GE P&C

GEK-105548A

DLP

DIGITAL TRANSMISSION LINE RELAYING SYSTEM WITH THREE PHASE TRIPPING

FOR MODELS: DLP3***CD
DLP3***KD

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GETTING STARTED

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

Prior to applying power, ensure that the model number of the relay listed on the front panel corresponds to the model ordered. Make sure that the DC supply power matches the rated voltage listed on the front panel. Refer to the elementary diagrams, Figures 1-6a,b in *Chapter 1 Product Description* for the locations of the DC power inputs

Instructions on how to use the keypad to change settings, and put the relay into test mode can be found in *Chapter 4:* ACCEPTANCE TESTS, under "*SETTING CHANGES*". Complete instructions on how to operate the keypad are found in *Chapter 8: INTERFACE,* under "LOCAL MAN MACHINE INTERFACE (MMI) OPERATION."

PASSWORDS, FACTORY SET

The DLP relay requires the use of passwords to change Settings or to perform Actions. No password is required to view information on the MMI of 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 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 PASSWORD).

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

REMOTE COMMUNICATIONS VIA LOCAL PC

To communicate with the relay locally via a PC, connect the relay to a serial port of an IBM-compatible computer with a DLP 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 at the end of *Chapter 8 - INTERFACE* , Figure 9-2.

The communications software required to access the relay, DLP-LINK, is included on the diskette in the plastic pocket at the back of this manual. Follow instructions in *Chapter 9 - SOFTWARE* under "INSTALLATION" to load DLP-LINK onto the PC.

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

DLP-LINK PROGRAM – QUICK REFERENCE

The 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 *Chapter 4 - ACCEPTANCE* TESTS, "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.

NOTE: This instruction book covers the following models:

DLP3***CD
DLP3***KD

The DLP3***KD contains the optional recloser function. Any mention to the recloser function refers only to this model.

The DLP3 is a microprocessor-based digital relay system that uses waveform sampling with appropriate algorithms to provide three-phase-tripping schemes for transmission line protection, fault location, and related features.

1–1 Application

The DLP3 system is designed to be used on transmission lines of any voltage level, without series capacitor. The DLP3's operating time range (typically 0.75 - 1.5 cycles) must be consistent with the requirements of the installation. Detailed application considerations are described in this chapter and in *Chapter 2 – Calculation of Settings*.

1–2 Line Protection Schemes and Features

The DLP3 provides four zones of distance protection and six different protection schemes. The protection schemes are as follows:

- 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 nondirectional 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 when a reversed or blocking function is required. When the Blocking or Hybrid scheme is 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 available; three for phase distance and three for ground distance. The algorithm that implements the variable-mho measuring functions is derived from designs that have evolved through several different families of static analog relay systems, which have accumulated decades of dependable and secure in-service experience.

The measurement functions included are listed in *Table 1–1* .

1–3 Protection Scheme Descriptions

The six available protection schemes are described in this section. Five functional logic diagrams, Figures 1–1, 1–2, 1–3, 1–4, and 1–5, show the scheme logic for the six protection schemes using conventional AND/OR combinational logic. The elementary diagram in Figure 1–6 shows the external connections to the DLP3 relay system. Figure 1–7 defines the symbols used in Figures 1–1 through 1–6. Figures 1–8, 1–9, and 1–10 show typical interconnections between the DLP3 and an appropriate carrier/tone equipment for three pilot schemes:

- BLOCKING with CS28A (Figure 1–8)
- POTT with NS40A (Figure 1–9)
- HYBRID with Unblocking CS61C (Figure 1–10)

Zone or Type	Functions
Zone 1	3 Variable-mho phase-distance functions 3 Variable-mho ground-distance functions or 3 Reactance ground-distance functions with "adaptive reach" mho supervision
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 – Nondirectional phase-overcurrent direct trip IDT – Ground-overcurrent direct trip (directional or nondirectional) TOC – Ground time-overcurrent direct trip (directional or nondirectional)
Overcurrent Supervision	IT – Trip-supervision overcurrent IB – Block-supervision overcurrent
Fault Detector	FD
Line-Pickup Overcurrent	I1
Remote-Open Detector	ROD
Line-Overload Detectors	Level 1 Overcurrent Level 2 Overcurrent
Positive-Sequence Voltage Detectors	V1

Table 1–1. Measurement functions included in the DLP3.

Step Distance

Figure 1–1 is the logic diagram for the Step Distance scheme. Since this nonpilot scheme overlays the other protection schemes in the DLP3, it is in essence a part of all of them. The Zone 1 distance functions are set to reach no greater than 90% of the positive-sequence impedance of the protected line. All of the ground-distance functions are provided with self-compensation so that they see only the positive-sequence impedance to a ground fault when the compensation setting is properly selected to reflect the difference between the zero-sequence and positive-sequence impedance of the line. This setting is explained in *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% of the protected line not covered by Zone 1. If the application permits, a forward-looking third zone can be used to provide backup protection for adjacent line sections out of the remote bus. If a reverse-looking zone is desired, the Zone 4 functions can be reversed. For some applications it may be desirable to implement both a forward-looking Zone 3 and a forward-looking Zone 4.

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

Zone 1 Extension

Figure 1–2 is the logic diagram for the Zone 1 Extension scheme. Like the Step Distance scheme, Zone 1 Extension does not use 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 (Zone 2 initially acts as the Zone 1 function via OR102) for the initial fault occurrence. Opening the breaker starts the associated automatic-reclose function, so 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.

If the recloser function is in the LOCKOUT state, the Zone 1 Reach Reset flag remains set until the breaker is closed manually and the recloser function times out to the RESET state. A Z1RR output contact, closed when the Zone 1 Reach Reset flag is set, is provided for controlling an external Zone 1 Extension scheme.

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 is exactly the same as for the Step Distance scheme described earlier. 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.

Permissive Overreach Transfer Trip (POTT)

Figure 1–3 is the logic diagram for the POTT 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 is generally a frequency-shift (FSK) type. When a power-line carrier channel is used, it is possible that an internal fault may attenuate the carrier signal sufficiently to preclude receipt of the trip signal. For such cases, an unblocking channel that provides a time window of trip permission for an attenuated signal caused by an internal fault should be considered.

For any multiphase fault on the protected line, one or more of the overreaching zone variable-mho functions operates at each terminal of the line and applies one of the inputs to the comparer, AND1, via OR2 and TL4. The output from OR2 also keys the transmitter to the trip frequency via OR5. The receiver produces a trip output at each terminal of a two-terminal line. This 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 is present, resulting in a trip output via OR3, TL1, OR4, AND3, OR13, AND13, OR7, and AND7.

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

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

The above description assumes a two-terminal line. When a 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 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.

Permissive Underreach Transfer Trip (PUTT)

Figure 1–3 is the logic diagram for the PUTT scheme. A PUTT scheme requires Zone 1 functions as well as overreaching zone functions. Zone 1 trips directly via OR1, AND4, OR25, OR3, OR4, AND3, OR13, AND13, 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) produce an output, satisfying the input conditions of the comparer, 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, do not use 52/b contact keying of the transmitter. Because the two receivers are ORed together, a continuous trip signal sent from the open end, when only one end is open, results in over-tripping for external faults within the reach of the pilot overreaching functions. Unfortunately, this means a portion of the line is not protected by the pilot scheme. In the DLP3, 52/b contact keying of the transmitter is automatically prevented if SELSCM = 2 [PUTT] and NUMRCVR = 2 [2 RCVRS], as indicated in Figure 1–3 by the link between AND5 and OR5. 52/b contact keying of the transmitter should be used for a two-terminal PUTT application.

Blocking Scheme

Figure 1–4 is the basic logic diagram for the three available Blocking schemes. Figures 1-4a, 1-4b, and 1-4c show the ground carrier start options for the three available Blocking schemes. Since a reverse-looking blocking function is required in these schemes, the Zone 4 distance functions must be set for reversed reach. As far as channel operation is concerned, a blocking scheme has 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 multiphase fault on the protected line, one or more of the overreaching zone variable-mho functions operates at each end of the line and applies one of the inputs to the comparer AND407 via OR2. An output from OR110 inhibits the blocking functions at AND503 via OR103 and NOT2, and any carrier that may have been started is stopped via OR2, AND209, and OR213. Consequently, the carrier is stopped or is not started at any terminal of the line; there is no receiver output and no blocking input applied to comparer AND407 via CC3 and NOT3.

Assuming that the out-of-step blocking function has not operated, AND407 produces an output to initiate tripping following the coordination time-delay pickup set on timer TL1. The coordinating time is required to allow time for receiving a blocking signal from the remote terminal(s) to prevent misoperation on external faults. The required setting is described in *Chapter 2 – Calculation of Settings*. Note that tripping, as in all the schemes, is supervised by the Fault Detector at AND7, thus confirming that a trip only occurs 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 to start the carrier for ground faults. Ground-distance, ground-directional-overcurrent, or both functions acting in parallel may be selected for ground-fault protection. Ground-distance and ground-directional-overcurrent each have separate trip and block functions as well as separate transient blocking circuits.

The BLK1 scheme uses the IPB function ANDed with the NB function to start carrier in the GDOC or MGDOC 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 operates 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 that blocks tripping when clearing external faults or during current reversals that occur when clearing faults on a parallel line.

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

The ground-distance and phase-distance transient blocking logic consists of OR20, AND503, TL25, and OR302. It operates in a similar manner to the GDOC transient blocking logic. Thus, if any of the overreaching zone tripping functions operate as a result of a current reversal or a fault-clearing transient, tripping is initiated because of the blocking output maintained by the blocking function(s). TL24 never picks up on internal ground faults. On internal phase faults, the tripping functions take priority over the blocking functions and prevent them from operating, or cause them to reset if an internal fault occurs following an initial external fault.

In a typical application with ON-OFF carrier sets, only one receiver is used at each terminal of the line, regardless of the number of line terminals. CC3 (RCVR 1 in Figure 1–4) converts 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 has two receivers and CC4 is used in conjunction with CC3. CC5 and CC6 provide additional transmitter and scheme control.

CC5 turns the local transmitter OFF. This feature is typically used when the remote breaker must trip to clear a fault following a breaker failure. An external contact closure, indicating a breaker failure, produces an output from CC5 that turns the transmitter OFF, permitting the remote end to trip.

CC6 output disables 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 overtripping on external faults.

Hybrid Scheme

Figure 1–5 is the logic diagram for the Hybrid scheme. A Hybrid scheme combines aspects of a tripping scheme with aspects of a blocking scheme, but it is perhaps easiest to explain as an enhanced POTT scheme.

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

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

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

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

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

- The NOT input to AND405 is satisfied because there is no output from the blocking functions.
- There is an output from OR305, since either
  - FD has operated, or
  - V1 has dropped out when all three poles are closed.
- 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 AND405 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.

Recloser (optional)

The optional reclosing function (recloser) can be set to provide one or two reclose attempts. The setting Select Recloser Scheme, SELRCLR, allows the selection of four different modes of operation, as described in Table 1–2.

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

Table 1–2. Modes of operation of recloser function.

The recloser may be operated from an external protective-relay system via the digital inputs (contact converters CC1, etc.) and output contacts shown in Figure 1–11. 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.

The digital inputs are as follows:

1. MANUAL LOCKOUT is a switch on the front panel of the DLP3. When this switch is set to ON, the recloser goes to LOCKOUT from any position in the reclosing cycle except DWELL TIME. This ensures that the CLOSE CONTACT stays closed for a sufficient time. When DWELL TIME ends, the recloser then goes to LOCKOUT. The recloser stays at LOCKOUT as long as the switch remains ON.
2. RECLOSE INITIATE, informs the recloser that a trip has occurred.
3. RECLOSE INHIBIT keeps the recloser from issuing the CLOSE BREAKER signal. If this signal is ON when the RECLOSE TIMER times out, the recloser either starts counting the Hold Time Delay (HOLDDLY) if the setting HOLD = YES or goes to LOCKOUT if the setting HOLD = NO. During the HOLDDLY, the CLOSE BREAKER signal is issued as soon as RECLOSE INHIBIT goes OFF. If RECLOSE INHIBIT is still ON when the HOLD TIMER times out, the recloser goes to LOCKOUT.
4. RECLOSE CANCEL, RC, produces different effects depending on the recloser's state when this signal goes ON.
   - In RESET, the recloser disregards any RECLOSE INITIATE received while RECLOSE CANCEL is ON and stays in RESET.
   - During a reclose cycle, RECLOSE CANCEL sends the recloser to LOCKOUT.
   - During the DWELL TIME, RECLOSE CANCEL removes the CLOSE BREAKER signal and then sends the recloser to LOCKOUT.
   - In LOCKOUT, RECLOSE CANCEL has no effect.
5. RECLOSE RESET sends the recloser from LOCKOUT to RESET without counting the RESET TIME. It attempts 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 returns 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 as follows:

1. ZONE 1 REACH RESET, Z1RR, controls the reach of the Zone 1 distance functions in a Zone 1 Extension protection scheme. Z1RR is ON when the recloser is in LOCKOUT and OFF when the recloser is in RESET.
   - 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.
   - During a reclose cycle, Z1RR goes ON as soon as the first CLOSE BREAKER signal is issued, and it remains ON until the recloser goes back to RESET.

- If the setting SELRCLR = 1, then Z1RR is permanently ON.

2. RECLOSE IN PROGRESS, RIP, is set when a reclosing cycle begins following detection of RI. RIP is cleared when the recloser goes to LOCKOUT or to RESET.
3. 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 is set to one of four modes of operation, as described above.
- TPRDLY1 –Reclose Delay First Attempt sets the time between an initial trip and the breaker's reclosing.
- RDLY2 – Reclose Delay Second Attempt sets the time between the second trip and the reclosing of the breaker.
- HOLD – HOLD is either YES or NO and determines the action taken by the recloser just before a CLOSE BREAKER signal is issued. The recloser checks the status of the RECLOSE INHIBIT input, with the next step determined by HOLD, as explained under RECLOSE INHIBIT above.
- HOLDDLY – Hold Delay sets the duration of the HOLD timer.
- DWELLTM – Dwell Time Delay sets the time that the CLOSE BREAKER signal stays on.
- RSTDLY – Reset Time Delay sets the time delay of the RESET TIMER.

Events associated with the recloser are part of the Sequence of Events function. The recloser events are as follows:

- Lockout – Reclose Inhibit: This event is stored when the recloser is sent to LOCKOUT after RECLOSE INHIBIT is detected for either of the following conditions:
  - HOLD = NO, RECLOSE INHIBIT is ON after the RECLOSE TIMER times out.
  - 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 after either of the following conditions:
  - A second RI is detected with a one-attempt scheme or a third RI is detected with a two-attempt scheme.
  - 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: These events are stored when an external RI is detected and 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.

Figure 1–12 shows the flow charts for the recloser operating in mode 6, SELRCLR = 6. Recloser operation is described using this mode, since it encompasses the full capability of the recloser.

Following either DLP3 power-up or a change in settings, the recloser checks to see if MANUAL LOCKOUT is ON. If it is, the recloser goes to LOCKOUT, but the Manual Lockout ON event is not recorded. If MANUAL LOCKOUT is not ON, the recloser checks if the breaker is open.

The recloser goes to LOCKOUT if the breaker is open and to RESET if the breaker is closed.

When the recloser is at LOCKOUT, it sets Z1RR, and LOA and clears RIP, then enters a loop to check for conditions that permit a return to RESET. If the breaker is open or RI is ON, the recloser stays 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, the following conditions are checked:

- If an open breaker is detected, then the recloser goes to LOCKOUT without storing an event message.
- Any RI signal going ON causes a Lockout – Permanent Fault event to be stored and the recloser goes to LOCKOUT.
- Either the RECLOSE RESET signal or the RESET RECLOSER command sends the recloser to RESET immediately.

After reaching RESET, the recloser clears Z1RR, LOA, and RIP. It then 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 checks 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 reads 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.

When 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 are checked, with results as follows:

- 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, with results as follows:

- 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.

If the first reclosing attempt was unsuccessful, the RECLOSE TIMER is counting down. Meanwhile, 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 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.

Out-of-Step Blocking

Figures 1–13 and 1–14 contain the functional logic diagram of out-of-step blocking and an R-X diagram depicting an assumed swing-impedance locus superimposed on the associated distance relay characteristics. For an out-of-step condition, the impedance locus first enters the MOB characteristic, then later enters the phase trip function.

When MOB picks up during the power swing, it applies the upper input to AND201. The lower input is present from the NOT via OR203, since the phase trip function has not operated yet. The AND201 output then energizes timer TL1.

If the impedance stays between the MOB and phase trip function characteristics for the pickup time of TL1, an OSB output results. The OSB output is routed back to the lower input of AND201 via OR203 to seal-in the OSB output for as long as MOB is picked up. The OSB output resets 50 ms after the swing-impedance locus leaves the MOB characteristic.

OSB is always routed to block reclosing. OSB can be selected to:

1) Block all tripping
2) Block tripping for everything except the direct trip overcurrent functions.
3) Allow tripping.

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

Remote-Open Detector

The Remote-Open Detector (ROD) function issues a trip signal when the remote breaker opens during an unbalanced internal fault. This function detects that the remote breaker has opened by recognizing charging current on one or more phases following opening of the remote breaker. As shown in the functional logic diagrams of Figures 1–1, 1–2, 1–3, 1–4, and 1–5, the ROD output trips via OR8, AND10, OR13, AND13, OR7, and AND7. The Remote-Open Detector will not operate when a balanced three-phase fault is present.

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

Figure 1–15 is a functional logic diagram of the ROD function. The sequence of events that results in a ROD output is as follows:

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

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

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

Line Pickup

Line Pickup provides tripping in the event that the breaker is closed into a zero-voltage bolted fault, such as occurs if the grounding chains were left on the line following maintenance. Figure 1–16 shows the functional logic for Line Pickup.

When the line is de-energized, the open breaker detector, IB, and the positive-sequence voltage detector, V1, reset, indicating that the line is dead. The resulting output from AND4 causes timer TL2 to operate 150 ms later. Consequently, when the line is energized and a fault exists, current detector I1 picks up and AND2 produces an output.

If the link connected to the bottom input of AND3 is connected to (+), then AND3 immediately produces an output to initiate tripping of the breaker. If the link is connected to reference (REF), then tripping occurs 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 Figure 1–16. 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 picks up and timer TL1 will begin timing; 25 ms later the output of TL1 resets timer TL2 via the fast reset input. AND2 has 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. TL3 then allows time for the voltage to return to normal and take Line Pickup out of service before it can trip on load current. If simultaneous high-speed reclosing is not used, timer TL3 can be permanently bypassed.

Line Pickup is primarily intended to trip for closing into zero-voltage bolted faults where the distance functions connected to line-side potential will not operate. However, regardless of the I1 pickup setting, it can also be used to trip on any type of permanent fault along the entire line length that produces voltage at the relay location that is sufficient to operate a Zone 2 distance function, but not enough to 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 is slower than normal since the prefault 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 still results in faster tripping for permanent faults located at the remote bus (or anywhere past the local Zone 1 reach).

Potential Transformer Fuse Failure (PTFF)

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 function PH4, nondirectional IDT, and nondirectional TOC are allowed to trip. If IDT or TOC is directionally supervised by NT, then that function is not allowed to trip. Figure 1–17 shows the functional logic for the PTFF function.

If ac potential is lost, the positive-sequence voltage detector V1 drops out, NOT1 produces a logic 1 output, and the upper input is present at AND1. The V1 pickup setting is fixed at 75% of 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, while the bottom input is dependent upon whether 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 produces an output that causes timer TL1 to time out and produce a PTFF output via OR2. The output of OR2 is routed to AND2 to seal in the PTFF output, based on the output of V1, so that PTFF output is 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 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 resets, but the fault detector operates to prevent an output from AND1. PTFF does not operate on fault conditions.

Overcurrent Backup

An instantaneous, nondirectional phase overcurrent tripping function (PH4) provides direct tripping for three-phase and phase-to-phase faults. Since PH4 is nondirectional, power system conditions determine whether or not this function can be set to distinguish between internal and external faults.

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

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 OTHER FEATURES

Alarms

Two separate self-test alarms and a power supply alarm are provided:

- The noncritical alarm is a normally open contact that closes when self-test detects a problem that does not warrant taking the relay system out of service. The following conditions can create a non-critical alarm.

  1.Three successive remote login failures.

  2.Loss of potential detected by the Fuse Failure function

  3.A sustained unbalanced current condition.

- The critical alarm is a normally closed contact, held open under normal conditions, that closes when self-test detects a problem that warrants taking the relay system out of service.
- The power supply alarm is a normally closed contact, held open when the power supply is normal, 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.

Current Unbalance Detection

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

Breaker Control

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

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

Remote breaker tripping and closing are enabled or disabled with a jumper on the PROCESSOR module, as shown in Figure 3–14. The DLP is shipped from the factory with this jumper removed and Breaker Control enabled. Install the jumper to disable Remote Breaker Control.

Configurable Inputs

Three of the digital inputs, contact converters CC4, CC5, and CC6, are user configurable. Nine possible combinations of setting 1701, CONCCI determine how these digital inputs are used. Refer to *Chapter 2 – Calculation of Settings* for details.

Configurable Outputs

Six digital outputs are available for customer configuration, as listed in Table 1–3. The first column lists the default conditions for these contacts, as indicated on Figures 1–1 to 1–6. Each output has a unique settings category, listed in the second column of Table 1–3, comprising nine settings.

Digital Output	Settings Category
1. Close Contact, BC-1	18. BKR1CLSOUT
2. Close Contact, BC-2	19. BKR2CLSOUT
3. Reclose Contact, RC	20. RCANCLOUT
4. Line Overload	21. LNOVLDOUT
5. Noncritical Alarm	22. NONCRITOUT
6. Reclose Initiate, RI (two contacts)	23. RINITOUT

Table 1–3. Configurable outputs and their settings categories.

For example, settings category 18, BKR1CLSOUT, controls the use of configurable digital output #1. For all of the above settings categories, except Line Overload, the first setting, CONOUTX (x= 1, 2, 3, 5,-6) may be set to:

0 BC-1, the default setting
1 Energized by an 8-input logical OR
2 Energized by an 8-input logical AND)

For Line Overload , CONOUT4 may be set to:

0 BC-1, the default setting
1 Energized by an 8-input logical OR
2 Energized by an 8-input logical AND
3 Energized by an 8-input logical OR and activates the trip bus
4 Energized by an 8-input logical AND and activates the trip bus.

When set to 3 or 4 the function produces a DLP trip and closes the Line Overload contact. A "CTB" trip is 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 or 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 milliseconds regardless of the setting at which (1310) is set

The eight 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. Refer to *Chapter 2 – Calculation of Settings* for details.

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 and closes the Line Overload contact. If the programmed condition is the primary cause of the trip, the trip type displayed is CTB (Configurable Trip Bus). Setting CONOUT4 to 3 or 4 enables the Line Overload category to cause a trip. Setting CONOUT4 = 0, 1, or 2 only operates the Line Overload contact.

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 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.

Fault Report

When a fault occurs, pertinent information, consisting of unit ID, date and time, operating time, prefault currents, fault currents and voltages, fault type, trip type, distance to fault, and selected events, is stored in memory. The five most recent fault events are stored. See *Chapter 8 – Interface* for a full description of this function.

Local Man-Machine Interface (MMI)

A local MMI, incorporating a keypad and light emitting diode (LED) display, is provided to enter settings, display present values, view fault target information, and access stored data. The MMI is fully described in *Chapter 8 – Interface*.

Oscillography

Oscillography data are 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) triggers 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.

Note that OSC Trigger stores oscillography data, but does not necessarily set t=0, the time sample that delineates between prefault and postfault oscillography cycles. The term *disturbance period* is defined as the number of cycles of oscillography data (prefault plus postfault) as determined by the setting 1513, NUMFLTS. If the internal Fault Detector, FD, comes up initially and OSC Trigger follows within the disturbance period, oscillography data are stored whether or not the 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 pseudofault report is created. The trip type is listed as OSC, the trip time is set to when the OSC Trigger occurred, the operating time is set to zero, and the fault type and location are computed, based on post-OSC Trigger data. The local MMI LED display does not show target information, but an event message and fault report are stored in memory. In either case above, t=0 is determined by the internal Fault Detector, FD.

If OSC Trigger comes up initially and FD follows within the disturbance period, the same actions occur and FD determines t=0. If only OSC Trigger occurs, then a pseudofault report is created and OSC Trigger determines t=0. This arrangement assures that the oscillography function always captures a DLP3 trip, with FD determining t=0, regardless of whether an optional internal or external trigger is used.

Oscillography data include station and line identification, a complete list of settings, the fault report, internal flags, and a selectable number of prefault and postfault data samples. Further description of this function is found in *Chapter 9 – Software*.

This DLP3 no longer stores flags for any function that is disabled. For example, if SELZIG = NO and SELZ1P = NO, the zone 1 flags (indicating zone 1 operation or non-operation) are not stored. Previously, if SELZIG = NO and SELZ1P = 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.

Password Protection

Passwords provide security for the local man-machine interface (MMI), and remote communications interface. 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 setting changes.
- Settings changes.

A single view only password provides ASCII port security.

Refer to *Chapter 8 – Interface* for a description of MMI password usage, and refer to *Chapter 9 – Software* for a description of DLP-LINK and ASCII port password usage.

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 PC-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 PC compatible computer using an ASCII protocol interface.

A DB-9 plug (PL-4)(front panel port) located on the front panel of the unit provides communication with the DLP3 using DLP-LINK from an IBM PC-compatible computer.

A PC may be connected via the proper null-modem cable, as long as the cable length does not exceed 50 feet, or the PC may be connected via interposing modems when it is remote from the DLP3. Unique PC software, DLP-LINK, is required to communicate with the relay system when using either the front panel port or PL-1. The capabilities and use of DLP-LINK are described in *Chapter 9 – Software*. Refer to *Chapter 8 – Interface* for details on the required cables.

The two RS232 serial ports, PL-1 and the front panel port, PL-4, 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 panel port. If PL-1 is connected to a modem and the front panel 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.

The third port, PL-2, is also implemented with a separate UART. This port is never disabled and may be used when the other ports are active. The capabilities and use of the ASCII port are described in *Chapter 9 – Software*. . Refer to *Chapter 8 – Interface* for details on the required cables.

SCADA Digital to Analog (DTA) Interface

An internal DTA function, standard on the DLP3, provides the following:

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

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

The DTA provides either a nominal 0 to 1 ma dc output or a nominal 0 to 5 Vdc output. The choice of output ranges is made by a switch located on the Processor Board the default setting is voltage. The Processor Board must be removed from the DLP3 chassis to access this switch. The proper sequence for selecting the output range is as follows:

1. Remove the front plastic bezel by unscrewing the four thumbscrews. Note, the thumbscrews are retained to the front bezel.
2. Turn the power switch off on the front panel.
3. Remove DC power from the DLP1, and remove all voltage inputs from the terminals on the rear panel of the unit.

WARNING: Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF.

4. Remove the four 1/4” hex nuts at the four corners of the front panel. Gently pull the front panel away from the unit to expose the cable connections to the front panel.
5. Disconnect the power switch cable from the Output board and the ribbon cable from the Processor board.
6. Remove the two ribbon cables and power cables from the front of the PC boards.

7. Remove the two PC board retainers by unscrewing the two phillips head screws that hold each in place.
8. Remove the Processor board, refer to figure 3–3, and lay on a antistatic surface component side up.
9. The SCADA DTA switch is located on the right side of the board about 2/3 back. Set the switch for the appropriate output type (V = Voltage, I = Current), Figure 3-15 indicates the location of this switch on the board. Reinsert the Processor Board.
10. Reinstall the PC board retainers.
11. Reinstall the power cable and the two ribbon cables on the PC boards.
12. Reconnect the front panel power switch cable to the Output Board and the ribbon cable to the Processor Board. Install the front panel with the four 1/4" hex standoffs.
13. Restore dc power to the DLP1.
14. Turn on the front panel power switch.
15. Reinstall the plastic cover with the four thumbscrews.

When the fault location is calculated to be 100% of the line length, the DTA output is either 0.8 ma dc or 4.0 Vdc. The DTA output goes to full scale (either 1 ma dc or 5 Vdc) 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 Vdc, which covers the 0 to 110% fault-location range. The SCADA system should be programmed to recognize a full-scale output as an indication of an invalid output, resulting from either an out-of-limit fault-location calculation or a DTA reset.

There are two settings associated with the SCADA DTA Interface. FLTLOCK specifies a time period after a fault during which fault-location calculations resulting from subsequent faults are prevented from updating the fault-location information stored in the DTA logic. FLTRESET specifies the time after a fault at which the fault-location information stored in the DTA logic is reset (output forced to full-scale value) and those fault-type contacts that have closed will open. Note when either the DLP3's date or time is changed the timers associated with FLTLOCK and FLTRESET are reset and the DTA function is reset.

Fault location and phase identification dry contacts for A, B, C and N phases may be accessed through PL-3. PL-3 is a DB-15 connector located at the rear of the DLP3. Refer to the Elementary Diagram in Figure 1-6 for the pin out of PL-3.

Sequence of Events

This function time tags and stores the last 100 events in memory. The resolution of the time-tagging is 1 millisecond. The event list contains power system events, operator actions, recloser actions, and self-test alarms. The sequence of events can be accessed remotely via the front panel port, PL-1 or PL-2 and a PC. A full description of this function is contained in *Chapter 8 – Interface.*

Selectable Groups of Settings

Four separate groups of settings may be stored in nonvolatile memory. Only one group can be active at a given time, but the active group may be selected by external switch contacts or by a command issued from the local MMI or DLP-LINK communication software. If the selection is to be made by an external switch, then two of the digital inputs (contact converters) are used for this purpose. A four position SB1 or SBM switch with two stages (two effective contacts) could be used to select the active group of settings, as shown in Figure 1–18.

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 DLP1 is not connected to a G-NET host computer, then an unmodulated IRIG-B signal connected to the IRIG-B terminals, located on terminal block "D" on the rear panel, may be used to synchronize the clock.

In both cases, the clock in a given DLP3 is synchronized to within ± 1 ms of any other DLP3 clock, if the two relays are wired to the same synchronizing signal.

Trip Bus Check

After a settings change is made in the active settings group, the DLP3 automatically returns to its normal protection-on mode following:

- Storage of the new setting values in nonvolatile memory.
- A Trip Bus Check to determine that the changed settings have not caused any of the trip functions to operate for system conditions (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.

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 determine if the associated trip circuit is intact. If the monitored dc voltage drops to 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.

Operation of the Trip Circuit Monitor causes the noncritical alarm contact to close. If one or more poles of the breaker are 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 opens and drops the voltage across the open contact to zero. To avoid a noncritical alarm for this condition, closure of the associated 52/b contact disables the Trip Circuit Monitor function for the involved pole.

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, indicating breaker 1 or breaker 2. Y is A, B, or C, indicating the phase that was tripped.

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.

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

During power-up, each of the three microprocessors performs start-up self-tests on its associated hardware (including PROM, local RAM, shared RAM, interrupt controller, timer chip, serial and parallel I/O ports, nonvolatile memory, analog and digital I/O circuitry, and MMI hardware). In addition, the DLP3 verifies that the PROM version numbers in all three processor boards are compatible, and that the Model Number stored in nonvolatile memory agrees with the unit's configuration. The components tested at start-up are listed in *Table 6–1*.

In most cases, if any critical self-test failure is detected, the DLP3 discontinues start-up and does not reset. It attempts to store the DLP3 status and to initialize the MMI and remote communications hardware/software for communicating status. The critical alarm output is energized.

If no failures are detected, the DLP3 completes initialization of its hardware and software; this includes reading information from the serial Nonvolatile RAM (NVRAM) in the magnetics module, stored during the manufacturing process, to determine the current rating of the magnetics in the unit (1 A or 5 A). Next, each processor board (DAP and SSP) enables 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 takes approximately one minute. As soon as the SSP successfully completes its PROM test and initializes the display hardware, the message INITIALIZING appears on the display. When all DLP3 initialization is completed satisfactorily, the display is blanked and the DLP3 begins acquiring and processing data.

Run-Time Self Tests

Each of the three processors has idle time when the DLP3 is not performing fault or post-fault processing. During this idle time, each processor performs background self-tests that do not interfere with the foreground tasks' use of serial and parallel ports and that do not inhibit interrupts to any processor. If any background self-test fails, the test is repeated. For a component to be declared as failed, the test must fail three consecutive times. In the case of most critical failures, the DLP3 forces 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 after an intermittent failure. The reset activities are identical to the start-up activities except that not all start-up self-tests are performed. If the reset was caused by failure of a specific background self-test, then only the start-up self-tests associated with that same hardware are performed.

A reset is not reported by the DLP3. If the reset is successful no failure status is recorded, and the critical alarm output is not energized; however, during the reset procedure, the red LED on the front panel will light and a failure code may appear on the display. Therefore, if the reset is not successful, the processor board is shut down, leaving the error information on the front panel display. Refer to *Chapter 6 Table 6–5 Failure Messages.*

To prevent continual resets in the case of a solid failure, both hardware and software permit only four resets in a one-hour period. On the fifth reset, the DLP3 does not initialize, but attempts to initialize the 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 Table 6–2. Testing of I/O hardware is done in the foreground, so that the processors know when a given component or port is in use and therefore not available for testing. The components tested in the foreground are listed in the *Table 6–3*. Some foreground tests are performed every sample period, while others are performed less frequently.

As with background self-tests, any failed foreground test is repeated and must fail three consecutive times to be considered a failure. Although not specifically a self-test, the trip circuit continuity monitoring is performed as a foreground test. Refer to *Trip Circuit Monitor* in this chapter.

The operator may initiate a visual-response test of the MMI components. Refer to *Chapter 4 – Acceptance Testing* for details.

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 without 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.

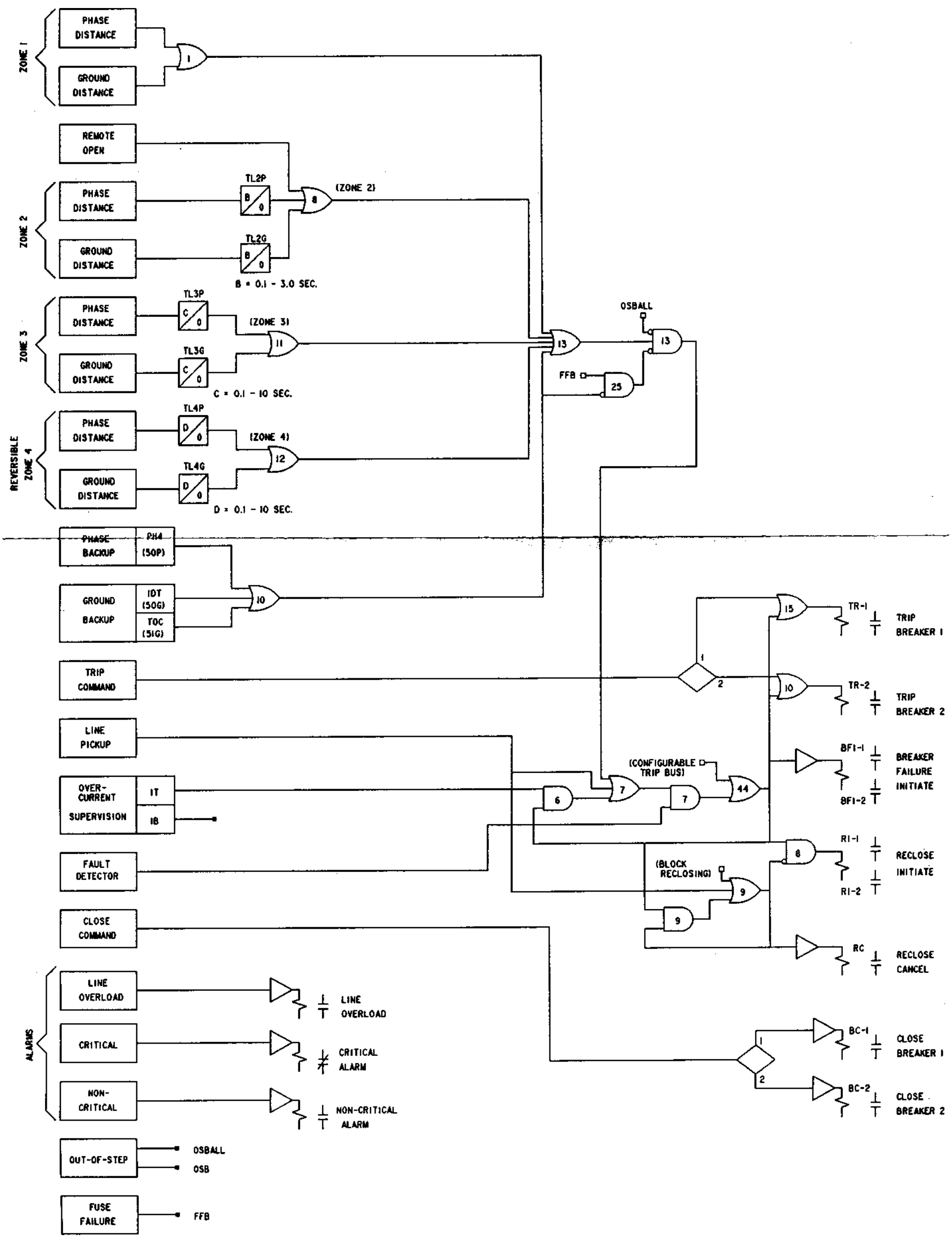


Figure 1–1. (0145D8335) Step Distance logic diagram.

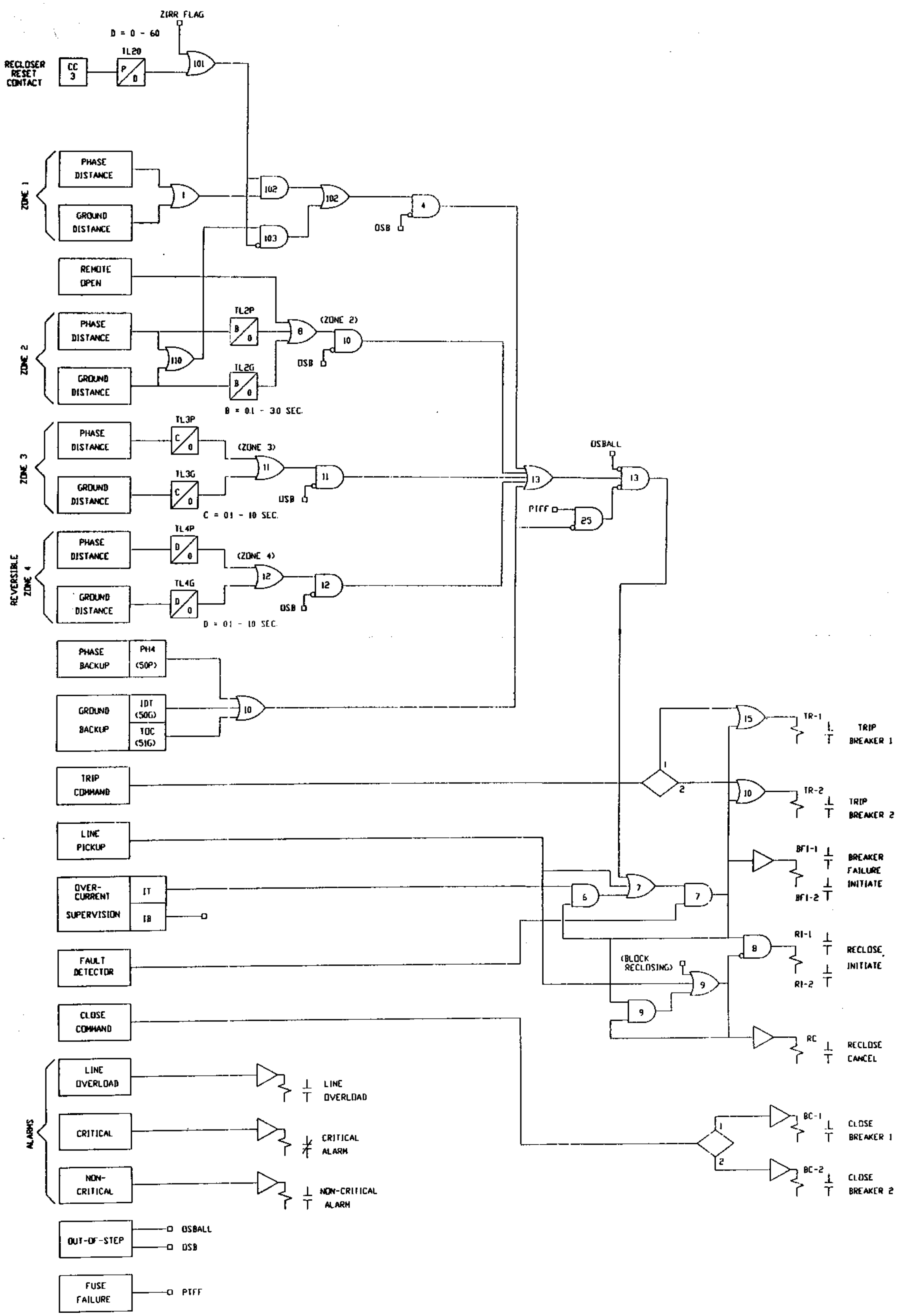


Figure 1–2. (0145D8386) Zone 1 Extension logic diagram.

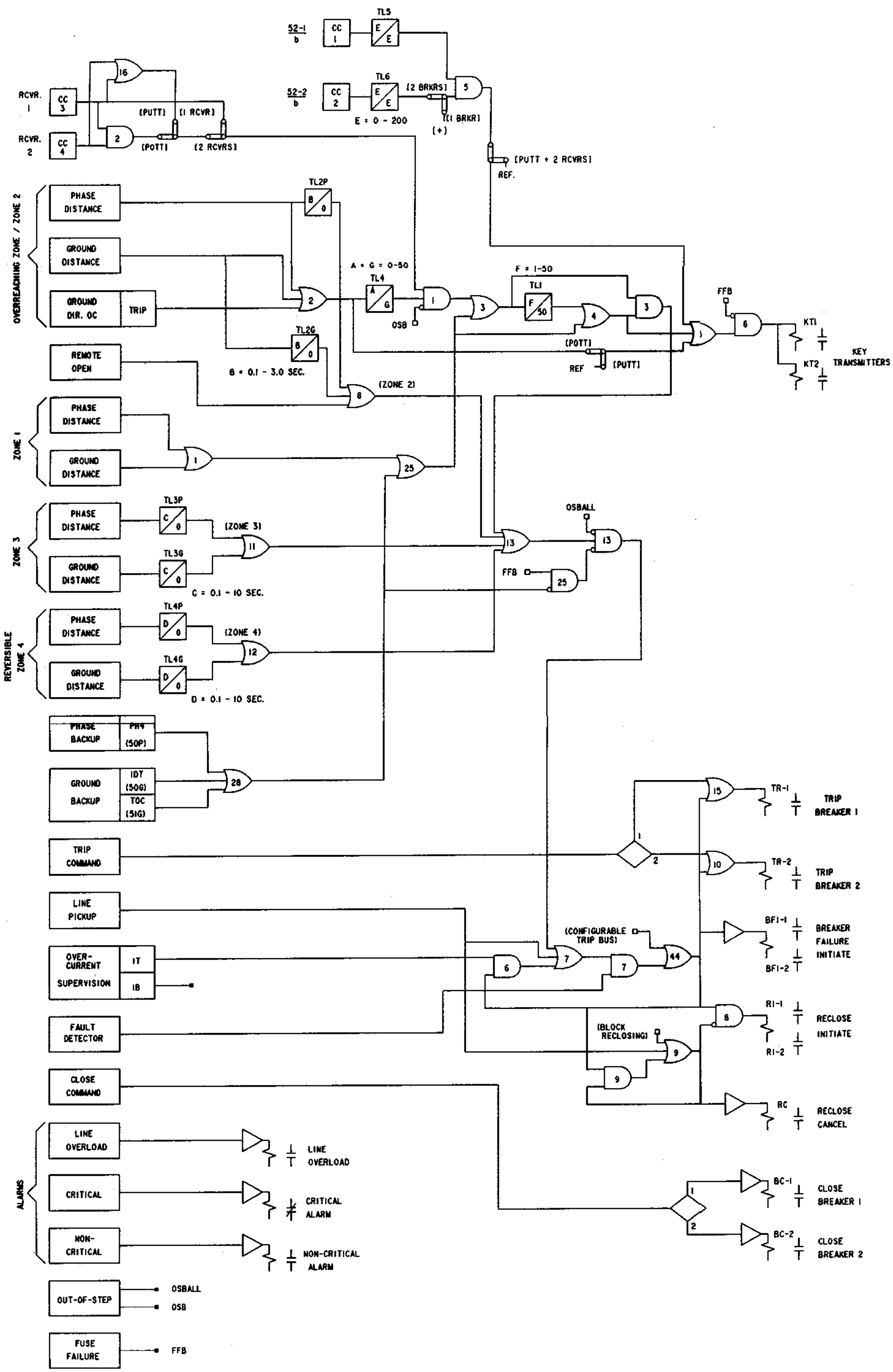


Figure 1–3. (0145D8337) POTT/PUTT logic diagram.

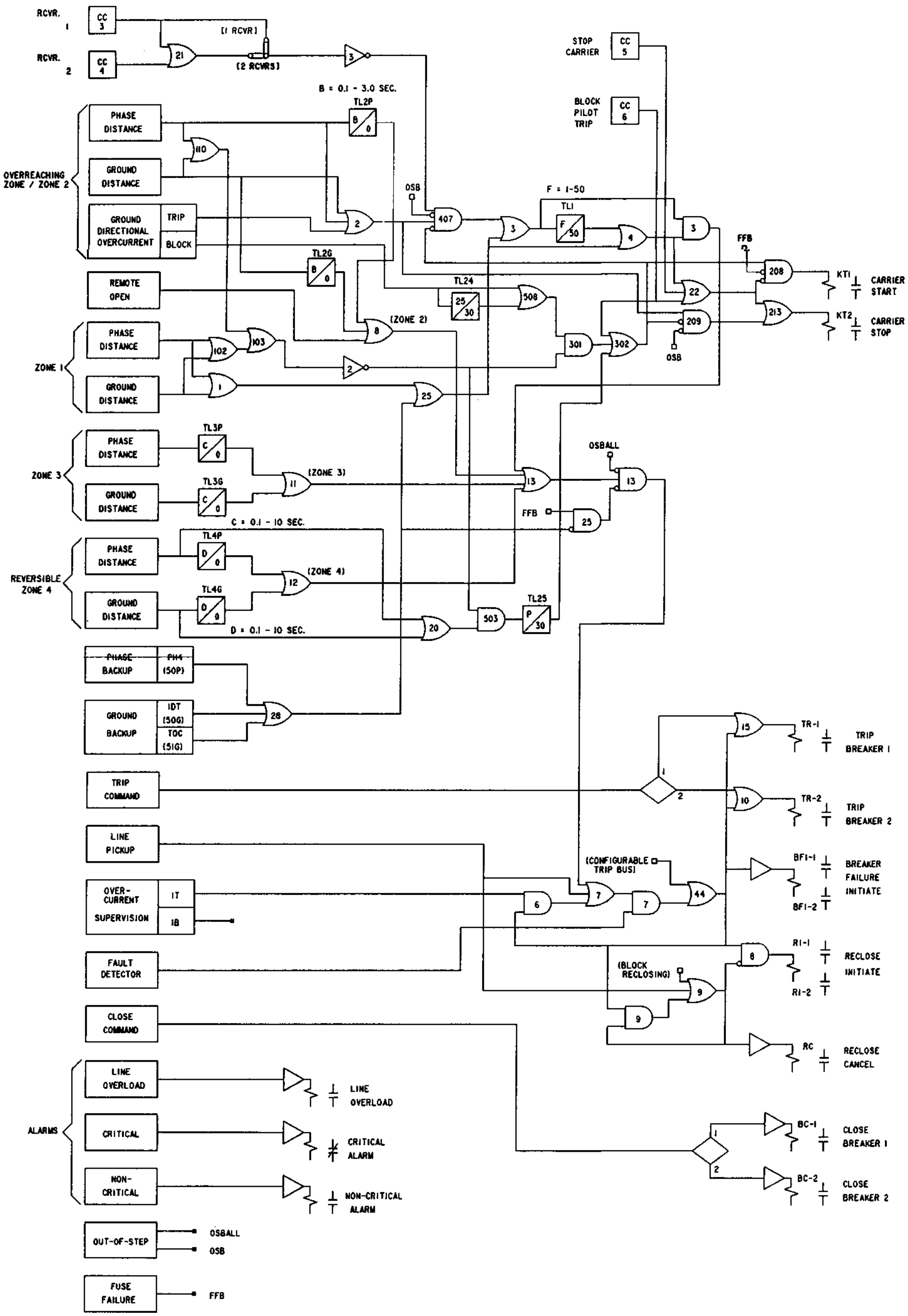


Figure 1–4. (0145D8338) Blocking logic diagram.

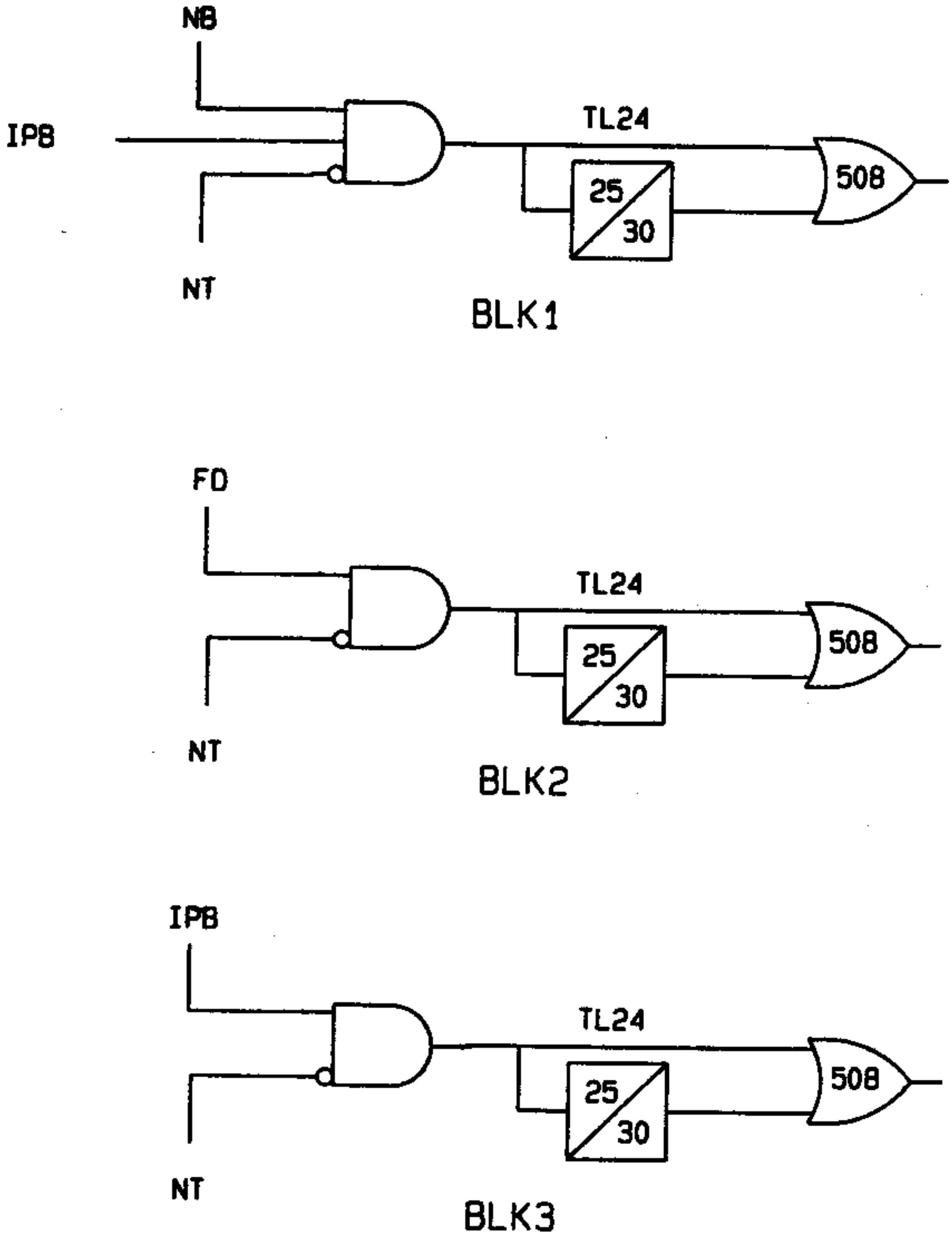


Figure 1–4a, b, c. (0355A3389) Ground Carrier Start Options.

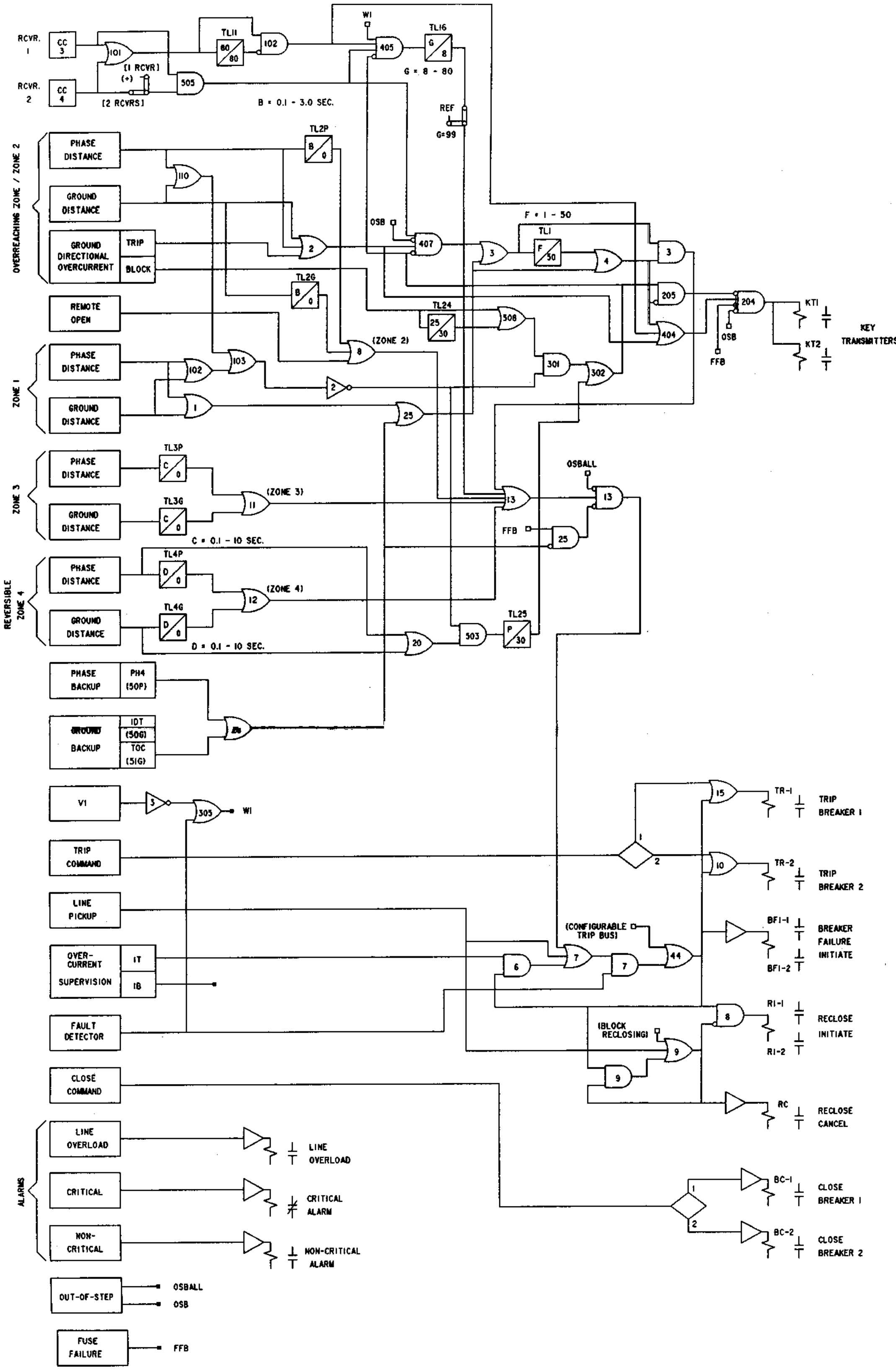


Figure 1–5. (0145D8339) Hybrid logic diagram.

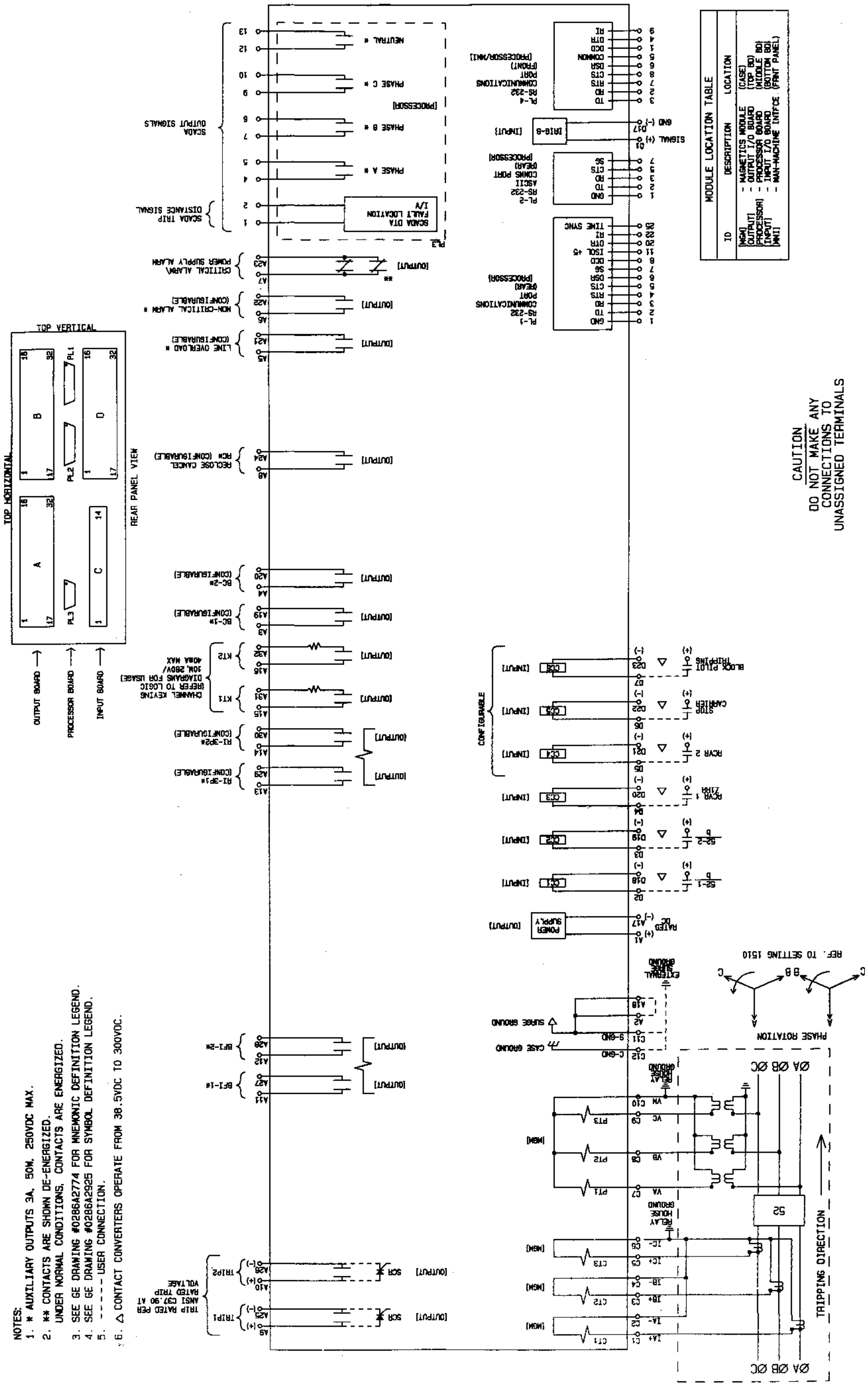


Figure 1–6 . (0215B9168) Elementary diagram (sh. 1 of 2).

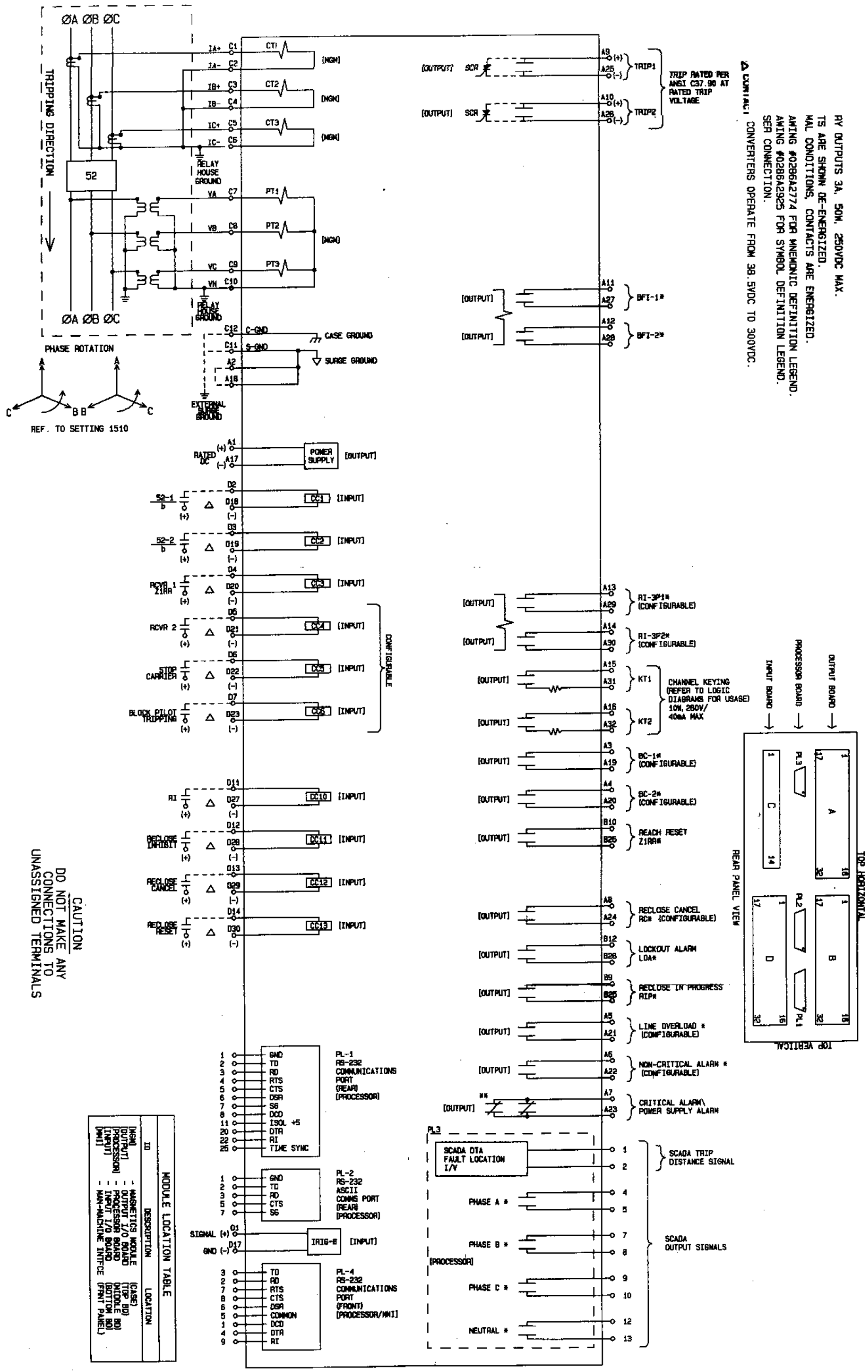


Figure 1–6 . (0215B9167) Elementary diagram
(sh. 2 of 2).

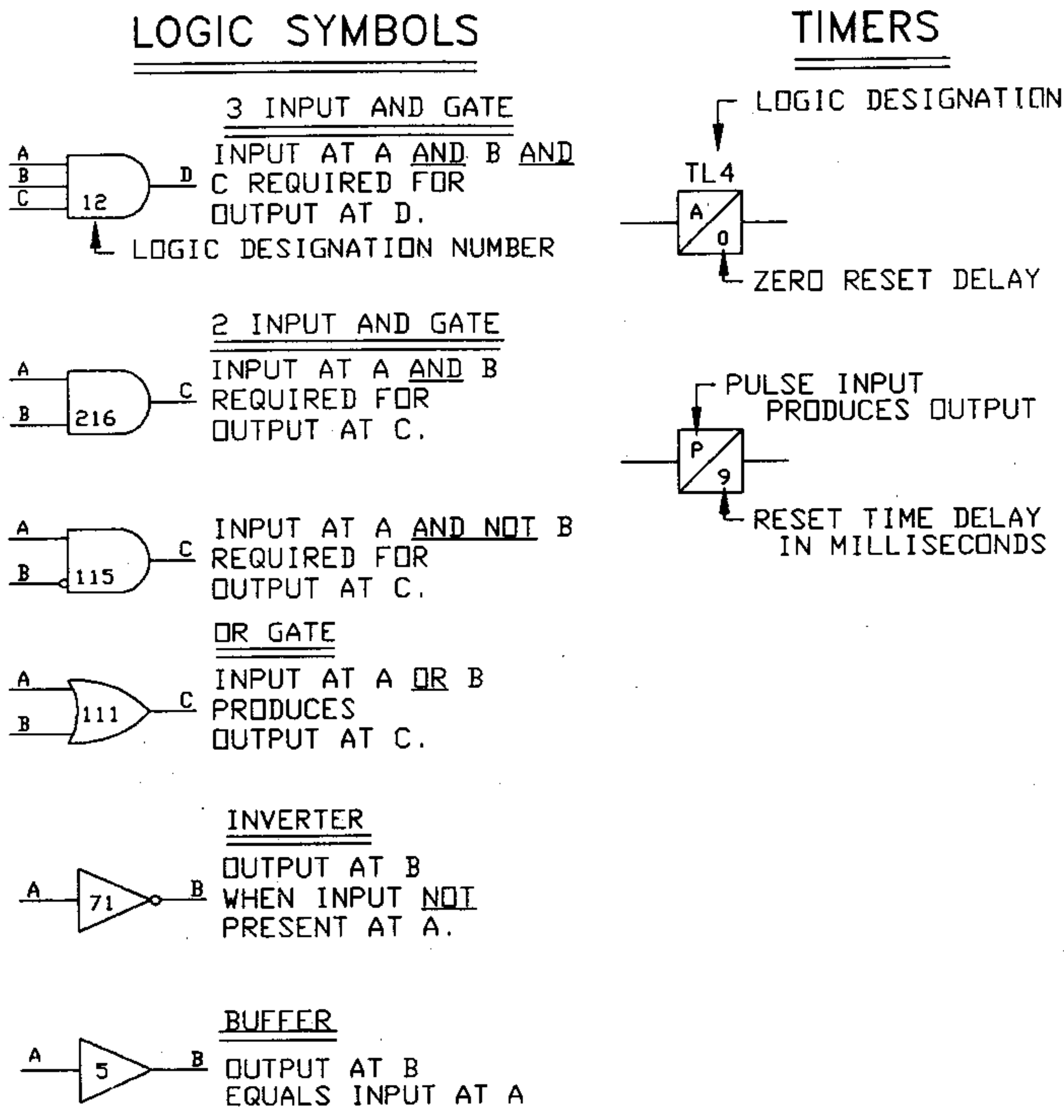


Figure 1–7. (0286A2925) Digital relay symbol legend. (sh.. 1 of 2)

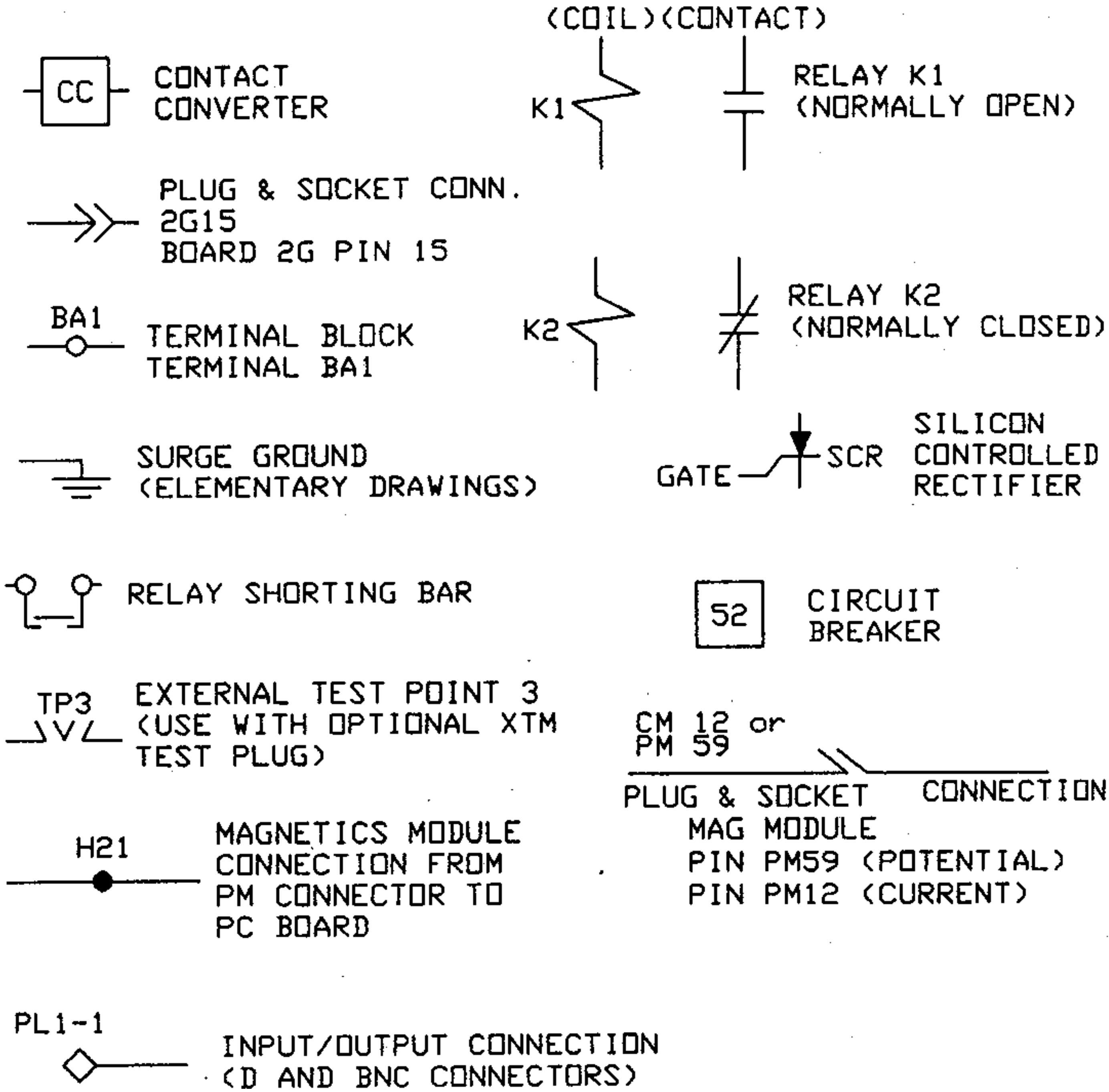


Figure 1–7. (0286A2925) Digital relay symbol legend. (sh.. 2 of 2)

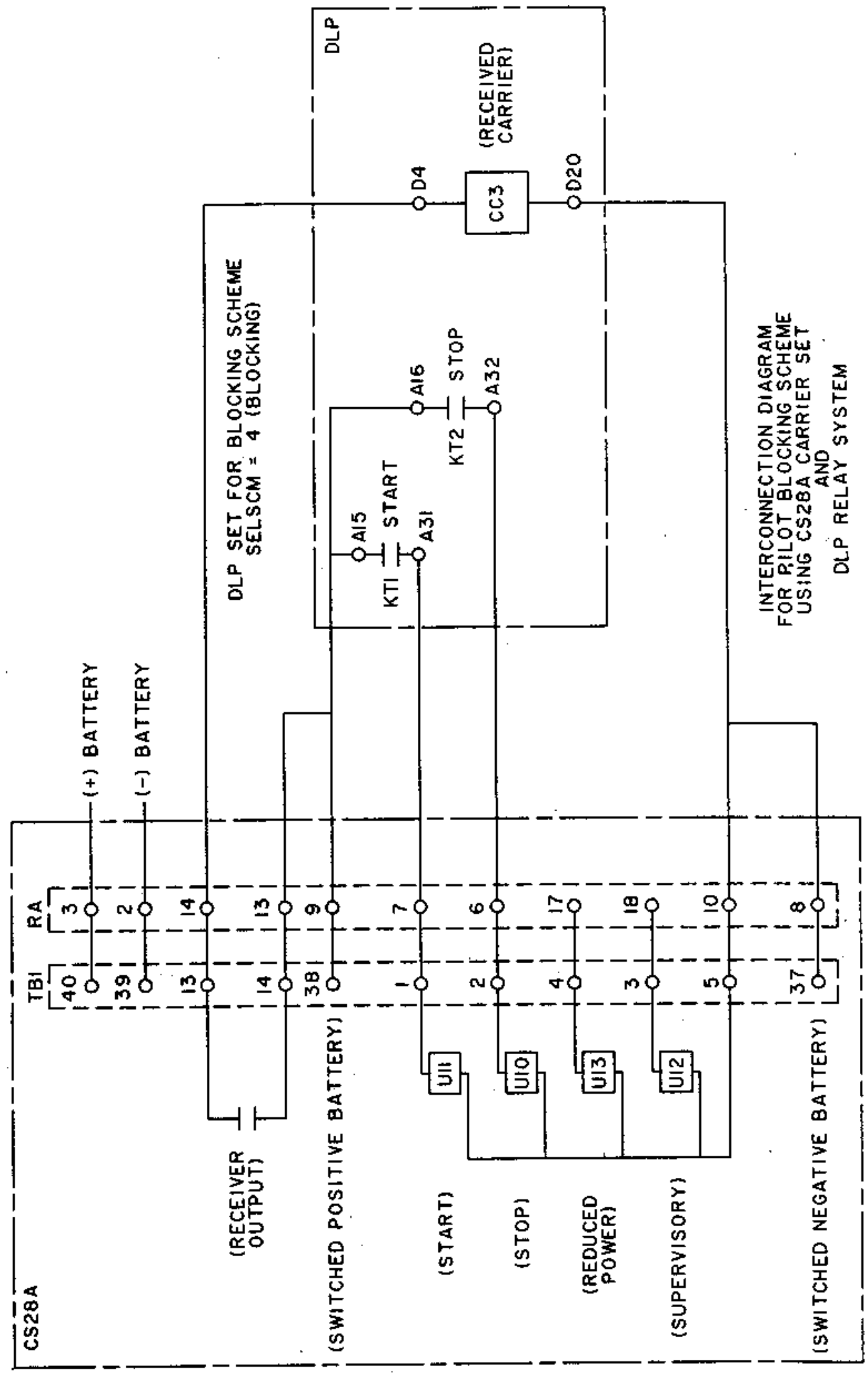


Figure 1–8. Blocking protection scheme interconnections.

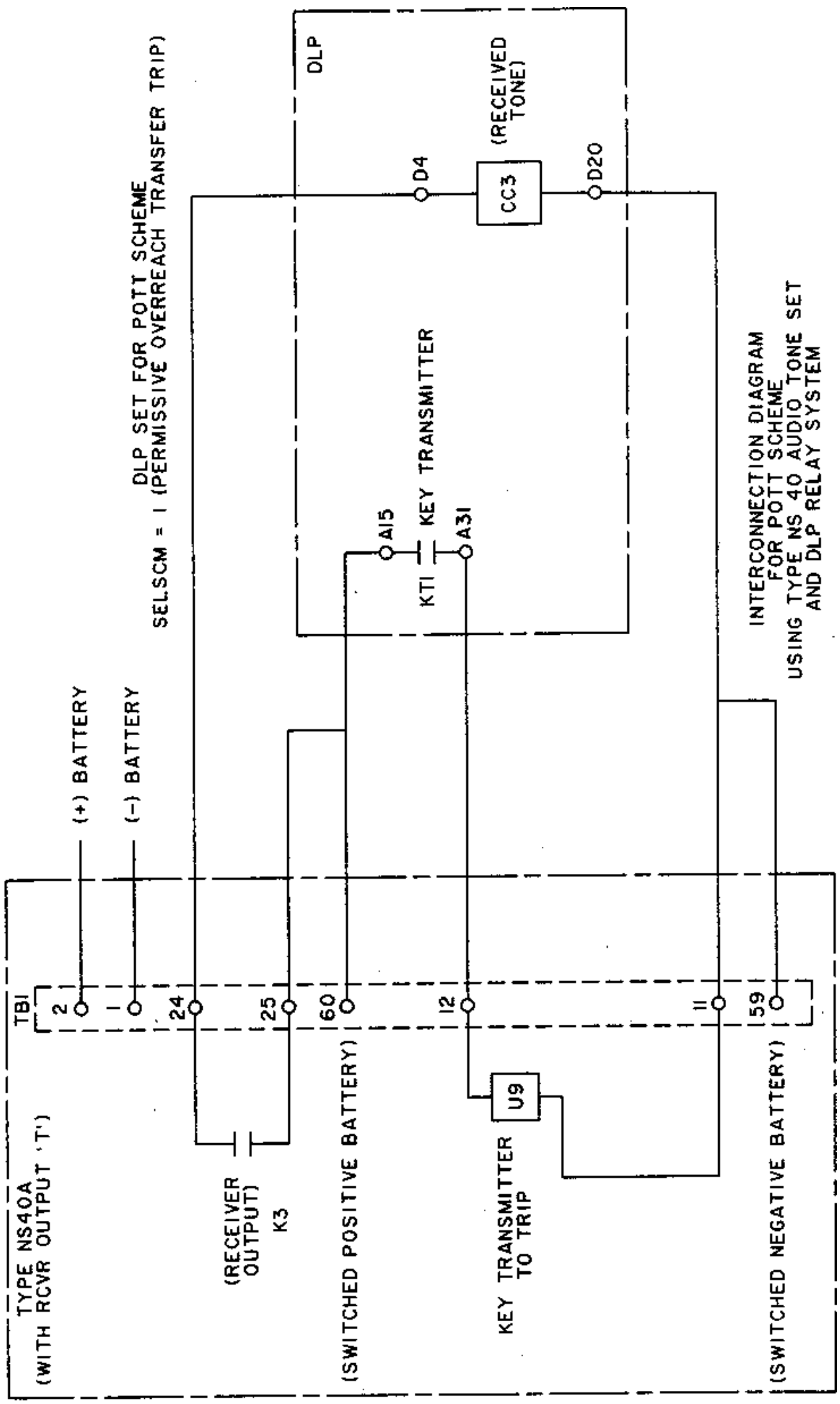


Figure 1–9. POTT protection scheme interconnections.

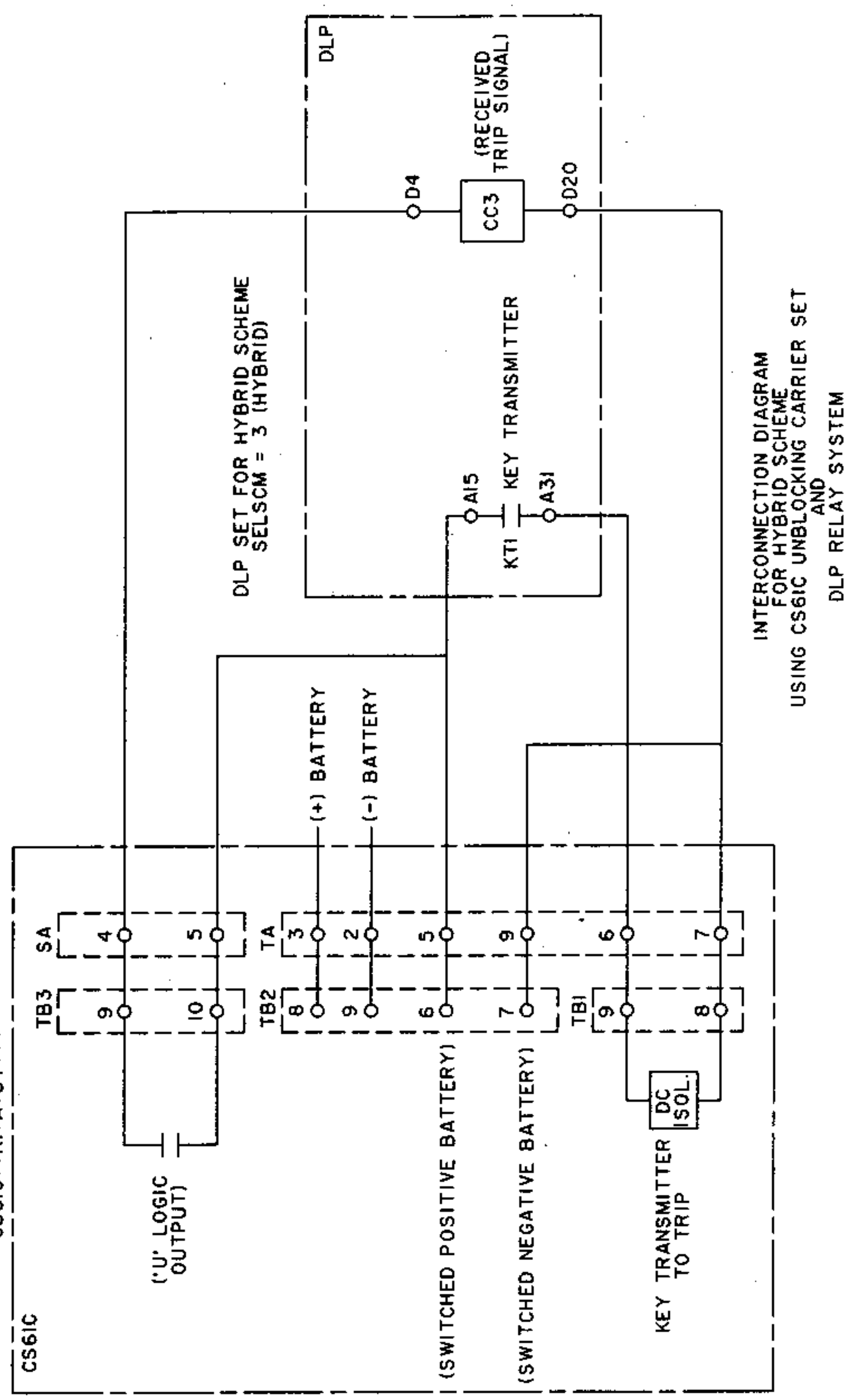


Figure 1–10. Hybrid protection scheme interconnections.

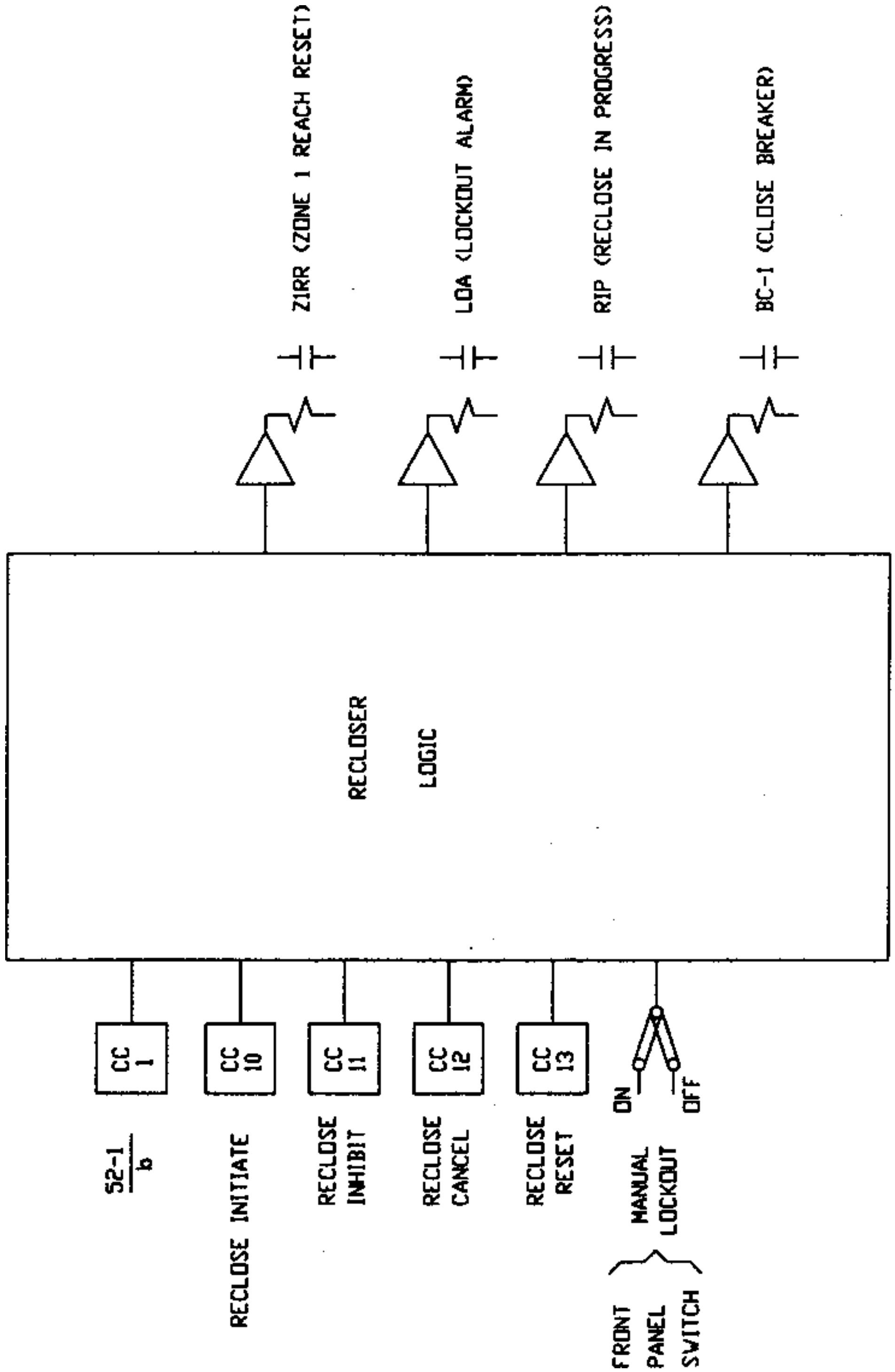


Figure 1–11. (0215B8674) Recloser input/output diagram.

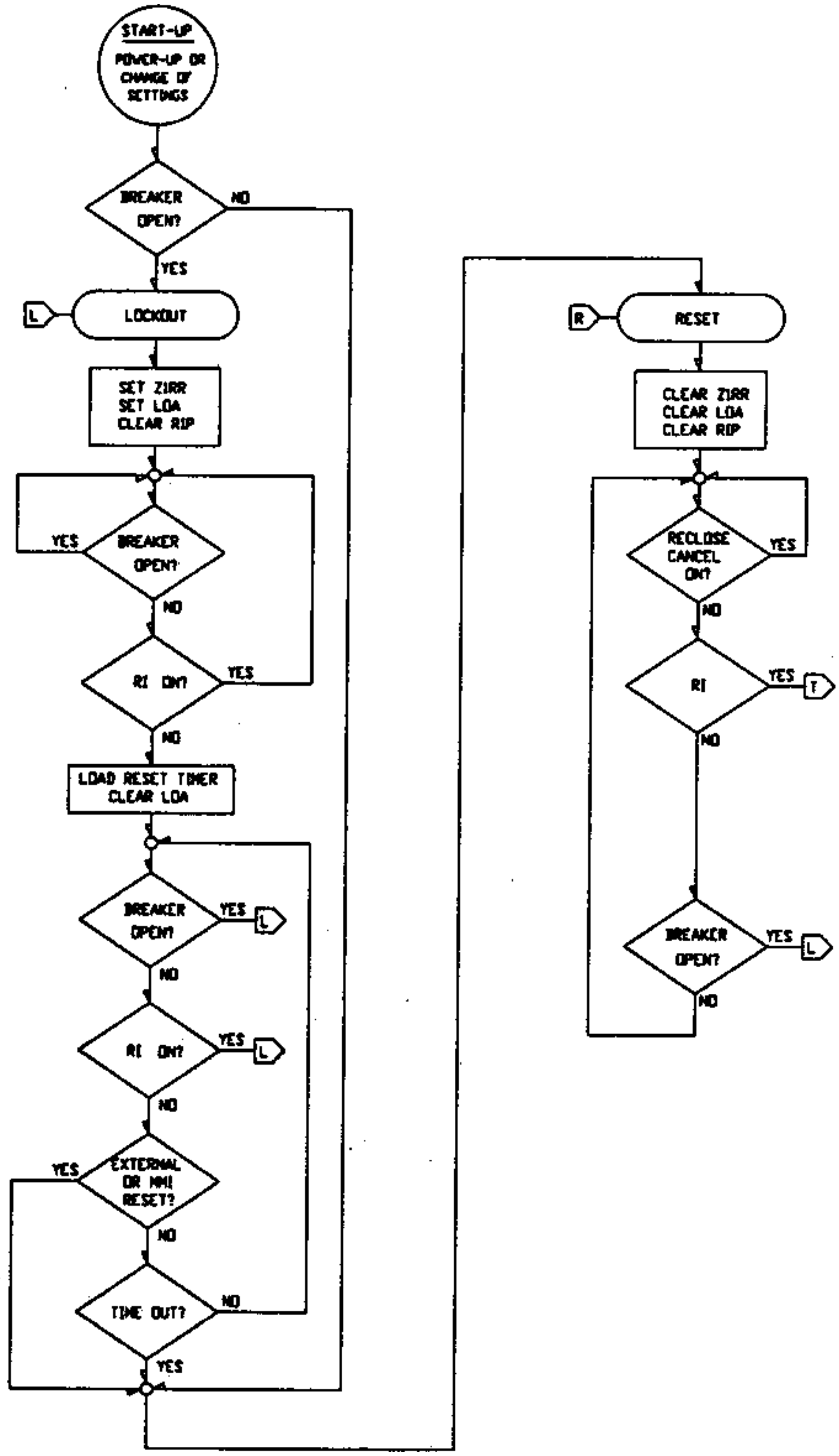


Figure (0215B8675) 1–12. Recloser flow chart. (sh. 1 of 3)

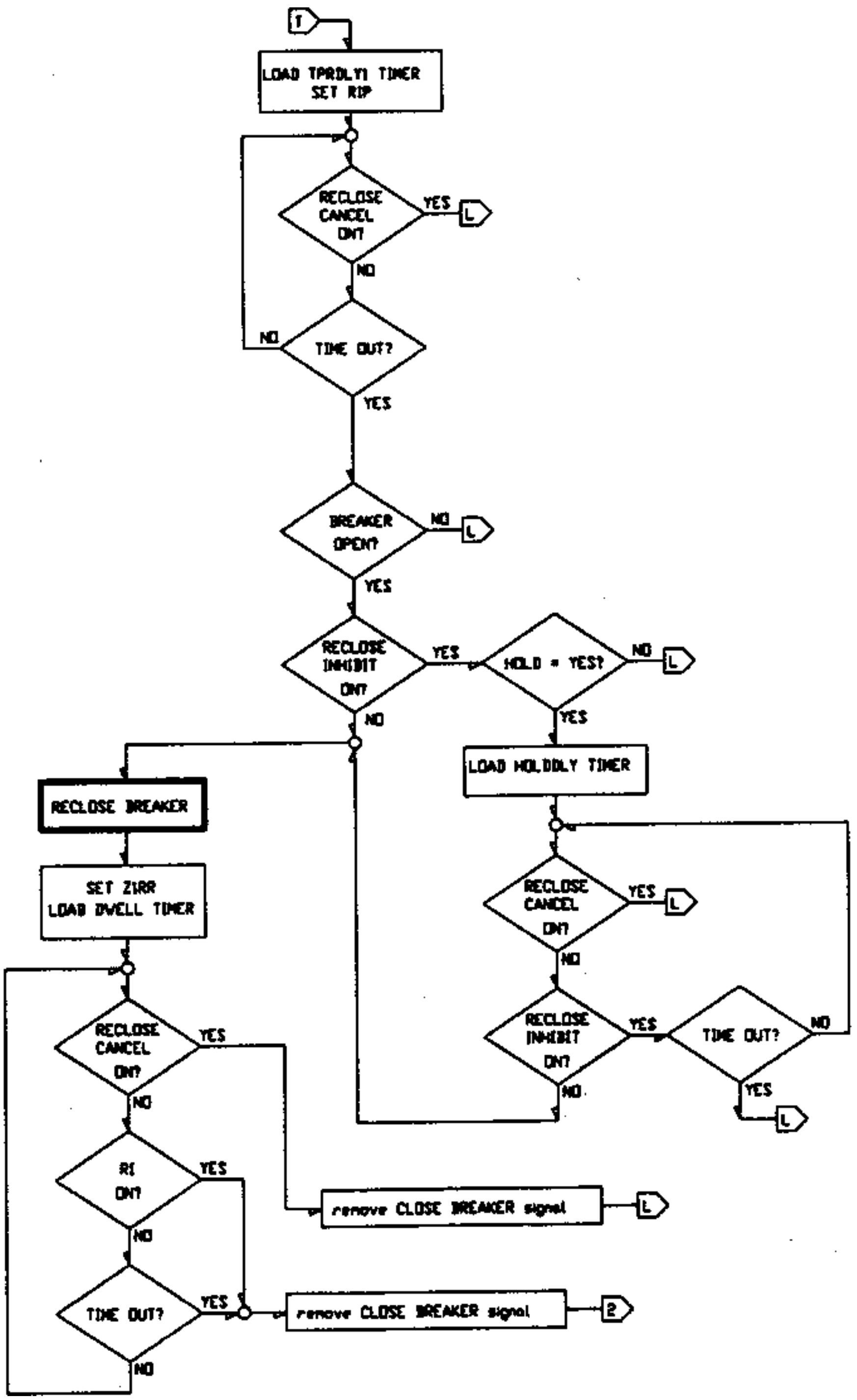


Figure (0215B8675) 1–12. Recloser flow chart.(sh. 2 of 3)

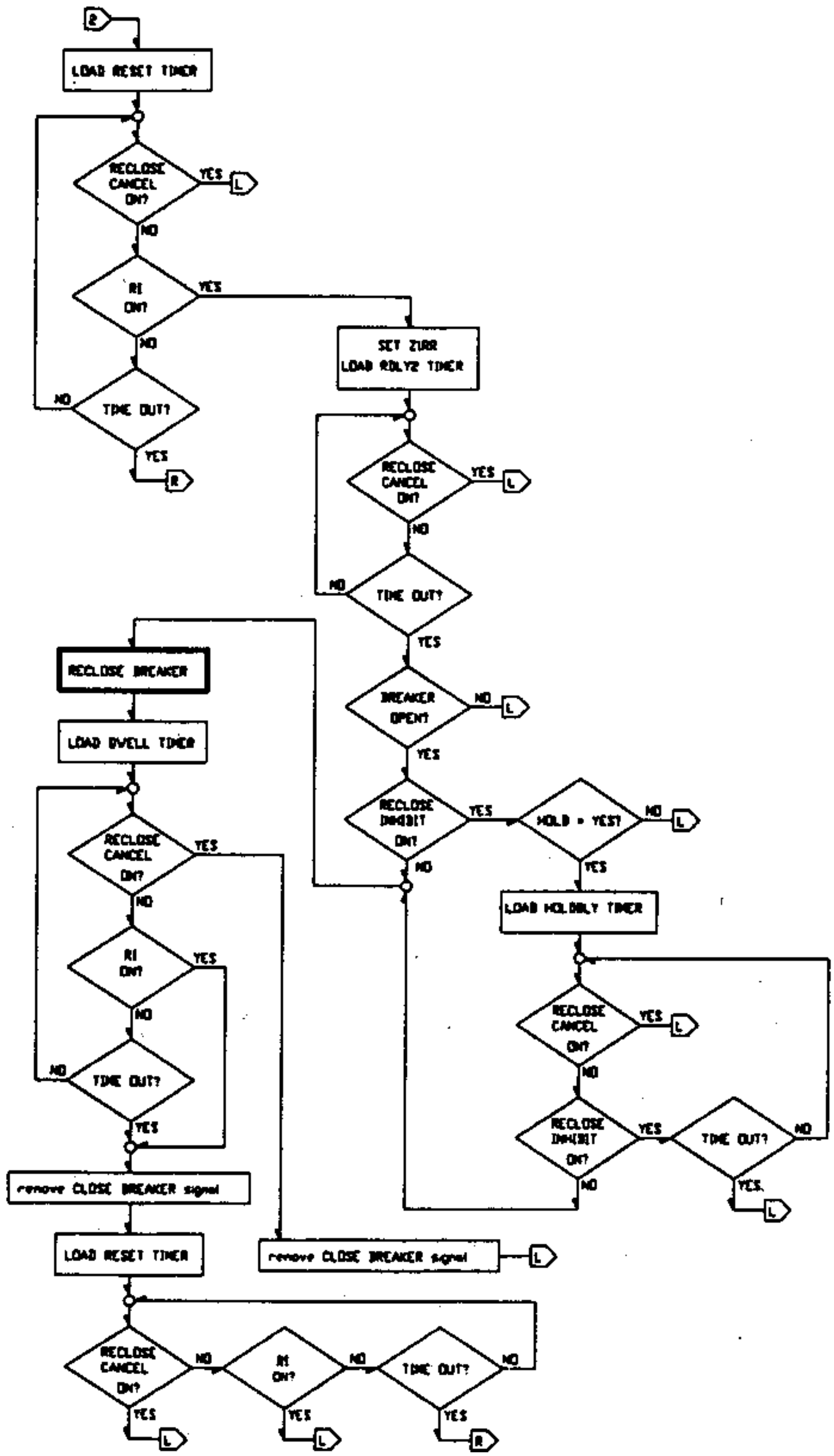


Figure (0215B8675) 1–12. Recloser flow chart.(sh. 3 of 3)

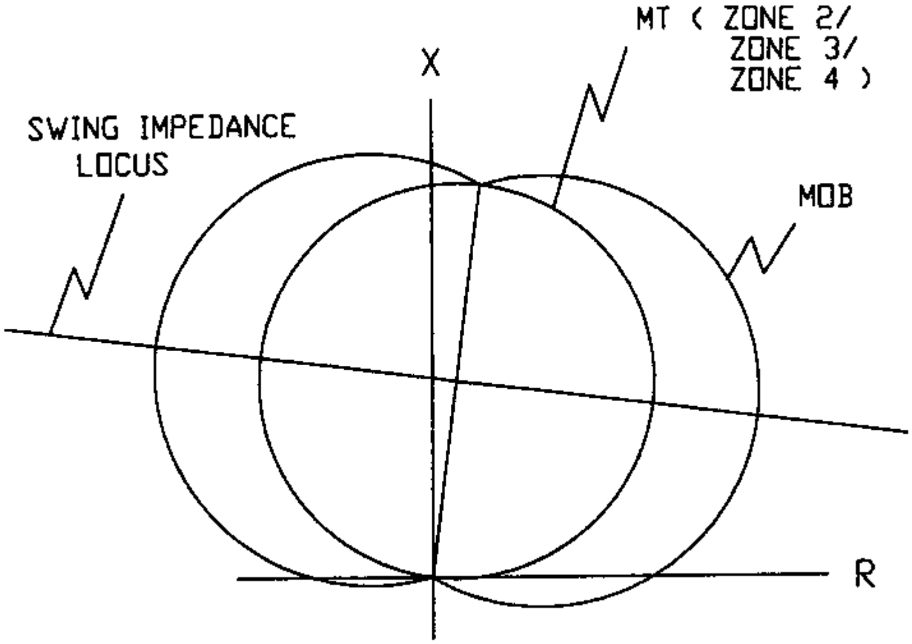


Figure 1–13. (0286A4816) Out-of-Step Block R-X diagram.

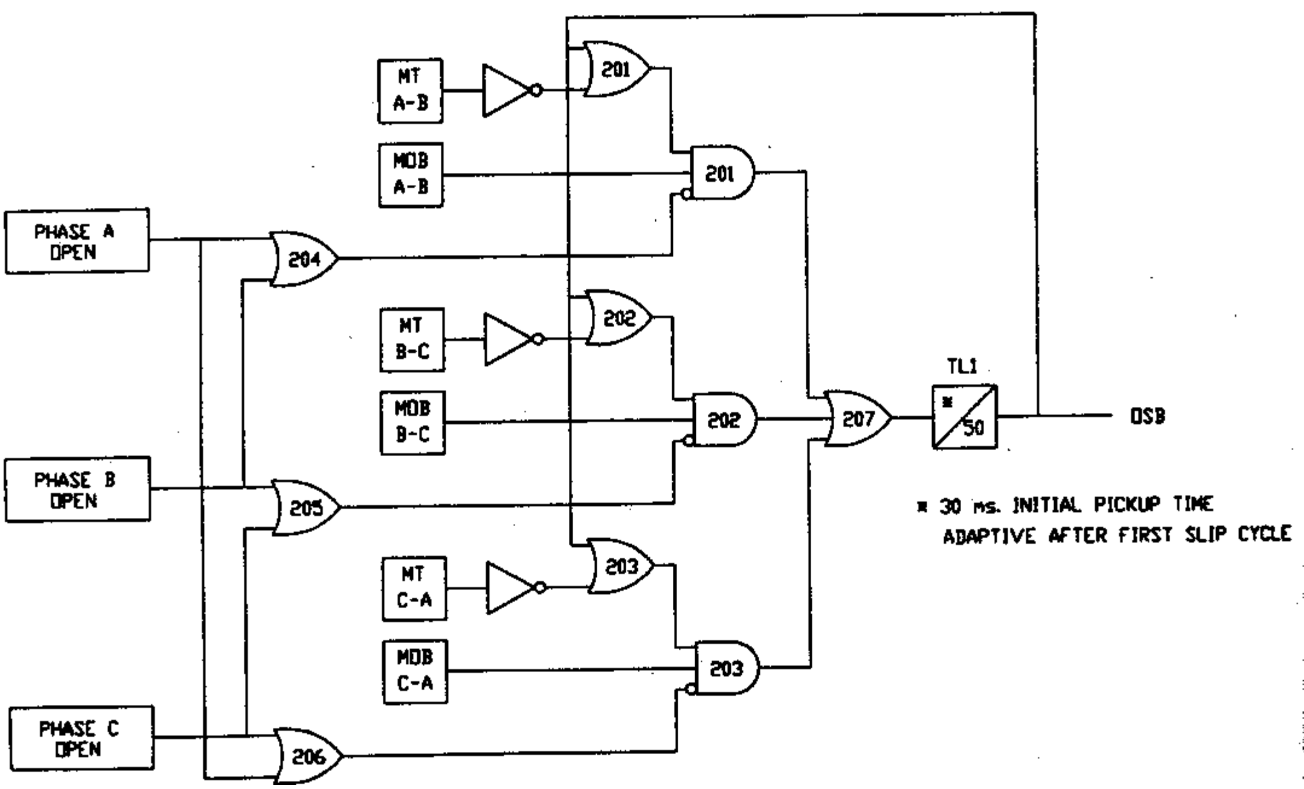


Figure 1–14. (0215B8616) Out-of-Step Block logic diagram.

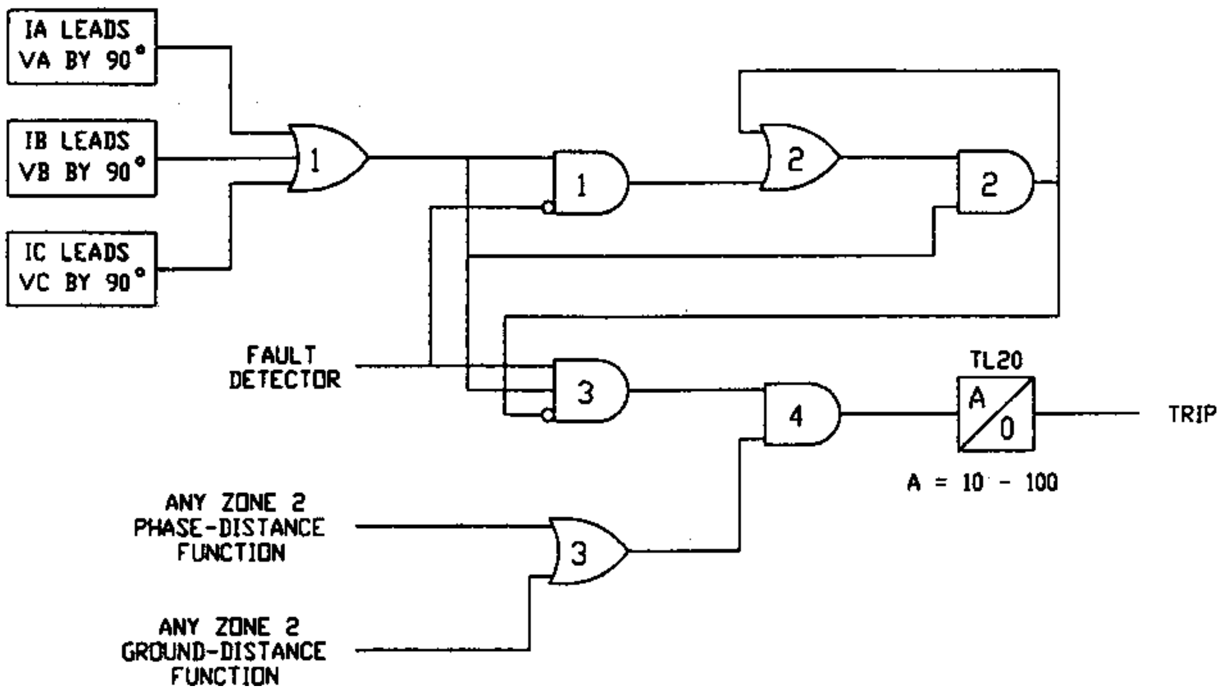


Figure 1–15. (0215B8619) Remote Open logic diagram.

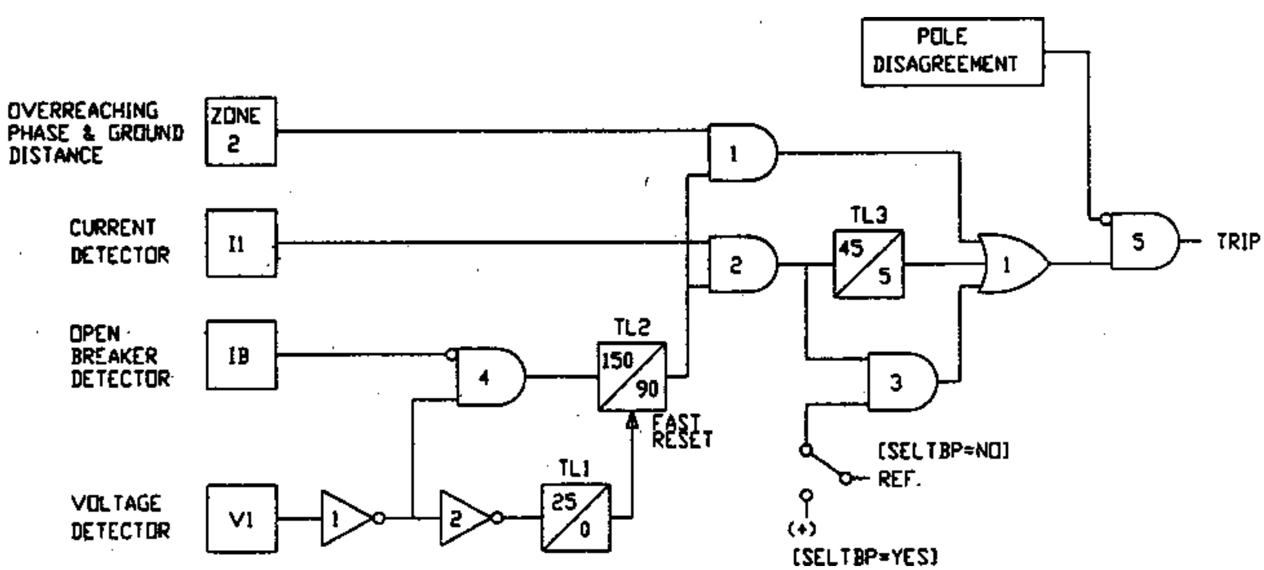


Figure 1–16. (0215B8615) Line Pickup logic diagram.

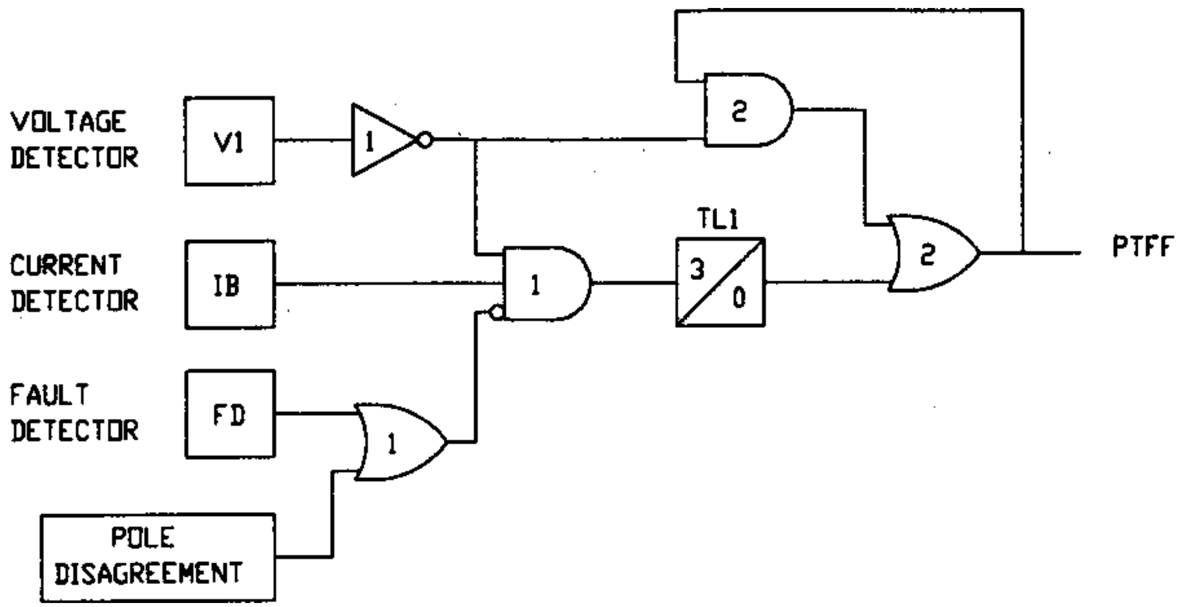


Figure 1–17. (0215B8617) PT Fuse Failure logic diagram.

TRUTH TABLE

CC5 --> bit 1

CC6 --> bit 0

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

SG

SETTINGS GROUP SWITCH 16SB1______					
CONTACT NUMBER		G4	G3	G2	G1
1 ⊣⊢ ⊣⊢ 2	1	X	X		
	2				
3 ⊣⊢ ⊣⊢ 4	3	X		X	
	4				

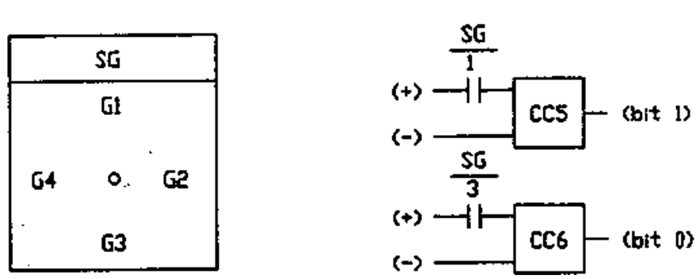


Figure 1–18. (0286A4817) Switch selection of active settings group.

2–1 Introduction

This chapter provides information for determining the required settings for the DLP3 relay system. Some settings are a function of the selected protection scheme, while others are the same, for all schemes. Certain settings are determined by user preference. For example, the Zone 1 direct trip functions may be used with a pilot blocking scheme, but is not required.

Those settings that are independent of the selected scheme are presented first, followed by scheme-dependent settings. Scheme-dependent settings are described in separate sections for each of the six possible schemes. There is a blank settings form at the end of this chapter that may be copied and used to record the required settings for a particular application.

Tables 2–1 to 2–24 list all the settings and the corresponding ranges and units for each category of settings. The column labeled Default lists the DLP3 settings stored in memory as shipped from the factory. The settings descriptions are arranged by category, corresponding to the headings on the man-machine interface (MMI).

In the following descriptions, categories and individual settings are listed by their full names, with mnemonics in parentheses in the headings and in a different typeface in the text. The mnemonics are displayed on the local MMI to identify each category or setting. Each setting is further identified by a unique number, listed in square brackets, that can be used to access it directly (see *Chapter 8 – Interface*).

Setting ranges for distance and overcurrent functions differ, depending upon whether the DLP3 model is designed for use with current transformers having a nominal 1 amp secondary rating or a nominal 5 amp secondary rating. Tables 2–1 to 2–24 list these different ranges (where applicable) under the columns labeled 5 Ampere and 1 Ampere. If the setting is the same for either case, it is centered across the two columns.

The transmission system shown in Figure 2–1 is used for determining example settings for a DLP3 relay system located at bus Able on protected line section A-B. *The current transformers are assumed to have 5-ampere-rated secondaries and the DLP3 a 5-ampere secondary rating.* Only 5-ampere ranges for distance and overcurrent functions are mentioned in the example calculations that follow.

All reach settings are in secondary values

2–2 Scheme-Independent Settings

This section contains descriptions of the settings that must or may be used with all protection schemes.

Configuration (CONFIG) Settings

Following are descriptions of the settings available under the Configuration category *Table 2–15*.

Unit ID Number (UNITID) [1501]

UNITID is a decimal number between 0 and 9999 that uniquely identifies a DLP3 relay system and which is stored in nonvolatile memory. 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 at the keypad of the local MMI. It is not possible to change UNITID via DLP-LINK communications software. For models ending with NC, the UNITID cannot be changed. The factory set UNITID can be viewed through th Request Line/ Station ID menu item under Information in the Relay functions menu of DLP-LINK

System Frequency (SYSFREQ) [1502]

SYSFREQ can be set to either 50 or 60 Hz. When this setting is changed, the DLP3 must be reinitialized by cycling the power off and on.

Number of Breakers (NUMBKRS) [1503]

NUMBKRS can be set to either 1 or 2, with the following results:

- 1 – the TRIP and CLOSE commands only activate their respective BREAKER 1 outputs.
- 2 – the TRIP and CLOSE commands selectively activate either the BREAKER 1 or BREAKER 2 outputs.

[Continued on p. 10.]

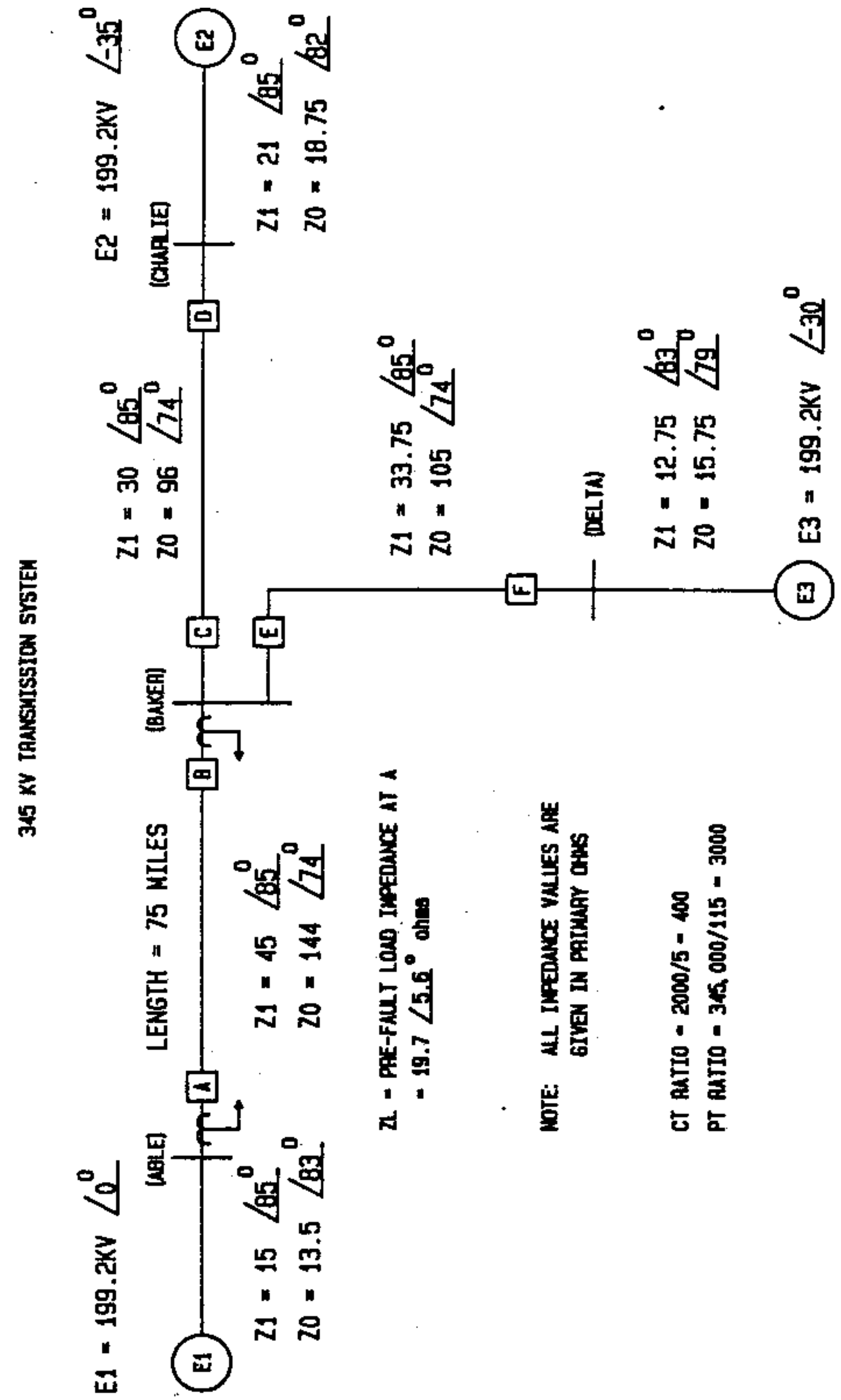


Figure 2–1. (0286A2912)Sample 345 kV system.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–1. Ranges and default values for the Z1DIST (Zone 1 Distance) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–2. Ranges and default values for the Z2DIST (Zone 2 Distance) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	
0307	Z3PANG	90, 105, 120		deg	90	
0308	Z3GANG	90, 105, 120		deg	90	

Table 2–3. Ranges and default values for the Z3DIST (Zone 3 Distance) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
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)	

Table 2–4. Ranges and default values for the Z4DIST (Zone 4 Distance) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
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

Table 2–5. Ranges and default values for the CURSUPVIS (Overcurrent Pilot / Supervision) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
0601	SELPH4	YES, NO		N/A	YES	
0602	PUPH4	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	
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	

Table 2–6. Ranges and default values for the OVERCUR (Overcurrent Backup) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–7. Ranges and default values for the BLKRECLOS (Reclosing) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–8. Ranges and default values for the OUTOFSTEP (Out-of-Step Blocking) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
0901	SELLPU	YES, NO		N/A	YES	
0902	SELTBP	YES, NO		N/A	YES	
0903	PUI1	1.0–15.0	0.2–3.0	amps	5.0	1.0

Table 2–9. Ranges and default values for the LINEPU (Line Pickup) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
1001	SELROD	YES, NO		N/A	YES	
1002	PUTLB	10–100		msec	100	
1003	SELFFB	YES, NO		N/A	YES	

Table 2–10. Ranges and default values for the REMOTEOPEN (Remote Open Detector) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
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	

Table 2–11. Ranges and default values for the LINEOVRLD (Line Overload) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
1201	SELSCM	0 (STEPDST), 2 (PUTT), 4 (BLK1), 6 (BLK2),	1 (POTT), 3 (HYBRID), 5 (ZNE1EXT) 7 (BLK3)	N/A	0 (STEPDST)	
1202	NUMRCVR	0, 1, 2		N/A	0	

Table 2–12. Ranges and default values for the SCHEMESEL (Scheme Selection) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
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	

Table 2–13. Ranges and default values for the SCHEMETIM (Scheme Logic Timers) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
1401	POSANG	45–90		deg	85	
1402	ZERANG	45–90		deg	75	
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	

Table 2–14. Ranges and default values for the LINEQTY (Line Quantities) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
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 (see note below)	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	

Table 2–15. Ranges and default values for the CONFIG (Configuration) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
1601	FLTLOCK	0–99.9		sec	0	
1602	FLTRESET	0–999		min	0	

Table 2–16. Ranges and default values for the SCADATA (SCADA DTA Interface) category.

Setting		Range			Default	
No.	Mnemonic	5 Ampere	1 Ampere	Units	5 Ampere	1 Ampere
1701	CONCCI	0–8		N/A	3	
1702	SETGRP	0–4		N/A	1	

Table 2–17. Ranges and default values for the CFGINPUTS (Configurable Inputs) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–18. Ranges and default values for the BKR1CLSOUT (Breaker 1 Close / Configurable Output) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–19. Ranges and default values for the BKR2CLSOUT (Breaker 2 Close / Configurable Output) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	
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	

Table 2–20. Ranges and default values for the RCANCLOUT (Reclose Cancel / Configurable Output) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–21. Ranges and default values for the LNOVLDOUT (Line Overload / Configurable Output) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–22. Ranges and default values for the NONCRITOUT (Noncritical Alarm / Configurable Output) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
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	

Table 2–23. Ranges and default values for the RINITOUT (Reclose Initiate / Configurable Output) category.

Setting		Range		Units	Default	
No.	Mnemonic	5 Ampere	1 Ampere		5 Ampere	1 Ampere
2401	SELRCLR	0 (NONE), 1 (OFF), 3 (1-TPOLE), 6 (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	

Table 2–24. Ranges and default values for the RECLOSER (Recloser) category.

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.

When the DLP3 is connected to a single breaker, set NUMBKRS to 1. When the DLP3 is connected to two breakers in breaker-and-a-half or ring bus arrangements, set NUMBKRS to 2. A relay trip causes both of the appropriate phase trip contacts or SCRs to operate, regardless of the NUMBKRS setting.

NUMBKRS also affects the optional recloser, as follows:

- If NUMBKRS = 1, then the recloser operates as defined by its settings (2401–2408).
- If NUMBKRS = 2, then setting 2401, SELRCLR, is automatically set to 0 (NONE), which disables the recloser.

Trip Circuit Monitor (TRIPCIRC) [1504]

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 Figures 1–1, 1–2, 1–3, 1–4, and 1–4) for which the function is active. For instance, with TRIPCIRC = 1 a separate trip circuit monitor function is active for each of the three trip contacts (or SCRs) associated with breaker 1.

Select Primary/Secondary Units (SELPRIM) [1505]

SELPRIM can be set to either 0 (CVT PRI), 1 (CVT SEC), 2 (PT PRI), or 3 (PT SEC). This setting determines two different aspects of the DLP3's operation. First, the setting determines how PRESENT VALUES (currents, voltages, watts, and vars) are displayed.

- SELPRIM = 0 or 2, the PRESENT VALUES are displayed and stored as primary values.
- 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 setting.

This setting also 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 is slower at lower values of operating signal (IZ-V) where the transient error signals associated with CVTs become significant.
- Always set SELPRIM = 0 or 1 when CVT's are used.. A setting of SELPRIM = 2 or 3 may result in Zone 1 overreach for line-end faults.

Current Transformer Ratio (CTRATIO) [1506]

CTRATIO has a setting range of 1–5000.

Potential Transformer Ratio (PTRATIO) [1507]

PTRATIO has a setting range of 1–7000.

Units of Distance (DISTUNIT) [1508]

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

Communications Port (COMMPORT) [1509]

COMMPORT sets the baud rate, parity, and stop bits for all three of the DLP3's RS232 serial ports. The setting format is xxyz, corresponding to the following:

- 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

The baud rate setting must match the baud rate of the modem or serial device connected to any of the three RS232 serial ports (PL-1, PL2, or the front port) 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 may require 2 stop bits. DLP-LINK communications software can be configured to match this DLP3 settings for baud rate, parity, and stop bits. The DLP3 settings must match the setting of the ASCII device connected to port PL-2.

COMMPORT can only be changed via the keypad of the local MMI, or for models ending in NC, via jumpers. It is not possible to change COMMPORT with the 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.

Phase Designation (PHASDESG) [1510]

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 faulted phase or phase pair in the appropriate way.

Select Time Synchronization {SELTSYNC) [1511]

SELTSYNC determines the method of synchronizing the DLP3's internal clock. It can have the following settings:

0 (INTERNAL) – lets the clock run freely from the internal oscillator.

1 (IRIG-B) – synchronizes the clock using an IRIG-B signal connected directly to the DLP3 relay via port PL-4.

2 (G-NET) – synchronizes the clock using a signal on pin 25 of RS232 port PL-1, when connected to a G-NET host computer.

Number of Faults (NUMFLTS) [1512]

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 are stored in memory, the oscillography data associated with a subsequent storage event overwrites the data from the first (oldest).

This setting apportions a fixed amount of memory into different sized blocks for oscillography storage. Table 2–25 shows the total number of oscillography cycles allowed per storage event as a function of NUMFLTS.

NUMFLTS	Cycles Stored
2	72
4	36
7	18
14	9

Table 2–25. Number of fault cycles stored as a function of NUMFLTS setting.

Prefault Cycles (PREFLT) [1513]

PREFLT selects the number of pretrigger (or prefault) cycles in each oscillography data set. It can have a value of 1–8. PREFLT determines how many of the storage cycles set by NUMFLTS are pretrigger cycles.

Oscillography Trigger (OSCTRIG) [1514]

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 *Chapter 1 – Product Description* for further explanation. OSCTRIG may have the following settings:

0 (NONE)

1 (FLTDET) – 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

6 (V1 DET) – Positive-sequence under-voltage function

Current Unbalance Alarm, (UNBALALM) [1515]

UNBALALM can be set to:

- YES In service
- NO Not in service

Example Settings for Configuration Category

The following are examples of settings for the sample system in Figure 2–1.

- 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

Line Quantities (LINEQTY) Settings

Following are descriptions of the settings available under the Line Quantities category *Table 2–14*.

Positive-Sequence Angle of Maximum Reach (POSANG) [1401]

POSANG has a setting 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.

Zero-Sequence Angle of Maximum Reach (ZERANG) [1402]

ZERANG has a setting 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.

Positive-Sequence Impedance (ZP) [1403]

ZP has a setting range of 0.01–50.00 ohms. It should be set for the positive-sequence impedance of the protected line.

Zero-Sequence Current Compensation (K0) [1404]

K0 has a setting 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 to the value,

$$K0 = \frac{Z0L}{Z1L}$$

where:

Z0L = the zero-sequence impedance of the line

Z1L = the positive-sequence impedance of the line.

Line Length (LINELEN) [1405]

LINELEN has a setting range of 0.0–200.0 miles or 0.0–322.0 kilometers. This setting is the physical length of the protected line and is used to report the fault location in miles or kilometers from the relay location.

Example Settings for Line Quantities Category

The following are examples of settings for the sample system in Figure 2–1.

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

Overcurrent Backup (OVERCUR)

Following are descriptions of the settings available under the Overcurrent Backup category *Table 2–6*.

Select Phase Instantaneous Overcurrent, PH4 (SELPH4) [0601]

SELPH4 can be set to either YES or NO, to put the PH4 function either in or out of service.

Phase Instantaneous Overcurrent Setting (PUPH4) [0602]

Since PH4 is a nondirectional direct-trip function, it must be set to not 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 multiphase faults and 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 multiphase 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 has a setting range of 2.0–100.0 amps.

Select Ground Instantaneous Overcurrent, IDT (SELIDT) [0603]

SELIDT can be set to either YES or NO, to put the IDT function either in or out of service.

Directional Control of IDT (SELDIDT) [0604]

SELDIDT can be set to either YES or NO:

YES – IDT is directionally controlled.

NO – IDT is nondirectional.

Ground Instantaneous Overcurrent Setting (PUIDT) [0605]

The considerations used to determine the IDT setting depend on whether IDT is nondirectional or is directionally controlled, as follows:

- If IDT is nondirectional, then it must be set to not 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 to not operate, considering only the worst-case external fault 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 given by

$$3 \times |I_0| - 3 \times KD \times |I_1|$$

where:

KD = 0 or 0.3.

When KD is set to 0.3, positive-sequence current restraint provides 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 operating signal plus a margin of 25% of the 3 |I0| value from this same maximum operating signal, as given by

$$PUIDT = 3 \times |I_0| - 3 \times KD \times |I_1| + 0.25 \times 3 \times |I_0|$$

When KD is set to 0, the setting is based on 3 |I0|. PUIDT has a setting range of 0.5–80.0 amps.

Select Ground Time Overcurrent, TOC (SELTOC) [0606]

SELTOC can be set to either YES or NO, to put the TOC function either in or out of service.

Select Directional Control of TOC (SELDTOC) [0607]

SELDTOC can be set to either YES or NO:

YES – TOC is directionally controlled.

NO – TOC is nondirectional.

Ground Time Overcurrent Setting (PUTOC) [0608]

The TOC function provides time-delayed backup tripping for single-line-to-ground faults. Its operating quantity is

$$3 \times |I0|$$

The curve shape used for TOC is determined by the SELCURV setting, as described below. PUTOC has a setting 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.

Ground Time Overcurrent Time Dial (TDTOC) [0609]

TDTOC selects the time-dial setting for the TOC function. TDTOC has a setting 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.

Definite Time Delay (PUTTM) [0610]

When the TOC function is selected to have a definite time characteristic, PUTTM determines the associated fixed time delay. PUTTM has a setting range of 0.5–30.0 seconds.

Select TOC Characteristic Curve (SELCURV) [0611]

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

0 (INV) – inverse curve, Figure 2–2.

1 (V-INV) – very inverse curve, in Figure 2–3.

2 (E-INV) – extremely inverse, Figure 2–4.

3 (CUSTOM) – user-defined custom curve.

4 (DEFT) – definite time.

A 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.

Select IDT Restraint Constant, KD (KDCONST) [0612]

KDCONST can be set to 0.0 or 0.3 to determine whether or not a portion of the positive-sequence current, 3 KD |I1|, is used to restrain the operating quantity, 3 |I0|.

Example Settings for Overcurrent Backup Category

The following are examples of settings for the sample system in Figure 2–1.

- SELPH4 = YES

The three-phase fault currents at the two protected-line busses are as follows:

- 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 x 1.732 x 8.3 = 18.0 amps
- SELIDT = YES

Table 2–26 lists the results of the evaluation of the IDT operate quantity,

$$3 \times |I0| - 3 \times KD \times |I1|$$

where KD = 0.3, for phase A-to-ground faults at the two protected-line busses under the conditions indicated.

- SELDIDT = NO
- PUIDT = 3.79 + (0.25 X 5.41) = 5.14 amps
- SELTOC = YES
- SELDTOC = YES

It is assumed that 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

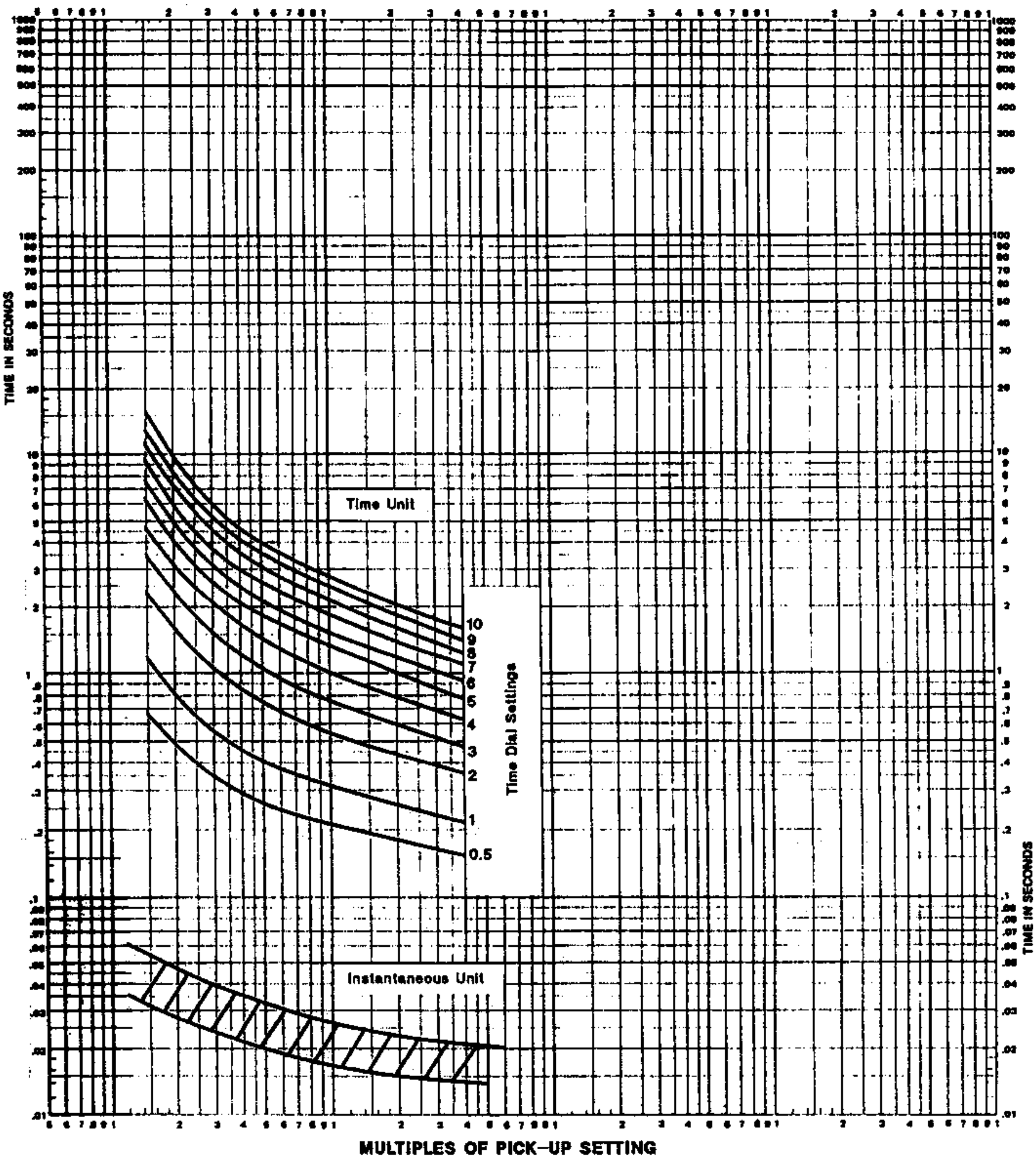


Figure 2–2. Inverse time-current curve (GES–9857).

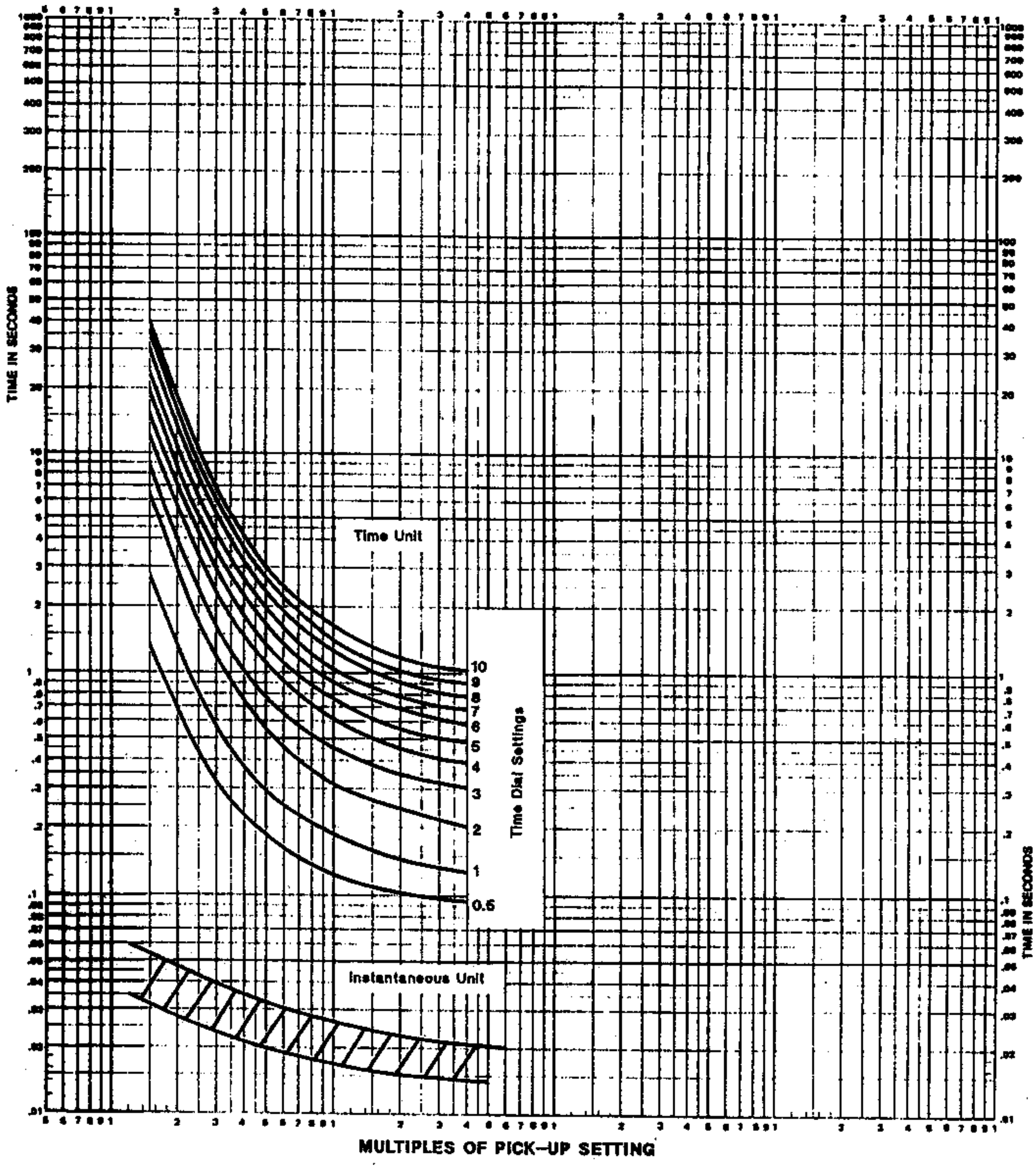


Figure 2–3. Very inverse time-current curve (GES–9858).

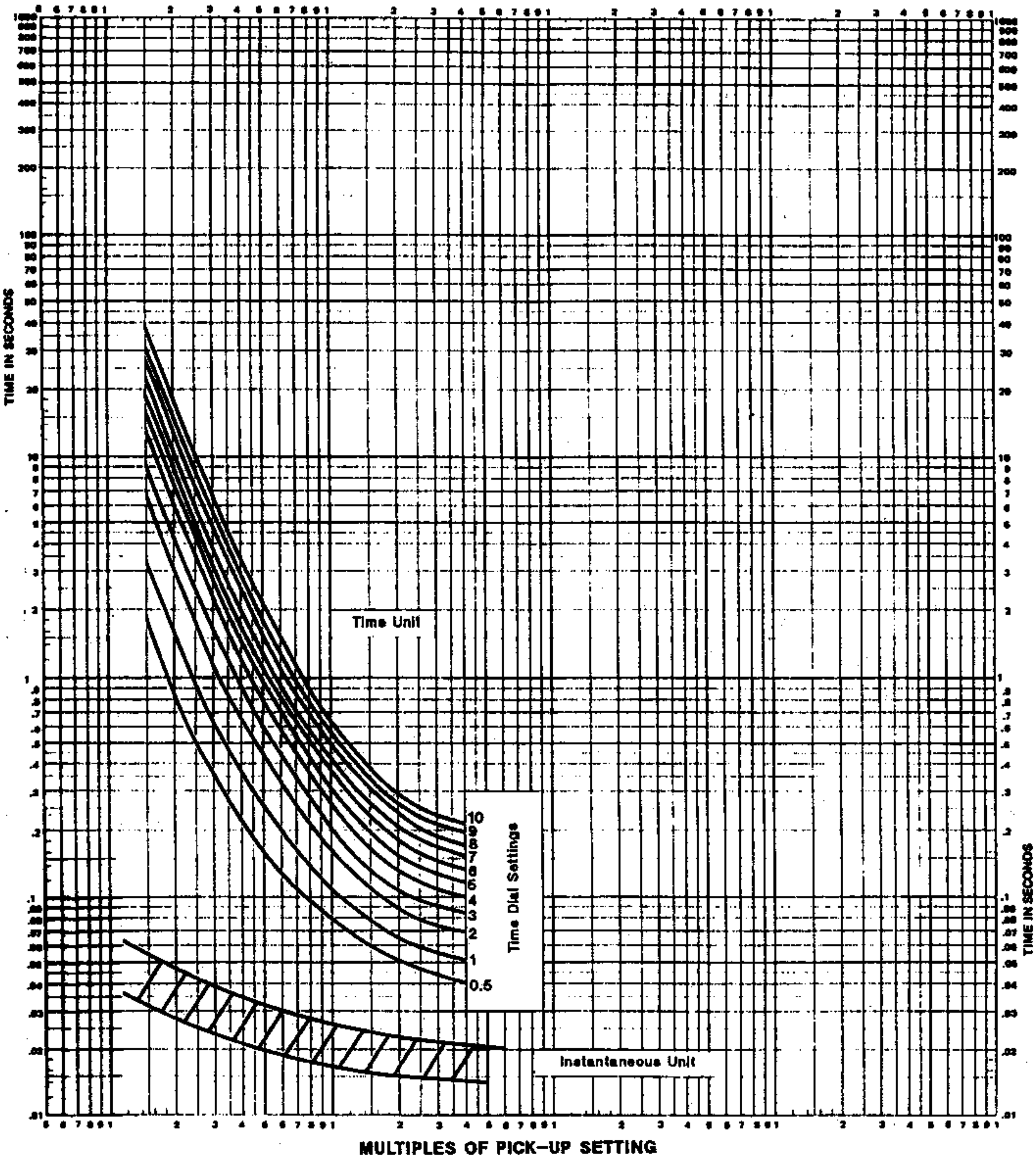


Figure 2–4. Extremely inverse time-current curve (GES–9859).

Fault Bus	Status of Breaker C	Status of Breaker E	Load?	3 |I0|	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 the equivalent source impedance.

Table 2–26. Evaluation of the IDT operate quantity for the sample system.

Line Pickup (LINEPU)

Following are descriptions of the settings available under the Line Pickup category *Table 2–9*.

Select Line Pickup (SELLPU) [0901]

SELLPU can be set to either YES or NO, to put the Line Pickup function either in or out of service.

Select Timer Bypass (SELTBP) [0902]

SELTBP controls whether the coordinating timer TL3 in Figure 1-15 is bypassed (YES)or 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 the load current that might be present immediately after picking up the line. SELTBP should be set to YES, to bypass coordinating timer TL3 to obtain faster tripping, if any of the following conditions are met:

- I1 can be set with a pickup of at least 110% of the maximum load current.
- Sequential reclosing is used.
- There is no automatic reclosing.

Positive-Sequence Overcurrent, I1, Setting (PUI1) [0903]

I1 is the overcurrent trip unit within the Line Pickup function. It operates on the magnitude of the positive-sequence current. PUI1 has a setting 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.

Example Settings for Line Pickup Category

The following are examples of settings for the sample system in Figure 2–1.

- SELLPU = YES

The three-phase fault current for a fault just in front of the 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

Line Overload (LINE OVRLD)

The Line Overload function consists of two overcurrent units, Level 1 and Level 2, with independent time delays. There is one alarm contact output that 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.

Following are descriptions of the settings available under the Line Overload category *Table 2–11*.

Select Line Overload (SELOVL) [1101]

SELOVL can be set to either YES or NO to put the Line Overload function either in or out of service.

Level 1 Overcurrent Setting (PULV1) [1102]

PULV1 has a setting range of 2.5–20.0 amps.

Level 2 Overcurrent Setting (PULV2)]1103]

PULV2 has a setting range of 5.0–40.0 amps.

Level 1 Time Delay, TL31 (PUTL31) [1104]

PUTL31 has a setting range of 10–990 seconds.

Level 2 Time Delay, TL32 (PUTL32) [1105]

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

Example Settings for Line Overload Category

The following are examples of settings for the sample system in Figure 2–1.

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

Out-of-Step Blocking, OSB (OUTOFSTEP)

Following are descriptions of the settings available under the Out-of-Step Blocking category *Table 2–8*.

Select Phase Trip Unit to Coordinate With (SELPTZ) [0801]

SELPTZ can be set to 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 1–13). Note that the maximum reach angle 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.

Characteristic Angle (MOBANG) [0802]

This setting determines the shape of the MOB characteristic and 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 1–14, determines whether or not the OSB function will detect the fastest swing-impedance locus during the first slip cycle.

Since the initial pickup of TL1 is fixed at 30 milliseconds, 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 available, then MOBANG should 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 has a setting range of 30°–130°.

Select Block Trip Actions (SELOSB) [0803]

This setting determines which trip functions are blocked from tripping when the Out-of-Step function operates. SELOSB has the following settings:

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 instantaneous overcurrent and time overcurrent functions can produce a trip during an out of step condition.

Select Zone 1 Block, OSBLKZ1 (0804)
Select Zone 2 Block, OSBLKZ2 (0805)
Select Zone 3 Block, OSBLKZ3 (0806)
Select Zone 4 Block, OSBLKZ4 (0807)

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 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.

Example Settings for Out-of Step Blocking Category

The following are examples of settings for the sample system in Figure 2–1.

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

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

Block Reclosing (BLKRECLOS)

These settings, in *Table 2–7,* 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 Figures 1–1, 1–2, 1–3, 1–4, and 1–5.

The available settings are:

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 these can be set to either YES or NO:

YES – The signal blocks RI and operates RC.

NO – The signal has no affect on RI or RC operation.

Example Settings for Block Reclosing Category

The following is an example of a setting for the sample system in Figure 2–1.

- SELALL = YES

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

SCADA DTA Interface (SCADADTA)

Following are descriptions of the settings available under the SCADA DTA category *Table 2–16*.

SCADA DTA Fault Location Lock (FLTLOCK) [1601]

FLTLOCK can be set over the range of 0–99.9 seconds. FLTLOCK is used to specify a time period after an initial fault during which subsequent faults are prevented from updating the fault location information stored in the DTA interface.

SCADA DTA Fault Location Reset (FLTRESET) [1602]

FLTRESET can be set over the range of 0–999 minutes. FLTRESET is used to specify when the fault-location information stored in the DTA interface is reset (output forced to full-scale value) and all fault-type contacts are forced open. A setting of 0 prevents the DTA from resetting.

Example Settings for SCADA DTA Interface Category

The following are examples of settings for the sample system in Figure 2–1.

- FLTLOCK = 10 seconds
- FLTRESET = 5 minutes

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

Configurable Inputs (CNFGINPUTS)

Following are descriptions of the settings available under the Configurable Inputs category *Table 2–17*.

Configurable Input Mode (CONCCI) [1701]

CONCCI determines how the three configurable digital inputs, contact converters CC4, CC5, and CC6, are used. CONCCI has a setting range of 0–8, where the selected value chooses from nine predetermined combinations, as listed in Table 2–27.

CON CCI	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	Config 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	Config Input 1	Stop Carrier	Block Pilot Trip
6	RCVR 2	Config Input 2	Config Input 3
7	External Trigger	Config Input 2	Config Input 3
8	Config Input 1	Config Input 2	Config Input 3

Table 2–27. Settings of the configurable digital inputs according to the CONCCI setting.

The entries in Table 2–27 have the following meanings:

- 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.
- Config Input 1, 2, or 3 indicates that the external contact wired to CC4, CC5, or CC6 is used as one of the 64 input numbers associated with the Configurable Outputs (described below).
- 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 (see *Chapter 1 – Product Description* and Figure 1–18).
- 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 Trip 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).

CONCCI = 3 is the default setting as shipped from the factory. The designations for CONCCI = 3 appear on the five functional logic diagrams, Figures 1–1, 1–2, 1–3, 1–4, 1–5.

Settings Group (SETGRP) [1702]

SETGRP determines the active settings group from the four different groups that are stored in nonvolatile memory. SETGRP has the following settings:

0 Active settings group is determined by outputs from CC5 and CC6.
1 Active group is 1.
2 Active group is 2.
3 Active group is 3.
4 Active group is 4.

When a settings group is changed while the DLP3 is on line and protecting (green light ON), a Trip Bus Check is performed before the new settings become effective. Refer to *Chapter 1 – 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 in the active settings group, the new values are also stored in the other three settings groups.* SETGRP *and* CONCCI *always have the same values in all four settings groups.*

NOTE: Certain combinations of SETGRP and CONCCI are mutually exclusive. If these settings are not chosen correctly, the DLP3 will not function as intended.

- 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.

Example Settings for Settings Group Category

The following are examples of settings for the sample system in Figure 2–1.

- CONCCI = 3
- SETGRP = 1

Configurable Output #1 (BKR1CLSOUT)

Following are descriptions of the settings available under the Configurable Output #1 category *Table 2–18*.

Close Contact 1 (CONOUT1) [1801]

CONOUT1 determines how configurable output #1 is used. Its settings are illustrated in the functional logic diagram in Figure 2–5.

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.

1 The contact closes when one or more of the eight inputs to OR1 are present.

2 The contact closes when all of the eight inputs to AND1 are present.

Settings CO1IN1–CO1IN8 determine what internal DLP3 signals are routed to each of the eight inputs as explained below.

Input Number 1 (CO1IN1) [1802]

CO1IN1 has a setting range of 0 to 64. A 0 indicates that the OR or AND input is not used (the input is set to logic 0 for an OR or logic 1 for an AND). Settings 1 to 64 are selected from the DLP3 internal signals listed in Table 2–28. The logical NOT of any of the 64 inputs is selected by adding 100 to the Input Number. For example, the logical NOT of FD for input #1 is CO1IN1 = 137.

Input Number 2 (CO1IN2) [1803]

Same as CO1INI1.

Input Number 3 (CO1IN3) [1804]

Same as CO1INI1.

Input Number 4 (CO1IN4) [1805]

Same as CO1INI1.

Input Number 5 (CO1IN5) [1806]

Same as CO1INI1.

Input Number 6 (CO1IN6) [1807]

Same as CO1INI1.

Input Number 7 (CO1IN7) [1808]

Same as CO1INI1.

Input Number 8 (CO1IN8) [1809]

Same as CO1INI1.

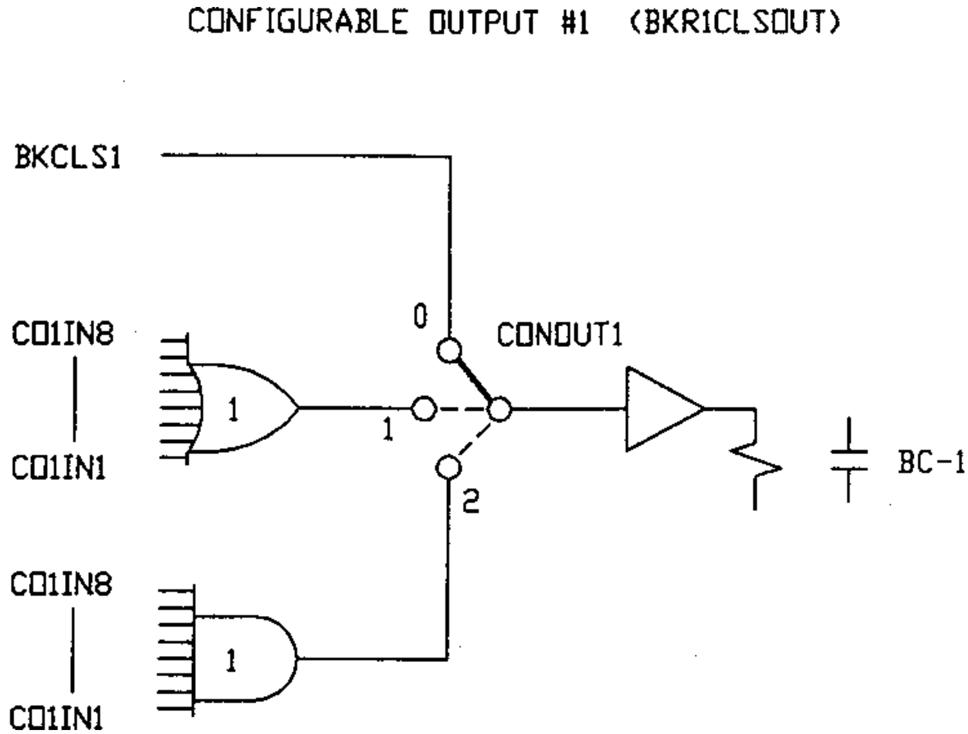


Figure 2–5. (0286A4818) Configurable Output #1 logic diagram.

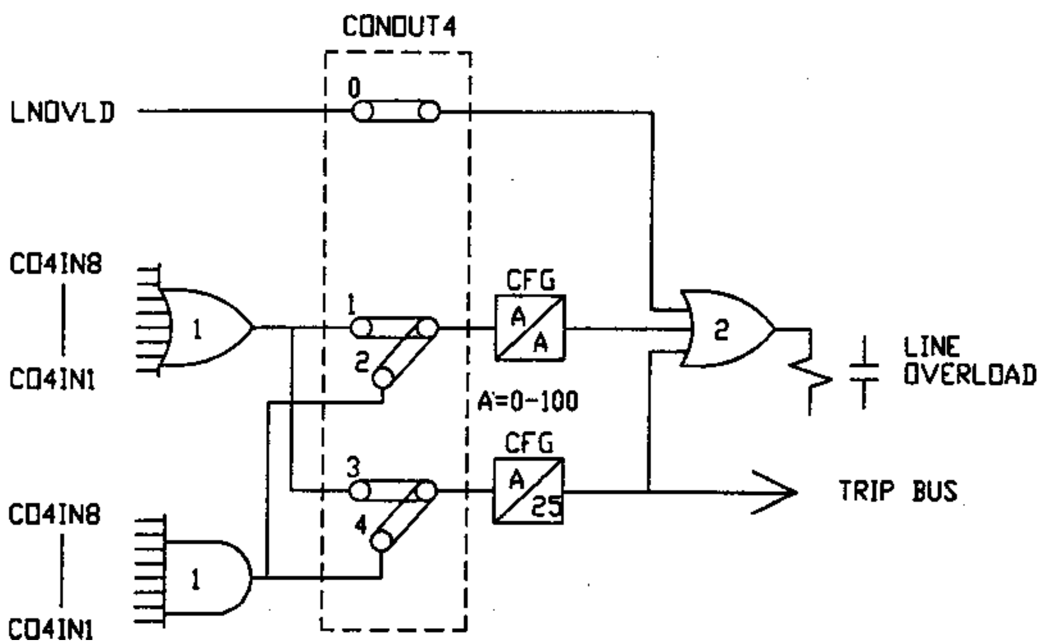


Figure 2–5a. (0286A5597) Configurable Output #4 logic diagram.

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 ZONE1 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

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	V1DET
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
CONFG. INPUT 1	50	CNFIN1
CONFG. INPUT 2	51	CNFIN2
CONFG. 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	57	TRPBFI
MAN. CLOSE BRKR. 1	58	BKCLS1
MAN. CLOSE BRKR. 2	59	BKCLS2
RI-3P	60	RECIN3
RI-1P	61	RECIN1
RECLOSER - CLOSE BRKR	62	BKRCLS
RECLOSER - CC2	63	ERCIN3
RECLOSER - CC1	64	ERCIN1

Table 2–28. Input signals available at the configurable inputs.

CONFIGURABLE OUTPUT #2 (BKR2CLSOUT)

The following nine settings, in *Table 2–19,* of Configurable Output #2 are set similarly to those of Configurable Output #1:

Close Contact 2 (CONOUT2) [1901]

Input Number 1 (CO2IN1) [1902]

Input Number 2 (CO2IN2) [1903]

Input Number 3 (CO2IN3) [1904]

Input Number 4 (CO2IN4) [1905]

Input Number 5 (CO2IN5) [1906]

Input Number 6 (CO2IN6)[1907]

Input Number 7 (CO2IN7) [1908]

Input Number 8 (CO2IN8) [1909]

CONFIGURABLE OUTPUT #3 (RCCANCLOUT)

The following nine settings, *Table 2–20,* of Configurable Output #3 are set similarly to those of Configurable Output #1:

Reclose Cancel (CONOUT3) [2001]

Input Number 1 (CO3IN1) [2002]

Input Number 2 (CO3IN2) [2003]

Input Number 3 (CO3IN3) [2004]

Input Number 4 (CO3IN4) [2005]

Input Number 5 (CO3IN5) [2006]

Input Number 6 (CO3IN6)[2007]

Input Number 7 (CO3IN7) [2008]

Input Number 8 (CO3IN8) [2009]

CONFIGURABLE OUTPUT #4 (LNOVLDOUT)

Following are descriptions of the settings available under the Configurable Output #4 category *Table 2–21*.

Line Overload (CONOUT4) [2101]

CONOUT4 determines how configurable output #4 is used. Its settings are illustrated in the functional logic diagram in Figure 2–5a.

0 (used as Line Overload, the default setting)
1 (energized by an 8-input logical OR)
2 (energized by an 8-input logical AND)
3 (energized by an 8-input logical OR and activates the trip bus)
4 (energized by an 8-input logical AND and activates the trip bus)

The following nine settings of Configurable Output #4 are set similarly to those of Configurable Output #1:

Input Number 1 (CO4IN1) [2102]

Input Number 2 (CO4IN2) [2103]

Input Number 3 (CO4IN3) [2104]

Input Number 4 (CO4IN4) [2105]

Input Number 5 (CO4IN5) [2106]

Input Number 6 (CO4IN6)[2107]

Input Number 7 (CO4IN7) [2108]

Input Number 8 (CO4IN8) [2109]

CONFIGURABLE OUTPUT #5 (NONCRITOUT)

The following nine settings, in *Table 2–22,* of Configurable Output #5 are set similarly to those of Configurable Output #1:

Non-Critical Alarm (CONOUT5) [2201]

Input Number 1 (CO5IN1) [2202]

Input Number 2 (CO5IN2) [2203]

Input Number 3 (CO5IN3) [2204]

Input Number 4 (CO5IN4) [2205]

Input Number 5 (CO5IN5) [2206]

Input Number 6 (CO5IN6)[2207]

Input Number 7 (CO5IN7) [2208]

Input Number 8 (CO5IN8) [2209]

CONFIGURABLE OUTPUT #6 (RINITOUT)

The following nine settings, in *Table 2–23,* of Configurable Output #6 are set similarly to those of Configurable Output #1:

3-Pole Reclose Initiate, (CONOUT6) [2301]

Input Number 1 (CO6IN1) [2302]

Input Number 2 (CO6IN2) [2303]

Input Number 3 (CO6IN3) [2304]

Input Number 4 (CO6IN4) [2305]

Input Number 5 (CO6IN5) [2306]

Input Number 6 (CO6IN6) [2307]
Input Number 7 (CO6IN7) [2308]
Input Number 8 (CO6IN8) [2309]

Example Settings for Configurable Output Categories

The following are examples of settings for the sample system in Figure 2–1.

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

Identical settings apply for configurable outputs 2–6.

Recloser Settings (RECLOSER)

Following are descriptions of the settings available under the Recloser Settings category *Table 2–24*.

Recloser Scheme (SELRCLR) [2401]

SELRCLR has the following settings that select four different modes of operation:

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

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

3 One reclosing attempt is allowed.

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

Reclose Delay #1 (TPRDLY1) [2403]

TPRDLY1 is the time delay for the first three-pole reclose. It has a setting range of 0.01–2.55 seconds.

Reclose Delay #2 (RDLY2) [2404]

RDLY2 is the time delay for the second reclose. It has a setting range of 1–255 seconds.

Hold Mode (HOLD) [2405]

HOLD can be set to YES or NO and affects the action taken by the recloser just before 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 is set to YES, the recloser starts counting the Hold Time Delay (HOLDDLY). During this time, the CLOSE BREAKER signal is issued when RECLOSE INHIBIT goes OFF. If RECLOSE INHIBIT is still ON when HOLDDLY times out, the recloser goes to LOCKOUT.
  - If HOLD is set to NO, the recloser immediately goes to LOCKOUT.

Hold Time Delay (HOLDDLY) [2406]

HOLDLDY is the time delay used when HOLD is set to YES. It has a setting range of 1–255 seconds.

Dwell Time Delay (DWELLTM) [2407]

DWELLTM is the time that the CLOSE BREAKER signal will stay on once it has been issued. It has a setting range of 0.1–2.0 seconds.

Reset Time Delay (RSTDLY) [2408]

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 has a setting range of 1–255 seconds.

Example Settings for Recloser Setting Categories

The following are examples of settings for the sample system in Figure 2–1.

- SELRCLR = 2
- TPRDLY1 = 1.00
- RDLY2 = 3.00
- HOLD = NO
- HOLDDLY = <NOT APPLICABLE>

- HOLDDLY = <NOT APPLICABLE>
- DWELLTM = 0.5
- RSTDLY = 30

2–3 Settings for Step Distance Scheme

This section describes the settings appropriate for the Step Distance protection scheme.

Scheme Selection (SCHEMESEL)

Select Scheme (SELSCM) [1201]

The Step Distance scheme is selected with the setting,

SELSCM = 0 (STEPDST)

Number of Receivers (NUMRCVR) [1202]

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

Zone 1 Distance Functions (Z1DIST)

Select Zone 1 Ground (SELZ1G) [0101]

SELZ1G can be set to:

YES – Zone 1 ground-distance functions are in service.

NO – Zone 1 ground-distance functions are out of service.

For a Step Distance scheme, set SELZ1G = YES.

Select Zone 1 Phase (SELZ1P) [0102]

SELZ1P can be set to:

YES – Zone 1 phase-distance functions are in service.

NO – Zone 1 phase-distance functions are out of service.

For a Step Distance scheme, set SELZ1P = YES.

Reach Setting M1, Zone 1 Phase (Z1R) [0103[

Z1R 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 2–6 to determine the maximum reach in percent of positive-sequence impedance of the protected line as a function of the source- to-line ratio.

Reach Setting M1G, Zone 1 Ground (Z1GR) [0104]

Z1GR is set the same as Z1R.

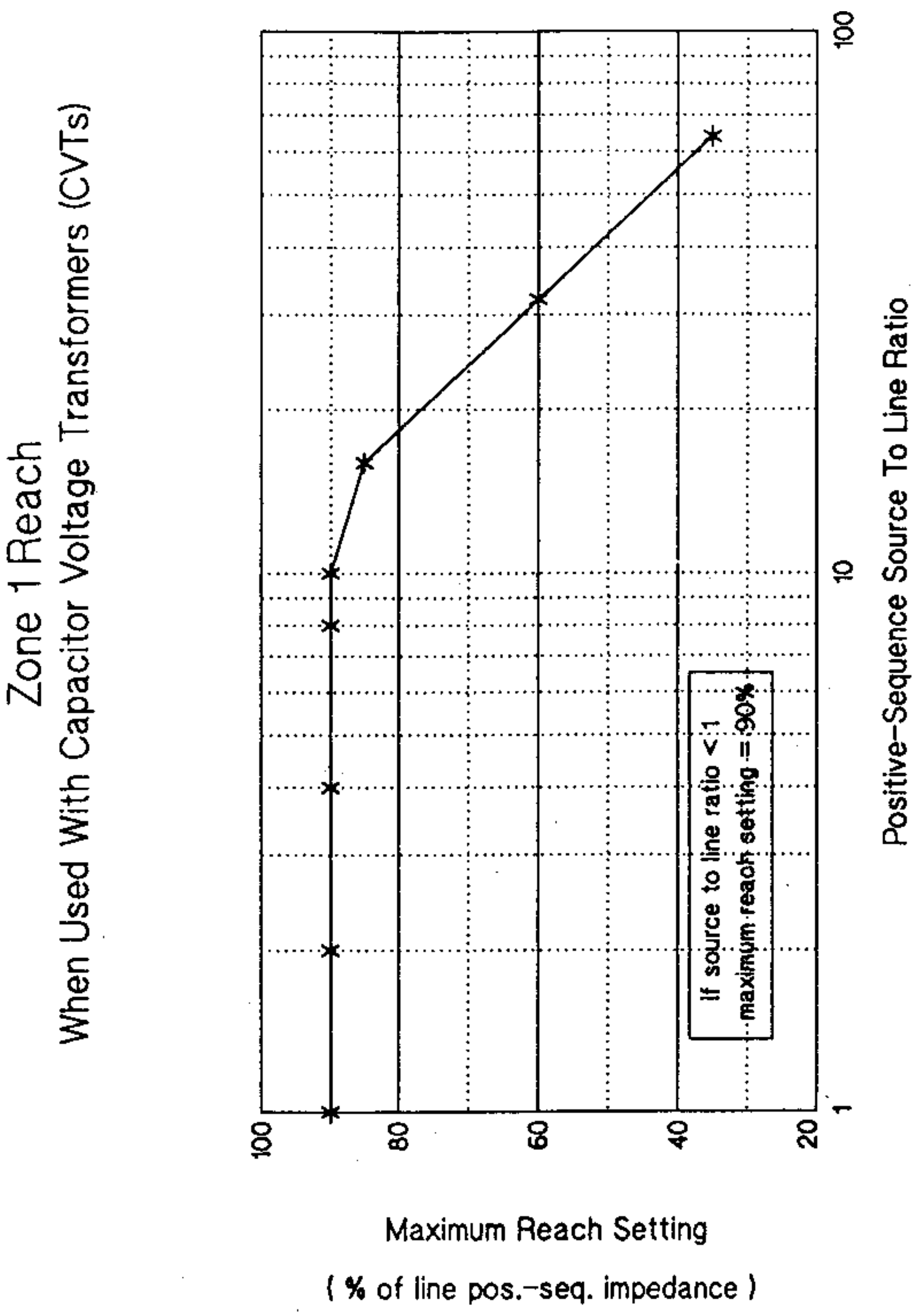


Figure 2–6. Zone 1 Reach with CVTs (Drawing #0286A3530)).

Select Zone 1 Ground Unit (SELZ1U) [0105]

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 conductance or reactance. Except for very short lines, it is recommended that mhos be used, since operating time is slightly faster than that of reactance. A very short line has positive-sequence source impedance (equivalent source impedance behind the relay location) divided by the positive-sequence impedance of the protected line 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.

Reach Setting of Mho Unit (Z1SU) [0106]

This setting is not relevant unless the Zone 1 ground-distance functions have been set to reactance units (see SELZ1U above). Since the reactance unit is nondirectional, it is supervised by a mho unit, as shown in Figure 2–7, to make it directional. Z1SU can be set over the range of 0.01–50.00 ohms.

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 2–8 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 is decreased but will never be less than Z1SU. This adaptive-reach feature optimizes the reactance unit coverage for ground-fault impedance.

Zero-Sequence Current Compensation (Z1K0) [0107]

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 to the value,

$$Z1K0 = 0.95 \times \frac{Z0L}{Z1L}$$

where:

Z0L = zero-sequence impedance of the line.

Z1L = positive-sequence impedance of the line.

Zone 1 Reach Reset Timer (Z1ERST) [0108]

Z1ERST is the pickup time delay of timer TL20 in Figure 1–2, the functional logic diagram for the Zone 1 Extension Scheme. Z1ERST has a setting range of 0.0–60.0 seconds. Refer to *Chapter 1 – Product Description* 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.

Zone 2 / Pilot Zone (Z2DIST)

Select Zone 2 Ground (SELZ2G) [0201]

SELZ2G can be set to either YES or NO:

- YES – When Zone 2 ground-distance functions are selected. Normally this is chosen for Step Distance schemes.
- NO – When only phase-distance functions are selected. Ground faults are detected by the backup ground-overcurrent functions IDT and TOC.

Select Zone 2 Phase (SELZ2P) [0202]

For a Step Distance scheme, Zone 2 phase-distance functions are required and SELZ2P should be set to YES.

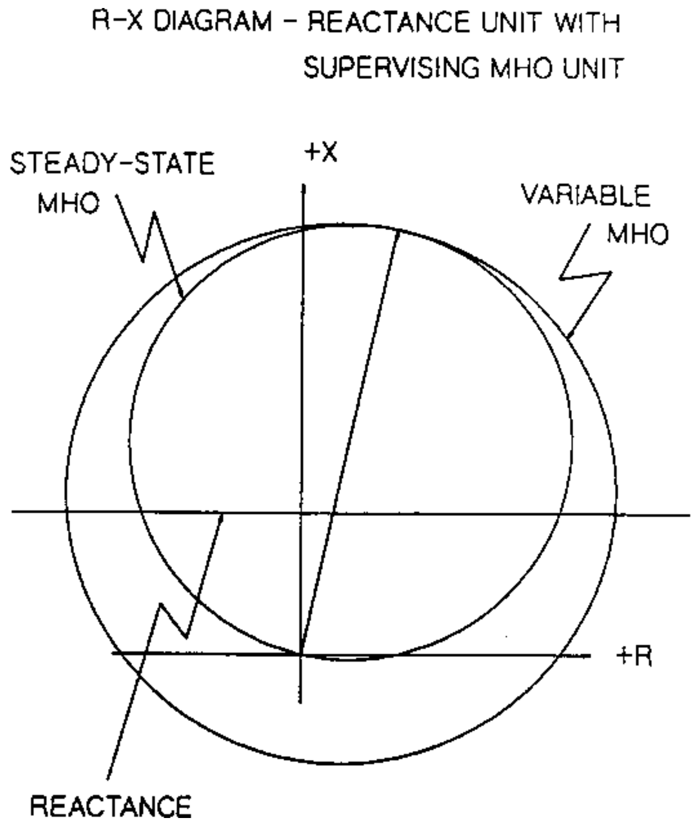


Figure 2–7. (0286A2917) MHO unit R-X diagram – supervision of reactance unit.

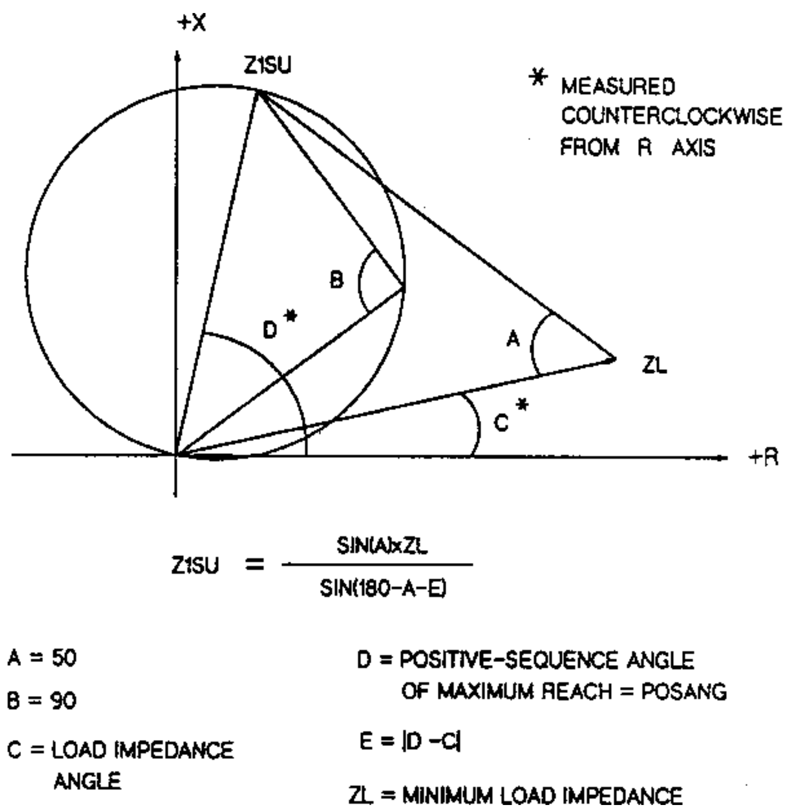


Figure 2–8. (0286A2918) Diagram showing calculation of Z1SU.

Reach Setting, MT, Zone 2 Phase)Z2R) [0203]

Z2R has a setting range of 0.01–50.00 ohms. With a Step Distance scheme, Z2R must be set to see a multiphase 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 is set for 125–150% of the positive-sequence impedance of the protected line. Z2R should never be set so large that:

- The MT functions pick up on the maximum load flow.
- The MT functions lose selectivity with the second zone phase-distance functions on the shortest adjoining line section.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2P with additional time delay.

Reach Setting (MTG) Zone 2 Ground (Z2GR) [0204]

Z2GR has a setting 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 that:

- The impedance point associated with the maximum load flow plots within the MTG characteristic on an R-X diagram.
- The MTG functions lose selectivity with the second zone ground-distance functions on the shortest adjoining line section.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2G with additional time delay.

Select Zone 2 Ground Unit (SELZ2U) [0205]

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.

Select Zone 2 Timers (SELZ2T) [0206]

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

Phase Timer Setting (PUTL2P) [0207]

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 has a setting range of 0.10–3.00 seconds.

Ground Timer Setting (PUTL2G) [0208]

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 has a setting range of 0.10–3.00 seconds.

Phase Characteristic Angle (Z2PANG) [0209]

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 2–9. 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 2–10. The criterion used for establishing the maximum reach in Figure 2–10 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle (Z2GANG) [0210]

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 of Figure 2–10. The criterion used for establishing the maximum reach in Figure 2–10 is based on maintaining a 40° angular margin between angle A and angle B.

Zone 3 Distance Functions (Z3DIST)

Select Zone 3 Ground (SELZ3G) [0301]

SELZ3G can be set to either YES or NO as follows:

YES – Zone 3 is used as part of a Step Distance scheme and ground-distance functions are required.

NO – Zone 3 ground-distance functions are not required.

Select Zone 3 Phase (SELZ3P) [0302]

SELZ3P can be set to either YES or NO, as follows:

YES – Zone 3 is used as part of a Step Distance scheme and phase-distance functions are required.

NO – Zone 3 phase distance functions are not required.

Reach Setting, M3, Zone 3 Phase (Z3R) [0303]

Z3R has a setting 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. Z3R should be set to see a multiphase 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 that:

- The M3 functions pick up on the maximum load flow.
- The M3 functions lose selectivity with the third zone phase-distance functions on the shortest adjoining line section out of the remote bus.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Reach Setting, M3G, Zone 3 Ground (Z3GR) [0304]

Z3GR has a setting 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. 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 that:

- The impedance point associated with the maximum load flow plots within the M3G characteristic on an R-X diagram.
- The M3G functions lose selectivity with the third zone ground-distance functions on the shortest adjoining line section out of the remote bus.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Phase Timer Setting (PUTL3P) [0305]

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 has a setting range of 0.10–10.00 seconds.

Ground Timer Setting (PUTL3G) [0306]

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 has a setting range of 0.10–10.00 seconds.

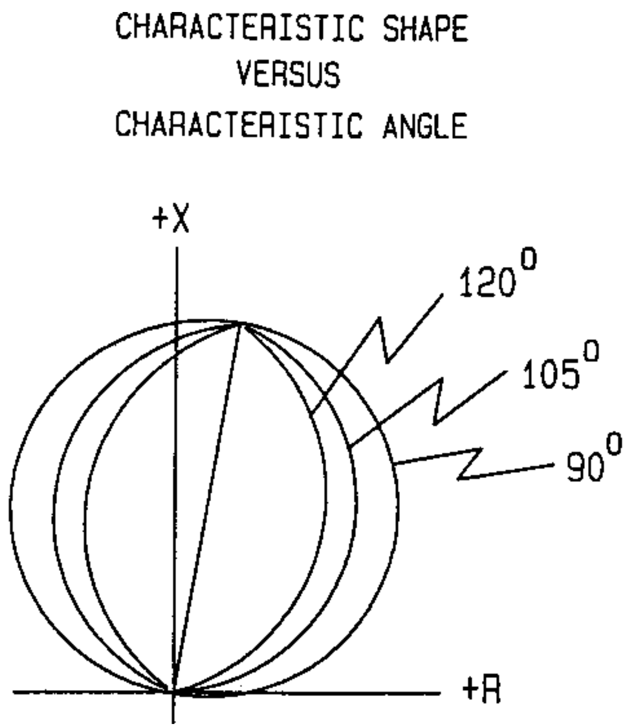
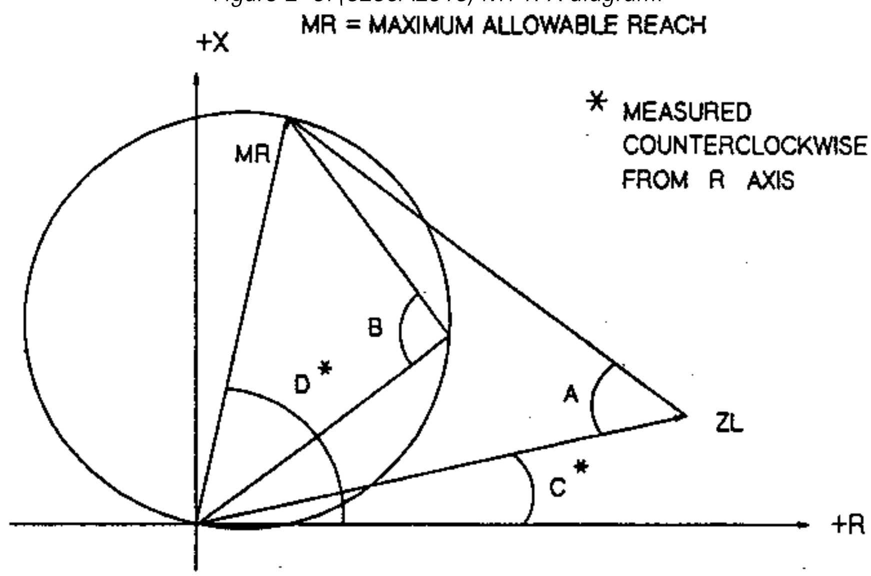


Figure 2–9. (0286A2910) MT R-X diagram.



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

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 2–10. (0286A2913) Maximum allowable reach.

Phase Characteristic Angle (Z3PANG) [0307]

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 2–9. Z3PANG can be set to 90°, 105°, or 120°, with 90° 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 of Figure 2–10. The criterion used for establishing the maximum reach given in Figure 2–10 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle (Z3GANG) [0308]

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°. The 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 of Figure 2–10. The criterion used for establishing the maximum reach given in Figure 2–10 is based on maintaining a 40° angular margin between angle A and angle B.

Zone 4 Distance Functions (Z4DIST)

Select Zone 4 Ground (SELZ4G) [0401]

SELZ4G can be set to either YES or NO, as follows:

- YES – Zone 4 is used as part of a Step Distance scheme and ground-distance functions are required.
- NO – Zone 3 ground-distance functions are not required.

Select Zone 4 Phase (SELZ4P) [0402]

SELZ4P can be set to either YES or NO, as follows:

- YES – Zone 3 is used as part of a Step Distance scheme and phase-distance functions are required.
- NO – Zone 3 phase distance functions are not required.

Select Direction (SELZ4D) [0411]

The directional sense of Zone 4, 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 is limited due to maximum-reach constraints. Normally, a reverse-looking Zone 4 is used when a forward-looking Zone 3 cannot be used due to maximum-reach constraints. Then the reverse-looking Zone 4 becomes a *reversed third zone* function.

Reach Setting M4, Zone 4 Phase (Z4R) [0403]

Z4R has a setting 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. Z4R should be set to see a multiphase fault at the end of the longest line section, considering such factors as arc resistance and underreach caused by intermediate fault current sources. Z4R should never be set so large that:

- The M4 functions pick up on the maximum load flow
- The M4 functions lose selectivity with the second zone phase-distance functions on the shortest line section out of the local bus.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Phase Offset Reach (Z4OR) [0405]

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) x Z4R. A reversed-M4 characteristic with offset is shown in Figure 2–11. For Step Distance schemes, an offset reach should only be considered when SELZ4D is set to 1 (REVERS). For 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 only operate on fault current.

Reach Setting M4G, Zone 4 Ground (Z4GR) [0404]

Z4GR has a setting 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. 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 that:

- The impedance point associated with the maximum load flow plots within the M4G characteristic on an R-X diagram.
- The M4G functions lose selectivity with the second zone ground-distance functions on the shortest line section out of the local bus.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Note: There is an application limit on the maximum value of Z4GR

If Z4GR is set too large, then this function may operate for a ground fault located in the opposite direction to the Zone 4 reach direction, as determined by setting *0411 SELZ4D*. The factors that determine whether the DLP Zone 4 ground distance functions will operate for a reverse fault are: (1) the magnitude of the zero-sequence current at the relay during the reverse fault, (2) the K0 setting, and (3) the reach setting, Z4GR. For these three factors, a higher value tends to make Zone 4 ground operation more likely.

The following is the recommended procedure for determining the maximum Zone 4 ground reach setting to prevent a mis-operation for a reverse fault:

1. For a reverse AG fault at the relay location calculate the currents and voltages at the relay.
2. For a reverse BCG fault at the relay location calculate the currents and voltages at the relay.
3. Use the following equation to determine the maximum allowable reach:

$$Z4GR\,(\text{max.}) = \frac{|V_f|}{|K_0 \cdot I_0|} \qquad (1)$$

where

I_0 = zero-sequence current at relay

$K_0 = \dfrac{\text{zero-sequence line impedance}}{\text{positive-sequence line impedance}}$ [setting #1404]

V_f = phase-to-ground voltage at relay (AG, BG, or CG)

- For the AG fault, evaluate phases B and C
- For the BCG fault, evaluate phase A

4. The maximum allowable reach is the smallest Zone 4 reach determined from equation (1) in step 3.

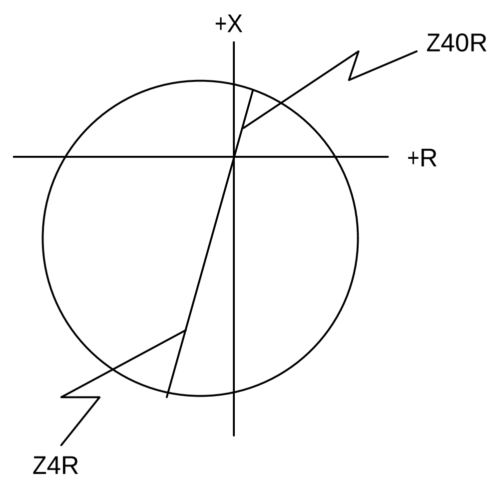


Figure 2–11. ZONE 4 phase distance R-X diagram

Select Zone 4 Timers (SELZ4T) [0406]

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

Phase Timer Setting (PUTL4P) [0407]

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 has a setting range of 0.10–10.00 seconds.

Ground Timer Setting (PUTL4G) [0408]

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 has a setting range of 0.10–10.00 seconds.

Phase Characteristic Angle (Z4PANG) [0409]

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°, with 90° 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.

Ground Characteristic Angle (Z4GANG) [0410]

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°. The 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.

Overcurrent Supervision (CURSUPVIS)

Ground Pilot Trip, IPT, Overcurrent (PUIPT) [0501]

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

Ground Pilot Block, IPB, Overcurrent (PUIPB) [0502]

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

Trip Supervision, IT, Overcurrent (PUIT) [0503]

This overcurrent function provides supervision for the distance functions. IT is used in the trip bus seal-in circuit. For a Step Distance scheme, IT and IB should have the same setting. PUIT has a setting range of 0.20–4.00 amps. It is recommended that PUIT be set to its minimum value.

Block Supervision, IB, Overcurrent (PUIB) [0504]

This overcurrent function provides supervision for the distance functions. For a Step Distance scheme, IT and IB should have the same setting. PUIB has a setting range of 0.20–4.00 amps. It is recommended that PUIB be set to its minimum value.

Scheme Logic Timers (SCHEMETIM)

Trip Integrator TL1 Pickup (PUTL1) [1301]

PUTL1 has a setting range of 1–50 milliseconds. For a Step Distance scheme, PUTL1 can be left at any setting within its range without affecting scheme operation.

POTT Coordination TL4 Pickup (PUTL4) [1306]

PUTL4 has a setting range of 0–50 milliseconds. For a Step Distance scheme, PUTL4 can be left at any setting within its range without affecting scheme operation.

POTT Coordination TL4 Dropout (DOTL4) [1307]

DOTL4 has a setting range of 0–50 milliseconds. For a Step Distance scheme, DOTL4 can be left at any setting within its range without affecting scheme operation.

52/b Contact Coordination TL5 Pickup (PUTL5) [1302]

PUTL5 has a setting range of 0–200 milliseconds. See DOTL6 for a description of this setting.

52/b Contact Coordination TL5 Dropout (DOTL5) [1303]

DOTL5 has a setting range of 0–200 milliseconds. See DOTL6 for a description of this setting.

52/b Contact Coordination TL6 Pickup (PUTL6) [1304]

PUTL6 has a setting range of 0–200 milliseconds. See DOTL6 for a description of this setting.

52/b Contact Coordination TL6 Dropout (DOTL6) [1305]

DOTL6 has a setting range of 0–200 milliseconds.

Since breaker position information is not required for the Step Distance scheme logic, timers TL5 and TL6 are not a part of that logic. However, the DLP3 Sequence of Events 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 1-1. 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 Chapter 1 - Trip Circuit Monitor for more information.

If the recloser is diasbled (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 the 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.

Pickup time coordination is determined by PUTL5 or PUTL6. The dropout time coordination is determined by DOTL5 or DOTL6. The settings are dependent upon the design of the breaker. The object is to get an output from TL5 or TL6 when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip TL16 Pickup (PUTL16) [1308]

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.

Configurable Trip Pickup (PUTLCFG) [1309]

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

Configurable Trip Dropout (DOTLCFG) [1310]

DOTLCFG can be set over the range of 0 - 100 msecs. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1, or 2. With CONOUT4 = 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. Its value depends upon how Configurable Output #4 is being used.

Remote Open Detector (REMOTEOPEN)

Select Remote Open Detector (SELROD) [1001]

SELROD can be set to either YES or NO, as follows:

YES – The Remote Open function is in service.

NO – The Remote Open function is out of service.

For a three-pole 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.

Timer TL20 Delay Setting (PUTL20) [1002]

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.

Block Tripping for Fuse Failure (SELFFB) [1003]

SELFFB can be set to either YES or NO, as follows:

YES – The output of the Potential Transformer Fuse Failure function blocks 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.

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 be set to YES.

Example Settings for Step Distance Protection Scheme

The following are examples of settings for the sample system in Figure 2–1.

Scheme Selection (SCHEMESEL)

- SELSCM = 0 (STEPDST)
- NUMRCVR= 0

Zone 1 Distance Functions (Z1DIST)

- SELZIG = YES
- SELZ1P = YES
- Z1R = 0.9 x 6 = 5.4
- Z1GR = 0.9 x 6 = 5.4

Since Z1 (source)/Z1 (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>

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

Figures 2–1 and 2–8 show that:

- ZL = 19.7∠5.6°
- K0 = 3.0
- A = 50
- C = 5.6
- D = 85
- E = 85 – 5.6 = 79.4
- Z1SU = 19.7 x sin(50°) / sin(180° – 50° – 79.4°)
- Z1SU = 19.53

Zone 2 / Pilot Zone (Z2DIST)

- SELZ2G = YES
- SELZ2P = YES
- Z2R = 1.25 x 6 = 7.50 ohms
- Z2GR = 1.25 x 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 2–10 is used to check Z2R and Z2PANG:

- MR = sin(50°) x 19.7 / sin(180° – 50° – (85° – 5.6°))
- MR = 19.5 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.

Zone 3 Distance Functions (Z3DIST)

- SELZ3G = YES
- SELZ3P = YES

Line section C-D and source E2 provide an intermediate current source that amplifies the apparent impedance seen by the M3 functions at ABLE for a multiphase 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:

$$Z(ABLE) = Z(AB) + Z(EF) + (ICD / IAB) \times Z(EF) ,$$

where:

ICD = 4.41 amps ,

IAB = 5.04 amps ,

Z(ABLE) = 6 + 4.5 +(4.41 / 5.04) x 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. With the simplifying assumption,

$$Z0(AB)/Z1(AB) = Z0(CD) / Z1(CD)$$

$$= Z0(EF) / Z1(EF) = K0 ,$$

the following equation is valid.

$$Z(ABLE) = Z(AB) + Z(EF) + Z(EF) \times \frac{\left[I\phi + (K0 - 1) \times I0\right] \times CD}{\left[I\phi + (K0 - 1) \times I0\right] \times AB}$$

where:

Iφ is the phase current for the faulted phase

I0 is the zero-sequence current

K0 = 3.2.

For no prefault load flow and an A-G fault at DELTA, the currents are:

Iφ(AB) =2.71 amps

Iφ(CD) = 3.29 amps

I0(AB) = 0.50 amps

I0(CD) = 0.68 amps

Therefore, the value of Z(ABLE) is

$$Z(ABLE) = 6 + 4.5 + 4.5 \frac{3.29 + 2.2 \times 0.68}{2.71 + 2.2 \times 0.50} = 16.15 \text{ ohms.}$$

The angle of the calculated impedance above is assumed to be at POSANG = 85°. 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:

$$Z(ABLE) = \frac{V\phi G}{I\phi + (K0 - 1) I0} ,$$

where

$$I\phi = 2.71 \angle -82.0^\circ ,$$

$$I0 = 0.50 \angle -76.9^\circ ,$$

$$V\phi G = 61.1 \angle -0.2^\circ ,$$

$$Z(ABLE) = 16.00 \angle 80.3^\circ .$$

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

The formula from Figure 2–10 is used to check Z3R and Z3PANG:

MR = sin(50°) x 19.7 / sin(180° – 50° – (85° – 5.6°))

MR = 19.5 ohms.

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

Zone 4 Distance Functions (Z4DIST)

- SELZ4G = NO
- SELZ4P = NO

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

Overcurrent Supervision (CURSUPVIS)

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

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>

Remote Open Detector (REMOTEOPEN)

- SELROD = YES
- PUTL20 = 40ms
- SELFFB = YES

2–4 Settings for Zone 1 Extension Scheme

This section describes the settings appropriate for the Zone 1 Extension protection scheme.

Scheme Selection (SCHEMESEL)

Select Scheme (SELSCM) [1201]

- SELSCM = 5 (ZNE1EXT)

Number of Receivers (NUMRCVR) [1202]

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

Zone 1 Distance Functions (Z1DIST)

Select Zone 1 Ground (SELZ1G) [0101]

SELZ1G must be set to YES for a Zone 1 Extension Scheme.

Select Zone 1 Phase (SELZ1P) [0102]

SELZ1P must be set to YES for a Zone 1 Extension Scheme.

Reach Setting M1, Zone 1 Phase (Z1R) [0103]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting M1G, Zone 1 Ground (Z1GR) [0104]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Select Zone 1 Ground Unit (SELZ1U) [0105]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting of Mho Unit (Z1SU) [0106]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zero-Sequence Current Compensation (Z1K0) [0107]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 1 Reach Reset Timer (Z1ERST) [0108]

Z1ERST is the pickup time delay of timer TL20 in Figure 2–2, the functional logic diagram for the Zone 1 Extension Scheme. Z1ERST has a setting range of 0.0–60.0 seconds. Refer to *Chapter 1 – Product Description* under Zone 1 Extension for an explanation of when the Z1ERST time delay is required. Z1ERST is set to the reset or reclaim time setting of the external recloser.

Zone 2 / Pilot Zone (Z2DIST)

Select Zone 2 Ground (SELZ2G) [0201]

SELZ2G is set to YES for a Zone 1 Extension scheme.

Select Zone 2 Phase, SELZ2P (0202)

SELZ2P is set to YES for a Zone 1 Extension scheme.

Reach Setting MT, Zone 2 Phase (Z2R) [0203]

Z2R has a setting range of 0.01–50.00 ohms. In a Zone 1 Extension scheme, Z2R must be set to see a multiphase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. On a two-terminal line, Z2R is typically set for 125–150% of the positive-sequence impedance of the protected line. Z2R should never be set so large that:

- The MT functions pick up on the maximum load flow.
- The MT functions lose selectivity with the second zone phase-distance functions on the shortest adjoining line section.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2P with additional time delay.

Reach Setting MTG, Zone 2 Ground (Z2GR) [0204]

Z2GR has a setting 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 that:

- The impedance point associated with the maximum load flow plots within the MTG characteristic on an R-X diagram.
- The MTG functions lose selectivity with the second zone ground-distance functions on the shortest adjoining line section.

If the second item cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2G with additional time delay.

Select Zone 2 Ground Unit (SELZ2U) [0205]

This setting permits choosing either Mho ground distance, 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.

Select Zone 2 Timers (SELZ2T) [0206]

SELZ2T is set to YES for a Zone 1 Extension scheme.

Phase Timer Setting (PUTL2P) [0207]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Timer Setting (PUTL2) [0208]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Phase Characteristic Angle (Z2PANG) [0209]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Characteristic Angle (Z2GANG) [0210]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Zone 4 Distance Functions (Z4DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Overcurrent Supervision (CURSUPVIS)

Ground Pilot Trip, IPT, Overcurrent (PUIPT) [0501]

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

Ground Pilot Block, IPB, Overcurrent (PUIPB) [0502]

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

Trip Supervision, IT, Overcurrent (PUIT) [0503]

This overcurrent function provides 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 has a setting range of 0.20–4.00 amps and should be set to its minimum value.

Block Supervision, IB, Overcurrent (PUIB) [0504]

This overcurrent function provides supervision for the distance functions. For a Zone 1 Extension scheme, IT and IB should have the same setting. PUIB has a setting range of 0.20–4.00 amps and should be set to its minimum value.

Scheme Logic Timers (SCHEMETIM)

Trip Integrator TL1 Pickup (PUTL1) [1301]

PUTL1 has a setting range of 1–50 milliseconds. For a Zone 1 Extension scheme, PUTL1 can be left at any setting within its range without affecting scheme operation.

POTT Coordination TL4 Pickup (PUTL4) [1306]

PUTL4 has a setting range of 0–50 milliseconds. For a Zone 1 Extension scheme, PUTL4 can be left at any setting within its range without affecting scheme operation.

POTT Coordination TL4 Dropout (DOTL4) [1307]

DOTL4 has a setting range of 0–50 milliseconds. For a Zone 1 Extension scheme, DOTL4 can be left at any setting within its range without affecting scheme operation.

52/b Contact Coordination TL5 Pickup (PUTL5) [1302]

PUTL5 has a setting range of 0–200 milliseconds. See DOTL6 for a description of this setting.

52/b Contact Coordination TL5 Dropout (DOTL5) [1303]

DOTL5 has a setting range of 0–200 milliseconds. See DOTL6 for a description of this setting.

52/b Contact Coordination TL6 Pickup (PUTL6) [1304]

PUTL6 has a setting range of 0–200 milliseconds. See DOTL6 for a description of this setting.

52/b Contact Coordination TL6 Dropout (DOTL6) [1305]

DOTL6 has a setting 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 Sequence of Events 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 1-1. 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 Chapter 1 - Trip Circuit Monitor for more information.

If the recloser is diasbled (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 the 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.

Pickup time coordination is determined by PUTL5 or PUTL6. The dropout time coordination is determined by DOTL5 or DOTL6. The settings are dependent upon the design of the breaker. The object is to get an output from TL5 or TL6 when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip TL16 Pickup (PUTL16) [1308]

PUTL16 has a setting range of 8–99 milliseconds. Since TL16 is not part of the Zone 1 Extension scheme logic, PUTL16 can be set to any value within its range.

Configurable Trip Pickup (PUTLCFG) [1309]

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

Configurable Trip Dropout (DOTLCFG) [1310]

DOTLCFG can be set over the range of 0 - 100 msecs. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1, or 2. With CONOUT4 = 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.

Remote Open Detector (REMOTEOPEN)

Select Remote Open Detector (SELROD) [1001]

SELROD can be set to either YES or NO, as follows:

YES – The Remote Open function is in service.

NO – The Remote Open function is out of service.

For a three-pole trip Zone 1 Extension scheme, it is suggested that the Remote Open function be placed in service. This provides 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.

Timer TL20 Delay Setting (PUTL20) [1002]

TL20 provides the time delay associated with the Remote Open function. PUTL20 has a setting range of 10–100 milliseconds. It is suggested that PUTL20 be set to 40.

Block Tripping for Fuse Failure (SELFFB) [1003]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Example Settings for Zone 1 Extension Protection Scheme

The following are examples of settings for the sample system in Figure 2–1.

Scheme Selection (SCHEMESEL)

- SELSCM = 5 (ZNE1EXT)
- NUMRCVR = 0

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 (source)/Z1 (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 = 0

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

Figures 2–1 and 2–8 show that:

$ZL = 19.7\angle 5.6°$

K0 = 3.0

A = 50

C = 5.6

D = 85

E = 85 – 5.6 = 79.4

$$Z1SU = 19.7 \times \sin(50°) / \sin(180° - 50° - 79.4°) = 19.53$$

Zone 2 / Pilot Zone (Z2DIST)

- SELZ2G = YES
- SELZ2P = YES
- Z2R = 1.25 x 6 = 7.50 ohms
- Z2GR = 1.25 x 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 2–10 is used to check Z2R and Z2PANG:

$$MR = \sin(50°) \times 19.7 / \sin(180° - 50° - (85° - 5.6°)),$$

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

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.

Zone 3 Distance Functions (Z3DIST)

- SELZ3G = NO
- SELZ3P = NO

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

Zone 4 Distance Functions (Z4DIST)

- SELZ4G = NO
- SELZ4P = NO

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

Overcurrent Supervision (CURSUPVIS)

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

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>

Remote Open Detector (REMOTEOPEN)

- SELROD = YES
- PUTL20 = 40 ms.
- SELFFB = YES

2–5 Settings for Permissive Overreach Transfer Trip Scheme

This section describes the settings appropriate for the Permissive Overreach Transfer Trip protection scheme.

Scheme Selection (SCHEMESEL)

Select Scheme (SELSCM) [1201]

- SELSCM = 1 (POTT)

Number of Receivers (NUMRCVR) [1202]

For a POTT scheme using frequency-shift channel equipment, set NUMRCVR as follows:

1 Two-terminal line application; wire the receiver output contact to contact converter 3 (CC3).

2 Three-terminal line application; wire one receiver to CC3 and the second receiver to CC4.

Zone 1 Distance Functions (Z1DIST)

Select Zone 1 Ground (SELZ1G) [0101]

SELZ1G can be set to either YES or NO to put the Zone 1 Ground distance function in or out of service. For a POTT scheme, the Zone 1 functions may be used as a backup zone, but are not required.

Select Zone 1 Phase (SELZ1P) [0102]

SELZ1P can be set to either YES or NO to put the Zone 1 Phase distance function in or out of service. For a POTT scheme, the Zone 1 functions may be used as a backup zone, but are not required.

Reach Setting M1, Zone 1 Phase (Z1R) [0103]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting M1G, Zone 1 Ground (Z1GR) [0104]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Select Zone 1 Ground Unit (SELZ1U) [0105]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting of Mho Unit (Z1SU) [0106]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zero-Sequence Current Compensation (Z1K0) [0107]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 1 Reach Reset Timer (Z1ERST) [0108]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 2 / Pilot Zone (Z2DIST)

Select Zone 2 Ground (SELZ2G) [0201]

SELZ2G is set to YES for a POTT scheme.

Select Zone 2 Phase (SELZ2P) [0202]

SELZ2P is set to YES for a POTT scheme.

Reach Setting MT, Zone 2 Phase (Z2R) [0203]

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

In a POTT scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, these functions may be used for Zone 2 backup. A Z2R and Z2GR reach setting that satisfies the requirements of both functions 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.

These 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 Section *2–3 Settings for Step Distance Scheme* for a discussion of the settings for Zone 2 backup.

Reach Setting MTG, Zone 2 Ground (Z2GR) [0204]

Z2GR has a setting 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, Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large that the impedance point associated with the maximum load flow plots within the MTG characteristic on an R-X diagram.

Select Zone 2 Ground Unit (SELZ2U) [0205]

SELZ2U can be set to the following:

0 (MHO) – Mho ground-distance operates for the pilot overreaching zone.

1 (GDOC) – Ground directional-overcurrent operates for the pilot overreaching zone. Ground directional overcurrent units operate for higher levels of ground-fault impedance than the Mho units. If SELZ2G is also set to YES then Zone 2 distance backup is provided.

2 (MHOGDOC) – Both Mho ground-distance and ground directional-overcurrent operate for the pilot overreaching zone. . If SELZ2G is also set to YES then both functions operate simultaneously in the pilot overreaching zone

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

Select Zone 2 Timers (SELZ2T) [0206]

SELZ2T can be set to either YES or NO:

YES – When the MT and MTG functions are also used for Zone 2 backup.

NO – When the MT and MTG functions are used exclusively for the pilot overreaching zone.

Phase Timer Setting (PUTL2P) [0207]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Timer Setting (PUTL2G) [0208]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Phase Characteristic Angle (Z2PANG) [0209]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Characteristic Angle (Z2GANG) [0210]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Zone 4 Distance Functions (Z4DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Overcurrent Supervision (CURSUPVIS)

Ground Pilot Trip, IPT, Overcurrent (PUIPT) [0501]

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

$$3\,|I0|\ .$$

PUIPT has a setting range of 0.50–5.00 amps, but should be set to its minimum value of 0.50 amps.

Ground Pilot Block, IPB, Overcurrent (PUIPB) [0502]

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

Trip Supervision, IT, Overcurrent (PUIT) [0503]

This overcurrent function provides 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 has a setting range of 0.20–4.00 amps and should be set to its minimum value.

Block Supervision, IB, Overcurrent (PUIB) [0504]

This overcurrent function provides supervision for the distance functions. For a POTT scheme, IT and IB should have the same setting. PUIB has a setting range of 0.20–4.00 amps and should be set to its minimum value.

Scheme Logic Timers (SCHEMETIM)

Trip Integrator TL1 Pickup (PUTL1) [1301]

PUTL1 has a setting range of 1–50 milliseconds. For a POTT 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. If current reversals are possible, see the discussion below for TL4.

POTT Coordination TL4 Pickup (PUTL4) [1306]

PUTL4 has a setting 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 to 0 and set PUTL1 as described above under TL1. If there is a parallel line, then use the settings,

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

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

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

POTT Coordination TL4 Dropout (DOTL4) [1307]

DOTL4 has a setting range of 0–50 milliseconds. For a POTT scheme, DOTL4 is normally set to 0.

52/b Contact Coordination TL5 Pickup (PUTL5) [1302]

PUTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL5 Dropout (DOTL5) [1303]

DOTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Pickup (PUTL6) [1304]

PUTL6 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Dropout (DOTL6) [1305]

DOTL6 has a setting 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 all three poles of 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 1-1. 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 Chapter 1 - Trip Circuit Monitor for more information.

If the recloser is diasbled (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 the 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 or PUTL6. The dropout time coordination is determined by DOTL5 or DOTL6. The settings are dependent upon the design of the breaker. The object is to get an output from TL5 or TL6 when the breaker main contacts open and have the output go away when the breaker main contacts close.

Weak In-feed Trip TL16 Pickup (PUTL16) [1308]

PUTL16 has a setting range of 8–99 milliseconds. Since TL16 is not part of the POTT scheme logic, PUTL16 can be set at any value within its range.

Configurable Trip Pickup (PUTLCFG) [1309]

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

Configurable Trip Dropout (DOTLCFG) [1310]

DOTLCFG can be set over the range of 0 - 100 msecs. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1, or 2. With CONOUT4 = 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.

Remote Open Detector (REMOTEOPEN)

Select Remote Open Detector (SELROD) [1001]

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

Remote Open Timer TL20 Pickup (PUTL20) [1002]

TL20 provides the time delay associated with the Remote Open function. PUTL20 has a setting range of 10–100 milliseconds and should be set to 40. If SELROD is set to NO, this setting has no effect.

Select Fuse Failure Block (SELFFB) [1003]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Example Settings for Permissive Overreach Transfer Trip Protection Scheme

The following are examples of settings for the sample system in Figure 2–1.

Scheme Selection (SCHEMESEL)

- SELSCM = 1 (POTT)
- NUMRCVR = 1

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 (source)/Z1 (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>

Zone 2 / Pilot Zone (Z2DIST)

- SELZ2G = YES
- SELZ2P = YES
- Z2R = 2.0 x 6 = 12.0 ohms
- Z2GR = 2.0 x 6 = 12.0 ohms
- SELZ2U = 2 (MHOGDOC)
- SELZ2T = NO
- PUTL2P = <NOT APPLICABLE>
- PUTL2G = <NOT APPLICABLE>s
- Z2PANG = 90
- Z2GANG = 90

The formula from Figure 2–10 is used to check Z2R and Z2PANG:

$$MR = \sin(50°) \times 19.7 / \sin(180° - 50° - (85° - 5.6°)) ,$$

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

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.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for an example of the calculations for this category. For this example, SELZ2T is set to NO, so the Z3DIST settings are based on Zone 2 considerations.

Zone 4 Distance Functions (Z4DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for an example of the calculations for this category. For this example, SELZ2T is set to NO, so the Z4DIST settings are based on Zone 3 considerations.

Overcurrent Supervision (CURSUPVIS)

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

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>

Remote Open Detector (REMOTEOPEN)

- SELROD = NO
- PUTL20 = <NOT APPLICABLE>

- SELFFB = YES

2–6 Settings for Permissive Underreach Transfer Trip Scheme

This section describes the settings appropriate for the Permissive Underreach Transfer Trip protection scheme.

Scheme Selection (SCHEMESEL)

Select Scheme (SELSCM) [1201]

- SELSCM = 2 (PUTT)

Number of Receivers (NUMRCVR) [1202]

Set NUMRCVR as follows:

1 Two-terminal PUTT scheme using frequency-shift channel equipment; wire the receiver output contact to contact converter 3 (CC3).

2 Three-terminal line application; wire one receiver to CC3 and the second receiver to CC4.

Zone 1 Distance Functions (Z1DIST)

Select Zone 1 Ground (SELZ1G) [0101]

For a PUTT scheme, set SELZ1G to YES to put the Zone 1 Ground function in service..

Select Zone 1 Phase (SELZ1P) [0102]

For a PUTT scheme, set SELZ1P to YES to put the Zone 1 Phase function in service.

Reach Setting M1, Zone 1 Phase (Z1R) [0103]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting M1G, Zone 1 Ground (Z1GR) [0104]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Select Zone 1 Ground Unit (SELZ1U) [0105]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting of Mho Unit (Z1SU) [0106]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zero-Sequence Current Compensation (Z1K0) [0107]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 1 Reach Reset Timer (Z1ERST) [0108]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 2 / Pilot Zone (Z2DIST)

Select Zone 2 Ground (SELZ2G) [0201]

For a PUTT scheme set SELZ2G to YES.

Select Zone 2 Phase (SELZ2P) [0202]

For a PUTT scheme set SELZ2P to YES .

Reach Setting MT, Zone 2 Phase (Z2R) [0203]

Refer to section *2–5 – Settings for Permissive Overreach Transfer Trip Scheme* for a description of the considerations for this setting.

Reach Setting MTG, Zone 2 Ground (Z2GR) [0204]

Refer to section *2–5 – Settings for Permissive Overreach Transfer Trip Scheme* for a description of the considerations for this setting.

Select Zone 2 Ground Unit (SELZ2U) [0205]

SELZ2U can be set to the following:

0 (MHO) – Mho ground-distance operates for the pilot overreaching zone.

1 (GDOC) – Ground directional-overcurrent operates for the pilot overreaching zone. Ground directional overcurrent units operate for higher levels of ground-fault impedance than the Mho units. If SELZ2G is also set to YES then Zone 2 distance backup is provided.

2 (MHOGDOC) – Both Mho ground-distance and ground directional-overcurrent operate for the pilot overreaching zone. . If SELZ2G is also set to

YES then both functions operate simultaneously in the pilot overreaching zone

For a PUTT scheme, any one of the three settings is possible. Also, since Zone 1 uses only distance functions, there is not much value in using ground directional-overcurrent functions for the overreaching zone, so SELZ2U should be set to 0 (MHO).

Select Zone 2 Timers (SELZ2T) [0206]

For a PUTT scheme, SELZ2T should be set as follows:

YES - When the MT and MTG functions are also used for Zone 2 backup.

NO - When the MT and MTG functions are used exclusively for the pilot overreaching zone.

Phase Timer Setting (PUTL2P) [0207]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Timer Setting (PUTL2G) [0208]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Phase Characteristic Angle (Z2PANG) [0209]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Characteristic Angle (Z2GANG) [0210]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Zone 4 Distance Functions (Z4DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Overcurrent Supervision (CURSUPVIS)

Ground Pilot Trip, IPT, Overcurrent (PUIPT) [0501]

If IPT is not used as suggested, set SELZ2U to 0 (MHO). If IPT is used, refer to section *2–5 Settings for Permissive Overreach Transfer Trip Scheme.*

Ground Pilot Block, IPB, Overcurrent (PUIPB) [0502]

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

Trip Supervision, IT, Overcurrent (PUIT) [0503]

This overcurrent function provides 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 has a setting range of 0.20–4.00 amps and should be set to its minimum value.

Block Supervision, IB, Overcurrent (PUIB) [0504]

This overcurrent function provides supervision for the distance functions. For a POTT scheme, IT and IB should have the same setting. PUIB has a setting range of 0.20–4.00 amps and should be set to its minimum value.

Scheme Logic Timers (SCHEMETIM)

Trip Integrator TL1 Pickup (PUTL1) [1301]

PUTL1 has a setting 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.

POTT Coordination TL4 Pickup (PUTL4) [1306]

PUTL4 has a setting 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 to 0.

POTT Coordination TL4 Dropout (DOTL4) [1307]

DOTL4 has a setting range of 0–50 milliseconds. For a PUTT scheme, set DOTL4 to 0.

52/b Contact Coordination TL5 Pickup (PUTL5) [1302]

PUTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL5 Dropout (DOTL5) [1303]

DOTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Pickup (PUTL6) [1304]

PUTL6 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Dropout (DOTL6) [1305]

DOTL6 has a setting 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 1-1. 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 Chapter 1 - Trip Circuit Monitor for more information.

If the recloser is diasbled (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 the 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 or PUTL6. The dropout time coordination is determined by DOTL5 or DOTL6. The settings are dependent upon the design of the breaker. The object is to get an output from TL5 or TL6 when the breaker main contacts open and have the output go away when the breaker main contacts close.

Weak In-feed Trip TL16 Pickup (PUTL16) [1308]

PUTL16 has a setting range of 8–99 milliseconds. Since TL16 is not part of the PUTT scheme logic, PUTL16 can be set at any value within its range.

Configurable Trip Pickup (PUTLCFG) [1309]

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

Configurable Trip Dropout (DOTLCFG) [1310]

DOTLCFG can be set over the range of 0 - 100 msecs. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1, or 2. With CONOUT4 = 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.

Remote Open Detector (REMOTEOPEN)

Select Remote Open Detector (SELROD) [1001]

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

Remote Open Timer TL20 Pickup (PUTL20) [1002]

TL20 provides the time delay associated with the Remote Open function. PUTL20 has a setting range of 10–100 milliseconds and should be set to 40. If SELROD is set to NO, this setting has no effect.

Select Fuse Failure Block (SELFFB) [1003]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Example Settings for Permissive Underreach Transfer Trip Protection Scheme

The following are examples of settings for the sample system in Figure 2–1.

Scheme Selection (SCHEMESEL)

- SELSCM = 2 (PUTT)
- NUMRCVR = 1

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 (source)/Z1 (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>

Zone 2 / Pilot Zone (Z2DIST)

- SELZ2G = YES
- SELZ2P = YES
- Z2R = 2.0 x 6 = 12.0 ohms
- Z2GR = 2.0 x 6 = 12.0 ohms
- SELZ2U = 0 (MHO)
- SELZ2T = NO
- PUTL2P = <NOT APPLICABLE>
- PUTL2G = <NOT APPLICABLE>s
- Z2PANG = 90
- Z2GANG = 90

The formula from Figure 2–10 is used to check Z2R and Z2PANG:

$$MR = \sin(50°) \times 19.7 / \sin(180° - 50° - (85° - 5.6°)) ,$$

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

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.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for an example of the calculations for this category. For this example, SELZ2T is set to NO, so the Z3DIST settings are based on Zone 2 considerations.

Zone 4 Distance Functions (Z4DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for an example of the calculations for this category. For this example, SELZ2T is set to NO, so the Z4DIST settings are based on Zone 3 considerations.

Overcurrent Supervision (CURSUPVIS)

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

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>

Remote Open Detector (REMOTEOPEN)

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

2–7 Settings for Blocking Scheme

This section describes the settings appropriate for the Blocking protection scheme.

Scheme Selection (SCHEMESEL)

Select Scheme (SELSCM) [1201]

- SELSCM = 4 (BLK1)
- SELSCM = 6 (BLK2)
- SELSCM = 7 (BLK3)

BLK1 scheme is the standard DLP blocking scheme. 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 the 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, the pickup 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 in design to the carrier start functions in many existing electro-mechanical relay schemes. The operating time versus current magnitude for the FD and IPB functions used in the BLK2 and BLK3 schemes is shown in Fig. 2-12

Number of Receivers (NUMRCVR) [1202]

For a Blocking scheme using ON-OFF channel equipment, set NUMRCVR to 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.

Zone 1 Distance Functions (Z1DIST)

Select Zone 1 Ground (SELZ1G) [0101]

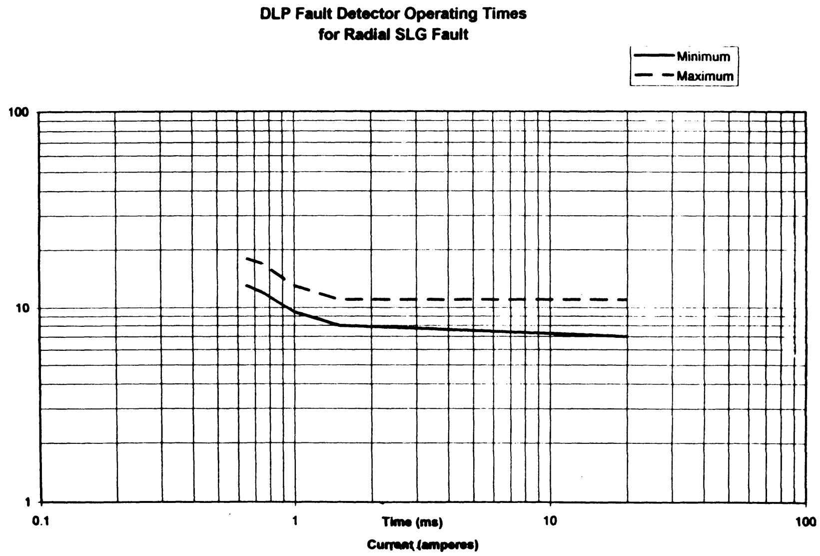
SELZ1G can be set to either YES or NO to put the Zone 1 Ground function in or out of service. For a Blocking scheme, this function may be used as a backup zone, but is not required.

Select Zone 1 Phase (SELZ1P) [0102]

SELZ1P can be set to either YES or NO to put the Zone 1 Phase function in or out of service. For a Blocking scheme, this function may be used as a backup zone, but is not required.

Reach Setting M1, Zone 1 Phase (Z1R) [0103]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.



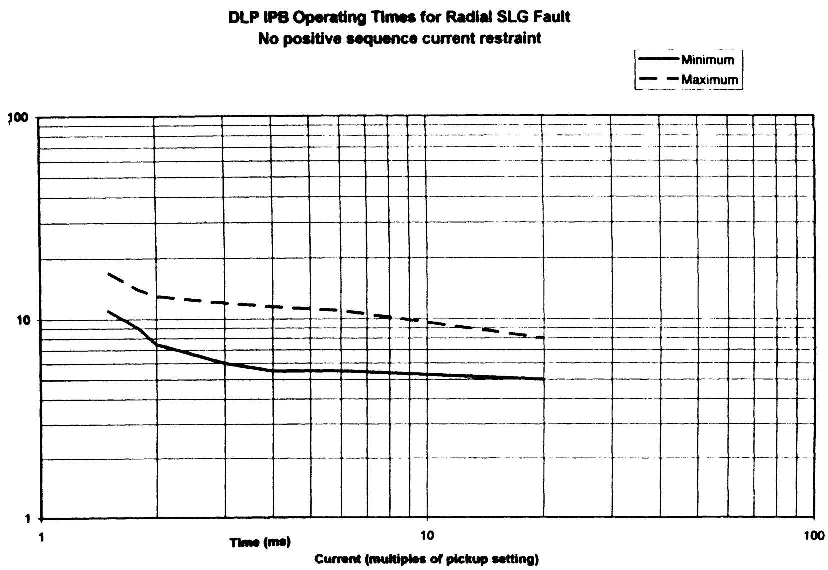


Figure 2–12. (0355A3388) [1],[2] FD and IPB Operating Times..

Reach Setting M1G, Zone 1 Ground (Z1GR) [0104]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Select Zone 1 Ground Unit (SELZ1U) [0105]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting of Mho Unit (Z1SU) [0106]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zero-Sequence Current Compensation (Z1K0) [0107]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 1 Reach Reset Timer (Z1ERST) [0108]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 2 / Pilot Zone (Z2DIST)

Select Zone 2 Ground (SELZ2G) [0201]

For a Blocking scheme set SELZ2G to YES

Select Zone 2 Phase (SELZ2P) [0202]

For a Blocking scheme set SELZ2P to YES

Reach Setting MT, Zone 2 Phase (Z2R) [0203]

Z2R has a setting range of 0.01–50.00 ohms. In a Blocking scheme, Z2R must be set to see a multiphase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. For a two-terminal line, Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large that the MT functions 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).

In a Blocking scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, these functions may be used for Zone 2 backup. A Z2R and Z2GR reach setting that satisfies the requirements of both functions 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.

These 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 Section *2–3 Settings for Step Distance Scheme* for a discussion of the settings for Zone 2 backup.

Reach Setting MTG, Zone 2 Ground (Z2GR) [0204]

Z2GR has a setting 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, Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large that the impedance point associated with the maximum load flow plots 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).

Select Zone 2 Ground Unit (SELZ2U) [0205]

SELZ2U can be set to the following:

0 (MHO) – Mho ground-distance operates for the pilot overreaching zone.

1 (GDOC) – Ground directional-overcurrent operates for the pilot overreaching zone. Ground directional overcurrent units operate for higher levels of ground-fault impedance than the Mho units. If SELZ2G is also set to YES then Zone 2 distance backup is provided.

2 (MHOGDOC) – Both Mho ground-distance and ground directional-overcurrent operate for the pilot overreaching zone. . If SELZ2G is also set to YES then both functions operate simultaneously in the pilot overreaching zone

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

Select Zone 2 Timers (SELZ2T) [0206]

For a Blocking scheme, SELZ2T should be set as follows:

YES - When the MT and MTG functions are also used for Zone 2 backup.

NO - When the MT and MTG functions are used exclusively for the pilot overreaching zone.

Phase Timer Setting (PUTL2P) [0207]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Timer Setting (PUTL2G) [0208]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Phase Characteristic Angle (Z2PANG) [0209]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Characteristic Angle (Z2GANG) [0210]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Zone 4 Distance Functions (Z4DIST)

Select Zone 4 Ground (SELZ4G) [0401]

SELZ4G can be set to either YES or NO as follows:

- YES – With SELZ2U set to 0 (MHO) or 2 (MHOGDOC), the MTG tripping functions are active.
- NO – If SELZ2U is set to 1 (GDOC).

Select Zone 4 Phase (SELZ4P) [0402]

Set SELZ4P to YES for a Blocking scheme, since the MT tripping functions are always used.

Select Direction (SELZ4D) [0411]

In a Blocking scheme, the Zone 4 distance functions *must* be reverse-looking, so set SELZ4D to 1 (REVERS).

Reach Setting M4, Zone 4 Phase (Z4R) [0403]

Z4R has a setting 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 multiphase 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 that the M4 functions pick up on the maximum load flow.

Phase Offset Reach (Z4OR) [0405]

The Zone 4 phase-distance functions can be set with an offset reach 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) x Z4R. A reversed-M4 characteristic with offset is shown in Figure 2–11. An offset reach is required for a Blocking scheme. 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 sent to the remote end.

Reach Setting M4G, Zone 4 Ground (Z4GR) [0404]

Z4GR has a setting 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 that the impedance point associated with the maximum load flow plots 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 as follows:

Z4R = 0.85 x (Z2R [REMOTE])

Z4GR = 0.85 x (Z2GR [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 given by

Z4R = 1.7 x (Z2R [REMOTE]– Z1L)

Z4GR = 1.7 x (Z2GR [REMOTE]– Z1L) ,

where Z1L is the positive-sequence impedance of the protected line.

Note: There is an application limit on the maximum value of Z4GR

If Z4GR is set too large, then this function may operate for a ground fault located in the opposite direction to the Zone 4 reach direction, as determined by setting *0411 SELZ4D*. The factors that determine whether the DLP Zone 4 ground distance functions will operate for a reverse fault are: (1) the magnitude of the zero-sequence current at the relay during the reverse fault, (2) the K0 setting, and (3) the reach setting, Z4GR. For these three factors, a higher value tends to make Zone 4 ground operation more likely.

The following is the recommended procedure for determining the maximum Zone 4 ground reach setting to prevent a mis-operation for a reverse fault:

1. For a reverse AG fault at the relay location calculate the currents and voltages at the relay.
2. For a reverse BCG fault at the relay location calculate the currents and voltages at the relay.
3. Use the following equation to determine the maximum allowable reach:

$$Z4GR\,(\text{max.}) = \frac{|V_f|}{|K_0 \cdot I_0|} \qquad (1)$$

where

I_0 = zero - sequence current at relay

$K_0 = \dfrac{\text{zero - sequence line impedance}}{\text{positive - sequence line impedance}}$ [setting #1404]

V_f = phase - to - ground voltage at relay (AG, BG, or CG)

- For the AG fault, evaluate phases B and C
- For the BCG fault, evaluate phase A

4. The maximum allowable reach is the smallest Zone 4 reach determined from equation (1) in step 3.

Select Zone 4 Timers (SELZ4T) [0406]

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 to YES to put TL4P and TL4G in service. Set SELZ4T to NO to place TL4P and TL4G out of service.

Phase Timer Setting (PUTL4P) [0407]

PUTL4P has a setting range of 0.10–10.00 seconds and should be set as follows:

- If SELZ4 is set to 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 is set to NO, then PUTL4P may be set to any value within its range with no effect on scheme operation..

Ground Timer Setting (PUTL4G) [0408]

PUTL4G has a setting range of 0.10–10.00 seconds and should be set as follows:

- If SELZ4T is set to 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 is set to NO, then PUTL4G may be set to any value within its range with no effect on scheme operation.

Phase Characteristic Angle (Z4PANG) [0409]

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 has settings of 80°, 90°, 95°, 105°, 110°, or 120°, with 80° 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.

Ground Characteristic Angle (Z4GANG) [0410]

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 has settings of 80°, 90°, 95°, 105°, 110°, or 120°, with 80° recommended. If the desired reach, Z4GR, is such that the impedance point associated with the maximum load flow plots within the M4G steady-state characteristic, the 90°, 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

Overcurrent Supervision (CURSUPVIS)

Ground Pilot Trip, IPT, Overcurrent (PUIPT) [0501]

The pilot overcurrent functions are in service if SELZ2U is set to 1 (GDOC) or 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

$$3 \times |I0| - 3 \times KT \times |I1| ,$$

where KT is 0.1.

Positive-sequence restraint is used to provide secure operation during steady-state unbalance, error currents, and external faults. PUIPT has a setting range of 0.50–5.00 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, 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.

Ground Pilot Block, IPB, Overcurrent (PUIPB) [0502]

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

$$3 \times |I0| - 3 \times KB \times |I1| ,$$

where KB is 0.066, BLK1

KB is 0.0, BLK3

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

For a BLK1 scheme, should be set to its minimum setting of 0.25 amps.

In a BLK3 scheme, PUIPB should be set to provide coordination with the ground pilot tripping function used at the remote 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.

Trip Supervision, IT, Overcurrent (PUIT) [0503]

This tripping zone overcurrent function provides supervision for the distance functions and IT is used in the trip bus seal-in circuit. PUIT has a setting range of 0.20–4.00 amps.

The local PUIT and remote PUIB settings must coordinate. 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 long, 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.

Block Supervision, IB, Overcurrent (PUIB) [0504]

This overcurrent function provides supervision for the reversed-M4 and reversed-M4G blocking-zone distance functions. PUIB has a setting range of 0.20–4.00 amps and should be set for 0.20 amps.

Scheme Logic Timers (SCHEMETIM)

Trip Integrator TL1 Pickup (PUTL1) [1301]

PUTL1 has a setting 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:

- The worst-case time coordination between the remote blocking functions and the local pilot tripping functions.
- 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,

PUTL1 = 8 ms + channel time + propagation time .

POTT Coordination TL4 Pickup (PUTL4) [1306]

TL4 is not used with a Blocking scheme. PUTL4 can be left at any setting within its range without affecting scheme operation.

POTT Coordination TL4 Dropout (DOTL4) [1307]

TL4 is not used with a Blocking scheme. DOTL4 can be left at any setting within its range without affecting scheme operation.

52/b Contact Coordination TL5 Pickup (PUTL5) [1302]

PUTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL5 Dropout (DOTL5) [1303]

DOTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Pickup (PUTL6) [1304]

PUTL6 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Dropout (DOTL6) [1305]

DOTL6 has a setting 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 outputs of TL5 and TL6 are used by the DLP3 Sequence of Events 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 1-1. 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 Chapter 1 - 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 the 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 or PUTL6. The dropout time coordination is determined by DOTL5 or DOTL6. The settings are dependent upon the design of the breaker. The object is to get an output from TL5 or TL6 when the breaker main contacts open and have the output go away when the breaker main contacts close.

Weak In-feed Trip TL16 Pickup (PUTL16) [1308]

PUTL16 has a setting range of 8–99 milliseconds. Since TL16 is not part of the Blocking scheme logic, PUTL16 can be set at any value within its range.

Configurable Trip Pickup (PUTLCFG) [1309]

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

Configurable Trip Dropout (DOTLCFG) [1310]

DOTLCFG can be set over the range of 0 - 100 msecs. It establishes the dropout delay associated with

Configurable Output #4 when CONOUT4 = 1, or 2. With CONOUT4 = 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.

Remote Open Detector (REMOTEOPEN)

Select Remote Open Detector (SELROD) [1001]

SELROD can be set to either YES or NO to set the Remote Open function either in or 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, the Remote Open function should be placed in service to possibly obtain faster tripping.

Remote Open Timer TL20 Pickup (PUTL20) [1002]

TL20 provides the time delay associated with the Remote Open function. PUTL20 has a setting range of 10–100 milliseconds and should be set to 40.

Select Fuse Failure Block (SELFFB) [1003]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Example Settings for Blocking Protection Scheme

The following are examples of settings for the sample system in Figure 2–1.

Scheme Selection (SCHEMESEL)

- SELSCM = 4 (BLK1)
- NUMRCVR = 1

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(source)/Z1(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>

Zone 2 / Pilot Zone (Z2DIST)

- SELZ2G = YES
- SELZ2P = YES
- Z2R = 2.0 x 6 = 12.0 ohms
- Z2GR = 2.0 x 6 = 12.0 ohms
- SELZ2U = 2 (MHOGDOC)
- SELZ2T = NO
- PUTL2P = <NOT APPLICABLE>
- PUTL2G = <NOT APPLICABLE>s
- Z2PANG = 90
- Z2GANG = 90

The formula from Figure 2–10 is used to check Z2R and Z2PANG:

$$MR = \sin(50°) \times 19.7 / \sin(180° - 50° - (85° - 5.6°)),$$

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

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.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for an example of the calculations for this category. For this example, SELZ2T is set to NO, so the Z3DIST settings are based on Zone 2 considerations.

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, then

- Z4R = 0.85 x 12.00 = 10.20 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 set to 0.05,

$$\text{Offset ohms} = Z4OR \times Z4R$$

= 0.05 x 10.20 = 0.51 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

Overcurrent Supervision (CURSUPVIS)

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

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 ms.

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

Since NUMBKRS is set to 1, only TL5 requires settings:

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

Remote Open Detector (REMOTEOPEN)

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

2–8 Settings for Hybrid Scheme

This section describes the settings appropriate for the Hybrid protection scheme.

Scheme Selection (SCHEMESEL)

Select Scheme (SELSCM) [1201]

- SELSCM = 3 (HYBRID)

Number of Receivers (NUMRCVR) [1202]

Set this function as follows:

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

Zone 1 Distance Functions (Z1DIST)

Select Zone 1 Ground (SELZ1G) [0101]

SELZ1G can be set to either YES or NO to put the Zone 1 Ground function in or out of service. For a Hybrid scheme, this function may be used as a backup zone, but is not required.

Select Zone 1 Phase (SELZ1P) [0102]

SELZ1P can be set to either YES or NO to put the Zone 1 Phase function in or out of service. For a Hybrid scheme, this function may be used as a backup zone, but is not required.

Reach Setting M1, Zone 1 Phase (Z1R) [0103]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting M1G, Zone 1 Ground (Z1GR) [0104]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Select Zone 1 Ground Unit (SELZ1U) [0105]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Reach Setting of Mho Unit (Z1SU) [0106]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zero-Sequence Current Compensation (Z1K0) [0107]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 1 Reach Reset Timer (Z1ERST) [0108]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 2 / Pilot Zone (Z2DIST)

Select Zone 2 Ground (SELZ2G) [0201]

For a Hybrid scheme set SELZ2G to YES.

Select Zone 2 Phase (SELZ2P) [0202]

For a Hybrid scheme set SELZ2P to YES.

Reach Setting MT, Zone 2 Phase (Z2R) [0203]

Z2R has a setting range of 0.01–50.00 ohms. In a Hybrid scheme, Z2R must be set to see a multiphase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. For a two-terminal line, Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large that the MT functions 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).

In a Hybrid scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, these 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 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.

These 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 Section *2–3 Settings for Step Distance Scheme* for a discussion of the settings for Zone 2 backup.

Reach Setting MTG, Zone 2 Ground (Z2GR) [0204]

Z2GR has a setting 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, Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large that the impedance point associated with the maximum load flow plots 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).

Select Zone 2 Ground Unit (SELZ2U) [0205]

SELZ2U can be set to the following:

0 (MHO) – Mho ground-distance operates for the pilot overreaching zone.

1 (GDOC) – Ground directional-overcurrent operates for the pilot overreaching zone.

Ground directional overcurrent units operate for higher levels of ground-fault impedance than the Mho units. If SELZ2G is also set to YES then Zone 2 distance backup is provided.

2 (MHOGDOC) – Both Mho ground-distance and ground directional-overcurrent operate for the pilot overreaching zone. . If SELZ2G is also set to YES then both functions operate simultaneously in the pilot overreaching zone

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

Select Zone 2 Timers (SELZ2T) [0206]

SELZ2T can be set to either YES or NO, as follows:

YES – When the MT and MTG functions are also used for Zone 2 backup.

NO – When the MT and MTG functions are used exclusively for the pilot overreaching zone.

Phase Timer Setting (PUTL2P) [0207]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Timer Setting (PUTL2G) [0208]

If SELZ2T is set to YES, refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Phase Characteristic Angle (Z2PANG) [0209]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Ground Characteristic Angle (Z2GANG) [0210]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the required settings for this category.

Zone 4 Distance Functions (Z4DIST)

Select Zone 4 Ground (SELZ4G) [0401]

SELZ4G can be set to either YES or NO as follows:

YES – If SELZ2U is set to 0 (MHO) or 2 (MHOGDOC), the MTG tripping functions are active.

NO – If SELZ2U is set to 1 (GDOC).

Select Zone 4 Phase (SELZ4P) [0402]

Set SELZ4P YES for a Hybrid scheme, since the MT tripping functions are always used.

Select Direction (SELZ4D) [0411]

In a Hybrid scheme, the Zone 4 distance functions *must* be reverse-looking, so set SELZ4D to 1 (REVERS).

Reach Setting M4, Zone 4 Phase (Z4R) [0403]

Z4R has a setting range of 0.01–50.00 ohms. In a Hybrid 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 multiphase 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 that the M4 functions pick up on the maximum load flow.

Phase Offset Reach (Z4OR) [0405]

The Zone 4 phase-distance functions can be set with an offset reach 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) x Z4R. A reversed-M4 characteristic with offset is shown in Figure 2–11. An offset reach is required for a Hybrid scheme. 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.

Reach Setting M4G, Zone 4 Ground (Z4GR) [0404]

Z4GR has a setting 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 that the impedance point associated with the maximum load flow plots 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 as follows:

Z4R = 0.85 x (Z2R [REMOTE])

Z4GR = 0.85 x (Z2GR [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 given by

Z4R = 1.7 x (Z2R [REMOTE]– Z1L)

Z4GR = 1.7 x (Z2GR [REMOTE]– Z1L) ,

where Z1L is the positive-sequence impedance of the protected line.

Note: There is an application limit on the maximum value of Z4GR

If Z4GR is set too large, then this function may operate for a ground fault located in the opposite direction to the Zone 4 reach direction, as determined by setting *0411 SELZ4D*. The factors that determine whether the DLP Zone 4 ground distance functions will operate for a reverse fault are: (1) the magnitude of the zero-sequence current at the relay during the reverse fault, (2) the K0 setting, and (3) the reach setting, Z4GR. For these three factors, a higher value tends to make Zone 4 ground operation more likely.

The following is the recommended procedure for determining the maximum Zone 4 ground reach setting to prevent a mis-operation for a reverse fault:

1. For a reverse AG fault <u>at the relay location</u> calculate the currents and voltages at the relay.
2. For a reverse BCG fault <u>at the relay location</u> calculate the currents and voltages at the relay.
3. Use the following equation to determine the maximum allowable reach:

$$Z4GR\,(\text{max.}) = \frac{|V_f|}{|K_0 \cdot I_0|} \qquad (1)$$

where

I_0 = zero - sequence current at relay

$K_0 = \dfrac{\text{zero - sequence line impedance}}{\text{positive - sequence line impedance}}$ [setting #1404]

V_f = phase - to - ground voltage at relay (AG, BG, or CG)

- For the AG fault, evaluate phases B and C
- For the BCG fault, evaluate phase A

4. The maximum allowable reach is the smallest Zone 4 reach determined from equation (1) in step 3.

Select Zone 4 Timers (SELZ4T) [0406]

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 to YES to put TL4P and TL4G in service. Set SELZ4T to NO to place TL4P and TL4G out of service.

Phase Timer Setting (PUTL4P) [0407]

PUTL4P has a setting range of 0.10–10.00 seconds and should be set as follows:

- If SELZ4 is set to 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 is set to NO, then PUTL4P may be set to any value within its range with no effect on scheme operation..

Ground Timer Setting (PUTL4G) [0408]

PUTL4G has a setting range of 0.10–10.00 seconds and should be set as follows:

- If SELZ4T is set to 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 is set to NO, then PUTL4G may be set to any value within its range with no effect on scheme operation.

Phase Characteristic Angle (Z4PANG) [0409]

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 has settings of 80°, 90°, 95°, 105°, 110°, or 120°, with 80° 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.

Ground Characteristic Angle (Z4GANG) [0410]

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 has settings of 80°, 90°, 95°, 105°, 110°, or 120°, with 80° recommended. If the desired reach, Z4GR, is such that the impedance point associated with the maximum load flow plots within the M4G steady-state characteristic, the 90°, 95°, 105°, 110°, or 120° setting may prevent operation on load without having to reduce the reach.

Overcurrent Supervision (CURSUPVIS)

Ground Pilot Trip, IPT, Overcurrent (PUIPT) [0501]

The pilot overcurrent functions are in service if SELZ2U is set to 1 (GDOC) or 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

$$3 \times |I0| - 3 \times KT \times |I1| ,$$

where KT is 0.1.

Positive-sequence restraint is used to provide secure operation during steady-state unbalance, error currents, and external faults. PUIPT has a setting range of 0.50– 5.00 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, 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.

Ground Pilot Block, IPB, Overcurrent (PUIPB) [0502]

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

$$3 \times |I0| - 3 \times KB \times |I1| ,$$

where KB is 0.066. PUIPB can be set over the range of 0.25–3.75 amps. It should be set to its minimum setting of 0.25 amps.

Trip Supervision, IT, Overcurrent (PUIT) [0503]

This overcurrent function provides supervision for the distance functions and IT is used in the trip bus seal-in circuit. PUIT has a setting range of 0.20–4.00 amps.

The local PUIT and remote PUIB settings must coordinate. 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 long, 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.

Block Supervision, IB, Overcurrent (PUIB) [0504]

This overcurrent function provides supervision for the reversed-M4 and reversed-M4G blocking-zone distance functions. PUIB has a setting range of 0.20–4.00 amps and should be set for 0.20 amps.

Scheme Logic Timers (SCHEMETIM)

Trip Integrator TL1 Pickup (PUTL1) [1301]

PUTL1 has a setting 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.

POTT Coordination TL4 Pickup (PUTL4) [1306]

TL4 is not used with a Hybrid scheme. PUTL4 can be left at any setting within its range without affecting scheme operation.

POTT Coordination TL4 Dropout (DOTL4) [1307]

TL4 is not used with a Hybrid scheme. DOTL4 can be left at any setting within its range without affecting scheme operation.

52/b Contact Coordination TL5 Pickup (PUTL5) [1302]

PUTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL5 Dropout (DOTL5) [1303]

DOTL5 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Pickup (PUTL6) [1304]

PUTL6 has a setting range of 0–200 milliseconds. See the DOTL6 for a complete discussion of this function.

52/b Contact Coordination TL6 Dropout (DOTL6) [1305]

DOTL6 has a setting 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 outputs of TL5 and TL6 are used by the DLP3 Sequence of Events 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 1-1. 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 Chapter 1 - 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 the 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 or PUTL6. The dropout time coordination is determined by DOTL5 or DOTL6. The settings are dependent upon the design of the breaker. The object is to get an output from TL5 or TL6 when the breaker main contacts open and have the output go away when the breaker main contacts close.

Weak In-feed Trip TL16 Pickup (PUTL16) [1308]

PUTL16 has a setting range of 8–99 milliseconds. The pickup delay of timer TL16 provides security in the weak in-feed tripping logic. It should be set to ride over any outputs from the receiver during weak in-feed fault conditions. PUTL16 should normally be set at its minimum value of 8 ms.

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

If weak in-feed tripping is desired, PUTL16 should never be set greater than the pickup delay of timer TL16 in figure 1-5.For a Hybrid scheme (SELSCM = 3) the pickup delay of TL11 is 80 milliseconds for two-terminal applications (NUMRCVR = 1) and 50 milliseconds for three terminal applications (NUMRCVR = 2).

Configurable Trip Pickup (PUTLCFG) [1309]

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

Configurable Trip Dropout (DOTLCFG) [1310]

DOTLCFG can be set over the range of 0 - 100 msecs. It establishes the dropout delay associated with Configurable Output #4 when CONOUT4 = 1, or 2. With CONOUT4 = 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.

Remote Open Detector (REMOTEOPEN)

Select Remote Open Detector (SELROD) [1001]

SELROD can be set to either YES or NO to set the Remote Open function either in or out of service. For a three-pole trip Hybrid scheme, the Remote Open Detector function will not normally provide faster tripping and may be placed out of service.

Remote Open Timer TL20 Pickup (PUTL20) [1002]

TL20 provides the time delay associated with the Remote Open function. PUTL20 has a setting range of 10–100 milliseconds and should be set to 40. If SELROD is set to NO, then this setting has no effect.

Select Fuse Failure Block (SELFFB) [1003]

Refer to Section *2–3 Settings for Step Distance Scheme* for a description of the considerations for this setting.

Example Settings for Hybrid Protection Scheme

The following are examples of settings for the sample system in Figure 2–1.

Scheme Selection (SCHEMESEL)

- SELSCM = 3 (HYBRID)
- NUMRCVR = 1

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(source)/Z1(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>

Zone 2 / Pilot Zone (Z2DIST)

- SELZ2G = YES
- SELZ2P = YES
- Z2R = 2.0 x 6 = 12.0 ohms
- Z2GR = 2.0 x 6 = 12.0 ohms
- SELZ2U = 2 (MHOGDOC)
- SELZ2T = NO
- PUTL2P = <NOT APPLICABLE>
- PUTL2G = <NOT APPLICABLE>s
- Z2PANG = 90
- Z2GANG = 90

The formula from Figure 2–10 is used to check Z2R and Z2PANG:

$$MR = \sin(50°) \times 19.7 / \sin(180° - 50° - (85° - 5.6°)),$$

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

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.

Zone 3 Distance Functions (Z3DIST)

Refer to Section *2–3 Settings for Step Distance Scheme* for an example of the calculations for this category.

For this example, SELZ2T is set to NO, so the Z3DIST settings are based on Zone 2 considerations.

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, then

- Z4R = 0.85 x 12.00 = 10.20 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 set to 0.05,

Offset ohms= Z4OR x Z4R

= 0.05 x 10.20 = 0.51 ohms,

which is as close to 0.5 ohms as is 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

Overcurrent Supervision (CURSUPVIS)

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

Scheme Logic Timers (SCHEMETIM)

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

Since NUMBKRS is set to 1, only TL5 requires settings:

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

Remote Open Detector (REMOTEOPEN)

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

2–9 Current Sensitivity of Distance Functions

The current sensitivity for the phase distance functions is determined from the relation,

$$I_{\phi\phi} Z_{R1} = \frac{0.294}{1 - X},$$

where:

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

Z_{R1} = positive-sequence relay reach

X = actual reach divided by the 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 0.1 or 10%.

Example:

For the phase pair A-B where:

Z_{R1} = 1 ohm

X = 0.9 then $(1 - X) = 0.1$, (10% pullback)

The phase-phase current is:

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

For a phase-phase fault, the phase A current is given by:

$$I_A - I_B = 2\, I_A = 2.94 \text{ A,}$$

$$I_A = 1.47 \text{ A.}$$

For a three-phase fault, the phase A current is given by:

$$I_A - I_B = 1.732\, I_A = 2.94 \text{ A,}$$

$$I_A = 1.7 \text{ A.}$$

The current sensitivity for the ground distance functions is determined from the relation,

$$\left| (I_\phi - I_0) Z_{R1} \angle\phi 1 + I_0 \, KO \, Z_{R1} \angle\phi 0 \right| = \frac{0.22}{1 - X},$$

where

- I_ϕ = phase current at the relay,
- I_0 = zero-sequence current at the relay,
- Z_{R1} = positive-sequence relay reach,
- $\angle\phi 1$ = positive-sequence relay angle (POSANG),
- $\angle\phi 0$ = zero-sequence relay angle (ZERANG),
- K0 = zero-sequence current compensation, and
- X = actual reach divided by the nominal reach.

Example:

For phase A where:

$I_A = I_0$,

$\angle\phi 1 = \angle\phi 0$,

$K0 = 3$

Z_{R1} = 1 ohm

X = 0.9, then $(1 - X) = 0.1$, (10% pullback)

The phase A current is given by

$$\frac{5}{3} I_A = \frac{0.22}{0.2} = 2.2 \text{ A},$$

$$I_A = 1.32 \text{ A}.$$

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.

Example:

For the phase-pair A-B where:

Z_{R1} = 1 ohm

X = 0 then $(1 - X) = 1$, (100% pullback)

The phase-phase current is:

$$I_A - I_B = \frac{0.294}{1} = 0.294 \text{ A}.$$

For a phase-phase fault, the phase A current is given by:

$$I_A - I_B = 2 I_A = 0.294 \text{ A},$$

$$I_A = 0.147 \text{ A}.$$

For a three-phase fault, the phase A current is given by

$$I_A - I_B = 1.732 I_A = 0.294 \text{ A},$$

$$I_A = 0.17 \text{ A}.$$

For a 5-A-rated DLP3, the IT current supervision function limits 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.

2–10 DLP3 Settings Form

Set #	Description	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)	

Set #	Description	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)	________

Set #	Description	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 (LINEOVRLD)	
1101	Select Line Overload (SELOVL)	______
1102	Level 1 Overcurrent Setting (PULV1)	______
1103	Level 2 Overcurrent Setting (PULV2)	

Set #	Description	Setting
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)	
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)	
1506	Current Transformer Ratio (CTRATIO)	
1507	Potential Transformer Ratio (PTRATIO)	
1508	Unit of Distance (DISTUNIT)	

Set #	Description	Setting
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 (UNALALM)	________________
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)	________________
1904	Input Number 3 (CO2IN3)	________________
1905	Input Number 4 (CO2IN4)	________________
1906	Input Number 5 (CO2IN5)	________________
1907	Input Number 6 (CO2IN6)	________________

Set #	Description	Setting
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)	________
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)	________

Set #	Description	Setting
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)	______

CAUTION: Power down the relay by turning off the front panel power switch. Disconnect the control DC power and remove all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF. Failure to do so can permanently damage the relay.

3–1 Case Assembly

Construction

The case that houses the electronics is constructed from an aluminum alloy. It consists of a main frame, mounting brackets, a front panel, top plate, and a rear panel. Two types of relays are offered, a vertical, and a horizontal mount unit. The description will be limited to the horizontal unit since the construction of both types is essentially the same.

Two outline drawings are shown in Figures 3-1 and 3-2. Figure 3-1 presents the front and rear views of the horizontal mount DLP3, and provides a panel cutout and drill pattern for mounting the DLP3. Figures 3-2 represents the information for a vertical mount DLP3.

To access the front panel, the front bezel must be removed first. The front bezel has four thumb screws with a hole in each screw that permits a tamper proof installation when a sealing wire is passed through all four thumbscrews. A hole in the front bezel makes it possible to access the clear key on the front panel keypad to clear the display without removing the bezel.

The rear panel, shown in Figure 3–1 and 3–2 supports the terminal blocks for external connections to the DLP3.

Three printed circuit boards are mounted horizontally inside the case, refer to Figure 3–3. Each circuit board is mounted on an aluminum plate which supports the circuit board and rides in the card guides in the DLP3 case. The printed circuit boards are held in place by two retainers located at the corners of the case in front of the circuit boards.

The magnetics module due to its weight is rigidly attached to the rear panel and the case.

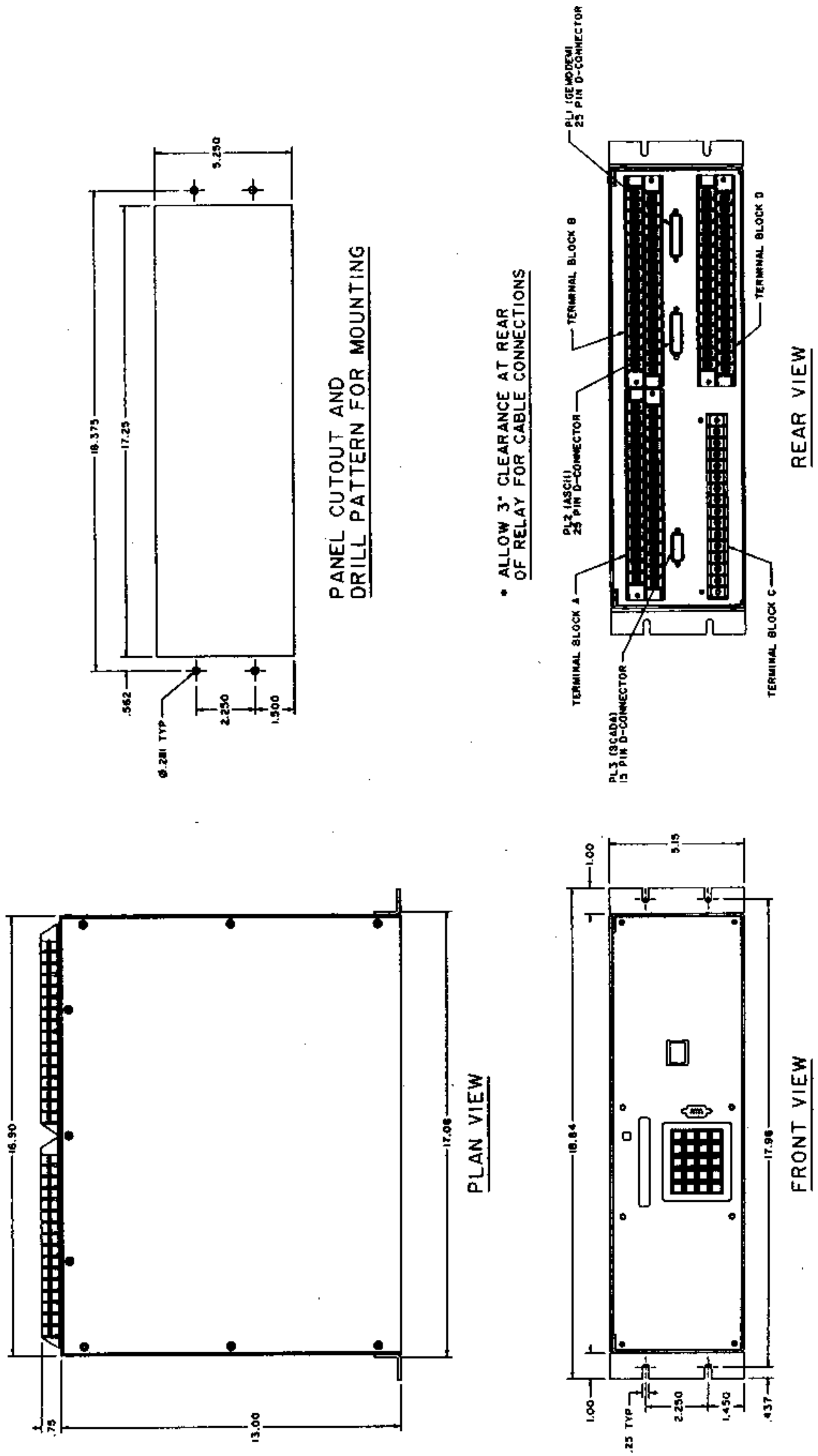


Figure 3–1. DLP3 Outline Horizontal

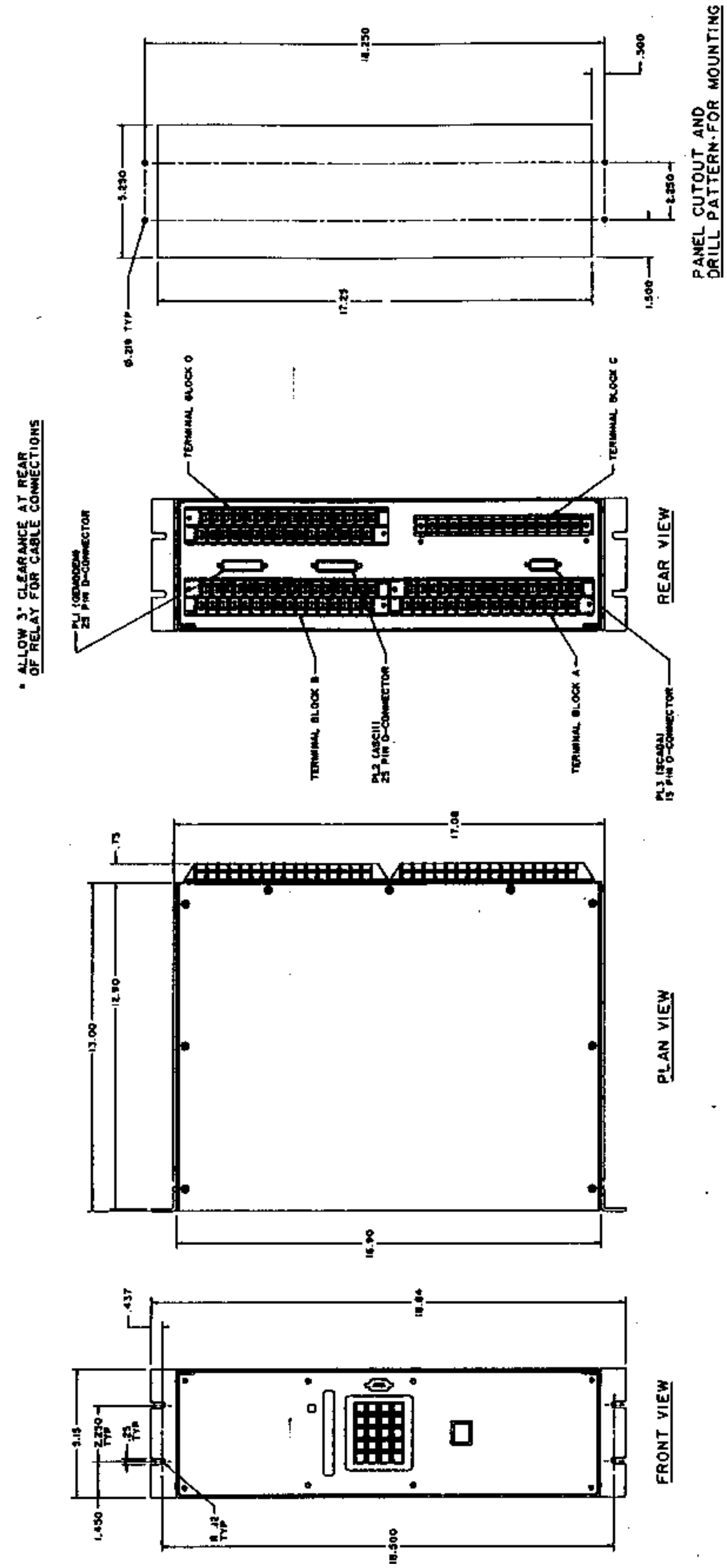


Figure 3–2. DLP3 Outline Vertical

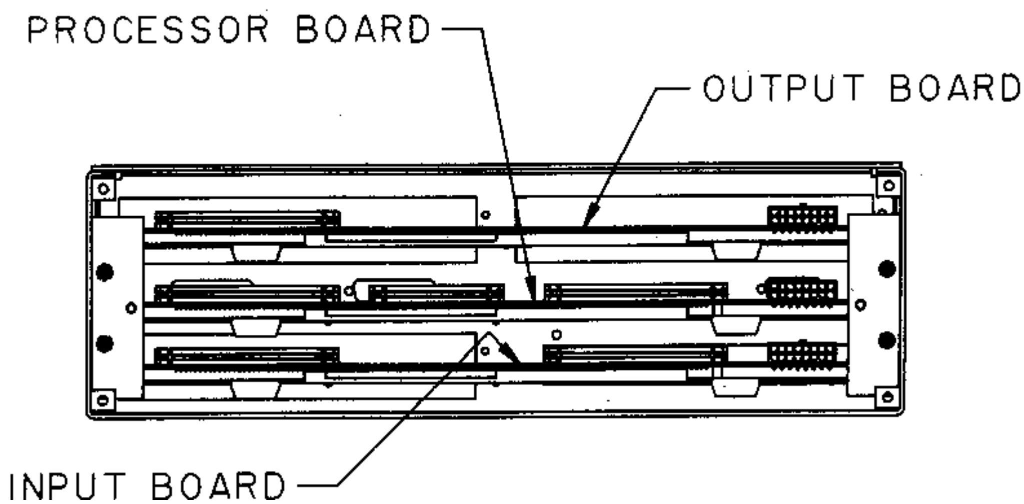


Figure 3–3. Location of the circuit boards inside the case

3–2 Electrical Connections and Internal Wiring

Electrical connections are made to the DLP through four terminal blocks (A, B, C, D) mounted on the rear panel. Terminal blocks A, B, C contain 32 terminal points each, which consist of a #6 screw threaded into a flat contact plate. Terminal D contains 14 terminal points, which consist of a #6 screw threaded into a flat contact plate.

The printed circuit boards are located inside the case in the positions shown in Figure 3–3.

The Output board, located in the top set of card guides, connects directly to terminal blocks A and B via two sets of edge fingers on the rear of the board.

The Input board, located in the bottom set of card guides, connects directly to terminal block D, and the magnetic module via two sets of edge fingers on the rear of the board. Terminal block C, accessible through a cutout in the rear panel, is part of the magnetics module assembly.

The Processor board, located in the middle set of card guides, has 3 DB plugs, *PL1 (GEMODEM), PL2 (ASCII),* and PL3 (SCADA) mounted to the board which are accessible through cutouts in the rear panel.

Interconnections between the Output, Processor, and Input boards is done via ribbon cables, and a wire connector assembly. The circuit board on the front panel is connected to the Processor board via a ribbon cable, and the power switch on the front panel plugs into the Output board.

Identification

The DLP3 system model number is laser etched into the front panel, and a label with the date code and serial number is located inside the case below the Input board. Identification for the Output, Processor, and Input boards are located on the tabs of the aluminum plates. If the top plate is removed, along with the Output, Processor, and Input Boards, the magnetic module label will be visible below the two spare terminals on the module terminal block.

The terminal blocks and DB connectors located on the rear panel are uniquely identified by silk-screened labels.

3–3 Receiving, Handling, and Storage

CAUTION: This relay contains electronic components that can be damaged by electrostatic discharge currents. The main source of electrostatic discharge currents is the human body, 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 printed circuit boards. Each person handling the printed circuit boards must ensure that their body charge has been discharged by touching some surface at ground potential *before* touching any of the components on the boards or the boards themselves.

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 Installation

Environment

The DLP3 should be installed in a clean and dry location, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

Mounting

The DLP3 case has been designed for standard rack mounting. The case is three rack units (3 RU) high. Two mounting ears, and the hardware to attach them to the DLP3 case is shipped inside the carton.

Figure 3–1 shows the outline and mounting dimensions. The DLP case has two additional mounting locations for locations where the existing panel does not have enough depth to accommodate the DLP3 case.

External Connections

External connections are made according to the elementary diagrams, Figures 1–6A & B. This is a general diagram incorporating all of the available options. Connection need not be made to terminals for options that are not used.

3–5 Surge Ground Connections

CAUTION: The DLP3 comes from the factory with: Terminals C12 (case ground) and C11 (surge ground) tied together, along with a jumper from A2 to A18. Terminal C11 must be tied to station ground, as shown in the elementary diagram, Figure 1–6. The connection to the ground bus must be made as short as possible, using 12 gage wire or larger.

3–6 Functional Modules

System Block Diagram

Figure 3–4 is the DLP3 system block diagram.

- The Outout board contains the Single pole Relay(SP Relay), Standard Relay(STD relay), and the Power Supply functional modules.
- The Processor board contains the DCI, DAP, DTA, and the SSP functional modules.
- The Input board contains the SPIO, DSP, and ANI functional modules.
- The Magnetic module, and MMI board contain components detailed later in this section

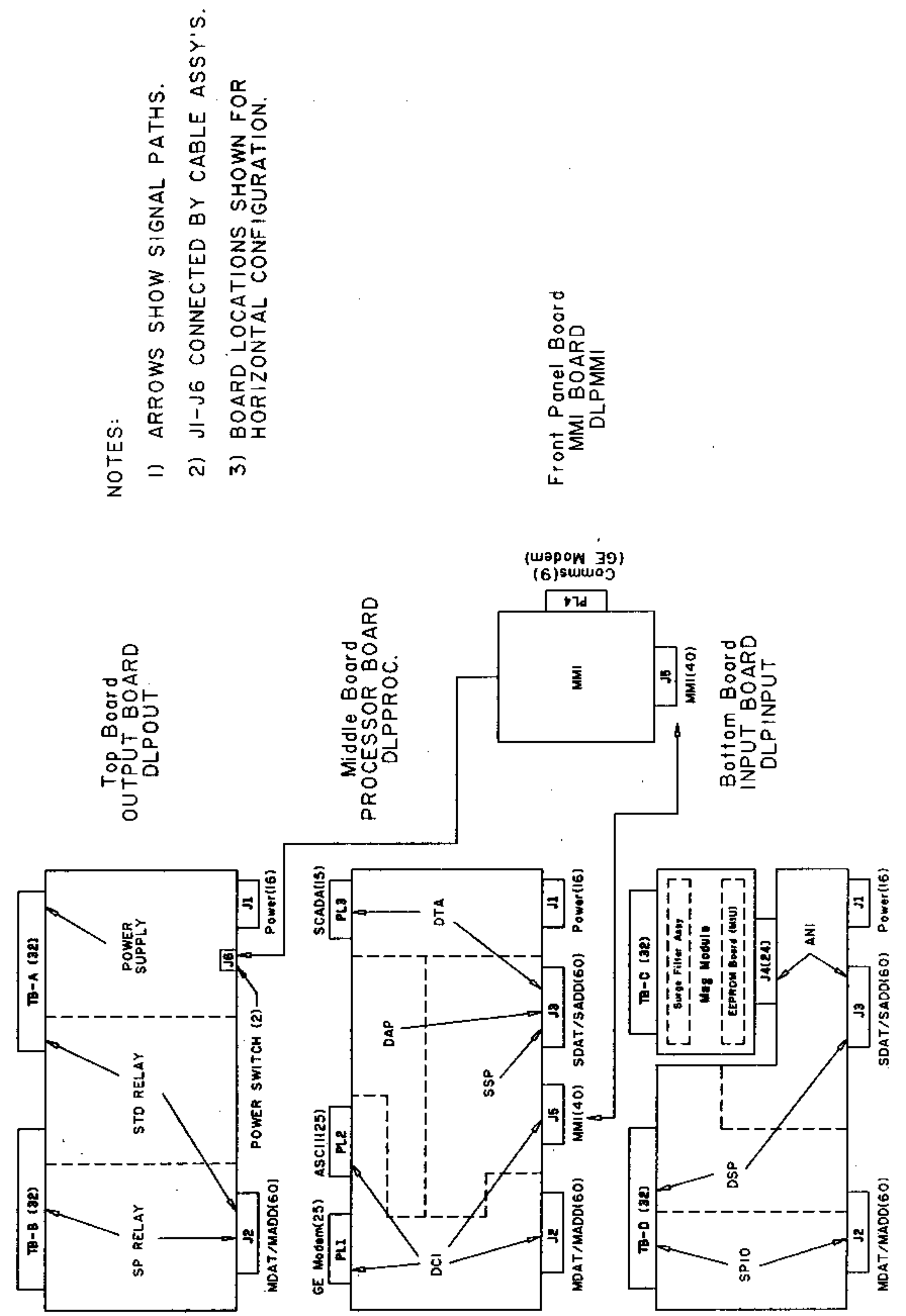


Figure 3–4. DLP3 System Block Diagram

Man-Machine Interface Logic

The logic for the MMI (man-machine interface) is shown in Figure 3–5. These circuits contain the 16-character LED display, the green/red status LED, a 9-pin RS-232 port, the 20-character keypad, and the (optional) Manual Lock Out (MLO) switch.

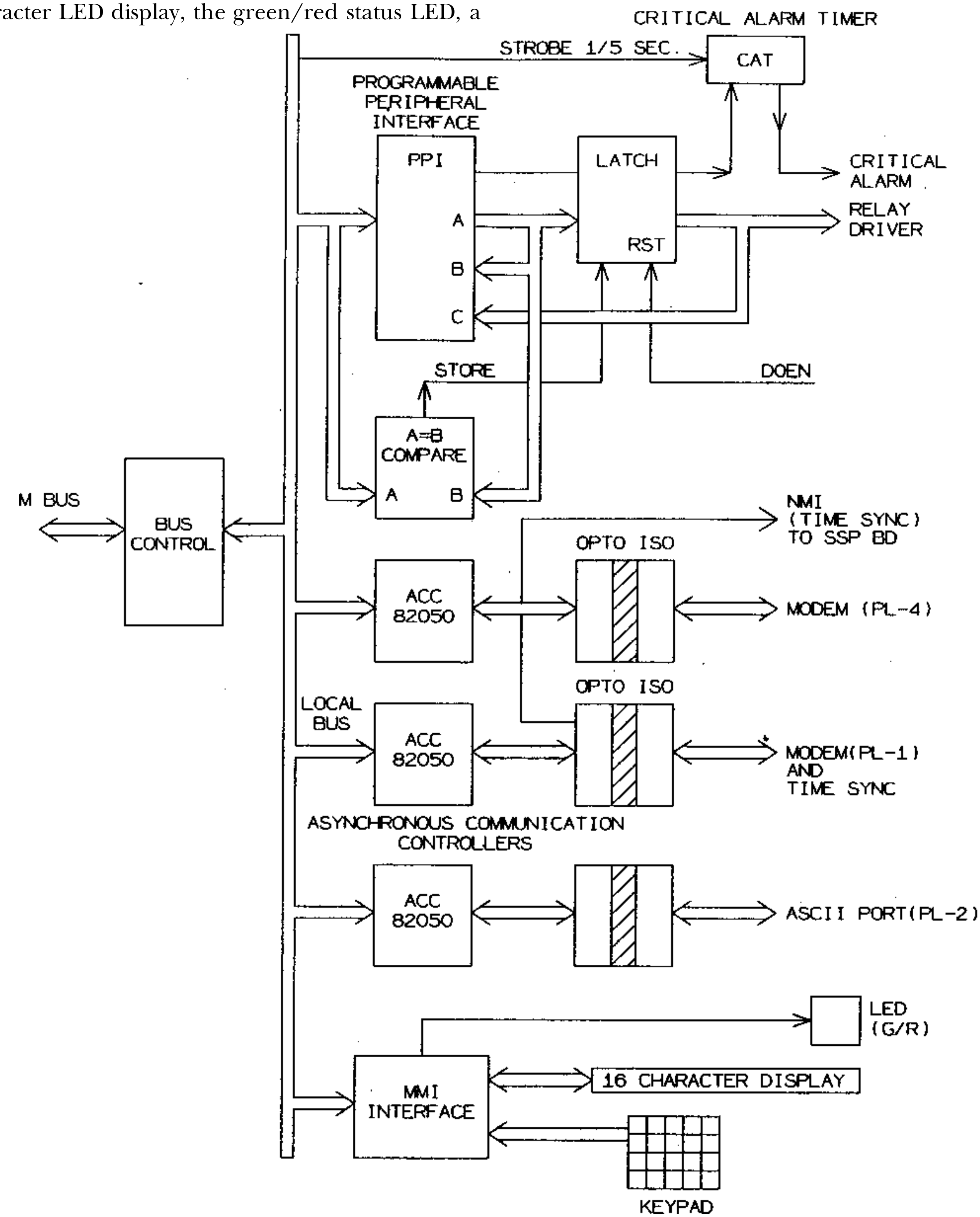


Figure 3–5. Block diagram of the MMI and DCI Logic

SPIO Logic

Figure 3–6 is the block diagram of the SPIO module. The SPIO (single-pole input/output) logic includes additional relay driver outputs and isolated contact converter inputs to allow for.

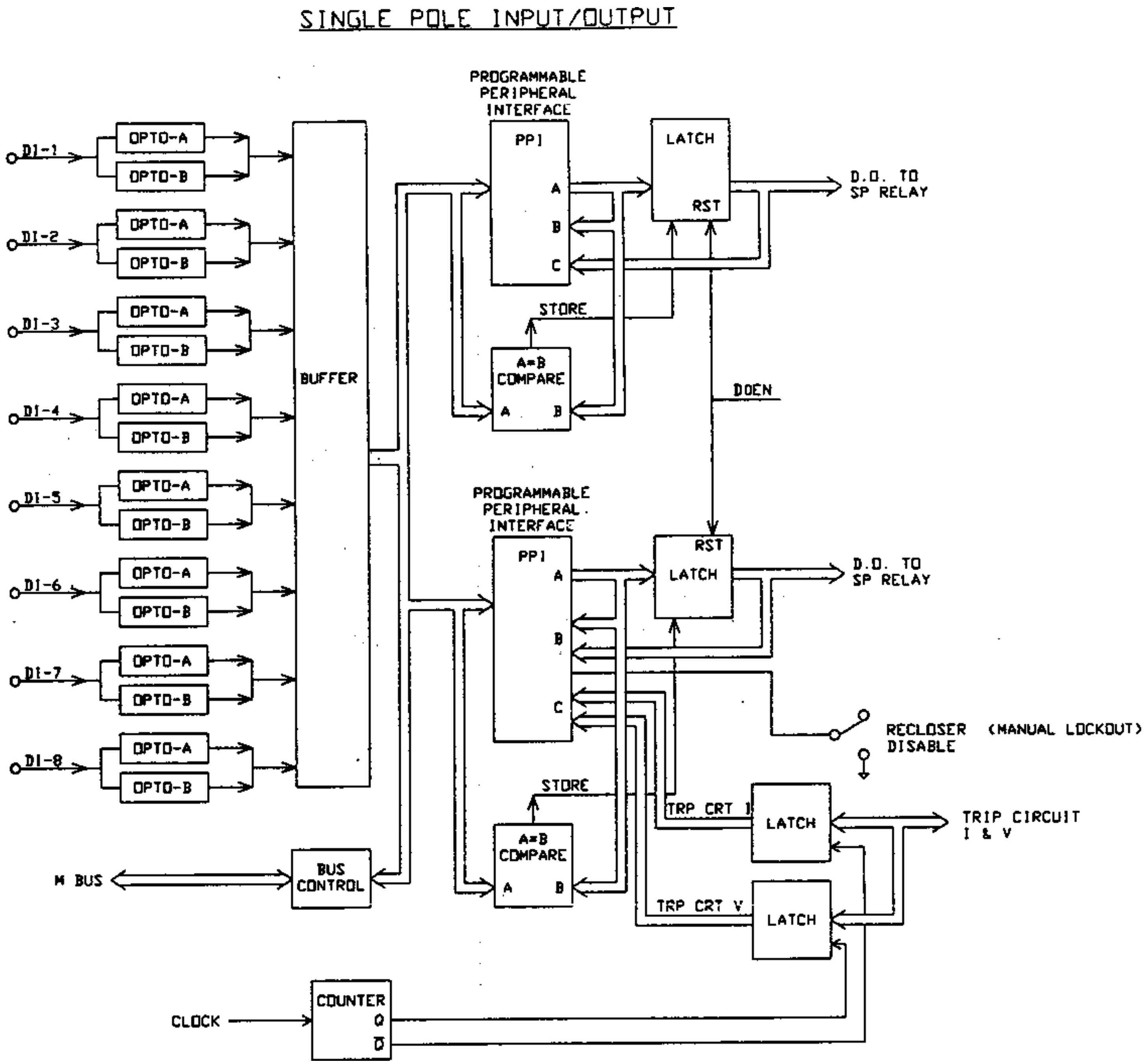


Figure 3–6.SPIO Block diagram.

Magnetic Module

The magnetics module (MGM) contains the input current transformers and voltage transformers. The MGM also contains an EEPROM with factory-stored DLP model information. The EEPROM stores DC voltage rating, AC current rating, and gain-calibration information for the analog channels. Figure 3–7 is a block diagram of the magnetics module.

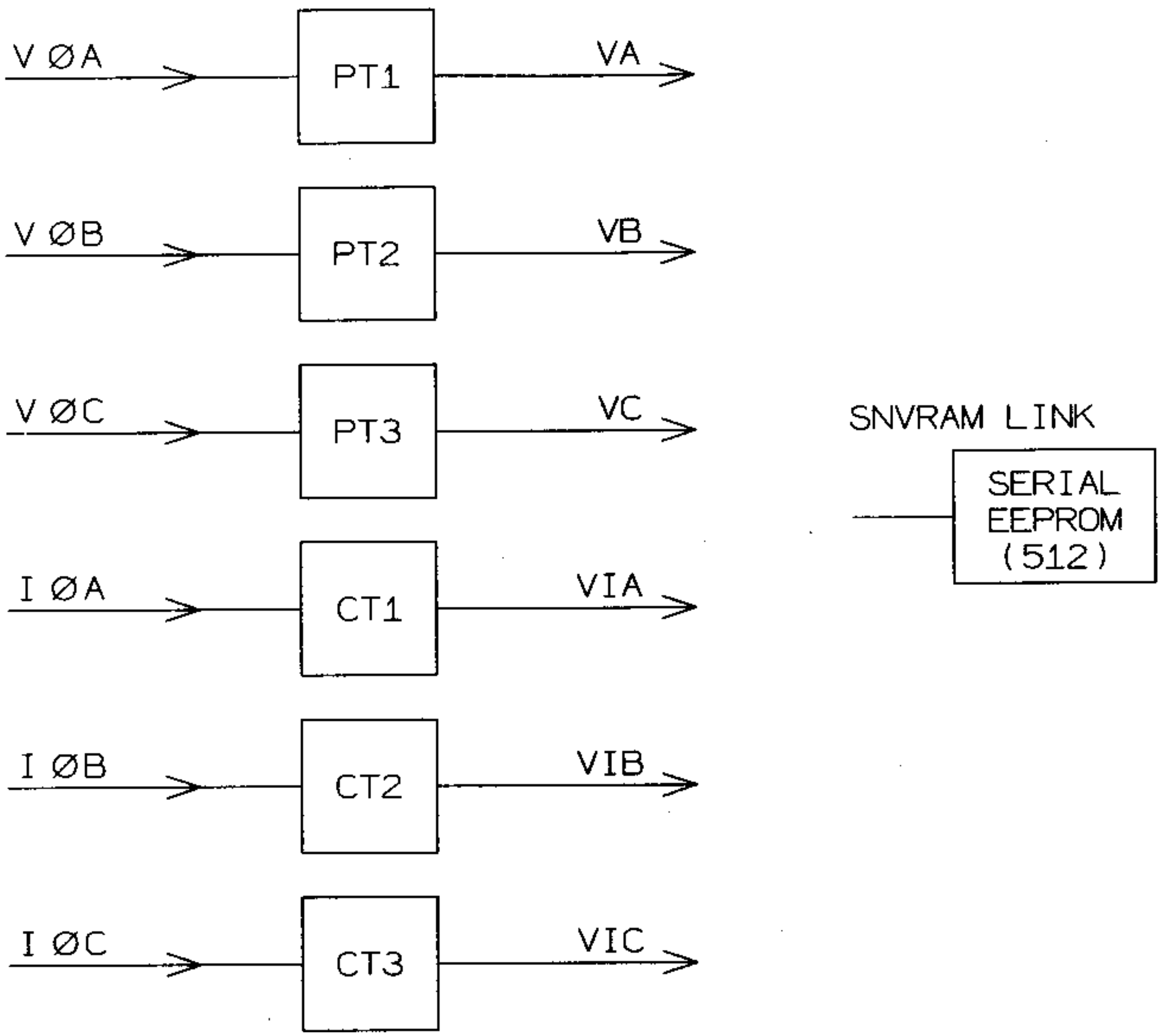


Figure 3–7. Block diagram of the Magnetics Module (MGM).

Analog Interface Logic

The analog interface logic (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. Figure 3–8 is a block diagram of the analog interface logic.

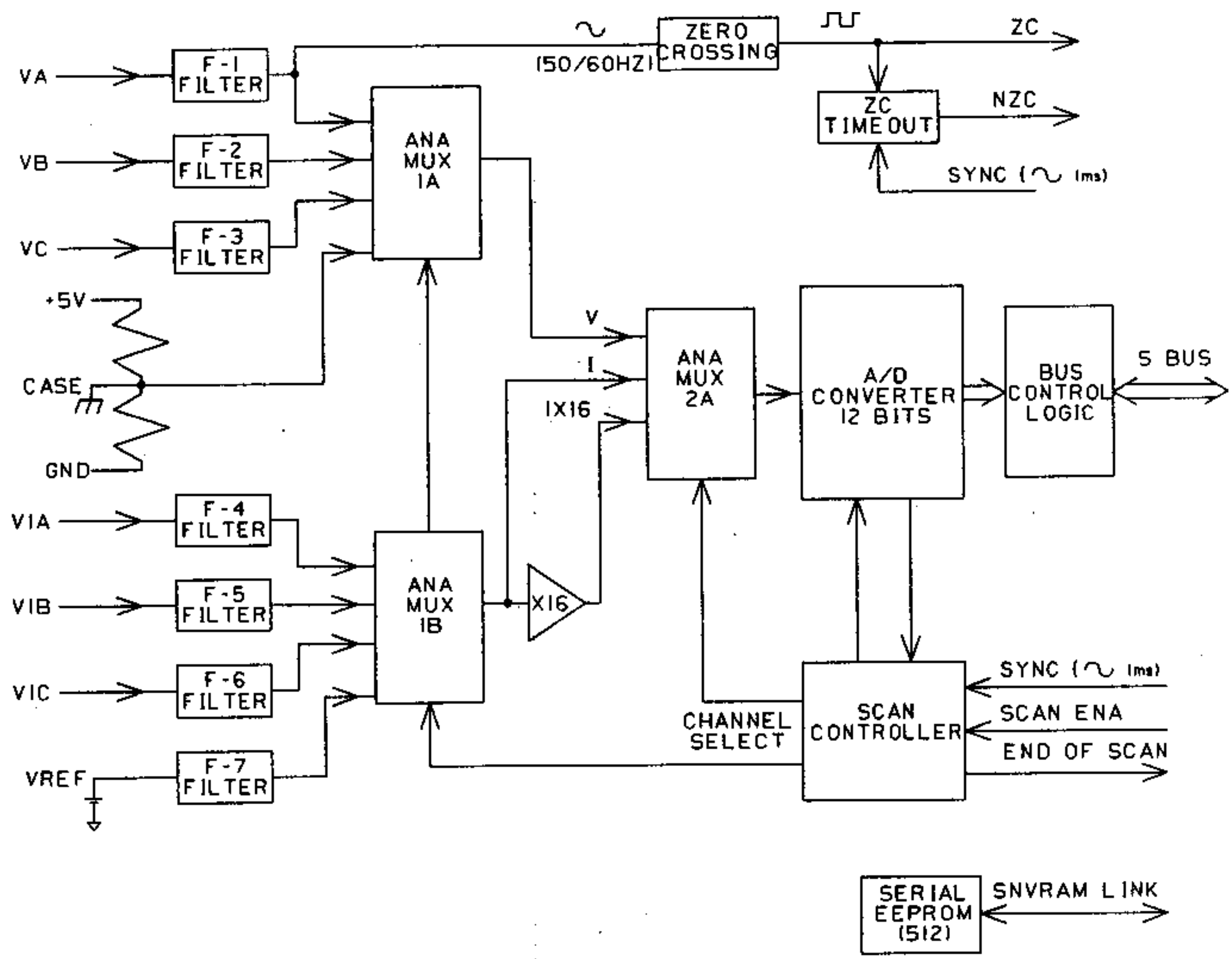


Figure 3–8. Block diagram of the Analog Interface Logic (ANI).

Data-Acquisition Processor

The Data-Acquisition Processor (DAP), located on the processor board, contains one of the two 80C186 processors used in the DLP and the associated memory. The DAP performs the following functions:

- 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 3–9 is a block diagram of the data-acquisition processor logic.

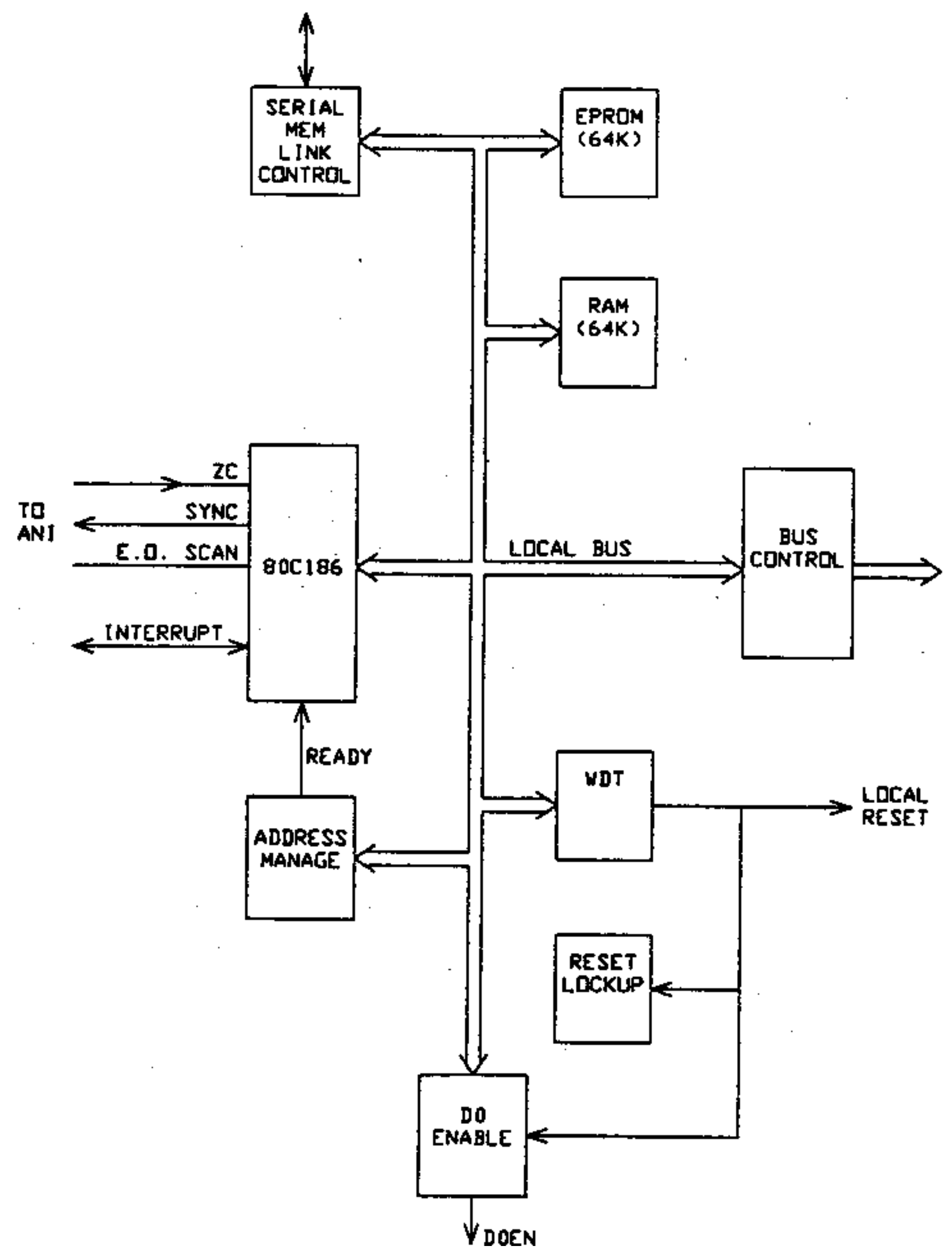


Figure 3–9. Block diagram of the Data-Acquisition Processor (DAP).

Digital Signal Processor

The Digital Signal Processor (DSP), located on the input board, contains the TMS320C10 digital signal processor chip and its required memory. The DSP is responsible for most of the numerical calculations in the DLP3. It performs the calculations to transform the digitized waveforms into phasor quantities.

The DSP also handles the coincidence logic for zones 1 and 2. The DSP also includes the isolated contact converters (digital inputs) and IRIG-B time-sync input. Figure 3–10 is the block diagram of the digital signal processor logic.

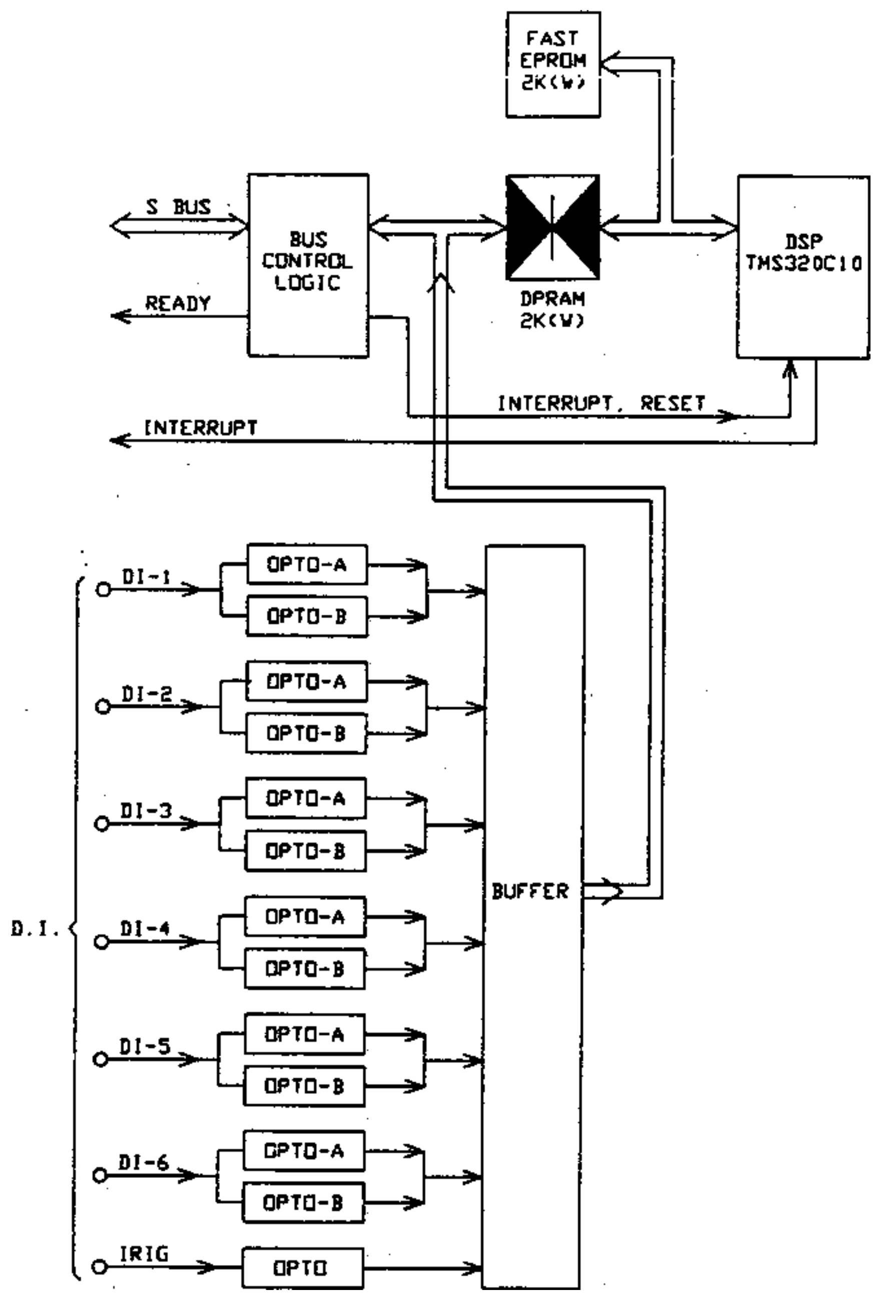


Figure 3–10. Block diagram of the Digital Signal Processor (DSP).

System Processor

The system processor (SSP), located on the processor board, contains one of the two 80C186 processors used for storage of user settings, and for storage of fault data and oscillography, and shared memory for data transfer to other modules The following functions are performed by the SSP:

- Scheme Logic
- Test Mode
- Peripheral Protection Trip Logic
- Digital Output Logic
- Fault Reporting
- MMI Control
- Power System Alarming
- Communications and Printer Control

Figure 3–11 contains the block diagram of the system processor logic.

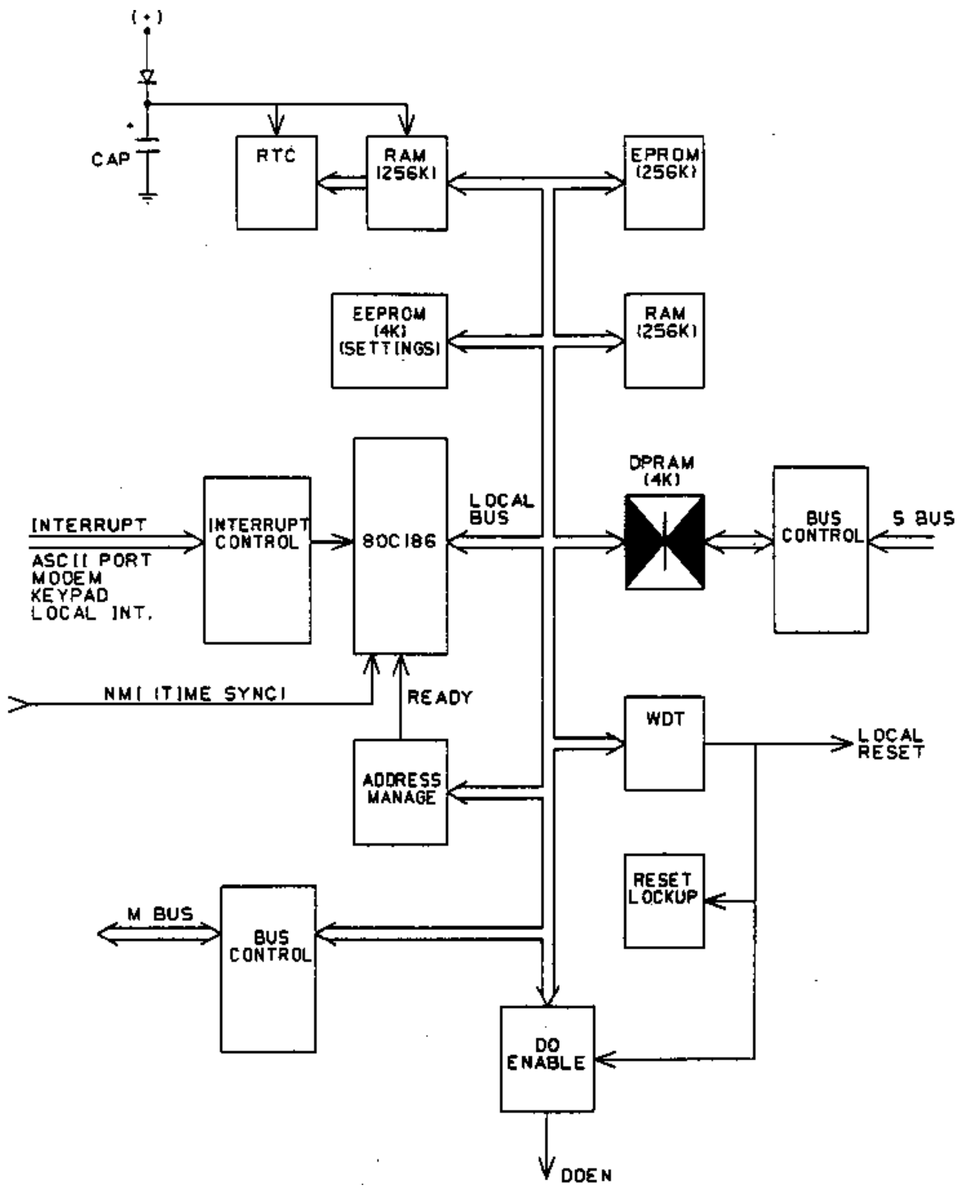


Figure 3–11. Block diagram of the System Processor (SSP).

Single-Pole Relay Logic

The Single-Pole Relay (SPRELAY), located on the output board. The SPRELAY contains the additional relays and SCRs used by the recloser.

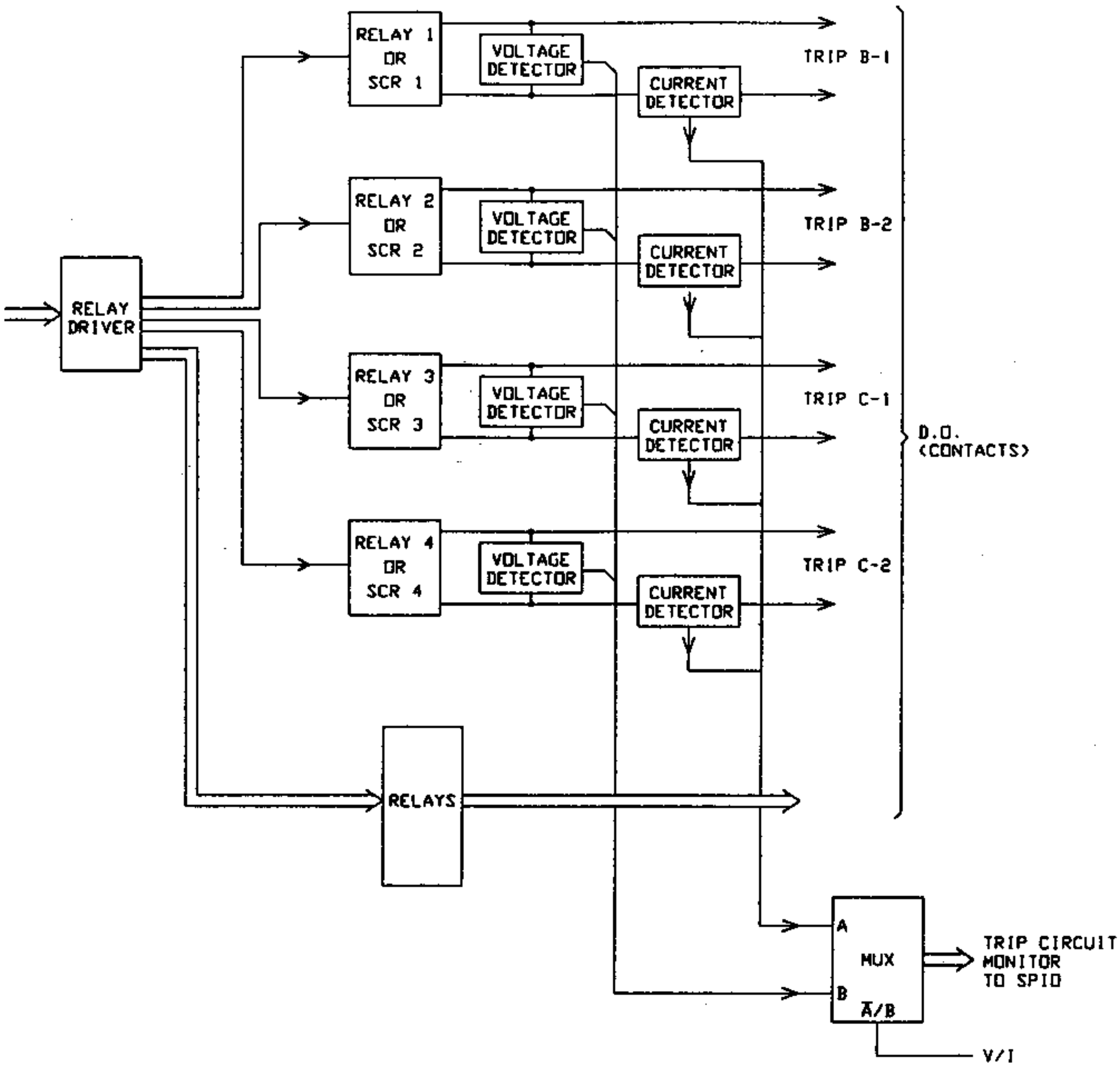


Figure 3–12. Block diagram of the single-pole relay logic (SPRELAY).

Digital-To-Analog Module

The Digital-To-Analog logic (DTA), located on the processor board, contains 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 3–13 is the block diagram of the digital-to-analog logic. Figure 3–14 is a outline drawing of the processor board, showing the SCADA–DTA switch that selects between current and voltage output.

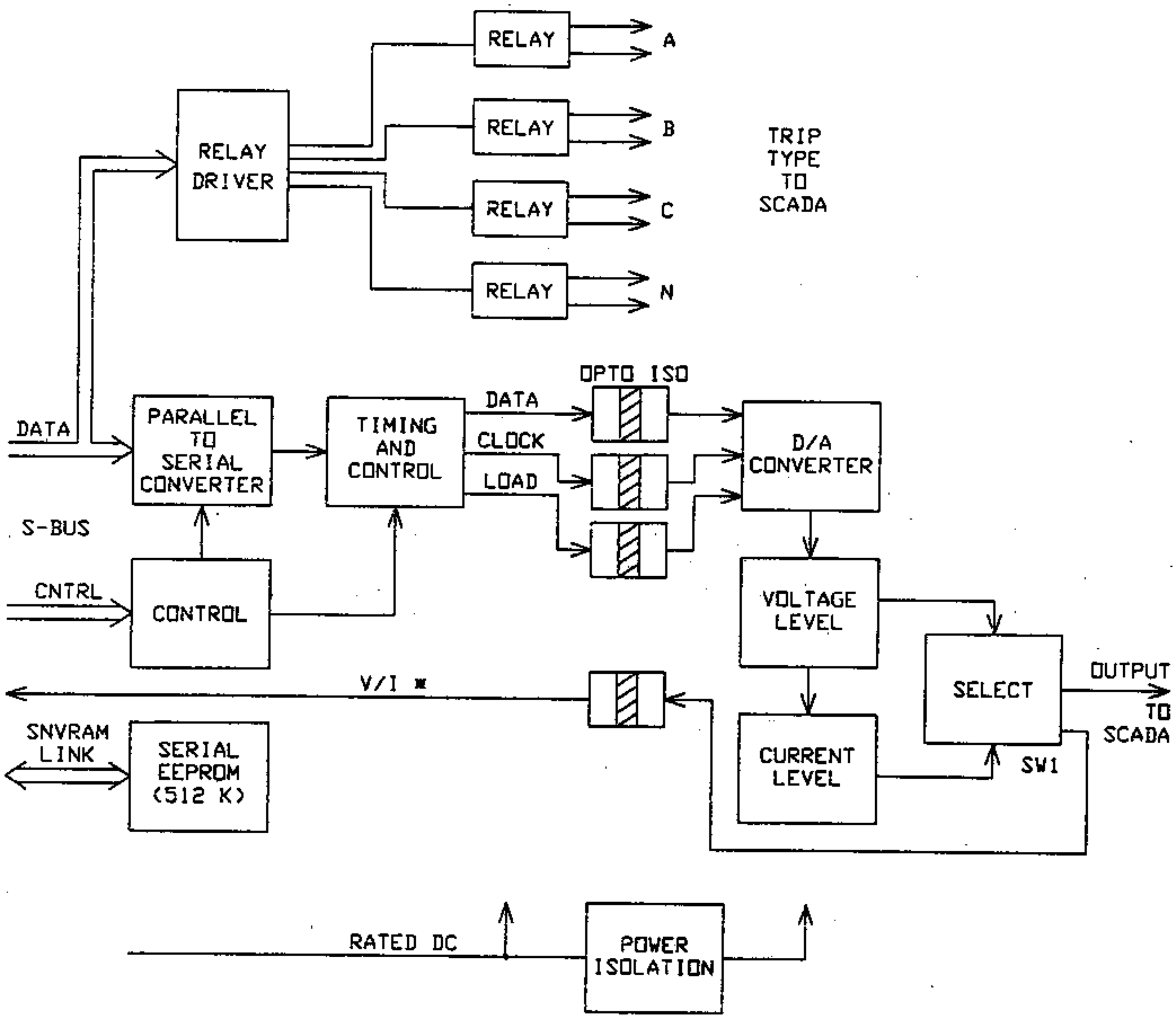


Figure 3–13. Block diagram of the digital-to-analog logic (DTA).

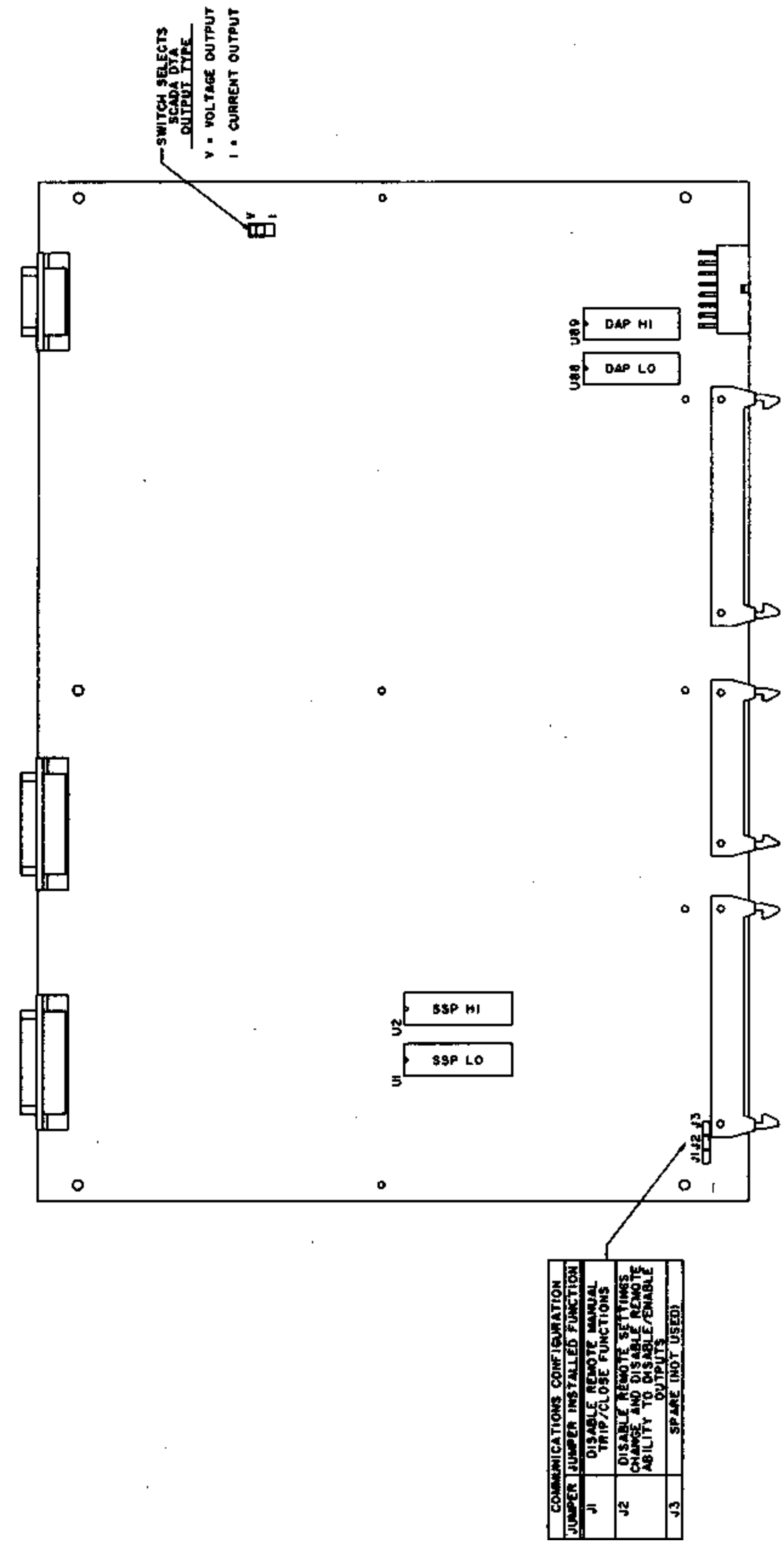


Figure 3–14. Top view of processor board, showing current-voltage selector switch.

Relay Driver Logic

The Relay Driver logic, located on the Output board, contains the alarms, BFI, RI, RC, breaker close, key transmitter, and phase “A” tripping contacts (or SCR’s) Figure 3–15 is a block diagram of the relay driver logic.

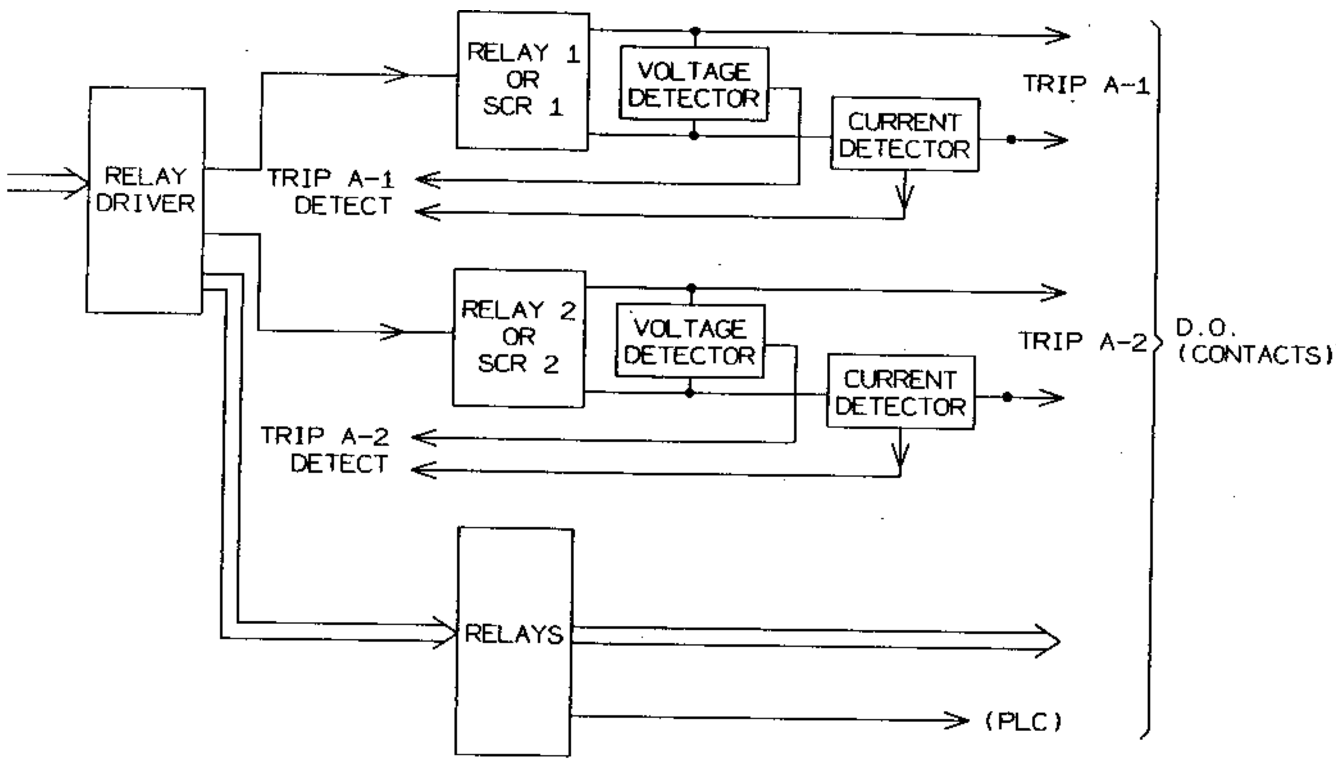


Figure 3–15. Block diagram of the Relay Driver logic.

Warning: Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF.

4–1 Overview

This section is a guide for testing the DLP3. These tests are not necessary for incoming inspection. The relay was tested at the factory with automated test equipment. The DLP3 is controlled by self-checking software. If a system failure is detected, it is reported through the MMI.

The following tests include self-tests of the relay status, display, and MMI. Tests of backup protection functions, measuring units, and zone timers are also included, and can be performed at the customer's discretion.

General Relay Tests

T1 – MMI Status and Display Tests (Self Tests)
T2 – Digital Output Tests
T3 – Configurable Input and Output Tests
T4 – AC System Input Test

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

Backup Protection Tests

T10 – Phase Instantaneous Overcurrent PH4
T11 – Ground Instantaneous Over-current IDT
T12 – Ground Time Over-current TOC

Zone Ground / Phase Reach and Timers Tests

T13 – Zone1 Ground Reach M1G
T14 – Zone2 Ground Reach MTG
T15 – Zone3 Ground Reach M3G
T16 – Zone4 Ground Reach M4G
T17 – Zone Ground Timer Tests
T18 – Zone1 Phase Reach M1
T19 – Zone2 Phase Reach MT
T20 – Zone3 Phase Reach M3
T21 – Zone4 Phase Reach M4
T22 – Zone Phase Timer Tests
T23 – Out of Step MOB

Recloser Test

T24 – Recloser (if applicable)

Test Equipment

- A three-phase source of voltage and current at rated frequency.
- A DC Control voltage source.
- Three ac voltmeters.
- Three ac ammeters.
- A continuity tester or ohmmeter.
- An IBM PC-compatible computer with a serial port and mouse.
- An RS232 null modem cable to connect the PC to the DLP3.
- A precision timer for testing timed events.

The specific equipment requirements are listed in the instructions for each 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 within the voltage range listed in *Chapter 7 – Specifications*.

Alternatively, a three-phase electronic test source may be used. In many cases, these devices allow simplification of the test circuits.

Drawings and References

The following drawings should be used for reference during testing.

Drawings

Elementary Diagram, Figure 1–6
Logic Diagrams, Figures 1–1, 1–2, 1–3, 1–4, 1–5
TOC curves, Figures 2–2, 2–3, 2–4

References

Chapter 9 – Software
Default Relay Settings

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 and the DLP3 itself.

The ground connection on the DLP3 is terminal C11. The common for surge protection is terminal C12.

NOTE: C12 should be connected to C11 with the factory installed jumper, or a wire 12 gage or larger. (The separate surge ground is for High Pot testing purposes.)

Required Settings

Most tests use the default settings. Any required setting changes are listed with the test procedure.

For details on performing the relay test with user-specific settings during periodic testing, see *Chapter 5 – Periodic Tests*.

General Instructions

1. Tests are performed in the DLP3's test mode, which mode allows viewing of the internal measuring units and functions. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

   The test mode selects and isolates various test functions and measuring units, then routes their status to the RC (reclose cancel) contact. When the particular function under test has picked up, the RC contact closes. Target information is displayed for tests that cause tripping.

   Testing can be performed with outputs disabled. The RC contacts still close whenever a trip condition exists, however the tripping contacts do not operate. Disabling outputs can be accomplished from the ACTIONS menu.

   CAUTION: The RC contact will chatter when the unit under test is near its threshold. *Do not let it continue to chatter.* Remove the test current. A single contact closure is enough to determine that the unit picked up.

   In tests that cause tripping, the trip target type may not match the type explained in the test procedure.. 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.

   Use a continuity tester with high-input impedance, such as a digital ohmmeter, to monitor the RC contact during relay testing.

   NOTE: Tripping contacts will operate while the DLP3 is in test mode unless the outputs are disabled..

2. Where appropriate, current levels are defined with two numbers as xx(yy); xx is the value to be used for relays rated at 5 amperes and (yy) is the value to be used for 1-ampere relays.

3. One or more of the electronic current sources may not be used during a test. If the source is not used, it must be set to zero, in addition to being disabled. Also, the currents should always be set at or near zero whenever a current source is powered on or off.

4. The phase angles of the test sources are shown relative to phase A voltage. A positive phase angle means that the referenced quantity is leading phase A voltage. A negative phase angle means that the referenced quantity is lagging phase A voltage.

5. All test voltages are phase-to-ground measurements unless otherwise specified.

6. Entries at the keypad are shown as KEY, with the label of the key to be pressed. For tests that require a setting change, the setting number is shown in parentheses next to the setting. This is performed by pressing the SET key, the setting number (nnnn), and ENT. The new setting may then be entered.

NOTE: Operation of Potential Transformer Fuse Failure (PTFF) will cause the Critical Alarm to operate.

7. When testing the relay using 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. At the end of testing, make sure that all settings are returned to their initial values. This can be done through the DLP-LINK by downloading the settings and then printing them. Alternately the ASCII Port may also be interrogated for the setpoints. If a PC is not available, scroll through all settings with the MMI Display and verify each one.

Setting Changes

Setting changes required for a particular test are listed before the test. A sample setting change using the MMI keypad is shown below. For models ending in NC, see Using DLP-LINK below. Refer to *Chapter 8 – Interface* for further details on making setting changes.

Example Setting Change

This example illustrates changing the reach of the Zone 1 Ground Unit to 5.6 Ohms.

1. Apply rated DC and wait for relay initialization to complete, as indicated by the green LED on the MMI.

2. Press the ACT key. Scroll with the ↑ key until

   ACT: ENTER PASSWORD

   is displayed, then press the ENT 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". This password must be changed before any setting functions can be accessed. See *Chapter 8 – Interface* for details on changing the password.

3. Enter the current Settings or Master level password. If the password is not known, see *Chapter 8 – Interface* for details on viewing the password. When the correct password is entered,

   SELECTED

   is displayed.

4. Press the SET key. Press the 1/Y and ENT keys to select settings group 1.

5. Scroll with the arrow key until

   SET: Z1DIST

   is displayed, then press the ENT key.

6. Scroll through the Z1DIST settings until

   Z1GR = #.#

   appears on the display.

7. Press 5.6 on the keypad. The inputs appear on the MMI display at half intensity, to indicate that a change has been made but not yet entered.

8. When the correct reach is entered, press the ENT key. The typed inputs then appear on the MMI display at full intensity. This indicates that the change is entered into the settings buffer, but not permanently changed in the relay.

9. To complete the setting change, press the END key followed by the ENT key. If the END and ENT keys are not pressed after setting changes, the settings are not stored into memory.

10. Restore the Z1GR setting to its original value before beginning the test. You will have to enter the settings level password again.

Entering Test Mode

Before a test can be performed, the DLP3 must be put in test mode and select the function to be tested. The test mode is set as follows:

1. Apply rated DC and wait for relay initialization to complete, as indicated by the green LED on the MMI.

2. Press the ACT key. Scroll with the ↑ key until

   ACT: ENTER PASSWORD

   is displayed, then press the ENT key.

   If this is the first time the Master Level functions are used, the password has the factory value "5678.". This password must be changed before any Control functions can be accessed. See

Chapter 8 – Interface for details on changing the password.

3. Enter the current Master Level password. If the password is not known, see *Chapter 8 – Interface* for details on viewing the password. When the correct password is entered,

   SELECTED

   is displayed.

4. Press the ACT key. Scroll with the ↑ key until

   ACT: RELAY TEST

   is displayed, then press the ENT key.

5. Scroll through the different test mode functions or enter the number of the desired test, such as 38 for the Fault Detector. Press ENT and the display indicates

   FAULT DETECTOR ON

   and the MMI LED turns red, indicating that the relay is in test mode. When the DLP3 picks up for the selected function it closes the RC contacts.

6. To exit 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 indicates

   END TST MODE?

   or enter 1, then press the ENT key. The MMI LED should return to green, indicating that normal operation has resumed.

Using DLP-LINK (Optional)

The relay can be tested without using the DLP3 keypad via a PC and 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. When the DLP3 is in test mode, currents and voltages are applied to the relay to simulate the desired system conditions.

This section contains a step-by-step procedure to test the relay, from setting up communications to the application of the voltage and current inputs. You must be familiar with the DLP-LINK software. Refer to *Chapter 9 – Software* for details on using DLP-LINK.

Hardware Setup

The appropriate cable to connect the 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 25-pin connector. Null modem cables are shown in *Chapter 8 – Interface* for connecting to the DLP3 with a 9-pin-to-25-pin and a 25-pin-to-25-pin setup.

PC Software Setup

The software setup consists of loading the software into the PC, starting the program, and configuring the program to the port and baud rate of the PC and DLP3.

Load & Start DLP-LINK

1. Use the installation guide in *Chapter 9 – Software* for directions for loading DLP-LINK into the PC.
2. Change directories to the location of the DLP-LINK program.
3. Start the program by typing DLP-LINK at the DOS prompt.

Set the Local PC configuration.

1. When you start DLP-LINK the MAIN MENU is displayed.
2. Select the SETUP heading. (Refer to *Chapter 9 – Software* for details on selecting items using the keyboard or a mouse.) The SETUP menu is now displayed.
3. Select COMMUNICATION PORT NUMBER. The default communications port is displayed.
4. Type in the port number that matches the PC port connected to the DLP3. If port 3 or 4 is selected, the IRQ number must also be selected.
5. Select OK when the port is configured.

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. Usually, the DLP3 is accessed locally during testing; therefore, the PHONE NUMBER and SWITCH CODE are left blank. The BAUD RATE is set to the factory setting of 2400 with one stop bit and no parity.

1. Select the ADD RELAY TO LIST heading from the SETUP menu.
2. 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.
3. At the PHONE NUMBER prompt, press TAB.
4. At the SWITCH CODE prompt, press TAB.
5. At the BAUD RATE prompt, select 2400 and press TAB.
6. At the STOP BITS prompt, select 1 and press TAB.
7. At the PARITY prompt, select None and press TAB.
8. The Unit Description for TEST is complete. Enter OK to return to the SETUP MENU.

Relay Setup

Before shipment, the relay is set with factory default settings. These include the Unit ID, the Baud Rate, and the Factory Passwords. The default communications parameters are listed in Table 4–1.

Parameter	Setting
Unit ID	0
View Password	VIEW!
Master Password	CTRL!
Settings Password	SETT!
Baud Rate	2400

Table 4–1. Factory-default communication parameters.

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 Table 4–1 and must be changed before any of the relay functions except CHANGE PASSWORD and LOGOUT will operate. See *Chapter 9 – Software* for details on changing a password.
3. Type in the current password and press TAB. If the password is not known, refer to *Chapter 8 – Interface* for details on displaying the current password.
4. DLP-LINK prompts for the unit ID. Type 0 and press TAB.
5. Select OK. DLP-LINK responds with the message,

   SUCCESSFUL LOGIN

   If this was an initial login, you must log out at this point and log in again, in order to get a complete display of all the DLP menus.
6. Select LOGOUT from the RELAY FUNCTIONS menu and select OK.

Setting Changes

Setting changes required for a particular test are listed before the test. A setting can be changed either by category or individually, by selecting either 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 *Chapter 9 – Software.*

It is important to remember to select END SETTING CHANGES from the DLP SETTINGS menu after all settings changes for a particular test are complete. This is necessary because settings are stored in a buffer so that they can all be downloaded at once. Selecting END SETTINGS CHANGES changes the settings in the relay itself.

Entering the Test Mode

Before most tests it is necessary to set the relay in test mode according to the function to be tested. The test mode is set as follows:

1. 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 *Chapter 8 – Interface* for details on viewing the current password.
3. When the password is accepted,

   CONTROL LEVEL

   appears at the bottom of the screen.

Steps 1 - 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.
6. The MMI LED changes from green to red when the DLP3 is in test mode.

Exiting the Test Mode

To end test mode and turn relay protection on, select END TEST MODE from the RELAY TEST list box and then select OK. The MMI LED changes from red to green, indicating that normal operation has resumed.

Initial Test Setup

Before beginning a test, the relay settings should be checked for reference and verification. The factory settings are listed in *Chapter 2 – Calculation of Settings*. You may use either the communications ports or scroll through the settings to ensure they all match the defaults.

For testing with 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 prompts for a name for the file, after which you should enter a valid MS-DOS filename. More information on how to use this command can be found in *Chapter 9 – Software.*

4–2 General Relay Tests

T1 – MMI Status and Display Testing

The DLP3's Status is reported through the MMI, the noncritical alarm contact, and the critical alarm contact. If a system error causes relaying functions to cease, the LED on the MMI turns red and the critical alarm contact closes. A failure that does not interrupt relaying is indicated by closing of the noncritical alarm and by a WARN message on the MMI display.

Status Check

This test demonstrates the use of the MMI to check relay status. See *Chapter 8 – Servicing* for further details.

1. Only the DC power supply voltage is required for this test. Apply the rated DC power and wait for initialization to complete, as indicated by the green LED.
2. Press the INF key, then scroll with the ↑ or ↓ key until the heading

   INF: STATUS

   is displayed.
3. Press the ENT key. The display should contain

   STATUS OK

   which means that the relay is operational and there are no errors.
4. Change the setting of the trip circuit monitor (#1504) to BKR1:

   TRIPCIRC = 1

   Be sure to press the END and ENT keys after the setting is changed. When this is done, the relay expects wetting voltage across the trip contacts.
5. Press the INF key, then scroll with the ↑ and ↓ keys until the display contains

   INF: STATUS
6. Press the ENT key. The display should contain

   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

   TRIPCIRC = 0

   before proceeding with the next test.

Display and Keypad Tests

The MMI test is built into the software and allows testing the keypad, and the display.

1. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.

2. Press the ACT key, then scroll with the arrow keys until the display contains the heading,

    ACT: MMI TEST

3. Press the ENT key. The display should contain eight fully lit rectangles followed by NEXT?.

4. Press the 1/Y key followed by the ENT key. The display changes to eight fully lit rectangles on the right of the display preceded by LED TST?.

5. Press the 1/Y key followed by the ENT key. The green LED momentarily turns red.

6. Next the display prompts 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 key. As you press each key, verify that the display indicates the key that was pressed. For example, pressing the up arrow is indicated on the displayed by UP. The display corresponding to the other keys is the legend that is on printed the key itself. Note that when the DASH (–) key is pressed the display responds with SPARE.

9. When all the keys have been checked, press the CLR key.

10. When the test is completed, press the END followed by the ENT key. This ends the MMI test mode.

T2 – Digital Output Test

This test checks all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults. Protection can be enabled or disabled, as deemed necessary.

Note: If this test is run remotely over the DLP-LINK, then jumper J1 must be removed to allow the outputs to operate. Refer to section 8-3 for details on removing jumper J1. Note that jumper J1 is shipped in the open postion to allow the outputs to operate.

1. Connect the relay as shown in Figure 4–1.

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 ↑ or ↓ key to scroll to the desired output, such as TRIP1A, and press the ENT key.

    Before the contact is allowed to close, the display prompts

    PROTECT OFF?

    Press the 1/Y key followed by the ENT key to turn protection off. Protection remains off until the test mode is ended. (If desired, protection can be left enabled during the test.)

    When the protection choice is chosen, the selected relay output closes. 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 closes and the previously selected output opens. 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, press END followed by the ENT key to end the test and re-enable protection.

DIGITAL OUTPUT	X	Y
TRIP-1	A9	A25
TRIP-2	A10	A26
BFI	A11	A27
	A12	A28
RI	A13	A29
	A14	A30
BC-1	A3	A19
BC-2	A4	A20
RC	A8	A24
NCA	A6	A22
CA	A7	A23
KT-1	A15	A31
KT-2	A16	A32
LN OVRLD	A5	A21
RIP	B9	B25
LOA	B12	B28
ZIRR	B10	B26

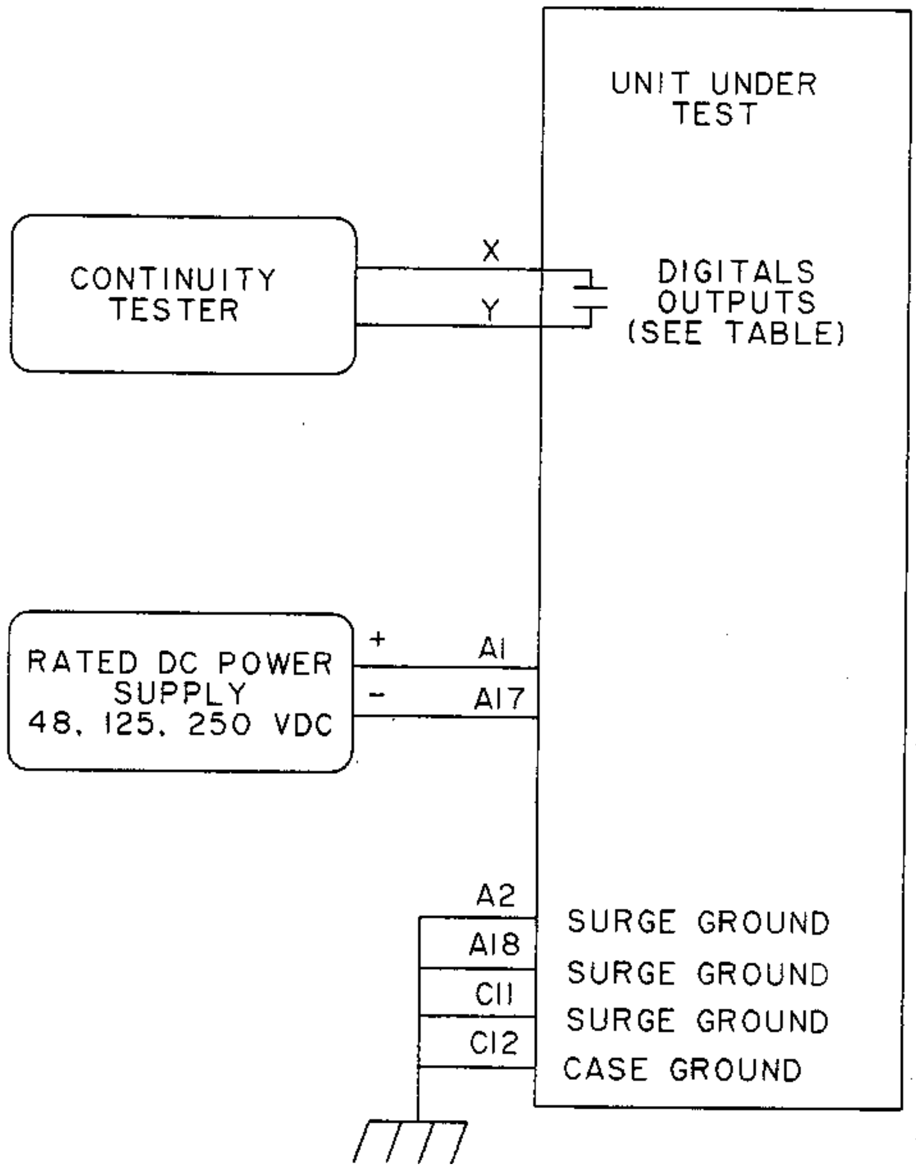


Figure 4–1. Digital output test connections (drawing #0357A3044, sh. 1).

T3 – Configurable Input and Output Test

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, while 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 8 of the 64 measuring units of the relay. In the test case used below, the digital inputs are used as logic inputs to the configurable output. The configurable output contacts close when the input is energized.

Pretest Setup

To perform this test, first change the following settings for MODE0 operation. In MODE0, CC4 is the RCVR2 input and CC5 and CC6 select the settings group used by the relay.

Settings:

CONFGINPUTS

(1701)	CONCCI = 0	(MODE0)
(1702)	SETGRP = 0	(ADAPT SET GRP)

SCHEMESEL

(1201)	SELSCM = 1	(POTT)
(1202)	NUMRCVR = 2	

CONFIG

(1503)	NUMBKRS = 2	

Test T3 Procedure

The steps of test T3 are as follows:

1. Connect the relay as shown in Figure 4–2.
2. Apply rated DC across CC4 (D5-D21). Using the MMI and the INFORMATION – VALUES command, verify that PLC #2 is ON.
3. Remove DC from CC4. Using the MMI and the INFORMATION – VALUES command, verify that PLC #2 is OFF.
4. Remove any inputs to CC5 (D6-D22), and CC6 (D7-D23). Using the MMI and the INFORMATION – VALUES 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 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.

Settings:

CONFGINPUTS

(1701)	CONCCI = 8	(MODE8)
(1702)	SETGRP = 1	(SET GROUP 1)

SCHEMESEL

(1201)	SELSCM = 1	(POTT)
(1202)	NUMRCVR = 2	

CONFIG

(1503)	NUMBKRS = 2	

BKR1CLSOUT

(1801)	CONOUT1 = 1	(LOGICAL 'OR')
(1802)	CO1IN1 = 52	(CFG INP 3, CC6)
(1803-1809) = 0		(UNUSED)

BKR21CLSOUT

(1901)	CONOUT2 = 1	(LOGICAL 'OR')
(1902)	CO2IN1 = 52	(CFG INP 3, CC6)
(1903-1909) = 0		(UNUSED)

RCANCLSOUT

(2001)	CONOUT3 = 1	(LOGICAL 'OR')
(2002)	CO3IN1 = 51	(CFG INP 2, CC5)
(2003-2009) = 0		(UNUSED)

LNOVLDOUT

(2101)	CONOUT4 = 1	(LOGICAL 'OR')
(2102)	CO4IN1 = 51	(CFG INP 2, CC5)
(2103-2109) = 0		(UNUSED)

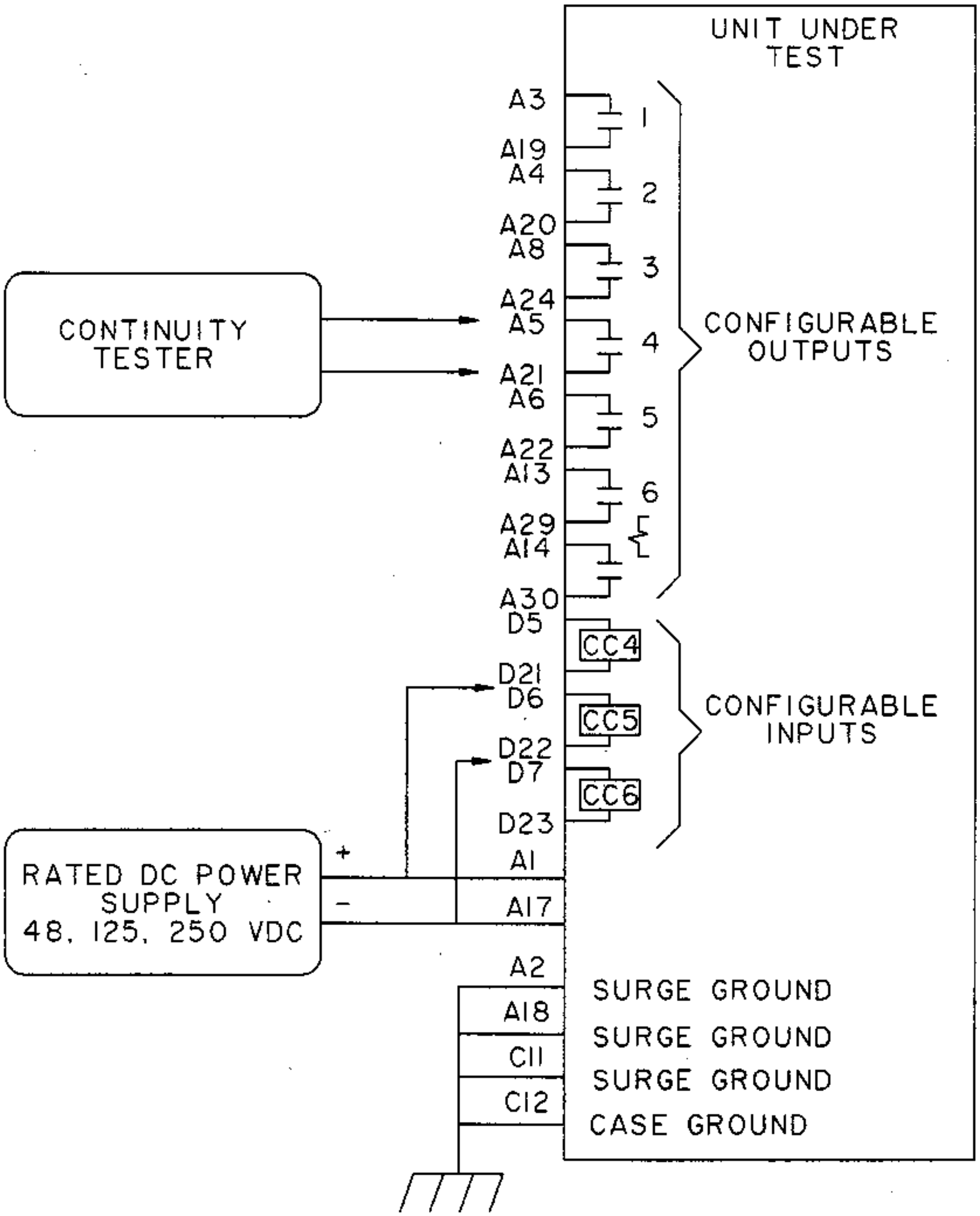


Figure 4–2. Configurable input and output test connections (drawing #0357A3044, sh. 2).

NONCRITOUT

(2201)	CONOUT5 = 1	(LOGICAL 'OR')
(2202)	CO5IN1 = 50	(CFG INP 1, CC4)
(2203-2209) = 0 (UNUSED)		

RINITOUT

(2301)	CONOUT6 = 1	(LOGICAL 'OR')
(2302)	CO6IN1 = 50	(CFG INP 1, CC4)
(2303-2309) = 0		(UNUSED)

9. Apply rated DC across CC4, (D5-D21).
10. Verify that the following contacts close:

Output	Contacts
CONOUT5	A6-A22
CONOUT6	A13-A29 & A14-A30

11. Remove DC from CC4.
12. Verify that the contacts in step 10 are now open.
13. Apply rated DC across CC5 (D6-D22).
14. Verify that the following contacts close:

Output	Contacts
CONOUT3	A8-A24
CONOUT4	A5-A21

15. Remove DC from CC5.
16. Verify that the contacts in step 14 are now open.
17. Apply rated DC across CC6 (D7-D23).
18. Verify that the following contacts close:

Output	Contacts
CONOUT1	A3-A19
CONOUT2	A4–A20

19. Remove DC from CC6.
20. Verify that the contacts in step 18 are now open.

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.

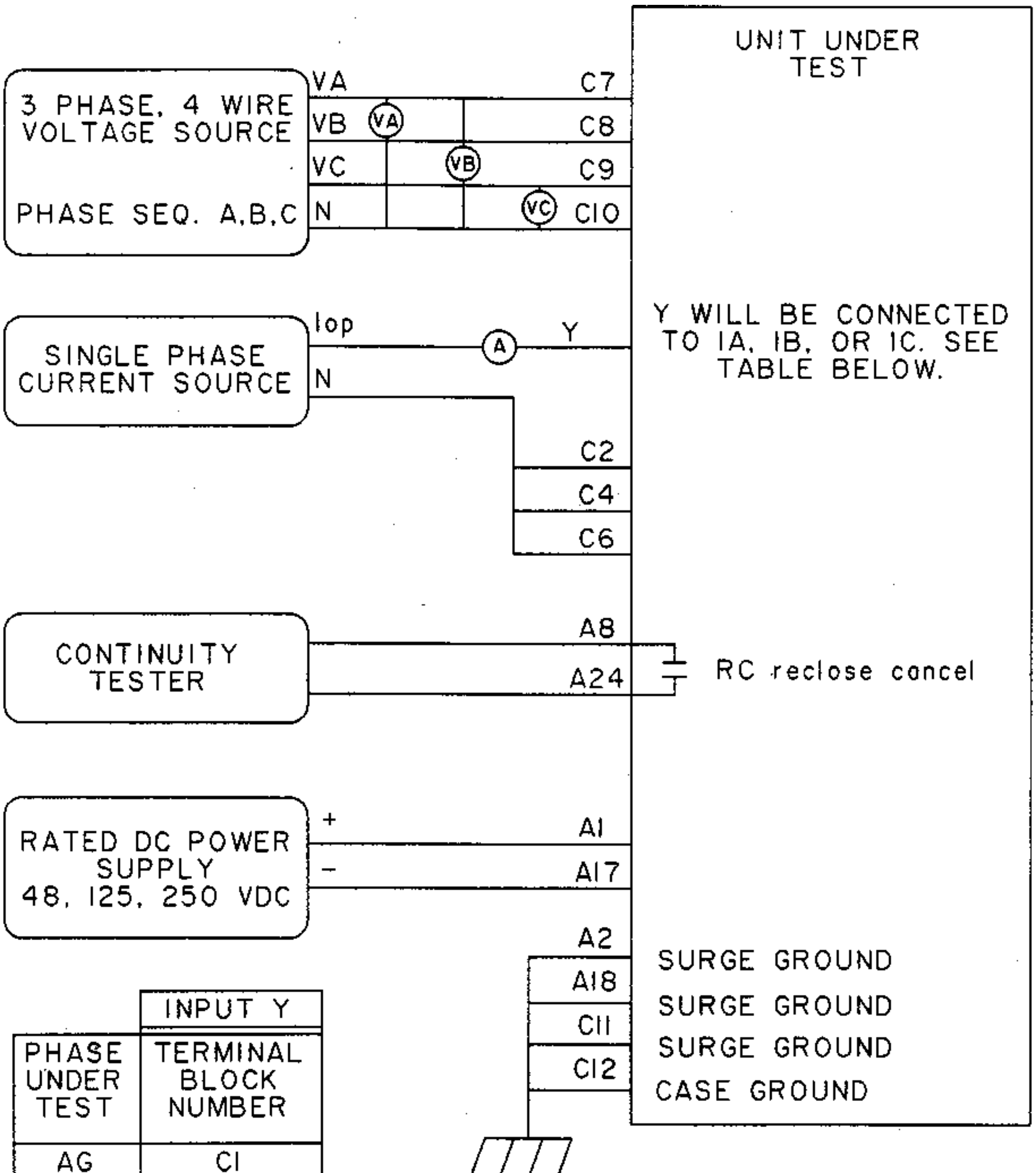
1. Connect the relay as shown in Figure 4–3.
2. Set VA to 67 Vrms 0°, VB to 57 Vrms –120°, and VC to 47 Vrms 120°.
3. Press the INF key on the MMI. Scroll with the ↑ key to the heading,

   INF: VALUES

   then press the ENT key. The present values are now selected.
4. With the ↑ and ↓ keys, scroll through the values of VA, VB, and VC and verify that the voltages are within ±2 volts of the voltage source setting. This verifies the connections of the voltage sources.

Note: Alternately, whenever the MMI display is blank, press the CLR key to automatically scroll through all of the present values.

5. Set Iop to 1.0 amp rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4–3.
6. With the ↑ or ↓ key, 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.
7. Reduce the test current to zero amps.



PHASE UNDER TEST	INPUT Y TERMINAL BLOCK NUMBER
AG	C1
BG	C3
CG	C5

Figure 4–3. Phase-to-ground test connections (drawing #0357A3044, sh. 3).

4–3 Measuring Unit Tests

CAUTION: The RC contacts will chatter when the unit under test is near the threshold. *Do not allow this to continue.* Remove the test current. A single contact closure is enough to determine that the unit picked up.

T5 – Fault Detector Test

The Fault Detector responds to sudden changes in current levels. Slow changes are not picked up.

1. Connect the relay as shown in Figure 4–3.
2. Set the relay into test mode 38 (the fault detector). The MMI then displays

   FAULT DETECTOR ON

   Set : VA = 67 V rms 0°

   VB = 67 V rms –120°

   VC = 67 V rms +120°.
3. Slowly increase Iop to 1.2 (0.4) A rms, at approximately 0.1 (0.01) A per second. Slowly decrease the current to 0 A. The RC contacts should not close.
4. Immediately increase Iop to 1.5 (0.3) A rms. The RC contacts should close momentarily.
5. Immediately increase Iop to 2.5 (0.5) A rms. The RC contact should close until current is removed.
6. Reduce Iop to 0.

T6 – IT Trip Supervision Test

1. Setting:

   CURSUPVIS

   (503) PUIT = 0.25(0.05) AMP
2. Connect the DLP3 as shown in Figure 4–3.
3. Set the relay into test mode 34 (IT Detector). The MMI should display

   IT DETECTOR ON
4. Set Iop to .40 (.08) A rms and apply to the relay. The RC contacts should close. Lower Iop to .15 (.03) amp rms, at which point the RC contacts should open.
5. Reduce Iop to 0.

T7 – IB Blocking Supervision Test

1. Setting:

   CURSUPVIS

   (504) PUIB = 0.2(0.04) AMP
2. Connect the DLP3 as shown in Figure 4–3.
3. Set the relay into test mode 35 (IB Detector). The MMI should display

   IB DETECTOR ON
4. Set Iop to .30 (.06) A rms and apply to the relay. The RC contacts should close. Lower Iop to .10 (.02) A rms, at which point the RC contacts should open.
5. Reduce Iop to 0.

T8 – Ground Directional Trip Test, IPT + NT

1. Setting:

   CURSUPVIS

   (501) PUIPT = 0.5(0.1) AMP
2. Connect the relay as shown in Figure 4–3.
3. Set VA to 57 V rms 0°, VB to 67 V rms –120°, and VC to 67 V rms 120°.
4. Set the relay into test mode 36 (Ground Directional Trip). The MMI should display

   GRD DIR TRIP ON
5. Set IA, the current of Iop, to .70 (.14) A rms –85°, and apply to the relay. The RC contacts should close. Lower Iop to .40 (.08) A rms, at which point the RC contacts should open.
6. Reduce Iop to 0.

T9 – Ground Directional Block Test, IPB + NB

1. Setting:

   CURSUPVIS

   (502) PUIPB = 0.25(0.05) AMP
2. Connect the relay as shown in Figure 4–3.
3. Set VA to 55 V rms 0°, VB to 67 V rms ÷120°, and VC to 67 V rms 120°.

4. Set the relay into test mode 37 (Ground Directional Block). The MMI should display

   GRD DIR BLK ON

5. Set IA, the current of Iop, to .40 (.08) A rms –265° and apply to the relay. The RC contacts should close. Lower Iop to .15 (.03) A rms, and the RC contacts should open.
6. Reduce Iop to 0.

T10 – Phase Instantaneous Overcurrent PH4

1. Setting:

   OVERCUR

   (601) SELPH4 = YES

   (602) PUPH4 = 5.0 (1.0) AMPS

2. Connect the relay as shown in Figure 4–5 for a phase AB, BC, or CA fault.
3. Set the relay into test mode 43 (Phase Overcurrent). The MMI should display

   INST PHS OVRC ON

4. Set Iop to 2.8 (.6) A rms and apply to the relay. The RC contacts should close. Lower Iop to 2.0 (.4) A rms, at which point the RC contacts should open.
5. Reduce Iop to 0.
6. Retore the following setting

   OVERCUR

   (602) PUPH4 = 20 (4.0) AMPS

T11 – Ground Instantaneous Overcurrent IDT

1. Setting:

   OVERCUR

   (603) SELIDT = YES

   (604) SELDIDT = NO (Directional ctrl off)

   (605) PUIDT = 2.5 (0.5) AMPS

2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 44 (Ground Overcurrent). The MMI displays

   INST GND OVRC ON

4. Set Iop to 4.0 (.80) A rms and apply to the relay. The RC contact should close. Lower Iop to 2.4 (.40) A rms, at which point the RC contacts should open.
5. Reduce Iop to zero.
6. Restore the following settings

   OVERCUR

   (604) SELDIDT = YES

   (605) PUIDT = 10 (2.0) AMPS

T12 – Ground Time Overcurrent TOC

1. Setting:

   OVERCUR

   (606) SELTOC = YES

   (607) SELDTOC = NO (Direct. ctrl off.)

   (608) PUTOC = 1.0 (0.2) AMPS

   (609) TDTOC = 5

2. Connect the relay as shown in Figure 4–4.

NOTE: Start the timer when Iop is applied, and stop the timer when the RC closes (the relay trips).

3. Set the relay into test mode 45 (TOC). The MMI displays

   TIM DLY GD OC ON

4. Apply Iop at 3.0 (0.6) A rms and start the timer. Leave the current on until the RC contacts close and stop the timer. The TOC should time out in 2.8 to 3.2 seconds.
5. Reduce Iop to zero.
6. Repeat steps 3 and 4 with the values for Iop from Table 4–2. Verify that the TOC times out within the specified time.

Iop, A rms	TOC time out, s
3	2.8–3.2
6	1.0–1.2
10	0.7–0.8

Table 4–2. Values for Iop and TOC timeouts for repeating T12.

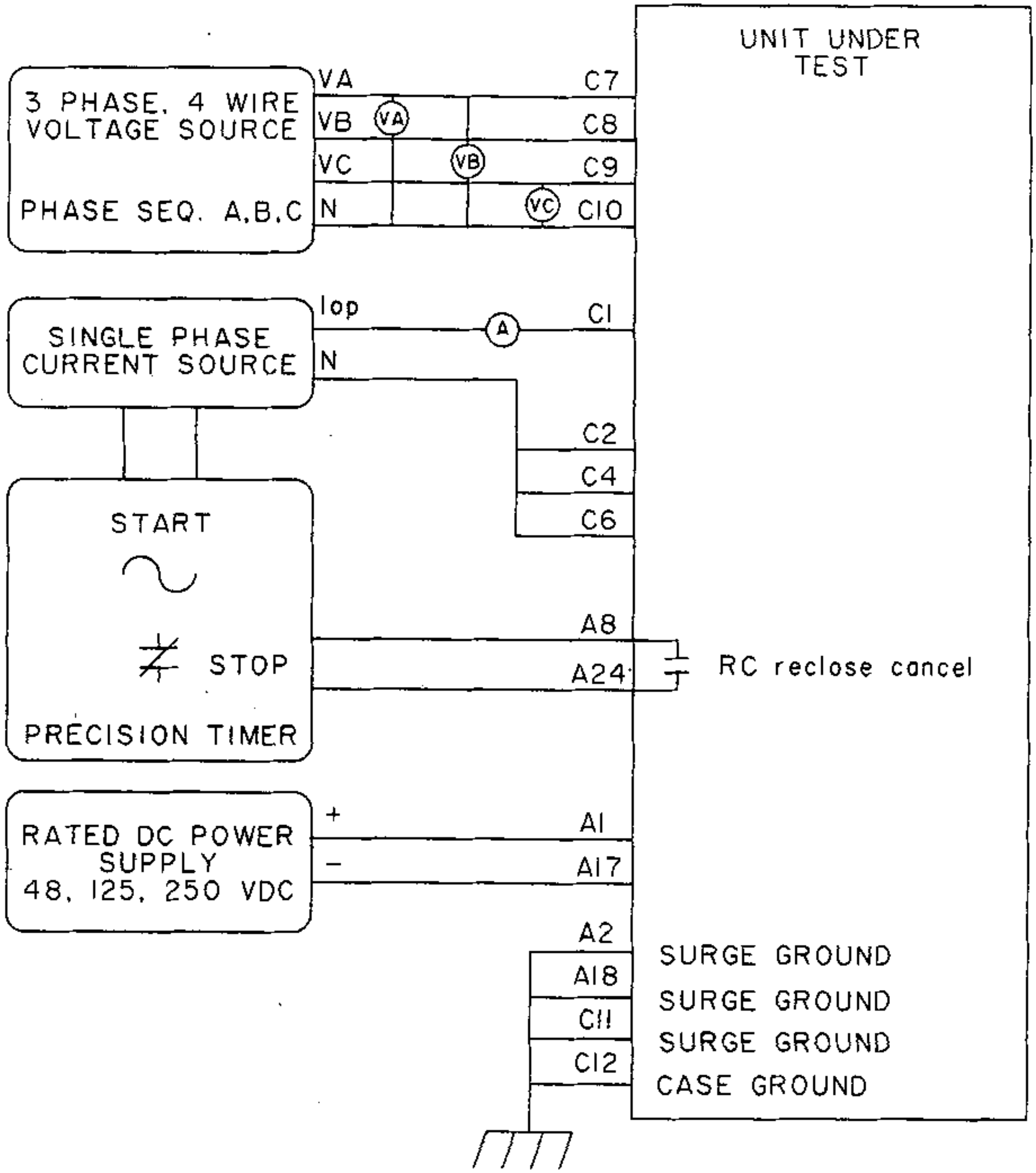
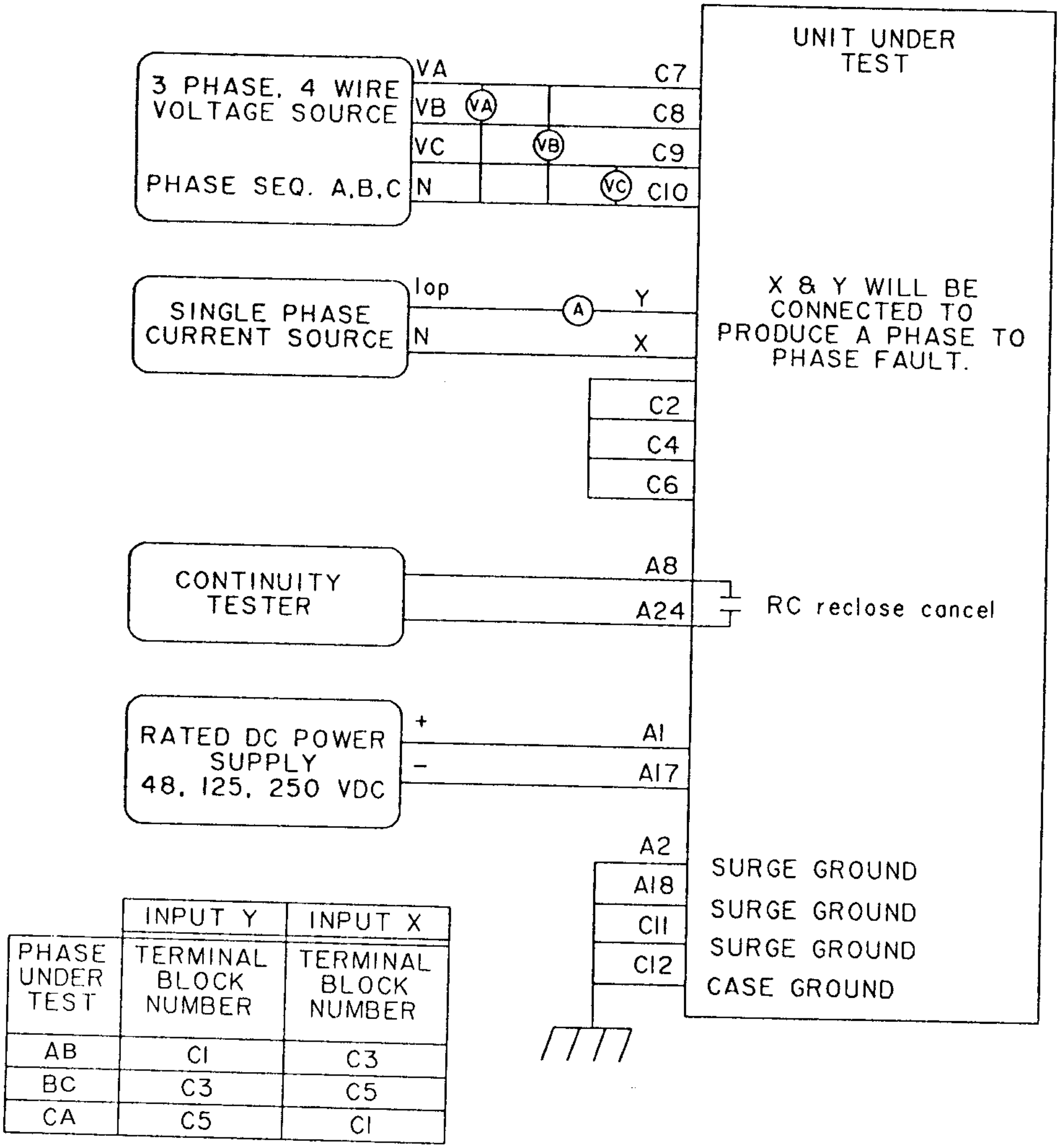


Figure 4–4. Ground Reach Timer Test Connections (Drawing #0357A3044 Sh.-4)).



PHASE UNDER TEST	INPUT Y TERMINAL BLOCK NUMBER	INPUT X TERMINAL BLOCK NUMBER
AB	C1	C3
BC	C3	C5
CA	C5	C1

Figure 4–5. Phase-to-phase test connections (drawing #0357A3044, sh. 5).

7. Restore the following setting

   OVERCUR

   (607) SELDTOC = YES

   (608) PUTOC = Pretest setting

4–5 Zone Reach and Timer Tests

General Zone Reach Testing Considerations

1. The Zone measuring units are checked 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 since different test equipment and test methods can alter the MMI output from what is shown.

   The MMI output is shown for reference only; it is not part of the test. The MMI output includes the displayed target information.

2. When a particular zone is under test, the other protection zones are disabled so that they do not time out and distort the results of the zone under test.

   The backup protection functions will cause the relay to trip during zone testing, as they should. They must be disabled to isolate the unit zone reach under test. Before doing any of the reach tests make the following setting changes:

   OVERCUR

   (601) SELPH4 = NO

   (603) SELIDT = NO

   (606) SELTOC = NO

   OUTOFSTEP

   (803) SELOSB = 3 (BLKNONE)

NOTE: After the zone reach testing is completed, restore these settings to their pretest values.

T13 – Zone 1 Ground Reach Test, M1G Ground Faults (AG, BG, and CG)

1. Setting:

   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

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

3. Set the relay into test mode 14 (Any Zone1 Ground). The MMI displays

   ANY Z1 GRND ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°

   VB: 67 volts rms –120°

   VC: 67 volts rms –240°.

   Set the fault current, Iop, to the phase angle listed in Table 4–3. (Increase VA, VB, and VC to 75 V when Iop = –79°)

I Degrees*	Volts rms	DIST**
–49	56–63	—
–79	65–73	82–88
–109	56–63	—

* For phase A only. For B and C, add phase shift 120° and 240° respectively

** Reference only.

Table 4–3. Fault current phase settings for test T13.

5. Set the fault current, Iop, to 7.7 (1.54) A rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown in Table 4–3.

6. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as

   TRIP: AG Z1 "DIST"

7. Repeat the test for phase BG and CG faults.

T14 – Zone 2 Ground Reach, MTG Ground Faults (AG, BG, and CG)

1. Setting:

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

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

3. Set the relay to the ZONE 2 ground test mode for the appropriate phase under test. The MMI displays, for instance,

AG Test: ZONE 2 AG ON

BG Test: ZONE 2 BG ON

CG Test: ZONE 2 CG ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,
VB: 67 volts rms –120°,
VC: 67 volts rms –240°.

Set the fault current, Iop, to the phase-angle value listed in Table 4–4. (Increase VA, VB, and VC to 75 V when Iop = –79°)

I Degrees	Volts rms	DIST*
–49	56–63	—
–79	65–72	146–154
–109	56–63	—

* *Reference only.*

Table 4–4. Fault current phase settings for test T14.

5. 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 in Table 4–4.

6. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as

TRIP: AG Z2 "DIST"

7. Repeat the test for phase BG and CG faults.

T15 – Zone 3 Ground Reach, M3G Ground Faults (AG, BG, and CG)

1. Setting:

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

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

3. Set the relay to the ZONE 3 ground test mode for the appropriate phase under test. The MMI displays, for instance:

ZONE 3 AG ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,
VB: 67 volts rms –120°,
VC: 67 volts rms –240°.

Set the fault current, Iop, to the phase-angle value listed in Table 4–5. (Increase VA, VB, and VC to 75V when Iop = – 79°.)

I Degrees	Volts rms	DIST*
–49	57–64	—
–79	66–73	195–205
–109	57–64	—

* *Reference only.*

Table 4–5. Fault current phase settings for test T15.

5. 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 in Table 4–5.
6. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault will be displayed as follows:

   TRIP: AG Z3 "DIST"

7. Repeat the test for phase BG and CG faults.

T16 - Zone 4 Ground Reach, M4G Ground Faults (AG, BG, and CG)

1. Setting:

   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

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
3. Set the relay to the ZONE 4 ground test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 4 AG ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, to the phase-angle value listed in Table 4–6. (Increase VA, VB, VC to 75V when Iop = –79°.)

I Degrees	Volts rms	DIST*
–49	56–63	—
–79	65–72	290–310
–109	56–63	—

* Reference only.

Table 4–6. Fault current phase settings for test T16.

5. 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 in Table 4–6.
6. Reduce the fault current to zero.
7. Repeat the test for phase BG and CG faults.

T17 – Ground (Zone Backup) Timer Tests

1. Setting:

   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) PUTL4P = 5.0
   (408) PUTL4G = 5.0

ZONE 2 Timer

2. Connect the relay as shown in Figure 4–4 for the appropriate phase under test.
3. Set the relay to test mode 15 (Zone 2 Timer). The MMI displays:

Z2 GRND TIMER ON

4. Set the voltage inputs to the following values:
   VA: 55 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.
   Set the fault current, Iop, to –55°.
5. 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, but should be applied at that level.) This is an AG fault that is within pickup of all four zones.
6. Stop the timer when the RC contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE2 trip, such as: AG Z2. This verifies that the second zone tripped. The time for the trip should be in the range 0.9–1.1 seconds.
7. Leave the voltages at the values of step 4.

ZONE3 Time Out

8. Setting:
   Z2DIST
   (201) SELZ2G = NO
   (202) SELZ2P = NO
9. Set the relay to test mode 16 (Zone 3 Timer). The MMI displays:
   Z3 GRND TIMER ON
10. Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps, but should be applied at that level.) This is an AG fault that is within pickup of all four zones.
11. Stop the timer when the RC contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE3 trip, such as: AG Z3. This verifies that the third zone tripped. The time for the trip should be in the range 2.9–3.1 seconds.
12. Leave the voltages at the values of step 4.

ZONE4 Time Out

13. Setting:
   Z3DIST
   (301) SELZ3G = NO
   (302) SELZ3P = NO
14. Set the relay to test mode 17 (Zone 4 Timer). The MMI displays:
   Z4 GRND TIMER ON
15. 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, but should be applied at that level.) This is an AG fault that is within pickup of all four zones.
16. Stop the timer when the RC contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE4 trip, such as: AG Z4. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8–5.2 seconds.
17. If not continuing with Phase Reach testing, return all settings to their pretest values:
   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

4–6 Phase-to Phase Zone Reach Testing

The following setting changes apply to all Phase-to-Phase tests:

OVERCUR
(601) SELPH4 = NO
(603) SELIDT = NO
(606) SELTOC = NO

OUTOFSTEP
(803) SELOSB = 2 (BLKNONE)

T18 – Zone1 Phase Reach, M1 Faults (AB, BC, and CA)

1. Setting:
   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
2. Connect the relay as shown in Figure 4–5 for the appropriate phases under test. Set the relay to test mode 30 (ANY ZONE 1 Phase). The MMI displays:

   ANY Z1 PHASE ON
3. Set the voltage inputs to the following values:
   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, to the phase-angle value listed in Table 4–7.

I Degrees	Volts rms	DIST*
–25	51–57	—
–55	59–66	82–88
–85	51–57	—

* Reference only.

Table 4–7. Fault current phase settings for test T18.

4. 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 in Table 4–7.
5. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

   TRIP: AB Z1 "DIST"
6. Repeat the test for phase BC and CA faults.

T19 – Zone 2 Phase Reach, MT Faults (AB, BC, and CA)

1. Setting:
   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
2. Connect the relay as shown in Figure 4–5 for the appropriate phases under test. Set the relay to the ZONE 2 Phase test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 2 AB ON
3. Set the voltage inputs to the following values:
   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, to the phase-angle value listed in Table 4–8.

I Degrees	Volts rms	DIST*
–25	57–64	—
–55	65–73	146–154
–85	57–64	—

* Reference only.

Table 4–8. Fault current phase settings for test T19.

4. 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 4–8.

5. Reduce Iop of the faulted phase to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

   TRIP: AB Z2 "DIST"

6. Repeat the test for phase BC and CA faults.

T20 – Zone 3 Phase Reach, M3 Faults (AB, BC, and CA)

1. Setting:

   Z1DIST
   (101) SELZ1G = NO
   (102) SELZ1P = NO
   Z2DIST
   (201) SELZ2G = NO
   (202) SELZ2P = NO
   Z3DIST
   (301) SELZ3G = NO
   (302) SELZ3P = YES
   (305) PUTL3P = 0.1
   (306) PUTL3G = 0.1
   Z4DIST
   (401) SELZ4G = NO
   (402) SELZ4P = NO

2. Connect the relay as shown in Figure 4–5 for the appropriate phase under test. Set the relay to the ZONE 3 Phase test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 3 AB ON

3. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, to the phase-angle value listed in Table 4–9. Note that the leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, and VC to 75 V when Iop = –55°)

I Degrees	Volts rms	DIST*
–25	56–63	—
–55	65–73	195–205
–85	56–63	—

* Reference only.

Table 4–9. Fault current phase settings for test T20.

4. 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 in Table 4–9.

5. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as:

   TRIP: AB Z3 "DIST"

6. Repeat the test for phase BC and CA faults.

T21 – Zone 4 Phase Reach, M4 Faults (AB, BC, and CA)

1. Setting:

   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

2. Connect the relay as shown in Figure 4–5 for the appropriate phase under test. Set the relay into the ZONE 4 Phase test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 4 AB ON

3. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,

VB: 67 volts rms –120°,
VC: 67 volts rms –240°.

Set the fault current, Iop, to the phase-angle value listed in Table 4–10. (Increase VA, VB, and VC to 75 V when Iop = –55°)

I Degrees	Volts rms	DIST*
–25	56–63	—
–55	64–72	290–310
–85	56–63	—

* Reference only.

Table 4–10. Fault current phase settings for test T21.

4. 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 in Table 4–10.
5. Reduce the fault current to zero.
6. Repeat the test for phase BC and CA faults.

T22 – Phase (Zone Back-up) Timer Tests

1. Setting:

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

ZONE2 Timer

2. Connect the relay as shown in Figure 4–6 for an AB fault.
3. Set the relay to test mode 31 (Zone 2 Phase Timer). The MMI displays

   Z2 PHASE TIMER ON

4. Set the voltage inputs to the following values:
   VA: 55 volts rms 0°,
   VB: 55 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, to –55°.
5. 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, but should be applied at that level.) This is an AB fault that is within pickup of all four zones.
6. Stop the timer when the RC contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE2 trip, such as: AB Z2. This verifies that the second zone tripped. The time for the trip should be in the range 0.9–1.1 seconds.
7. Leave the voltages at the values of step 4.

ZONE3 Time Out

8. Setting:

Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO

9. Set the relay to test mode 32 (Zone 3 Phase Timer). The MMI displays

   Z3 PHASE TIMER ON

10. 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, but should be applied at that level.) This is an AB fault that is within pickup of all four zones.
11. Stop the timer when the RC contact closes, and reduce the fault current to zero. Verify that the

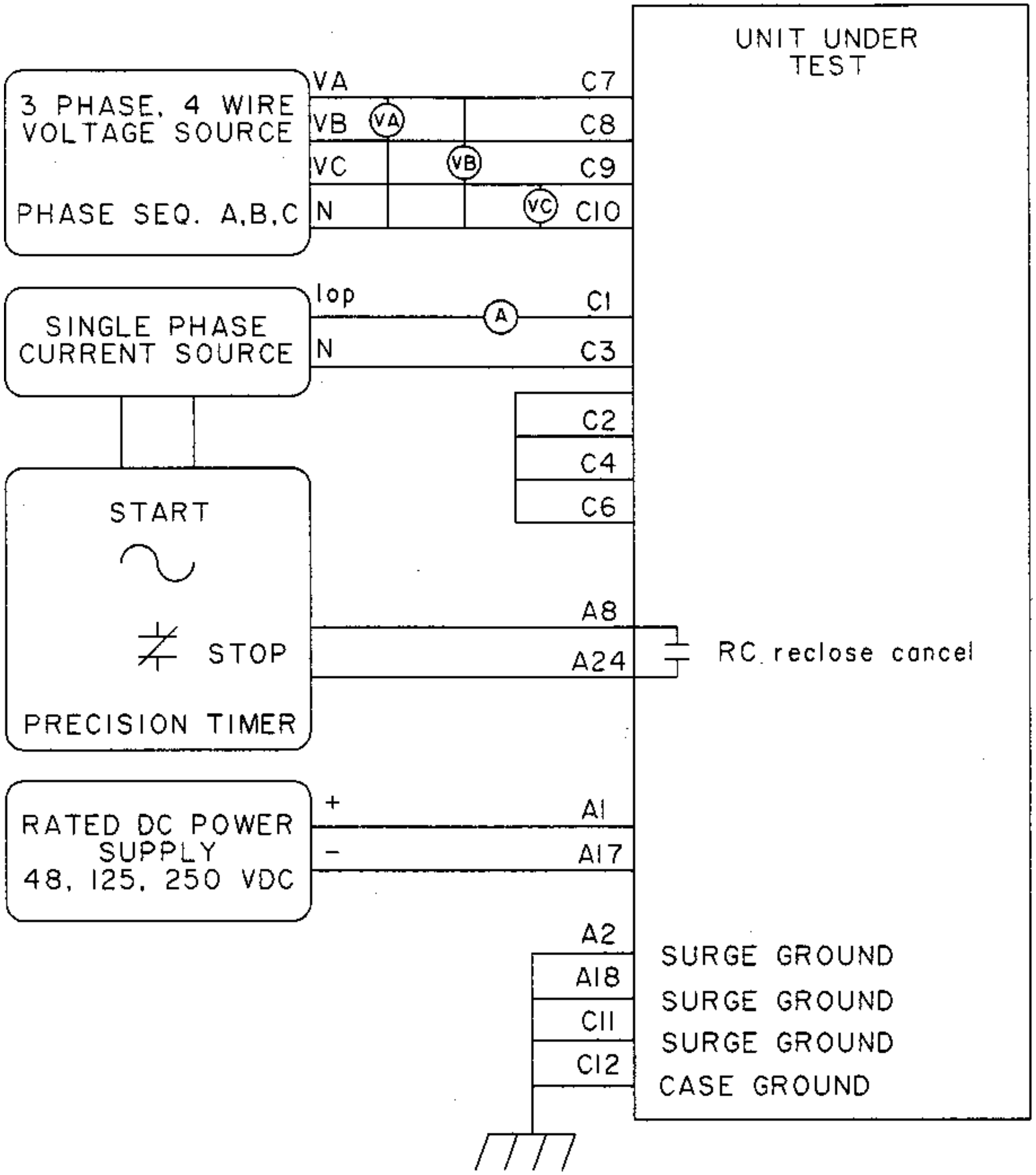


Figure 4–6. Phase-reach timer test connections (drawing #0357A3044, sh. 6).

trip target indication shows a ZONE3 trip, such as: AB Z3. This verifies that the third zone tripped. The time for the trip should be in the range 2.9–3.1 seconds.

12. Leave the voltages at the values in step 4.

ZONE4 Time Out

13. Setting:

Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO

14. Set the relay to test mode 33 (Zone 4 Phase Timer). The MMI displays the following:

Z4 PHASE TIMER ON

15. 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, but should be applied at that level. This is an AG fault within pickup of all four zones.

16. Stop the timer when the RC contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE4 trip, such as: AB Z4. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8–5.2 seconds.

17. If not continuing with MOB testing, return all settings to their pretest values:

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

4–7 MOB Testing

T23 – Out of Step Reach, MOB

1. Setting:

OUTOFSTEP
(801) SELPTZ = 0 (ZONE2)
(803) SELOSB = 0 (BLKALL)
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

2. Connect the relay as shown in Figure 4–5 for the appropriate phase under test.

3. Set the relay to test mode 40 (OUT OF STEP). The MMI displays the following:

OUT OF STEP ON

4. Set the voltage inputs to the following values:

VA: 75 volts rms 0°,
VB: 75 volts rms –120°,
VC: 75 volts rms –240°.

Set the fault current, Iop, to the phase-angle value listed in Table 4–11. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.

I Degrees	Volts rms
–85	62–72
–25	62–72

Table 4–11. Fault current phase settings for test T23.

5. 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 Table 4–11.

6. Reduce the current in the faulted phase to zero.

7. Repeat the test for phases BC and CA
8. Return settings to their 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

4–8 Recloser Testing

The following tests should be performed if the relay includes the optional recloser. The tests are not intended to demonstrate all functions of the recloser but to show that all inputs and outputs are operational.

T24 – Recloser

1. Connect the relay as shown in Figure 4–7. Rated DC voltage is applied to the three 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 as follows. If the settings are already at these values, enter them again. The test sequence is based on starting from power up or settings initialization.

RECLOSER

(2401) SELRCLR = 3 (2 SHOT RECLOSE)

(2403) TPRDLY1 = 2.55 SECONDS

(2408) RSTDLY = 2.55 SECONDS

3. After the settings change the relay will go into LOCKOUT, since it detects open breakers. Verify the state of the following contacts shown in Table 4–13.

Contact	Terminals	State
Z1RR	B10-B26	closed
LOA	B12-B28	closed
RIP	B9-B25	open

Table 4–12. State of contacts with relay in LOCKOUT.

4. Remove voltage from the three 52b inputs so that the DLP3 detects closed breakers. Momentarily apply rated DC voltage across the RECLOSE RESET input (D14-D30), then release. RECLOSE RESET bypasses the reset delay timer, RSTDLY.

   Verify that the contacts listed in Table 4–13 are all open.
5. This test verifies that Reclose Cancel prevents a reclose from a single-pole reclose initiation and a three-pole reclose initiation. Apply rated DC voltage across the RECLOSE CANCEL input (D13-D29). While keeping the RC input energized, momentarily apply rated DC voltage across the RI input (D11-D27), then release.

   Verify that the recloser output contacts remain open. Remove the voltage from the RC input.
6. In this test, RECLOSE INITIATE is issued, followed by RECLOSE CANCEL before RECLOSE DELAY can time out.

   Apply rated DC voltage across the RI input, then release. RIP will close.

   Apply rated DC voltage across the RECLOSE CANCEL input, before TPRDLY1 times out (2.55 seconds). RIP opens and Z1RR and LOA 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 verifies that RECLOSE INHIBIT prevents a reclose.

   Apply rated DC voltage across the RECLOSE INHIBIT input (D12-D28). While keeping the RINH input energized, momentarily apply rated DC voltage across the RI input, then release.

   Verify the state of the contacts listed in Table 4–13. The recloser has returned to LOCKOUT due to the RINH.

Contact	Terminals	State
Z1RR	B10-B26	closes after 2.55 sec
LOA	B12-B28	closes after 2.55 sec
RIP	B9-B25	closes for 2.55 sec
BC–1	A3-A19	open

Table 4–13. State of contacts after RECLOSE INHIBIT.

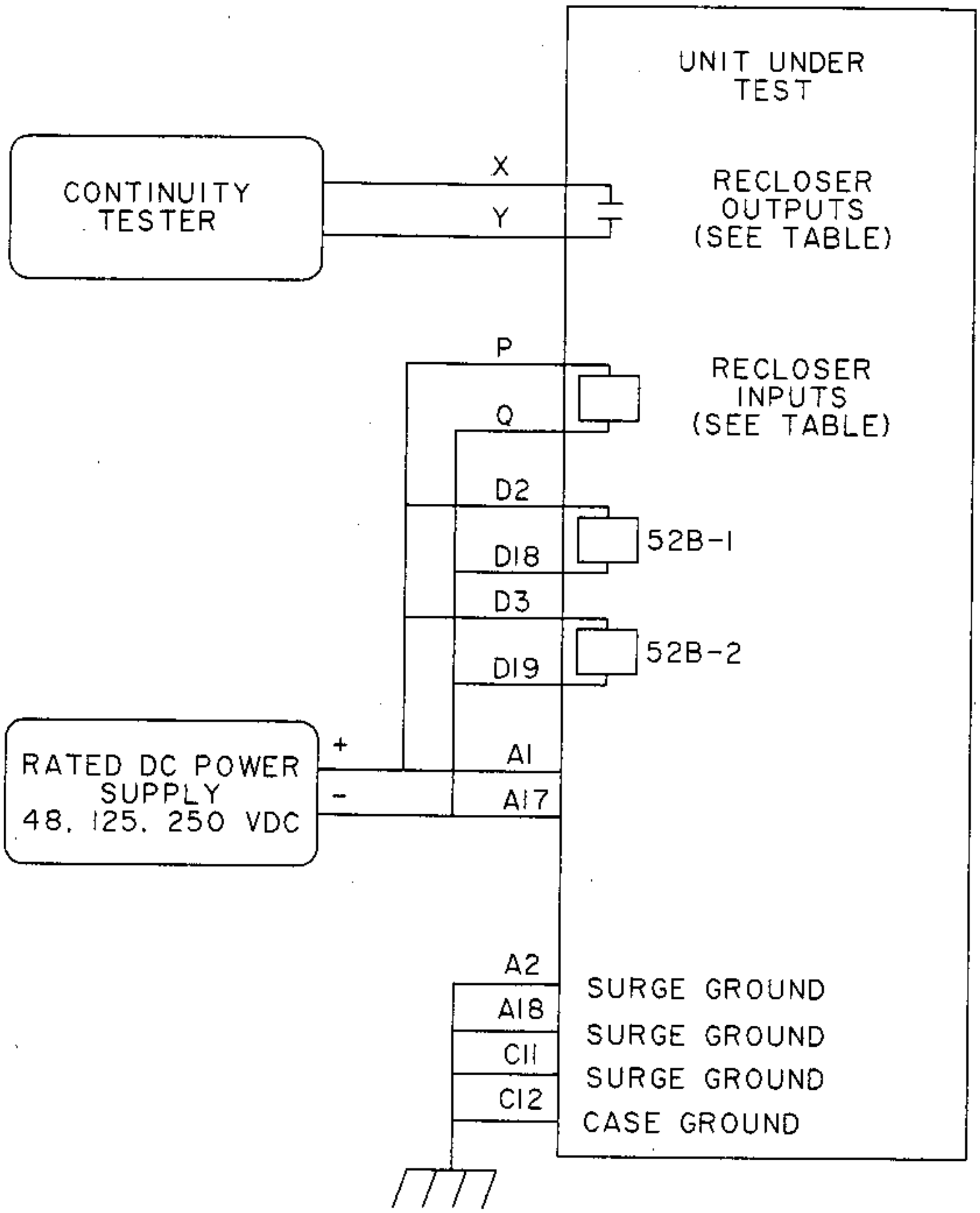
9. Remove the rated DC voltage from the RINH input. Momentarily apply rated DC voltage across the RECLOSE RESET input, then release. All recloser output contacts will open.

10. Momentarily apply rated DC voltage across the RI input, then release. Apply rated DC voltage across the three 52b inputs. RIP will close.

After 5 seconds the BREAKER CLOSE contact (A3-A19) will close and stay closed for 1 second (Dwell Time delay, DWELLTM). The recloser will then return to LOCKOUT.

4–9 End of Test

Make sure that the relay is no longer in test mode; select END TEST MODE from the test mode menu. Print out or scroll through all of the settings. Compare them with the initial settings of the relay, and change to initial values. If the initial settings were saved to a disk file with DLP-LINK before testing, download the file to the relay.



RECLOSER INPUTS	P	Q
RECL RST	D14	D30
RECL CAN	D13	D29
RI	D11	D27
RECL INH	D12	D28

RECLOSER OUTPUTS	X	Y
ZIRR	B10	B26
LOA	B12	B28
RIP	B9	B25
BC-1	A3	A19

Figure 4–7 Recloser test connections (drawing #0357A3044, sh. 7).

WARNING: Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF.

5–1 DLP3 Periodic Testing

This chapter contains formulas for 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 *Chapter 4 – Acceptance Tests*.

The customer must determine the extent of the testing to be performed. These tests are intended as guides; they are not required for every periodic test of the relay. The desired test procedures can be incorporated into the standard test procedures. However, it is suggested that the relay's built-in self tests be incorporated into the test procedures, since they test the operational status of the unit.

It is assumed in what follows that you are familiar with DLP3 testing. If not, refer to *Chapter 4 – Acceptance Test* for details.

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

Measuring Unit Tests

T5 – IT Detector Test
T6 – IB Detector Test
T7 – Ground Directional Trip Test, IPT + NT
T8 – Ground Directional Block Test, IPB + NB

Backup Protection Tests

T9 – Phase Instantaneous Overcurrent PH4
T10 – Ground Instantaneous Over-current IDT
T11 – Ground Time Over-current TOC

Zone Ground/Phase Reach Measuring Units

T12 – Zone1 Ground Reach M1G
T13 – Zone2 Ground Reach MTG
T14 – Zone3 Ground Reach M3G
T15 – Zone4 Ground Reach M4G
T16 – Zone1 Phase Reach M1
T17 – Zone2 Phase Reach MT
T18 – Zone3 Phase Reach M3
T19 – Zone4 Phase Reach M4

Drawings and References

The following drawings should be used for reference during testing.

Drawings

Elementary Diagram, Figure 1–6
Logic Diagrams, Figures 1–1, 1–2, 1–3, 1–4, 1–5
TOC curves, Figures 2–2, 2–3, 2–4

Reference

Chapter 9 – Software

General Instructions

Tests are performed in the DLP3's test mode, which allows viewing of the internal measuring units and functions. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

The test mode selects and isolates various test functions and measuring units, then routes their status to the RC (reclose cancel) contact. When the particular function under test has picked up, the RC contact closes. Target information is displayed for tests that cause tripping.

Testing can be performed with outputs disabled. The RC contacts still close whenever a trip condition exists, however the tripping contacts do not operate. Disabling outputs can be accomplished from the ACTIONS menu.

CAUTION: The RC contact will chatter when the unit under test is near its threshold. *Do not let it continue to chatter.* Remove the test current. A single contact closure is enough to determine that the unit picked up.

In tests that cause tripping, the trip target type may not match the unit under test. For example, if a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. It is important to keep that in mind during the tests.

Use a continuity tester with high-input impedance, such as a digital ohmmeter, to monitor the RC contact during relay testing.

NOTE: Tripping contacts will operate while the DLP3 is in test mode unless the outputs were disabled by the user..

Entering Test Mode

Before a test can be performed, the DLP3 must be put in test mode and select the function to be tested. The test mode is set as follows:

1. Apply rated dc and wait for relay initialization to complete, as indicated by the green LED on the MMI.
2. Press the ACT key. Scroll with the ↑ key until

   ACT: ENTER PASSWORD

   is displayed, then press the ENT key.

   If this is the first time the Control Level functions are used, the password has the factory value "5678.". This password must be changed before any Control functions can be accessed. See *Chapter 8 – Interface* for details on changing the password.
3. Enter the current Control Level password. If the password is not known, see *Chapter 8 – Interface* for details on viewing the password. When the correct password is entered,

   SELECTED

   is displayed.
4. Press the ACT key. Scroll with the ↑ key until

   ACT: RELAY TEST

   is displayed, then press the ENT key.
5. Scroll through the different test mode functions or enter the number of the desired test, such as 38 for the Fault Detector. Press ENT and the display indicates

   FAULT DETECTOR ON

   and the MMI LED turns red, indicating that the relay is in test mode. When the DLP3 picks up for the selected function it closes the RC contacts.
6. To exit 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 indicates

   END TST MODE?

   or enter 1, then press the ENT key. The MMI LED should return to green, indicating that normal operation has resumed.

Using DLP-LINK (Optional)

The relay can be tested without using the DLP3 keypad via a PC and 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. When the DLP3 is in test mode, currents and voltages are applied to the relay to simulate the desired system conditions.

Follow the procedure in *Chapter 4 – Acceptance Tests* to test the relay with DLP-LINK.

5–2 General Relay Tests

T1 – MMI Relay Status

The DLP3's Status is reported through the MMI, the noncritical alarm contact, and the critical alarm contact. If a system error causes relaying functions to cease, the LED on the MMI turns red and the critical alarm contact closes. A failure that does not interrupt relaying is indicated by closing of the noncritical alarm and by a FAIL or WARN message on the MMI display.

If a STATUS error is detected, see *Chapter 8 – Servicing* for further information.

1. Apply rated dc power and wait for initialization to complete, as indicated by the green LED.
2. Press the INF key, then scroll with the ↑ and ↓ keys until the heading

INF: STATUS

is displayed.

3. Press the ENT key. The display should contain

STATUS OK

which means that the relay is operational and there are no errors.

T2 – MMI Display Test

The MMI test is built into the software and tests the keypad, and the display.

1. Apply rated dc power and wait for initialization to complete, as indicated by the green LED.
2. Press the ACT key, then scroll with the ↑ and ↓ keys until the display contains

   ACT: MMI TEST

3. Press the ENT key. The display should contain eight fully lit rectangles followed by NEXT?
4. Press the 1/Y key followed by the ENT key. The display changes to eight fully lit rectangles on the right of the display, preceded by LED TST?
5. Press the 1/Y key followed by the ENT key. The green LED turns red momentarily.
6. The display next prompts 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 key. As you press each key, verify that the display indicates the key that was pressed. For example, after ↑ is pressed the display contains UP. The other keys produce a display to match the description of the key.
9. When all the keys have been checked, press the CLR key.
10. When the test is complete, press the END key followed by the ENT key. This ends the MMI test mode.

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. Protection can be enabled or disabled, as deemed necessary.

Note: If this test is run remotely over the DLP-LINK, then jumper J1 must be removed to allow the outputs to operate. Refer to section 8-3 for details on removing jumper J1. Note that jumper J1 is shipped from the factory in the open position allowing the outputs to operate.

1. Connect the relay as shown in Figure 4–1.
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 ↑ or ↓ key to scroll to the desired output, such as TRIP1A, and press the ENT key.

   Before the contact is allowed to close, the display prompts

   PROTECT OFF?

   Press the 1/Y key followed by the ENT key to turn protection off. Protection remains off until the test mode is ended. (If desired, protection can be left enabled during the test.)

   When the protection choice is chosen, the selected relay output closes. 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 closes and the previously selected output opens. 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, press END followed by the ENT key to end the test and re-enable protection.

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.

1. Connect the relay as shown in Figure 4–3.
2. Set the voltage inputs to the following values:
   VA: 67 Vrms 0°
   VB: 57 Vrms –120°
   VC: 47 Vrms 120°
3. Press the INF key on the MMI. Scroll with the ↑ and ↓ keys to the heading,
   INF: VALUES

   then press the ENT key. The present values are now selected.
4. With the ↑ and ↓ keys, scroll through the values of VA, VB, and VC and verify that the voltages are within ±2 volts of the voltage source setting.
5. Apply Iop at 1.0 amps rms to the Y test point for the current under test.
6. With the ↑ or ↓ key, scroll to the value of IA, IB, or IC. Verify that the current reading is within 5% of the input current.
7. Reduce the test current to zero amps.

5–3 Measuring Unit Tests

CAUTION: The RC contact will chatter when the unit under test is near its threshold. *Do not allow this to continue.* Remove the test current. A single contact closure is enough to determine that the unit has picked up.

At the start of each test is an area to record your specific setting for the function under test.

T5 – IT Trip Supervision Test

1. Setting:

   CURSUPVIS
   (0503) PUIT = [________] amps,

   where I_T is set as follows:

   $$I_T = IA, IB, \text{or } IC. \qquad (1)$$

   The test current, Iop, is single-phase and is applied to IA. Thus, the DLP3 should pick up when Iop is equal to IT.
2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 34 (I_T Detector). The MMI display contains
   IT DETECTOR ON
4. Set the level of Iop to I_T + 0.1 = [________] amps rms and apply to the relay. The RC contact should close. Lower Iop to I_T – 0.1 = [________] amps rms; the RC contact should open.
5. Reduce Iop to zero.

T6 – IB Blocking Supervision Test

1. Setting:

   CURSUPVIS
   (0504) PUIB = [________] amps,

   where IT is set as follows:

   $$IT = IA, IB, \text{or } IC. \qquad (1)$$

   The test current, Iop, is single-phase and is applied to IA. Thus, the DLP3 should pick up when Iop is equal to IB.
2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 35 (IB Detector). The MMI display contains
   IB DETECTOR ON
4. Set the level of Iop to IB + 0.1 = [________] amps rms and apply to the relay. The RC contact should close. Lower Iop to IB – 0.1 = [________] amps rms; the RC contact should open.
5. Reduce Iop to zero.

T7 – Ground Directional Trip Test, IPT + NT

1. Setting:

   CURSUPVIS
   (0501) PUIPT = [________] amps,

   The IPT operating quantity is given by

   $$3 \cdot |I0| - 3 \cdot KT \cdot |I1| , \qquad (3)$$

   where I0 is equal to the Zero-Sequence Current; I1 is equal to the Positive-Sequence Current; and KT is equal to 0.3 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes.

   Since the test current, Iop, is single-phase, I0 and I1 are given by

$$I0 = Iop/3\ , \quad (4)$$

$$I1 = Iop/3\ . \quad (5)$$

Substituting Equations 4 and 5 into Equation 3 and assuming a Blocking or Hybrid scheme yields

$$PUIPT = Iop - 0.1\ Iop \quad (6)$$

$$= 0.9\ Iop.$$

Therefore IPT will pick up when Iop $\geq$ PUIPT/0.9.

2. Connect the relay as shown in Figure 4–1.
3. Set the voltage inputs to the following values:
   VA: 57 V rms 0°
   VB: 67 V rms –120°
   VC: 67 V rms 120°
4. Set the relay into test mode 36 (Ground Directional Trip). The MMI should display
   GRD DIR TRIP ON
5. Set the current of Iop to (PUIPT/0.9) + 0.10 = [________] amps rms at ∠ POSANG lagging and apply to the relay. The RC contact should close. Lower Iop to (PUIPT/0.9) – 0.1 = [________] amps rms; the RC contact should open.
6. Reduce Iop to zero.

T8– Ground Directional Block Test, IPB + NB

1. Setting:

   CURSUPVIS
   (0502) PUIPB = [________] amps,

   The IPT operating quantity is given by

$$3 \cdot |I0| - 3 \cdot KB \cdot |I1|\ , \quad (7)$$

where I0 is equal to the zero-sequence current; I1 is equal to the positive-sequence current; and KB is equal to 0.066 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes.

Since the test current, Iop, is single-phase, I0 and I1 are given by

$$I0 = Iop/3 \quad (8)$$

and

$$I1 = Iop/3 \quad (9)$$

Substituting Equations 8 and 9 into Equation 7 and assuming a Blocking or Hybrid scheme yields

$$PUIPT = Iop - 0.066 \cdot Iop \quad (10)$$

$$= 0.934\ Iop.$$

Therefore IPT will pick up when Iop $\geq$ PUIPT/0.934.

2. Connect the relay as shown in Figure 4–1.
3. Set the voltage inputs to the following values:
   VA: 57 V rms 0°
   VB: 67 V rms –120°
   VC: 67 V rms 120°.
4. Set the relay into test mode 37 (Ground Directional Block). The MMI should display
   GRD DIR BLK ON
5. Set the current of Iop to (PUIPB/0.934) + 0.1 = [________] amps rms at ∠ POSANG + 180 °and apply to the relay. The RC contact should close. Lower Iop to (PUIPB/0.934) – 0.1 = [________] amps rms; the RC contact should open.
6. Reduce Iop to zero.

5–4 Backup Protection Tests

T9– Phase Instantaneous Overcurrent PH4

1. Setting:

   OVERCUR
   (0601) SELPH4 = YES
   (0602) PUPH4 = [________] amps,

   PH4 is calculated with the following equation:

$$PH4 = (IA - IB) \text{ or } (IB - IC) \text{ or } (IC - IA)\ , \quad (11)$$

where PH4 is the difference in phase-to-phase current.

The test current, Iop, 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 (Iop – (–Iop)) = 2 Iop. Therefore PH4 will pick up when Iop = .5 PH4

2. Connect the relay as shown in Figure 4–5, for a phase AB, BC, or CA fault.

3. Set the relay into test mode 43 (Phase Overcurrent). The MMI should display

INST PHS OVRC ON

4. Set Iop = .5·PH4 + 0.05·PH4 = [________] amps rms and apply to the relay. The RC contact should close. Lower Iop to .5·PH4 – (0.05·PH4) = [________] amps rms; the RC contact should open.

5. Reduce Iop to zero.

T10 – Ground Instantaneous Overcurrent IDT

1. Setting:

OVERCUR

(0603) SELIDT = YES

(0604) SELDID = NO

(0605) PUIDT = [_________] amps

(0612) KDCONST = [_________] (0 or 0.3)

The IDT operating quantityis

$$IDT = 3(I0) - 3(KDCONST)(I1)\,, \quad (12)$$

where I0 is the zero-sequence current and I1 is the positive-sequence current. Since the test current, Iop, is single-phase, I0 and I1 are given by

$$I0 = Iop/3 \quad (13)$$

and

$$I1 = Iop/3 \quad (14)$$

Substituting Equations 13 and 14 into 12 yields

$$IDT = Iop - (KDCONST)(Iop) \quad (15)$$

The IDT balance point occurs when:

PUIDT = Iop (1 - KDCONST)
Iop = PUIDT / (1 - KDCONST)

2. Connect the relay as shown in Figure 4–3.

3. Set the relay into test mode 44 (Ground Overcurrent). The MMI will display

INST GND OVRC ON

4. Set Iop to

[PUIDT/(1 - KDCONST)] + 0.5 = [________] amps rms and apply to the relay. The RC contact should close.

Lower Iop to
[PUIDT/(1 - KDCONST)] – 0.5 = [________] amps rms; the RC contact should open.

5. Reduce Iop to zero.

6. Change the setting of SELDIDT back to YES to restore directional control, if required.

T11 – Ground Time Overcurrent TOC

1. Setting:

OVERCUR

(0606) SELTOC = YES

(0607) SELDTOC = NO

(0608) PUTOC = [_________] amps,

(0609) TDTOC = [________] Time dial,

(0611) SELCURV = [________] Curve,

TOC is calculated with the equation

$$TOC = 3 \cdot I0\,, \quad (16)$$

where I0 is equal to the zero-sequence current. Since Iop is single-phase, I0 is given by

$$Iop/3 = I0. \quad (17)$$

Substituting Equation 17 into Equation 16 yields

$$Iop = TOC\,. \quad (18)$$

Therefore, TOC will pick up when Iop ≥ TOC. The time it takes for TOC to pick up is determined by the time-dial curve in *Chapter 2 – Calculation of Settings*.

CAUTION: If the test current exceeds 2 In (In is the rated current), then the current test should be applied with a 50% duty cycle. For instance, if current is applied for 5 minutes, it should be left off for 5 minutes before it is reapplied.

2. Connect the relay as shown in Figure 4–5.

NOTE: Start the timer when Iop is applied and stop the timer when the RC closes (the relay trips).

3. Set the relay into test mode 45 (TOC). The MMI displays

TIM DLY GD OC ON

4. Apply Iop at 2·TOC = [________] amps rms and start the timer. Leave the current on until the RC contact closes, then stop the timer. The time should be within ±7% of the value found on the DLP3 time-dial curve in use.

5. Reduce Iop to zero.

6. Repeat steps 4 and 5 for Iop at 6·TOC = [________] and 10·TOC = [________].
7. Change the setting of SELDTOC back to YES if directional control of TOC is required.

5–5 Zone Reach Tests

General Considerations

Testing the reach of the relay requires a few organized steps, as follows:

1. Choosing a test current (I_T) for the impedance of the reach.
2. Calculating the voltage range in which the unit will pick up.
3. Applying the test voltage and currents in accordance with the test procedure.

Equations are given for calculating the pickup voltage for a chosen current magnitude and phase. If you wish to test the complete characteristic, the software program, DLPTEST, can be used to generate test currents and voltage pickups for the complete characteristic. DLPTEST is included in the plastic pocket at the back of this book.

Zone 1–4 Phase-to-Ground Calculations

This section describes how to determine the test currents and voltages for Z1G, Z2G, Z3G and Z4G. The same procedure is used for each zone to determine the test values. The procedure is as follows:

- Choose a test current.
- Calculate the impedance of the zone.
- Calculate the operate voltage at the test current and impedance.

The test current, I_T, is determined from Table 5–1. The value of I_T is chosen according to the reach of the zone. The nominal pickup voltage, VNOM, is calculated with respect to I_T and to several settings of the relay.

NOTE: The pickup voltage calculations at a particular magnitude and phase of I_T are referenced to the faulted phase under test. For instance, if a BG Fault was applied, the current angles would be with respect to the phase angle of VB.

The nominal pickup voltage is given by

$$\mathrm{VNOM} = [Z \cdot ZR \cdot I_T / \cos(90 - øT)] \cdot \cos(øI - øZ - øT + 90) \quad (19)$$

for $(øZ + øT - 180) < øI < øZ$, or

$$\mathrm{VNOM} = [Z \cdot ZR \cdot I_T / \cos(90 - øT)] \cdot \cos(øI - øZ + øT - 90) \quad (20)$$

for $øZ < øI < (øZ - øT + 180)$.

Definitions

Z	= Impedance correction factor.
ZR	= Relay reach for Z1G, Z2G, Z3G, or Z4G.
øZ	= Angle of maximum reach.
I_T	= Test current for Iop, chosen for the zone.
øT	= Characteristic timer of the zone.
øI	= 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.

Settings and Calculations

1. Record the following relay settings:
   (1401), POSANG = [________]
   (1402), ZERANG = [________]
   (0104), Z1GR = [________] (Zone 1)
   (0204), Z2GR = [________] (Zone 2)
   (0304), Z3GR = [________] (Zone 3)
   (0404), Z4GR = [________] (Zone 4)
   Z1GANG = 90 (fixed for Zone1)
   (0210), Z2GANG = [________] (Zone 2)
   (0308), Z3GANG = [________] (Zone 3)
   (0410), Z4GANG = [________] (Zone 4)
   (0107), Z1K0 = [________] (Zone 1 only)
   (1404), K0 = [________] (Zones 2, 3, and 4)

2. Determine the test current, I_T, for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 5–1.
- I_T(Z1GR) = [________] Amps rms
- I_T(Z2GR) = [________] Amps rms
- I_T(Z3GR) = [________] Amps rms
- I_T(Z4GR) = [________] Amps rms

ZR Reach (In = 5 A)	I_T, A	ZR Reach (In = 1 A)	I_T, A
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	0.8	150.0 – 200.0	0.2
40.0 – 50.0	1.0	200.0 – 250.0	0.2

Table 5–1. Test current ranges for phase-to-ground reach.

3. Calculate the impedance, Z, for each zone, where Z equals the magnitude of the expression,

(2/3)/(POSANG) + (K0/3)/(ZERANG).

The real and imaginary components of Z are given by

$$Z(\text{real}) = (2/3)\cos(\text{POSANG}) + (K0/3)\cos(\text{ZERANG}) \quad (21)$$

= [________]

and

$$Z(\text{imag}) = (2/3)\sin(\text{POSANG}) + (K0/3)\sin(\text{ZERANG}) \quad (22)$$

= [________] .

The magnitude is then given by

$$Z = [Z(\text{real})^2 + Z(\text{imag})^2] , \quad (23)$$

so the settings are
- Z1 = [________] (Zone 1magnitude)
- Zn = [________] (magnitude of Zones 2, 3, and 4)

4. Calculate the impedance angle, øZ, for each zone, where øZ is the phase angle of the expression,

(2/3)∠POSANG + (K0/3)∠ZERANG ,

and is given by

$$øZ = \arctan\,[Z(\text{imag})/Z(\text{real})]. \quad (24)$$

The settings are
- øZ1 = [________]° (impedance angle of Zone 1)
- øZn = [________]° (impedance angle of Zones 2, 3, and 4)

5. Choose the I_T test angle (øI) for the zone:
- øI1 = [________]° (Zone 1)
- øI2 = {________]° (Zone 2)
- øI3 = [________]° (Zone 3)
- øI4 = [________]° (Zone 4)

6. Calculate VNOM for each zone by substituting the values of ZR, Z, øZ, and øI into Equation 19 or 20.
- 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, #0411 SEL4ZD = 1, remember to add 180° to both the test angle, øI4, and the impedance angle, øZ4.

T12 – Zone 1 Ground Reach Test, M1G Ground Faults (AG, BG, and CG)

1. Setting:

Z1DIST

(0101) SELZ1G = YES
(0102) SELZ1P = NO
(0104) Z1GR = [________] ohms,
VNOM1 = [________] V,
I_T = [________] A,
øI1 = [________]°,

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

3. Set the relay into test mode 14 (Any Zone1 Ground). The MMI displays

ANY Z1 GRND ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°

VB: 67 volts rms –120°
VC: 67 volts rms –240°.

Set the fault current, Iop, phase angle to øI = [________], lagging.

5. Set the fault current, Iop, to I_T = [________] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
6. Reduce the fault current to zero.
7. Return the Zone 1 phase, SELZ1P, to your specific setting.

T13 – Zone 2 Ground Reach, MTG Ground Faults (AG, BG, and CG)

1. Setting:

Z2DIST

(0201) SELZ2G = YES
(0202) SELZ2P = NO
(0204) Z2GR = [_________] ohms,
VNOM2 = [_________] V,
I_T = [_________] A,
øI2 = [_________]°,

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
3. Set the relay to the Zone 2 ground test mode for the appropriate phase under test. The MMI displays, for instance,

ZONE 2 AG ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,
VB: 67 volts rms –120°,
VC: 67 volts rms –240°.

Set the fault current, Iop, phase angle to øI = [________], lagging.

5. Set the fault current to I_T = [________] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
6. Reduce the fault current to zero.
7. Return Zone 2 phase, SELZ2P, to your specific setting.

T14 – Zone 3 Ground Reach, M3G Ground Faults (AG, BG, and CG)

1. Setting:

Z3DIST

(0301) SELZ3G = YES
(0302) SELZ3P = NO
(0304) Z3GR = [_________] ohms,
VNOM3 = [_________] V,
I_T = [_________] A,
øI3 = [_________]°,

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
3. Set the relay to the Zone 3 ground test mode for the appropriate phase under test. The MMI displays, for instance:

ZONE 3 AG ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,
VB: 67 volts rms –120°,
VC: 67 volts rms –240°.

Set the fault current, Iop, phase angle to øI = [________], lagging.

5. Set the fault current to I_T = [________] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.
7. Reduce the fault current to zero.
8. Return Zone 3 phase, SELZ3P, to your specific setting.

T15 – Zone 4 Ground Reach, M4G Ground Faults (AG, BG, and CG)

1. Setting:

Z4DIST

(0401) SELZ4G = YES
(0402) SELZ4P = NO
(0404) Z4GR = [_________] ohms,
VNOM4 = [_________] V,
I_T = [_________] A,
øI4 = [_________]°,

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

3. Set the relay to the Zone 4 ground test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 4 AG ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,

   VB: 67 volts rms –120°,

   VC: 67 volts rms –240°.

   Set the fault current, Iop, phase angle to øI = [________], lagging.

5. Set the fault current to I_T = [________] amps rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within 7% of VNOM.

6. Reduce the fault current to zero.

7. Return Zone 4 phase, SELZ4P, to your specific setting.

Zone 1–4 Phase-to-Phase Reach Calculations

This section describes how to determine the test currents and voltages for Z1P, Z2P, Z3P, and Z4P. The same procedure is used for each zone to determine the test values.

The test current, I_T, is determined from Table 5–2. The value of I_T is chosen according to the value of the reach of the zone. The nominal pickup voltage, VNOM, is calculated with respect to I_T and to several settings of the relay.

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° are included in Equations 25 and 26.

The nominal pickup voltage is given by

$$VNOM = [(2/1.732) \cdot ZR \cdot I_T / \cos(90 - øT)] \cdot \cos((øI + 30) - øZ - øT + 90) \quad (25)$$

for (øZ + øT – 180) < øI < øZ, or

$$VNOM = [(2/1.732) \cdot ZR \cdot I_T / \cos(90 - øT)] \cdot \cos((øI + 30) - øZ + øT - 90) \quad (26)$$

for øZ < øI < (øZ – øT + 180).

Definitions

ZR = relay reach for Z1P, Z2P, Z3P, or Z4P.

øZ = Angle of maximum reach.

I_T = Test current for Iop, chosen for the zone.

øT = Characteristic timer of the zone.

øI = Test current angle with respect to the faulted phase.

POSANG = Positive-sequence angle of maximum reach.

Settings and Calculations

1. Record the following relay settings:

   (1401), POSANG = [________]

   (0103), Z1R = [________] (Zone 1)

   (0203), Z2R = [________] (Zone 2)

   (0303), Z3R = [________] (Zone 3)

   (0403), Z4R = [________] (Zone 4)

   Z1PANG = 90 (fixed for Zone 1)

   (0209), Z2PANG = [________] (Zone 2)

   (0307), Z3PANG = [________] (Zone 3)

   - #0409, Z4PANG = [________] (Zone 4)

2. Determine the test current, I_T, for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 5–2.

   - I_T(Z1R) = [________] Amps rms
   - I_T(Z2R) = [________] Amps rms
   - I_T(Z3R) = [________] Amps rms
   - I_T(Z4R) = [________] Amps rms

ZG Reach (In = 5 A)	I_T, A	ZG Reach (In = 1 A)	I_T, A
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

Table 5–2. Test current ranges for phase-to-phase reach.

3. Choose øI (the I_T angle). VNOM is at maximum when øI = øZ – 30.

   - øI1 = [________]° (Zone 1)
   - øI2 = [________]° (Zone 2)

- øI3 = [________]° (Zone 3)
- øI4 = [________]° (Zone 4)

4. Calculate VNOM for each zone by substituting the values of ZR, øZ (POSANG), I_T, and øI into Equations 25 and 26 for VNOM according to zone.
   - VNOM1 = [________] Volts rms (nominal test voltage for Z1P)
   - VNOM2 = [________] Volts rms (nominal test voltage for Z2P)
   - VNOM3 = [________] Volts rms (nominal test voltage for Z3P)
   - VNOM4 = [________] Volts rms (nominal test voltage for Z4P)

NOTE: If Zone 4 is reversed, #0411 SEL4ZD = 1, remember to add 180° to both the test current angle, øI4, and the impedance angle, øZ4. If Zone 4 has a nonzero offset, use the DLPTEST software to calculate VNOM4.

5. Record VNOMn, I_T, and øIn in the space provided in the appropriate Zone reach test.

T16 – Zone 1 Phase Reach, M1 Faults (AB, BC, and CA)

1. Setting:

   Z1DIST

   (0101) SELZ1G = NO
   (0102) SELZ1P = YES
   (0103) Z1R = [_________] ohms,
   VNOM1 = [_________] V,
   I_T = [_________] A,
   øI1 = [_________]°,

2. Connect the relay as shown in Figure 4–4 for the appropriate phases under test.
3. Set the relay to test mode 30 (ANY ZONE 1 Phase). The MMI displays:

   ANY Z1 PHASE ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, phase angle to øI = [________], lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

5. Set the fault current to I_T = [________] 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.
6. Reduce the fault current to zero.
7. Return Zone 1 ground SELZ1G to your specific setting.

T17 – Zone 2 Phase Reach, MT Faults (AB, BC, and CA)

1. Setting:

   Z2DIST

   (0201) SELZ2G = NO
   (0202) SELZ2P = YES
   (0203) Z2R = [_________] ohms,
   VNOM2 = [_________] V,
   I_T = [_________] A,
   øI2 = [_________]°,

2. Connect the relay as shown in Figure 4–4 for the appropriate phases under test.
3. Set the relay to the Zone 2 Phase test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 2 AB ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, phase angle to øI = [________], lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

5. Set the fault current to I_T = [________] 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.
6. Reduce the current in the faulted phase to zero.
7. Return Zone 2 ground SELZ2G to your specific setting.

T18 – Zone 3 Phase Reach, M3 Faults (AB, BC, and CA)

1. Setting:

   Z3DIST

   (0301) SELZ3G = NO
   (0302) SELZ3P = YES
   (0303) Z3R = [_________] ohms,
   VNOM3 = [_________] V,
   I_T = [_________] A,
   øI3 = [_________]°,

2. Connect the relay as shown in Figure 4–4 for the appropriate phase under test.
3. Set the relay to the Zone 3 Phase test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 3 AB ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, phase angle to øI = [________], lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

5. Set the fault current to I_T = [________] 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.
6. Reduce the fault current to zero.
7. Return Zone 3 ground SELZ3G to your specific setting.

T19 – Zone 4 Phase Reach, M4 Faults (AB, BC, and CA)

1. Setting:

   Z4DIST

   (0401) SELZ4G = NO
   (0402) SELZ4P = YES
   (0403) Z4R = [_________] ohms,
   VNOM4 = [_________] V,
   I_T = [_________] A,
   øI4 = [_________]°,

2. Connect the relay as shown in Figure 4–4 for the appropriate phase under test.
3. Set the relay into the Zone 4 Phase test mode for the appropriate phase under test. The MMI displays, for instance:

   ZONE 4 AB ON

4. Set the voltage inputs to the following values:

   VA: 67 volts rms 0°,
   VB: 67 volts rms –120°,
   VC: 67 volts rms –240°.

   Set the fault current, Iop, phase angle to øI = [________], lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

5. Set the fault current to I_T = [________] 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.
6. Reduce the fault current to zero.
7. 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 may be helpful to print out the settings and check them one by one.

5–6 General Zone Reach Testing Considerations

Testing the reach of the DLP3 requires a few organized steps. They are as follows:

1. Choose a test current, I_T, for the impedance of the reach.
2. Calculate the voltage range in which the unit will pick up.
3. Apply the test voltage and currents in accordance with the test procedure.

The equations in this section are used to calculate the pickup voltage for a chosen magnitude and current phase (at or below the angle of maximum reach). If you wish to test the complete characteristic, the software program DLPTEST can be used to generate test currents and voltage pickups for the complete characteristic. DLPTEST is described in *Chapter 9 – Software*.

Zone 1–3 Phase-to-Ground Calculations

This section describes how to determine the test currents and voltages for Z1G, Z2G, and Z3G. The same procedure is used for each zone to determine the test values. The procedure is as follows:

- Choose a test current.
- Calculate the replica impedance of the zone.
- Calculate the operate voltage at the test current and impedance.

The test current, I_T, is determined from Table 5–3. The value of I_T is chosen according to the reach of the zone. The nominal pickup voltage, VNOM, is calculated with respect to I_T and to several settings of the relay.

NOTE: The pickup voltage calculations at a particular magnitude and phase of I_T are referenced to the faulted phase under test. For instance, if a BG Fault was applied, the current angles would be with respect to the phase angle of VB.

The nominal pickup voltage is given by

$$VNOM = [Z \cdot ZR \cdot I_T / \cos(90 - øT)] \cdot \cos(øI - øZ - øT + 90)\ . \qquad (27)$$

Definitions

Z = Replica impedance, calculated for each zone.

ZR = Relay reach for Z1G, Z2G, or Z3G.

øZ = Replica impedance angle, calculated for each zone.

I_T = Test current for Iop, chosen for the zone.

øT = Characteristic timer of the zone.

ø = 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.

Settings and Calculations

1. Record the following relay settings:
   (1401), POSANG = [________]
   (1402), ZERANG = [________]
   (0104), Z1GR = [________] = ZR
   (0204), Z2GR = [________] = ZR
   (0304), Z3GR = [________] = ZR
   Z1GANG = 90 (fixed for Zone1)
   (0210), Z2GANG = [________] = øT
   (0308), Z3GANG = [________] = øT
   (0107), Z1K0 = [________]= K0 for Zone 1 only
   (1404), K0 = [________] for Zones 2 and 3
2. Determine the test current, I_T, for Zone 1, Zone 2, and Zone 3 from Table 5–3.
   - I_T(Z1GR) = [________] Amps rms
   - I_T(Z2GR) = [________] Amps rms
   - I_T(Z3GR) = [________] Amps rms

ZR Reach (In = 5 A)	I_T, A	ZR Reach (In = 1 A)	I_T, A
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

Table 5–3. Test current ranges for Zone 1–3 phase-to-ground reach.

3. Calculate the replica impedance, Z, for Z1G, where Z is the magnitude of the expression,

   (2/3)/(POSANG) + (Z1K0/3)/(ZERANG).

   The real and imaginary components of Z are given by

$$Z(\text{real}) = (2/3)\cos(\text{POSANG}) + (\text{Z1K0}/3)\cos(\text{ZERANG}) \qquad (28)$$

= [________]

and

$$Z(\text{imag}) = (2/3)\sin(\text{POSANG}) + (\text{Z1K0}/3)\sin(\text{ZERANG}) \qquad (29)$$

= [________] .

The magnitude is then given by

$$Z = [Z(\text{real})^2 + Z(\text{imag})^2] , \quad (30)$$

= [________] .

4. Calculate the replica impedance angle, øZ, for Z1G. øZ is the phase angle of the expression,

(2/3)/POSANG + (Z1K0/3)/ZERANG ,

and is given by

$$øZ = \arctan [Z(\text{imag})/Z(\text{real})]. \quad (31)$$

= [________]° .

5. Choose the I_T test angle, øI, for Z1G in the range (øZ + øT – 180) < øI1 < øZ

- øI1 = [________]°

6. Calculate VNOM for Z1G by substituting the values of ZR, Z, øZ, and øI1 into Equation 27 for VNOM,

$$VNOM1 = [Z \cdot ZR \cdot I_T/\cos(90 - øT)] \cdot \cos(øI1 - øZ - øT + 90) \quad (32)$$

= [________] V rms.

7. Calculate the replica impedance, Z, for Z2G and Z3G, where Z equals the magnitude of the expression,

(2/3)/(POSANG) + (K0/3)/(ZERANG).

The real and imaginary components of Z are given by

$$Z(\text{real}) = (2/3)\cos(POSANG) + (Z1K0/3)\cos(ZERANG) \quad (33)$$

= [________]

and

$$Z(\text{imag}) = (2/3)\sin(POSANG) + (K0/3)\sin(ZERANG) \quad (34)$$

= [________] .

The magnitude is then given by

$$Z = [Z(\text{real})^2 + Z(\text{imag})^2] , \quad (35)$$

= [________] .

8. Calculate the replica impedance angle, øZ, for Z2G and Z3G. øZ is the phase angle of the expression,

(2/3)/POSANG + (K0/3)/ZERANG ,

and is given by

$$øZ = \arctan [Z(\text{imag})/Z(\text{real})]. \quad (36)$$

= [________]° .

9. Choose the I_T test angle, øI, for Z2G and Z3G in the range (øZ + øT – 180) < øIn < øZ

- øI2 = [________]°
- øI3 = [________]°

10. Calculate VNOM for Z2G by Z3G and substituting the values of ZR, Z, øZ, and øI1 into Equation 27 for VNOM,

$$VNOM2 = [Z \cdot ZR \cdot I_T/\cos(90 - øT)] \cdot \cos(øI2 - øZ - øT + 90) \quad (37)$$

= [________] V rms.

and

$$VNOM3 = [Z \cdot ZR \cdot I_T/\cos(90 - øT)] \cdot \cos(øI3 - øZ - øT + 90) \quad (38)$$

= [________] V rms.

Zone 1–3 Phase-to-Phase Reach Calculations

This section describes how to determine the test currents and voltages for Z1P, Z2P, and Z3P. The same procedure is used for each zone to determine the test values.

The test current, I_T, is determined from Table 5–4. The value of I_T is chosen according to the value of the reach of the zone. The nominal pickup voltage, VNOM, is calculated with respect to I_T and to several settings of the relay.

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° are included in Equations 25 and 26.

The nominal pickup voltage for Zone n is given by

$$VNOMn = [(2/1.732) \cdot ZR \cdot I_T/\cos(90 - øT)] \cdot \cos((øIn + 30) - øZ - øT + 90) . \quad (39)$$

Definitions

ZR	=	Relay reach for Z1P, Z2P, or Z3P.
I_T	=	Test current for Iop, chosen for the zone.
øZ	=	Replica impedance angle, POSANG.
øT	=	Characteristic timer of the zone.

øI = Test current angle with respect to the faulted phase.

POSANG = Positive-sequence angle of maximum reach.

Settings and Calculations

1. Record the following relay settings:
   (1401), POSANG = [________]
   (1402), ZERANG = [________]
   (0103), Z1R = [________] = ZR
   (0203), Z2R = [________] = ZR
   (0303), Z3R = [________] = ZR
   Z1PANG = 90 (fixed for Zone 1)
   (0209), Z2PANG = [________] = øT
   (0307), Z3PANG = [________] = øT

2. Determine the test current, I_T, for Zone 1, Zone 2, and Zone 3 from Table 5–4.
   - I_T(Z1R) = [________] Amps rms
   - I_T(Z2R) = [________] Amps rms
   - I_T(Z3R) = [________] Amps rms

ZG Reach (In = 5 A)	I_T, A	ZG Reach (In = 1 A)	I_T, A
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

Table 5–4. Test current ranges for phase-to-phase reach.

3. Choose øI (the I_T angle) in the range (øZ + øT – 180) < øIn + 30 < øZ.
   - øI1 = [________]° (Zone 1)
   - øI2 = [________]° (Zone 2)
   - øI3 = [________]° (Zone 3)

4. Calculate VNOMn for each zone by substituting the values of ZR, øZ (POSANG), I_T, and øIn into Equation 37 according to zone (where n is the zone under test).
   - VNOM1 = [________] V rms
   - VNOM2 = [________] V rms
   - VNOM3 = [________] V rms

5. Record VNOMn, I_T, and øIn in the space provided in the appropriate Zone reach test.

6–1 Spares

There are two servicing methods for the DLP3, as follows:

- Spare board replacement.
- Component level repair.

The preferred method is board replacement using the DLP3's automatic self-tests to isolate failed boards. When the defective board is found, it can be replaced with a spare, and the system can be returned to service. This method typically yields the shortest system down time. To further reduce down time, we recommend keeping a complete set of spare boards at the maintenance center.

We do not recommend servicing the relay at the component level. This requires a substantial investment in test and repair equipment and in technical expertise, and usually results in longer down time than board replacement. For those who do wish to trouble-shoot to the component level, drawings can be requested from the factory. When you request drawings, you must supply the following information:

- The model number of the board. This is found on the front tab of the board assembly.
- The assembly number of the board. 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 with a group-identification suffix, such as 0216B3051G001.
- The revision number. This is found on the printed circuit board adjacent to the assembly number of the board.

WARNING: Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF.

6–2 Servicing with the 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 noncritical and critical alarm contacts. The failure report is dependent on the type or level of the failure. Some failures operate the critical alarm contact and the MMI LED, while others only operate the noncritical alarm contact.

There are three levels of self-test performed by the DLP3:

1. The first level indicates severe relaying failures, indicated by a FAIL message on the MMI, the critical alarm contact’s opening, and the MMI LED’s turning red. These failures indicate that the relay is not providing protection.
2. The second level displays warning messages. They are indicated by a WARN message on the MMI and closure of the noncritical alarm contact. These failures indicate that the relay is still providing some degree of protection.
3. The third level indicates system status errors that are due to power system errors (Trip Circuit Open) or are caused by a DLP3 command that disables the relay (Disable Outputs). They are indicated by the closing of the noncritical alarm contact, a red LED, or by the opening of the critical alarm contact. However, no MMI display is provided until the Information Status command is issued.

The types of self-tests performed are described in the *Chapter 1 – Product Description*. The components tested during the start-up self-tests are listed in Table 6–1. The components tested during run-time background and foreground self-tests are listed in tables 6–2 and 6–3, respectively.

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
Nonvolatile 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, noncritical if SSP
Interrupt Chips	Test all processor and external interrupt controllers	DAP SSP	Critical
Serial Chips	Wraparound and interrupt tests for serial interface	SSP	Noncritical
A/D Controller	DMA interface	DAP	Critical, DLP3 will restart
Digital Output Circuitry	Loop-back via parallel port	SSP	Critical, DLP3 will restart
Digital Input Circuitry	Comparison of bits read via two separate optocouplers	DAP	Noncritical, turn off pilot protection
Real-Time Clock	Test of real-time clock operation and interrupts	SSP	Noncritical
LED Display	Self-test built in by manufacturer	SSP	Noncritical

Table 6–1. Components tested during start-up 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
Nonvolatile 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, noncritical if SSP; restart

Table 6–2. Run-time background self-tests.

Component	Method	Processor	Nature
A/D Controller	DMA interface	DAP	Critical
Digital Input Circuitry	Comparison of bits read via two separate optocouplers	DAP	Noncritical, turn off pilot protection
Digital Output Circuitry	Loop-back via parallel port	SSP	Critical; restart
Trip Circuit Continuity	Bit read via parallel port	SSP	Critical
MMI	Operator initiated, visual feedback	SSP	Noncritical

Table 6–3. Run-time foreground self-tests.

6–3 Trouble-Shooting

Trouble shooting the DLP3 comprises three steps, as follows:

1. Determine the type of failure as either critical, noncritical, or system status.
2. Use the list of failure codes and warning codes or the Information Status command to determine the defective board(s).
3. Replace the defective board(s) in accordance with safety and static-discharge precautions.

NOTE: Refer to *Chapter 4 – Acceptance Testing* for tests of the MMI display, and keypad and of the measuring units.

The Information Status Command

Tables 6–5 and 6–6 contain the failure and warning codes that appear in the MMI display. The Information Status command can also be used to obtain the same data from the MMI display without having to look up the code on the table. The Information Status command can be used at the relay or remotely over a modem link.

The Information Status command is invoked as follows:

1. Apply rated dc power to the relay and wait for initialization to complete.
2. Press the INF key, then scroll with the ↑ and ↓ keys until the MMI display indicates
   INF: STATUS
3. Press the ENT key. The display indicates a failure with the words
   STATUS: FAIL
4. Press the ↑ key to get a detailed report of the failure. A complete list of the possible errors is found in Tables 6–4, 6–5, and 6–6. The FAIL and WARN messages are also included. Their descriptions can also be displayed on the MMI, with the Information Status command.

NOTE: After initial power up or a loss of power exceeding 24 hours, the time and date reset to 00:00:00 01/01/90. All event and fault data are reset.

Error	Indication	Description
WARN	NCA	Warn condition, press ↑
FAIL	CA/LED	Fail condition, press ↑
MISC	LED	Miscellaneous condition, press ↑

LED: Red LED lights on the MMI.
CA: Critical alarm contacts close.
NCA: Noncritical alarm contacts close.

Table 6–4. System status error messages.

Servicing a Critical Failure

A critical failure indicates total interruption of protection. When a failure occurs on one of the boards (excluding the power supply), the critical alarm contact opens and the MMI LED turns red. Remove and reapply dc power to bring up the fail message on the display. If the DLP3 successfully restarts, the LED turns green.

The Fail message has the format FAIL xxx. The xxx field 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 6–5 for the list of failure codes and their meanings.

If the failt message is a non-board assciated message, then check all external connections to the DLP3.

NOTE: As an alternative, the Information Status command can be used to display the failure type directly on the MMI.

Locating the Defective Board

Use Table 6–5 or the Information Status command to isolate the cause of the failure. Refer to Figure 3–4, (DLP3 System Block Diagram), to determine which board contains the defective logic module. When the suspected board is found, power down the DLP3 and replace the board.

The proper sequence for replacing a board is as follows:

1. Remove the front plastic bezel by unscrewing the four thumbscrews. Note, the thumbscrews are retained to the front bezel.
2. Turn the power switch off on the front panel.

3. Remove DC power from the DLP1, and remove all voltage inputs from the terminals on the rear panel of the unit.

WARNING: Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF.

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4. Remove the four 1/4" hex nuts at the four corners of the front panel. Gently pull the front panel away from the unit to expose the cable connections to the front panel.

5. Disconnect the power switch cable from the Output board and the ribbon cable from the Processor board.

6. Remove the two ribbon cables and power cables from the front of the PC boards.

7. Remove the two PC board retainers by unscrewing the two phillips head screws that hold each in place.

8. Remove the defective circuit board and place it into an anti-static bag for storage or shipment.

9. Remove the replacement board from its protective material and insert it into the DLP3 case.

10. Reinstall the PC board retainers.

11. Reinstall the power cable and the two ribbon cables on the PC boards.

12. Reconnect the front panel power switch cable to the Output Board and the ribbon cable to the Processor Board. Install the front panel with the four 1/4" hex standoffs.

13. Restore dc power to the DLP3.

14. Turn on the front panel power switch.

15. Reinstall the plastic cover with the four thumbscrews.

If the FAIL message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that another board requires replacement.

Code	Description
	DAP Logic
100	PROM: PROM Failure
101	LOCAL RAM: Local RAM Failure
102	SYSRAM CRC: DSPRAM CRC Failure
103	SYSRAM: DSPRAM Failure
104	INTERRUPT: SYSRAM Failure
105	EEPROM: Interrupt Failure
106	TIMER: Timer Failure
124	VERSION NUM: Version no. Failure
—	NO DSP INT: No DSP interrupt
—	NO SSP INT: No SSP interrupt
	DSP Logic
207	PROM: PROM Failure
208	LOCAL RAM: Local RAM Failure
209	DSPRAM: DSP RAM Failure
210	INTERRUPT: Interrupt Failure
225	VERSION NUM: Version no. Failure
	Non Board Associated Failures
—	FUSE FAILURE: Fuse Failure
—	TRIP BUS CHK FAIL: Auto trip bus check failure
—	BKR1 TRP CIR OPN: BKR 1 Trip Circuit Open
—	BKR2 TRP CIR OPN: BKR 2 Trip Circuit Open

Code	Description
	ANI Logic
311	CONTROLLER: Controller Failure
312	SERIAL MEM: Serial NVM Failure
313	REFERENCE: Reference Failure
—	NO DMA INT: No DMA interrupt
	MGM Logic
414	SERIAL MEM: Serial NVM Failure
422	MODEL NUMBER: Model No.
	SSP Logic
515	PROM: PROM Failure
516	LOCAL RAM: Local RAM Failure
517	SYSRAM CRC: SYSRAM CRC Failure
518	SYSRAM: SYSRAM Failure
519	INTERRUPT: Interrupt Failure
520	EEPROM: EEPROM Failure
523	VERSION NUM: Version Number
—	NO DAP INT: No DAP Interrupt
	MMI Logic
621	DIG OUT: Digital Output Failure

Table 6–5. Failure messages.

Servicing a Noncritical Failure

A noncritical failure indicates an interruption in the DLP3's protection, but not a total loss. When a noncritical failure occurs, the DLP3's noncritical alarm contact closes, but the LED remains green. Turn off the dc input power, then reapply it. The WARN XXX message reappears if the failure still exists.

The noncritical failure message has the format WARN XXX. The xxx field is the numeric code that indicates the nature of the failure. The WARN message remains on the display until a key is pressed or until the DLP3 restarts successfully with no self-test failures. See Table 6–6 for the list of Warning codes and their meanings.

NOTE: As an alternative, the Information Status command can be used to display the warning type directly on the MMI.

Locating the Defective Board

Use Table 6–6 or the Information Status command to isolate the cause of the failure. Refer to Figure 3–4, (DLP3 System Block Diagram), to determine which board contains the defective logic module. Power down the DLP3 and replace the suspected board, if appropriate. Reapply power; if the WARN message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that another board requires replacement.

Code	Description
	DSP Logic
235	DIG INP: Digital Input fail on
	SSP
537	TIMER: Timer Failure
538	CAPRAM: CAPRAM Failure
539	CLOCK: Real-Time Clock Failure
	MMI Logic
640	SERIAL CHP 1: ASCII serial Port failure
641	DISPLAY: LED display failure
645	SERIAL CHP 2: Rear comm port failure
646	SERIAL CHP 3: Front comm port failure
	DTA Logic
844	SERIAL MEMRY: Serial memory failure
643	TIME STROBE FAIL: Time strobe failure
742	LOGON FAILURE: Login failed
	Non Board Associated Warning Messages
-	UNBALANCED SYS: Unbalanced currents detected

Table 6–6. Warning messages.

Miscellaneous Messages

Table 6–7 is a list of the miscellaneous messages and their meanings.

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

Table 6–7. Miscellaneous messages.

Servicing System Status Failures

A system failure indicates a failure of a power system input or that the relay has been disabled by a user command. It is indicated by the closing of the noncritical alarm contact, by a red LED, or by the closing of the critical alarm contact. However, no MMI display is provided until the Information Status command is invoked.

Turn off and reapply the dc input power. The noncritical alarm contact is closed if the failure still exists. Use the Information Status command to determine the cause of the trouble.

7–1 Ratings

Table 7–1 contains the electrical and environmental ratings of the DLP, Table 7–2 contains the burden ratings, and Table 7–3 contains the contact ratings.

Parameter	Value
Rated frequency	50–60 Hz
Rated voltage (phase to phase)	100–120 Vac
Rated current	I_n = 1 or 5 A
DC control voltage, operating range	48, 38.5–60 Vdc 110/125, 88–150 Vdc 220/250, 176–300 Vdc
Maximum permissible current Continuous 3 seconds 1 seconds	 2 x I_n 50 x I_n 100 x I_n
Maximum permissible ac voltage Continuous 1 minute (once per hour)	 2 x rated 3.5 x rated
Insulation test voltage	2 kV, 50/60 Hz, 1 minute
Impulse voltage withstand	5 kV peak, 1.2/50 ms, 0.5 joules
Interference test withstand	SWC, per ANSI C37.90.1
Ambient temperature range Storage Operation	 –30° to 75° C –20° to 55 ° C

Table 7–1. Electrical ratings of the DLP.

Parameter	Value
Current circuits	0.022 Ω, 5 deg, I_n = 5 A 0.12 Ω, 30 deg, I_n = 1 A
Voltage circuits	0.15 VA, 60 Hz 0.20 VA, 50 Hz
DC battery (for contact converters)	2.5 mA at rated dc input V
DC battery (power supply)	20 W

Table 7–2. Burden ratings of the DLP.

Contacts	Ratings
Digital-to-analog (DTA) output	0–1 mA, 10 V load or 0–5 V output (4 V = full scale, 5 V = error)
Trip outputs	Continuous rating = 3 A, Make and carry for tripping duty = 30 A (per ANSI C37.90)
SCR outputs	Same as trip contacts
Auxiliary outputs (including alarms and configurable inputs)	Continuous rating = 3 A, Make and carry for tripping duty = 30 A (per ANSI C37.90)
Channel control and SCADA DTA phase-identification contacts	10 W max voltage = 280 Vdc max current = 40 mA dc
Trip-circuit monitor, contact converters, and configurable inputs	38.5–300 Vdc 150 mA for trip-circuit monitor current-flow sensor

Table 7–3. Contact ratings of the DLP.

7–2 Protection Scheme Selection

The six available protection schemes are:

- Stepped distance
- POTT
- PUTT
- Blocking
- Hybrid
- Zone 1 extension

Reach Setting

Reach setting ranges are listed in Table 7–4.

Directional Control

Directional control is forward or reverse.

Time Synchronization

The time-synchronization input is by demodulated IRIG B signal (5 Vdc).

Out-of-Step Blocking

The reach of MOB is that of the zone it is coordinated with—Zone 2, Zone 3, or Zone 4.

The characteristic angle is 30°–130°.

Setting	Measuring Unit	Range, Ω		Resolution, Ω	
		I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1 A
Z1DIST	M1G	0.01–50	0.05–250	0.01	0.01
	M1	0.01–50	0.05–250	0.01	0.01
Z2DIST	MTG	0.01–50	0.05–250	0.01	0.01
	MT	0.01–50	0.05–250	0.01	0.01
Z3DIST	M3G	0.01–50	0.05–250	0.01	0.01
	M3	0.01–50	0.05–250	0.01	0.01
Z4DIST	M4G	0.01–50	0.05–250	0.01	0.01
	M4	0.01–50	0.05–250	0.01	0.01

Table 7–4. Reach setting ranges of the protection schemes.

7–3 Protection Function Settings

Current Supervision Function

The current supervision function settings are listed in Table 7–5.

Function	Range, A		Resolution, A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1 A
IPT	0.50–5.00	0.10–1.00	0.01	0.01
IPB	0.25–3.75	0.05–0.75	0.01	0.01
PT	0.20–4.00	0.04–0.80	0.01	0.01
IB	0.20–4.00	0.04–0.40	0.01	0.01

Table 7–5. Current supervision function settings.

Overcurrent Backup

The overcurrent backup settings are listed in Table 7–6.

Function	Range, A		Resolution, A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1 A
PH4	2.0–100.0	0.4–20.0	0.1	0.1
IDT	0.5–80.0	0.1–16.0	0.1	0.1
TOC	0.2–15.0	0.04–3.0	0.1	0.1

Table 7–6. Overcurrent backup settings.

TOC Time Dial

The TOC time dial is set as follows:

- Range: 0.5–10× the pickup setting.
- Steps: 0.1×.

Line Pickup

The line pickup settings are listed in Table 7–7.

Function	Range, A		Resolution, A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1 A
I1	1.0–15.0	0.2–3.0	0.1	0.1

Table 7–7. Line pickup settings.

Remote Open Detector Timer

The remote open detector timer (TL20) is set as follows:

- Range: 10–100 ms
- Steps: 1 ms

Line Overload

The line overload overcurrent and timer settings are listed in Tables 7–8 and 7–9, respectively.

Function	Range, A		Resolution, A	
	I_n = 5 A	I_n = 1 A	I_n = 5 A	I_n = 1 A
Level 1 OC	5.0–20.0	1.0–4.0	0.1	0.1
Level 2 OC	10.0–40.0	2.0–8.0	0.1	0.1

Table 7–8. Line overload overcurrent settings.

Function	Range, s	Resolution, s
LV1 timer (TL31)	10–990	1
LV2 timer (TL32)	10–99	1

Table 7–9. Line overload timer settings.

Compensation Factor

The compensation factor, K0 (zero-sequence compensation for Z2, Z3, and Z4 ground-distance units), is set as follows:

- Range: 1.0–7.0
- Resolution: 0.1

K0 compensation for Z1G is a separate setting in the Z1DIST category, with the same range and resolution as above.

Protection Scheme Logic Timers

The protection scheme logic timer settings are listed in Table 7–10.

Timer	Description	Range	Resolution
TL1	Trip integrator pickup	1–50 ms	1 ms
TL2	Zone 2 timer	0.1–3.0 s	0.01 s
TL3	Zone 3 timer	0.1–10.0 s	0.01 s
PUTL4P, G	Zone 4 timer	0.1–10.0 s	0.01 s
TL4	POTT/PUTT coordination	0.1–10.0 s	0.01 s
TL5	b contact coordination for breaker 1 (pickup and dropout timers)	0–200 ms	1 ms
TL6	b contact coordination for breaker 1 (pickup and dropout timers)	0–200 ms	1 ms
TL16	Weak infeed trip pickup	8–80 ms	1 ms

Table 7–10. Protection scheme logic timer settings.

System Configuration

The system configuration settings are listed in Table 7–11.

Parameter	Settings Range
Communications baud rate	300, 1200, 2400, 4800, 9600
Number of breakers	0–2
CT ratios	1–5000
PT ratios	1–7000
Units of distance for reports	Miles or kilometers

Table 7–11. System configuration settings.

7–4 Accuracies

The accuracies of various DLP parameters are listed in Table 7–12.

Parameter	Accuracy
Distance measuring units	Reach: ±5% of setting at angle of maximum reach and rated current.
Zone timers	±3% of setting
Fault locator	±3% (typical)
Data sample time tag resolution	±1 ms

Table 7–12. Accuracies of DLP measurements and settings.

7–5 Dimensions and Weight

The dimensions of the DLP case are listed in Table 7–13.

Parameter	Dimension
Height	5.15" [130mm] 3 standard rack units
Width	19.00" w/ ears (3 std. rack units) 16.90" w/oears [430mm]
Depth	13.75" [350mm]

Table 7–13. Dimensions of the DLP case.

The standard rack-mounted unit weighs approximately 23 pounds.

8–1 Local Man-Machine (MMI) Interface Operation

Display

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; for example, numeric keys are echoed as they are pressed, function keys produce an abbreviated word when they are pressed, and the ENT key always causes some change in the display.

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.
- 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 maximum intensity. User input is echoed at a still-lower intensity to help distinguish the stored setting value from one that has not yet been entered into the DLP3.

Trip messages are displayed at highest intensity and have the format,

TRIP xxx xxx xxx

The word TRIP blinks to indicate that the DLP3 has caused a protective trip. The three fields of information following TRIP do not blink and contain the following information:

- A three-character fault type (such as ABG).
- A three-character trip type (see the description of the Information key below for a list of trip types).
- A three-digit distance to the fault (in the specified units).

A TRIP message remains on the display until removed by a keyboard operation. If the DLP3 restarts or is powered down and up, the trip indicator is redisplayed. As soon as any key is pressed, the Trip message is removed and no longer remembered.

Fail messages have the format,

FAIL xxx

The field following FAIL is a numeric code that indicates the nature of the critical self-test failure. A 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 *Chapter 6 – Servicing*.

Warning messages have the format,

WARN xxx

The field following WARN is a numeric code that indicates the nature of the noncritical self-test failure. The Warning message remains on the display until the 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 *Chapter 6 – Servicing*.

While the DLP3 is initializing itself during a power-up sequence,

INITIALIZING

is displayed. The display is blanked as soon as initialization is complete.

All other messages that are the result of keyboard operations remain on the display until another key is pressed, or until no keys have been pressed for 15 minutes; at the end of this time-out interval, the display is blanked.

Keyboard

The keyboard, shown in Figure 8–1, contains twenty keys:

- A 10-key numeric pad
- A decimal point
- Nine function keys

Some models of the DLP3 (ending with NC) do not include a keypad. For these see Chapter 9 -Software to learn how to perform these functions.

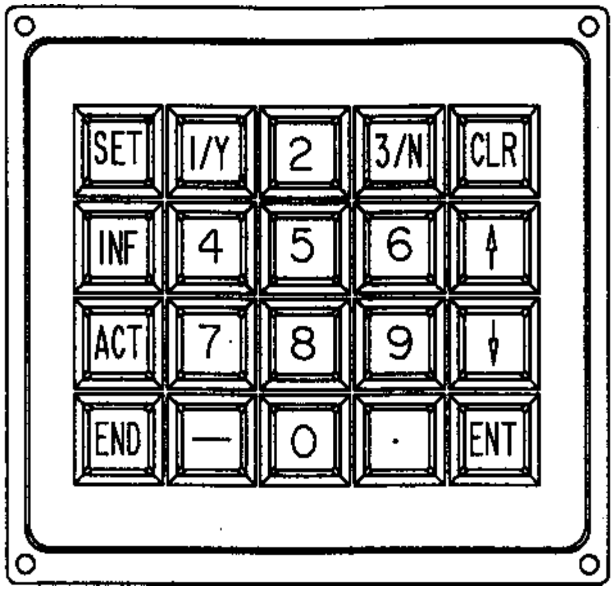

Figure 8–1. DLP3 MMI keyboard.

CLR (Clear) Key

The CLR key aborts a keyboard sequence in progress (for example, to correct an error). When the CLR key is pressed, all or part of the display is blanked.

If there is user-entered information on the display, only that information is blanked. For example, if a setting value has been entered when the CLR key is pressed, only that input is blanked; the name of the setting remains on the display. Also, if the response is to an action prompt, only the response is blanked; the prompt question remains on the display. If there is no user-entered information on the display, the entire display is blanked and the DLP3 expects a command key to be pressed.

If a TRIP, FAIL, or WARN message is on the display, the CLR key must be pressed to blank the error message (all other keys are ignored). When the error message is blanked, the last message is displayed, allowing reentry of the correct response.

If the CLR key is pressed when the display is blank, the DLP3 automatically scrolls through all present values.

DASH (–) Key

The (–) key presently is not supported by the DLP3. Pressing it will cause the DLP3 to display:

SPARE

Arrow Keys

The arrow keys scroll the display through the list of categories for a command key or to scroll through the list of items within a category. For example, pressing the INF key displays the name of the first category (STATUS). Pressing the ↑ key then displays the name of the second category (FAULT). When the desired category is reached, press the ENT key to display the first item of that category. From that point on, pressing the ↑ key displays each subsequent item in the category.

The ↓ key scrolls in the opposite direction through a list from the ↑ key. Press ↓ to return to a previous item on the list.

When the ↑ (or ↓) is used to scroll to the last (or first) entry in a list of categories or items, pressing the same key again displays the first (or last) entry on the display. At any time while scrolling through items within a category, press the Command key again to display the current category name. Press one of the arrow keys to scroll through the categories.

ENT (Enter) Key

The ENT key stores data or 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) press the ENT key to select that category for scrolling. When establishing or changing a setting, press the numeric keys and decimal point key to indicate the value; after the last digit is entered, press the ENT key to store that value. When the display prompts for a number entry (such as for Fault Information), enter the number that represents the choice, followed by the ENT key.

Data Entry Keys

The data Entry keys consist of the numeric and decimal point keys. They 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 numeric values are being entered, the 1/Y and 3/N keys are processed and echoed as 1 and 3. If the entry is in response to a YES/NO prompt, the 1/Y key is processed and echoed as YES and the 3/N key as NO.

END Key

The END key causes two actions, as follows:

- It indicates that no more setting changes will be made. Protection processing is halted as soon as any setting change is made, and is not resumed until the END key is pressed to indicate that all setting changes are complete.
- It ends a session. That is, pressing the END key idles the MMI (without the 15-minute time-out) and remote communication actions and settings are enabled, if they were previously locked out by the MMI.

The key sequence for indicating the end of setting changes and/or the end of a session is END followed by ENT. When the END key is pressed, the display shows

HIT ENT TO END

When the ENT key is pressed, the display shows ENDED. The DLP3 responds in one of the following ways:

1. If no setting values have been entered (the DLP3 has not stopped its protection activities), the DLP3 ends the session in response to the END–ENT key sequence, other than to enable action items previously locked by the MMI and to allow action commands from remote communications to be executed. Note that the ASCII port communications are never locked out by the MMI interface.
2. If protection activities had been stopped, the DLP3 reinitializes itself to use the new setting values and the Event message

   SETTING CHANGE DONE

   is displayed. The DLP3 then checks whether or not outputs are disabled:
   - If outputs are disabled, the MMI LED remains red.
   - If outputs are enabled, and there are no critical self-test failures of the DLP3, the MMI LED turns green. The displayed message changes to

     ENDED

     The MMI unlocks the settings lock to allow remote communication to display and change settings from the DLP3. 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 pressed a second time.

If the END-ENT sequence is 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.

Displayed	Decoded	Displayed	Decoded
(space)	P	@	0
!	T	A	4
"	X	B	8
$	Q	D	1
%	U	E	5
&	Y	F	9
(	R	H	2
)	V	I	6
*	Z	L	3
,	S	M	7
-	W	P	(space)
1	D	Q	$
2	H	R	(
3	L	S	,
4	A	T	!
5	E	U	%
6	I	V	)
7	M	W	-
8	B	X	"
9	F	Y	&
:	J	Z	*
;	N	[	.
<	C	\	#
=	G	]	'
>	K	^	+
?	O	_	/

Table 8–1. Password encryption key.

Passwords

There are two sets of passwords, MMI and Communication. Passwords are required to enable certain operations with the DLP3. The five types of passwords are as follows:

- MMI: allow access to actions and settings from the MMI keyboard.
  - Master: allows access to both actions and settings
  - Settings: allows access only to settings.
- Communication: allows logging into the relay, remote settings changes, and performing remote actions.
  - Master: allows access to settings and actions.
  - Settings: allows access to settings only.
  - View: allows uploading and viewing information only.

When the first entry in a list of actions or settings is selected, a prompt for entering the password appears (see the ACT key description below). If an action or setting change is not performed within 15 minutes, the password becomes inactive. For settings, password privileges become inactive after the key sequence END–ENT is pressed. Settings and actions may be viewed at any time, but may only be changed if the password for that function is active.

MMI passwords are limited to the numeric digits on the keypad. Communication passwords can contain any of the allowable alphanumeric characters in Table 8–1.

Communication passwords can only be viewed at the MMI using the INF key, while MMI passwords can only be viewed from the Information Menu under Relay Functions in DLP-LINK. All passwords are displayed in encoded form, as listed in Table 8–1.

SET (Settings) Key

The SET key displays, or changes 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, as listed in *Chapter 2 – Calculation of Settings*. For convenience, each setting within a category is assigned a number that is entered to go directly to that setting. If the settings or master password is inactive, the setting may only be viewed.

The key sequence for selecting a settings group is

SET {n} ENT

where n is the optional setting group number.

When the SET key is pressed, the display shows

SET:GRP 1,2,3,4

listing the four setting groups. If a group was previously selected but not saved with the END–ENT key sequence, then its number is highlighted. Pressing a digit key displays

SET:{n}

The entered digit is in position five.

When the ENT key is pressed, one of the following can happen:

- If the digit reselects the currently highlighted group or if no group is currently selected, then the group corresponding to the entered digit is selected.

- If 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. Press 1 for YES to indicate that changes to the previously selected group should be overwritten by the newly selected group, or 3 for NO to prevent the overwrite.

Simply pressing the ENT key without any preceding digit reselects the group that is highlighted.

When a group is finally selected, the display shows SET: in the first four positions and the name of the first category starting in position five. Three actions can be taken here, as follows:

- To select the first category as shown, press the ENT key to display the first item.
- Press ↑ or ↓ to scroll to the desired category.
- To select another group, press the SET key, which redisplays

  SET: GRP 1,2,3,4

When the ENT key is pressed 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 the following:

UNITID = 1234

LINELEN = 100.0

SELZ2U = YES

When one or more digit keys are pressed following the SET key, the name of the category is blanked and the digits are displayed. Pressing the ENT key after the last digit displays the setting corresponding to the entered setting number as described above. If the setting number is invalid, an error message is displayed.

Press ↑ and ↓ to scroll through all of the settings in a category. To leave a category, press the SET key to display the current category name. Press ↑ or ↓ to scroll through the categories or enter a setting number followed by the ENT key to go directly to another setting.

To change a setting, first display that setting (item) as described above. With the present value of the setting displayed, press 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 value is displayed as it the key is pressed, in a lower than normal intensity, while the : symbol continues to blink.

Note that there are some settings that logically represent a state rather than a number (such as 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, pressing the ENT key has the following effects:

- The blinking : symbol is replaced by an = symbol.
- The value is displayed at normal intensity.
- The DLP3 stores the new value as the value of the setting.

Pressing any command key or the ↑, ↓, or CLR key instead of the ENT key retains the old value and the newly entered value is lost.

When a new setting value is entered, it 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 ensure it is set to either a YES or NO. Entering any other digit for this type of setting displays an error message. If an error message is displayed, the setting name and unchanged value are displayed again when the CLR key is pressed.

The first time a setting is successfully changed, remote communication is inhibited from reading and changing settings in the DLP3.

After the value of a setting is changed, the setting name and the new value remain on the display. Press either of the ↑ or ↓ keys to move to the next setting in the category. Press any command key to begin performing other operations:

- Press the SET key to display the current category.
  - Press the ↑ or ↓ key to scroll to another category.
  - Press the SET key again to display the first setting category.
- Press any of the other command keys to display the first category associated with that key.

It is important to note that while values are being entered., the DLP3 system does not stop its protection activities. The new settings are stored in a temporary buffer until the user presses the END/ENT sequence. This causes a transfer of the new settings to permanent storage and reinitializes protection with the new settings. **If the END/ENT sequence is not done, and the DLP3 systems times out, then all of the settings in the temporary buffer are lost.**

Table 8–2 contains an example of changing a setting after going through the categories with the ↑ and ↓ keys. Table 8–3 contains an example of changing a setting after entering the setting number directly.

Key	Display
SET	SET:Z1DIST
↑	SET:Z2DIST
ENT	SELZ2G = YES
↑	SELZ2P = YES
↑	Z2R = 9.00
8	Z2R :8
.	Z2R :8.
4	Z2R :8.4
5	Z2R :8.45
ENT	Z2R = 8.45

Table 8–2. Example of changing a setting after finding the category with arrow keys.

Key	Display
SET	SET:Z1DIST
1	SET:1
2	SET:12
0	SET:120
1	SET:1201
ENT	SELSCM = STEPDST
1	SELSCM :POTT
ENT	SELSCM = POTT

Table 8–3. Example of changing a setting after entering the setting number directly.

Tables 8–30 to 8–53 list the settings available under each category.

ACT (Actions) Key

The ACT key provides access to the 12 categories of actions listed in Table 8–4. You can scroll through these categories with the ↑ and ↓ keys. Each category has a number that can be entered to go directly to that category.

Category Number	Action	Display Entry
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 Pass word	CHANGE PASSWORD

Table 8–4. Action categories.

The key sequence for selecting actions is

ACT n [ENT]

where n is the optional category number. If this number is omitted, category 1 is assumed. When the ACT key is pressed, the display shows ACT:, followed by the abbreviated name of the first category. The following responses are possible:

- Select the first category by pressing the ENT key to display the first item in that category.
- Scroll to the desired category with the ↑ and ↓ keys.
- Jump to a specific category by pressing a digit key; the category name is blanked and the digit is displayed. Press the ENT key to display the abbreviated name of the category corresponding to that number.
- Entering an invalid category number displays an error message.

If the one of the categories DISABLE, ENABLE, TRIP or CLOSE is selected, the MMI attempts to acquire the action lock. The action lock prevents remote communication from performing those functions. If remote communication already has the action lock, the MMI displays the message,

REMOTE LINK ACTIVE

If the category contains a list of items, scroll through the items with the ↑ and ↓ keys. Press the ACT key followed by ↑ or ↓ to switch to the next or previous category.

If a category contains prompts, respond to each prompt or press any command key or the END key to get out of the sequence of prompts. Respond to each prompt and press the ENT key to automatically display the next prompt (if any) in the sequence. The DLP3 performs the appropriate action after the last prompt has been satisfied.

As soon as an action is complete, the display returns to the category name. The DLP3 is expecting one of the following responses:

- Press the ENT key to produce the first prompt.
- Press the ↑ or ↓ key to move to another category.
- Press a command key.

Each of the action categories is described below.

Enter Password

Select this category to enter the MMI password that activates a privilege level for access through the keypad.

After the ENT key is pressed, the display contains the prompt,

ENTER PASSWORD

Press the digit keys that represent the password. The digits are echoed on the display as *. After the final digit of the password is entered, press the ENT key, which results in one of the following:

- SELECTED appears on the display if the password was valid.
- NOT SELECTED appears on the display if the password was invalid.

MMI privilege is set to the level associated with the selected password.

NOTE: When a DLP3 is first shipped, special control and setting passwords are installed. Selecting these passwords does not increase one's privilege level, but only allows changing the password by selecting action category 12. Change Password. A higher privilege level may then be selected.

Disable Outputs

This category inhibits the DLP3 from energizing any of the digital output channels except the four alarm outputs. Press the ENT key to display the prompt,

DIS OUTPUTS?

Press the 3/N key for NO or the 1/Y key for YES, then press the ENT key. The response is echoed on the display as NO or YES.

- A NO response displays the message

  CANCELLED

  and no DLP3 action occurs.
- A YES response displays the message

  OUTPUTS DISABLED

  the action is performed, the MMI LED turns red:

If a data entry key other than 3/N or 1/Y is pressed, an error message is displayed and the outputs are not disabled.

Table 8–5 lists the key sequence for disabling outputs.

Key	Display
ACT	ACT:PASSWORD
2	ACT:2
ENT	DIS OUTPUTS?
1/Y	DIS OUTPUTS? YES
ENT	OUTPUTS DISABLED

Table 8–5. Key sequence and display contents for disabling outputs.

Enable Outputs

This category energizes all of the DLP3 digital output channels. Press the ENT key to display the prompt,

EN OUTPUTS?

Press the 3/N key for NO or the 1/Y key for YES, then press the ENT key. The response is echoed on the display as NO or YES.

- A NO response displays the message

  CANCELLED

  and no DLP3 action occurs.
- A YES response displays the message

  OUTPUTS ENABLED

  the action is performed, the MMI LED turns green.

If a data entry key other than 3/N or 1/Y is pressed, an error message is displayed and outputs are not disabled.

Table 8–6 lists the key sequence for enabling outputs.

Key	Display
ACT	ACT:PASSWORD
3	ACT:3
ENT	EN OUTPUTS?
1/Y	EN OUTPUTS? YES
ENT	OUTPUTS ENABLED

Table 8–6. Key sequence and display contents for enabling outputs.

Trip

This category trips a breaker manually. If the DLP3 is controlling two breakers, each must be tripped individually.

The DLP3 responds differently for one or two breakers. In the following procedure, go to step 2 if the DLP3 is controlling only one breaker.

1. Press the ENT key to display the prompt,

   TRIP BKR 1/2?

   Press 1 or 2 to indicate which breaker (pressing any other data entry key displays an error message).
2. Press the ENT key to display the prompt,

   TRIP BKR x?
3. Press the 3/N key for NO or the 1/Y key for YES, then press the ENT key. The response is echoed on the display as NO or YES.
   - A NO response displays the message

     CANCELLED

     and no DLP3 action occurs.
   - A YES response causes the DLP3 to send a trip command to the selected breaker. When the 52/b contact reports that the breaker is open, then the message

     BKR x TRIPPED

     appears on the display.

     If the 52/b contact reports that the breaker is not open, then the message

     NOT TRIPPED

     appears on the display.
   - If a data entry key other than 3/N or 1/Y is pressed, an error message is displayed and the breaker is not tripped. The trip command is issued for approximately .5 to 1 second.

Table 8–7 contains the key sequence for manually tripping a breaker when two breakers are controlled by the DLP3.

Key	Display
ACT	ACT:PASSWORD
4	ACT:4
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

Table 8–7. Key sequence and display contents for manually tripping a breaker.

Close

This category closes a breaker manually. If the DLP3 is controlling two breakers, each must be closed individually.

The DLP3 responds differently for one or two breakers. In the following procedure, go to step 2 if the DLP3 is controlling only one breaker.

1. Press the ENT key to display the prompt,

   CLOSE BKR 1/2?

   Press 1 or 2 to indicate which breaker (pressing any other data entry key displays an error message).

2. Press the ENT key to display the prompt,

   CLOSE BKR x?

3. Press the 3/N key for NO or the 1/Y key for YES, then press the ENT key. The response is echoed on the display as NO or YES.
   - A NO response displays the message

     CANCELLED

     and no DLP3 action occurs.
   - A YES response causes the DLP3 to send a trip command to the selected breaker. When the 52/b contact reports that the breaker is closed, then the message

     BKR x CLOSED

     appears on the display.

     If the 52/b contact reports that the breaker is not closed then the message

     NOT CLOSED

     appears on the display.
   - If a data entry key other than 3/N or 1/Y is pressed, an error message is displayed and the breaker is not closed. The close command is issued for approximately .5 to 1 second.

Table 8–8 contains the key sequence for manually closing a breaker when only one breaker is controlled by the DLP3.

Key	Display
ACT	ACT:PASSWORD
5	ACT:5
ENT	CLOSE BKR?
1/Y	CLOSE BKR? YES
ENT	BKR CLOSED

Table 8–8. Key sequence and display contents for closing a breaker.

Date/Time

Select this category to display or change the current date and/or time stored in the DLP3. Press the ENT key to display,

DATE: xx/xx/xx

The current date is displayed in the format mm/dd/yy. To change the date, enter six digits from the numeric keypad. When the first digit is entered, the six digits on the display are blanked, and numeric key presses are echoed in place of the original digits. Press the ENT key to store the new date. If any key other than ENT is pressed, or if the digits entered do not comprise a valid date, the old date is retained and an error message is displayed.

NOTE: After initial power up or loss of power for more than 24 hours, the time and date are reset to 00:00:00 01/01/90. All event and fault data are also reset.

After viewing or changing the date, press the ↑ key to display the current time,

TIME: xx:xx:xx

in the format hh:mm:ss. To change the time, enter six digits. When the first digit is entered, the six digits on the display are blanked, and numeric key presses are echoed in place of the original digits. Press the ENT key to store the new time. If any key other than ENT is pressed, or if the digits entered do not comprise a valid time, the old time is retained and an error message is displayed.

Table 8–9 contains a sample key sequence for setting the date and time.

Key	Display
ACT	ACT:PASSWORD
6	ACT:6
ENT	DATE:08/29/94
0	DATE:0 / /
7	DATE:07/ /
0	DATE:07/0 /
4	DATE:07/04/
9	DATE:07/04/9
5	DATE:07/04/05
ENT	DATE=07/04/95
↑	TIME:12:34:55
0	TIME:0 : :
1	TIME:01: :
3	TIME:01:3 :
7	TIME:01:37:
5	TIME:01:37:5
5	TIME:01:37:55
ENT	TIME=01:37:55

Table 8–9. Sample key sequence and display contents for setting the date and time.

Relay Test

This category tests the relay functions of the DLP3. After the ENT key is pressed, one of the following occurs:

- If the DLP3 is already in Test Mode, the display show the current Test Mode selection.
- If the DLP3 is not in Test Mode, the first item is displayed,

  END TEST MODE

Select or cancel a test by one of the following:

- Scroll through the list with the ↑ and ↓ keys.
- Enter the number corresponding to the test, followed by the ENT key.

Press the ENT key to select the displayed test for execution. When the test is selected, ON is displayed in the rightmost two characters of the display.

When Test Mode is selected (see *Chapter 4 – Acceptance Testing*) the pickup of the selected function results in the output of a signal on the Reclose Cancel digital output. Only one signal can be monitored at a time, so selecting a function for monitoring disables monitoring of any previously selected function.

Remove the DLP3 from Test Mode by one of the following:

- Press the ↑ and ↓ keys until

  END TEST MODE

  is displayed, then press the ENT key.
- Press the 1/Y key, then press the ENT key twice.

The currently selected function is no longer monitored and the Reclose Cancel digital output reverts to its normal use.

A sample key sequence for selecting a relay test is contained in table 8–10. The available tests and their corresponding numbers are shown in Table 8–11.

Key	Display
ACT	ACT:PASSWORD
7	ACT:7
ENT	END TEST MODE
↑	ZONE 1 AG
↑	ZONE 1 BG
ENT	ZONE 1 BG ON

Table 8–10. Sample key sequence and display contents for selecting a relay test.

Test #	Test Name	Test #	Test Name	Test #	Test Name
1	END TEST MODE	17	Z4 GRND TIMER	32	Z3 PHASE TIMER
2	ZONE 1 AG	18	ZONE 1 AB	33	Z4 PHASE TIMER
3	ZONE 1 BG	19	ZONE 1 BC	34	IT DETECTOR
4	ZONE 1 CG	20	ZONE 1 CA	35	IB DETECTOR
5	ZONE 2 AG	21	ZONE 2 AB	36	GRD DIR TRIP
6	ZONE 2 BG	22	ZONE 2 BC	37	GRD DIR BLOCK
7	ZONE 2 CG	23	ZONE 2 CA	38	FAULT DETECTOR
8	ZONE 3 AG	24	ZONE 3 AB	39	REM OP DETCT
9	ZONE 3 BG	25	ZONE 3 BC	40	OUT OF STEP
10	ZONE 3 CG	26	ZONE 3 CA	41	V1 DETECTOR
11	ZONE 4 AG	27	ZONE 4 AB	42	LINE OVERLOAD
12	ZONE 4 BG	28	ZONE 4 BC	43	INST PHS OVRC
13	ZONE 4 CG	29	ZONE 4 CA	44	INST GND OVRC
14	ANY Z1 GRND	30	ANY Z1 PHASE	45	TIM DLY GD OC
15	Z2 GRND TIMER	31	Z2 PHASE TIMER	46	LINE PICKUP
16	Z3 GRND TIMER				

Table 8–11. Tests available in Test Mode.

Channel Test

This category keys (turns on) the local transmitter when a channel scheme (POTT, PUTT, BLOCKING, or HYBRID) is active.

Press the ENT key is pressed to display the first of the two items,

END CHNL TEST

or

CHNL TEST

Press the ↑ or ↓ key to toggle between the two.

Press the ENT key to select the current item for execution. At this point two checks are performed:

- Privilege must be Control level.
- Communication must not be currently performing an action.

If the checks fail, an error message is displayed and the test is not performed. When the item is selected, the word ON appears in the rightmost two characters of the display.

MMI Test

This category tests the display, keyboard, and MMI LED.

Following is the sequence of MMI tests:

1. The first press of the ENT key lights the entire left 8-character display, for verification that all those LED segments are working.
2. The right 8-character display prompts with

   ########NEXT?.

- Press the 3/N key, followed by the ENT key, to skip the next test (testing the right 8-character display).
- Press the 1/Y key, followed by the ENT key, to light the right 8-character display, for verification that all those LED segments are working.

3. The left 8-character display prompts with

   LED TST?.

   - Press the 3/N key, followed by the ENT key, to skip the next test (testing the LED).
   - Press the 1/Y key, followed by the ENT key, to test the LED. If the LED is green, it will turn red for 5 seconds and return to green. If the LED is red, it will turn green for 5 seconds and return to red.

4. The display prompts with

   KEYBRD TEST?

   - Press the 3/N key, followed by the ENT key, to skip the next test (testing the keyboard).
   - Press the 1/Y key, followed by the ENT key, to test the keyboard. After the display blanks, press any keys on the keyboard. The keys' mnemonics are echoed on the display, to verify that each key is being sensed correctly. Press the CLR key to terminate the keyboard test.

At any point in the MMI test sequence, pressing any Command or Control key other than ENT terminates the test. An error message is displayed if any Data Entry key other than 1/Y or 3/N is pressed.

Table 8–12 contains the key sequence for a sample MMI test.

Key	Display
ACT	ACT:PASSWORD
9	ACT:9
ENT	########NEXT?
1/Y	########NEXT?YES
ENT	LED TST?
3/N	LED TST?NO
ENT	KEYBRD TEST?
3/N	KEYBRD TEST?NO
ENT	ACT:UMI TEST

Table 8–12. Sample key sequence and display contents for a MMI test.

Fix Up Settings

This category is used after the DLP3 has reported an EEPROM failure, indicating that the stored settings do not match their CRC (cyclic redundancy check) code. It is important to *examine every DLP3 setting*, to assure that each setting is correct, before performing the END-ENT key sequence to resume protection (see *Chapter 8 – Servicing*).

Press the ENT key to display the message

FIXUP SETTS?

- Press the 3/N key to cancel the procedure. The message

CANCELLED

appears on the display and no action is taken.

- Press the 1/Y key to recalculate the setting's CRC code. The message

  CHECK SETTINGS

  appears on the display.

When the setting's CRC code has been calculated and *every DLP3 setting has been examined*, then press the END key followed by the ENT key to resume protection. Pressing any Data Entry key other than 3/N or 1/Y displays an error message and the setting's CRC code is not recalculated.

Table 8–13 contains the key sequence to fix up the settings.

Key	Display
ACT	ACT:PASSWORD
11	ACT:11
ENT	FIXUP SETTS?
1/Y	FIXUP SETTS?YES
ENT	CHECK SETTINGS

Table 8–13. Key sequence and display contents for fix up settings.

Change Password

This category is used to change the current MMI password. The new password becomes effective after selection of Enter Password in this category. The procedure is as follows:

1. Press ENT to display the message

   NEW PASSWORD

2. Press the digit keys corresponding to the new password. The digits are echoed as * on the display.
3. Press ENT to display the message

   REPEAT

4. Reenter the new password again, then press ENT.
   - If the two entered passwords are exactly the same, then the message

     CHANGED

     is displayed and the new password is in effect.
   - If the two entered passwords are not the same, then the message

     NOT CHANGED

     is displayed and the old password remains selected.

Digital Output Test

This category is used to test the digital outputs of the DLP3. Only one signal at a time can be monitored; any previously selected signal is no longer monitored. Table 8–14 lists the available tests.

Test #	Test Name	Test #	Test Name
1	End Test Mode	16	Noncritical Alarm
2	Trip–1	17	Critical Alarm
5	Trip–2	18	Key Transmitter 1
8	BFI	19	Key Transmitter 2
11	Reclose Initiate	20	Line Overload Alarm
13	Breaker Close 1	21	Reclose in Progress
14	Breaker Close 2	22	Recloser Lockout
15	Reclose Cancel	24	Z1 Extension Reset

Table 8–14. Digital output test.

The procedure is as follows:

1. Press the ENT key to display the first item,

   END DIG TEST

2. Scroll to the desired test name by pressing the ↑ or ↓ keys or enter the number corresponding to the test, followed by ENT.
3. Press ENT to select that test.

Note: At this point the privilege level must be Control. If the privilege level is wrong, then an error message is displayed and the test is not performed. Communication interference is not checked.

4. 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.

5. If outputs are enabled, then the message

    PROTECT OFF?

   is displayed.
   - Press the 3/N key, followed by ENT, to stop test selection. The message

        CANCELLED

     is displayed.
   - Press the 1/Y key to redisplay the test name, followed by ON in the rightmost two characters of the display. The test is then performed.

6. To stop the digital output test and reenable protection, do one of the following, then press ENT:
   - Press the ↑ or ↓ key until

        END TEST MODE

     is displayed.
   - Press the 1/Y key, followed by ENT.

The test can also be stopped by pressing END and ENT in sequence, which ends the DLP3 session.

INF Key (Information)

The INF key is used to request information about any of the eight categories listed in Table 8–15.

No.	Category	Display
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

Table 8–15. Categories available with the INF key.

The procedure is as follows:

1. Press the INF key to display:

    INF:STATUS

2. Select a category as follows:
   - Press ENT to access the first category, STATUS.
   - Press the ↑ or ↓ key to scroll through the list of categories.
   - Press the digit key for the desired category. The display shows that number. Press ENT to display the category name. An error message appears in response to an invalid category number.

3. Press ENT to display the first item or prompt in the category.
   - If the category contains a list of items, scroll through the list with the ↑ or ↓ key. Press the ENT key when the desired item appears.
   - If the category contains prompts, respond to the prompt and press either the ENT key to display the next prompt (if any). To leave the prompt sequence, press any Command key or the END key.

4. The DLP3 displays the appropriate information after a list item is selected or the last prompt is satisfied. Press the INF key to return to the category name, as in step 2.

Request DLP3 Status Information

This category displays the present status of the DLP3 (see *Chapter 6 – Servicing*).

Press the ENT key to first display the overall status of the DLP3, in the following priority order:

1. If the DLP3 is working properly and protecting the line, the display contains

    STATUS: OK

2. If there is a critical failure, the display contains

    STATUS: FAIL

3. If there is a noncritical failure, the display contains

    STATUS: WARN

4. If the DLP3 is working properly but not protecting the line, the display contains

    STATUS: PROT OFF

5. If the DLP3 is working properly but outputs are disabled, the display contains

    STATUS: DIS OUTS.

If the display indicates that the status is a critical failure, a noncritical failure, or not protecting the line, press the arrow keys for more information. (If the DLP3 is working properly and protecting the line, pressing an arrow key displays an error message.) If the status indicates a critical failure, logic modules containing critical failures are reported in the following order:

1. SSP, displayed as SSP
2. DAP, displayed as DAP
3. DSP, displayed as DSP
4. Analog interface, displayed as ANI
5. Digital communications interface, and the MMI, both displayed as MMI.
6. Magnetics module (displayed as MGM)
7. Critical failures that are not related to a board.

Press the ↑ key to display the first critical failure (if any), based on the above order. Successive presses of the ↑ key display additional critical failures until there are no more critical failures, at which point any noncritical failures are displayed, based on the same order. When all critical and non-critical failures have been displayed, press the ↑ key again to return to the overall DLP3 status. Press the ↑ key to again scroll through the failures, or the ↓ key to scroll the list in reverse order.

If the status indicates protection off or protection on but outputs disabled, only the corresponding status messages are displayed. In these cases, there are no critical or noncritical failures.

Table 8–16 contains the key sequence for a sample Status information request. Table 8–17 lists the failure messages that appear on the MMI display.

Key	Display
INF	INF:STATUS
ENT	STATUS:WARN
↑	LOGIN FAILURE

Table 8–16. Key sequence and display contents for a sample Status information request.

SSP:PROM ERROR SSP:RAM ERROR SSP:CRC RAM ERR SSP:SYSRAM ERROR SSP:INT ERROR SSP:TIMER ERROR SSP:EEPROM ERROR SSP:CAPRAM ERROR SSP:RTC ERROR SSP:D O HW ENA SSP:PROCSR SHTDN
DAP:PROM ERROR DAP:RAM ERROR DAP:CRC RAM ERR DAP:DSPRAM ERROR DAP:SYSRAM ERROR DAP:INT ERROR DAP:TIMER ERROR DAP:D O HW ENA DAP:PROCSR SHTDN
DSP:PROM ERROR DSP:RAM ERROR DSP:DSPRAM ERROR DSP:INT ERROR DSP:D I ERROR DSP:D I ERR COR DSP:PROCSR SHTDN
ANI:A/D CNTRL ER ANI:A/D S NVM ER ANI:A/D REF ERR ANI:A/D REF COR ANI:ZERO CRSS ER
MMI:SER CHIP ERR MMI:D O ERROR MMI:LED DISP ERR
MGM:MAG S NVM ER
BK1 TRP CIR OPEN BK2 TRP CIR OPEN FUSE FAILURE LOGON FAILURE RELAY TEST D O TEST PROT OFF DIS OUTS

Table 8–17. List of event messages displayed at the MMI.

Request Fault Information

This category displays information associated with up to the last 14 faults that the DLP3 has stored, depending on setting 1512.

Press the ENT key to display the prompt

FAULT #?

Enter a number from 1 to 14 (where 1 is the most-recent fault, 2 the second most-recent fault, etc.), then press ENT. If there is no valid information available for that fault, the message

NO FAULT DATA

is displayed. Entering any number not in the range 1–14 displays an error message.

If ENT is pressed after the fault number is entered, the fault information appears on the display in the following order. Press ↑ to scroll through the list.

1. DATE: xx/xx/xx.
2. TIME: xx:xx:xx
3. FAULT TYPE: xxx (examples: AG, ABG, CA, 3PH)
4. TRIP TYPE: xxx (see Table 8–19)
5. DIST: xxx MI (in user-selected units)

Trip Type	Description
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
SZ1	Single-pole, zone 1
SZ2	Single-pole, zone 2
SPI	Sinple-pole pilot
SWI	Single-pole, weak infeed
CTB	Configurable Trip Bus

Table 8–19. Trip type abbreviations in Fault information displays.

Press the ↑ key after the last entry (distance) to return to the top of the list (date). The ↓ key can be used at any time to scroll backwards through the list.

Table 8–19 contains the key sequence for a sample Fault information request

Key	Display
INF	INF:STATUS
↑	INF:FAULT
ENT	FAULT#?
1	FAULT#?1
ENT	DATE: MM/DD/YY
↑	TIME: HH:MM:SS
↑	FAULT TYPE: AG
↑	TRIP TYPE: Z1
↑	DIST: 1.0MI

Table 8–19. Key sequence and display contents for a sample Fault information request.

Request Present Values

This category displays the present analog values and the status of the contact inputs that the DLP3 is monitoring.

The PLC and BKR names displayed refer to contact converters CC3–CC6 and CC8–CC13 defined in the Elementary Diagram, Figure 1–6. The PLC signals, PLC SIG and PLC STS, are present for all the pilot schemes except blocking. For a blocking scheme, PLC STS signals are replaced with

```
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 Blocking. No action is taken for these signals except with the Blocking scheme.

To view the Present Values on the DLP display, press the ENT key. The first item is displayed as

IA = xxx.xx

Press the ↑ key to scroll through the list of parameters. Press the ↓ key to scroll backwards through the items.

The values are periodically updated while on display.

Table 8–20 contains the key sequence for a sample Present Values information request.

Key	Display
INF	INF:STATUS
↑	INF:FAULT
↑	INF:VALUES
ENT	IA = 5.00A
↑	ANGLE IA = -50
↑	IB = 5.00A
↑	ANGLE IB = -120

Table 8–20. Key sequence and display contents for a sample Present Values information request.

View Password

This category displays the communication passwords in encrypted form. When the ENT key is pressed, the DLP3 checks that Communication is not in the process of changing the passwords. If the check fails, then an error message is displayed and the action is not performed. If the check passes, then the word VIEW is displayed. Press the ↑ key to display the View-level password. Press the ↑ key repeatedly to display the word CONTROL, the Control-level password, the word SETTING, the Setting-level password, and back to the word VIEW. All passwords are displayed in encrypted form.

Table 8–21 contains the key sequence for a sample View Password information request.

Key	Display
INF	INF:STATUS
↑	INF:FAULT
↑	INF:VALUES
↑	INF:EVENTS
↑	INF:PASSWORD
ENT	ENTER PASSWORD

Table 8–21. Key sequence and display contents for a sample View Password information request.

Request DLP3 Model/Version

This category displays the DLP3 model number and the PROM version number.

Press the ENT key to display the model number in the form,

MD:AAAAAAAAAAAA

Press the ↑ key to display the PROM version number in the form,

VER:AAAAAAAAAAAA

Press the ↑ key again to return to the model number. Press the ↓ key to scroll backwards through the items.

Table 8–22 contains the key sequence for a Model/Version information request.

Key	Display
INF	INF:STATUS
↑	INF:FAULT
↑	INF:VALUES
↑	INF:EVENTS
↑	INF:PASSWORD
↑	INF:MODEL
ENT	MD:DLP3521AA
↑	VER:V001.111A

Table 8–22. Key sequence and display contents for a sample Model/Version information request.

Station ID

This category displays the 32-character Station ID string that was downloaded by remote communications.

When the ENT key is pressed, the DLP3 checks that Communication is not in the process of changing the Station ID. If the check fails, 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. Press the ↑ or ↓ key to display the next 16 characters of the Station ID.

Line Id

This category displays the 32-character Line ID string that was downloaded by Remote Communications.

When the ENT key is pressed, the DLP3 checks that Communication is not in the process of changing the Line ID. If the check fails, 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. Press the ↑ or ↓ key to display the next 16 characters of the ID.

Errors

Whenever an incorrect response is entered to a request for data or a choice of options, the DL:P1 displays an error message. Table 8–23 contains a list of the error messages.

After an incorrect response, the display blanks and an error message is displayed. Press the CLR key to blank the error message (all other keys are ignored). The last message is redisplayed, providing the opportunity to enter the correct response.

If the setting's CRC code is corrupted, certain MMI functions become unavailable. When this error occurs, no settings can be changed, although they can still be viewed. If the error occurs during startup, the only Action command available is Fixup Settings. When the setting's CRC has been recalculated by the FIXUP SETTINGS command, all normal commands are again available..

The CRC (Cyclic Redundancy Check) code is stored in memory and is automatically set up whenever a setting is changed. The CRC code enables the EEPROM Self Test to verify the integrity of the settings area in EEPROM.

Error Message	Cause of Error
VAL OUT OF RANGE	The setting value is either greater than the upper limit or less than the lower limit.
SETT NUM INVALID	The setting number is not valid.
Y/N NOT ENTERED	A YES or NO response key was required, but the 1/Y or 3/N key was not pressed.
REQUEST INVALID	A key was pressed that is not valid for a sequence; for example: The ENT key is pressed to view events. The ↑ key is pressed during entry of a settings value.
CATEGORY INVALID	An incorrect category number was entered for an action or information item.
BKR NUM INVALID	A breaker number other than 1 or 2 was entered.
DATE INVALID	The day, month, or year entry is invalid.
TIME INVALID	The hour, minute, or seconds entry is invalid.
FAULT # INVALID	A fault number out of the range 1–5 was entered.
REMOTE LINK ACT	The remote communication link is in use for actions or settings; local settings or changes can't be done.
UMI KEY ERROR	The MMI received an invalid key code from the keyboard (hardware error).
ACT INVALID NOW	The current action is invalid because the setting's CRC code is in error.

Table 8–23. MMI error messages.

8–2 ASCII Interface

The pin-to-pin connections for the cable connecting the ASCII port to plug PL2 on the back of the DLP3 are shown in Figure 8–2. 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 setting COMMPORT affects both the baud rate of the RS232 port (plug PL1) and the ASCII port PL2.

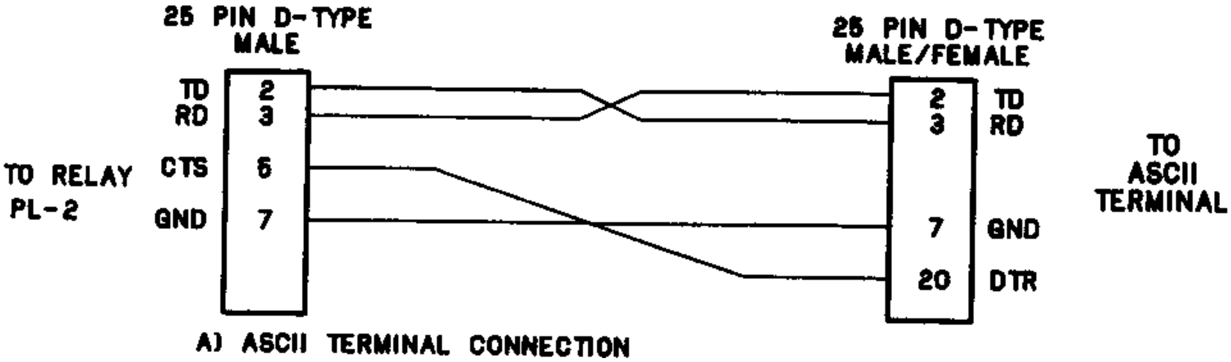

Figure 8–2. Pin connections for cable connecting ASCII Port to DLP3.

Recommended Remote Communications Package

The following programs have been tested and known to support the ASCII interface on the DLP3. Note that most any communications package that emulates a TTY type terminal should communicate successfully..

Description	Vendor
Procomm Plus	Datastorm
Windows Terminal Program	Microsoft

Table 8–24. Recommended terminal emulation programs.

8–3 Remote Communication Interface

Hardware Jumpers

There are jumpers J1, J2, and J3, located on the Processor board (see *Chapter 3 – Hardware Description*) that disable the Remote Manual Trip, the Remote Manual Close, the Remote Change DLP3 Settings, the Remote Disable Outputs, and the Remote Enable Outputs functions. Removing these jumpers will enable the functions.

NOTE: Jumpers J1, J2, and J3, are shipped from the factory in the closed position which disables the functions in Table 8–25.

The proper sequence for removing these jumpers is as follows:

1. Remove the front plastic bezel by unscrewing the four thumbscrews. Note, the thumbscrews are retained to the front bezel.
2. Turn the power switch off on the front panel.
3. Remove DC power from the DLP1, and remove all voltage inputs from the terminals on the rear panel of the unit.

WARNING: Completely power down the relay by disconnecting the control DC power and by removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous high voltages may be present inside the unit even if the power switch is OFF.

4. Remove the four 1/4” hex nuts at the four corners of the front panel. Gently pull the front panel away from the unit to expose the cable connections to the front panel.
5. Disconnect the power switch cable from the Output board and the ribbon cable from the Processor board.

6. Remove the two ribbon cables and power cables from the front of the PC boards.
7. Remove the two PC board retainers by unscrewing the two phillips head screws that hold each in place.
8. Remove the Processor board, located in the middle card guides, and lay on a antistatic surface component side up.
9. The jumpers J1, J2, and J3, defined in Table 8–25, are located near the left front of the board. Figure 3-14 indicates the location of the jumpers on the board. Remove the jumpers to enable the desired functions, and reinsert the Processor Board.

Jumper	Function
J1	Manual Trip and Manual Close
J2	Change DLP Settings, Disable Outputs, and Enable Outputs
J3	Spare (not used)

Table 8–25. Hardware jumper descriptions.

10. Reinstall the PC board retainers.
11. Reinstall the power cable and the two ribbon cables on the PC boards.
12. Reconnect the front panel power switch cable to the Output Board and the ribbon cable to the Processor Board. Install the front panel with the four 1/4" hex standoffs.
13. Restore dc power to the DLP3.
14. Turn on the front panel power switch.
15. Reinstall the plastic cover with the four thumbscrews.

Modem Connections and Settings

When establishing communication between the DLP3 and a remote PC, Two modems connected by a phone line are required to establish a connection between the DLP3 and a remote PC. One modem is located at the DLP3 and the other modem at the PC. The pin connections for the cable that connects the modem with either the DLP3 or the PC is shown in Figure 8–3. Both modems must be "Hayes-compatible," which means that they 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 logging into and communicating with the DLP3 using DLP-LINK software.*

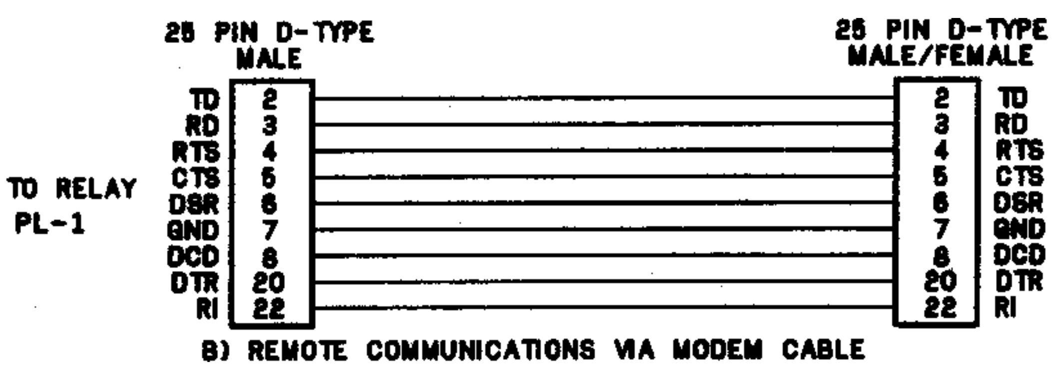

Figure 8–3. Pin connections for cables connecting the modem to the DLP3 and to the PC.

The required configuration settings are presented as changes to the factory-default configuration settings for a Hayes V-Series 2400 SmartModem. The default settings are listed in Table 8–26.

B1	Y0	&S0	S12=50
E1	&C0	&T4	S18=0
L2	&D0	&X0	S25=5
M1	&G0	S0=0	S26=1
N1	&J0	S6=2	S36=1
P	&K3	S7=30	S37=0
Q0	&L0	S8=2	S38=20
V1	&P0	S9=6	
W0	&Q5	S10=14	
X4	&R0	S11=95	

Table 8–26. Modem configuration settings required for DLP3 communications.

Other "Hayes-compatible" modems may implement a subset of the full Hayes command set. *It is the responsibility of the customer to determine the exact commands accepted by a particular modem.* The proper syntax for entering the Hayes-compatible commands (sometimes referred to as the "AT" command set) is not described here. Refer to the manual of your modem for an explanation of this syntax.

PC Modem

The PC modem must be configured for "intelligent" (command recognition enabled) operation. For the Hayes V-Series 2400 SmartModem, this setting is made with an internal jumper. The default settings listed in Table 8–26 are valid for DLP-LINK. The configuration settings critical to the operation of DLP-LINK are sent to the modem from DLP-LINK:

+++

(delay 2 seconds)

ATE0L0Q0S7=60V0X4Y0

These commands are explained in Table 8–27.

Command	Meaning
+++	Set modem to command mode
AT	Modem attention command
E0	disable command state echo
L0	Low speaker volume (desirable, not required)
Q0	Modem returns result codes
V0	Result codes returned in numeric form
X4	Enables result code features
Y0	Disable long-space disconnect
S7=60	Modem hangs up if no connection within 60 sec.

Table 8–27. Explanation of command sequence sent by DLP-LINK to the modem.

The S7=60 command is present starting with version 1.05 of DLP-LINK. Earlier versions of DLP-LINK do not send this command, leaving the time out at the default value, which is typically 30 seconds.

If any of the above commands are not recognized by the modem, then the modem will not operate properly. In addition to the required configuration settings listed in Table 8–26, it is suggested that the following two settings also be made:

&D3 – the modem resets on the ON-to-OFF transition of DTR (Data Terminal Ready).

&C1 – DCD (Data Carrier Detect) tracks the received carrier signal.

The modem will operate properly without these two settings, but it will not hang up if the appropriate handshaking signal is lost.

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 (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.

DLP3 Modem

The DLP3 modem must be configured for "dumb" (command recognition disabled) operation. On the Hayes V-Series 2400 SmartModem, this setting is made with an internal jumper. Since the DLP3 sends no configuration commands to its modem, the required configuration settings must be made before 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 with switch settings via switches or by saving the settings in nonvolatile memory.

The required configuration settings are listed in Table 8–28.

Command	Description
E0	Disable command state echo
L0	Low speaker volume (desirable, not required)
Q1	Disable result code display
&C1	DCD (Data Carrier Detect) tracks the received carrier signal
&D3	Modem resets on the ON-OFF transition of DTR (Data Terminal Ready)
&Q0	Asynchronous mode
S0=1	Enable auto-answer

Table 8–28. Configuration settings for the modem connected to the DLP3.

If any of the settings in Table 8–28 cannot be implemented, the modem may not answer, the DLP3 may not connect properly, or you may not be able to log into the DLP3.

With a Hayes V-Series 2400 SmartModem or equivalent, the DLP3 modem performs 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 better to use identical modems at each end.

Note that auto-answering is controlled by register S0:

- S0=0 – disables auto-answer.
- S0=1 – the DLP3 modem answers incoming calls after one ring.

S0 can be set for any value between 1 and 255, if it is desirable to delay modem answering. Note that 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 (answer after 12 rings), the PC modem may time out and hang up before the DLP3 modem can answer. S0=12 corresponds approximately to the 60 second delay (S7=60) at the PC modem; however, you should verify the number of rings that correspond to 60 seconds for a particular application.

Table 8–29 lists the modem command set required to communicate to the DLP3 from a remote PC.

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)

Table 8–29. Modem commands required for communication between the DLP3 and a remote PC.

Connection to G-NET (optional)

The G-NET host computer provides a complete communication package to send and retrieve information automatically from the DLP3. The pin-to-pin connections to the G-NET host are shown in Figure 8–4. Refer to the G-NET Instructions (GEK–100642) for complete information on G-NET Host Computer cable connections and operation.

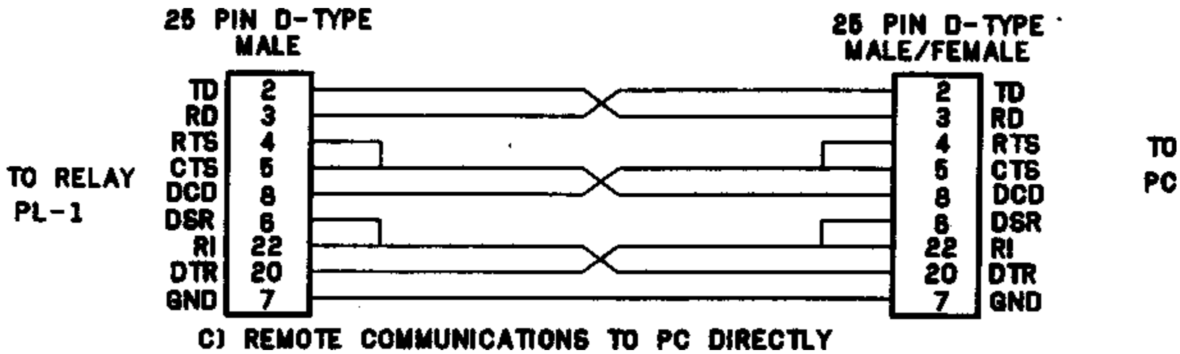

Figure 8–4. Pin connections for the cable connecting the DLP3 to the G-NET host.

Null-Modem Connections

A PC can be connected to a DLP3 without the intervening modems and phone line with a special null-modem cable. The required pin-to-pin connections for this null-modem cable are shown in Figure 8–5. The pin-to-pin connections for a null-modem cable to the Comm connector on the MMI are shown in Figure 8–6. Neither null modem cable should be longer than 50 feet.

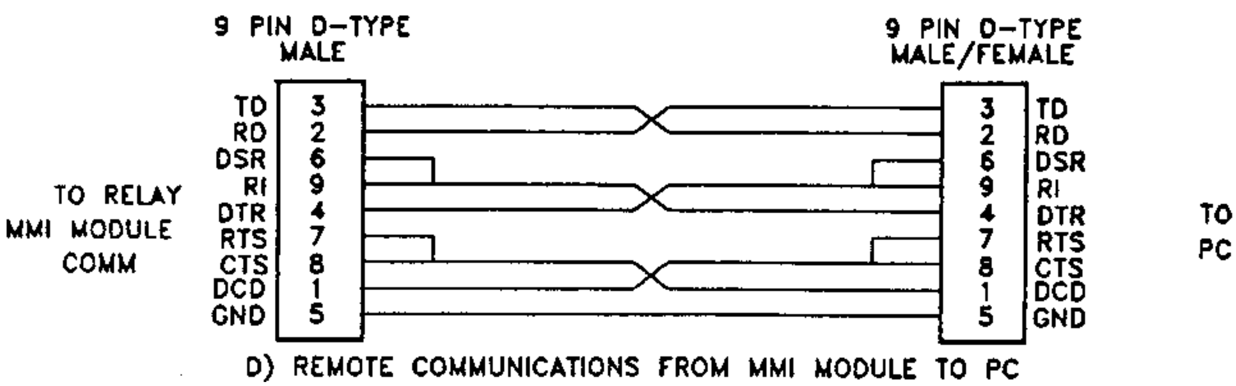

Figure 8–5. Pin connections for a null-modem cable connecting relay PL–1 to a PC.

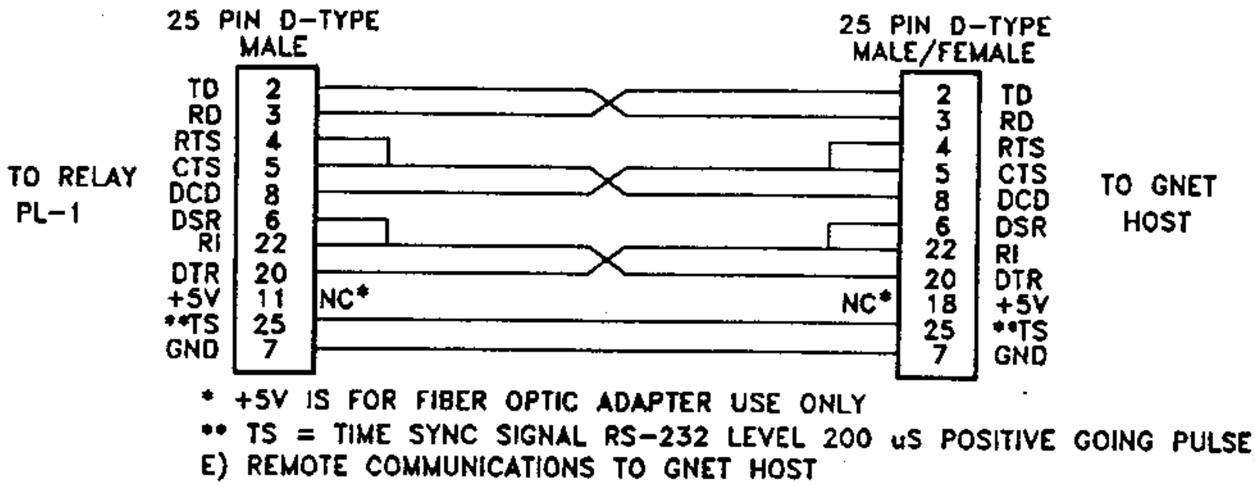

Figure 8–6. Pin connections for a null-modem cable connecting the MMI Comm connector to a PC.

8–4 Recloser Manual Lockout

On units that are equiped with the recloser manual lockout option, a toggle switch for this fuction will be found on the left side of the keypad on the front panel labeled MLO. When this switch is ON, the recloser is in manual lockout mode. When the switch is OFF, the recloser operates according to the 52b signal received from the breaker.

8–5 DLP3 Settings

Tables 8–30 to 8–53 list the settings available on the DLP3 for each category. Table 8–54 lists the input condition codes required for a number of settings categories.

Setting #	Description	Abbreviation	Units	Range	Format
0101	Select Zone 1 Ground	SELZ1G	N/A	YES/NO	YES/NO
0102	Select Zone 1 Phase	SELZ1P	N/A	YES/NO	YES/NO
0103	Phase Reach (M1)	Z1R	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0104	Ground Reach (M1G)	Z1GR	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0105	Select Zone 1 Ground Unit – Mho – Reactance	SELZ1U MHO REACT	N/A	0, 1 0 1	x
0106	Reach Setting of Mho Unit Supv. Reactance Unit	Z1SU	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0107	Zero-Sequence Current Compensation (K0)	Z1K0	N/A	1.0–7.0	x.x
0108	Zone 1 Extension Reset	Z1ERST	sec	0.0–60.0	xx.x

Table 8–30. Settings available in Z1DIST (Zone 1 Distance) category.

Setting #	Description	Abbreviation	Units	Range	Format
0201	Select Zone 2 Ground	SELZ2G	N/A	YES/NO	YES/NO
0202	Select Zone 2 Phase	SELZ2P	N/A	YES/NO	YES/NO
0203	Phase Reach (MT)	Z2R	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0204	Ground Reach (MTG)	Z2GR	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0205	Select Zone 2 Ground Unit – Mho – Ground Directional OC – Mho & GDOC	SELZ2U MHO GDOC MHOGDOC	N/A	0, 1, 2 0 1 2	x
0206	Select Zone 2 Timers	SELZ2T	N/A	YES/NO	YES/NO
0207	Phase Timer Setting	PUTL2P	sec	0.10–3.00	x.xx
0208	Ground Timer Setting	PUTL2G	sec	0.10–3.00	x.xx
0209	Phase Characteristic Angle	Z2PANG	deg	90, 105, 120	xxx
0210	Ground Characteristic Angle	Z2GANG	deg	90, 105, 120	xxx

Table 8–31. Settings available in Z2DIST (Zone 2 Distance / GDOC) category.

Setting #	Description	Abbreviation	Units	Range	Format
0301	Select Zone 3 Ground	SELZ3G	N/A	YES/NO	YES/NO
0302	Select Zone 3 Phase	SELZ3P	N/A	YES/NO	YES/NO
0303	Phase Reach (M3)	Z3R	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0204	Ground Reach (M3G)	Z3GR	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0305	Phase Timer Setting	PUTL3P	sec	0.10–10.00	xx.xx
0306	Ground Timer Setting	PUTL3G	sec	0.10–10.00	xx.xx
0307	Phase Characteristic Angle	Z3PANG	deg	90, 105, 120	xxx
0308	Ground Characteristic Angle	Z3GANG	deg	90, 105, 120	xxx

Table 8–32. Settings available in Z3DIST (Zone 3 Distance) category.

Setting #	Description	Abbreviation	Units	Range	Format
0401	Select Zone 4 Ground	SELZ4G	N/A	YES/NO	YES/NO
0402	Select Zone 4 Phase	SELZ4P	N/A	YES/NO	YES/NO
0403	Phase Reach (M4)	Z4R	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0404	Ground Reach (M4G)	Z4GR	ohms	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
0405	Phase Offset Reach	Z4OR	N/A	0.00–0.40	x.xx
0406	Select Zone 4 Timer	SELZ4T	N/A	YES/NO	YES/NO
0407	Phase Timer Setting	PUTL4P	sec	0.10–10.00	xx.xx
0408	Ground Timer Setting	PUTL4G	sec	0.10–10.00	xx.xx
0409	Phase Characteristic Angle	Z4PANG	deg	80, 90, 95, 105, 110, 120	xxx
0410	Ground Characteristic Angle	Z4GANG	deg	80, 90, 95, 105, 110, 120	xxx
0411	Select Direction – Forward – Reverse	SELZ4D	N/A	0,1 0 1	x

Table 8–33. Settings available in Z4DIST (Zone 4 Distance) category.

Setting #	Description	Abbreviation	Units	Range	Format
0501	Ground Pilot Trip OC (IPT)	PUIPT	amp	0.50–5.00 for 5 A 0.10–1.00 for 1 A	xx.xx
0502	Ground Pilot Block OC (IPB)	PUIPB	amp	0.25–3.75 for 5 A 0.05–0.75 for 1 A	x.xx
0503	Trip Supervision OC Setting (IT)	PUIT	amp	0.20–4.00 for 5 A 0.04–0.80 for 1 A	x.xx
0504	Block Supervision OC Setting (IB)	PUIB	amp	0.20–4.00 for 5 A 0.04–0.80 for 1 A	x.xx

Table 8–34. Settings available in CURSUPVIS (Overcurrent Pilot / Supervision) category.

Setting #	Description	Abbreviation	Units	Range	Format
0601	Select Phase Instantaneous OC PH4	SELPH4	N/A	YES/NO	YES/NO
0602	Phase Instantaneous OC Setting	PUPH4	amp	2.0–100.0 for 5 A 0.4–20.0 for 1 A	xxx.x
0603	Select Ground Inst. OC IDT	SELIDT	N/A	YES/NO	YES/NO
0604	Directional Control of IDT	SELDIDT	N/A	YES/NO	YES/NO
0605	Ground Instantaneous OC Setting	PUIDT	amp	0.5–80.0 for 5 A 0.1–16.0 for 1 A	xx.x
0606	Select Ground Time OC (TOC)	SELTOC	N/A	YES/NO	YES/NO
0607	Directional Control of TOC	SELDTOC	N/A	YES/NO	YES/NO
0608	Ground Time OC Setting	PUTOC	amp	0.20–15.0 for 5 A 0.04–3.00 for 1 A	xx.xx
0609	Ground Time OC Time Dial	TDTOC	N/A	0.5–10.0	xx.x
0610	TOC Pickup Time	PUTTM	sec	0.5–30.0	xx.x
0611	Select TOC Curve – Inverse – Very Inverse – Extremely Inverse – Custom Curve – Definite Time	SELCURV INV V-INV E-INV CUSTOM DEFT	N/A	0, 1, 2, 3, 4 0 1 2 3 4	x
0612	KD Constant	KDCONST	N/A	0.0, 0.3	x.x

Table 8–35. Settings available in OVERCUR (Overcurrent Backup) category.

Setting #	Description	Abbreviation	Units	Range	Format
0701	All of the Above	SELALL	N/A	YES/NO	YES/NO
0702	Out-of-Step Block	RBOSB	N/A	YES/NO	YES/NO
0703	All Zone 3 Phase Units	RB3PH	N/A	YES/NO	YES/NO
0704	Ground Time OC (TOC)	RBTOC	N/A	YES/NO	YES/NO
0705	Zone 2 Timers	RBZ2T	N/A	YES/NO	YES/NO
0706	Zone 3 Timers	RBZ3T	N/A	YES/NO	YES/NO
0707	Zone 4 Timers	RBZ4T	N/A	YES/NO	YES/NO
0708	All Zone 1 Phase Units	RBZ1PH	N/A	YES/NO	YES/NO
0709	All Zone 2 Phase Units	RBZ2PH	N/A	YES/NO	YES/NO
0710	Configurable Trip Bus	RBCTB	N/A	YES/NO	YES/NO

Table 8–36. Settings available in BLKRECLOS (Reclosing) category.

Setting #	Description	Abbreviation	Units	Range	Format
0801	Select Phase Trip Unit to coord with – Zone 2 – Zone 3 – Zone 4	SELALL ZONE2 ZONE3 ZONE4	N/A	0, 1, 2 0 1 2	x
0802	Characteristic Angle	MOBANG	deg	30–130	xxx
0803	Select Block Trip Actions – Block all tripping – Block: Channel and distancetrip – Block: Phase distance – Block none	SELOSB BLKALL BLKDIST BLKPHAS BLKNONE	N/A	0 – 3 0 1 2 3	x
0804	Select Zone 1 Block	OSBBLK1	N/A	YES/NO	YES/NO
0805	Select Zone 2 Block	OSBBLK2	N/A	YES/NO	YES/NO
0806	Select Zone 3 Block	OSBBLK3	N/A	YES/NO	YES/NO
0807	Select Zone 4 Block	OSBBLK4	N/A	YES/NO	YES/NO

Table 8–37. Settings available in OUTOFSTEP (Out-of-Step Blocking) category.

Setting #	Description	Abbreviation	Units	Range	Format
0901	Select Line Pickup	SELLPU	N/A	YES/NO	YES/NO
0902	Select Timer Bypass	SELTBP	N/A	YES/NO	YES/NO
0903	Positive Sequencve OC (I1)	PUI1	amp	1.0–15.0 for 5 A 0.2–3.0 for 1 A	xx.x

Table 8–38. Settings available in LINEPU (Line Pickup) category.

Setting #	Description	Abbreviation	Units	Range	Format
1001	Select Remote Open Detect	SELROD	N/A	YES/NO	YES/NO
1002	Time Delay Setting (TL20)	PUTL20	msec	10–100	xxx
1003	Fuse Failure Block	SELFFB	N/A	YES/NO	YES/NO

Table 8–39. Settings available in REMOTEOPEN (Remote Open Detector) category.

Setting #	Description	Abbreviation	Units	Range	Format
1101	Select Line Overload	SELOVL	N/A	YES/NO	YES/NO
1102	Level 1 OC Setting	PULV1	amp	5.0–10.0 for 5 A 1.0–4.0 for 1 A	xx.x
1103	Level 2 OC Setting	PULV2	amp	10.0–40.0 for 5 A 2.0–8.0 for 1 A	xx.x
1104	Level 1 Time Delay (TL31)	PUTL31	sec	10–990	xxx
1105	Level 2 Time Delay (TL32)	PUTL32	sec	10–99	xx

Table 8–40. Settings available in LINEOVRLD (Line Overload) category.

Setting #	Description	Abbreviation	Units	Range	Format
1201	Select Scheme – Step Distance – Permissive Overreaching – Permissive Underreaching – Hybrid – Blocking 1 – Zone 1 Extension – Blocking 2 – Blocking 3	SELSCM STEPDST POTT PUTT HYBRID BLK1 ZNE1EXT BLK2 BLK3	N/A	0, 1, 2, 3, 4 0 1 2 3 4 5 6 7	x
1202	Number of Receivers	NUMRCVR	N/A	0, 1, 2	x
1203	Trip Mode	TRPMODE	N/A	x	x

Table 8–41. Settings available in SCHEMESEL (Scheme Selection) category.

Setting #	Description	Abbreviation	Units	Range	Format
1301	Trip Integrator PU (TL1)	PUTL1	msec	1–50	xx
1302	b Contact Coordination Pickup (TL5) Breaker 1	PUTL5	msec	0–200	xxx
1303	b Contact Coordination Dropout (TL5) Breaker 1	DOTL5	msec	0–200	xxx
1304	b Contact Coordination Pickup (TL6) Breaker 2	PUTL6	msec	0–200	xxx
1305	b Contact Coordination Dropout (TL6) Breaker 2	DOTL6	msec	0–200	xxx
1306	POTT/PUTT Coordination Pickup (TL4)	PUTL4	msec	0–50	xx
1307	b Contact Coordination Dropout (TL4)	DOTL4	msec	0–50	xx
1308	Weak Infeed Trip Pickup (TL16)	PUTL16	msec	8–99	xx
1309	Configurable Pickup Time	PUTLCFG	msec	0–100	xxx
1310	Configurable Dropout Time	DOTLCFG	msec	0–100	xxx

Table 8–42. Settings available in SCHEMETIM (Scheme Logic Timers) category.

Setting #	Description	Abbreviation	Units	Range	Format
1401	Positive Sequence Angle of Maximum Reach (ZR1)	POSANG	deg	45–90	xx
1402	Zero Sequence Angle of Maximum Reach (ZR0)	ZERANG	deg	45–90	xx
1403	Positive Sequence Impedance	ZP	ohm	0.01–50 for 5 A 0.01–250 for 1 A	xxx.xx
1404	Zero Sequence Current Compensation for Z2, Z3, Z4 Ground Distance (K0)	K0	N/A	1.0–7.0	x.x
1405	Line Length	LINELEN	mile km	0.0–200.0 0.0–322.0	xxx.x

Table 8–43. Settings available in LINEQTY (Line Quantities) category.

Setting #	Description	Abbreviation	Units	Range	Format
1501	Unit ID Number	UNITID	N/A	0–9999	xxxx
1502	System Frequency	SYSFREQ	Hz	50, 60	xx
1503	Number of Breakers	NUMBKRS	N/A	1, 2	x
1504	Trip Circuit Continuity – None – Breaker 1 – Breaker 2 – Both Breakers	TRIPCIRC NONE BKR1 BKR2 BOTH	N/A	0, 1, 2, 3 0 1 2 3	x
1505	Primary/Secondary Units for Report – Primary – Secondary	SELPRIM CVTPRIM PT SEC CVTSEC PTSEC	N/A	0, 1, 2, 3 0 1 2 3	x
1506	CT Ratio	CTRATIO	N/A	1–5000	xxxx
1507	PT Ratio	PTRATIO	N/A	1–7000	xxxx
1508	Units of Distance – Miles – Kilometers	DISTUNIT MILES KM	N/A	0, 1 0 1	x
1509	Communication Configuration – 300 baud (xx=03) – 1200 baud (xx=12) – 2400 baud (xx=24) – 4800 baud (xx=48) – 9600 baud (xx=96) – No Parity (y=0) – Odd Parity (y=1) – Even Parity (y=2) – 1 Stop Bit (z=1), – 2 Stop Bits (z=2)	COMMPORT	N/A	 03yz 12yz 24yz 48yz 96yz xx0z xx1z xx2z xxy1, xxz2	xxyx
1510	Phase Designation – A-B-C – A-C-B	PHASDESG A-B-C A-C-B	N/A	0, 1 0 1	x
1511	Select Time Synch – Internal – IRIG-B – G-NET	SELTSYNC NONE IRIG-B G-NET	N/A	0, 1, 2 0 1 2	x
1512	Select Number of Faults Stored	NUMFLTS	N/A	2, 4, 7, 14	xx
1513	Select Number of Prefault Cycles Stored for Faults	PREFLT	N/A	1–8	x
1514	Select Trigger to Store Oscillography Data – Not Used – Fault Detector – Any Zone 2 – Any Zone 3 – Any Zone 4 – Out of Step – V1 Detector	OSCTRG UNUSED FLTDET ANYZ2 ANYZ3 ANYZ4 OUTSTP V1DET	N/A	0, 1, 2, 3, 4, 5 ,6 0 1 2 3 4 5 6	X
1515	Unbalance Detection Alarm	UNBALALM	N/A	YES/NO	YES/NO

Table 8–44. Settings available in CONFIG (Configuration) category.

Setting #	Description	Abbreviation	Units	Range	Format
1601	Fault Location Lock	DAFLTLCK	sec	0, 1.0–99.9	xx.x
1602	Fault Location Reset	DAFLTRST	min	0–999	xxx

Table 8–45. Settings available in SCADADTA (SCADA DTA Interface) category.

Setting #	Description	Abbreviation	Units	Range	Format
1701	Configurable Input Mode	CONCCI	N/A	0–8	x
1702	Settings Group	SETGRP	N/A	0–4	x

Table 8–46. Settings available in CNFGINPUTS (Configurable Inputs) category.

Setting #	Description	Abbreviation	Units	Range	Format
1801	Contact Output – Breaker 1 Close – OR – AND	CONOUT1 DEFAULT ORGATE ANDGATE	N/A	0, 1, 2 0 1 2	x
1802	Configurable Output 1, Input 1	CO1IN1	N/A	0–64, 101–164	xxx
1803	Configurable Output 1, Input 2	CO1IN2	N/A	0–64, 101–164	xxx
1804	Configurable Output 1, Input 3	CO1IN3	N/A	0–64, 101–164	xxx
1805	Configurable Output 1, Input 4	CO1IN4	N/A	0–64, 101–164	xxx
1806	Configurable Output 1, Input 5	CO1IN5	N/A	0–64, 101–164	xxx
1807	Configurable Output 1, Input 6	CO1IN6	N/A	0–64, 101–164	xxx
1808	Configurable Output 1, Input 7	CO1IN7	N/A	0–64, 101–164	xxx
1809	Configurable Output 1, Input 8	CO1IN8	N/A	0–64, 101–164	xxx

Table 8–47. Settings available in BKR1CLSOUT (Breaker 1 Close / Configurable Output) category (see Table 8–54 for a description of the input numbers).

Setting #	Description	Abbreviation	Units	Range	Format
1901	Contact Output – Breaker 1 Close – OR – AND	CONOUT2 DEFAULT ORGATE ANDGATE	N/A	0, 1, 2 0 1 2	x
1902	Configurable Output 2, Input 1	CO2IN1	N/A	0–64, 101–164	xxx
1903	Configurable Output 2, Input 2	CO2IN2	N/A	0–64, 101–164	xxx
1904	Configurable Output 2, Input 3	CO2IN3	N/A	0–64, 101–164	xxx
1905	Configurable Output 2, Input 4	CO2IN4	N/A	0–64, 101–164	xxx
1906	Configurable Output 2, Input 5	CO2IN5	N/A	0–64, 101–164	xxx
1907	Configurable Output 2, Input 6	CO2IN6	N/A	0–64, 101–164	xxx
1908	Configurable Output 2, Input 7	CO2IN7	N/A	0–64, 101–164	xxx
1909	Configurable Output 2, Input 8	CO2IN8	N/A	0–64, 101–164	xxx

Table 8–48. Settings available in BKR2CLSOUT (Breaker 2 Close / Configurable Output) category (see Table 8–54 for a description of the input numbers).

Setting #	Description	Abbreviation	Units	Range	Format
2001	Contact Output – Reclose Cancel – OR – AND	CONOUT3 DEFAULT ORGATE ANDGATE	N/A	0, 1, 2 0 1 2	x
2002	Configurable Output 3, Input 1	CO3IN1	N/A	0–64, 101–164	xxx
2003	Configurable Output 3, Input 2	CO3IN2	N/A	0–64, 101–164	xxx
2004	Configurable Output 3, Input 3	CO3IN3	N/A	0–64, 101–164	xxx
2005	Configurable Output 3, Input 4	CO3IN4	N/A	0–64, 101–164	xxx
2006	Configurable Output 3, Input 5	CO3IN5	N/A	0–64, 101–164	xxx
2007	Configurable Output 3, Input 6	CO3IN6	N/A	0–64, 101–164	xxx
2008	Configurable Output 3, Input 7	CO3IN7	N/A	0–64, 101–164	xxx
2009	Configurable Output 3, Input 8	CO3IN8	N/A	0–64, 101–164	xxx

Table 8–49. Settings available in RCANCLOUT (Reclose Cancel / Configurable Output) category (see Table 8–54 for a description of the input numbers).

Setting #	Description	Abbreviation	Units	Range	Format
2101	Contact Output – Breaker 1 Close – OR – AND – OR with Configurable Trip Bus – AND w/ Configurable Trip Bus	CONOUT4 DEFAULT ORGATE ANDGATE ORCTB ANDCTB	N/A	0, 1, 2 0 1 2 3 4	x
2102	Configurable Output 4, Input 1	CO4IN1	N/A	0–64, 101–164	xxx
2103	Configurable Output 4, Input 2	CO4IN2	N/A	0–64, 101–164	xxx
2104	Configurable Output 4, Input 3	CO4IN3	N/A	0–64, 101–164	xxx
2105	Configurable Output 4, Input 4	CO4IN4	N/A	0–64, 101–164	xxx
2106	Configurable Output 4, Input 5	CO4IN5	N/A	0–64, 101–164	xxx
2107	Configurable Output 4, Input 6	CO4IN6	N/A	0–64, 101–164	xxx
2108	Configurable Output 4, Input 7	CO4IN7	N/A	0–64, 101–164	xxx
2109	Configurable Output 4, Input 8	CO4IN8	N/A	0–64, 101–164	xxx

Table 8–50. Settings available in LNOVLDOUT (Line Overload / Configurable Output) category (see Table 8–54 for description of input numbers).

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 milliseconds. Setting 1310 is not used.

Setting #	Description	Abbreviation	Units	Range	Format
2201	Contact Output – Breaker 1 Close – OR – AND	CONOUT5 DEFAULT ORGATE ANDGATE	N/A	0, 1, 2 0 1 2	x
2202	Configurable Output 5, Input 1	CO5IN1	N/A	0–64, 101–164	xxx
2203	Configurable Output 5, Input 2	CO5IN2	N/A	0–64, 101–164	xxx
2204	Configurable Output 5, Input 3	CO5IN3	N/A	0–64, 101–164	xxx
2205	Configurable Output 5, Input 4	CO5IN4	N/A	0–64, 101–164	xxx
2206	Configurable Output 5, Input 5	CO5IN5	N/A	0–64, 101–164	xxx
2207	Configurable Output 5, Input 6	CO5IN6	N/A	0–64, 101–164	xxx
2208	Configurable Output 5, Input 7	CO5IN7	N/A	0–64, 101–164	xxx
2209	Configurable Output 5, Input 8	CO5IN8	N/A	0–64, 101–164	xxx

Table 8–51. Settings available in NONCRITOUT (Noncritical Alarm / Configurable Output) category (see Table 8–54 for description of input numbers).

Setting #	Description	Abbreviation	Units	Range	Format
2301	Contact Output – Breaker 1 Close – OR – AND	CONOUT6 DEFAULT ORGATE ANDGATE	N/A	0, 1, 2 0 1 2	x
2302	Configurable Output 6, Input 1	CO6IN1	N/A	0–64, 101–164	xxx
2303	Configurable Output 6, Input 2	CO6IN2	N/A	0–64, 101–164	xxx
2304	Configurable Output 6, Input 3	CO6IN3	N/A	0–64, 101–164	xxx
2305	Configurable Output 6, Input 4	CO6IN4	N/A	0–64, 101–164	xxx
2306	Configurable Output 6, Input 5	CO6IN5	N/A	0–64, 101–164	xxx
2307	Configurable Output 6, Input 6	CO6IN6	N/A	0–64, 101–164	xxx
2308	Configurable Output 6, Input 7	CO6IN7	N/A	0–64, 101–164	xxx
2309	Configurable Output 6, Input 8	CO6IN8	N/A	0–64, 101–164	xxx

Table 8–52. Settings available in RINITOUT (Reclose Initiate / Configurable Output) category (see Table 8–54 for description of input numbers).

Setting #	Description	Abbreviation	Units	Range	Format
2401	Recloser Scheme – No Internal Recloser – Relcoser Off – One Reclose – Two Recloses	SELRCLR NONE OFF 1-XPOLE 2-TPOLE	N/A	0, 1, 2, 3 0 1 2 3	x
2402	Reclose Delay1	XPRDLY1	sec	0.01–2.55	x.xx
2403					
2404	Reclose Delay 2	RDLY2	sec	1–255	xxx
2405	Hold Mode	HOLD	N/A	YES/NO	YES/NO
2406	Hold Time Delay	HLODDLY	sec	1–255	xxx
2407	Dwell Time Delay	DWELLTM	sec	0.1–2.0	x.x
2408	Reset Time Delay	RSTDLY	sec	1–255	xxx

Table 8–53. Settings available in RECLOSER (Recloser) category.

Input Condition	Relay Test Number	Config. Input No.	Condition Desc. Code
ZONE 1 AG	2	1	Z1AG
ZONE 1 BG	3	2	Z1BG
ZONE 1 CG	4	3	Z1CG
ZONE 2 AG	5	4	Z2AG
ZONE 2 BG	6	5	Z2BG
ZONE 2 CG	7	6	Z2CG
ZONE 3 AG	8	7	Z3AG
ZONE 3 BG	9	8	Z3BG
ZONE 3 CG	10	9	Z3CG
ZONE 4 AG	11	10	Z4AG
ZONE 4 BG	12	11	Z4BG
ZONE 4 CG	13	12	Z4CG
ANY Z1 GRND	14	13	Z1GRN
Z2 GRND TIMER	15	14	Z2GTMR
Z3 GRND TIMER	16	15	Z3GTMR
Z4 GRND TIMER	17	16	Z4GTMR
ZONE 1 AB	18	17	Z1AB
ZONE 1 BC	19	18	Z1BC
ZONE 1 CA	20	19	Z1CA
ZONE 2 AB	21	20	Z2AB
ZONE 2 BC	22	21	Z2BC
ZONE 2 CA	23	22	Z2CA
ZONE 3 AB	24	23	Z3AB
ZONE 3 BC	25	24	Z3BC
ZONE 3 CA	26	25	Z3CA
ZONE 4 AB	27	26	Z4AB
ZONE 4 BC	28	27	Z4BC
ZONE 4 CA	29	28	Z4CA
ANY Z1 PHASE	30	29	Z1PHS
Z2 PHASE TIMER	31	30	Z2PTMR
Z3 PHASE TIMER	32	31	Z3PTMR
Z4 PHASE TIMER	33	32	Z4PTMR
IT DETECTOR	34	33	ITDET
IB DETECTOR	35	34	IBDET
GRD DIR TRIP	36	35	GRDTRP
GRD DIR BLOCK	37	36	GRDBLK
FAULT DETECTOR	38	37	FLTDET
REM OP DETCT	39	38	REMOPN
OUT OF STEP	40	39	OUTSTP
V1 DETECTOR	41	40	V1DET
LINE OVERLOAD	42	41	LNOVLD
INST PHS OVRC	43	42	INPOVR
INST GRD OVRC	44	43	INGOVR
TIM DLY GD OC	45	44	TMGOVR
LINE PICKUP	46	45	LPCKUP
FUSE FAILURE		46	FUSEFL
GRND FORWARD		47	GRFWR
GRND REVERSE		48	GRRVR
RCLOSE CNCL		49	RECCAN
CNFG INPUT 1		50	CNFIN1
CNFG INPUT 2		51	CNFIN2
CNFG INPUT 3		52	CNFIN3
NON-CRIT ALM		53	NOCALM
ANY Z2 UNIT		54	ANYZ2
ANY Z3 UNIT		55	ANYZ3
ANY Z4 UNIT		56	ANY Z4
TRIP BUS/BFI		57	TRPBFI
MAN BRK CLS1		58	BKCLS1
MAN BRK CLS2		59	BKCLS2
RECLOSE INIT3		60	RECIN3
RECLOSE INIT1		61	RECIN1
BRKR RECLOSE		62	BKRCLS
EXT RCL INIT3		63	ERCIN3
EXT RCL INIT1		64	ERCIN1

Table 8–54. Input condition codes used in Tables 8–47 to 8–52.

9–1 DLP-LINK Software

Overview

A personal computer (PC) provides a remote man-machine interface to the DLP3 for operating personnel.

System Requirements

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 3$^1/_2$-inch floppy drive, EGA monitor, and one of the printers described below for plotting oscillography data.

Software

MSDOS (PCDOS) 3.1 or higher is required for the PC operating system.

Installation

View the file README.TXT for updated information and installation instructions for this program. This file is found on the 3$^1/_2$-inch floppy disk located at the end of this manual.

General Operation

Mouse/Keyboard Usage

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).

Main Horizontal Menu Bar

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. The hot key is the combination of the ALT key and the letter that is highlighted in the item description (blue).
- 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.

Pull-Down Menus

Pull-down menu items are selected 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.

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.

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.

Entering Text and 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.

Program Operation

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.

Relay Functions

Relay functions includes the menu items listed in Table 9–1 with their associated hot key combinations.

Menu Item	Hot Key
Login	ALT-L
lOgout	ALT-O
Change access level	ALT-C
Hang up phone	ALT-H
Actions...	ALT-A
Information...	ALT-I
Settings...	ALT-S
TOC...	ALT-T

Table 9–1. Menu items under Relay Functions, with associated hot keys.

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 8 – 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.

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.

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.

Table 9–2 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

Table 9–2. Password level required for DLP-LINK operations.

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.

Actions

The Actions... menu item displays the additional choices listed in Table 9–3.

Action Item	Hot Key
change Password	ALT-P
Manual trip	ALT-M
manual Close	ALT-C
Enable outputs	ALT-E
Disable outputs	ALT-D
change Time and date	ALT-T
change Station/line ID	ALT-S
cAlculate CRC	ALT-A
Relay test mode	ALT-R
digital Output test	ALT-O
chaNnel test	ALT-N

9–3. Menu items available with Actions under Relay Functions.

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 *8* 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 8* 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 8* 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* for a description of the jumpers). 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 *Chapter 6 – 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 th microproccessor board must be removed. See Chapter 8 for information on removeing 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.

Information

The Information... menu item displays the additional choices listed in Table 9–4.

Information Item	Hot Key
request Present values	ALT-P
request fault report Identification	ALT-I
request Fault report	ALT-F
request Events	ALT-E
request Oscillography data	ALT-O
request dlp Status	ALT-S
request dlp Model	ALT-M
request Line/station id	ALT-L
request MMI pAssword	ALT-A

Table 9–4. Menu items available with Information under Relay Functions.

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 Information 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 *Chapter 6 – 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 8 – Interface*. When finished viewing the passwords, select OK.

Settings

The Settings... menu displays the additional choices listed in Table 9–5.

Settings Item	Hot Key
Upload dlp settings	ALT-U
Print dlp settings	ALT-P
view/change Category of settings	ALT-C
view/change Individual settings	ALT-I
Download changed settings to dlp	ALT-D
End settings change	ALT-E
Save settings to file	ALT-S

Table 9–5. Menu items available with Settings under Relay Functions.

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 valued 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 automatically 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.

TOC

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 DLPTOC 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.

Local Functions

Local functions includes the menu items listed in Table 9–6 with their associated hot key combinations.

Menu Item	Hot Key
Settings...	ALT-S
Graph oscillography data	ALT-G
Custom TOC curves	ALT-C
go to DOS	ALT-D

Table 9–6. Menu items available under Local Functions, with their associated hot keys.

Settings

The Settings... menu under Local functions displays the additional choices listed in Table 9–7.

Settings Items	Hot Keys
Load settings from file	ALT-L
Print local settings	ALT-P
view/change Category of local settings	ALT-C
view/change Individual local setting	ALT-I
Save local settings to file	ALT-S
Model/version number	ALT-M
station/Line id	ALT-L
Download local settings to dlp	ALT-D
End setting changes	ALT-E

Table 9–7. Menu items available with Settings under Local Functions.

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 subdirectories. 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 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 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 *Chapter 8* 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.

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.

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 DLPTOC.exe program. The path is entered via the Setup menu, and is stored for use here.

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.

Setup

The Setup menu has the items listed in Table 9–8 with their associated hot keys.

Menu Item	Hot Key
Communication port number	ALT-C
Dial Type	ALT-D
Modem connection time	ALT-M
Relay parameters	ALT-R
Add relay to list	ALT-A
dElete relay from list	ALT-E
Set path for DL-DATA	ALT-L
Set path for TOC curves	ALT-T
Memory available	N/A

Table 9–8. Items available under the Setup menu, with their associated hot keys.

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.

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.

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.

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, <u>and should only be filled in if DLP-LINK is using a modem for the unit being described</u>.

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.

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.

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.

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.

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.

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.

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.

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.

9–2 DL-DATA Software (Optional)

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:

- The fault report (in the format that is displayed on the screen in the DLP-LINK program).
- The events associated with the fault report (again, in the format that is displayed on the screen by DLP-LINK).
- The title columns for a spread sheet.
- 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 Table 9–9.

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)

Table 9–9. Data contained in flags in oscillography data file.

System Requirements

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 3 1/2-inch floppy drive.
- EGA monitor
- A printer for plotting oscillography data.

Software

MSDOS (PCDOS) 3.1 or above is required as the PC operating system.

Installation

Copy all files from the distribution diskette to your hard drive using the DOS copy command.

General Operation

Mouse and Keyboard Usage

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).

Main Horizontal Menu Bars

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. 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).
3. When an item on the menu has been selected, the → and ← keys can be used to move to adjacent menu items.

Pull-Down Menus

Pull-down menus can be selected in the following ways:

1. Position the mouse cursor on top of the menu item and click the left button.
2. 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.
3. 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.
4. Use the ↑ and ↓ keys to highlight the desired menu item, then press ENTER.

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.

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.

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).

Entering Text and 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.

Plots of Currents or Voltages and Flags

Each window containing a plot of the currents and voltages and flags has several characteristics.

The prefault 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 Figures 9–1 through 9–3.)

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.

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.

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.

Program Operation

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.

File Menu

The file menu has the items and hot keys listed in Table 9–10.

Menu Item	Hot Key
Open	ALT-O
Create pcx file	ALT-C
Print screen	ALT-P
Information	ALT-I

Table 9–10. Menu items under the File menu, with associated hot keys.

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.

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.

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.

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.

Graphs Menu

The Graphs menu has the items and hot keys listed in Table 9–11.

Menu Item	Hot Key
All currents/voltages	ALT-A
Select currents/voltages	ALT-S
select Reference current/voltage	ALT-R
sElect groups for all flags display	ALT-E
all Flags	ALT-F
flag Group	ALT-G
Custom (flag) group	ALT-C

Table 9–11. Menu items under the Graphs menu, with associated hot keys.

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.

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.

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.

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.

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.

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.

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.

Reports Menu

The Reports menu has the items and hot keys listed in Table 9–12.

Menu Item	Hot Keys
Fault report	ALT-F
Events	ALT-E
Settings	ALT-S

Table 9–12. Menu items under the Reports menu, with associated hot keys.

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.

Fault Report

Select this item to display the fault report associated with the oscillography data (the report is generated at the DLP3).

Events

Select this item to display the events associated with the oscillography data (the events are generated at the DLP3).

Settings

Select this item to display the settings from the relay at the time of the fault. The settings can only be viewed.

Setup Menu

The Setup menu has the items and hot keys listed in Table 9–13.

Menu Item	Hot Keys
Line frequency	ALT-L
Flag names	ALT-F
Colors	ALT-C
Default colors	ALT-D
Printer grey shades	ALT-P

Table 9–13. Menu items under the Setup menu, with associated hot keys.

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.

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.

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.

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.

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.

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.

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.

9–3 DLPTEST Software

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 DLPTEST<ENTER>. View the file README.TXT for updated information and installation instructions for this program. These files are found on the 3$^1/_2$-inch floppy disk provided with this book.

9–4 DLPSET Software

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 3$^1/_2$-inch floppy disk provided with this book.

9–5 DLP-ASCII Interface

Overview

A personal computer (PC) or any ASCII terminal provides a remote man-machine interface to the DLP3 for operating personnel.

System Requirements

Hardware

The minimum hardware requirements would be any ASCII style terminal capable of supporting the baud rate of the DLP3..

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.

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.

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.

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.

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 ignors any control characters except for 'XON' and 'XOFF' which are used for transmit control.

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 succesful "Logged in."
If unsuccesful "Bad Password."

If the login was unsuccesful, confirm that the View password was used.

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.”

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.

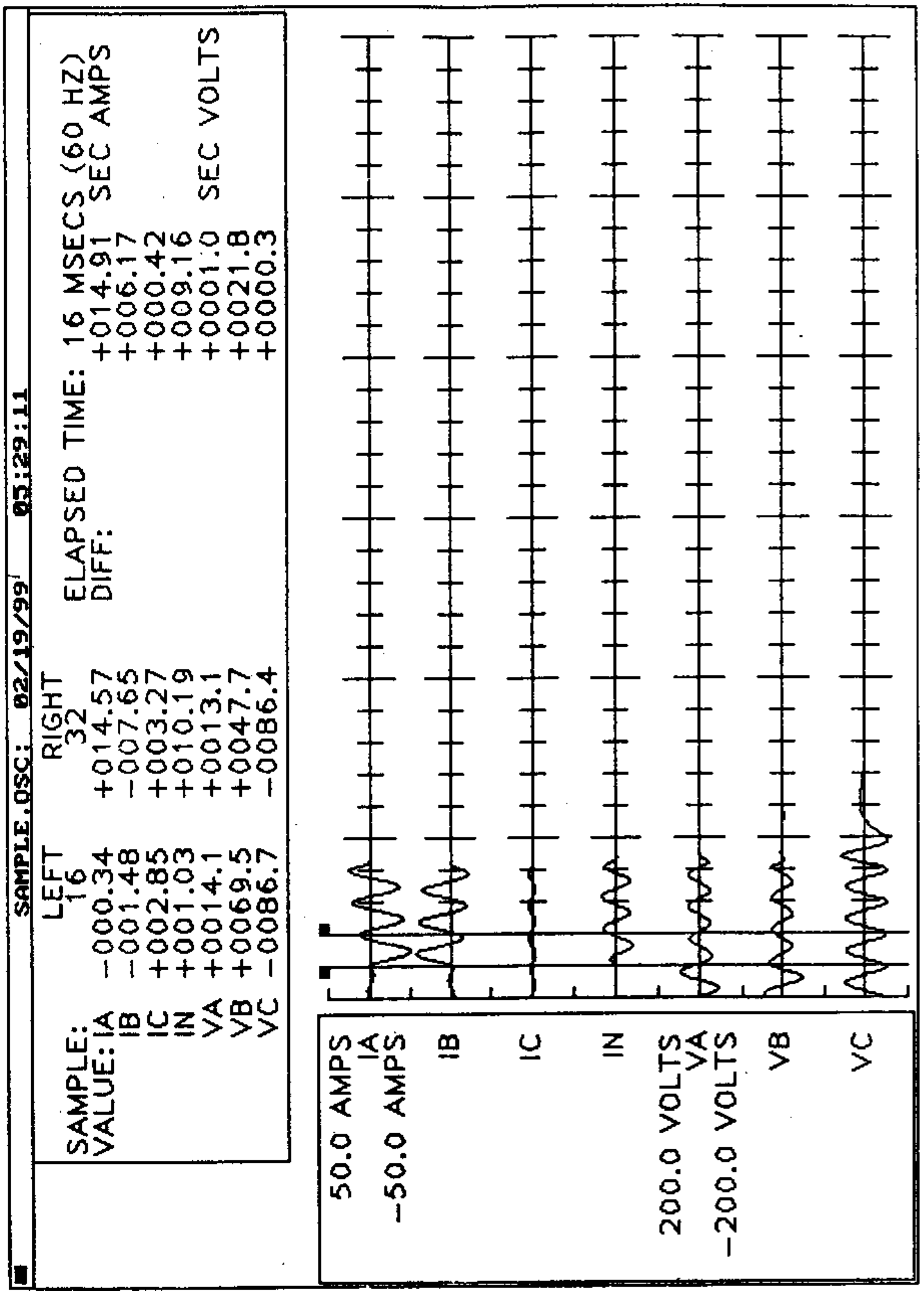

Figure 9–1. Example of oscillography plot showing currents and voltages (0286A2931, Sh. 1)

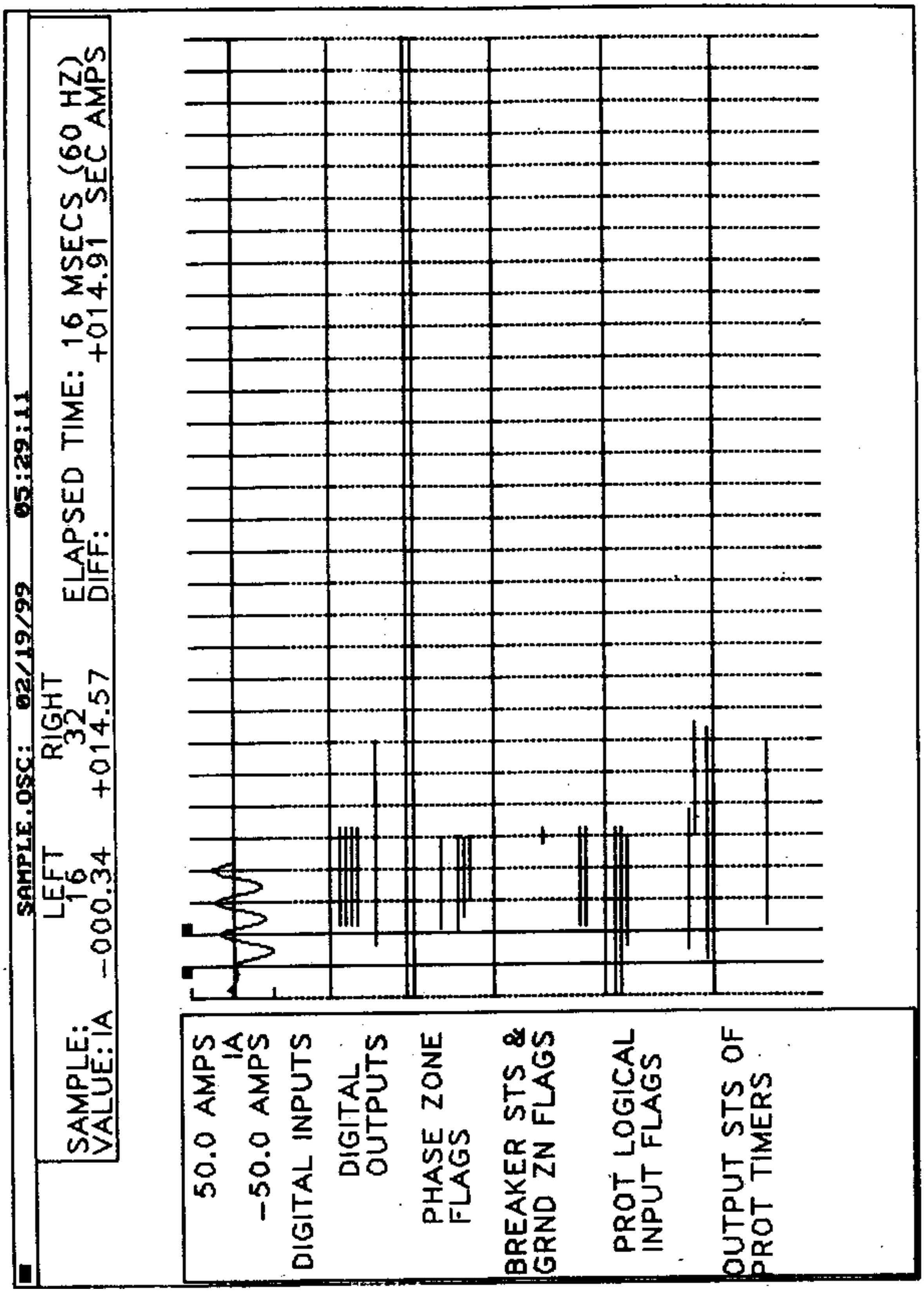

Figure 9–2. Example of flag groups graph (0286A2931, Sh.2).

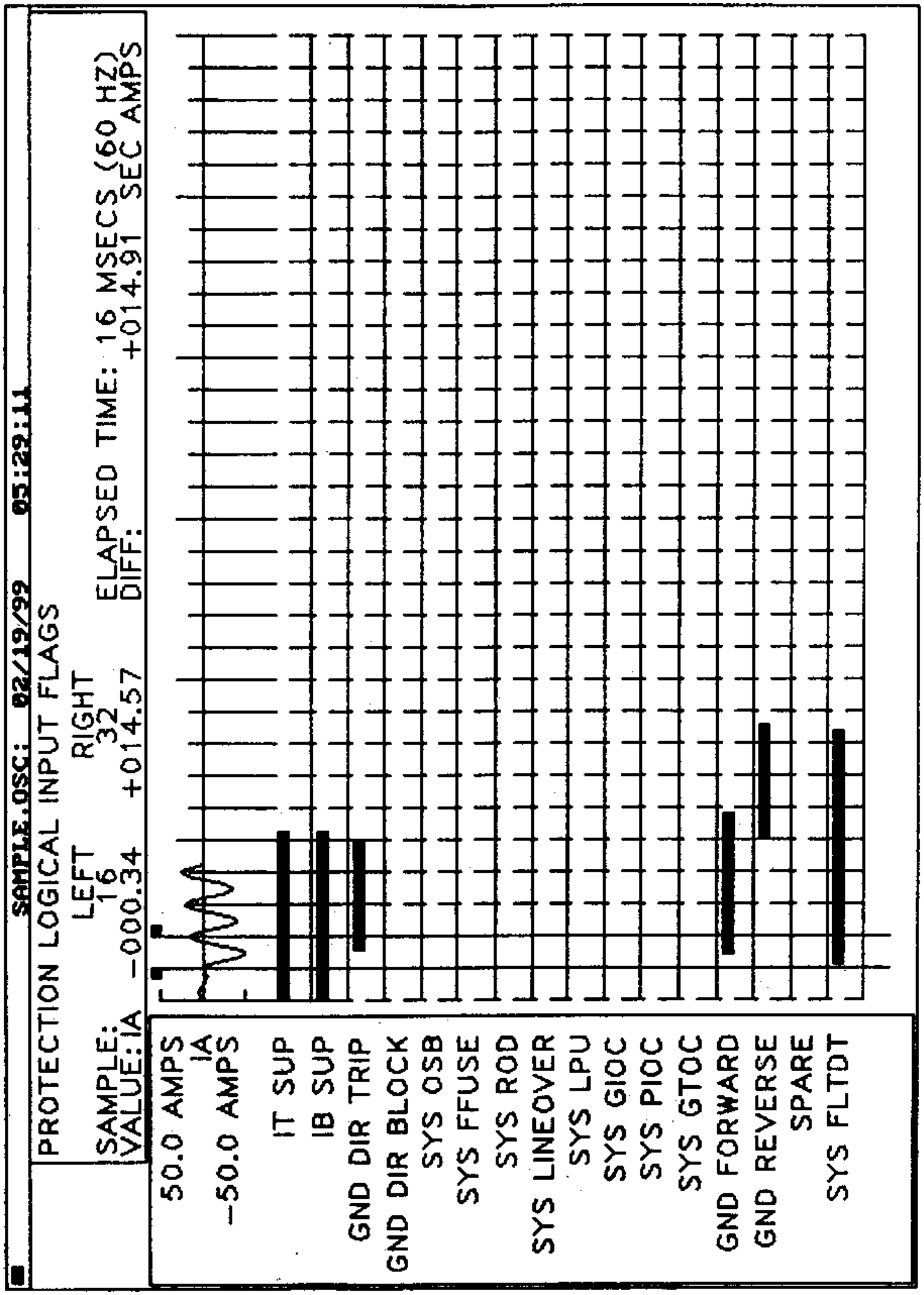

Figure 9–3. Example of protection logic input flags graph (0286A2931, Sh.3).