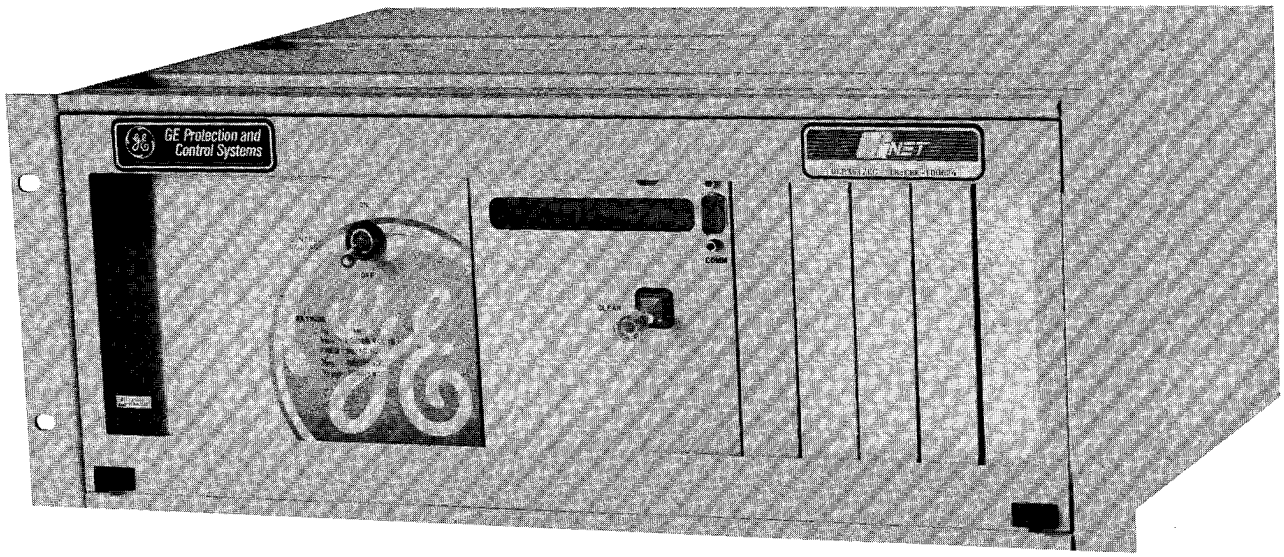
GEK-100624C
DLP3™
DIGITAL
TRANSMISSION LINE
RELAYING SYSTEM
WITH THREE-PHASE TRIPPING



GE Power Management

The Technology Center
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Malvern, Pa. 19355,USA

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 respect to local codes and ordinances because they vary greatly.

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Cover Photo: 8919516

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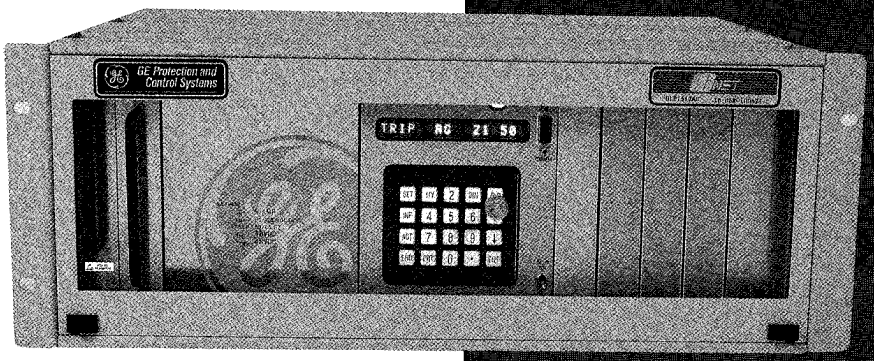
DLP DIGITAL LINE PROTECTION SYSTEM

The DLP Digital Relaying System
for Single and Three Pole Tripping Applications.



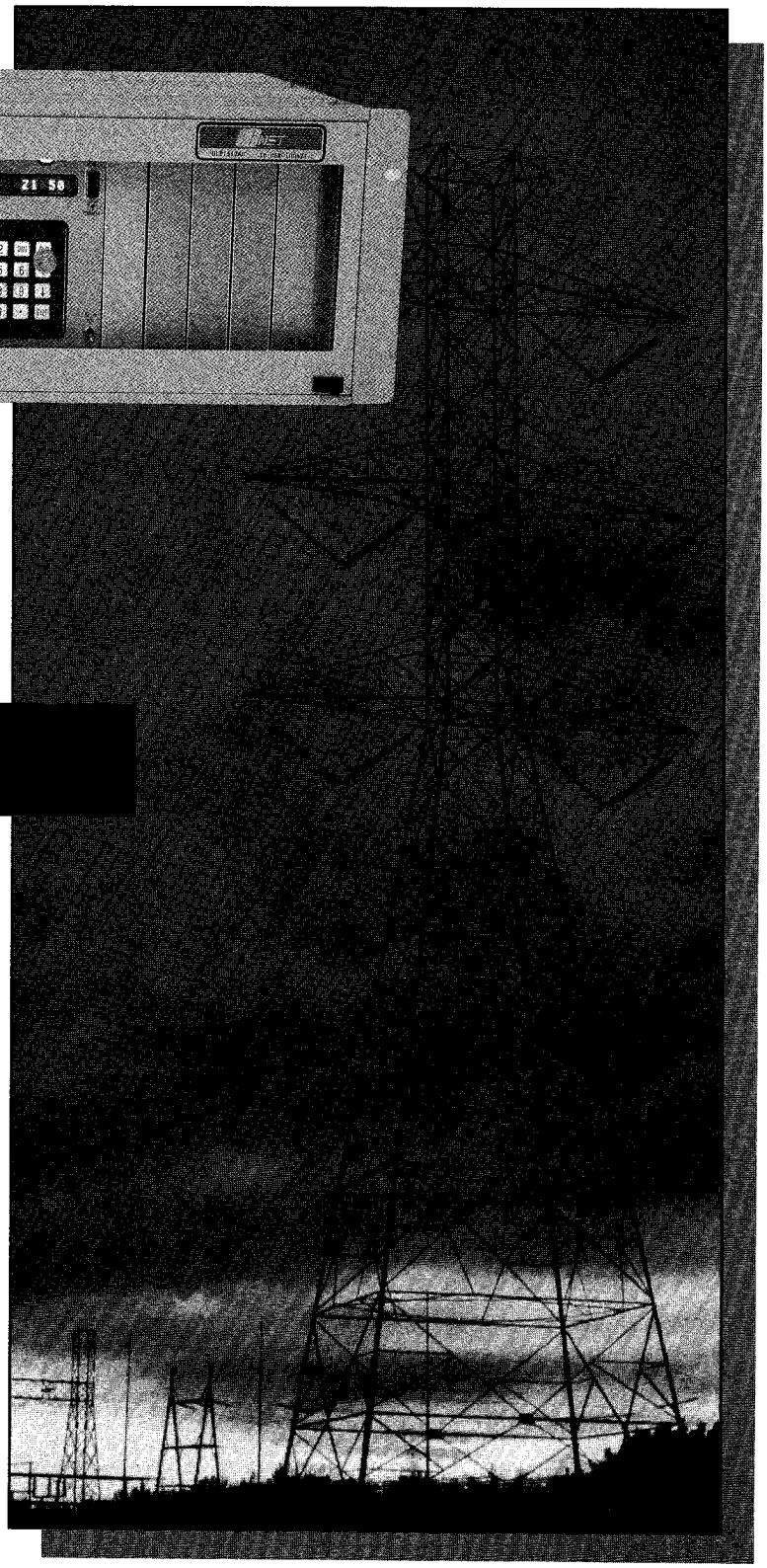
The DLP is a microprocessor-based digital relay system that uses wave-form sampling together with appropriate algorithms to provide transmission line protection, fault location, and related features that enhance the interface between the user and the DLP. The DLP is based on research and development work supported by EPRI (Electric Power Research Institute).

Building upon the success of three years of field experience, enhancements have been added to the DLP's thoroughly tested software and hardware which make it even more versatile. Models are available which allow the user to select the combination of features to meet their particular application needs. Major enhancements include:

- Single Pole Tripping Logic with optional (2) shot recloser
- IRIG-B time-sync input
- Zone 1 Extension logic
- Configurable Inputs and Outputs
- Internal/external oscillography triggering
- Flexible oscillography data storage
- Adaptive settings capability - (4) sets
- Multiple TOC curves (Inverse, Very Inverse, Extremely Inverse)
- Custom TOC curves can be downloaded into the DLP from various sources:
  - Curves generated by GE's TOC curve editor
  - Any curve from GE's TOC curve database
  - The Existing Library of ASPEN RelayEditor™ curves
  - Any custom curve designed with ASPEN RelayEditor™

This Custom Curve feature allows the DLP to coordinate with other manufacturers' TOC relays as well as adapt to unique coordination requirements.

- SCADA involved-phases-indication
- Multi-layered password protection
- Enhanced present value reporting:
  -voltages -watts -phase angle
  -currents -vars are automatically displayed and updated in four second intervals.



DLP DIGITAL LINE PROTECTION SYSTEM

TECHNICAL DATA

Ratings

Voltage	• 110-120 Vac (phase-to-phase)
Frequency	• 50 or 60 Hz
Current	• I_N = 1 or 5 amperes
DC Control Voltage	• 48 Vdc (38.5 to 60 volts) • 125 Vdc (88 to 150 volts) • 220/250 Vdc (176 to 300 volts)

Maximum Permissible Currents

Continuous	• 2 × I_N
Three Seconds	• 50 × I_N
One Second	• 100 × I_N

Maximum Permissible AC Voltage

Continuous	• 2 x Rated
One Minute (One per hour)	• 3.5 x Rated

Outputs

Trip Output Contacts
- Continuous 3 amperes, make and carry for tripping duty = 30 amperes (per ANSI C37.90)
- Break 180 va resistive @ 125/250 Vdc
- Break 60 va inductive @ 125/250 Vdc

Single Pole

Dedicated	Qty.
Trip (SCR or Contact, 2 per phase)	6
BFI (2 per phase)	6
RI-1P	2
Transmitter Key	2
Zone 1 Extension Reset	1
3 Pole Trip Enable	1
Reclose in Process	1
Alarm (PS/Critical)	1
Configurable	
RI-3P (Configurable as pair)	2
BKR Close (Independent - Except Reclosing)	2
Line Overload	1
Non-Critical Alarm	1
Reclose Cancel	1
Optional	
SCADA Contacts for Faulted Phase ID	4

Three Pole

Dedicated	Qty.
Trip (SCR or Contact)	2
BFI	2
Transmitter Key	2
Alarm (PS/Critical)	1
Configurable	
RI (must be same)	2
Brkr Close (Independent)	2
Reclose Cancel	1
Line Overload	1
Non-Critical Alarm	1
Optional	
SCADA Contacts for Faulted Phase ID	4

SCR Outputs	• Same as trip contacts except no interrupting rating
Auxiliary Contacts (Including Alarms)	• Continuous 3 amperes, make and carry for tripping duty = 30 amperes (per ANSI C37.90) • Break 25 watts inductive @ 125/250 Vdc; maximum 250 volts or 0.5 amperes
Channel Control Contacts	• 10 watts; maximum voltage 280 Vdc and maximum current 50 mA DC

Environmental

Ambient Temperature	• Storage: -30°C to +70°C
Range	• Operation: -20°C to +55°C
Humidity	• 95% without condensing
Insulation Test Voltage	• 2 kV 50/60 Hz, one minute
Impulse Voltage Withstand	• 5 kV peak, 1.2/50 mseconds, 0.5 joules
Interference Test Withstand	• SWC per ANSI C37.90.1

Dimensions

Height	• 7 inches (176 millimeters) 4 rack units
Width	• 19.0 inches (484 millimeters) standard 19 inch rack
Depth	• 16 inches (406 millimeters)
Weight	• 26 pounds (11.8 kilograms)
Scheme Selection	• Step Distance • POTT • PUTT • Blocking • Hybrid • Z1 Extension
Burdens	
Current Circuits	• 0.022 ∠ 5° ohms, I_N = 5 amps • 0.12 ∠ 30° ohms, I_N = 1 amp
Voltage Circuits	• 0.15 VA, 60 Hz • 0.20 VA, 50 Hz
DC Battery	• Contact converters = 2.5 milliamperes at rated DC input voltage • Power supply = 20 watts

Recloser Settings (Single Pole Models Only)

Single Pole Reclose Delay #1:	0.01-2.55 seconds
Three Pole Reclose Delay #1:	0.01-2.55 seconds
Reclose Delay #2:	1-255 seconds
Dwell Time Delay:	0.1-2.0 seconds
Reset Time Delay:	1-255 seconds

Reach Setting Ranges

Measuring Units	Range in Ohms I_N=5	Range in Ohms I_N=1	Resolution I_N=5	Resolution I_N=1
Ground	0.01-50	0.01-250	0.01	0.01
Phase	0.01-50	0.01-250	0.01	0.01

Out of Step Blocking

	Range in Ohms I_N=5	Range in Ohms I_N=1	Resolution I_N=5	Resolution I_N=1
MOB	0.01-50	0.01-250	0.01	0.01

Note: MOB reach coordinated with Zone 2, Zone 3 or Zone 4's reach setting.

Current Supervision Function Settings

	Range in Amps I_N=5	Range in Amps I_N=1	Resolution I_N=5	Resolution I_N=1
IPT	0.5-5	0.1-1	0.01	0.01
IPB	0.25-3.75	0.05-.75	0.01	0.01
IT	0.2-4	0.04-0.8	0.01	0.01
IB	0.2-2	0.04-0.4	0.01	0.01

Overcurrent Backup Settings

	Range in Amps I_N=5	Range in Amps I_N=1	Resolution I_N=5	Resolution I_N=1
PH4	2-100	0.4-20	0.1	0.1
IDT	0.5-80	0.1-16	0.1	0.1
TOC	0.2-15	0.04-3	0.1	0.1

TOC Time Dial Setting 0.5 to 10 with 0.1 Resolution

Line Pickup

	Range in Amps I_N=5	Range in Amps I_N=1	Resolution I_N=5	Resolution I_N=1
I1	1-15	0.2-3	0.1	0.1

Line Overload

	Range in Amps I_N=5	Range in Amps I_N=1	Resolution I_N=5	Resolution I_N=1
Level 1 OC	5.0-20.0	1.0-4.0	0.1	0.1
Level 2 OC	10.0-40.0	2.0-8.0	0.1	0.1

Accuracy

Distance Measuring Units	Reach: +/- 5% of setting at angle of maximum reach and rated curre
Zone Timers	+/- 3% setting
Fault Locator	+/- 3%

NOMENCLATURE SELECTION GUIDE

DLP Model Numbers Single and Three-Pole Tripping Models

DLP * * * * * C

1					1 Pole Tripping	
3					3 Pole Tripping	
	1				1 AMP Rated Current	
	5				5 AMP Rated Current	
		0			Vps = 48 VDC Battery Voltage	
		1			Vps = 110/125 VDC Battery Voltage	
		2			Vps = 220/250 VDC Battery Voltage	
			1		SCR Tripping Output	
			2		Relays - Tripping Output	
					KEYPAD	RCLR	TSTPLG	SCADA	#ZONES
3				A	X	—	X	—	4
1,3				B	—	—	—	—	4
3				C	X	—	X	X	4
3				D	—	—	—	X	4
3				E	—	—	—	—	2
3				F	—	—	—	X	2
1				G	X	—	X	—	4
1				H	X	X	X	—	4
1				J	X	—	X	X	4
1,3				K	X	X	X	X	4
3				L	X	X	—	—	4
3				M	X	—	—	—	4
3				N	—	X	—	—	4
1,3				P	—	—	X	—	4
3				R	—	—	X	X	4
1				S	—	X	—	X	4

Example: DLP3512CC - DLP rated 5 amperes, 50/60 Hz, 110/125 VDC, wit relay contact outputs for 3 pole tripping, keypad and RS232 communications, with SCADA, test plugs, no recloser, revision C.

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GEA-12188A
QG-5/95-500

GETTING STARTED

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

2. Prior to applying power, make sure each module is properly seated in the relay. Then, apply rated DC power to the relay at the power supply input terminals. Refer to the fold-out Elementary Diagram, Figure PD-6, 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 (COM).

   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."**

The following information is intended to provide a "Quick Reference" to the DLP-LINK program. This DLP relay requires the use of PASSWORDs to obtain information from the relay, to change Settings, or to perform Actions. The relay is shipped from the factory with the following communications passwords:

VIEW: VIEW!
SETTINGS: SETT!
ACTIONS: CTRL!

NOTE: The exclamation point following the letters is part of the factory password. The factory passwords MUST be changed before the user can modify Settings or initiate Actions. The user can Log into the relay at any password level. After logging into the relay, the password can be changed under the ACTION menu, (CHANGE PASSWORD). Before the user can change another password, he must LOGOUT from the DLP. The user can then change the remaining passwords by first logging into the DLP using another of the default passwords listed above.

The communications passwords may be viewed, in an encoded format, by placing a jumper on J2 of the MMI module (see figure 4-2). When repowered, the relay will display each password type, followed by that password in encoded form. Jumper J2 must then be removed to make the relay operational.

The relay UNIT ID is 0 and the baud rate is set at the factory to 2400 baud by the installation of jumper J3

NOTE : This instruction book covers the following models:

DLP3***BC
DLP3***DC
DLP3***EC
DLP3***FC
DLP3***PC
DLP3***RC

The models ending in EC and FC contain only Zone 1 and Zone 2 distance functions. The models ending in BC and DC contain Zone 1, 2, 3, and 4 distance functions. Where appropriate, the text is marked with an asterisk (*) to remind the user that sections pertaining to Zone 3 and Zone 4 should be disregarded for the EC and FC models. The models ending PR and RC contain test plugs and a printer interface. Any references to test plugs or printers refer to these models, and not to models BC, DC, EC, and FC.

PRODUCT DESCRIPTION

GENERAL

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

APPLICATION

The DLP3™ system is designed to be used on transmission lines of any voltage level that do not incorporate series capacitor compensation. It should be determined that the DLP3 system's operating time range (typically 0.75 - 1.5 cycles) is consistent with the requirements of the application. 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 DLP3 system incorporates four zones of distance protection to implement six different protection schemes. These schemes are:

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

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

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

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

*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 six available protection schemes are described below. Five functional logic diagrams, Figures 1-1, -2, -3, -4, and -5 show the scheme logic for the six protection schemes using conventional AND/OR combinational logic. Each functional logic diagram is presented as an aid in describing the scheme operation. The elementary diagram of Figure 1-6 shows the external connections to the DLP3 relay system. Figure 1-7 defines the symbols used in Figures 1-1 through 1-6. Figures 1-14, -15, and -16 show typical interconnections between the DLP3 system and an appropriate carrier/tone equipment for three pilot schemes:

BLOCKING with CS28A (Figure 1-14)
POTT with NS40A (Figure 1-15)
HYBRID with Unblocking CS61C (Figure 1-16)

Step Distance

Figure 1-1 is the logic diagram for the Step Distance scheme. Since the step distance scheme overlays the other schemes available in the DLP3 system, 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% or more of the protected line not covered by zone 1. If the application permits, a forward-looking third zone can be used to provide backup protection for adjacent line sections out of the remote bus. If a reverse-looking zone is desired, the zone 4 functions can be reversed in direction. For some applications it may prove feasible and desirable to implement both a forward-looking zone 3 and a forward-looking zone 4.

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

Zone 1 Extension

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

An external recloser contact must be wired to CC3. If the external recloser contact wired to CC3 closes momentarily at the beginning of each recloser step but does not stay closed until the recloser goes to RESET, then the "D" dropout time of TL20 should be set to a value equal to the reset or reclaim time setting of the external recloser. If the external recloser contact wired to CC3 stays closed until the recloser goes to RESET, then the "D" dropout time of TL20 should be set to 0.

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

Permissive Overreach Transfer Trip (POTT)

Figure 1-3 is the logic diagram for the POTT scheme. Also note that Figure 1-3 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, 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 used in conjunction with timer TL1 to prevent a possible misoperation when a fault current reversal occurs as a result of sequential clearing of a fault on a parallel line. Note that tripping is supervised by the Fault Detector at AND7, thus confirming that tripping will only occur when a fault has occurred on the power system.

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

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

Permissive Underreach Transfer Trip (PUTT)

Figure 1-3 is the logic diagram for the PUTT scheme. A PUTT scheme requires zone 1 functions as well as overreaching zone functions. Zone 1 trips directly, via OR1, AND4, OR25, OR3, OR4, AND3, OR13, AND13, OR7, and AND7 and keys the transmitter to the trip frequency via OR5. Tripping for internal faults not seen by the zone 1 functions occurs when an overreaching function operates and the receiver(s) 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. In the DLP3 system, 52/b contact keying of the transmitter is automatically prevented if SELSCM=2 [PUTT] and NUMRCVR=2 [2 RCVRS] as indicated in Figure 1-3 by the link located between AND5 and OR5. For a two-terminal PUTT application 52/b contact keying of the transmitter should be used.

*** Blocking Scheme**

Figure 1-4 is the basic logic diagram for the three available Blocking schemes. Figures 1-4a, 1-4b, and 1-4c show the ground carrier start options for the three available Blocking schemes. Since a reverse-looking blocking function is required in these schemes, the Zone 4 distance functions must be set for reversed reach. As far as channel operation is concerned, a blocking scheme has 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.

*** Not applicable to Models DLP3***EC and DLP3***FC**

An output from OR110 will inhibit the blocking functions at AND503 via OR103 and NOT2, and any carrier that may have been started will be stopped via OR2, AND209, and OR213. Consequently, carrier will be stopped or will not be started at any terminal of the line; there will be no receiver output and no blocking input applied to comparer AND407 via CC3 and NOT3. Assuming that the out-of-step blocking function has not operated, AND407 will produce an output to initiate tripping following the coordination time delay pickup set on timer TL1. The coordinating time is required to allow time for a blocking signal to be received from the remote terminal(s) to prevent misoperation on external faults. The required setting is described in the CALCULATION OF SETTINGS section. Note that tripping, as in all the schemes, is supervised by the Fault Detector at AND35, thus confirming that a trip will only occur when a fault is present on the power system.

The sequence of operations is similar for an internal ground fault; however, the three Blocking schemes each use a different logic for starting carrier for ground faults. Ground-distance, ground-directional-overcurrent, or both functions acting in parallel, may be selected for ground-fault protection. Ground-distance and ground-directional-overcurrent each have separate trip and block functions as well as separate transient blocking circuits. The BLK1 scheme uses the IPB function ANDed with the NB function to start carrier in the GDOC or MGDOC schemes. The BLK2 and BLK3 schemes use a non-directional carrier start function. BLK2 uses the fault detector (FD) function; BLK3 uses the IPB function. In the BLK3 scheme, the IPB function operates on the zero sequence current without positive sequence current restraint; in the BLK1 scheme, the IPB function operates on zero sequence current with positive sequence current restraint.}} For remote external faults within the reach of the local overreaching zone tripping functions, one of the remote blocking functions will operate to key the transmitter ON, sending a blocking signal to the local end. The receiver output blocks tripping at the local end by removing the upper input to AND407 via CC3 and NOT3. At the remote end the output of the blocking functions is applied to the lower NOT input of AND407 to block tripping there. This lower NOT input to AND407 forms part of the transient blocking logic 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-4) is used to convert the receiver output into a blocking signal usable by the DLP1. 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.

*** Not applicable to Models DLP3***EC and DLP3***FC**

CC6 output is used to disable the pilot scheme logic while allowing the backup Zone 1, Zone 2, etc. to function. Typically an external contact wired to CC6 is closed when the associated carrier set is removed from service to prevent over-tripping for external faults.

*** Hybrid Scheme**

Figure 1-5 is the logic diagram for the Hybrid scheme. A Hybrid scheme combines aspects of a tripping scheme with aspects of a blocking scheme, but it is perhaps easiest to explain as 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 circuit is used to permit the strong in-feed terminal to trip. The weak in-feed tripping circuit may be used to trip the weak in-feed terminal. If weak in-feed tripping is not desired, then this feature may be disabled.

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. For three-terminal line applications, the pickup time of TL11 is decreased from 80 to 50 ms. and the dropout time of TL25 is increased from 30 to 60 ms., to maintain security when an external fault is cleared quickly. These changes occur automatically when setting 1202, Number of Receivers (NUMRCVR), is set at 2, provided that setting 1201, Select Scheme (SELSCM), is set at 3 (HYBRID).

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

1. the NOT input to AND405 is satisfied because there is no output from the blocking functions
2. there is an output from OR305 since either IB has operated or V1 has dropped out
3. the other two inputs to AND405 are satisfied since a trip signal is being received and timer TL11 has not timed out yet.

The output from AND405 energizes timer TL16, which produces a trip output when it times out. The adjustable time delay pickup of timer TL16 is provided for security against any spurious receiver output that might occur during fault conditions.

Out-of-Step Blocking

Figures 1-8 and 1-9 show a functional diagram of the out-of-step blocking logic plus an R-X diagram depicting an assumed swing-impedance locus superimposed on the associated distance relay characteristics. For an out-of-step condition, the impedance locus will first enter the MOB characteristic and then some time later it will enter the phase trip function.

*** Not applicable to Models DLP3***EC and DLP3***FC**

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 tripping of 1) all functions, 2) all functions except the direct trip overcurrent functions, 3) only the phase distance functions, or 4) no functions. For 2) and 3), each of the four distance zones (Zone 1,2,3, or 4) may be individually selected to be blocked or not.

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

Remote-Open Detector

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

ROD tripping, 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.

Figure 1-10 is a functional logic diagram of the ROD function which will be used as an aid in describing ROD operation. The sequence of events which results in an ROD output is (1) no charging current detected prior to the fault - logic 0 output from AND2, (2) fault detected - logic 1 output from OR3, (3) remote breaker opens - logic 1 output from AND3, and (4) fault still present so that the two inputs to AND4 persist for the time delay setting of timer TL20.

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

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

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 1-11 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, SELTBP (0902), and the setting that corresponds to a specific link position is shown in Figure 1-11.

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

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

While Line Pickup is primarily intended to trip for closing into zero-voltage bolted faults where the distance functions connected to line-side potential will not operate, it can also be used to trip for any type of permanent fault along the entire line length, regardless of the I1 pickup setting, that produces voltage at the relay location which 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 a distance or directional function may operate for a full or partial loss of AC potential caused by one or more blown fuses, PTFF is provided to block distance and directional function tripping when a fuse failure is detected. The backup overcurrent functions PH4, non-directional IDT, and non-directional TOC are allowed to trip. If IDT or TOC is directionally supervised by NT, then that function is not allowed to trip. Figure 1-12 shows the functional logic for the PTFF function.

If AC potential is lost as indicated by the positive-sequence voltage detector V1 dropping out and NOT1 producing a logic 1 output, the upper input will be present at AND1. The V1 pickup setting is fixed at 75% of nominal - 50 volts secondary - and the pickup to dropout ratio is approximately 100%. The middle input to AND1 is present if load current is sufficient to operate the current detector IB, and the bottom input is dependent upon whether or not the fault detector FD has operated.

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

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

whether or not PTFF has been selected to block tripping.

Overcurrent Backup

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

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

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

Alarms

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

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

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

Current Unbalance Detection

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

Breaker Control

By using the local MMI or a remote PC connected to the RS232 port, it is possible to selectively 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 relay 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 4-2. As shipped from the factory, this jumper is physically present and Breaker Control is disabled. To enable Breaker Control, the jumper must be removed.

Configurable Inputs

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

Configurable Outputs

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

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

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

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

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

CONOUT4
- = 0 (used as Line Overload, the default setting)
- = 1 (energized by an 8-input logical OR)
- = 2 (energized by an 8-input logical AND)
- = 3 (energized by an 8-input logical OR and activates the trip bus)
- = 4 (energized by an 8-input logical AND and activates the trip bus)

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

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

Configurable Trip Bus

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

Fault Location

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

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

It is important to note that OSC Trigger acts to cause oscillography storage but does not necessarily set t=0, the time sample that delineates between "pre-fault" and "post-fault" oscillography cycles. For discussion purposes, the term "disturbance period" is defined as the number of cycles of oscillography data (pre-fault plus post-fault) as determined by the setting 1513, NUMFLTS. If the internal Fault Detector, FD, comes up initially and OSC Trigger follows any time within the disturbance period, oscillography data is stored whether or not the DLP3 system issues a trip. If the DLP3 system issues a trip, then a normal fault report is stored as part of the oscillography data. If the DLP3 system does not issue a trip, a pseudo fault report is created where the trip type is listed as OSC, the trip time is the time at which the OSC Trigger occurred, the operating time is set to zero, and the fault type and location are computed based on post-OSC Trigger data. The local MMI LED display will not show "target" information, but an event message and fault report will be stored in memory. In either case above, t=0 is determined by the internal Fault Detector, FD.

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

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

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

Password Protection

Passwords provide security during remote communications while running the DLP-LINK program. Three different passwords provide remote communications security for 1) view and upload information, 2) control operations, and 3) settings changes. Refer to the SOFTWARE section for a description of DLP-LINK password usage.

Remote Communications

Two RS232 serial ports are provided. A DB-25 plug (PL-1) located on the rear of the case is provided to permit the user to 1) communicate with the DLP3 system from an IBM PC-compatible computer or 2) to connect the DLP3 system to the host computer of a G-NET substation information and control system. A DB-9 plug located on the front plate of the MMI module (front port) permits the user to communicate with the DLP3 system from an IBM PC-compatible computer, but it cannot be used to connect the DLP3 system to the host computer of a G-NET system.

When communication via a PC is desired, the PC may be connected via the proper null-modem cable

provided the cable length does not exceed 50 feet, or the PC may be connected via interposing modems when physically remote from the DLP3 system. 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. Refer to the INTERFACE section for details regarding the required cables.

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

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

SCADA Digital to Analog (DTA) Interface (optional)

An optional DTA module is available that provides 1) an analog output proportional to the distance from the relay to the fault as calculated by the fault location algorithm and 2) four contact outputs that provide fault type information. The analog output is intended to be wired into an analog port of a SCADA RTU to provide remote indication of distance to the fault. The four contact outputs are designated phase A, phase B, phase C, and neutral and are intended to be wired into four separate RTU digital ports. A particular contact closes when its phase (or neutral) is involved in the fault. For a phase B to C to ground fault, the phase B, phase C, and neutral contacts will close.

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

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

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

There are two settings associated with the SCADA DTA Interface. FLTLOCK is used to specify a time period after a fault during which fault location calculations resulting from subsequent faults will be prevented from updating the fault location information stored in the DTA module.

FLTRESET is used to specify a time period after a fault at the expiration of which the fault location information stored in the DTA module is reset (output forced to full-scale value) and those fault-type contacts that have closed will open. Note when either the DLP3 system's date or time is changed the timers associated with FLTLOCK and FLTRESET are reset and the DTA module is reset.

Fault Location and phase identification dry contacts for A,B, C, and N phases may be accessed by PL-3. PL-3 is a female DB-15 connector located at the rear

of the DLP. Refer to the Elementary Diagram (Figure 1-6) for the pin out of PL-3.

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 remotely via the RS232 port and a PC. A full description of this function is contained in the INTERFACE section.

Selectable Groups of Settings

Four separate groups of settings may be stored in non-volatile memory. Only one group can be active at a given time, but the active group may be selected via external switch contacts or via a command issued from the local MMI or DLP-LINK communication software. If the selection is to be made via an external switch then two of the digital inputs (contact converters) are used for this purpose. A four position SB1 or SBM switch with two stages (two effective contacts) could be used to select the active group of settings as shown in Figure 1-13.

Time Synchronization

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

Trip Bus Check

After a settings change is made in the active settings group, the DLP3 system will automatically return to its normal protection-on-mode following 1) storage of the new setting values in non-volatile memory and 2) a Trip Bus Check to determine that the changed settings have not caused any of the trip functions to operate for system conditions (i.e., current and voltage at the relay) at that instant. A Trip Bus Check also occurs before a newly selected settings group is allowed to become the active settings group. If Trip Bus Check finds a picked-up trip function, protection is turned off and a critical alarm is issued.

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

Trip Circuit Monitor

Within the DLP3 relay system the DC battery voltage across each of the open trip contacts (or SCRs) may be continuously monitored to indicate 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, which is normally wired in series with the trip coil, has opened. This function is intended to replace the red light indicator typically used for trip circuit monitoring, and it can be selectively disabled for each breaker.

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

Trip Current Monitor

A current sensor is wired in series with each trip output contact or SCR to monitor the DC current in the external trip circuit after the DLP3 system issues a trip signal. An event message that reads TRIP CIRCUIT #X ENERGIZED or TRIP CIRCUIT #X NOT ENERGIZED is issued depending upon

whether or not DC current is detected. X is either 1 or 2 signifying breaker 1 or breaker 2.

Start-Up Self Tests

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

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

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

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

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

The start-up procedure will take approximately one minute. As soon as the SSP successfully completes its PROM test and initializes the display hardware, the message "INITIALIZING" will appear on the display. When all DLP3 system initialization is completed satisfactorily, the display will be blanked and the DLP3 system 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 DLP3 system is not performing fault or post-fault processing. During this idle time, each processor will perform "background" self-tests that are not disruptive to the foreground processing; that is, tests that do not interfere with the foreground tasks' use of serial and parallel ports, and tests that do not inhibit interrupts to any processor. If any background self-test fails, the test is repeated. To declare a component "failed", the test must fail three consecutive times. In the case of most critical failures, the DLP3 system will force a reset to attempt to get the failed component working again.

The DLP3 system is able to distinguish between a start-up (power-up) and a reset caused automatically by a DLP3 malfunction. The reset is a fault tolerant feature of the DLP3 system; it is performed as an attempt to resume operation again after an intermittent failure. The reset activities are identical to the start-up activities except that not all start-up self-tests are performed. If the reset was caused by failure of a specific background self-test, then only the start-up self-tests associated with that same hardware are performed.

A reset is not reported to the user by the DLP3 system. 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 DLP3 system will not perform initialization, but will attempt to initialize MMI, communications, and the critical alarm output as in the case of a start-up with a critical self-test failure. The reset procedure takes approximately one second, depending upon which start-up self-tests are to be run.

The components tested in the background are listed in the **Run Time Background Self Tests** Table in the SERVICING section. The testing of I/O hardware is done in the foreground, so that the processors know when a given component or port is in use and therefore not available for testing. The components tested in the foreground are listed in the **Run Time Foreground Self Tests** Table in the SERVICING section. Some foreground tests are performed every sample period, while others are performed less frequently. As with background self-tests, any failed test is repeated and must fail three consecutive times to be considered a failure. Although not specifically a "self" test, the trip circuit continuity monitoring is performed as a foreground test. Refer to the **Trip Circuit Monitor** portion of this section.

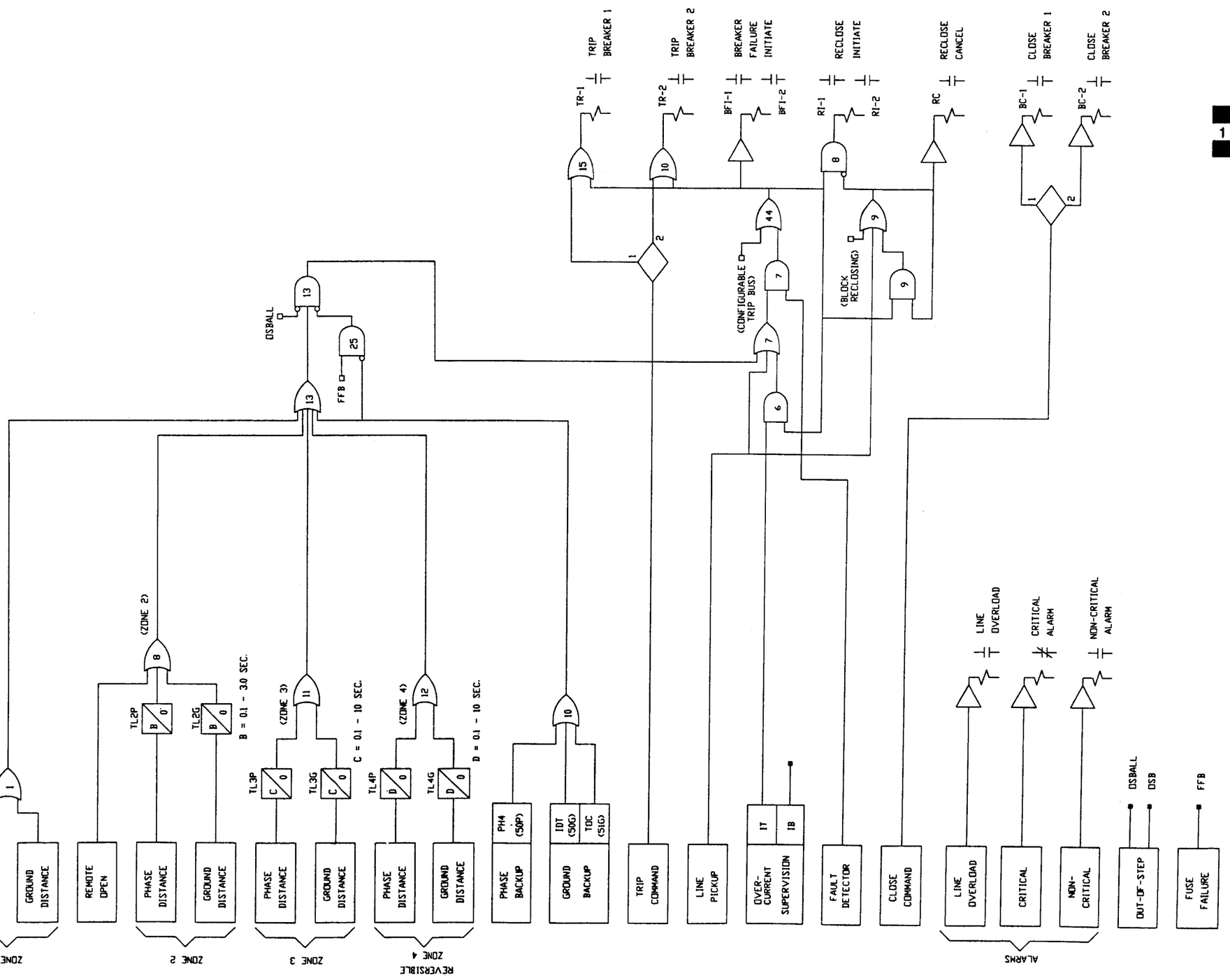


Figure 1-1 (0145D8335 [1]) Step Distance Logic Diagram

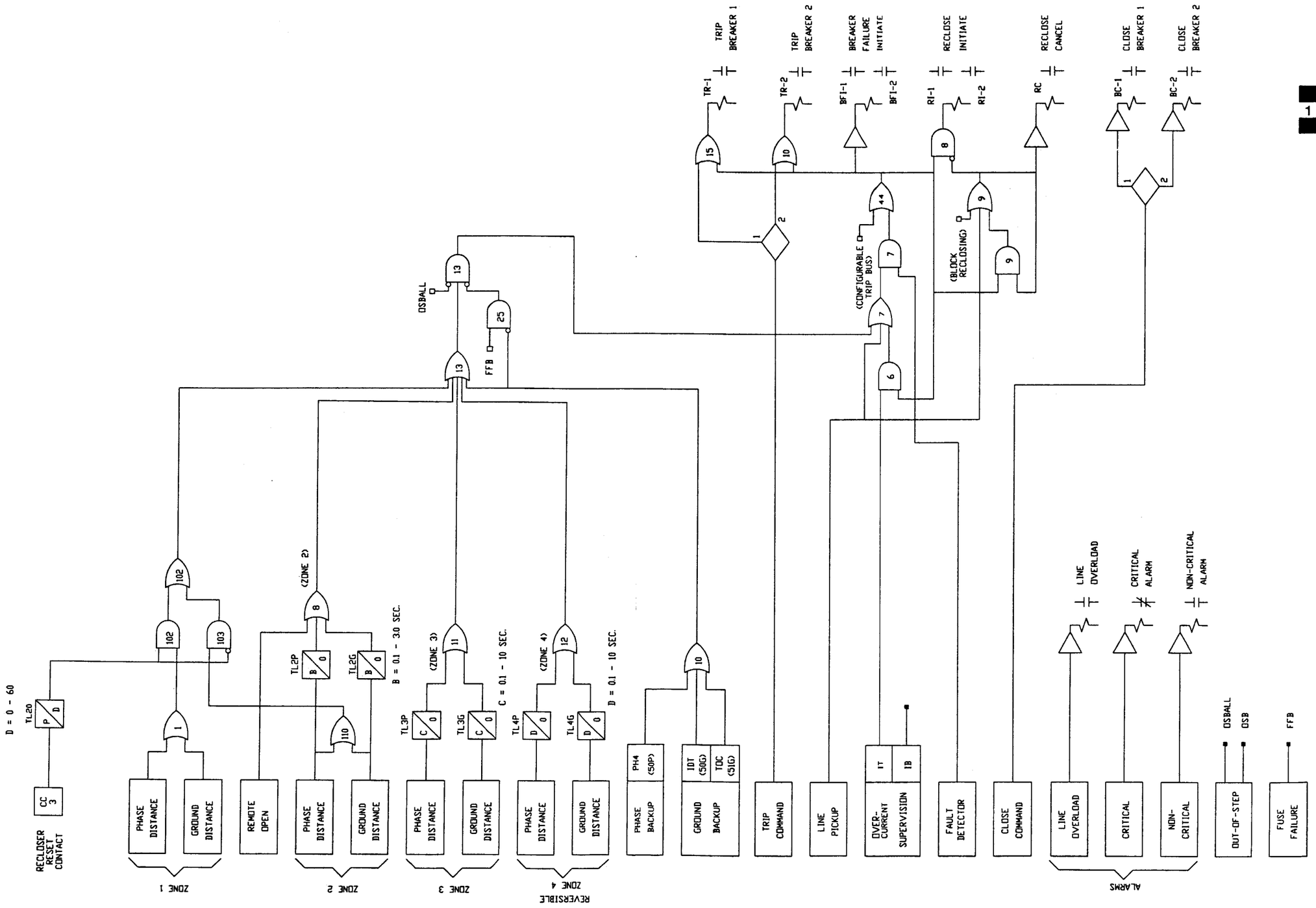


Figure 1-2 (0145D8336 [2]) Zone 1 Extension Logic Diagram

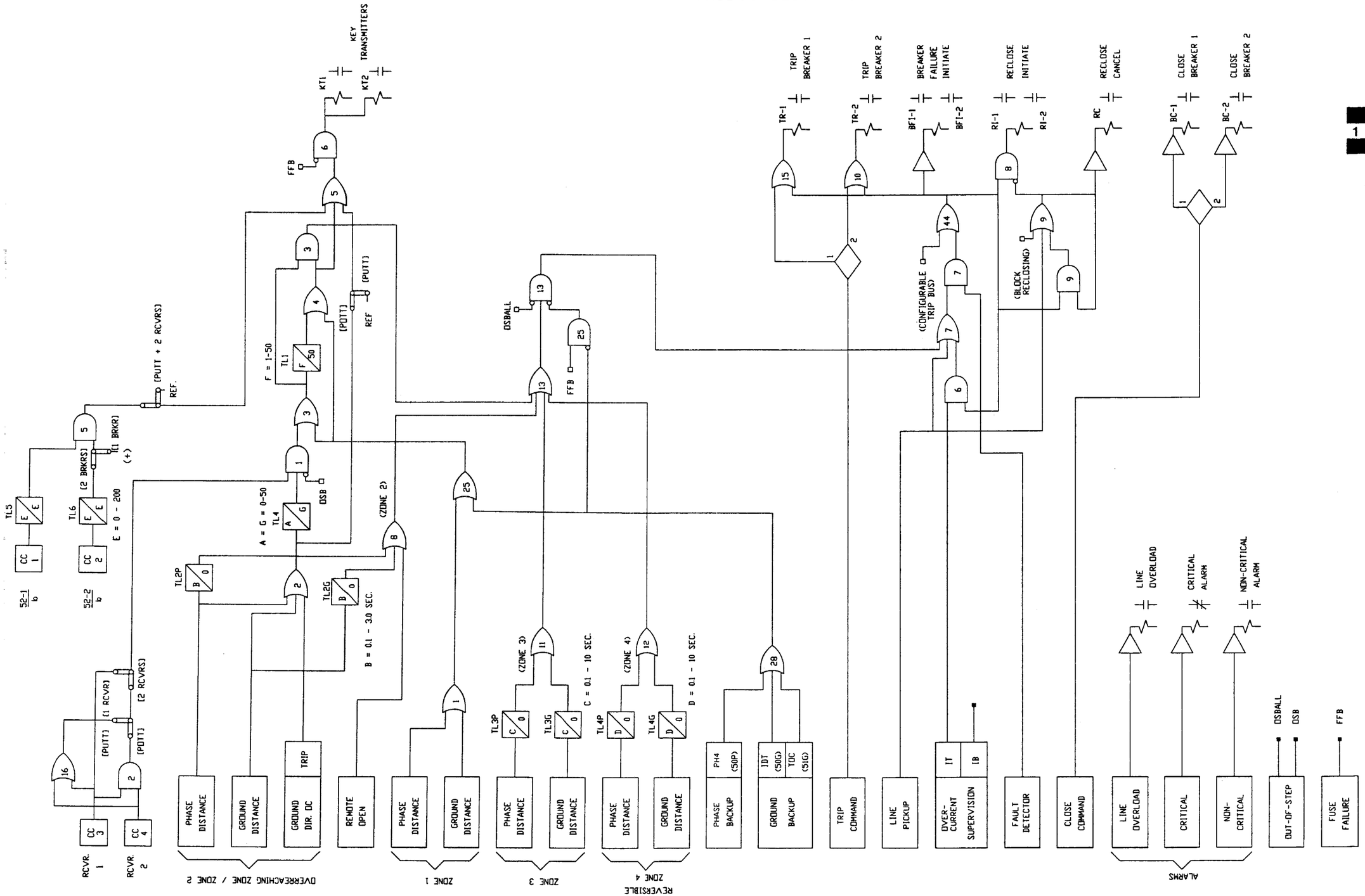


Figure 1-3 (0145D8337 [2]) POTT/PUTT Logic Diagram

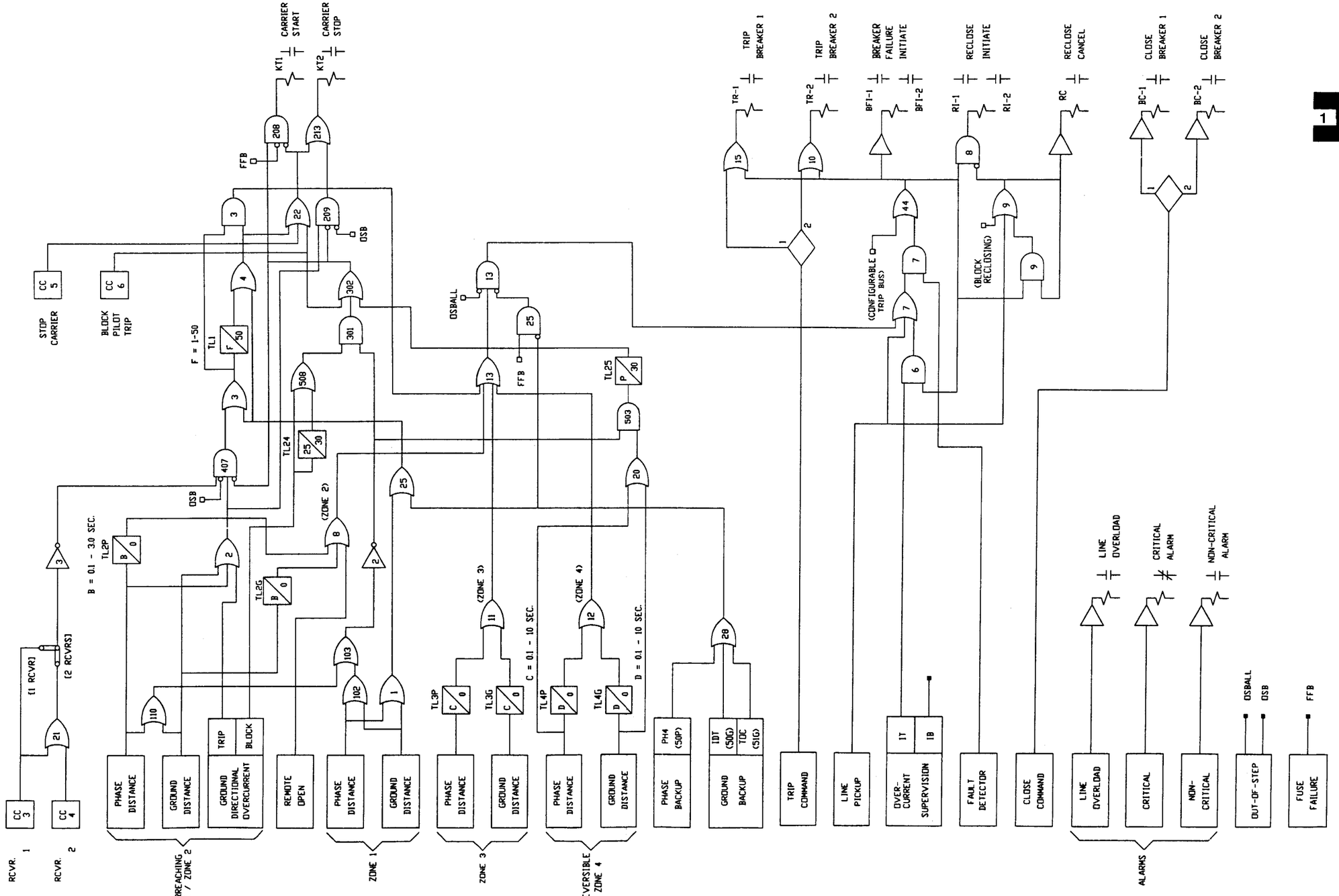


Figure 1-4 (0145D8338 [4]) Blocking Logic Diagram

* Not applicable to Models DLP3***EC and DLP3***FC

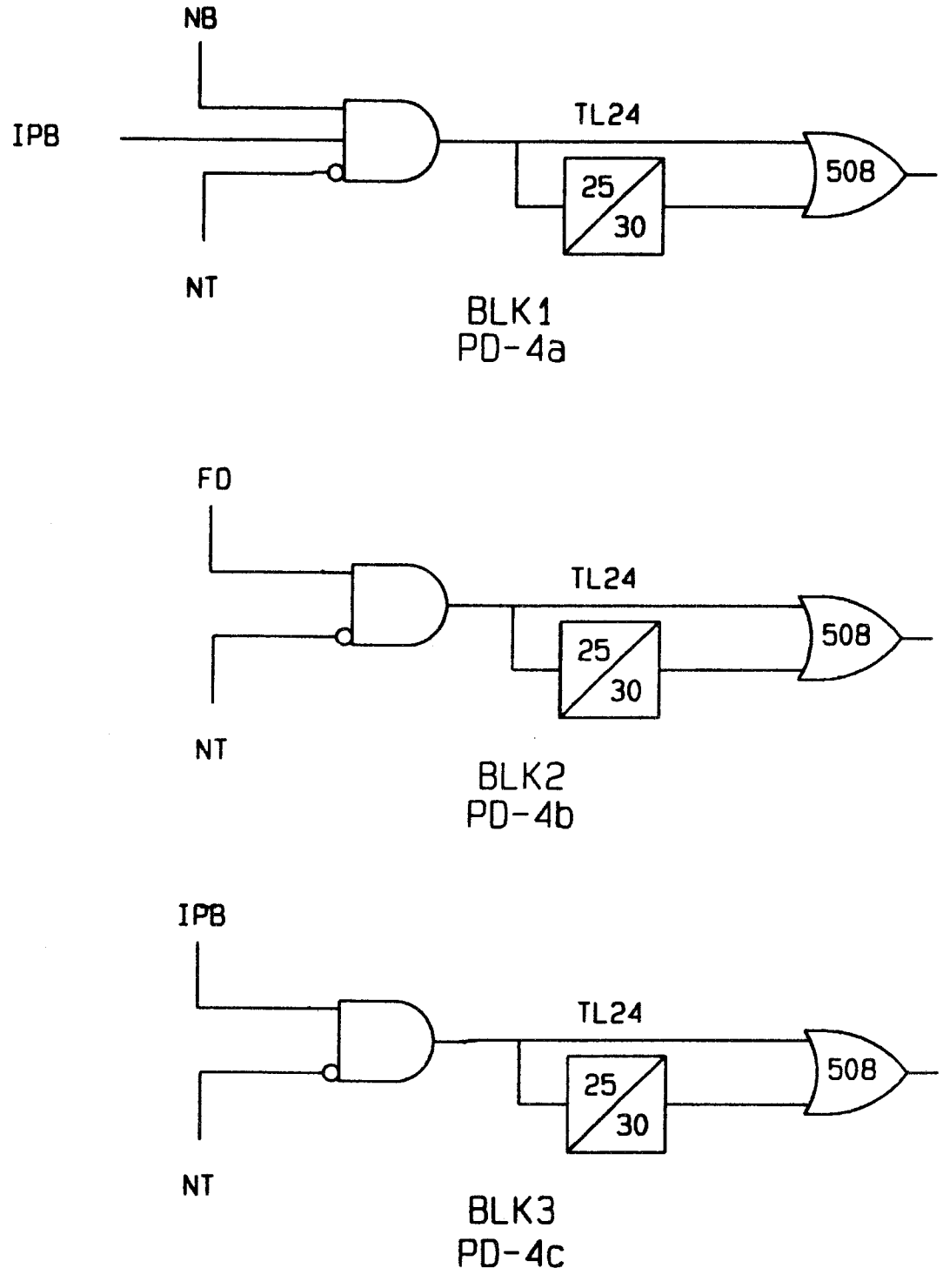


Figure 1-4a, 4b,4c (0355A3389) Ground Carrier Start Options

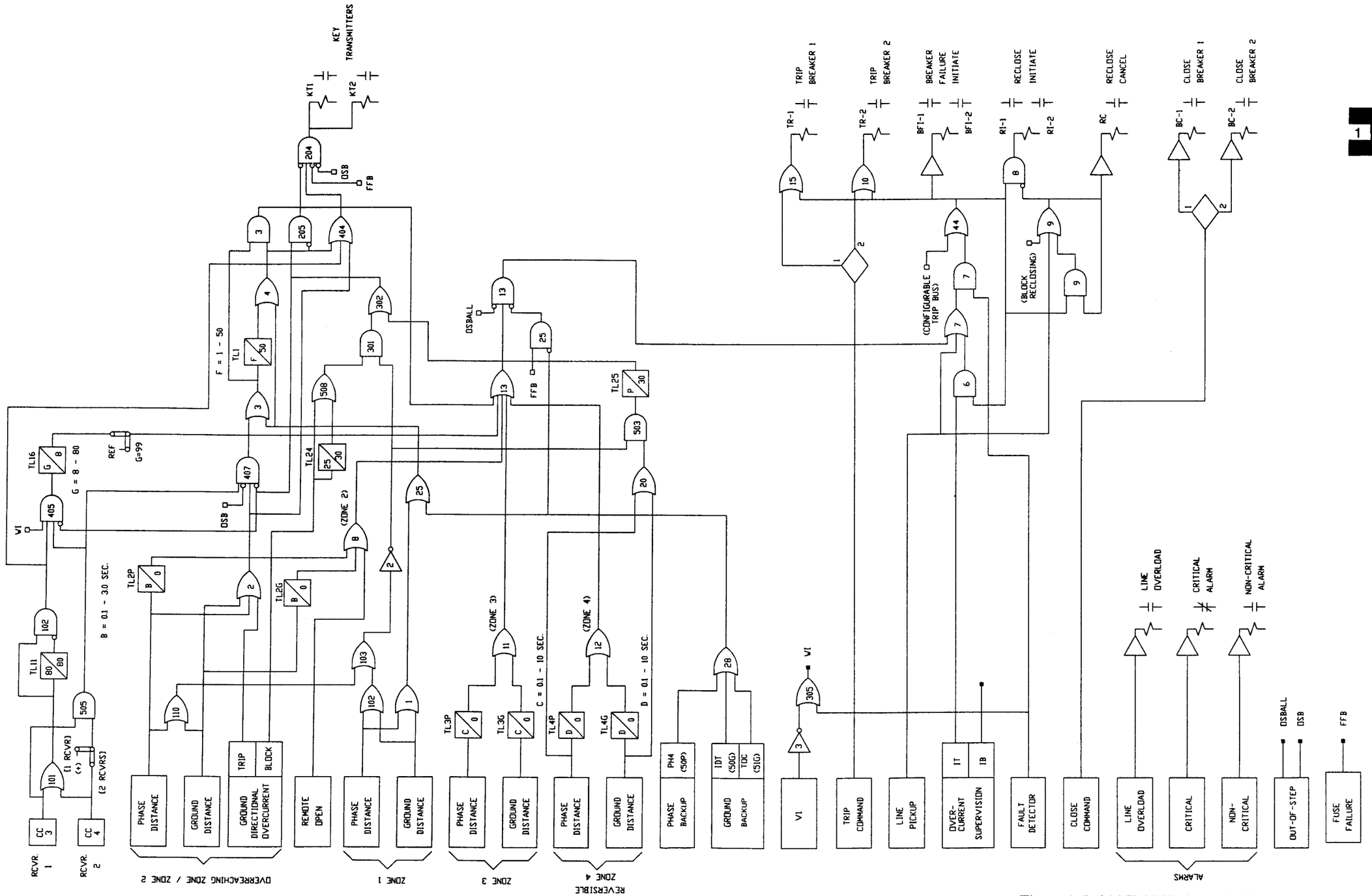


Figure 1-5 (0145D8339 [3]) Hybrid Logic Diagram

* Not applicable to Models DLP3***EC and DLP3***FC

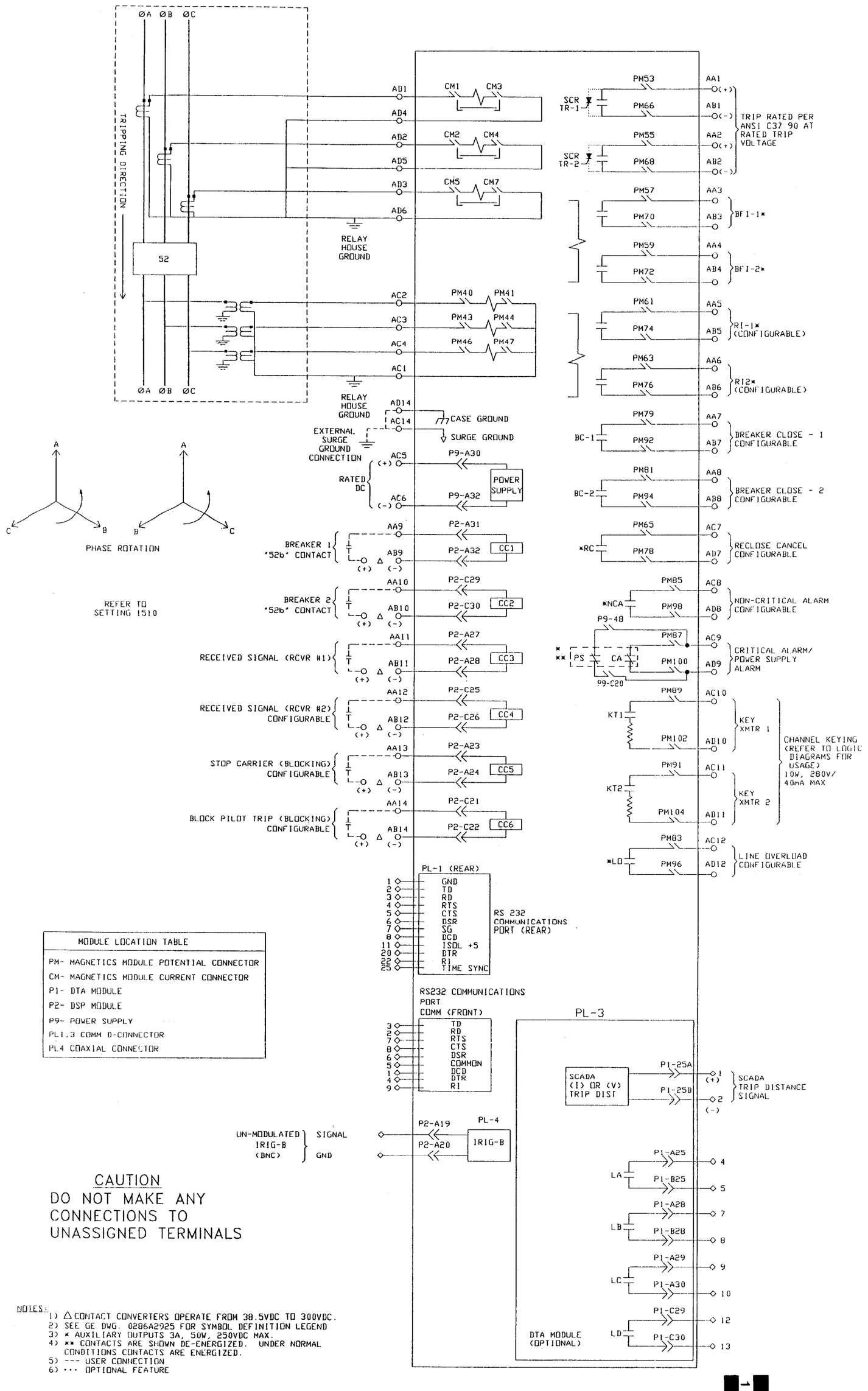
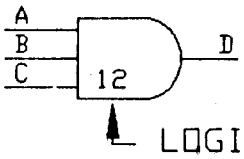


Figure 1-6 (0145D8314[4]) Elementary Diagram

LOGIC SYMBOLS

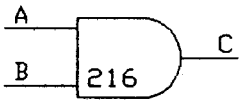
3 INPUT AND GATE



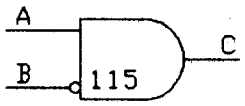
INPUT AT A AND B AND C REQUIRED FOR OUTPUT AT D.

LOGIC DESIGNATION NUMBER

2 INPUT AND GATE

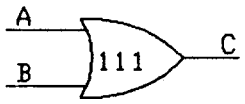


INPUT AT A AND B REQUIRED FOR OUTPUT AT C.



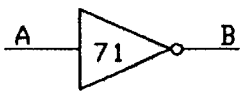
INPUT AT A AND NOT B REQUIRED FOR OUTPUT AT C.

OR GATE



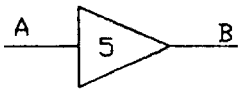
INPUT AT A OR B PRODUCES OUTPUT AT C.

INVERTER



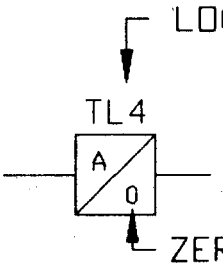
OUTPUT AT B WHEN INPUT NOT PRESENT AT A.

BUFFER



OUTPUT AT B EQUALS INPUT AT A

TIMERS



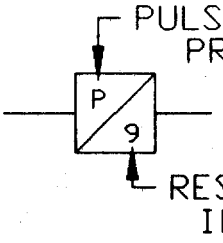


Figure 1-7 (0286A2925 Sh.1 [2]) Digital Relay Symbol Legend

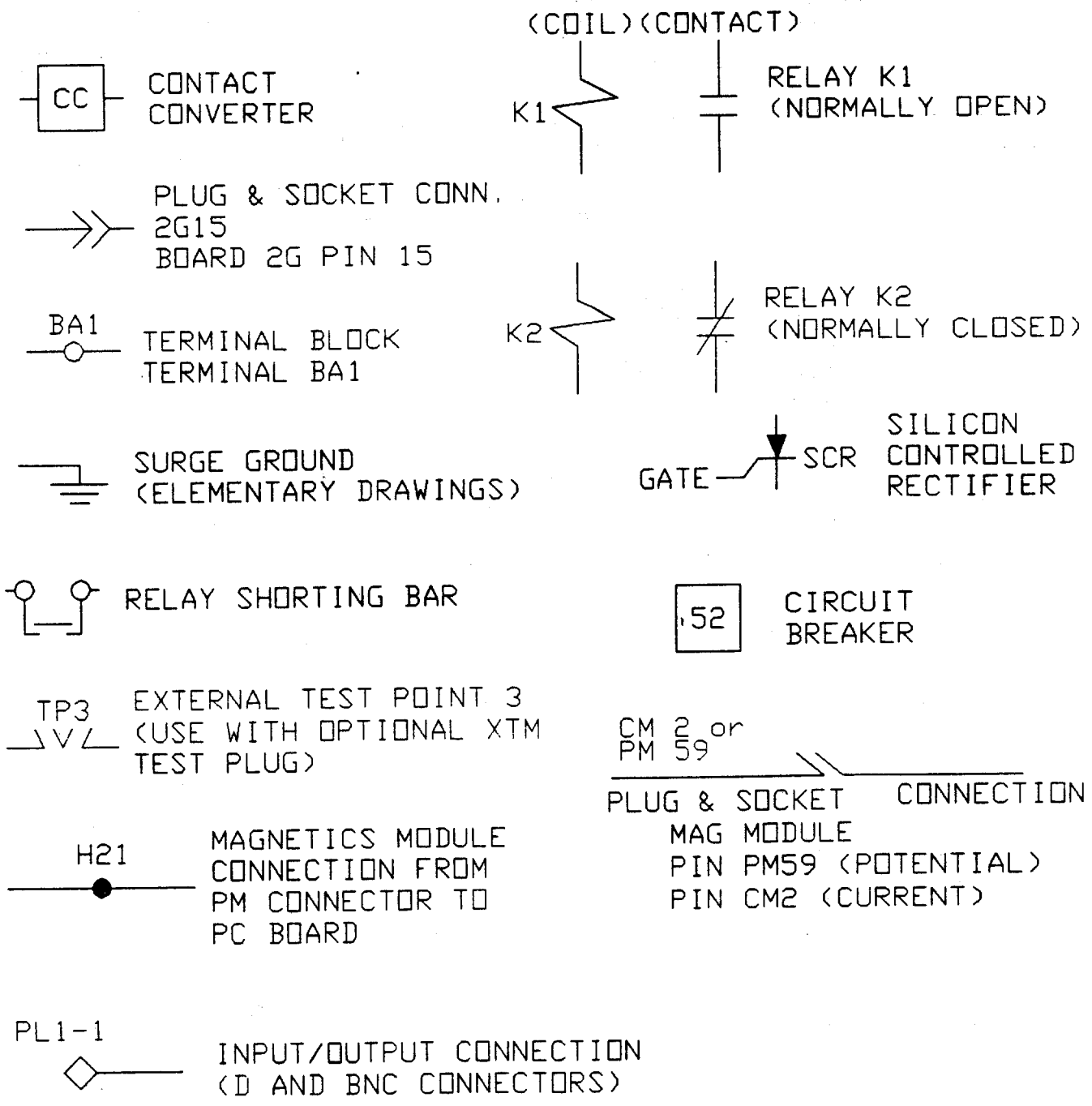


Figure 1-7 (0286A2925 Sh.2 [4]) Digital Relay Symbol Legend

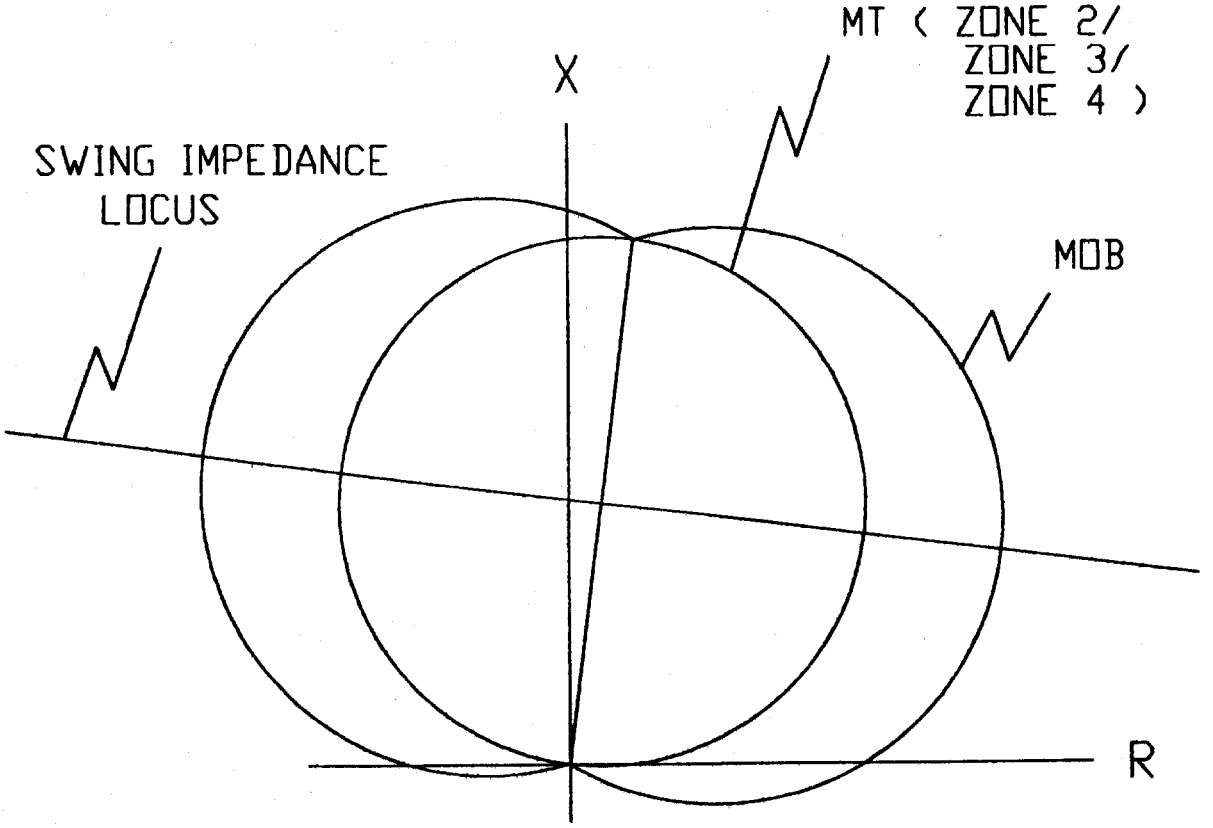


Figure 1-8 (0286A4816) Out-of-Step Block R-X Diagram

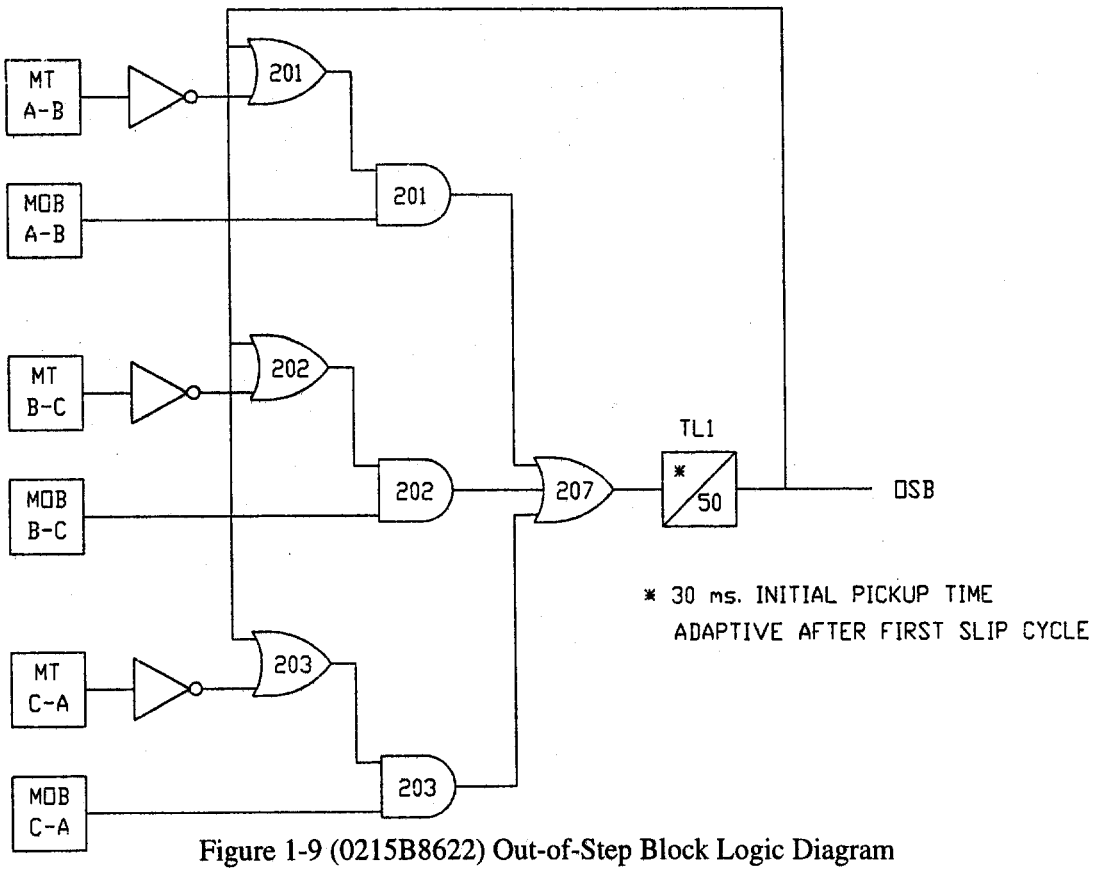


Figure 1-9 (0215B8622) Out-of-Step Block Logic Diagram

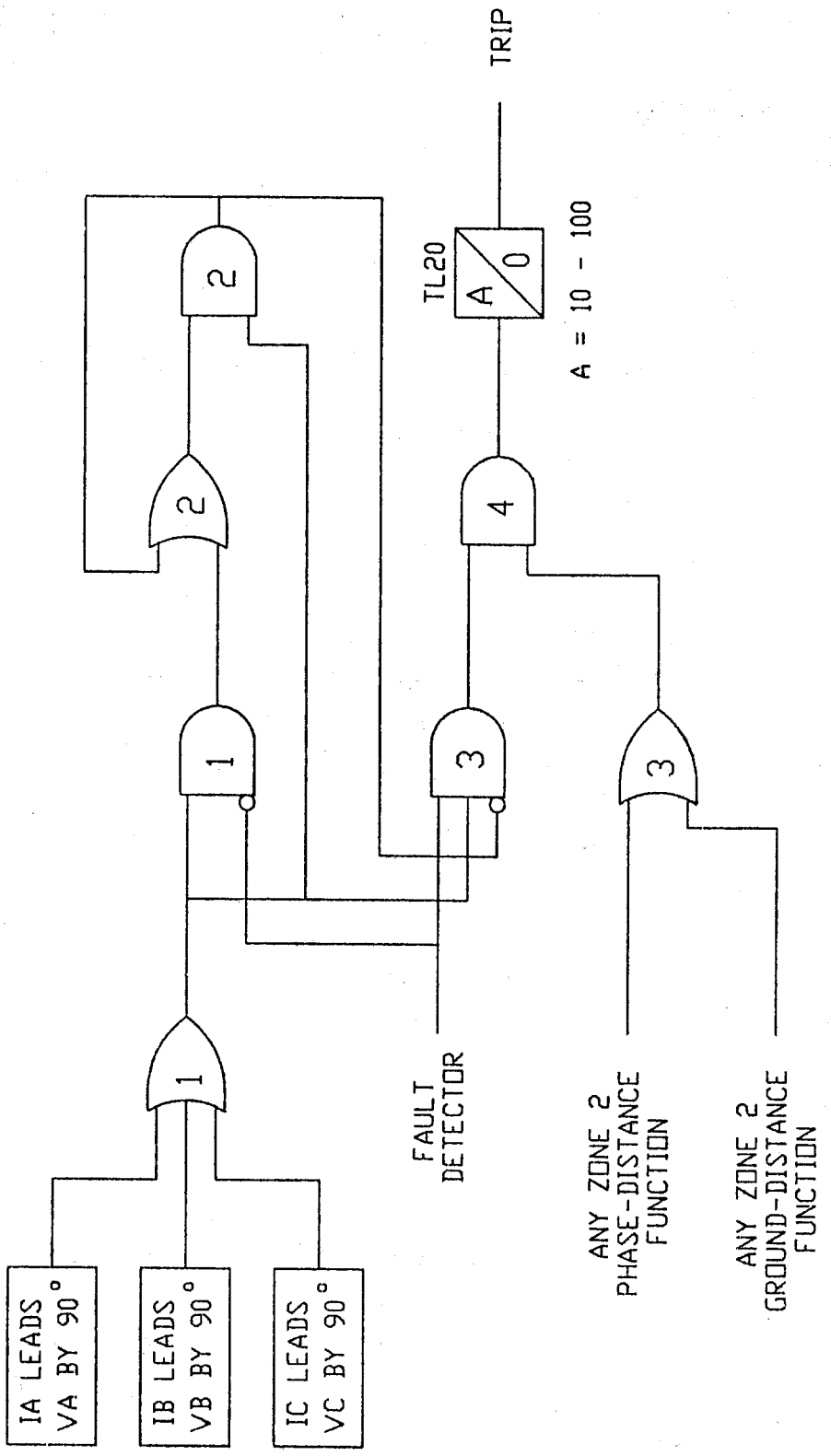


Figure 1-10 (0215B8619) Remote Open Logic Diagram

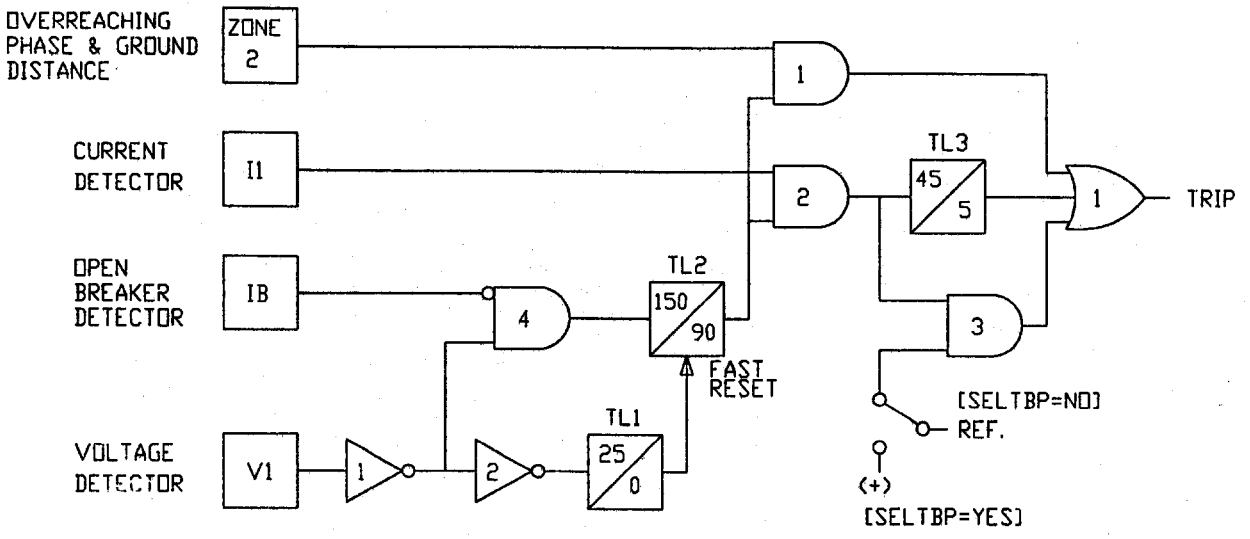


Figure 1-11 (0215B8621 [1]) Line Pickup Logic Diagram

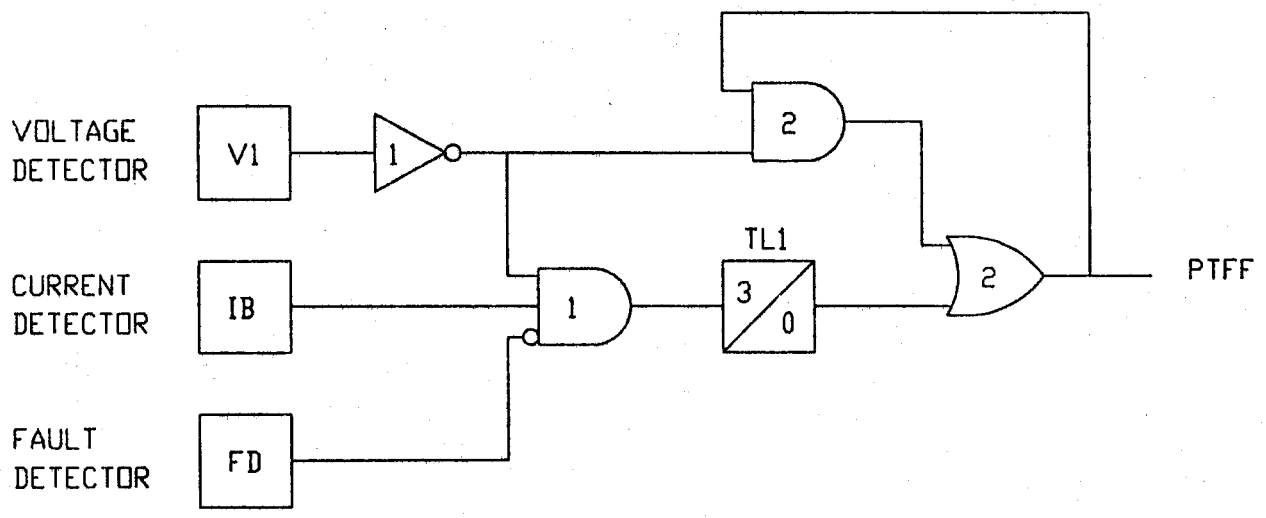


Figure 1-12 (0215B8623) PT Fuse Failure Logic Diagram

TRUTH TABLE

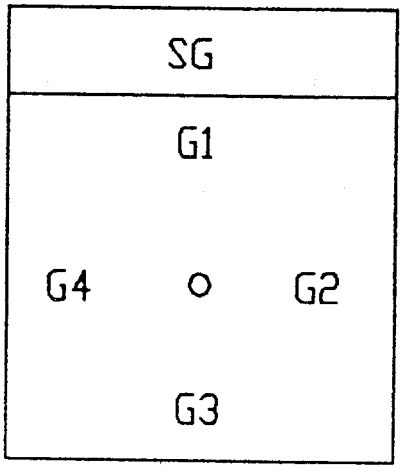
CC5 --> bit 1

CC6 --> bit 0

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

SG

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



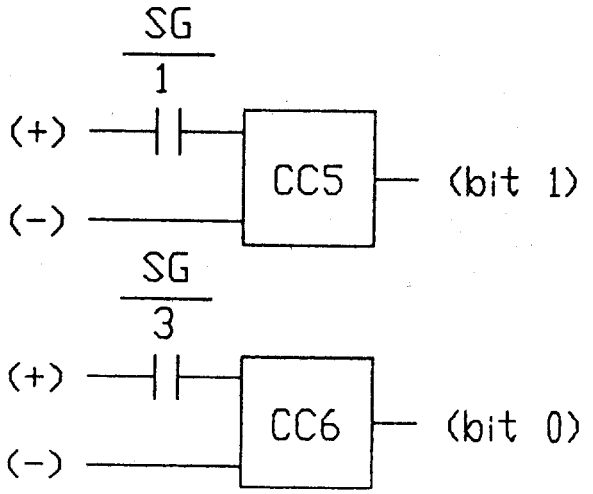


Figure 1-13 (0286A4817) Switch Selection of Active Settings Group

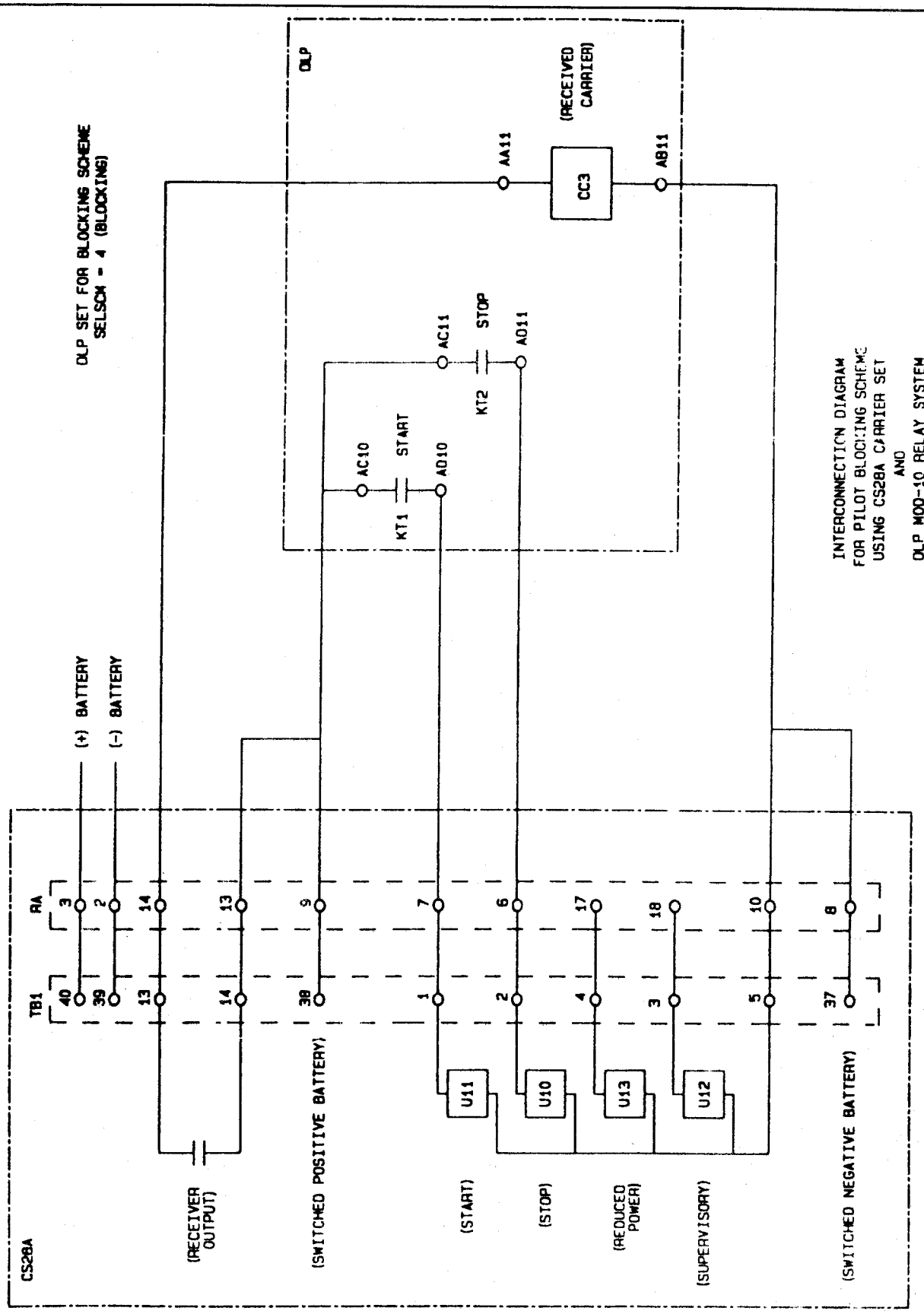


Figure 1-14 (0286A3531) Blocking Scheme Interconnections

* Not applicable to Models DLP3***EC and DLP3***FC

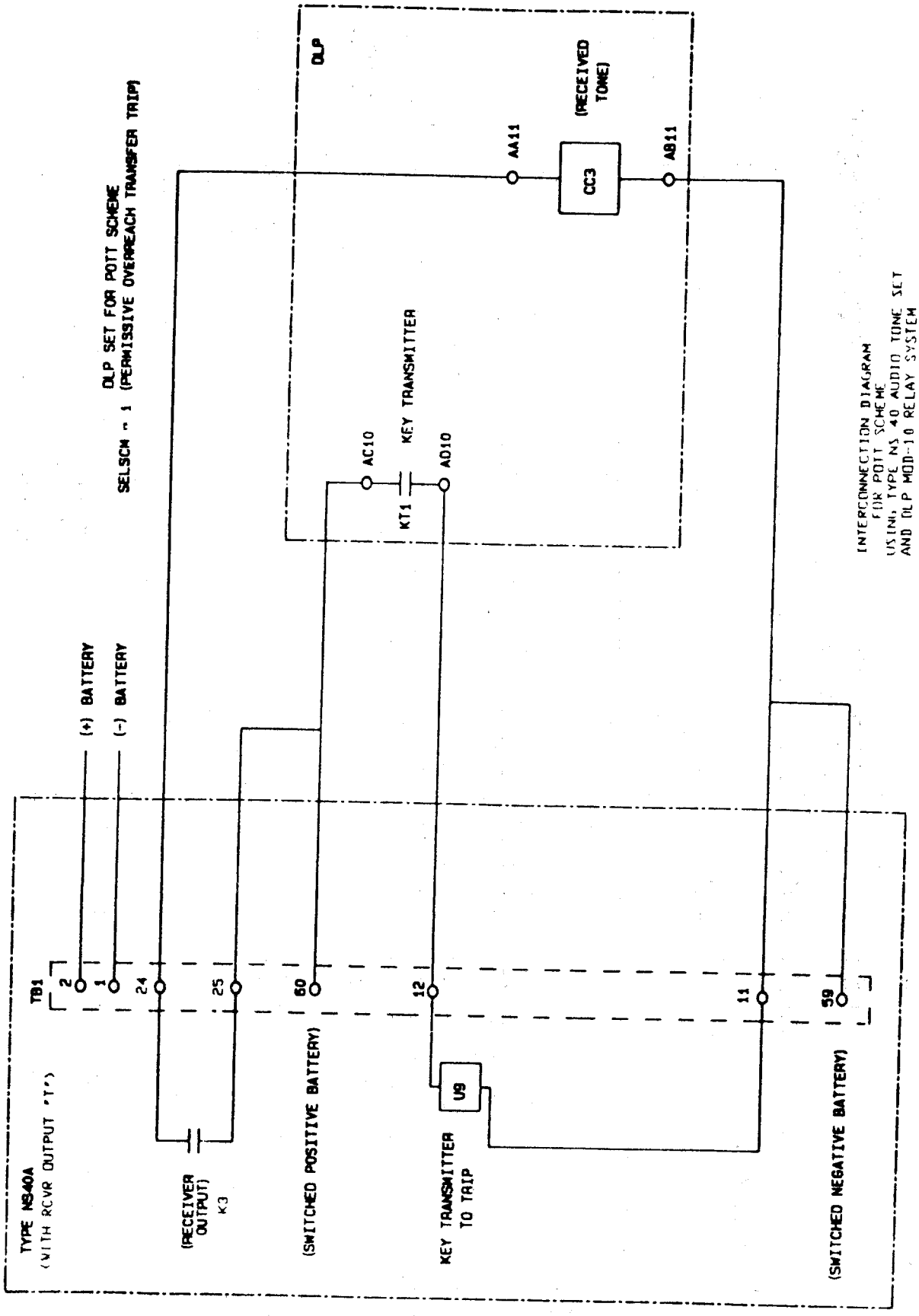


Figure 1-15 (0286A3532 [1]) POTT Scheme Interconnections

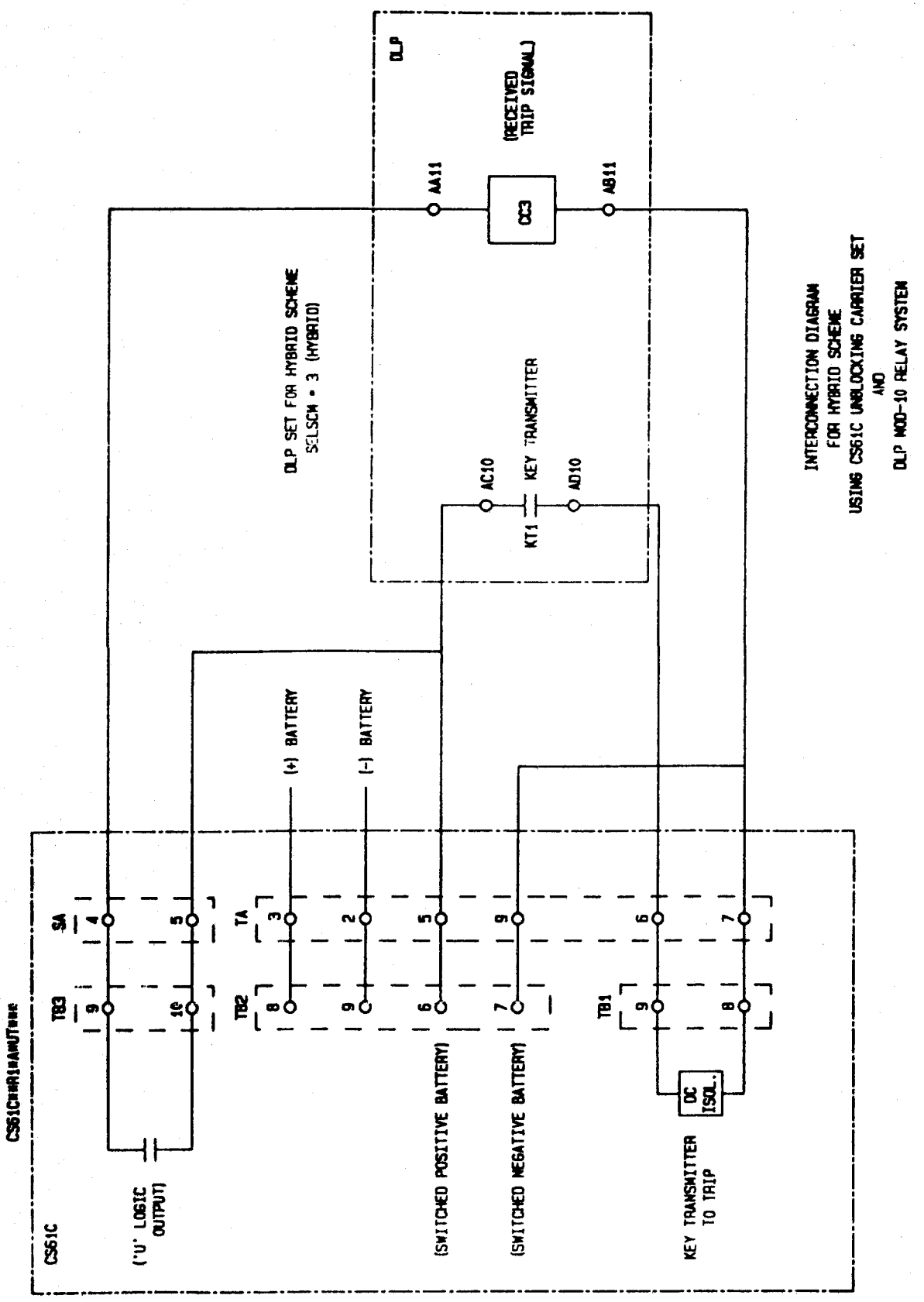


Figure 1-16 (0286A3533) Hybrid Scheme Interconnections

* Not applicable to Models DLP3***EC and DLP3***FC

CALCULATION OF SETTINGS

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

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

Table 2-1 lists all the settings and the corresponding ranges and units. The column labeled DEFAULT in Table 2-1 indicates the DLP3™ settings stored in memory as shipped from the factory. The settings described in the subsequent text are arranged by category of settings, which correspond to the category-of-settings headings displayed in DLP-LINK. 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 in DLP-LINK to identify the particular setting or category-of-settings heading.

Setting ranges for distance and overcurrent functions are different depending upon whether the DLP3™model is designed for use with current transformers having a nominal 1 amp secondary rating or a nominal 5 amp secondary rating. Table 2-1 lists these different ranges (where applicable) under the columns labelled "5 AMP" and "1 AMP."

The sample transmission system shown in Figure 2-1 will be used to determine example settings for a DLP3™ relay system located at bus Able on protected line section A-B. **The current transformers are assumed to have a 5-ampere-rated secondary, and the DLP3 system has a 5 amp secondary rating.** Only "5 AMP" ranges for distance and overcurrent functions are mentioned in the text and example calculations that follow. **All reach settings are in secondary values.**

SETTINGS INDEPENDENT OF THE SELECTED SCHEME

CONFIGURATION SETTINGS, CONFIG

Unit ID Number, UNITID (1501)

The UNITID is the number 0 and is stored in non-volatile memory. It is not possible to change UNITID via DLP-LINK communications software.

System Frequency, SYSFREQ (1502)

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

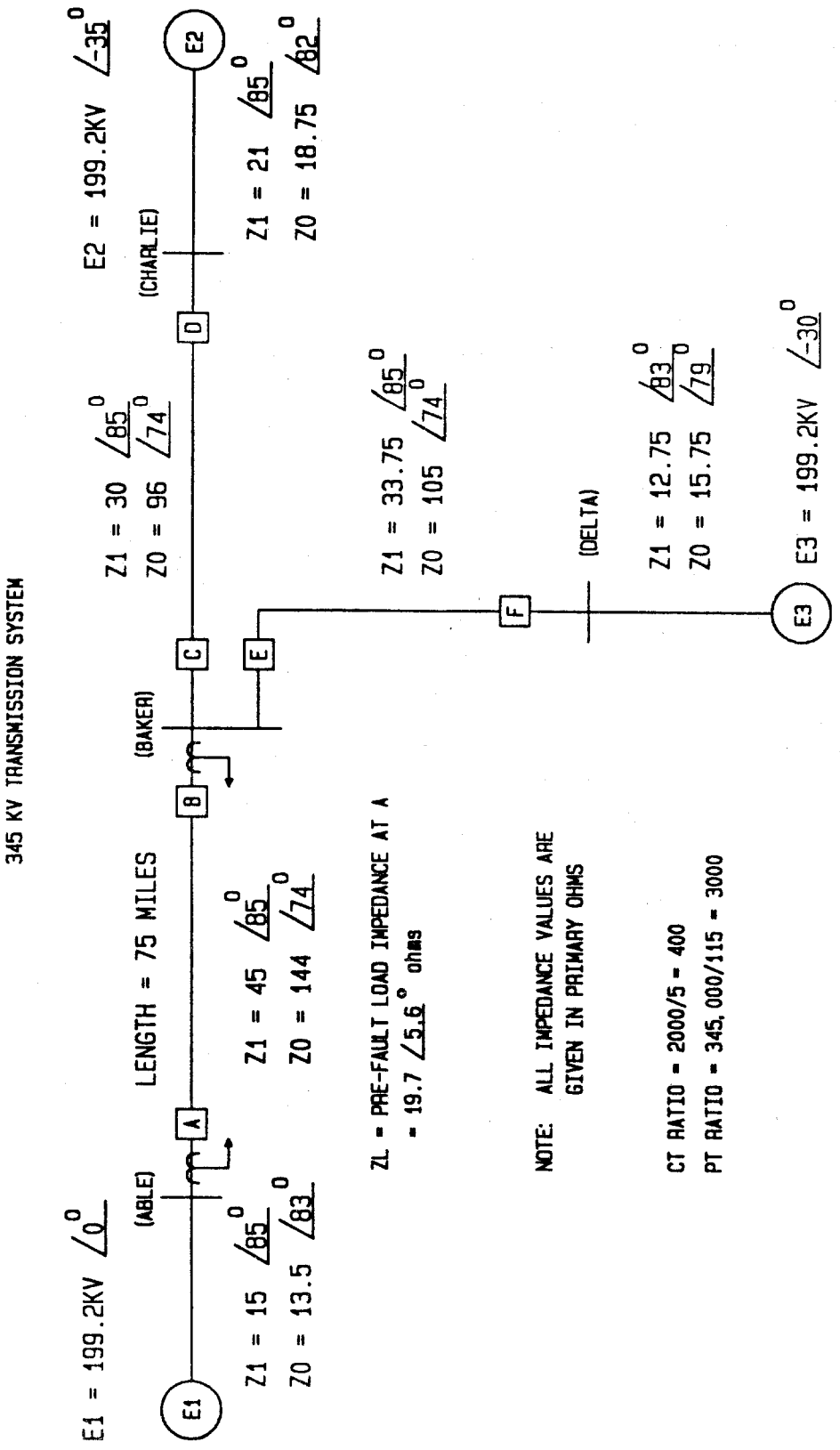


Figure 2-1 (0286A2912) Sample 345 KV system

TABLE 2-1: SETTINGS AND RANGES

SETTING #	DESC.	RANGE 5 AMP	RANGE 1 AMP	UNITS	DEFAULT 5 AMP	DEFAULT 1 AMP
Z1DIST						
0101	SELZ1G	YES, NO		NA	YES	
0102	SELZ1P	YES, NO		NA	YES	
0103	Z1R	0.01-50.00	0.01-250.00	ohms	5.40	27.00
0104	Z1GR	0.01-50.00	0.01-250.00	ohms	5.40	27.00
0105	SELZ1U	0 (MHO) 1 (REACT)		NA	0 (MHO)	
0106	Z1SU	0.01-50.00	0.01-250.00	ohms	20.00	100.00
0107	Z1K0	1.0 - 7.0		NA	2.7	
0108	Z1ERST	0.0 - 60.0		sec.	4.0	
Z2DIST						
0201	SELZ2G	YES, NO		NA	YES	
0202	SELZ2P	YES, NO		NA	YES	
0203	Z2R	0.01-50.00	0.01-250.00	ohms	9.00	45.00
0204	Z2GR	0.01-50.00	0.01-250.00	ohms	9.00	45.00
0205	SELZ2U	0 (MHO) 1 (GDOC) 2 (MHOGDOC)		NA	0 (MHO)	
0206	SELZ2T	YES, NO		NA	YES	
0207	PUTL2P	0.10 - 3.00		sec.	1.00	
0208	PUTL2G	0.10 - 3.00		sec.	1.00	
0209	Z2PANG	90, 105, 120		deg.	90	
0210	Z2GANG	90, 105, 120		deg.	90	
* Z3DIST						
0301	SELZ3G	YES, NO		NA	YES	
0302	SELZ3P	YES, NO		NA	YES	
0303	Z3R	0.01-50.00	0.01-250.00	ohms	12.00	60.00
0304	Z3GR	0.01-50.00	0.01-250.00	ohms	12.00	60.00
0305	PUTL3P	0.10 - 10.00		sec.	3.00	
0306	PUTL3G	0.10 - 10.00		sec.	3.00	
0307	Z3PANG	90, 105, 120		deg.	90	
0308	Z3GANG	90, 105, 120		deg.	90	
* Z4DIST						
0401	SELZ4G	YES, NO		NA	YES	
0402	SELZ4P	YES, NO		NA	YES	
0403	Z4R	0.01-50.00	0.01-250.00	ohms	18.00	90.00
0404	Z4GR	0.01-50.00	0.01-250.00	ohms	18.00	90.00
0405	Z4OR	0.00 - 0.40		NA	0.10	
0406	SELZ4T	YES, NO		NA	YES	
0407	PUTL4P	0.10 - 10.00		sec.	5.00	
0408	PUTL4G	0.10 - 10.00		sec.	5.00	
0409	Z4PANG	80,90,95,105,110,120		deg.	90	
0410	Z4GANG	80,90,95,105,110,120		deg.	90	
0411	SELZ4D	0 (FORWRD) 1 (REVERS)		NA	0 (FORWRD)	

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-1 - (CONTINUED)

SETTING #	DESC.	RANGE 5 AMP	RANGE 1 AMP	UNITS	DEFAULT 5 AMP	DEFAULT 1 AMP
CURSUPVIS						
0501	PUIPT	0.50-5.00	0.10-1.00	amps	0.50	0.10
0502	PUIPB	0.25-3.75	0.05-0.75	amps	0.25	0.05
0503	PUIT	0.20-4.00	0.04-0.80	amps	0.20	0.04
0504	PUIB	0.20-4.00	0.04-0.80	amps	0.20	0.04
OVERCUR						
0601	SELPH4	YES, NO		NA	YES	
0602	PUPH4	2.0-100.0	0.4-20.0	amps	20.0	4.0
0603	SELIDT	YES, NO		NA	YES	
0604	SELDIDT	YES, NO		NA	YES	
0605	PUIDT	0.5-80.0	0.1-16.0	amps	10.0	2.0
0606	SELTOC	YES, NO		NA	YES	
0607	SELDTOC	YES, NO		NA	YES	
0608	PUTOC	0.20-15.00	0.04-3.00	amps	1.00	0.20
0609	TDTOC	0.5 - 10.0		NA	5.0	
0610	PUTTM	0.5 - 30.0		sec.	1.0	
0611	SELCURV	0 [INV] 1 [V-INV] 2 [E-INV] 3 [CUSTOM] 4 [DEFT]		NA	1	
0612	KDCONST	0.0, 0.3		NA	0.3	
BLK RECLOS						
0701	SELALL	YES, NO		NA	YES	
0702	RBOSB	YES, NO		NA	NO	
0703	RB3PH	YES, NO		NA	NO	
0704	RBTOC	YES, NO		NA	NO	
0705	RBZ2T	YES, NO		NA	NO	
*0706	RBZ3T	YES, NO		NA	NO	
*0707	RBZ4T	YES, NO		NA	NO	
0708	RBZ1PH	YES, NO		NA	NO	
0709	RBZ2PH	YES, NO		NA	NO	
0710	RBCTB	YES, NO		NA	NO	
OUTOFSTEP						
0801	SELPTZ	0 (ZONE 2)				
*		1 (ZONE 3)				
*		2 (ZONE 4)		NA	0 (ZONE 2)	
0802	MOBANG	30 - 130		deg.	70	
0803	SELOSB	0 (BLKALL)				
		1 (BLKDIST)				
		2 (BLKPHAS)		NA	0 (BLKALL)	
		3 (BLKNONE)				
0804	OSBLKZ1	YES, NO		NA	YES	
0805	OSBLKZ2	YES, NO		NA	YES	
*0806	OSBLKZ3	YES, NO	NA	YES		
*0807	OSBLKZ4	YES, NO	NA	YES		

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-1 - (CONTINUED)

SETTING #	DESC.	RANGE 5 AMP	RANGE 1 AMP	UNITS	DEFAULT 5 AMP	DEFAULT 1 AMP
LINEPU						
0901	SELLPU	YES, NO		NA	YES	
0902	SELTBP	YES, NO		NA	YES	
0903	PUI1	1.0-15.0	0.2-3.0	amps	5.0	1.0
REMOTEOPEN						
1001	SELROD	YES, NO		NA	YES	
1002	PUTL20	10 - 100		msec.	100	
1003	SELFFB	YES, NO		NA	YES	
LINE OVRLD						
1101	SELOVL	YES, NO		NA	NO	
1102	PULV1	2.5-20.0	0.5-4.0	amps	10.0	2.0
1103	PULV2	5.0-40.0	1.0-8.0	amps	20.0	4.0
1104	PUTL31	10-990		sec.	200	
1105	PUTL32	10-99		sec.	20	
SCHEMESEL						
1201	SELSCM	0 (STEPDST) 1 (POTT) 2 (PUTT) 3 (HYBRID) 4 (BLK1)}} 5 (ZNE1EXT) 6 (BLK2) 7 (BLK3)		NA	0 (STEPDST)	
1202	NUMRCVR	0, 1, 2		NA	0	
SCHEMETIM						
1301	PUTL1	1 - 50		msec.	1	
1302	PUTL5	0 - 200		msec.	50	
1303	DOTL5	0 - 200		msec.	50	
1304	PUTL6	0 - 200		msec.	50	
1305	DOTL6	0 - 200		msec.	50	
1306	PUTL4	0 - 50		msec.	0	
1307	DOTL4	0 - 50		msec.	0	
*1308	PUTL16	8 - 99		msec.	8	
1309	PUTLCFG	0 - 100		msec.	10	
1310	DOTLCFG	0 - 100		msec.	0	
LINE QTY						
1401	POSANG	45-90		deg.	85	
1402	ZERANG	45-90		deg.	75	
1403	ZP	0.01-50.0	0.01-250.00	ohms	6.00	30.00
1404	K0	1.0 - 7.0		NA	3.0	
1405	LINELEN	0.0 - 200.0 0.0 - 322.0		miles km	100.0 161.0	

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-1 - (CONTINUED)

SETTING #	DESC.	RANGE 5 AMP	RANGE 1 AMP	UNITS	DEFAULT 5 AMP	DEFAULT 1 AMP
CONFIG						
1501	UNITID	0000		NA	0000	
1502	SYSFREQ	50,60		Hz	60	
1503	NUMBKRS	1,2		NA	1	
1504	TRIPCIRC	0 (NONE) 1 (BKR 1) 2 (BKR 2) 3 (BOTH)		NA	0 (NONE)	
1505	SELPRIM	0 (CVT PRI) 1 (CVT SEC) 2 (PT PRI) 3 (PT SEC)		NA	3 (PT SEC)	
1506	CTRATIO	1 - 5000		NA	400	
1507	PTRATIO	1 - 7000		NA	2000	2000
1508	DISTUNIT	0 (MILES) 1 (KM)		NA	0 (MILES)	
1509	COMMPORT	2400 baud, 1 stop bit, no parity** 9600 baud, 1 stop bit, no parity**		2401 baud 9601 baud		
1510	PHASDESG	0 (A-B-C) 1 (A-C-B)		NA	0 (A-B-C)	
1511	SELTSYNC	0 (NONE) 1 (IRIG-B) 2 (G-NET)		NA	0 (NONE)	
1512	NUMFLTS	2 4 7 14		NA	4	
1513	PREFLT	1 - 8		NA	3	
1514	OSCTRIG	0 (UNUSED) 1 (FLTDET) 2 (ANY Z2) 3 (ANY Z3) 4 (ANY Z4) 5 (OUTSTP) 6 (V1 DET)		NA	0 (UNUSED)	
* * 1515	UNBALALM	YES,NO		NA	YES	
SCADA DTA						
1601	FLTLOCK	0 - 99.9		sec.	0	
1602	FLTRESET	0 - 999		minutes	0	
CNFGINPUTS						
1701	CONCCI	0 - 8		NA	3	
1702	SETGRP	0 - 4		NA	1	

*** Not applicable to Models DLP3***EC and DLP3***FC**

**** Not remotely settable. Refer to Figure 4-2 in the MODULES section for COMMPORT setting.**

TABLE 2-1 - (CONTINUED)

SETTING #	DESC.	RANGE 5 AMP	RANGE 1 AMP	UNITS	DEFAULT 5 AMP	DEFAULT 1 AMP
BKR1CLSOUT						
1801	CONOUT1	0 (DEFAULT) 1 (OR GATE) 2 (ANDGATE)		NA	0 (DEFAULT)	
1802	CO1IN1	0-59, [101-159]		NA	0	
1803	CO1IN2	0-59, [101-159]		NA	0	
1804	CO1IN3	0-59, [101-159]		NA	0	
1805	CO1IN4	0-59, [101-159]		NA	0	
1806	CO1IN5	0-59, [101-159]		NA	0	
1807	CO1IN6	0-59, [101-159]		NA	0	
1808	CO1IN7	0-59, [101-159]		NA	0	
1809	CO1IN8	0-59, [101-159]		NA	0	
BKR2CLSOUT						
1901	CONOUT2	0 (DEFAULT) 1 (OR GATE) 2 (ANDGATE)		NA	0 (DEFAULT)	
1902	CO2IN1	0-59, [101-159]		NA	0	
1903	CO2IN2	0-59, [101-159]		NA	0	
1906	CO2IN5	0-59, [101-159]		NA	0	
1907	CO2IN6	0-59, [101-159]		NA	0	
1908	CO2IN7	0-59, [101-159]		NA	0	
1909	CO2IN8	0-59, [101-159]		NA	0	
RCANCLOUT						
2001	CONOUT3	0 (DEFAULT) 1 (OR GATE) 2 (ANDGATE)		NA	0 (DEFAULT)	
2002	CO3IN1	0-59, [101-159]		NA	0	
2003	CO3IN2	0-59, [101-159]		NA	0	
2004	CO3IN3	0-59, [101-159]		NA	0	
2005	CO3IN4	0-59, [101-159]		NA	0	
2006	CO3IN5	0-59, [101-159]		NA	0	
2007	CO3IN6	0-59, [101-159]		NA	0	
2008	CO3IN7	0-59, [101-159]		NA	0	
2009	CO3IN8	0-59, [101-159]		NA	0	
LNOVLDOUT						
2101	CONOUT4	0 (DEFAULT) 1 (OR GATE) 2 (ANDGATE) 3 (OR CTB) 4 (AND CTB)		NA	0 (DEFAULT)	
2102	CO4IN1	0-59, [101-159]		NA	0	
2103	CO4IN2	0-59, [101-159]		NA	0	
2104	CO4IN3	0-59, [101-159]		NA	0	
2105	CO4IN4	0-59, [101-159]		NA	0	
2106	CO4IN5	0-59, [101-159]		NA	0	
2107	CO4IN6	0-59, [101-159]		NA	0	
2108	CO4IN7	0-59, [101-159]		NA	0	
2109	CO4IN8	0-59, [101-159]		NA	0	

TABLE 2-1 - (CONTINUED)

SETTING #	DESC.	RANGE 5 AMP	RANGE 1 AMP	UNITS	DEFAULT 5 AMP	DEFAULT 1 AMP
NONCRITOUT						
2201	CONOUT5	0 (DEFAULT) 1 (OR GATE) 2 (ANDGATE)		NA	0 (DEFAULT)	
2202	CO5IN1	0-59, [101-159]		NA	0	
2203	CO5IN2	0-59, [101-159]		NA	0	
2204	CO5IN3	0-59, [101-159]		NA	0	
2205	CO5IN4	0-59, [101-159]		NA	0	
2206	CO5IN5	0-59, [101-159]		NA	0	
2207	CO5IN6	0-59, [101-159]		NA	0	
2208	CO5IN7	0-59, [101-159]		NA	0	
2209	CO5IN8	0-59, [101-159]		NA	0	
RINITOUT						
2301	CONOUT6	0 (DEFAULT) 1 (OR GATE) 2 (ANDGATE)		NA	0 (DEFAULT)	
2302	CO6IN1	0-59, [101-159]		NA	0	
2303	CO6IN2	0-59, [101-159]		NA	0	
2304	CO6IN3	0-59, [101-159]		NA	0	
2305	CO6IN4	0-59, [101-159]		NA	0	
2306	CO6IN5	0-59, [101-159]		NA	0	
2307	CO6IN6	0-59, [101-159]		NA	0	
2308	CO6IN7	0-59, [101-159]		NA	0	
2309	CO6IN8	0-59, [101-159]		NA	0	

Number of Breakers, NUMBKRS (1503)

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

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

Trip Circuit Monitor, TRIPCIRC (1504)

The four possible settings are 0 (NONE), 1 (BKR 1), 2 (BKR 2), or 3 (BOTH). These select the trip contacts or SCRs (1 or 2 - see Figures 1-1,2,3,4,5) for which the function is active. For instance, with TRIPCIRC=1 the trip circuit monitor function is active only for the trip contact (or SCR) associated with breaker 1.

Select Primary/Secondary Units, SELPRIM (1505)

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

stored as secondary values. All settings are expressed in terms of secondary values, regardless of the SELPRIM setting.

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

Current Transformer Ratio, CTRATIO (1506)

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

Potential Transformer Ratio, PTRATIO (1507)

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

Units of Distance, DISTUNIT (1508)

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 Port, COMMPORT (1509)

Refer to the INTERFACE section for setting the links on the MMI module to select the Baud rate (either 2400 or 9600); 1 stop bit and no parity are preset.

Phase Designation, PHASDESG (1510)

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

Select Time Synchronization, SELTSYNC (1511)

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

Number of Faults, NUMFLTS (1512)

NUMFLTS selects the maximum number of oscillography "storage events" (faults) that may be stored in memory without overwriting, and can be set to 2, 4, 7, or 14. When the maximum number are stored in memory, the oscillography data associated with a subsequent storage event will overwrite the data from the first (oldest).

This setting allows the user to apportion a fixed amount of memory into different sized blocks for oscillography storage. The following tabulation shows the total number of oscillography cycles allowed per storage event as a function of NUMFLTS.

NUMFLTS	STORAGE CYCLES
2	72
4	36
7	18
14	9

Prefault Cycles, PREFLT (1513)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

Oscillography Trigger, OSCTRIG (1514)

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

Current Unbalance Alarm, UNBALALM (1515)

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

Example Settings (based on Figure 2-1):

UNITID	= 0
SYSFREQ	= 60
TRIPCIRC	= 1
SELPRIM	= 1 (SECNDRY)
CTRATIO	= 400 [2000/5]
PTRATIO	= 3000 [345,000/115]
DISTUNIT	= 0 (MILES)
COMMPORT	= NOT APPLICABLE
PHASEDESG	= 0 (A-B-C)
SELTSYNC	= 0 (INTERNAL)
NUMFLTS	= 4
PREFLT	= 3
OSCTRIG	= 0 (UNUSED)

LINE QUANTITIES, LINE QTY

Positive-Sequence Angle of Maximum Reach, POSANG (1401)

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 (1402)

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 (1403)

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

Zero-Sequence Current Compensation, K0 (1404)

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 (1405)

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 2-1):

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

OVERCURRENT BACKUP, OVERCUR

Select Phase Instantaneous Overcurrent (PH4), **SELPH4** (0601)

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 (0602)

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

PH4 provides direct tripping for multi-phase faults, and it operates on the highest of the three delta currents, IA-IB, IB-IC, or IC-IA. This permits PH4 to have the same response for all multi-phase faults at the same location. PUPH4 should be set at least 25% greater than the maximum three-phase fault delta current at either terminal of the protected line. The setting is calculated on the basis of the delta current which for a three phase fault is equal to the square root of three times the phase current. PUPH4 can be set over the range of 2.0-100.0 amps.

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

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 (0604)

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 (0605)

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 or 0.3

When KD is set to 0.3, positive-sequence current restraint is used to provide secure operation during steady-state unbalances, error currents, and external faults. The IDT setting is established by first determining the maximum positive value of the operating quantity listed above. PUIDT is then this maximum operate signal plus a margin of 25% of the $3x|I0|$ value from this same maximum operate signal.

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

When KD is set to 0, the setting is based on $3x|I0|$. PUIDT can be set over the range of 0.5-80.0 amps.

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

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 (0607)

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 (0608)

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

$3x|I0|$

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

Ground Time Overcurrent Time Dial, TDTOC (0609)

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.

Definite Time Delay, PUTTM (0610)

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

Select TOC Characteristic Curve, SELCURV (0611)

SELCURV determines the characteristic curve shape for the TOC function. The choices are 0 (INV) inverse curve - Figure 2-2, 1 (V-INV) very inverse curve - Figure 2-3, 2 (E-INV) extremely inverse - Figure 2-4, 3 (CUSTOM) user-defined custom curve, and 4 (DEFT) definite time. The user-defined custom curve is created by running the PC program DLPTOC.EXE. This program may be run from the DOS prompt or called from a menu item in the DLP-LINK communications program. The resultant data file created by DLPTOC is downloaded to the DLP3 system using DLP-LINK.

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

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

Example Settings (based on Figure 2-1):

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

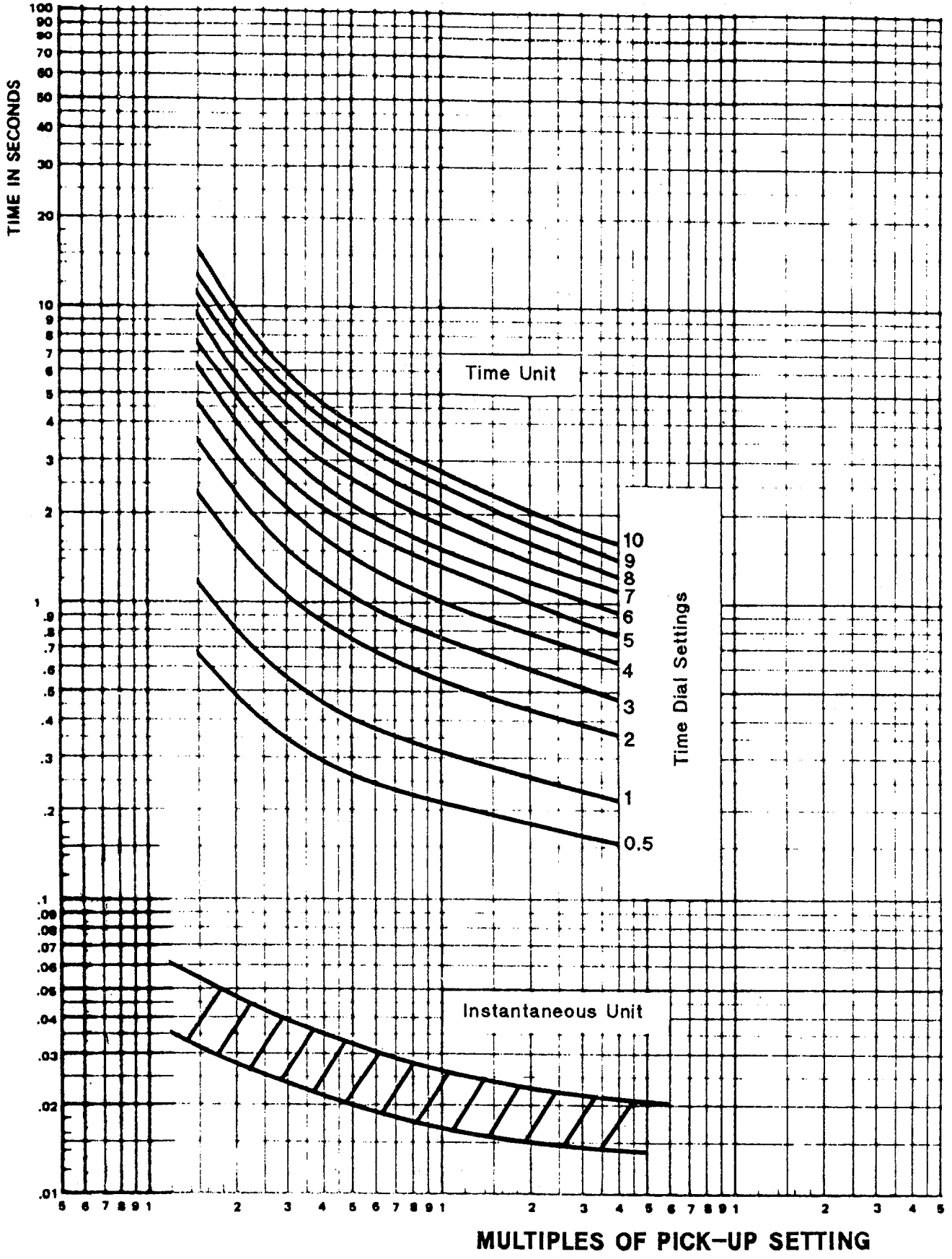


Figure 2-2 (GES-9857) TOC - Inverse Time-Current Curve

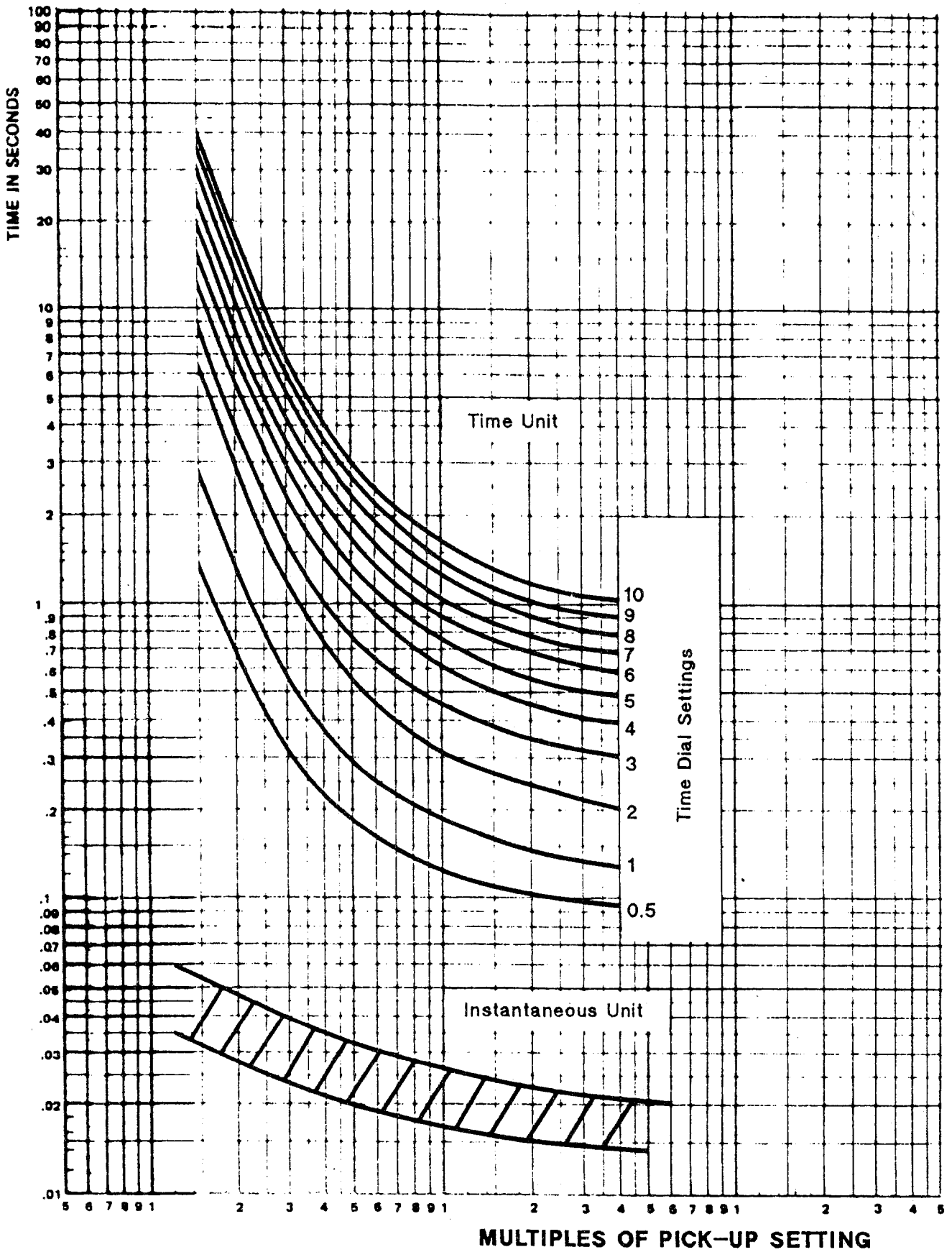


Figure 2-3 (GES-9858) TOC - Very Inverse Time-Current Curve

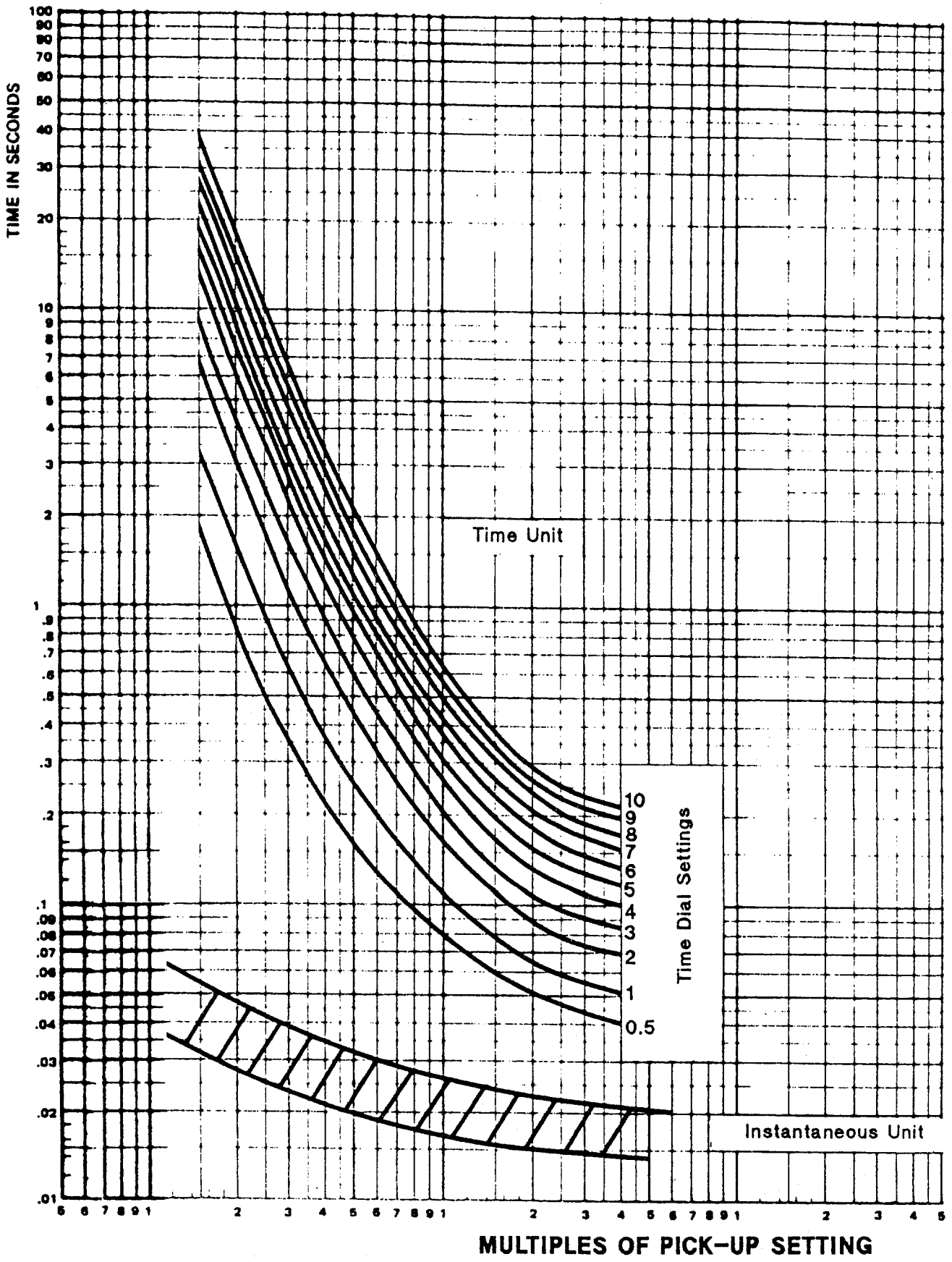


Figure 2-4 (GES-9859) TOC - Extremely Inverse Time-Current Curve

The table below lists the results of the evaluation of the IDT operate quantity, 3x|I0| - 3xKDx|I1| where KD=0.3, 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
PUTTM = <NOT APPLICABLE>
SELCURV = 0 (INV)
KDCONST = 0.3

LINE PICKUP, LINEPU

Select Line Pickup, SELLPU (0901)

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).

Select Timer Bypass, SELTBP (0902)

SELTBP can be set to either YES or NO. This setting determines whether the coordinating timer TL3 in Figure 1-12 is bypassed (YES) or left in service (NO).

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

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

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

PUI1 should be set no greater than 2/3 of the minimum fault current for an internal three-phase fault at the relay location. If the minimum fault current is greater than the maximum load current on

the protected line, then the I1 setting can be reduced to provide greater coverage of the line. For this case, a setting of 110% of the maximum load current is proposed.

Example Settings (based on Figure 2-1):

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 (1101)

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 (1102)

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

Level 2 Overcurrent Setting, PULV2 (1103)

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

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

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

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

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

Example Settings (based on Figure 2-1):

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

OUT-OF-STEP BLOCKING (OSB), OUTOFSTEP

Select Phase Trip Unit to Coordinate With, SELPTZ (0801)

* 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 1-10). 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 (0802)

This setting determines the shape of the MOB characteristic on the R-X diagram, and it determines the separation between the MOB and phase trip functions on the R-X diagram. This separation and the initial pickup delay of timer TL1 in Figure 1-8 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°.

*** Some parts not applicable to Models DLP3***EC and DLP3***FC**

Select Block Trip Actions, SELOSB (0803)

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

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

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

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

Example Settings (based on Figure 2-1):

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)
OSBLKZ1	= YES
OSBLKZ2	= YES
*OSBLKZ3	= YES
*OSBLKZ4	= YES

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 1-1,2,3,4, and 5.

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

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

Example Settings (based on Figure 2-1):

SELALL = YES

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

SCADA DTA INTERFACE, 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 DLP3 system.

SCADA DTA Fault Location Lock, FLTLOCK (1601)

FLTLOCK can be set over the range of 0 - 99.9 seconds. FLTLOCK is used to specify a time period after 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.

*** Some parts not applicable to Models DLP3***EC and DLP3***FC**

SCADA DTA Fault Location Reset, FLTRESET (1602)

FLTRESET can be set over the range of 0 - 999 minutes. FLTRESET is used to specify a time period after a fault at the expiration of which the fault location information stored in the DTA module is reset (output forced to full-scale value) and those fault-type contacts that have closed will open. A setting of 0 refers to an infinite time.

Example Settings (based on Figure 2-1):

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.

CONFIGURABLE INPUTS, CNFGINPUTS

Configurable Input Mode, CONCCI (1701)

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

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

where:

RCVR. 2 indicates that the external contact wired to CC4 is used as receiver number 2 in a pilot scheme.

External Trigger indicates that the external contact wired to CC4 is used as an oscillography trigger.

Confg. Input 1, 2, or 3 indicates that the external contact wired to CC4, 5, or 6 is used as one of the 59 "input numbers" associated with the Configurable Outputs (refer to the next section for an explanation).

Select Grp. bit 0 or 1 indicates that the external contact wired to CC5 or CC6 is used as one of the two bits that determine which settings group (1, 2, 3, or 4) is active. Two bits allow four combinations to select the settings group (refer to PRODUCT DESCRIPTION and Figure 1-13 for an explanation).

Stop Carrier indicates that the external contact wired to CC5 is used to close the KT2 CARRIER STOP contact and prevent the KT1 CARRIER START contact from closing when a blocking scheme is selected, SELSCM=4 (BLOCK).

Block Pilot Tripping indicates that the external contact wired to CC6 is used to block pilot tripping and stop carrier (see above) when a blocking scheme is selected, SELSCM=4 (BLOCK).

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

Settings Group, SETGRP (1702)

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

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

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

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

Example Settings (based on Figure 2-1):

CONCCI = 3
SETGRP = 1

CONFIGURABLE OUTPUT #1, BKR1CLSOUT

Close Contact 1, CONOUT1 (1801)

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

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

Figure 2-5 is a functional logic diagram for configurable output #1. The link represents the CONOUT1 setting. When CONOUT1=0 the contact closes when a breaker #1 close command, BKCLS1, is received, and the contact is labelled, BC-1, to correspond to this default setting. When CONOUT1=1 the contact closes when any of 8 inputs to OR1 are present. When CONOUT1=2 the contact closes when all of the 8 inputs to AND1 are present. Settings CO1IN1-8 determine what internal DLP3 system signals are routed to each of the 8 inputs as explained below.

Input Number 1, CO1IN1 (1802)

CO1IN1 may be set over the range from 0 to 59. A "0" indicates that the OR or AND input is not used (i.e., the input is set to be a "logic 0" for an OR or a "logic 1" for an AND). Settings 1 to 59 are selected from the DLP3 internal signals tabulated below:

Input Number 2, CO1IN2 (1803) - see CO1IN1
Input Number 3, CO1IN3 (1804) - see CO1IN1
Input Number 4, CO1IN4 (1805) - see CO1IN1
Input Number 5, CO1IN5 (1806) - see CO1IN1
Input Number 6, CO1IN6 (1807) - see CO1IN1
Input Number 7, CO1IN7 (1808) - see CO1IN1
Input Number 8, CO1IN8 (1809) - see CO1IN1

INPUT SIGNAL	INPUT NUMBER	MMI MNEMONIC
ZONE 1 AG	1	Z1 AG
ZONE 1 BG	2	Z1 BG
ZONE 1 CG	3	Z1 CG
ZONE 2 AG	4	Z2 AG
ZONE 2 BG	5	Z2 BG
ZONE 2 CG	6	Z2 CG
* ZONE 3 AG	7	Z3 AG
* ZONE 3 BG	8	Z3 BG
* ZONE 3 CG	9	Z3 CG
* ZONE 4 AG	10	Z4 AG
* ZONE 4 BG	11	Z4 BG
* ZONE 4 CG	12	Z4 CG
ANY ZONE 1 GND.	13	Z1 GRN
Z2 GND. TIMER, TL2G	14	Z2 GRND TIMER
Z3 GND. TIMER, TL3G	15	Z3 GRND TIMER
Z4 GND. TIMER, TL4G	16	Z4 GRND TIMER
ZONE 1 AB	17	Z1 AB
ZONE 1 BC	18	Z1 BC
ZONE 1 CA	19	Z1 CA
ZONE 2 AB	20	Z2 AB
ZONE 2 BC	21	Z2 BC
ZONE 2 CA	22	Z2 CA
ZONE 3 AB	23	Z3 AB
ZONE 3 BC	24	Z3 BC
ZONE 3 CA	25	Z3 CA
ZONE 4 AB	26	Z4 AB
ZONE 4 BC	27	Z4 BC
ZONE 4 CA	28	Z4 CA
ANY ZONE 1 PHASE	29	Z1 PHS
Z2 PHASE TIMER, TL2P	30	Z2 PHASE TIMER
Z3 PHASE TIMER, TL3P	31	Z3 PHASE TIMER
Z4 PHASE TIMER, TL4P	32	Z4 PHASE TIMER
IT	33	IT DET
IB	34	IB DET
IPT+NT	35	GRDTRP
IPB+NB	36	GRDBLK

INPUT SIGNAL	INPUT NUMBER	MMI MNEMONIC
FAULT DETECTOR, FD	37	FLTDET
REMOTE OPEN, ROD	38	REMOPN
OUT OF STEP, OSB	39	OUTSTP
V1 DETECTOR	40	V1 DET
LINE OVERLOAD	41	LNOVLD
PH4 (50P)	42	INPOVR
IDT (50G)	43	INGOVR
TOC (51G)	44	TMGOVR
LINE PICKUP	45	LPCKUP
FUSE FAILURE	46	FUSEFL
NT	47	GR FWR
NB	48	GR RVR
RECLOSE CANCEL, RC	49	RECCAN
CONFG. INPUT 1	50	CNFIN1
CONFG. INPUT 2	51	CNFIN2
CONFG. INPUT 3	52	CNFIN3
NON-CRITICAL ALARM	53	NOCALM
ANY ZONE 2 - PH. OR GND.	54	ANY Z2
ANY ZONE 3 - PH. OR GND.	55	ANY Z3
ANY ZONE 4 - PH. OR GND.	56	ANY Z4
TRIP BUS	57	TRPBFI
MANUAL CLOSE - BRKR. 1	58	BKCLS1
MANUAL CLOSE - BRKR. 2	59	BKCLS2

*** Not applicable to Models DLP3***EC and DLP3***FC**

The logical NOT of any of the above 59 inputs is selected by adding 100 to the Input Number listed above. For example, the logical NOT of FD for input #1 is CO1IN1=137.

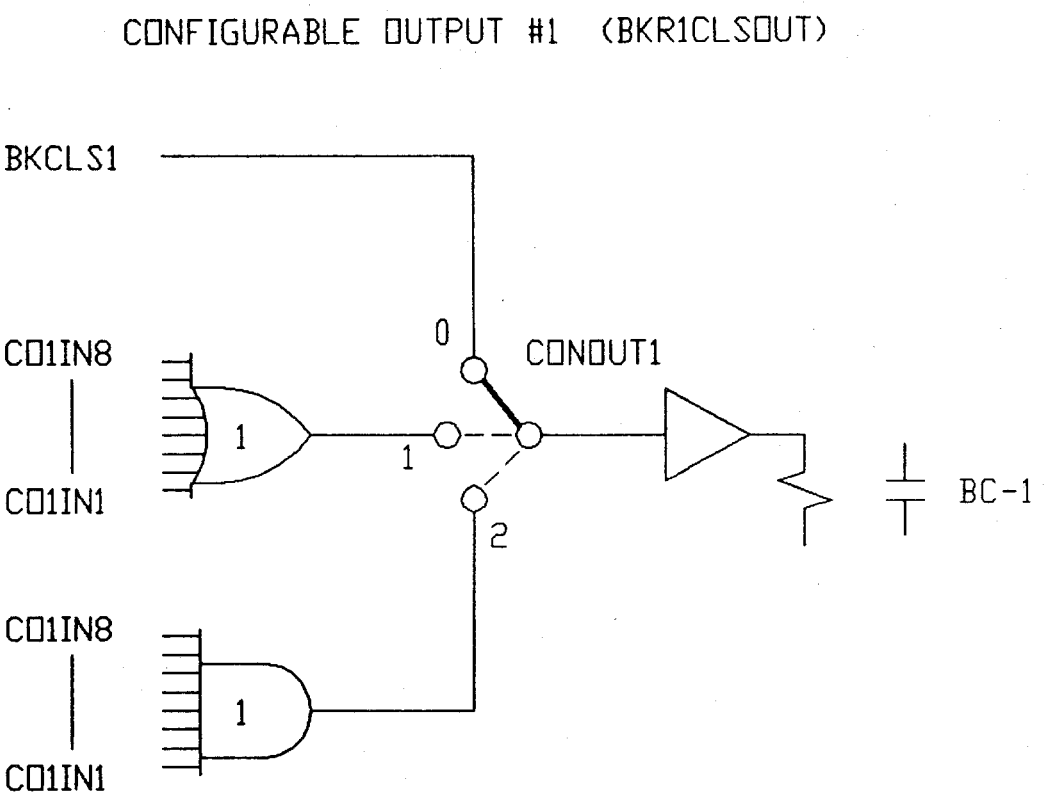


Figure 2-5 (0286A4818) Configurable Output #1 Logic

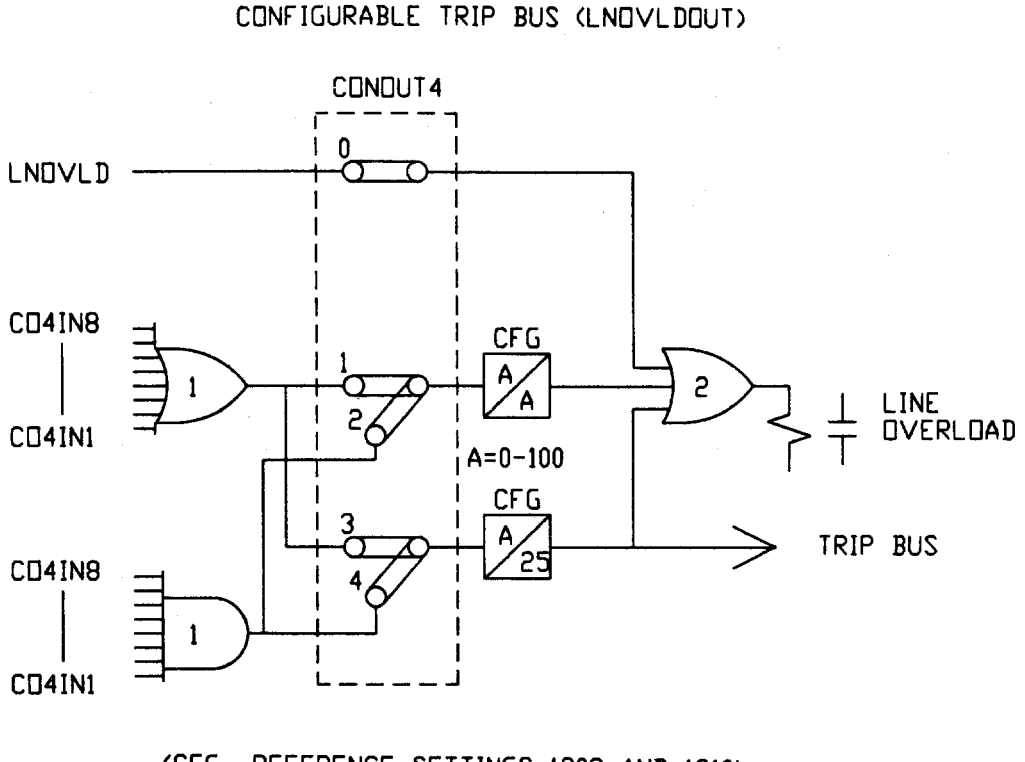


Figure 2-5A (0286A5597) Configurable Output #4 Logic

CONFIGURABLE OUTPUT #2, BKR2CLSOUT (see BKR1CLSOUT)

Close Contact 2, CONOUT2 (1901)
Input Number 1, CO2IN1 (1902)
Input Number 2, CO2IN2 (1903)
Input Number 3, CO2IN3 (1904)
Input Number 4, CO2IN4 (1905)
Input Number 5, CO2IN5 (1906)
Input Number 6, CO2IN6 (1907)
Input Number 7, CO2IN7 (1908)
Input Number 8, CO2IN8 (1909)

CONFIGURABLE OUTPUT #3, RCCANCLOUT (see BKR1CLSOUT)

Reclose Cancel, CONOUT3 (2001)
Input Number 1, CO3IN1 (2002)
Input Number 2, CO3IN2 (2003)
Input Number 3, CO3IN3 (2004)
Input Number 4, CO3IN4 (2005)
Input Number 5, CO3IN5 (2006)
Input Number 6, CO3IN6 (2007)
Input Number 7, CO3IN7 (2008)
Input Number 8, CO3IN8 (2009)

CONFIGURABLE OUTPUT #4, LNOVLDOUT

Line Overload, CONOUT4 (2101)

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

CONOUT4
- = 0 (used as Line Overload, the default setting)
- = 1 (energized by an 8-input logical OR)
- = 2 (energized by an 8-input logical AND)
- = 3 (energized by an 8-input logical OR and activates the trip bus)
- = 4 (energized by an 8-input logical AND and activates the trip bus)

Figure 2-5A is a functional logic diagram for configurable output #4. The links in the dotted box represent the CONOUT4 setting. When CONOUT4=0 the contact closes when the Line Overload function operates, and the contact is labelled Line Overload, to correspond to this default setting. When CONOUT4=1 the contact closes when any of the 8 inputs to OR1 are present. When CONOUT4=2 the contact closes when all of the 8 inputs to AND1 are present. When CONOUT4=3 the contact closes and a DLP trip is produced when any of the 8 inputs to OR1 are present. When CONOUT4=4 the contact closes and a DLP trip is produced when all of the 8 inputs to AND1 are present.

Settings CO4IN1-8 determine what internal DLP3 signals are routed to each of the 8 inputs as explained below:

Input Number 1, CO4IN1 (2102)

CO4IN1 may be set over the range from 0 to 60. A "0" indicates that the OR or AND input is not used (i.e., the input is set to be a "logic 0" for an OR or a "logic 1" for an AND). Settings 1 to 60 are selected from the DLP3 internal signals tabulated below:

Input Number 2, CO4IN2 (2103)
Input Number 3, CO4IN3 (2104)
Input Number 4, CO4IN4 (2105)
Input Number 5, CO4IN5 (2106)
Input Number 6, CO4IN6 (2107)
Input Number 7, CO4IN7 (2108)
Input Number 8, CO4IN8 (2109)

CONFIGURABLE OUTPUT #5, NONCRITOUT (see BKR1CLSOUT)

Non-Critical Alarm, CONOUT5 (2201)
Input Number 1, CO5IN1 (2202)
Input Number 2, CO5IN2 (2203)
Input Number 3, CO5IN3 (2204)
Input Number 4, CO5IN4 (2205)
Input Number 5, CO5IN5 (2206)
Input Number 6, CO5IN6 (2207)
Input Number 7, CO5IN7 (2208)
Input Number 8, CO5IN8 (2209)

CONFIGURABLE OUTPUT #6, RINITOUT (see BKR1CLSOUT)

Reclose Initiate, CONOUT6 (2301)
Input Number 1, CO6IN1 (2302)
Input Number 2, CO6IN2 (2303)
Input Number 3, CO6IN3 (2304)
Input Number 4, (2305)

Input Number 5, CO6IN5 (2306)
Input Number 6, CO6IN6 (2307)
Input Number 7, CO6IN7 (2308)
Input Number 8, CO6IN8 (2309)

Example Settings (based on Figure 2-1):

CONOUT1 = 0
CO1IN1 = 0
CO1IN2 = 0
CO1IN3 = 0
CO1IN4 = 0
CO1IN5 = 0
CO1IN6 = 0
CO1IN7 = 0
CO1IN8 = 0 Identical settings for configurable outputs 2 - 6.

SCHEME SELECTION, SCHEMESEL

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

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

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

SETTINGS FOR STEP DISTANCE SCHEME

SCHEME SELECTION, SCHEMESEL

Select Scheme, SELSCM (1201)

SELSCM=0 (STEPDST)
Number of Receivers, NUMRCVR (1202)

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

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

Select Zone 1 Ground, SELZ1G (0101)

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

Select Zone 1 Phase, SELZ1P (0102)

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

Reach Setting (M1) Zone 1 Phase, Z1R (0103)
Reach Setting (M1G) Zone 1 Ground, Z1GR (0104)

Z1R and Z1GR can be set over the range of 0.01 - 50.00 ohms. When potential transformers are used, the first zone distance functions should be set to reach no more than 90% of the positive-sequence impedance of the protected line regardless of the source to line ratio. When capacitor voltage transformers (CVTs) are used, refer to Figure 2-6 to determine the maximum reach in percent of positive-sequence impedance of the protected line as a function of the source to line ratio.

Select Zone 1 Ground Unit, SELZ1U (0105)

SELZ1U can be set to either 0 (MHO) or 1 (REACT). This setting determines the type of measuring unit used for the zone 1 ground-distance functions, either 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.

*** Not applicable to Models DLP3***EC and DLP3***FC**

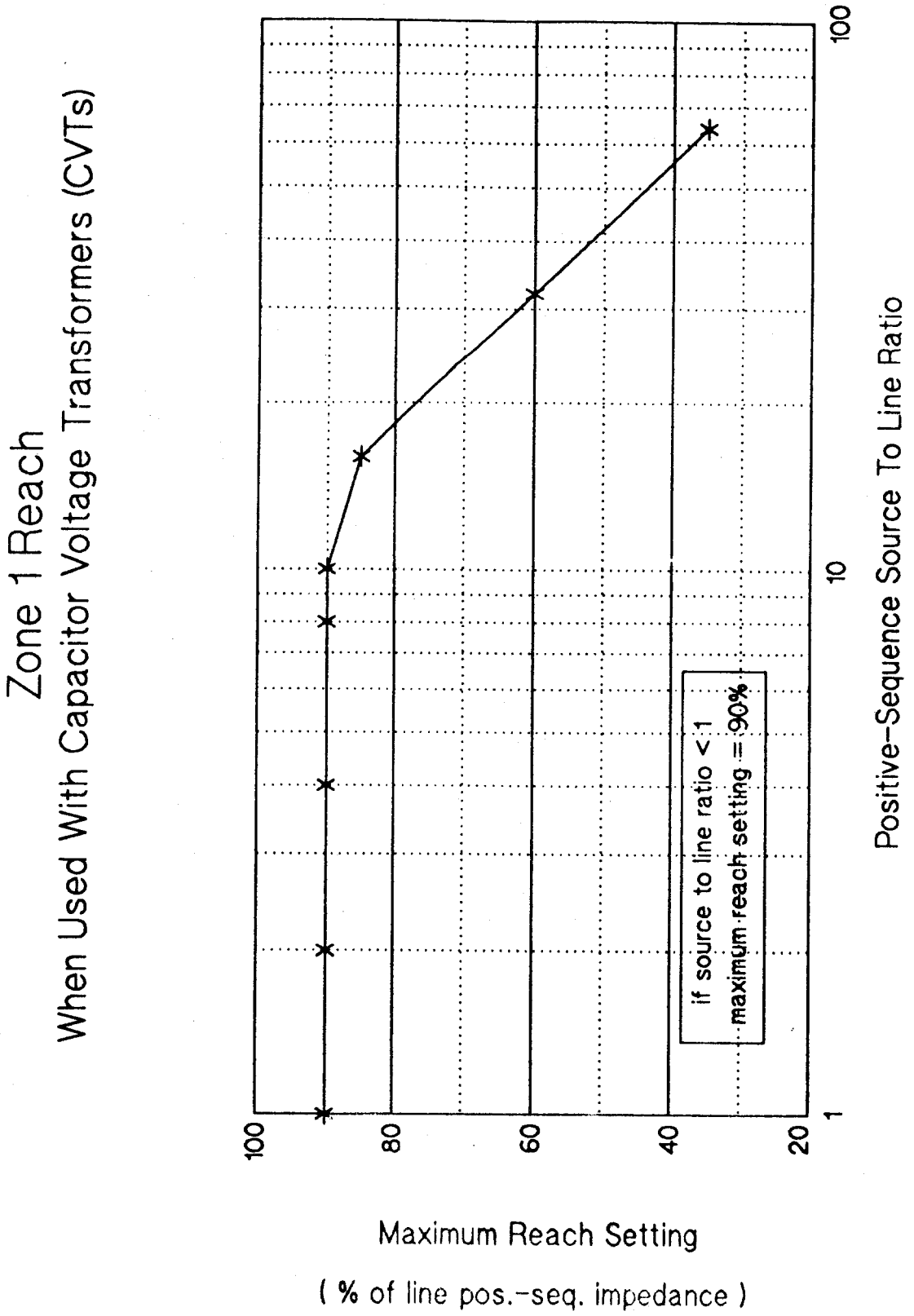


Figure 2-6 (0286A3530) Zone 1 Reach With CVTs

Reach Setting of Mho Unit, Z1SU (0106)

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 2-7, to make it directional. Z1SU can be set over the range of 0.01 - 50.00 ohms.

Z1SU is the minimum reach for the supervising Mho unit. This setting can be easily calculated if the maximum load flow across the line is known; refer to Figure 2-8 for details. The criterion used for establishing the minimum reach is based on maintaining a 40° angular margin between angle A and angle B. Note that B is the "constant chord" angle of the characteristic where the minimum reach is the chord. Since the supervising Mho unit has a circular characteristic, angle B is 90°.

An adaptive feature of the DLP3 system 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 (0107)

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

Z1K0 = 0.95 x (Z0L / Z1L)
where:

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

Zone 1 Reach Reset Timer, Z1ERST (0108)

Z1ERST is the pickup time delay of timer TL20 in Figure 1-2, the functional logic diagram for the Zone 1 Extension Scheme. Z1ERST can be set over the range of 0.0-60.0 seconds. Refer to the PRODUCT DESCRIPTION section under Zone 1 Extension for an explanation of when the Z1ERST time delay is required. When required, Z1ERST is set to the reset or reclaim time setting of the external recloser. TL20 is used in a Zone 1 Extension scheme only. For any other scheme, Z1ERST may be set to any value within its range without affecting scheme operation.

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G (0201)

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

Select Zone 2 Phase, SELZ2P (0202)

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 (0203)

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

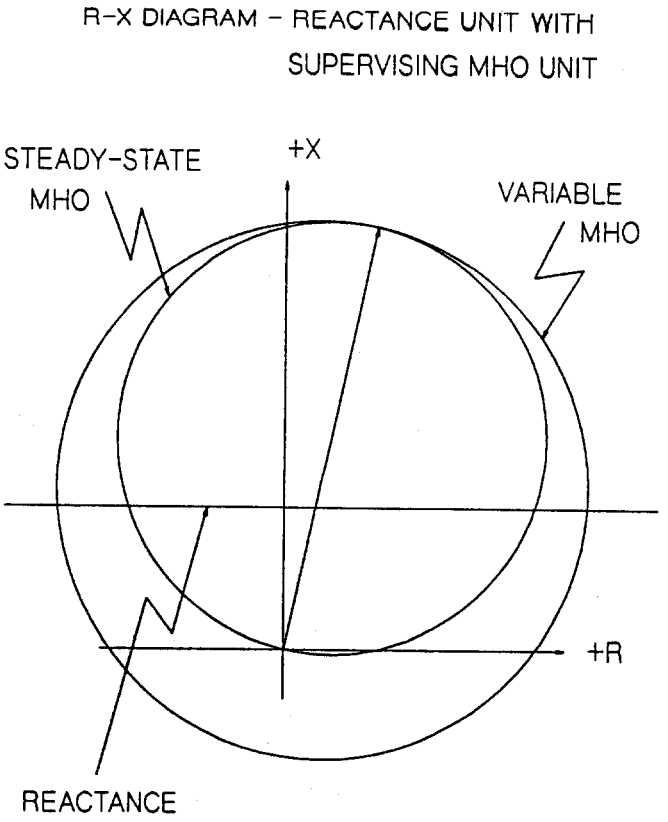
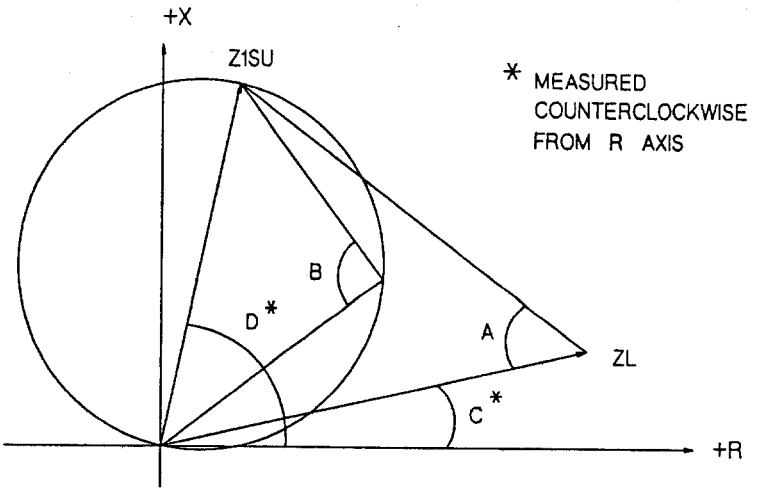


Figure 2-7 (0286A2917) MHO Unit R-X Diagram (Supervision of Reactance Unit)



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

A = 50

B = 90

C = LOAD IMPEDANCE ANGLE

D = POSITIVE-SEQUENCE ANGLE OF MAXIMUM REACH = POSANG

E = |D –C|

ZL = MINIMUM LOAD IMPEDANCE

Figure 2-8 (0286A2918) Z1SU

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

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

Select Zone 2 Ground Unit, SELZ2U (0205)

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

Select Zone 2 Timers, SELZ2T (0206)

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

Phase Timer Setting, PUTL2P (0207)

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

Ground Timer Setting, PUTL2G (0208)

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

Phase Characteristic Angle, Z2PANG (0209)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the MT phase-distance functions as shown in Figure 2-9. Z2PANG can be set to 90°, 105°, or 120°. A 90° setting is recommended. If the desired reach, Z2R, causes the resultant steady-state characteristic to pick up on the maximum load flow, then a "lens-shaped" characteristic associated with the 105° or 120° setting may prevent operation on load without having to reduce the reach. The settings of both Z2R and Z2PANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method of Figure 2-10. The criterion used for establishing the maximum reach given in Figure 2-10 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle, Z2GANG (0210)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the MTG ground-distance functions. Z2GANG can be set to 90°, 105°, or 120°. A 90° setting should be used unless the desired reach, Z2GR, is such that the impedance point associated with the maximum load flow plots within the MTG steady-state characteristic. The settings of both Z2GR and Z2GANG may be evaluated by using the formula associated with the "Maximum Allowable Reach" method of Figure 2-10. The criterion used for establishing the maximum reach given in Figure 2-10 is based on maintaining a 40° angular margin between angle A and angle B.

*** ZONE 3 DISTANCE FUNCTIONS, Z3DIST**

Select Zone 3 Ground, SELZ3G (0301)

SELZ3G can be set to either YES or NO. 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.

*** Not applicable to Models DLP3***EC and DLP3***FC**

Select Zone 3 Phase, SELZ3P (0302)

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 (0303)

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

*** Reach Setting (M3G) Zone 3 Ground, Z3GR** (0304)

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

Phase Timer Setting, PUTL3P (0305)

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

Ground Timer Setting, PUTL3G (0306)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

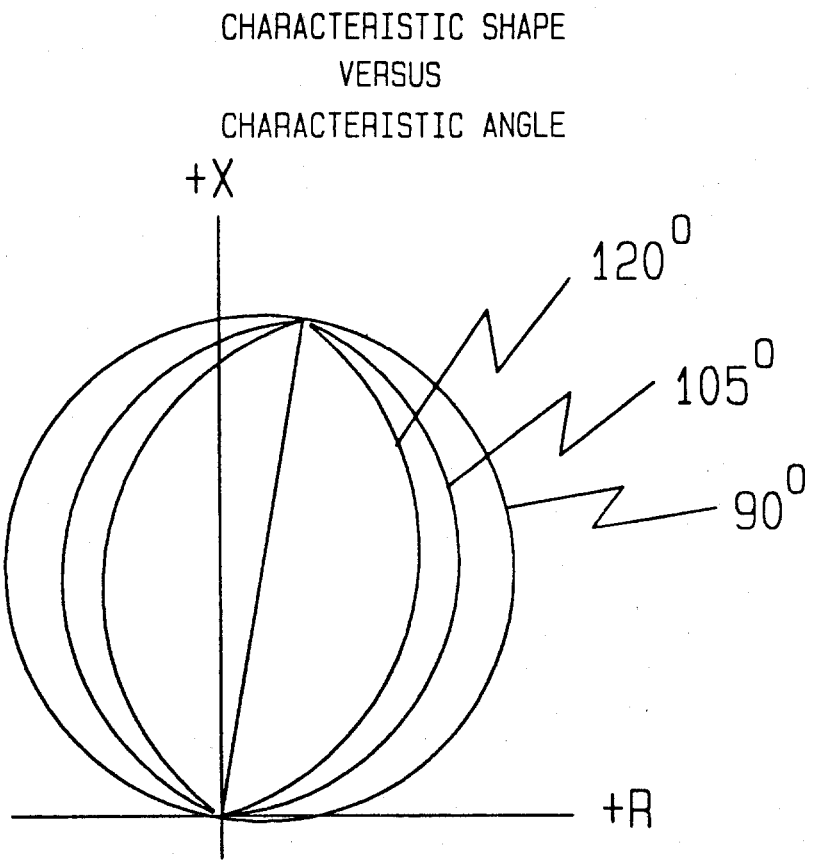
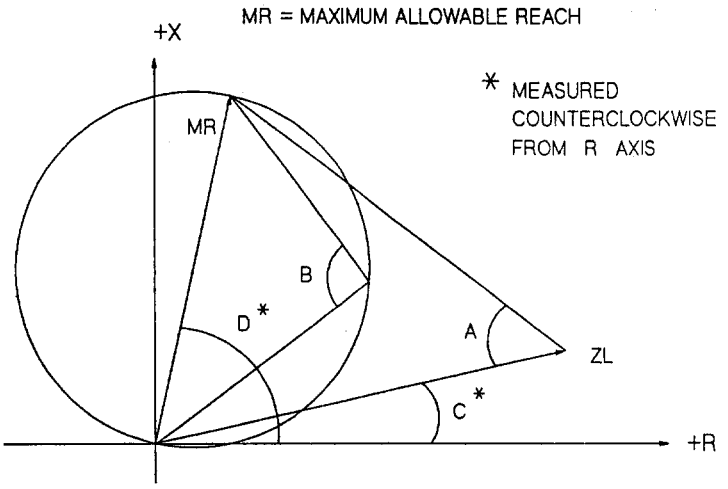


Figure 2-9 (0286A2910) MT R-X Diagram



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

A = 50 for circle (B=90)

A = 65 for lens (B=105)

A = 80 for lens (B=120)

C = LOAD IMPEDANCE ANGLE

D = POSITIVE-SEQUENCE ANGLE OF MAXIMUM REACH = POSANG

E = |D -C|

ZL = MINIMUM LOAD IMPEDANCE

Figure 2-10 (0286A2913) Maximum Allowable Reach

Phase Characteristic Angle, Z3PANG (0307)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the M3 phase-distance functions as shown in Figure 2-9. Z3PANG can be set to 90°, 105°, or 120°. 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 2-10. The criterion used for establishing the maximum reach given in Figure 2-10 is based on maintaining a 40° angular margin between angle A and angle B.

Ground Characteristic Angle, Z3GANG (0308)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the M3G ground-distance functions. Z3GANG can be set to 90°, 105°, or 120°. 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 2-10. The criterion used for establishing the maximum reach given in Figure 2-10 is based on maintaining a 40° angular margin between angle A and angle B.

*** ZONE 4 DISTANCE FUNCTIONS, Z4DIST**

Select Zone 4 Ground, SELZ4G (0401)

SELZ4G can be set to either YES or NO. 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 (0402)

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 (0411)

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 (0403)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

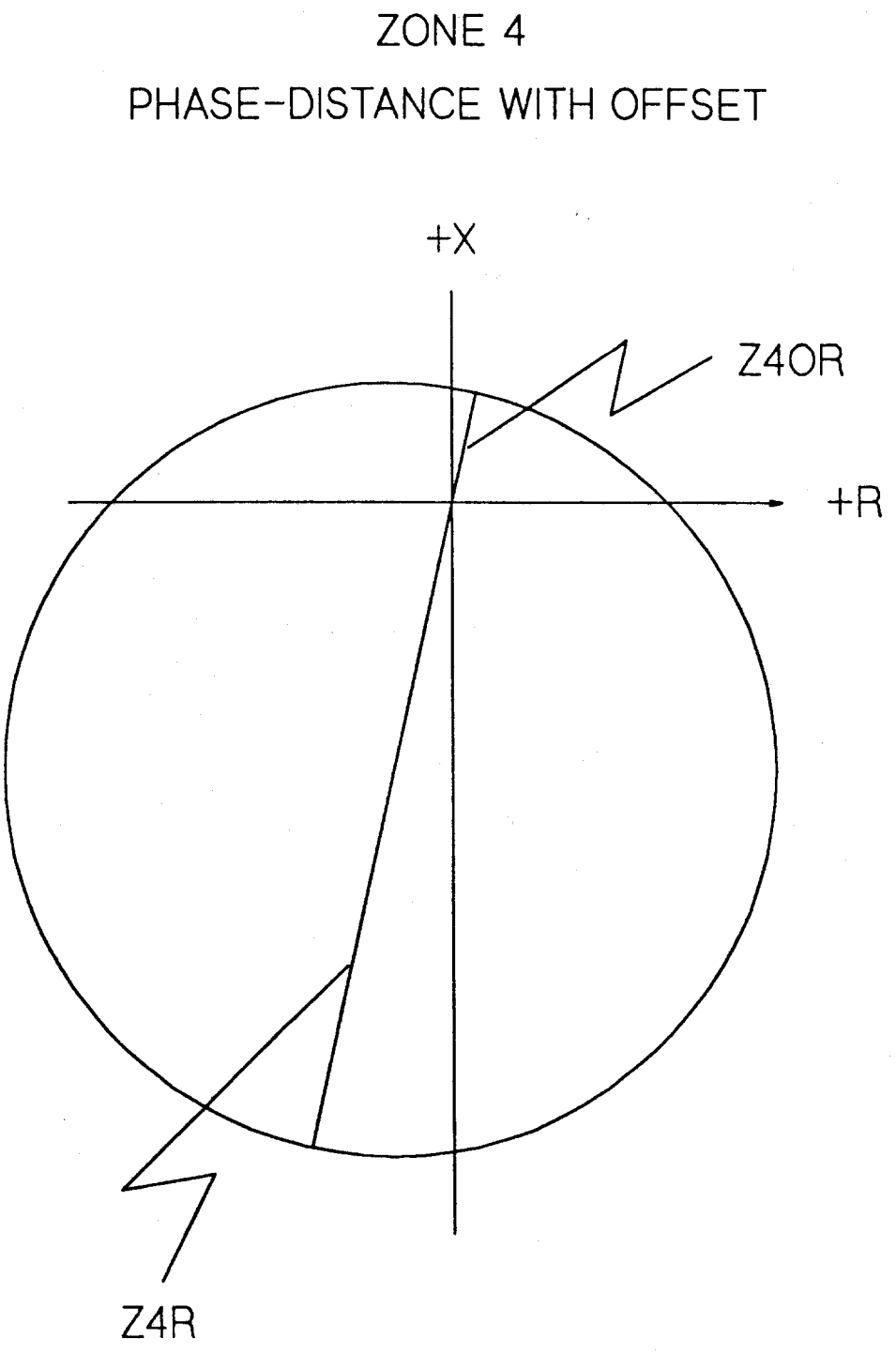


Figure 2-11 (0286A2914) ZONE 4 Phase Distance R-X Diagram

Phase Offset Reach, Z4OR (0405)

The zone 4 phase-distance functions can be set with an "offset" reach that is in the opposite direction from that determined by the SELZ4D setting. The Z4OR setting is a multiplier and the actual ohmic offset is equal to (0.00 - 0.40) x Z4R. A reversed-M4 characteristic with offset is shown in Figure 2-11. For Step Distance schemes, an offset reach should only be considered when SELZ4D=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 (0404)

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

Select Zone 4 Timers, SELZ4T (0406)

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

Phase Timer Setting, PUTL4P (0407)

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

Ground Timer Setting, PUTL4G (0408)

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

Phase Characteristic Angle, Z4PANG (0409)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the M4 phase-distance functions. Z4PANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. 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 (0410)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the M4G ground-distance functions. Z4GANG can be set to 80°, 90°, 95°, 105°, 110°, or 120°. 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 (0501)
Ground Pilot Block (IPB) Overcurrent, PUIPB (0502)

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

Trip Supervision (IT) Overcurrent, PUIT (0503)
Block Supervision (IB) Overcurrent, PUIB (0504)

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

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1 (1301)
POTT Coordination (TL4) Pickup, PUTL4 (1306)
POTT Coordination (TL4) Dropout, DOTL4 (1307)

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

52/b Contact Coordination (TL5) Pickup, PUTL5 (1302)
52/b Contact Coordination (TL5) Dropout, DOTL5 (1303)
52/b Contact Coordination (TL6) Pickup, PUTL6 (1304)
52/b Contact Coordination (TL6) Dropout, DOTL6 (1305)

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the Step Distance scheme logic, these timers are not a part of that logic. However, the DLP3 system's Sequence of Events uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1-6. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

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** (1308)

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.

Configurable Trip Pickup, PUTLCFG (1309)

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

Configurable Trip Dropout, DOTLCFG (1310)

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

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD (1001)

SELROD can be set to either YES or NO. When SELROD=YES, the Remote Open function is in service. When SELROD=NO, the Remote Open function is out of service.

*** Not applicable to Models DLP3***EC and DLP3***FC**

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 (1002)

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

Block Tripping for Fuse Failure, SELFFB (1003)

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

Example Settings (based on Figure 2-1):

SCHEME SELECTION, SCHEMESEL

SELSCM = 0 (STEPDST)
NUMRCVR = 0

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

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

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

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

For purposes of illustration, the Z1SU reach setting will be determined assuming SELZ1U= 1(REACT). Referring to Figures 2-1 and 2-8:

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

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure 2-10 is used to check Z2R and Z2PANG.

MR = SIN(50°) x 19.7 / SIN(180°-50°-(85°- 5.6°))
MR = 19.5 ohms

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

*** ZONE 3 DISTANCE FUNCTIONS, Z3DIST**

SELZ3G = YES
SELZ3P = YES

*** Not applicable to Models DLP3***EC and DLP3***FC**

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 next is valid.

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

where: Iϕ = 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:
Iϕ(AB) = 2.71 amps Iϕ(CD) = 3.29 amps
I0(AB) = 0.50 amps 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: Iϕ = 2.71 /-82.0°

I0 = 0.50 /-76.9°

VϕG = 61.1 /-0.2° (phase-to-ground voltage)

$$Z(ABLE) = 16.00 \,/80.3°$$

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 2-10 is used to check Z3R and Z3PANG.

MR = SIN(50°) x 19.7 / SIN(180°-50°-(85°-5.6°))
MR = 19.5 ohms

Consequently, with Z3R = 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 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 = <NOT APPLICABLE>
PUTL4 = <NOT APPLICABLE>
DOTL4 = <NOT APPLICABLE>

Since NUMBKRS=1, only TL5 requires settings.

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

REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD = YES
PUTL20 = 40 ms.
SELFFB = YES

*** Not applicable to Models DLP3***EC and DLP3***FC**

SETTINGS FOR ZONE 1 EXTENSION SCHEME

SCHEME SELECTION, SCHEMESEL

Select Scheme, SELSCM (1201)

Three Blocking scheme logics are available. The schemes are descibed in the PRODUCT DESCRIPTION section.

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

The BLK1 scheme is the standard DLP Blocking scheme logic; the BLK2 and BLK3 schemes offer alternative carrier starting options to aid in coordination when the DLP relay is used in a blocking scheme with relays of different designs at other terminals. The BLK2 scheme starts the blocking carrier whenever the DLP Fault Detector operates. Because the DLP Fault Detector responds to all fault types and some changes in load current, carrier may be started for more conditions than desired. The pickup of the Fault Detector is not adjustable, the pickup is approximately 0.6 ampere of phase current for a radial single line to ground fault. The BLK3 scheme uses a non-directional zero sequence current function (IPB) to start carrier. This function is intended to respond only to faults involving ground, and is similar in design to the carrier start functions in many existing electromechanical relay schemes. The operateing time versus current magnitude for the FD and IPB functions used in the BLK2 and BLK3 schemes is shown in Fig. 2-(NEW)

Number of Receivers, NUMRCVR (1202)

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

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

Select Zone 1 Ground, SELZ1G (0101)
Select Zone 1 Phase, SELZ1P (0102)

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

Reach Setting (M1) Zone 1 Phase, Z1R (0103)
Reach Setting (M1G) Zone 1 Ground, Z1GR (0104)
Select Zone 1 Ground Unit, SELZ1U (0105)
Reach Setting of Mho Unit, Z1SU (0106)
Zero-Sequence Current Compensation, Z1K0 (0107)

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

Zone 1 Reach Reset Timer, Z1ERST (0108)

Z1ERST is the pickup time delay of timer TL20 in Figure 1-2, the functional logic diagram for the Zone 1 Extension Scheme. Z1ERST can be set over the range of 0.0-60.0 seconds. Refer to the PRODUCT DESCRIPTION section under Zone 1 Extension for an explanation of when the Z1ERST time delay is required. When required, Z1ERST is set to the reset or reclaim time setting of the external recloser.

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G (0201)

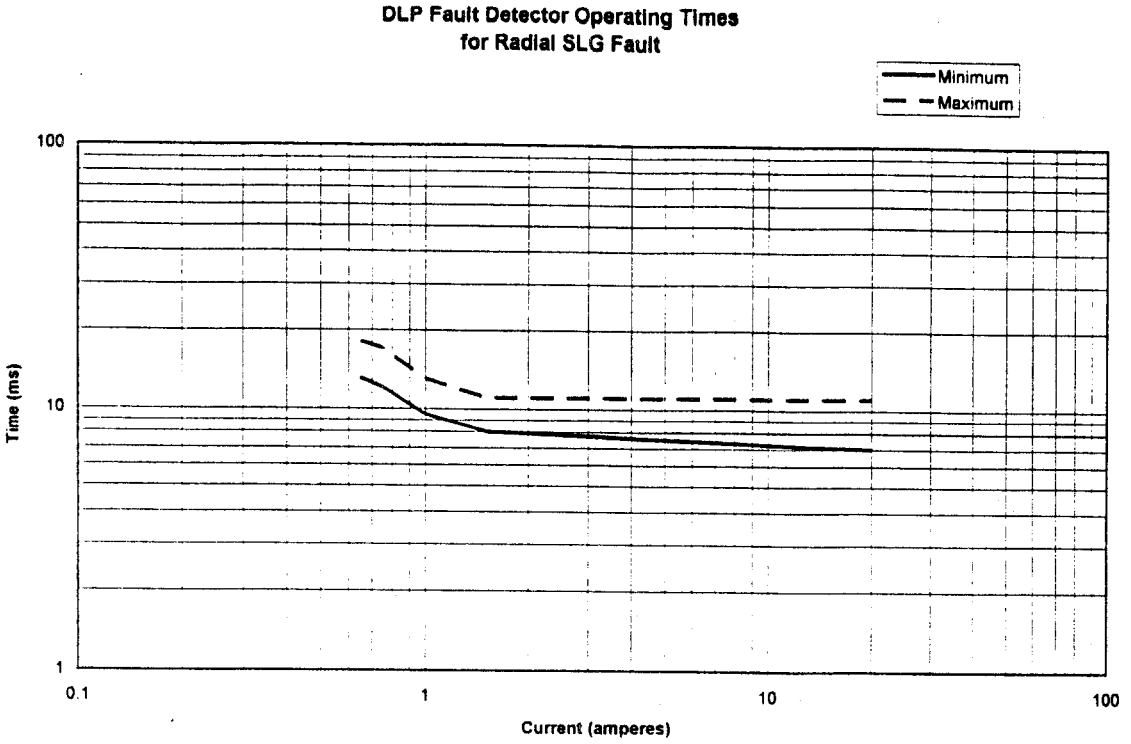
SELZ2G can be set to either YES or NO. For a Zone 1 Extension scheme, set SELZ2G=YES.

Select Zone 2 Phase, SELZ2P (0202)

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

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

Z2R can be set over the range of 0.01 - 50.00 ohms. In a Zone 1 Extension scheme Z2R must be set to see a multi-phase fault at the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources.



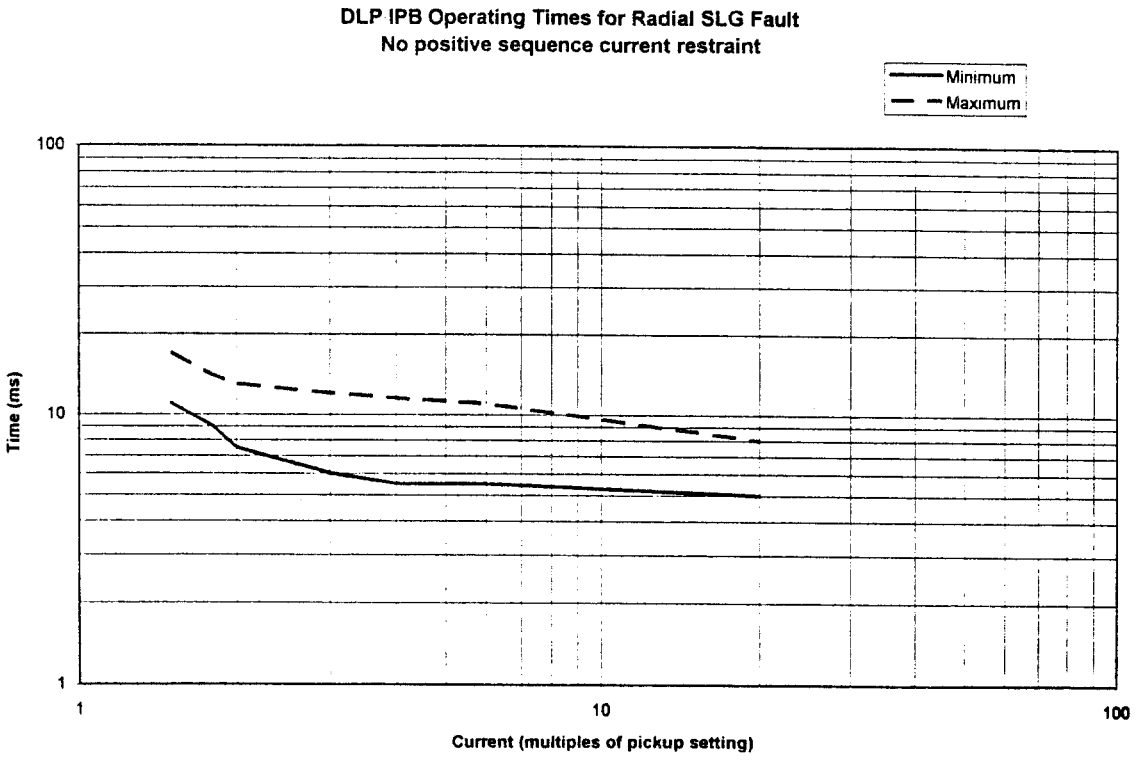


Figure 2-12 (0355A3388[1],[2]) FD and IPB Operating Times

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 (0204)

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

Select Zone 2 Ground Unit, SELZ2U (0205)

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

Select Zone 2 Timers, SELZ2T (0206)

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

Phase Timer Setting, PUTL2P (0207)
Ground Timer Setting, PUTL2G (0208)
Phase Characteristic Angle, Z2PANG (0209)
Ground Characteristic Angle, Z2GANG (0210)

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

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

Refer to the previous section 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 (0501)
Ground Pilot Block (IPB) Overcurrent, PUIPB (0502)

For all of the DLP Blocking schemes, 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 0.50 - 5.00 amps.

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

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

where:
KB = 0.066, BLK1
KB = 0.0, BLK3
PUIPB can be set over the range of 0.25 - 3.75 amps.

*** Not applicable to Models DLP3***EC and DLP3***FC**

In the BLK1 scheme, PUIPB should be set to its minimum setting of 0.25 amps. For two-terminal line applications, PUIPT should be set to its minimum setting of 0.50 amps for lines less than 100 miles long, and 0.75 amps for lines greater than 100 miles in length, to compensate for the increased charging current. PUIPT must be set higher than PUIPB at the remote terminal, to assure local-trip remote-block coordination. For three-terminal line applications, the coordination margins indicated by the suggested PUIPT and PUIPB settings given here may, in the worst case, have to be doubled. For two- or three-terminal applications, such as cable circuits, where the zero-sequence charging current is significant, the magnitude of charging current should be calculated to establish an adequate coordination margin.

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

Trip Supervision (IT) Overcurrent, PUIT (0503)
Block Supervision (IB) Overcurrent, PUIB (0504)

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

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1 (1301)
POTT Coordination (TL4) Pickup, PUTL4 (1306)
POTT Coordination (TL4) Dropout, DOTL4 (1307)

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

52/b Contact Coordination (TL5) Pickup, PUTL5 (1302)
52/b Contact Coordination (TL5) Dropout, DOTL5 (1303)
52/b Contact Coordination (TL6) Pickup, PUTL6 (1304)
52/b Contact Coordination (TL6) Dropout, DOTL6 (1305)

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the Zone 1 Extension scheme logic, these timers are not a part of that logic. However, the DLP3 system's Sequence of Events uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1-6. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

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** (1308)

PUTL16 can be set over the range of 8 - 80 milliseconds. Since TL16 is not part of the Zone 1 Extension scheme logic, PUTL16 can be set at any value within its range.

*** Not applicable to Models DLP3***EC and DLP3***FC**

Configurable Trip Pickup, PUTLCFG (1309)

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

Configurable Trip Dropout, DOTLCFG (1310)

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

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD (1001)

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

Timer (TL20) Delay Setting, PUTL20 (1002)
TL20 provides the time delay associated with the Remote Open function. PUTL20 can be set over the range of 10 - 100 milliseconds. It is suggested that PUTL20 be set at 40.

Block Tripping for Fuse Failure, SELFFB (1003)

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

Example Settings (based on Figure 2-1):

SCHEME SELECTION, SCHEMESEL

SELSCM = 4 (BLK1)
NUMRCVR = 1

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

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

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

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

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

Referring to Figures 2-1 and 2-8:

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

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure 2-10 is used to check Z2R and Z2PANG.

MR = SIN(50°) x 19.7 / SIN(180°-50°-(85°- 5.6°))
MR = 19.5 ohms

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

*** ZONE 3 DISTANCE FUNCTIONS, Z3DIST**

SELZ3G=NO
SELZ3P=NO

*** ZONE 4 DISTANCE FUNCTIONS, Z4DIST**

SELZ4G=NO
SELZ4P=NO

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

OVERCURRENT SUPERVISION, CURSUPVIS

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

SCHEME LOGIC TIMERS, SCHEMETIM

PUTL1 = <NOT APPLICABLE>
PUTL4 = <NOT APPLICABLE>
DOTL4 = <NOT APPLICABLE>
Since NUMBKRS =1, only TL5 requires settings.
PUTL5 = 80 ms.
DOTL5 = 100 ms.
PUTL6 = <NOT APPLICABLE>
DOTL6 = <NOT APPLICABLE>
PUTL16 = <NOT APPLICABLE>

REMOTE OPEN DETECTOR, REMOTEOPEN

SELROD=YES
PUTL20=40 ms.
SELFFB=YES

SETTINGS FOR PERMISSIVE OVERREACH TRANSFER TRIP SCHEME

SCHEME SELECTION, SCHEMESEL

Select Scheme, SELSCM (1201)

SELSCM=1 (POTT)

Number of Receivers, NUMRCVR (1202)

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 1 DISTANCE FUNCTIONS, Z1DIST

Select Zone 1 Ground, SELZ1G (0101)
Select Zone 1 Phase, SELZ1P (0102)

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

Reach Setting (M1) Zone 1 Phase, Z1R (0103)
Reach Setting (M1G) Zone 1 Ground, Z1GR (0104)
Select Zone 1 Ground Unit, SELZ1U (0105)
Reach Setting of Mho Unit, Z1SU (0106)
Zero-Sequence Current Compensation, Z1K0 (0107)
Zone 1 Reach Reset Timer, Z1ERST (0108)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G (0201)
Select Zone 2 Phase, SELZ2P (0202)

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

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

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

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

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

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

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

Select Zone 2 Ground Unit, SELZ2U (0205)

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

Select Zone 2 Timers, SELZ2T (0206)

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

Phase Timer Setting, PUTL2P (0207)
Ground Timer Setting, PUTL2G (0208)

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

Phase Characteristic Angle, Z2PANG (0209)
Ground Characteristic Angle, Z2GANG (0210)

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

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

Refer to the previous section 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 (0501)

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

$$3x|I0|$$

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

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

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 (0503)
Block Supervision (IB) Overcurrent, PUIB (0504)

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

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1 (1301)

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 (1306)

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

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.

POTT Coordination (TL4) Dropout, DOTL4 (1307)

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

52/b Contact Coordination (TL5) Pickup, PUTL5 (1302)
52/b Contact Coordination (TL5) Dropout, DOTL5 (1303)
52/b Contact Coordination (TL6) Pickup, PUTL6 (1304)
52/b Contact Coordination (TL6) Dropout, DOTL6 (1305)

All of these can be set over the range of 0 - 200 milliseconds. For a POTT scheme, the 52/b contacts are required to key the local transmitter to the TRIP frequency when the breaker(s) is open.

*** Not applicable to Models DLP3***EC and DLP3***FC**

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.

Wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1-3. The 52/b contact(s) prevents a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information. The output of TL5 and TL6 are also used by the DLP3 system's Sequence of Events to provide a time-tagged event to indicate either "breaker open" or "breaker closed."

Weak In-feed Trip (TL16) pickup, PUTL16 (1308)

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.

Configurable Trip Pickup, PUTLCFG (1309)

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

Configurable Trip Dropout, DOTLCFG (1310)

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

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD (1001)

SELROD can be set to either YES or NO. 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 (1002)

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

Select Fuse Failure Block, SELFFB (1003)

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

Example Settings (based on Figure 2-1):

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

ZONE 1 DISTANCE FUNCTIONS, Z1DIST
SELZIG=YES
SELZ1P=YES
Z1R = 0.9 x 6 = 5.40
Z1GR = 0.9 x 6 = 5.40

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

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

ZONE 2 / PILOT ZONE, Z2DIST
SELZ2G=YES
SELZ2P= YES

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

The formula from Figure 2-10 is used to check Z2R and Z2PANG.

MR = SIN(50°) x 19.7 / SIN(180°-50°-(85°- 5.6°))
MR = 19.5 ohms

Consequently, with Z2R=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 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
DOTL4	= 0
PUTL5	= 80 ms.
DOTL5	= 100 ms.
PUTL6	= <NOT APPLICABLE>
DOTL6	= <NOT APPLICABLE>
PUTL16	= <NOT APPLICABLE>

REMOTE OPEN DETECTOR, REMOTEOPEN

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

SETTINGS FOR PERMISSIVE UNDERREACH TRANSFER TRIP SCHEME

SCHEME SELECTION, SCHEMESEL

Select Scheme, SELSCM (1201)

SELSCM=2 (PUTT)

Number of Receivers, NUMRCVR (1202)

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 1 DISTANCE FUNCTIONS, Z1DIST

Select Zone 1 Ground, SELZ1G (0101)
Select Zone 1 Phase, SELZ1P (0102)

SELZ1G and SELZ1P can be set to either YES or NO. Both SELZ1G and SELZ1P must be set to YES for a PUTT scheme.

Reach Setting (M1) Zone 1 Phase, Z1R (0103)
Reach Setting (M1G) Zone 1 Ground, Z1GR (0104)
Select Zone 1 Ground Unit, SELZ1U (0105)
Reach Setting of Mho Unit, Z1SU (0106)
Zero-Sequence Current Compensation, Z1K0 (0107)
Zone 1 Reach Reset Timer, Z1ERST (0108)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G (0201)
Select Zone 2 Phase, SELZ2P (0202)

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

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

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

Reach Setting (MT) Zone 2 Phase, Z2R (0203)
Reach Setting (MTG) Zone 2 Ground, Z2GR (0204)

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

Select Zone 2 Ground Unit, SELZ2U (0205)

SELZ2U can be set to 0 (MHO), 1 (GDOC), or 2 (MHOGDOC). This setting chooses either Mho ground-distance, ground directional-overcurrent, or both, for the pilot overreaching zone. The ground directional overcurrent units will operate for higher levels of ground-fault impedance than will the Mho units. Note that if SELZ2U=1 (GDOC), zone 2 distance backup protection is provided with SELZ2G=YES. With SELZ2U=2 (MHOGDOC), both Mho ground-distance and ground directional-overcurrent functions are operating simultaneously for the pilot overreaching zone provided SELZ2G=YES. For a PUTT scheme, any one of the three settings is possible. Since zone 1 uses only distance functions, there is not much value in using ground directional-overcurrent functions for the overreaching zone, and it is suggested that SELZ2U=0 (MHO).

Select Zone 2 Timers, SELZ2T (0206)

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

Phase Timer Setting, PUTL2P (0207)
Ground Timer Setting, PUTL2G (0208)

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

Phase Characteristic Angle, Z2PANG (0209)
Ground Characteristic Angle, Z2GANG (0210)

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

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

Refer to the previous section 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 (0501)

*** Not applicable to Models DLP3***EC and DLP3***FC**

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

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

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 (0503)
Block Supervision (IB) Overcurrent, PUIB (0504)

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

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1 (1301)

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 (1306)

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.

POTT Coordination (TL4) Dropout, DOTL4 (1307)

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

52/b Contact Coordination (TL5) Pickup, PUTL5 (1302)
52/b Contact Coordination (TL5) Dropout, DOTL5 (1303)
52/b Contact Coordination (TL6) Pickup, PUTL6 (1304)
52/b Contact Coordination (TL6) Dropout, DOTL6 (1305)

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.

Wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1-3. The 52/b contact(s) prevents a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor
for more information. The output of TL5 and TL6 are also used by the DLP3 system's Sequence of Events to provide a time-tagged event to indicate either "breaker open" or "breaker closed."

*** Not applicable to Models DLP3***EC and DLP3***FC**

*** Weak In-feed Trip (TL16) pickup, PUTL16 (1308)**

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.

Configurable Trip Pickup, PUTLCFG (1309)

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

Configurable Trip Dropout, DOTLCFG (1310)

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

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD (1001)

SELROD can be set to either YES or NO. 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 (1002)

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

Select Fuse Failure Block, SELFFB (1003)

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

Example Settings (based on Figure 2-1):

SCHEME SELECTION, SCHEMESEL

SELSCM=2 (PUTT)
NUMRCVR=1

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

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

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

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

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 2-10 is used to check Z2R and Z2PANG.

MR = SIN(50°) x 19.7 / SIN(180°-50°-(85°- 5.6°))
MR = 19.5 ohms

*** Not applicable to Models DLP3***EC and DLP3***FC**

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

REMOTE OPEN DETECTOR, REMOTEOPEN

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

*** SETTINGS FOR BLOCKING SCHEME**

SCHEME SELECTION, SCHEMESEL

Select Scheme, SELSCM (1201)

SELSCM=4 (BLOCK)

Number of Receivers, NUMRCVR (1202)

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 1 DISTANCE FUNCTIONS, Z1DIST

Select Zone 1 Ground, SELZ1G (0101)
Select Zone 1 Phase, SELZ1P (0102)

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

Reach Setting (M1) Zone 1 Phase, Z1R (0103)
Reach Setting (M1G) Zone 1 Ground, Z1GR (0104)
Select Zone 1 Ground Unit, SELZ1U (0105)
Reach Setting of Mho Unit, Z1SU (0106)
Zero-Sequence Current Compensation, Z1K0 (0107)
Zone 1 Reach Reset Timer, Z1ERST (0108)

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G (0201)
Select Zone 2 Phase, SELZ2P (0202)

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

* In a **BLOCKING** scheme, the pilot overreaching zone consists of the MT and MTG functions. Secondarily, the MT and MTG functions may be used for zone 2 backup.

*** Not applicable to Models DLP3***EC and DLP3***FC**

A Z2R and Z2GR reach setting that satisfies the requirements of both uses simultaneously may be impossible or undesirable. For example, the required zone 2 backup reach may be less than the desired reach for the pilot overreaching zone. In this case, the zone 2 timers are disabled and the MT and MTG functions are used only for the pilot overreaching zone. The M3 and M3G functions can then be set for the zone 2 reach, and the M4 and M4G functions can be set for the zone 3 reach. The following considerations are for the MT and MTG reaches, Z2R and Z2GR respectively, when these functions are used solely for the pilot overreaching zone. Refer to the previous section entitled **SETTINGS FOR STEP DISTANCE SCHEME** for a discussion of the settings for zone 2 backup.

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

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

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

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

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

Select Zone 2 Ground Unit, SELZ2U (0205)

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

Select Zone 2 Timers, SELZ2T (0206)

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

Phase Timer Setting, PUTL2P (0207)
Ground Timer Setting, PUTL2G (0208)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

*** Phase Characteristic Angle, Z2PANG** (0209)
Ground Characteristic Angle, Z2GANG (0210)

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

ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the previous section 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 (0401)

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 (0402)

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 (0411)

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 (0403)

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

Phase Offset Reach, Z4OR (0405)

The zone 4 phase-distance functions can be set with an "offset" reach that is in the opposite direction from that determined by the SELZ4D setting. The Z4OR setting is a multiplier and the actual ohmic offset is equal to (0.00 - 0.40) x Z4R. A reversed-M4 characteristic with offset is shown in Figure 2-11. For 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** (0404)

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

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

Z4R = 0.85 x (Z2R [REMOTE])

Z4GR = 0.85 x (Z2GR [REMOTE])

*** Not applicable to Models DLP3***EC and DLP3***FC**

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

Select Zone 4 Timers, SELZ4T (0406)

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

Phase Timer Setting, PUTL4P (0407)

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

Ground Timer Setting, PUTL4G (0408)

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

***Phase Characteristic Angle, Z4PANG** (0409)

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

Ground Characteristic Angle, Z4GANG (0410)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the reverse-M4G ground-distance functions. Z4GANG 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 (0501)
Ground Pilot Block (IPB) Overcurrent, PUIPB (0502)

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 0.50 - 5.00 amps.

*** Not applicable to Models DLP3***EC and DLP3***FC**

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 0.25 - 3.75 amps.

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

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

***Trip Supervision (IT) Overcurrent, PUIT** (0503)
Block Supervision (IB) Overcurrent, PUIB (0504)

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

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

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1 (1301)

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 (1306)
POTT Coordination (TL4) Dropout, DOTL4 (1307)

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

52/b Contact Coordination (TL5) Pickup, PUTL5 (1302)
52/b Contact Coordination (TL5) Dropout, DOTL5 (1303)
52/b Contact Coordination (TL6) Pickup, PUTL6 (1304)
52/b Contact Coordination (TL6) Dropout, DOTL6 (1305)

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.

*** Not applicable to Models DLP3***EC and DLP3***FC**

However, the DLP3 system's Sequence of Events uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1-6. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

* 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** (1308)

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.

Configurable Trip Pickup, PUTLCFG (1309)

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

Configurable Trip Dropout, DOTLCFG (1310)

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

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD (1001)

SELROD can be set to either YES or NO. 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 (1002)

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

Select Fuse Failure Block, SELFFB (1003)

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

Example Settings (based on Figure 2-1):

SCHEME SELECTION, SCHEMESEL

SELSCM	= 4 (BLOCK)
NUMRCVR	= 1
TRPMODE	= 1 (1POLE)

***ZONE 1 DISTANCE FUNCTIONS, Z1DIST**

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

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

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

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure 2-10 is used to check Z2R and Z2PANG.

MR = SIN(50°) x 19.7 /SIN(180°-50-(85°- 5.6°))
MR = 19.5 ohms

Consequently, with Z2R=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 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
SELZ4T	=NO
PUTL4P	= <NOT APPLICABLE>
PTTL4G	= <NOT APPLICABLE>

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

Z4PANG	=80
Z4GANG	=80

OVERCURRENT SUPERVISION, CURSUPVIS

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

SCHEME LOGIC TIMERS, SCHEMETIM

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

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

Since NUMBKRS=1, only TL5 requires settings.

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

REMOTE OPEN DETECTOR, REMOTEOPEN

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

*** SETTINGS FOR HYBRID SCHEME**

SCHEME SELECTION, SCHEMESEL

Select Scheme, SELSCM (1201)

SELSCM =3 (HYBRID)

Number of Receivers, NUMRCVR (1202)

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 1 DISTANCE FUNCTIONS, Z1DIST

Select Zone 1 Ground, SELZ1G (0101)
Select Zone 1 Phase, SELZ1P (0102)

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

Reach Setting (M1) Zone 1 Phase, Z1R (0103)
Reach Setting (M1G) Zone 1 Ground, Z1GR (0104)
Select Zone 1 Ground Unit, SELZ1U (0105)
Reach Setting of Mho Unit, Z1SU (0106)
Zero-Sequence Current Compensation, Z1K0 (0107)
Zone 1 Reach Reset Timer, Z1ERST (0108)

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

ZONE 2 / PILOT ZONE, Z2DIST

Select Zone 2 Ground, SELZ2G (0201)
Select Zone 2 Phase, SELZ2P (0202)

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

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

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

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

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

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

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

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

Select Zone 2 Ground Unit, SELZ2U (0205)

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

Select Zone 2 Timers, SELZ2T (0207)

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

Phase Timer Setting, PUTL2P (0208)
Ground Timer Setting, PUTL2G (0209)

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

*** Phase Characteristic Angle, Z2PANG** (0209)
Ground Characteristic Angle, Z2GANG (0210)

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

ZONE 3 DISTANCE FUNCTIONS, Z3DIST

Refer to the previous section 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 (0401)

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.

*** Not applicable to Models DLP3***EC and DLP3***FC**

Select Zone 4 Phase, SELZ4P (0402)

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 (0411)

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 (0403)

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

Phase Offset Reach, Z4OR (0405)

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 2-11. 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** (0404)

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

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

Z4R = 0.85 x (Z2R [REMOTE])

Z4GR = 0.85 x (Z2GR [REMOTE])

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

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

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

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

Select Zone 4 Timers, SELZ4T (0406)

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

Phase Timer Setting, PUTL4P (0407)

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

Ground Timer Setting, PUTL4G (0408)

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

Phase Characteristic Angle, Z4PANG (0409)

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

Ground Characteristic Angle, Z4GANG (0410)

This setting determines the characteristic shape and, consequently, the area of coverage provided on the R-X diagram of the reverse-M4G ground-distance functions. Z4GANG 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 (0501)
Ground Pilot Block (IPB) Overcurrent, PUIPB (0502)

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 0.50 - 5.00 amps.

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

$$3x|I0| - 3xKBx|I1|$$
where: KB = 0.066

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

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

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

Trip Supervision (IT) Overcurrent, PUIT (0503)
Block Supervision (IB) Overcurrent, PUIB (0504)

The IT overcurrent function provides supervision for the tripping-zone distance functions, and IT is used in the trip bus seal-in circuit.

*** Not applicable to Models DLP3***EC and DLP3***FC**

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

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

SCHEME LOGIC TIMERS, SCHEMETIM

Trip Integrator (TL1) Pickup, PUTL1 (1301)

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 (1306)
POTT Coordination (TL4) Dropout, DOTL4 (1307)

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

52/b Contact Coordination (TL5) Pickup, PUTL5 (1302)
52/b Contact Coordination (TL5) Dropout, DOTL5 (1303)
52/b Contact Coordination (TL6) Pickup, PUTL6 (1304)
52/b Contact Coordination (TL6) Dropout, DOTL6 (1305)

All of these can be set over the range of 0 - 200 milliseconds. Since breaker position information is not required for the HYBRID scheme logic, these timers are not a part of that logic. However, the DLP3 system's Sequence of Events uses these timer outputs to provide a time-tagged event to indicate either "breaker open" or "breaker closed." If these events are required, then wire the 52/b contact from breaker 1 to CC1 (TL5) and wire the 52/b contact from breaker 2 to CC2 (TL6) as shown in Figure 1-6. Another reason for wiring in the 52/b contacts is to avoid a non-critical alarm resulting from the Trip Circuit Monitor operating when the breaker is opened manually or by SCADA. Refer to the PRODUCT DESCRIPTION section under Trip Circuit Monitor for more information.

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** (1308)

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

PUTL16 can be set over the range of 8 - 99 milliseconds. The pickup delay of timer TL16 is used to provide security in the weak in-feed tripping logic. It should be set 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.

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

PUTL16 should never be set greater than the pickup delay of timer TL11 in Figure 1-5, if weak in-feed tripping is desired. For a Hybrid scheme (SELSCM = 3) the pickup delay of TL11 is 80 milliseconds for two terminal applications (NUMRCVR = 1) and 50 milliseconds for three terminal applications (NUMRCVR = 2).

Configurable Trip Pickup, PUTLCFG (1309)

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

Configurable Trip Dropout, DOTLCFG (1310)

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

REMOTE OPEN DETECTOR, REMOTEOPEN

Select Remote Open Detector, SELROD (1001)

SELROD can be set to either YES or NO. 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 (1002)

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

Select Fuse Failure Block, SELFFB (1003)

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

*** Example Settings (based on Figure 2-1):**

SCHEME SELECTION, SCHEMESEL

SELSCM	=3 (HYBRID)
NUMRCVR	=1

ZONE 1 DISTANCE FUNCTIONS, Z1DIST

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

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

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

ZONE 2 / PILOT ZONE, Z2DIST

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

The formula from Figure 2-10 is used to check Z2R and Z2PANG.

MR = SIN(50°) x 19.7 / SIN(180°- 50°- (85°- 5.6°))
MR = 19.5 ohms

*** Not applicable to Models DLP3***EC and DLP3***FC**

*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 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
SELZ4T	=NO
PUTL4P	= <NOT APPLICABLE>
PTTL4G	= <NOT APPLICABLE>

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

Z4PANG	=80
Z4GANG	=80

OVERCURRENT SUPERVISION, CURSUPVIS

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

SCHEME LOGIC TIMERS, SCHEMETIM

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

Since NUMBKRS=1, only TL5 requires settings.

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

REMOTE OPEN DETECTOR, REMOTEOPEN

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

*** Not applicable to Models DLP3***EC and DLP3***FC**

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-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:

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

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
$\underline{/\phi 1}$ = positive-sequence relay angle (POSANG)
$\underline{/\phi 0}$ = zero-sequence relay angle (ZERANG)
K0 = zero-sequence current compensation factor
X = actual reach / nominal reach

example:

For phase A and:

$I_A = 3(I_0)$

$\underline{/\phi 1} = \underline{/\phi 0}$

$K0 = 3$

$Z_{R1} = 1$ ohm

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

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

$I_A = 1.32$ 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 a 5 AMP rated DLP3 system, the IT current supervision function will limit the distance function current sensitivity in the above example since the minimum IT setting is 0.2 amps. In general, the IT function setting determines the distance function current sensitivity when its setting exceeds the value calculated from the above formulas.

TABLE 2-2: SETTINGS - (1 OF 7)

SET#	DESCRIPTION	SETTING
(01)	ZONE 1 DISTANCE FUNCTIONS, Z1DIST	
(0101)	SELECT ZONE 1 GROUND, SELZ1G	
(0102)	SELECT ZONE 1 PHASE, SELZ1P	
(0103)	REACH SETTING (M1) ZONE 1 PHASE, Z1R	
(0104)	REACH SETTING (M1G) ZONE 1 GROUND, Z1GR	
(0105)	SELECT ZONE 1 GROUND UNIT, SELZ1U	
(0106)	REACH SETTING OF MHO UNIT, Z1SU	
(0107)	ZERO-SEQUENCE CURRENT COMPENSATION, Z1KO	
(0108)	ZONE 1 EXTENSION REACH RESET TIMER, Z1ERST	
(02)	ZONE 2/PILOT ZONE, Z2DIST	
(0201)	SELECT ZONE 2 GROUND, SELZ2G	
(0202)	SELECT ZONE 2 PHASE, SELZ2P	
(0203)	REACH SETTING (MT) ZONE 2 PHASE, Z2R	
(0204)	REACH SETTING (MTG) ZONE 2 GROUND, Z2GR	
(0205)	SELECT ZONE 2 GROUND UNIT, 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 GROUND CHARACTERISTIC ANGLE, Z3GANG	

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-2: SETTINGS - (2 OF 7)

SET#	DESCRIPTION	SETTING
* (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)	SELECT ZONE 4 TIMERS, SELZ4T	_____
(0407)	PHASE TIMER SETTING, PUTL4P	_____
(0408)	GROUND TIMER SETTING, PUTL4G	_____
(0409)	PHASE CHARACTERISTIC ANGLE, Z4PANG	_____
(0410)	GROUND CHARACTERISTIC ANGLE, Z4GANG	_____
(0411)	SELECT DIRECTION, SELZ4D	
(05)	OVERCURRENT SUPERVISION, CURSUPVIS	
(0501)	GROUND PILOT TRIP (IPT) OVERCURRENT, PUIPT	_____
(0502)	GROUND PILOT BLOCK (IPB) OVERCURRENT, PUIPB	_____
(0503)	TRIP SUPERVISION (IT) OVERCURRENT, PUIT	_____
(0504)	BLOCK SUPERVISION (IB) OVERCURRENT, PUIB	_____
(06)	OVERCURRENT BACKUP, OVERCUR	
(0601)	SELECT PHASE 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	_____
(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	_____
(0610)	DEFINITE TIME CURVE DELAY SETTING, PUTTM	_____
(0611)	SELECT TOC CURVE, SELCURV	_____
(0612)	GROUND INST. POS.-SEQ. RESTRAINT, KDCONST	_____

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-2: SETTINGS - (3 OF 7)

SET#	DESCRIPTION	SETTING
(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	
(0708)	ANY ZONE 1 PHASE FUNCTION, RBZ1PH	
(0709)	ANY ZONE 2 PHASE FUNCTION, RBZ2PH	
(0710)	CONFIGURABLE TRIP BUS	
(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	
(0804)	SELECT ZONE 1 BLOCK, OSBBLK1	
(0805)	SELECT ZONE 2 BLOCK, OSBBLK2	
(0806)	SELECT ZONE 3 BLOCK, OSBBLK3	
(0807)	SELECT ZONE 4 BLOCK, OSBBLK4	
(09)	LINE PICKUP, LINEPU	
(0901)	SELECT LINE PICKUP, SELLPU	
(0902)	SELECT TIMER BYPASS, SELTBP	
(0903)	POSITIVE-SEQUENCE OC (I1) SETTING, PUI1	
(10)	REMOTE OPEN DETECTOR (ROD), REMOTEOPEN	
(1001)	SELECT REMOTE OPEN DETECTOR, SELROD	
(1002)	TIMER (TL20) DELAY SETTING, PUTL20	
(1003)	BLOCK TRIPPING FOR FUSE FAILURE, SELFFB	

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-2: SETTINGS - (4 OF 7)

SET#	DESCRIPTION	SETTING
(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	
(12)	SCHEME SELECTION, SCHEMESEL	
(1201)	SELECT SCHEME, SELSCM	
(1202)	NUMBER OF RECEIVERS, NUMRCVR	
(13)	SCHEME LOGIC TIMERS, SCHEMETIM	
(1301)	TRIP INTEGRATOR (TL1) PICKUP, PUTL1	
(1302)	52/B CONTACT COORDINATION (TL5) 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)	POTT COORDINATION (TL4) DROPOUT, DOTL4	
*(1308)	WEAK-IN-FEED TRIP (TL16) PICKUP, PUTL16	
(1309)	CONFIGURABLE PICKUP TIME, PUTLCTB	
(1310)	CONFIGURABLE DROPOUT TIME, DOTLCTB	
(14)	LINE QUANTITIES, LINE QTY	
(1401)	POS.-SEQUENCE ANGLE OF MAX. REACH, POSANG	
(1402)	ZERO-SEQUENCE ANGLE OF MAX. REACH, ZERANG	

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 2-2: SETTINGS - (5 OF 7)

SET#	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	
(1510)	PHASE DESIGNATION, PHASDESG	
(1511)	SELECT TIME SYNCHRONIZATION, SELTSYNC	
(1512)	NUMBER OF FAULTS, NUMFLTS	
(1513)	NUMBER OF PRE-FAULT CYCLES, PREFLT	
(1514)	OSCILLOGRAPHY TRIGGER, OSCTRIG	
(1515)	CURRENT UNBALANCE ALARM, UNBALALM	
(16)	SCADA DTA INTERFACE, SCADA DTA	
(1601)	SCADA DTA FAULT LOCATION LOCK, FLTLOCK	
(1602)	SCADA DTA FAULT LOCATION RESET, FLTRESET	
(17)	CONFIGURABLE INPUTS, CNFGINPUTS	
(1701)	CONFIGURABLE INPUT MODE, CONCCI	
(1702)	SETTINGS GROUP, SETGRP	
(18)	CONFIGURABLE OUTPUT #1, BKR1CLSOUT	
(1801)	CLOSE CONTACT 1, CONOUT1	
(1802)	INPUT NUMBER 1, CO1IN1	
(1803)	INPUT NUMBER 2, CO1IN2	
(1804)	INPUT NUMBER 3, CO1IN3	
(1805)	INPUT NUMBER 4, CO1IN4	
(1806)	INPUT NUMBER 5, CO1IN5	
(1807)	INPUT NUMBER 6, CO1IN6	
(1808)	INPUT NUMBER 7, CO1IN7	
(1809)	INPUT NUMBER 8, CO1IN8	

TABLE 2-2: SETTINGS - (6 OF 7)

SET#	DESCRIPTION	SETTING
(19)	CONFIGURABLE OUTPUT #2, BKR2CLSOUT	
(1901)	CLOSE CONTACT 2, CONOUT2	_____
(1902)	INPUT NUMBER 1, CO2IN1	_____
(1903)	INPUT NUMBER 2, CO2IN2	_____
(1904)	INPUT NUMBER 3, CO2IN3	_____
(1905)	INPUT NUMBER 4, CO2IN4	_____
(1906)	INPUT NUMBER 5, CO2IN5	_____
(1907)	INPUT NUMBER 6, CO2IN6	_____
(1908)	INPUT NUMBER 7, CO2IN7	_____
(1909)	INPUT NUMBER 8, CO2IN8	_____
(20)	CONFIGURABLE OUTPUT #3, RCCANCLOUT	
(2001)	RECLOSE CANCEL, CONOUT3	_____
(2002)	INPUT NUMBER 1, CO3IN1	_____
(2003)	INPUT NUMBER 2, CO3IN2	_____
(2004)	INPUT NUMBER 3, CO3IN3	_____
(2005)	INPUT NUMBER 4, CO3IN4	_____
(2006)	INPUT NUMBER 5, CO3IN5	_____
(2007)	INPUT NUMBER 6, CO3IN6	_____
(2008)	INPUT NUMBER 7, CO3IN7	
(2009)	INPUT NUMBER 8, CO3IN8	
(21)	CONFIGURABLE OUTPUT #4, LNOVLDOUT	
(2101)	LINE OVERLOAD, CONOUT4	_____
(2102)	INPUT NUMBER 1, CO4IN1	_____
(2103)	INPUT NUMBER 2, CO4IN2	_____
(2104)	INPUT NUMBER 3, CO4IN3	_____
(2105)	INPUT NUMBER 4, CO4IN4	_____
(2106)	INPUT NUMBER 5, CO4IN5	_____
(2107)	INPUT NUMBER 6, CO4IN6	_____
(2108)	INPUT NUMBER 7, CO4IN7	_____
(2109)	INPUT NUMBER 8, CO4IN8	_____

TABLE 2-2: SETTINGS - (7 OF 7)

SET#	DESCRIPTION	SETTING
(22)	CONFIGURABLE OUTPUT #5, NONCRITOUT	
(2201)	NON-CRITICAL ALARM, CONOUT5	
(2202)	INPUT NUMBER 1, CO5IN1	
(2203)	INPUT NUMBER 2, CO5IN2	
(2204)	INPUT NUMBER 3, CO5IN3	
(2205)	INPUT NUMBER 4, CO5IN4	
(2206)	INPUT NUMBER 5, CO5IN5	
(2207)	INPUT NUMBER 6, CO5IN6	
(2208)	INPUT NUMBER 7, CO5IN7	
(2209)	INPUT NUMBER 8, CO5IN8	
(23)	CONFIGURABLE OUTPUT #6, RIINITOUT	
(2301)	RECLOSE INITIATE, CONOUT6	
(2302)	INPUT NUMBER 1, CO6IN1	
(2303)	INPUT NUMBER 2, CO6IN2	
(2304)	INPUT NUMBER 3, CO6IN3	
(2305)	INPUT NUMBER 4, CO6IN4	
(2306)	INPUT NUMBER 5, CO6IN5	
(2307)	INPUT NUMBER 6, CO6IN6	
(2308)	INPUT NUMBER 7, CO6IN7	
(2309)	INPUT NUMBER 8, CO6IN8	

HARDWARE DESCRIPTION

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.

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 and obtain present values 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 4-1 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.

Connector PL1 is used for serial communication between the DLP3™ system and the PC/Modem. PL3 is used for the SCADA DTA output and phase identification contacts. PL4 is a BNC connector, used for an unmodulated IRIG B input.

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, care should be exercised when removing and handling the modules to make settings on the internal switches. The persons handling the modules should make sure that their body charge has been discharged, by touching some surface at ground potential before touching any of the components on the modules.

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.

XTM TEST PLUGS (OPTION)

Description

The XTM test plugs are designed specifically for post-installation testing of the DLP system. There are two plugs; XTM28L1 (left-hand plug) and XTM28R1 (right-hand plug), each providing access to fourteen relay-side and fourteen system-side points. The system-side points are designated "S" and the relay-side points are designated "R". The plugs are keyed by the contact finger arrangement so that there may be no accidental interchange between the left-hand and right-hand plugs.
The plugs are fitted with a sliding handle that swings out to facilitate wiring to the terminals. The terminals consist of number 8 screws threaded into flat contact plates. The handles each have a tab on the outside edge to guide the wire dress of the test leads.

CAUTION:Not all external connections to the DLP system are wired through the test receptacle.

Terminal Designation

The test receptacle and connection plugs are located to the left of the magnetics module (extreme left-hand position). Their terminals are labeled 1 through 28, with 1 through 14 corresponding to the left-hand side and 15 through 28 corresponding to the right-hand side. These points are designated on the elementary diagram, Figure 1-5 as TP1 through TP28.

The left-hand test plug (XTM28L1) terminals are labeled 1R through 14R and 1S through 14S for the relay side and system side, respectively, with the system side labeled in red. Similarly, the right-hand test plug (XTM28R1) terminals are labeled 15R through 28R and 15S through 28S.

XTM Test-Circuit Connections

Test-circuit connections, designated as TP points in the elementary diagrams, should be made to the relay side of the test plug. Where it is desired to use available system quantities for testing, e.g., DC control power, jumpers may be inserted between the corresponding system-side and relay-side test plug terminals. Appropriate precautions should be taken when working with station battery DC. Connections should be made to the test plugs **prior to insertion** into the DLP system.

Test Plug Insertion

To insert the test plugs, the two connection plugs must first be removed. In so doing, electrical continuity is broken between the power system and the DLP system for those signals that are wired through the test receptacle (refer to TP points on the elementary diagram, Figure 1-6 in the PRODUCT DESCRIPTION section).

For the terminals connected to the current-transformer secondaries, shorting bars are included on the system side of the test receptacle. These are clearly visible through the transparent plastic face plate on the receptacle. The shorting bars make contact before the connection-plug contacts break during removal, so that the CT secondaries are never open-circuited.Both test plugs may be inserted at the same time. Otherwise, if using only one test plug, the connection plug may remain in the other half of the receptacle.

When the test plugs are inserted into the receptacle, parts of the power system become isolated from the DLP system. Refer to the elementary diagram for the TP points associated with each of the test plugs.

NOTE: To remove power from the relay, remove at least one of the connection plugs positioned to the left of the MGM module (see Figure 4-1).

WARNING: IT IS CRITICAL THAT JUMPERS BE INSERTED ON THE SYSTEM-SIDE TEST PLUG TERMINALS THAT ARE CONNECTED TO THE CT SECONDARIES, AS SHOWN IN FIGURE 1-6. IF THESE JUMPERS ARE LEFT OUT, THE RESULTING HIGH VOLTAGES DEVELOPED PRESENT A SERIOUS HAZARD TO PERSONNEL AND MAY SEVERELY DAMAGE EQUIPMENT.

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 DLP3 case has been designed for standard rack mounting. The case measures four rack units (4 RU) in height. Refer to Figure 3-1 for the outline and mounting dimensions.

External Connections

External connections are made according to the elementary diagram, Figure 1-6 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.

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

SURGE GROUND CONNECTIONS

CAUTION:Terminals AC14 and AD14 must be tied together, and terminal AD14 must be tied to station ground, as shown in the elementary diagram Figure 1-6. The connection to the ground bus must be made as short as possible, using No.12 wire or larger.

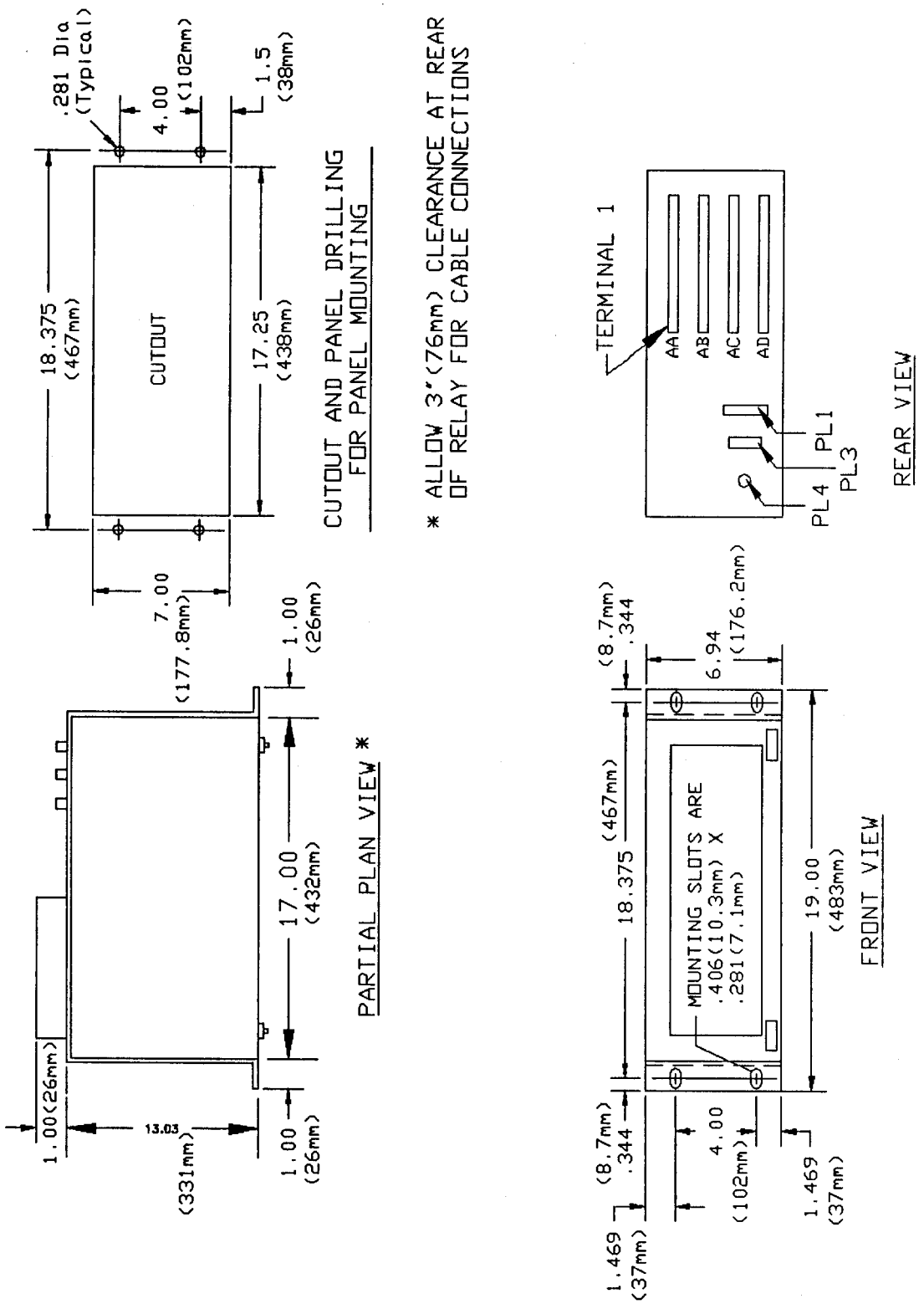


Figure 3-1 (0286A4851 [1]) DLP3 System Outline drawing

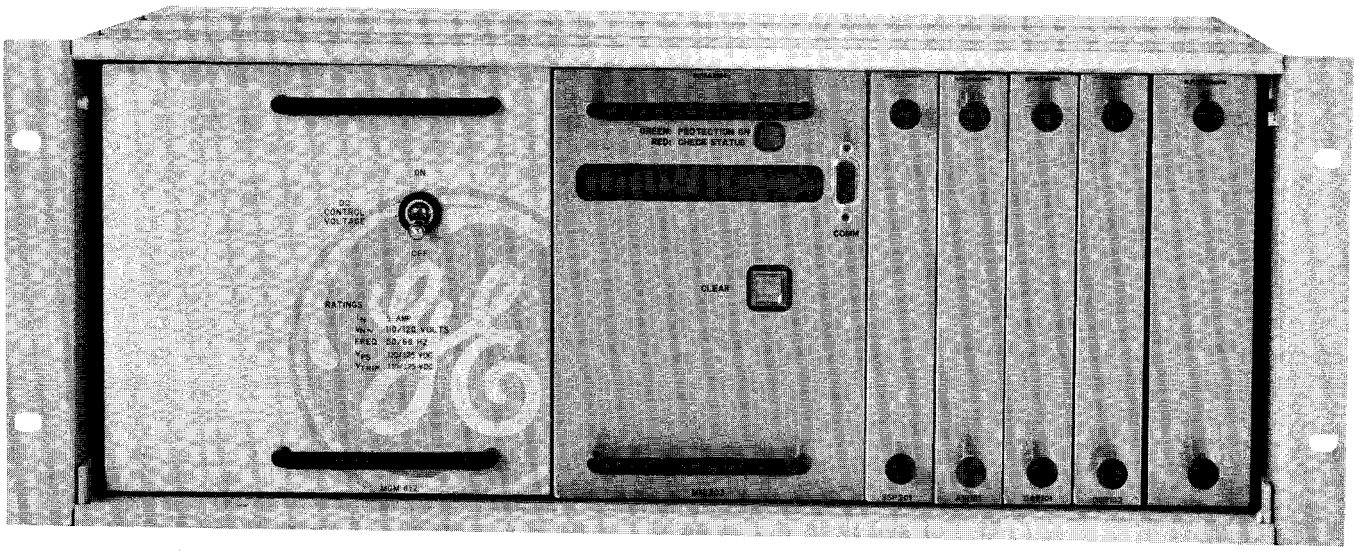


Figure 3-2 (8919517) DLP3 Relaying System (front view)

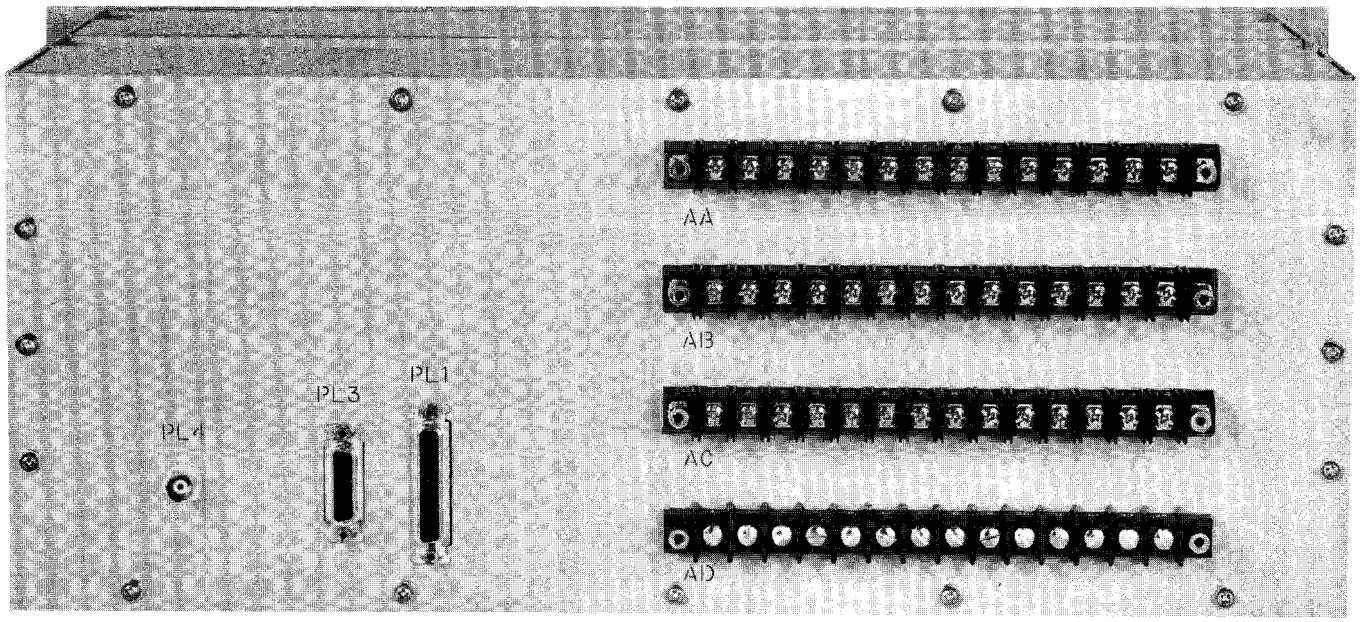


Figure 3-3 (8919522) DLP3 Relaying System (rear view)

MODULES

CAUTION

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

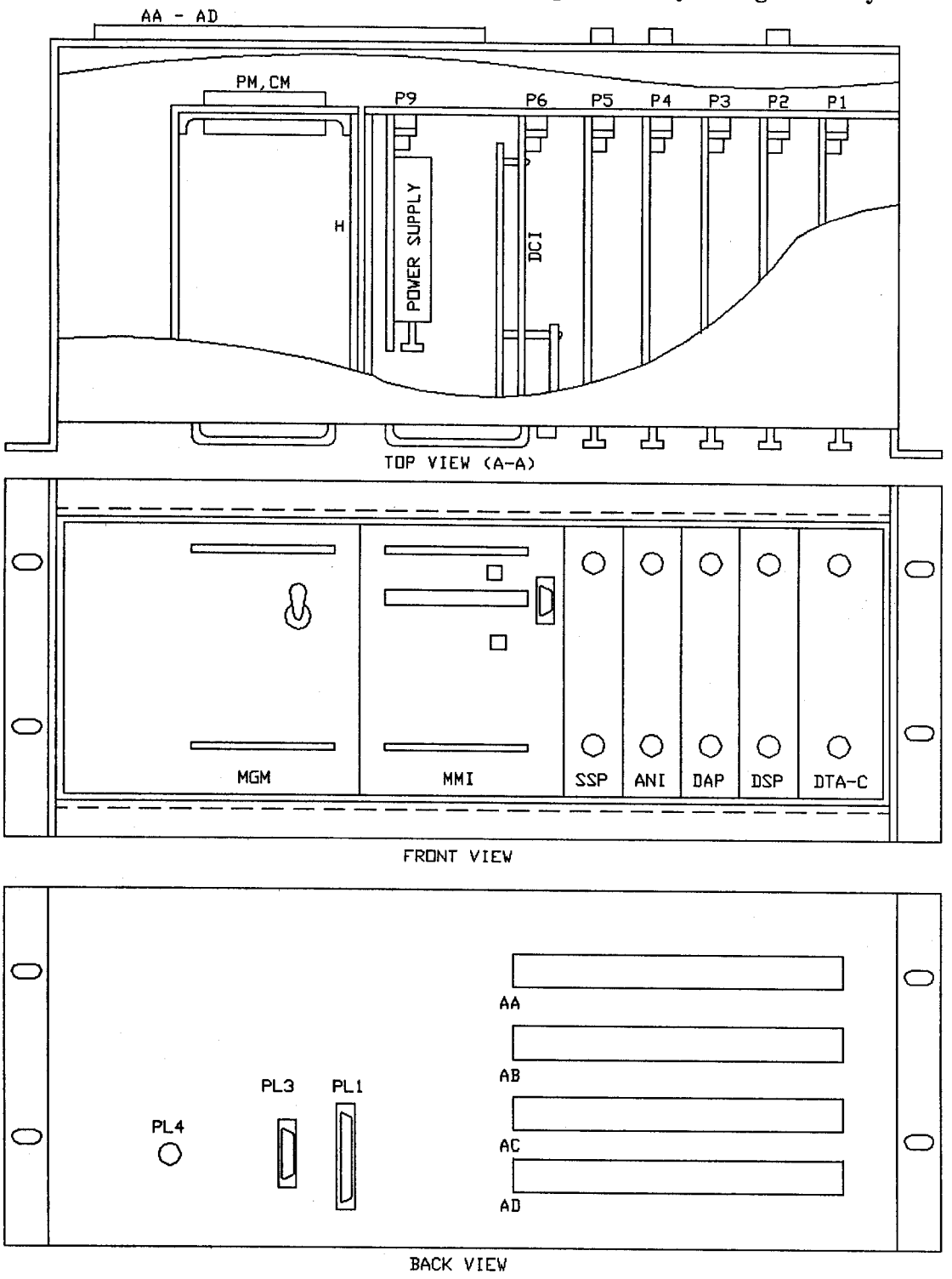


Figure 4-1 (0286A4863) Module Location

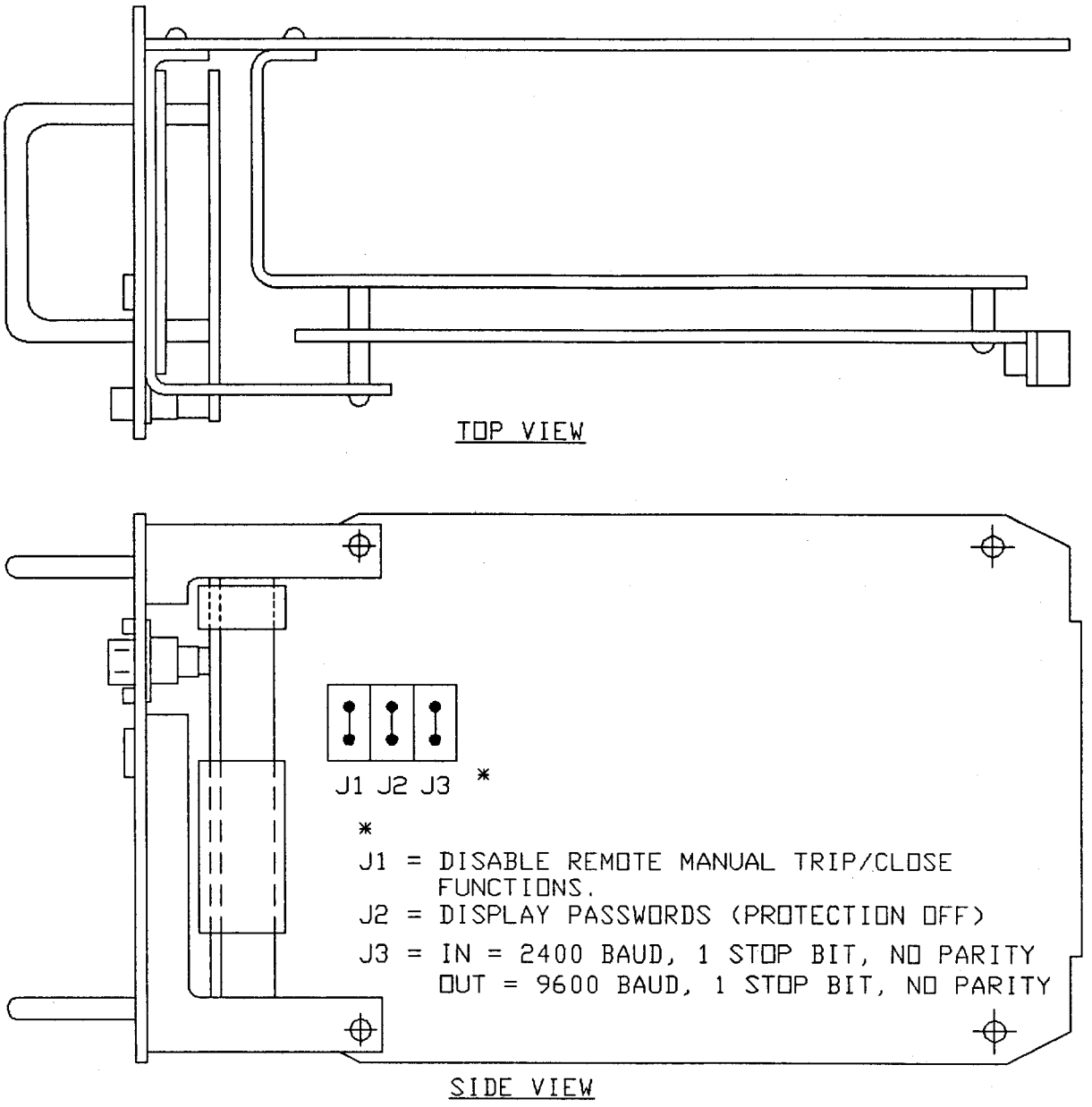


Figure 4-2 (0286A4856 [1]) MMI Module

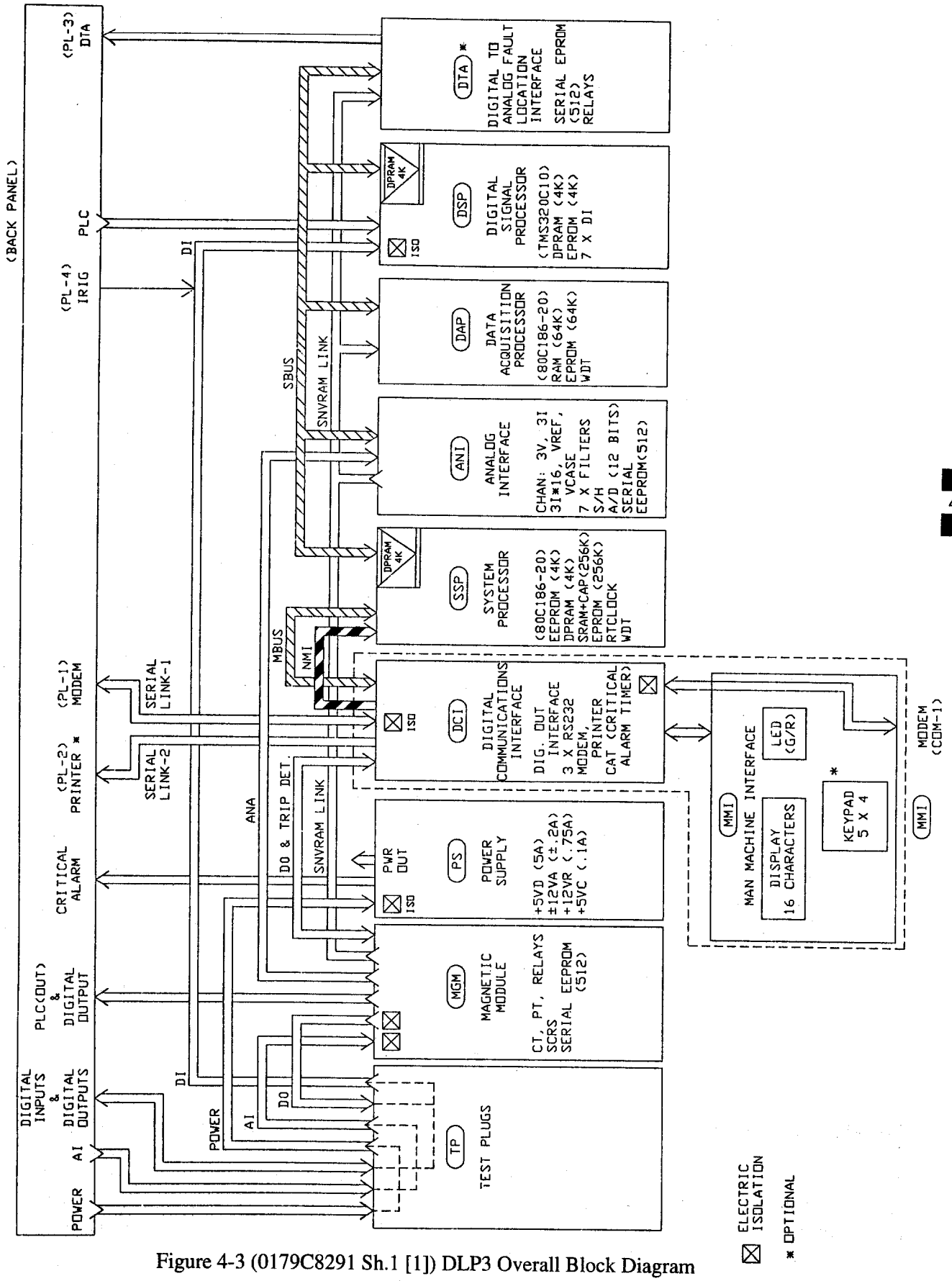
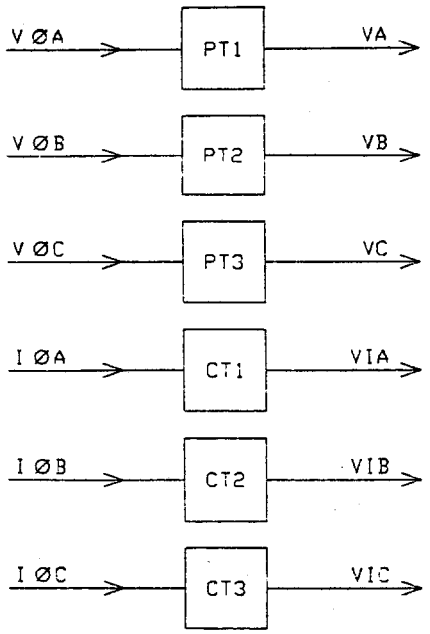


Figure 4-3 (0179C8291 Sh.1 [1]) DLP3 Overall Block Diagram



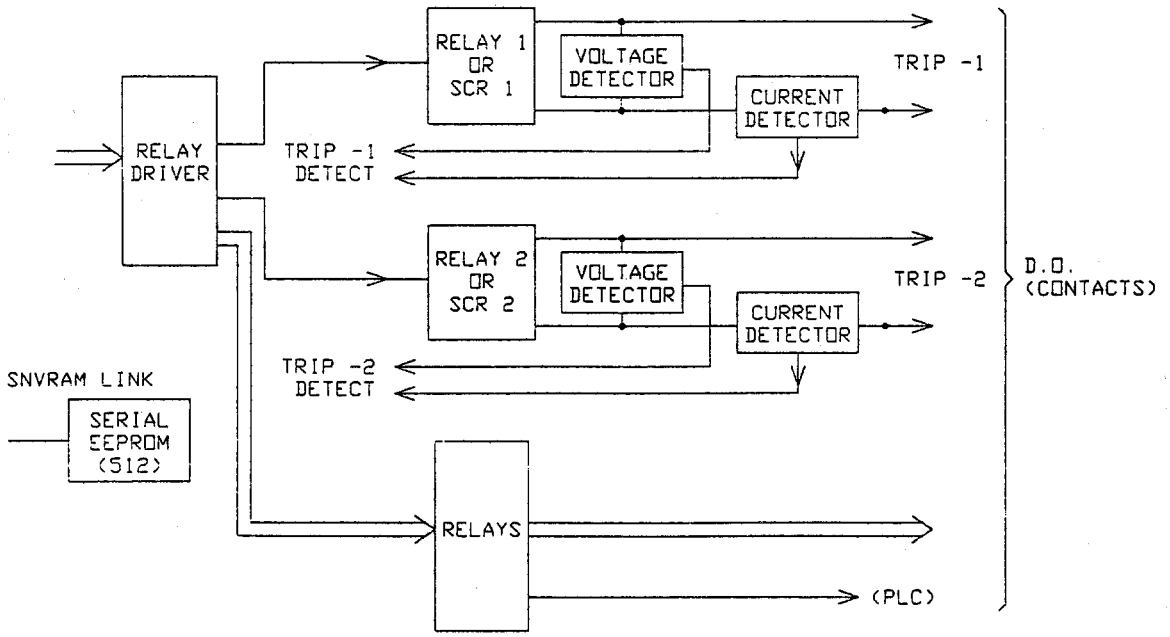


Figure 4-4 (0179C8291 Sh.2) MGM Block Diagram

MAGNETICS MODULE

The Magnetics Module (MGM) contains the input current transformers, voltage transformers and a Relay Driver circuit board. The Relay Driver circuit board contains the alarm, BFI, RI, RC, breaker close, key transmitter, and tripping contacts (or SCRs). In addition, the MGM contains an EEPROM with factory stored DLP model information (DC voltage rating, AC current rating) and gain calibration information for the analog channels.

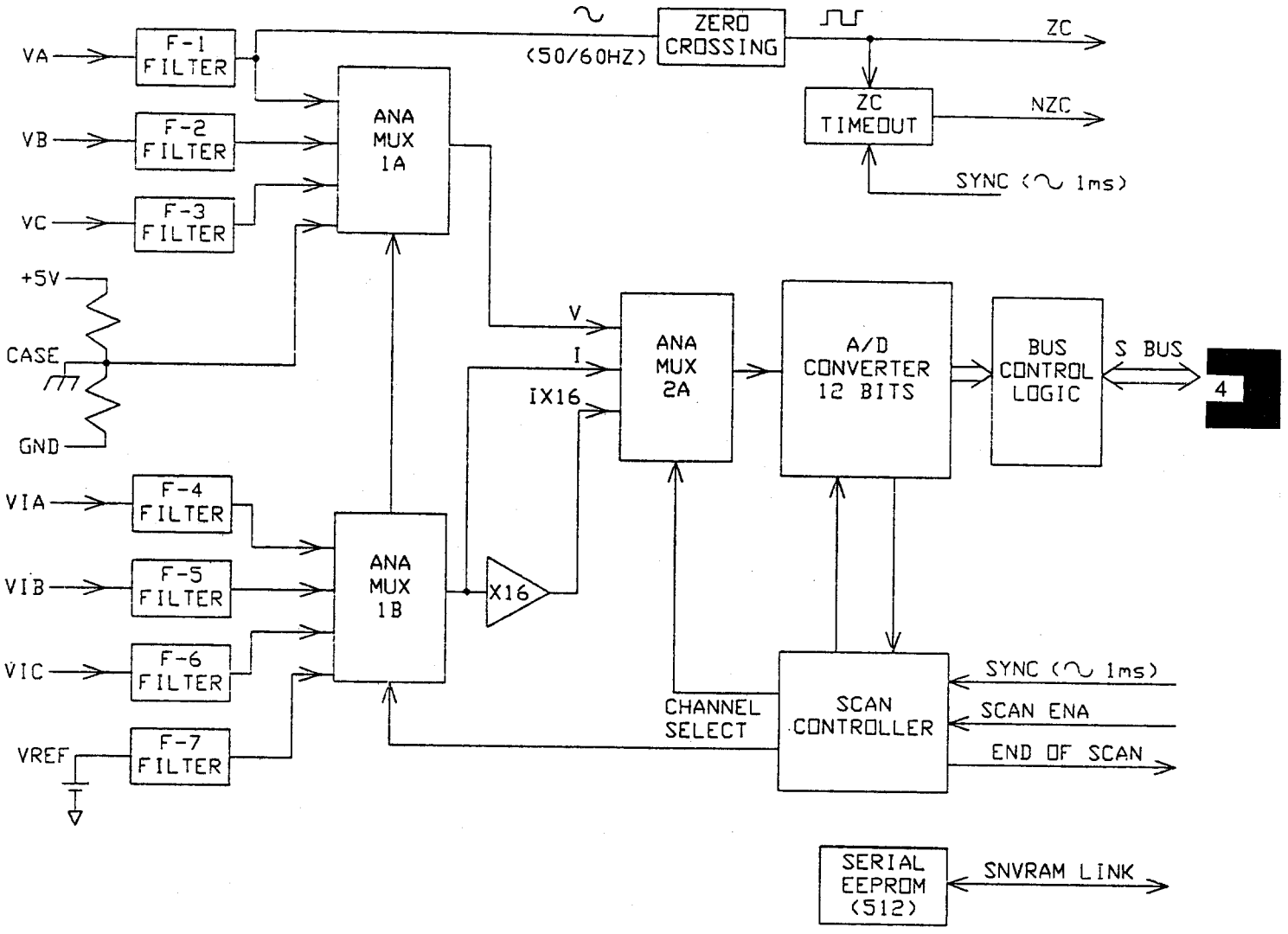


Figure 4-5 (0179C8291 Sh.4) ANI Block Diagram

ANALOG INTERFACE MODULE

The Analog Interface Module (ANI) contains the anti-aliasing filters, the multiplexing and control logic for the analog to digital converter, and an EEPROM to store factory set channel gains and offsets.

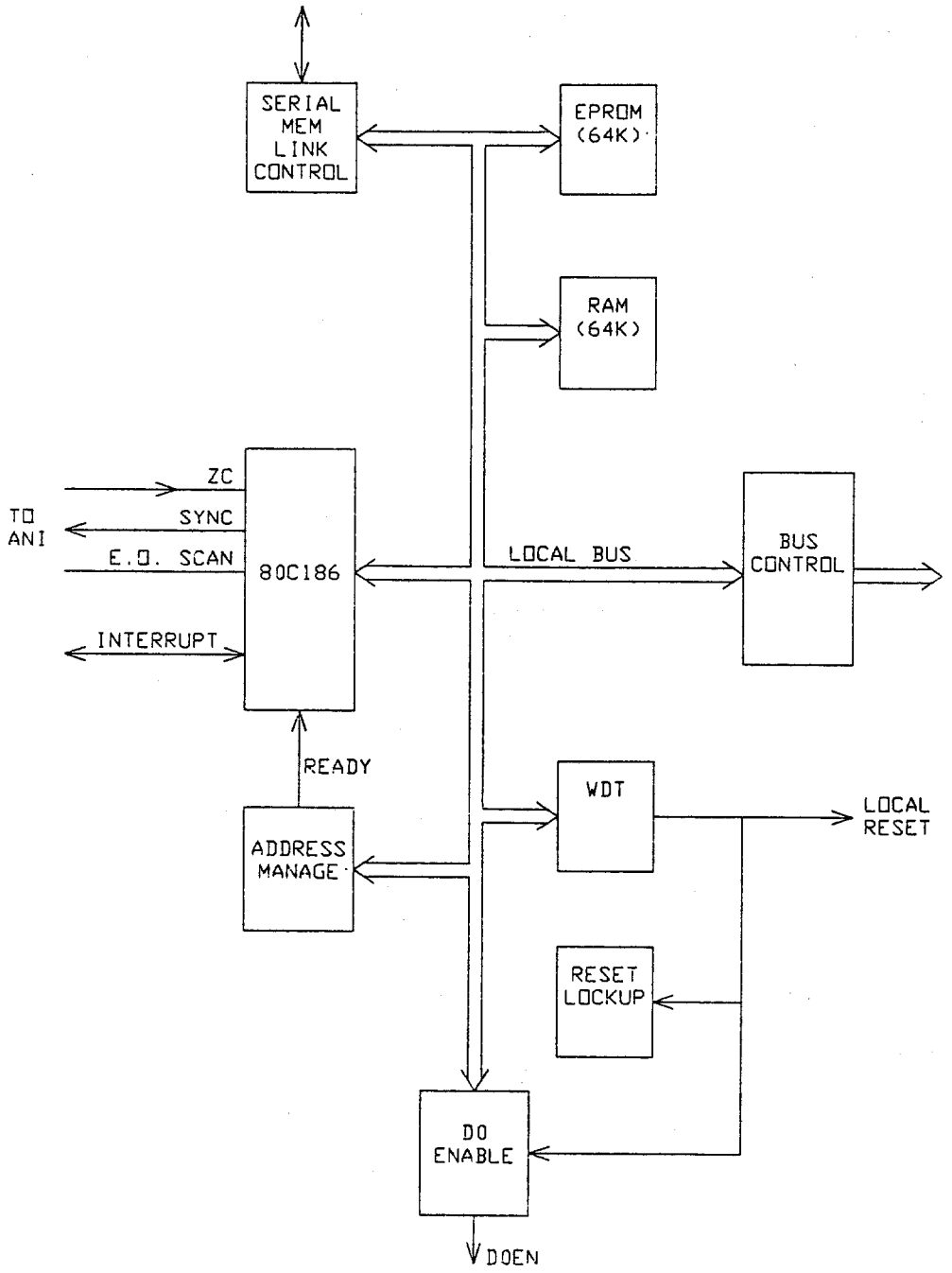


Figure 4-6 (0179C8291 Sh.3) DAP Block Diagram

DATA AQUISITION PROCESSOR MODULE

The Data Aquisition Processor Module (DAP) contains one of the two 80C186 processors used in the DLP and the associated memory. The functions performed by the DAP include:

Zone Determination
Out of Step Logic
Analog to Digital Interface
Coincidence Logic for Zones 3 and 4
Digital Input Logic
Frequency Tracking
IRIG-B Interface
SCADA Output

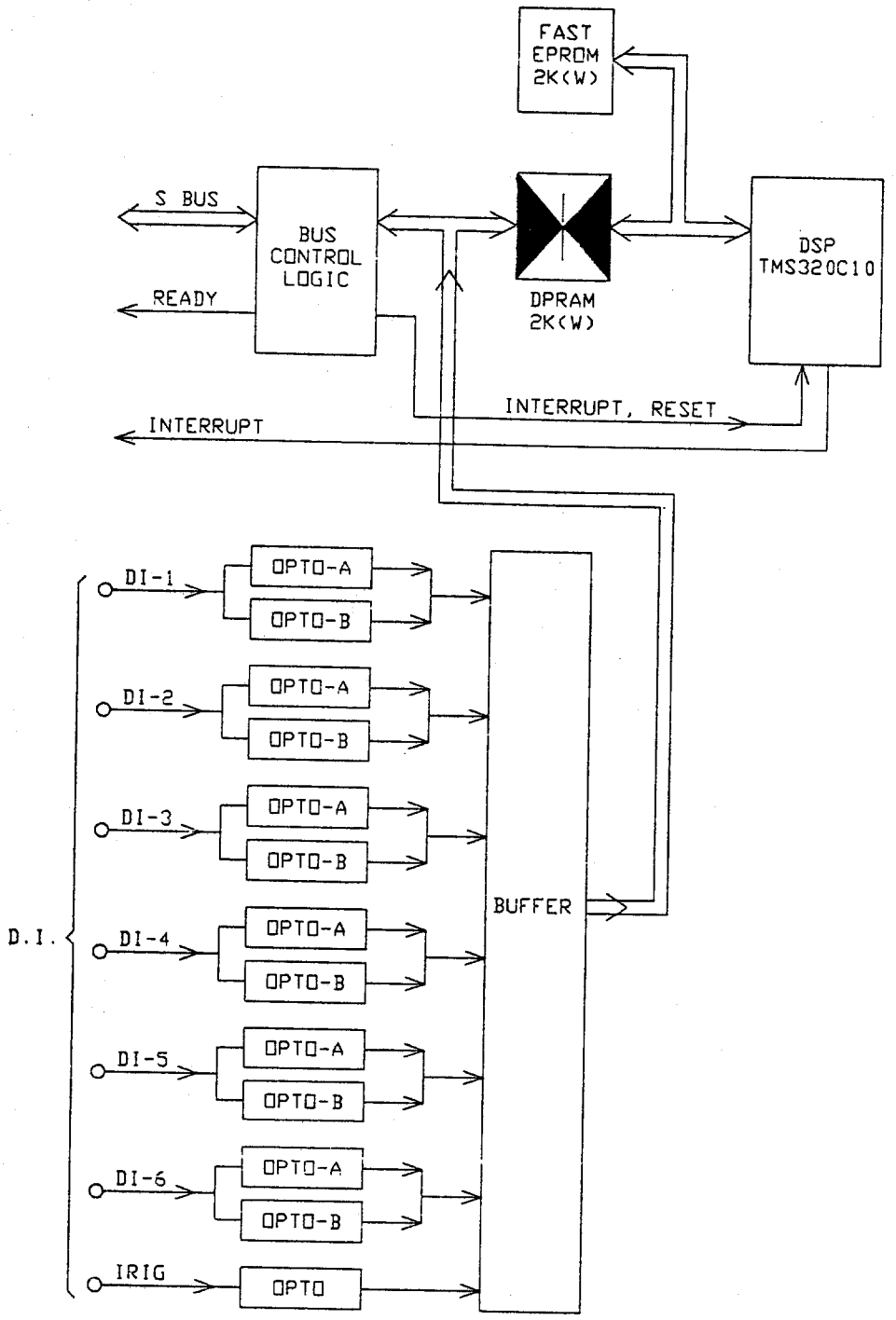


Figure 4-7 (0179C8291 Sh.3) DSP Block Diagram

DIGITAL SIGNAL PROCESSOR MODULE

The Digital Signal Processor Module (DSP) contains the TMS320C10 digital signal processor chip and its required memory. The DSP is responsible for most of the numerical calculations in the DLP. It performs a recursive Fourier Transform calculation to transform the digitized waveforms into phasor quantities. It also handles the coincidence logic for zones 1 and 2. In addition, the DSP includes the isolated contact converters (Digital Inputs) and IRIG-B time sync input.

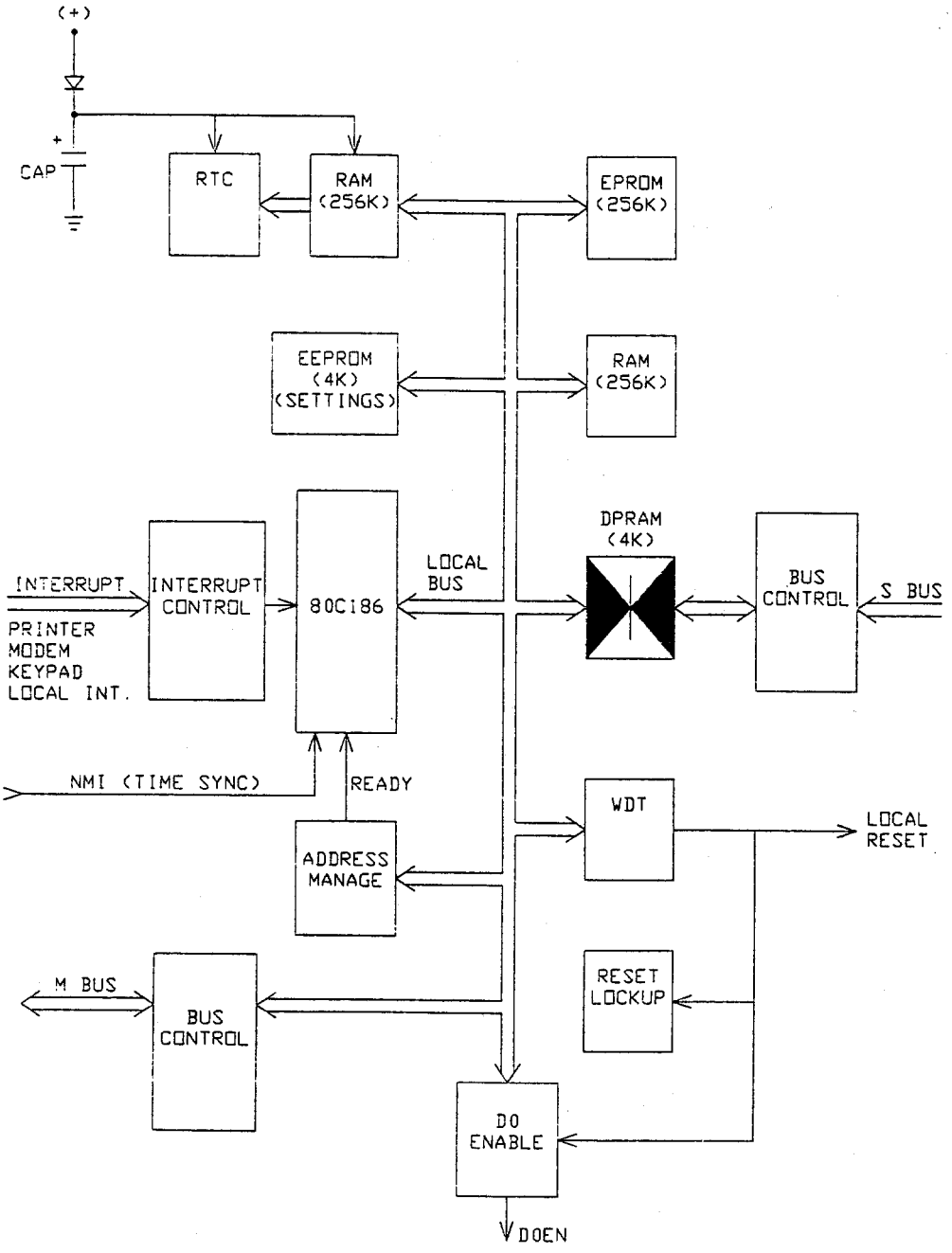


Figure 4-8 (0179C8291 Sh.4) SSP Block Diagram

SYSTEM PROCESSOR MODULE

The System Processor Module (SSP) contains one of the two 80C186 processors used in the DLP, EEPROM for storage of user settings, CAPRAM for storage of fault data and oscillography, and shared memory used for data transfer to other modules.

The functions performed by the SSP include:

Scheme Logic
Peripheral Protection Trip Logic
Fault Reporting
Power System Alarming
Communications and Printer Control

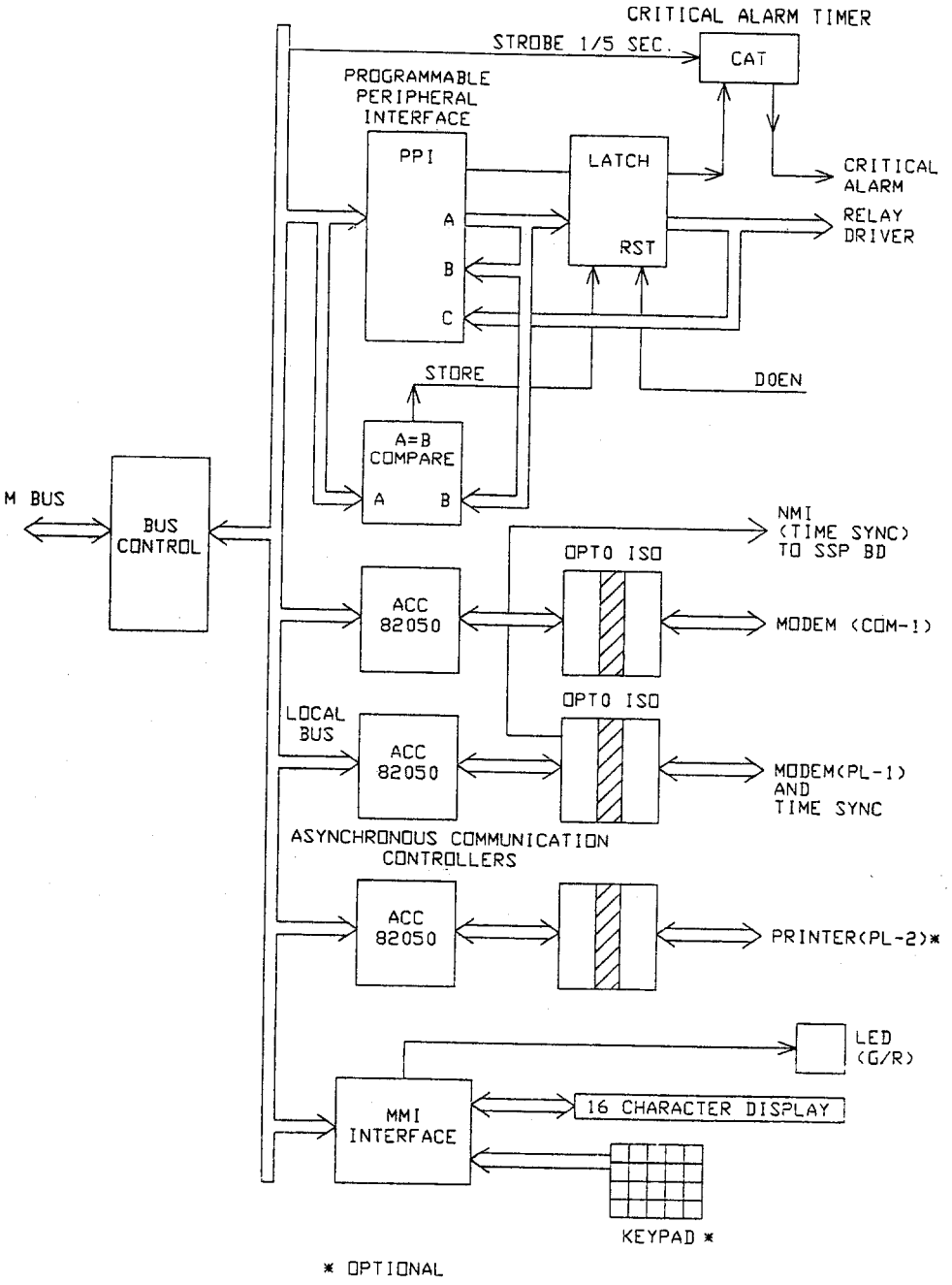


Figure 4-9 (0179C8291 Sh.2) DCI and MMI Block Diagram

MAN MACHINE INTERFACE MODULE

The Man Machine Interface Module (MMI) contains the 16 character LED display, the green/red status LED, a 9-pin RS-232 port, and the 20 character keypad. The module includes two circuit boards: the MMI and DCI. The MMI board contains all of the items listed above. The DCI contains the DLP communications interface (two RS-232 ports and a printer port), Critical Alarm Timer, and various output relay drivers. In addition, the DCI contains user selectable jumpers to enable remote functions (refer to Figure 4-2).

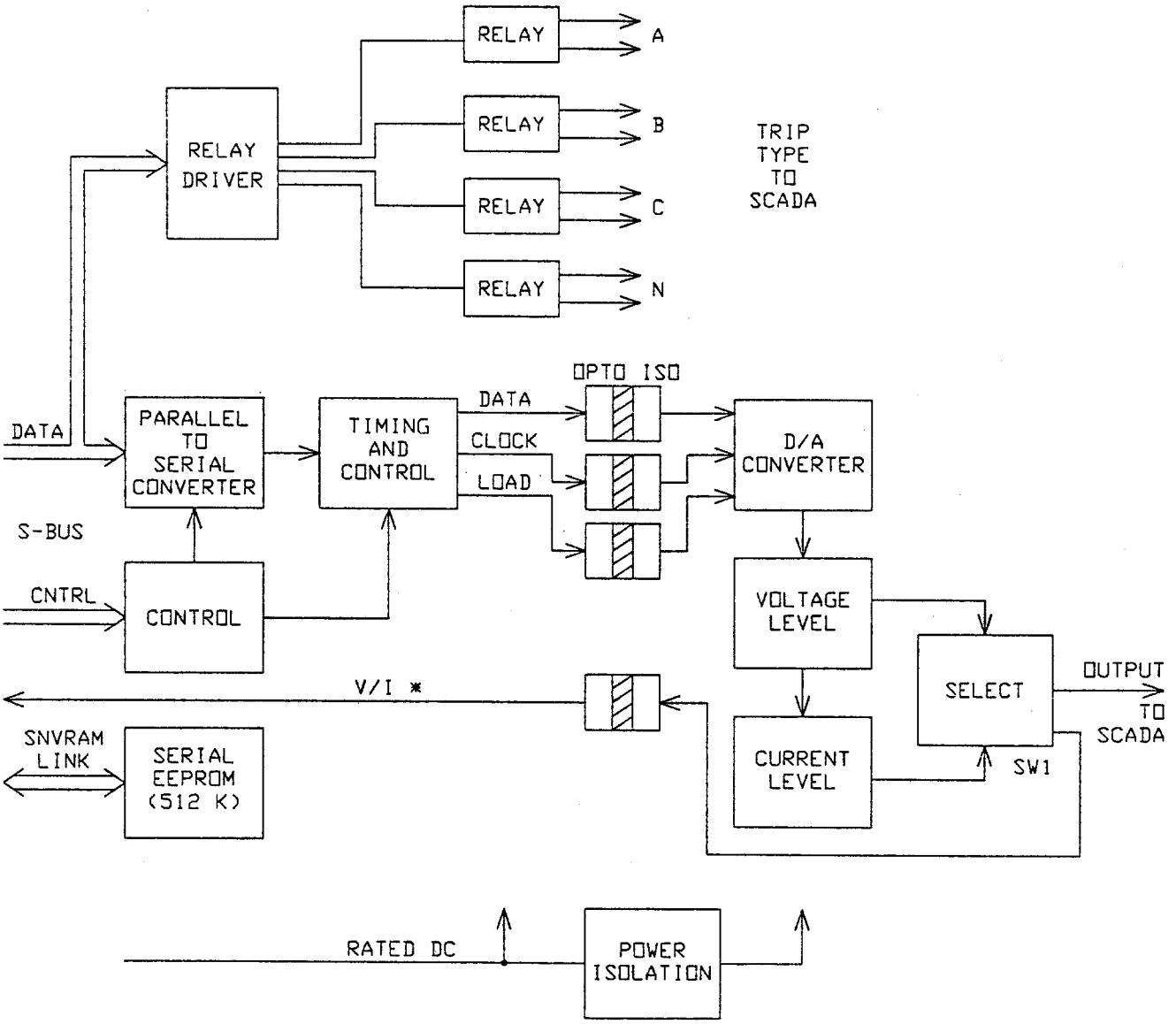


Figure 4-10 (0179C8291 Sh.5) DTA Block Diagram

DIGITAL TO ANALOG MODULE (Optional)

The Digital to Analog Module (DTA) contains the circuits to produce an isolated analog output, either voltage or current, proportional to the distance to the fault. It also contains four dry contacts which close to indicate the faulted phases.

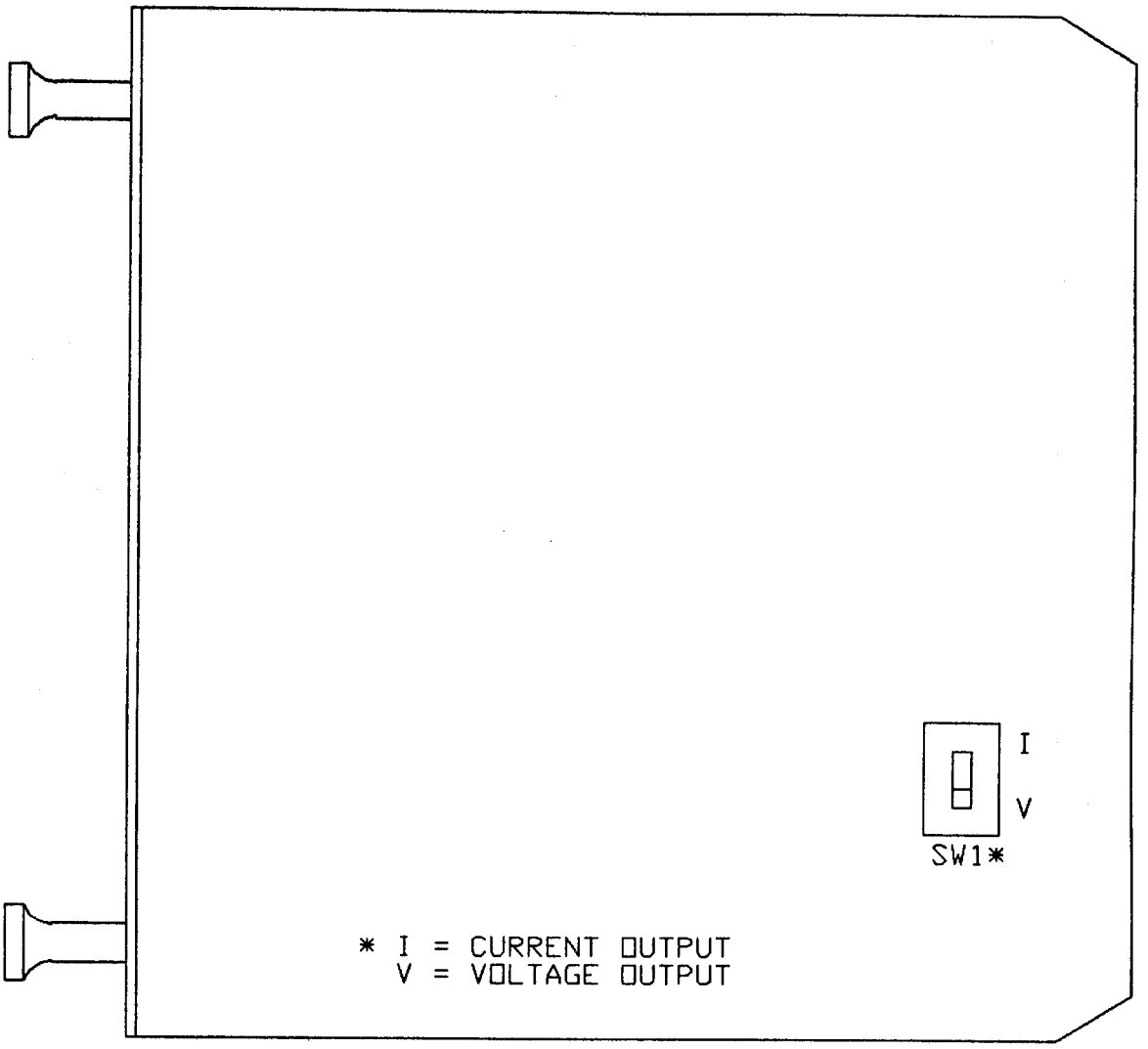


Figure 4-11 (0286A3847) DTA Module

ACCEPTANCE TESTS

CAUTION: Power Down the relay, by turning off the power switch or by removing a connecting plug, 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. The DLP3™system 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; tests of backup protection functions, measuring units, and Zone timers are also included, and can be performed at the user's discretion.

General Tests

T1 MMI Status and Self Tests
T2 Digital Output Tests
T3 Configurable Input and Output Tests
T4 AC System Input Test

Measuring Unit Tests

T5 FD Fault Detector
T6 IT Trip Supervision Test
T7 IB Blocking Supervision Test
T8 Ground Directional Trip Test, IPT + NT
T9 Ground Directional Block Test, IPB + NB

Backup Protection Tests

T10 Phase Instantaneous Overcurrent PH4
T11 Ground Instantaneous Over-current IDT
T12 Ground Time Over-current TOC

Zone Ground/Phase Reach and Timers Tests

T13 Zone1 Ground Reach M1G
T14 Zone2 Ground Reach MTG
* T15 Zone3 Ground Reach M3G
* T16 Zone4 Ground Reach M4G
T17 Zone Ground Timer Tests
T18 Zone1 Phase Reach M1
T19 Zone2 Phase Reach MT
* T20 Zone3 Phase Reach M3
* T21 Zone4 Phase Reach M4
T22 Zone Phase Timer Tests
T23 Out of Step MOB

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 and mouse port
7. An RS232 null modem cable to connect the PC to the DLP3™ system
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 AND REFERENCES:

The following drawings should be used for reference during testing. They are located in the PRODUCT DESCRIPTION and the CALCULATION OF SETTINGS sections.

Drawings:

1. The Elementary Diagram	FIG 1-6
2. The Logic Diagrams	FIG 1-1,2,3,4,5
3. The TOC curves	FIG 2-2,3,4

*** Not applicable to Models DLP3***EC and DLP3***FC**

References:

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

EQUIPMENT GROUNDING

All equipment used in testing the DLP3™ relay should be connected to a common grounding point, to provide noise immunity. This includes the voltage and current sources, as well as the DLP3™ system itself.

The ground connection on the DLP3™ system 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 DLP3 system is tested in the "test mode" of operation. This mode allows the internal measuring units and functions to be brought out and viewed. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

   The test mode selects and isolates various test functions and measuring units, and routes their status to the RC "reclose cancel" contact. When the particular function under test has picked up, the RC contact will close. Target information will be displayed for tests that cause tripping. Testing can be performed with outputs disabled, in which case RC is the only contact that will operate. Outputs can be disabled from the **ACTIONS** menu.

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

Before each zone reach test, backup protection functions and zones not under test should be disabled, using the settings. This is not strictly necessary when using the test mode, but if it is not done, the trip target type may not match the unit under test. Example: If a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. It is important to keep that in mind during the tests.

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

NOTE: TRIPPING CONTACTS WILL OPERATE IN THE TEST MODE UNLESS OUTPUTS ARE DISABLED BY THE USER.

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

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

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

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

6. For tests that require a setting change, the setting number will be shown in parentheses next to the setting, to facilitate direct access to the setting.

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

At the end of testing, make sure that all settings are returned to initial values. Print them out, and verify them, before placing the relay in service. If a printer is not available, use DLP-LINK to view and verify each one.

USING DLP-LINK

To test the relay, communication is accomplished via a PC with the program DLP-LINK. DLP-LINK is required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Once in test mode, current and voltages are applied to the relay to simulate the desired system conditions.

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

Hardware Setup

The hardware, specifically the cable to connect your PC to the relay, depends on the connection the PC requires and that of the DLP3 system. The DLP3 port PL-1 accepts a 25 pin male D-connector. Port COMM accepts a 9 pin male D-connector. The PC used may require a 9 or a 25 pin connector. Null modem cables are shown in the INTERFACE section for connecting to the DLP3 system with a 9-pin-to-25-pin and a 25-pin-to-25-pin setup.
Connect the PC to the DLP3 system with the appropriate null modem connector.

See INTERFACE section for Cable diagrams.

PC Software Setup

The Software set up consists of loading the software on to the PC, starting the program, and configuring the program to the PORT and BAUD RATE of the PC and DLP3 system.

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 DLP3 system.

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 DLP3 system's baud rate, phone number, and switch code. The DLP3 system 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 2400 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. For **BAUD RATE**, select 2400, stop bits, 1, and parity, none.

The Unit Description for "TEST" is complete.
Enter "OK" to return to the SETUP MENU.

Relay Setup

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

Setting		Default (from the factory)
UNIT ID	0	(CONFIG setting)
VIEW PASSWORD	VIEW!	(Local Communication ACTION)
CONTROL PASSWORD	CTRL!	(Local Communication ACTION)
SETTINGS PASSWORD	SETT!	(Local Communication ACTION)
BAUD RATE	2400	(MMI Jumper)

If this is the first login to the relay, these parameters will need to be changed. The remote passwords must be changed before any functions except CHANGE PASSWORD or LOGOUT can be used. Refer to the Actions menu under Relay functions in 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 passwords are those listed in the table above, and must be changed before any of the relay functions except CHANGE PASSWORD and LOGOUT will operate. See the SOFTWARE section of this manual for information on how to change a password.

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.

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 DLP3 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 DLP3 Settings menu after all settings changes for a particular test are completed. This is necessary because settings are stored in a buffer so that they can all be downloaded at once. Selecting END SETTINGS CHANGES changes the settings in the relay itself.

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 "Change access level" from the Relay Functions menu.

Enter the Control Level password. If the password is not known, see the INTERFACE section for information on how it can be viewed.

When the password is accepted, "CONTROL ACCESS" will appear at the bottom of the screen.

Select "Relay test mode" from the DLP3 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 DLP3 system 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.

Before testing, the relay settings should be uploaded from the DLP3 system and printed for reference and verification. Verify that each DLP3 setting matches the default setting listed. If no printer is available, use the VIEW/CHANGE CATEGORY OF SETTINGS command for verification.

Once uploaded, the current DLP3 settings can be saved to a disk file so that they can be reloaded back into the DLP3 system when testing is completed. Select "Save settings to file" from the DLP3 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.

GENERAL RELAY TESTS

T1 - Status and Testing

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

Status Check

The preceding test will demonstrate how 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. Select "request DLP Status" from the 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 of the trip circuit monitor: (1504) TRIPCIRC = 1 (BKR1). When this is done, the relay expects wetting voltage across the trip contacts.

NOTE: Select "End Settings changes" to complete each setting change.

4. Select "request DLP Status" from the Information menu.

   The display should be "STATUS: WARN".

5. "BKR1 TRIP CIRCUIT OPEN", should also appear on the screen. 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 = NONE, before proceeding with the next test.

Digital Output Testing

This test is used to check all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults.

NOTE: None of the outputs will operate unless jumper J1 on the MMI module is removed. Refer to figure 4-2.

T2 - Output Test

1. Connect the relay as shown in Figure 5-1.

2. Enter the "Control Level" password.

3. Select "digital Output test" from the Actions menu.

4. Select the desired output, such as TRIP1.

   Before the contact is allowed to close you will be prompted to turn protection off during the test. The prompt is: "PROTECT OFF?". Select "OK" to turn protection off. Protection will remain off until the test mode is ended.

   Once the protection choice is chosen, the "relay output" selected will close.

   Verify that the output under test has closed, using an ohm meter or other suitable device.

5. After the output is tested, select the next output to test. This output will close and the previously selected output will open. Continue in this fashion until all outputs are tested.

6. End the test mode by selecting "END TEST MODE" selection.

Configurable Input and Output Testing

The DLP3 system includes three configurable inputs and six configurable outputs, which provide great flexibility in applying and testing the relay.

The configurable inputs are set in "modes of operation" that determine how the inputs will be used. In one mode, the input could be used to trigger oscillography, and in another it could be used to control a configurable output.

The configurable outputs are set in a different manner. Each output can be set as a logical 'AND' or a logical 'OR' of up to eight of the 64 measuring units of the relay. In the test case used below, the digital inputs will be used as "logic" inputs to the configurable output. When the input is energized, the configurable output contacts will close.

T3 - Configurable Input and Output Test

Change the following settings for MODE0 operation. In MODE0, CC4 will be RCVR2 input and CC5 and CC6 will select the settings group used by the relay.

Settings:
CURSUPVIS
(1701) CONCCI = 0 (MODE0)
(1702) SETGRP = 0 (ADAPTIVE SETTINGS GROUP)

SCHEMESEL
G1 (1201) SELSCM = 1 (POTT)
G1 (1202) NUMRCVR = 2
CONFIG
G1 (1503) NUMBKRS = 2

1. Connect the relay as shown in Figure 5-2.

2. Apply rated DC across CC4 (AA12-AB12). Select "request Present values" from the Information menu and verify that PLC #2 is ON.

3. Remove DC from CC4. Verify that PLC #2 is OFF.

Settings Group Selection

In MODE0, CC5 and CC6 are used to select the settings group to be used by the relay.

4. Remove any input to CC5 (AA13-AB13), and CC6 (AA14-AB14). Select "request Present values" from the Information menu and verify that SETTINGS GROUP 1 is selected.

5. Apply rated DC across CC5. Verify that SETTINGS GROUP 3 is selected.

6. Apply rated DC across CC5, and across CC6. Verify that SETTINGS GROUP 4 is selected.

7. Remove any input to CC5, and apply rated DC across CC6. Verify that SETTINGS GROUP 2 is selected.

8. Change the following settings to place the inputs into MODE8 and configure the outputs. In MODE8 CC4, CC5, and CC6 are used as inputs to the configurable outputs.

Settings:
CNFGINPUTS
(1701) CONCCI = 8 (MODE8)
(1702) SETGRP = 1 (SETTINGS GROUP 1)
SCHEMESEL
G1 (1201) SELSCM = 1 (POTT)
G1 (1202) NUMRCVR = 1
CONFIG
G1 (1503) NUMBKRS = 2
BKR1CLSOUT
G1 (1801) CONOUT1 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
G1 (1802) CO1IN1 = 52 (CONFIGURABLE INPUT 3, CC6)
G1 (1803-1809) = 0 (UNUSED)
BKR21CLSOUT
G1 (1901) CONOUT2 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
G1 (1902) CO2IN1 = 52 (CONFIGURABLE INPUT 3, CC6)
G1 (1903-1909) = 0 (UNUSED)
RCANCLSOUT
G1 (2001) CONOUT3 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
G1 (2002) CO3IN1 = 51 (CONFIGURABLE INPUT 2, CC5)
G1 (2003-2009) = 0 (UNUSED)
LNOVLDOUT
G1 (2101) CONOUT4 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
G1 (2102) CO4IN1 = 51 (CONFIGURABLE INPUT 2, CC5)
G1 (2103-2109) = 0 (UNUSED)
NONCRITOUT
G1 (2201) CONOUT5 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
G1 (2202) CO5IN1 = 50 (CONFIGURABLE INPUT 1, CC4)
G1 (2203-2209) = 0 (UNUSED)
RINITOUT
G1 (2301) CONOUT6 = 1 (LOGICAL 'OR' OF THE FOLLOWING SETTINGS)
G1 (2302) CO6IN1 = 50 (CONFIGURABLE INPUT 1, CC4)
G1 (2302-2309) = 0 (UNUSED)

9. Apply rated DC across CC4, AA12-AB12.

10. Verify that the following contacts close:

Output	Contacts
CONOUT5	AC8-AD8
CONOUT6	AA5-AB5 and AA6-AB6

11. Remove DC from CC4.

12. Verify that these contacts are now open.

13. Apply rated DC across CC5 (AA13-AB13).

14. Verify that the following contacts close:

Output	Contacts
CONOUT3	AC7-AD7
CONOUT4	AC12-AD12

15. Remove DC from CC5.

16. Verify that these contacts are now open.

17. Apply rated DC across CC6, (AA14-AB14).

18. Verify that the following contacts close:

Output	Contacts
CONOUT1	AA7-AB7
CONOUT2	AA8-AB8

19. Remove DC from CC6.

20. Verify that these contacts are now open.

T4 - AC System Input Test

This test uses the " PRESENT VALUES" function 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 to verify that the relay has the correct voltages and currents applied.

1. Connect the relay as shown in Figure 5-3.

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

3. Select "request Present values" from the Information menu. The present values are now selected.

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 5-3.

6. Again select "request Present values" 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.

Alternately, whenever the MMI display is blank, pressing the [CLR] key will automatically scroll through all of the present values.

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 picked up.

T5 - Fault Detector Test

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

1. Connect the relay as shown in Figure 5-3.

2. Set the relay into test mode 38 (the fault detector). Set VA = 67 volts rms 0°; VB = 67 volts rms -120°; VC = 67 volts rms +120°.

3. Slowly increase Iop to 1.2(0.4) amps rms, approximately 0.1(0.01) amp per second. Slowly decrease the current to zero (0) amp. The RC contact should not close.

4. Immediately increase the current of Iop to 1.5(0.3) amps rms. The RC contact will close momentarily.

5. Immediately increase the current of Iop to 2.5 (0.5) amperes rms. The RC contact will close until current is removed.
6. Reduce Iop to Zero (0).

T6 - IT Trip Supervision Test

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

1. Connect the relay as shown in Figure 5-3.
2. Set the relay into test mode 34 (IT Detector).
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).

T7 - IB Blocking Supervision Test

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

1. Connect the relay as shown in Figure 5-3.
2. Set the relay into test mode 35 (IB Detector).
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).

T8 - Ground Directional Trip Test, IPT + NT

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

1. Connect the relay as shown in Figure 5-3.
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 36 (Grd Dir Trip).
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).

T9 - Ground Directional Block Test, IPB + NB

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

1. Connect the relay as shown in Figure 5-3.
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 37 (Grd Dir Blk).
4. Set IA, the current of Iop, to .40(.08) amp rms -265°, 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).

T10 - Phase Instantaneous Overcurrent PH4

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

1. Connect the relay as shown in Figure 5-5, for a phase AB, BC or CA fault.
2. Set the relay into test mode 43 (Phase Overcurrent).
3. Set the current of Iop to 2.8(.7) amps rms and apply to the relay. The RC contact should close. Lower Iop to 2.0(.3) 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.

T11 - Ground Instantaneous Overcurrent IDT

Settings Changes:

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

1. Connect the relay as shown in Figure 5-3.

2. Set the relay into test mode 44 (Ground Overcurrent).

3. Set the current of Iop to 4.0(.80) amps rms and apply to the relay. The RC contact should close. Lower Iop to 2.4(.40) amps rms, and the RC contact should open.

4. Reduce Iop to zero (0).

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

T12 - Ground Time Overcurrent TOC

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 5-4.

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

2. Set the relay into test mode 45 (TOC).

3. Apply Iop at the magnitude listed in Table 5-1 and start the timer. Leave the current "on" until the RC contact closes, and stop the timer. Verify that the TOC times out in the time interval listed.

TABLE 5-1

Current RMS	Time in Seconds
3 A (0.6)	2.5 - 3.5
6 A (1.2)	1.0 - 1.2
A (2.0)	0.7 - 0.8

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.

   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

T13 - Zone 1 Ground Reach test, M1G 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 5-3, for the appropriate phase under test.

2. Set the relay into test mode 14 (ANY Zone1 Ground).

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 5-2. (Increase VA, VB, VC to 75V when Iop = -79°)

TABLE 5-2

I Degrees	Volts RMS	**DIST
-49	56 - 63	-
-79	65 - 73	82-88
-109	56 - 63	-

4. Set the fault current, "Iop", to 8.2(1.7) 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 5-2.

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 Z1 "DIST" **.

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

** Reference only

T14 - 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

5

Ground Faults (AG, BG, and CG)

1. Connect the relay as shown in Figure 5-3, for the appropriate phase under test.

2. Set the relay into the ZONE 2 ground test mode for the appropriate phase under test: e.g., "ZONE 2 AG".

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 5-3. (Increase VA, VB, VC to 75V when Iop = -79°)

TABLE 5-3

I Degrees	Volts RMS	**DIST
-49	56 - 63	-
-79	65 - 72	146-154
-109	56 - 63	-

*** Not applicable to Models DLP3***EC and DLP3***FC**

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 5-3.

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 Z2 "DIST"**.

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

** Reference only

*** T15 - Zone 3 Ground Reach , M3G**

Setti ng Changes:

Z1DIS T
- (101) SELZ1 G = NO
- (102) SELZ1 P = NO

Z2DIS T
- (201) SELZ2 G = NO
- (202) SELZ2 P = NO

Z3DIS T
- (301) SELZ3 G = YES
- (302) SELZ3 P = NO
- (305) PUTL3 P = 0.1
- (306) PUTL3 G = 0.1

Z4DIS T
- (401) SELZ4 G = NO
- (402) SELZ4 P = NO

Groun d Fault s (AG, BG, and CG)

1. Connect the relay as shown in Figure 5-3, for the appropriate phase under test.

2. Set the relay into the ZONE 3 ground test mode for the appro priate phase under test: e.g., "ZONE 3 AG".

3. Set the volta ge input s to: VA = 67 volts rms 0°, VB = 67 volts rms -120° , and VC = 67 volts rms -240° . Set the fault curre nt, "Iop" , to the phase -angl e value liste d in Table 5-4. (Incr ease VA, VB, VC to 75V when Iop = -79°)

TABLE 5-4

I Degrees	Volts RMS	**DIST
-49	57 - 64	-
-79	66 - 73	195-205
-109	57 - 64	-

4. Set the fault current to 3.5(0 .7) amperes rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limit s shown in Table 5-4.

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.

** Refer ence only

*** T16 - Zone 4 Ground Reach , M4G**

Setti ng Changes:

Z1DIS T
- (101) SELZ1 G = NO
- (102) SELZ1 P = NO

Z2DIS T
- (201) SELZ2 G = NO
- (202) SELZ2 P = NO

Z3DIS T
- (301) SELZ3 G = NO
- (302) SELZ3 P = NO

Z4DIS T
- (401) SELZ4 G = YES
- (402) SELZ4 P = NO
- (407) PUTL4 P = 0.1
- (408) PUTL4 G = 0.1

Z4 Groun d Fault s (AG, BG, and CG)

1. Connect the relay as shown in Figure 5-3, for the appropriate phase under test.

*** Not applicable to Models DLP3* **EC and DLP3* **FC***

2. Set the relay into the ZONE 4 ground test mode for the appropriate phase under test: e.g., "ZONE 4 AG".

3. Set the voltage input s 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 5-5. (Incr ease VA, VB, and VC to 75V when Iop = -79°.)

TABLE 5-5

I Degrees	Volts RMS	*DIST
-49	56-63	-
-79	62-72	290-310
-109	56-63	-

4. Set the fault current to 2.3(0 .5) amperes rms. Reduce the voltage of the faulted phase and check that the RC contact closes when the voltage is within the limits shown in Table 5-5.

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

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

** Reference only

T17 - Ground (Zone Back- up) Timer Tests

Setti ngs:
LINEP U
(901) SELLP U = NO
Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = NO
Z2DIS T
(201) SELZ2 G = YES
(202) SELZ2 P = NO
(207) PUTL2 P = 1.0
(208) PUTL2 G = 1.0
* Z3DIS T
(301) SELZ3 G = YES
(302) SELZ3 P = NO
(305) PUTL3 P = 3.0
(306) PUTL3 G = 3.0
* Z4DIS T
(401) SELZ4 G = YES
(402) SELZ4 P = NO
(407) PUTL4 G = 5.0
(408) PUTL4 P = 5.0

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

1. Connect the relay as shown in Figure 5-4, for the appropriate phase under test.

2. Set the relay into test mode 15 (Zone 2 Timer).

3. Set the volta ge input s to: VA = 55 volts rms 0°, VB = 67 volts rms -120° , and VC = 67 volts rms -240° . Set the fault current, "Iop" , to -55°.

4. Apply the fault current at 8.2(1 .7) amps rms to the relay and start the Precision Timer. (The fault current shoul d not be ramped to 8.2 amps. It shoul d be appli ed at that level .) This is an AG fault that is withi n pickup of all four zones .

5. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a 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.

6. Leave the voltages at the values in step 3.

*** Zone 3 Time Out Z3 timer default value of 3.0 sec.**

Setting Change:
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = NO

7. Set the relay into test mode 16 (Zone 3 Timer).

8. Apply the fault current at 8.2(1 .7) 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 .

*** Not applicable to Models DLP3***EC and DLP3* **FC**

9. Stop the timer when the RC contact closes, and reduc e the fault current to zero (0). Verify that the trip target indication shows a ZONE3 trip, such as: **AG Z3.** This verif ies that the third zone tripped.

The time for the trip should be in the range of 2.9 to 3.1 seconds.

10. Leave the voltages at the values in step 3.

*** Zone 4 Time Out Z4 timer default value of 5.0 sec.**

Setting Change:

Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = NO

11. Set the relay into test mode 17 (Zone 4 Timer).

12. Apply the fault current at 8.2(1 .7) amps rms to the relay and start the Precision Timer . (The fault current should not be rampe d to 8.2 amps. It should be applied at that level .) This is an AG fault that is within pickup of all four zones .

13. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). 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. If not continuing with phase reach testing, return all settings to pretest values:

Settings:

Z1DIS T
(101) SELZ1 G = YES
(102) SELZ1 P = YES
Z2DIS T
(201) SELZ2 G = YES
(202) SELZ2 P = YES
Z3DIS T
(301) SELZ3 G = YES
(302) SELZ3 P = YES
Z4DIS T
(401) SELZ4 G = YES
(402) SELZ4 P = YES

PHASE-TO- PHASE ZONE REACH TESTI NG

Setting Changes for all Phase-to-Phase tests :

OVERC UR
(601) SELPH 4 = NO
(603) SELID T = NO
(606) SELTO C = NO
OUTOF STEP
(803) SELOS B = 2 (BLKN ONE)

T18 - Z1 Phase Reach , M1

Setting Changes:

Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = YES
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = NO
* Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = NO
* Z4DIS T
(401) SELZ4 G = NO
(402) SELZ4 P = NO

Fault s (AB, BC, and CA)

1. Connec t the relay as shown in Figur e 5-5, for the appropriate phases under test. Set the relay into test mode 30 (ANY ZONE 1 Phase).

2. Set the volta ge input s 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 5-6. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.

*** Not applicable to Models DLP3***EC and DLP3* **FC**

3. Set the fault current to 10.0(2.0) amps rms. Simul taneo usly reduce the volta ge of the fault ed phases and check that the RC contact closes when the voltages are within the limits shown in Table 5-6.

TABLE 5-6

I Degrees	Volts RMS	**DIST
-25	51 - 57	-
-55	59 - 66	82-88
-85	51 - 57	-

** Reference only

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.

T19 - Z2 Phase Reach , MT

Setting Changes:

Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = NO
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = YES
(207) PUTL2 P = 0.1
(208) PUTL2 G = 0.1
* Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = NO
* Z4DIS T
(401) SELZ4 G = NO
(402) SELZ4 P = NO

Fault s (AB, BC, and CA)

1. Connect the relay as shown in Figure 5-5, for the appropriate phases under test. Set the relay into the ZONE 2 Phase test mode for the appropriate phase under test: e.g., "ZONE 2 AB".

2. Set the voltage input s 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 5-7. Note: The leading phase angle is 180°out of phasewith the line to which it is shorted. (Increase VA, VB, VC to 75V when Iop = -55°)

3. Set the fault current to 6.7(1 .4) amps rms. Simultaneously reduce the voltages of the faulted phase s and check that the RC contact close s when the voltages are within the limits shown in Table 5-7.

TABLE 5-7

I Degrees	Volts RMS	**DIST
-25	57-64	-
-55	65-73	146-154
-85	57-64	-

** Reference only

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.

*** T20 - Z3 Phase Reach , M3**

Setting Changes:

Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = NO
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = NO
Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = YES
(306) PUTL3 G = 0.1
(305) PUTL3 P = 0.1
Z4DIS T
(401) SELZ4 G = NO
(402) SELZ4 P = NO

*** Not applicable to Models DLP3***EC and DLP3***FC**

Fault s (AB, BC, and CA)

1. Connect the relay as shown in Figure 5-5, for the appropriate phase under test. Set the relay into the ZONE 3 Phase test mode for the appropriate phase under test: e.g., "ZONE 3 AB".

2. Set the volta ge input s 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 5-8. 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 = -55°)

3. Set the fault current to 5.0(1 .0) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the RC contact closes when the voltages are within the limits shown in Table 5-8.

TABLE 5-8

I Degrees	Volts RMS	**DIST
-25	56 - 63	-
-55	65 - 73	195-205
-85	56 - 63	-

** Refer ence only

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.

*** T21 - Z4 Phase Reach , M4**

Setting Changes:

Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = NO
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = NO
Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = NO
Z4DIS T
(401) SELZ4 G = NO
(402) SELZ4 P = YES
(407) PUTL4 P = 0.1
(408) PUTL4 G = 0.1

Fault s (AB, BC, and CA)

1. Connect the relay as shown in Figure 5-5, for the appropriate phase under test. Set the relay into the ZONE 4 Phase test mode for the appropriate phase under test: e.g., "ZONE 4 AB".

2. Set the voltage input s 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 5-9. Note: The leading phase angle is 180° out of phase with the line to which it is shorted. (Incr ease VA, VB, VC to 75V when Iop = -55°)

3. Set the fault current to 3.3(0 .7) amper es rms. Simultaneously reduce the voltages of the fault ed phases and check that the RC contact closes when the voltages are within the limits shown in Table 5-9.

TABLE 5-9

I Degrees	Volts RMS	**DIST
-25	56 - 63	-
-55	64 - 72	290-310
-85	56 - 63	-

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

** Reference only

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

5. Repea t the test for phase BC and CA faults.

*** Not applicable to Models DLP3***ECand DLP3* **FC**

T22 - Phase (Zone Back- up) Timer Tests

Settings:

Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = NO
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = YES
(207) PUTL2 P = 1.0
(208) PUTL2 G = 1.0
* Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = YES
(305) PUTL3 P = 3.0
(306) PUTL3 G = 3.0
* Z4DIS T
(401) SELZ4 G = NO
(402) SELZ4 P = YES
(407) PUTL4 P= 5.0
(408) PUTL4 G= 5.0

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

1. Connect the relay as shown in Figure 5-6, for an AB fault.

2. Set the relay into test mode 31 (Zone 2 Phase Timer).

3. Set the voltage input s to: **VA = 55 volts rms 0°, VB = 55 volts rms -120°** , and VC = 67 volts rms -240° .Set the fault current, "Iop" , to -55°.

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

5. Stop the timer when the RC contact close s, and reduc e the fault current to zero (0). Verif y that the trip target indication shows a ZONE2 trip, such as: **AB Z2.** This verifies that the secon d zone tripped.

The time for the trip should be in the range of 0.9 to 1.1 seconds.

6. Leave the voltages at the value in step 3.

*** Zone 3 Time Out Z3 timer default value of 3.0 sec.**

Setting Change:

Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = NO

7. Set the relay into test mode 32 (Zone 3 Phase Timer).

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

9. Stop the timer when the RC contact closes, and reduce the fault current to zero (0). Verify that the trip target indication shows a 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.

10. Leave the voltages at the values in step 3.

*** Zone 4 Time Out Z4 timer defau lt value of 5.0 sec.**

Setting Change:

Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = NO

11. Set the relay into test mode 33 (Zone 4 Phase Timer).

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 rampe d to 10.0 amps. It should be applied at that level. This is an AG fault within pickup of all four zones .

*** Not applicable to Models DLP3* **EC and DLP3* **FC***

13. Stop the timer when the RC contact closes, and reduc e 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. If not conti nuing with MOB testing, return all settings to pretest values:

Settings:

Z1DIS T
(101) SELZ1 G = YES
(102) SELZ1 P = YES
Z2DIS T
(201) SELZ2 G = YES
(202) SELZ2 P = YES
Z3DIS T
(301) SELZ3 G = YES
(302) SELZ3 P = YES
Z4DIS T
(401) SELZ4 G = YES
(402) SELZ4 P = YES

MOB TESTI NG

T23 - Out of Step Reach , MOB

Setting Changes:

OUTOF STEP
(803) SELOS B = 0 (BLKA LL)
(801) SELPT Z = 0 (ZONE 2)
Z1DIS T
(101) SELZ1 G = NO
(102) SELZ1 P = NO
Z2DIS T
(201) SELZ2 G = NO
(202) SELZ2 P = YES
* Z3DIS T
(301) SELZ3 G = NO
(302) SELZ3 P = NO
* Z4DIS T
(401) SELZ4 G = NO
(402) SELZ4 P = NO

1. Connect the relay as shown in Figure 5-5, for the appropriate phase under test.

2. Set the relay into the test mode 40 (OUT OF STEP) .

3. Set the voltage input s to: VA = 75 volts rms 0°, VB = 75 volts rms -120° , and VC = 75 volts rms -240° . Set the fault current, "Iop" , to the phase-angle value listed in Table 5-10. Note: The leading phase angle is 180° out of phase with the line to which it is shorted.

TABLE 5-10

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

4. Set the curre nts in the faulted phase s 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 5-10.

5. Reduce the current in the faulted phase to zero (0).

6. Repeat the test for phase s BC and CA

7. Return Settings to pretest values:

LINEP U
(901) SELLP U = YES
Z1DIS T
(101) SELZ1 G = YES
(102) SELZ1 P = YES
Z2DIS T
(201) SELZ2 G = YES
(202) SELZ2 P = YES
* Z3DIS T
(301) SELZ3 G = YES
(302) SELZ3 P = YES
* Z4DIS T
(401) SELZ4 G = YES
(402) SELZ4 P = YES

END OF TEST

Make sure that the relay is no longer in test mode; select END TEST MODE from the test mode menu.

Print out or scroll through all of the settings. Compare them with the initial Settings of the relay , and change to initial values.

If the initial settings were saved to a disk file before testing using DLP-L INK, download the file to the relay .

*** Not applicable to Models DLP3***EC and DLP3* **FC**

DIGITAL OUTPUT	X	Y
TRIP–1	AA1	AB1
TRIP–2	AA2	AB2
BFI	AA3 AA4	AB3 AB4
RI	AA5 AA6	AB5 AB6
BC–1	AA7	AB7
BC–2	AA8	AB8
RC	AC7	AD7
NCA	AC8	AD8
CA	AC9	AD9
KT–1	AC9	AD10
KT–2	AC11	AD11
LN OVRLD	AC12	AD12

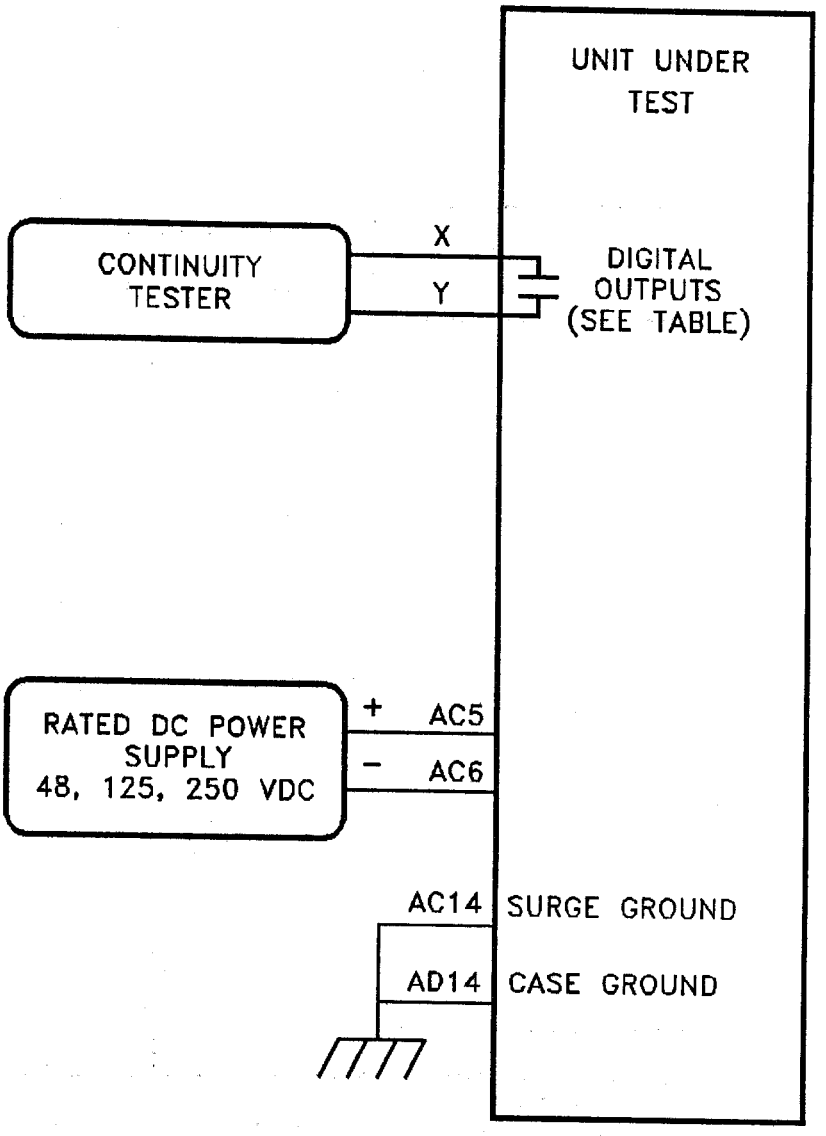


Figure 5-1 (0286A4867 Sh.1) Digital Output Test Connections

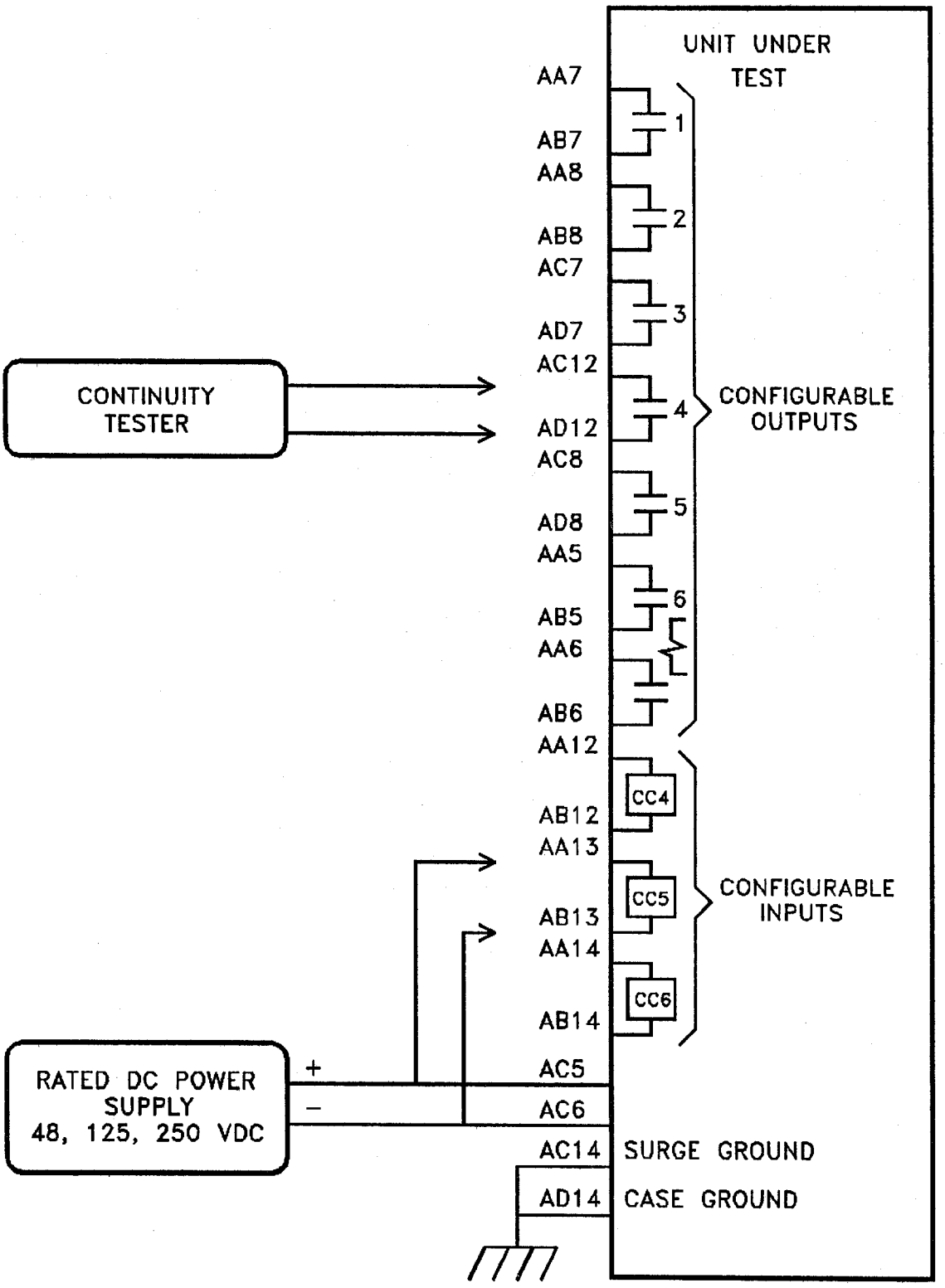
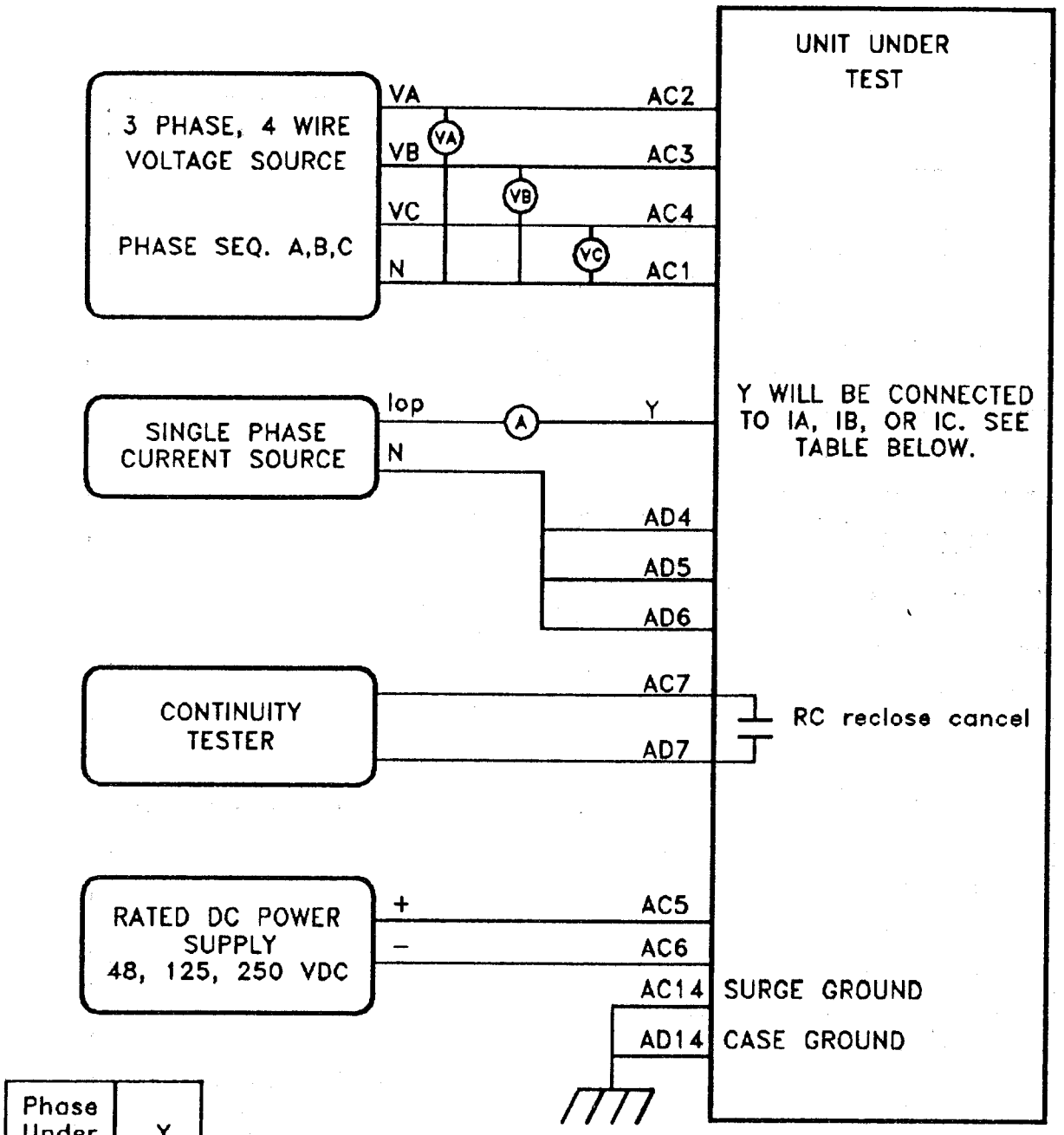


Figure 5-2 (0286A4867 Sh.2) Configurable Input and Output Test Connections



Phase Under Test	Y
AG	AD1
BG	AD2
CG	AD3

Figure 5-3 (0286A4867 Sh.3 [1]) Phase to Ground Test Connections

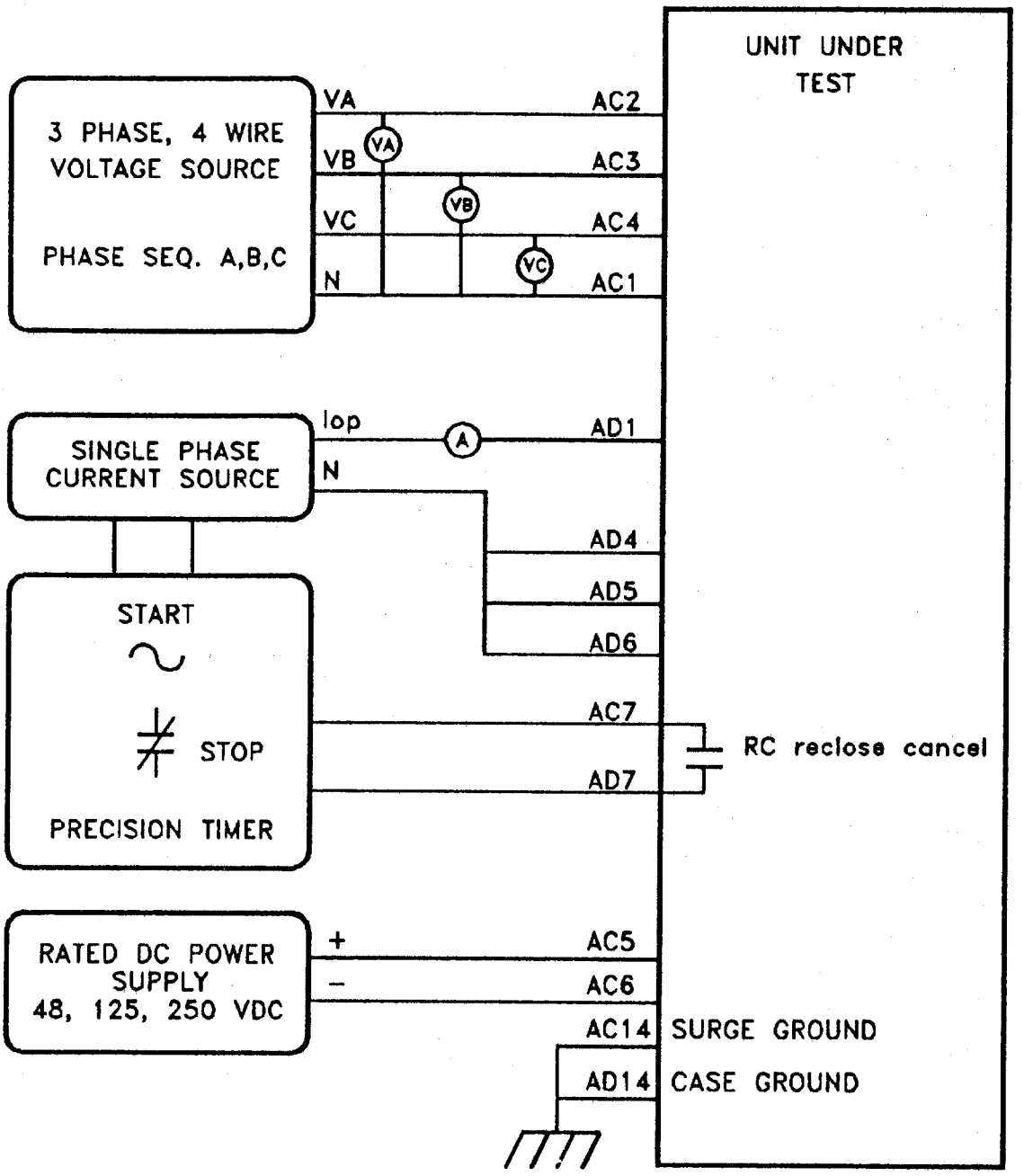
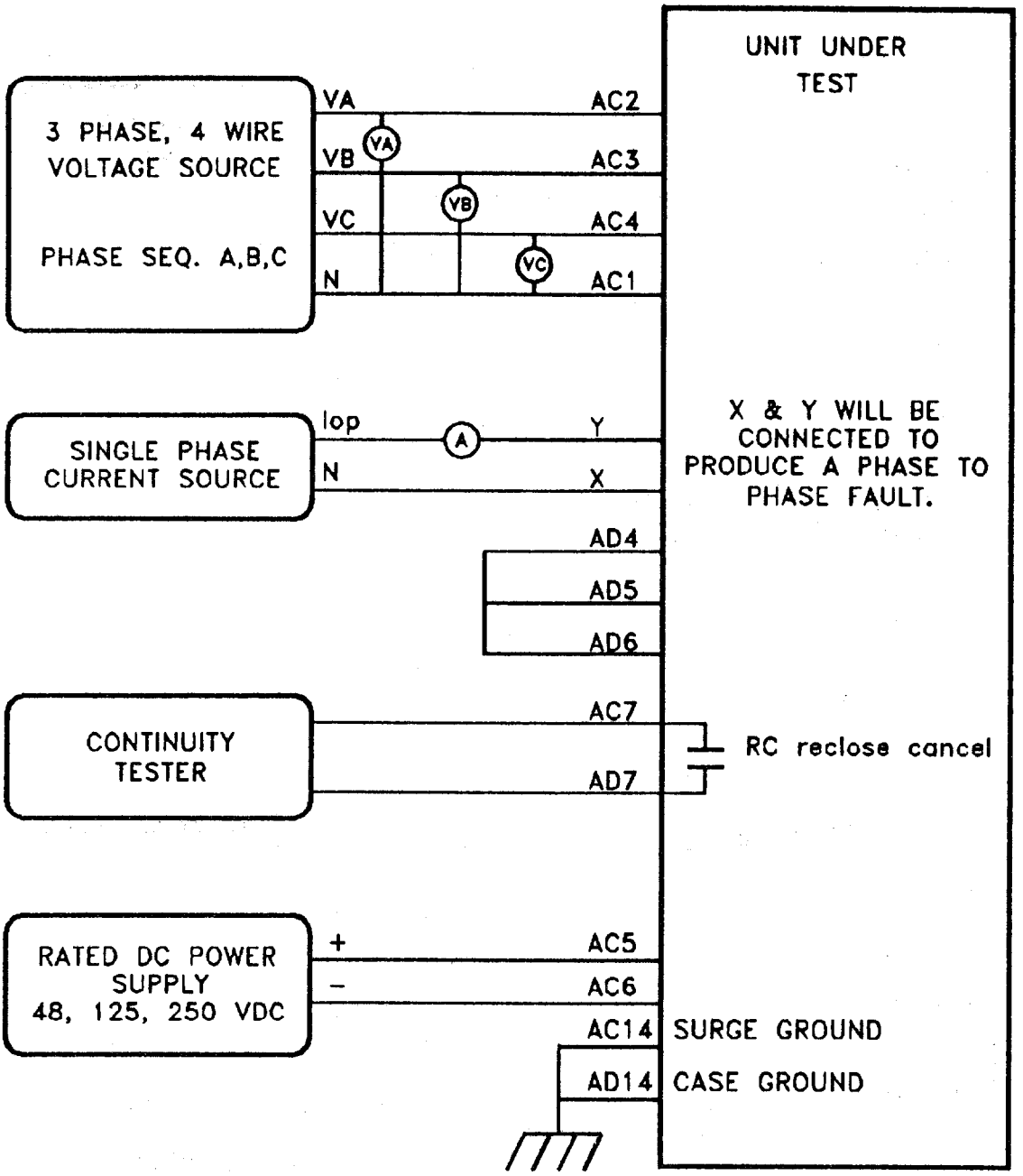


Figure 5-4 (0286A4867 Sh.4 [1]) Ground Reach Timer Test Connections



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

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

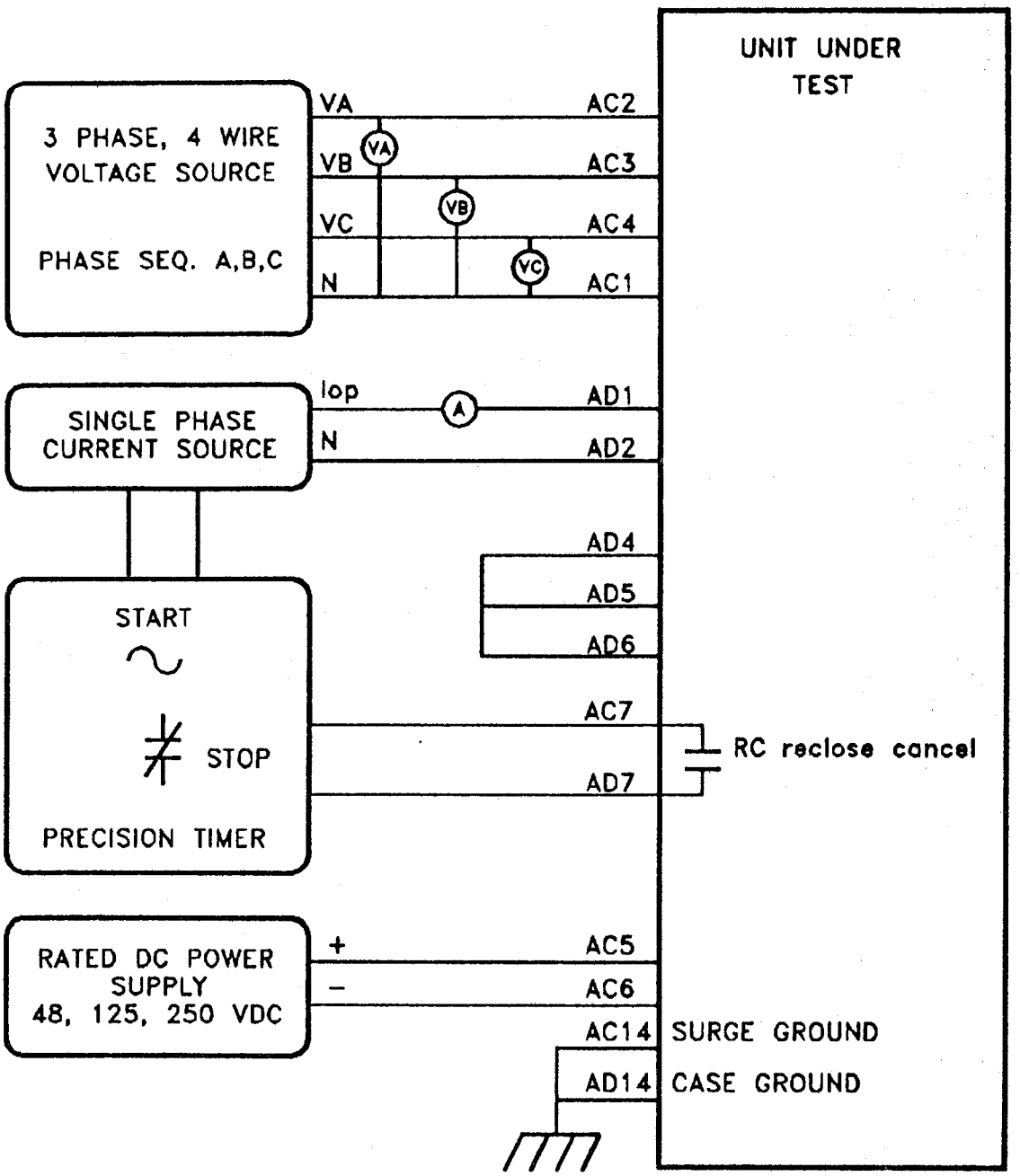


Figure 5-6 (0286A4867 Sh.6 [1]) Phase Reach Timer Test Connections

PERIODIC TESTS

CAUTION: Power Down the relay, by turning off the power switch or by removing a connecting plug, before removing or inserting modules. Failure to do so can permanently damage the relay.

PERIODIC TESTING OF THE DLP3™ SYSTEM

The formulas below will permit the calculation of pickup currents and voltages for testing the DLP3™ system 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 DLP3™ system. If not, refer to the ACCEPTANCE TEST section for details.

General Tests

- T1 MMI Status Test (Built-In Self Tests)
- T2 Digital Output Test
- T3 AC System Input Test

Measuring Unit Tests

- T4 IT Trip Supervision Test
- T5 IB Blocking Supervision Test
- 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 Measuring Units

- T11 Zone1 Ground Reach M1G
- T12 Zone2 Ground Reach MTG
- * T13 Zone3 Ground Reach M3G
- * T14 Zone4 Ground Reach M4G
- T15 Zone1 Phase Reach M1
- T16 Zone2 Phase Reach MT
- * T17 Zone3 Phase Reach M3
- * T18 Zone4 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 1-6
2. The Logic Diagrams	Figure 1-1, 2, 3, 4, 5
3. The TOC curves	Figure 2-2, 3, 4

References:

1. SOFTWARE section of this manual.

GENERAL INSTRUCTIONS

The DLP3 system 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, and target information will be displayed for tests that cause tripping. Testing can be performed with outputs disabled, in which case RC is the only contact that will operate. Outputs can be disabled from the ACTIONS menu.

*** Not applicable to Models DLP3***EC and DLP3***FC**

CAUTION: The RC contact will chatter when the unit under test is near its threshold. DO NOT LET IT CONTINUE. REMOVE THE TEST CURRENT. A single contact closure is enough to determine that the unit picked up.

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

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

NOTE: TRIPPING CONTACTS WILL OPERATE IN THE TEST MODE UNLESS OUTPUTS ARE DISABLED BY THE USER.

INITIAL TEST SET UP

Before each zone reach test, backup protection functions and zones not under test should be disabled, using the settings. This is not strictly necessary when using the test mode, but if it is not done, in tests that cause tripping the trip target type may not match the unit under test. Example: If a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. It is important to keep that in mind during the tests.

Before beginning the test, the relay settings should be printed for reference and verification. If no printer is available, scroll through each setting and make sure they match the required settings of the relay.

At the beginning of each test there is space provided to record the user-specific setting for the function under test.

USING DLP-LINK

Communication with the relay is accomplished via a PC with the program DLP-LINK. DLP-LINK is required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Once in test mode, current and voltages are applied to the relay to simulate the desired system conditions.

Follow the procedure specified in the ACCEPTANCE TEST section to test the relay with DLP-LINK.

RELAY TESTS

T1 - MMI Relay Status

The Relay's Status is reported through the MMI, the non-critical alarm contact and the critical alarm contact. If a system error caused relaying functions to cease, the LED on the MMI would turn "red" and the critical alarm contact would 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 MMI display.

If a STATUS error is detected, see the SERVICING section for further information.

1. Apply rated DC power and wait for initialization to complete, as indicated by the green LED.

2. Select "request DLP3 Status" from the Information menu.

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

T2 - Digital Output Test

This test is used to check all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults.

NOTE: None of the outputs will operate unless jumper J1 on the MMI module is removed. Refer to Figure 4-2.

Output Test

1. Connect the relay as shown in Figure 5-1.

2. Enter the "Control Level" password.

3. Select "digital Output test" from the Actions menu.

4. Select the desired output to test, such as TRIP1.

   Before the contact is allowed to close, you will be prompted to turn protection off during the test. The prompt is: "PROTECT OFF?". Select "OK" to turn protection off. Protection will remain off until the test mode is ended.

   Once the protection choice is chosen, the selected "relay output" will close.

   Verify that the output under test has closed, using an ohm meter or other suitable device.

5. After the output is tested, select the next output to test. This output will close and the previously selected output will open. Continue in this fashion until all outputs are tested.

6. End the test mode by selecting "END TEST MODE".

T3 - AC System Input Test

This test uses the "PRESENT VALUES" function to observe the voltage and current levels applied to the relay.

1. Connect the relay as shown in Figure 5-3.

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

3. Select "request Present values" from the Information menu. The present values are now selected.

4. Note the values of VA, VB, and VC and verify that the voltages are within ± 2 volts of the voltage input to the relay.

5. Apply Iop at 1.0 amps rms to the "Y" test point for the current under test.

6. Again select "request Present values" from the Information menu.

7. Note the value of IA, IB, or IC. Verify that the current reading is within 5% of the input current.

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.

T4 - IT Trip Supervision Test

Settings:
CURSUPVIS
(503)PUIT = [_____] amps

IT is calculated with the following equation:

IT = 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 = IT**.

1. Connect the relay as shown in Figure 5-3.

2. Set the relay into the test mode 34: (IT Detector).

3. Set the current of Iop to **[IT+0.10** =_____] amps rms and apply to the relay. The RC contact should close. Lower Iop to **[IT-0.1** =_____] amps rms and the RC contact should open.

4. Reduce Iop to zero (0).

T5 - IB Blocking Supervision Test

Settings:
CURSUPVIS
(504)PUIB = [_____] amps

IB is calculated with the following equation:

IB = IA, IB, or IC (2)

The test current, "Iop", is single-phase current equal to IA.
Thus the unit should pick up when **Iop = IB**.

1. Connect the relay as shown in Figure 5-3.
2. Set the relay into test mode 35 (IB Detector).
3. Set the current of Iop to **[IB+0.1 =**_____] amps rms and apply to the relay. The RC contact should close. Lower Iop to **[IB-0.1 =**_____] amps rms and the RC contact should open.
4. Reduce Iop to zero (0).

T6 - Ground Directional Trip Test, IPT + NT

Settings:
CURSUPVIS
(501)PUIPT = [___] amps

The IPT operating quantity is:

3*|I0| - 3*KT*|I1| (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 5-3.
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 36 (GND DIR TRIP ON).
4. Set the current of Iop to **[(PUIPT/0.9)+0.10** =] amps rms at /POSANG and apply to the relay. The RC contact should close. Lower Iop to **[(PUIPT/0.9)- 0.1** =____] amps rms and the RC contact should open.
5. Reduce Iop to zero (0).

T7 - Ground Directional Block Test, IPB + NB

Settings:
CURSUPVIS
(502)PUIPB =[___] amps

The IPB operating quantity is:

3*|I0| - 3*KB*|I1| (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 5-3.

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 37 (GND DIR BLOCK ON).

4. Set the current of Iop to **[(PUIPB/0.934)+0.1 =**] amps rms at /POSANG + 180° and apply to the relay. The RC contact should close. Lower Iop to [**(PUIPB/0.934) - 0.1 =**____] amps rms 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 = [_____] amps

PH4 is calculated with the following equation:

PH4 = (IA - IB), (IB - IC), or (IC - IA) (3)

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*PH4**

1. Connect the relay as shown in Figure 5-5, for a phase AB, BC or CA fault.

2. Set the relay into test mode 43 (Phase Overcurrent).

3. Set the current of Iop to **[.5*PH4+(0.05*PH4)=**_____] amps rms and apply to the relay. The RC contact should close. Lower Iop to **[.5*PH4 - (0.05*PH4) =**_____] amps rms and the RC contact should open.

4. Reduce Iop to zero (0).

T9 - Ground Instantaneous Overcurrent IDT

Settings Changes:
OVERCUR
(603)SELIDT = YES
(604)SELDIDT = NO (directional unit off)
(605)PUIDT = [_____] amps

IDT is internally calculated with the following equation:

IDT = 3*[I0] - 0.9* $|I1|$ (4)

I0 is equal to Zero-Sequence Current.
I1 is equal to Positive-Sequence Current.

Since the test current, "Iop", is single-phase current:

Iop/3 = I0
and **Iop/3 = I1.**

Substituting **Iop/3** for I1 and I0 into equation (4) yields:

IDT = Iop - 0.3*Iop, or
IDT = 0.7*Iop.

Therefore IDT will pick up when: **Iop = IDT/0.7**

1. Connect the relay as shown in Figure 5-3.

2. Set the relay into test mode 44 (Ground Overcurrent).

3. Set the current of Iop to **[(IDT/0.7)+ 0.5=**_____] amps rms and apply to the relay. The RC contact should close. Lower Iop to **[(IDT/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.

T10 - 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
(611)SELCURV = [_____] (curve in use)

TOC is calculated with the following equation:

TOC = 3*[I0] (5)

I0 is equal to zero-sequence current.

Since "Iop" is single-phase current, **Iop/3 = I0**.

Substituting **Iop/3** for **I0** in equation (5) yields:

TOC = Iop

Therefore TOC will pick up when: **Iop ≥ TOC**

The time it takes for TOC to pick up is determined by the Time-dial curves in the CALCULATION OF SETTINGS section.

CAUTIONIf 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 5-3.

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 45(T DLY GND OC).

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. Repeat steps 3 and 4 for Iop at **[6*TOC=_____]** and **[10*TOC=_____]**.

6. 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.

ZONE 1-4 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 6-1. 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.

$$VNOM = [(Z)*(ZR)*(I_T)/COS(90- \phi T)]*(COS(\phi I - \phi Z - \phi T+90)) \quad (8)$$

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 = [____]	Zone 1
(204)Z2GR = [____]	Zone 2
* (304)Z3GR = [____]	Zone 3
* (404)Z4GR = [____]	Zone 4

ϕT

Z1GANG =90	fixed for Zone 1
(210)Z2GANG = [____]	Zone 2
* (308)Z3GANG = [____]	Zone 3
* (410)Z4GANG = [____]	Zone 4

K0

(107)Z1K0 = [____]	Zone 1 only
(1404)K0 = [____]	Zone 2, Zone 3, and Zone 4

2. Determine the Test Current I_T for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 6-1 below:

6

Table 6-1 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	7	12.5 - 30.0	1.4
6.0 - 12.0	3.5	30.0 - 60.0	0.7
12.0 - 20.0	2.1	60.0 - 100.0	0.4
20.0 - 30.0	1.4	100.0 - 150.0	0.3
30.0 - 40.0	1.0	150.0 - 200.0	0.2
40.0 - 50.0	0.8	200.0 - 250.0	0.2

I_T(Z1GR) = [____] Amps rms
I_T(Z2GR) = [____] Amps rms
I_T(Z3GR) = [____] Amps rms
I_T(Z4GR) = [____] Amps rms

*** Not applicable to Models DLP3***EC and DLP3***FC**

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 (_I) 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**.

T11 Zone 1 Ground Reach test, M1G

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 5-3, for the appropriate phase under test.

2. Set the relay into test mode 14 (Any Zone1 Ground).

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.

T12 - 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 5-3, for the appropriate phase under test.

2. Set the relay into the ZONE 2 Ground test mode for the appropriate phase under test: e.g., "ZONE 2 AG".

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 ϕ**I** [_____] 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.

*** T13 - 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 5-3, for the appropriate phase under test.

2. Set the relay into the ZONE 3 Ground test mode for the appropriate phase under test: e.g., "ZONE 3 AG".

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 ϕ**I** [_____], 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.

*** T14 - 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 5-3, for the appropriate phase under test.

2. Set the relay into the ZONE 4 Ground test mode for the appropriate phase under test: e.g., "ZONE 4 AG".

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 ϕ**I** [_____], lagging.

*** Not applicable to Models DLP3***EC and DLP3***FC**

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.

ZONE 1-4 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 6-2. 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 equation (9).

$$\mathbf{VNOM} = [(2/1.732)*(ZR)*(I_T)/COS(90-\phi T)]*(COS((\phi I+30)- \phi Z-\phi T+90)) \quad (9)$$

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
I_T =	Test current for Iop chosen for the zone
ϕ**Z** =	Angle of maximum reach = POSANG
ϕ**T** =	The Characteristic Timer setting of the zone
ϕ**I** =	Test current angle with respect to the faulted phase
POSANG =	Positive-Sequence Angle of Maximum Reach

1. Record the Relay Settings:

ϕ**Z**

(1401)POSANG = [___]

ZR

(103)Z1R = [___]	Zone 1
(203)Z2R = [___]	Zone 2
(303)Z3R = [___]	Zone 3
(403)Z4R = [___]	Zone 4

ϕ**T**

Z1PANG = 90	fixed for Zone 1
(209)Z2PANG = [___]	Zone 2
(307)Z3PANG = [___]	Zone 3
(409)Z4PANG = [___]	Zone 4

2. Determine the Test Current "I_T" for Zone 1, Zone 2, Zone 3 and Zone 4 from Table 6-2:

Table 6-2 TEST CURRENT RANGES

In=5 AMPS ZR Reach	I_T AMPS Test	In=1 AMPS ZR Reach	I_T AMPS Test
0.1 - 6.0	10	0.5 - 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	1.2	200.0 - 250.0	0.2

I_T(Z1R) = [___] Amps rms
I_T(Z2R) = [___] Amps rms
I_T(Z3R) = [___] Amps rms
I_T(Z4R) = [___] Amps rms

3. Choose ϕI (the I_T angle). VNOM will be at maximum when $\phi I = \phi Z - 30$

   ϕI1 = [___]° for Zone 1
   ϕI2 = [___]° for Zone 2
   ϕI3 = [___]° for Zone 3
   ϕI4 = [___]° for Zone 4

4. Calculate "VNOM" for each zone by substituting the values of ZR, ϕZ (POSANG), 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, I_T and ϕIn in the space provided in the appropriate Zone reach test.

T15 - 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 5-5, for the appropriate phases under test.

2. Set the relay into test mode 30 (Any Zone1 Phase).

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.

T16 - 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 5-5, for the appropriate phases under test.

2. Set the relay into the Zone 2 Phase test mode for the appropriate phases under test: e.g., "ZONE 2 AB".

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.

*** T17 - 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 5-5, for the appropriate phase under test.

2. Set the relay into the Zone 3 Phase test mode for the appropriate phases under test: e.g., "ZONE 3 AB".

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.

*** T18 - 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

*** Not applicable to Models DLP3***EC and DLP3***FC**

1. Connect the relay as shown in Figure 5-5, for the appropriate phase under test.

2. Set the relay into the Zone 4 Phase test mode for the appropriate phases under test: e.g., "ZONE 4 AB".

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 DLP3™ system. They are: spare module replacement and component level repair. The preferred method is module replacement using the DLP3™ system'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 by turning off power switch before removing or inserting modules. Failure to do so can permanently damage the relay.

SERVICING WITH THE RELAY SELF-TEST

The DLP3™ system automatically performs tests of major functions and critical hardware components and reports their status via the MMI Display, the 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, since the relay is still providing some degree of protection.

The third level of tests indicate "System Status" errors that are due to power system errors (Trip Circuit Open), or caused by the use of a DLP3™ command that disables the relay (Disable Outputs). They are indicated by the "non-critical alarm" contact closing, a red LED, or by the "critical alarm" contact closing. However, no MMI display is provided and the information must be found using the DLP-LINK "request dlp Status" command.

The types of self-tests performed are described in the PRODUCT DESCRIPTION section of this manual. The components tested during the start-up self-tests are listed in Table 7-1. The components tested during run time background and foreground self-tests are listed in tables 7-2 and 7-3, respectively.

TABLE 7-1 Start-Up Self Tests

COMPONENT	METHOD	PROCESSOR	NATURE
PROM	CRC-type check on DAP and SSP; checksum on DSP	All	Critical
Local RAM	Patterns to check for stuck bits, stuck address lines, cross-talk between adjacent bits	All	Critical
Shared RAM	Same as Local RAM	All	Critical
Non-volitile RAM NVRAM	CRC-type check on settings area; checksum on fault storage area; duplicate locations on serial NVRAM	SSP	Critical if settings area or Serial
Timer Chip SSP	Test all processor timers and their interrupts	DAP SSP	Critical if DAP, Non-Critical if
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, DLP3 will restart
Digital Output Circuitry	Loop-back via parallel port	SSP	Critical, DLP3 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 7-2 Run Time Background Self Tests

COMPONENT	METHOD	PROCESSOR	NATURE
PROM	CRC-type check on DAP and SSP; checksum on DSP	All	Critical, Restart
RAM	CRC-type check on areas holding settings	All	Critical, Restart
Non-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 7-3 Run Time Foreground Self Tests

COMPONENT	METHOD	PROCESSOR	NATURE
A/D Controller	DMA Interface	DAP	Critical
Digital Input Circuitry	Comparison of bits read via 2 separate 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

7

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

NOTE: Refer to the ACCEPTANCE TEST section for test of the measuring units.

Using the Information Status Command

Tables have been provided in the SERVICING A CRITICAL FAILURE "FAIL" and SERVICING A NON-CRITICAL FAILURE "WARN" sections below. They can be used to decode "Fail xxx" and "Warn xxx" codes. The "dlp Status" command can also be used to extract the same data without looking up the code on the table.

The INFORMATION STATUS command is invoked as follows:

1. While rated DC power is applied to the relay and after initialization is complete, log in to the relay.

2. Select "request dlp Status" from the "Information" menu under RELAY FUNCTIONS.

3. The display will indicate the status of the relay, for example "STATUS: FAIL" if there is a failure, followed by a detailed report of the status. A complete list of the possible errors is shown in tables 7-4,5,and 6 below.

NOTE: After initial power up or loss of power exceeding 24 hours, the time and date will reset to 00:00:00 01/01/90. All event and fault data will be reset.

TABLE 7-4 System Status Error Messages

SYSTEM STATUS ERROR	INDICATION	DESCRIPTION
WARN	NCA	WARN condition, press up arrow
FAIL	CA/LED	FAIL condition, press up arrow
MISC	LED	Miscellaneous condition, press up arrow

NOTE:
LED = A red LED on the MMI,
NCA = the non-critical alarm contact closing,
CA = the critical alarm contact closing

SERVICING A CRITICAL FAILURE "FAIL"

A critical failure indicates total interruption of the protection function. When a failure occurs on one of the modules the critical alarm contact will close, and the MMI LED will turn red. Remove and re-apply the DC power to bring up the fail message on the display. If the DLP3 system successfully restarts the LED will turn green.

The Fail message has the format "FAIL xxx". The "xxx" field following the word "FAIL" is the numeric code that indicates the nature of the critical failure. The Fail message remains on the display until a key is pressed or until the DLP3 system starts successfully (with no self-test failures). See Table 7-5 for the list of Failure codes and their meanings.

NOTE: As an alternative, the "dlp Status" command can be used to display the failure type directly on a PC, using DLP-LINK.

Locating the defective module

Use the table below, or the "dlp Status" command, to isolate the cause of the failure. When the suspected module is found, power down the unit, replace it, and reapply 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 7-5 Failure Messages

CODE	Description
	DAP BOARD
100	PROM: PROM Failure
101	LOCAL RAM: Local RAM Failure
102	SYSRAM CRC: DSPRAM CRC Failure
103	SYSRAM: DSPRAM Failure
104	INTERRUPT: SYSRAM Failure
105	EEPROM: Interrupt Failure
106	TIMER: Timer Failure
124	VERSION NUM: Version no. Failure
–	NO DSP INT: No DSP interrupt
–	NO SSP INT: No SSP interrupt

TABLE 7-5 Failure Messages (continued)

CODE	Description
	DSP BOARD
207	PROM: PROM Failure
208	LOCAL RAM: Local RAM Failure
209	DSPRAM: DSP RAM Failure
210	INTERRUPT: Interrupt Failure
225	VERSION NUM: Version no. Failure
	ANI BOARD
311	CONTROLLER: Controller Failure
312	SERIAL MEM: Serial NVM Failure
313	REFERENCE: Reference Failure
–	NO DMA INT: No DMA interrupt
	MGM Module
414	SERIAL MEM: Serial NVM Failure
422	MODEL NUMBER: Model No.
	SSP BOARD
515	PROM: PROM Failure
516	LOCAL RAM: Local RAM Failure
517	SYSRAM CRC: SYSRAM CRC Failure
518	SYSRAM: SYSRAM Failure
519	INTERRUPT: Interrupt Failure
520	EEPROM: EEPROM Failure
523	VERSION NUM: Version Number
–	NO DAP INT: No DAP Interrupt
	MMI BOARD
621	DIG OUT: Digital Output Failure

SERVICING A NON-CRITICAL FAILURE "WARN"

A non-critical failure indicates an interruption in the relay's protection, but not a total loss. When a "WARN" condition occurs, the DLP3 system's non-critical alarm contact will close. The LED will remain green. Turn off the DC input power, then re-apply. The "WARN xxx" message should appear if the failure still exists.

The Warn message has the format "WARN xxx". The "xxx" field following the word "WARN" is the numeric code that indicates the nature of the failure. The WARN message remains on the display until a key is pressed or until the DLP3 system restarts successfully (with no self-test failures). See Table 7-6 for the list of Warning codes and their meanings.

NOTE: As an alternative to using the table of warnings, the "dlp Status" command can be used to display the warning type directly on a PC, using **DLP-LINK**.

Locating the defective module

Use the table below, or the "dlp 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 7-6 Warning Messages

Number	Description
	DSP
235	DIG INP: Digital Input fail on
	SSP
537	TIMER: Timer Failure
538	CAPRAM: CAPRAM Failure
539	CLOCK: Real Time Clock Failure
	MMI
640	SERIAL CHP 1: Printer serial Port failure
641	DISPLAY: LED display failure
643	TIME STROBE FAIL: Time strobe failure
645	SERIAL CHP 2: Rear com port failure
646	SERIAL CHP 3: Front com port failure
742	LOGON FAILURE: Login failed
	DTA
844	SERIAL MEMRY: Serial memory failure

TABLE 7-7 Miscellaneous Messages

Miscellaneous Message	Description	Indication
PROT OFF	Protection off	LED
DIS OUTS	Outputs Disabled	LED
RELAY TEST	Relay in Test Mode	LED
D O TEST	Digital Output test	LED
CHANNEL TEST	Channel Test	None

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.

Turn off the DC input power, then re-apply. The non-critical alarm contact will be closed if the failure still exists. Use the "dlp Status" to determine the cause of the trouble.

SERVICING A NON-BOARD ASSOCIATED FAILURE OR WARNING MESSAGE

If the FAIL or WARN message is a Non-board assoiated failure or warning message (see Table 7-8 for the list of these Failure and Warning messages), then check external inputs and connections to the DLP relay.

TABLE 7-8 Non-Board associated Failure and Warning Messages

Message	Description	Type
FUSE FAILURE	Potentential Fuse Failure	FAIL
TRIP BUS CNK FAIL	Auto trip bus check failure	FAIL
BKR1 TRP CIR OPN	BKR 1 Trip Circuit Open	FAIL
BKR2 TRP CIR OPN	BKR 2 Trip Circuit Open	FAIL
UNBALANCED SYS	Unbalanced Currents detected	WARN

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 & configurable outputs)	Continuous Rating=3 amperes. Make and carry for tripping duty: = 30 Amperes (per ANSI C37.90)
Channel Control and SCADA DTA Phase Identification Contacts (PL-3)	10 Watts: Max. Voltage 280 VDC Maximum Current 40 milliamperes DC DB-15 female connector
Trip Circuit Monitor**, Contact Converters, & Configurable Inputs	38.5 - 300 VDC input **150 mA minimum for trip circuit monitor current flow sensor

SCHEME SELECTION

	Stepped Distance
	POTT
	PUTT
*	Blocking
*	Hybrid
	Zone 1 Extension

REACH SETTING RANGES

TABLE 8-1

			RANGE IN OHMS		RESOLUTION	
	Z1DIST	MEASURING UNITS	In=5	In=1	In=5	In=1
		M1G	0.01-50	0.01-250	0.01	.01
		M1	0.01-50	0.01-250	0.01	.01
	Z2DIST	MEASURING UNITS	RANGE IN OHMS		RESOLUTION	
			In=5	In=1	In=5	In=1
		MTG	0.01-50	0.01-250	0.01	.01
		MT	0.01-50	0.01-250	0.01	.01
*	Z3DIST	MEASURING UNITS	RANGE IN OHMS		RESOLUTION	
			In=5	In=1	In=5	In=1
		M3G	0.01-50	0.01-250	0.01	.01
		M3	0.01-50	0.01-250	0.01	.01
*	Z4DIST	MEASURING UNITS	RANGE IN OHMS		RESOLUTION	
			In=5	In=1	In=5	In=1
		M4G	0.01-50	0.01-250	0.01	.01
		M4	0.01-50	0.01-250	0.01	.01

DIRECTIONAL CONTROL: Forward/Reversed

TIME SYNC. INPUT **Demodulated IRIG B signal (5 VDC signal)**

*** Not applicable to Models DLP3***EC and DLP3***FC**

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	0.20-4.00	0.04-0.80	0.01	0.01

OVERCURRENT BACKUP SETTINGS

	RANGE IN AMPS		RESOLUTION	
	In=5	In=1	In=5	n=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	ms	1	ms
TL2	Zone 2 Timer	.1	-	3.00	s	.01	s
TL3	Zone 3 Timer	.1	-	10.00	s	.01	s
PUTL4P,G	Zone 4 Timer	0.10	-	10.00	s	.01	s
TL4	POTT/PUTT coordination	0	-	50	ms	1	ms
TL5	'b'contact coordination for breaker 1. (pickup and dropout timers)	0	-	200	ms	1	ms
TL6	'b'contact coordination for breaker 2. (pickup and dropout timers)	0	-	200	ms	1	ms
TL16	Weak Infeed Trip pickup	8	-	80	ms	1	ms

SYSTEM CONFIGURATION SETTINGS

Communications Baud Rate	2400 or 9600 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.

The messages on the display are: the Trip message when the DLP3™ system has caused a protective trip, the Fail message when the DLP3™system has discovered a critical self-test failure, the Warn message when the DLP3™ system has discovered a non-critical self-test failure, and the Initialization message when the DLP3™ system is initializing during a power up.

All messages other than the Trip message are displayed at the same intensity, about half of full-intensity.

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 DLP3 system 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 end of Table 9-6), 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 the CLR key. If the DLP3 system restarts or is powered down and up, the trip indicator is remembered and redisplayed. As soon as the CLR 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 CLR key is pressed or until the DLP3 system 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 the CLR key is pressed or until the DLP3 system restarts successfully (with no self-test failures). A list of the warning numbers and their meanings can be found in the SERVICING section.

The Initialization message has the format **"INITIALIZING"** and is displayed while the DLP3 system 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. When all messages have been cleared from the display, pressing the CLR key will display the present values of the current and voltage for 4 seconds each. The display of the values will only cycle once.

Passwords

Passwords are needed to perform certain operations with the DLP3 system. A password for actions, settings, or viewing is entered when logging into DLP-LINK. If an action or setting change is not performed for a period of 15 minutes, the password becomes inactive. The settings and actions may be viewed at any time but may only be changed if the password for that function is active.

The Communications passwords, which are for viewing relay data, making remote settings changes, and performing remote actions, are listed below. The communication passwords can contain any of the allowable alpha-numeric characters in Table 9-8. Any of the passwords can be used in DLP-LINK to log into the relay.

Communications Password Types
Control
Settings
View

View Password

To view the remote communications passwords in encrypted form, follow the procedure outlined below. See Table 9-8 for Password decoder table to translate the encrypted passwords. 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 passwords 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 4-2)
4) Re-insert the MMI module and power up the relay.
5) The encoded passwords will be shown for ten seconds each continuously. The order in which the passwords will be displayed is: View, Control, then Settings.
6) Decode the password by using table 9-8.
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.

* PRINTER INTERFACE

(Models DLP3***PC and DLP3***RC only)

The required pin-to-pin connections for the cable that connects the printer to plug PL2 on the back of the DLP system is shown in Figure IN-2A). Virtually any ASCII character printer may be used provided it contains a serial interface. In addition, the printer's serial interface must be programmable to 1200 baud, 8 character bits, 1 stop bit, and no parity. The printer's handshaking mode must be set to either XON/XOFF or DTR Ready. **The DLP printer port (plug PL2) is fixed at 1200 baud.** The DLP setting COMMPORT affects the baud rate of the RS232 port (plug PL1) but not the printer port.

* Recommended printer

If the printer is to be installed permanently at the DLP location, then the following RADIX thermal printer is recommended because of its temperature range specification.

RADIX PRINTER ORDER INFORMATION

Part No.	Description	VENDOR
100700.001	FP40 Printer	RADIX
100890.001	FC401 Single unit battery charger	RADIX
105050.000	FC405 Multi-unit battery charger (optional)	RADIX
0246A9866 P2	GE PRINTER CABLE	GE
Printer Paper	8" paper for Radix FP40	Lord Label

ADDRESS: RADIX Corporation (Printer)
4855 Wiley Post Way
Salt Lake City, UT 84116
PHONE #: 800-453-5195

ADDRESS: Lord Label & MFG. (Paper)
3435 W. Madison
Skokie, IL 60076
PHONE #: 800-621-9301

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 2400 baud, or removed to select 9600 baud.

CAUTION:Power Down the relay, with the power switch or by removing a connecting plug, before removing or inserting modules. Failure to do so can permanently damage the relay.

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 (IN) = 2400;
Disabled (OUT)= 9600.

*** Not applicable to Models DLP3***BC, DLP3***DC, DLP3***EC, DLP3***FC**

DLP3 Settings

Table 9-1 contains a listing of all DLP3 settings that can be accessed through DLP-LINK communication software. The setttings are listed by setting number and category. This information can also be found in the Quick Reference Guide, GEK-100626.

The following tables are supplied for reference. These tables can be used with DLP-LINK.

TABLE 9-1 DLP3 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 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0104	Ground Reach (M1/MG1)	Z1GR	OHMS	0.01 - 50 5 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0105	Select zone 1 gnd. unit	SELZ1U	N/A	0 - 1	x
	- Mho	MHO		0	
	- Reactance	REACT		1	
0106	Reach setting of mho unit supv. reactance unit	Z1SU	OHMS	0.01 - 50 5 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0107	Zero seq. current compensation (K0)	Z1K0	N/A	1.0 - 7.0	x.x
0108	Zone 1 extension reset	Z1ERST	SECS	0.0 - 60.0	xx.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 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0204	Ground Reach (MT/MTG)	Z2GR	OHMS	0.01 - 50 5 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0205	Select zone 2 gnd. unit	SELZ2U	N/A	0 - 2	x
	- Mho	MHO		0	
	- Ground Directional OC	GDOC		1	
	- Mho + GDOC	MHOGDOC	2		
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 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0304	Ground Reach (M3/M3G)	Z3GR	OHMS	0.01 - 50 5 AMP	xxx.xx
				0.01 - 250 1 AMP	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 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0404	Ground Reach (M4/M4G)	Z4GR	OHMS	0.01 - 50 5 AMP	xxx.xx
				0.01 - 250 1 AMP	xxx.xx
0405	Phase offset reach	Z4OR	N/A	0.00 - 0.40	x.xx
0406	Select zone 4 timer	SELZ4T	N/A	YES/NO	YES/NO
0407	Phase timer setting	PUTL4P	SECS	0.10 - 10.00	xx.xx
0408	Ground timer setting	PUTL4G	SECS	0.10 - 10.00	xx.xx
0409	Phase characteristic Angle	Z4PANG	DEGS	80, 90, 95, 105, 110, 120	xxx
0410	Ground characteristic Angle	Z4GANG	DEGS	80, 90, 95, 105, 110, 120	xxx
0411	Select Direction	SELZ4D	N/A	0 - 1	x
	- Forward	FORWRD		0	
	- Reverse	REVERS		1	

CATEGORY: CURSUPVIS -- Overcurrent Pilot/Supervision

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
0501	Gnd. pilot trip OC (IPT)	PUIPT	AMPS	0.50 - 5.00 5 AMP	xx.xx
				0.10 - 1.00 1 AMP	xx.xx
0502	Gnd. pilot block OC (IPB)	PUIPB	AMPS	0.25 - 3.75 5 AMP	xx.xx
				0.05 - 0.75 1 AMP	xx.xx
0503	Trip supv. OC setting(IT)	PUIT	AMPS	0.20 - 4.00 5 AMP	x.xx
				0.04 - 0.80 1 AMP	x.xx
0504	Block supv.OC setting (IB)	PUIB	AMPS	0.20 - 4.00 5 AMP	x.xx
				0.04 - 0.80 1 AMP	x.xx

*** Not applicable to Models DLP3***EC and DLP3***FC**

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	2.0 - 100.0 5 AMP	xxx.x
				0.4 - 20.0 1 AMP	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	0.5 - 80.0 5 AMP	xx.x
				0.1 - 16.0 1 AMP	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	0.20 - 15.00 5 AMP	xx.xx
				0.04 - 3.00 1 AMP	xx.xx
0609	Gnd. time OC time dial	TDTOC	N/A	0.5 - 10.0	xx.x
0610	TOC pickup time	PUTTM	SECS	0.5 - 30.0	xx.x
0611	Select TOC curve	SELCURV	N/A	0 - 4	x
	-inverse	INV		0	
	-very inverse	V-INV		1	
	-extremely inverse	E-INV		2	
	-custom curve	CUSTOM		3	
	-definite time	DEFT		4	
0612	KD constant	KDCONST	N/A	0.0, 0.3	x.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
0708	All zone 1 phase units	RBZ1PH	N/A	YES/NO	YES/NO
0709	All zone 2 phase units	RBZ2PH	N/A	YES/NO	YES/NO
0710	Configurable Trip Bus	RBCTB	N/A	YES/NO	YES/NO

*** Not applicable to Models DLP3***EC and DLP3***FC**

CATEGORY: OUTOFSTEP -- Out-of-step blocking

	SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
	0801	Select phase trip unit to coordinate with	SELPTZ	N/A	0 - 2	x
		- zone 2	ZONE2		0	
*		- zone 3	ZONE3		1	
*		- zone 4 (forward only)	ZONE4		2	
	0802	Characteristic angle	MOBANG	DEGS	30 - 130	xxx
	0803	Select block trip actions	SELOSB	N/A	0 - 2	x
		- block all tripping	BLKALL		0	
		- block channel and distance trip	BLKDIST		1	
		- block phase distance	BLKPHAS		2	
		- block none	BLKNONE		3	
	0804	Select Zone 1 Block	OSBBLK1	N/A	YES/NO	YES/NO
	0805	Select Zone 2 Block	OSBBLK2	N/A	YES/NO	YES/NO
*	0806	Select Zone 3 Block	OSBBLK3	N/A	YES/NO	YES/NO
*	0807	Select Zone 4 Block	OSBBLK4	N/A	YES/NO	YES/NO

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	1.0 - 15.0 5 AMP	xx.x
				0.2 - 3.0 1 AMP	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	2.5 - 20.0 5 AMP	xx.x
				0.5 - 4.0 1 AMP	xx.x
1103	Level 2 OC setting	PULV2	AMPS	5.0 - 40.0 5 AMP	xx.x
				1.0 - 8.0 1 AMP	xx.x
1104	Level 1 time delay (TL31)	PUTL31	SEC	10 - 990	xxx
1105	Level 2 time delay (TL32)	PUTL32	SEC	10 - 99	xx

*** Not applicable to Models DLP3***EC and DLP3***FC**

CATEGORY: SCHEMESEL -- Scheme Selection

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1201	Select Scheme	SELSCM	N/A	0 - 5	x
	- Step Distance	STEPDST		0	
	- Permissive Overreaching	POTT		1	
	- Permissive Underreaching	PUTT		2	
*	- Hybrid	HYBRID		3	
*	- Blocking 1	BLK1		4	
	- Zone 1 Extension	ZNE1EXT		5	
*	- Blocking 2	BLK2		6	
*	- Blocking 3	BLK3		7	
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
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	'b' contact coordination dropout (TL4)	DOTL4	MSECS	0 - 50	xx
*1308	Weak infeed trip pickup (TL16): 81 - 99 (or 51 - 99 for 3 Terminal Lines) = Out of Service	PUTL16	MSECS	8 - 99	xx
1309	Configurable pickup time	PUTLCFG	MSECS	0 - 100	xxx
1310	Configurable dropout time	DOTLCFG	MSECS	0 - 100	xxx

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 AMP 0.01 - 250 1 AMP	xxx.xx 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	

*** Not applicable to Models DLP3***EC and DLP3***FC**

CATEGORY: CONFIG -- Configuration Settings

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1501	Unit ID number	UNITID	N/A	0000	0000
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	NONE		0	
	- Breaker 1	BKR 1		1	
	- Breaker 2	BKR 2		2	
	- Both	BOTH		3	
1505	Primary/secondary units for reports	SELPRIM	N/A	0 - 3	x
	- CVT Primary	CVT PRI		0	
	- CVT Secondary	CVT SEC		1	
	- PT Primary	PT PRI		2	
	- PT Secondary	PT SEC		3	
1506	CT ratio	CTRATIO	N/A	1 - 5000	xxxx
1507	PT ratio	PTRATIO	N/A	1 - 7000	xxxx
1508	Units of distance	DISTUNIT	N/A	0 - 1	x
	- Miles	MILES		0	
	- Kilometers	KM		1	
1509	Communication Configuration	COMMPORT	N/A	See below	not used
	- 2400 Baud, 1 stop bit, no parity **		2401		
	- 9600 Baud, 1 stop bit, no parity **		9601		
1510	Phase designation	PHASDESG	N/A	0 - 1	x
	- (A-B-C)	A-B-C		0	
	- (A-C-B)	A-C-B		1	
1511	Select time synch	SELTSYNC	N/A	0 - 2	x
	- Internal	NONE		0	
	- IRIG-B	IRIG-B		1	
	- G-NET	G-NET		2	
1512	Select number of faults stored	NUMFLTS	N/A	2,4,7,14	xx
1513	Select number of prefault cycles stored for faults	PREFLT	N/A	1 - 8	x
1514	Select trigger to store oscillography data	OSCTRG	N/A	0 - 6	x
	- Not Used	UNUSED	0		
	- Fault Detector	FLTDET	1		
	- Any Zone 2	ANY Z2	2		
*	- Any Zone 3	ANY Z3	3		
*	- Any Zone 4	ANY Z4	4		
	- Out of Step	OUTSTP	5		
	- V1 Detector	V1 DET	6		
1515	Unbalance Detection Alarm	UNBALALM	N/A	YES/NO	YES/NO

*** Not applicable to Models DLP3***EC and DLP3***FC**

** Not remotely settable. Refer to Figure 4-2 in the MODULES section for COMMPORT setting.

CATEGORY: SCADA DTA -- SCADA DTA Interface

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1601	Fault location lock	DAFLPLCK	SEC	0, 1.0 - 99.9	xx.x
1602	Fault location reset	DAFLTRST	MIN	0 - 999	xxx

CATEGORY: CNFGINPUTS -- Configurable Inputs

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1701	Configurable input mode	CONCCI	N/A	0 - 8	x
1702	Settings Group	SETGRP	N/A	0 - 4	x

CATEGORY: BKR1CLSOUT -- Breaker 1 close/Configurable output
(See Table 9-2 for a description of the input numbers)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1801	Contact output	CONOUT1	N/A	0 - 2	x
	- Breaker 1 Close	DEFAULT		0	
	- OR	OR GATE		1	
	- AND	AND GATE		2	
1802	Configurable output 1, input 1	CO1IN1	N/A	0 - 59,101 - 159	xxx
1803	Configurable output 1, input 2	CO1IN2	N/A	0 - 59,101 - 159	xxx
1804	Configurable output 1, input 3	CO1IN3	N/A	0 - 59,101 - 159	xxx
1805	Configurable output 1, input 4	CO1IN4	N/A	0 - 59,101 - 159	xxx
1806	Configurable output 1, input 5	CO1IN5	N/A	0 - 59,101 - 159	xxx
1807	Configurable output 1, input 6	CO1IN6	N/A	0 - 59,101 - 159	xxx
1808	Configurable output 1, input 7	CO1IN7	N/A	0 - 59,101 - 159	xxx
1809	Configurable output 1, input 8	CO1IN8	N/A	0 - 59,101 - 159	xxx

*** Not applicable to Models DLP3***EC and DLP3***FC**

CATEGORY: BKR2CLSOUT -- Breaker 2 close/Configurable output
(See Table 9-2 for a description of the input numbers)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
1901	Contact output	CONOUT2	N/A	0 - 2	x
	- Breaker 2 close	DEFAULT		0	
	- OR	OR GATE		1	
	- AND	AND GATE		2	
1902	Configurable output 2, input 1	CO2IN1	N/A	0 - 59,101 - 159	xxx
1903	Configurable output 2, input 2	CO2IN2	N/A	0 - 59,101 - 159	xxx
1904	Configurable output 2, input 3	CO2IN3	N/A	0 - 59,101 - 159	xxx
1905	Configurable output 2, input 4	CO2IN4	N/A	0 - 59,101 - 159	xxx
1906	Configurable output 2, input 5	CO2IN5	N/A	0 - 59,101 - 159	xxx
1907	Configurable output 2, input 6	CO2IN6	N/A	0 - 59,101 - 159	xxx
1908	Configurable output 2, input 7	CO2IN7	N/A	0 - 59,101 - 159	xxx
1909	Configurable output 2, input 8	CO2IN8	N/A	0 - 59,101 - 159	xxx

CATEGORY: RCANCLOUT -- Reclose cancel/Configurable output
(See Table 9-2 for a description of the input numbers)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
2001	Contact output	CONOUT3	N/A	0 - 2	x
- Reclose cancel		DEFAULT		0	
- OR		OR GATE		1	
- AND		AND GATE		2	
2002	Configurable output 3, input 1	CO3IN1	N/A	0 - 59,101 - 159	xxx
2003	Configurable output 3, input 2	CO3IN2	N/A	0 - 59,101 - 159	xxx
2004	Configurable output 3, input 3	CO3IN3	N/A	0 - 59,101 - 159	xxx
2005	Configurable output 3, input 4	CO3IN4	N/A	0 - 59,101 - 159	xxx
2006	Configurable output 3, input 5	CO3IN5	N/A	0 - 59,101 - 159	xxx
2007	Configurable output 3, input 6	CO3IN6	N/A	0 - 59,101 - 159	xxx
2008	Configurable output 3, input 7	CO3IN7	N/A	0 - 59,101 - 159	xxx
2009	Configurable output 3, input 8	CO3IN8	N/A	0 - 59,101 - 159	xxx

CATEGORY: LNOVLDOUT -- Line overload/Configurable output
(See Table 9-2 for a description of the input numbers)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
2101	Contact output	CONOUT4	N/A	0 - 2	x
	- Line overload	DEFAULT		0	
	- OR	OR GATE		1	
	- AND	AND GATE		2	
	- OR with Configurable Trip Bus (CTB)	OR CTB		3	
	- AND with CTB	AND CTB		4	
2102	Configurable output 4, input 1	CO4IN1	N/A	0 - 59,101 - 159	xxx
2103	Configurable output 4, input 2	CO4IN2	N/A	0 - 59,101 - 159	xxx
2104	Configurable output 4, input 3	CO4IN3	N/A	0 - 59,101 - 159	xxx
2105	Configurable output 4, input 4	CO4IN4	N/A	0 - 59,101 - 159	xxx
2106	Configurable output 4, input 5	CO4IN5	N/A	0 - 59,101 - 159	xxx
2107	Configurable output 4, input 6	CO4IN6	N/A	0 - 59,101 - 159	xxx
2108	Configurable output 4, input 7	CO4IN7	N/A	0 - 59,101 - 159	xxx
2109	Configurable output 4, input 8	CO4IN8	N/A	0 - 59,101 - 159	xxx

NOTE!- A value of 1 or 2 for setting 2101 will use settings 1309 and 1310 for the pickup and dropout times of the contact. For a value of 3 or 4, the trip type will be CTB if the relay trips for the set condition. In addition, setting 1309 will be used as the contact pickup time, and the output will remain active until the condition is false for a fixed value of 25 milliseconds. Setting 1310 is not used.

CATEGORY: NONCRITOUT -- Non-critical alarm/Configurable output
(See Table 9-2 for a description of the input numbers)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
2201	Contact output	CONOUT5	N/A	0 - 2	x
	- Non-critical alarm	DEFAULT		0	
	- OR	OR GATE		1	
	- AND	AND GATE		2	
2202	Configurable output 5, input 1	CO5IN1	N/A	0 - 59,101 - 159	xxx
2203	Configurable output 5, input 2	CO5IN2	N/A	0 - 59,101 - 159	xxx
2204	Configurable output 5, input 3	CO5IN3	N/A	0 - 59,101 - 159	xxx
2205	Configurable output 5, input 4	CO5IN4	N/A	0 - 59,101 - 159	xxx
2206	Configurable output 5, input 5	CO5IN5	N/A	0 - 59,101 - 159	xxx
2207	Configurable output 5, input 6	CO5IN6	N/A	0 - 59,101 - 159	xxx
2208	Configurable output 5, input 7	CO5IN7	N/A	0 - 59,101 - 159	xxx
2209	Configurable output 5, input 8	CO5IN8	N/A	0 - 59,101 - 159	xxx

CATEGORY: RINITOUT -- Reclose initiate/Configurable output
(See Table 9-2 for a description of the input numbers)

SETT #	DESCRIPTION	ABBREV.	UNITS	RANGE (LOW-HIGH)	FORMAT
2301	Contact output	CONOUT6	N/A	0 - 2	x
	- Reclose initiate	DEFAULT		0	
	- OR	OR GATE		1	
	- AND	AND GATE		2	
2302	Configurable output 6, input 1	CO6IN1	N/A	0 - 59,101 - 159	xxx
2303	Configurable output 6, input 2	CO6IN2	N/A	0 - 59,101 - 159	xxx
2304	Configurable output 6, input 3	CO6IN3	N/A	0 - 59,101 - 159	xxx
2305	Configurable output 6, input 4	CO6IN4	N/A	0 - 59,101 - 159	xxx
2306	Configurable output 6, input 5	CO6IN5	N/A	0 - 59,101 - 159	xxx
2307	Configurable output 6, input 6	CO6IN6	N/A	0 - 59,101 - 159	xxx
2308	Configurable output 6, input 7	CO6IN7	N/A	0 - 59,101 - 159	xxx
2309	Configurable output 6, input 8	CO6IN8	N/A	0 - 59,101 - 159	xxx

TABLE 9-2 INPUT CONDITION CODE TABLE

	Input Signal	Relay Test Number	Signal Input Number	MMI Mnemonic
	ZONE 1 AG	2	1	Z1 AG
	ZONE 1 BG	3	2	Z1 BG
	ZONE 1 CG	4	3	Z1 CG
	ZONE 2 AG	5	4	Z2 AG
	ZONE 2 BG	6	5	Z2 BG
	ZONE 2 CG	7	6	Z2 CG
*	ZONE 3 AG	8	7	Z3 AG
*	ZONE 3 BG	9	8	Z3 BG
*	ZONE 3 CG	10	9	Z3 CG
*	ZONE 4 AG	11	10	Z4 AG
*	ZONE 4 BG	12	11	Z4 BG
*	ZONE 4 CG	13	12	Z4 CG
	ANY Z1 GRND	14	13	Z1 GRN
	Z2 GRND TIMER	15	14	Z2GTMR
*	Z3 GRND TIMER	16	15	Z3GTMR
*	Z4 GRND TIMER	17	16	Z4GTMR
	ZONE 1 AB	18	17	Z1 AB
	ZONE 1 BC	19	18	Z1 BC
	ZONE 1 CA	20	19	Z1 CA
	ZONE 2 AB	21	20	Z2 AB
	ZONE 2 BC	22	21	Z2 BC
	ZONE 2 CA	23	22	Z2 CA

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 9-2 INPUT CONDITION CODE TABLE (Contd.)

	Input Signal	Relay Test Number	Signal Input Number	MMI Mnemonic
*	ZONE 3 AB	24	23	Z3 AB
*	ZONE 3 BC	25	24	Z3 BC
*	ZONE 3 CA	26	25	Z3 CA
*	ZONE 4 AB	27	26	Z4 AB
*	ZONE 4 BC	28	27	Z4 BC
*	ZONE 4 CA	29	28	Z4 CA
	ANY Z1 PHASE	30	29	Z1 PHS
	Z2 PHASE TIMER	31	30	Z2PTMR
*	Z3 PHASE TIMER	32	31	Z3PTMR
*	Z4 PHASE TIMER	33	32	Z4PTMR
	IT DETECTOR	34	33	IT DET
	IB DETECTOR	35	34	IB DET
	GRD DIR TRIP	36	35	GRDTRP
	GRD DIR BLOCK	37	36	GRDBLK
	FAULT DETECTOR	38	37	FLTDET
	REM OP DETCT	39	38	REMOPN
	OUT OF STEP	40	39	OUTSTP
	V1 DETECTOR	41	40	V1 DET
	LINE OVERLOAD	42	41	LNOVLD
	INST PHS OVRC	43	42	INPOVR
	INST GND OVRC	44	43	INGOVR
	TIM DLY GD OC	45	44	TMGOVR
	LINE PICKUP	46	45	LPCKUP
	FUSE FAILURE		46	FUSEFL
	GRND FORWARD		47	GR FWR
	GRND REVERSE		48	GR RVR
	RCLOSE CANCL		49	RECCAN
	CNFG INPUT 1		50	CNFIN1
	CNFG INPUT 2		51	CNFIN2
	CNFG INPUT 3		52	CNFIN3
	NON-CRIT ALM		53	NOCALM
	ANY Z2 UNIT		54	ANY Z2
*	ANY Z3 UNIT		55	ANY Z3
*	ANY Z4 UNIT		56	ANY Z4
	TRIP BUS/BFI		57	TRPBFI
	MAN BRK CLS1		58	BKCLS1
	MAN BRK CLS2		59	BKCLS2

NOTE: Add 100 to the configurable input signal number to use as a NOT input.

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*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 9-3 RELAY TEST MODES

	1: END TEST MODE
	2: ZONE 1 AG
	3: ZONE 1 BG
	4: ZONE 1 CG
	5: ZONE 2 AG
	6: ZONE 2 BG
	7: ZONE 2 CG
*	8: ZONE 3 AG
*	9: ZONE 3 BG
*	10: ZONE 3 CG
*	11: ZONE 4 AG
*	12: ZONE 4 BG
*	13: ZONE 4 CG
	14: ANY Z1 GRND
	15: Z2 GRND TIMER
*	16: Z3 GRND TIMER
*	17: Z4 GRND TIMER
	18: ZONE 1 AB
	19: ZONE 1 BC
	20: ZONE 1 CA
	21: ZONE 2 AB
	22: ZONE 2 BC
	23: ZONE 2 CA
*	24: ZONE 3 AB
*	25: ZONE 3 BC
*	26: ZONE 3 CA
*	27: ZONE 4 AB
*	28: ZONE 4 BC
*	29: ZONE 4 CA
	30: ANY Z1 PHASE
	31: Z2 PHASE TIMER
*	32: Z3 PHASE TIMER
*	33: Z4 PHASE TIMER
	34: IT DETECTOR
	35: IB DETECTOR
	36: GRD DIR TRIP
	37: GRD DIR BLOCK
	38: FAULT DETECTOR
	39: REM OP DETCT
	40: OUT OF STEP
	41: V1 DETECTOR
	42: LINE OVERLOAD
	43: INST PHS OVRC
	44: INST GND OVRC
	45: TIM DLY GD OC
	46: LINE PICKUP

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 9-4 DIGITAL OUTPUT TESTS

1:	End test mode
2:	Trip-1
3:	Trip-2
4:	BFI
5:	Reclose Initiate - RI
6:	Breaker Close 1
7:	Breaker Close 2
8:	Reclose Cancel
9:	Non-Critical Alarm
10:	Critical Alarm
11:	Key Transmitter 1
12:	Key Transmitter 2
13:	Line Overload

TABLE 9-5 Present Values

	UNIT ID:	1234	
	DATE:	07/12/90	
	TIME:	10:23:22	
	IA = xxx.xx A	**Note:**	Currents and voltages
ANGLE	IA = xxx.xx		are RMS values and
	IB = xxx.xx A		are either primary or
ANGLE	IB = xxx.xx		secondary as the user
	IC = xxx.xx A		selected.
ANGLE	IC = xxx.xx		
	IN = xxx.xx A	**Note:**	Phase angles go from
ANGLE	IN = xxx.xx		0°to 180°or -1°to -179°
	VA = xxx.x V		referenced to phase A voltage.
ANGLE	VA = xxx.x		VA must be present for this
	VB = xxx.x V		function to operate.
ANGLE	VB = xxx.x		
	VC = xxx.x V		
ANGLE	VC = xxx.xx		
	Watts = xxxxxx	Note:	Watts and Vars are
	Vars = xxxxxx		primary or secondary.
	Bkr1 = OPEN		
	Bkr2 = CLOSED	Note:	Signals are reported
	PLC 1 SIG = ON		only for the number
	PLC 2 SIG = ON		of breakers and carrier
	PLC 1 STS = ON		sets present in the configuration
	PLC 2 STS = OFF		

The above PLC mnemonics refer to contact converters 3, 4, 5, and 6 (CC3, CC4, CC5, CC6) defined by the Elementary Diagram in the PRODUCT DESCRIPTION section. The PLC signals, PLC SIG and PLC STS, are present for all pilot schemes except the blocking scheme. For a blocking scheme, the following mnemonics replace PLC STS signals:

STOP CAR = OFF
BLK PILOT = OFF

The PLC STS signals report the state of STOP CAR and BLK PILOT when the scheme selected is NOT the Blocking scheme. No action is taken for these signals outside the Blocking scheme.

TABLE 9-6 FAULT REPORT

UNIT ID: 1234
TRIP DATE: 07/20/90
TRIP TIME: 13:01:23.205
OPERATING TIME: 10 MS

FAULT TYPE: AG
TRIP TYPE: Z1
DISTANCE: 34.3 MI

PREFAULT IA: 5.61 A
PREFAULT IB: 5.23 A
PREFAULT IC: 5.30 A
PREFAULT IN: 0.51 A

FAULT VA: 51.2 V
FAULT VB: 66.2 V
FAULT VC: 67.3 V

FAULT IA: 15.34 A
FAULT IB: 5.12 A
FAULT IC: 4.96 A
FAULT IN: 12.13 A

07/20/90 13:01:23.205
TRIP SIGNALS ON
07/20/90 13:01:23.210
TRIP CIRCUIT #1 ENERGIZED
07/20/90 13:01:23.210
TRIP CIRCUIT #2 ENERGIZED
07/20/90 13:01:23.249
TRIP SIGNALS RESET
07/20/90 13:01:23.261
BREAKER #1 OPEN
07/20/90 13:01:23.261
BREAKER #2 OPEN

The abbreviations for the trip types are as follows:

Z1 (Zone 1)
Z2 (Zone 2)
* Z3 (Zone 3)
* Z4 (Zone 4)
PLT (Pilot)
50G (Ground instantaneous overcurrent)
50P (Phase instantaneous overcurrent)
51G (Ground time delayed overcurrent)
LPU (Line pickup)
REM (Remote open)
WI (Weak In-feed)
OSC (Oscillography Trigger)
CTB (Configurable Trip Bus)

*** Not applicable to Models DLP3***EC and DLP3***FC**

TABLE 9-7 EVENT MESSAGES

The following is the list of events printed by the DLP3 system:

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

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 - REMOTE COMM LOGIN FAILED

Note: If the 3rd login attempt fails this message will be evented

WARN - DTA BOARD: SERIAL MEMORY
WARN - SPURIOUS TIME STROBES

UNBALANCED SYSTEM DETECTION ALARM ON
UNBALANCED SYSTEM DETECTION ALARM OFF
CONTINUOUS MONITOR ALARM ON
CONTINUOUS MONITOR ALARM OFF

A list of MMI messages for certain events in the relay is as follows:

DAP:PROM ERROR
DAP:RAM ERROR
DAP:CRC RAM ERR
DAP:DSPRAM ERROR
DAP:SYSRAM ERROR
DAP:INT ERROR
DAP:TIMER ERROR
DAP:D O HW ENA
DAP:PROCSR SHTDN

DSP:PROM ERROR
DSP:RAM ERROR
DSP:DSPRAM ERROR
DSP:INT ERROR
DSP:D I ERROR
DSP:D I ERR COR
DSP:PROCSR SHTDN

ANI:A/D CNTRL ER
ANI:A/D S NVM ER
ANI:A/D REF ERR
ANI:A/D REF COR
ANI:ZERO CRSS ER

SSP:PROM ERROR
SSP:RAM ERROR
SSP:CRC RAM ERR
SSP:SYSRAM ERROR
SSP:INT ERROR
SSP:TIMER ERROR
SSP:EEPROM ERROR
SSP:CAPRAM ERROR
SSP:RTC ERROR
SSP:D O HW ENA
SSP:PROCSR SHTDN

MMI:SER CHIP ERR
MMI:D O ERROR
MMI:LED DISP ERR

MGM:MAG S NVM ER

BK1 TRP CIR OPEN
BK2 TRP CIR OPEN
FUSE FAILURE
LOGON FAILURE
RELAY TEST
D O TEST
PROT OFF
DIS OUTS

UNBALANCED SYSTEM DETECTED
CONTINUOUS MONITOR ALARM

TABLE 9-8 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				

Modem Connections and Settings

When establishing communication between the DLP3 system and a remote PC, two modems connected via a phone line are required; one modem is located at the DLP3 system and the other modem is located at the PC. The cable that connects the modem with either the DLP3 system or the PC is shown in Figure 9-2A). Each of these modems must be "Hayes-compatible" meaning that they must accept configuration commands first developed by Hayes. This is necessary since the DLP-LINK communications software that runs on the PC sends a Hayes-compatible command string to the modem located at the PC. The DLP3 system does not send any configuration commands to its modem. **The DLP3 modem must be uniquely configured to permit the user to log into and communicate with the DLP3 system 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 of 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. The commands sent to the modem from DLP-LINK are as follows:

+++

ATQ0E0V0S0=0X1X4&C1&D2
(see explanation below)

Command explanation:

AT	-	modem attention command
E0	-	disable command state echo
&D2	-	terminal must send DTR for modem to accept commands
Q0	-	modem returns result codes
V0	-	result codes returned in numeric form
X4	-	enables features represented by result codes
X1	-	extended result code set
S0=0	-	turn off auto answer
&C1	-	causes DCD to track the received carrier signal

A DLP-LINK setting establishes the baud rate, which must match the baud-rate setting of the DLP3 system. 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.

DLP3 Modem

The DLP3 modem must be configured for "dumb" operation (i.e., command recognition disabled). For the Hayes V-Series 2400 SmartModem this setting is made via an internal jumper. Since the DLP3 system does not send any configuration commands to its modem, the required configuration settings must be made prior to connecting the modem to the DLP3 system. **Additionally, the modem must be initialized to the required configuration settings each time modem power is turned OFF and then ON.** Depending on the design of the modem this is accomplished by making all the required settings via switches or saving the settings in non-volatile memory.
The required configuration settings are:

E0	-	disable command state echo
L0	-	low speaker volume (advisable - not necessary)
Q1	-	disable result code display
&C1	-	causes DCD (Data Carrier Detect) to track the received carrier signal
&D3	-	causes the modem to reset on the ON-to-OFF transition of DTR (Data Terminal Ready)
&Q0	-	asynchronous mode
S0=1	-	enable auto-answer

If any of the above settings cannot be implemented, the modem may not answer, the DLP3 system may not connect properly, or the user may not be able to log into the DLP3 system.

With a Hayes V-Series 2400 SmartModem or equivalent, the DLP3 modem will perform a modulation handshake with the PC modem to set the baud rate of the DLP3 modem. The default setting of "N1" permits handshaking to occur at any baud rate supported by both modems. This is one reason why it is preferable to use identical modems at each end.

Note that auto-answering is controlled with register S0. S0=0 disables auto-answer. S0=1 will cause the DLP3 modem to answer the incoming call after one ring. S0 can be set for any value between 1 and 255, for the Hayes modem assumed here, if it is desirable to delay modem answering. Note that DLP-LINK (version 1.05 or higher) configures the PC modem to wait 60 seconds for the DLP3 modem to answer. If the DLP3 modem register S0 is set higher than 12, the PC modem may time out and hang up before the DLP3 modem can answer. S0=12 means that the DLP3 modem will answer after twelve rings and corresponds approximately to the 60 second delay (S7=60) at

the PC modem, however the user should verify the number of rings that correspond to 60 seconds for a particular application.

Table 9-9 is a listing of the modem command set required to communicate to the DLP3 system from a remote PC.

TABLE 9-9 MODEM SETUP CRITERIA (Hayes Compatible)

Function	DLP3 Modem (remote)	PC Modem (local)
DTR Status	Follow DTR (&D3)	Follow DTR (&D3)
Result Code Format	Numeric (V0)	Numeric (V0)
Result Code Display	Disable (Q1)	Disable (Q1)
Command State Echo	Disable (E0)	Disable (E0)
Auto-Answer	Enable (S0=1)	Disable (S0=0)
Carrier Detect	Follow CD (&C1)	Follow CD (&C1)
Jack Type	RJ-11, etc. (&J0)	RJ-11, etc. (&J0)
Command Recognition	Disable (Dumb)	Enable (Smart)
Comm. Std. (@1200 bps)	Bell 212A (B1)	Bell 212A (B1)
Response to DTR	Modem Reset (&D3)	Modem Reset (&D3)
Pulse Dial Ratio	39%Mk/61%Bk (&P0)	39%Mk/61%Bk (&P0)

Connection to GNET (optional)

The GNET host computer provides a complete communication package to send and retrieve information automatically from the DLP3 system. The pin-to-pin connections to the GNET host are shown in Figure 9-2D). Refer to the GNET Instruction Book (GEK-100642) for complete information on GNET Host Computer cable connections and operation.

Null Modem Connections

A PC can be connected to a DLP3 system without the intervening modems and phone line by using a special cable called a "null modem" cable. The required pin-to-pin connections for this null modem cable are shown in Figure 9-2B). The pin-to-pin connections for a null modem cable to connector COMM on the MMI are shown in Figure 9-2C). Neither null modem cable should exceed 50 feet in length.

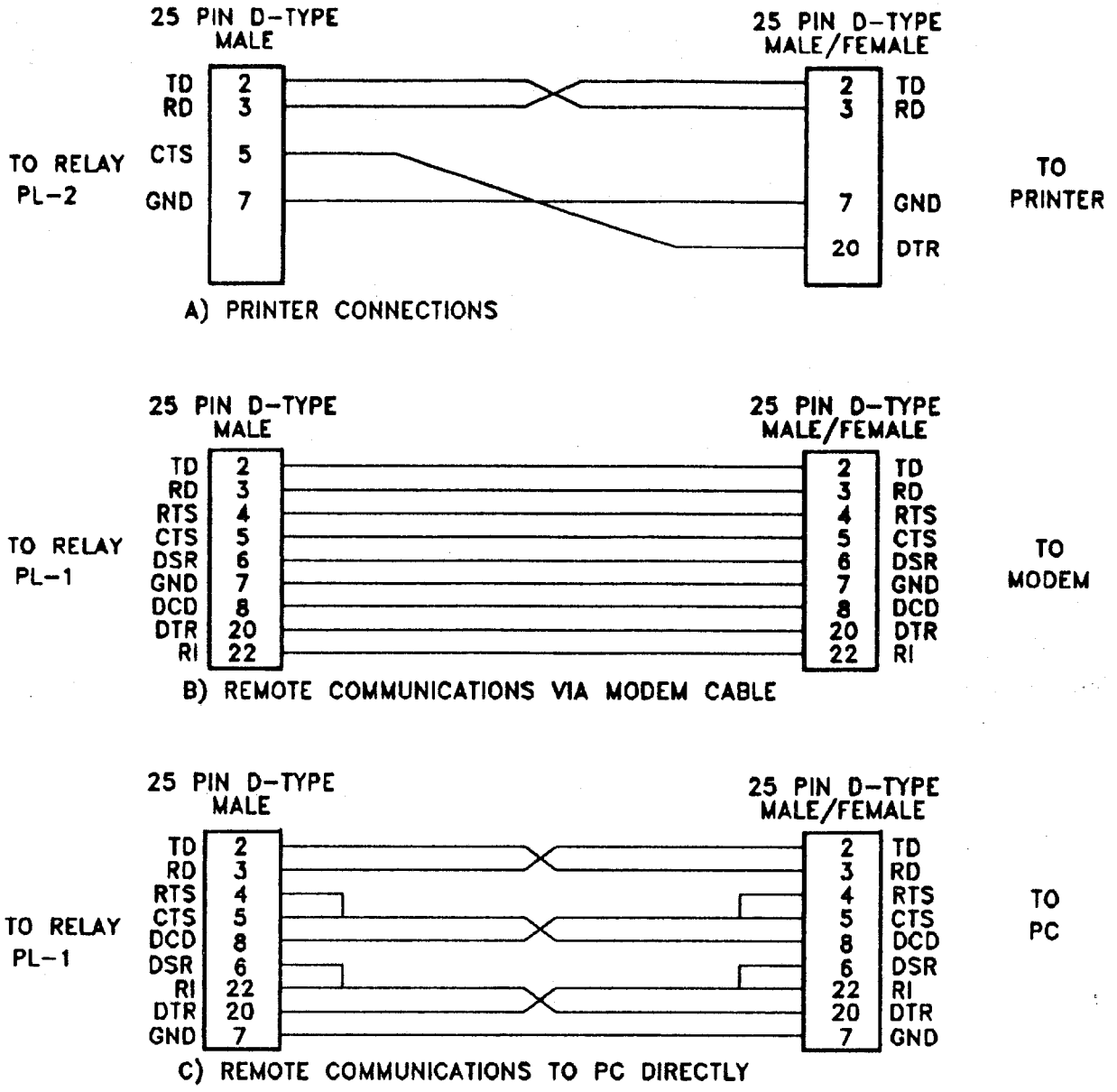

Figure 9-1 (0286A4821 Sh.1 [1]) DLP3 Communications

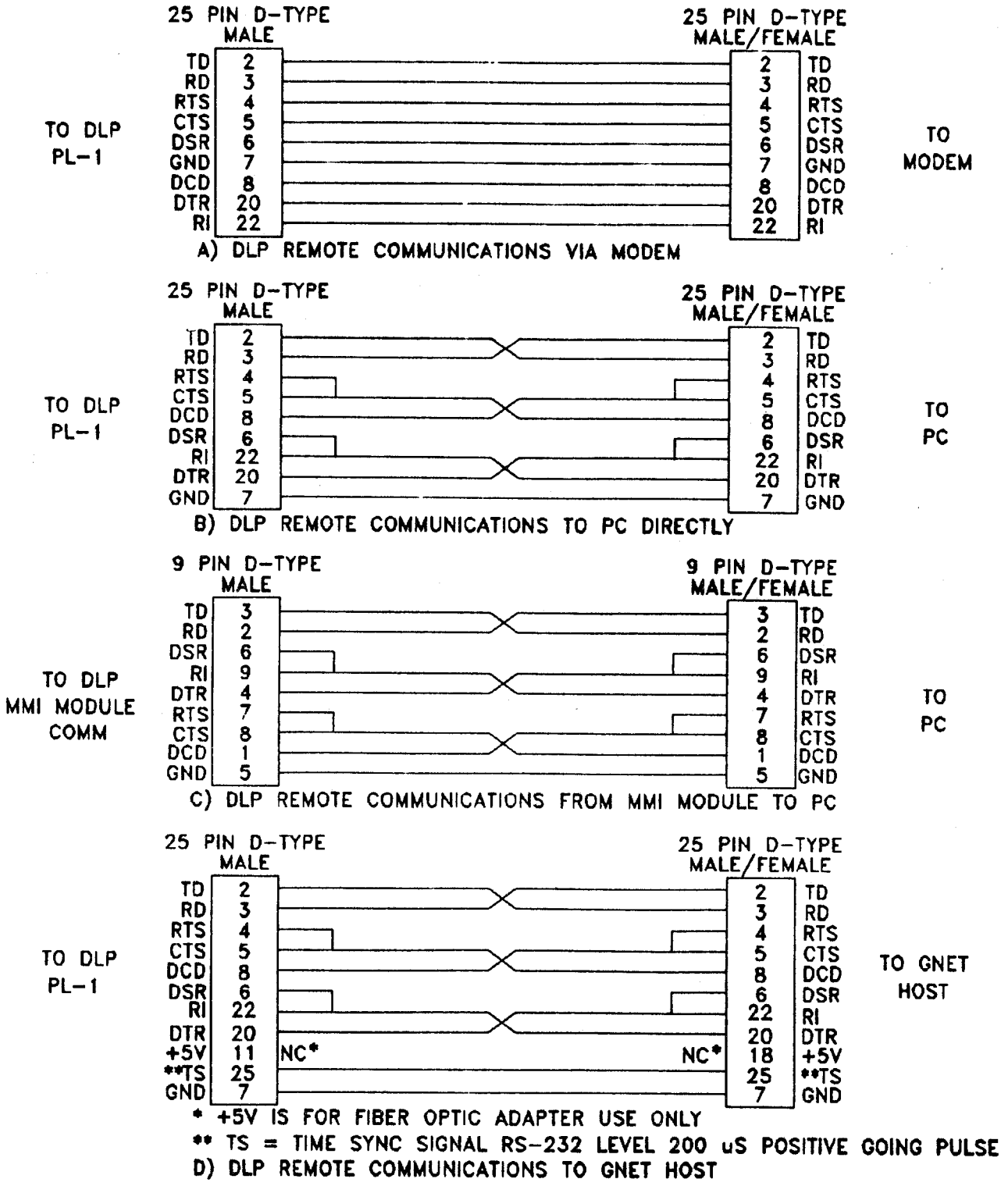

Figure 9-2 (0286A4849 Sh.1) DLP3 Communications

DLP-LINK SOFTWARE

OVERVIEW

A personal computer (PC) will provide a remote man-machine interface to the relay for operating personnel.

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 400K 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

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.

PROGRAM STARTUP

Start the program using the DLP-LINK.bat file. Do not use the DLPLINK.exe file.

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 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 then releasing the mouse button.

Keyboard

"Activating a 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, on the right side of the list box, 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 or the end of the list is reached.

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.

RELAY FUNCTIONS

Relay functions has the following menu items and associated hot keys:

Login	ALT-L
lOgout	ALT-O
Change access level	ALT-C
Hang up phone	ALT-H
Actions...	ALT-A
Information...	ALT-I
Settings...	ALT-S
TOC...	ALT-T

Login

Login is used to gain access to the relay. When logging into a DLP3™ system for the first time, the user must use the factory passwords. When a user is logged in under a 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 DLP3™ systems, a place to enter the password, a place to enter the unit ID, a button for adding a new DLP3™ system to the configured DLP3 list, an OK button and a CANCEL button.

The list of currently configured DLP3™ systems contains the unit description, phone number, baud rate, and multiplexor switch code for each DLP3™system.

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. Any of the three passwords for Communications can be used to log in to the relay. (See PASSWORDS in the INTERFACE section.) The password used will determine the access level when the login procedure is complete. For example, if settings changes will be performed, then the password should be the Settings access password. Another method of logging in would be to use the View access password to log into the DLP3™system and change the access level when settings changes are needed. See **Change access level** below for more information.

lOgout

Logout disables access to the relay. A check is made to determine the status of protection at the DLP3 system (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** under **Settings** in the RELAY FUNCTIONS menu.

Change access level

Change access level allows the user to enter another password so that the settings can be changed, actions can be performed, or access is restricted to viewing only. The access level is displayed on the bottom line of the display.

To choose **Change access level**, move the mouse cursor to the item and click on it with the left mouse button or use the hot key ALT-C. A dialog box will appear with space to enter a password. The user can change the access level by entering a password for one of the other levels and selecting the OK button by clicking on it with the left mouse button or using the ALT-O hot key. Selecting the CANCEL button will exit **Change access level** without changing the level. Once the level has been changed, the new level will be displayed at the bottom of the screen. The following table contains operations performed by DLP-LINK and the associated password level required to perform the operation. All items can be viewed at any level, but only changed with the proper access level displayed.

DLP-LINK Operation	Required Access Level
Change Password	Any Level
Trip Breaker	Actions Level
Close Breaker	Actions Level
Enable Outputs	Actions Level
Disable Outputs	Actions Level
Change Time and Date	Settings Level
Change Station/Line Id	Settings Level
Calculate CRC	Any Level
Relay Test	Actions Level
Digital Output Test	Actions level
Channel Test	Actions Level
Perform Settings Changes	Settings Level

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
change Station/line id	ALT-S
cAlculate CRC	ALT-A
Relay test mode	ALT-R
digital Output test	ALT-O
chaNnel test	ALT-N

change Password

This item allows the user to change the password in the DLP3 system. 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 for subsequent password use. 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 DLP3 system, 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 DLP3 system, 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 DLP3 system 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 DLP3 system from energizing any of the relay outputs except the four Alarm Outputs. Note that the digital outputs cannot be disabled if the appropriate jumper is installed (see 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 DLP3 system 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 the DLP3 system'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 DLP3 system.

change Station/line id

This dialog box displays the station and line ID for the relay the user is logged in to. The IDs can be up to 32 characters long and must be all printable characters. To change an ID, select the desired ID with the TAB key or click on it with the left mouse button. Once the correct ID has been selected, use the insert, delete and backspace keys to edit and enter data. After the correct data has been entered, select the OK button by clicking on it with the left mouse button or using the ALT-O hot key. The user will be asked to confirm the IDs before sending them to the DLP3 system. Selecting the OK button again will send the IDs to the DLP3 system.

Selecting the CANCEL button in the confirmation dialog box will return the user to the dialog box with the Station and Line IDs. Selecting the CANCEL button in the **Station/Line** ID dialog box before sending the IDs to the relay will exit the dialog box without sending the IDs to the DLP3 system. Selecting the CANCEL button after sending the IDs to the relay will simply return the user to the Actions menu.

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 DLP3 system. **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 46 test entries in the list box, only a few will be seen at one time. To find the desired test, use the PAGE UP/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.

digital Output test

This item allows the user to perform digital output tests in the relay. The tests are displayed in a list box. Note that this test cannot be performed if jumper J1 on the MMI module is installed (see MODULES section for the location and description of the jumpers).

The user selects the test to perform. When the user selects the OK button, the user is asked to confirm the test. If the user again selects the OK button, the test is performed. This will put the relay in test mode, with protection OFF. To put the relay back in operating mode, the user executes "End test mode".

chaNnel test

This item allows the user to key (turn on) the local transmitter when a channel scheme is used. To select **chaNnel test**, either click on it with the left mouse button or use the ALT-N hot key.
After **chaNnel test** has been selected, a dialog box will be displayed with the choice to start or stop the test. Either the START or the STOP radio button must be selected. To select the Start/Stop chaNnel test item, use the TAB key until the selected radio button is highlighted or click directly on the desired button. Once the Start/Stop choice is made, selecting the OK button will display another dialog box to confirm that the channel test is to be performed. Selecting the CANCEL button will return to the Actions menu box.

If the user selects the OK button, another dialog box is displayed to confirm the channel test. Selecting the OK button will either start or stop the channel test, depending on which radio button was selected from the previous dialog box. Selecting the CANCEL button will not perform the action and will return to the previous dialog box. Selecting the CANCEL button from the **chaNnel test** dialog box will return to the Actions menu.

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 Line/station id	ALT-L
request MMI pAssword	ALT-A

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 ¸1° to ¸179°, and are referenced to Phase A voltage (VA). VA must be present for this function to operate. Currents and voltages are RMS values and are either primary or secondary, as 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 Ids. 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 report. 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 14) 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 stored 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 14) 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, the settings in effect at the time of the fault, and the data are saved to the specified file.

The oscillography data is an ASCII text file consisting of the fault report, the events associated with the fault report, the settings, the currents, the voltages, the digital inputs, digital outputs, and protection flags. This file can be read directly by Lotus 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 DLP3 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 DLP3 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 status 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 are displayed in the same order as those at the DLP3 system (described in the SERVICING section).

request dlp Model

This item allows the user to display, print and/or file the DLP3 model and PROM version number. To select this menu item, either click on it with the left mouse button or use the ALT-M hot key. Once this item is selected, a dialog box will appear with three independent choices for displaying, printing and filing the DLP3 model number and PROM version. 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 data 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.

request Line/station id

To select this menu item, either click on it with the left mouse button or use the ALT-L hot key. This dialog box displays the station and line ID of the relay from which information is being uploaded. Both the station ID and line ID can only be **viewed** with this item. To change the station ID and line ID select **Change station/line id** from the Actions menu. When finished viewing the IDs, click on the OK button or use the ALT-O hot key.

request mmi pAssword

To select this menu item, either click on it with the left mouse button or use the ALT-A hot key. The dialog box displays the MMI keypad passwords in encrypted form. These passwords are the ones to be used at the MMI keypad. These are not the Communications password used with DLP-LINK. The MMI passwords can only be **viewed** from this item. The MMI passwords can only be changed at the MMI keypad. For more information see the INTERFACE section. When finished viewing the passwords, click on the OK button with the left mouse button or use the hot key ALT-O.

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 DLP3 system. 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.

If the access level is not Settings, the option to **Download changed settings to the DLP3** will not be available.

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 all desired categories have 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.

If the access level is not Settings, the option to **Download changed settings to the DLP3** will not be available.

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 DLP3 system, 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 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.

If the access level is not Settings, the option to **Download changed settings to the DLP** will not be available.

Download changed settings to dlp

This item allows the user to transmit all the changed settings to the DLP3 system.

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.

The group number must be set correctly to make sure the desired group of settings is changed. The default will be the group that was uploaded from the relay. If another group is to be selected, the item can be chosen by using the TAB key or clicking on the box that contains the group number with the left mouse button. The cursor will move to the box. Use the normal editing keys to change the group number. The acceptable group numbers are 1, 2, 3 and 4.

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 DLP3 system that settings changes are complete and protection should use the new settings. (If the option to end settings changes automatically was picked when downloading settings to the DLP3 system, 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 also include a path) 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.

TOC...

Download TOC curve

This item allows the user to download a TOC curve to the relay from a disk file.

A dialog box will appear 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 using 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 TOC values (a file previously created by the **Upload TOC curve** menu item discussed below, or a TOC-curve-generating program), or enter a partial file name using the standard DOS wild card characters * and ?.

The field labeled "Directory" indicates the current drive and directory 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 download a TOC curve to the relay from the selected file.

Upload TOC curve

This item allows the user to upload, into DLP-LINK, the TOC curve from the relay and write the values to a disk file. 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 upload the TOC curve and save the values in the specified file.

The field marked "File name" contains the file that is currently selected. This field may be selected by the user to specify a file containing TOC values (a file previously created by the **Upload TOC curve** menu item or TOC program), or enter a partial file name using the standard DOS wild card characters * and ?.

The field labeled "Directory" indicates the current drive and directory where the list of files is obtained from. 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 upload a TOC curve from the relay to the selected file.

Local functions

The Local functions menu has the following items and hot keys.

Settings...	ALT-S
Graph oscillography data	ALT-G
Custom TOC curves	ALT-C
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
Save local settings to file	ALT-S
Model/version number	ALT-M
station/Line id	ALT-L
Download local settings to dlp	ALT-D
End setting changes	ALT-E

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 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 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 DLP3 system from the saved-settings file, a field to enter a new setting value for a selected setting, and an informational field with the valid range for the setting value. Each of the different items can be selected 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 also include a path) 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. 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.**

station/Line ID

This entry displays the station and line IDs of the relay from which the settings were retrieved. These IDs can be used to identify the relay that the settings in the file match. This menu item is selected by clicking on the menu item with the left mouse button or using the ALT-L hot key.

Download local settings to DLP

This item will appear on the menu only if the Communications access level is Settings.

This item allows the user to transmit all the local settings to the DLP3 system. 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 DLP3 system in order to use this menu item. Note that if the appropriate jumper is installed, the DLP3 system 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 DLP3 system 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 DL-DATA 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 DL-DATA 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 DL-DATA, refer to the pages describing DL-DATA at the end of this SOFTWARE section.

Custom TOC curves

A TOC-curve-generating program will be started if this entry is chosen. This enables the user to customize their overcurrent time curve data without leaving DLP-LINK. The data can then be downloaded to the relay. The DOS path for the

program needs to be entered. The path is entered via the **Setup** menu, and is stored for use here.

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 initialization string	ALT-M
mOdem connection time	ALT-O
Relay parameters	ALT-R
Add relay to list	ALT-A
dElete relay from list	ALT-E
Set path for DL-DATA	ALT-L
Set path for TOC curves	ALT-T
Memory available	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 DLP3 system, or the modem used to talk to the DLP3 system, 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 Initializtion string

To select this item, either click on it with the left mouse button or use the ALT-D hot key. This item allows the user to enter an additional initialzation string. This string will be sent by DLP_LINK to the PC modem before dialing. Please consult your modem instruction manual for information on modem initialization commands.

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, or 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 phone number. 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.

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 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 dialog box will exit from the menu entry.

set path for DL-DATA

DL-DATA (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.

set path for TOC curves

A TOC-curve-generating program 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-T 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.

DL-DATA SOFTWARE (Optional)

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 DLP-LINK program. Refer to DLP3 INFORMATION under DLP-LINK SOFTWARE for a description of how to retrieve oscillography data from the DLP3 system.

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 DLP-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 DLP-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)

The updated version (V002.110B and later) of the DLP system differs from previous versions as to which internal flags are stored as part of Oscillography data. Now, when a function is disabled, the associated flags are NOT stored. For example, if (101)SELZ1G = NO and (102)SELZ1P = NO, the zone 1 flags (indicating zone 1 operation or non-operation) are not stored. Previously, if these settings were both set to NO, the zone 1 flags were stored even though the zone 1 functions were disabled, and this feature caused some confusion, especially when appropriate reach or pickup settings were not used.

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 450K of RAM in which to run the program, 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 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 (cancels) 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 through the graph that can be moved 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, then release. (See Figures 10-1 through 10-3.)

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 from which the list of files is obtained. 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; then the user only has to select a printer type if the user's printer changes.

The next item in the dialog box is a button that determines whether the printer performs 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 (selected state of the button).

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 by closing the window, using the QUIT button just below the title block.

Note: An item can be saved by making it an icon, which can be restored and saved as many times as necessary. This eliminates the need to close the window to be able to view the item again.

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, plot the flags, and return to the main menu; or 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
Settings	ALT-S

Once an item is selected to be displayed, the same item cannot be selected again until it is cleared from the display by closing the window, using the QUIT button just below the title block.

Note: An item can be saved by making it an icon, which can be restored and saved as many times as necessary. This eliminates the need to close the window to be able to view the item again.

Fault Report

Selection of this item displays the fault report associated with the oscillography data (the report is generated at the DLP3 system).

Events

Selection of this item displays the events associated with the oscillography data (the events are generated at the DLP3 system).

Settings

Selection of this item displays the settings from the relay at the time of the fault. The settings can only be viewed.

SETUP MENU

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 that 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 DLP3 system 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" 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" floppy disk located at the end of this section.

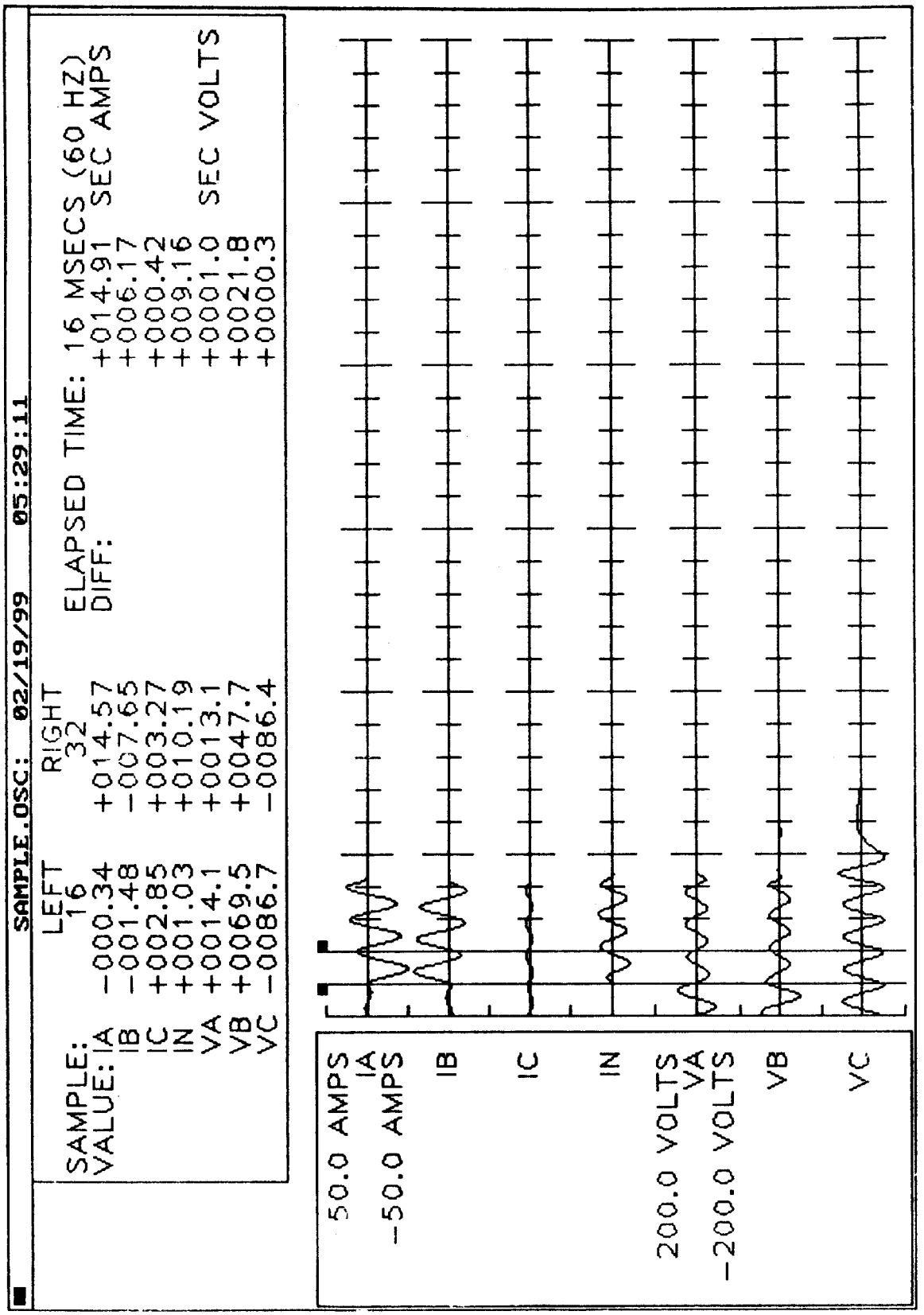

Figure 10-1 (0286A2931 Sh.1 [1]) Oscillography -- Currents and Voltages

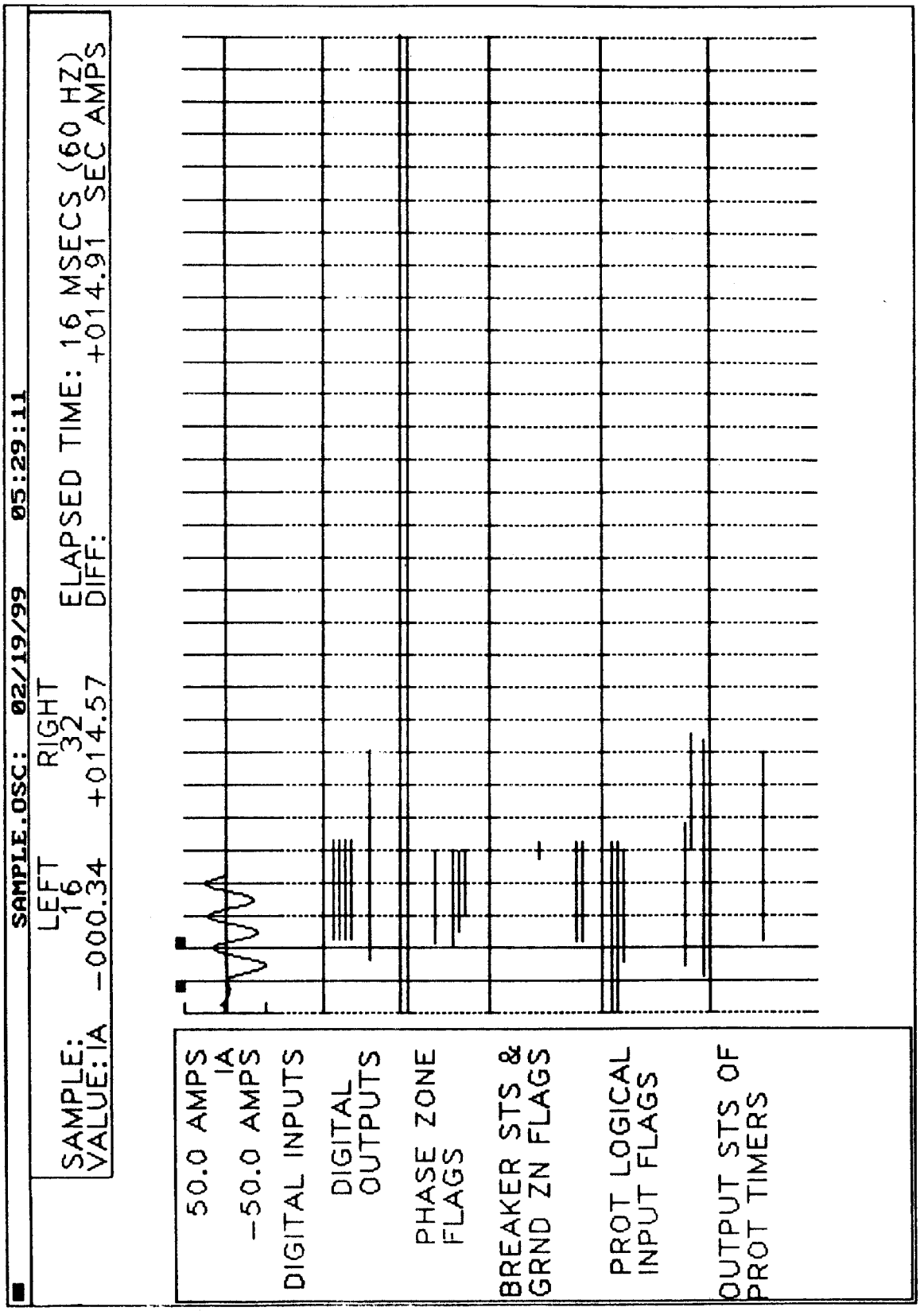

Figure 10-2 (0286A2931 Sh.2) Flag Groups Screen

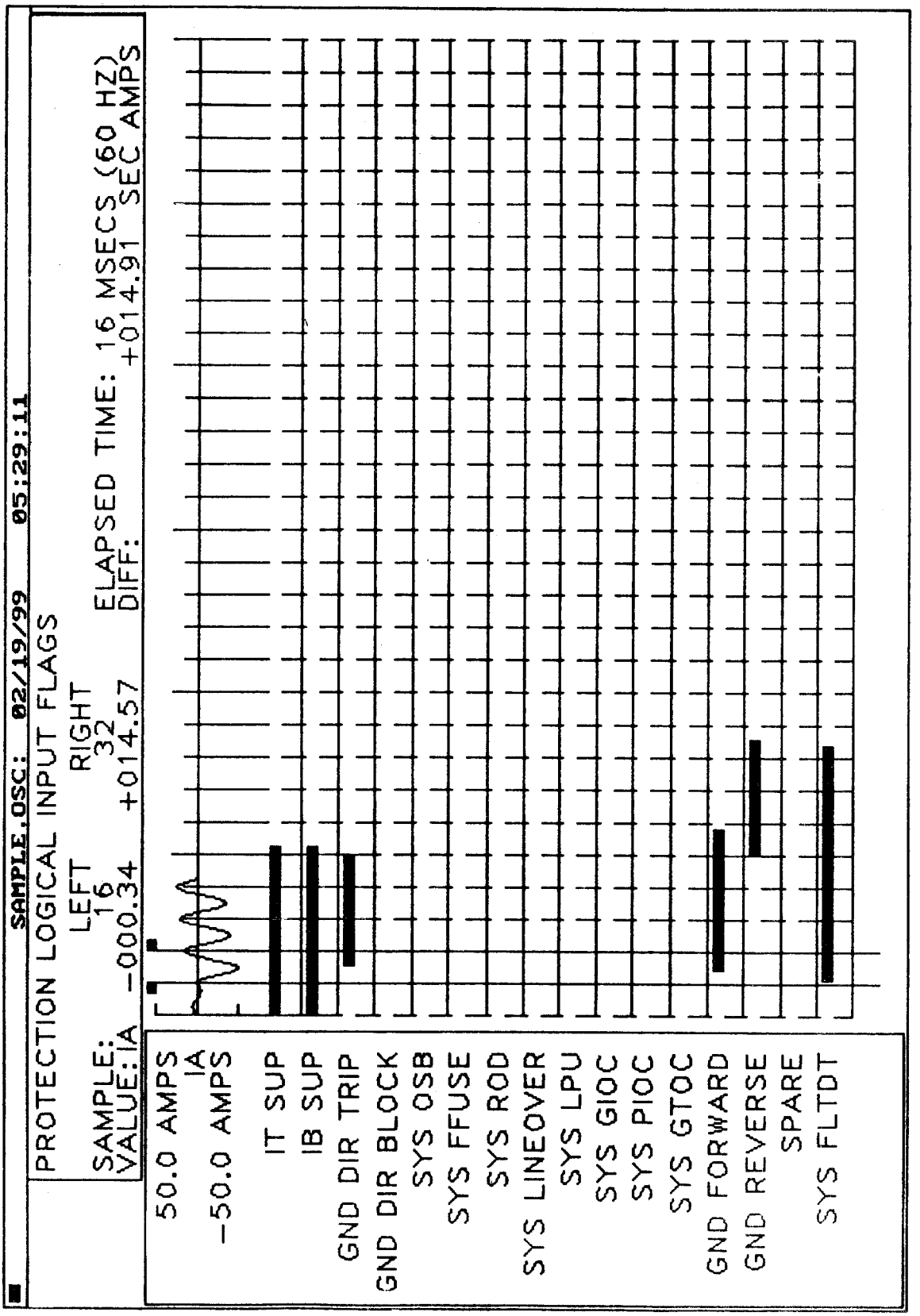

Figure 10-3 (0286A2931 Sh.3) Protection Logic Input Flags Screen