DLP-B

DIGITAL TRANSMISSION LINE RELAYING SYSTEM

Instruction Manual

Manual P/N: GEK-100562C

Manufactured under an ISO9002
Registered System

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

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

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GETTING STARTED

1. Unpack and examine the relay according to the instructions in the **HARDWARE DESCRIPTION** section of this manual.

2. Before powering the relay, all modules should be checked to see that they are seated properly.

   Apply rated DC power to the relay at the power supply input terminals. Refer to the fold-out Elementary Diagram, Figure PD-4, at the end of the **PRODUCT DESCRIPTION** section for the location of these terminals.

   The rated DC value for the relay is found on the nameplate located inside the front cover on the right side.

3. Connect the relay to a serial port of an IBM-compatible computer with a null-modem cable. Connection can be made either to the 25 pin D-connector on the back of the relay (PL-1), or the 9 pin D-connector on the front (Model DLP***DB only).

   Cable diagrams can be found at the end of the **INTERFACE** section, Figure IN-1.

4. 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 the **SOFTWARE** section under "**INSTALLATION**" to load DLP-LINK onto the PC.

5. To log into the relay, follow the instructions in the **ACCEPTANCE TEST** section under "**USING DLP-LINK.**"

6. The jumpers in the Hardware bag are to be used in place of the hard wired jumpers on the MMI module. Refer to figure MO-2 in the **MODULES** section for jumper function.

PRODUCT DESCRIPTION

GENERAL

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

APPLICATION

The DLP system is designed to be used on transmission lines of any voltage level where the application rules listed below are consistent with the requirements of the application:

Three-pole tripping
Lines without series capacitors

More detailed application considerations are contained below in the remaining headings of this section and in the CALCULATION OF SETTINGS section.

LINE PROTECTION SCHEMES AND FEATURES

The DLP incorporates four zones of distance protection to implement five different protection schemes. These schemes are:

Step Distance
Permissive Overreach Transfer Trip (POTT)
Permissive Underreach Transfer Trip (PUTT)
Blocking
Hybrid

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

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

When phase- and ground-distance functions are used for a zone of protection, six individual measuring functions are present; 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:

Zone 1
(3) variable-mho phase-distance functions
(3) variable-mho ground-distance functions
-or-
(3) reactance ground-distance functions with "adaptive reach" mho supervision

Zone 2
(3) variable-mho phase-distance functions
(3) variable-mho ground-distance functions
-and/or-
ground directional overcurrent functions consisting of:
IPT - ground trip overcurrent
NT - negative-sequence directional trip
IPB - ground block overcurrent
NB - negative-sequence directional block

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

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

Overcurrent Backup

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

Overcurrent Supervision -

IT - trip supervision overcurrent
IB - block supervision overcurrent

Fault Detector - FD

Line Pickup Overcurrent - I1

Remote-Open Detector - ROD

Line Overload Detectors
Level 1 Overcurrent
Level 2 Overcurrent

Positive-sequence Voltage Detector - V1

SCHEME DESCRIPTIONS

The five available protection schemes are described below. Three functional logic diagrams, Figures PD-1, PD-2, and PD-3, show the scheme logic for the four pilot-relaying schemes using conventional AND/OR combinational logic. Each functional logic diagram is presented as an aid in describing the scheme operation. The elementary diagram of Figure PD-4 shows the external connections to the DLP relay system. Figure PD-5 defines the symbols used in Figures PD-1 through PD-4. Figures PD-9, 10, and 11 shows typical interconnections between the DLP

and an appropriate carrier/tone equipment for three pilot schemes:

BLOCKING with CS28A (Figure PD-9)
POTT with NS40A (Figure PD-10)
HYBRID with Unblocking CS61C (Figure PD-11)

Step Distance

Since the step distance scheme overlays the other four pilot schemes available in the DLP, this non-pilot scheme is in essence a part of all the schemes. The zone 1 distance functions are set to reach no greater than 90% of the positive-sequence impedance of the protected line. All of the ground-distance functions are provided with "self-compensation" so that they see virtually only the positive-sequence impedance to a ground fault when the compensation setting is properly selected to reflect the difference between the zero-sequence and positive-sequence impedance of the line. This setting is explained in the CALCULATION OF SETTINGS section.

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. If the application permits, a forward-looking third zone can be used to provide backup protection for adjacent line sections out of the remote bus. If a reverse-looking zone is desired, the zone 4 functions can be reversed in direction. For some applications it may prove feasible and desirable to implement both a forward-looking zone 3 and a forward-looking zone 4.

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

Permissive Overreach Transfer Trip (POTT)

Figure PD-1 is the logic diagram for the POTT scheme. Also note that Figure PD-1 applies to both a POTT scheme and a Permissive Underreach Transfer Trip (PUTT) scheme. Both the POTT and PUTT schemes require receipt of a tripping signal from the remote end(s) to permit tripping at the local end. The channel equipment used is generally a frequency-shift (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 which provides a "time window" of trip permission for an attenuated signal caused by an internal fault should be considered.

For any multi-phase fault on the protected line, one or more of the overreaching zone variable-mho functions will operate at each terminal of the line and apply one of the inputs to the comparer, AND1, via OR2 and TL4. The output from OR2 will also key the transmitter to the trip frequency via OR5. At each terminal of a two-terminal line, the receiver will produce a trip output, which is recognized by the relay as an output from contact converter 3 (CC3). Assuming that the out-of-step blocking function has not operated, an AND1 output will be present, resulting in a trip output via OR3, TL1, OR4, AND3, OR6, OR13, AND13, OR7, and AND7. The same sequence of operation occurs for an internal ground fault when an overreaching zone ground-distance variable-mho function or the ground-directional-overcurrent function (or both) operates at each line terminal. Note that if the fault current contribution at one end is insufficient to pick up the overreaching trip function located there, then neither end can trip via the POTT logic. For such a weak- or zero-in-feed condition, a Hybrid scheme is preferable.

Timer TL1 is provided to allow the relay to ride through spurious outputs that might be produced from the channel during external faults within the reach of the overreaching trip functions. Timer TL4 is provided to prevent a possible misoperation when a fault current reversal occurs for sequential clearing of a fault on a parallel line. Note that tripping is supervised by the Fault Detector at AND7, thus confirming that tripping will only occur when a fault has occurred on the power system.

The above description assumes a two-terminal line. When a POTT scheme is applied on a three-terminal line, each terminal has two receivers and one transmitter, with each frequency-shift transmitter operating at a different frequency. Now the permissive trip signal must be received from each of the two remote terminals, as indicated by an output from AND2.

On a line protected by a POTT scheme, a problem arises if the line is operated with the breaker at one end open, but the breaker(s) at the other end(s) closed. For this condition, the relay at the closed end(s) cannot operate for a fault on the line unless the transmitter at the open end is keyed to the trip frequency. A 52/b contact from the breaker is used to key the transmitter continuously to the trip frequency when the breaker is open. Contact converters CC1 and CC2 are used for this purpose. If a single breaker is involved, then only CC1 is required. If two breakers are involved, as in a ring bus or breaker-and-a-half bus arrangement, then CC1 and CC2 are combined at AND5 to indicate that the line is open.

Permissive Underreach Transfer Trip (PUTT)

Figure PD-1 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 OR14, OR4, AND3, OR6, OR13, AND13, OR7, and AND7, and keys the transmitter to the trip frequency. Tripping for internal faults not seen by the zone 1 functions occurs when an overreaching function operates and the receiver(s) produces an output, satisfying the input conditions of the 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, 52/b contact keying of the transmitter should not be used. Because the two receivers are ORed together, a continuous trip signal sent from the open end, when only one end is open, would result in over-tripping for external faults within the reach of the pilot overreaching functions. Unfortunately, this means a portion of the line is not protected by the pilot scheme. For a two-terminal PUTT application 52/b contact keying of the transmitter should be used.

Blocking Scheme

Figure PD-2 is the logic diagram for the Blocking scheme. Since a reverse-looking blocking function is required in this scheme, the zone 4 distance functions must be set for reversed reach. As far as channel operation is concerned, a blocking scheme has virtually opposite sense from a POTT or PUTT scheme. For a remote external fault, the blocking functions at the remote end key the transmitter, and the receipt of this "blocking signal" at the local end prevents a trip output. For an internal fault, the transmitters are not keyed, or, if keyed on initially at fault inception, they are quickly turned off by operation of the overreaching trip functions. Therefore,

receiver output is not required for tripping at either end. The channel equipment generally used is an ON-OFF type, rather than an FSK type. Note that both Carrier Start and Carrier Stop contact outputs are provided to control the transmitter in the GE CS28A ON-OFF carrier set.

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

The sequence of operations is similar for an internal ground fault. 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.

For remote external faults within the reach of the local overreaching zone tripping functions, one of the remote blocking functions will operate to key the transmitter ON, sending a blocking signal to the local end. The receiver output blocks tripping at the local end by removing the upper input to AND407 via CC3 and the associated NOT. 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 is used to block tripping when clearing external faults or during current reversals that might occur when clearing faults on a parallel line.

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

In a typical application utilizing ON-OFF carrier sets, only one receiver is used at each terminal of the line regardless of the number of line terminals, and CC3 (RCVR 1 in Figure PD-2) is used to convert the receiver output into a blocking signal usable by the DLP. Some blocking schemes use frequency-shift tone channels such as the GE type NS40. For a three-terminal application employing FSK tones, each terminal would have two receivers, and CC4 is used in conjunction with CC3. CC5 and CC6 are provided for additional transmitter and scheme control. CC5 is used to turn the local transmitter OFF. This feature is typically used when the remote breaker must trip to clear a fault following a breaker failure. An external contact closure, indicating a breaker failure, produces an output from CC5 which turns OFF the transmitter permitting the

remote end to trip. CC6 output is used to disable the pilot scheme logic while allowing the backup zone1, zone2, etc. to function. Typically an external contact wired to CC6 is closed when the associated carrier set is removed from service to prevent over-tripping for external faults.

Hybrid Scheme

Figure PD-3 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 being an enhanced POTT scheme. As explained under the POTT scheme description, a pure POTT scheme cannot trip any terminal of the protected line for an internal fault that produces little or no fault current at one terminal such that the trip functions there do not operate. A Hybrid scheme incorporates an "echo" or "repeat" transmitter-keying circuit that permits the strong in-feed end(s) to trip. Also present is a "weak in-feed trip" circuit that permits the weak in-feed end to trip virtually simultaneously with the strong in-feed end. A Hybrid scheme requires reverse-looking blocking functions to implement these enhancements, and the same transient blocking logics that are used in a Blocking scheme are used in a Hybrid scheme. Like a POTT scheme a Hybrid scheme generally uses a frequency-shift channel.

When an internal fault produces sufficient fault current to operate the tripping functions at each terminal of the line, the Hybrid scheme operates exactly like the POTT scheme described under the previous heading. When a weak- or zero-in-feed condition exists at one terminal, then the echo keying and weak in-feed tripping circuits are utilized.

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 will be keyed to the trip frequency. At the weak in-feed terminal the blocking functions will not have operated and the receiver will produce an output when it receives the trip frequency. This output will be applied to timer TL11 and AND102 via OR101. AND102 will produce an output until timer TL11 times out 80 ms. after receipt of the trip signal. An AND102 output initiates keying of the transmitter via OR404 and AND204. Transmission (echo) of the trip signal will then allow the strong terminal(s) to trip.

The echo circuit with the addition of OR305, AND406 and timer TL16, comprises the weak in-feed tripping circuit. For the same internal fault condition outlined in the previous paragraph, AND406 will produce an output since:

1. the NOT input to AND406 is satisfied because there is no output from the blocking functions
2. there is an output from OR305 since either IB has operated or V1 has dropped out
3. the other two inputs to AND406 are satisfied since a trip signal is being received and timer TL11 has not timed out yet.

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

Out-of-Step Blocking

Figure PD-6 shows a functional diagram of the out-of-step blocking logic plus an R-X diagram depicting an assumed swing-impedance locus superimposed on the associated distance relay characteristics. For an out-of-step condition, the impedance locus will first enter the MOB characteristic and then some time later it will enter the phase trip function. When MOB picks up during the power swing it will apply the upper input to AND201, and the lower input will be present from the NOT via OR203, since the phase trip function has not operated yet. AND201 will then produce an output to energize timer TL1. If the impedance stays between the MOB and phase trip function characteristic for the pickup time of TL1, an OSB output will result. The OSB output is routed back to the lower input of AND201 via OR203 to seal-in the OSB output for as long as the MOB is picked up. The OSB output will reset 50 ms. after the swing-impedance locus leaves the MOB characteristic. OSB is always routed to block reclosing. OSB can be selected to block all tripping, to block tripping for everything except the direct trip overcurrent functions, or to allow tripping.

Timer TL1 has an adaptive pickup feature that has an initial pickup setting of 30 ms. for the first slip cycle, and the pickup delay becomes progressively lower during successive slip cycles. This adaptive pickup provides improved capability to detect the out-of-step condition during the increasing slip frequencies that will typically be encountered if the function does not operate during the first slip cycle.

Remote-Open Detector

The Remote-Open Detector (ROD) function operates when the remote breaker opens during an unbalanced internal fault. The principle of operation used to detect that the remote breaker has opened is to recognize charging current on one or more phases following opening of the remote breaker. As shown in Figures PD-1, PD-2, and PD-3, the ROD output trips via OR8, AND10, OR6, OR13, OR7, and AND7. The Remote-Open Detector will not operate when a balanced three-phase fault is present.

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

Line Pickup

Line Pickup provides tripping in the event that the breaker is closed into a zero-voltage bolted fault, such as would occur if the grounding chains were left on the line following maintenance. Figure PD-7 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, will be reset indicating that the line is dead. The resulting output from AND4 will cause timer TL2 to operate 150 ms. later. Consequently, when the line is energized and a fault exists, current detector I1 will pick up and AND2 will produce an output. If the link connected to the bottom input of AND3 is connected to (+), then AND3 will produce an output immediately to initiate tripping of the breaker. If the link is connected to reference (REF.), then tripping will occur after the 45 ms. pickup delay of timer TL3. The bypass of timer TL3, which is shown functionally as AND3 and the associated link, is in reality simply a setting, SELTB (0902), and the setting that corresponds to a specific link position is shown in Figure PD-7.

If the line is energized and no fault exists, V1 will pick up and timer TL1 will begin timing. 25 ms. later, the output of TL1 will reset timer TL2 via the fast reset input. AND2 will have its lower input removed at that time to take Line Pickup out of service.

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

While Line Pickup is primarily intended to trip for closing into zero-voltage bolted faults where the distance functions connected to line-side potential will not operate, it can also be used to trip for any type of permanent fault along the entire line length, regardless of the I1 pickup setting, that produces voltage at the relay location that is sufficient to operate a Zone 2 distance function but not so high as to operate the V1 voltage detector. This is accomplished by routing Zone 2 phase-distance OR ground-distance function outputs to AND1. The other input to AND1 is the normal Line-Pickup-enable output from timer TL2 previously described. Operating time for the distance functions will be slower than normal, since the pre-fault voltage is zero (assuming line-side potential) and it takes the relay several cycles to establish a "memory" polarizing voltage. However, for a Step Distance scheme, this feature will still result in faster tripping for permanent faults located at the remote bus (or anywhere past the local Zone 1 reach).

Potential Transformer Fuse Failure (PTFF)

Since one or more distance functions may operate for a full or partial loss of potential caused by one or more blown fuses, PTFF is provided to block all tripping when a fuse failure is detected. Figure PD-8 shows the functional logic for the PTFF detection function.

If potential is lost as indicated by an output from the positive-sequence voltage detector V1, the upper input will be present at AND1. The lower input to AND1 is present if load current is sufficient to operate the current detector IB, and the middle input is dependent upon whether or not the fault detector FD has operated.

If potential is lost for any reason, including a blown fuse or fuses, and there is no fault on the power system, the fault detector will not be operated at that time. Consequently AND1 will produce an output that will cause timer TL1 to time out and produce a PTFF output via OR1. The output of OR1 is routed to AND2 to seal-in the PTFF output based on the output of V1 so that PTFF output will be maintained as long as the potential is below normal. When the potential returns to normal, V1 will reset to remove the seal-in, allowing the PTFF output to reset.

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

Overcurrent Backup

An instantaneous non-directional phase overcurrent tripping function (PH4) is included to provide direct tripping for severe phase-to-phase and phase-to-ground faults. Since PH4 is non-directional, power system conditions will determine whether or not this function can be set to distinguish between internal and external faults.

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

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.

OTHER FEATURES

Local LED Display

A local light-emitting-diode (LED) display and clear button are provided to allow the user to view and clear fault target information. The use and functioning of the display are fully described in the INTERFACE section.

Remote Communications

A modified RS232 port (PL-1) located on the rear of the case is provided to permit the user to 1) communicate with the DLP from an IBM PC-compatible computer or 2) to connect the DLP to the host computer of a G-NET substation information and control system. These two possible uses of PL-1 are mutually exclusive. For example, if PL-1 is physically connected to the G-NET host computer it will not be possible to communicate with the DLP from a separate PC. Refer to the INTERFACE section for details regarding the required PL-1 cables.

When communication via a separate PC is desired, the PC may be connected via the proper cable when within 50 feet of the DLP, or the PC may be connected via interposing modems when physically remote from the DLP. Unique PC software, DLP-LINK, is required to communicate with the relay system. The capabilities and use of DLP-LINK are described in the SOFTWARE section.

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

Trip Circuit Monitor

Within the DLP relay system the DC battery voltage across each of the open trip contacts (or SCRs) may be continuously monitored to indicate if the associated trip circuit is intact. If the monitored DC voltage becomes virtually zero, then the trip circuit has failed open or the breaker 52/a contact has opened. This function replaces the red light indicator typically used for trip-circuit monitoring, and it can be selectively disabled for each trip contact (or SCR).

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 DLP issues a trip signal. For normal conditions, a DC trip current will be detected and the target information will be immediately displayed on the local MMI. At the same time, Fault Report and Oscillography information will be stored in memory. If no DC trip current is detected, then target information will not be displayed on the local MMI until after the fault has been cleared by backup protection and the DLP has detected that the fault current is zero. For this case, Fault Report and Oscillography information will be stored at the time the DLP detects the fault current is zero. The Fault Report for the normal-condition case will include an event message that reads TRIP CIRCUIT #1 ENERGIZED. The Fault Report for the case where no DC trip current was detected will include an event message that reads TRIP CIRCUIT #1 NOT ENERGIZED.

Sequence of Events

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

Fault Report

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

Oscillography

A set of oscillography data is stored in memory for each Fault Report. Oscillography data consist of date and time of trip, one cycle of pre-fault data samples, and 29 cycles of post-fault data samples. A full description of this function is contained in the SOFTWARE section.

Alarms

Two separate self-test alarm outputs (contacts) are provided. The non-critical alarm indicates that self-test has detected a problem that does not warrant taking the relay system out of service. This is a normally open contact that closes when a non-critical alarm occurs. The critical alarm indicates that self-test has detected a problem that warrants taking the relay system out of service. This is a normally closed contact that is held open for normal conditions but that closes when a critical alarm occurs. The critical alarm and power supply alarm described below are paralleled.

A separate alarm is located on the power supply to provide a contact closure if the power supply fails or is turned off. This is a normally closed contact that is held open when the power supply is normal but that closes when the power supply fails. The output contact associated with the previously described Line Overload function is also classified as an alarm output.

Breaker Control

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

Fault Location

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

Start-Up Self Tests

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

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

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

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

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

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

Run-Time Self Tests

Each of the three processors will have "idle time" when the system is in a quiescent state; i.e., when the DLP is not performing fault or post-fault processing. During this idle time, each processor will perform self-tests that are not disruptive to the foreground processing; that is, tests that do not interfere with the foreground tasks' use of serial and parallel ports, and tests that do not inhibit interrupts to any processor.

If any background self-test fails, the test is repeated. To declare a component "failed", the test must fail three consecutive times. In the case of most critical failures, the DLP will force a reset to attempt to get the failed component working again.

The DLP is able to distinguish between a start-up (power-up) and a reset caused automatically by a DLP malfunction. The reset is a fault tolerant feature of the DLP; it is performed as an attempt to resume operation again after an intermittent failure.

The reset activities are identical to the start-up activites except that not all start-up self-tests are performed. If the reset was caused by failure of a specific background self-test, then only the start-up self-tests associated with that same hardware are performed.

A reset is not reported to the user by the DLP. If the reset is successful, no message is printed, no failure status is recorded, and the critical alarm output is not energized; however, during the reset procedure, the red LED on the MMI panel will light and a failure code may appear on the MMI display. Therefore, if the reset is not successful, the processor board will be shut down, leaving the MMI panel displaying the above error information. Refer to the SERVICING Section of this manual for error codes.

To prevent continual resets in the case of a solid failure, both hardware and software will permit only four resets in a one-hour period. On the fifth reset, the DLP will not perform initialization, but will attempt to initialize MMI, communications, and the critical alarm output as in the case of a start-up with a critical self-test failure.

The reset procedure takes approximately one second, depending upon which start-up self-tests are to be run.

The components tested in the background are listed in the **Run Time Background Self Tests** Table in the SERVICING section.

The testing of I/O hardware is done in the foreground, so that the processors know when a given component or port is in use and therefore not available for testing. Some tests are performed every sample period, while others are performed less frequently.

As with background self-tests, any failed test is repeated and must fail three consecutive times to be considered a failure.

Although not specifically a "self" test, the trip circuit continuity monitoring is performed as a foreground test. Refer to the Trip Circuit Monitor portion of this section.

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

The components tested in the foreground are listed in the **Run Time Foreground Self Tests** Table in the SERVICING section.

OPTIONAL FEATURE

SCADA Digital to Analog (DTA) Interface

An optional DTA module is available that provides an analog output proportional to the distance from the relay to the fault as calculated by the fault location algorithm. This 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 DTA module provides either a nominal 0 to 1 ma DC output or a nominal 0 to 5 volt DC output. The choice of output range is selected by a switch located on the DTA module. The DTA module must be removed from the DLP chassis to access this switch. The proper sequence for selecting the output range is:

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

When the fault location is calculated to be 100% of the line length, the DTA module output will be either 0.8 ma DC or 4.0 volts DC. The DLP's MMI fault target display will show asterisks if the fault location is calculated to be greater than 110% of the line length. Similarly, the DTA module output goes to full scale (either 1 ma DC or 5 volts DC) when the fault location is calculated to be greater than 110% of the line length. Consequently, the usable output ranges are 0 to 0.88 ma DC or 0 to 4.4 volts DC which covers the 0 to 110% fault location range. The SCADA system should be programmed to recognize a full-scale output as an indication of an invalid output resulting from either an out of limit fault location calculation or a DTA module reset.

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

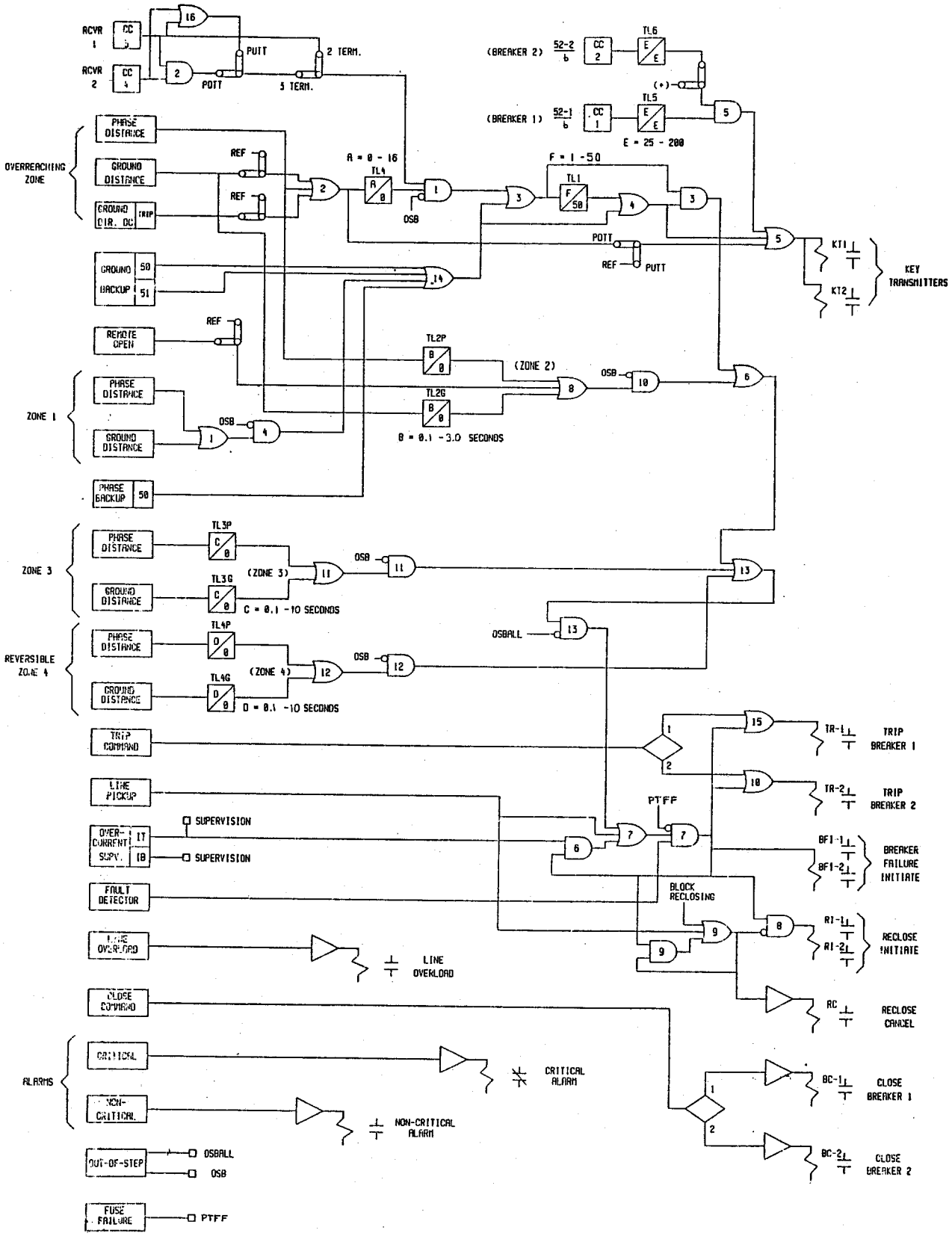


Figure PD-1 (0179C8284 [1]) POTT/PUTT Logic Diagram

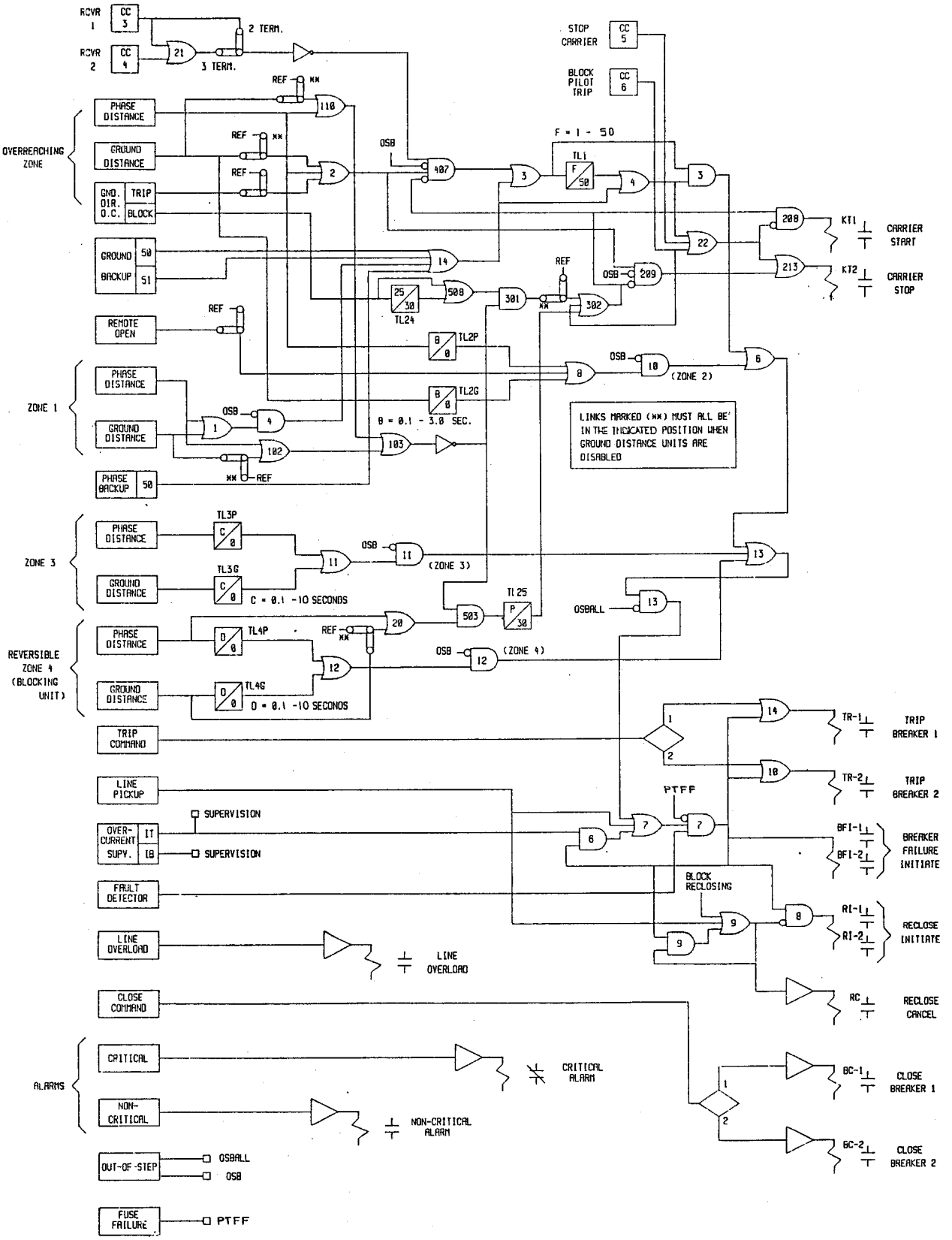


Figure PD-2 (0179C8285 [1]) Blocking Logic Diagram

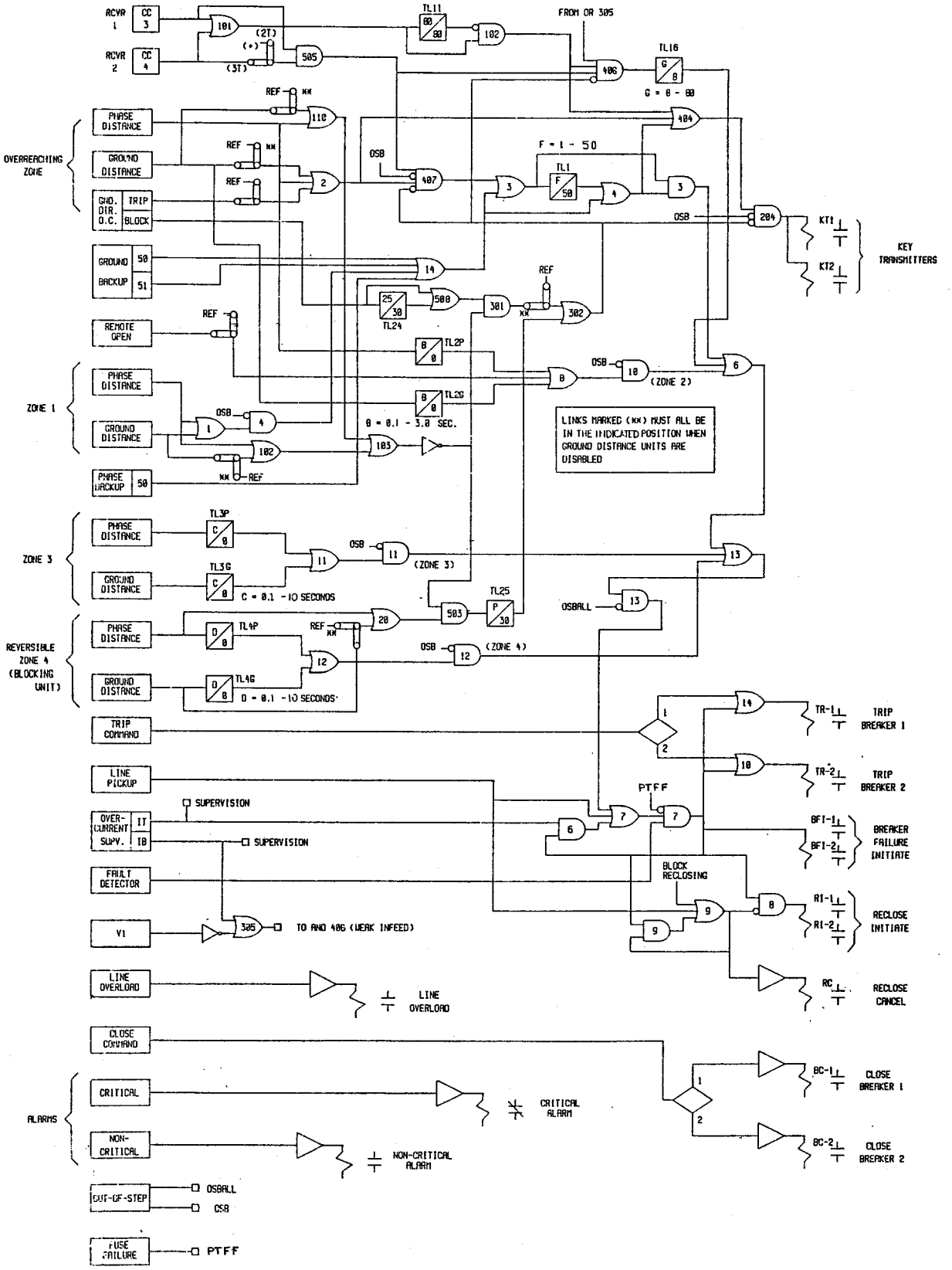
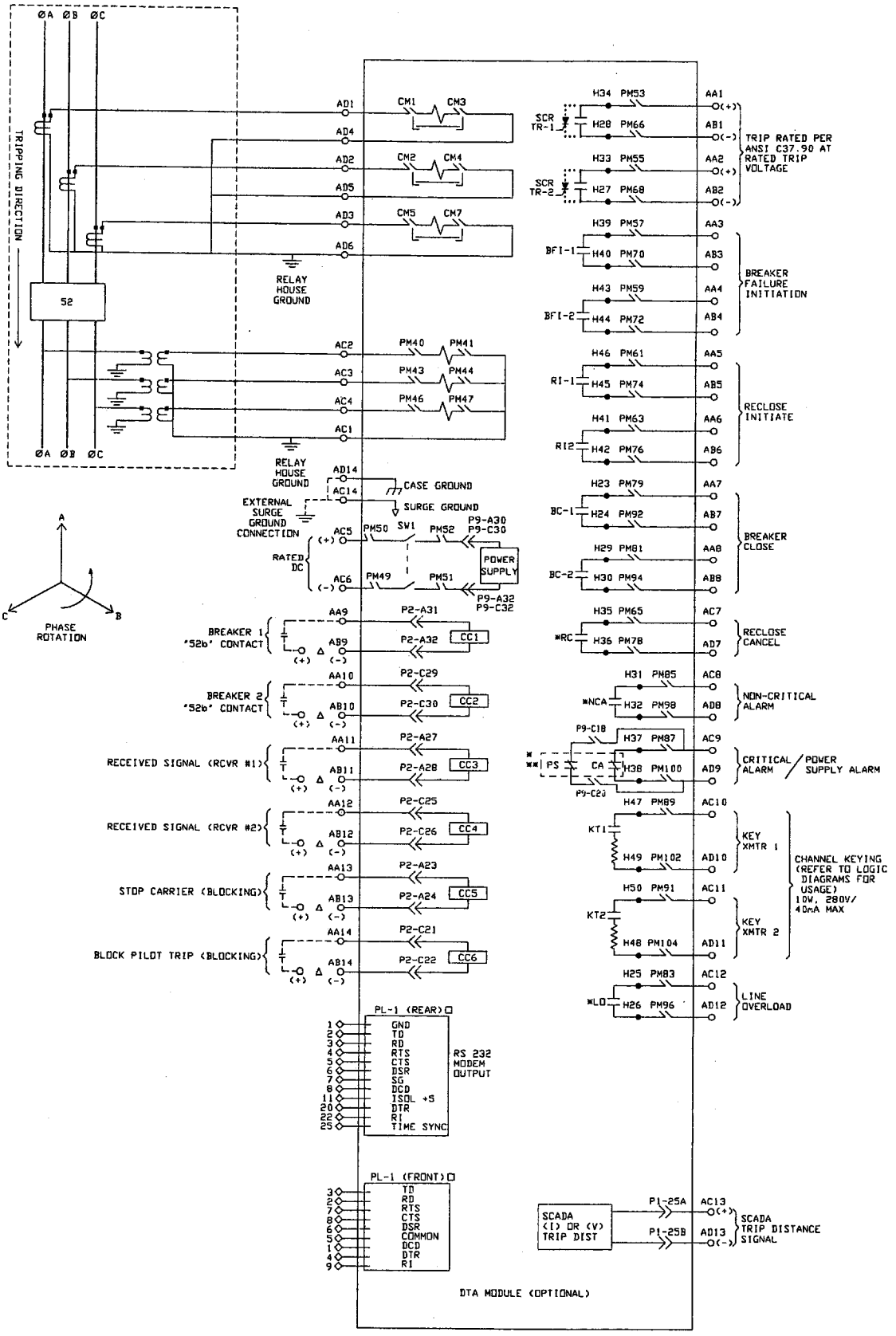


Figure PD-3 (0179C8283 [1]) Hybrid Logic Diagram



NOTES:
1) ☐ PL-1 FRONT & PL-1 REAR CANNOT BOTH BE CONNECTED AT THE SAME TIME
2) SEE GE DWG. 0286A2775 FOR SYMBOL DEFINITION LEGEND
3) * AUXILIARY OUTPUTS 3A, 50W, 250VDC MAX.
4) ** CONTACTS ARE SHOWN DE-ENERGIZED. UNDER NORMAL CONDITIONS CONTACTS ARE ENERGIZED.

Figure PD-4 (0145D8125 [4]) Elementary Diag

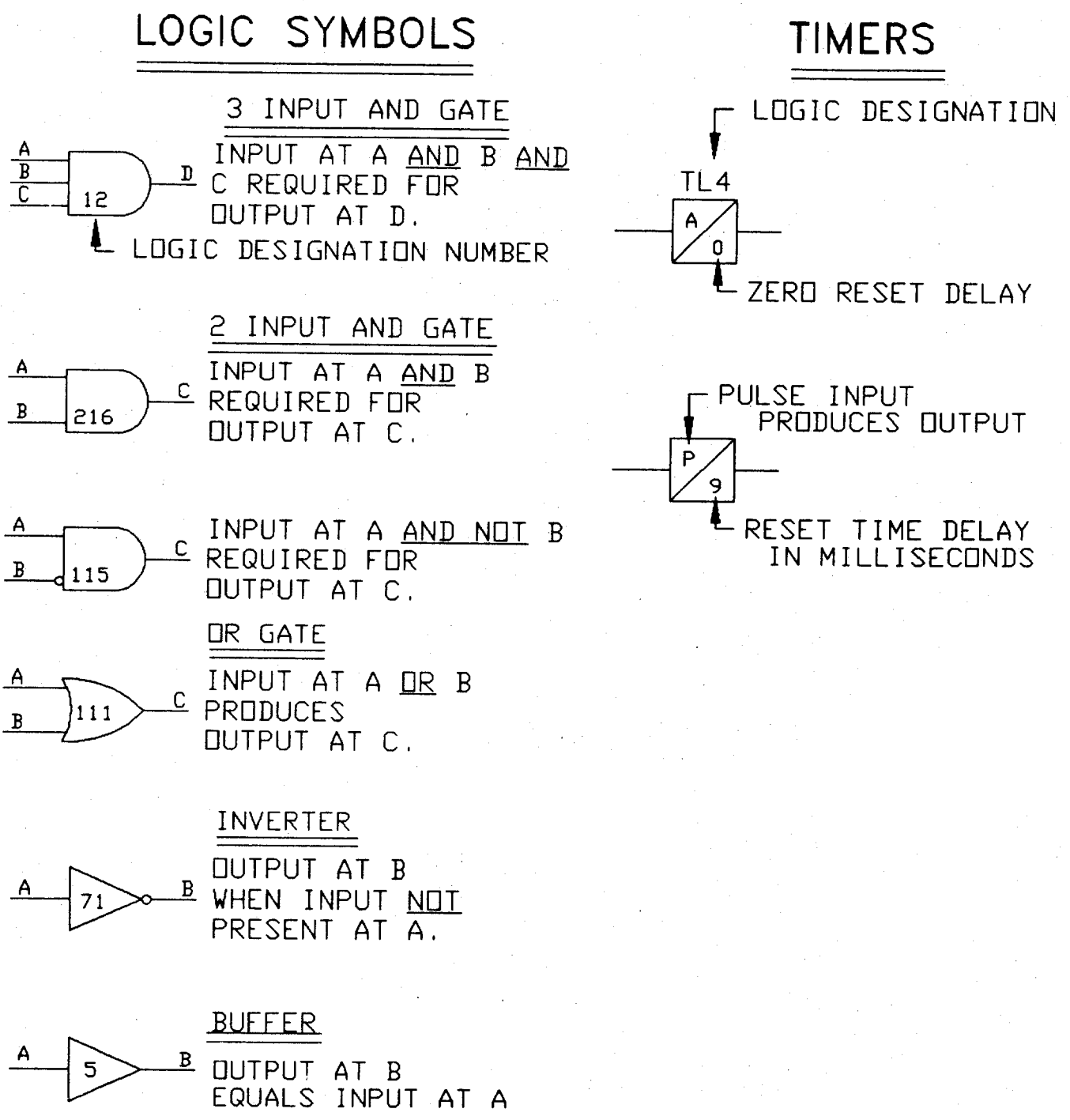


Figure PD-5 (0286A2925 Sh.1 [2]) Digital Relay Symbol Legend

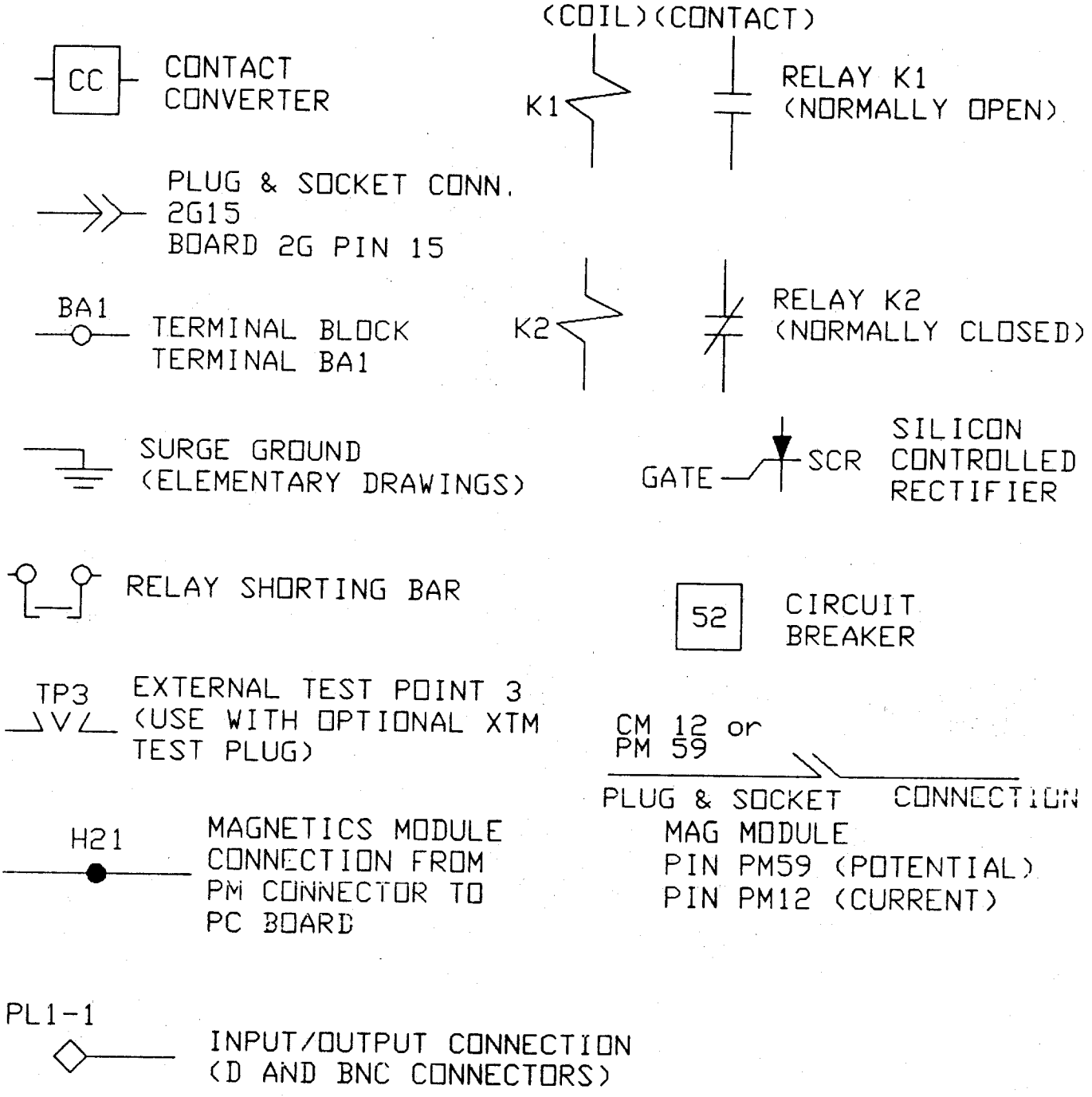


Figure PD-5 (0286A2925 Sh.2 [3]) Digital Relay Symbol Legend

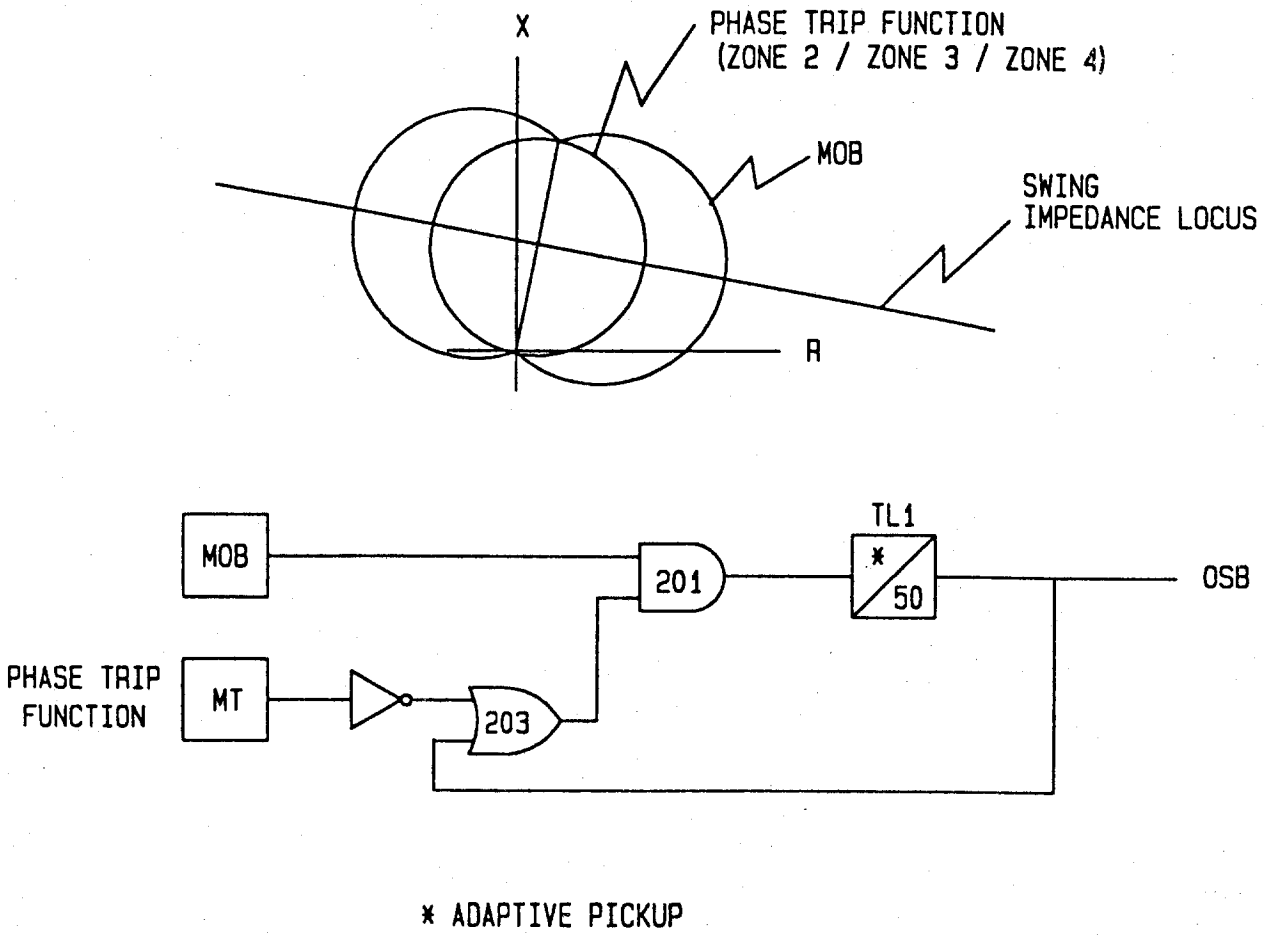


Figure PD-6 (0286A2911) Out of Step Blocking

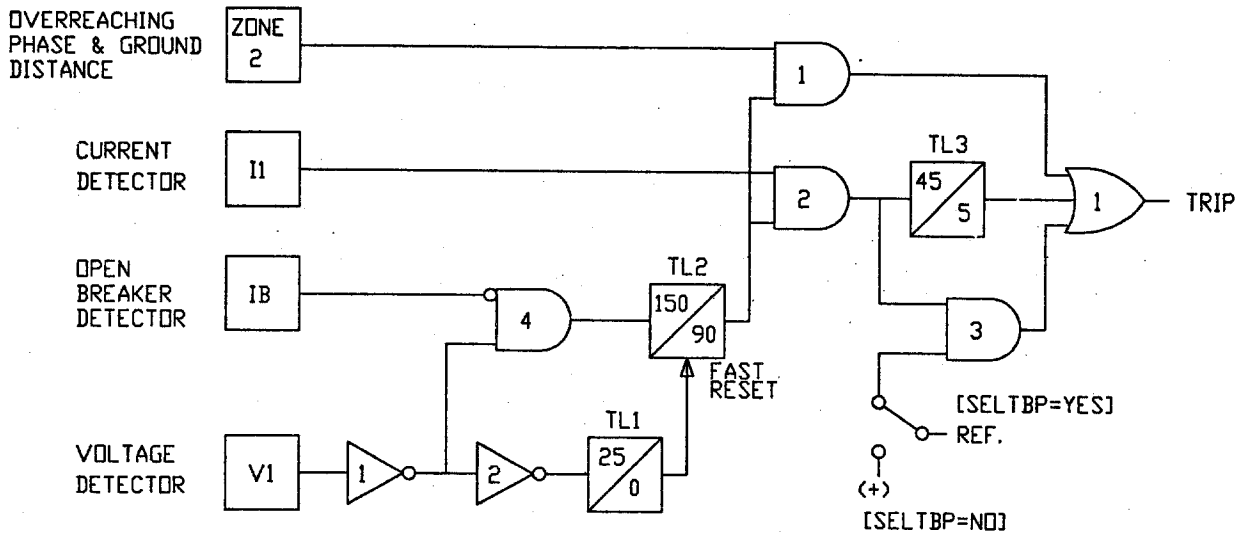


Figure PD-7 (0215B8621) Line Pickup

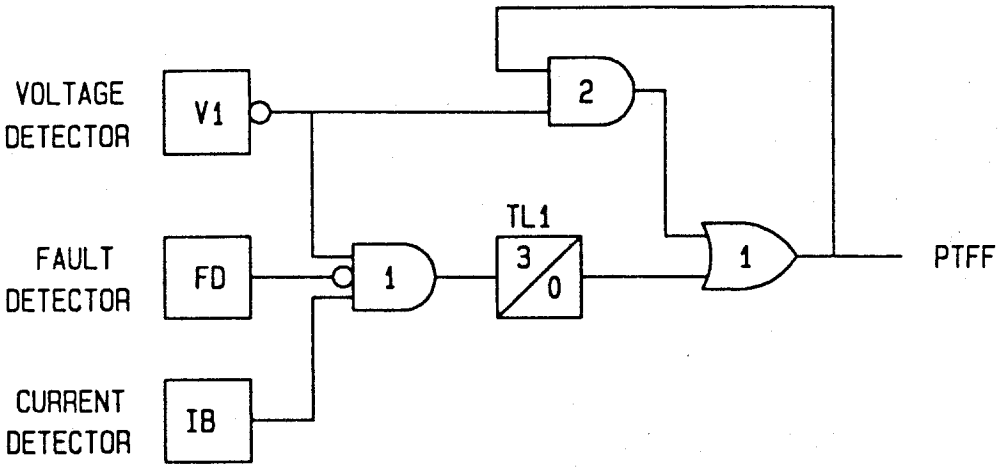


Figure PD-8 (0286A2915) Potential Transformer Fuse Failure Detection

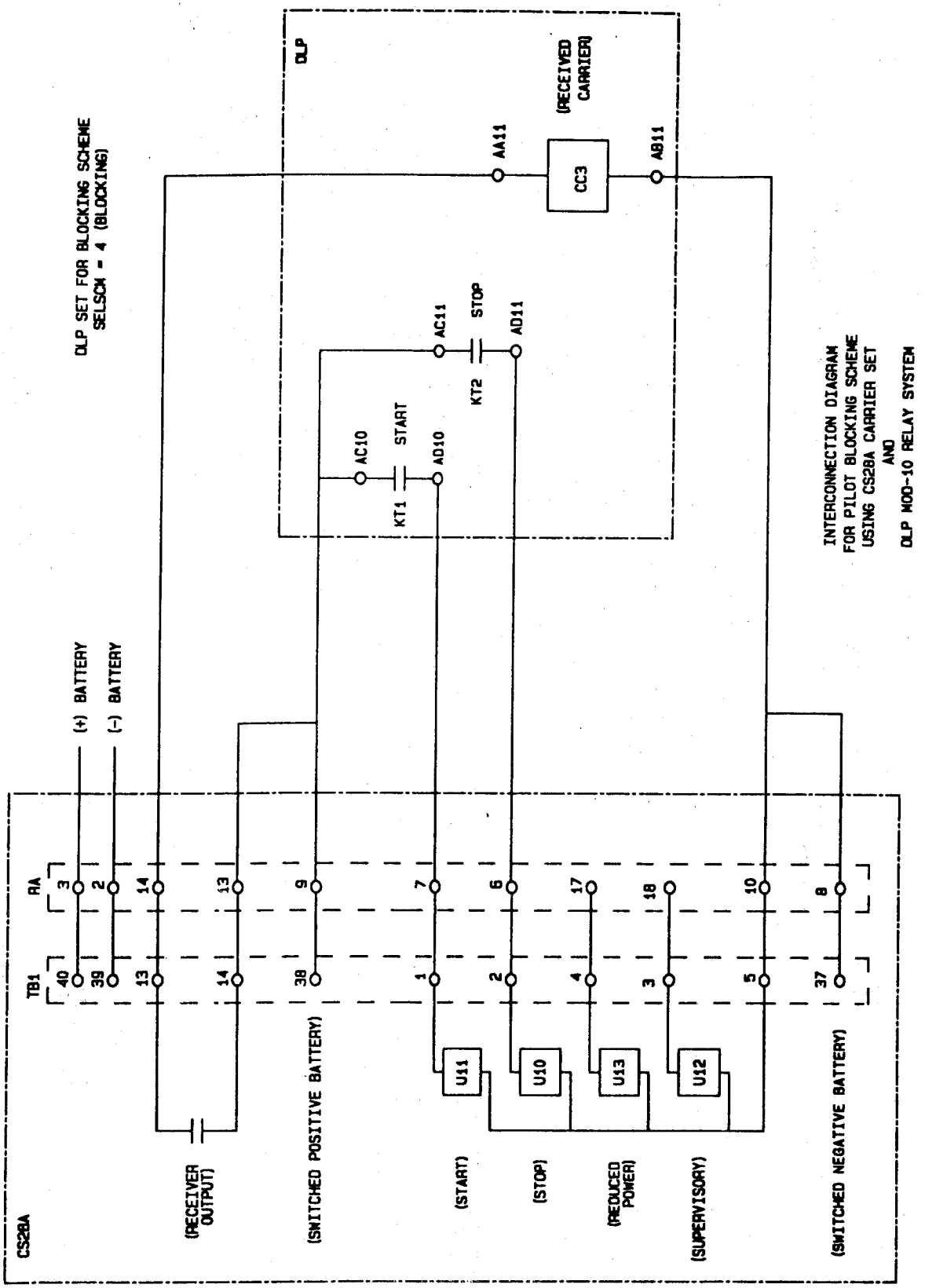


Figure PD-9 (0286A3531) Blocking Scheme Interconnections

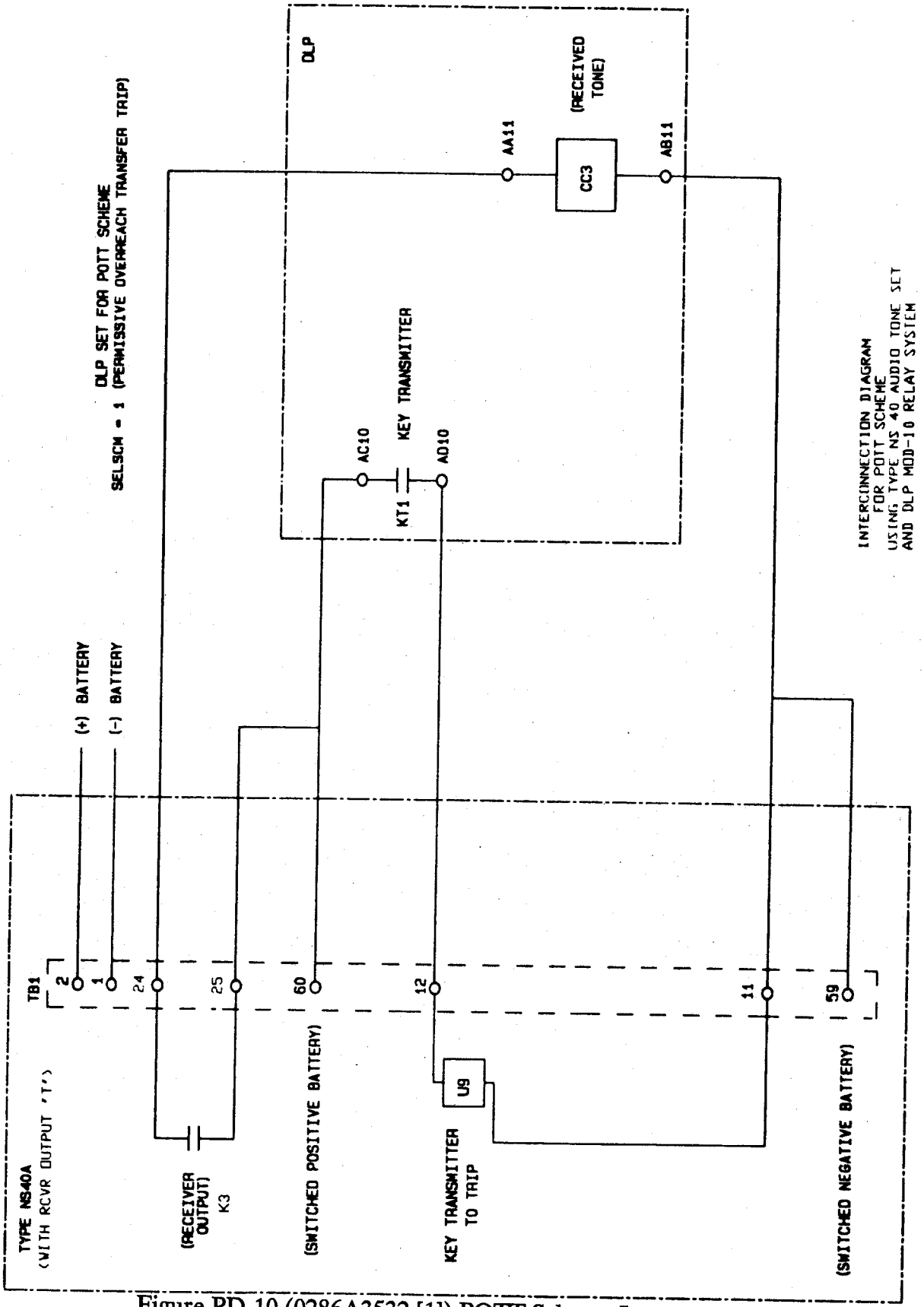


Figure PD-10 (0286A3532 [1]) POTT Scheme Interconnections

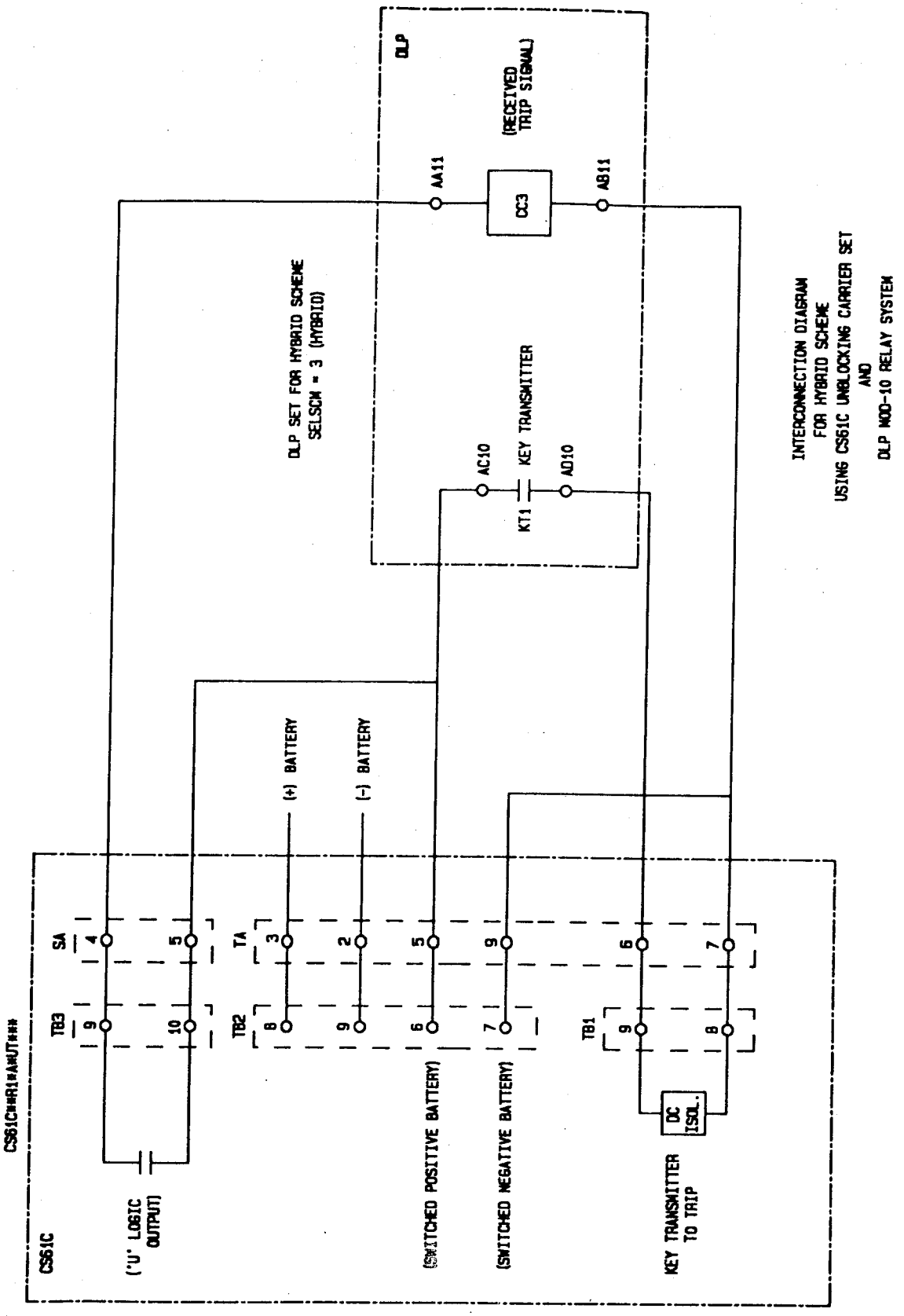


Figure PD-11 (0286A3533) Hybrid Scheme Interconnections

CALCULATION OF SETTINGS

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

Those settings that are independent of the selected scheme will be presented first, followed by scheme-dependent settings. For scheme-dependent settings, five separate sections, corresponding to the five possible schemes, are used. Following each of these five sections is a blank settings form, which may be copied and used to record the required settings for a particular application. Marked on these settings forms are those setting selections that are required, and those settings marked <NA>, for not applicable, that do not require a setting.

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

Setting ranges for distance functions are given as a multiplier range times the quantity (5/IN). Setting ranges for overcurrent functions are given as a multiplier range times IN. IN is the nominal current rating, either 1 or 5 amps, for a particular DLP model. Those DLP relay systems used with current transformers that have a 5-amp-rated secondary have IN = 5. Those DLP relay systems used with current transformers that have a 1-amp-rated secondary have IN = 1.

The sample transmission system shown in Figure CS-1 will be used to determine example settings for a DLP relay system located at bus Able on protected line section A-B. The current transformers are assumed to have a 5-ampere-rated secondary, and the DLP has IN = 5.

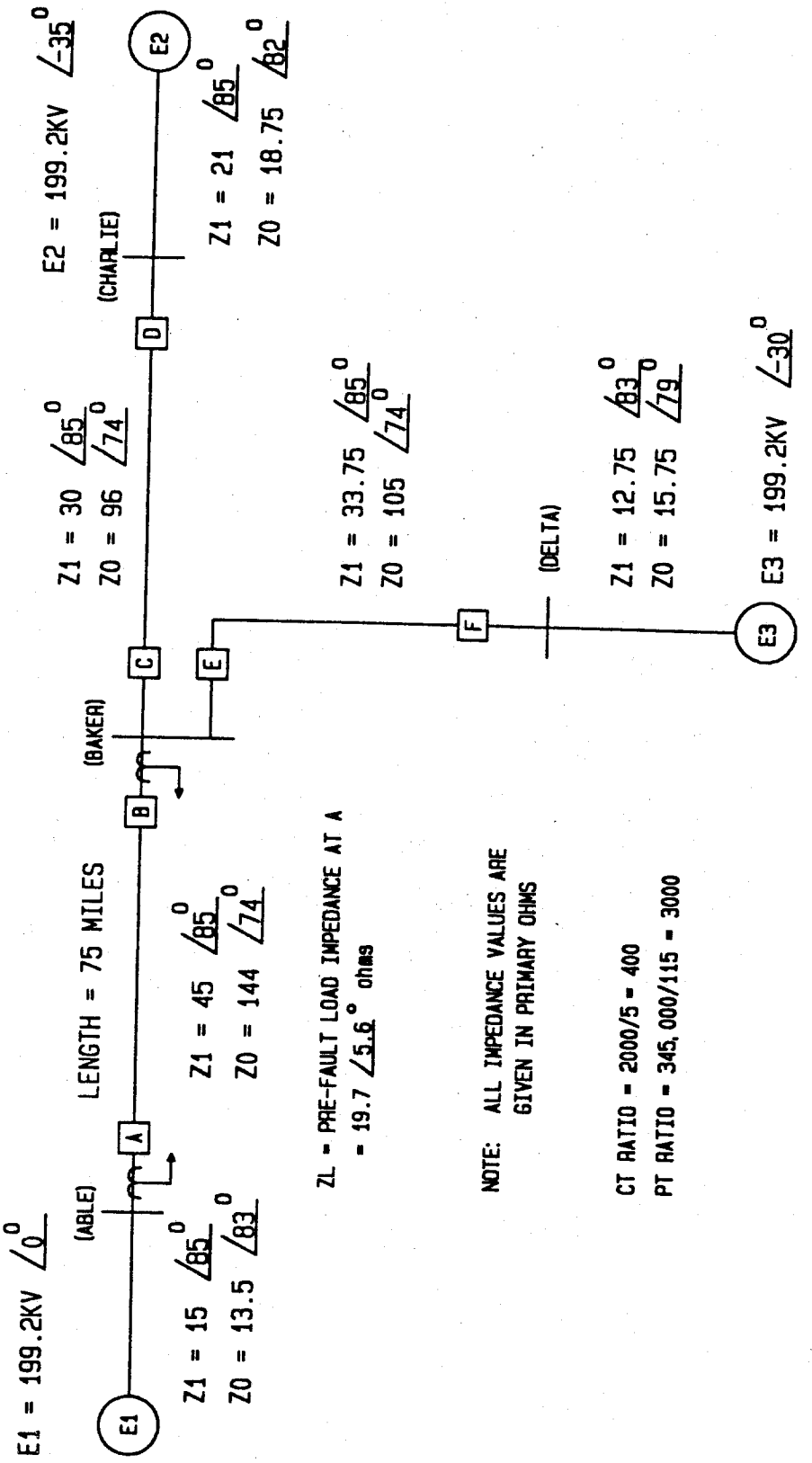


Figure CS-1 (0286A2912) Sample 345 KV system

TABLE CS-1: SETTINGS AND RANGES

SETTING	RANGE	UNITS	DEFAULT
CONFIG			
UNITID	0		0
SYSFREQ	50,60	Hz	60
NUMBKRS	1,2		1
TRIPCIRC	0 (NONE), 1 (BKR 1), 2 (BKR 2) 3 (BOTH)		NONE
SELPRIM	0 (PRIMARY) 1 (SECNDRY)		SECNDRY
CTRATIO	1 - 5000		400
PTRATIO	1 - 7000		2000
DISTUNIT	0 (MILES) 1 (KM)		MILES
BAUDRATE	300, 1200, 2400	BAUD	1200
PHASDESG	0 (A-B-C) 1 (A-C-B)		A-B-C
LINE QTY			
POSANG	45-90	deg.	85
ZERANG	45-90	deg.	75
ZP	.01-(50.00)(5/IN)	ohms	(6.00)(5/IN)
K0	1.0 - 7.0		3.0
LINELEN	0.0 - 200.0	miles	100.0
	0.0 - 322.0	km	161.0
Z1DIST			
SELZ1G	YES, NO		YES
SELZ1P	YES, NO		YES
Z1R	.01-(50.00)(5/IN)	ohms	(5.40)(5/IN)
Z1GR	.01-(50.00)(5/IN)	ohms	(5.40)(5/IN)
SELZ1U	0 (MHO) 1 (REACT)		MHO
Z1SU	.01-(50.00)(5/IN)	ohms	(20.00)(5/IN)
Z1K0	1.0 - 7.0		2.7
OVERCUR			
SELPH4	YES, NO		YES
PUPH4	(0.4 - 20.0)(IN)	amps	(4.0)(IN)
SELIDT	YES, NO		YES
SELDIDT	YES, NO		YES
PUIDT	(0.1 - 16.0)(IN)	amps	(2.0)(IN)
SELTOC	YES, NO		YES
SELDTOC	YES, NO		YES
PUTOC	(0.04 - 3.00)(IN)	amps	(.20)(IN)
TDTOC	0.5 - 10.0		5.0
LINEPU			
SELLPU	YES, NO		YES
SELTBP	YES, NO		YES
PUI1	(0.2 - 3.0)(IN)	amps	(1.0)(IN)

TABLE CS-1 - (CONTINUED)

SETTING	RANGE	UNITS	DEFAULT
LINE OVRLD			
SELOVL	YES, NO		NO
PULV1	(1.0 - 4.0)(IN)	amps	(2.0)(IN)
PULV2	(2.0 - 8.0)(IN)	amps	(4.0)(IN)
PUTL31	10-990	sec.	200
PUTL32	10-99	sec.	20
OUTOFSTEP			
SELPTZ	0 (ZONE 2), 1 (ZONE 3), 2 (ZONE 4)		ZONE 2
MOBANG	30-130	deg.	70
SELOSB	0 (BLKALL) 1 (BLKDIST) 2 (BLKNONE)		BLKALL
BLK RECLOS			
SELALL	YES, NO		YES
RBOSB	YES, NO		NO
RB3PH	YES, NO		NO
RBTOC	YES, NO		NO
RBZ2T	YES, NO		NO
RBZ3T	YES, NO		NO
RBZ4T	YES, NO		NO
SCADA DTA INTERFACE			
FLTLOCK	0 - 99.9	sec.	0
FLTRESET	0 - 999	minutes	0
SCHEMESEL			
SELSCM	0 (STEPDST) 1 (POTT) 2 (PUTT) 3 (HYBRID) 4 (BLOCK)		STEPDST
NUMRCVR	0, 1, 2		0
Z2DIST			
SELZ2G	YES, NO		YES
SELZ2P	YES, NO		YES
Z2R	.01-(50.00)(5/IN)	ohms	(9.00)(5/IN)
Z2GR	.01-(50.00)(5/IN)	ohms	(9.00)(5/IN)
SELZ2U	0 (MHO) 1 (GDOC) 2 (MHOGDOC)		MHO
SELZ2T	YES, NO		YES
PUTL2P	0.10 - 3.00	sec.	1.00
PUTL2G	0.10 - 3.00	sec.	1.00
Z2PANG	90, 105, 120	deg.	90
Z2GANG	90, 105, 120	deg.	90

TABLE CS-1 (CONTINUED)

SETTING	RANGE	UNITS	DEFAULT
Z3DIST			
SELZ3G	YES, NO		YES
SELZ3P	YES, NO		YES
Z3R	.01-(50.00)(5/IN)	ohms	(12.00)(5/IN)
Z3GR	.01-(50.00)(5/IN)	ohms	(12.00)(5/IN)
PUTL3P	0.10 - 10.00	sec.	3.00
PUTL3G	0.10 - 10.00	sec.	3.00
Z3PANG	90, 105, 120	deg.	90
Z3GANG	90, 105, 120	deg.	90
Z4DIST			
SELZ4G	YES, NO		YES
SELZ4P	YES, NO		YES
Z4R	.01-(50.00)(5/IN)	ohms	(18.00)(5/IN)
Z4GR	.01-(50.00)(5/IN)	ohms	(18.00)(5/IN)
Z4OR	0.00 - 0.40		0.10
PUTL4P	0.10 - 10.00	sec.	5.00
PUTL4G	0.10 - 10.00	sec.	5.00
Z4PANG	80, 90, 95, 105, 110, 120	deg.	90
Z4GANG	80, 90, 95, 105, 110, 120	deg.	90
SELZ4D	0 (FORWRD) 1 (REVERS)		0
CURSUPVIS			
PUIPT	(0.10 - 1.00)(IN)	amps	(0.10)(IN)
PUIPB	(0.05 - 0.75)(IN)	amps	(0.05)(IN)
PUIT	(0.04 - 0.80)(IN)	amps	(0.04)(IN)
PUIB	(0.04 - 0.40)(IN)	amps	(0.04)(IN)
SCHEMETIM			
PUTL1	1 - 50	msec.	1
PUTL5	0 - 200	msec.	50
DOTL5	0 - 200	msec.	50
PUTL6	0 - 200	msec.	50
DOTL6	0 - 200	msec.	50
PUTL4	0 - 50	msec.	0
PUTL16	8 - 80	msec.	8
REMOTEOPEN			
SELROD	YES, NO		YES
PUTL20	10 - 100	msec.	100
SELFFB	YES, NO		YES

SETTINGS INDEPENDENT OF THE SELECTED SCHEME

CONFIGURATION SETTINGS, CONFIG

Unit ID Number, UNITID

The UNITID is the decimal number 0 stored in non-volatile memory, which uniquely identifies a DLP relay system. When the DLP is accessed via its PL-1 serial port the UNITID must be known to establish communication, thus providing a measure of security. The UNITID cannot be changed.

System Frequency, SYSFREQ

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

Number of Breakers, NUMBKRS

NUMBKRS can be set to either 1 or 2. When set to 1, the TRIP and CLOSE commands will only activate their respective BREAKER 1 output. When set to 2, the TRIP and CLOSE commands will selectively activate either the BREAKER 1 or BREAKER 2 output. When a POTT or PUTT scheme is selected, this setting also determines whether a 52/b contact from one breaker or two breakers is required to key the transmitter with the breaker(s) open.

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

Trip Circuit Monitor, TRIPCIRC

The four possible settings are 0 (NONE), 1 (BKR 1), 2 (BKR 2), or 3 (BOTH). These select the trip contact or SCR (BREAKER 1 or BREAKER 2 - see Figures PD-1,2,3) for which the function is active.

Select Primary/Secondary Units, SELPRIM

SELPRIM can be set to either 0 (PRIMARY) or 1 (SECNDRY), secondary. This setting determines whether current and voltage will be displayed and stored as primary or secondary values. All settings are expressed in terms of secondary values regardless of whether SELPRIM is set to 0 or 1.

Current Transformer Ratio, CTRATIO

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

Potential Transformer Ratio, PTRATIO

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

Units of Distance, DISTUNIT

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

Communications Baud Rate, BAUDRATE

The BAUDRATE setting of 1200 or 2400 must be set to match the baud rate of the modem or serial device connected to the RS232 serial port (PL-1) of the DLP relay system. Refer to the **INTERFACE** section for setting links on the MMI module to select the baud rate; 1 stop bit and no parity are pre-set.

Phase Designation, PHASDESG

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 DLP is installed. This setting permits the DLP to properly report the proper faulted phase or phase pair.

Example Settings (based on Figure CS-1):

UNITID = 0
SYSFREQ = 60
NUMBKRS = 1
TRIPCIRC = 1
SELPRIM = 1 (SECNDRY)
CTRATIO = 400 (2000/5)
PTRATIO = 3000 (345,000/115)
DISTUNIT = MILES
BAUDRATE = 1200

LINE QUANTITIES, LINE QTY

Positive-Sequence Angle of Maximum Reach, POSANG

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

Zero-Sequence Angle of Maximum Reach, ZERANG

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

Positive-Sequence Impedance, ZP

ZP can be set over the range of .01 - 50.00 x (5/IN) ohms where IN (nominal current) is either 1 or 5 amperes depending on the model number of the DLP relay system. It should be set to the positive-sequence impedance of the protected line.

Zero-Sequence Current Compensation, K0

K0 can be set over the range of 1.0 - 7.0. This setting determines the amount of zero-sequence current fed back into all the ground-distance functions, except zone 1, to provide "self-compensation." This permits the reach setting for the ground-distance functions to be based on the positive-sequence impedance to a ground fault. It should be set for:

$$K0 = Z0L / Z1L$$

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

Line Length, LINELEN

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

Example Settings (based on Figure CS-1):

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

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

The requirements for the zone 1 settings are independent of which scheme is selected.

Select Zone 1 Ground, SELZ1G

SELZ1G can be set to either YES or NO. This setting determines whether the zone 1 ground-distance functions are in service (YES) or out of service (NO).

Select Zone 1 Phase, SELZ1P

SELZ1P can be set to either YES or NO. This setting determines whether the zone 1 phase-distance functions are in service (YES) or out of service (NO).

Reach Setting (M1) Zone 1 Phase, Z1R

Reach Setting (M1G) Zone 1 Ground, Z1GR

Z1R and Z1GR can be set over the range of 0.01 - 50.00 x (5/IN) 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 CS-8 to determine the maximum reach in percent of positive-sequence impedance of the protected line as a function of the source to line ratio.

Select Zone 1 Ground Unit, SELZ1U

SELZ1U can be set to either 0 (MHO) or 1 (REACT). This setting determines the type of measuring unit used for the zone 1 ground-distance functions, either a Mho unit or a Reactance unit. Except for very short lines, it is recommended that the Mho unit be used, since its operating time is slightly faster than that of the Reactance unit. A "very short line" is one where the positive-sequence source impedance (equivalent source impedance behind the relay location) divided by the positive-sequence impedance of the protected line is greater than 5. Note that the value of 5 is a suggested boundary value, not an absolute cutoff, and that a reactance unit can be selected for a long line if desired.

Reach Setting of Mho Unit, Z1SU

This setting is not relevant unless the zone 1 ground-distance functions have been set to be reactance units (see SELZ1U above). Since the reactance unit is non-directional, it is supervised by a Mho unit, as shown in Figure CS-2, to make it directional. Z1SU can be set over the range of 0.01 - 50.00 x (5/IN) 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 CS-3 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 DLP is that the reach of the supervising Mho unit is adjusted as the load flow changes. The reach can never be less than Z1SU, but it can be larger. As the load flow decreases, the load impedance becomes larger, and the reach is increased while maintaining the 40° differential between angles A and B. If the load now increases, the reach will be decreased but will never be less than Z1SU. This adaptive-reach feature optimizes the reactance unit coverage for ground-fault impedance.

Zero-Sequence Current Compensation, Z1K0

Z1K0 can be set over the range of 1.0 - 7.0. This setting determines the amount of zero-sequence current fed back into the zone 1 ground-distance functions to provide "self-compensation." This permits the reach setting to be based on the positive-sequence impedance to a ground fault. It should be set for:

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

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

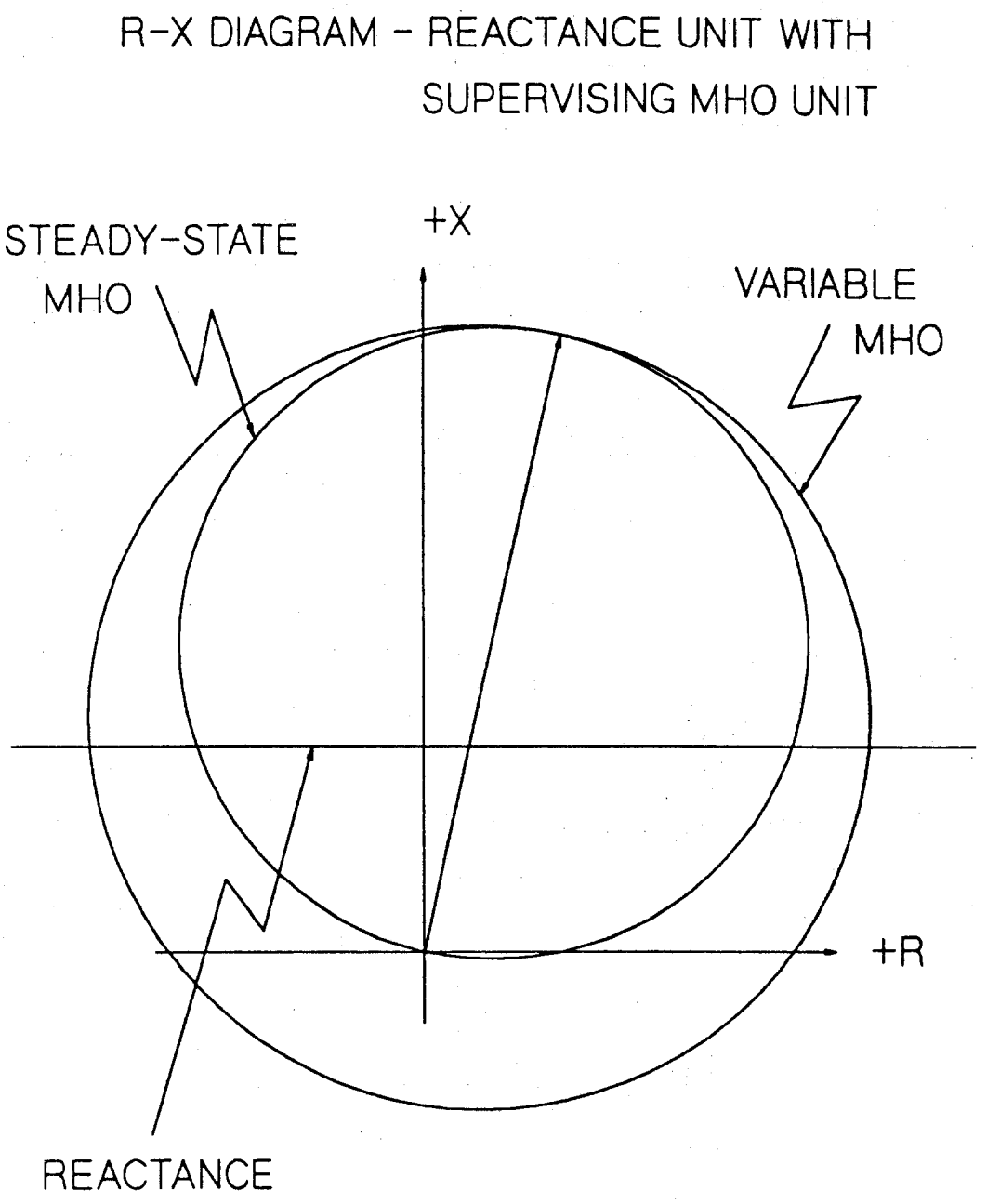
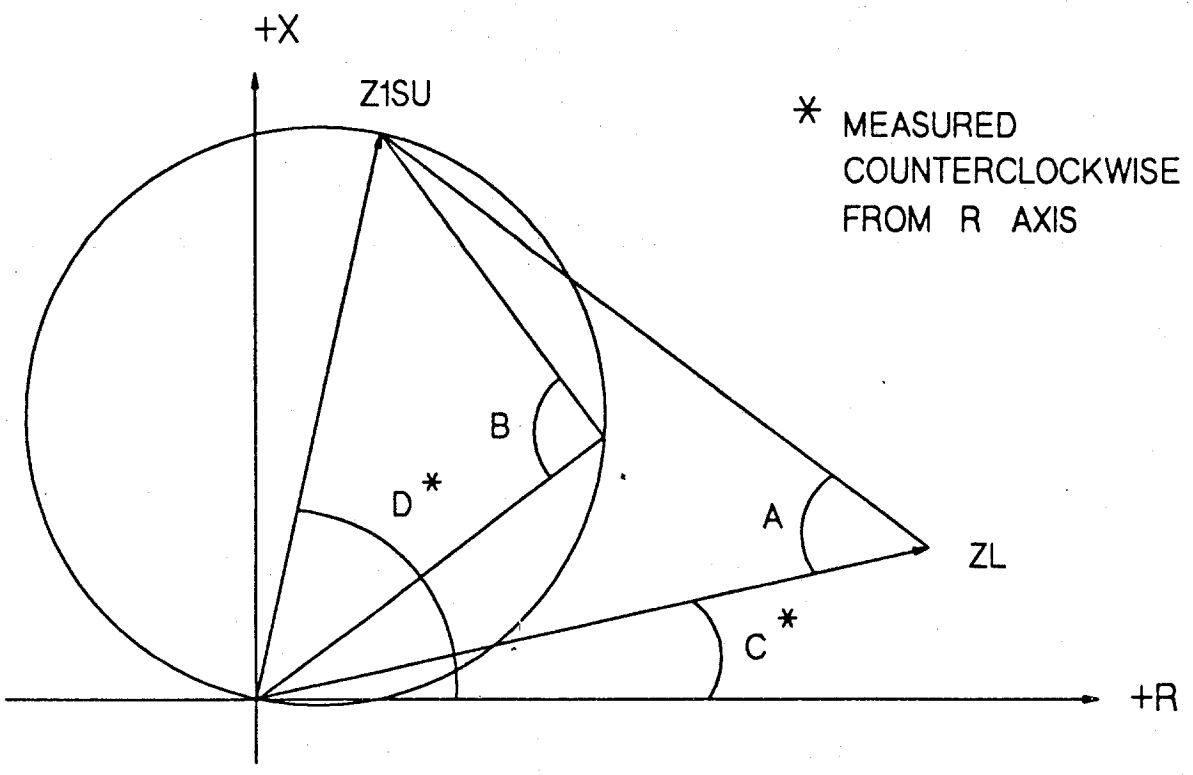


Figure CS-2 (0286A2917) MHO Unit R-X Diagram (Supervision of Reactance Unit)



$$Z1SU = \frac{SIN(A) \times ZL}{SIN(180-A-E)}$$

A = 50

B = 90

C = LOAD IMPEDANCE ANGLE

D = POSITIVE-SEQUENCE ANGLE OF MAXIMUM REACH = POSANG

E = |D -C|

ZL = MINIMUM LOAD IMPEDANCE

Figure CS-3 (0286A2918) Z1SU

Example Settings (based on Figure CS-1):

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

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

Referring to Figures CS-1 and CS-3:

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 x sin(50°) / sin(180° -50° -79.4°) = 19.53

OVERCURRENT BACKUP, OVERCUR

Select Phase Instantaneous Overcurrent (PH4), SELPH4

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

Phase Instantaneous Overcurrent Setting, PUPH4

Since PH4 is a non-directional direct-trip function it must be set not to operate on the worst case external fault at either end of the line. Such a safe setting may mean that little or no coverage is provided for internal faults. Whether or not a usable setting can be made will depend on the system impedance values.

PH4 provides direct tripping for multi-phase faults, and it operates on the highest of the three delta currents, IA-IB, IB-IC, or IC-IA. This permits PH4 to have the same response for all multi-phase faults at the same location. PUPH4 should be set at least 25% greater than the maximum three-phase fault current at either terminal of the protected line. The setting is calculated on the basis of the delta current which for a three phase fault is equal to the square root of three times the phase current. PUPH4 can be set over the range of (0.4-20.0) x IN amps.

Select Ground Instantaneous Overcurrent (IDT), SELIDT

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

Directional Control of IDT, SELDIDT

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

Ground Instantaneous Overcurrent Setting, PUIDT

The considerations used to determine the IDT setting depend on whether IDT is non-directional or directionally controlled. If IDT is non-directional, then it must be set not to operate on the worst case external fault at either end of the line. If IDT is controlled by the NT directional function, then it must be set not to operate, 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:

$$3x|I0| - 3xKDx|I1|$$

where: KD = 0.3

Positive-sequence current restraint is used to provide secure operation during steady-state unbalances, error currents, and external faults. The IDT setting is established by first determining the maximum positive value of the operating quantity listed above. PUIDT is then this maximum operate signal plus a margin of 25% of the 3x|I0| value from this same maximum operate signal.

$$PUIDT = 3x|I0| - 3xKDx|I1| + 0.25x3x|I0|$$

PUIDT can be set over the range of (0.1-16.0) x IN amps.

Select Ground Time Overcurrent (TOC), SELTOC

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

Select Directional Control of TOC, SELDTOC

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

Ground Time Overcurrent Setting, PUTOC

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

$$3x|I0|$$

TOC uses a very-inverse time-current curve shape as shown in Figure CS-7. PUTOC can be set over the range of (0.04-3.00) x IN 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

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

Example Settings (based on Figure CS-1):

SELPH4 = YES

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

Bus	Fault Current
Able	7.18 amps
Baker	8.3 amps

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

PUPH4 = 1.25 x 1.732 x 8.3 = 18.0 amps
SELIDT = YES

The table below lists the results of the evaluation of the IDT operate quantity, $3x|I0| - 3xKDx|I1|$, for phase-A-to-ground faults at the two protected-line busses under the conditions indicated:

Fault Bus	Brkr. C	Brkr. E	Load ?	3x|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 equivalent source impedance

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

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

PUTOC = 0.20 amps
TDTOC = 2.0

LINE PICKUP, LINEPU

Select Line Pickup, SELLPU

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

Positive-Sequence Overcurrent (I1) Setting, PUI1

I1 is the overcurrent trip unit within the Line Pickup function, and it operates on the magnitude of the positive-sequence current. PUI1 can be set over the range of (0.2-3.0)xIN amps.

I1 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.

Select Timer Bypass, SELTBP

SELTBP can be set to either YES or NO. This setting determines whether the coordinating timer TL3 in Figure PD-7 is bypassed (YES) or left in service (NO).

If high-speed simultaneous reclosing is used and I1 is set below the maximum load current, then SELTBP should be set to NO to place timer TL3 in service. This will prevent tripping on load current that might be initiated when picking up the line. If I1 can be set with a pickup of at least 110% of the maximum load current, if sequential reclosing is used, or if there is no automatic reclosing, then SELTBP should be set to YES, to bypass coordinating timer TL3 to obtain faster tripping.

Example Settings (based on Figure CS-1):

SELLPU = YES

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

PUI1 = 1.1 x 3.29 = 3.6 amps
SELTBP = YES

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.

Select Line Overload, SELOVL

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

Level 1 Overcurrent Setting, PULV1

PULV1 can be set over the range of (1.0-4.0) x IN amps.

Level 2 Overcurrent Setting, PULV2

PULV2 can be set over the range of (2.0-8.0) x IN amps.

Level 1 Time Delay (TL31), PUTL31

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

Level 2 Time Delay (TL32), PUTL32

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

Example Settings (based on Figure CS-1):

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

OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP

Select Phase Trip Unit to Coordinate With, SELPTZ

SELPTZ can be set for 0 (ZONE 2), 1 (ZONE 3), or 2 (ZONE 4). This setting establishes which zone of phase-distance functions the out-of-step characteristic (MOB) coordinates with (see Figure PD-6). Note that the reach at the angle of maximum reach for the MOB characteristic is equal to that of the selected zone. SELPTZ can only be set to 2 if zone 4 is set with a forward reach.

Characteristic Angle, MOBANG

This setting determines the shape of the MOB characteristic on the R-X diagram, and it determines the separation between the MOB and phase trip functions on the R-X diagram. This separation and the initial pickup delay of timer TL1 in Figure PD-6 determines whether or not the OSB function will detect the fastest swing-impedance locus during the first slip cycle.

The initial pickup of TL1 is fixed at 30 milliseconds, consequently MOBANG must be adjusted to assure operation on the first slip cycle. If complete information, consisting of the fastest swing-impedance locus and time rate of change along the locus, is not known, then it is suggested that MOBANG be set for 20° less than the characteristic angle of the associated phase-distance functions. A lower limit on MOBANG is that MOB should not operate for the maximum load (minimum load impedance). MOBANG may be set over the range of 30° - 130°.

Select Block Trip Actions, SELOSB

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

0 (BLKALL) - Block all tripping
1 (BLKDIST) - Block all distance function and channel tripping
2 (BLKNONE) - No tripping functions are blocked

When SELOSB = 1, only the instantaneous overcurrent and time overcurrent functions can produce a trip.

Example Settings (based on Figure CS-1):

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

SELPTZ = 0 (ZONE 2)
MOBANG = 90 - 20 = 70
SELOSB = 1 (BLKDIST)

BLOCK RECLOSING, BLK RECLOS

These settings determine which function or logic outputs are used to block the Reclose Initiate (RI) output and operate the Reclose Cancel (RC) output in addition to Line Pickup. Refer to the OR9 input labelled "BLOCK RECLOSING" in Figures PD-1, PD-2, and PD-3.

Select All (of the below)	SELALL
Out-of-Step Block,	RBOSB
3-Phase Faults,	RB3PH
Ground Time Overcurrent,	RBTOC
Zone 2 Timers,	RBZ2T
Zone 3 Timers,	RBZ3T
Zone 4 Timers,	RBZ4T

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

Example Settings (based on Figure CS-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, SCADA DTA

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

SCADA DTA Fault Location Lock, FLTLOCK

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

SCADA DTA Fault Location Reset, FLTRESET

FLTRESET can be set over the range of 0 - 999 minutes. FLTRESET is used to specify a time period after a fault at the expiration of which the fault location information stored in the DTA module is reset (output forced to full-scale value). A setting of 0 corresponds to an infinite time.

Example Settings (based on Figure CS-1):

FLTLOCK = 10 seconds
FLTRESET = 5 minutes

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

SCHEME SELECTION, SCHEMESEL

The settings that have not been discussed above are directly or indirectly related to the type of scheme selected. Consequently, the remaining settings under category-of-settings headings ZONE 2 / PILOT ZONE, ZONE 3 DISTANCE FUNCTIONS, ZONE 4 DISTANCE FUNCTIONS, OVERCURRENT SUPERVISION, SCHEME LOGIC TIMERS, and REMOTE OPEN DETECTOR will be considered separately for each of the five possible schemes.

Select Scheme, SELSCM

SELSCM has five possible settings:

0 (STEPDST) - Step Distance
1 (POTT) - Permissive Overreach Transfer Trip
2 (PUTT) - Permissive Underreach Transfer Trip
3 (HYBRID) - Hybrid
4 (BLOCK) - Blocking

All the schemes except Step Distance require a communications channel.

SETTINGS FOR STEP DISTANCE SCHEME

Select Scheme, SELSCM

SELSCM = 0 (STEPDST)

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G

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

Select Zone 2 Phase, SELZ2P

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

Reach Setting (MT) Zone 2 Phase, Z2R

Z2R can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Step Distance scheme Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. Typically, on a two-terminal line, Z2R would be set for 125-150% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to: (1) cause the MT functions to pick up on the maximum load flow or (2) cause the MT functions to lose selectivity with the second zone phase-distance functions on the shortest adjoining line section. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2P with additional time delay.

Reach Setting (MTG) Zone 2 Ground, Z2GR

Z2GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Step Distance scheme Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z2GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram or (2) cause the MTG functions to lose selectivity with the second zone ground-distance functions on the shortest adjoining line section. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity by setting timer TL2G with additional time delay.

Select Zone 2 Ground Unit, SELZ2U

This setting permits choosing either Mho ground distance, ground directional-overcurrent, or both, for zone 2. For a Step Distance scheme, SELZ2U = 0 (MHO) must be selected. If SELZ2G = NO, then this setting has no effect.

Select Zone 2 Timers, SELZ2T

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

Phase Timer Setting, PUTL2P

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

Ground Timer Setting, PUTL2G

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

Phase Characteristic Angle, Z2PANG

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 CS-4. 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 CS-5. The criterion used for establishing the maximum reach given in Figure CS-5 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle, Z2GANG

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 CS-5. The criterion used for establishing the maximum reach given in Figure CS-5 is based on maintaining a 40° angular margin between angle A and angle B.

ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Select Zone 3 Ground, SELZ3G

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

Select Zone 3 Phase, SELZ3P

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

Reach Setting (M3) Zone 3 Phase, Z3R

Z3R can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Step Distance scheme zone 3 provides backup protection for adjoining line sections out of the remote bus, and Z3R should be set to see a multi-phase fault at the end of the longest adjoining line section out of the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. Z3R should never be set so large as to: (1) cause the M3 functions to pick up on the maximum load flow or (2) cause the M3 functions to lose selectivity with the third zone phase-distance functions on the shortest adjoining line section out of the remote bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

CHARACTERISTIC SHAPE
VERSUS
CHARACTERISTIC ANGLE

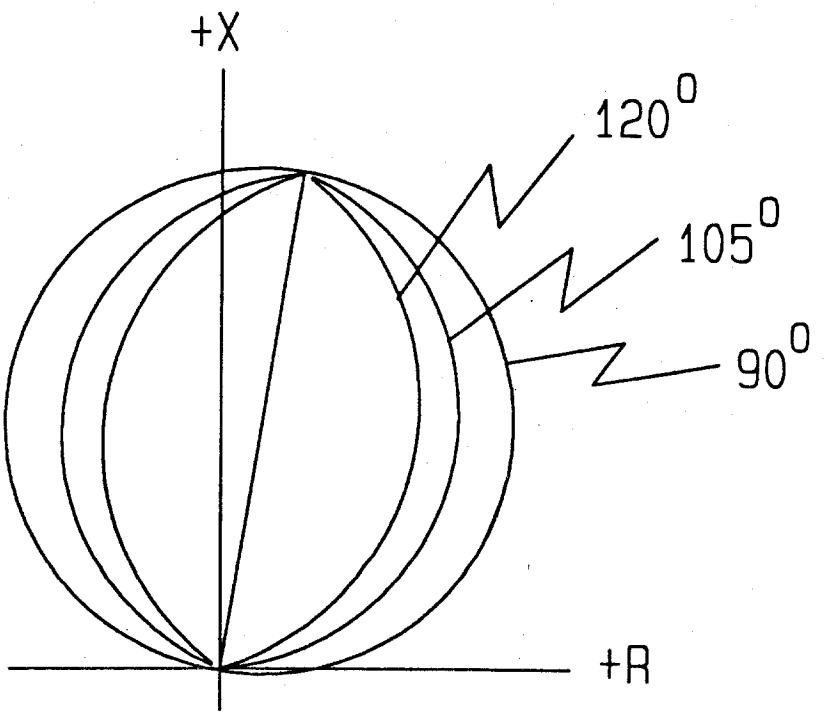
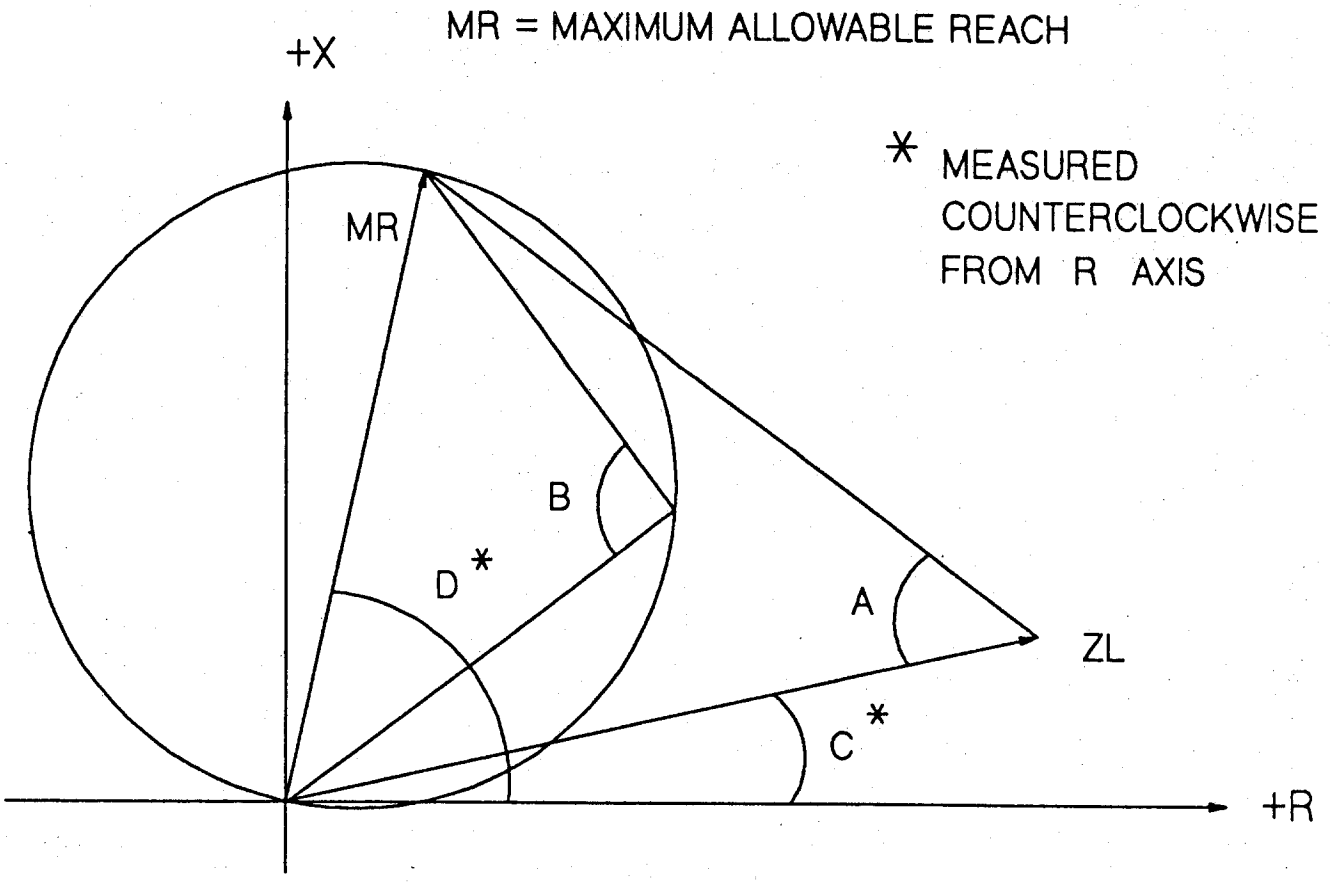


Figure CS-4 (0286A2910) MT R-X Diagram



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

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 CS-5 (0286A2913) Maximum Allowable Reach

Reach Setting (M3G) Zone 3 Ground, Z3GR

Z3GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Step Distance scheme zone 3 provides backup protection for adjoining line sections out of the remote bus, and Z3GR should be set to see a ground fault at the end of the longest adjoining line section out of the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z3GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the M3G characteristic on an R-X diagram or (2) cause the M3G functions to lose selectivity with the third zone ground-distance functions on the shortest adjoining line section out of the remote bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Phase Timer Setting, PUTL3P

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

Ground Timer Setting, PUTL3G

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

Phase Characteristic Angle, Z3PANG

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 CS-4. Z3PANG can be set to 90°, 105°, or 120°. A 90° setting is recommended. If the desired reach, Z3R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a "lens-shaped" characteristic associated with the 105° or 120° setting may prevent operation on load without having to reduce the reach. The settings of both Z3R and Z3PANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method of Figure CS-5. The criterion used for establishing the maximum reach given in Figure CS-5 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle, Z3GANG

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the M3G ground-distance functions. Z3GANG can be set to 90°, 105°, or 120°. A 90° setting should be used unless the desired reach, Z3GR, is such that the impedance point associated with the maximum load flow plots within the M3G steady-state characteristic. The settings of both Z3GR and Z3GANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method of Figure CS-5. The criterion used for establishing the maximum reach given in Figure CS-5 is based on maintaining a 40° angular margin between angle A and angle B.

ZONE 4 DISTANCE FUNCTIONS, Z4DIST

Select Zone 4 Ground, SELZ4G

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

Select Zone 4 Phase, SELZ4P

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

Select Direction, SELZ4D

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

Reach Setting (M4) Zone 4 Phase, Z4R

Z4R can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Step Distance scheme a reversed-zone 4 provides backup protection for line sections out of the local bus, and Z4R should be set to see a multi-phase fault at the end of the longest line section, considering such factors as arc resistance and underreach caused by intermediate fault current sources. Z4R should never be set so large as to: (1) cause the M4 functions to pick up on the maximum load flow or (2) cause the M4 functions to lose selectivity with the second zone phase-distance functions on the shortest line section out of the local bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Phase Offset Reach, Z4OR

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 CS-6. For Step Distance schemes, an offset reach should only be considered when SELZ4D = 1 (REVERS). For the case of a zero-voltage three-phase fault at the relay location, an offset setting keeps the M4 functions and the associated zone timer continuously energized for the duration of the fault since M4 can now operate on fault current only.

Reach Setting (M4G) Zone 4 Ground, Z4GR

Z4GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Step Distance scheme a reverse-looking zone 4 provides backup protection for line sections out of the local bus, and Z4GR should be set to see a ground fault at the end of the longest line section, considering such factors as ground-fault impedance, underreach caused by intermediate fault current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. Z4GR should never be set so large as to: (1) cause the impedance point associated with the maximum load flow to plot within the M4G characteristic on an R-X diagram or (2) cause the M4G functions to lose selectivity with the second zone ground-distance functions on the shortest line section out of the local bus. If item (2) above cannot be met by limiting the reach, then it may be necessary to get this selectivity with additional time delay.

Phase Timer Setting, PUTL4P

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

Ground Timer Setting, PUTL4G

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

Phase Characteristic Angle, Z4PANG

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

Ground Characteristic Angle, Z4GANG

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

OVERCURRENT SUPERVISION, CURSUPVIS

Ground Pilot Trip (IPT) Overcurrent, PUIPT
Ground Pilot Block (IPB) Overcurrent, PUIPB

For a Step Distance scheme, the pilot overcurrent functions are not used since SELZ2U = 0 (MHO). IPT and IPB can be set for any value within their range without affecting scheme operation.

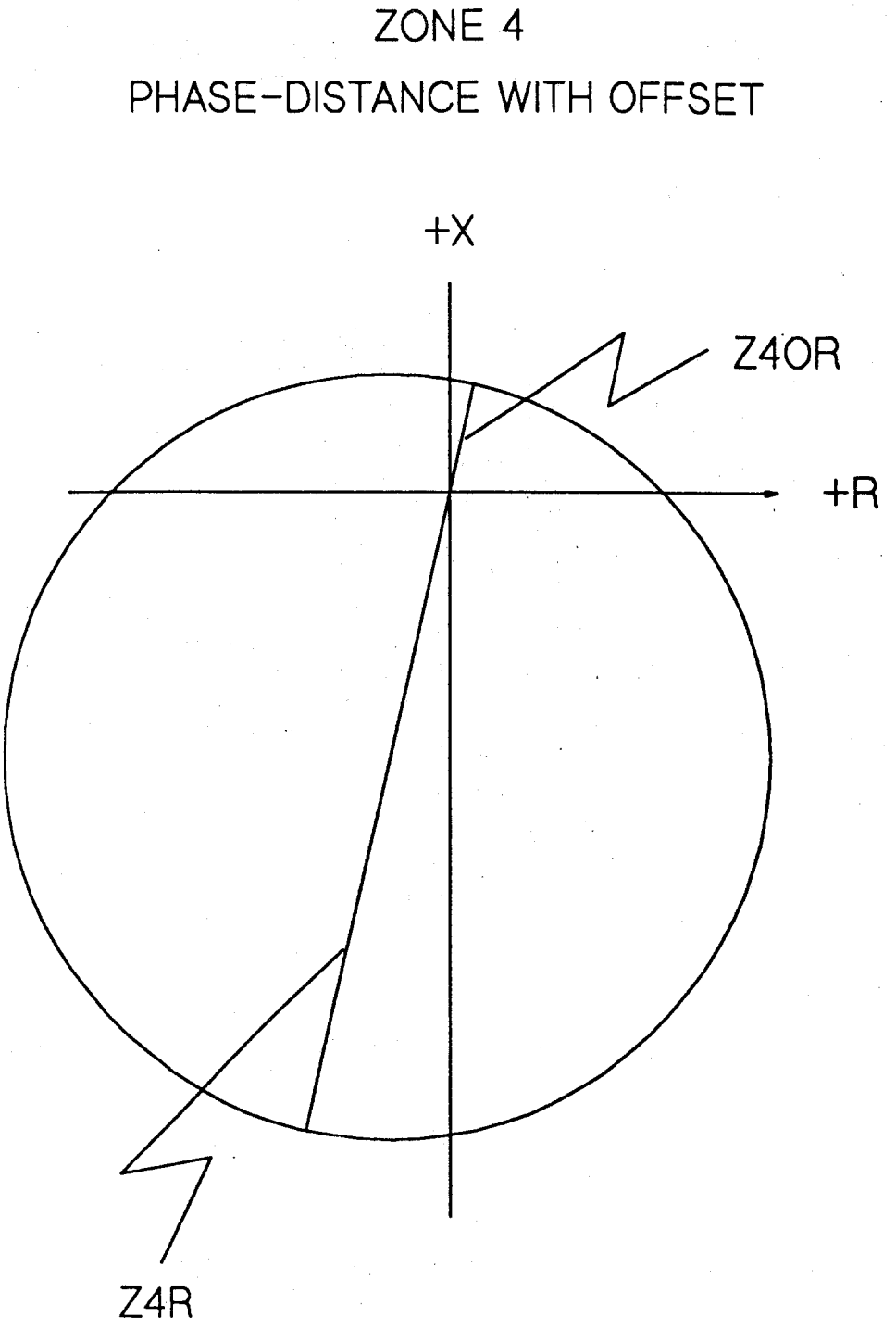


Figure CS-6 (0286A2914) ZONE 4 Phase Distance Diagram

Trip Supervision (IT) Overcurrent, PUIT
Block Supervision (IB) Overcurrent, PUIB

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip bus seal-in circuit. For a Step Distance scheme, IT and IB should have the same setting. PUIT can be set over the range of (0.04 - 0.80) x IN amps, but PUIB can only be set over the range of (0.04 - 0.40) x IN amps. It is recommended that PUIT and PUIB be set at their minimum value.

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1
POTT Coordination (TL4) Pickup, PUTL4

PUTL1 can be set over the range of 1 - 50 milliseconds. PUTL4 can be set over the range of 0 - 50 milliseconds. For a Step Distance scheme, both PUTL1 and PUTL4 should be set at their minimum values.

52/b Contact Coordination (TL5) Pickup, PUTL5
52/b Contact Coordination (TL5) Dropout, DOTL5
52/b Contact Coordination (TL6) Pickup, PUTL6
52/b Contact Coordination (TL6) Dropout, DOTL6

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the Step Distance scheme logic, these timers are not a part of that logic. However, the DLP's Sequence of Events uses the 52/b contact(s) to provide a time-tagged event to indicate either "breaker tripped" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure PD-4. TL5 and TL6 provide coordinating times to synchronize the breaker 52/b switch contact operation with the opening and closing of the breaker's main interrupting contacts. The pickup time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip (TL16) pickup, PUTL16

PUTL16 can be set over the range of 8 - 80 milliseconds. Since TL16 is not part of the Step Distance scheme logic, PUTL16 can be set at any value within its range.

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD

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

Timer (TL20) Delay Setting, PUTL20

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

SELFFB can be set to either YES or NO. When SELFFB = YES, the output of the Potential Transformer Fuse Failure function will block all tripping. When SELFFB = NO, the Potential Transformer Fuse Failure function will not block tripping when it operates for a blown potential fuse(s). It is suggested that SELFFB = YES.

Example Settings (based on Figure CS-1):

SCHEME SELECTION, SCHEMESEL

SELSCM = 0 (STEPDST)
NUMRCVR = 0

ZONE2 / PILOT ZONE, Z2DIST

SELZ2G = YES
SELZ2P = YES
Z2R = 1.25 x 6 = 7.50 ohms
Z2GR = 1.25 x 6 = 7.50 ohms
SELZ2U = 0 (MHO)
SELZ2T = YES
PUTL2P = 0.2 seconds
PUTL2G = 0.2 seconds
Z2PANG = 90
Z2GANG = 90

The formula from Figure CS-5 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 will amplify the apparent impedance seen by the M3 functions at ABLE for a multi-phase fault at the end of the longest adjoining line section EF. With line section CD switched out, the positive-sequence impedance at ABLE for a three-phase fault at DELTA is 6 + 4.5 = 10.5 ohms. With line section C-D in service, the positive-sequence impedance at ABLE for a three-phase fault at DELTA is:

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

where: ICD = 4.41 amps

IAB = 5.04 amps

$$Z(ABLE) = 6 + 4.5 + (4.41/5.04) \times 4.5 = 14.44 \text{ ohms}$$

$$Z3R = 14.44 \text{ ohms}$$

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

$$Z0(AB)/Z1(AB) = Z0(CD)/Z1(CD) = Z0(EF)/Z1(EF) = K0$$

is made, then the equation presented below is valid.

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

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

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

$I\phi(AB) = 2.71$ amps $\quad I\phi(CD) = 3.29$ amps
$I0(AB) = 0.50$ amps $\quad I0(CD) = 0.68$ amps

Therefore,

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

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

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: $I\phi = 2.71 \angle -82.0°$
$I0 = 0.50 \angle -76.9°$

$V\phi G = 61.1 \angle -0.2°$ (phase-to-ground voltage)

$$Z(ABLE) = 16.00 \angle 80.3°$$

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 CS-5 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 = 14.44 and Z3PANG = 90, there is no risk of having the M3 functions pick up for the maximum load condition. Similarly, with Z3GR = 16.00 and Z3GANG = 90, the apparent impedance for the maximum load condition will not plot within the M3G characteristic.

ZONE 4 DISTANCE FUNCTIONS, Z4DIST

SELZ4G = NO
SELZ4P = NO

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

OVERCURRENT SUPERVISION, CURSUPVIS

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

SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1 = 1 ms.
PUTL4 = 0

Since NUMBKRS=1, the 52/b contact would be wired to CC1 if breaker-trip-and-close-event reporting is desired. 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

TABLE CS-2: SETTINGS - STEP DISTANCE SCHEME (1 OF 4)

SETT#	DESCRIPTION	SETTING
(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 UNITS, SELPRIM	
(1506)	CURRENT TRANSFORMER RATIO, CTRATIO	
(1507)	POTENTIAL TRANSFORMER RATIO, PTRATIO	
(1508)	UNITS OF DISTANCE, DISTUNIT	
(1509)	COMMUNICATION BAUD RATE, BAUDRATE	
(1510)	PHASE DESIGNATION, PHASDESG	
(14)	LINE QUANTITIES, LINE QTY	
(1401)	POS.-SEQUENCE ANGLE OF MAX. REACH, POSANG	
(1402)	ZERO-SEQUENCE ANGLE OF MAX. REACH, ZERANG	
(1403)	POSITIVE-SEQUENCE IMPEDANCE, ZP	
(1404)	ZERO-SEQUENCE CURRENT COMPENSATION, K0	
(1405)	LINE LENGTH, LINELEN	
(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	
(06)	OVERCURRENT BACKUP, OVERCUR	
(0601)	SELECT PHASE INST. OC (PH4), SELPH4	
(0602)	PHASE INST. OVERCURRENT SETTING, PUPH4	
(0603)	SELECT GROUND INST. OC (IDT), SELIDT	
(0604)	DIRECTIONAL CONTROL OF IDT, SELDIDT	
(0605)	GROUND INST. OVERCURRENT SETTING, PUIDT	

TABLE CS-2: SETTINGS - STEP DISTANCE SCHEME (2 OF 4)

SETT#	DESCRIPTION	SETTING
(0606)	SELECT GROUND TIME OC (TOC), SELTOC	
(0607)	DIRECTIONAL CONTROL OF TOC, SELDTOC	
(0608)	GROUND TIME OVERCURRENT SETTING, PUTOC	
(0609)	GROUND TIME OVERCURRENT TIME DIAL, TDTOC	
(09)	LINE PICKUP, LINEPU	
(0901)	SELECT LINE PICKUP, SELLPU	
(0902)	SELECT TIMER BYPASS, SELTBP	
(0903)	POSITIVE-SEQUENCE OC (I1) SETTING, PUI1	
(11)	LINE OVERLOAD, LINE OVRLD	
(1101)	SELECT LINE OVERLOAD, SELOVL	
(1102)	LEVEL 1 OVERCURRENT SETTING, PULV1	
(1103)	LEVEL 2 OVERCURRENT SETTING, PULV2	
(1104)	LEVEL 1 TIME DELAY, PUTL31	
(1105)	LEVEL 2 TIME DELAY, PUTL32	
(08)	OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP	
(0801)	SELECT PHASE UNIT TO COORD. WITH, SELPTZ	
(0802)	CHARACTERISTIC ANGLE, MOBANG	
(0803)	SELECT BLOCK TRIP ACTIONS, SELOSB	
(07)	BLOCK RECLOSING, BLK RECLOS	
(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	
(16)	SCADA DTA INTERFACE, SCADA DTA	
(1601)	SCADA DTA FAULT LOCATION LOCK, FLTLOCK	
(1602)	SCADA DTA FAULT LOCATION RESET, FLTRESET	

TABLE CS-2: SETTINGS - STEP DISTANCE SCHEME (3 OF 4)

SETT#	DESCRIPTION	SETTING
(12)	SCHEME SELECTION, SCHEMESEL	
(1201)	SELECT SCHEME, SELSCM	
(1202)	NUMBER OF RECEIVERS, NUMRCVR	
(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, SELZ2U	
(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, Z2PANG	
(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 2 GROUND, Z3GR	
(0305)	PHASE TIMER SETTING, PUTL3P	
(0306)	GROUND TIMER SETTING, PUTL3G	
(0307)	PHASE CHARACTERISTIC ANGLE, Z3PANG	
(0308)	GROUND CHARACTERISTIC ANGLE, Z3GANG	
(04)	ZONE 4 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, Z40R	
(0406)	PHASE TIMER SETTING, PUTL4P	

TABLE CS-2: SETTINGS - STEP DISTANCE SCHEME (4 OF 4)

SETT#	DESCRIPTION	SETTING
(0407)	GROUND TIMER SETTING, PUTL4G	
(0408)	PHASE CHARACTERISTIC ANGLE, Z4PANG	
(0409)	GROUND CHARACTERISTIC ANGLE, Z4GANG	
(0410)	SELECT DIRECTION, SELZ4D	
(05)	OVERCURRENT SUPERVISION, CURSUPVIS	
(0501)	GROUND PILOT TRIP (IPT) OVERCURRENT, PUIPT	<NA>
(0502)	GROUND PILOT BLOCK (IPB) OVERCURRENT, PUIPB	<NA>
(0503)	TRIP SUPERVISION (IT) OVERCURRENT, PUIT	
(0504)	BLOCK SUPERVISION (IB) OVERCURRENT, PUIB	
(13)	SCHEME LOGIC TIMERS, SCHEMETIM	
(1301)	TRIP INTEGRATOR (TL1) PICKUP, PUTL1	1
(1302)	52/B CONTACT COORDINATION (TL5) PU, PUTL5	
(1303)	52/B CONTACT COORDINATION (TL5) DO, DOTL5	
(1304)	52/B CONTACT COORDINATION (TL6) PU, PUTL6	
(1305)	52/B CONTACT COORDINATION (TL6) DO, DOTL6	
(1306)	POTT COORDINATION (TL4) PICKUP, PUTL4	0
(1307)	WEAK-IN-FEED TRIP (TL16) PICKUP, PUTL16	<NA>
(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	

<NA> = NOT APPLICABLE (no setting required: setting can be at any value within specified range without affecting scheme operation)

OTHER VALUES SHOWN ABOVE ARE REQUIRED FOR THIS SCHEME.

SETTINGS FOR PERMISSIVE OVERREACH TRANSFER TRIP SCHEME

Select Scheme, SELSCM

SELSCM = 1 (POTT)

Number of Receivers, NUMRCVR

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G

SELZ2G can be set to either YES or NO. For a POTT scheme, set SELZ2G = YES since ground-fault protection is required.

Select Zone 2 Phase, SELZ2P

SELZ2P can be set to either YES or NO. For a POTT scheme, set SELZ2P = YES since phase-fault protection is required.

In a POTT scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, the MT and MTG functions may be used for zone 2 back-up. 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 back-up reach may be less than the desired reach for the pilot overreaching zone. In this case, the zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the zone 2 reach, and the M4 and M4G functions can be set for the zone 3 reach.

The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the section above entitled "Settings for Step Distance Scheme" for a discussion of the settings for zone 2 back-up.

Reach Setting (MT) Zone 2 Phase, Z2R

Z2R can be set over the range of 0.01 - 50.00 x (5/IN ohms). In a POTT scheme, Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. For a two-terminal line, it is suggested that Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to cause the MT functions to pick up on the maximum load flow.

Reach Setting (MTG) Zone 2 Ground, Z2GR

Z2GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a POTT scheme, Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. For a two-terminal line with no mutual coupling, it is suggested that Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram.

Select Zone 2 Ground Unit, SELZ2U

SELZ2U can be set for 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting permits choosing either Mho ground-distance, ground directional-overcurrent, or both, for the pilot overreaching zone. For a POTT scheme, any one of the three settings is possible. The ground directional overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U = GDOC, zone 2 back-up protection can still be provided by the MTG functions. With SELZ2U = MHOGDOC, both Mho ground-distance and ground directional-overcurrent are operating simultaneously for the pilot overreaching zone.

Select Zone 2 Timers, SELZ2T

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

Phase Timer Setting, PUTL2P
Ground Timer Setting, PUTL2G

Refer to the section above entitled "Settings for Step Distance Scheme: SELSCM = 0 (STEPDST)" for a description of the required settings for these two functions if SELZ2T = YES.

Phase Characteristic Angle, Z2PANG

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 CS-4. 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 CS-5. The criterion used for establishing the maximum reach given in Figure CS-5 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle, Z2GANG

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 CS-5. The criterion used for establishing the maximum reach given in Figure CS-5 is based on maintaining a 40° angular margin between angle A and angle B.

ZONE 3 DISTANCE FUNCTIONS, Z3DIST
ZONE 4 DISTANCE FUNCTIONS, Z4DIST

Refer to the section above entitled "Settings for Step Distance Scheme" for a description of the required settings for these two categories.

OVERCURRENT SUPERVISION, CURSUPVIS

Ground Pilot Trip (IPT) Overcurrent, PUIPT

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

$$3x|I0|$$

PUIPT can be set over the range of (0.10 - 1.00) x IN amps. It is suggested that PUIPT be set to its minimum value of (0.10) x IN amps.

Ground Pilot Block (IPB) Overcurrent, PUIPB

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

Trip Supervision (IT) Overcurrent, PUIT
Block Supervision (IB) Overcurrent, PUIB

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip bus seal-in circuit. For a POTT scheme, IT and IB should have the same setting. PUIT can be set over the range of (0.04 - 0.80) x IN amps, but PUIB can only be set over the range of (0.04 - 0.40) x IN amps. It is recommended that PUIT and PUIB be set at their minimum value.

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1

PUTL1 can be set over the range of 1 - 50 milliseconds. For a POTT scheme, TL1 provides security against spurious channel output during external faults within the reach of the 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

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

PUTL1 = 8 ms.

PUTL4 = 17 ms. - PUTL1 + channel release time (in ms.)

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

52/b Contact Coordination (TL5) Pickup, PUTL5
52/b Contact Coordination (TL5) Dropout, DOTL5
52/b Contact Coordination (TL6) Pickup, PUTL6
52/b Contact Coordination (TL6) Dropout, DOTL6

All of these can be set over the range of 0 - 200 milliseconds. For a POTT scheme, 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 52/b contact(s) is used to key the local transmitter to the TRIP frequency when the breaker is open. The pickup time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip (TL16) pickup, PUTL16

PUTL16 can be set over the range of 8 - 80 milliseconds. Since TL16 is not part of the POTT scheme logic, PUTL16 can be set at any value within its range.

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD

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

Remote Open Timer (TL20) Pickup, PUTL20

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

Select Fuse Failure Block, SELFFB

SELFFB can be set to either YES or NO. When SELFFB = YES, the output of the Potential Transformer Fuse Failure function will block all tripping. When SELFFB = NO, the Potential Transformer Fuse Failure function will not block tripping when it operates for a blown potential fuse(s). It is suggested that SELFFB = YES.

Example Settings (based on Figure CS-1):

SCHEME SELECTION, SCHEMESEL
SELSCM = 1 (POTT)
NUMRCVR = 1

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure CS-5 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 = 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
ZONE 4 DISTANCE FUNCTIONS, Z4DIST

Refer to the "Example Settings" section above under "Settings for Step Distance Scheme" for an example of how to calculate the settings for these two categories. For this example SELZ2T = NO, therefore the Z3DIST settings will be based on zone 2 considerations and Z4DIST settings will be based on zone 3 considerations.

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
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

TABLE CS-3: SETTINGS - POTT SCHEME (1 OF 4)

SETT#	DESCRIPTION	SETTING
(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 UNITS, SELPRIM	
(1506)	CURRENT TRANSFORMER RATIO, CTRATIO	
(1507)	POTENTIAL TRANSFORMER RATIO, PTRATIO	
(1508)	UNITS OF DISTANCE, DISTUNIT	
(1509)	COMMUNICATION BAUD RATE, BAUDRATE	
(1510)	PHASE DESIGNATION, PHASDESG	
(14)	LINE QUANTITIES, LINE QTY	
(1401)	POS.-SEQUENCE ANGLE OF MAX. REACH, POSANG	
(1402)	ZERO-SEQUENCE ANGLE OF MAX. REACH, ZERANG	
(1403)	POSITIVE-SEQUENCE IMPEDANCE, ZP	
(1404)	ZERO-SEQUENCE CURRENT COMPENSATION, KO	
(1405)	LINE LENGTH, LINELEN	
(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, Z1KO	
(06)	OVERCURRENT BACKUP, OVERCUR	
(0601)	SELECT PHASE INST. OC (PH4), SELPH4	
(0602)	PHASE INST. OVERCURRENT SETTING, PUPH4	
(0603)	SELECT GROUND INST. OC (IDT), SELIDT	
(0604)	DIRECTIONAL CONTROL OF IDT, SELDIDT	
(0605)	GROUND INST. OVERCURRENT SETTING, PUIDT	

TABLE CS-3: SETTINGS - POTT SCHEME (2 OF 4)

SETT#	DESCRIPTION	SETTING
(0606)	SELECT GROUND TIME OC (TOC), SELTOC	
(0607)	DIRECTIONAL CONTROL OF TOC, SELDTOC	
(0608)	GROUND TIME OVERCURRENT SETTING, PUTOC	
(0609)	GROUND TIME OVERCURRENT TIME DIAL, TDTOC	
(09)	LINE PICKUP, LINEPU	
(0901)	SELECT LINE PICKUP, SELLPU	
(0902)	SELECT TIMER BYPASS, SELTBP	
(0903)	POSITIVE-SEQUENCE OC (I1) SETTING, PUI1	
(11)	LINE OVERLOAD, LINE OVRLD	
(1101)	SELECT LINE OVERLOAD, SELOVL	
(1102)	LEVEL 1 OVERCURRENT SETTING, PULV1	
(1103)	LEVEL 2 OVERCURRENT SETTING, PULV2	
(1104)	LEVEL 1 TIME DELAY, PUTL31	
(1105)	LEVEL 2 TIME DELAY, PUTL32	
(08)	OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP	
(0801)	SELECT PHASE UNIT TO COORD. WITH, SELPTZ	
(0802)	CHARACTERISTIC ANGLE, MOBANG	
(0803)	SELECT BLOCK TRIP ACTIONS, SELOSB	
(07)	BLOCK RECLOSING, BLK RECLOS	
(0701)	SELECT ALL, SELALL	
(0702)	OUT-OF-STEP BLOCK, RBOSB	
(0703)	ALL ZONE 2 PHASE FUNCTIONS, RB3PH	
(0704)	GROUND TIME OVERCURREN, RBTOC	
(0705)	ZONE 2 TIMERS, RBZ2T	
(0706)	ZONE 3 TIMERS, RBZ3T	
(0707)	ZONE 4 TIMERS, RBZ4T	
(16)	SCADA DTA INTERFACE, SCADA DTA	
(1601)	SCADA DTA FAULT LOCATION LOCK, FLTLOCK	
(1602)	SCADA DTA FAULT LOCATION RESET, FLTRESET	

TABLE CS-3: SETTINGS - POTT SCHEME (3 OF 4)

SETT#	DESCRIPTION	SETTING
(12)	SCHEME SELECTION, SCHEMESEL	
(1201)	SELECT SCHEME, SELSCM	
(1202)	NUMBER OF RECEIVERS, NUMRCVR	1 (POTT)
(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, SELZ2U	
(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 2 GROUND, Z3GR	
(0305)	PHASE TIMER SETTING, PUTL3P	
(0306)	GROUND TIMER SETTING, PUTL3G	
(0307)	PHASE CHARACTERISTIC ANGLE, Z3PANG	
(0308)	GROUND CHARACTERISTIC ANGLE, Z3GANG	
(04)	ZONE 4 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, Z40R	
(0406)	PHASE TIMER SETTING, PUTL4P	

TABLE CS-3: SETTINGS - POTT SCHEME (4 OF 4)

SETT#	DESCRIPTION	SETTING
(0407)	GROUND TIMER SETTING, PUTL4G	
(0408)	PHASE CHARACTERISTIC ANGLE, Z4PANG	
(0409)	GROUND CHARACTERISTIC ANGLE, Z4GANG	
(0410)	SELECT DIRECTION, SELZ4D	
(05)	OVERCURRENT SUPERVISION, CURSUPVIS	
(0501)	GROUND PILOT TRIP (IPT) OVERCURRENT, PUIPT	
(0502)	GROUND PILOT BLOCK (IPB) OVERCURRENT, PUIPB	<NA>
(0503)	TRIP SUPERVISION (IT) OVERCURRENT, PUIT	
(0504)	BLOCK SUPERVISION (IB) OVERCURRENT, PUIB	
(13)	SCHEME LOGIC TIMERS, SCHEMETIM	
(1301)	TRIP INTEGRATOR (TL1) PICKUP, PUTL1	
(1302)	52/B CONTACT COORDINATION (TL5) PU, PUTL5	
(1303)	52/B CONTACT COORDINATION (TL5) DO, DOTL5	
(1304)	52/B CONTACT COORDINATION (TL6) PU, PUTL6	
(1305)	52/B CONTACT COORDINATION (TL6) DO, DOTL6	
(1306)	POTT COORDINATION (TL4) PICKUP, PUTL4	
(1307)	WEAK-IN-FEED TRIP (TL16) PICKUP, PUTL16	<NA>
(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	

<NA> = NOT APPLICABLE (no setting required: setting can be at any value within specified range without affecting scheme operation)

OTHER SPECIFIC VALUES SHOWN ABOVE ARE REQUIRED FOR THIS SCHEME.

SETTINGS FOR PERMISSIVE UNDERREACH TRANSFER TRIP SCHEME

Select Scheme, SELSCM

SELSCM = 2 (PUTT)

Number of Receivers, NUMRCVR

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G

SELZ2G can be set to either YES or NO. For a PUTT scheme, set SELZ2G = YES since ground-fault protection is required.

Select Zone 2 Phase, SELZ2P

SELZ2P can be set to either YES or NO. For a PUTT scheme, set SELZ2P = YES since phase-fault protection is required.

In a PUTT scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, the MT and MTG functions may be used for zone 2 back-up. 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 back-up reach may be less than the desired reach for the pilot overreaching zone. In this case, the zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the zone 2 reach, and the M4 and M4G functions can be set for the zone 3 reach. The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the section above entitled "Settings for Step Distance Scheme" for a discussion of the settings for zone 2 back-up.

Reach Setting (MT) Zone 2 Phase, Z2R

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

Reach Setting (MTG) Zone 2 Ground, Z2GR

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

Select Zone 2 Ground Unit, SELZ2U

SELZ2U can be set for 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting permits choosing either Mho ground-distance, ground directional-overcurrent, or both, for the pilot overreaching zone. For a PUTT scheme, any one of the three settings is possible. However, since zone 1 uses only distance functions, there is not much value in selecting ground directional-overcurrent for zone 2. Consequently, it is suggested that SELZ2U = 0 (MHO).

Select Zone 2 Timers, SELZ2T

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

Phase Timer Setting, PUTL2P
Ground Timer Setting, PUTL2G

Refer to the section above entitled "Settings for Step Distance Scheme" for a description of the required settings if SELZ2T = YES.

Phase Characteristic Angle, Z2PANG

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

Ground Characteristic Angle, Z2GANG

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

ZONE 3 DISTANCE FUNCTIONS, Z3DIST
ZONE 4 DISTANCE FUNCTIONS, Z4DIST

Refer to the section above entitled "Settings for Step Distance Scheme" for a description of the required settings for these two categories.

OVERCURRENT SUPERVISION, CURSUPVIS

Ground Pilot Trip (IPT) Overcurrent, PUIPT

If the suggested setting SELZ2U = 0 (MHO) is used for this PUTT scheme, IPT is not used. Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" if IPT is used.

Ground Pilot Block (IPB) Overcurrent, PUIPB

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

Trip Supervision (IT) Overcurrent, PUIT
Block Supervision (IB) Overcurrent, PUIB

These two overcurrent functions provide supervision for the distance functions, and IT is used in the trip bus seal-in circuit. For a PUTT scheme, IT and IB should have the same setting. PUIT can be set over the range of (0.04 - 0.80) x IN amps, but PUIB can only be set over the range of (0.04 - 0.40) x IN amps. It is recommended that PUIT and PUIB be set at their minimum value.

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1

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

POTT Coordination (TL4) Pickup, PUTL4

PUTL4 can be set over the range of 0 - 50 milliseconds. A PUTT scheme does not require a transient-blocking time delay. Since zone 1 functions are used to key the transmitter, the transmitter is not keyed to the TRIP frequency during an external fault, and there is no race between the reset of the receiver and pickup of a local pilot overreaching function following current reversals associated with sequential clearing of faults on a parallel line. Set PUTL4 = 0.

52/b Contact Coordination (TL5) Pickup, PUTL5
52/b Contact Coordination (TL5) Dropout, DOTL5
52/b Contact Coordination (TL6) Pickup, PUTL6
52/b Contact Coordination (TL6) Dropout, DOTL6

All of these can be set over the range of 0 - 200 milliseconds. For a PUTT scheme, 52/b contact keying of the local transmitter to the TRIP frequency when the breaker is open is **required** with a two-terminal line, but it should **not** be used at any end of a three-terminal line, to prevent tripping on external faults with one end open. TL5 and TL6 provide coordinating times to synchronize the breaker 52/b switch contact operation with the opening and closing of the breaker's main interrupting contacts. The pickup time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip (TL16) pickup, PUTL16

PUTL16 can be set over the range of 8 - 80 milliseconds. Since TL16 is not part of the PUTT scheme logic, PUTL16 can be set at any value within its range.

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD

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

Remote Open Timer (TL20) Pickup, PUTL20

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

Select Fuse Failure Block, SELFFB

SELFFB can be set to either YES or NO. When SELFFB = YES, the output of the Potential Transformer Fuse Failure function will block all tripping. When SELFFB = NO, the Potential Transformer Fuse Failure function will not block tripping when it operates for a blown potential fuse(s). It is suggested that SELFFB = YES.

Example Settings (based on Figure CS-1):

SCHEME SELECTION, SCHEMESEL

SELSCM = 2 (PUTT)
NUMRCVR = 1

ZONE2 / PILOT ZONE, Z2DIST

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

The formula from Figure CS-5 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 = 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
ZONE 4 DISTANCE FUNCTIONS, Z4DIST

Refer to the "Example Settings" section above under "Settings for Step Distance Scheme" for an example of how to calculate the settings for these two categories. For this example SELZ2T = NO, therefore the Z3DIST settings will be based on zone 2 considerations and Z4DIST settings will be based on zone 3 considerations.

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
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

TABLE CS-4: SETTINGS - PUTT SCHEME (1 OF 4)

SETT#	DESCRIPTION	SETTING
(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 UNITS, SELPRIM	
(1506)	CURRENT TRANSFORMER RATIO, CTRATIO	
(1507)	POTENTIAL TRANSFORMER RATIO, PTRATIO	
(1508)	UNITS OF DISTANCE, DISTUNIT	
(1509)	COMMUNICATION BAUD RATE, BAUDRATE	
(1510)	PHASE DESIGNATION, PHASDESG	
(14)	LINE QUANTITIES, LINE QTY	
(1401)	POS.-SEQUENCE ANGLE OF MAX. REACH, POSANG	
(1402)	ZERO-SEQUENCE ANGLE OF MAX. REACH, ZERANG	
(1403)	POSITIVE-SEQUENCE IMPEDANCE, ZP	
(1404)	ZERO-SEQUENCE CURRENT COMPENSATION, KO	
(1405)	LINE LENGTH, LINELEN	
(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, Z1KO	
(06)	OVERCURRENT BACKUP, OVERCUR	
(0601)	SELECT PHASE INST. OC (PH4), SELPH4	
(0602)	PHASE INST. OVERCURRENT SETTING, PUPH4	
(0603)	SELECT GROUND INST. OC (IDT), SELIDT	
(0604)	DIRECTIONAL CONTROL OF IDT, SELDIDT	
(0605)	GROUND INST. OVERCURRENT SETTING, PUIDT	

TABLE CS-4: SETTINGS - PUTT SCHEME (2 OF 4)

SETT#	DESCRIPTION	SETTING
(0606)	SELECT GROUND TIME OC (TOC), SELTOC	
(0607)	DIRECTIONAL CONTROL OF TOC, SELDTOC	
(0608)	GROUND TIME OVERCURRENT SETTING, PUTOC	
(0609)	GROUND TIME OVERCURRENT TIME DIAL, TDTOC	
(09)	LINE PICKUP, LINEPU	
(0901)	SELECT LINE PICKUP, SELLPU	
(0902)	SELECT TIMER BYPASS, SELTBP	
(0903)	POSITIVE-SEQUENCE OC (I1) SETTING, PUI1	
(11)	LINE OVERLOAD, LINE OVRLD	
(1101)	SELECT LINE OVERLOAD, SELOVL	
(1102)	LEVEL 1 OVERCURRENT SETTING, PULV1	
(1103)	LEVEL 2 OVERCURRENT SETTING, PULV2	
(1104)	LEVEL 1 TIME DELAY, PUTL31	
(1105)	LEVEL 2 TIME DELAY, PUTL32	
(08)	OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP	
(0801)	SELECT PHASE UNIT TO COORD. WITH, SELPTZ	
(0802)	CHARACTERISTIC ANGLE, MOBANG	
(0803)	SELECT BLOCK TRIP ACTIONS, SELOSB	
(07)	BLOCK RECLOSING, BLK RECLOS	
(0701)	SELECT ALL, SELALL	
(0702)	OUT-OF-STEP BLOCK, RBOSB	
(0703)	ALL ZONE 2 PHASE FUNCTIONS, RB3PH	
(0704)	GROUND TIME OVERCURREN, RBTOC	
(0705)	ZONE 2 TIMERS, RBZ2T	
(0706)	ZONE 3 TIMERS, RBZ3T	
(0707)	ZONE 4 TIMERS, RBZ4T	
(16)	SCADA DTA INTERFACE, SCADA DTA	
(1601)	SCADA DTA FAULT LOCATION LOCK, FLTLOCK	
(1602)	SCADA DTA FAULT LOCATION RESET, FLTRESET	

TABLE CS-4: SETTINGS - PUTT SCHEME (3 OF 4)

SETT#	DESCRIPTION	SETTING
(12)	SCHEME SELECTION, SCHEMESEL	
(1201)	SELECT SCHEME, SELSCM	
(1202)	NUMBER OF RECEIVERS, NUMRCVR	2 (PUTT)
(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, SELZ2U	0 (MHO)
(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 2 GROUND, Z3GR	
(0305)	PHASE TIMER SETTING, PUTL3P	
(0306)	GROUND TIMER SETTING, PUTL3G	
(0307)	PHASE CHARACTERISTIC ANGLE, Z3PANG	
(0308)	GROUND CHARACTERISTIC ANGLE, Z3GANG	
(04)	ZONE 4 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, Z40R	
(0406)	PHASE TIMER SETTING, PUTL4P	

TABLE CS-4: SETTINGS - PUTT SCHEME (4 OF 4)

SETT#	DESCRIPTION	SETTING
(0407)	GROUND TIMER SETTING, PUTL4G	
(0408)	PHASE CHARACTERISTIC ANGLE, Z4PANG	
(0409)	GROUND CHARACTERISTIC ANGLE, Z4GANG	
(0410)	SELECT DIRECTION, SELZ4D	
(05)	OVERCURRENT SUPERVISION, CURSUPVIS	
(0501)	GROUND PILOT TRIP (IPT) OVERCURRENT, PUIPT	<NA>
(0502)	GROUND PILOT BLOCK (IPB) OVERCURRENT, PUIPB	<NA>
(0503)	TRIP SUPERVISION (IT) OVERCURRENT, PUIT	
(0504)	BLOCK SUPERVISION (IB) OVERCURRENT, PUIB	
(13)	SCHEME LOGIC TIMERS, SCHEMETIM	
(1301)	TRIP INTEGRATOR (TL1) PICKUP, PUTL1	
(1302)	52/B CONTACT COORDINATION (TL5) PU, PUTL5	
(1303)	52/B CONTACT COORDINATION (TL5) DO, DOTL5	
(1304)	52/B CONTACT COORDINATION (TL6) PU, PUTL6	
(1305)	52/B CONTACT COORDINATION (TL6) DO, DOTL6	
(1306)	POTT COORDINATION (TL4) PICKUP, PUTL4	<NA>
(1307)	WEAK-IN-FEED TRIP (TL16) PICKUP, PUTL16	<NA>
(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	

<NA> = NOT APPLICABLE (no setting required: setting can be at any value within specified range without affecting scheme operation)

OTHER SPECIFIC VALUES SHOWN ABOVE ARE REQUIRED FOR THIS SCHEME.

SETTINGS FOR BLOCKING SCHEME

Select Scheme, SELSCM

SELSCM = 4 (BLOCK)

Number of Receivers, NUMRCVR

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G

SELZ2G can be set to either YES or NO. For a Blocking scheme, set SELZ2G = YES since ground-fault protection is required.

Select Zone 2 Phase, SELZ2P

SELZ2P can be set to either YES or NO. For a Blocking scheme, set SELZ2P = YES since phase-fault protection is required.

In a Blocking scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, the MT and MTG functions may be used for zone 2 back-up. 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 back-up reach may be less than the desired reach for the pilot overreaching zone. In this case, the zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the zone 2 reach, and the M4 and M4G functions can be set for the zone 3 reach. The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the section above entitled "Settings for Step Distance Scheme" for a discussion of the settings for zone 2 back-up.

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

Reach Setting (MT) Zone 2 Phase, Z2R

Z2R can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Blocking scheme, Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. For a two-terminal line, it is suggested that Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to cause the MT functions to pick up on the maximum load flow. In addition, the Z2R setting must allow the MT tripping functions to coordinate with the reversed-M4 blocking functions at the remote end(s).

Reach Setting (MTG) Zone 2 Ground, Z2GR

Z2GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Blocking scheme, Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. For a two-terminal line with no mutual coupling, it is suggested that Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram. In addition, the Z2GR setting must allow the MTG tripping functions to coordinate with the reversed-M4G blocking functions at the remote end(s).

Select Zone 2 Ground Unit, SELZ2U

SELZ2U can be set for 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting permits choosing either Mho ground-distance, ground directional-overcurrent, or both, for the pilot overreaching zone. For a Blocking scheme, any one of the three settings is possible. The ground directional overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U = GDOC, zone 2 back-up protection can still be provided by the MTG functions. With SELZ2U = MHOGDOC, both Mho ground-distance and ground directional-overcurrent are operating simultaneously for the pilot overreaching zone.

Select Zone 2 Timers, SELZ2T

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

Phase Timer Setting, PUTL2P
Ground Timer Setting, PUTL2G

Refer to the section above entitled "Settings for Step Distance Scheme" for a description of the required settings if SELZ2T = YES.

Phase Characteristic Angle, Z2PANG

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

Ground Characteristic Angle, Z2GANG

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the section above entitled "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

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

Select Zone 4 Phase, SELZ4P

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

Select Direction, SELZ4D

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

Reach Setting (M4) Zone 4 Phase, Z4R

Z4R can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Blocking scheme the local blocking zone reversed-M4 functions key the local transmitter to send a blocking signal to the remote end to prevent the remote end from tripping on an external multi-phase fault behind the local end. The Z4R setting must be such that the reversed-M4 functions coordinate with the MT tripping functions at the remote end(s). Z4R should never be set so large as to cause the M4 functions to pick up on the maximum load flow.

Phase Offset Reach, Z4OR

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 CS-6. For a Blocking scheme, an offset reach is required. An offset setting keeps the reversed-M4 functions continuously energized for the duration of an external, bolted, zero-voltage fault at the relay location, since with offset M4 can operate on fault current only. This permits continuous keying of the local transmitter to sustain the blocking signal being sent to the remote end.

Reach Setting (M4G) Zone 4 Ground, Z4GR

Z4GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Blocking scheme the local blocking zone reversed-M4G functions key the local transmitter to send a blocking signal to the remote end to prevent the remote end from tripping on an external ground fault behind the local end. The Z4GR setting must be such that the reversed-M4G functions coordinate with the MTG tripping functions at the remote end(s). Z4GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the M4G characteristic on an R-X diagram.

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

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

$$Z4GR = 0.85 \times (Z2G4\ [REMOTE])$$

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

$$Z4R = 1.7 \times (Z2R\ [REMOTE] - Z1L)$$
$$Z4GR = 1.7 \times (Z2GR\ [REMOTE] - Z1L)$$

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

Phase Timer Setting, PUTL4P

If the reversed-M4 functions are to serve as a back-up 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 the reversed-M4 functions are not to be used as a back-up zone, then set PUTL4P to the maximum value. PUTL4P can be set over the range of 0.10 - 10.00 seconds.

Ground Timer Setting, PUTL4G

If the reversed-M4G functions are to serve as a back-up 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 the reversed-M4G functions are not to be used as a back-up zone, then set PUTL4G to the maximum value. PUTL4G can be set over the range of 0.10 - 10.00 seconds.

Phase Characteristic Angle, Z4PANG

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

Ground Characteristic Angle, Z4GANG

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

OVERCURRENT SUPERVISION, CURSUPVIS

Ground Pilot Trip (IPT) Overcurrent, PUIPT
Ground Pilot Block (IPB) Overcurrent, PUIPB

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

$$3x|I0| - 3xKTx|I1|$$

where: KT = 0.1

Positive-sequence restraint is used to provide secure operation during steady-state unbalance, error currents, and external faults. PUIPT can be set over the range of (0.10 - 1.00) x IN amps.

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

$$3x|I0| - 3xKBx|I1|$$

where: KB = 0.066

PUIPB can be set over the range of (0.05 - 0.75) x IN amps.

PUIPB should be set to its minimum setting of 0.05 x IN amps. For two-terminal line applications, PUIPT should be set to its minimum setting of 0.10 x IN amps for lines less than 100 miles long and 0.15 x IN amps for lines greater than 100 miles in length, to compensate for the increased charging current. PUIPT must be set higher than IPB at the remote terminal, to assure local-trip remote-block coordination.

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

Trip Supervision (IT) Overcurrent, PUIT
Block Supervision (IB) Overcurrent, PUIB

The IT overcurrent function provides supervision for the tripping-zone distance functions, and IT is used in the trip bus seal-in circuit. The IB overcurrent function provides supervision for the reversed-M4 and reversed-M4G blocking-zone distance functions. For a Blocking scheme, the local PUIT and remote PUIB settings must coordinate. PUIT can be set over the range of (0.04 - 0.80) x IN amps. PUIB can be set over the range of (0.04 - 0.40) x IN amps. For two-terminal line applications, it is recommended that PUIB be set at 0.04 x IN amps and PUIT be set at 0.08 x IN amps. For three-terminal line applications, this coordination margin may, in the worst case, have to be doubled by increasing the PUIT setting to 0.16 x IN amps.

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1

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

PUTL1 = 8 ms. + channel time (ms.) + propagation time (ms.)

POTT Coordination (TL4) Pickup, PUTL4

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

52/b Contact Coordination (TL5) Pickup, PUTL5
52/b Contact Coordination (TL5) Dropout, DOTL5
52/b Contact Coordination (TL6) Pickup, PUTL6
52/b Contact Coordination (TL6) Dropout, DOTL6

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the Blocking scheme logic, these timers are not a part of that logic. However, the DLP's Sequence of Events uses the 52/b contact(s) to provide a time-tagged event to indicate either "breaker tripped" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure PD-4. TL5 and TL6 provide coordinating times to synchronize the breaker 52/b switch contact operation with the opening and closing of the breaker's main interrupting contacts. The pickup time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip (TL16) pickup, PUTL16

PUTL16 can be set over the range of 8 - 80 milliseconds. Since TL16 is not part of the Blocking scheme logic, PUTL16 can be set at any value within its range.

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD

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

Remote Open Timer (TL20) Pickup, PUTL20

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.

Select Fuse Failure Block, SELFFB

SELFFB can be set to either YES or NO. When SELFFB = YES, the output of the Potential Transformer Fuse Failure function will block all tripping. When SELFFB = NO, the Potential Transformer Fuse Failure function will not block tripping when it operates for a blown potential fuse(s). It is suggested that SELFFB = YES.

Example Settings (based on Figure CS-1):

SCHEME SELECTION, SCHEMESEL

SELSCM = 4 (BLOCK)
NUMRCVR = 1

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure CS-5 is used to check Z2R and Z2PANG.

$$MR = SIN(50^\circ) \times 19.7 / SIN(180^\circ - 50^\circ - (85^\circ - 5.6^\circ))$$
$$MR = 19.5 \text{ ohms}$$

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

ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the "Example Settings" section above under "Settings for Step Distance Scheme" for an example of how to calculate the settings for this category. For this example SELZ2T = NO, therefore the Z3DIST settings will be based on zone 2 considerations.

ZONE 4 DISTANCE FUNCTIONS, Z4DIST

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

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

Z4R = 0.85 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 = 0.05:

Offset ohms = Z4OR x 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

PUTL4P = 10.00 seconds
PTTL4G = 10.00 seconds

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 milliseconds.

PUTL1 = 10 ms.
PUTL4 = <NOT APPLICABLE>

Since NUMBKRS=1, the 52/b contact would be wired to CC1 if breaker-trip-and-close-event reporting is desired. 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

TABLE CS-5: SETTINGS - BLOCKING SCHEME (1 OF 4)

SETT#	DESCRIPTION	SETTING
(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 UNITS, SELPRIM	
(1506)	CURRENT TRANSFORMER RATIO, CTRATIO	
(1507)	POTENTIAL TRANSFORMER RATIO, PTRATIO	
(1508)	UNITS OF DISTANCE, DISTUNIT	
(1509)	COMMUNICATION BAUD RATE, BAUDRATE	
(1510)	PHASE DESIGNATION, PHASDESG	
(14)	LINE QUANTITIES, LINE QTY	
(1401)	POS.-SEQUENCE ANGLE OF MAX. REACH, POSANG	
(1402)	ZERO-SEQUENCE ANGLE OF MAX. REACH, ZERANG	
(1403)	POSITIVE-SEQUENCE IMPEDANCE, ZP	
(1404)	ZERO-SEQUENCE CURRENT COMPENSATION, KO	
(1405)	LINE LENGTH, LINELEN	
(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, Z1KO	
(06)	OVERCURRENT BACKUP, OVERCUR	
(0601)	SELECT PHASE INST. OC (PH4), SELPH4	
(0602)	PHASE INST. OVERCURRENT SETTING, PUPH4	
(0603)	SELECT GROUND INST. OC (IDT), SELIDT	
(0604)	DIRECTIONAL CONTROL OF IDT, SELDIDT	
(0605)	GROUND INST. OVERCURRENT SETTING, PUIDT	

TABLE CS-5: SETTINGS - BLOCKING SCHEME (2 OF 4)

SETT#	DESCRIPTION	SETTING
(0606)	SELECT GROUND TIME OC (TOC), SELTOC	
(0607)	DIRECTIONAL CONTROL OF TOC, SELDTOC	
(0608)	GROUND TIME OVERCURRENT SETTING, PUTOC	
(0609)	GROUND TIME OVERCURRENT TIME DIAL, TDTOC	
(09)	LINE PICKUP, LINEPU	
(0901)	SELECT LINE PICKUP, SELLPU	
(0902)	SELECT TIMER BYPASS, SELTBP	
(0903)	POSITIVE-SEQUENCE OC (I1) SETTING, PUI1	
(11)	LINE OVERLOAD, LINE OVRLD	
(1101)	SELECT LINE OVERLOAD, SELOVL	
(1102)	LEVEL 1 OVERCURRENT SETTING, PULV1	
(1103)	LEVEL 2 OVERCURRENT SETTING, PULV2	
(1104)	LEVEL 1 TIME DELAY, PUTL31	
(1105)	LEVEL 2 TIME DELAY, PUTL32	
(08)	OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP	
(0801)	SELECT PHASE UNIT TO COORD. WITH, SELPTZ	
(0802)	CHARACTERISTIC ANGLE, MOBANG	
(0803)	SELECT BLOCK TRIP ACTIONS, SELOSB	
(07)	BLOCK RECLOSING, BLK RECLOS	
(0701)	SELECT ALL, SELALL	
(0702)	OUT-OF-STEP BLOCK, RBOSB	
(0703)	ALL ZONE 2 PHASE FUNCTIONS, RB3PH	
(0704)	GROUND TIME OVERCURREN, RBTOC	
(0705)	ZONE 2 TIMERS, RBZ2T	
(0706)	ZONE 3 TIMERS, RBZ3T	
(0707)	ZONE 4 TIMERS, RBZ4T	
(16)	SCADA DTA INTERFACE, SCADA DTA	
(1601)	SCADA DTA FAULT LOCATION LOCK, FLTLOCK	
(1602)	SCADA DTA FAULT LOCATION RESET, FLTRESET	

TABLE CS-5: SETTINGS - BLOCKING SCHEME (3 OF 4)

SETT#	DESCRIPTION	SETTING
(12)	SCHEME SELECTION, SCHEMESEL	
(1201)	SELECT SCHEME, SELSCM	4 (BLOCK)
(1202)	NUMBER OF RECEIVERS, NUMRCVR	1
(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, SELZ2U	
(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 2 GROUND, Z3GR	
(0305)	PHASE TIMER SETTING, PUTL3P	
(0306)	GROUND TIMER SETTING, PUTL3G	
(0307)	PHASE CHARACTERISTIC ANGLE, Z3PANG	
(0308)	GROUND CHARACTERISTIC ANGLE, Z3GANG	
(04)	ZONE 4 DISTANCE FUNCTIONS, Z4DIST	
(0401)	SELECT ZONE 4 GROUND, SELZ4G	
(0402)	SELECT ZONE 4 PHASE, SELZ4P	YES
(0403)	REACH SETTING (M4) ZONE 4 PHASE, Z4R	
(0404)	REACH SETTING (M4G) ZONE 4 GROUND, Z4GR	
(0405)	PHASE OFFSET REACH, Z40R	
(0406)	PHASE TIMER SETTING, PUTL4P	

TABLE CS-5: SETTINGS - BLOCKING SCHEME (4 OF 4)

SETT#	DESCRIPTION	SETTING
(0407)	GROUND TIMER SETTING, PUTL4G	
(0408)	PHASE CHARACTERISTIC ANGLE, Z4PANG	
(0409)	GROUND CHARACTERISTIC ANGLE, Z4GANG	
(0410)	SELECT DIRECTION, SELZ4D	1 (REVRSE)
(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	
(13)	SCHEME LOGIC TIMERS, SCHEMETIM	
(1301)	TRIP INTEGRATOR (TL1) PICKUP, PUTL1	
(1302)	52/B CONTACT COORDINATION (TL5) PU, PUTL5	
(1303)	52/B CONTACT COORDINATION (TL5) DO, DOTL5	
(1304)	52/B CONTACT COORDINATION (TL6) PU, PUTL6	
(1305)	52/B CONTACT COORDINATION (TL6) DO, DOTL6	
(1306)	POTT COORDINATION (TL4) PICKUP, PUTL4	<NA>
(1307)	WEAK-IN-FEED TRIP (TL16) PICKUP, PUTL16	<NA>
(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	

<NA> = NOT APPLICABLE (no setting required: setting can be at any value within specified range without affecting scheme operation)

OTHER SPECIFIC VALUES SHOWN ABOVE ARE REQUIRED FOR THIS SCHEME.

SETTINGS FOR HYBRID SCHEME

Select Scheme, SELSCM

SELSCM = 3 (HYBRID)

Number of Receivers, NUMRCVR

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G

SELZ2G can be set to either YES or NO. For a Hybrid scheme, set SELZ2G = YES since ground-fault protection is required.

Select Zone 2 Phase, SELZ2P

SELZ2P can be set to either YES or NO. For a Hybrid scheme, set SELZ2P = YES since phase-fault protection is required.

In a Hybrid scheme, the pilot-overreaching zone consists of the MT and MTG functions. Secondarily, the MT and MTG functions may be used for zone 2 back-up. 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 back-up reach may be less than the desired reach for the pilot overreaching zone. In this case, the zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the zone 2 reach, and the M4 and M4G functions can be set for the zone 3 reach.

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

The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the section above entitled "Settings for Step Distance Scheme" for a discussion of the settings for zone 2 back-up.

Reach Setting (MT) Zone 2 Phase, Z2R

Z2R can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Hybrid scheme, Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources.

For a two-terminal line, it is suggested that Z2R should be set for 200% of the positive-sequence impedance of the protected line. Z2R should never be set so large as to cause the MT functions to pick up on the maximum load flow. In addition, the Z2R setting must allow the MT tripping functions to coordinate with the reversed-M4 blocking functions at the remote end(s).

Reach Setting (MTG) Zone 2 Ground, Z2GR

Z2GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Hybrid scheme, Z2GR must be set to see a ground fault at the remote bus, considering such factors as ground-fault impedance, underreach caused by intermediate fault current sources, and underreach caused by zero-sequence mutual coupling with a parallel line. For a two-terminal line with no mutual coupling, it is suggested that Z2GR should be set for 200% of the positive-sequence impedance of the protected line. Z2GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the MTG characteristic on an R-X diagram. In addition, the Z2GR setting must allow the MTG tripping functions to coordinate with the reversed-M4G blocking functions at the remote end(s).

Select Zone 2 Ground Unit, SELZ2U

SELZ2U can be set for 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting permits choosing either Mho ground-distance, ground directional-overcurrent, or both, for the pilot-overreaching zone. For a Hybrid scheme, any one of the three settings is possible. The ground directional overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U = GDOC, zone 2 back-up protection can still be provided by the MTG functions. With SELZ2U = MHOGDOC, both Mho ground-distance and ground directional-overcurrent are operating simultaneously for the pilot-overreaching zone.

Select Zone 2 Timers, SELZ2T

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

Phase Timer Setting, PUTL2P
Ground Timer Setting, PUTL2G

Refer to the section above entitled "Settings for Step Distance Scheme" for a description of the required settings if SELZ2T = YES.

Phase Characteristic Angle, Z2PANG

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

Ground Characteristic Angle, Z2GANG

Refer to the section above entitled "Settings for Permissive Overreach Transfer Trip Scheme" for setting considerations.

ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the section above entitled "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

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

Select Zone 4 Phase, SELZ4P

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

Select Direction, SELZ4D

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

Reach Setting (M4) Zone 4 Phase, Z4R

Z4R can be set over the range of 0.01 - 50.00 x (5/IN) 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 multi-phase fault behind the local end. The Z4R setting must be such that the reversed-M4 functions coordinate with the MT tripping functions at the remote end(s). Z4R should never be set so large as to cause the M4 functions to pick up on the maximum load flow.

Phase Offset Reach, Z4OR

The zone 4 phase-distance functions can be set with an "offset" reach, which is in the opposite direction from that determined by the SELZ4D setting. The Z4OR setting is a multiplier and the actual ohmic offset is equal to (0.00 - 0.40) x Z4R ohms. A reversed-M4 characteristic with offset is shown in Figure CS-6. For a Hybrid scheme, an offset reach is required. An offset setting keeps the reversed-M4 functions continuously energized for the duration of an external, bolted, zero-voltage fault at the relay location, since with offset M4 can operate on fault current only. This prevents the echo circuit from keying the local transmitter for the duration of the external fault.

Reach Setting (M4G) Zone 4 Ground, Z4GR

Z4GR can be set over the range of 0.01 - 50.00 x (5/IN) ohms. In a Hybrid scheme the local blocking zone reversed-M4G functions key the local transmitter to send a blocking signal to the remote end to prevent the remote end from tripping on an external ground fault behind the local end. The Z4GR setting must be such that the reversed-M4G functions coordinate with the MTG tripping functions at the remote end(s). Z4GR should never be set so large as to cause the impedance point associated with the maximum load flow to plot within the M4G characteristic on an R-X diagram.

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

Z4R = 0.85 x (Z2R [REMOTE])

Z4GR = 0.85 x (Z2G4 [REMOTE])

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

Z4R = 1.7 x (Z2R [REMOTE] - Z1L)

Z4GR = 1.7 x (Z2GR [REMOTE] - Z1L)

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

Phase Timer Setting, PUTL4P

If the reversed-M4 functions are to serve as a back-up 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 the reversed-M4 functions are not to be used as a back-up zone, then set PUTL4P to the maximum value. PUTL4P can be set over the range of 0.10 - 10.00 seconds.

Ground Timer Setting, PUTL4G

If the reversed-M4G functions are to serve as a back-up 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 the reversed-M4G functions are not to be used as a back-up zone, the set PUTL4G to the maximum value. PUTL4G can be set over the range of 0.10 - 10.00 seconds.

Phase Characteristic Angle, Z4PANG

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

Ground Characteristic Angle, Z4GANG

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

OVERCURRENT SUPERVISION, CURSUPVIS

Ground Pilot Trip (IPT) Overcurrent, PUIPT
Ground Pilot Block (IPB) Overcurrent, PUIPB

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

$$3x|I0| - 3xKTx|I1|$$

where: KT = 0.1

Positive-sequence restraint is used to provide secure operation during steady-state unbalance, error currents, and external faults. PUIPT can be set over the range of (0.10 - 1.00) x IN amps.

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

$$3x|I0| - 3xKBx|I1|$$

where: KB = 0.066

PUIPB can be set over the range of (0.05 - 0.75) x IN amps.

PUIPB should be set to its minimum setting of 0.05 x IN amps. For two-terminal line applications, PUIPT should be set to its minimum setting of 0.10 x IN amps for lines less than 100 miles long and 0.15 x IN amps for lines greater than 100 miles in length, to compensate for the increased charging current. PUIPT must be set higher than IPB at the remote terminal, to assure local-trip remote-block coordination.

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

Trip Supervision (IT) Overcurrent, PUIT
Block Supervision (IB) Overcurrent, PUIB

The IT overcurrent function provides supervision for the tripping-zone distance functions, and IT is used in the trip bus seal-in circuit. The IB overcurrent function provides supervision for the reversed-M4 and reversed-M4G blocking-zone distance functions. For a Hybrid scheme, the local PUIT and remote PUIB settings must coordinate. PUIT can be set over the range of (0.04 - 0.80) x IN amps. PUIB can be set over the range of (0.04 - 0.40) x IN amps. For two-terminal line applications, it is recommended that PUIB be set at 0.04 x IN amps and PUIT be set at 0.08 x IN amps. For three-terminal line applications, this coordination margin may, in the worst case, have to be doubled by increasing the PUIT setting to 0.16 x IN amps.

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1

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

POTT Coordination (TL4) Pickup, PUTL4

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

52/b Contact Coordination (TL5) Pickup, PUTL5
52/b Contact Coordination (TL5) Dropout, DOTL5
52/b Contact Coordination (TL6) Pickup, PUTL6
52/b Contact Coordination (TL6) Dropout, DOTL6

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the Hybrid scheme logic, these timers are not a part of that logic. However, the DLP's Sequence of Events uses the 52/b contact(s) to provide a time-tagged event to indicate either "breaker tripped" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure PD-4. TL5 and TL6 provide coordinating times to synchronize the breaker 52/b switch contact operation with the opening and closing of the breaker's main interrupting contacts. The pickup time coordination is determined by PUTL5(6). The dropout time coordination is determined by DOTL5(6). The settings are dependent upon the design of the breaker. The object is to get an output from TL5(6) when the breaker main contacts open, and have the output go away when the breaker main contacts close.

Weak In-feed Trip (TL16) pickup, PUTL16

PUTL16 can be set over the range of 8 - 80 milliseconds. The pickup delay of timer TL16 is used to provide security in the weak in-feed tripping logic. It should be set with sufficient delay time to ride over any outputs from the receiver during weak in-feed fault conditions. Normally PUTL16 will be set at its minimum value of 8 milliseconds.

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD

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

Remote Open Timer (TL20) Pickup, PUTL20

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

Select Fuse Failure Block, SELFFB

SELFFB can be set to either YES or NO. When SELFFB = YES, the output of the Potential Transformer Fuse Failure function will block all tripping. When SELFFB = NO, the Potential Transformer Fuse Failure function will not block tripping when it operates for a blown potential fuse(s). It is suggested that SELFFB = YES.

Example Settings (based on Figure CS-1):

SCHEME SELECTION, SCHEMESEL

SELSCM = 3 (HYBRID)
NUMRCVR = 1

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure CS-5 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 = 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 the "Example Settings" section above under "Settings for Step Distance Scheme" for an example of how to calculate the settings for this category. For this example SELZ2T = NO, therefore the Z3DIST settings will be based on zone 2 considerations.

ZONE 4 DISTANCE FUNCTIONS, Z4DIST

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

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

Z4R = 0.85 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 = 0.05:

Offset ohms = Z4OR x 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

PUTL4P = 10.00 seconds
PTTL4G = 10.00 seconds

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>

Since NUMBKRS=1, the 52/b contact would be wired to CC1 if breaker-trip-and-close-event reporting is desired. 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

TABLE CS-6: SETTINGS - HYBRID SCHEME (1 OF 4)

SETT#	DESCRIPTION	SETTING
(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 UNITS, SELPRIM	_____
(1506)	CURRENT TRANSFORMER RATIO, CTRATIO	_____
(1507)	POTENTIAL TRANSFORMER RATIO, PTRATIO	_____
(1508)	UNITS OF DISTANCE, DISTUNIT	_____
(1509)	COMMUNICATION BAUD RATE, BAUDRATE	_____
(1510)	PHASE DESIGNATION, PHASDESG	_____
(14)	LINE QUANTITIES, LINE QTY	
(1401)	POS.-SEQUENCE ANGLE OF MAX. REACH, POSANG	_____
(1402)	ZERO-SEQUENCE ANGLE OF MAX. REACH, ZERANG	_____
(1403)	POSITIVE-SEQUENCE IMPEDANCE, ZP	_____
(1404)	ZERO-SEQUENCE CURRENT COMPENSATION, KO	_____
(1405)	LINE LENGTH, LINELEN	_____
(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, Z1KO	_____
(06)	OVERCURRENT BACKUP, OVERCUR	
(0601)	SELECT PHASE INST. OC (PH4), SELPH4	_____
(0602)	PHASE INST. OVERCURRENT SETTING, PUPH4	_____
(0603)	SELECT GROUND INST. OC (IDT), SELIDT	_____
(0604)	DIRECTIONAL CONTROL OF IDT, SELDIDT	_____
(0605)	GROUND INST. OVERCURRENT SETTING, PUIDT	_____

TABLE CS-6: SETTINGS - HYBRID SCHEME (2 OF 4)

SETT#	DESCRIPTION	SETTING
(0606)	SELECT GROUND TIME OC (TOC), SELTOC	
(0607)	DIRECTIONAL CONTROL OF TOC, SELDTOC	
(0608)	GROUND TIME OVERCURRENT SETTING, PUTOC	
(0609)	GROUND TIME OVERCURRENT TIME DIAL, TDTOC	
(09)	LINE PICKUP, LINEPU	
(0901)	SELECT LINE PICKUP, SELLPU	
(0902)	SELECT TIMER BYPASS, SELTBP	
(0903)	POSITIVE-SEQUENCE OC (I1) SETTING, PUI1	
(11)	LINE OVERLOAD, LINE OVRLD	
(1101)	SELECT LINE OVERLOAD, SELOVL	
(1102)	LEVEL 1 OVERCURRENT SETTING, PULV1	
(1103)	LEVEL 2 OVERCURRENT SETTING, PULV2	
(1104)	LEVEL 1 TIME DELAY, PUTL31	
(1105)	LEVEL 2 TIME DELAY, PUTL32	
(08)	OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP	
(0801)	SELECT PHASE UNIT TO COORD. WITH, SELPTZ	
(0802)	CHARACTERISTIC ANGLE, MOBANG	
(0803)	SELECT BLOCK TRIP ACTIONS, SELOSB	
(07)	BLOCK RECLOSING, BLK RECLOS	
(0701)	SELECT ALL, SELALL	
(0702)	OUT-OF-STEP BLOCK, RBOSB	
(0703)	ALL ZONE 2 PHASE FUNCTIONS, RB3PH	
(0704)	GROUND TIME OVERCURREN, RBTOC	
(0705)	ZONE 2 TIMERS, RBZ2T	
(0706)	ZONE 3 TIMERS, RBZ3T	
(0707)	ZONE 4 TIMERS, RBZ4T	
(16)	SCADA DTA INTERFACE, SCADA DTA	
(1601)	SCADA DTA FAULT LOCATION LOCK, FLTLOCK	
(1602)	SCADA DTA FAULT LOCATION RESET, FLTRESET	

TABLE CS-6: SETTINGS - HYBRID SCHEME (3 OF 4)

SETT#	DESCRIPTION	SETTING
(12)	SCHEME SELECTION, SCHEMESEL	
(1201)	SELECT SCHEME, SELSCM	3 (HYBRID)
(1202)	NUMBER OF RECEIVERS, NUMRCVR	
(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, SELZ2U	
(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 2 GROUND, Z3GR	
(0305)	PHASE TIMER SETTING, PUTL3P	
(0306)	GROUND TIMER SETTING, PUTL3G	
(0307)	PHASE CHARACTERISTIC ANGLE, Z3PANG	
(0308)	GROUND CHARACTERISTIC ANGLE, Z3GANG	
(04)	ZONE 4 DISTANCE FUNCTIONS, Z4DIST	
(0401)	SELECT ZONE 4 GROUND, SELZ4G	
(0402)	SELECT ZONE 4 PHASE, SELZ4P	YES
(0403)	REACH SETTING (M4) ZONE 4 PHASE, Z4R	
(0404)	REACH SETTING (M4G) ZONE 4 GROUND, Z4GR	
(0405)	PHASE OFFSET REACH, Z40R	
(0406)	PHASE TIMER SETTING, PUTL4P	

TABLE CS-6: SETTINGS - HYBRID SCHEME (4 OF 4)

SETT#	DESCRIPTION	SETTING
(0407)	GROUND TIMER SETTING, PUTL4G	
(0408)	PHASE CHARACTERISTIC ANGLE, Z4PANG	
(0409)	GROUND CHARACTERISTIC ANGLE, Z4GANG	
(0410)	SELECT DIRECTION, SELZ4D	1 (REVRSE)
(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	
(13)	SCHEME LOGIC TIMERS, SCHEMETIM	
(1301)	TRIP INTEGRATOR (TL1) PICKUP, PUTL1	
(1302)	52/B CONTACT COORDINATION (TL5) PU, PUTL5	
(1303)	52/B CONTACT COORDINATION (TL5) DO, DOTL5	
(1304)	52/B CONTACT COORDINATION (TL6) PU, PUTL6	
(1305)	52/B CONTACT COORDINATION (TL6) DO, DOTL6	
(1306)	POTT COORDINATION (TL4) PICKUP, PUTL4	<NA>
(1307)	WEAK-IN-FEED TRIP (TL16) PICKUP, PUTL16	
(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	

<NA> = NOT APPLICABLE (no setting required: setting can be at any value within specified range without affecting scheme operation)

OTHER SPECIFIC VALUES SHOWN ABOVE ARE REQUIRED FOR THIS SCHEME.

DISTANCE FUNCTIONS CURRENT SENSITIVITY

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

$$I\phi\phi Z_{R1} = \frac{0.294}{(1\text{-}X)}$$

where: $I\phi\phi$ = phase-phase current at relay (i.e., $I_A - I_B$)
Z_{R1} = positive-sequence relay reach
X = actual reach / nominal reach

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

example:

For the phase pair A-B and:
$Z_{R1} = 1$ ohm
$X = 0.9$; $(1\text{-}X) = 0.1$ (10% pull-back)

$$I_A - I_B = \frac{0.294}{0.1} = 2.94 \text{ amps}$$

For a phase-phase fault:
$I_A - I_B = 2(I_A) = 2.94$ amps

$I_A = 1.47$ amps

For a three-phase fault:
$I_A - I_B = 1.732(I_A) = 2.94$ amps

$I_A = 1.7$ amps

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

$$| (I\phi - I_0)Z_{R1}\angle\phi 1 + I_0 K0 Z_{R1}\angle\phi 0 | = \frac{0.22}{(1\text{-}X)}$$

To use this formula, the ratio I_0 to I_ϕ must be known or assumed.

where: I_ϕ = phase current at relay
I_0 = zero-sequence current at relay
Z_{R1} = positive-sequence relay reach
$\angle\phi 1$ = positive-sequence relay angle (POSANG)
$\angle\phi 0$ = zero-sequence relay angle (ZERANG)
$K0$ = zero-sequence current compensation factor
X = actual reach / nominal reach

example:

For phase A and:

$I_A = 3(I_0)$

$\angle\phi 1 = \angle\phi 0$

$K0 = 3$

$Z_{R1} = 1$ ohm

$X = 0.9$; $(1-X) = 0.1$ (10% pull-back)

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

$I_A = 1.32$ amps

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

example:

For the phase pair A-B and:

$Z_{R1} = 1$ ohm

$X = 0$; $(1-X) = 1$ (100% pull back)

$$I_A - I_B = \frac{0.294}{1} = 0.294 \text{ amps}$$

For a phase-phase fault:

$I_A - I_B = 2(I_A) = 0.294$ amps

$I_A = 0.147$ amps

For a three-phase fault:

$I_A - I_B = 1.732(I_A) = 0.294$ amps

$I_A = 0.17$ amps

Assuming IN=5, the IT current supervision function will limit the distance function current sensitivity in the above example since the minimum IT setting is 0.04x(IN) = 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.

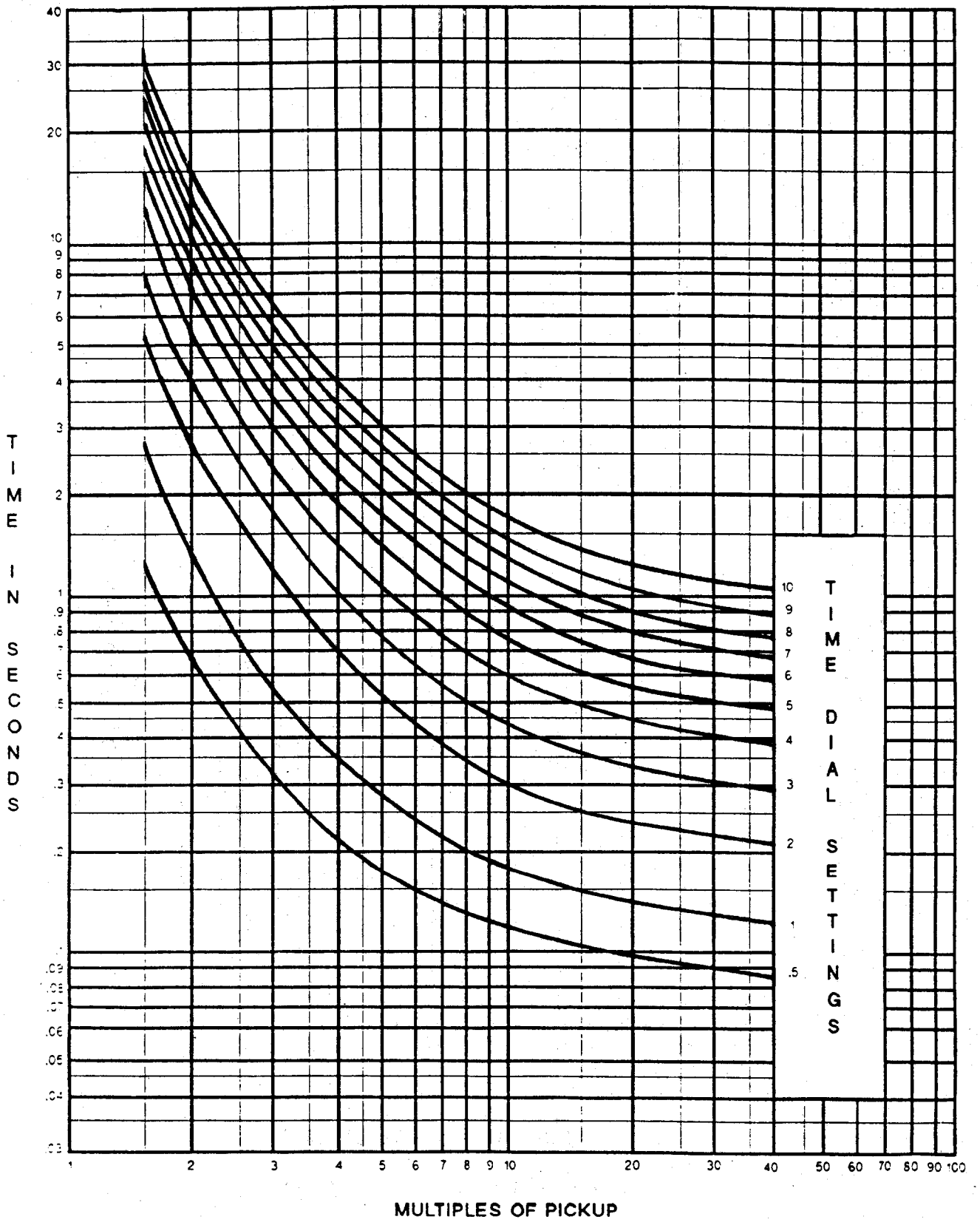


Figure CS-7 (0286A2935 [1]) ITOC Time Curve

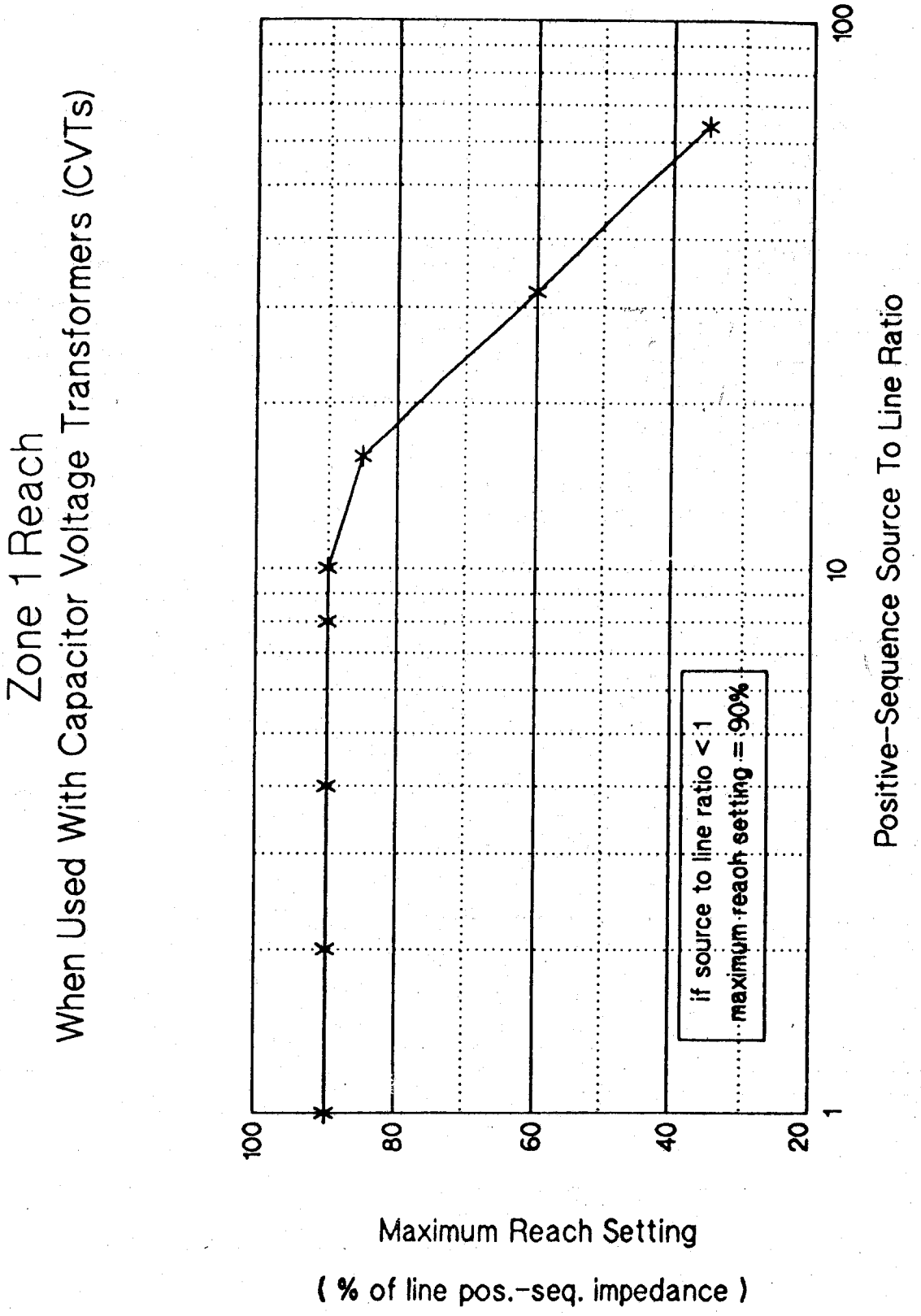


Figure CS-8 (0286A3530) Zone 1 Reach

HARDWARE DESCRIPTION

CAUTION

Power down the relay by removing at least one of the connection plugs before removing or inserting modules. Failure to do so can permanently damage the relay.

CASE ASSEMBLY

Construction

The case that houses the electronic modules is constructed from an aluminum alloy. It consists of a main frame with side mounting brackets, a front cover and a rear cover.

The front cover, comprised of a metal frame with plate glass, is pivoted on the top and is opened from the bottom by way of two spring-loaded latches. The door is constrained from coming off by tabs that require the door to be unlatched and lifted slightly in order to be removed. A pushbutton extender installed into the plate glass makes it possible to clear the display without removing the front cover.

The rear cover supports terminal blocks that are used in making external connections to the case. The modules are mounted vertically inside the case, and they are supported by sockets on the mother board within the case. In addition to providing this mechanical support, the sockets also offer the means of making the electrical connection to the modules. The modules are further restrained inside the case by the front cover.

Proper alignment of the module with respect to the socket is maintained by slotted guides, one guide above and one guide beneath each module, with the exception of the magnetics module, MGM, which requires two guides above and two beneath, and the man-machine interface module, MMI, which requires three pairs of guides.

Electrical Connections and Internal Wiring

As mentioned earlier, electrical connections are made to the case through four terminal blocks mounted on the rear cover plate. Each block contains 14 terminal points, which consist of a Number 6 screw threaded into a flat contact plate.

Connection to the printed-circuit-board module is made by means of 96-pin Eurocard connectors. Connection to the MGM module is made by means of two connector sockets; an 8-contact current block and a 104-pin signal block. The current block contacts are rated to handle current transformer (CT) secondary currents, and they are shorted upon removal of the MGM module.

Identification

The DLP system model number label is located on the outside of the front cover, and on the right-hand sidesheet inside the case. A marking strip indicating the name and position of every module in a case is included on the front bottom of the case. It is placed to be read when the front cover is removed. Figure MO-1 in the MODULES section shows the location of the modules.

The terminal blocks located on the rear cover plate are uniquely identified by a two-letter code that is found directly beneath the outermost edge of each terminal block. Also, the terminal points (1 through 14) are identified by stamped numbers.

A connector, PL1, is used for serial communication between the DLP and the PC/Modem.

PRINTED-CIRCUIT-BOARD MODULES

CAUTION

This relay contains electronic components that could be damaged by electrostatic discharge currents if those currents flow through certain terminals of the components. The main source of electrostatic discharge currents is the human body, and the conditions of low humidity, carpeted floors and isolating shoes are conducive to the generation of electrostatic discharge currents. Where these conditions exist, are should be exercised when removing and handling the modules to make settings on the internal switches. The persons handling the modules should make sure that their body charge has been discharged by touching some surface at ground potential before touching any of the components on the modules.

Basic Construction

Each module consists of a printed-circuit board and front panel. Two knobs are provided on the front panel for removing and inserting the module. Electrical connection is made by the 96 pins of the Eurocard connector located at the back of the board.

Identification

Each module has its own identification number, consisting of a three-letter code followed by a three-digit number. These are found at the bottom of each front panel and may be read when the front cover is removed.

RECEIVING, HANDLING AND STORAGE

Immediately upon receipt, the equipment should be unpacked and examined for any damage sustained in transit. If damage resulting from rough handling is evident, file a damage claim at once with the transportation company and promptly notify the nearest GE Sales Office.

If the equipment is not to be installed immediately, it should be stored indoors in a location that is dry and protected from dust, metallic chips, and severe atmospheric conditions.

INSTALLATION

Environment

The location should be clean and dry, free from dust and excessive vibration, and well lighted to facilitate inspection and testing.

Mounting

The DLP case has been designed for standard rack mounting. The case measures four rack units (4 RU) in height. Refer to Figure HD-1 for the outline and mounting dimensions.

External Connections

External connections are made according to the elementary diagram, Figure PD-4 in the PRODUCT DESCRIPTION section. This is a general diagram incorporating all of the available options. Connection need not be made to those terminals associated with options that will not be used.

Note: Before powering the relay, all modules should be checked to see that they are seated properly.

SURGE GROUND CONNECTIONS

CAUTION

DLP Terminals AC14 and AD14 must be tied together, and terminal AD14 must be tied to station ground, as shown in the elementary diagram figure PD-4. The connection to the ground bus must be made as short as possible using No.12 wire or larger.

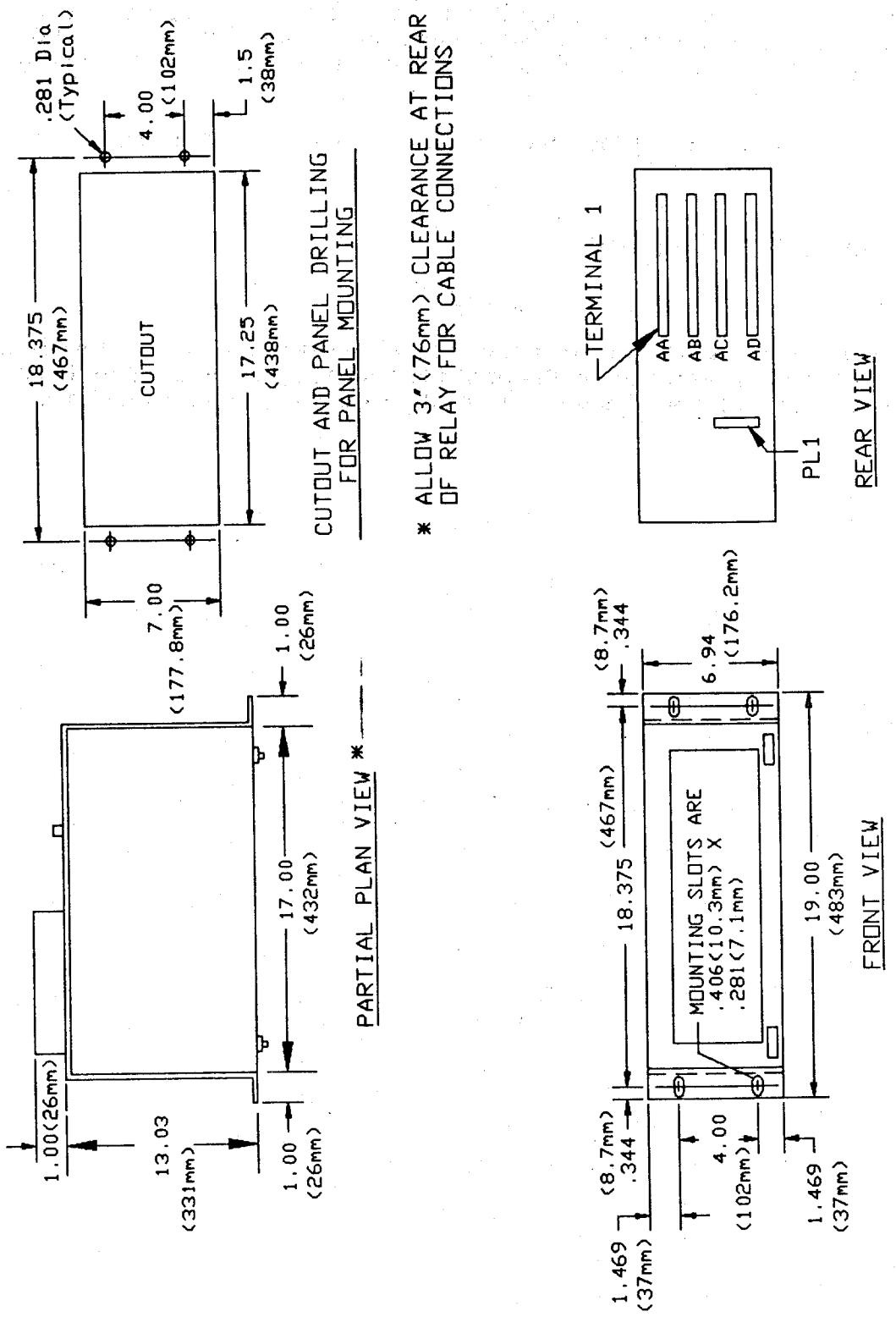


Figure HD-1 (0286A3562) DLP Outline drawing

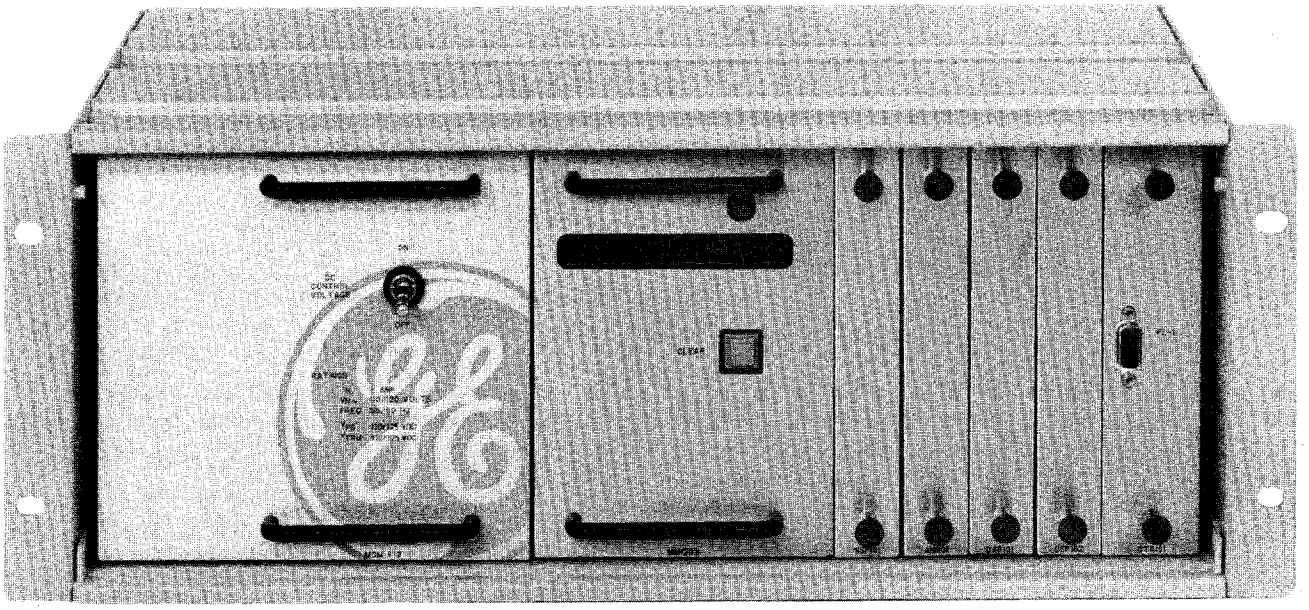


Figure HD-2 (8919375) DLP Relaying System (front view)

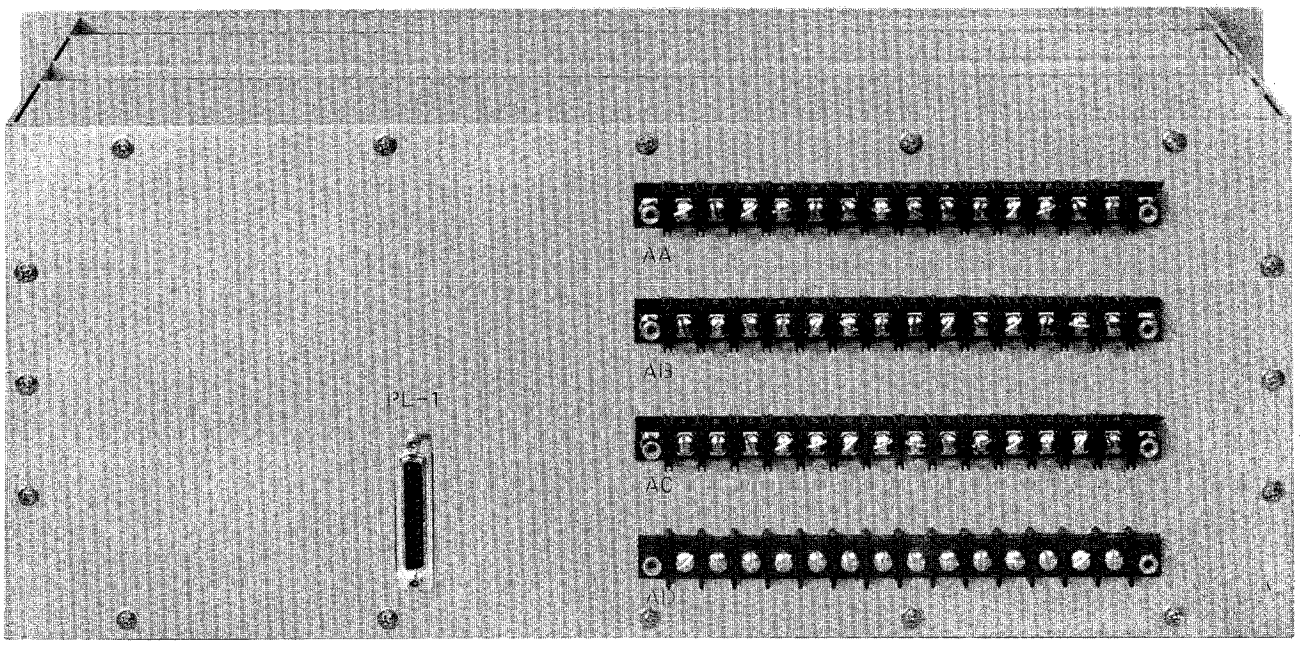


Figure HD-3 (8919373) DLP Relaying System (rear view)

MODULES

CAUTION

Power Down the relay by removing the test plugs before removing or inserting modules. Failure to do so can permanently damage the relay.

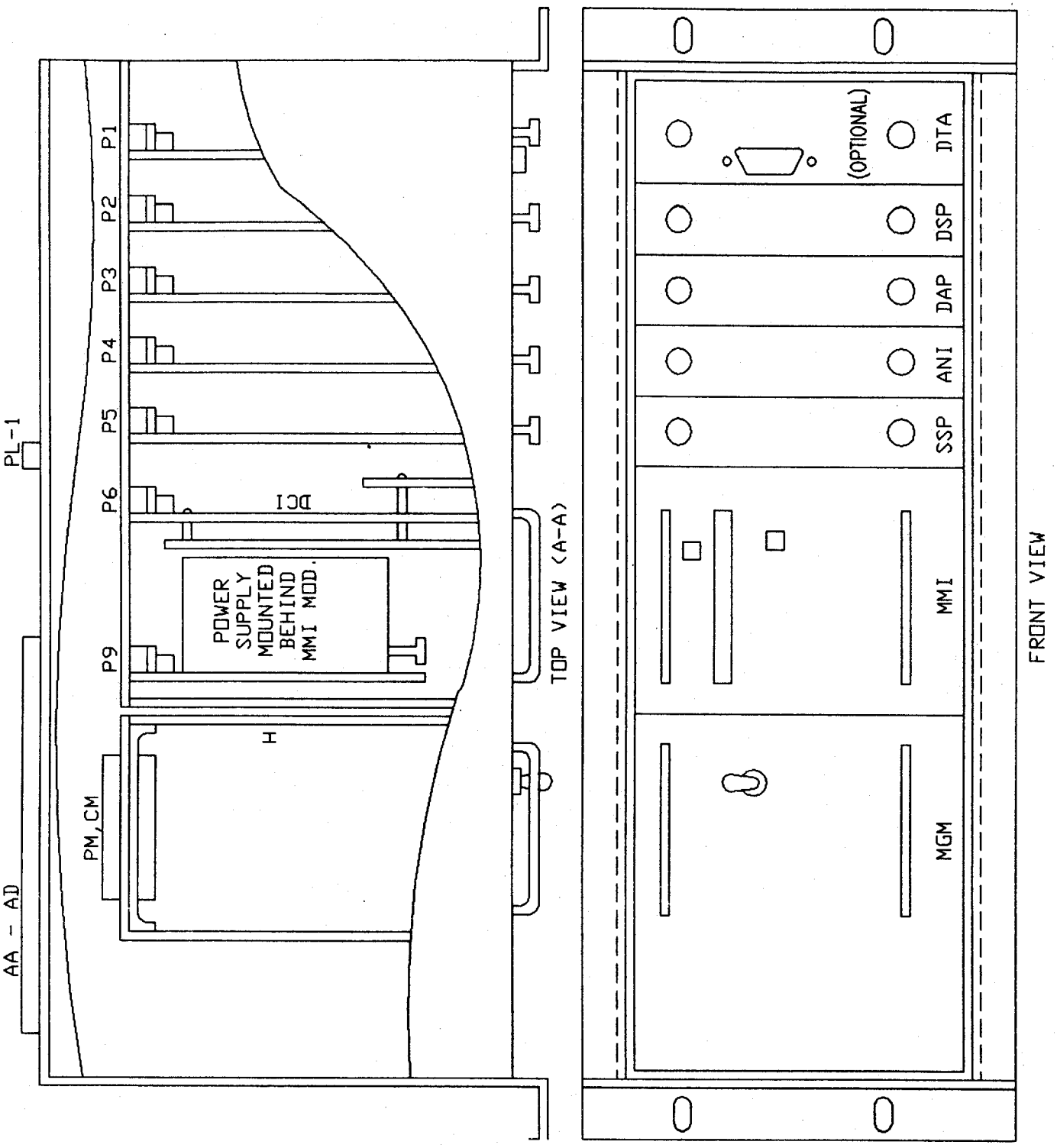


Figure MO-1 (0286A2996) Module Location

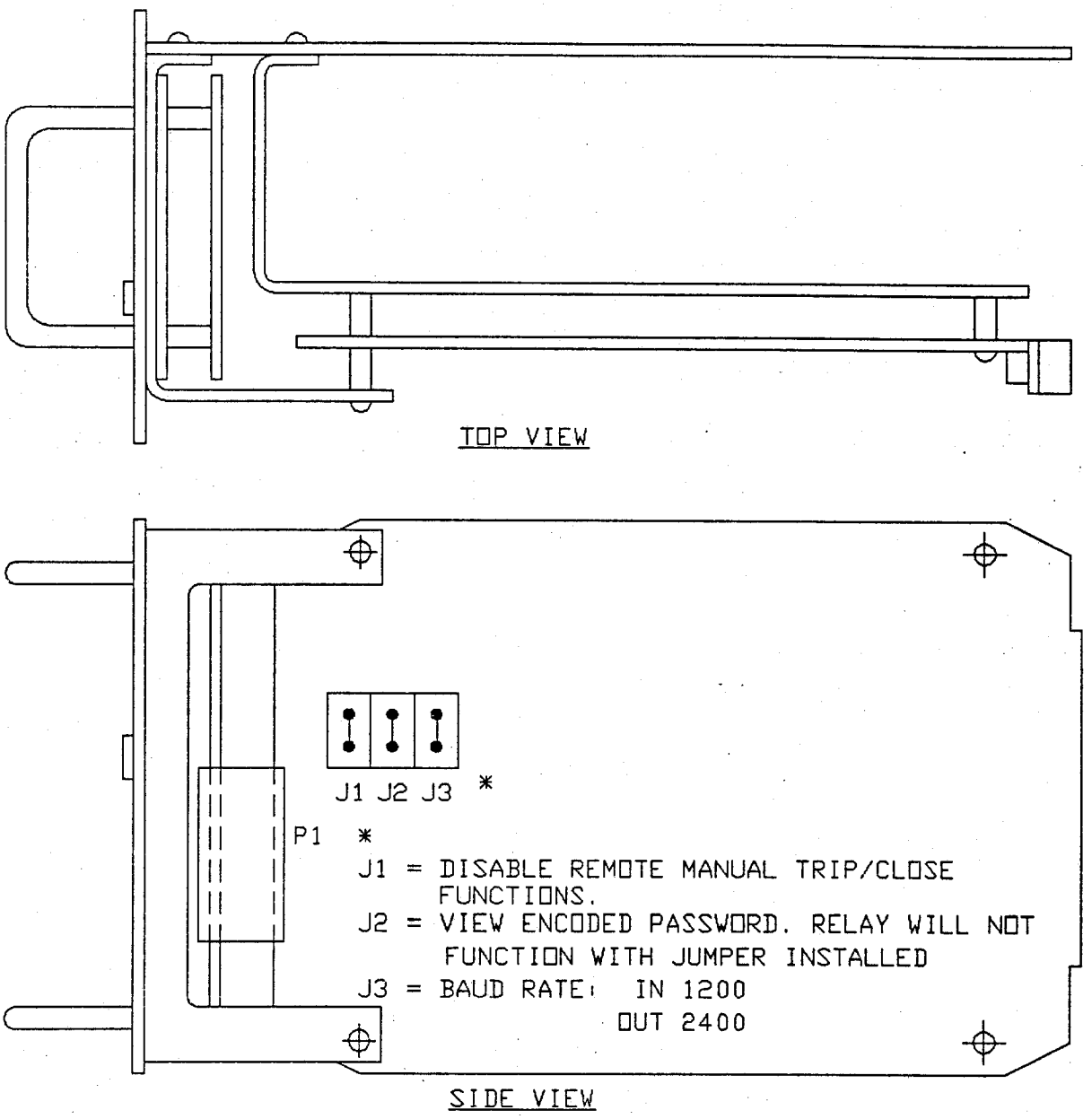


Figure MO-2 (0286A2998) MMI Module

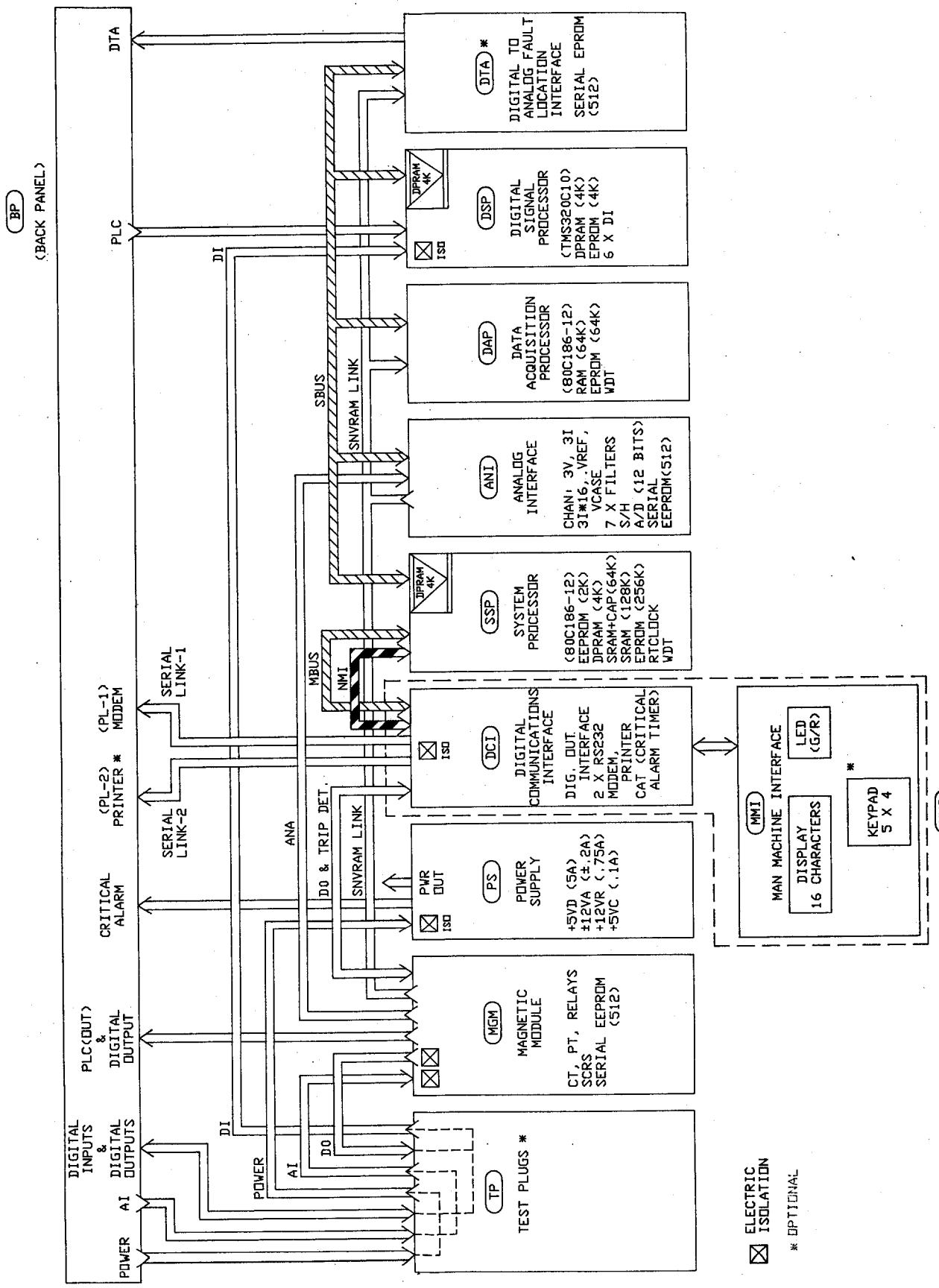


Figure MO-3 (0179C8450 Sh.1 [2]) DLP Overall Block Diagram

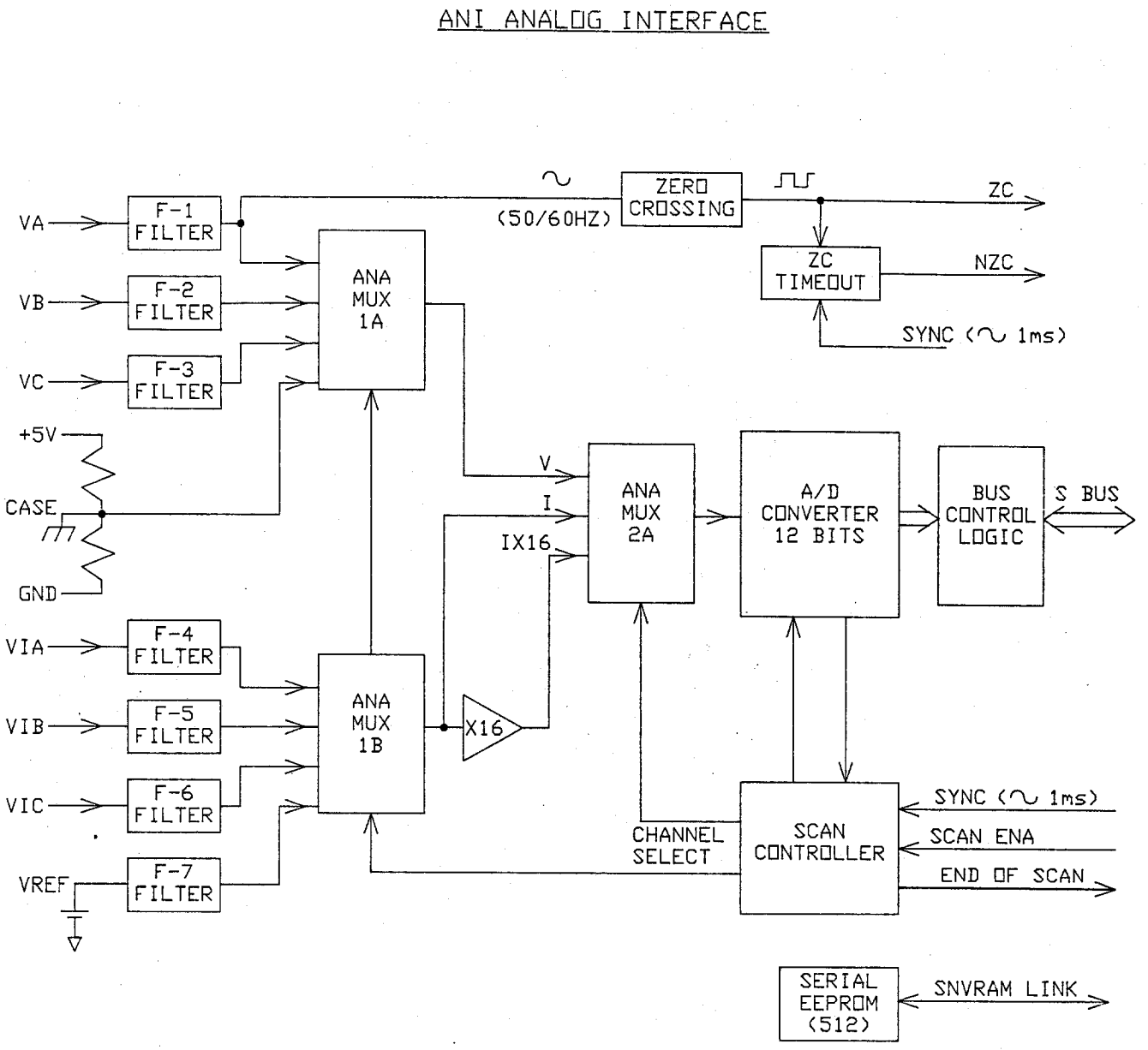


Figure MO-4 (0179C8450 Sh.4 [1]) ANI Block Diagram

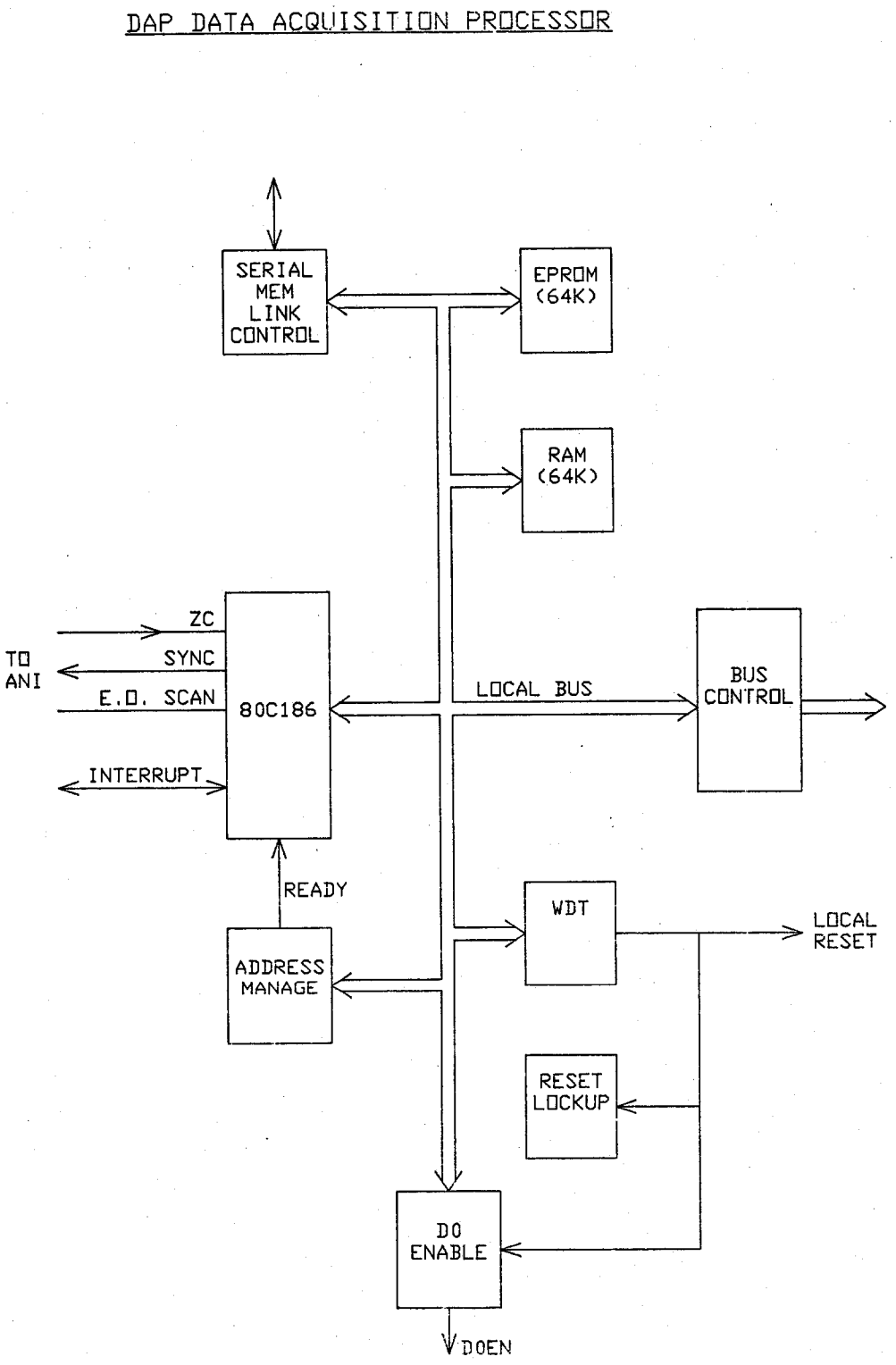


Figure MO-5 (0179C8450 Sh.5) DAP Block Diagram

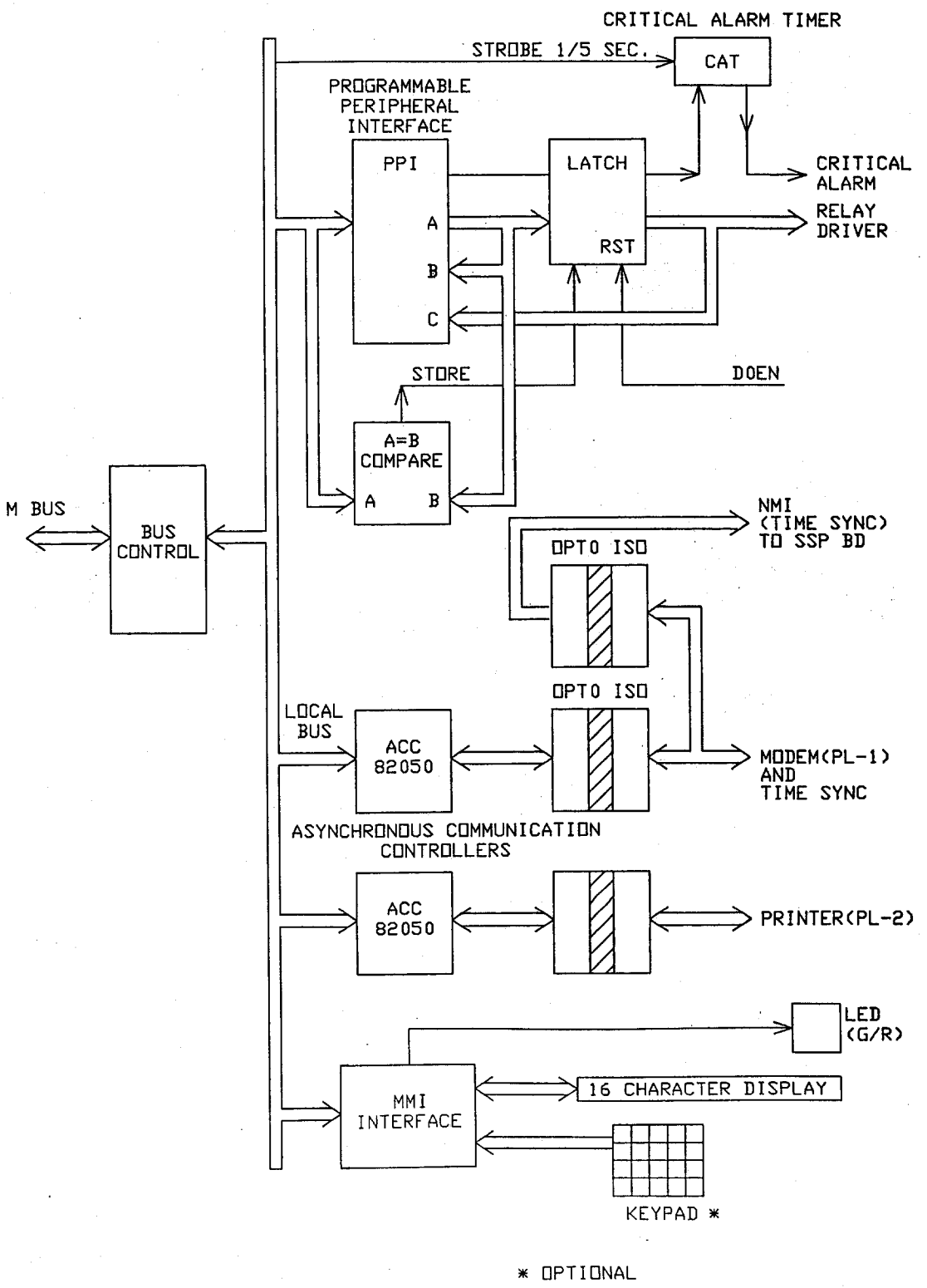


Figure MO-6 (0179C8450 Sh.3 [1]) DCI and MMI Block Diagram

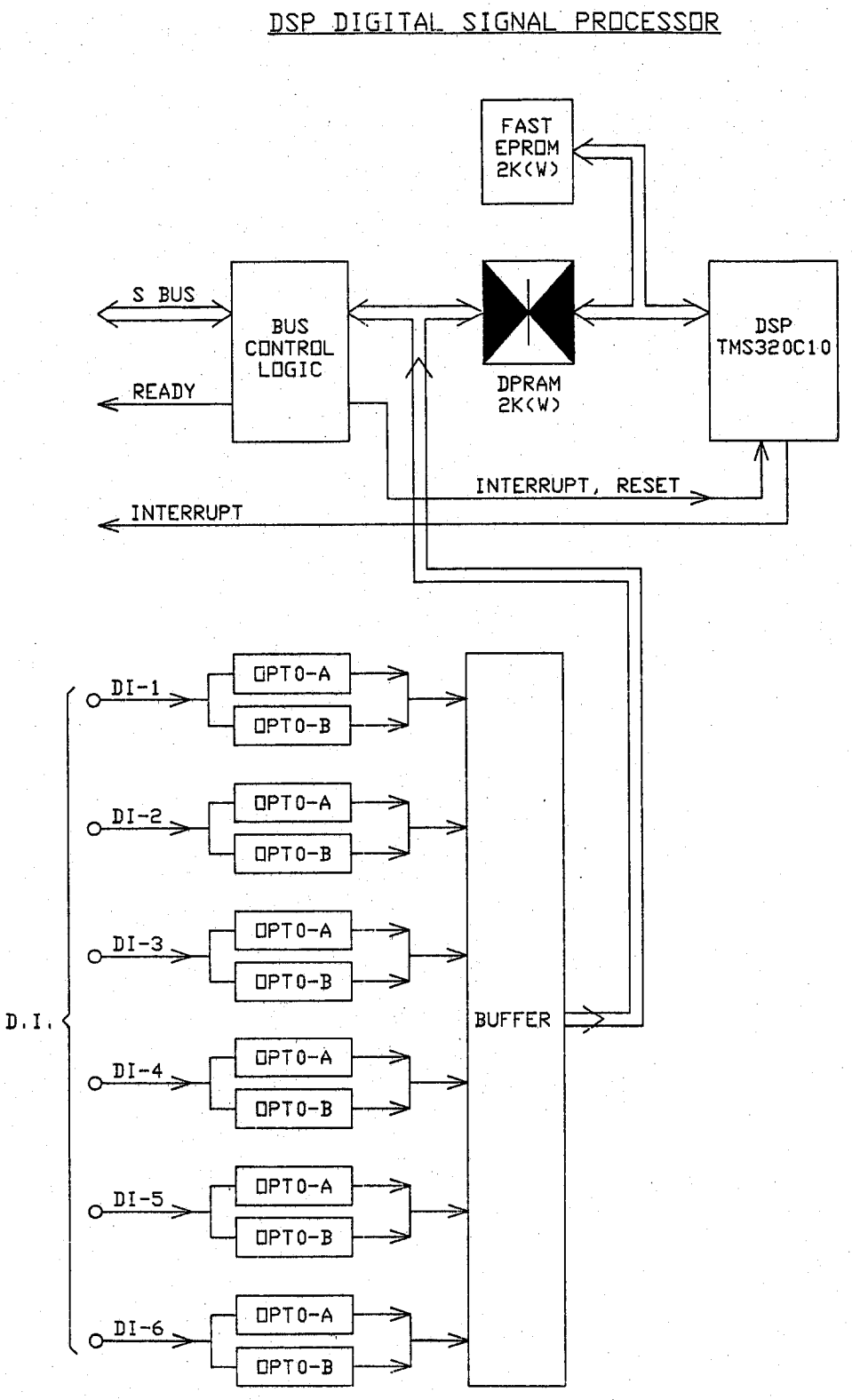


Figure MO-7 (0179C8450 Sh.5) DSP Block Diagram

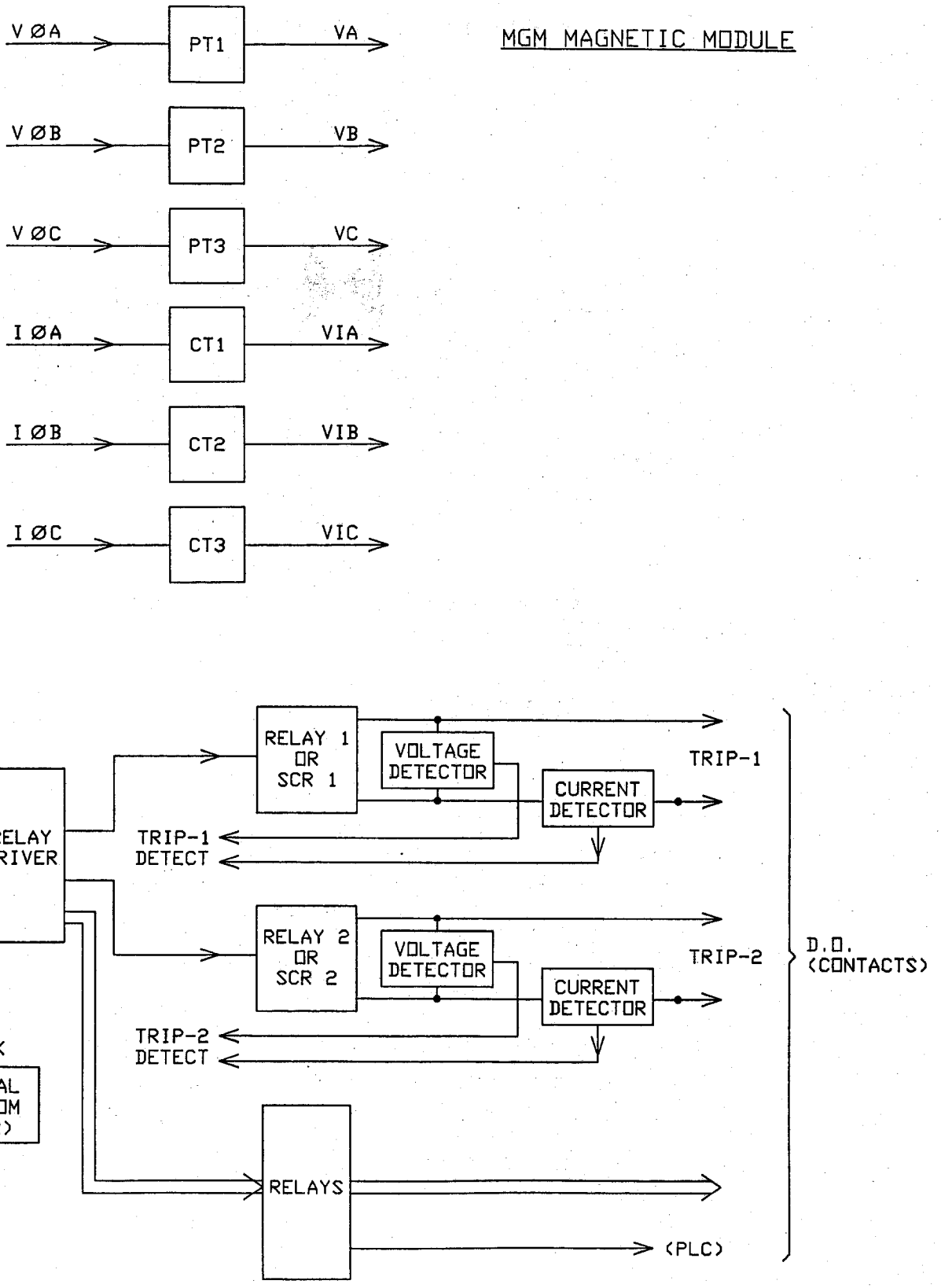


Figure MO-8 (0179C8450 Sh.3 [1]) MGM Block Diagram

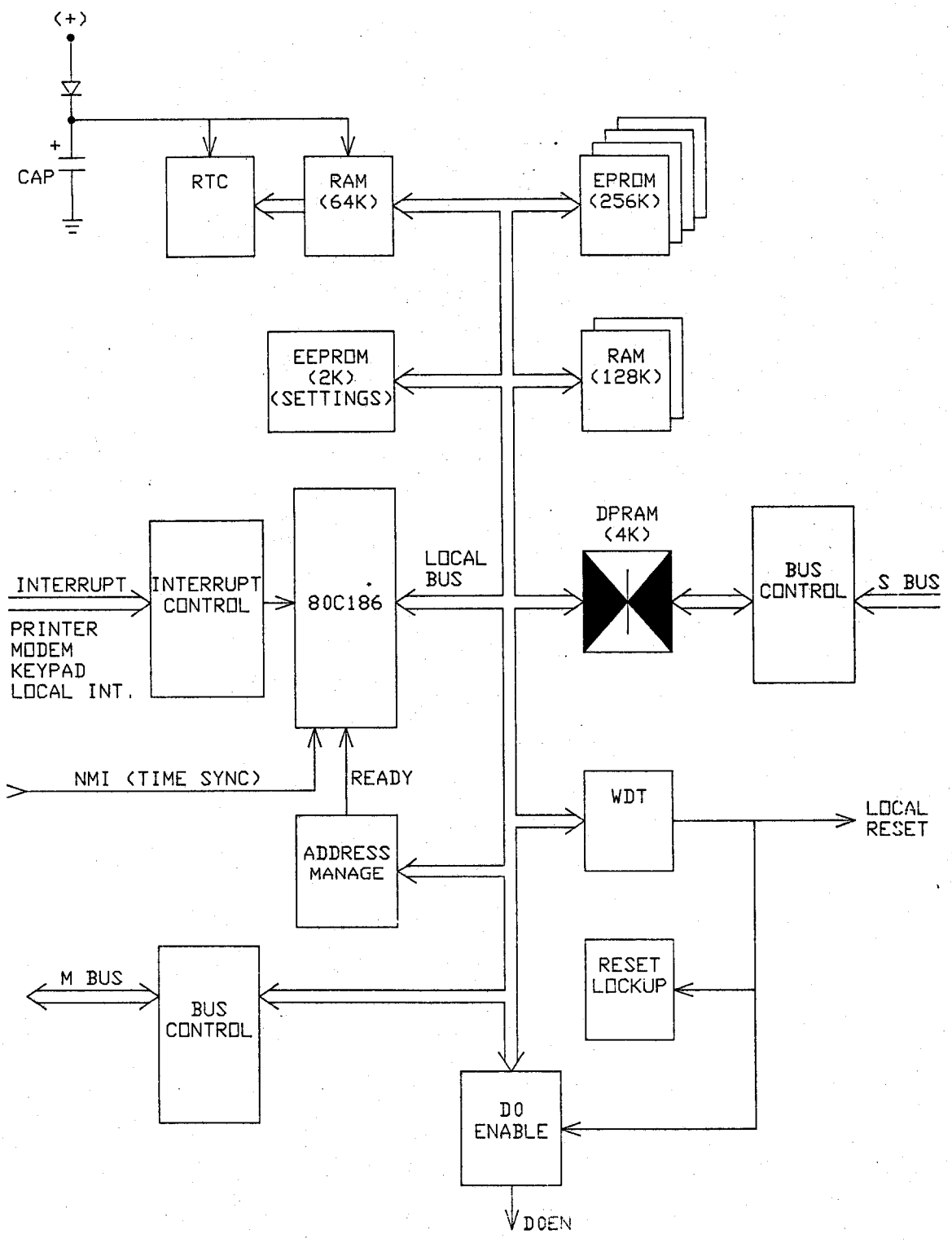


Figure MO-9 (0179C8450 Sh.4 [1]) SSP Block Diagram

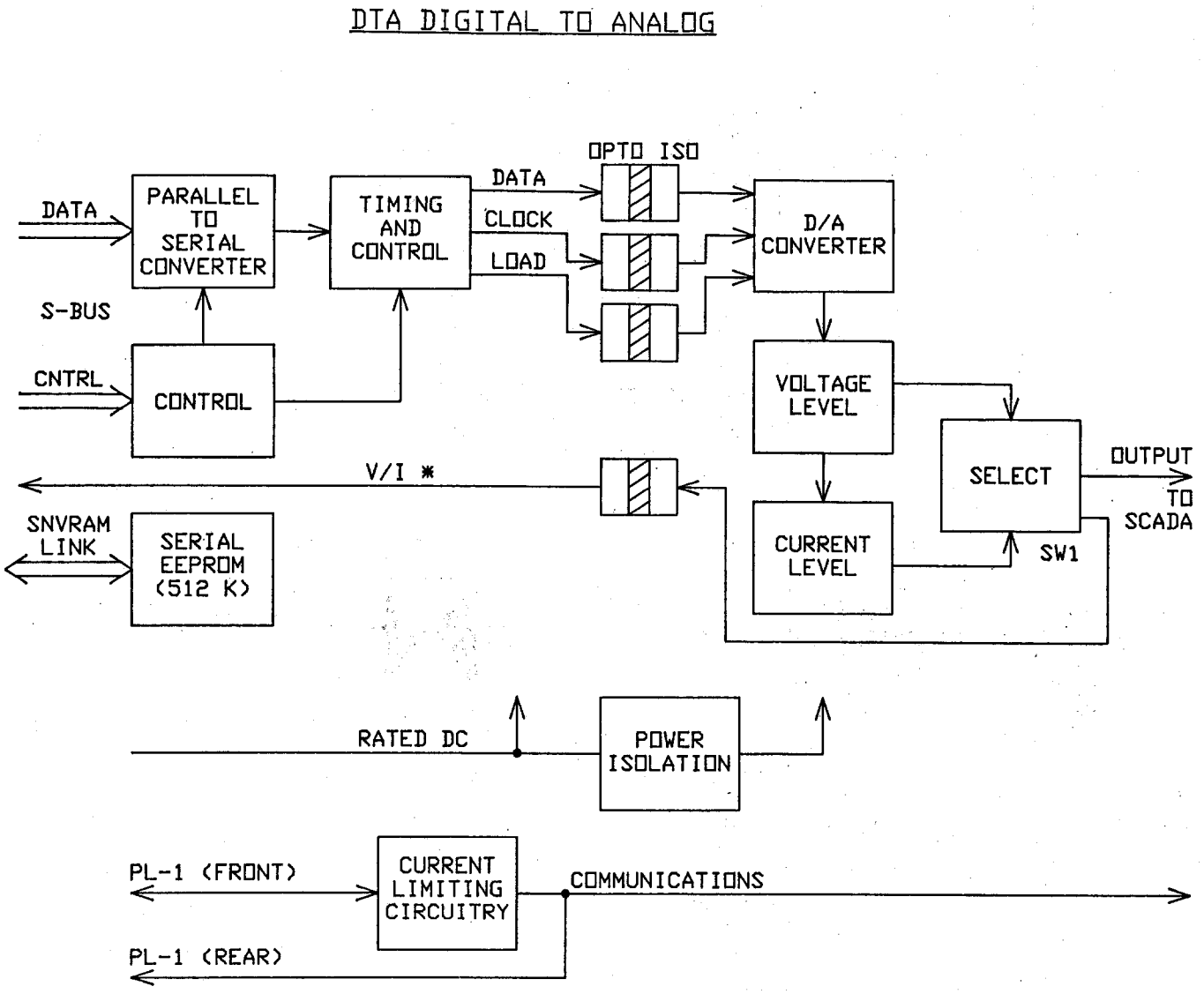


Figure MO-10 (0179C8450 Sh.6) DTA Block Diagram

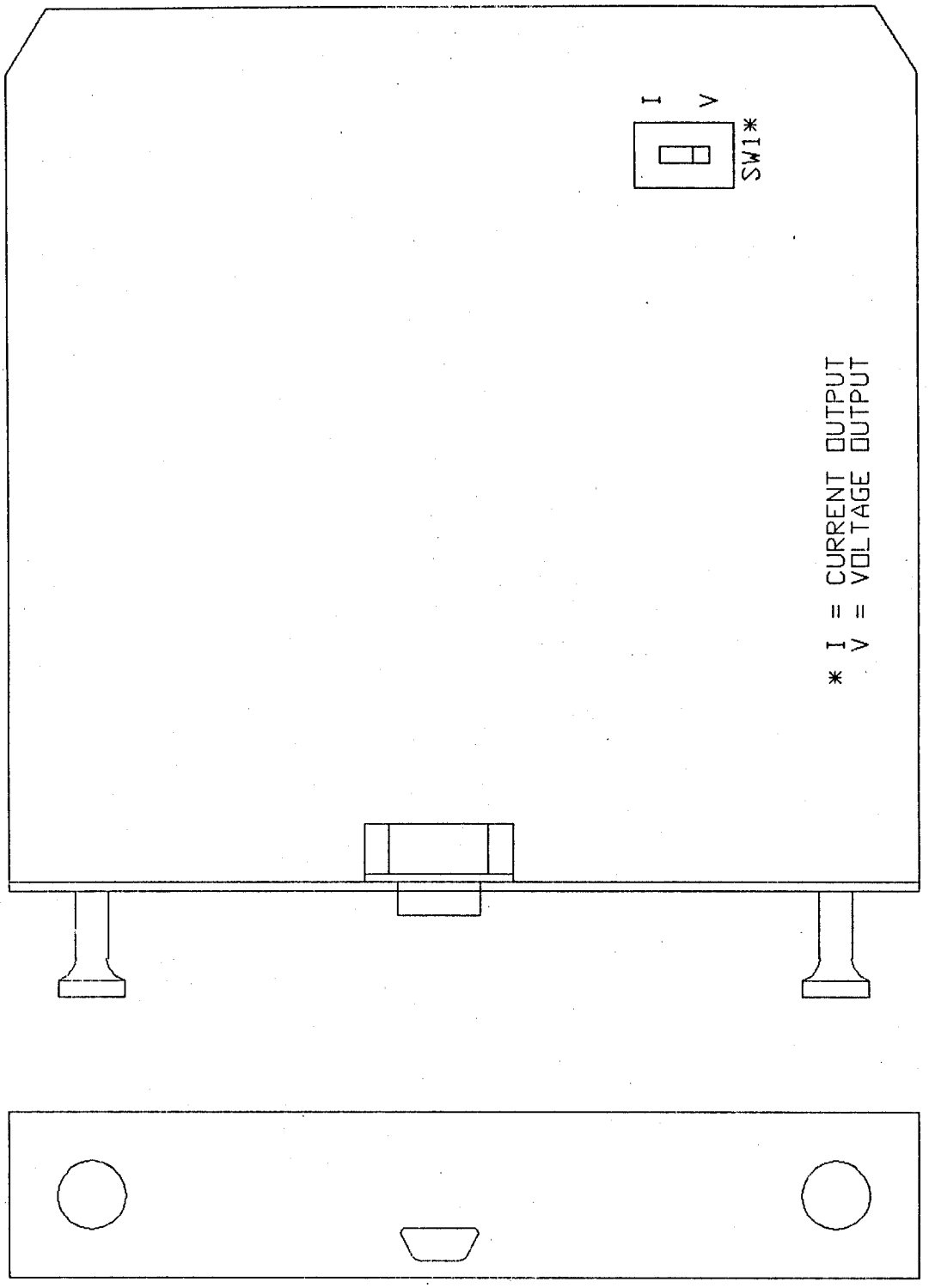


Figure MO-11 (0286A2999[1]) DTA Module

ACCEPTANCE TESTS

CAUTION

Power Down the relay by turning off the power switch before removing or inserting modules. Failure to do so can permanently damage the relay.

GENERAL

This section is a guide for testing the relay. It is not necessary that the tests be performed for incoming inspection. The relay has been tested at the factory with automated test equipment. And the DLP is a digital relay controlled by "self checking" software. If a system failure is detected it will be reported through the MMI.

The following tests include: Relay status self test and display and MMI self test. Tests of backup protection functions, measuring units, and Zone timers are also included, and can be performed at the users discretion.

General Tests

T1	Relay Status Tests
T2	AC system input test

Measuring Unit Tests

T3	FD fault detector
T4	IT Trip Supervision
T5	IB Blocking Supervision
T6	Ground Directional Trip Test, IPT + NT
T7	Ground Directional Block Test, IPB + NB

Backup Protection Tests

T8	Phase Instantaneous Overcurrent PH4
T9	Ground Instantaneous Over-current IDT
T10	Ground Time Over-current TOC

Zone Ground/Phase Reach and Timers Tests

T11	Zone1 Ground Reach MG1
T12	Zone2 Ground Reach MTG
T13	Zone3 Ground Reach M3G
T14	Zone4 Ground Reach M4G
T15	Zone Ground Timer Tests
T16	Zone1 Phase Reach M1
T17	Zone2 Phase Reach MT1
T18	Zone3 Phase Reach M31
T19	Zone4 Phase Reach M41
T20	Zone Phase Timer Tests
T21	Out of Step MOB

TEST EQUIPMENT

1. Three-phase source of voltage and current at rated frequency.
2. DC Control voltage source
3. Three AC voltmeters
4. Three AC ammeters
5. A continuity tester or Ohm meter
6. An IBM compatible computer with a serial port.
7. An RS232 null modem cable to connect the PC to the DLP.
8. A Precision Timer for testing timed events.

The specific requirements of the equipment are given in the text of this section, and in the associated circuit diagrams.

The three-phase AC sinusoidal voltage must be balanced and undistorted. Similarly, the DC power should come from a "good" source with less than 5% ripple. A "good source" is one that is within the voltage range shown in the **SPECIFICATIONS** section.

As an alternative, a three-phase electronic test source may be used. In many cases, these devices enable the test circuits to be simplified greatly.

DRAWINGS & REFERENCE:

The following drawings should be used for reference during testing. They are located in the **PRODUCT DESCRIPTION** (PD), and the **CALCULATION OF SETTINGS** (CS) and the **INTERFACE** (IN) sections.

Drawings

1. The Elementary Diagram	FIG PD-4
2. The Logic Diagram	FIG PD-1,2,3
3. The TOC curve	FIG CS-7

References

1. **SOFTWARE** section of this manual.
2. Default Relay Settings

EQUIPMENT GROUNDING

All equipment used in testing the DLP relay should be connected to a common grounding point to provide noise immunity. This includes the voltage and current sources, as well as the DLP itself.

The ground connection on the DLP is terminal AD14. The common for surge protection is terminal AC14. NOTE: AC14 should be connected to AD14 with #12 wire or larger during test as well as operation. (The separate surge ground is for High pot testing purposes.)

REQUIRED SETTINGS

Most tests will utilize the Default Settings. If setting changes are required, they will be listed prior to the test procedure.

For periodic testing purposes, see the following section. It provides details on doing the relay test with user-specific settings.

GENERAL INSTRUCTIONS

1. The DLP is tested in the "test mode" of operation. This mode allows the internal measuring units and functions to be brought out and viewed. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

   The test mode selects and isolates various test functions, measuring units, and routes their status to the RC "reclose cancel" contact. When the particular function under test has picked up, the RC contact will close. Target information will be displayed for tests that cause tripping.

WARNING
The RC contact will chatter when the unit under test is near its threshold. DO NOT let it continue. Remove the test current. A single contact closure is enough to determine that the unit picked up.

In tests that cause tripping, the trip target type may not match the unit under test. Example: If a Zone 1 ground fault was being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. It is important to keep that in mind during the tests.

A continuity tester with high-input impedance such as a Digital Ohmmeter should be used to monitor the RC contact during the testing of the relay.

NOTE: TRIPPING CONTACTS WILL OPERATE IN THE TEST MODE. For example, The Zone1 ground fault test will cause the trip contacts to close. If desired the trip contacts can be tested during the test along with the RC contact.

2. Where appropriate, voltage and current levels are defined with two numbers as: xx(yy), xx is the value to be used for relays rated at 5 amperes and (yy) is the value to be used for 1 ampere relays.

3. During the test one or possibly more of the electronic current sources may not be used. If the source is not used it must be set to zero (0) in addition to being turned OFF. Also, the current sources should only be powered on or off with the currents set at or near zero (0).

4. The phase angles of the test sources are shown relative to phase A voltage. A positive (+) phase angle refers to the referenced quantity leading phase A voltage. A negative (−) phase angle refers to the referenced quantity lagging phase A voltage.

5. All test voltages are phase-to-ground measurements unless otherwise specified.

6. In the ZONE REACH testing, fault distances are given. In some cases the distance calculated will be beyond the 100 mile default setting of the relay. When that happens the distance will be displayed as "***" on the MMI.

7. NOTE: Operation of the Potential Fuse Failure function (PTFF) will cause the Critical Alarm to operate

At the end of testing, make sure that all settings are returned to initial values. Save them to a disk file before testing and reload them before placing the relay in service.

USING DLP-LINK

To test the relay without the DLP Keypad, communications with the relay are established via a PC with the program DLP-LINK. DLP-LINK is required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Once in test mode, current and voltages are applied to the relay to simulate the desired system conditions.

The following section is intended to give a step by step procedure to test the relay, from setting up communications to the application of the voltages and current inputs. It will be necessary to be familiar with the DLP-LINK software. Refer to the **SOFTWARE** section of this manual for information on how to use DLP-LINK.

Hardware Set Up

The hardware, specifically the cable to connect the PC to the relay, depends on the connection the PC requires and that of the DLP. The DLP port accepts a 25 pin male D-connector. The PC used may require a 9 or a 25 pin connector. Null modem cables are shown in the **INTERFACE** section for connecting to the DLP with a 9 pin to 25 pin and a 25 pin to 25 pin setup. Use the one that suits the system.

Connect the PC to the DLP with the appropriate null modem connector.

See **INTERFACE** section for Cable diagrams.

PC Software Set Up

The Software set up consists of loading the software on to the PC, starting the program, and configuring the program to the PORT and BAUD RATE of the PC and DLP.

Load & Start DLP-LINK

Use the INSTALLATION guide in the **SOFTWARE** section of this manual for directions to load DLP-LINK onto your PC.

Change directories to the location of the DLP-LINK program.

Start the program by typing "DLP-LINK" at the DOS prompt.

Set the Local (PC) Configuration

When you start DLP-LINK the MAIN MENU is displayed.

Select the **SETUP** item from the menu bar. Refer to the **SOFTWARE** section for information on how to select items using the keyboard or a mouse.

The **SETUP** menu will now be displayed.

Select **Communication port number.**

The default communications port will be displayed.

Type in the port number that matches the PC port connected to the DLP and press ENTER.

If port 3 or 4 is selected, the IRQ number must also be selected.

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 DLP's baud rate, phone number, and switch code. The DLP is accessed locally during testing therefore the PHONE NUMBER and the SWITCH CODE will not be set. The BAUD RATE will be set to the factory setting of 1200 with one stop bit and no parity.

Select the "**Add relay to list**" heading from the **SETUP** menu.

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.

At the PHONE NUMBER prompt, press [TAB]. (This is the default used when there is no phone.)

At the SWITCH CODE prompt, press [TAB]. (This is the default value for no switch.)

The Baud rate, stop bits, and parity are selected with a jumper on the MMI module. Refer to the **INTERFACE** section. cFor BAUD RATE, select 1200, stop bits, 1, and parity, none.

The Unit Description for "TEST" is complete.

Enter "OK" to return to the **SETUP** menu.

Relay Set Up

Before shipment, the relay is set with factory default settings. These include the UnitID, the Baud Rate, and the Factory Password. The default communications parameters are:

Setting	Default (from the factory)
UNIT ID	0 (CONFIGURATION setting)
PASSWORD	DLP! (Remote Communications password)
BAUD RATE	1200 (jumper selected with J3 on the DCI Board)

If this is the first login to the relay, these parameters may need to be changed. The password must be changed before any functions except CHANGE PASSWORD or LOGOUT can be used. Refer to the **SOFTWARE** section of this manual.

Logging Into the Relay

Select **Login** from the **RELAY FUNCTIONS** menu.

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 password is the one listed in the table above, and must be changed before any of the relay functions except CHANGE PASSWORD and LOGOUT will operate. See the **SOFTWARE** section of this manual for information on how to change a password.

Type in the current password and press [TAB].

If the password is not known, refer to the **INTERFACE** section of this manual for information on how to display the current password.

DLP-LINK will prompt for the unit ID.

Type in "0" and press [TAB].

Select "OK".

DLP-LINK will respond with a "SUCCESSFUL LOGIN" message.

If this was an initial login, the user must logout at this point, and login again, in order to get a complete display of all the DLP menus.

Select **lOgout** from the Relay functions menu and select "OK".

Setting Changes

Setting changes required for a particular test will be listed before the test. A setting can be changed in two ways, by category or individually, by selecting either "**view/change Category of settings**" or "**view/change Individual settings**" from the **RELAY FUNCTIONS Settings...** menu. A procedure for and example of how to change settings is provided in the **SOFTWARE** section of this manual.

It is important to remember to select "**End settings change**" from the Relay functions **Settings...** menu after all settings changes for a particular test are completed. This is necessary because settings are stored in a buffer so that they can all be downloaded at once. Selecting **End settings change** changes the settings in the relay itself.

Entering the Test Mode

Before most tests it is necessary to set the relay in the test mode according to the function to be tested. The test mode is set as follows:

Select "Relay test mode" from the **Actions...** menu.

The RELAY TEST list box appears.

Select the test you wish to enter from the menu and then select "OK".

The MMI LED will change from green to red when the DLP is in the test mode.

Exiting the Test Mode

The test mode is ended, and the relay protection turned on, by selecting "**End test mode**" from the RELAY TEST list box and then selecting "OK". The MMI LED changes from red to green, indicating that normal operation has resumed.

Saving and Verifying Initial Settings

Before testing, the relay settings should be uploaded from the DLP and printed for reference and verification. Verify that each DLP setting matches the default setting listed. If no printer is available, use the **view/change Category of settings** command in the Relay functions **Settings...** menu for verification.

Once uploaded, the current DLP settings can be saved to a disk file so that they can be reloaded back into the DLP when testing is completed. Select "Save settings to file" from **RELAY FINCTIONS Settings...** menu. DLP-LINK will prompt you for a name for the file, after which you should enter a valid MS-DOS filename. More information on how to use this command can be found in the **SOFTWARE** section of this manual.

USING D-LINK

The older version of the communications software, D-LINK, may still be used to communicate with the relay. Only the new software, DLP-LINK, is included with this book. D-LINK software may be obtained by request from the GE Sales office.

The following section is intended to give a step by step procedure to log into the relay, change settings, and enter test mode, using D-Link. Refer to the **SOFTWARE** *section of this manual for information on how to use D-LINK.*

PC SOFTWARE SET UP

The Software set up consists of loading the software on to the PC, starting the program, and configuring the program to the PORT and BAUD RATE of the PC and DLP.

Load & Start D-LINK

Use the INSTALLATION guide in the **SOFTWARE** *section of this manual for directions to load D-LINK onto the PC.*

Change directories to the location of the D-LINK program.

Start the program by typing "D-LINK" at the DOS prompt.

Set the Local (PC configuration)

When D-LINK is started the MAIN MENU is displayed.

Select (using the arrow keys) the CONFIGURATION PARAMETERS heading by pressing the [ENT] key when that heading is highlighted.

The Configuration menu will now be displayed.

Select VIEW/CHANGE PC COMMUNICATIONS PORT and press the [ENT] key.

The default communications port will be displayed.

Type in the correct port number and press the [ENT] key or just press [ENT] if the PC port connected to the DLP matches the default displayed.

Set Up a Unit Test Description

The next step is to create a new "UNIT DESCRIPTION" that matches the DLP's BAUD RATE, PHONE NUMBER, and SWITCH CODE. The DLP is accessed locally during testing therefore the PHONE NUMBER and the SWITCH CODE will be set to zeros. The BAUD RATE will be set to the factory setting of 1200.

Select the ADD RELAY UNIT DESCRIPTION heading from the CONFIGURATION PARAMETERS menu and press [ENT].

At the ENTER NEW RELAY UNIT DESCRIPTION prompt type "TEST" and press [ENT].

A new unit description called "TEST" is created and must now have parameters set for it.

Select the VIEW/CHANGE RELAY LOGIN DATA heading and press [ENT].

All of the relay unit descriptions will be listed.

Select the unit "TEST" and press [ENT].

The parameters PHONE NUMBER, SWITCH CODE, AND BAUD RATE will be displayed.

Select PHONE NUMBER and press [ENT].

After the prompt, type in 10 zeros and press [ENT]. (Ten zeros is the default used when there is no phone.)

Select SWITCH CODE and press [ENT].

After the prompt, type in "0" and press [ENT]. (This is the default value for no switch.)

Select BAUD RATE and press [ENT].

After the prompt, type in "1200" and press [ENT].

The Unit Description for "TEST" is complete.

Press [ESC] three times to return to the MAIN MENU.

LOGIN TO THE RELAY

Select LOGIN from the MAIN MENU and press [ENT].

Select the relay login data for "TEST" and press [ENT].

D-LINK will prompt the user for the password. If this is the first login to the relay, the password is "DLP!" and must be changed before any of the relay functions except CHANGE PASSWORD and LOGOUT will operate. See the **SOFTWARE** *section of this manual for information on how to change the password.*

Type in the current password and press [ENT].

If the password is not known, refer to the **INTERFACE** *section of this manual for information on how to display the current password.*

D-LINK will prompt for the unit ID.

Type in "0" and press [ENT].

D-LINK will respond with a "SUCCESSFUL LOGIN" message.

If this was an initial login, the user must logout at this point and login again in order to get a complete display of all the DLP menus.

Select LOGOUT from the MAIN MENU and press [ENT].

SETTING CHANGES

Setting changes required for a particular test will be listed before the test. A setting can be changed in two ways, by category or individually, by selecting either VIEW/CHANGE CATEGORY OF SETTINGS or VIEW/CHANGE INDIVIDUAL SETTINGS from the DLP SETTINGS menu. A procedure for and example of how to change settings is provided in the **SOFTWARE** *section of this manual.*

It is important to remember to select END SETTING CHANGES from the DLP SETTINGS menu after all settings changes for a particular test are completed. This is necessary because protection is turned off at the DLP whenever a setting is changed. (The LED on the MMI changes from green to red.) Selecting END SETTINGS CHANGES turns protection back on. (The LED changes back to green.)

INITIAL TEST SETUP

Entering the Test Mode

Before each test it is necessary to set the relay in the test mode according to the function to be tested. The test mode is set as follows:

1. *Select RELAY TEST MODE from the DLP ACTIONS menu press [ENT].*

2. *Select the test to be performed from the menu, press [ENT].*

The MMI LED will change from green to red when the DLP is in the test mode.

Exiting the Test Mode

The test mode is ended and the relay protection turned on by selecting END TEST MODE from the RELAY TEST MODE menu and pressing [ENT]. The MMI LED changes from red to green indicating that normal operation has resumed.

Saving and Verifying Initial Settings

Before beginning the test, the relay settings should be uploaded from the DLP and printed for reference and verification. The factory settings are listed in the **CALCULATION OF SETTINGS** *section. Verify that each DLP 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 DLP settings can be saved to a disk file so that they can be reloaded back into the DLP when testing is completed. Use the SAVE DLP SETTINGS TO FILE command in the DLP SETTINGS menu. D-LINK will prompt for a name for the file after which the user should enter a valid MS-DOS filename. More information on how to use this command can be found in the **SOFTWARE** *section of this manual.*

GENERAL RELAY TESTS

T1 - Relay Status Check

The Relay's Status is reported through the MMI, the non-critical alarm contact, and the critical alarm contact. If a system error caused relaying functions to cease, the LED on the MMI would turn "red" and the critical alarm contact would open. A failure that did not interrupt relaying would be indicated by the non-critical alarm closing, and by a "FAIL" or "WARN" message on the DLP STATUS display.

This test will demonstrate the use of the **RELAY FUNCTIONS Information...** menu to check relay status. See the **SERVICING** section for further information.

Setting Change
CONFIG
(1504) TRIPCIRC = 0 (NONE)

1. The AC inputs are not required for this test, only the DC power supply voltage. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.

2. Log into the relay and select **request DLP Status** from the **RELAY FUNCTIONS Information...** menu.

   The display should be "STATUS: OK". "OK" represents that the relay is operational and there are no errors.

Failure Status

3. Change the setting (f the trip circuit monitor: (1504) TRIPCIRC = 1 (BKR1) (using the **RELAY FUNCTIONS Settings...** menu). When this is done the relay expects a wetting voltage across the trip contacts.

   NOTE: Select End settings change after each setting change.

4. Select **request DLP Status** from the **RELAY FUNCTIONS Information...** menu.

   The display should indicate "DLP STATUS: WARN
   BKR1 TRIP CIRCUIT MONITOR".

This verifies that the relay detected the absence of wetting voltage across the trip contact.

5. Change the setting of the trip circuit monitor back to: (1504) TRIPCIRC = 0 (NONE). before proceeding with the next test.

T2 - AC System Input Test

This test uses the PRESENT VALUES function of DLP-LINK to determine that the voltages and currents are applied to the proper connections on the terminal strip. This 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 AT-1.

2. Set VA = 67 volts rms 0°, VB = 57 volts rms −120°, and VC = 47 volts rms 120°.

3. Select the **request Present values** function from the **RELAY FUNCTIONS Information...** menu.

4. Note 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.

5. Set Iop = 1.0 amp rms for phases IA, IB, or IC, as shown by the "Y" connection point in Figure AT-1.

6. Again select the **request Present values** function from the **RELAY FUNCTIONS Information...** menu.

7. Note 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.

8. Reduce the test current to zero (0) amps.

MEASURING UNIT TESTS

WARNING

THE RC CONTACT WILL CHATTER WHEN THE UNIT UNDER TEST IS NEAR ITS THRESHOLD. DO NOT LET IT CONTINUE. REMOVE THE TEST CURRENT. A SINGLE CONTACT CLOSURE IS ENOUGH TO DETERMINE THAT THE UNIT PICKED UP.

T3 - Fault Detector Test

The Fault Detector responds to sudden changes in current levels. Slow changes will not be picked up.

1. Connect the relay as shown in Figure AT-1.
2. Select the relay into the test mode with the fault detector selected: "FAULT DETECTOR ON". Set VA = 67 volts rms 0° ; VB = 67 volts rms −120° ; VC = 67 volts rms +120° .
3. Select the **Relay test mode** function from the **RELAY FUNCTIONS Actions...** menu. Then select FAULT DETECTOR and press [ENT].
4. Slowly increase Iop to 1.2(0.24) amps rms, approximately 0.1(0.01) amp per second. Slowly decrease the current to zero (0) amp. The RC contact should not close.
5. Immediately increase the current of Iop to 1.5(0.3) amps rms. The RC contact will close momentarily.
6. Immediately increase the current of Iop to 2.5 (0.5) amperes rms. The RC contact will close until current is removed.
7. Reduce Iop to Zero (0).

T4 - IT Detector Test

Settings:
CURSUPVIS
(503) PUIT = 0.25(.05) AMP

1. Connect the relay as shown in Figure AT-1.
2. Set the relay into the test mode with IT DETECTOR selected.
3. Set the current of Iop to .40(.08) amp rms and apply to the relay. The RC contact should close. Lower Iop to .15(.03) amp rms, and the RC contact should open.
4. Reduce Iop to zero (0).

T5 - IB Detector Test

Settings:
CURSUPVIS
(504) PUIB = 0.2 (.04) AMP

1. Connect the relay as shown in Figure AT-1.
2. Set the relay into the test mode with IB DETECTOR selected.
3. Set the current of Iop to .30(.06) amp rms and apply to the relay. The RC contact should close. Lower Iop to .10(.02) amp rms, and the RC contact should open.
4. Reduce Iop to zero (0).

T6 - Ground Directional Trip Test, IPT + NT

Settings:
CURSUPVIS
(501) PUIPT = 0.5(0.1) AMP

1. Connect the relay as shown in Figure AT-1.
2. Set VA = 57 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms 120°.
3. Set the relay into the test mode with GRD DIR TRIP selected.
4. Set IA, the current of Iop, to .70(.14) amp rms −85°, and apply to the relay. The RC contact should close. Lower Iop to .40(.08) amp rms, and the RC contact should open.
5. Reduce Iop to zero (0).

T7 - Ground Directional Block Test, IPB + NB

Settings:
CURSUPVIS
(502) PUIPB = 0.25(.05) AMP

1. Connect the relay as shown in Figure AT-1.
2. Set VA = 55 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms 120°.
3. Set the relay into the test mode with GRD DIR BLK selected.
4. Set IA, the current of Iop, to .40(.08) amp rms −165°, and apply to the relay. The RC contact should close. Lower Iop to .15(.03) amp rms, and the RC contact should open.
5. Reduce Iop to zero (0).

T8 - Phase Instantaneous Overcurrent PH4

Settings Changes:
OVERCUR
(601) SELPH4 = YES
(602) PUPH4 = 5.0 (1.0) AMPS

1. Connect the relay as shown in Figure AT-2, for a phase AB, BC or CA fault.

2. Set the relay into the test mode with INST PHASE OC selected.

3. Set the current of Iop to 2.8(0.6) amps rms and apply to the relay. The RC contact should close. Lower Iop to 2.0(0.4) amps rms, and the RC contact should open.

4. Reduce Iop to zero (0).

5. Change (602) PUPH4 back to pretest setting of 20 amps.

T9 - Ground Instantaneous Overcurrent IDT

Settings Changes:
OVERCUR
(603) SELIDT = YES
(604) SELDIDT = NO (directional control off)
(605) PUIDT = 2.5 (0.5) AMPS

1. Connect the relay as shown in Figure AT-1.

2. Set the relay into the test mode with INST GROUND OC selected.

3. Set the current of Iop to 4.0(.80) amps rms and apply to the relay. The RC contact should close. Lower Iop to 2.4(.48) amps rms, and the RC contact should open.

4. Reduce Iop to zero (0).

5. Change the setting of (604) SELDIDT back to "YES" to restore directional control, and change (605) PUIDT back to pretest setting. (10A Default)

T10 - Ground Time Overcurrent ITOC

Settings Changes:
OVERCUR
(606) SELTOC = YES
(607) SELDTOC = NO (directional control off)
(608) PUTOC = 1.0 (0.2)
(609) TDTOC = 5

1. Connect the relay as shown in Figure AT-3.

NOTE: Start the timer when Iop is applied, and stop the timer when the RC closes (the relay trips).

2. Set the relay into the test mode with TIME DELAY GROUND OC selected.

3. Apply Iop at 3.0 amps rms and start the timer. Leave the current "on" until the RC contact closes, and stop the timer. The TOC will time out in 2.50 to 3.5 seconds.

4. Reduce Iop to zero (0).

5. Change the setting of (607)SELDTOC to "YES". Change (608)PUTOC to pretest setting.

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. This is due to the fact that different test equipment and test methods might be used. They 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 testing a particular zone, the other protection zones will be disabled so 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 need to be disabled to isolate the unit ZONE REACH under test. If left enabled, they may trip before the Zone under test does. In this case the MMI target information will reflect that trip and not the Zone.

   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 = 2 (BLKNONE)

NOTE: AFTER THE ZONE REACH TESTING IS COMPLETED RESTORE THE ABOVE SETTINGS TO THE PRETEST VALUES.

PHASE-TO-GROUND TESTING

T11 - Zone 1 Ground Reach test, MG1 Ground Faults (AG, BG, and CG)

Setting Changes:
Z1DIST
(101) SELZ1G = YES
(102) SELZ1P = NO
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO
Z4DIST
(401) SELZ4G = NO
(402) SELZ4P = NO

Ground Faults (AG, BG, and CG) M1G

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.

2. Set the relay into the test mode with ZONE 1 selected.

3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle listed in Table AT-1. (Increase VA, VB, VC to 75V when Iop = −85°)

TABLE AT-1

I Degrees	Volts RMS	*DIST
−25	36 - 42	15-30
−55	58 - 67	60-75
−85	64 - 72	80-95

4. Set the fault current, "Iop", to 8.2(1.6) amps rms . Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown in Table AT-1.

5. Reduce the fault current to zero (0).

   Note that the trip target indication concurs with the fault. An AG fault will be displayed as: TRIP: AG Z1 "DIST" *.

6. Repeat the test for phase BG and CG faults.

* reference only

T12 - Zone 2 Ground Reach, MTG

Setting Changes:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO
Z2DIST
(201) SELZ2G = YES
(202) SELZ2P = NO
(207) PUTL2P = 0.1
(208) PUTL2G = 0.1
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO
Z4DIST
(401) SELZ4G = NO
(402) SELZ4P = NO

Ground Faults (AG, BG, and CG)

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.

2. Set the relay into the test mode with ZONE 2 selected.

3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-2. (Increase VA, VB, VC to 75V when Iop = −85°)

TABLE AT-2

I Degrees	Volts RMS	*DIST
−25	36 - 44	30-45
−55	60 - 66	95-***
−85	63 - 72	***

NOTE: Distances beyond 110% of the line are shown as ***.

4. 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 AT-2.

5. Reduce the fault current to zero (0).

   Note that the trip target indication concurs with the fault. An AG fault will be displayed as: TRIP: AG Z2 "DIST"*.

6. Repeat the test for phase BG and CG faults.

* reference only

T13 - Zone 3 Ground Reach, M3G

Setting Changes:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO
Z3DIST
(301) SELZ3G = YES
(302) SELZ3P = NO
(305) PUTL3P = 0.1
(306) PUTL3G = 0.1
Z4DIST
(401) SELZ4G = NO
(402) SELZ4P = NO

Ground Faults (AG, BG, and CG)

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.

2. Set the relay into the test mode with ZONE 3 selected.

3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-3. (Increase VA, VB, VC to 75V when Iop = −85°)

TABLE AT-3

I Degrees	Volts RMS	*DIST
−25	35 - 44	45-60
−55	60 - 66	***
−85	64 - 72	***

4. Set the fault current to 3.5(0.7) amperes rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown in Table AT-3.

5. Reduce the fault current to zero (0).

   Note that the trip target indication concurs with the fault. An AG fault will be displayed as: TRIP: AG Z3 "DIST"*.

6. Repeat the test for phase BG and CG faults.

* reference only

T14 - Zone 4 Ground Reach, M4G

Setting Changes:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO
Z4DIST
(401) SELZ4G = YES
(402) SELZ4P = NO
(406) PUTL4P = 0.1
(407) PUTL4G = 0.1

Z4 Ground Faults (AG, BG, and CG)

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.
2. Set the relay into the test mode with ZONE 4 selected.
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-4.

TABLE AT-4

I Degrees	Volts RMS	*DIST
−25	37 - 45	70-85
−55	57 - 65	***

4. Set the fault current to 2.3(0.46) 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 AT-4.
5. Reduce the fault current to zero (0).
6. Repeat the test for phase BG and CG faults.

* reference only

T15 - Ground Timer Tests

Settings:
(901) SELLPU = NO
Z1DIST
(101) SELZ1G = YES
(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
(406) PUTL4P = 5.0
(407) PUTL4G = 5.0

Zone 1 Ground Fault (AG)

1. Connect the relay as shown in Figure AT-4, for a phase AG fault.

2. Set the voltage inputs to: VA = 55 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to −55°.

3. Apply the fault current at 8.2(1.64) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.

4. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a ZONE1 trip, such as: AG Z1. This verifies that the primary zone picked up.
The time for the trip should be in the range of 15 to 50 milliseconds.

5. Leave the voltages at the values in step 2.

Zone 2 Timer - Z2 timer default value of 1.0 sec.

Setting Change:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO

6. Apply the fault current at 8.2(1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.

7. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). 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 of 0.9 to 1.1 seconds.

8. Leave the voltages at the values in step 2.

Zone 3 time out Z3 timer default value of 3.0 sec.

Setting Change:
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO

9. Apply the fault current at 8.2(1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.

10. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). 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 of 2.9 to 3.1 seconds.

11. Leave the voltages at the values in step 2.

Zone 4 time out Z4 timer default value of 5.0 sec.

Setting Change:
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO

12. Apply the fault current at 8.2(1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps. It should be applied at that level.) This is an AG fault that is within pickup of all four zones.

13. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). 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 of 4.8 to 5.2 seconds.

14. Return all settings to pretest values:

    Settings:
    Z1DIST
    (101) SELZ1G = YES
    (102) SELZ1P = YES
    Z2DIST
    (201) SELZ2G = YES
    (202) SELZ2P = YES
    Z3DIST
    (301) SELZ3G = YES
    (302) SELZ3P = YES
    Z4DIST
    (401) SELZ4G = YES
    (402) SELZ4P = YES

PHASE-TO-PHASE ZONE REACH TESTING

Setting Changes for all Phase-to-Phase tests:
OVERCUR
(601) SELPH4 = NO
(603) SELIDT = NO
(606) SELTOC = NO
OUTOFSTEP
(803) SELOSB = BLKNONE

T16 - Z1 Phase Reach, M1

Setting Changes:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = YES
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO
Z4DIST
(401) SELZ4G = NO
(402) SELZ4P = NO

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure AT-2, for the appropriate phases under test. Set the relay into the test mode with ZONE 1 selected.

2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-5. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.

3. Set the fault current to 10.0(2.0) amps rms. Simultaneously reduce the voltage of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table AT-5.

TABLE AT-5

I Degrees	Volts RMS	*DIST
−55	57 - 66	82-97
−85	50 - 57	60-75
−115	26 - 34	15-30

4. Reduce the fault current to zero (0).

   Note that the trip target indication concurs with the fault. An AB fault will be displayed as: TRIP: AB Z1 "DIST"*.

5. Repeat the test for phase BC and CA faults.

* reference only

T17 - Z2 Phase Reach, MT

Setting Changes:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = YES
(207) PUTL2P = 0.1
(208) PUTL2G = 0.1
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO
Z4DIST
(401) SELZ4G = NO
(402) SELZ4P = NO

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure AT-2, for the appropriate phases under test. Set the relay into the test mode with ZONE 2 selected.

2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-6. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.

3. Set the fault current to 6.7(1.34) amps rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table AT-6.

TABLE AT-6

I Degrees	Volts RMS	*DIST
−55	64 - 75	***
−85	55 - 65	***
−115	31 - 39	30-45

NOTE: Distances beyond 110% of the line are shown as ***.

4. Reduce Iop of the faulted phase to zero (0). Note that the trip target indication concurs with the fault. An AB fault will be displayed as: TRIP: AB Z2 "DIST"*.

5. Repeat the test for phase BC and CA faults.

* reference only

T18 - Z3 Phase Reach, M3

Setting Changes:
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

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure AT-2, for the appropriate phase under test. Set the relay into the test mode with ZONE 3 selected.

2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-7. Note: The leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, VC to 75V when Iop = −85°)

3. Set the fault current to 5.0(1.0) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table AT-7.

TABLE AT-7

I Degrees	Volts RMS	*DIST
−55	64 - 73	***
−85	55 - 64	***
−115	31 - 39	40-60

NOTE: Distances beyond 110% of the line are shown as ***.

4. Reduce the fault current to zero (0). Note that the trip target indication concurs with the fault. An AB fault will be displayed as: TRIP: AB Z3 "DIST"*.

5. Repeat the test for phase BC and CA faults.

* reference only

T19 - Z4 Phase Reach, M4

Setting Changes:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO
Z2DIST
(201) SELZ2G = NO
(202) SELZ2P = NO
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO
Z4DIST
(401) SELZ4G = NO
(402) SELZ4P = YES
(406) PUTL4P = 0.1
(407) PUTL4G = 0.1

Faults (AB, BC, and CA)

1. Connect the relay as shown in Figure AT-2, for the appropriate phase under test. Set the relay into the test mode with ZONE 4 selected.

2. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-8. Note: The leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, VC to 75V when Iop = −85°)

3. Set the fault current to 3.3 (0.7) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table AT-8.

TABLE AT-8

I Degrees	Volts RMS	*DIST
−55	62 - 72	***
−85	55 - 64	***

NOTE: Distances beyond 110% of the line are shown as ***.

4. Reduce the fault current to zero (0).

5. Repeat the test for phase BC and CA faults.

* reference only

T20 - Phase Timer Tests

Settings:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = YES
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
(406) PUTL4P= 5.0
(407) PUTL4G= 5.0

Zone 1 (AB)

1. Connect the relay as shown in Figure AT-5, for an AB fault. Set the relay into Test mode with ZONE 1 selected.

2. Set the voltage inputs to: VA = 55 volts rms 0°, VB = 55 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to −55°.

3. Apply the fault current at 10.0(2.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps. It should be applied at that level.) This is an AB fault that is within pickup of all four zones.

4. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a ZONE1 trip, such as: **AB Z1.** This verifies that the primary zone picked up.

   The time for the trip should be in the range of 15 to 50 milliseconds.

5. Leave the voltages at the values in step 2. Set the relay into the test mode with ZONE 2 selected.

Zone 2 Timer - Z2 timer default value of 1.0 sec.

Setting Change:
Z1DIST
(101) SELZ1G = NO
(102) SELZ1P = NO

6. Apply the fault current at 10.0(2.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps. It should be applied at that level.) This is an AB fault that is within pickup of all four zones.

5. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). 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 of 0.9 to 1.1 seconds.

8. Leave the voltages at the values in step 2. Set the relay into the test mode with ZONE 3 selected.

Zone 3 time out Z3 timer default value of 3.0 sec.

Setting Change:
Z2D2ST
(201) SELZ2G = NO
(202) SELZ2P = NO

9. Apply the fault current at 10.0(2.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps. It should be applied at that level.) This is an AB fault that is within pickup of all four zones.

10. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). Verify that the 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 of 2.9 to 3.1 seconds.

11. Leave the voltages at the values in step 2. Set the relay into the test mode with ZONE 4 selected.

Zone 4 time out Z4 timer default value of 5.0 sec.

Setting Change:
Z3DIST
(301) SELZ3G = NO
(302) SELZ3P = NO

12. Apply a fault current of 10.0(2.0) amps rms to the relay and start the Precision Timer. The fault current should not be ramped to 10.0 amps. It should be applied at that level. This is an AG fault within pickup of all four zones.

13. Stop the timer when the BFI contact closes, and reduce the fault current to zero (0). 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 of 4.8 to 5.2 seconds.

14. Return all settings to pretest values:

Settings:
Z1DIST
(101) SELZ1G = YES
(102) SELZ1P = YES
Z2DIST
(201) SELZ2G = YES
(202) SELZ2P = YES
Z3DIST
(301) SELZ3G = YES
(302) SELZ3P = YES
Z4DIST
(401) SELZ4G = YES
(402) SELZ4P = YES

MOB TESTING

T21 - Out of Step reach, MOB

Setting Changes:
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

1. Connect the relay as shown in Figure AT-2, for phases A and B.
2. Set the relay into the test mode with OUT OF STEP selected.
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase-angle value listed in Table AT-9. Note: The leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, VC to 75V when Iop = 85°)

TABLE AT-9

I Degrees	Volts RMS
−25	62 - 72
−85	62 - 72

4. Set the currents in the faulted phases to 6.3 (1.3) amperes rms. Reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table AT-9.
5. Reduce the current in the faulted phase to zero (0).
6. Return Settings to pretest values:

(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

End of Test

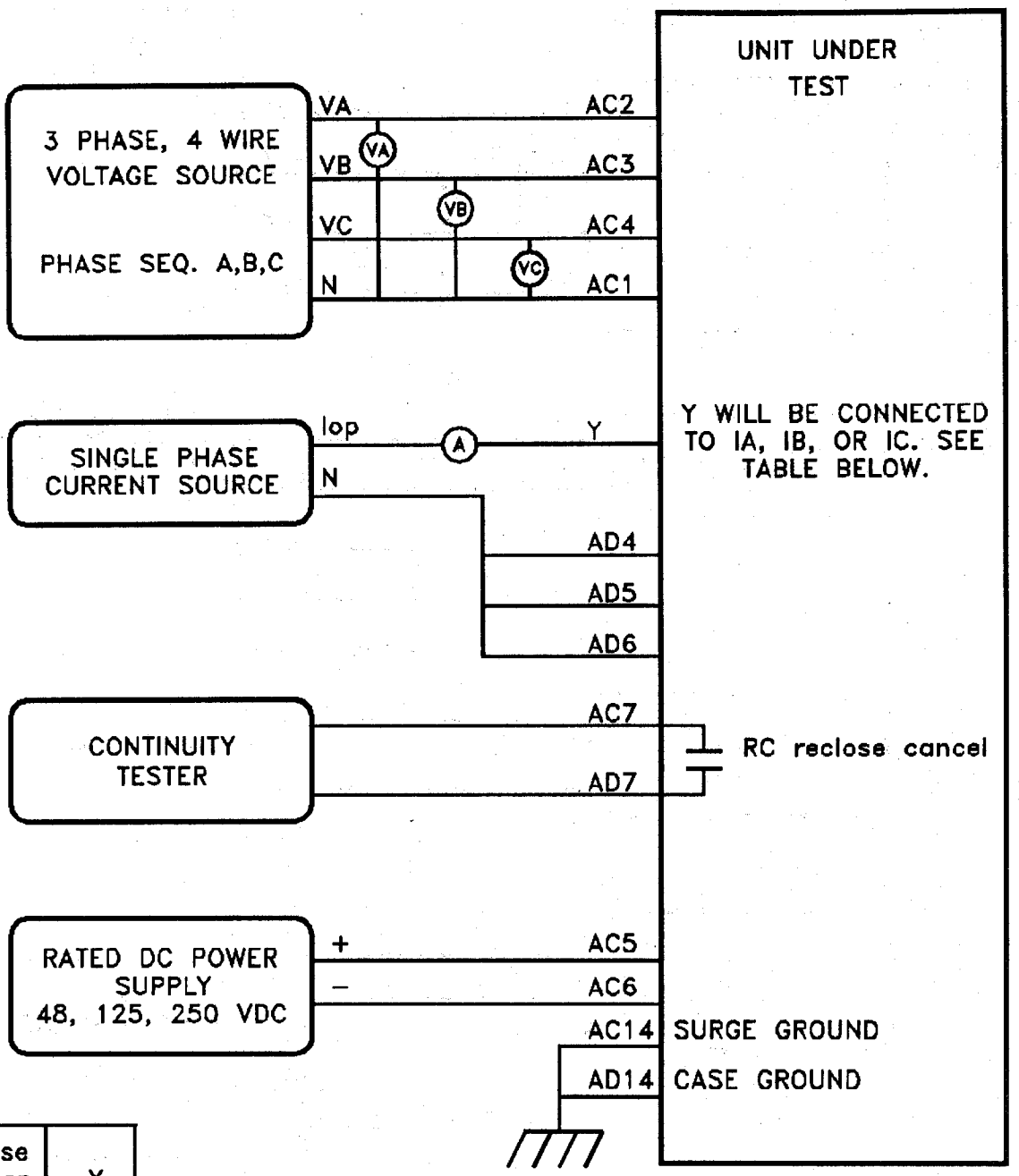
Print out all settings or use **view/change Category of settings** to compare all of the settings with the initial settings of the relay, and change to initial values. Alternately, if the initial values had been saved to a disk file before testing, they should be downloaded to the relay now using the **Load settings from file** and **Download local settings to DLP function** in the **LOCAL FUNCTIONS Settings...** menu. Details on how to use these functions can be found in the **SOFTWARE** section of this manual.

Remember to select **End setting changes** after all the settings are restored.

Exit the test mode by selecting the END TEST MODE function from the **Relay test mode** menu.

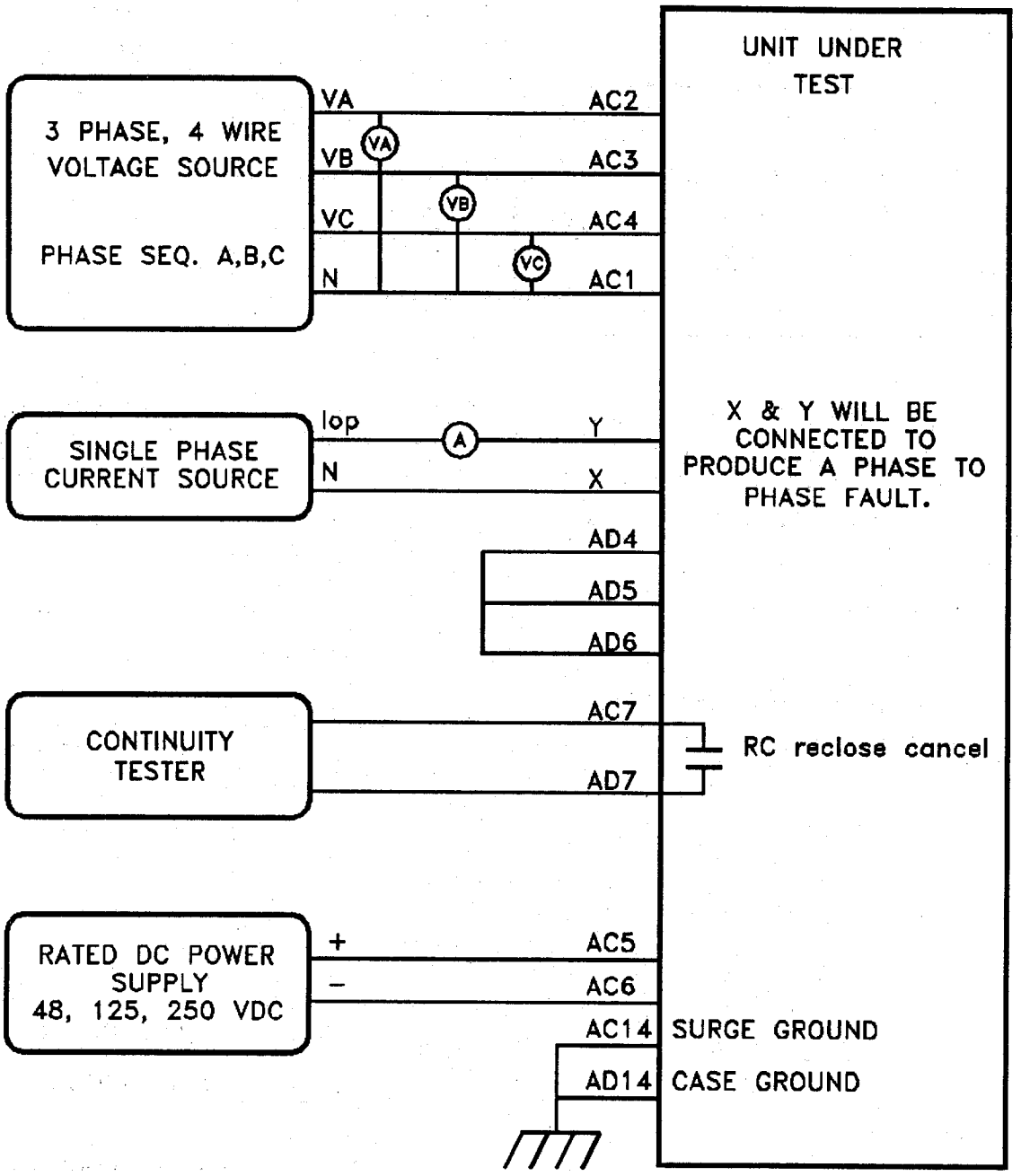
Logout of the relay.

Return to the MAIN MENU, select **Logout.**



Phase Under Test	Y
AG	AD1
BG	AD2
CG	AD3

Figure AT-1 (0286A4867 Sh.3 [1]) Phase to Ground Test Connections



Phase Under Test	X	Y
AB	AD1	AD2
BC	AD2	AD3
CA	AD3	AD1

Figure AT-2 (0286A4867 Sh.5 [1]) Phase to Phase Test Connections

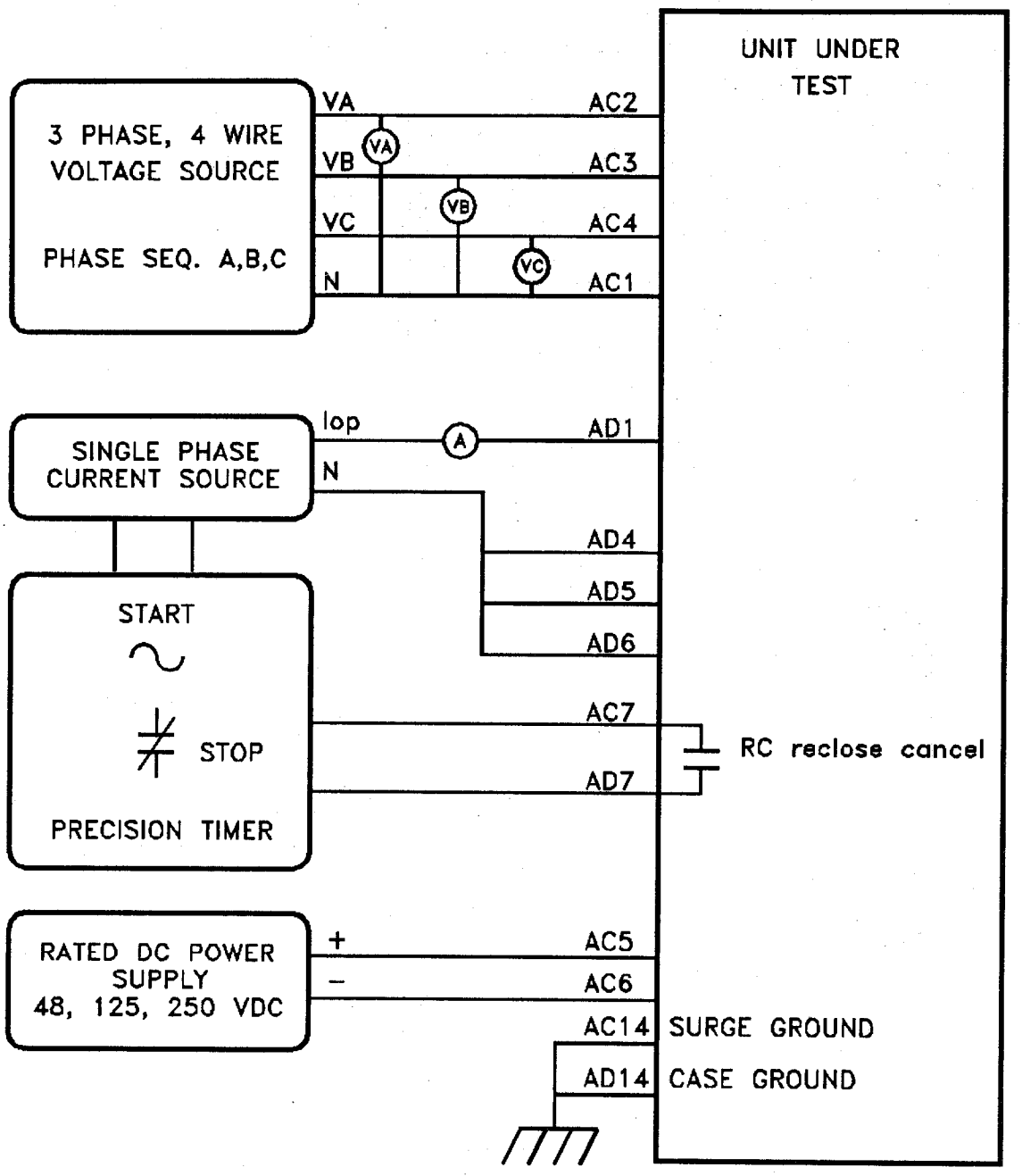


Figure AT-3 (0286A4867 Sh.4 [1]) TOC Timer Test Connections

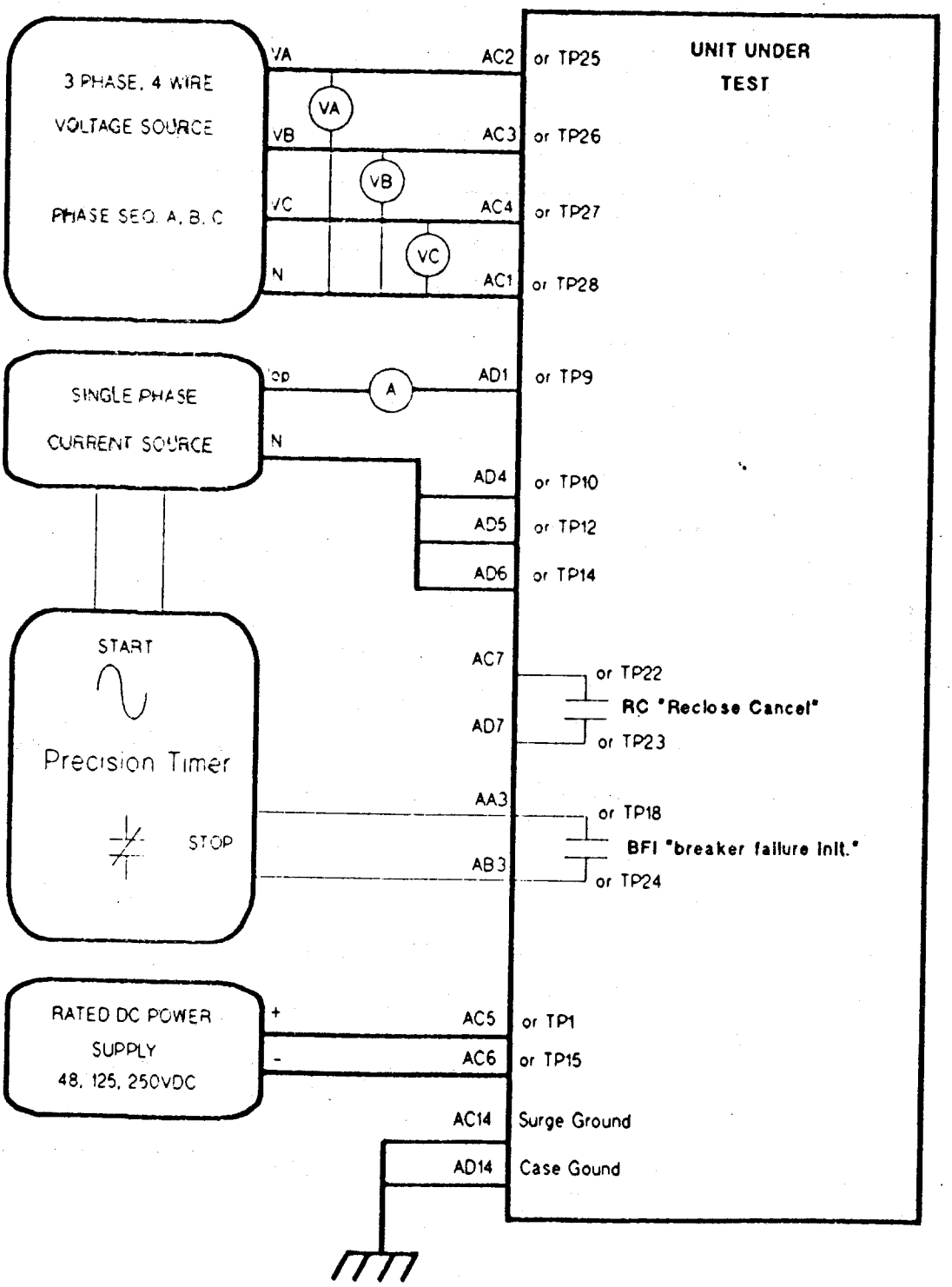


Figure AT-4 (0286A1820 [2]) Ground Reach Timer Test Connections

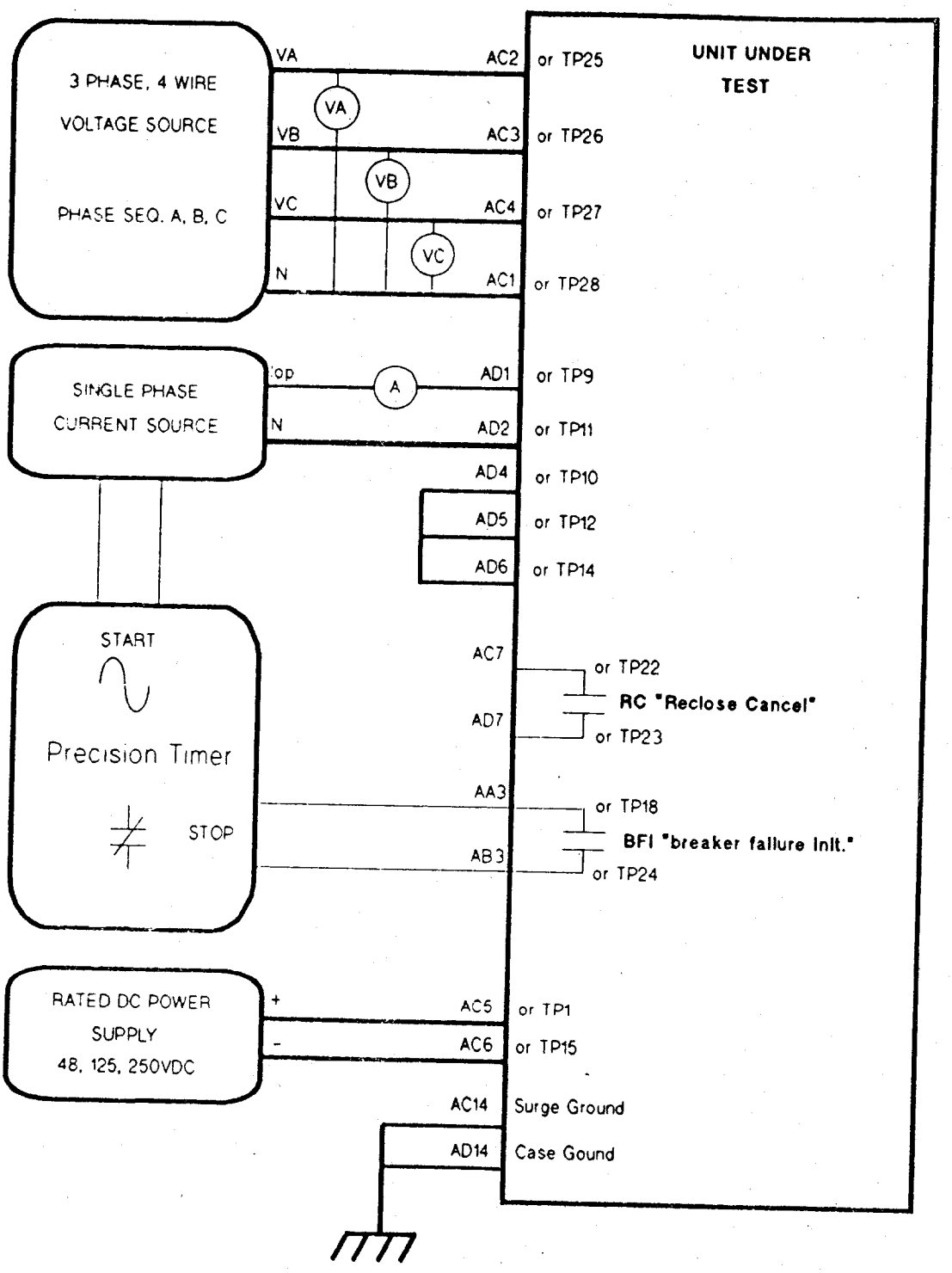


Figure AT-5 (0286A1822 [2]) Phase Reach Timer Test Connections

PERIODIC TESTS

CAUTION

Power Down the relay by turning off the power switch before removing or inserting modules. Failure to do so can permanently damage the relay.

PERIODIC TESTING OF THE DLP

The formulas below will permit the calculation of pickup currents and voltages for testing the DLP with settings specific to a particular application. The test circuits and procedures are the same as used and illustrated in the **ACCEPTANCE TESTS** section of this book.

It is up to the user to determine the extent of the testing to be performed. The tests shown are guides for performing the test; they are not strictly required to be done at every periodic test of the relay. The desired test procedures can be incorporated into the user's standard test procedures.

However, it is suggested that the relay's built-in "Self Tests" be incorporated into the user's test procedures. They will give the operational status of the unit.

It is assumed that the user is familiar with testing the DLP. If not, refer to the **ACCEPTANCE TEST** section for details.

General Tests

T1	MMI Status Test (Built-In Self Tests)
T2	AC system input test

Measuring Unit Tests

T3	IT Trip Supervision
T4	IB Blocking Supervision
T5	Ground Directional Trip Test, IPT + NT
T6	Ground Directional Block Test, IPB + NB

Backup Protection Tests

T7	Phase Instantaneous Overcurrent PH4
T8	Ground Instantaneous Over-current IDT
T9	Ground Time Over-current TOC

Zone Ground/Phase Reach Measuring Units

T10	Zone1 Ground Reach MG1
T11	Zone2 Ground Reach MTG
T12	Zone3 Ground Reach M3G
T13	Zone 4 Ground Reach M4G
T14	Zone1 Phase Reach M1
T15	Zone2 Phase Reach MT
T16	Zone3 Phase Reach M3
T17	Zone 4 Phase Reach M4

DRAWINGS AND REFERENCES:

The following drawings should be used for reference during testing. They are located in the **PRODUCT DESCRIPTION** (PD), and the **CALCULATION OF SETTINGS** (CS) sections.

Drawings:

1. The Elementary Diagram	Figure PD-4
2. The Logic Diagram	Figure PD-1,2,3
3. The TOC curve	Figure CS-7

References:
1. **SOFTWARE** section of this manual.

USING DLP-LINK

To test the relay without the DLP Keypad, communications with the relay is accomplished using a PC with the program DLP-LINK. DLP-LINK is required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Once in test mode, current and voltages are applied to the relay to simulate the desired system conditions. The older version of this communications software, D-LINK, can still also be used.

Follow the procedure in the **ACCEPTANCE TESTS** section to test the relay using D-LINK and DLP-LINK.

SETTING CHANGES

Setting changes required for a particular test will be listed before the test. A setting can be changed in two ways, by category or individually, by selecting either **view/change Category of settings** or **view/change Individual settings** from the **RELAY FUNCTIONS Settings...** menu. A procedure for and example of how to change settings is provided in the **SOFTWARE** section of this manual.

When all the settings changes are complete, select **Download changed settings to dlp** from the **Settings...** menu. When the dialog box appears with the changed settings, there will be a selection box in the lower left portion of the screen to end the settings changes. Be sure either to click on this with the left mouse button or use the TAB key to highlight it, and the ENTER key to activate it. Once the selection has been made, click on the Ok button or use the Alt O hot key to send the settings to the relay. A confirmation box will appear. Click on the Ok button again. The MMI LED will turn red briefly and turn green again, indicating that the settings change has been completed.

INITIAL TEST SETUP

Before beginning the test, the relay settings should be uploaded from the DLP and printed for reference and verification. If no printer is available, use the **view/change Category of settings** command for verification.

At the beginning of each test there is a space provided to record the user-specific setting for the function under test.

Entering the Test Mode

Before each test it is necessary to set the relay in the test mode according to the function to be tested. The test mode is set as follows:

1. Select **Relay test mode** from the **ACTIONS...** menu under **RELAY FUNCTIONS**.
2. Select the test to be performed from the list box, and click on the Ok button or use the ALT-O hot key.
3. Another dialog box will appear to confirm your choice; click on the Ok button again.

The MMI LED will change from green to red when the DLP is in the test mode.

Exiting the Test Mode

The test mode is ended and the relay protection turned on by selecting **End test mode** from the TEST MODE list box. The MMI LED changes from red to green indicating that normal operation has resumed.

GENERAL RELAY TESTS

T1 - Relay Status Check

The Relay's Status is reported through the MMI, the non-critical alarm contact, and the critical alarm contact. If a system error caused relaying functions to cease, the LED on the MMI would turn "red" and the critical alarm contact would open. A failure that did not interrupt relaying would be indicated by the non-critical alarm closing, and by a "FAIL" or "WARN" message on the DLP STATUS display.

The following test will demonstrate the use of the **Information...** menu to check relay status. See the **SERVICING** section for further information.

Setting Change
CONFIG
(1504) TRIPCIRC = 0 (NONE)

1. Connect the relay as shown in Figure AT-1. The AC inputs are not required for this test, only the DC power supply voltage.

2. Select **request DLP Status** from the **Information...** menu by clicking on it with the left mouse button or using the Alt-I hot key.

3. Click on the Ok button to display the status.

   The display should indicate "DLP STATUS: OK". "OK" represents that the relay is operational and there are no errors. When finished, use the ALT-F4 hot key (F4 is the function key, "F4", NOT "F" followed by "4") to exit the display, and then the ALT-C hot key to return to the **Information.....** menu.

Failure Status

4. Change the setting of the trip circuit monitor: (1504) TRIPCIRC = 1 (BKR1) (using the **RELAY FUNCTIONS Settings...** menu). When this is done, the relay expects a wetting voltage across the trip contacts.

5. Select **request DLP Status** from the **Information...** menu.

   NOTE: Select End settings change after each setting change.

   The display should indicate "DLP STATUS: WARN
   BKR1 TRIP CIRCUIT MONITOR".

This verifies that the relay detected the absence of wetting voltage across the trip contact.

6. Change the setting of the trip circuit monitor back to: (1504) TRIPCIRC = 0 (NONE). before proceeding with the next test.

T2 - AC system input test

This initial test uses the **request Present values** function of DLP-LINK to determine that the voltages and currents are applied to the proper connections on the terminal strip. This 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 AT-1.
2. Set VA = 67 volts rms 0°, VB = 57 volts rms −120°, and VC = 47 volts rms 120°.
3. Select the **request Present values** function from the **RELAY FUNCTIONS Information...** menu and press [ENT].
4. Note 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.
5. Set Iop = 1.0 amp rms for phases IA, IB, or IC, as shown by the "Y" connection point in Figure AT-1.
6. Again select the **request Present values** function from the **Information...** menu.
7. Note 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.
8. Reduce the test current to zero (0) amps.

MEASURING UNIT TESTS

CAUTION
The RC contact will chatter when the unit under test is near its threshold. DO NOT LET IT CONTINUE. REMOVE THE TEST CURRENT. A single contact closure is enough to determine that the unit has picked up.

Prior to each test there is space provided to record the user specific setting for the function under test.

T3 - IT Trip Supervision Test

Settings:
CURSUPVIS
(503)PUIT = [___] amps

The IT operating quantity is:

IA, IB, or IC (1)

The test current, "Iop", is single-phase current applied to phase IA.

Thus the unit should pick up when **Iop ≥ PUIT**.

1. Connect the relay as shown in Figure AT-1.
2. Set the relay into the test mode with IT selected: "IT DETECTOR ON".

3. Set the current of Iop to [**PUIT+0.10** =____] amps rms and apply to the relay. The RC contact should close. Lower Iop to [**PUIT – 0.10** =____] amps rms and the RC contact should open.

4. Reduce Iop to zero (0).

T4 - IB Blocking Supervision Test

Settings:
CURSUPVIS
(504)PUIB = [___] amps

The IB operating quantity is:

IA, IB, or IC (2)

The test current, "Iop", is single-phase current equal to IA.

Thus the unit should pick up when **Iop ≥ PUIB**.

1. Connect the relay as shown in Figure AT-1.

2. Set the relay into the test mode with IB selected: "IB DETECTOR ON".

3. Set the current of Iop to [**PUIB+0.1** =____] amps rms and apply to the relay. The RC contact should close. Lower Iop to [**PUIB – 0.10** =___] amps rms and the RC contact should open.

4. Reduce Iop to zero (0).

T5 - Ground Directional Trip Test, IPT + NT

Settings:
CURSUPVIS
(501)PUIPT = [___] amps

The IPT operating quantity is:

$$3*|I0| - 3*KT*|I1| \quad (3)$$

I0 is equal to Zero-Sequence Current.
I1 is equal to Positive-Sequence Current.
KT is equal to 0.3 for Blocking and Hybrid schemes, and equal to 0 for POTT and PUTT schemes.

Since the test current, "Iop", is single-phase current:

I0 = Iop/3
and **I1 = Iop/3.**

Substituting **Iop/3** for I1 and I0 into equation (3), and assuming a Blocking or Hybrid scheme, yields:

PUIPT = Iop – 0.1*Iop
= 0.9*Iop.

Therefore IPT will pick up when: **Iop ≥ PUIPT/0.9**

1. Connect the relay as shown in Figure AT-1.
2. Set VA = 57 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms 120°.
3. Set the relay into the test mode with IPT selected: "GND DIR TRIP ON".
4. Set the current of Iop to [**(PUIPT/0.9)+0.10** =____] amps rms and apply to the relay. The RC contact should close. Lower Iop to [**(PUIPT/0.9) − 0.1** =____] amps rms and the RC contact should open.
5. Reduce Iop to zero (0).

T6 - Ground Directional Block Test, IPB + NB

Settings:
CURSUPVIS
(502)PUIPB =[___] amps

The IPB operating quantity is:

$$3*|I0| - 3*KB*|I1| \qquad (4)$$

I0 is equal to Zero-Sequence Current.
I1 is equal to Positive-Sequence Current.
KB is equal to .066 for Blocking and Hybrid schemes and equal to 0 for POTT and PUTT schemes.

Since the test current, "Iop", is single-phase current:

I0 = Iop/3
and **I1 = Iop/3.**

Substituting **Iop/3** for I1 and I0 into equation (4), and assuming a Blocking or Hybrid scheme, yields:

PUIPB = Iop − 0.066*Iop
= 0.934*Iop.

Therefore IPB will pick up when: **Iop ≥ PUIPB/0.934**

1. Connect the relay as shown in Figure AT-1.
2. Set VA = 57 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms 120°.
3. Set the relay into the test mode with IPB selected: "GND DIR BLOCK ON".
4. Set the current of Iop to [**(PUIPB/0.934)+0.1** =____] amps rms and apply to the relay. The RC contact should close. Lower Iop to [**(PUIPB/0.934) − 0.1** =____] amps rms and the RC contact should open.
5. Reduce Iop to zero (0).

T7 - Phase Instantaneous Overcurrent PH4

Settings Changes:
OVERCUR
(601)SELPH4 = YES
(602)PUPH4 = [___] amps

The PH4 operating quantity is:

(IA – IB), (IB – IC), or **(IC – IA)** (5)

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))**, or **2*Iop**.

Therefore PH4 will pick up when: **Iop ≥ .5*PUPH4**

1. Connect the relay as shown in Figure AT-2, for a phase AB, BC or CA fault.

2. Set the relay into the test mode with Phase Overcurrent selected: "INST PH OC ON".

3. Set the current of Iop to [**.5*PUPH4 + (0.05*PUPH4) =**_____] amps rms and apply to the relay. The RC contact should close. Lower Iop to [**.5*PUPH4 – (0.05*PUPH4) =**___] amps rms and the RC contact should open.

5. Reduce Iop to zero (0).

T8 - Ground Instantaneous Overcurrent IDT

Settings Changes:
OVERCUR
(603)SELIDT = YES
(604)SELDIDT = NO (directional unit off)
(605)PUIDT = [___] amps

The IDT operating quantity is:

3*|I0| – 3*KD*|I1| (6)

I0 is equal to Zero-Sequence Current.
I1 is equal to Positive-Sequence Current.
KD is equal to 0.3.

Since the test current, "Iop", is single-phase current:

I0 = Iop/3
and **I1 = Iop/3.**

Substituting **Iop/3** for I1 and I0 into equation (6) yields:

PUIDT = Iop – 0.3*Iop, or
= 0.7*Iop.

Therefore IDT will pick up when: **Iop ≥ PUIDT/0.7**

1. Connect the relay as shown in Figure AT-1.
2. Set the relay into the test mode with Ground Overcurrent selected: "INST GND OC ON".
3. Set the current of Iop to [**(PUIDT/0.7) + 0.5=____**] amps rms and apply to the relay. The RC contact should close. Lower Iop to [**(PUIDT/0.7) − 0.5=____**] amps rms and the RC contact should open.
4. Reduce Iop to zero (0).
5. Change the setting of SELDIDT back to "YES" to restore directional control, if required.

T9 - Ground Time Overcurrent TOC

Settings Changes:
OVERCUR
(606)SELTOC = YES
(607)SELDTOC = NO (directional control off)
(608)PUTOC = [___] amps, TOC pick up current
(609)TDTOC = [___] Time-dial setting

The TOC operating quantity is:

$$3*|I0| \qquad (7)$$

I0 is equal to zero-sequence current.

Since "Iop" is single-phase current, **I0 = Iop/3.**

Substituting **Iop/3** for **I0** in equation (7) yields:

PUTOC = Iop

Therefore TOC will pick up when: **Iop ≥ PUTOC**

The time it takes for TOC to pick up is determined by the Time-dial curve in the **CALCULATION OF SETTINGS** section.

CAUTION
If the test current exceeds 2*In (In = rated current) then the current test should be applied with a 50% duty cycle. For instance: If current is applied for 5 minutes, it should be left **off** for 5 minutes before re-applying current.

1. Connect the relay as shown in Figure AT-3.

   NOTE: Start the timer when Iop is applied, and stop the timer when the RC closes (the relay trips).

2. Set the relay into the test mode with TOC selected:
   "T DLY GND OC ON".
3. Apply Iop at [**2*TOC=____**] amps rms and start the timer. Leave the current "on" until the RC contact closes, and stop the timer. The time should be within 7% of the value found on the DLP Time-Dial Curve.

4. Reduce Iop to zero (0).

5. Change the setting of SELDTOC back to "Yes" if directional control of TOC is required.

GENERAL ZONE REACH TESTING CONSIDERATIONS

Testing the reach of the relay requires a few organized steps. They are: choosing a test current (I_T) for the impedance of the reach, calculating the voltage range in which the unit will pick up, and applying the test voltage and currents in accordance with the test procedure.

The equations shown will be used to calculate the voltage of pickup for a chosen magnitude and phase of current. If you wish to test the complete characteristic, the software program, DLPTEST, can be used to generate test currents and voltage pickups for the complete characteristic. The software is included in the plastic pocket at the back of this book.

ZONE1-4 PHASE-TO-GROUND CALCULATIONS

The following section provides a means for determining the test currents and voltages for Z1G, Z2G, Z3G and Z4G. The same procedure is used for each zone to determine the test values. The procedure consist of: choosing a test current, calculating the impedance of the zone, and then calculating the operate voltage at the test current and impedance.

The test current, "I_T", is determined from the table PT-1. 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.

NOTE:
The pickup voltage calculations at a particular magnitude and phase of "I_T" are referenced to the faulted phase under test. If a BG Fault was applied, the current angles would be with respect to the phase angle of VB.

$$\mathbf{VNOM} = [(Z)*(ZR)*(I_T)/COS(90-\phi T)]*(COS(\phi I-\phi Z-\phi T+90)) \quad (8)$$

for $(\phi Z + \phi T - 180) < \phi I < \phi Z$

$$= [(Z)*(ZR)*(I_T)/COS(90-\phi T)]*(COS(\phi I-\phi Z+\phi T-90))$$

for $\phi Z < \phi I < (\phi Z-\phi T+180)$

Definitions

Z =	Impedance correction factor
ZR =	Relay reach for Z1G, Z2G, Z3G, or Z4G
ϕZ =	Angle of maximum reach
I_T =	Test current for Iop, chosen for the zone
ϕT =	The Characteristic Timer of the zone.
ϕI =	Test current angle with respect to the faulted phase
K0 =	Zero-Sequence compensation Factor, of the zone
POSANG =	Positive-Sequence Angle of Maximum Reach
ZERANG =	Zero-Sequence Angle of Maximum Reach

1. Record the following Relay Settings:

(1401)POSANG = [____]
(1402)ZERANG = [____]

ZR

(104)Z1GR = [____] Zone1
(204)Z2GR = [____] Zone2
(304)Z3GR = [____] Zone3
(404)Z4GR = [____] Zone4

ϕT

Z1GANG =90 fixed for Zone1
(210)Z2GANG = [____] Zone2
(308)Z3GANG = [____] Zone3
(410)Z4GANG = [____] Zone4

K0

(107)Z1K0 = [____] Zone1 only
(1404)K0 = [____] Zone2, Zone3, and Zone4

2. Determine the Test Current I_T for Zone1, Zone2, Zone 3, and Zone4 from Table PT-1 below:

Table PT-1 TEST CURRENT RANGES

In=5 AMPS ZR Reach	**I_T AMPS Test**	**In=1 AMPS ZR Reach**	**I_T AMPS Test**
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

I_T(Z1GR) = [____] Amps rms
I_T(Z2GR) = [____] Amps rms
I_T(Z3GR) = [____] Amps rms
I_T(Z4GR) = [____] Amps rms

3. Calculate the impedance "Z" for each zone.

Z equals the magnitude of the equation: (2/3)/(**POSANG**) + (**K0**/3)/(**ZERANG**), and is calculated as shown below:

z(real) = (2/3)cos(**POSANG**) + (**K0**/3)cos(**ZERANG**)
z(real) = [____]Ω real component of Z

z(imag) = (2/3)sin(**POSANG**) + (**K0**/3)sin(**ZERANG**)
z(imag) = [____]Ω imaginary component of Z

$\mathbf{Z} = \sqrt{[\mathbf{z(real)}^2 + \mathbf{z(imag)}^2]}$

Z1 = [____]Ω = magnitude of Zone 1
Zn = [____]Ω = magnitude of Zone 2, 3, and 4

4. Calculate the impedance angle, "ϕZ" for each zone.

   ϕZ equals the angle of the equation: (2/3)/**POSANG** + (**K0**/3)/**ZERANG**, and is calculated as shown below:

   ϕZ = arcTAN[**z(imag)/z(real)**]

   ϕZ1 = [____]° impedance angle, Zone 1
   ϕZn = [____]° impedance angle, Zone 2, 3, and 4

5. Choose the I_T test angle (ϕI) for the zone.

   ϕI1 = [____]°, Zone 1
   ϕI2 = [____]°, Zone 2
   ϕI3 = [____]°, Zone 3
   ϕI4 = [____]°, Zone 4

6. Calculate VNOM for each zone by substituting the values of **ZR**, **Z**, ϕZ, and ϕI into equation (8).

   VNOM1 = [____] Volts rms nominal test voltage Zone 1
   VNOM2 = [____] Volts rms nominal test voltage Zone 2
   VNOM3 = [____] Volts rms nominal test voltage Zone 3
   VNOM4 = [____] Volts rms nominal test voltage Zone 4

NOTE: If Zone 4 is reversed, (411)SEL4ZD=1, remember to add 180° to both the test angle, ϕI4, and impedance angle, ϕZ4.

T10 - Zone 1 Ground Reach test, MG1

Setting Changes:
Z1DIST
(101)SELZ1G = YES
(102)SELZ1P = NO

Ground Faults (AG, BG, and CG) M1G

Z1GR = [___] ohms
VNOM1 = [___] volts
I_T = [___] amps
ϕI1 = [___] deg

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.

2. Set the relay into the test mode with Z1DIST selected: "ZONE1 ON".

3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle of ϕI [___], lagging.

4. 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**.

5. Reduce the fault current to zero (0).

6. Return the ZONE1 phase "SELZ1P" to your specific setting.

T11 - Zone 2 Ground Reach, MTG
Setting Changes:

Z2DIST
(201)SELZ2G = YES
(202)SELZ2P = NO

Ground Faults (AG, BG, and CG)

Z2GR = [___] ohms
VNOM2 = [___] volts
I_T = [___] amps
ϕI2 = [___] deg

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.
2. Set the relay into the test mode with Z2DIST selected: "ZONE2 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle ϕI [___] lagging.
4. Set the fault current to [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**.
5. Reduce the fault current to zero (0).
6. Return ZONE2 phase "SELZ2P" to your specific setting.

T12 - Zone 3 Ground Reach, M3G

Setting Changes:
Z3DIST
(301)SELZ3G = YES
(302)SELZ3P = NO

Ground Faults (AG, BG, and CG)

Z3GR = [___] ohms
VNOM3 = [___] volts
I_T = [___] amps
ϕI3 = [___] deg

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.
2. Set the relay into the test mode with Z3DIST selected: "ZONE3 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle value of ϕI [___], lagging.
4. 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**.
5. Reduce the fault current to zero (0).
6. Return ZONE3 phase "SELZ3P" to your specific setting.

T13 - Zone 4 Ground Reach, M4G

Setting Changes:
Z4DIST
(401)SELZ4G = YES
(402)SELZ4P = NO

Ground Faults (AG, BG, and CG)

Z4GR = [___] ohms
VNOM4 = [___] volts
I_T = [___] amps
ϕI4 = [___] deg

1. Connect the relay as shown in Figure AT-1, for the appropriate phase under test.
2. Set the relay into the test mode with Z4DIST selected: "ZONE4 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle value of ϕI [___], lagging.
4. 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.**
5. Reduce the fault current to zero (0).
6. Return ZONE4 phase "SELZ4P" to your specific setting.

ZONE1-4 PHASE-TO-PHASE REACH CALCULATIONS

The following section provides a means for determining the test currents and voltages for Z1P, Z2P, Z3P and Z4P. The same procedure is used for each zone to determine the test current "I_T" and the voltage of pickup "VNOM".

The test current, "I_T", is determined from table PT-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 relay settings.

VNOM calculations are referenced to the "leading" phase-to-ground faulted voltage. When an AB fault is applied, the current angle is with respect to the phase angle of VA, not the phase-to-phase voltage. That is why the "1.732" (square root of three) factor and the added angle of 30° is included in the equation below.

$$\mathbf{VNOM} = [(2/1.732)*(ZR)*(I_T)/COS(90-\phi T)]*(COS((\phi I+30)-\phi Z-\phi T+90)) \quad (9)$$

for $(\phi Z + \phi T - 180) < \phi I < \phi Z$

$$= [(2/1.732)*(ZR)*(I_T)/COS(90-\phi T)]*(COS((\phi I+30)-\phi Z+\phi T-90))$$

for $\phi Z < \phi I < (\phi Z - \phi T + 180)$

Definitions

ZR = Relay reach for Z1P, Z2P, Z3P, or Z4P
$\mathbf{I_T}$ = Test current for Iop chosen for the zone
ϕZ = Angle of maximum reach = POSANG
ϕT = The Characteristic Timer setting of the zone
ϕI = Test current angle with respect to the faulted phase
POSANG = Positive-Sequence Angle of Maximum Reach

1. Record the Relay Settings:

ϕZ

(1401)POSANG = [___]

ZR

(103)Z1R = [___] Zone1
(203)Z2R = [___] Zone2
(303)Z3R = [___] Zone3
(403)Z4R = [___] Zone4

ϕT

Z1PANG = 90 fixed for Zone 1
(209)Z2PANG = [___] Zone2
(307)Z3PANG = [___] Zone3
(409)Z4PANG = [___] Zone4

2. Determine the Test Current "$\mathbf{I_T}$" for Zone1, Zone2, Zone3 and Zone4 from Table PT-1:

$\mathbf{I_T}$(Z1R) = [___] Amps rms
$\mathbf{I_T}$(Z2R) = [___] Amps rms
$\mathbf{I_T}$(Z3R) = [___] Amps rms
$\mathbf{I_T}$(Z4R) = [___] Amps rms

3. Choose ϕI (the $\mathbf{I_T}$ angle). VNOM will be at maximum when ϕI = ϕZ−30

ϕI1 = [___]° for Zone1
ϕI2 = [___]° for Zone2
ϕI3 = [___]° for Zone3
ϕI4 = [___]° for Zone4

4. Calculate "VNOM" for each zone by substituting the values of **ZR**, ϕZ(POSANG), $\mathbf{I_T}$, and ϕI into equation (9) 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, (411)SEL4ZD=1, remember to add 180° to both the test current angle, ϕI4, and impedance angle, ϕZ4. If Zone 4 has a non-zero offset, use the DLPTEST software to calculate VNOM4.

7. Record VNOMn, $\mathbf{I_T}$ and ϕIn in the space provided in the appropriate Zone reach test.

T14 - Zone 1 Phase Reach, M1

Setting Changes:
Z1DIST
(101)SELZ1G = NO
(102)SELZ1P = YES

Faults (AB, BC, and CA)

Z1R = [___] ohms
VNOM1 = [___] volts
I_T = [___] amps
ϕI1 = [___] deg

1. Connect the relay as shown in Figure AT-2, for the appropriate phases under test.
2. Set the relay into the test mode with Z1DIST selected: "ZONE1 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle of ϕI [__], lagging. Note: The leading phase angle is 180° out of phase with the line it is shorted to.
4. 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**.
5. Reduce the fault current to zero (0).
6. Return ZONE1 ground "SELZ1G" to your specific setting.

T15 - Zone 2 Phase Reach, MT
Setting Changes:
Z2DIST
(201)SELZ2G = NO
(202)SELZ2P = YES

Faults (AB, BC, and CA)

Z2R = [___] ohms
VNOM2 = [___] volts
I_T = [___] amps
ϕI2 = [___] deg

1. Connect the relay as shown in Figure AT-2, for the appropriate phases under test.
2. Set the relay into the test mode with Z2DIST selected: "ZONE2 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle of ϕI [____], lagging. Note: The leading phase angle is 180° out of phase with the line it is shorted to.
4. 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**.
5. Reduce the current in the faulted phase to zero (0).
6. Return ZONE2 ground "SELZ2G" to your specific setting.

T16 - Zone 3 Phase Reach, M3

Setting Changes:
Z3DIST
(301)SELZ3G = NO
(302)SELZ3P = YES

Faults (AB, BC, and CA)

Z3R = [___] ohms
VNOM3 = [___] volts
I_T = [___] amps
ϕI3 = [___] deg

1. Connect the relay as shown in Figure AT-2, for the appropriate phase under test.
2. Set the relay into the test mode with Z3DIST selected: "ZONE3 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle of ϕI [____], lagging. Note: The leading phase angle is 180° out of phase with the line it is shorted to.
4. 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**.
5. Reduce the fault current to zero (0).
6. Return ZONE3 ground "SELZ3G" to your specific setting.

T17 - Zone 4 Phase Reach, M4

Setting Changes:
Z4DIST
(401)SELZ4G = NO
(402)SELZ4P = YES

Faults (AB, BC, and CA)

Z4R = [___] ohms
VNOM4 = [___] volts
I_T = [___] amps
ϕI4 = [___] deg

1. Connect the relay as shown in Figure AT-2, for the appropriate phase under test.
2. Set the relay into the test mode with Z4DIST selected: "ZONE4 ON"
3. Set the voltage inputs to: VA = 67 volts rms 0°, VB = 67 volts rms −120°, and VC = 67 volts rms −240°. Set the fault current, "Iop", to the phase angle of ϕI [____], lagging. Note: The leading phase angle is 180° out of phase with the line it is shorted to.
4. 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**.

5. Reduce the fault current to zero (0).

6. Return ZONE4 ground "SELZ4G" to your specific setting.

CAUTION

When testing is completed, verify that all settings are returned to your specified values. It is helpful to print out the settings and check them one by one.

SERVICING

SPARES

There are two possible servicing methods for the DLP. They are: spare module replacement and component level repair. The preferred method is module replacement using the DLP's automatic self-tests to isolate failed modules. When the defective module is found, it can be replaced with a spare, and the system can be returned to service. This method typically yields the shortest "down time" of the system. To further reduce "down time" it is recommended that a complete set of spare modules be kept at the maintenance center.

It is not recommended that the relay be serviced at the component level. This requires a substantial investment in test/repair equipment, and in technical expertise, and usually results in longer "down times" than module replacement. For those who do wish to trouble-shoot to the component level, drawings can be obtained by requesting them from the factory. When requesting drawings, the following information must be supplied to the factory:

1. The model number of the module. This is found on the lower part of the front nameplate of each module, e.g. MGM703.

2. The assembly number of the module. This is found on the component side of the printed circuit board. It is an eight digit number with a letter inserted between the fourth and fifth digit and suffixed with a group identification, e.g. 0215B8011G001.

3. The revision number. This is found on the printed circuit board adjacent to the assembly number of the board.

CAUTION

Power down the relay before removing or inserting modules. Failure to do so can permanently damage the relay.

SERVICING WITH THE RELAY SELF-TEST

The DLP automatically performs tests of major functions and critical hardware components and reports their status via the MMI Display/LED and the non-critical and critical alarm contacts. The failure report is dependent on the type or level of the failure. Some failures will operate the critical alarm contact and the MMI LED, while others will only operate the non-critical alarm contact.

There are three levels of self-test performed by the relay. The first level indicates severe relaying failures. They are indicated by a "FAIL" message on the MMI, an opening of the "critical alarm" contact, and by the MMI LED turning red. These failures are the most critical because they indicate that the relay is not providing protection.

The second level of self-test displays warning messages. They are indicated by a "WARN" message on the MMI, and closure of the "non-critical alarm" contact. These failures are a less critical condition whereby the relay is still providing some degree of protection.

The types of self-tests performed are described in the PRODUCT DESCRIPTION section of this manual. The components tested during the start-up self-tests are listed in Table SE-1. The components tested during run time background and foreground self-tests are listed in tables SE-2 and SE-3, respectively.

The third level of tests indicate "System Status" errors that are due to power system errors (Trip Circuit Open), or caused by the use of a DLP command that disables the relay (Disable Outputs). They are indicated by the "non-critical alarm" contact closing, a red LED, or by the critical alarm contact opening. However, no MMI display is provided until the "Information Status" command is used.

TABLE SE-1 Start-Up Self Tests

COMPONENT	METHOD	PROCESSOR	NATURE
PROM	CRC-type check on DAP and SSP; checksum on DSP	All	Critical
Local RAM	Patterns to check for stuck bits, stuck address lines, cross-talk between adjacent bits	All	Critical
Shared RAM	Same as Local RAM	All	Critical
Non-volitile RAM	CRC-type check on settings area; checksum on fault storage area; duplicate locations on serial NVRAM	SSP	Critical if settings area or Serial NVRAM
Timer Chip	Test all processor timers and their interrupts	DAP SSP	Critical if DAP, Non-Critical if SSP
Interrupt Chips	Test all processor and external Interrupt Controllers	DAP SSP	Critical
Serial Chips	Wrap around and Interrupt tests for serial interface	SSP	Non-Critical
A/D Controller	DMA Interface	DAP	Critical, DLP will restart
Digital Output Circuitry	Loop-back via parallel port	SSP	Critical, DLP will restart
Digital Input Circuitry	Comparison of bits read via 2 separate opto-couplers	DAP	Non-Critical, turn off Pilot protection
Real Time Clock	Test of real time clock Operation and Interrupts	SSP	Non-Critical
LED display	Self-test built in by manufacturer	SSP	Non-critical

TABLE SE-2 Run Time Background Self Tests

COMPONENT	METHOD	PROCESSOR	NATURE
PROM	CRC-type check on DAP and SSP; checksum on DSP	All	Critical, Restart
RAM	CRC-type check on areas holding settings	All	Critical, Restart
Non-volitile RAM	CRC-type check on settings area; checksum on fault storage area	SSP	Critical if settings area
Timer Chip	Test that all timers are counting	DAP SSP	Critical if DAP, Non-Critical if SSP, Restart

TABLE SE-3 Run Time Foreground Self Tests

COMPONENT	METHOD	PROCESSOR	NATURE
A/D Controller	DMA Interface	DAP	Critical
Digital Input Circuitry	Comparison of bits read via 2 separate opto-couplers	DAP	Non-Critical, 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

TROUBLE SHOOTING

Trouble shooting the relay requires three steps. The first step is to determine the type of failure. The type is either a critical, non-critical, or a system-status failure. Next, the list of failure codes, warning codes or the "Information Status" command is used to determine what module is defective. Lastly, the defective module is replaced in accordance with safety and static-discharge precautions.

The trouble shooting sections are as follows:

1. Servicing a Critical Failure "FAIL"
2. Servicing a Non-Critical Failure "WARN"
3. Servicing a System Status Failure

Using the Information Status Command

Tables have been provided in the "SERVICING A FAIL" and "SERVICING A WARN" sections below. They can be used to decode "Fail xxx" and "Warn xxx" codes. The "Information Status" command can also be used to extract the same data from the MMI display without looking up the code on the table. The "Information Status" command can be used at the relay site or remotely over a modem link.

The INFORMATION STATUS command is invoked as follows:

1. Using DLP-LINK, select REQUEST DLP STATUS from the DLP INFORMATION menu.
2. The relay status will display and should indicate that there is a failure with the words "STATUS: FAIL" followed by a detailed report of the failure. A complete list of the possible errors is shown in table SE-4, 5, & 6, below.

The "FAIL" and "WARN" messages are also included. Their descriptions can also be displayed on the MMI, by using the "Information Status" command. Only the "Fail" or "Warn" message will appear on the MMI display.

NOTE: After initial power up or loss of power exceeding 24 hours, the time and date will reset to 00:00:00 01/01/90. All event and fault data will be reset.

TABLE SE-4 System Status Error Messages

SYSTEM STATUS ERROR	INDICATION	DESCRIPTION
FAIL	CA/LED	A FAIL condition exists
WARN	NCA	A WARN condition exists
DIS OUTS	LED	Output Contacts Disabled
PROT OFF	LED	Relay protection turned off
TEST	LED	The relay has been placed in Test Mode

NOTE: LED = A red LED on the MMI, NCA = the non-critical alarm contact closing, CA = the critical alarm contact closing

SERVICING A CRITICAL FAILURE "FAIL"

A critical failure indicates total interruption of the protection function. When a failure occurs on one of the modules (excluding the power supply) the critical alarm contact will open, and the MMI LED will turn red. Remove and re-apply the DC power to bring up the fail message on the display. If the DLP successfully restarts the LED will turn green.

The Fail message has the format "FAIL xxx". The "xxx" field following the word "FAIL" is the numeric code that indicates the nature of the critical failure. The Fail message remains on the display until a key is pressed or until the DLP restarts successfully (with no self-test failures). See Table SE-2 for the list of Failure codes and their meanings.

NOTE: As an alternative, the "Information Status" command can be used to display the failure type.

Locating the defective module

Use the table below, or the "Information Status" command, to isolate the cause of the failure. When the suspected module is found, power down the unit and replace it. Re-apply power. If the "FAIL" message is gone then the unit has been successfully repaired. If the message has changed it is possible that another module requires replacement.

TABLE SE-5 Failure Messages

CODE	Description
	DAP
100	PROM: Failure
101	LOCAL RAM: Local RAM Failure
102	DSPRAM CRC: DSPRAM CRC Failure
103	DSPRAM: DSPRAM Failure
104	SYSRM: SYSRAM Failure
105	INTERRUPT: Interrupt Failure
106	TIMER: Timer Failure
124	VERSION NUM: Version Number Failure
	DSP
207	PROM Failure
208	Local RAM Failure
209	DSPRAM Failure
210	Interrupt Failure
225	Version Number Failure
N/A	FUSE FAILURE: A potential fuse failure condition exists
N/A	BRKR1 TRP CIR OPN: Breaker 1 Trip Circuit open
N/A	BRKR2 TRP CIR OPN: Breaker 2 Trip Circuit open

CODE	Description
	ANI
311	CONTROLLER: Controller Failure
312	SERIALMEM: Serial NVM Failure
313	REFERENCE: Reference Failure
	MGM
414	SERIALMEM: Serial NVM Failure
422	MODEL NUMBER: Model Number Failure
	SSP
515	PROM Failure
516	Local RAM Failure
517	SYSRAM CRC Failure
518	SYSRAM Failure
519	Interrupt Failure
520	EEPROM Failure
523	Version Number
	MMI
621	Digital Output Failure

SERVICING A NON-CRITICAL FAILURE "WARN"

When a "WARN" condition occurs, the DLP's non-critical alarm contact will close. A non-critical failure does not indicate an interruption in the relay's protection. The LED will remain green. Turn off the DC input power, then re-apply. The "WARN XXX" message should appear if the failure still exists.

The Warn message has the format "WARN xxx". The "xxx" field following the word "WARN" is the numeric code that indicates the nature of the failure. The WARN message remains on the display until a key is pressed or until the DLP restarts successfully (with no self-test failures). See SEE Table-6 for the list of Warning codes and their meanings.

NOTE: As an alternative to using the table of warnings, the "Information Status" command can be used to display the warning type.

Locating the defective module

Use the table below, or the "Information Status" command to isolate the cause of the failure. Power down the unit and replace the suspected module if appropriate. Re-apply power and the WARN message should clear. If the "WARN" message is gone then the unit has been successfully repaired. If the message has changed, it is possible that another module requires replacement.

TABLE SE-6 Warning Messages

Number	Description
	DSP
235	Digital Input fail on
	SSP
537	Timer Failure
538	CAPRAM Failure
539	RTC Failure
	MMI
640	Serial chip failure
641	LED display failure
742	Remote Comm - Login failed
844	DTA Board: Serial NVM Failure

SERVICING SYSTEM "STATUS" FAILURES

A system failure is one that indicates a failure of a power system input, or indicates that the relay has been disabled by a user command. They are indicated by the non-critical alarm contact closing, by a red LED, or by the critical alarm contact closing. However, no MMI display is provided until the "Information Status" command is used.

Turn off the DC input power, then re-apply. The non-critical alarm contact will be closed if the failure still exists. Use the "Information Status" to determine the cause of the trouble.

FIXUP SETTINGS

If the setting's CRC code has become corrupted, certain MMI functions will become unavailable. Whenever the error occurs, the user will not be able to change any settings (although the settings can still be viewed). If the error occurs during startup, the user will not be able to perform any of the Action commands except Fixup Settings. Once the setting's CRC has been recalculated by issuing the FIXUP SETTINGS command, the user will be able to perform the Action commands and change settings.

The CRC code is a Cyclic Redundancy Check value stored in memory that is automatically set up whenever a setting is changed. This CRC code enables the EEPROM Self Test to verify the integrity of the settings area in EEPROM.

SPECIFICATIONS

RATINGS

Rated Frequency	50 to 60 Hertz
Rated Voltage (phase to phase)	100 to 120 Volts AC
Rated Current	In = 1 or 5 Amperes
DC Control Voltage	48VDC, Operating Range 38.5-60 VDC 110/125VDC, Operating Range 88-150 VDC 220/250VDC, Operating Range 176-300 VDC
Maximum Permissible Current	
Continuous	2 X In
Three Seconds	50 X In
One Second	100 X In
Maximum Permissible AC Voltage	
Continuous	2 X Rated
One minute (one per hour)	3.5 X Rated
Ambient temperature Range	
Storage	-30C to + 75C
Operation	-20C to + 55C
Humidity	95% without condensation
Insulation Test Voltage	2kV 50/60 Hz, one minute
Impulse Voltage Withstand	5kV peak, 1.2/50 milliseconds, 0.5 joules
Interference Test Withstand	SWC, per ANSI C37.90.1

BURDENS

Current Circuits	0.022 ohm, 5 DEG, In = 5 amps 0.12 ohm, 30 DEG, In = 1 amp
Voltage Circuits	.15 VA, 60 Hz .20 VA, 50 Hz
DC Battery (for contact converters)	2.5 milliamperes at rated DC Input voltage
DC Battery (power supply)	20 Watts

CONTACT DATA

Digital to Analog Output (DTA)	0 - 1mA, 10V load or 0 - 5V output (4V = fullscale; 5V = error)
Trip Outputs	Continuous Rating=3 amperes Make and carry for tripping duty: = 30 amperes, (per ANSI C37.90).
SCR Outputs	Same as trip contacts.
Auxiliary Outputs (including alarms)	Continuous Rating=3 amperes. Make and carry for tripping duty: = 30 Amperes (per ANSI C37.90)
Channel Control Contacts	10 Watts: Max. Voltage 280 VDC Maximum Current 40 milliamperes DC
Trip Circuit Monitor	150 mA minimum

SCHEME SELECTION

Stepped Distance
POTT
PUTT
Blocking
Hybrid

REACH SETTING RANGES

TABLE SP-1

		RANGE IN OHMS		RESOLUTION	
Z1DIST	**MEASURING UNITS**	**In=5**	**In=1**	**In=5**	**In=1**
	M1G	0.01-50	0.05-250	0.01	.01
	M1	0.01-50	0.05-250	0.01	.01
Z2DIST	**MEASURING UNITS**	**RANGE IN OHMS**		**RESOLUTION**	
		In=5	**In=1**	**In=5**	**In=1**
	MTG	0.01-50	0.05-250	0.01	.01
	MT	0.01-50	0.05-250	0.01	.01
Z3DIST	**MEASURING UNITS**	**RANGE IN OHMS**		**RESOLUTION**	
		In=5	**In=1**	**In=5**	**In=1**
	M3G	0.01-50	0.05-250	0.01	.01
	M3	0.01-50	0.05-250	0.01	.01
Z4DIST	**MEASURING UNITS**	**RANGE IN OHMS**		**RESOLUTION**	
		In=5	**In=1**	**In=5**	**In=1**
	M4G	0.01-50	0.05-250	0.01	.01
	M4	0.01-50	0.05-250	0.01	.01

DIRECTIONAL CONTROL: Forward/Reversed

OUT OF STEP BLOCKING

The reach of MOB is coordinated with ZONE2, ZONE3 or ZONE4's reach setting. Thus, range will be that of the ZONE it is coordinated with.

CHARACTERISTIC ANGLE	30° - 130°

CURRENT SUPERVISION FUNCTION SETTINGS

	RANGE IN AMPS		RESOLUTION	
	In=5	In=1	In=5	In=1
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
IT	0.20-4.00	0.04-0.80	0.01	0.01
IB	0.20-2.00	0.04-0.40	0.01	0.01

OVERCURRENT BACKUP SETTINGS

	RANGE IN AMPS		RESOLUTION	
	In=5	In=1	In=5	In=1
PH4	2-100.0	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

TOC TIME DIAL SETTING

	RANGE IN MULTIPLES OF PICKUP	RESOLUTION
TOC Time Dial Setting	.5 TO 10	0.1

LINE PICKUP

	RANGE IN AMPS		RESOLUTION	
	In=5	In=1	In=5	In=1
I1	1.0-15.0	0.2-3.0	0.1	0.1

REMOTE OPEN DETECTOR TIMER SETTING

	RANGE(msec)	RESOLUTION(msec)
TL20 (remote open timer)	10 to 100	1

LINE OVERLOAD

	RANGE IN AMPS		RESOLUTION	
	In=5	In=1	In=5	In=1
LEVEL1 OC	5.0-20.0	1.0-4.0	.1	.1
LEVEL2 OC	10.0-40.0	2.0-8.0	.1	.1

	RANGE IN SECS	RESOLUTION
LV1 TIMER(TL31)	10-990	1 SECOND
LV2 TIMER(TL32)	10- 99	1 SECOND

COMPENSATION FACTOR SETTINGS

	RANGE	RESOLUTION
K0 (zero sequence compensation for Z2, Z3 and Z4 ground distance units)	1.0 - 7.0	0.1

K0 compensation for Z1G is a separate setting in the Z1DIST category of settings with the same range and resolution as above.

SCHEME LOGIC TIMERS

	DESCRIPTION	RANGE(msec)	RESOLUTION
TL1	Trip Integrator pickup	1 - 50	1
TL4	POTT/PUTT coordination	0 - 16	1
TL5	'b'contact coordination for breaker 1. (pickup and dropout timers)	0 - 200	1
TL6	'b'contact coordination for breaker 2. (pickup and dropout timers)	0 - 200	1
TL16	Weak Infeed Trip pickup	8 - 80	1

SYSTEM CONFIGURATION SETTINGS

Communications Baud Rate	300, 1200 or 2400 Baud
Number of Breakers	0 to 2
CT ratios	1 to 5000
PT ratios	1 to 7000
Units of Distance for reports	Miles or Kilometers

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 msec

DIMENSIONS

Height	6.945 inches (176 millimeters) Standard 4 rack unit
Width	19.0 inches (484 millimeters) Standard 19 inch rack
Depth	16 inches (406 millimeters)

WEIGHT

Standard rack-mounted unit weighs approximately 26 pounds (11.8 kilograms)

INTERFACE

LOCAL MAN MACHINE INTERFACE (MMI) OPERATION

Display

The display consists of 16 LED alphanumeric character positions arranged side-by-side horizontally.

All messages on the display are the result of a Trip message when the DLP has caused a protective trip, the Fail message when the DLP has discovered a critical self-test failure, the Warning message when the DLP has discovered a non-critical self-test failure, and the Initialization message when the DLP is initializing during a power up.

The Trip message is displayed at highest intensity and has the following format: "TRIP xxx xxx xxx". The word "TRIP" blinks to indicate that the DLP has caused a protective trip. The three fields of information following the word "TRIP" are non-blinking and contain the following information: a three-character fault type (e.g. ABG), a three-character trip type (see the section "Request Fault Information" for a list of the trip types), and a three-digit distance to the fault (in the units specified by the user). The message will remain on the display permanently until removed by a clear key operation. If the DLP restarts or is powered down and up, the trip indicator is remembered and redisplayed. As soon as the clear key is pressed, the Trip message is removed and no longer remembered.

The Fail message has the format "FAIL xxx". The field following the word "FAIL" is a numeric code that indicates the nature of the critical self-test failure. The Fail message remains on the display until the clear key is pressed or until the DLP restarts successfully (with no self-test failures). A list of the failure numbers and their meanings can be found in the SERVICING section.

The Warning message has the format "WARN xxx". The field following the word "WARN" is a numeric code that indicates the nature of the non-critical self-test failure. The Warning message remains on the display until the clear key is pressed or until the DLP restarts successfully (with no self-test failures). A list of the warning numbers and their meanings can be found in the SERVICING section.

The Initialization message has the format "INITIALIZING" and is displayed while the DLP is initializing itself during a power-up sequence. The display is blanked as soon as initialization is complete.

CLEAR Key (CLR)

If a trip, fail, or warn message is being displayed, the user must press the CLR key to blank the error message. When the error message is blanked, the last message will be displayed, allowing the user to re-enter the correct response.

View Password

To view the remote communications password in encrypted form, follow the procedure outlined below. See table IN-1 for Password Key card to translate encrypted password. This function can only be performed if jumper J2 is installed. **NOTE:** While jumper J2 is installed, no other relay functions may be performed and protection is turned off.

The password may be viewed as follows:

1) Power down the relay.
2) Remove the MMI module.
3) Install a jumper in the J2 position. (SEE Figure MO-2)
4) Re-insert the MMI module and power up the relay.
5) The encoded password may now be viewed.
6) Decode the password by using table IN-1.
7) Power down the relay and remove jumper J2 from the MMI.
8) Re-insert the MMI module and power up the relay to return the relay to service.

REMOTE COMMUNICATION INTERFACE

Hardware Jumpers

There are three factory installed hardware jumpers in the MMI module (see MODULE section) used to inhibit the ability to perform the Remote Manual Trip function and the Remote Manual Close function, to view the Encrypted Password, and to set the baud rate.

The Manual Trip and Manual Close jumper, J1, must be removed to enable this function. The View Password jumper, J2, is installed as described above. The baud rate jumper, J3, is installed to select 1200 baud, or removed to select 2400 baud.

CAUTION

Power Down the relay with the power switch before removing or inserting modules. Failure to do so can permanently damage the relay.

The hardware jumpers are defined as follows:

Hardware Jumper J1 = Manual Trip and Manual Close functions; remove to enable.
Hardware Jumper J2 = View Encrypted Password.
Hardware Jumper J3 = Baud Rate Setting; Enabled = 1200; Disabled = 2400.

DLP Settings

Table IN-2 contains a listing of all DLP settings that can be accessed through DLP-LINK (or D-LINK) communication software. The setttings are listed by setting number and category. This information can also be found in the Quick Reference Guide, GEK-99291.

Modem Connections and Settings

When establishing communication between the DLP and a remote PC two modems connected via a phone line are required; one modem is located at the DLP and the other modem is located at the PC. The cable that connects the modem with either the DLP or the PC is shown in Figure IN-1a). Each of these modems must be "Hayes compatible" meaning that they must accept configuration commands first developed by Hayes. This is necessary since the DLP-LINK communications software that runs on the PC sends a Hayes compatible command string to the modem located at the PC. The DLP does not send any configuration commands to its modem. **Both, the DLP modem and the PC modem must be uniquely configured to permit the user to log into and communicate with the DLP using DLP-LINK software.**

The required configuration settings are presented as changes to the factory default configuration settings for a Hayes V-Series 2400 SmartModem. These default settings are:

B1	&C0	S0=0	S37=0
E1	&D0	S6=2	S38=20
L2	&G0	S7=30	
M1	&J0	S8=2	
N1	&K3	S9=6	
P	&L0	S10=14	
Q0	&P0	S11=95	
V1	&Q5	S12=50	
W0	&R0	S18=0	
X4	&S0	S25=5	
Y0	&T4	S26=1	
	&X0	S36=1	

Other "Hayes compatible" modems may implement a subset of the full Hayes command set. **It is the responsibility of the user to ascertain the exact commands accepted by a particular modem.** The proper syntax for entering the Hayes compatible commands (sometimes referred to as the "AT" command set) is not described here. Refer to the manual for your modem for an explanation of this syntax.

PC Modem

The PC modem must be configured for "intelligent" operation (i.e., command recognition enabled). For the Hayes V-Series 2400 SmartModem this setting is made via an internal jumper. The default settings listed above are valid for DLP-LINK. Those configuration settings critical to the operation of DLP-LINK are changed by DLP-LINK. The configuration commands sent to the modem from DLP-LINK are:

```
+++                          (set modem to command mode)
(delay 2 seconds)
ATE0L0Q0S7=60V0X4Y0 (see explanation below)
```

Command explanation:

AT	-	modem attention command
E0	-	disable command state echo
L0	-	low speaker volume (desirable - not required)
Q0	-	modem returns result codes
V0	-	result codes returned in numeric form
X4	-	enables features represented by result codes
Y0	-	disable long space disconnect
S7=	-	allows the modem to hang up if connection is not made within the specified number of seconds.

The S7 command is started in version 1.05 of D-LINK. Earlier versions of D-LINK do not execute this command, leaving the time out at the default value, which is typically 30 seconds.

The S7 command is user-settable, starting in version 1.07 of D-LINK or Version 2.1 of DLP-LINK. The "Modem Connection Time" menu item, under the Configuration Parameters menu in D-LINK or under **SETUP** in DLP-LINK, is used to set this time.

If all of the above commands are not programmable, then the modem will not operate properly. In addition to the required configuration settings listed above, it is suggested that two other settings be made by the user. These are:

&D3 - causes the modem to reset on the ON-to-OFF transition of DTR (Data Terminal Ready)
&C1 - causes DCD (Data Carrier Detect) to track the received carrier signal

The modem will operate properly without making these two settings but the modem will not hang up if the appropriate handshaking signal is lost.

A DLP-LINK setting establishes the baud rate which must match the baud rate setting of the DLP. DLP-LINK will then set the specified PC serial port (i.e., COM1, COM2) to the proper baud rate, parity, databits, and stopbits. 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.

DLP Modem

The DLP modem must be configured for "dumb" operation (i.e., command recognition disabled). For the Hayes V-Series 2400 SmartModem this setting is made via an internal jumper. Since the DLP does not send any configuration commands to its modem, the required configuration settings must be made prior to connecting the modem to the DLP. **Additionally, the modem must be initialized to the required configuration settings each time modem power is turned OFF and then ON.** Depending on the design of the modem this is accomplished by making all the required settings via switches or saving the settings in non-volatile memory.

The required configuration settings are:

E0 - disable command state echo
L0 - low speaker volume (advisable - not necessary)
Q1 - disable result code display
&C1 - causes DCD (Data Carrier Detect) to track the received carrier signal
&D3 - causes the modem to reset on the ON-to-OFF transition of DTR (Data Terminal Ready)
&Q0 - asynchronous mode
S0=1 - enable auto-answer

If any of the above settings cannot be implemented, the modem may not answer, the DLP may not connect properly, or the user may not be able to log into the DLP.

With a Hayes V-Series 2400 SmartModem or equivalent, the DLP modem will perform a modulation handshake with the PC modem to set the baud rate of the DLP modem. The default setting of "N1" permits handshaking to occur at any baud rate supported by both modems. This is one reason why it is preferable to use identical modems at each end.

The S0 register of the DLP modem must coordinate with the PC's modem connection time if the PC modem is to wait for the DLP modem to answer. The DLP modem is configured before it is connected to the DLP. S0=0 disables auto-answer, S0=1 will cause the DLP modem to answer the incoming call after one ring, and with S0=12 it will answer after 12 rings. S0 can be set for any number of rings between 1 and 255, for the Hayes modem assumed here. If it is desirable to delay modem answering, a number greater than 1 should be used.

The modem at the PC, on the other hand, is set via DLP-LINK, through the **Modem connection time** under **SETUP**. Here the unit of measure is up to 255 seconds, with 12 rings at the DLP modem roughly corresponding to 60 seconds. The user should verify for a particular application that the number of rings set at the DLP corresponds to the PC's **Modem connection time**, chosen under **SETUP** .

Modem Setup

The modem command set required to communicate to the DLP from a remote PC is as follows:

Modem Setup Criteria (Hayes Compatible)

Function	DLP 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)	Enable (Q0)
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)

Connection to GNET (optional)

The GNET host computer provides a complete communication package to send and retrieve information automatically from the DLP. The pin-to-pin connections to the GNET host are shown in Figure IN-1d). Refer to the GNET Instruction Book for complete information on GNET Host Computer cable connections and operation.

Null Modem Connections

A PC can be connected to a DLP without the intervening modems and phone line by using a special cable called a "null modem" cable. The required pin-to-pin connections for a null modem cable to connector PL1 on the back of the unit is shown in Figure IN-1b). The pin-to-pin connections for a null modem cable to Connector PL1 on the optional DTA module are shown in Figure IN-1c). Neither null modem cable should exceed 50 feet in length.

Table IN-1 PASSWORD DECODER KEY
ENCRYPTED PASSWORD CONVERSION TABLE

MMI	DECODED	MMI	DECODED	FACTORY USE ONLY MMI	FACTORY USE ONLY DECODED
(sp)	P	:	J	Q	$
!	T	;	N	R	(
"	X	<	C	S	,
$	Q	=	G	T	!
%	U	>	K	U	%
&	Y	?	O	V	)
(	R	@	0	W	-
)	V			X	"
*	Z	A	4	Y	&
,	S	B	8	Z	*
-	W	D	1	[	.
		E	5	\	#
1	D	F	9	]	'
2	H	H	2	^	+
3	L	I	6	_	/
4	A	L	3		
5	E	M	7		
6	I	P	(sp)		
7	M				
8	B				
9	F				

Table IN-2 DLP SETTINGS

NOTE: IN = rated current, which is either 1 amp or 5 amps.

CATEGORY: Z1DIST -- Zone 1 Distance

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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/MG1)	Z1R	OHMS	0.01 - (50)(5/IN)	xxx.xx
0104	Ground Reach (M1/MG1)	Z1GR	OHMS	0.01 - (50)(5/IN)	xxx.xx
0105	Select zone 1 gnd. unit - Mho - Reactance	SELZ1U	N/A	0 - 1 0 1	x
0106	Reach setting of mho unit supv. reactance unit	Z1SU	OHMS	0.01 - (50)(5/IN)	xxx.xx
0107	Zero seq. current compensation (K0)	Z1K0	N/A	1.0 - 7.0	x.x

CATEGORY: Z2DIST -- Zone 2 distance/GDOC (Pilot Zone)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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/MTG)	Z2R	OHMS	0.01 - (50)(5/IN)	xxx.xx
0204	Ground Reach (MT/MTG)	Z2GR	OHMS	0.01 - (50)(5/IN)	xxx.xx
0205	Select zone 2 gnd. unit - Mho - Ground Directional OC - Mho + GDOC	SELZ2U	N/A	0 - 2 0 1 2	x
0206	Select zone 2 TIMERS	SELZ2T	N/A	YES/NO	YES/NO
0207	Phase timer setting	PUTL2P	SECS	0.10 - 3.00	x.xx
0208	Ground timer setting	PUTL2G	SECS	0.10 - 3.00	x.xx
0209	Phase characteristic Angle	Z2PANG	DEGS	90, 105, 120	xxx
0210	Ground characteristic Angle	Z2GANG	DEGS	90, 105, 120	xxx

CATEGORY: Z3DIST -- Zone 3 Distance

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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/M3G)	Z3R	OHMS	0.01 - (50)(5/IN)	xxx.xx
0304	Ground Reach (M3/M3G)	Z3GR	OHMS	0.01 - (50)(5/IN)	xxx.xx
0305	Phase timer setting	PUTL3P	SECS	0.10 - 10.00	xx.xx
0306	Ground timer setting	PUTL3G	SECS	0.10 - 10.00	xx.xx
0307	Phase characteristic Angle	Z3PANG	DEGS	90, 105, 120	xxx
0308	Ground characteristic Angle	Z3GANG	DEGS	90, 105, 120	xxx

CATEGORY: Z4DIST -- Zone 4 Distance

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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/M4G)	Z4R	OHMS	0.01 - (50)(5/IN)	xxx.xx

CATEGORY: Z4DIST -- Zone 4 Distance, continued

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
0404	Ground Reach (M4/M4G)	Z4GR	OHMS	0.01 - (50)(5/IN)	xxx.xx
0405	Phase offset reach	Z4OR	N/A	0.00 - 0.40	x.xx
0406	Phase timer setting	PUTL4P	SECS	0.10 - 10.00	xx.xx
0407	Ground timer setting	PUTL4G	SECS	0.10 - 10.00	xx.xx
0408	Phase characteristic Angle	Z4PANG	DEGS	80, 90, 95, 105, 110, 120	xxx
0409	Ground characteristic Angle	Z4GANG	DEGS	80, 90, 95, 105, 110, 120	xxx
0410	Select Direction - Forward - Reverse	SELZ4D	N/A	0 - 1 0 1	x

CATEGORY: CURSUPVIS -- Overcurrent Pilot/Supervision

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
0501	Gnd. pilot trip OC (IPT)	PUIPT	AMPS	(0.10 - 1.00)(IN)	xx.xx
0502	Gnd. pilot block OC (IPB)	PUIPB	AMPS	(0.05 - 0.75)(IN)	xx.xx
0503	Trip supv. OC setting(IT)	PUIT	AMPS	(0.04 - 0.80)(IN)	x.xx
0504	Block supv.OC setting (IB)	PUIB	AMPS	(0.04 - 0.40)(IN)	x.xx

CATEGORY: OVERCUR -- Overcurrent Backup

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
0601	Select phase inst. OC PH4	SELPH4	N/A	YES/NO	YES/NO
0602	Phase inst. OC setting	PUPH4	AMPS	(0.4 - 20.0)(IN)	xxx.x
0603	Select gnd. inst. OC IDT	SELIDT	N/A	YES/NO	YES/NO
0604	Directional control of IDT	SELDIDT	N/A	YES/NO	YES/NO
0605	Gnd. inst. OC setting	PUIDT	AMPS	(0.1 - 16.0)(IN)	xx.x
0606	Select gnd. time OC (TOC)	SELTOC	N/A	YES/NO	YES/NO
0607	Directional control of TOC	SELDTOC	N/A	YES/NO	YES/NO
0608	Gnd. time OC setting	PUTOC	AMPS	(0.04 - 3.00)(IN)	xx.xx
0609	Gnd. time OC time dial	TDTOC	N/A	0.5 - 10.0	xx.x

CATEGORY: BLK RECLOS -- Reclosing

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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 2 phase units	RB3PH	N/A	YES/NO	YES/NO
0704	Gnd. 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

CATEGORY: OUTOFSTEP -- Out-of-step blocking

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
0801	Select phase trip unit to coordinate with - zone 2	SELPTZ	N/A	0 - 2 0	x

CATEGORY: OUTOFSTEP -- Out-of-step blocking, continued

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
	- zone 3			1	
	- zone 4 (forward only)			2	
0802	Characteristic angle	MOBANG	DEGS	30 - 130	xxx
0803	Select block trip actions	SELOSB	N/A	0 - 2	x
	- block all tripping			0	
	- block: channel trip			1	
	+zone 1 trip				
	+zone 2 trip				
	+zone 3 trip				
	+zone 4 trip				
	- block none			2	

CATEGORY: LINEPU -- Line Pickup

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
0901	Select line pickup	SELLPU	N/A	YES/NO	YES/NO
0902	Select timer bypass	SELTBP	N/A	YES/NO	YES/NO
0903	Pos. seq. OC setting (I1)	PUI1	AMPS	(0.2 - 3.0)(IN)	xx.x

CATEGORY: REMOTEOPEN -- Remote Open Detector

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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

CATEGORY: LINE OVRLD -- Line Overload

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1101	Select line overload	SELOVL	N/A	YES/NO	YES/NO
1102	Level 1 OC setting	PULV1	AMPS	(1.0 - 4.0)(IN	xx.x
1103	Level 2 OC setting	PULV2	AMPS	(2.0 - 8.0)(IN)	xx.x
1104	Level 1 time delay (TL31)	PUTL31	SEC	10 - 990	xxx
1105	Level 2 time delay (TL32)	PUTL32	SEC	10 - 99	xx

CATEGORY: SCHEMESEL -- Scheme Selection

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1201	Select Scheme	SELSCM	N/A	0 - 4	x
	- Step Distance			0	
	- Permissive Overreaching			1	
	- Permissive Underreaching			2	
	- Hybrid			3	
	- Blocking			4	
1202	Number of Receivers	NUMRCVR	N/A	0, 1, 2	x

CATEGORY: SCHEMETIM -- Scheme Logic Timers

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1301	Trip integrator PU(TL1)	PUTL1	MSECS	1 - 50	xx
1302	'b' contact coordination pickup (TL5) breaker 1	PUTL5	MSECS	0 - 200	xxx

CATEGORY: SCHEMETIM -- Scheme Logic Timers, continued

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1303	'b' contact coordination dropout (TL5) breaker 1	DOTL5	MSECS	0 - 200	xxx
1304	'b' contact coordination pickup (TL6) breaker 2	PUTL6	MSECS	0 - 200	xxx
1305	'b' contact coordination dropout (TL6) breaker 2	DOTL6	MSECS	0 - 200	xxx
1306	POTT/PUTT coordination pickup (TL4)	PUTL4	MSECS	0 - 50	xx
1307	Weak infeed trip pickup (TL16)	PUTL16	MSECS	8 - 80	xx

CATEGORY: LINE QTY -- Line Quantities

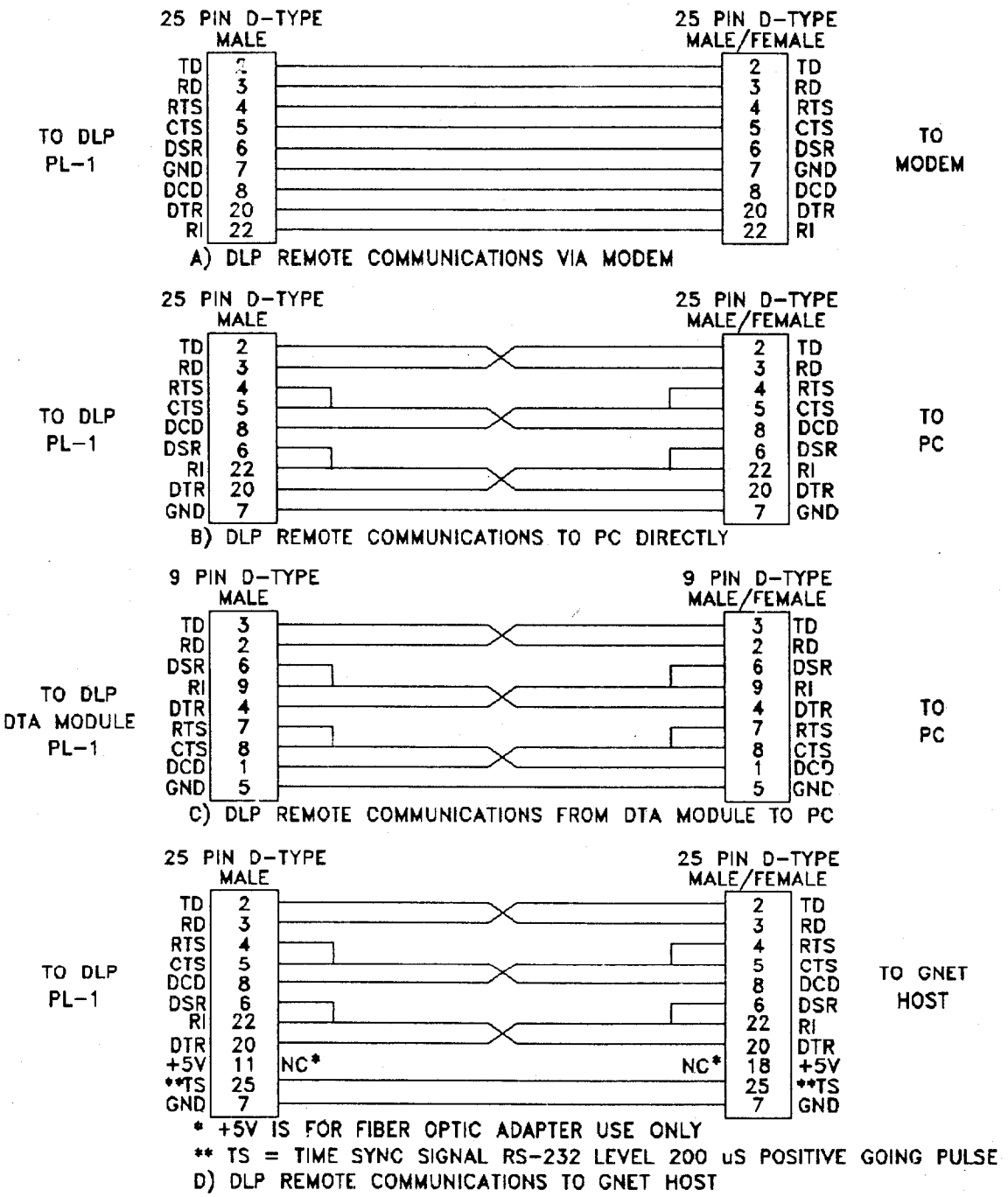
SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1401	Pos. seq. angle of max. reach (ZR1)	POSANG	DEG	45 - 90	xx
1402	Zero seq. angle of max. reach (ZR0)	ZERANG	DEG	45 - 90	xx
1403	Pos. seq. impedance	ZP	OHMS	0.01 - (50)(5/IN)	xxx.xx
1404	Zero seq. current compensation for Z2, Z3, Z4 gnd. dist. (K0)	K0	N/A	1.0 - 7.0	x.x
1405	Line length	LINELEN	MILES Km	0.0 - 200.0 miles 0.0 - 322.0 Km	xxx.x

CATEGORY: CONFIG -- Configuration Settings

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	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	TRIPCIRC	N/A	0 - 3	x
	- None			0	
	- Breaker 1			1	
	- Breaker 2			2	
	- Both			3	
1505	Primary/secondary units for reports	SELPRIM	N/A	0 - 1	x
	- Primary			0	
	- Secondary			1	
1506	CT ratio	CTRATIO	N/A	1 - 5000	xxxx
1507	PT ratio	PTRATIO	N/A	1 - 7000	xxxx
1508	Units of distance for reports	DISTUNIT	N/A	0 - Miles 1 - Km	x
1509	Communication baud rate	BAUDRATE	N/A	300, 1200, 2400	xxxx
1510	Phase designation	PHASDESG	N/A	0 - 1	x
	- (A-B-C)			0	
	- (A-C-B)			1	

CATEGORY: SCADA DTA -- SCADA DTA Interface

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1601	Fault location lock	FLTLOCK	SEC	0 - 99.9	xx.x
1602	Fault location reset	FLTRESET	MIN	0 - 999	xxx



CABLES AVAILABLE UNDER GE PART NO. 0246A9866. SPECIFY CABLE TYPE AND CONNECTOR GENDER.

Figure IN-1 (0286A3581 [1]) DLP Communications Cables (PL1)

SOFTWARE

The following section describes two software programs, either of which can be used to communicate with a Revision B DLP relay. The program D-LINK is the older version of the communications package. It has been superseded by DLP-LINK for the DLP relay, which has some added advantages, such as the ability to use a mouse. Although D-LINK will still be available, we feel DLP-LINK is a better program, and are supplying DLP-LINK as the standard communications software, to be found in the back pouch of this Instruction Book. If a copy of the older version of the program is needed, it can be ordered through your local GE Sales Office.

The first part of the **SOFTWARE** section describes the new DLP-LINK software; the second part describes the older D-LINK software. The third part covers the optional DL-DATA, which may be purchased if desired. The Table of Contents in the front of the book gives the page numbers for the specific sections, as always.

DLP-LINK SOFTWARE

OVERVIEW

A personal computer (PC) will provide a remote man-machine interface to the relay for operating personnel.

USING DLP-LINK

Communications with the relay can be established via a PC with the program DLP-LINK.

SYSTEM REQUIREMENTS

Hardware

The minimum PC hardware requirements consists of the following components. An IBM-AT or compatible (Compaq, Zenith, Tandy, etc...) with one parallel port, a minimum of 500K bytes of free memory (RAM) to run the program in, 40MB hard drive, low density 3 1/2 inch floppy drive, EGA monitor, and one of the printers described below for plotting oscillography data.

Software

Requires MSDOS (PCDOS) 3.1 or above for the PC operating system.

INSTALLATION

Copy all files from the distribution diskette to your hard drive, using the DOS copy command.

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. For a description of how to use the mouse and keyboard in the various boxes and menus, refer to the following sections for menus and dialog boxes. For full manipulation of graphical data, the mouse is required.

The 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:

1. Position the mouse cursor on top of the menu item and click the left button.
2. Use a hot key. The hot key is the combination of the ALT key and the letter that is highlighted in the item description (blue).
3. Once either of the above methods has been used to select an item on the menu, indicated by one item being highlighted, the RIGHT and LEFT ARROW keys can be used to go to adjacent menu items. If the menu is not visible just below the highlighted item on the menu bar use the DOWN ARROW key to display the menu.

Pull-Down Menus

Pull-down menu items are selected in a number of ways:

Mouse

Position the mouse cursor on top of the menu item then press the left button once and release it (hereafter known as clicking on the mouse button) to display the pull-down menu. If the user wishes to select an item in the pull-down menu, position the mouse over 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 the releasing the mouse button.

Keyboard

"Activating the hot key" is the combination of holding the ALT key and striking the highlighted key. Using a hot key will activate the associated menu or dialog box. If there is no hot key for a desired menu item, use the UP and DOWN ARROW keys to highlight the desired item, then press the ENTER key. Pressing the ENTER key will activate 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 iconized. In addition, when a dialog box is displayed, the user can only access items in the dialog box, 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), the user can access this item from the keyboard by using the ALT key with the highlighted character (the hot key). Items in a dialog box can also be accessed from the keyboard by using the cursor keys: UP/DOWN/LEFT/RIGHT ARROW keys, PAGE UP/DOWN keys and the TAB/SHIFT TAB keys. In any dialog box the TAB key will move sequentially in one direction, or the SHIFT TAB key in the opposite direction, selecting items in the dialog box with each keystroke. The other cursor keys will generally move within a selected item.

Buttons in the dialog box can be accessed from the keyboard by using the UP/DOWN ARROW keys, the TAB/SHIFT TAB keys, or if the button has a highlighted character, the hot key. If the buttons require the user to make a selection, the selection is made by using the ENTER key.

To exit from the dialog box and clear it from the screen, the user selects either the OK button or the CANCEL button. The mouse can be used to select these buttons by moving the mouse cursor over the button and clicking the left mouse button. In addition, the keyboard can be used to select these buttons by using their hot keys. The hot key for the OK button is ALT-O and the hot key for the CANCEL button is ALT-C.

The mouse can be used to select any item in a dialog box by moving the cursor with the mouse to the desired item and clicking on it with the left mouse button.

The OK button accepts the selection(s) made by the user and allows the program to use these selections. The CANCEL button does not accept the selections made by the user and thus the program uses the previous selections. Any highlighted button can be selected by striking the ENTER key.

List Boxes

A list box is another box within a dialog box that lists all choices for an item in the 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 that allows the user to scroll through the list.

To operate the scroll bar with the mouse, place the tip of the pointing 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 mouse arrow cursor is in the grey hatched area, then the contents of the list box will 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 will move one line at a time. Holding down the mouse button will cause the movement to be repeated until the mouse button is released.

Once the desired item can be seen, click on the item with the left mouse button to select it. Once an item has been selected it will be highlighted.

To operate the scrolling of the list box with the keyboard, use the PAGE UP/DOWN keys to move the contents of the list box a section at a time and the UP/DOWN ARROW keys to move the contents one line at a time. Holding down the keys will cause the movement in the list box to repeat until the key is released.

Once the desired item can be seen, use the UP/DOWN ARROW keys to select it. The selected item is the highlighted one.

The following table lists the valid keys and their functions for list boxes:

UP ARROW	Move up one selection.
DOWN ARROW	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.

LEFT ARROW	Move the cursor one character to the left.
RIGHT ARROW	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/box
ESCAPE	Clear the text or number in the field/box.

The first keystroke other than the arrow keys will clear the field/box; this enables a new entry without having to clear the box first. If a minor change is desired and the user does not wish to clear the field/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. Some of the items will be displayed in a lighter shade or color. This is to denote the absence of the relay to perform that ability. Since DLP-LINK works for all revisons of the DLP relay there may be some functions that are present in one relay and not in another.

RELAY FUNCTIONS

Relay functions has the following active menu items and associated hot keys:

Login	ALT-L
lOgout	ALT-O
Hang up phone	ALT-H
Actions...	ALT-A
Information...	ALT-I
Settings...	ALT-S

Login

Login is used to gain access to the relay. When logging into a DLP for the first time, the user must use the factory password. When a user is logged in under the factory password, the only commands that can be used at the PC are those to change the password and to logout. The factory password is changed to the user's password by selecting the **change Password** menu item from the **Actions** menu item from the **RELAY FUNCTIONS** pull-down menu. The current password is the factory password and the new password is the user's password. The encoded Communications password can **only** be viewed locally, on the MMI.

The **Login** dialog box contains a list of the currently configured DLPs, a place to enter the password, a place to enter the unit ID, a button for adding a new DLP to the configured DLP list, an OK button and a CANCEL button.

The list of currently configured DLPs contains the unit description, phone number, baud rate, and multiplexor switch code for each DLP.

The NEW RELAY button in the dialog box allows the user to add a relay that has not been previously entered into the list of configured relays. The user enters the unit description, the phone number, the multiplexor switch code, and the phone number for the new relay. The new relay is added to the list of configured relays.

Once a relay is selected from the list of relays, the user is asked for the password and the unit ID. Neither of these is echoed on the screen. Once this information is entered, the user selects the OK button to log in to the relay.

lOgout

Logout disables access to the relay. A check is made to determine the status of protection at the DLP (ON or OFF). The status is displayed in the dialog box. Selecting the OK button logs out of the relay. Selecting the CANCEL button, leaves the user logged in to the relay. If the status of protection is OFF due to a setting change that was not ended, pick the CANCEL button and choose **End settings change** in **Settings** in the **RELAY FUNCTIONS** menu.

Hang up phone

This selection will disconnect the phone line at the modem. If the user is logged in to the relay, The logout procedure will be completed before hanging up the phone. To pick this selection, use the hot key ALT-H or click on the menu item with the left mouse button.

Actions...

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
cAlculate CRC	ALT-A
Relay test mode	ALT-R

change Password

This item allows the user to change the password in the DLP. The password always consists of ASCII characters, even the factory password. 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. The Communications password can only be viewed on the MMI, in encrypted form, therefore it is **IMPORTANT** that the user keep a record of the password in a safe place.

First, the user must enter the present password. If the entered password is valid, the user must then enter the new password. If the new password is valid, the user must enter the identical new password again.

The user selects the OK button; this does not yet cause the password to be changed. Next, the user is asked to confirm the change. If the user selects the OK button, the password is changed.

Manual trip

This item allows the user to trip the breakers manually. If two breakers are being controlled by the DLP, each must be tripped individually. Note that the breakers cannot be tripped if the appropriate jumper is installed (see the MODULE Section for the location and description of the jumpers). To select **Manual trip**, use the hot key ALT-(M) or click on the menu item with the left mouse button.

The user selects the breaker to trip by using the UP and DOWN ARROW keys or clicking on the breaker selection with the left mouse button.

When the user selects the OK button and a breaker is selected, the user is asked to confirm the action. If the user selects the OK button, the breaker is tripped and the user is returned to the previous screen. Selecting the CANCEL button from the confirmation dialog box will return the user to the breaker-selection dialog box, without tripping the selected breaker. Selecting the CANCEL button from the breaker-selection dialog box returns the user to the **Actions** menu.

manual Close

This item allows the user to close the breakers manually. If two breakers are being controlled by the DLP, each must be closed individually. Note that the breakers cannot be closed if the appropriate jumper is installed (see the MODULE Section for the location and description of the jumpers). To select **manual Close**, use the hot key ALT-C or click on the menu item with the left mouse button.

The user selects the breaker to close by using the UP and DOWN ARROW keys or clicking on the breaker selection with the left mouse button.

When the user selects the OK button and a breaker is selected, the user is asked to confirm the action. If the user selects the OK button, the breaker is closed and the user is returned to the previous screen. Selecting the CANCEL button from the confirmation dialog box will return the user to the breaker-selection dialog box without closing the selected breaker. Selecting the CANCEL button from the breaker-selection dialog box returns the user to the **Actions** menu.

Enable outputs

This item allows the user to permit the DLP to energize the relay outputs. Note that the digital outputs cannot be enabled remotely if the appropriate jumper is installed (see the MODULE Section for the location and description of the jumpers on the MMI board). This item is selected by using the ALT-E hot key or clicking on the menu item with the left mouse button.

If the user selects the CANCEL button then no action is taken and the **Actions** menu is redisplayed. If the user selects the OK button, another dialog box is displayed to confirm the action. If the user selects the OK button, the outputs are enabled. If the CANCEL button is selected, there is no change in the status of the digital outputs, and the previous dialog box will be displayed.

Disable outputs

This item allows the user to inhibit the DLP from energizing any of the relay outputs except for the four Alarm Outputs. Note that the digital outputs cannot be disabled if the appropriate jumper is installed (see the MODULE Section for the location and description of the jumpers). This item is selected by using the ALT-D hot key or clicking on the menu item with the left mouse button.

If the user selects the CANCEL button then no action is taken and the **Actions** menu is redisplayed. If the user selects the OK button, another dialog box is displayed to confirm the action. If the user selects the OK button, the outputs are disabled. If the CANCEL button is selected, there is no change in the status of the digital outputs, and the previous dialog box will be displayed.

change Time and date

This item allows the user to set the time and date in the DLP to the current time and date. Changing the time and date through this menu does not affect the time and date in the PC. This item is selected by using the ALT-T hot key or clicking on the menu item with the left mouse button.

First the DLP'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). The user may then edit the time and date.

When the user selects the OK button, the user is asked to confirm the action. If the user selects the OK button, the time and date are changed in the DLP.

cAlculate CRC

This item allows the user to recalculate the settings CRC code in non-volatile RAM. cAlculate CRC is selected by using the ALT-A hot key or clicking on the menu item with the left mouse button. Once cAlculate CRC has been chosen, a dialog box will be displayed. The dialog box contains only the OK and CANCEL buttons. If the user selects the CANCEL button at any time the user will be returned to the **Actions** menu box. For further information see the section on **SERVICING**.

If the OK button is selected, the user is asked to confirm the action with another dialog box. If the user selects the OK button, the settings CRC code is recalculated and all the settings are sent back to the PC. In addition, a message is displayed telling the user 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 the user selects the CANCEL button, the CRC value is not recalculated and the previous dialog box will be displayed again.

Relay test mode

This item allows the user to test the relay functions of the DLP. **Relay test mode** is selected with the ALT-R hot key or by placing the mouse cursor over the menu item and clicking on the left mouse button. Once **Relay test mode** has been selected, the test functions are displayed in a list box. Since there are 18 test entries in the list box, only a few will be seen at one time. To find the desired test, use the PAGE UP/DOWN and UP/DOWN ARROW keys or use the mouse on the scroll bar. See **List Boxes** under **GENERAL OPERATION** in this **DLP-LINK SOFTWARE** section for more information.

The user selects the desired test function to perform by clicking on it with the left mouse button or hitting the ENTER key, once the correct test has been highlighted. If the user selects the OK button, another dialog box will be displayed to confirm the test. If the user again selects the OK button, the test is performed. This will put the relay in test mode for the selected test. If the CANCEL button is selected, then the relay will not be put in test mode for the selected test and the user will be returned to the previous dialog box.

If the user selects the CANCEL button from the dialog box with the list of tests, the user will be returned to the **Actions** menu box. To put the relay back in operating mode, "End test mode" is selected from the list of tests.

Information...

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 Present values

This item allows the user to display, print and/or file the present values. To select this menu item, either click on it with the left mouse button or use the ALT-P hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the present values. To change any of the three choices, either click on it with the left mouse button 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 and no X indicates that choice has not been selected. One must be chosen for the present values to be retrieved from the relay.

If the user chooses to save the report in a file, a file name must be entered in the box supplied. To enter the file name, either move the mouse cursor to the box and click on the left mouse button or use the TAB key to highlight the box. Once the box has been selected, enter the filename followed by the ENTER key.

After all the choices have been made, click on the OK button, or use the ALT-O hot key, to retrieve the report from the relay. Selecting the CANCEL button will 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 with the left mouse button, or use the ALT-F4 hot key (F4 is the Function key F4, not the F key followed by the 4 key.). Once the present values have been cleared from the screen the **Present values** dialog box will be redisplayed. Use the ALT-C hot key or click on the CANCEL button to exit Present values.

NOTE: Phase angles go from 0° to 180° or −10° 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 the user has selected in setting 1505. Status is reported only for the number of breakers and carrier sets present in the configuration.

request fault report Identification

This item allows the user to display and/or print the identification of each fault report, which includes the time, date, and trip type for each fault. This information allows the user to determine easily which fault to examine.

To select this menu item either click on it with the left mouse button or use the ALT-I hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the fault report identifications. To change any of the three choices, either click on it with the left mouse button 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 and no X indicates that choice has not been selected. One must be chosen for the fault report identifications to be retrieved from the relay.

If the user chooses to save the report in a file, a file name must be entered in the box supplied. To enter the file name either move the mouse cursor to the box and click on the left mouse button or use the TAB key to highlight the box. Once the box has been selected, enter the filename followed by the ENTER key.

After all the choices have been made, click on the OK button or use the ALT-O hot key to retrieve the identifications from the relay. (Selecting the CANCEL button will return to the **Information** menu without any further action.) If the identifications have been displayed, when finished either click on the small box in the upper left corner with the left mouse button, or use the ALT-F4 hot key (F4 is the Function key F4, not the F key followed by the 4 key). Once the identifications have been cleared from the screen, the **fault report Identification** dialog box will be redisplayed. Use the ALT-C hot key or click on the CANCEL button to exit.

request Fault report

This item allows the user to display, print and/or file a fault report and its associated events. To select this menu item, either click on it with the left mouse button or use the ALT-F hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the fault reports. To change any of the three choices, either click on it with the left mouse button or use the TAB key to highlight one of the selections and the UP/DOWN ARROW keys to choose one of the three choices. An X in the brackets indicates that choice has been selected and no X indicates that choice has not been selected. Use 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. The user must enter the fault report number (from 1 to 5) in the box supplied on the first line of the **Fault report** dialog box.

If the user chooses to save the report in a file, a file name must be entered in the box supplied. To enter the file name, either move the mouse cursor to the box and click on the left mouse button, or use the TAB key to highlight the box. Once the box has been selected, enter the filename followed by the ENTER key.

After all the choices have been made, click on the OK button or use the ALT-O hot key to retrieve the fault report from the relay. (Selecting the CANCEL button will 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 with the left mouse button or, use the ALT-F4 hot key (F4 is the Function key F4, not the F key followed by the 4 key). Once the fault report has been cleared from the screen, the **Fault report** dialog box will be redisplayed. Use the ALT-C hot key or click on the CANCEL button to exit.

The voltages are displayed with units of "V" if they are secondary. If the voltages are primary, the units are KV. The user may scroll the screen to view the events associated with the fault. To scroll through the report, use the PAGE UP/DOWN keys, or place the mouse on the UP or DOWN ARROW on the scroll bar and use the left mouse button. Clicking the left mouse button will move one line in that direction and holding the button down will cause the scrolling to happen repetitively. The events are displayed with the most recent event last.

request Events

This item allows the user to display, print and/or file the events stored in the relay. To select this menu item, either click on it with the left mouse button or use the ALT-E hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the events. To change any of the three choices, either click on it with the left mouse button or use the TAB key to highlight one of the selections and the UP/DOWN ARROW keys to choose one of the three choices. An X in the brackets indicates that choice has been selected and no X indicates that choice has not been selected. Use the space bar to change any of the choices. At least one must be chosen for the events to be retrieved from the relay.

If the user chooses to save the report in a file, a file name must be entered in the box supplied. To enter the file name, either move the mouse cursor to the box and click on the left mouse button or use the TAB key to highlight the box. Once the box has been selected, enter the filename followed by the ENTER key.

After all the choices have been made, click on the OK button or use the ALT-O hot key to retrieve the events from the relay. Selecting the CANCEL button will return to the **Information** menu without any further action. The events are displayed chronologically, starting with the most recent event. There may be more events than can be displayed on one screen. If there are more events to see, a scroll bar will appear on the left side of the box. Use the PAGE UP/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 with the left mouse button or use the ALT-F4 hot key (F4 is the Function key F4, not the F key followed by the 4 key). Once the events have been cleared from the screen the **Events** dialog box will be redisplayed. Use the ALT-C hot key or click on the CANCEL button to exit.

NOTE: If DC power is removed for more than 24 hours, all event information will be lost.

request Oscillography data

This item allows the user to save on disk the oscillography data for a particular fault. To select this menu item either click on it with the left mouse button or use the ALT-O hot key. Once this item is selected a dialog box will appear with places to enter the fault number and a file name for the data to be stores in. To select one of the entries to change, click on it with the left mouse button or use the TAB key to highlight one of the selections. Once an entry has been chosen 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 5) and the file name for the data **must** be supplied, to have the oscillography data retrieved from the relay.

After the file name and fault number have been entered, click on the OK button or use the ALT-O hot key to retrieve the oscillography data from the relay. The fault report, the events associated with the fault report, 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 currents, the voltages, the digital inputs, digital outputs, and protection flags. This file can be read directly by Lotus 123, 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

This item allows the user to display, print and/or file the DLP status. To select this menu item either click on it with the left mouse button or use the ALT-S hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the DLP status. To change any of the three choices, either click on it with the left mouse button or use the TAB key to highlight one of the selections and the UP/DOWN ARROW keys to choose one of the three choices. An X in the brackets indicates that choice has been selected and no X indicates that choice has not been selected. Use the space bar to change any of the choices. At least one must be chosen for the events to be retrieved from the relay.

If the user chooses to save the report in a file, a file name must be entered in the box supplied. To enter the file name, either move the mouse cursor to the box and click on the left mouse button or use the TAB key to highlight the box. Once the box has been selected, enter the filename followed by the ENTER key.

After all the choices have been made, click on the OK button or use the ALT-O hot key to retrieve the status from the relay. (Selecting the CANCEL button will 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 with the left mouse button, or use the ALT-F4 hot key (F4 is the Function key F4, not the F key followed by the 4 key). Once the status has been cleared from the screen, the **Status** dialog box will be redisplayed. Use the ALT-C hot key or click on the CANCEL button to exit.

The status messages (not including the jumper status) are displayed in the same order as those at the DLP (described in the SERVICING section).

request dlp Model

This item allows the user to display, print and/or file the DLP model and PROM version number. To select this menu item, either click on it with the left mouse button or use the ALT-S hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the DLP Model number and PROM version number. To change any of the three choices, either click on it with the left mouse button or use the TAB key to highlight one of the selections and the UP/DOWN ARROW keys to choose one of the three choices. An X in the brackets indicates that choice has been selected and no X indicates that choice has not been selected. Use the space bar to change any of the choices. At least one must be chosen for the events to be retrieved from the relay.

If the user chooses to save the report in a file, a file name must be entered in the box supplied. To enter the file name, either move the mouse cursor to the box and click on the left mouse button or use the TAB key to highlight the box. Once the box has been selected, enter the filename followed by the ENTER key.

After all the choices have been made, click on the OK button or use the ALT-O hot key to retrieve the model and PROM version from the relay. Selecting the CANCEL button will 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 with the left mouse button, or use the ALT-F4 hot key (F4 is the Function key F4, not the F key followed by the 4 key). Once the model and version have been cleared from the screen the **Model** dialog box will be redisplayed. Use the ALT-C hot key or click on the CANCEL button to exit.

Settings...

The **RELAY FUNCTIONS Settings** menu has the following items and hot keys:

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

Upload dlp settings

This menu item uploads the settings from the DLP. To select this menu item, use the ALT-U hot key or click on the menu item with the left mouse button. Once the item has been selected, a dialog box will ask for the desired group of the settings. Enter the group and select the OK button, by using the ALT-O hot key or clicking on the OK button with the left mouse button. Selecting the CANCEL button returns the user to the **Settings** menu.

Once a group has been selected, all the settings for the group will be uploaded and the functions that can be performed in the **Settings** menu will be displayed in black writing.

Print dlp settings

This item allows the user to print all settings or a specific category of settings. First a list box is displayed with the category names, plus one additional item for printing all categories. If the desired selection is not visible, use PAGE UP/DOWN or the UP/DOWN ARROW keys to see the other entries. To select an entry, either click on it with the left mouse button or highlight the item with the cursor control keys and hit ENTER.

After a category has been picked, selecting the OK button will print the settings. The settings are printed by category, with one setting name and value per line. Selecting the CANCEL button will return the user to the **Settings** menu. If CANCEL is picked before the OK button, then no settings will be printed.

view/change Category of settings

This item allows the user to change or view one or all of the settings in a category. To select this menu item, use the ALT-C hot key or click on the menu item with the left mouse button. Once the menu item has been selected, a list box of category names is displayed. The user must select a category to view or change, with the left mouse button or the UP and DOWN ARROW keys followed by the ENTER key. Once a category has been chosen, selecting the OK button will display a dialog box with the settings in the category. Selecting the CANCEL button will return the user to the **Settings...** menu.

The dialog box for the 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 will select any of the above items in the list box. The arrow keys and PAGE UP/DOWN keys will move the contents to display the unseen settings. A setting can be chosen to be changed by highlighting it with the cursor keys and the hitting the ENTER key, or clicking on it with the left mouse button. After the setting has been selected, it can be changed in the box marked setting value.

After all the settings changes have been completed selecting the OK button will save the settings changes and return to the **Settings** menu. Selecting the CANCEL button at any time will return to the **Settings** menu without any further action.

view/change Individual settings

This item allows the user to change or view one setting at a time. To select this item, either click on it with the left mouse button or use the ALT-I hot key. Once this item has been selected, a dialog box is displayed containing a field to enter a setting number, a list box containing all the settings for the DLP, 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 by using the TAB key, or click on it with the left mouse button.

The field labeled "Enter setting number" allows the user to select a setting to change. Use the editing keys to enter and/or change the contents of the field. When a setting number has been entered, followed by the ENTER key, the list box scrolls to the setting and places the cursor in the setting value box so the setting may be changed. Hit ENTER after entering any setting value.

The list box contains a list of all the settings labeled "Setting list". To scroll to a setting that is not displayed, use the PAGE UP/DOWN keys or the ARROW keys, or place the tip of the mouse cursor in the scroll bar on the far-right side of the list box and click on the left mouse button. For more information see **List Boxes** near the beginning of this **DLP-LINK SOFTWARE** section.

The field labeled "Enter setting value" is used to enter a new value for the selected setting. The value is checked to make sure 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.

The user selects the OK button to save the setting changes. Selecting the CANCEL button will return to the **Settings** menu without any further action.

Download changed settings to dlp

This item allows the user to transmit all the changed settings to the DLP. Note that if the appropriate jumper is installed, the DLP will not allow setting changes from the PC. See the **MODULES** section for more information on the jumpers.

Selecting Download with the ALT-D hot key or clicking on it with the left mouse button will display a dialog box with the changed settings. There is an option to end the settings change automatically. To pick this option, either place the mouse cursor over the box and click on the left mouse button or use the TAB key to highlight the selection and use the SPACE BAR to select it. Striking the SPACE BAR, or clicking the left mouse button again will deselect the option.

If the CANCEL button is selected, the **Settings** menu is redisplayed and no further action is taken. If the OK button is selected, another dialog box is displayed to confirm that the settings are to be downloaded. If the OK button is selected the changed settings are sent, and the changes are ended if the automatic end settings option was chosen. If the CANCEL button is selected no settings are sent and the **Download settings** dialog box is redisplayed.

End setting changes

This item is selected after downloading settings to tell the DLP 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 DLP, then this menu item does not need to be selected again.) To select this menu item use the ALT-E hot key or click on it with the left mouse button. Once the item is selected, a dialog box that only contains the OK and CANCEL buttons is displayed. To end the settings changes, select the OK button with the ALT-O hot key or by clicking on it. Selecting the CANCEL button will return to the **Settings** menu. If the CANCEL button is selected before ending the settings changes, then the new settings will not be used.

If the OK button is selected, another dialog box will appear to confirm the choice to end the settings changes, since protection will be enabled with the new settings. If the user selects the OK button, the setting changes are ended. If the CANCEL button is selected from the confirmation dialog box, the settings changes are not ended and the previous dialog box will be active again.

Save dlp settings to file

This item allows the user to write the settings to a disk file. To select this item, use the ALT-S hot key or click on the menu item with the left mouse button. The user enters a file name (it may include a path also) in the field labeled "Enter file name". The user selects the OK button to save the settings in the specified file. The CANCEL button returns to the **Settings** menu. If CANCEL is selected before saving the settings, no settings will be saved.

The contents of the settings file saved with this menu item 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 **LOCAL FUNCTIONS Settings** menu if a description of the settings is desired.

LOCAL FUNCTIONS

The Local functions menu has the following items and hot keys.

Settings...	ALT-S
Graph oscillography data	ALT-G
go to DOS	ALT-D

Settings...

The **LOCAL FUNCTIONS Settings...** menu has the following items and 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
Model/version number	ALT-M
Save local settings to file	ALT-S
Download local settings to dlp	ALT-D
End setting changes	ALT-E

Load settings from file

This item allows the user to read settings from a disk file into the program as local settings. To select this item, either click on it with the left mouse button or use the ALT-L hot key. This permits the user to load and work on another set of settings other than the set that was initially loaded.

If the user then loads another set of local settings, the previous set of local settings is overwritten and lost, unless the user has saved the previous set of local settings by selecting **Save local settings to file** menu item from the **Settings...** menu.

Once this item has been selected, a dialog box is displayed 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 by selecting a file from the list box labeled "Files".

The field marked "File name" contains the file that is currently selected. This field may be selected by the user to specify a file containing settings (a file previously created by the **Save local settings to file** menu item or **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 by the user.

The next two fields are list boxes. The list box labeled "Files" contains a list of files in the current directory from which the user can select a file. The list box labeled "Directories" contains a list of subdirectories and drives where the user can go for additional lists of files.

The user selects the OK button to read into DLP-LINK the local settings from the selected file.

Print local settings

This item allows the user to print all settings or categories of settings. To select this item, use the ALT-P hot key or click on it with the left mouse button. Once this item has been selected, a list box is displayed with the category names, plus one additional item for printing all categories.

The user selects the desired category of settings to print. To select a category that is not displayed use the PAGE UP/DOWN and ARROW keys or place the mouse cursor in the scroll bar or on the arrows at each end and click on the left mouse button. The highlighted item in the list box is the one that is selected. The user selects the OK button to print the settings.

The settings are printed by category, with one setting name and value per line.

view/change Category of local settings

This item allows the user to change or view one or all of the settings in a category. To select this menu item, use the ALT-C hot key or click on the menu item with the left mouse button. Once the menu item has been selected, a list box of category names is displayed. The user must select a category to view or change with the left mouse button or the UP and DOWN ARROW keys followed by the ENTER key. Once a category has been chosen, selecting the OK button will display a dialog box with the settings in the category. Selecting the CANCEL button will return the user to the **Settings** menu.

The dialog box for the 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 will select any of the above items in the list box. The ARROW keys and PAGE UP/DOWN keys will move the contents to display the unseen settings. A setting can be chosen to be changed, by highlighting it with the cursor keys and then hitting the ENTER key, or clicking on it with the left mouse button. After the setting has been selected it can be changed in the box marked "Setting Value".

After all the settings changes have been completed, selecting the OK button will save the settings changes and return to the **Settings** menu. Selecting the CANCEL button at any time will return to the category names dialog box without any further action.

view/change Individual local setting

This item allows the user change or view one setting at a time. To select this item, either click on it with the left mouse button or use the ALT-I hot key. Once this item has been selected, a dialog box is displayed containing a field to enter a setting number, a list box containing all the settings for the DLP from a 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 by using the TAB key or clicking on it with the left mouse button.

The field labeled "Enter setting number" allows the user to select a setting to change. Use the editing keys to enter and/or change the contents of the field. When a setting number has been entered, followed by the ENTER key, the list box scrolls to the setting and places the cursor in the setting value box so the setting may be changed. Hit ENTER after entering any setting value.

The list box contains a list of all the settings labeled "Setting list". To scroll to a setting that is not displayed use the PAGE UP/DOWN keys and the ARROW keys, or place the tip of the mouse cursor in the scroll bar on the far right side of the list box and click on the left mouse button. See **List Boxes** under **GENERAL OPERATION** in this **DLP-LINK SOFTWARE** section for more information.

The field labeled "Enter setting value" is used to enter a new value for the selected setting. The value is checked to make sure 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.

The user selects the OK button to save the setting changes. Selecting the CANCEL button will return to the **Settings** menu without any further action.

Save local settings to file

This item allows the user to write the settings to a disk file. To select this item either click on it with the left mouse button or use the ALT-S hot key. The user enters a file name (it may include a path also) in the field labeled "Enter file name". Selecting the OK button will save the settings in the specified file. Selecting the CANCEL button will return to the **Settings** menu without any further action. Selecting CANCEL after saving the settings to a file will return to the **Settings** menu.

Model/version number

This entry displays the model number and PROM firmware revision that match the settings in the local file. To select this item, either click on it with the left mouse button or use the ALT-M hot key. These numbers should **match** any relay to which you wish to send the local settings. If they do not match, the local settings download **will fail.**

Download local settings to DLP

This item allows the user to transmit all the local settings to the DLP. To select this item, either click on it with the left mouse button or use the ALT-D hot key. The user must be logged in to a DLP in order to use this menu item. Note that if the appropriate jumper is installed, the DLP will not allow setting changes from the PC. See the **MODULES** section 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.**

Once this item has been selected a dialog box is displayed containing 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 with the left mouse button or use 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 the OK button with the mouse or the ALT-O hot key. To exit download at any time select the CANCEL button. If the OK button is selected, another dialog box will be displayed to confirm the download. To continue the download process select the OK button. If the settings are not to be downloaded then select the CANCEL button. When finished, select the CANCEL button from the **Download** dialog box to exit.

End setting changes

This item allows the user to tell the DLP 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 with the left mouse button or use the ALT-E hot key.

Once this item has been selected a dialog box containing the OK and CANCEL buttons is displayed. The user selects the OK button to end setting changes. Selecting the CANCEL button will exit **End setting change** without any further action. If the OK button was selected, another dialog box is displayed to confirm the ending of setting changes. Selecting the CANCEL button will return to the previous dialog box without ending the setting changes. Selecting the OK button will end the settings changes. Select the CANCEL button to exit.

Graph oscillography data

The optional program DLDATA will be started (if present) if this entry is chosen. This enables the user to graph oscillography data without leaving DLP-LINK. The DOS path for the DLDATA program needs to be entered. The path is entered from the **SETUP** menu (see below) and is stored for later use. For more information on DLDATA, refer to the pages describing DLDATA at the end of this **SOFTWARE** section.

go to DOS

This choice enables the user 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 following items and hot keys.

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 DLDATA	ALT-L
Memory available	no hot key

Communication port number

The communication port for the PC is chosen with this selection. To select this item, either click on it with the left mouse button or use the ALT-C hot key. Once this item is selected, a dialog box containing the port number and IRQ number will be displayed. The serial port that is connected to the DLP, or the modem used to talk to the DLP, must be entered before logging in to the relay. If the port chosen is not COM1(1) or COM2(2), 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 with the left mouse button.

Once a field has been selected, use the editing keys to change and/or enter data. When the port and IRQ numbers are correct, select the OK button to save the numbers. If the CANCEL button is selected, the **SETUP** menu will be redisplayed without any further action.

Dial type

To select this item, either click on it with the left mouse button or use the ALT-D hot key. Once this item is selected, a dialog box containing the dialing type will be displayed. Either tone or pulse dialing can be chosen. The UP and DOWN ARROW keys will toggle between the tone and pulse choices. The TAB key will move between the selected dialing type and the OK and CANCEL choices in the box. Once the dialing type has been chosen, selecting the OK button will store the change. Selecting the CANCEL button will exit Dial type without any further action.

Modem connection time

This item will change the time-out period for DLP-LINK to wait for the modem to make a connection. To select this item, either click on it with the left mouse button or use the ALT-M hot key. The modem connection time can be set for any time up to 255 seconds, provided the modem being used will accommodate that long a time-out period. This setting is useful for applications where the modem is set to pickup after a large number of rings, especially if the phone system has a lot of delay in making the initial connection. Once a connection time has been set, selecting the OK button with the left mouse button or the ALT-O hot key will store the new time-out period. Selecting the CANCEL button will exit this item without any further action.

Relay parameters

Relay parameters allows the communication parameters for a specific relay unit description to be changed or viewed. An entry in the list must be selected first, by clicking on it with the mouse or using the UP and DOWN ARROW keys to highlight the selection, and pressing the ENTER key.

Once 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 with the mouse or using the TAB key to move between the items, and then using the UP and DOWN ARROW keys to select the value for that item. To exit the dialog box for that unit description, select either the OK button or the CANCEL button. The OK button will accept the values in the dialog box and store them. Selecting the CANCEL button will exit the dialog box and will use the values that were already present when the unit description was selected.

The user should 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 with the left mouse button or use the TAB key to move the cursor to the phone number box. The normal text-editing keys may be used to enter or modify the phone number. This is an optional item, and should only be filled in if DLP-LINK is using a modem for the unit being described.

To enter or change the switch code, select it by clicking on it with the left mouse button or use 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 switch code. This is an optional item, and should only be filled in if a code-operated switch is being used.

The baud rate must have one of the values selected. The baud rate item can be selected by clicking on it with the left mouse button or using the TAB key until the selected item is highlighted. The UP and DOWN ARROW keys select the desired value. A specific value can be selected by clicking on it directly with the left mouse button.

A choice of one or two stop bits must be made for communications to work properly. The stop bits item can be selected by clicking on it with the left mouse button or using the TAB key until the selected item is highlighted. The UP and DOWN ARROW keys select the desired value. A specific value can also be selected by clicking on it directly with the left mouse button.

Parity must have one of the values selected for communications to work properly. The parity item can be selected by clicking on it with the left mouse button or using the TAB key until the selected item is highlighted. The UP and DOWN ARROW keys select the desired value. A specific value can also be selected by clicking on it directly with the left mouse button.

NOTE: Relays having model numbers ending with the letters "A" or "B" must have the number of stop bits set to "1" and parity set to "NONE".

Add relay to list

Selecting this item will enable the user to add a unit description and the related values to the list of stored relay unit descriptions. The user can either move the mouse cursor to the entry in the menu and click on the left mouse button or use the hot key ALT-A to select this entry. Once the entry has been selected, the user is prompted for a unit description. The description is limited to 20 characters. After the description has been entered, the user can either click on the OK button with the left mouse button or use the ALT-O hot key to accept it. (Selecting the CANCEL button will not add the new unit description and will exit the user from the menu entry.)

After the new unit description has been accepted, a dialog box will appear 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 UP and DOWN ARROW keys, or a value can be chosen by placing the mouse cursor over the desired value and clicking on the left mouse button.

dElete relay from list

This item allows the user to delete a relay unit description from the configuration file. To select this item, either click on it with the left mouse button or use the ALT-E hot key. Once this item has been selected, a dialog box will be displayed containing a list box with all the relay unit descriptions and the OK and CANCEL buttons.

The user selects the desired relay from a list box displaying the unit descriptions and logon parameters by using the UP and DOWN ARROW keys to highlight the desired relay and pressing the ENTER key, or moving the mouse cursor to the desired relay and clicking on it with the left mouse button. Selecting the OK button with the ALT-O hot key or clicking on it with the left mouse button will mark the unit description for deletion. Selecting the CANCEL button will exit without deleting any relay unit descriptions. If the OK button is selected, the user is asked to confirm the deletion of the unit description. Selecting the OK button will delete the relay unit description. Selecting the CANCEL button will return to the list box without deleting any relay unit description. Selecting the CANCEL button in the list box will exit from the menu entry.

set path for DLDATA

DLDATA (optional) can be started from DLP-LINK from the **LOCAL FUNCTIONS** pull-down menu. The DOS path must first be set so DLP-LINK knows where to start the program from. To set the path, select this menu item by using the hot key ALT-L or click on it with the left mouse button. A dialog box will appear, with space to enter a path. After entering the path, select the OK button to accept the new path, or the CANCEL button to exit without changing the previous path.

memory available

To display the amount of available memory while DLP-LINK is running either click on this menu item with the left mouse button, or use the UP or DOWN ARROW keys to highlight the menu item, and hit the ENTER key. There is no hot key for this item.

Exiting DLP-LINK

There are two ways to exit DLP-LINK:

ALT-F4 will produce a dialog box with the exit message. Selecting the OK button with the mouse or using the ALT-O hot key will exit DLP-LINK. Selecting the CANCEL button will return the program without exiting.

The ALT key combined with the space bar will produce the System Menu after all menus have been cleared from the screen. Choosing the CLOSE entry, with the mouse or the hot key ALT-C, will produce a dialog box with the exit message. Selecting the OK button with the mouse or using the ALT-O hot key will exit DLP-LINK. Selecting the CANCEL button will return to the program without exiting.

NOTE: To exit 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 pull-down menu is different from the other pull-down menus in that the items do not have hot keys associated with them. The user must either click on the mouse or use the UP and DOWN ARROW keys followed by the ENTER key, to access the menu items.

D-LINK SOFTWARE

USING D-LINK

The new software, DLP-LINK, is included with this book. However, the older version of the communications software, D-LINK, may still be used to communicate with the relay. It may be obtained by request through the GE Sales office.

SYSTEM REQUIREMENTS FOR D-LINK

Hardware

The minimum IBM PC-XT or compatible hardware requirements consist of the following components:

- one serial port
- one parallel port
- 640K of RAM
- one 10MB hard drive
- one 3.5" floppy drive
- a monochrome monitor
- an Epson-compatible printer
- a Hayes-compatible modem

The cable diagrams for the connections from the DLP to a modem, a PC or to G-NET are in the INTERFACE section of this book. The figure numbers are IN-1 through IN-4.

The modem commands used for the DLP and the PC are in the Modem Connections and Settings portion of the INTERFACE section of this book.

Software

Requires MS-DOS (PC-DOS) 3.1 or above for the PC operating system and the GE communication software package, D-LINK. If task swapping is desired then MS-DOS 5.0 or higher is required. See the **General Operation** section below for information on task swapping and shelling to DOS.

GENERAL DESCRIPTION

Relay Commands

Commands can be transmitted to the relay to perform the following operations:

- Initiate communications by presenting correct password to the relay
- Terminate communications
- Change password stored in the relay
- Change the time and date stored in the relay

- Download a single setting, a range of settings or all settings to the relay
- Request a single setting, a range of settings or all settings from the relay
- Indicate that setting changes are complete
- Request relay status
- Request any one of the five most recent fault reports
- Request present values of the acquired data (RMS currents, RMS voltages, input status)
- Enter test mode
- Request all sequence-of-events data (all events stored in the relay will be transmitted in chronological order, starting with the most recent event)
- Request oscillography data for any of the five most recent faults; every data sample for one cycle pre-fault and up to 29 cycles post-fault will be transmitted
- Request fault report status (abbreviated version of the fault report, to help determine which oscillography data or fault report the user needs)
- Request model number and PROM version number
- Enable/disable operation of relay outputs (i.e., all digital outputs except critical alarm, non-critical alarm, power supply alarm, and line overload alarm)
- Perform manual trip
- Perform manual close

General Operation

A hierarchy of menus is implemented to direct the user to the desired information, action, or settings. Menu items are selected with the use of the arrow keys on the PC keyboard. Once the desired information, action, or settings have been reached via the menus, the user is presented with a series of prompts to complete the task. While the user is responding to the prompts, the current menu remains displayed on the screen with the menu selection highlighted.

The user has the capability to shell to DOS using the function key F4. This will enable the user to get directory listings of files without logging out of the relay and exiting the program. To return to D-LINK from DOS, type EXIT followed by the ENTER key. Due to the size of D-LINK, if a user wants to shell to DOS and run other applications, DOS 5.0 or higher should be used. DOS 5.0 has a built in task swapper which will enable the user to run other applications. To access the task swapper, type DOSSHELL followed by an ENTER key at a DOS prompt. If the task swapper is enabled, it appears in the lower right hand section of the screen. If the task swapper is not enabled, enable it from the options menu. Now, every program run will be put in the task list. If, while running one program, the user wishes to temporarily leave (shell out of) the program to run another, use the following the key sequence: hold down the CTRL key and strike the ESC key. This will bring you out of the program, but keeping the program to be able to resume it later, enabling you to run another program. When finished with a program, simply exit it by the normal means. After exiting all programs the task list will be empty. To restart a task that has been suspended, pick it from the task list in the lower right hand corner not the directory list.

Prompts for various menu items request the user to enter the name of a file to store data in. The name the user enters must be a valid MS-DOS file name; refer to the MS-DOS user manual for a description of valid file names. If the user enters a valid file name, that file, if it already exists, is overwritten with the new data and the data already in the file is lost. Therefore, it is advisable that the user always enter the name of a file that does not exist (the software creates the new file for the user) so that data is not inadvertently lost.

If the user at the PC is logged into a DLP but does not send any commands or request any information for a period of 15 minutes, the DLP automatically logs the user off. When this happens, the user may get one or more error messages indicating this, depending on where he is in the hierarchy of menus. The user can simply log into the DLP again from LOGIN in the MAIN MENU (see the section on LOGIN below).

Screen Usage

The screen is divided into six areas; title, menu, prompt, error, status, and help.

The title area consists of the relay unit identification number, the relay unit description, and the menu title. The title area consists of the first two lines on the screen.

The menu area contains the items in the menu. The menu area consists of lines four through twenty (4-20) on the screen.

The prompt area is for asking the user for information and provides the user a place to enter the requested information. The prompt area consists of line twenty-two (22) on the screen.

The error area is for displaying any errors. The error area consists of line twenty-three (23) on the screen.

The status area consists of line twenty-four (24) on the screen. The first 50 characters of the line is for informing the user of program actions in situations where there will be no change in the screen for several seconds or more (such as retrying the sending of a message to the relay). The last 30 characters of the line show the status of the phone line connection and whether or not the user is logged into a relay.

The help area is for displaying information that helps the user respond to prompts. The help area consists of line twenty-five (25) on the screen. Many of the prompts have additional information displayed in the help area.

When the user is viewing data, the entire screen is used.

Menu Operation

Menus consist of a title line, followed by a blank line, followed by the menu items. An item is selected by using the UP-ARROW key or DOWN-ARROW key to move the highlight bar to the item and pressing the ENTER key to select the item. The HOME key can be used to move the highlight bar to the first item in the menu. The END key can be used to move the highlight bar to the last item in the menu.

Prompt Operation

The user responds to a prompt by entering the required information on the keyboard. The user terminates the response by pressing the ENTER key. The user may use the BACKSPACE key to delete any entered information prior to pressing the ENTER key.

The user may press the ENTER key only, if no information is to be entered for the prompt. This will have varying results, such as the current menu being displayed, or the next prompt being displayed. In the case where a user is asked to respond with a "Y" or "N", pressing the ENTER key only will result in an error message. In this case, the user must press a "Y" or "N".

Any time the user is responding to a prompt, he may press the ESCAPE key, which will terminate the response without causing any action. Again this will have varying results, such as the current menu being displayed, or the next prompt being displayed.

Viewing Data

When an action initiated by the user results in data being retrieved from the relay and displayed on the screen, the entire screen will be used. If there is more data than can be viewed on one screen, the bottom lines on the screen display a prompt that instructs the user on how to view the remaining screens. In general the user uses either the UP/DOWN ARROW keys or the PAGE UP/DOWN keys. To clear the data from the screen and display the current menu, the user can press the ESCAPE key.

If the prompt indicates the use of the UP/DOWN ARROW keys, the user may press the UP-ARROW and DOWN-ARROW keys to view backward and forward (respectively) through the data one line at a time. If the prompt indicates the use of the PAGE UP/DOWN keys, the user may press the PAGE-UP and PAGE-DOWN keys to view backward and forward (respectively) through the data one screen at a time.

Program Errors

Any errors are reported on the screen in the error area and require the user to acknowledge the error by pressing the ENTER key. Errors are caused either by conditions at the PC or conditions at the relay.

Error conditions at the PC include an invalid response to a prompt, receiving an invalid message from the relay, or problems on the line between the PC and the relay.

Error conditions at the relay include receiving an invalid message or command from the PC, a data error within a message, or problems on the line between the PC and the relay.

INSTALLATION

View the file README.TXT for updated information and installation instructions for this program. This file is found on the 3.5" floppy disk located at the end of this section.

STARTING PROGRAM

The user must first change directories to the directory containing the program files. The program can then be started by typing "D-LINK" at the MS-DOS prompt.

After the program has gone through its initialization, the MAIN MENU is displayed as shown below.

RELAY COMMUNICATIONS

MAIN MENU

LOGIN
LOGOUT
RELAY FUNCTIONS
LOCAL SETTINGS
CONFIGURATION PARAMETERS
HANG UP
EXIT PROGRAM

The first time the program is started, the default configuration file (one of the supporting files copied from the program disk during installation) must be set up according to the user's needs. The user should enter the DLP unit description, the baud rate, the phone number, and the switch code for each DLP this program is to communicate with. In addition, the user needs to select the PC communication port number that is used to communicate to the DLP's. This is done by selecting the CONFIGURATION PARAMETERS menu item from the above menu. The Configuration Parameters section below describes this item.

The relay functions are not accessible until the user logs into a relay. The user may perform operations on copies of local settings and may view and/or modify configuration parameters without being logged into a relay.

PROGRAM OPERATION

Login

Login from the MAIN MENU is selected (see **Menu Operations** above) to gain access to the relay. When logging into a DLP for the first time, the user has to use the factory password. When a user is logged in under the factory password, the only commands that can be used at the PC are those to change the password and to log out. The factory password is changed to the user's password by selecting the CHANGE PASSWORD menu item from the DLP ACTIONS Menu. The current password is the factory password and the new password is the user's password. The encoded password can only be viewed locally on the MMI. Refer to table IN-6 to decode the password.

First, a menu of the relay unit descriptions, phone numbers, and multiplexor switch codes is displayed.

Login Menu

Unit Number 1	0000000	000000
Unit Number 2	5551212	U0
Unit Number 3	9-2125551212	000000
Unit Number 4	0000000	000000

NEW RELAY
RETURN TO MAIN MENU

The item, NEW RELAY, selects a relay that has not been entered into the configuration file. The user selects the desired menu item.

If the user selects a relay that has already been configured, the phone number of the relay, the switch code for the multiplexor, and the baud rate are retrieved from the configuration file. If the phone number consists of 4 zeroes (the minimum number of digits for a phone number), a modem is not in use (i.e. there is a direct serial connection between the PC and relay). If the multiplexor switch code consists of a zero, a multiplexor switch is not in use. If any information is needed for the above items (i.e. information for these items is not in the configuration file), the user is asked for the information with the following prompt:

ENTER aaaaaaaa:

The aaaaaaaa is either the phone number, the multiplexor switch code, or the baud rate. The user may press the ESCAPE key only, press the ENTER key only, or enter the requested data followed by the ENTER key. If the ESCAPE key is entered for any item, the log-in procedure is cancelled and the MAIN MENU is displayed. If the user presses only the ENTER key, the item is considered as not needed and bypassed in the remaining log-in procedures except for the baud rate. If the user presses only the ENTER key for the baud rate, it defaults to 1200. If the user enters the requested value followed by the ENTER key, the data is verified as follows. The phone number is verified to make sure it contains only digits and the pause character (a dash, -, causes the modem to delay in dialing the number). The baud rate is checked to make sure it is either 300, 1200, or 2400. It is the user's responsibility to make sure the baud rate entered at the PC agrees with the baud rate setting in the DLP. If there is an error, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again.

If the user selects the menu item for a relay not in the configuration file, he is prompted for the phone number, multiplexor switch code, and the baud rate in the same manner as described above.

Once all the log-in parameters have been obtained, the password of the relay with which the user wishes to communicate is requested with the prompt:

ENTER PASSWORD:

NOTE: The password may only be changed remotely, using the D-LINK Software.

If the user presses the ENTER key only, the log-in attempt is cancelled and the MAIN MENU is displayed. If the user enters the password (which is echoed on the screen as a string of dots (.)) followed by the ENTER key (see the section **Change Password** for a description of the valid password characters), the user is requested for the relay unit identification with the following prompt:

ENTER RELAY UNIT IDENTIFICATION:

If the user presses the ENTER key only, the log-in attempt is cancelled and the MAIN MENU is displayed. If the user enters the relay unit identification (which is echoed on the screen as a string of dots (.)), it is checked to make sure it contains only digits and is four digits or less in length. If the relay unit identification does not meet these requirements, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If there is no error, the serial port is initialized with the baud rate specified in the configuration file. Next, the phone number of the modem connected to the relay (if there is one and if the line is not already connected, or if the line is already connected and the new phone number is different) is dialed. When the modem answers the phone, the switch code for the multiplexor, if there is one, is transmitted to the multiplexor. Then the unit identification number and the password are transmitted to the relay for verification.

If there is an error (e.g. phone does not get answered, the password is wrong), an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the error is acknowledged, the user is denied access to all menu items that would result in communication to the relay.

If the unit identification number and the password are verified and the password is the factory password, the user is only allowed to change the password and log out.

If the unit identification number and the password are verified and the password is not the factory password, the user is granted access to all the menu items that result in communication to the relay.

Logout

Logout from the MAIN MENU is selected to disable access to the relay. This item first asks the user for confirmation with the following prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user responds with a "N" followed by the ENTER key, the user is not logged out and is returned to the MAIN MENU. If the user responds with a "Y" followed by the ENTER key, a check is made to determine if protection is off at the DLP. If protection is off, the user is asked if he wishes to continue with the log out with the following prompt:

PROTECTION IS OFF, CONTINUE TO LOGOUT (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user responds with a "N" followed by the ENTER key, the user is not logged out and is returned to the MAIN MENU. If the user responds with a "Y" followed by the ENTER key or it is determined that protection is on, the access level at the relay is reset. It is important to note that even though the user has logged out, the telephone connection between the relay and the PC is still intact; the user must also hang up the line (HANG UP from the MAIN MENU).

Relay Functions

RELAY FUNCTIONS from the MAIN MENU is selected to communicate with the relay in the categories described in the RELAY FUNCTIONS Menu below.

RELAY FUNCTIONS

DLP ACTIONS
DLP INFORMATION
DLP SETTINGS
RETURN TO MAIN MENU

The user selects the desired menu item. Each item is described below.

DLP Actions

DLP ACTIONS from the RELAY FUNCTIONS Menu is selected to instruct the DLP to perform any of the actions in the DLP ACTIONS Menu described below.

DLP ACTIONS

CHANGE PASSWORD
MANUAL TRIP
MANUAL CLOSE
ENABLE OUTPUTS
DISABLE OUTPUTS
CHANGE TIME AND DATE
FIXUP SETTINGS
RELAY TEST MODE
RETURN TO RELAY FUNCTIONS MENU

The user selects the desired menu item. Each item is described below.

Change Password

Change Password from the DLP ACTIONS Menu is selected to change the password in the DLP. The password always consists of ASCII characters, even the factory password. 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. The password can only be viewed on the MMI in encrypted form, therefore it is IMPORTANT that the user keep a record of the password in a safe place.

First the user is asked for the present password with the following prompt:

ENTER CURRENT PASSWORD:

If the user presses the ENTER key only, the password is not changed and the DLP ACTIONS Menu is displayed. If the user enters the current password followed by the ENTER key, and it is not correct, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the current password followed by the ENTER key and it is correct, he is asked for the new password with the following prompt:

ENTER NEW PASSWORD:

If the user presses the ENTER key only, the password is not changed and the DLP ACTIONS Menu is displayed. If the user enters a new password followed by the ENTER key, it is checked for validity (i.e. it is no more than 16 characters in length and it consists only of the allowed characters described above). If the new password is invalid, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the password is valid, the user is asked to re-enter the new password a second time to verify the new password with the following prompt:

RE-ENTER NEW PASSWORD:

If the user presses the ENTER key only, the password is not changed and the DLP ACTIONS Menu is displayed. If the user incorrectly re-enters the new password followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user correctly re-enters the new password followed by the ENTER key, the new password is transmitted to the DLP and the old password changed to the new password. When a password is entered from the keyboard, dots are echoed so that a password is never displayed on the screen.

Manual Trip

Manual Trip from the DLP ACTIONS Menu is selected to trip the breakers manually. If two breakers are being controlled by the DLP, each must be tripped individually. Note that the breakers cannot be tripped if the appropriate jumper is installed (see the INTERFACE Section for a description of the jumpers).

The user is first asked which breaker to trip with the prompt:

TRIP WHICH BREAKER (1 OR 2)?

If the user presses the ENTER key only, no breaker is tripped and the DLP ACTIONS Menu is displayed. If the user enters a breaker number other than 1 or 2 followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters 1 or 2 followed by the ENTER key, an "arm" message is transmitted to the DLP. The user is then asked to verify the command with the prompt:

TRIP BREAKER x (Y/N)?

The "x" is either 1 or 2, whichever the user previously entered. The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, a message is not transmitted to the DLP, which the causes the DLP to be disarmed (i.e. the DLP will not issue a trip signal). If the user enters a "Y" followed by the ENTER key, an "execute" message is transmitted to the DLP, which causes the DLP to issue the appropriate trip signal. In either case the DLP ACTIONS Menu is displayed.

Manual Close

Manual Close from the DLP ACTIONS Menu is selected to close the breakers manually. If two breakers are being controlled by the DLP, each must be closed individually. Note that the breakers cannot be closed if the appropriate jumper is installed (see the INTERFACE Section for a description of the jumpers).

The user is first asked which breaker to close with the prompt:

CLOSE WHICH BREAKER (1 OR 2)?

If the user presses the ENTER key only, no breaker is closed and the DLP ACTIONS Menu is displayed. If the user enters a breaker number other than 1 or 2 followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters 1 or 2 followed by the ENTER key, an "arm" message is transmitted to the DLP. The user is then asked to verify the command with the prompt:

CLOSE BREAKER x (Y/N)?

The "x" is either 1 or 2, whichever the user previously entered. The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N"

followed by the ENTER key, a message is not transmitted to the DLP, which the causes the DLP to be disarmed (i.e. the DLP will not issue a close signal). If the user enters a "Y" followed by the ENTER key, an "execute" message is transmitted to the DLP, which causes the DLP to issue the appropriate close signal. In either case the DLP ACTIONS Menu is displayed.

Enable Outputs

Enable Outputs from the DLP ACTIONS Menu is selected to permit the DLP to energize the relay outputs. Note that the digital outputs cannot be enabled if the appropriate jumper is installed (see the INTERFACE Section for a description of the jumpers).

The user is first asked if he wishes to enable outputs with the prompt:

ENABLE OUTPUTS (Y/N)?

The user presses the ENTER key only, or a "Y" (yes) or "N" (no) followed by the ENTER key. If the user presses the ENTER key only, the outputs are not enabled, and the DLP ACTIONS Menu is displayed. If the user responds with any character other than a "Y", "N", or the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, no action is taken and the DLP ACTIONS Menu is displayed. If the user enters a "Y" followed by the ENTER key, an "arm" message is sent to the DLP. The user is then asked to verify that outputs should be enabled with the following prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, a message is not transmitted to the DLP and the outputs are not enabled. If the user enters a "Y" followed by the ENTER key, an "execute" message is transmitted to the DLP, which causes the outputs to be enabled. In either case the DLP ACTIONS Menu is displayed.

Disable Outputs

Disable Outputs from the DLP ACTIONS Menu is selected to inhibit the DLP from energizing any of the relay outputs except for the four Alarm Outputs. Note that the digital outputs cannot be disabled if the appropriate jumper is installed (see the INTERFACE Section for a description of the jumpers).

The user is first asked if he wishes to disable outputs with the prompt:

DISABLE OUTPUTS (Y/N)?

The user presses either the ENTER key only, or a "Y" (yes) or "N" (no) followed by the ENTER key. If the user presses the ENTER key only, the outputs are not disabled, and the DLP ACTIONS Menu is displayed. If the user responds with any character other than a "Y", "N", or the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, no action is taken and the DLP ACTIONS Menu is displayed. If the user enters a "Y" followed by the ENTER key, an "arm" message is sent to the DLP. The user is then asked to verify that outputs should be disabled with the following prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, a message is not transmitted to the DLP and the outputs are not disabled. If the user enters a "Y" followed by the ENTER key, an "execute" message is transmitted to the DLP, which causes the outputs to be disabled. In either case the DLP ACTIONS Menu is displayed.

Change Time and Date

Change Time and Date from the DLP ACTIONS Menu is selected to set the time and date in the DLP to the current time and date. Changing the time and date through this menu does not affect the time and date in the PC.

First a menu of the time and date is displayed as described below.

CHANGE TIME AND DATE

10:55:09
07/16/90
CHANGE TIME AND DATE IN RELAY
RETURN TO ACTION MENU

The time and date shown in the menu are the current time and date as set in the PC. The user selects the desired menu item. Each item is described below.

If time is selected, the user is prompted for a new time with the prompt:

ENTER NEW TIME:

The user either presses the ENTER key only, or enters a new time in the format shown in the menu followed by the ENTER key. If the user presses the ENTER key only, the time on the display remains unchanged. If the user enters an invalid time, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid time, the time is changed on the display.

If date is selected, the user is prompted for a new date with the prompt:

ENTER NEW DATE:

NOTE: After initial power up or loss of power exceeding 24 hours, the time and date will reset to 00:00:00 01/01/90. All event and fault data will be reset.

The user either presses the ENTER key only, or enters a new date in the format shown in the menu followed by the ENTER key. If the user presses the ENTER key only, the date on the display remains unchanged. If the user enters an invalid date, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid date, the date is changed on the display.

Once the display has been changed, if the menu item to change the time and date in the relay (DLP) is selected, the user is asked for confirmation with the prompt:

CHANGE TIME AND DATE IN RELAY (Y/N)?

The user enters a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the time and date in the DLP are not changed. If the user enters a "Y" followed by the ENTER key, a message is transmitted to the DLP that causes the time and date to be changed to the time and date shown in the menu. In any case, the TIME AND DATE menu is displayed.

If the menu item to return to the DLP ACTIONS Menu is selected, the DLP ACTIONS Menu is displayed.

Fix Up Settings

Fixup Settings from the DLP ACTIONS Menu is selected to recalculate the settings CRC code in non-volatile ram in the DLP. For further information see the section on SERVICING. The user is first asked if he wishes to recalculate the settings CRC code with the prompt:

FIXUP SETTINGS (Y/N)?

The user presses either the ENTER key only, or enters a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y", "N", or the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the ENTER key only or enters a "N" followed by the ENTER key, the settings CRC code is not recalculated, and the DLP ACTIONS Menu is displayed. If the user enters a "Y" followed by the ENTER key, the user is then asked to verify that the settings CRC code should be recalculated with the following prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, a message is not transmitted to the DLP and the settings CRC code is not recalculated. If the user enters a "Y" followed by the ENTER key, a message is transmitted to the DLP that causes the settings CRC code to be recalculated and all the settings to be sent back to the PC. In addition, a message is displayed telling the user to verify all settings. In either case the DLP ACTIONS Menu is displayed.

Note that 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.

Relay Test Mode

Relay Test Mode from the DLP ACTIONS menu is selected to test the relay functions of the DLP. After choosing the Relay Test Mode option, the following menu of test functions appears:

1: END TEST MODE
2: ZONE 1
3: ZONE 2
4: ZONE 3
5: ZONE 4
6: FAULT DETECTR
7: IT DETECTOR
8: IB DETECTOR
9: GND DIR TRIP
10: GND DIR BLOCK
11: INST PH OC
12: INST GND OC
13: T DLY GND OC
14: LINE PICKUP
15: REM OPN DETCT
16: OUT OF STEP
17: V1 DETECTOR
18: LINE OVERLOAD

For further information on the Relay Test Mode, refer to the INTERFACE and ACCEPTANCE TESTS sections.

Return to Relay Functions Menu

Return To Relay Functions Menu from the DLP ACTIONS Menu is selected to return to the RELAY FUNCTIONS Menu.

DLP Information

DLP Information from the RELAY FUNCTIONS Menu is selected to view and/or print the data in the REQUEST DLP INFORMATION Menu described below.

REQUEST DLP INFORMATION
REQUEST PRESENT VALUES
REQUEST FAULT REPORT IDENTIFICATION
REQUEST FAULT REPORT
REQUEST EVENTS
REQUEST OSCILLOGRAPHY DATA
REQUEST DLP STATUS
REQUEST DLP MODEL
RETURN TO RELAY FUNCTIONS MENU

The user selects the desired menu item. Each item is described below.

Request Present Values

Request Present Values from the REQUEST DLP INFORMATION Menu is selected to display and/or print the present values. The user is first asked whether to display the present values, print the present values, or both, with the following prompt:

ENTER D (DISPLAY), P (PRINT), OR B (BOTH):

If the user presses the ENTER key only, the present values are not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters any character other than a "D", "P", "B", followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "D", "P", or "B" followed by the ENTER key, the present values are retrieved from the DLP. If the user enters a "D" followed by the ENTER key, the present values are displayed on the screen only. If the user enters a "P" followed by the ENTER key, the present values are printed only. If the user enters a "B" followed by the ENTER key, the present values are both displayed on the screen and printed.

The following figure is a sample of the Present Values screen.

```
DLP UNIT 1                                                    0001

                        PRESENT VALUES

                      03/08/90  14:22:35

IA = 002.51 A   -79 DEGS          VA = 067.5 V     0 DEGS
IB = 002.48 A  -120 DEGS          VB = 067.7 V  -120 DEGS
IC = 002.53 A    30 DEGS          VC = 067.6 V   120 DEGS
IN = 000.01 A   -79 DEGS

BREAKER 1 = OPEN
BREAKER 2 = CLOSED

PLC #1 SIGNAL = ON                PLC #2 SIGNAL = ON
PLC #1 STATUS = OFF               PLC #2 STATUS = ON

STOP CARRIER: N/A
BLOCK PILOT TRIP: N/A

                   PRESS ESCAPE KEY TO CONTINUE
```

NOTE: Phase angles go from 0° to 180° or -10° to -179°, and are referenced to Phase A voltage. VA must be present for this function to operate.

Currents and voltages are RMS values and are either primary or secondary, as the user selected at the DLP. The above figure shows voltages as secondary. If voltages are primary, the units are KV.

Status is reported only for the number of breakers and carrier sets present in the configuration.

When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed.

If the present values are printed only, the REQUEST DLP INFORMATION Menu is displayed when the printing is complete.

Request Fault Report Identification

Request Fault Report Identification from the REQUEST DLP INFORMATION Menu is selected to display the identification of each fault report, which includes the time, date, and trip type for each fault. This information allows the user to determine easily which fault to examine.

The information is automatically retrieved from the DLP and displayed in the following format.

```
DLP UNIT 1                                                    0001

                        FAULT REPORT STATUS

FAULT #                 DATE/TIME                        TRIP TYPE

1                       05/20/90  13:01:23.605                Z1
2                       04/20/90  13:01:23.405                Z2
3                       03/12/90  13:01:23.205                Z3
4                       02/18/90  02:11:45.176               PLT
5                       10/05/89  10:23:12.984               LPU

                    PRESS ESCAPE KEY TO CONTINUE
```

When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed.

Request Fault Report

Request Fault Report from the REQUEST DLP INFORMATION Menu is selected to display and/or print a fault report and its associated events. The user is first asked for the fault report number to be printed/displayed with the following prompt:

ENTER FAULT NUMBER:

If the user presses the ENTER key only, the fault report is not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters an invalid fault report number followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid fault report number (1 to 5, 1 is the most recent fault and 5 is the oldest fault) followed by the ENTER key, he is then asked for the name of a file in which to save the fault report with the following prompt:

ENTER FILE NAME FOR FAULT REPORT:

If the user presses the ENTER key only, the fault report is not stored in a disk file, however, it is still displayed and/or printed. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the name of a file, the fault report is stored in the disk file.

Next, the user is asked whether to display the fault report, print the fault report, or both, with the following prompt:

ENTER D (DISPLAY), P (PRINT), OR B (BOTH):

If the user presses the ENTER key only, the fault report is not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters any character other than a "D", "P", "B", followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "D", "P", or "B" followed by the ENTER key, the fault report is retrieved from the DLP. If the user entered a file name for the previous prompt, the fault report is stored in the disk file. If the user enters a "D" followed by the ENTER key, the fault report is displayed on the screen only. If the user enters a "P" followed by the ENTER key, the fault report is printed only. If the user enters a "B" followed by the ENTER key, the fault report is both displayed on the screen and printed.

The fault report is displayed on the screen in the following format.

```
DLP UNIT 1                                                    0001

                              FAULT REPORT

TRIP DATE: 07/20/90                        TRIP TIME: 13:01:23.205

FAULT TYPE: AG                             DISTANCE: 34.3 MI
TRIP TYPE: Z1                              OPERATING TIME: 00021 MS

        PREFAULT                                FAULT
Ia:   5.61 A                            Ia: 15.34 A
Ib:   5.23 A                            Ib:  5.12 A
Ic:   5.30 A                            Ic:  4.96 A
In:   0.51 A                            In: 12.13 A

                                        Va: 51.2 V
                                        Vb: 66.2 V
                                        Vc: 67.3 V

      USE PAGE UP/DOWN KEYS TO VIEW MORE, PRESS ESCAPE KEY TO CONTINUE
```

The above example shows voltages as secondary. If voltages are primary, the units are KV.

When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed. The user may press the PAGE-UP key to view the next screen (below) of the fault report:

```
13:01:23.205 TRIP SIGNALS ON
13:01:23.208 TRIP CIRCUIT #1 ENERGIZED
13:01:23:208 TRIP CIRCUIT #2 ENERGIZED
13:01:23:248 TRIP SIGNALS RESET
13:01:23:260 BREAKER #1 OPEN
13:01:23:260 BREAKER #2 OPEN

  USE PAGE UP/DOWN KEYS TO VIEW MORE, PRESS ESCAPE  KEY TO CONTINUE
```

These are the events associated with the fault. The events are displayed with the most recent event last.

When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed. The user may press the PAGE-DOWN key to view the previous screen (above) of the fault report.

If the fault report is printed only, the REQUEST DLP INFORMATION Menu is displayed when the printing is complete.

Request Events

Table SO-1 EVENT MESSAGES

The following is the list of events printed by the DLP:

TRIP SIGNALS ON
TRIP SIGNALS RESET
TRIP CIRCUIT #1 ENERGIZED
TRIP CIRCUIT #2 ENERGIZED
TRIP CIRCUIT #1 NOT ENERGIZED
TRIP CIRCUIT #2 NOT ENERGIZED
OUT OF STEP CONDITION ON
OUT OF STEP CONDITION OFF
BREAKER #1 OPEN
BREAKER #1 CLOSED
BREAKER #2 OPEN
BREAKER #2 CLOSED
FUSE FAILURE ALARM ON
FUSE FAILURE ALARM OFF
RECEIVE CARRIER ON
RECEIVE CARRIER OFF
KEY TRANSMITTER ON
LINE OVERLOAD ALARM ON
LINE OVERLOAD ALARM OFF
TRIP CIRCUIT #1 MONITOR ALARM ON
TRIP CIRCUIT #1 MONITOR ALARM OFF
TRIP CIRCUIT #2 MONITOR ALARM ON
TRIP CIRCUIT #2 MONITOR ALARM OFF
PILOT PROTECTION ON
PILOT PROTECTION OFF

REMOTE COMM - PASSWORD CHANGED
REMOTE COMM - MANUAL TRIP
REMOTE COMM - MANUAL CLOSE
REMOTE COMM - ENABLE OUTPUTS
REMOTE COMM - DISABLE OUTPUTS
REMOTE COMM - SETTINGS CHANGE STARTED
REMOTE COMM - SETTINGS CHANGE DONE
REMOTE COMM - MANUAL TRIP ATTEMPTED
REMOTE COMM - MANUAL CLOSE ATTEMPTED

Table SO-1 EVENT MESSAGES (CONT'D.)

DAP BOARD: PROCESSOR FAILURE CLEARED
DSP BOARD: CO-PROCESSOR FAILURE CLEARED
SSP BOARD: FAILURE CLEARED
SSP BOARD: QUEUES REINITIALIZED
MGM BOARD: FAILURE CLEARED
ANI BOARD: FAILURE CLEARED
MMI BOARD: FAILURE CLEARED

FAIL - DAP BOARD: PROM
FAIL - DAP BOARD: LOCAL RAM
FAIL - DAP BOARD: DSPRAM CRC
FAIL - DAP BOARD: DSPRAM
FAIL - DAP BOARD: SYSRAM
FAIL - DAP BOARD: INTERRUPT
FAIL - DAP BOARD: TIMER
FAIL - DAP BOARD: VERSION NUMBER
FAIL - DSP BOARD: PROM
FAIL - DSP BOARD: LOCAL RAM
FAIL - DSP BOARD: DSPRAM
FAIL - DSP BOARD: INTERRUPT
FAIL - DSP BOARD: VERSION NUMBER
FAIL - ANI BOARD: CONTROLLER
FAIL - ANI BOARD: SERIAL MEMORY
FAIL - ANI BOARD: REFERENCE
ANI BOARD: REFERENCE CORRECTED
FAIL - MGM BOARD: SERIAL MEMORY
FAIL MGM BOARD: MODEL NUMBER
FAIL - SSP BOARD: PROM
FAIL - SSP BOARD: LOCAL RAM
FAIL - SSP BOARD: SYSRAM CRC
FAIL - SSP BOARD: SYSRAM
FAIL - SSP BOARD: INTERRUPT
FAIL - SSP BOARD: EEPROM
FAIL - SSP BOARD: VERSION NUMBER
FAIL - MMI BOARD: DIGITAL OUTPUT

WARN - DSP BOARD: DIGITAL INPUT
DSP BOARD: DIGITAL INPUT CORRECTED
WARN - ANI BOARD: ZERO CROSSING
WARN - SSP BOARD: TIMER
WARN - SSP BOARD: CAPRAM
WARN - SSP BOARD: REAL TIME CLOCK
WARN - MMI BOARD: SERIAL CHIP
WARN - MMI BOARD: LED DISPLAY
WARN - MMI BOARD: SPURIOUS TIME STROBES
WARN - REMOTE COMM LOGIN FAILED

Note: If the 3rd login attempt fails this message will be evented

WARN - DTA BOARD: SERIAL MEMORY
WARN - SPURIOUS TIME STROBES

Request Events from the REQUEST DLP INFORMATION Menu is selected to display and/or print the events. The user is first asked for the name of a file in which to save the events with the following prompt:

ENTER FILE NAME FOR EVENTS:

If the user presses the ENTER key only, the events are not stored in a disk file, however, the events are still displayed and/or printed. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the name of a file, the events are stored in the disk file.

Next, the user is asked whether to display the events, print the events, or both, with the following prompt:

ENTER D (DISPLAY), P (PRINT), OR B (BOTH):

If the user presses the ENTER key only, the events are not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters any character other than a "D", "P", "B", followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "D", "P", or "B" followed by the ENTER key, the events are retrieved from the DLP. If the user entered a file name for the previous prompt, the events are stored in the disk file. If the user enters a "D" followed by the ENTER key, the events are displayed on the screen only. If the user enters a "P" followed by the ENTER key, the events are printed only. If the user enters a "B" followed by the ENTER key, the events are both displayed on the screen and printed.

Events are displayed on the screen in the following format. Note that the events are displayed with the most recent event first.

```
DLP UNIT 1                                                    0001
                              EVENTS

          06/12/90 13:45:27:279 BREAKER 2 CLOSED
          06/12/90 13:45:26:278 BREAKER 1 CLOSED
          06/12/90 13:45:21:437 BREAKER 2 OPEN
          06/12/90 13:45:21:436 BREAKER 1 OPEN
          06/12/90 13:45:21:275 TRIP SIGNALS RESET
          06/12/90 13:45:21:240 TRIP SIGNALS ON

   USE UP/DOWN ARROW KEYS TO VIEW MORE, PRESS ESCAPE KEY TO CONTINUE

          USE PAGE UP/DOWN KEYS TO VIEW ANOTHER SCREEN
```

The user may press the UP-ARROW and DOWN-ARROW keys to view backward and forward (respectively) through the events, one event at a time. The user may press the PAGE UP and PAGE DOWN keys to view backward and forward (respectively) through the events one screen at a time. When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed.

If the events are printed only, the REQUEST DLP INFORMATION Menu is displayed when the printing is complete.

NOTE: If DC power is removed for more than 24 hours, the Event information will be lost.

Request Oscillography Data

Request Oscillography Data from the REQUEST DLP INFORMATION Menu is selected to save the oscillography data for a particular fault on disk. The user is first asked for the fault number associated with the oscillography data, with the following prompt:

ENTER FAULT NUMBER:

If the user presses the ENTER key only, the oscillography data is not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters an invalid fault report number followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid fault report number (1 to 5) followed by the ENTER key, he is then asked to enter the number of cycles he wants to save on disk, with the following prompt:

ENTER THE NUMBER OF CYCLES:

The number of cycles includes one cycle of prefault data. If the user presses the ENTER key only, the oscillography data is not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters an invalid number of cycles followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the number of cycles (1 to 30) followed by the ENTER key, he is then asked for the name of a file in which to save the data, with the following prompt:

ENTER FILE NAME FOR DATA:

If the user presses the ENTER key only, the oscillography data is not requested from the DLP and the REQUEST DLP INFORMATION Menu is displayed. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the name of a file, the oscillography data is retrieved from the DLP for the number of cycles requested. The fault report, the events associated with the fault report, and the data are saved to the disk file.

The oscillography data is an ASCII text file consisting of the fault report, the events associated with the fault report, the currents, the voltages, the digital inputs, digital outputs, and protection flags. This file can be read directly by Lotus 123 (without any modifications). For a more detailed description of the data, refer to the section describing the DLP-DATA program.

Once the data is stored on disk, the REQUEST DLP INFORMATION Menu is displayed.

NOTE: If DC power is removed for more than 24 hours, the fault data will be lost

Request DLP Status

Request DLP Status from the REQUEST DLP INFORMATION Menu is selected to display the DLP status. The status is automatically retrieved from the DLP. The status messages (not including the jumper status) are displayed in the same order as those at the DLP (described in the section on SERVICING). The status is displayed in the following format.

```
DLP UNIT 1                                                    0001

                              DLP STATUS

SYSTEM STATUS:     WARNING

                   PROTECTION ENABLED
                   DIGITAL OUTPUTS ENABLED
                   LOGIN FAILURE

JUMPER STATUS:     CHANGE SETTINGS: ENABLED
                   OPEN/CLOSE BREAKER: DISABLED

  USE UP/DOWN ARROW KEYS TO VIEW MORE, PRESS ESCAPE KEY TO CONTINUE
```

The user may press the UP-ARROW and DOWN-ARROW keys to view forward and backward (respectively) through the DLP Status messages, one message at a time. When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed.

Request DLP Model

Request DLP Model from the REQUEST DLP INFORMATION Menu is selected to view the model number and PROM version number of the DLP. These items are automatically retrieved from the DLP and displayed in the following format.

```
DLP UNIT 1                                                    0001

                              DLP MODEL

                   MODEL NUMBER: DLP3522AA

                   PROM VERSION: V00B.333A

                 PRESS ESCAPE KEY TO CONTINUE
```

When the user presses the ESCAPE key, the screen is cleared and the REQUEST DLP INFORMATION Menu is displayed.

Return to Relay Functions Menu

Return To Relay Functions Menu from the REQUEST DLP INFORMATION Menu is selected to return to the RELAY FUNCTIONS Menu.

DLP Settings

DLP Settings from the RELAY FUNCTIONS Menu is selected to view, change, and/or print the DLP settings as described in the DLP SETTINGS Menu below. Note that if the appropriate jumper is installed, the DLP will not allow setting changes from the PC, although the PC can still upload settings from the DLP. See the INTERFACE section for more information on the jumpers.

DLP SETTINGS

UPLOAD DLP SETTINGS
PRINT SETTINGS
VIEW/CHANGE CATEGORY OF SETTINGS
VIEW/CHANGE INDIVIDUAL SETTING
DOWNLOAD SETTINGS TO DLP
END SETTING CHANGES
SAVE DLP SETTINGS TO FILE
RETURN TO RELAY FUNCTIONS MENU

The user selects the desired menu item. Each item is described below.

When a user logs in (LOGIN from MAIN MENU), all settings are initialized so that there are no DLP settings at the PC. The first time the user selects a category of settings or an individual setting to change or print, that category or setting is retrieved from the DLP.

Thereafter (as long as the user remains logged in to the DLP) when the user selects that category of settings or individual setting again, it is not retrieved again from the DLP. If the user selects all settings to print or uploads settings just after a log in, then all the settings are retrieved from the DLP. Then, until the user logs out, settings are not retrieved again from the DLP.

Upload DLP Settings

Upload DLP Settings from the DLP SETTINGS Menu is selected to retrieve the settings from the DLP. This selection will cause any previous settings to be overwritten. The user is asked to confirm the upload with the following prompt:

UPLOAD DLP SETTINGS (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the settings are not retrieved from the DLP and the DLP SETTINGS Menu is displayed. If the user enters a "Y" followed by the ENTER key, the settings are retrieved from the DLP and the DLP SETTINGS Menu is displayed. The retrieved settings are not permanently stored on disk and will be lost if the user logs out. See the menu item SAVE DLP SETTINGS TO FILE of this menu to save the settings permanently to the disk.

Print Settings

Print Settings from the DLP SETTINGS Menu is selected to print all DLP settings or categories of DLP settings. First a menu is displayed with the category names as described below.

CATEGORY NAMES

ZONE 1 DISTANCE
ZONE 2 DISTANCE/GDOC (PILOT)
ZONE 3 DISTANCE
ZONE 4 DISTANCE
OVERCURRENT PILOT/SUPERVISION
OVERCURRENT BACKUP
BLOCK RECLOSING
OUT-OF-STEP BLOCKING
LINE PICKUP
REMOTE OPEN DETECTOR
LINE OVERLOAD
SCHEME SELECTION
SCHEME LOGIC TIMERS
LINE QUANTITIES
CONFIGURATION
SCADA DTA INTERFACE
ALL CATEGORIES
RETURN TO RELAY SETTINGS MENU

The user selects the desired category of DLP settings to print.
If the settings that are being printed have not been retrieved from the DLP during this log-in session, they are now retrieved. Then the settings are printed by category, with one setting name and value per line.

After the settings have been printed, the DLP SETTINGS Menu is displayed.

View/Change Category of Settings

View/change Category Of Settings from the DLP SETTINGS Menu is selected to change or view one or all of the DLP settings in a category. First a CATEGORY NAMES menu is displayed as described below.

CATEGORY NAMES

ZONE 1 DISTANCE
ZONE 2 DISTANCE/GDOC (PILOT)
ZONE 3 DISTANCE
ZONE 4 DISTANCE
OVERCURRENT PILOT/SUPERVISION
OVERCURRENT BACKUP
BLOCK RECLOSING
OUT-OF-STEP BLOCKING
LINE PICKUP
REMOTE OPEN DETECTOR
LINE OVERLOAD
SCHEME SELECTION
SCHEME LOGIC TIMERS
LINE QUANTITIES
CONFIGURATION
SCADA DTA INTERFACE
RETURN TO RELAY SETTINGS MENU

The user selects the desired category of settings to change or view. If the settings that are being changed or viewed have not been retrieved from the DLP during this log-in session, they are now retrieved.

The settings are displayed on the screen in a menu as described below.

ZONE 1 DISTANCE SETTINGS MENU

SELECT ZONE 1 GROUND	YES
SELECT ZONE 1 PHASE	YES
REACH SETTING (M1/MG1)	5.40
REACH SETTING (M1G)	5.40
SELECT ZONE 1 GROUND UNIT	MHO
REACH SETTING OF MHO UNIT	20.00
ZERO SEQ CURRENT COMPENSATION (K0)	2.7

PRESS ESC TO RETURN TO CATEGORY NAMES MENU

Each menu item consists of the setting name and its value. Pressing the ESCAPE key causes an exit to the CATEGORY NAMES menu. To change a setting, the user selects the desired setting (in the same way items in other menus are selected). The user is then asked for the new value with the following prompt:

ENTER NEW VALUE FOR setting name:

The "setting name" is the name of the setting. If the user presses the ENTER key only, the setting value is not changed and the menu of setting names and values is displayed. If the user enters a new value followed by the ENTER key, the new value is checked to determine if it is within its allowed range. If not, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again with the value that is in error displayed in the SETTING NAME AND VALUE menu, next to its present value, in reverse video. If the new value is within its allowed range, the new value is displayed in place of the old value. The setting value in the DLP is not changed yet.

When the user exits to the CATEGORY NAMES menu, all the setting values for the category are examined to determine if any have changed. If any have changed, the user is asked if the settings are to be transmitted to the DLP with the prompt:

SEND CHANGED SETTINGS TO THE DLP (Y/N/E)?

The user enters either a "Y" (yes), "N" (no) or "E" (yes and end settings change) followed by the ENTER key. If the user responds with any character other than a "Y", "N" or "E", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the new values are not transmitted to the DLP, but are retained in the PC (the original values are lost for this session) and the CATEGORY NAMES menu is displayed. If the user enters a "Y" followed by the ENTER key, the new values are transmitted to the DLP. If the status returned from the DLP indicates any errors, they are displayed and require an acknowledge (by pressing the ENTER key) from the user. When the user has acknowledged the errors, the SETTING NAME AND VALUE menu is displayed so that the user can correct the errors. If there are any errors, none of the settings are changed at the DLP. The settings are displayed with their original values and their new values. If a setting value is in error, the new value is displayed in reverse video. If no errors occur, the CATEGORY NAMES menu is displayed. If there are no errors, protection in the DLP is turned off (the user must select the END SETTING CHANGES command from the DLP SETTINGS menu to turn protection back on).

If the user enters an "E" followed by the ENTER key, the user is asked to verify that an automatic "end setting changes" is wanted with the prompt:

ARE YOU SURE(Y/N)?

The user responds with a "Y" or "N" followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N", no settings will be sent and the CATEGORY NAMES menu will be displayed. If the user enters a "Y", the new values are transmitted to the DLP. If the status returned from the DLP indicates any errors, they are displayed and require an acknowledge (by pressing the ENTER key) from the user. When the user has acknowledged the errors, the SETTING NAME AND VALUE menu is displayed so that the user can correct the errors. If there are any errors, none of the settings are changed at the DLP. The settings are displayed with their original values and their new values. If a setting value is in error, the new value is displayed in reverse video. If no errors occur, the END ENT command will be sent to the relay to end the settings change and turn protection on.

NOTE: The "E" option should only be used if the settings change being done is the end of the settings changes before putting the relay back in service.

View/Change Individual Setting

View/change Individual Setting from the DLP SETTINGS Menu is selected to change or view one of the DLP settings. The first setting name and value is displayed, and the user is asked which setting he wants to view or change with the prompt:

ENTER SETTING NUMBER:

The user may press the ENTER key only, the ESCAPE key only, enter a setting number, or use the UP and DOWN ARROW keys. If the user presses the ESCAPE key only, the DLP SETTINGS Menu is displayed. If the user enters an invalid setting number (i.e. one that doesn't exist) followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again.

If the user enters the UP or DOWN ARROW key, the previous or next setting, respectively, is displayed. The use of the UP and DOWN ARROW keys are indicated on the help line. If the user presses the ENTER key only, or enters the setting number or enters an UP or DOWN ARROW key followed by the ENTER key, and the setting has not been retrieved from the DLP, it is retrieved now. Then the setting name and value are displayed. The user is asked for a new value with the prompt:

ENTER NEW VALUE FOR setting name:

The "setting name" is the name of the setting. If the user presses the ENTER key only, the setting value is not changed and he is prompted for another setting number. If the user enters a new value for the setting followed by the ENTER key, the new value is checked to determine if it is within its allowed range. If not, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again with the value that is in error displayed in the SETTING NAME AND VALUE menu, next to its present value, in reverse video. If the value is within its allowed range, the new setting value is displayed in place of its old value and the user is asked if the setting is to be transmitted to the DLP with the prompt:

SEND CHANGED SETTING TO THE DLP (Y/N/E)?

The user enters either a "Y" (yes), "N" (no) or "E" (send and automatically end settings change) followed by the ENTER key. If the user responds with any character other than a "Y", "N" or "E", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the new value is not transmitted to the DLP and the user is again asked to enter a setting number. If the user enters a "Y" followed by the ENTER key, the new value is transmitted to the DLP. If the status returned from the DLP indicates an error, it is displayed and requires an acknowledge (by pressing the ENTER key) from the user. When the user acknowledges the error, the setting name, it's original value (i.e. the value that setting has in the DLP), and its new value (which is in reverse video) are displayed so that the user can correct the error. If no error occurs, protection in the DLP is turned off (the user must select the END SETTING CHANGES command from the DLP SETTINGS menu to turn protection back on). Then the user is again asked to enter a setting number.

If the user enters a "E" followed by the ENTER key, the user is asked to verify that he wants to automatically end the setting change after downloading with the prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the setting will not be downloaded and the user is again asked to enter a setting number. If the user enters a "Y" followed by the ENTER key, the new value is transmitted to the DLP. If the status returned from the DLP indicates an error, it is displayed and requires an acknowledge (by pressing the ENTER key) from the user. When the user acknowledges the error, the setting name, it's original value (i.e. the value that setting has in the DLP), and its new value (which is in reverse video) are displayed so that the user can correct the error. If no error occurs, the END ENT command is sent to the relay automatically to end the setting change and turn protection on. Then the user is again asked to enter a setting number.

Download Settings to DLP

Download Settings To DLP from the DLP SETTINGS Menu is selected to transmit all the present settings in the PC to the DLP. Any settings that have not been previously uploaded, are assigned a value of zero to be downloaded. The user is asked to confirm the download with the following prompt:

DOWNLOAD SETTINGS TO DLP (Y/N/E)?

The user enters either a "Y" (yes), "N" (no) or "E" (send and automatically end the settings changes) followed by the ENTER key. If the user responds with any character other than a "Y", "N" or "E", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the settings are not transmitted to the DLP, and the DLP SETTINGS Menu is displayed. If the user enters a "Y" followed by the ENTER key, the settings are transmitted to the DLP, and the DLP SETTINGS Menu is displayed. The user must choose the END SETTINGS CHANGE item in the DLP SETTINGS menu to turn on protection.

If the user enters an "E" followed by the ENTER key, the user will be asked to verify that he wants to automatically end the settings change and turn on protection with the prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters an "N" followed by the ENTER key, no settings will be downloaded and the RELAY FUNCTIONS menu will be displayed. If the user enters a "Y" followed by the ENTER key, the settings are transmitted to the DLP, and the END ENT command is sent to the relay to turn on protection. The DLP SETTINGS Menu is then displayed.

End Setting Changes

End Setting Changes from the DLP SETTINGS Menu is selected to tell the DLP that settings changes are complete and protection should be resumed. The user is first asked to verify that setting changes should be ended with the following prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the command is not transmitted to the DLP and protection is not initialized and started. If the user enters a "Y" followed by the ENTER key, a command is transmitted to the DLP to tell it setting changes are complete and to initialize and start protection. In any case, the DLP SETTINGS Menu is displayed. Note that the DLP status should be requested after this command to ensure that protection has been initialized and started.

Save DLP Settings to File

Save DLP Settings To File from the DLP SETTINGS Menu is selected to write the DLP settings to a disk file. Any settings that have not been previously uploaded from the DLP are now retrieved (any settings that have been previously retrieved from the DLP are not overwritten). The user is first asked for a file name with the prompt:

ENTER FILE NAME:

If the user presses the ENTER key only, the settings are not written to a file and the DLP SETTINGS Menu is displayed. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid file name followed by the ENTER key, the model number, version number, and settings are written to the file and the DLP SETTINGS Menu is displayed.

Return to Relay Functions Menu

Return To RELAY FUNCTIONS Menu from the DLP SETTINGS Menu is selected to return to the RELAY FUNCTIONS Menu.

Return to Main Menu

RETURN TO MAIN MENU from the RELAY FUNCTIONS Menu is selected to return to the MAIN MENU.

Local Settings

Local Settings from the MAIN MENU is selected to view, change, and/or print an image of settings as described in the LOCAL SETTINGS Menu below.

Treating settings as local enables the user to load settings from a disk file and modify the settings without being logged in to a DLP. The local settings can be saved in a disk file and later downloaded to a DLP.

If local settings have not yet been loaded from a disk file, the user is prompted for a file name with the prompt:

ENTER FILE NAME:

If the user presses the ENTER key only, the settings are not read from a disk file and the MAIN MENU is displayed. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid file name followed by the ENTER key, the settings are read from the file into the local settings buffer. Then the LOCAL SETTINGS Menu is displayed.

NOTE: The file must contain settings that were previously saved with D-LINK or the factory default settings supplied with D-LINK. The factory default file names are of the form: SETTxy.DLP. The "x" is the first number after the "DLP3" in the model number. The "y" is the version of the software in the relay. The version of the software and the model number can be determined with D-LINK. Choose the REQUEST DLP MODEL item in the DLP INFORMATION menu from the RELAY FUNCTIONS menu to display the above information. The last letter in the version number should match the "y" in the local settings filename. If the user makes a local settings file and then tries to download the file to the DLP, the file must contain the settings that match the relay version.

The user can use this menu (except DOWNLOAD LOCAL SETTINGS TO DLP) without being logged in to a DLP.

LOCAL SETTINGS

LOAD SETTINGS FROM FILE
PRINT LOCAL SETTINGS
VIEW/CHANGE CATEGORY OF LOCAL SETTINGS
VIEW/CHANGE INDIVIDUAL LOCAL SETTING
SAVE LOCAL SETTINGS TO FILE
DOWNLOAD LOCAL SETTINGS TO DLP
END SETTINGS CHANGES
RETURN TO MAIN MENU

The user selects the desired menu item. Each item is described below.

Load Settings from File

Load Settings From File from the LOCAL SETTINGS Menu is selected to read settings from a disk file into the local settings buffer. This permits the user to load and work on another set of settings other than the set that was initially loaded. If the user loads another set of local settings, the previous set of local settings are overwritten. The user can save the previous set of local settings by selecting the SAVE LOCAL SETTINGS TO FILE menu item from the above LOCAL SETTINGS Menu. The Local Settings file must match the PROM version letter.

The user is first asked for a file name with the prompt:

ENTER FILE NAME:

If the user presses the ENTER key only, the settings are not read from a disk file. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid file name followed by the ENTER key, the settings are read from the file into the local settings buffer. In either case the LOCAL SETTINGS Menu is displayed.

Print Local Settings

Print Local Settings from the LOCAL SETTINGS Menu is selected to print all local settings or categories of local settings. First a menu is displayed with the category names.

LOCAL CATEGORY NAMES
ZONE 1 DISTANCE
ZONE 2 DISTANCE/GDOC (PILOT)
ZONE 3 DISTANCE
ZONE 4 DISTANCE
OVERCURRENT PILOT/SUPERVISION
OVERCURRENT BACKUP
BLOCK RECLOSING
OUT-OF-STEP BLOCKING
LINE PICKUP
REMOTE OPEN DETECTOR
LINE OVERLOAD
SCHEME SELECTION
SCHEME LOGIC TIMERS
LINE QUANTITIES
CONFIGURATION
SCADA DTA INTERFACE
ALL CATEGORIES
RETURN TO LOCAL SETTINGS MENU

The user selects the desired category of local settings to print.

The settings are printed by category with one setting name and value per line.

View/Change Category of Local Settings

View/change Category Of Local Settings from the LOCAL SETTINGS Menu is selected to change or view one or all of the local settings in a category. First a CATEGORY NAMES menu is displayed as follows.

LOCAL CATEGORY NAMES
ZONE 1 DISTANCE
ZONE 2 DISTANCE/GDOC (PILOT)
ZONE 3 DISTANCE
ZONE 4 DISTANCE
OVERCURRENT PILOT/SUPERVISION
OVERCURRENT BACKUP
BLOCK RECLOSING
OUT-OF-STEP BLOCKING
LINE PICKUP
REMOTE OPEN DETECTOR
LINE OVERLOAD

SCHEME SELECTION
SCHEME LOGIC TIMERS
LINE QUANTITIES
CONFIGURATION
SCADA DTA INTERFACE
RETURN TO LOCAL SETTINGS MENU

The user selects the desired category of settings to change or view.

The local settings are displayed on the screen in a menu fashion. Each menu item consists of the setting name and it's value.

LOCAL ZONE 1 DISTANCE SETTINGS MENU	
SELECT ZONE 1 GROUND	YES
SELECT ZONE 1 PHASE	YES
REACH SETTING (M1/MG1)	5.40
REACH SETTING (M1G)	5.40
SELECT ZONE 1 GROUND UNIT	MHO
REACH SETTING OF MHO UNIT	20.00
ZERO SEQ CURRENT COMPENSATION(K0)	2.7
PRESS ESC TO RETURN TO LOCAL CATEGORY NAMES MENU	

Pressing the ESCAPE key causes an exit to the LOCAL CATEGORY NAMES menu. To change a setting, the user selects the desired setting to change (in the same manner as items from other menus are selected). The user is then asked for the new value with the following prompt:

ENTER NEW VALUE FOR setting name:

The "setting name" is the name of the setting. If the user presses the ENTER key only, the setting value is not changed and the menu of setting names and values is displayed. If the user enters a new value followed by the ENTER key, the new value is checked to determine if it is within its allowed range. If not, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again with the value that is in error displayed in the SETTING NAME AND VALUE menu, next to its present value, in reverse video. If the value is within its allowed range, the new value is displayed in the SETTING NAME AND VALUE menu.

View/Change Individual Local Setting

View/change Individual Local Setting from the LOCAL SETTINGS Menu is selected to change or view one of the local settings. The first setting name and value is displayed, and the user is asked which setting he wants to view or change with the prompt:

ENTER SETTING NUMBER:

The user may press the ENTER key only, the ESCAPE key only, enter a setting number, or use the UP and DOWN ARROW keys. If the user presses the ESCAPE key only, the LOCAL SETTINGS Menu is displayed. If the user enters an invalid setting number (e.g. one that doesn't exist) followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters the UP or DOWN ARROW key, the previous or next setting, respectively, is displayed. The use of the UP and DOWN ARROW keys is indicated on the help line. If the user presses the ENTER key only, or enters the setting number or enters an UP or DOWN ARROW key followed by the ENTER key, the setting name and value are displayed. The user is asked for a new value with the prompt:

ENTER NEW VALUE FOR setting name:

The "setting name" is the name of the setting. If the user presses the ENTER key only, the setting value is not changed and he is asked to enter another setting number. If the user enters a new value for the setting followed by the ENTER key, the new value is checked to determine if it is within its allowed range. If not, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again with the value that is in error displayed in the SETTING NAME AND VALUE menu, next to its present value, in reverse video. If the value is within its allowed range, the setting value is changed. The user is again asked to enter a setting number.

Save Local Settings to File

Save Local Settings To File from the LOCAL SETTINGS Menu is selected to write the local settings to a disk file. The user is first asked for a file name with the prompt:

ENTER FILE NAME:

If the user presses the ENTER key only, the settings are not written to a file and the LOCAL SETTINGS Menu is displayed. If the user enters an invalid file name followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a valid file name followed by the ENTER key, the settings are written to the file and the LOCAL SETTINGS Menu is displayed.

Download Local Settings to DLP

Download Local Settings To DLP from the LOCAL SETTINGS Menu is selected to transmit all the local settings to the DLP. The user must be logged in to a DLP in order to use this menu item. Note that if the appropriate jumper is installed, the DLP will not allow setting changes from the PC. See the INTERFACE section for more information on the jumpers.

The user is asked to confirm the download with the following prompt:

DOWNLOAD SETTINGS TO DLP (Y/N/E)?

The user enters either a "Y" (yes), "N" (no) or "E" (send and automatically send the END ENT command to turn on protection) followed by the ENTER key. If the user responds with any character other than a "Y", "N" or "E", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the settings are not transmitted to the DLP, and the LOCAL SETTINGS Menu is displayed. If the user enters a "Y" followed by the ENTER key, the settings are transmitted to the DLP, and the LOCAL SETTINGS Menu is displayed. The local settings file must match the PROM version number in the relay. If the user enters an "E" followed by the ENTER key, the user is prompted:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters an "N" followed by the ENTER key, no settings are downloaded and the LOCAL SETTINGS Menu is displayed. If the user enters a "Y" followed by the ENTER key, the settings are sent to the DLP and then the END ENT command is sent to turn on protection. The local settings file must match the PROM version number in the relay.

End Setting Changes

End Setting Changes from the DLP SETTINGS Menu is selected to tell the DLP that settings changes are complete and protection should be resumed. The user is first asked to verify that setting changes should be ended with the following prompt:

ARE YOU SURE (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user enters a "N" followed by the ENTER key, the command is not transmitted to the DLP and protection is not initialized and started. If the user enters a "Y" followed by the ENTER key, a command is transmitted to the DLP to tell it setting changes are complete and to initialize and start protection. In any case, the DLP SETTINGS Menu is displayed.

NOTE: that the DLP status should be requested after this command to ensure that protection has been initialized and started.

Return to Main Menu

RETURN TO MAIN MENU from the LOCAL SETTINGS Menu is selected to return to the MAIN MENU.

Configuration Parameters

CONFIGURATION PARAMETERS from the MAIN MENU is selected to alter the baud rate, the communications port, and various log-in parameters.

CONFIGURATION PARAMETERS
VIEW/CHANGE PC COMMUNICATION PORT
VIEW/CHANGE DIALING TYPE
VIEW/CHANGE RELAY LOGIN DATA
DELETE RELAY LOGIN DATA
ADD RELAY UNIT DESCRIPTION
DELETE RELAY UNIT DESCRIPTION
RETURN TO MAIN MENU

View/Change PC Communication Port

View/change PC Communication Port from the CONFIGURATION PARAMETERS Menu is selected to view and/or change the PC communication port number and the associated IRQ number for the port. The communication port number and interrupt number are displayed as follows:

PC COMMUNICATION PORT NUMBER =
PC COMMUNICATION IRQ NUMBER =
RETURN TO CONFIGURATION PARAMETERS MENU

NOTE: If the port number is 1 or 2 the IRQ number will not be displayed because IBM compatible PCs have fixed IRQs for COM1 and COM2.

The user selects the desired item from the menu. If the user selects the port number, he will be asked to enter a new port number with the following prompt:

ENTER NEW PC COMMUNICATION PORT NUMBER:

If the user presses the ENTER key only, the port number is not changed. If the user enters a new port number that is not valid, followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. After the user acknowledges the error, he is again asked for a new port number with the above prompt. If the user enters a new port number that is valid, followed by the ENTER key, the communication port immediately becomes the number that was entered.

If the user selects the IRQ number, he will be asked to enter a new IRQ number with the following prompt:

ENTER NEW PC COMMUNICATION IRQ NUMBER:

If the user presses the ENTER key only, the IRQ number is not changed. If the user enters a new IRQ number that is not valid, followed by the ENTER key, an error message is displayed, which the user must acknowledge by pressing the ENTER key. After the user acknowledges the error, he is again asked for a new IRQ number with the above prompt. If the user enters a new IRQ number that is valid, followed by the ENTER key, the communication port IRQ immediately becomes the number that was entered.

View/Change Dialing Type

View/change Dialing Type from the CONFIGURATION PARAMETERS Menu is selected to view and/or change how the modem at the PC dials, using touch tone or pulse dialing. The dialing type, tone or pulse, is displayed and the user is asked to enter the new dialing type with the following prompt:

ENTER NEW DIALING TYPE:

If the user presses the ENTER key only, the dialing type is not changed and the CONFIGURATION PARAMETERS Menu is displayed. If any character other than a "P" or "T" followed by the ENTER key is entered, an error message is displayed, which the user must acknowledge by pressing the ENTER key. After the user acknowledges the error, he is again asked for a new dialing type with the above prompt. If the user enters a "P" or "T" followed by the ENTER key, the dialing type is changed to what was entered, and the CONFIGURATION PARAMETERS Menu is displayed.

View/Change Relay Login Data

View/change Relay Login Data from the CONFIGURATION PARAMETERS Menu is selected to view and/or change data used during the log-in procedure (phone number, baud rate, and multiplexor switch code). First a menu of the relay unit descriptions will be displayed.

RELAY UNIT DESCRIPTIONS
Unit Number 1
Unit Number 2
Unit Number 3
Unit Number 4
RETURN TO CONFIGURATION PARAMETERS MENU

The user then selects the desired relay. The relay UNIT DESCRIPTION menu is cleared and the LOG-IN DATA menu, which includes the relay unit description, phone number, switch code, and baud rate, is displayed as shown below:

Unit Number 1
PHONE NUMBER 0000000
SWITCH CODE 000000
BAUD RATE 2400
RETURN TO UNIT DESCRIPTION MENU

All fields are displayed; if a field is empty, blanks are displayed. For example, if a phone number has not been entered (i.e. the relay does not utilize a modem), blanks are displayed for the phone number. The user then selects the desired item from the menu. The user is then asked for a new value with the following prompt:

ENTER NEW aaaaaaaa:

The "aaaaaaaa" is either the phone number, the switch code, or the baud rate, depending on the user's selection. If the user presses the ENTER key only, the item is not changed. If the user enters a new phone number, it is checked to make sure it contains only digits and the pause character (a dash, -, causes the modem to delay in dialing the number) and that it consists of between 4 and 16 characters (4 zeroes indicates that no phone is connected). If the user enters a baud rate it is checked to make sure it is either 300, 1200, or 2400 (see Baud Rate Setting in the CALCULATION OF SETTINGS section). It is the user's responsibility to make sure the baud rate entered at the PC agrees with the baud rate setting in the DLP. If the user enters a switch code, there is no validity check except that it is less than or equal to six characters (a switch code of zero indicates that there is no multiplexor). If the new value is invalid, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the new value is valid, it is stored in the configuration file and the new value displayed in the menu.

Delete Relay Login Data

Delete Relay Login Data from the CONFIGURATION PARAMETERS Menu is selected to delete data used during the log-in procedure (phone number, multiplexor switch code, and baud rate). First a menu of the relay unit descriptions is displayed; refer to the relay UNIT DESCRIPTION menu described above in the View/change Relay Login Data menu item. The user the selects the desired relay unit description. The relay UNIT DESCRIPTION menu is cleared and the LOG-IN-DATA menu is displayed; refer to the LOG-IN DATA menu described above in the View/change Relay Login Data menu item. All fields are displayed; if a field is empty, blanks are displayed. The user then selects the desired menu item. The user is asked to confirm the deletion of the value with the following prompt:

DELETE aaaaaaaa FROM RELAY bbbbbbbbbb (Y/N)?

The "aaaaaaaa" is either the phone number, the switch code, or the baud rate, depending on the user's selection. The "bbbbbbbbbb" is the relay unit description. The user enters either the ENTER key only, or a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key.

When the user acknowledges the error, the above prompt is displayed again. If the user responds with the ENTER key only or a "N" followed by the ENTER key, the specified item is not deleted. If the user responds with a "Y" followed by the ENTER key, the specified item is deleted from the configuration file. In either case, the present menu is displayed, reflecting any changes.

Add Relay Unit Description

Add Relay Unit Description from the CONFIGURATION PARAMETERS Menu is selected to add a relay unit description to the configuration file. This adds the new relay to the configuration file, which allows the user to add a phone number, a switch code, and a baud rate (by use of the above menu item VIEW/CHANGE RELAY LOGIN DATA). Once a relay is added to the configuration file, it is displayed in the LOGIN menu, allowing the program to automatically set the baud rate, dial the phone number and send the switch code. The user is asked for the new relay unit description with the prompt:

ENTER NEW RELAY UNIT DESCRIPTION:

If the user presses the ENTER key only, a new relay unit description is not added and the CONFIGURATION PARAMETERS Menu is displayed. If the user enters a description greater than 20 characters, or a duplicate description, an error message is displayed, which the user must acknowledge by pressing the ENTER key. Once the user acknowledges the error, the above prompt is again displayed. If the user enters a valid description, the new relay unit description is added to the configuration file and the CONFIGURATION PARAMETERS Menu is displayed.

Delete Relay Unit Description

Delete Relay Unit Description from the CONFIGURATION PARAMETERS Menu is selected to delete a relay unit description from the configuration file. First a menu of the relay unit descriptions is displayed; refer to the relay UNIT DESCRIPTION menu described above in the VIEW/CHANGE RELAY LOGIN DATA menu item. The user then selects the desired relay unit description. The user is asked to confirm the deletion of the relay unit description with the prompt:

DELETE RELAY bbbbbbbbbb (Y/N)?

The "bbbbbbbbbb" is the relay unit description. The user enters either the ENTER key only, or a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any other character, an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user responds with the ENTER key only or a "N" followed by the ENTER key, the relay unit description is not deleted. If the user responds with a "Y" followed by the ENTER key, the relay unit description is deleted from the configuration file. In either case, the relay UNIT DESCRIPTION menu is displayed.

Hang Up

Hang Up from the MAIN MENU is selected to hang up (disconnect) the phone line. This item requires no input from the user. The user is automatically logged out from the DLP (if he is not already logged out), the phone is disconnected, and the MAIN MENU is displayed.

When the user is logged out from the DLP, a check is made to determine if protection is off at the DLP. If protection is off, the user is asked if he wishes to continue with the log out with the following prompt:

PROTECTION IS OFF, CONTINUE TO LOGOUT (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user responds with a "N" followed by the ENTER key, the user is not logged out and is returned to the MAIN MENU. If the user responds with a "Y" followed by the ENTER key or it is determined that protection is on, the user is logged out.

Exit Program

Exit Program from the MAIN MENU is selected to exit the program and return to the MS-DOS environment. This item requires no input from the user. If the user has not already logged out from the DLP and hung up the phone, this item automatically logs the user out from the DLP, hangs up the phone, and restores the serial port interrupt vector and parameters.

When the user is logged out from the DLP, a check is made to determine if protection is off at the DLP. If protection is off, the user is asked if he wishes to continue with the log out with the following prompt:

PROTECTION IS OFF, CONTINUE TO LOGOUT (Y/N)?

The user enters either a "Y" (yes) or "N" (no) followed by the ENTER key. If the user responds with any character other than a "Y" or "N", an error message is displayed, which the user must acknowledge by pressing the ENTER key. When the user acknowledges the error, the above prompt is displayed again. If the user responds with a "N" followed by the ENTER key, the user is not logged out and is returned to the MAIN MENU. If the user responds with a "Y" followed by the ENTER key or it is determined that protection is on, the user is logged out.

DL-DATA SOFTWARE

OVERVIEW

This program plots oscillography data obtained during a fault and displays fault reports and fault events. The data displayed includes 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 D-LINK program. Refer to the D-LINK user manual (DLP INFORMATION section) for a description of how to retrieve oscillography data from the DLP.

The disk file containing the oscillography data is an ASCII file and is formatted as follows. The fault report (in the format that is displayed on the screen in the D-LINK program) is in the file first, followed by the events associated with the fault report (again, in the format that is displayed on the screen in the D-LINK program). Next are the title columns for a spread sheet. The remaining data consist of 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 following data.

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)

SYSTEM REQUIREMENTS

HARDWARE

The minimum PC hardware requirements consists of the following components. An IBM-AT or compatible (Compaq, Zenith, Tandy, etc...) with one parallel port, a minimum of 447K of RAM to run the program in, 40MB hard drive, low density 3 1/2 inch floppy drive, EGA monitor, and one of the printers described below for plotting oscillography data.

DL-DATA requires a minimum of 447K bytes of free memory. The program may actually run without problems with approximately 1% less free memory. However, if the program does not have enough memory, its performance starts to degrade. The degradation can range from a minor problem of a menu or dialog box not being displayed to hanging the system.

SOFTWARE

Requires MSDOS (PCDOS) 3.1 or above for the PC operating system.

INSTALLATION

Copy all files from the distribution diskette to your hard drive using the DOS copy command.

GENERAL OPERATION

MOUSE/KEYBOARD USAGE

Either the mouse or the keyboard can be used to access all items in menus and dialog boxes. For full manipulation of graphical data, the mouse is required.

The 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. The 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 - Once an item on the menu has been selected, the RIGHT and LEFT ARROW keys can be used to go to adjacent menu items.

PULL DOWN MENUS

Pull down menus are selected in a number of 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 UP ARROW and DOWN ARROW keys to highlight the desired menu item, then press the ENTER key.

WINDOWS

Windows contain several objects that are of interest to the user. The first object is the title bar, which is displayed across the top of the window and has a small solid rectangle on the left side. The title bar contains the oscillography data file name, and the date and time of the fault. The second object is the quit button, which is just below the title bar. The remaining objects 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. At this point, the window can be either resized or moved. To resize the window, hold the right mouse button down and drag the mouse until the window is the desired size, then release the right mouse 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 left mouse button.

Windows can also be iconized (i.e. made into a small window just large enough to contain a title). The window can be iconized by moving the mouse cursor to the solid rectange on the left of the title bar (the cursor will change shape to a left pointing arrow) and clicking 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 exited (or 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 the user can enter 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 iconized. In addition, when a dialog box is displayed, the user can only access items in the dialog box, not any 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 by using the UP/DOWN ARROW keys, the TAB/SHIFT TAB keys, or if the button has a highlighted character, the hot key. If the buttons require the user to make a selection, the selection is made by using the ENTER key. A button that is not selected has the same color as the dialog box (grey). A button that is selected turns white. Once a button is selected, it can be de-selected by using the ENTER key again. The mouse can also be used to select and de-select buttons. When the mouse cursor is moved inside a button, the cursor changes shape to a left pointing arrow. At this point, the user can select/de-select the button just by clicking the left mouse button to select an item and again clicking the left button to de-select the item.

To exit from the dialog box and clear it from the screen, the user selects either the OK or the CANCEL button. 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 using their hot keys. The hot key for the OK button is ALT-O and the hot key for the CANCEL button is ALT-C.

The OK button accepts the selection(s) made by the user and allows the program to use these selections. The CANCEL button does not accept the selections made by the user and thus the program uses the previous selections.

LIST BOXES

A list box is a box within a dialog box that lists all entries a command could affect (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 that allows the user to scroll through the list.

List boxes are accessed either with a mouse or the associated hot key. They can be used entirely with a mouse or from the keyboard. The following keys from the keyboard are valid:

UP ARROW	Move up one selection.
DOWN ARROW	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.

The user may also click the left mouse button on the scroll bar to move through the selections. When the mouse cursor moves to the list of items in the list box, the cursor changes shape to a left pointing arrow. Clicking the left mouse button on an item selects 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.

LEFT ARROW	Move the cursor one character to the left.
RIGHT ARROW	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 for the cursor. Insert mode is indicated by a block character for the cursor.
ENTER	Accept the text or number in the field/box
ESCAPE	Clear the text or number in the field/box.

PLOTS OF CURRENTS/VOLTAGES AND FLAGS

Each window containing a plot of the currents/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 in white that can be moved anywhere along the x axis to get information on timing and, in the case of currents/voltages, magnitudes of the currents/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. (See Figures SO-1 through SO-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 origin of the x axis represents sample number 0. Also the time difference (in milliseconds) between the two bars is displayed. The time difference is based on the line frequency. For currents and voltages, additional data is displayed, representing the magnitudes of the currents and voltages at each vertical bar.

On the left of the window is the area used for displaying 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 the user to select a rectangular area of a graph and expand that area for more detail. If the graph is a current/voltage graph, the area can include from one phase to all phases. If the graph is the all-flags graph, the area can include from one flag group to all flag groups on the display. If the graph is a flag-group graph, the area can include from one flag to all flags in the group.

The user starts the process by positioning the mouse cursor in one corner of the rectangular area to be viewed in more detail and clicking the right mouse button. The cursor changes shape to a cross hair. The user then moves the mouse in any direction to create a rectangle (yellow in the default colors). When the user is satisfied with the rectangular area, he clicks the left mouse button. Then a message box is displayed on the screen to ask the user to zoom in on the rectangular area or cancel it. If the user cancels it (selects the CANCEL button), then the rectangle is removed and the screen is restored. If the user selects the OK button 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 user resizes the new window to a smaller size, then some portion of the previous window is displayed.

REPORTS

The windows containing the reports have scroll bars on the right side. If the report is too long for the window, the user may 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 following items and hot keys.

Open	ALT-O
Create pcx file	ALT-C
Print screen	ALT-P
Information	ALT-I

Open

Selection of this item displays a dialog box that allows the user to select an oscillography data file to use. 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 file that is currently selected. The user can select this field by either clicking the left mouse button on the field or typing an ALT-S (the highlighted character in the field title). Once this field is selected, a file name can be entered. The file name can consist of any characters that DOS accepts, including wild card characters (* or ?). When the file name has been entered, the user types the ENTER key to accept the file name. This then places the user in the file name list box.

The next field indicates the current drive and directory where the list of files is obtained from. This field cannot be edited by the user.

The next two fields are list boxes. The left list box, titled "File list", contains a list of files from which the user can select. The right list box, titled "Directory list", contains a list of directories and drives where the user can go for additional lists of files.

The user can select the directory list box by using either the hot key, ALT-D (the letter highlighted in the title, with yellow in the default colors), or clicking the left mouse button inside the list box. When a new drive or directory is selected, both list boxes are rebuilt.

The user can select the file list box by using either the hot key, ALT-F (the letter highlighted in the title, with yellow in the default colors), or clicking the left mouse button inside the list box.

When the user selects a file, the file name is displayed in the data entry box above the list box and it becomes the current file selection.

The last two fields are the OK button and the CANCEL button. If the user selects the CANCEL button, the oscillography data file is not read into the program. Then the plotting of data and viewing reports are not allowed. If the user selects the OK button, the oscillography data file is read into the program and the plotting of data and viewing of reports are allowed.

Create PCX File

Selection of this item displays a dialog box that allows the user to select the file to which the screen is to be saved in PCX format. The screen is 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. The user can select this field either by clicking on the field with the mouse, or by typing an ALT-P (the highlighted character in the field title). Once this field is selected, the file name can be entered. When the file name is entered, the user uses the ENTER key to accept the file name.

The last two fields are the OK button and the CANCEL button. If the user selects the CANCEL button, the screen is not saved in PCX format. If the user selects the OK button, the screen is saved to the specified file in PCX format.

Print Screen

Selection of this item displays a dialog box that allows the user either to print the screen or to save the screen 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 listing the various types of printers that are supported. The printer type that the user selects can be saved in the setup file so that the user only has to select a printer type whenever the user's printer changes.

The next item in the dialog box is a button that causes the printer to perform a form feed after printing the screen. The button in its unselected state does not cause a form feed after printing. In its selected state, it causes a form feed after printing. This item can also be saved in the setup file, so that a user need only select it once. The default is to have the printer do a form feed after printing.

The next item allows the user to select a printer port (LPT1, LPT2, etc.). The default is LPT1. If the printer is attached to LPT1, the user can ignore this item. This item can also be saved in the setup file, so that a user need only select it once.

The next item allows the user to save 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. This item is always 1 unless the user changes it. If the user saves the screen to a file, this item is ignored.

Finally, there are the OK and CANCEL buttons. Selecting the OK button causes the screen to be printed (or saved in a file) and the necessary items to be saved in the setup file. Selecting the CANCEL button causes no action and the items are not saved in the setup file.

Information

Selection of this item displays a dialog box with the program name, version and copyright notice. It also displays the amount of memory available for the program to use. The amount of available

memory needs to be at least 80K bytes for the program to run properly (see **HARDWARE** under **SYSTEM REQUIREMENTS** for the consequences of reduced memory).

GRAPHS MENU

The graphs menu has the following items and hot keys.

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

Once an item is selected to be displayed, the same item cannot be selected again until it is cleared from the display.

All Currents/Voltages

This item plots all the currents and voltages in a single window.

Select Currents/Voltages

Selection of this item displays a dialog box that allows the user to select specific phases of currents and/or voltages for display. The user can select from one current or voltage to all seven currents and voltages.

The cursor is positioned at the first button. With the keyboard, the user can move through the buttons and select the currents and/or voltages to plot (this procedure is described under **DIALOG BOXES** under **GENERAL OPERATION**). Or the user can click the left mouse button on the dialog box buttons to select or de-select the currents/voltages.

The last two fields are the OK button and the CANCEL button. If the user selects the CANCEL button, the selected currents/voltages are not displayed. If the user selects the OK button, the selected currents/voltages are displayed and the selection remains in effect until the program is terminated.

Select Reference Current/Voltage

This item allows the user to select a reference current or voltage for display with the flags.

A dialog box is displayed allowing the user to select the reference. The user can select the reference with the keyboard by moving through the buttons to select the current or voltage (this procedure is described under **DIALOG BOXES** under **GENERAL OPERATION**). The user can also select the reference by moving the mouse cursor to the desired button and clicking the left mouse button. The user can then select either the OK or the CANCEL button to leave the dialog box. If the user selects the OK button, the selected reference remains in effect until the program is terminated. If the user selects the CANCEL button, the previously selected reference remains in effect.

The default reference is phase-A current.

Select Groups for All Flags Display

Selection of this item displays a dialog box that allows the user to select specific flag groups for displaying in the ALL FLAGS display. The user can select a maximum of 6 flag groups for a VGA display and a maximum of 5 flag groups for an EGA display.

The cursor is positioned at the first button. With the keyboard, the user can move through the buttons to select the flag groups (this procedure is described under **DIALOG BOXES** under **GENERAL OPERATION**). The user can also use the mouse and click the left button on the dialog box buttons to alternately select and de-select the flag groups.

The last two fields are the OK button and the CANCEL button. If the user selects the CANCEL button, the selected flag groups are not changed. If the user selects the OK button, the selected flag groups are changed to those selected, and saved in the setup file.

All Flags

This item displays all the flags in all the flag groups selected for display, along with the previously selected reference current/voltage. The number of flag groups that can be displayed depends on whether the display is EGA or VGA (see **Select Groups for All Flags Display** above). If a reference current/voltage has not been previously selected, the reference is defaulted to phase A current.

Flag Group

This item allows the user to select a single group of flags for display.

A dialog box is displayed, allowing the user to select the group. The user can select the group by moving the mouse cursor to the desired group and clicking the left button. The user can also select the group with the keyboard, by moving through the buttons to select the flag group (this procedure is described under **DIALOG BOXES** under **GENERAL OPERATION**). The user can then select either the OK or the CANCEL button to leave the dialog box. If the user selects the OK button, the selected group is displayed along with the previously selected reference current/voltage. If the user selects the CANCEL button, a flag group is not displayed.

Custom (Flag) Group

This menu item allows a user to select up to 16 flags from any of the flag groups and assign 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 re-configured by the user.

A dialog box is displayed with 6 list boxes (1 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. The list is automatically updated as the user selects and de-selects flags.

The user selects the OK button to save the custom group and plot the flags. The user selects the CANCEL button to cancel any changes made to the custom group and return to the main menu.

REPORTS MENU

The reports menu has the following items and hot keys.

Fault report	ALT-F
Events	ALT-E

Once an item is selected to be displayed, the same item cannot be selected again until it is cleared from the display.

Fault Report

Selection of this item displays the fault report associated with the oscillography data (the report is generated at the DLP).

Events

Selection of this item displays the events associated with the oscillography data (the events are generated at the DLP).

SETUP

The setup menu has the following items and hot keys.

Line frequency	ALT-L
Flag names	ALT-F
Colors	ALT-C
Default colors	ALT-D
Printer grey shades	ALT-P

Line Frequency

Selection of this item displays a dialog box that allows the user to select either 50Hz or 60Hz for the line frequency. Select either frequency by using the UP/DOWN ARROW keys or clicking the left mouse button on the desired frequency button. Select the OK button to make the change permanent (saved in the setup file). Select the CANCEL button to cancel the change.

Flag Names

Selection of this item displays a dialog box that allows the user to modify any of the flag names. The right list box is used to select the flag group. The left list box is used to select 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 above the left list box. The user may modify the name in the data entry box (it may be up to 13 characters long). When the name has been modified, press the ENTER key and the new name will be displayed in the left list box. Select the OK button to make the new flag names permanent (saved in the setup file) or select the CANCEL button to ignore any flag name changes.

Colors

Selection of this item displays a dialog box that allows the user with a color monitor to change any color that is displayed. The colors are divided into groups according to the types of objects that are displayed. The groups and their descriptions are:

HORIZONTAL MENU
: Colors associated with the main horizontal menu.

PULL DOWN MENU
: Colors associated with the pull down menus.

ACTION BUTTON
: Colors associated with buttons that cause an action, such as the QUIT, OK, and CANCEL buttons.

DIALOG BOX
: Colors associated with the basic (empty) dialog box and labels placed in the dialog box.

LIST BOX
: Colors associated with a list box.

MESSAGE BOX
: Colors associated with the message box.

DATA ENTRY BOX
: Colors associated with the data entry box.

SELECTION BUTTON
: Colors associated with selection buttons used to make selections in a dialog box.

WINDOW
Colors associated with the basic (empty) window (both the report and graph windows).
REPORT
Colors associated with the displaying of a report in a window.
GRAPH
Colors associated with the drawing of a graph.
GRAPH DATA
Colors associated with displaying the data in a graph.
GRAPH LABEL
Colors associated with displaying the axis labels in a graph.

This item uses two dialog boxes.

The first dialog box is used to select the color group, using either the mouse or the keyboard. Once the group has been selected, a second dialog box is displayed, which allows the modification of the colors of individual items in the group. The item is selected when it is highlighted. When an item is highlighted and the SPACE bar is pressed, the color of the item is changed to the color in the color box in the upper right corner of the dialog box. Also a sample of the color group is shown in the dialog box.

Select the OK button to make the new colors for the group permanent (saved in the setup file) or select the CANCEL button to ignore the new colors for the group. In either case, the first dialog box is displayed again.

Default Colors

This allows the user to put all items back to their original colors and shades of grey (those which are on the distribution diskettes). A message box is first displayed to make sure the user wants to do this. If the user wants to do this, the OK button in the message box should be selected; otherwise select the CANCEL button. If OK is selected, the original colors and shades of grey are made permanent (saved in the setup file).

Printer Grey Shades

Selection of this item displays a dialog box that allows the user to assign shades of grey to colors so that all items on a display can be seen on the output of a black and white printer. The user selects the color from the list box and then uses 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 cancel the changes.

BLACK cannot be assigned a shade of grey. It always results in the printer printing nothing (i.e. the color of the paper).

EXIT

This item causes the program to exit to DOS. A message box is first displayed to make sure the user really wants to exit the program. If the user wants to exit the program, the OK button in the message box should be selected; otherwise select the CANCEL button.

HELP

This item displays a pull down menu with a selection of topics for which help exists. This pull down menu is different from the other pull down menus in that the items do not have hot keys associated with them. The user must use either the mouse or the UP and DOWN ARROW keys, followed by the ENTER key, to access the menu items.

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 DLP 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. This file is found on the 3.5" high-density floppy disk located at the end of this section.

DLPSET SOFTWARE

This program places the CALCULATION OF SETTINGS section from this instruction book onto the PC screen. View the file README.TXT for updated information and installation instructions for this program. This file is found on the 3.5" high density floppy disk located at the end of this section.

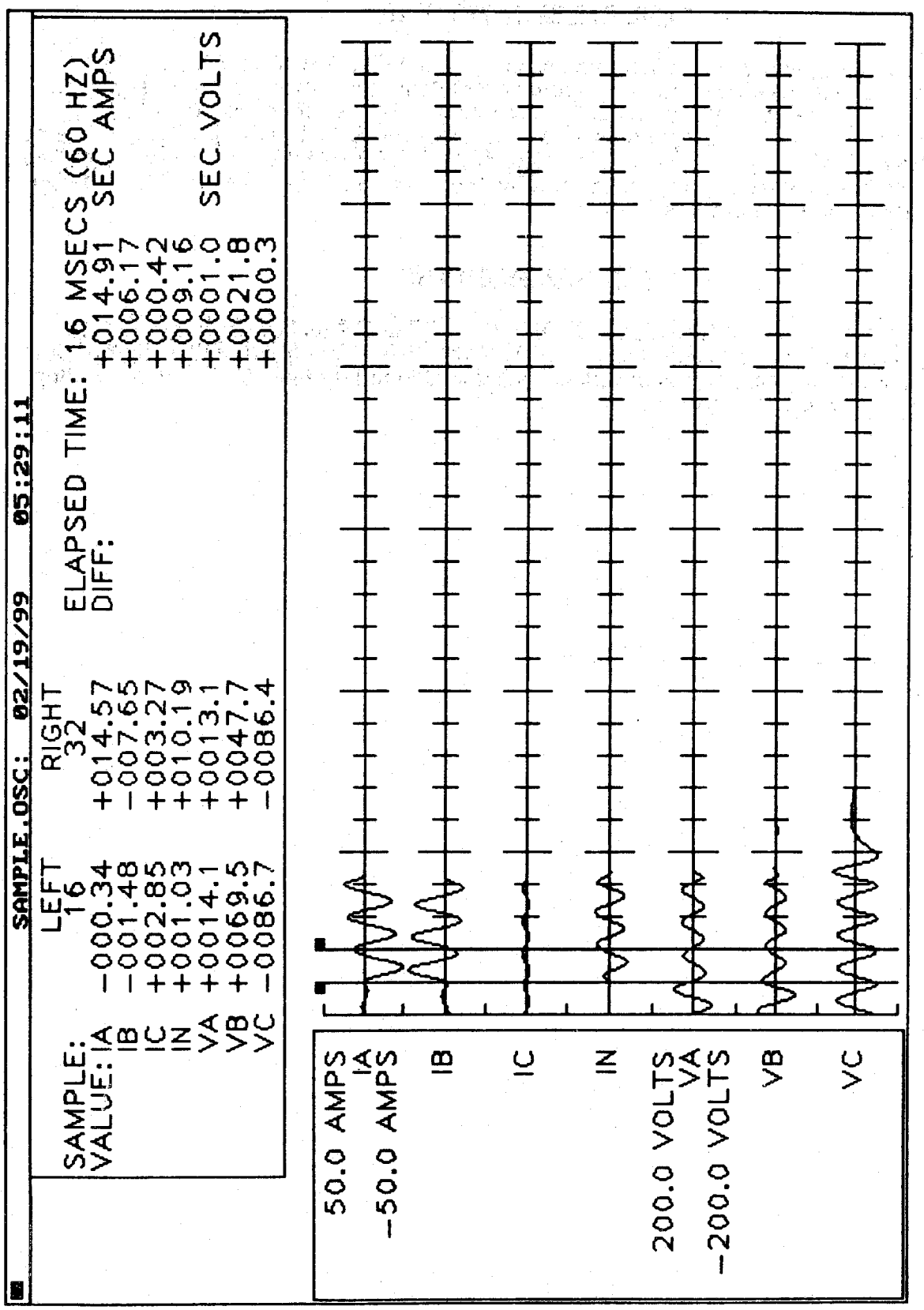


Figure SO-1 (0286A2931 Sh.1 [1]) Oscillography -- Currents and Voltages

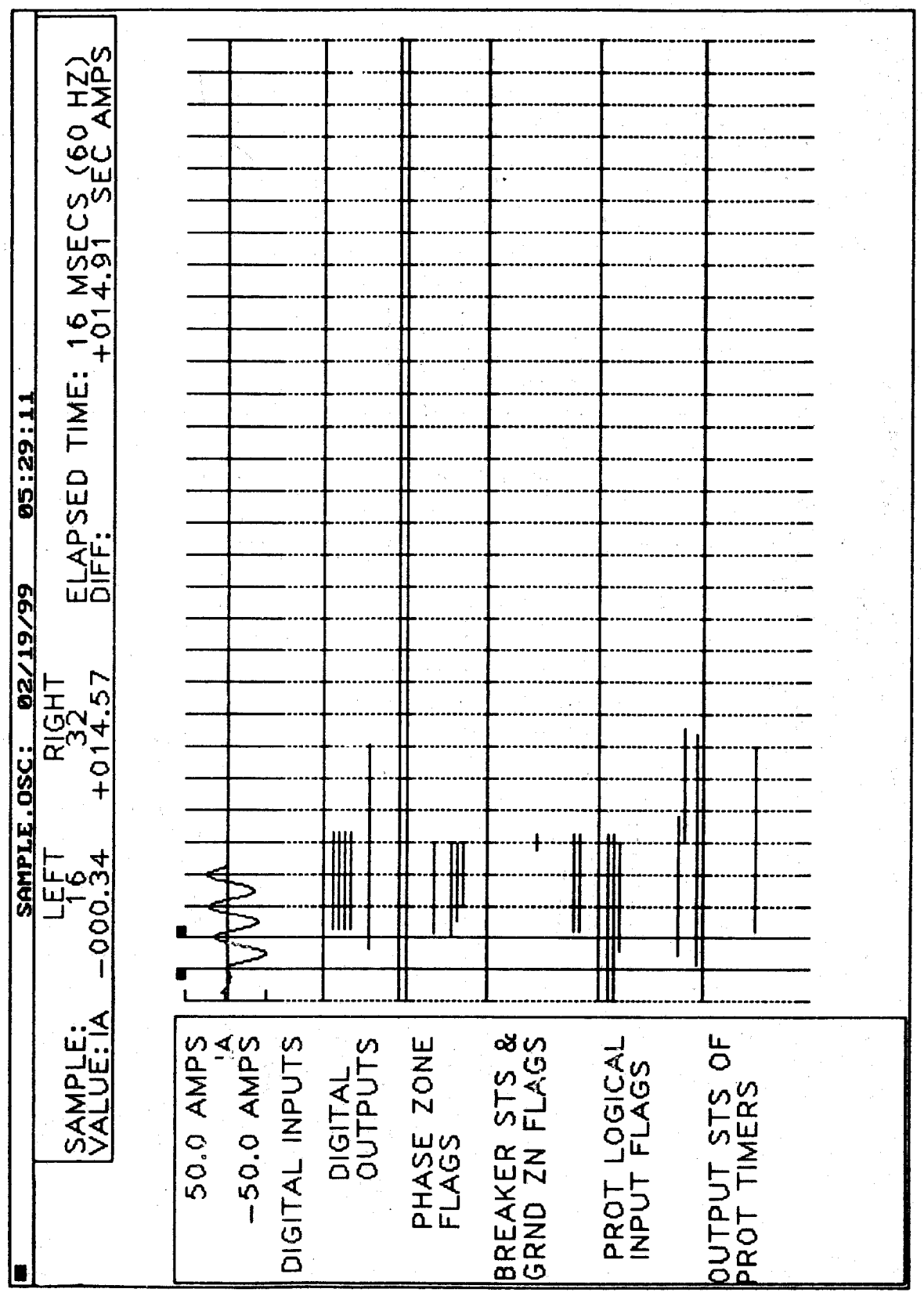


Figure SO-2 (0286A2931 Sh.2) Flag Groups Screen

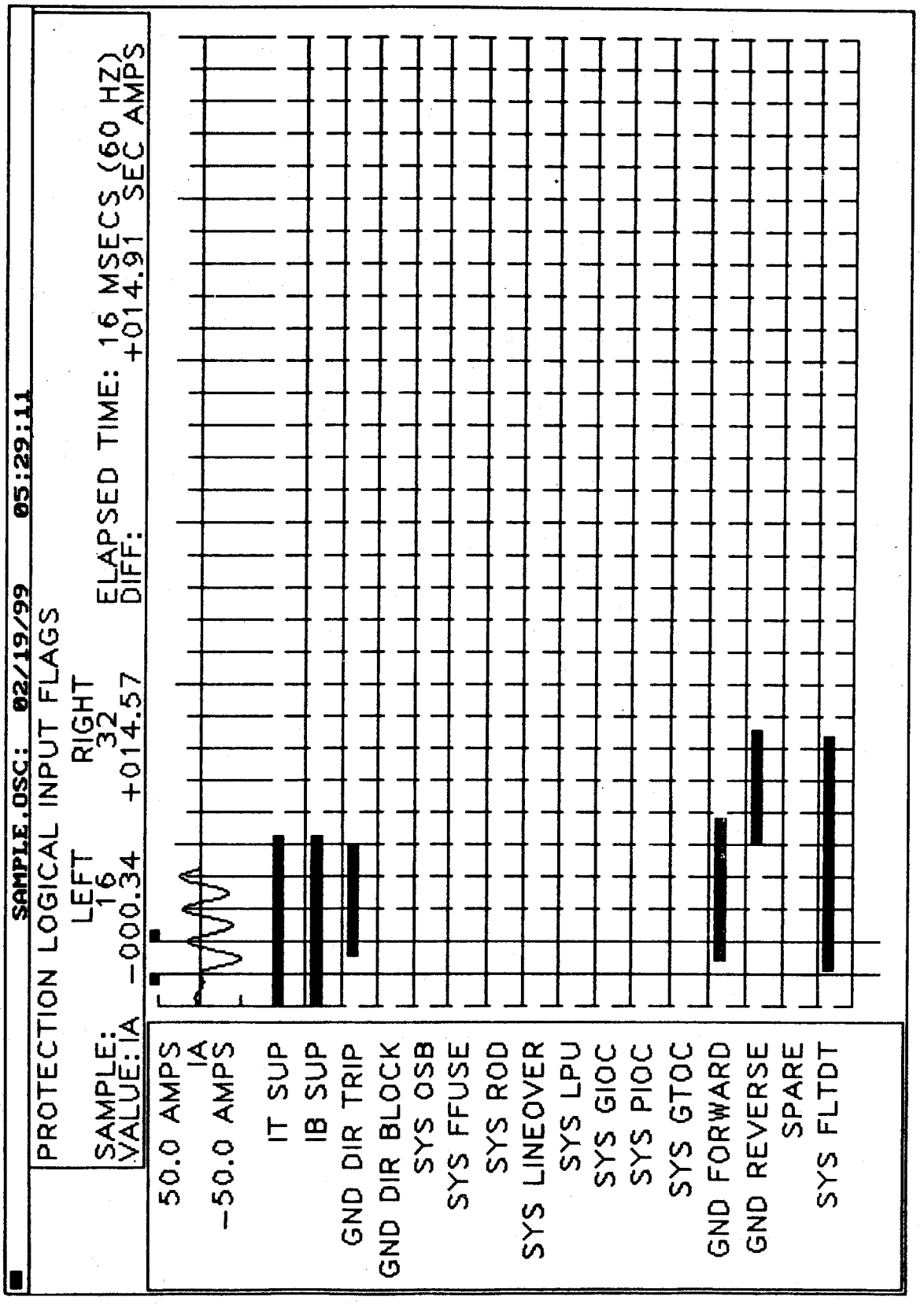


Figure SO-3 (0286A2931 Sh.3) Protection Logic Input Flags Screen

Revisions have been made in the following locations since GEK-100562B:

Page	Paragraph/Line beginning with
IND-1	A section on getting started has been added.
PD-7C	Second paragraph of **Line Pickup** section.
PD-8C	First and Third paragraphs (still in **Line Pickup** section).
PD-14C ff	Figures PD-1 through 5 and PD-7.
CS-3B	**Table CS-1**, UNITID.
CS-6B	**Unit ID Number, UNITID.**
CS-7B	**Communications Baud Rate, BAUDRATE**
	Example Settings, UNITID, and **Positive-Sequence Impedance, ZP.**
CS-15B	**Example Settings**, SELTBP.
CS-40B	**Example Settings**, SELZ2U
CS-61B	**Example Settings**, SELZ2U
CS-73B	**Example Settings**, SELZ2U
HD-3B	**External Connections**, Note added.
AT-1B-33B	This section has largely been rewritten to be compatible with DLP-LINK; the figures have also been changed
PT-1B-17B	This section has largely been rewritten to be compatible with DLP-LINK.
SE-4C	**Using the Information Status Command.**
SE-5-6C	This section has been extensively changed to be compatible with DLP-LINK.
SP-3B	**TOC TIME DIAL SETTING**
IN-3C	PC Modem
IN-4C	DLP Modem
IN-5C	Modem Setup Criteria, Result Code Display.
SO-1-22C	The DLP-LINK section has been added ahead of the D-LINK and DL-DATA sections

Throughout, former references to D-LINK have been replaced by DLP-LINK.

The Table of Contents has been updated accordingly.

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