain a title). Move the mouse cursor to the solid rectangle on the left of the title bar (the cursor changes shape to a left-pointing arrow) and click the left button. The window can later be restored to its last size and position by moving the mouse cursor over the icon and clicking the right button.

The window can be closed by moving the mouse cursor over the QUIT button (the mouse cursor changes shape to a left-pointing arrow) and clicking the left button. Alternatively, press ALT-Q to close the window.

A maximum of six windows can be placed on the screen at the same time, sized and positioned appropriately to view all of them.

10.4.6 DIALOG BOXES

Dialog boxes are generally characterized by a title bar (blue in the default colors), a grey box, and **OK** and **CANCEL** buttons. The dialog box cannot be moved, resized, or converted to an icon. In addition, when a dialog box is displayed, only items in the dialog box can be accessed and no other items on the screen.

If an item in the dialog box has a title with a highlighted character (yellow in the default colors), the user can access this item from the keyboard by using the ALT key with the highlighted character (the hot key).

Buttons in the dialog box can be accessed from the keyboard with the ↑ and ↓ keys, the TAB and SHIFT-TAB keys, or, if the button has a highlighted character, the hot key. If the buttons require a selection to be made, the selection is made with the ENTER key. A button that is not selected has the same color as the dialog box (grey), while button that is selected turns white. When a button is selected, it can be deselected by again pressing the ENTER key. The mouse can also be used to select and deselect buttons. When the mouse cursor is moved inside a button, it changes shape to a left-pointing arrow. At this point, click the left mouse button to select an item or click again to deselect.

To exit the dialog box and clear it from the screen, select either **OK** or **CANCEL**. The mouse can be used to select these buttons by moving the mouse cursor over the button (the cursor changes shape to a left pointing arrow) and clicking the left mouse button. In addition, the keyboard can be used to select these buttons by pressing their hot keys. The hot key for **OK** is ALT-O, while the hot key for **CANCEL** is ALT-C.

Select the **OK** button to accept the selection(s) and allow the program to use these selections. The **CANCEL** button cancels the new selections and the program retains the previous selections.

10.4.7 LIST BOXES

A list box appears within a dialog box and lists all entries a command could affect (for example, a list of file names). If the list of available entries is longer than the available space in the list box, there is a vertical scroll bar for scrolling through the list.

List boxes are accessed either with a mouse or the associated hot key and can be used entirely with a mouse or from the keyboard.

Following are the valid keys and their functions for list boxes:

- ↑ – Move up one selection.
- ↓ – Move down one selection.
- PAGE UP – Move up one page of selections.
- PAGE DOWN – Move down one page of selections.
- HOME – Move to the first selection.
- END – Move to the last selection.
- RETURN – Accept the current selection and exit the list box.
- ALT-X – Exit the list box without making a selection.

Click on the scroll bar to move through the selections. When the mouse cursor moves to the list of items in the list box, it changes shape to a left-pointing arrow. Click on an item to select that item. The current selection of a list box is highlighted (yellow in the default colors).

10.4.8 ENTERING TEXT & NUMBERS

The following keys are used when entering and editing text and numbers:

- ← – Move the cursor one character to the left.
- → – Move the cursor one character to the right.
- DELETE – Delete the character at the cursor.
- BACKSPACE – Delete the character to the left of the cursor.
- INSERT – Toggle between insert and overwrite mode. Overwrite mode is indicated by an underscore character for the cursor. Insert mode is indicated by a block character for the cursor.
- ENTER – Accept the text or number in the field or box
- ESCAPE – Clear the text or number in the field or box.

10.4.9 PLOTS OF CURRENTS, VOLTAGES, & FLAGS

Each window containing a plot of the currents and voltages and flags has several characteristics.

The predefault cycles are all in grey.

The y axis for currents and voltages is the magnitude of the currents and voltages. The y-axis has no specific meaning for the flags. The x-axis represents the sample number with sample number 0 being the origin of the x-axis.

There are two vertical bars through the graph that can be moved along the x-axis to get information on timing and, in the case of currents and voltages, the magnitudes of the currents and voltages. To move these vertical bars, place the left edge of the mouse cursor (the point of the left-pointing arrow) on the bar or on the box at the top of the bar, press and hold down the left mouse button, and move the mouse until the bar is in the desired position, then release. (See the figures at the end of this chapter.)

At the top of the window (just below the title line) is the area for displaying the sample numbers at the vertical bars. The time difference (in milliseconds) between the two bars is also displayed. The time difference is based on the line frequency. The magnitudes of the currents and voltages at each vertical bar are also displayed.

An area on the left of the window displays the range for the y-axis for currents and voltages and for displaying either the names of the flag groups or the individual flags in the group.

10.4.10 ZOOM

This feature allows enlargement of a rectangular area of a graph to show more detail. If the graph is currents and voltages, the area can include from one phase to all phases. If the graph is all of the flags, the area can include from one flag group to all flag groups on the display. If the graph is of flag groups, the area can include from one flag to all flags in the group.

To start the process, position the mouse cursor in one corner of the rectangular area to be expanded and click the right mouse button. The cursor changes shape to a cross hair. Then move the mouse in any direction to create a rectangle (yellow in the default colors). When satisfied with the rectangular area, click the left mouse button. A message box is displayed on the screen to verify the zoom or to cancel it. Press **CANCEL** to remove the rectangle and restore the screen. Select **OK** to zoom in on the rectangular area; a new window is created and the rectangular area is plotted. This window then can be manipulated in the same way as the previous window. In fact, the previous window is still there (under the new window). If the new window is resized smaller, then some portion of the previous window appears.

10.4.11 REPORTS

Report windows contain scroll bars on the right side. If the report is too long for the window, scroll through the report by clicking the left mouse button on the scroll bar.

10.4.12 MAIN MENU

The main menu has the following items and hot keys:

File – ALT-F

Graphs – ALT-G

Reports – ALT-R

Setup – ALT-S

eXit – ALT-X

F1=Help – F1

Each item in the main horizontal menu has a pull-down menu associated with it except for **eXit**.

10.4.13 FILE MENU

The file menu has the items and hot keys listed below.

Menu Item	Hot Key
<u>O</u> pen	ALT-O
<u>C</u> reate pcx file	ALT-C
<u>P</u> rint screen	ALT-P
<u>I</u> nformation	ALT-I

a) OPEN

Select this item to display a dialog box for selecting an oscillography data file. The file may be selected either by entering the file name in the data entry box or by using the left list box.

The first field in the dialog box, marked **Selected file**, contains the current file. Select this field by either clicking on it or by pressing the hot key, ALT-S, then enter a file name. The file name can consist of any characters acceptable to DOS, including wild card characters (* or ?). When the file name has been entered, press ENTER to accept the file name and move the cursor to the file name list box.

The next field indicates the current drive and directory from which the list of files is obtained. This field cannot be edited.

The next two fields are list boxes. The left list box, labeled **File list**, contains a list of files that can be selected. The right list box, labeled **Directory list**, contains a list of directories and drives containing additional lists of files.

Select the directory list box by either pressing the hot key, ALT-D, or by clicking inside the list box. When a new drive or directory is selected, both list boxes are rebuilt.

Select the file list box by either pressing the hot key, ALT-F, or by clicking inside the list box. When a file is selected, the file name is displayed in the data entry box above the list box and becomes the current file selection.

The last two fields are the **OK** and **CANCEL** buttons. Select **OK** to read the oscillography data file into the program and allow data plotting and report viewing. Select **CANCEL** to halt any further action.

b) CREATE PCX FILE

Select this item to display a dialog box for selecting the file to which the screen is to be saved in PCX format. The screen contents are saved without the main horizontal menu.

The first field in the dialog box, marked **PCX file** contains the file to which the screen is saved. Select this field either by clicking on the field or by pressing the hot key, ALT-P, then enter the file name. Press ENTER to accept the file name.

Select **OK** to save the screen to the specified file in PCX format. Selects **CANCEL** to halt any further action.

c) PRINT SCREEN

Select this item to display a dialog box to print the screen or to save it in a file that can be printed later. The screen is printed with the main horizontal menu.

The first item in the dialog box is a list box with the various types of printers that are supported. The printer type can be saved in the setup file, so that printer type need only be selected if the printer is changed.

The next item in the dialog box is a button that determines whether the printer performs a form feed after printing the screen. Leave the button in its unselected state for no form feed after printing. Select it to generate a form feed after printing. This item can also be saved in the setup file, so that it need only be selected once. The default is to generate a form feed after printing (selected state of the button).

Select a printer port (LPT1, LPT2, etc.) in the next field. The default is LPT1. If the printer is attached to LPT1, ignore this item. The printer port can also be saved in the setup file, so that it need only be selected once.

The next item saves the screen in a file for later printing. If this item is blank, the screen is not saved but is printed. If this item contains a file name (is not blank), the screen is saved in the file and not printed. The file can be printed later by entering the DOS command:

```
TYPE FILENAME > LPT1
```

The next item is the number of copies to be printed, which is always 1 unless it is changed. This item is ignored when the screen is saved to a file.

Select **OK** to print the screen or save it to a file, plus save the necessary items in the setup file. Select **CANCEL** to halt any further actions.

d) INFORMATION

Select this item to display a dialog box with the program name, version, and copyright notice and the amount of memory available to the program. The available memory must be at least 80K bytes for the program to run properly.

10.4.14 GRAPHS MENU

The Graphs menu has the items and hot keys listed below.

Menu Item	Hot Key
<u>A</u> ll currents/voltages	ALT-A
<u>S</u> elect currents/voltages	ALT-S
select <u>R</u> eference current/voltage	ALT-R
s <u>E</u> lect groups for all flags display	ALT-E
all <u>F</u> lags	ALT-F
flag <u>G</u> roup	ALT-G
<u>C</u> ustom (flag) group	ALT-C

When an item is selected for display, the same item cannot be selected again until it is cleared from the display by closing the window by pressing the **QUIT** button just below the title block.

Note: An item can be saved by converting it to an icon, which can be restored and saved as many times as necessary. This eliminates the need to close the window to view the item again.

a) ALL CURRENTS/VOLTAGES

This item plots all the currents and voltages in a single window.

Select Currents/Voltages

Select this item to display a dialog box for selecting specific phases of currents and/or voltages for display. Select from one current or voltage to all seven currents and voltages.

The cursor is positioned at the first button. Use the keyboard to move through the buttons and select the currents and/or voltages to plot, or click on the dialog box buttons to select or deselect the currents and voltages.

Select **OK** to display the selected currents and voltages; the selection remains in effect until the program is terminated. Select **CANCEL** to halt any further actions.

b) SELECT REFERENCE CURRENT/VOLTAGE

This item displays dialog box for selecting a reference current or voltage for display with the flags. Moved through the buttons with the keyboard to select the current or voltage or by clicking on the desired button. Select **OK** to maintain the selected reference in effect until the program is terminated. Select **CANCEL** to keep the previously selected reference in effect.

The default reference is Phase A current.

c) SELECT GROUPS FOR ALL FLAGS DISPLAY

Select this item to display a dialog box for selecting specific flag groups for the ALL FLAGS display. Select a maximum of six flag groups for a VGA display or a maximum of five flag groups for an EGA display.

The cursor is positioned at the first button. With the keyboard, move through the buttons to select the flag groups, or click on the dialog box buttons to alternately select and deselect the flag groups.

Select **OK** to change to the selected flag groups and save then in the setup file. Select **CANCEL** to retain the previous flag groups.

d) ALL FLAGS

This item displays all the flags in all the flag groups selected for display, along with the previously selected reference current or voltage. The number of flag groups that can be displayed is six for EGA or five for VGA. If a reference current or voltage has not been previously selected, the default is Phase A current.

e) FLAG GROUP

This item displays a dialog box for selecting a single group of flags for display. Select the group by clicking on it or by moving through the buttons with the keyboard. Select **OK** to display the selected group along with the previously selected reference current or voltage. Select **CANCEL** to halt any further actions.

f) CUSTOM (FLAG) GROUP

This menu item selects up to 16 flags from any of the flag groups and assigns them to a custom group. The custom flag group is saved in the setup file, so that once the flags are selected, they remain in the group until the group is reconfigured.

A dialog box is displayed with six list boxes (one for each flag group). Either the mouse or the keyboard can be used to select flags from any group in any order. The custom group is listed on the right side of the dialog box and is automatically updated as flags are selected and deselected.

Select **OK** to save the custom group, plot the flags, and return to the main menu. Select **CANCEL** to negate any changes made to the custom group and return to the main menu.

10.4.15 REPORTS MENU

The Reports menu has the items and hot keys listed below.

Menu Item	Hot Keys
Fault report	ALT-F
E <u>vents</u>	ALT-E
S <u>ettings</u>	ALT-S

Once an item is selected to be displayed, it cannot be selected again until it is cleared from the display by closing the window by selecting the QUIT button just below the title block.

Note: An item can be saved by converting it to an icon, which can be restored and saved as many times as necessary. This eliminates the need to close the window to be able to view the item again.

a) FAULT REPORT

Select this item to display the fault report associated with the oscillography data (the report is generated at the DLP3).

b) EVENTS

Select this item to display the events associated with the oscillography data (the events are generated at the DLP3).

c) SETTINGS

Select this item to display the settings from the relay at the time of the fault. The settings can only be viewed.

10.4.16 SETUP MENU

The Setup menu has the items and hot keys listed below.

Menu Item	Hot Keys
Line frequency	ALT-L
Flag names	ALT-F
Colors	ALT-C
Default colors	ALT-D
Printer grey shades	ALT-P

a) LINE FREQUENCY

Select this item to display a dialog box for selecting either 50 or 60 Hz for the line frequency. Select either frequency with the ↑ or ↓ keys or by clicking on the desired frequency button. Select **OK** to make the change permanent (saved in the setup file). Select **CANCEL** to ignore the change.

b) FLAG NAMES

Select this item to display a dialog box for modifying any of the flag names. The right list box contains the flag groups. The left list box contains the flag name to modify from the flag group selected in the right list box. The selected flag name is displayed in the data entry box, where it may be modified (it may be up to 13 characters long). When the name has been modified, press **ENTER** to display the new name in the left list box. Select **OK** to make the new flag names permanent (saved in the setup file) or select **CANCEL** to ignore any flag name changes.

c) COLORS

Select this item to display a dialog box for changing display colors. The colors are divided into groups according to the types of objects that are displayed. The groups and their descriptions are as follows:

- Horizontal Menu – Colors associated with the main horizontal menu.
- Pull-Down Menu – Colors associated with the pull down menus.
- Actions Button – Colors associated with buttons that cause an action, such as **QUIT**, **OK**, and **CANCEL**.
- Dialog Box – Colors associated with basic (empty) dialog boxes and labels placed in the dialog boxes.
- List Box – Colors associated with list boxes.
- Message Box – Colors associated with message boxes.
- Date-entry Box – Colors associated with data-entry boxes.
- Selection Button – Colors associated with selection buttons used to make selections in a dialog box.
- Window – Colors associated with basic (empty) windows (both the report and graph windows).
- Report – Colors associated with displaying reports in windows.
- Graph – Colors associated with drawing graphs.

- Graph Data – Colors associated with displaying data in graphs.
- Graph Label – Colors associated with displaying axis labels in graphs.

This item uses two dialog boxes. The color group is selected in the first dialog box, after which a second dialog box is displayed, in which the colors of individual items in the group can be modified. Select an item and press the SPACE bar to change the color of the item to the color in the color box in the upper right corner of the dialog box. A sample of the color group is displayed in the dialog box.

Select **OK** to make the new colors for the group permanent (saved in the setup file) or select **CANCEL** to ignore the new colors for the group. In either case, the first dialog box is redisplayed.

d) DEFAULT COLORS

Select this option to return all items back to their original colors and shades of grey (those on the distribution diskettes). A message box is displayed to confirm the change. Select **OK** to return to the default colors and grey shade, which are then saved in the setup file. Select **CANCEL** to retain the current color scheme.

e) PRINTER GREY SHADES

Select this item to display a dialog box for assigning shades of grey to colors so that all items on a display can be seen on the output of a black and white printer. Select the color from the list box and then press the indicated hot keys to select the button for the desired shade of grey. Select **OK** to make the changes permanent (saved in the setup file) or select **CANCEL** to ignore the changes.

Do not assign a shade of grey to BLACK, since then nothing will be printed.

10.4.17 EXIT

Select this item to exit to DOS. A message box is displayed to verify the choice. Select **OK** to exit the program; otherwise select **CANCEL**.

10.4.18 HELP

Select this item to display a pull-down menu with a selection of topics for which help exists. This menu is different from the other pull-down menus in that the items have no hot keys associated with them. Use either the mouse or the ↑ and ↓ keys, followed by ENTER, to access the menu items.

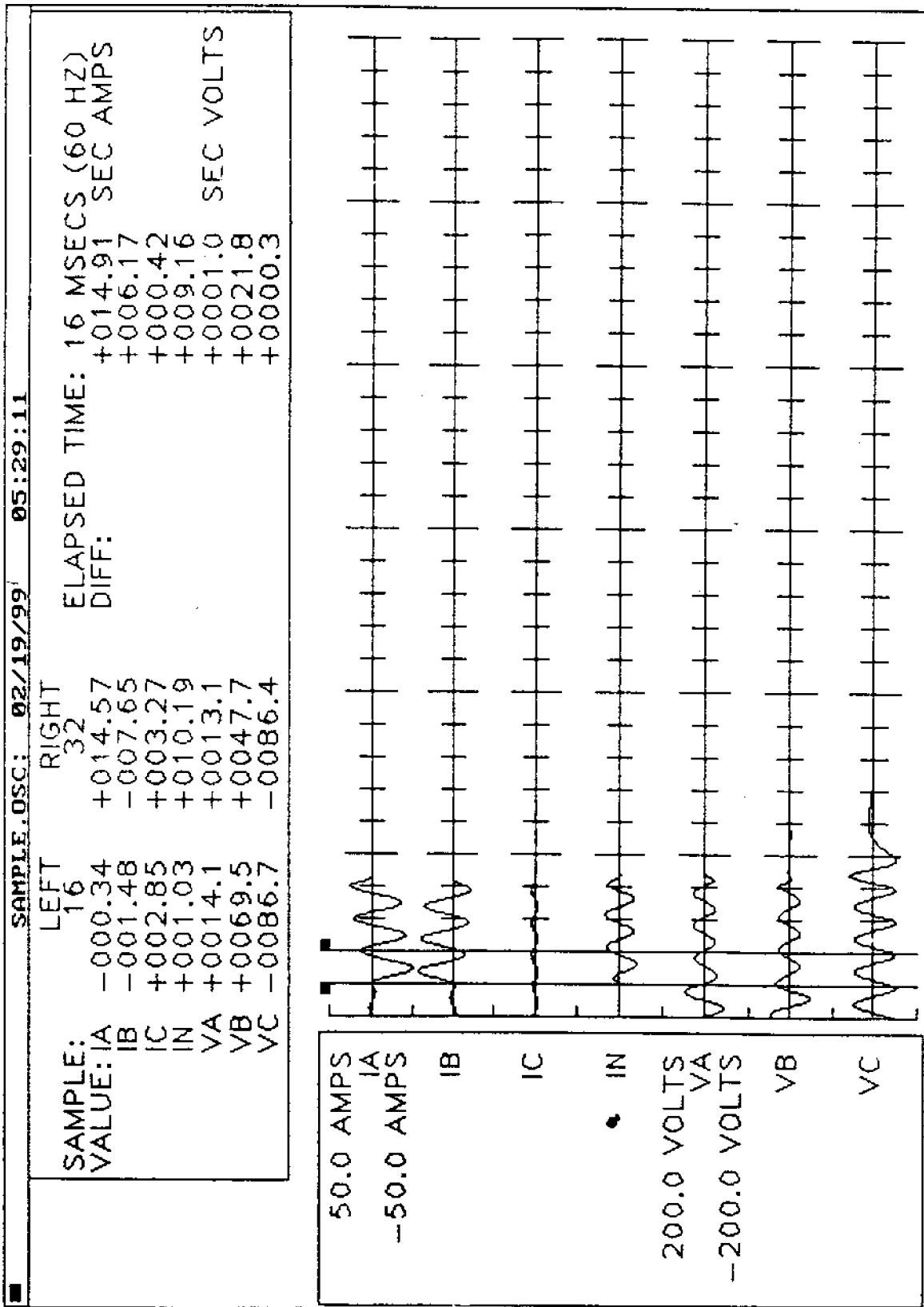


Figure 10-1: OSCILLOGRAPHY – CURRENTS AND VOLTAGES

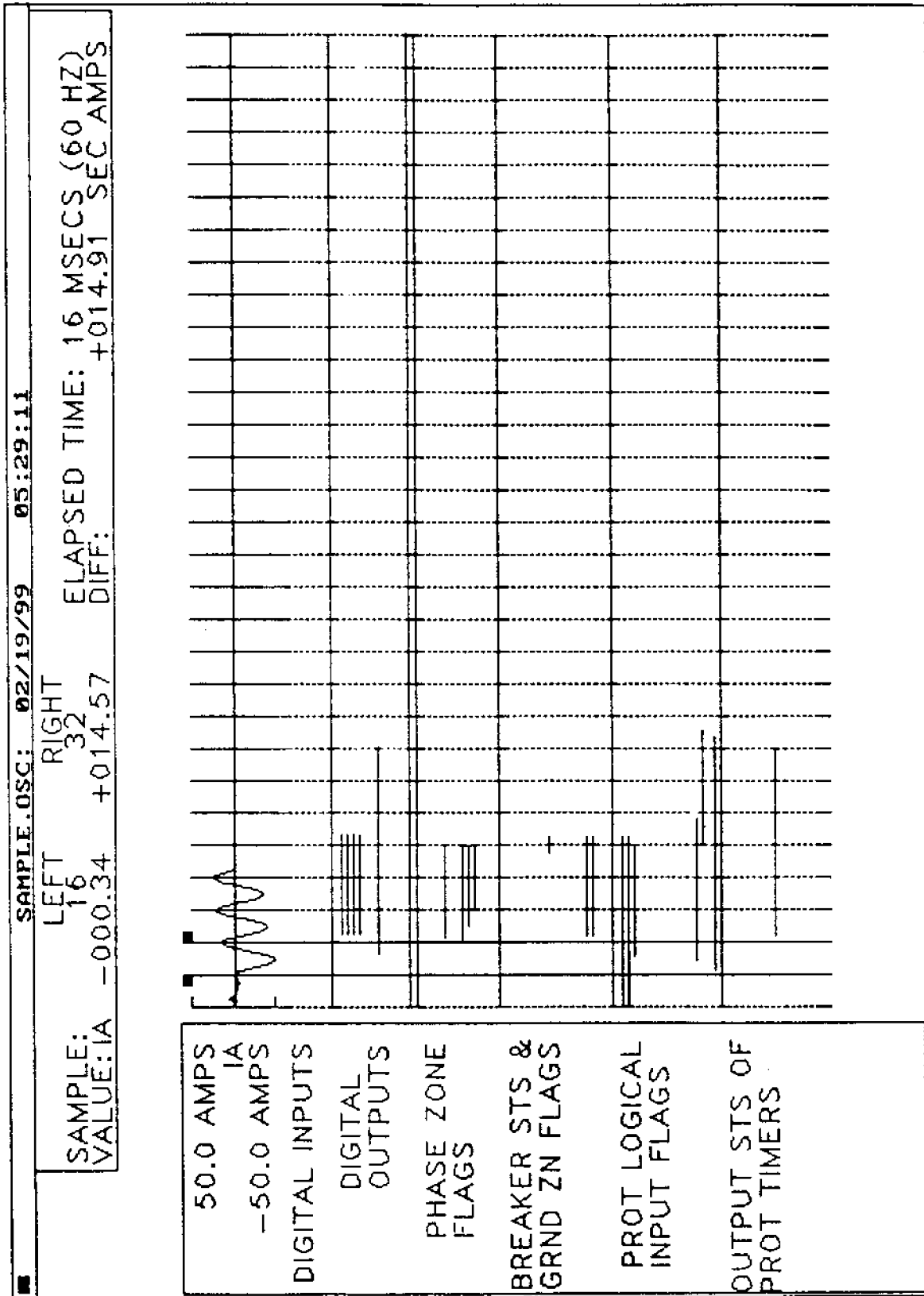


Figure 10-2: FLAG GROUPS SCREEN

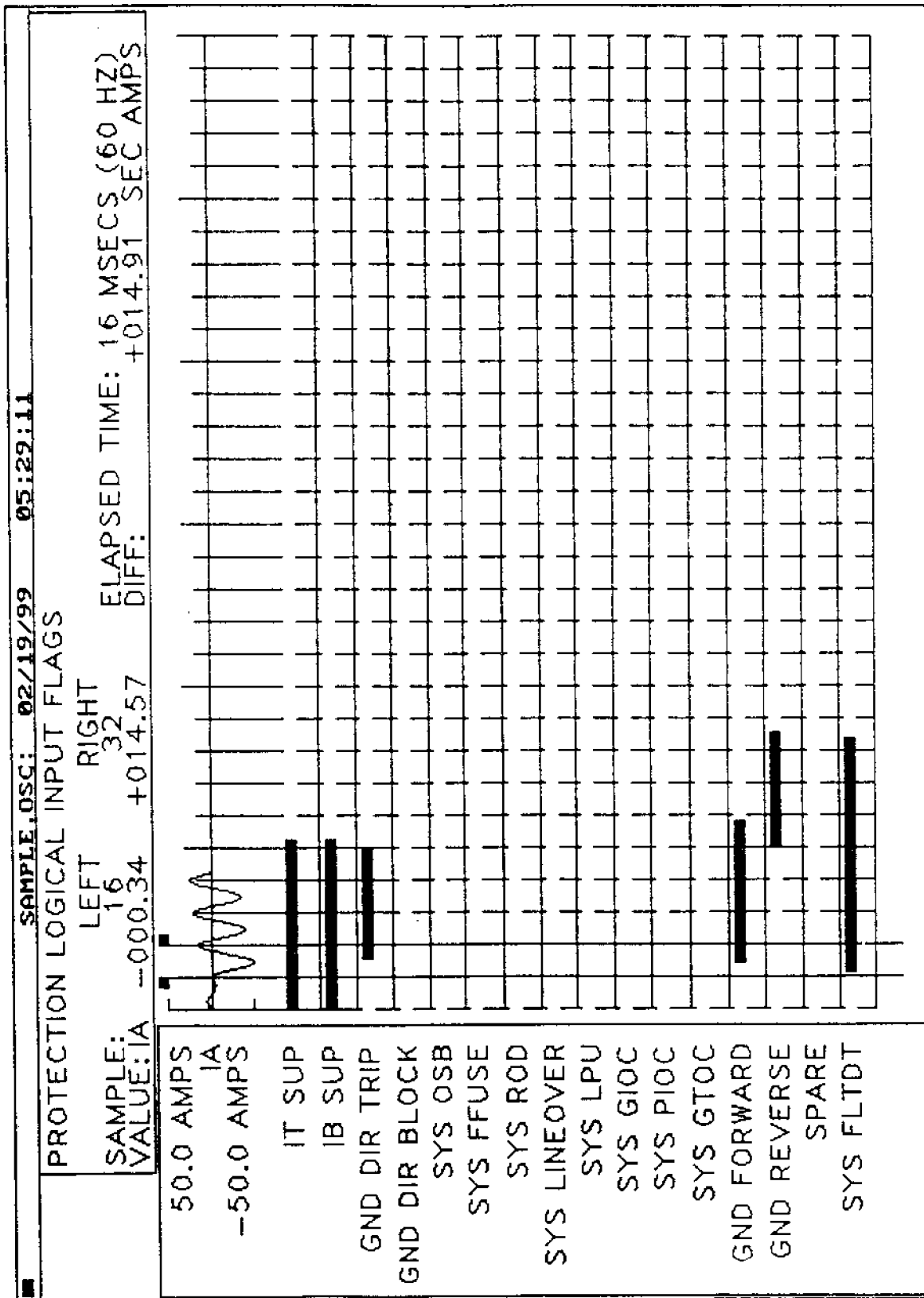


Figure 10-3: PROTECTION LOGIC INPUTS FLAGS SCREEN

10.5.1 DESCRIPTION

This program provides a convenient means of determining the recommended value of test current and permissible voltage range when plotting an entire characteristic for the various distance functions in the DLP3 using the test connections specified in this instruction book. The program is menu-oriented and is run simply by typing DLPTTEST<ENTER>. View the file README.TXT for updated information and installation instructions for this program. These files are found on the 3¹/₂-inch floppy disk provided with this book.

10.6.1 DESCRIPTION

This program places the *Calculation of Settings* chapter from this instruction book onto the PC screen. View the file README.TXT for updated information and installation instructions for this program. These files are found on the 3¹/₂-inch floppy disk provided with this book.

10.7.1 OVERVIEW

A personal computer (PC) or any ASCII terminal provides a remote man-machine interface to the DLP3 for operating personnel.

10.7.2 SYSTEM REQUIREMENTS**a) HARDWARE**

The minimum hardware requirements would be any ASCII style terminal capable of supporting the baud rate of the DLP3.

b) SOFTWARE

No software is needed for an ASCII terminal. For a typical installation with an IBM PC or compatible, any standard ASCII communications package should suffice.

10.7.3 GENERAL OPERATION

The ASCII interface will support most types of TTY compatible software and hardware. To simplify the description of the interface, this section describes using the terminal program supplied with Microsoft Windows. This program is a standard part of the Windows package.

Please review the options and features for the Windows terminal program. If you are more familiar with another program, such as ProComm Plus, please use this section as a guide for setting up your program.

10.7.4 MOUSE/KEYBOARD USAGE

Check the features for the terminal emulation program you are using for details on mouse/keyboard usage. The terminal program supplied with Windows, supports both keypad and Mouse usage and provides the standard Microsoft Windows interface.

10.7.5 SETUP

There are just three configuration items to define, the terminal emulation mode, the port parameters and if necessary the modem information.

Set the terminal emulation mode to TTY. The DLP ASCII interface does not support any special characters or control sequences therefore TTY emulation is sufficient.

The port parameters for the ASCII interface should be set to those defined by the DLP-LINK software. These can be found on the DLP3 under Setup in the Config section. It can also be accessed directly by typing 1509 after entering the Setup mode. See Chapter 2 for more details.

If a modem is being used to link to the DLP3 then setup the modem section and enter the phone number to call.

10.7.6 USER INTERFACE

The ASCII Interface has two interface features. It echoes any characters as they are typed. It supports the 'DELETE' key to erase the last typed character.

The interface does not distinguish between upper and lower case. It also ignores any control characters except for 'XON' and 'XOFF' which are used for transmit control.

10.7.7 LOGIN

The ASCII interface requires the user to login before any requests are recognized. The only password recognized is the View password described earlier in the DLP-LINK section.

To login, perform the following sequence:

```
User:          Press the carriage return key.
DLP:          "Type login."
User:          "login"
DLP:          "Enter password."
User:          Enter the valid View password. Note that the DLP echo's a '.' for every character.
DLP:          If successful "Logged in."
               If unsuccessful "Bad Password."
```

If the login was unsuccessful, confirm that the View password was used.

10.7.8 COMMANDS

The ASCII interface supports the following commands.

```
STATUS          Request DLP Status.
VALUES          Request present values.
MODEL           Request PROM and MODEL numbers.
EVENTS          Request event report.
SHOWSET         Request settings group information.
STLINID         Request station and line ID.
FAULT           Request fault report.
FSTATUS         Request status of all faults.
LOGIN           Login request.
LOGOUT          Logout request.
HELP            Prints a list of available commands.
```

The command may be typed in upper or lower case.

Certain commands require additional information to respond properly. The SHOWSET and FAULT need a value parameter in addition to the command name. This may be typed on the same line as the command separated by a space.

If only the command is typed and the DLP requires additional information a prompt will be displayed on the terminal requesting this information. Here is an example of two ways of entering the SHOWSET command.

1. With parameter on same line as command.

```
DLP> SHOWSET 1
```

DLP responds with settings group one information.

2. Command entered only.

```
DLP> SHOWSET
```

Enter setting group (1-4) - 1

DLP responds with settings group one information.

If a unrecognized command is typed, the DLP will respond with:

“Unknown command, type “help” for list of commands.”

10.7.9 LOGGING OUT

When finished requesting data use the LOGOUT command to end the session. Logging out prevents unauthorized access of the DLP through the ASCII port. The ASCII port also provides an automatic logout if the port has been inactive for 15 minutes.