

GE POWER MANAGEMENT

GEK-105556

Advanced Line Protection™ System

ADVANCED LINE PROTECTION
SYSTEM
WITH SINGLE PHASE TRIPPING

g Multilin

GE Power Management

GEK 105556

Advanced Line Protection System

WITH SINGLE PHASE TRIPPING



g MULTILIN

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

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

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Quick Reference Guide and PC Software (Located in pocket attached to rear cover)

GETTING STARTED

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

Prior to applying power, ensure that the model number of the relay listed on the front panel corresponds to the model ordered. Make sure that the DC supply power matches the rated voltage listed on the front panel. Refer to the elementary diagrams, Figures 1-23 & 1-24 in *Chapter 1 Product Description* for the locations of the DC power inputs

Instructions on how to use the keypad to change settings, and put the relay into test mode can be found in the *Chapter 4: ACCEPTANCE TESTS*, under "SETTING CHANGES". Complete instructions on how to operate the keypad are found in *Chapter 8: Local User Interface*.

PASSWORDS, FACTORY SET

The ALPS relay requires the use of passwords to change Settings or to perform Actions. No password is required to obtain information from the relay, including viewing the existing settings. The relay is shipped from the factory with the following MMI passwords:

SETTINGS: 123.
ACTIONS: 456.
MASTER: 789.

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

In order to change the default password, follow these steps:

1. Press the ACTIONS key (ACT)
2. Press the ENTER key (ENT)
3. Scroll to the CHANGE PASSWORD option.

4. Press ENT
5. Enter 789. (Factory Password)
6. Enter your password.
7. Re-enter your password.

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

REMOTE COMMUNICATIONS VIA LOCAL PC

To communicate with the relay locally via a PC, connect the relay to a serial port of an IBM-compatible computer with a null-modem cable. Connection can be made either to the 25 pin D-connector on the back of the relay (PL2A), or the 9 pin D-connector on the front (PL1). Cable diagrams can be found at the end of *Chapter 8 - Local User Interface*, Figure 8-5 & 8-6.

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

ALPS-LINK PROGRAM - QUICK REFERENCE

The ALPS 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:	SETTING!
ACTIONS:	CONTROL!
MASTER:	MASTER!

NOTE: The exclamation point following the letters is part of the factory password. The factory passwords **MUST** be changed before the user can modify Settings or initiate Actions. The user can log into the relay at any password level. After logging

To log into the relay, follow the instructions in the *Chapter 4 - ACCEPTANCE TESTS*, "USING COMMUNICATIONS." Any one of the factory passwords can be used to log on to the relay. The relay UNIT ID (setting 101) is factory set to 0.

Before the user can change another password, he must LOGOUT from the ALPS. The user can then change the remaining passwords by first logging into the ALPS using another default password. The communications passwords may be viewed, in an encoded format, via the keypad, under the INF (Information) key.

ALPS Selection Guide

ALPS	*	*	*	*	*	*	*	*	*	*
D										
A										
1										
3										
1										
5										
U										
C										
0										
1										
2										
1										
2										
3										
4										
2										
3										
H										
V										
S										
E										
0										
1										
2										
3										
N										
R										
S										

Distance Relay

Revision Level

Single phase tripping logic

Three phase tripping logic

1 Ampere rated current

5 Ampere rated current

For applications without Series Capacitors

For applications with Series Capacitors

48 VDC battery voltage

110/125 VDC battery voltage

220/250 VDC battery voltage

SCR trip outputs & contact channel interface

Contact trip outputs & contact channel interface

SCR trip outputs & 5V/20mA channel interface

Contact trip outputs & 5V/20mA channel interface

Front RS232 com port & 1 settable RS232/RS485 rear port (GE-Modem/ASCII)

Front RS232 com port & 2 settable RS232/RS485 rear ports (GE-Modem/ASCII)

Horizontal mounting

Vertical mounting

Standard Oscillography Memory

Extended Oscillography Memory

No Out of Step Tripping or Positive Sequence Overvoltage

With Out of Step Tripping

With Positive Sequence Overvoltage units

With Positive Sequence Overvoltage units & Out of Step Tripping

No Recloser

Recloser

Recloser with Sync Check

EXAMPLE: ALPSDA35U122VE1N = ALPS Digital Line Protection Distance Relay, Revision A, three phase tripping relay, rated at 5 amperes, Without series capacitor protection, 110/125 VDC supply, contact tripping outputs, 2 communications ports, vertical mounting, with extended memory, without OST functions, and no options.

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Description

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

The ALPS is packaged in a compact 3 rack unit high (one RU = 1.75 Inch) 19 inch rack mount case which is available for either horizontal or vertical mounting. The case outline and mounting dimensions for the ALPS are shown in Figure 3-1.

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

Application

The ALPS models covered by this instruction book are designed to be used on transmission lines of any voltage level, with or without series capacitor compensation, where either single or three phase tripping is required. Detailed application considerations are described in this chapter and in *Chapter 2 - Calculation of Settings*.

The ALPS can provide high speed detection and clearing of power system faults.

The ALPS includes logic for step distance and five standard pilot tripping schemes. The scheme logic diagrams are shown and discussed in the section entitled Protective Scheme Descriptions. The external connections for the ALPS are shown in the elementary diagram of Figure 1-24.

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

Protection Functions

The measurement functions included are listed in Table 1-1.

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

Overreaching Zone 2 phase and ground distance functions are used for pilot tripping schemes. Ground-directional overcurrent functions can be selected to replace or supplement the overreaching zone (Zone 2) ground-distance functions in any of the pilot schemes. The Zone 2 phase and ground distance functions are provided with independent timers for time delayed backup protection.

Overreaching Zone 3 phase and ground distance functions are provided with independent timers for time delayed backup protection.

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

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

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

Zone or Type	Functions
Zone 1	3 Variable-mho phase-distance functions, and 3 Variable-mho ground-distance functions or 3 Reactance ground-distance functions with "adaptive reach" mho supervision
Zone 2 (Pilot Zone)	3 Variable-mho phase-distance functions, and 3 Variable-mho ground-distance functions and/or Ground directional-overcurrent functions consisting of IPT – Ground trip overcurrent NT – Negative-sequence directional trip IPB – Ground block overcurrent NB – Negative-sequence directional block
Zone 3	3 variable-mho phase-distance functions, and 3 Variable-mho ground-distance functions
Zone 4	3 Reversible variable-mho phase-distance functions, and 3 Reversible variable-mho ground-distance functions

Out of Step Blocking (OSB)	3 Variable-mho phase-distance functions
Overcurrent Backup	50 – Phase-overcurrent direct trip (directional or nondirectional) 50G – Ground-overcurrent direct trip (directional or nondirectional) 51G – Ground time-overcurrent direct trip (directional or nondirectional)
Overcurrent Supervision	IT – Trip-supervision overcurrent IB – Block-supervision overcurrent
Fault Detector	FD
Line-Pickup Overcurrent	I1
Remote-Open Detector	ROD
Line-Overload Detectors	Level 1 Overcurrent Level 2 Overcurrent
Phase Undervoltage	Three fixed pickup phase undervoltage detectors
Phase Over/ Undervoltage	Three adjustable over or under voltage detectors with time delay
Positive-Sequence Voltage Detectors	V1 V1 compensated

Table 1-1. Measurement functions included in the ALPS.

Line Protection Schemes

The ALPS provides four zones of distance protection with overcurrent backup functions. The ALPS is a highly flexible system. The system includes predefined protection schemes, but also has the ability to be programmed by

the user. The custom programmability of the ALPS is discussed in the next section.

The ALPS pilot protection schemes are as follows:

- Permissive Underreach Transfer Trip (PUTT)
- Permissive Overreach Transfer Trip (POTT1)

- Permissive Overreach Transfer Trip with blocking functions (POTT2)
- Directional Comparison Blocking
- Hybrid

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

Custom Programmability

The ALPS offers a high degree of custom programmability, should the user desire to avail himself of this feature. The custom programming of the ALPS relay is accomplished by the use of the program, Xpression Builder. Xpression Builder is a Windows based program that allows the user

to graphically design Programmable Logic and make I/O (Input - Output) assignments for the ALPS and other GE Power Management relays. Xpression Builder is included with the software in this instruction book. A complete description of the ALPS custom programming features and Xpression Builder is included in *Chapter 13 - Configurable Logic Design Software (Xpression Builder)*.

Configurable Inputs

All of the contact converters (Digital Inputs) in the ALPS are user configurable. However, each ALPS relay is shipped with Default Contact Converter Assignments as shown in Table 1-2 and on the As Shipped elementary diagram of Figures 1-19 & 1-20.

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

Table 1-2. ALPS DEFAULT CONTACT CONVERTER ASSIGNMENTS-SINGLE PHASE TRIP

Configurable Outputs

All of the output relays in the ALPS, except for the alarm output relays, are user configurable.

However, each ALPS relay is shipped with Default Output Relay Assignments as shown in

Table 1-3 and on the As Shipped elementary diagram of Figure 1-24.

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

Table 1-3. ALPS DEFAULT OUTPUT CONTACT ASSIGNMENTS-SINGLE PHASE TRIP

Programmable Logic

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

Auxiliary Protection Functions

Potential Transformer Fuse Failure (PTFF)

Because a distance or directional function may operate for a full or partial loss of ac potential caused by one or more blown fuses, PTFF is provided to block distance and directional function tripping when a fuse failure is

detected. If the backup overcurrent functions 50, 50G, and 51G are not directionally controlled, they are allowed to trip during a potential fuse failure condition. If any of the backup, overcurrent functions, 50, 50G or 51G, is directionally supervised, then that function is not allowed to trip, but a second overcurrent function, 50_FF, 50G_FF, or 51G_FF is placed in service during the fuse failure condition. The pickup level setting of these functions is independent from the normal pickup setting. Figure 1-1 shows the functional logic for the PTFF function.

If ac potential is lost on one or more phases, the Any Phase Under Voltage signal produces a logic 1 output, and the upper input is present at AND1. The phase under voltage pickup setting is fixed at 75% of nominal and the pickup-to-dropout ratio is virtually 100%. The lower input to AND1 is dependent upon whether the fault detector FD has operated or whether one or more phases of the protected

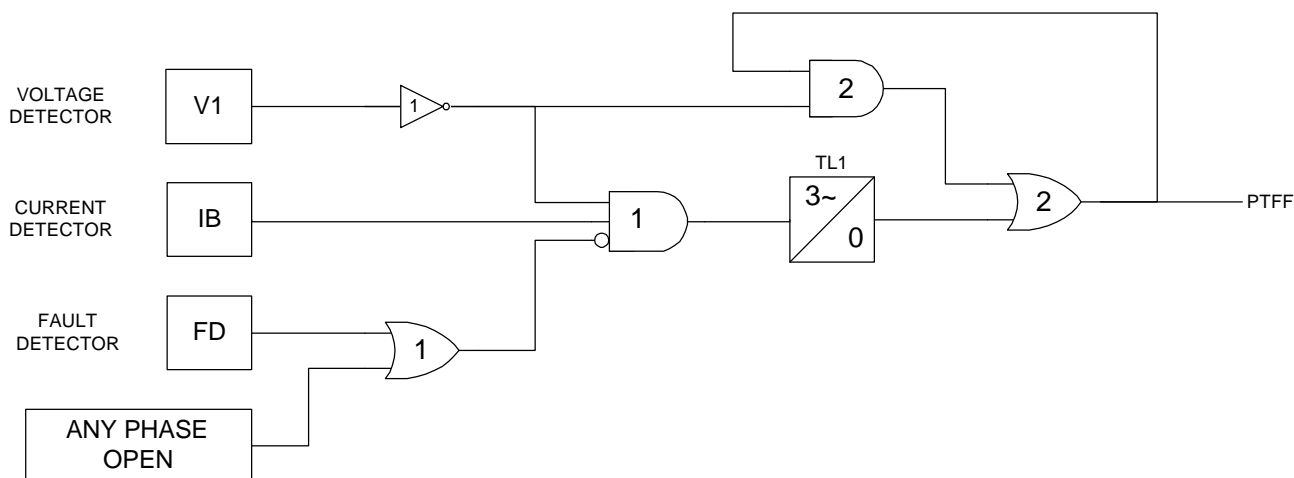


Figure 1-1 Potential Fure Failure (PTFF) Logic Diagram

line are de-energized (open). When one or more phases of protected line are open, PTFF is disabled.

If ac potential is lost for any reason, including a blown fuse or fuses, and there is no disturbance on the power system, so that the fault detector has not operated, AND1 produces an output that causes timer TL1 to time out and produce a PTFF output via OR2. The output of OR2 is routed to AND2 to seal in the PTFF output, based on the Any Phase Under Voltage signal, so that PTFF output is maintained as long as the potential is below normal. Setting 714, FUSEFAIL, determines whether PTFF operation blocks distance/directional tripping (FUSEFAIL = YES) or merely issues an event (FUSEFAIL = NO). When the potential returns to normal, the Any Phase Under Voltage signal resets to remove the seal-in, allowing the PTFF output to reset.

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

Line Pickup

Three Phase Close

The Line Pickup (Close-onto-Fault) logic provides tripping in the event that the breaker is closed into a zero-voltage bolted fault, such as occurs if the grounding chains were left on the line following maintenance. For this three phase zero voltage fault, the mho distance functions can not operate because they do not have a source of polarizing voltage. Figure 1-2 shows the functional logic for Line Pickup.

When the line is de-energized, the open breaker is detected by the All phases Open. The resulting output causes timer TL401 to pickup 150 ms later. Consequently, when the line is energized and a fault current higher than the setting of I1 exists, current detector I1 picks up and AND402 produces an output. If the Timer Bypass setting is set to YES, AND403 immediately produces an output to initiate tripping of the breaker. If the Timer Bypass setting is set to NO, then tripping occurs after the 45 ms pickup delay of timer TL403. Line Pickup is primarily intended to trip for closing into zero-voltage bolted faults where the distance functions connected to line-side potential will not operate. However, regardless of the I1 pickup setting, it can also be used to trip on any type of permanent fault along the

entire line length that produces voltage at the relay location that is sufficient to operate a Zone 2 distance function, but not enough to pickup the All Phase Voltages High signal. This is accomplished by routing Zone 2 phase-distance or ground-distance function outputs to AND401. The step distance backup timers are bypassed by the Line Pickup logic.

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

Timer TL403 is provided for those cases where simultaneous high-speed reclosing is employed at both ends of the line, and where the I1

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

Single Phase Close

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

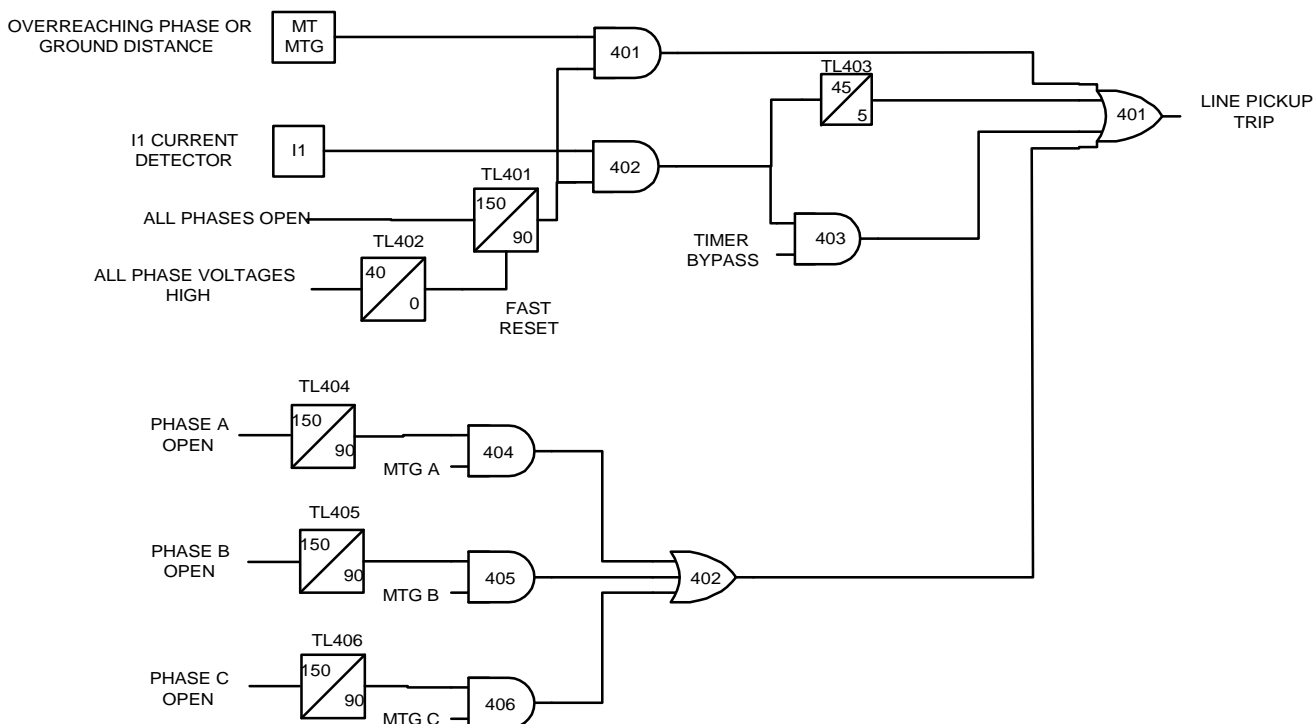


Figure 1-2 Line Pickup Logic Diagram (LPU)

Remote-Open Detector

The Remote-Open Detector (ROD) function issues a trip signal when the remote breaker opens during an unbalanced internal fault. This function detects that the remote breaker has opened by recognizing charging current on one or more phases following opening of the

remote breaker. As shown in the functional logic diagram of Figure 1-3, the ROD output trips via OR1, AND1, OR2, AND2, OR3, and AND4. The Remote-Open Detector will not operate when a balanced three-phase fault is present.

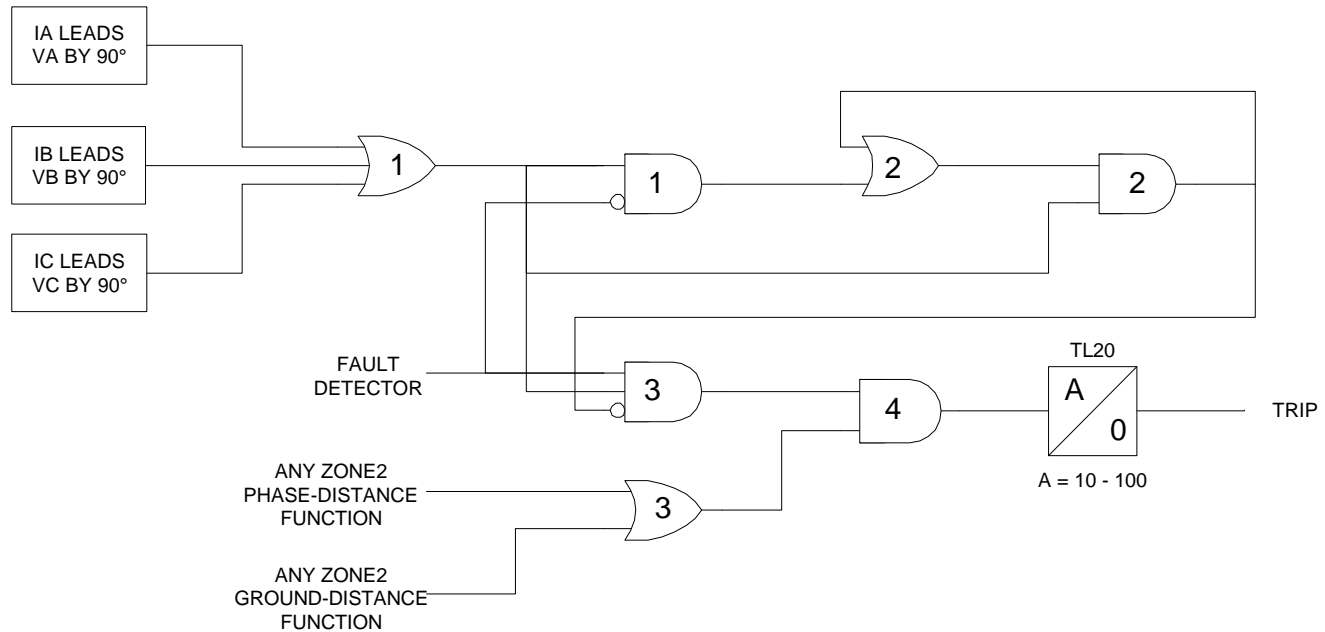


Figure 1-3 Remote open Detector Logic (ROD)

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

Figure 1-3 is a functional logic diagram of the ROD function. The sequence of events that results in an ROD output is as follows:

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

If charging current is initially detected but the fault detector (FD) is not picked up, indicating

no fault on the power system, then OR1 and AND1 produce outputs. AND2 produces an output and

seals itself in on the output of OR1 via OR2. AND3 is now blocked from producing an output as long as charging current is detected, regardless of whether FD is picked up or not. If a subsequent fault occurs and the remote breaker opens, ROD is prevented from producing an output.

If sufficient load current is flowing prior to the fault, there is no output from OR1, indicating that no charging current is detected, and

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

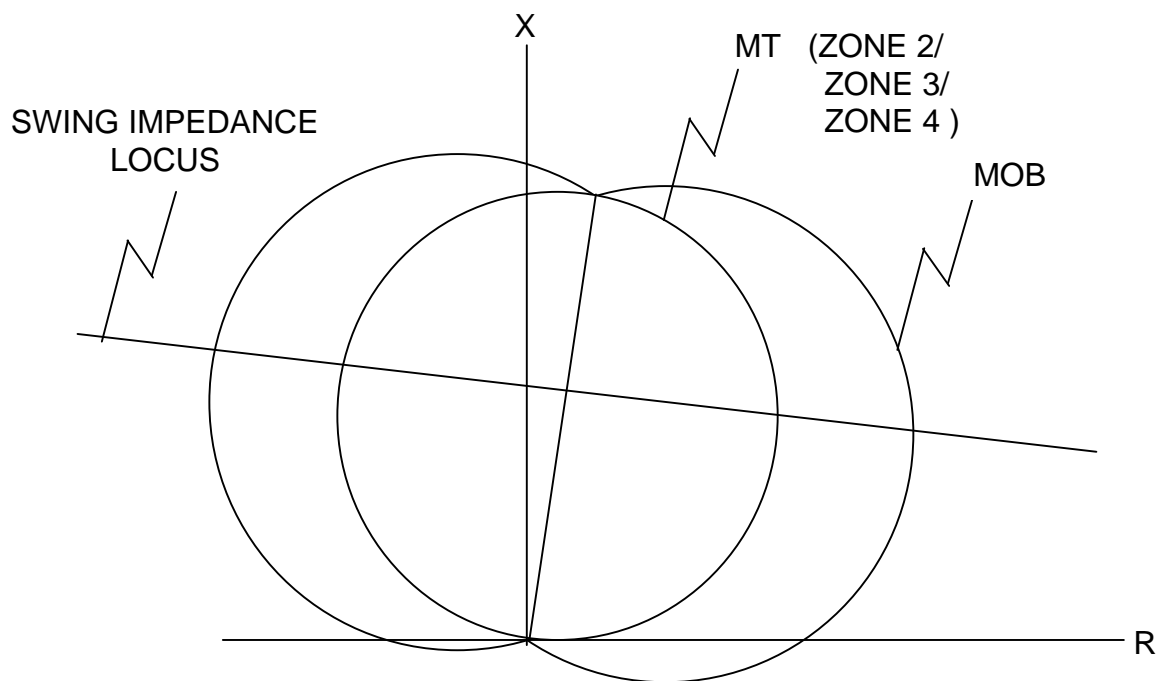


Figure 1-4 OSB R-X Diagram

Out-of-Step Blocking

Figures 1-4 and 1-5 contain the functional logic diagram of out-of-step blocking and an R-X diagram depicting an assumed swing-impedance locus superimposed on the associated distance relay characteristics. For an out-of-step condition, the impedance locus will first enter the MOB characteristic, then later

enter the MT (phase-distance trip function) characteristic.

When MOB (A-B) picks up during the power swing, it applies an input to AND202. The top input is present from OR201, since MT (A-B) has not operated yet. The bottom input of AND202 is satisfied, since it is assumed that no phase is open, and the AND202 output

energizes timer TL1. If the impedance stays between the MOB and MT characteristics for the pickup time of TL1, an OSB output results. The OSB output is routed back to the top input of AND201 via OR201 to seal-in the OSB output for as long as MOB is picked up. The OSB output resets 50 ms after the swing-impedance locus leaves the MOB characteristic. The same logic is repeated for the distance functions associated with phase pairs B-C and C-A, and all three phase-pair outputs energize TL1 via OR207. OSB is always routed to block reclosing. OSB can be selected to block tripping of:

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

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 via Settings 1604 through 1607 (BLOCKZ1, BLOCKZ2, BLOCKZ3, and BLOCKZ4).

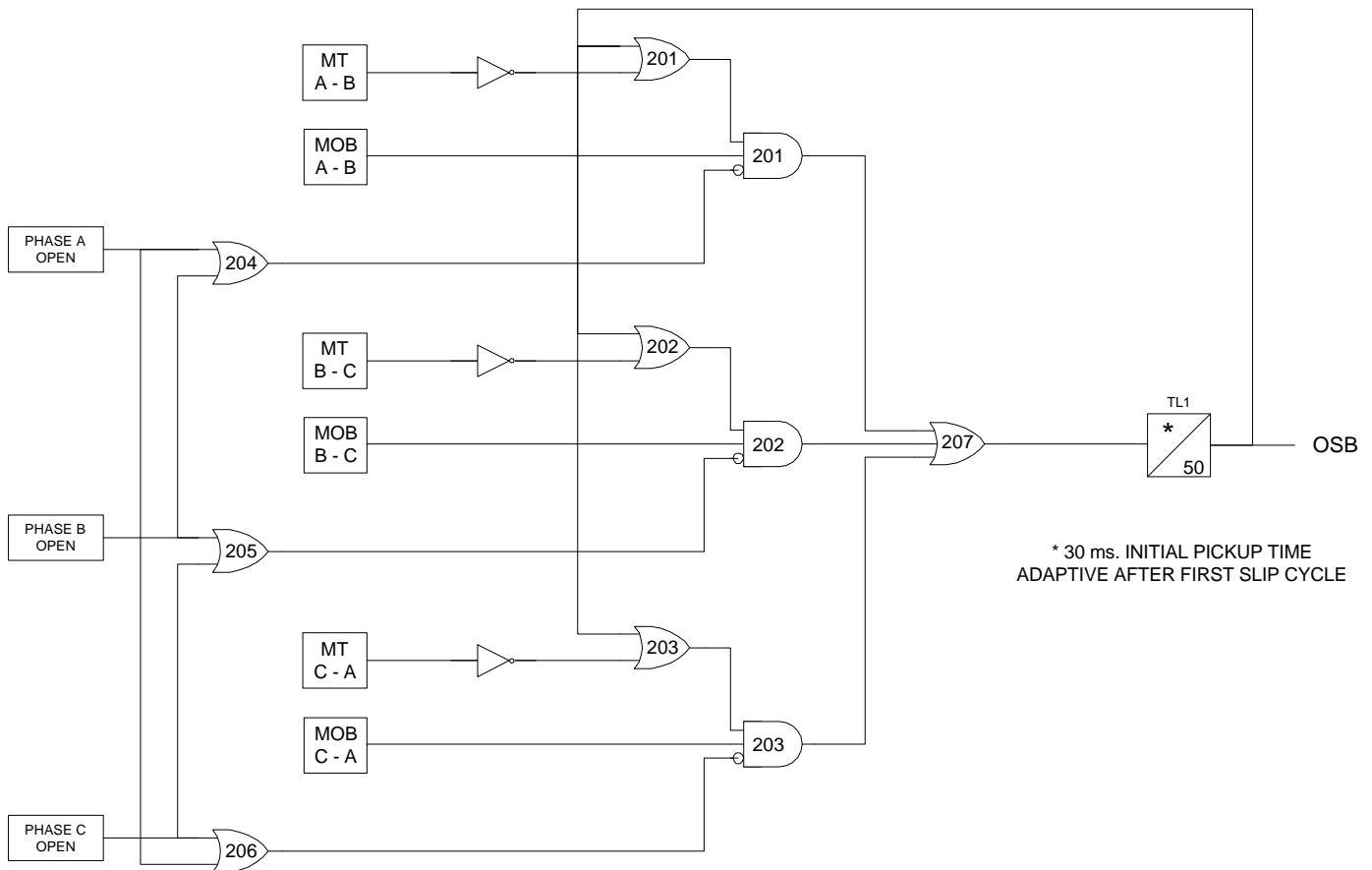


Figure 1-5 OSB Logic Diagram

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

Other Features

Flash Memory

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

Line Overload

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

Current Unbalance Detection

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

Fault Location

A separate algorithm provides fault-location information, which is presented as miles, kilometers, or percent of line from the relay

location to the fault. The distance to the fault is based on a line length provided by the user as a setting. Fault location output is displayed on the front panel liquid crystal display as part of the target information following a relay trip, and it is also contained in the Fault Report described below.

Fault Report

When a fault or oscillography trigger occurs, pertinent information, consisting of unit ID, date and time, operating time, prefault currents, fault currents and voltages, fault type, trip type, distance to fault, and selected events, is stored in memory. The number of fault events that are stored is selectable by the user. A relay with standard memory option may be set for: 2, 4, 8, or 12 fault reports. A relay with extended memory option may be set for: 6, 12, 24, or 36 fault reports. Each fault report is associated with an oscillography data file. See *Chapter 8 – Local User Interface* and *Chapter 11 - ALPS-LINK User's Guide* for a complete description of the Fault Report function.

Oscillography

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

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

If the ALPS issues a trip, then a normal fault report is stored as part of the oscillography data. If the ALPS does not issue a trip, a

pseudofault report is created. The trip type is listed as OSC, the trip time is set to when the OSC Trigger occurred, the operating time is set to zero, and the fault type and location are computed, based on post-OSC Trigger data. The local LCD display does not show target information, but an event message and fault report are stored in memory. In either case above, $t=0$ is determined by the internal Fault Detector, FD.

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

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

The ALPS does not store flags for functions that are disabled. For example, if Setting 104, Z1GROUND = NO and a Z1 ground fault is applied, the zone 1 ground flag will not operate or be stored.

Playback

The ALPS relay system has the ability to replay stored digital current and voltage signals from oscillography files through the protection algorithms. The currents and voltages may be obtained from a factory stored file, from any oscillography file currently stored in the relay, or from an oscillography file stored on a PC. See *Chapter 8 - Local User Interface* and *Chapter 11 - ALPS-LINK User's Guide* for a complete description of the Playback feature.

Sequence of Events

This function time tags and stores the last 150 events in memory. The resolution of the time-

tagging is 1 millisecond. The event list contains power system events, operator actions, and self-test alarms. The sequence of events can be accessed remotely via the front panel port, PL-1 or PL-2 and a PC. A full description of this function is contained in *Chapter 11 - ALPS-LINK User's Guide*.

Equipment Duty





When the ALPS is applied with a single breaker, the ALPS relay system incorporates the ability to monitor the number of breaker operations and the breaker duty. Alarm levels can be set for both the total number of breaker operations and the total equipment duty. See *Chapter 2 - Calculation of Settings*, *Chapter 8 - Local User Interface* and *Chapter 11 - ALPS-LINK User's Guide* for a complete description of the Equipment Duty feature.

Selectable Groups of Settings

Four separate groups of protection settings may be stored in nonvolatile memory. Only one group can be active at a given time, but the active group may be selected by external contacts, by a command issued from the local keypad, or remote \communication software. If the selection is to be made by an external switch, then two of the digital inputs (contact converters) are used for this purpose. A four position SB1 or SBM switch with two stages (two effective contacts) could be used to select the active group of settings, as shown in Figure 1-11. **NOTE:** FOR THIS EXAMPLE, CC5 HAS BEEN ASSIGNED TO "CGST2" (CHANGE SETTING GROUP INPUT, BIT1), AND CC6 HAS BEEN ASSIGNED TO "CGST1" (CHANGE SETTING GROUP INPUT, BIT0). OTHER CONTACT CONVERTERS MAY BE ASSIGNED TO THESE FUNCTIONS.

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								

SG
G1
G4 o G2
G3

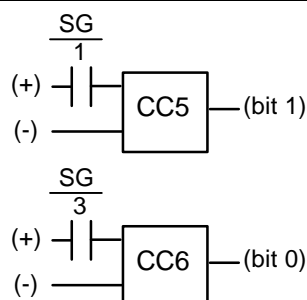


Figure 1-6 Switch selection of active setting group

Time Synchronization

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

Trip Bus Check

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

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

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

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

Trip Circuit Monitor

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

There are four trip contacts (or SCRs) in the ALPS. The voltage across each contact (or SCR) is monitored separately. Any combination of trip circuits may be monitored by Setting Number 107, NUM_MON.

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

Alarms

Two separate alarms are provided. The output relays associated with these alarms are not user programmable. Both of these alarms have

form C contacts and are energized under normal conditions.

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

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

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

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

Metering

Metering values may be obtained by using the keypad, or through remote communications. The following quantities are available: RMS voltage and current, phasor voltage and current, Watts, Vars, Power Factor, system frequency, and Breaker health. The voltage and current values are accurate to 1% of reading. Refer to *chapter 8 - Local User Interface* for a description on how to use the metering function.

Breaker Control

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

- Trip Breaker 1 and Trip Breaker 2 use the same output contacts or SCRs as a fault trip command.
- Close Breaker 1 and Close Breaker 2 use separate auxiliary relays. The contact of

each auxiliary relay must be wired to the appropriate breaker's close circuit.

Remote breaker tripping and closing are enabled or disabled with a jumper on the PROCESSOR module, as shown in Figure 3-15. The DLP is shipped from the factory with this jumper removed and Breaker Control enabled. Install the jumper to disable Remote Breaker Control.

Communications

Keypad and Display

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

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

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

Refer to *Chapter 8 - Local User Interface* for a description of the keypad password usage.

Serial Communications

Two serial communications ports are standard, and a third is optional. A DB-9 plug RS232 port (Port 1) located on the front panel of the unit provides local serial communication with the ALPS via an IBM PC-compatible computer. One or two rear ports are provided for serial communications is either RS232 or RS485. Port 2 is standard on all ALPS models. When PORT 2 is configured as an RS232 port, connection is made using a DB25 plug; when Port 2 is configured as an RS485, connection is made using a 4 pin Phoenix plug. Port 3 is

optional and uses a DB25 plug for either RS232 or RS485. The communications protocol for each port may be selected independently as either GE-Modem or ASCII. Each port may be set independently for data communications from 300 to 9600 bps. In addition, Port 3 has the ability to accept a plug in communication module that can support other communications protocols.

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

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

Refer to *Chapter 11- ALPS-LINK User's Guide* for a description of ALPS-LINK and ASCII port password usage.

SCADA Digital to Analog (DTA) Interface

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

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

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

The DTA provides either a nominal 0 to 1 ma dc output or a nominal 0 to 5 Vdc output. The choice of output ranges is made by a switch located on the Processor Board. The Processor Board must be removed from the ALPS chassis

to access this switch. For the proper sequence, see *Chapter 9 - Servicing*.

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

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

Fault phase identification dry contacts for A, B, C and N phases must be programmed by the user. Refer to *Chapter 3 - Hardware Description* for details.

Self Test Features

Start-Up Self Tests

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

Both processors participate in the start-up self-testing. The processors communicate their results to each other so that any failures can be reported and so that each processor successfully

completes its assigned self-tests before the ALPS begins protection activity.

During power-up, both microprocessors perform start-up self-tests on its associated hardware (including Flash Memory, EPROM, local RAM, shared RAM, interrupt controller, timer chip, serial I/O ports, nonvolatile memory, analog and digital I/O circuitry, and Keypad/LCD Display hardware). In addition, the ALPS verifies that the PROM version numbers on both processor boards are compatible, and that the Model Number stored in nonvolatile memory agrees with the unit's configuration. The components tested at start-up are listed in *Table 9-1*.

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

If no failures are detected, the ALPS completes initialization of its hardware and software; this includes reading information from the serial Nonvolatile RAM (NVRAM) in the magnetic module, stored during the manufacturing process, to determine the current rating of the magnetic in the unit (1 A or 5 A). Next, the 960 processor enables the outputs. As the final step, the ALPS checks the results of all the tests to determine whether to turn on the green status LED on the front panel.

The start-up procedure takes approximately one minute. As soon as the 960 CPU successfully completes its PROM test and initializes the display hardware, the message INITIALIZING appears on the display. When all ALPS initialization is completed satisfactorily, the ALSP message is displayed and the ALPS begins acquiring and processing data.

Run-Time Self Tests

Both of the processors have idle time when the ALPS is not performing fault or post-fault processing. During this idle time, each processor performs background self-tests that

do not interfere with the foreground tasks' use of serial and parallel ports and that do not inhibit interrupts to any processor. If any background self-test fails, the test is repeated. For a component to be declared as failed, the test must fail three consecutive times. In the case of most critical failures, the ALPS forces a reset to attempt to get the failed component working again.

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

A reset is not reported by the ALPS . If the reset is successful no failure status is recorded, and the critical alarm output is not energized; however, during the reset procedure, the red LED on the front panel is lit and a failure code may appear on the display. Therefore, if the reset is not successful, the processor board is shut down, leaving the Keypad/LCD Display displaying the error information. Refer to *Chapter 9 Table 9-5. Failure Messages*.

To prevent continual resets in the case of a solid failure, both hardware and software permit only four resets in a one-hour period. On the fifth reset, the ALPS does not initialize, but attempts to initialize the display, communications, and the critical-alarm output, as in the case of a start-up with a critical self-test failure. The reset procedure takes approximately one second, depending upon which start-up self-tests are to be run.

The components tested in the background are listed in the *Table 9-2*. Testing of I/O hardware is done in the foreground, so that the processors know when a given component or port is in use and therefore not available for testing. The components tested in the foreground are listed in the *Table 9-3*. Some

foreground tests are performed every sample period, while others are performed less frequently.

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

The operator may initiate a visual-response test of the KEYPAD/LCD DISPLAY components. Refer to *Chapter 4 – Acceptance/Periodic Tests* for details.

Continuous Monitor

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

These Continuous Monitor Alarm points can be found in the Index list found in *Chapter 2 - Calculation of settings*. The Index numbers used for the Continuous Monitor are: 48-Trip Circuit alarm, 49 ZONE flags on alarm, 50-Overcurrent Alarm, and 51-Unbalanced Current Detector alarm. They are assigned in the default settings as inputs to the non-critical alarm. These flags may also be used in configurable logic, or assigned to other alarm contacts if required.

Protection Scheme Descriptions

The six standard protection schemes are described in this section. Functional logic diagrams, Figures 1–7 through 1–15, show the scheme logic for the protection schemes using conventional AND/OR combinational logic. The elementary diagram in Figure 1–19 shows the external connections to the ALPS relay

system. Note that all of the output relays and input contact converters included in the ALPS are fully programmable by the user. However, for ease of application, the ALPS relay is shipped with the inputs and outputs assigned as shown in Figure 1-20. The programmability of the ALPS is discussed in *Chapter 13 - Configurable Logic Design Software (Xpression Builder)*. Figure 1–21 defines the symbols used in Figures 1-1 through 1–15. Figures 1–11, 1–13, and 1–14 show typical interconnections between the ALPS and an appropriate carrier/tone equipment for three pilot schemes:

- BLOCKING with CS28A (Figure 1–11)
- POTT with NS40A (Figure 1–13)
- HYBRID with Unblocking CS61C (Figure 1–14)

Step Distance

Figure 1–7 is the logic diagram for the Step Distance scheme. Since this nonpilot scheme overlays the other protection schemes in the ALPS, it is in essence a part of all of them. The Zone 1 distance functions are set to reach no greater than 90% of the positive-sequence impedance of the protected line. All of the ground-distance functions are provided with self-compensation so that they see only the positive-sequence impedance to a ground fault when the compensation setting is properly selected to reflect the difference between the zero-sequence and positive-sequence impedance of the line. This setting is explained in *Chapter 2 – Calculation of Settings*.

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

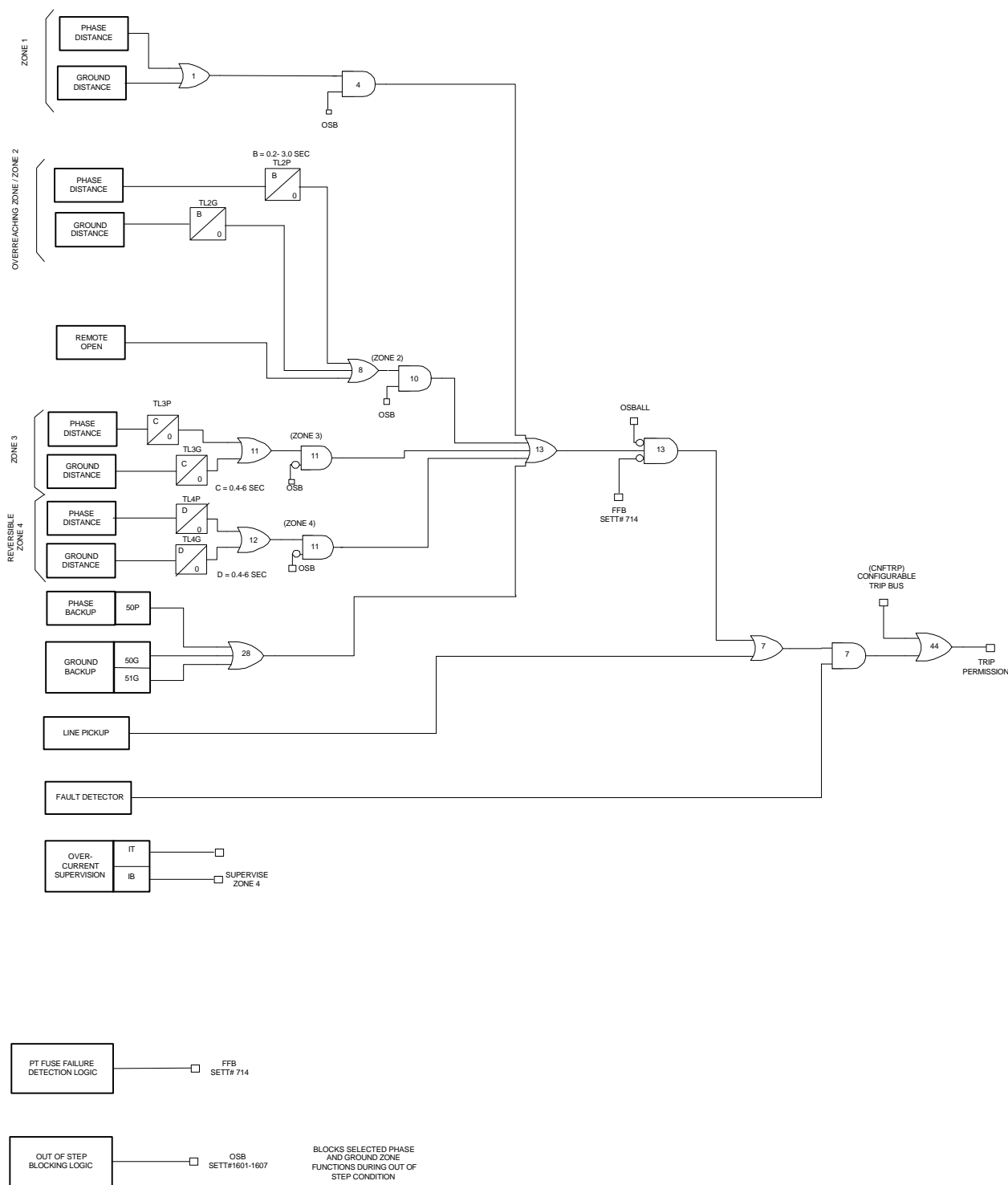


Figure 1-7 Step Distance Logic Diagram

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

Permissive Underreach Transfer Trip (PUTT)

Figure 1–8 is the logic diagram for the PUTT scheme. A PUTT scheme requires Zone 1 functions as well as overreaching zone functions. Zone 1 trips directly via OR1, AND4, OR25, OR3, OR4, AND3, OR13, AND13, OR35, and AND35 and keys the transmitter to the trip frequency via OR5. Tripping for internal faults not seen by the Zone 1 functions occurs when an overreaching function operates and the receiver(s) produce an output, satisfying the input conditions of the comparer, AND1.

The considerations for receiver connections for a three-terminal line application and 52/b contact keying of the transmitter with one end open are different from those described above under the POTT scheme. As with a POTT scheme, a PUTT three-terminal line application requires two receivers and one transmitter at each terminal, with each frequency-shift transmitter operating at a different frequency. However, the two receivers are ORed together at OR16, rather than ANDed together as with a POTT scheme. This is necessary since the Zone 1 functions at only one end of the three-terminal line may respond for an internal fault.

For a three-terminal PUTT application, do not use 52/b contact keying of the transmitter. Because the two receivers are ORed together, a continuous trip signal sent from the open end, when only one end is open, results in over-tripping for external faults within the reach of the pilot overreaching functions. Unfortunately, this means a portion of the line is not protected by the pilot scheme. In the ALPS, 52/b contact keying of the transmitter is automatically prevented if SELSCM = 2 [PUTT]

and NUMRCVR = 2 [2 RCVRs], as indicated in Figure 1–8 by the link between AND5 and OR5. 52/b contact keying of the transmitter should be used for a two-terminal PUTT application.

Permissive Overreach Transfer Trip (POTT1)

Figure 1–9 is the logic diagram for the POTT1 scheme. The POTT1 scheme requires receipt of a tripping signal from the remote end(s) to permit tripping at the local end. The channel equipment is generally a frequency-shift (FSK) type. When a power-line carrier channel is used, it is possible that an internal fault may attenuate the carrier signal sufficiently to preclude receipt of the trip signal. For such cases, an unblocking channel that provides a time window of trip permission for an attenuated signal caused by an internal fault should be considered.

For any multiphase fault on the protected line, one or more of the overreaching zone variable-mho functions operates at each terminal of the line and applies one of the inputs to the comparer, AND1, via OR2 and TL4. The output from OR2 also keys the transmitter to the trip frequency via OR5. The receiver produces a trip output at each terminal of a two-terminal line. This received permissive trip signal is supplied to the relay logic via one of the contact converters (CC1, As Shipped). Assuming that the out-of-step blocking function has not operated, an AND1 output is present, resulting in a trip output via OR3, TL1, OR4, AND3, OR13, AND13, OR35, and AND35.

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

Timer TL1 allows the relay to ride through spurious outputs that might be produced from the channel during external faults within the reach of the overreaching trip functions. Timer

TL4, in conjunction with timer TL1, prevents a possible misoperation when a fault-current reversal occurs as a result of sequential clearing of a fault on a parallel line. Note that tripping is supervised by the Fault Detector at AND35, thus confirming that tripping occurs only after a fault on the power system.

The above description assumes a two-terminal line. When a POTT1 scheme is applied on a three-terminal line, each terminal has two receivers and one transmitter, with each frequency-shift transmitter operating at a different frequency. Now the trip signal must be received from each of the two remote terminals, as indicated by an output from AND2.

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

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

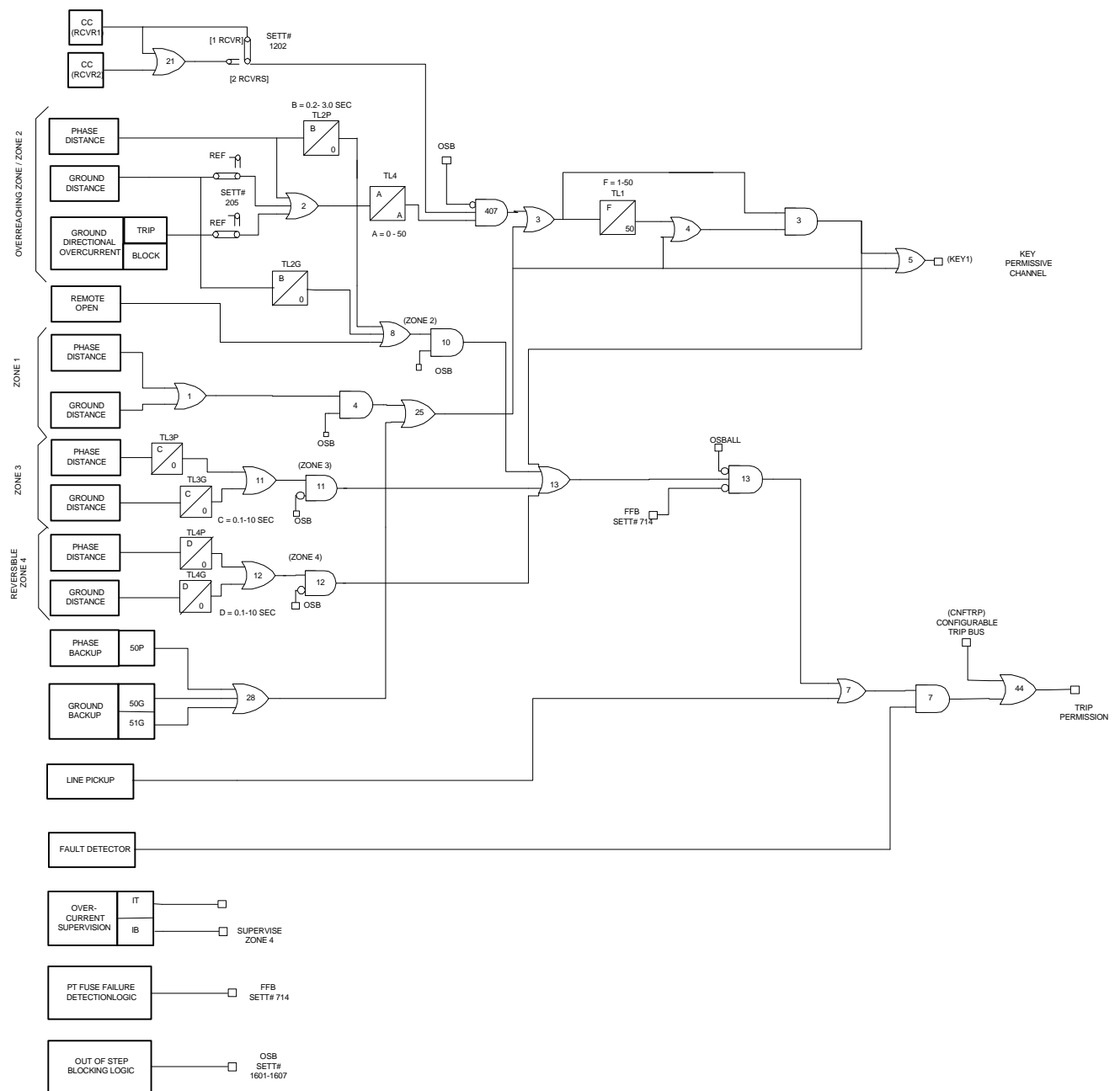


Figure 1-8 Permissive Underreaching Transfer Tripping Logic Diagram (PUTT)

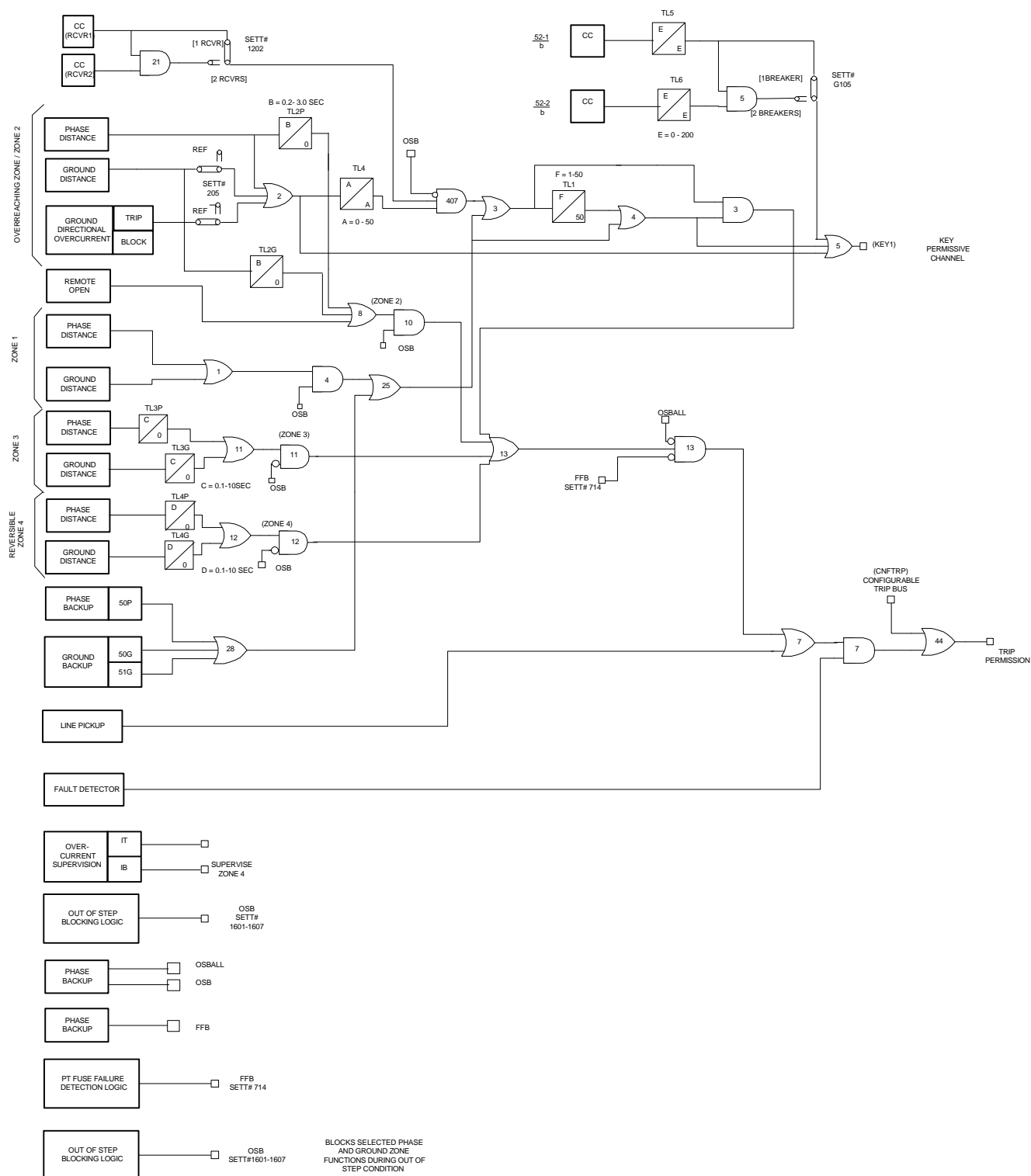


Figure 1-9 Permissive Overreaching Transfer Trip (POTT1)

Permissive Overreach Transfer Trip with Blocking Functions (POTT2)

Figure 1-10 is the logic diagram for the POTT2 scheme. The POTT2 scheme performs exactly the same as the POTT1 scheme for all internal faults. In the POTT2 scheme, the Zone 4 distance functions are set as reverse looking blocking units. The Zone 4 distance functions provide transient blocking for when a fault-current reversal occurs as a result of sequential clearing of a fault on a parallel line. This logic is the same as that used in the Hybrid scheme.

Directional Comparison Blocking Scheme

Figure 1-12 is the logic diagram for the Directional Comparison Blocking scheme. Since a reverse-looking blocking function is required in these schemes, the Zone 4 distance functions are automatically set for reversed reach when the Blocking scheme is selected. As far as channel operation is concerned, a blocking scheme has opposite sense from a PUTT, POTT or Hybrid scheme.

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

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

The ALPS Blocking scheme has provision for different logics to start the carrier for ground faults. The carrier starting option is

determined by setting number 1204, CARRSTART, and setting number 505, IPBKFACTOR. CARRSTART may be set to DIR, IPB, or FD. The DIR option uses the IPB function ANDed with the NB function to start carrier in the GDOC or MGDOC schemes. The IPB option uses the IPB overcurrent detector without NB supervision as a non-directional carrier start function. The FD option uses the fault detector (FD) without NB supervision as a non-directional carrier start function. In the DIR and IPB options, the IPB function may be selected to operate on the zero sequence current without positive sequence current restraint IPBKFACTOR=0.0, or to operate on zero sequence current with positive sequence current restraint, IPBKFACTOR=0.066.

The IPB option uses the IPB overcurrent detector without NB supervision as a non-directional carrier start function. The FD option uses the fault detector (FD) without NB supervision as a 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.

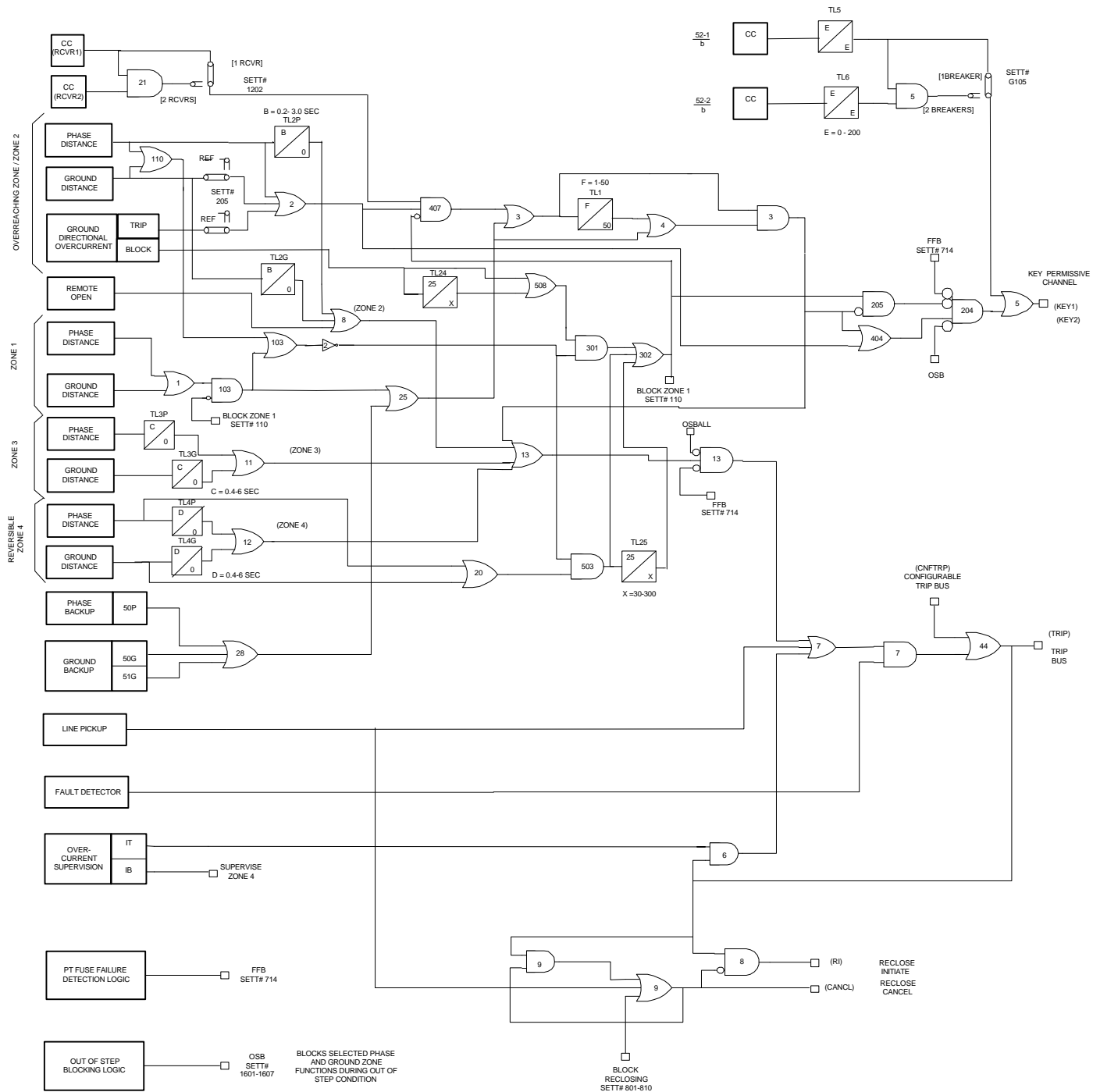


Figure 1-10 POTT with Blocking Functions Logic Diagram (POTT2)

For any multiphase fault on the protected line, one or more of the overreaching zone variable-mho functions operates at each end of the line and applies one of the inputs to the comparator AND407 via OR2. An output from OR110

inhibits the blocking functions at AND503 via OR103 and NOT2, and any carrier that may have been started is stopped via OR2, AND209, and OR213. Consequently, the carrier is stopped or is not started at any terminal of the

line; there is no receiver output and no blocking input applied to comparer AND407 via CC1 and NOT3.

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

The ALPS Blocking scheme has provision for different logics to start the carrier for ground faults. The carrier starting option is determined by setting number 1204, CARRSTART, and setting number 505, IPBKFACTOR. CARRSTART may be set to DIR, IPB, or FD. The DIR option uses the IPB function ANDed with the NB function to start carrier in the GDOC or MGDOC schemes.

The IPB option uses the IPB overcurrent detector without NB supervision as a non-directional carrier start function. The FD option uses the fault detector (FD) without NB supervision as a Assuming that the out-of-step blocking function has not operated, AND407 produces an output to initiate tripping following the coordination time-delay pickup set on timer TL1. The coordinating time is required to allow time for receiving a blocking signal from the remote terminal(s) to prevent misoperation on external faults. The required setting is described in *Chapter 2 – Calculation of Settings*. Note that tripping, as in all the schemes, is supervised by the Fault Detector at AND35, thus confirming that a trip only occurs when a disturbance is present on the power system.

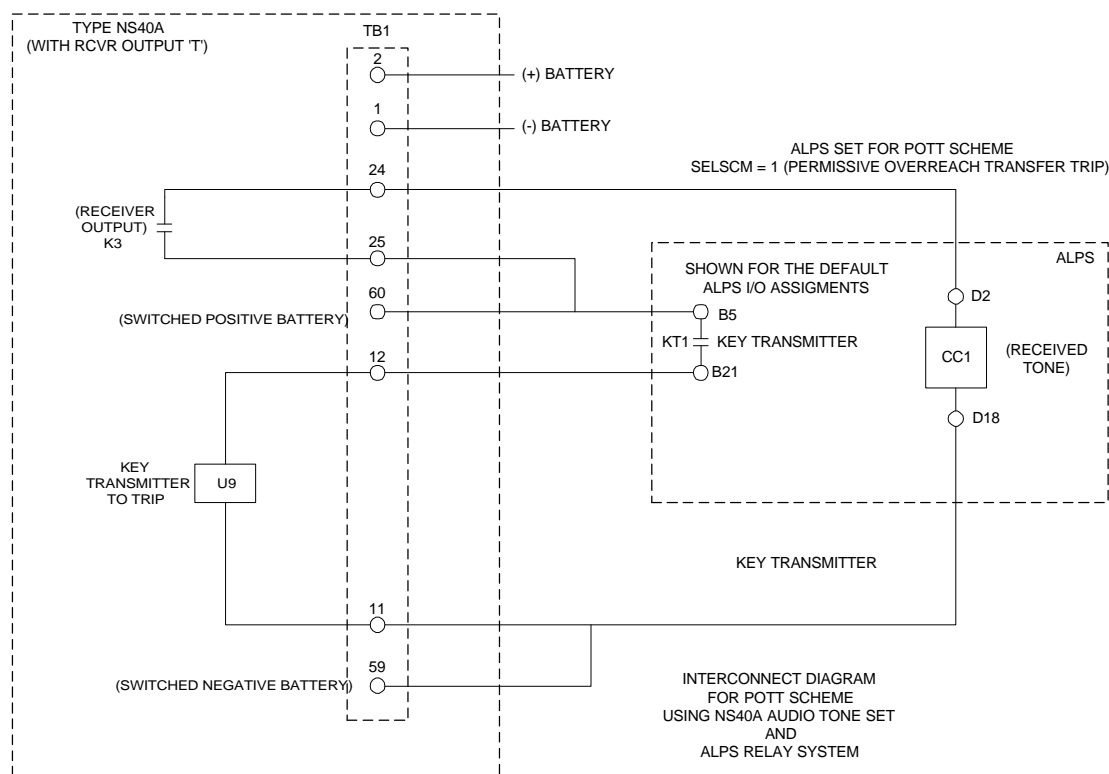


Figure 1-11 Interconnection Diagram for PUTT/POTT with NS40A

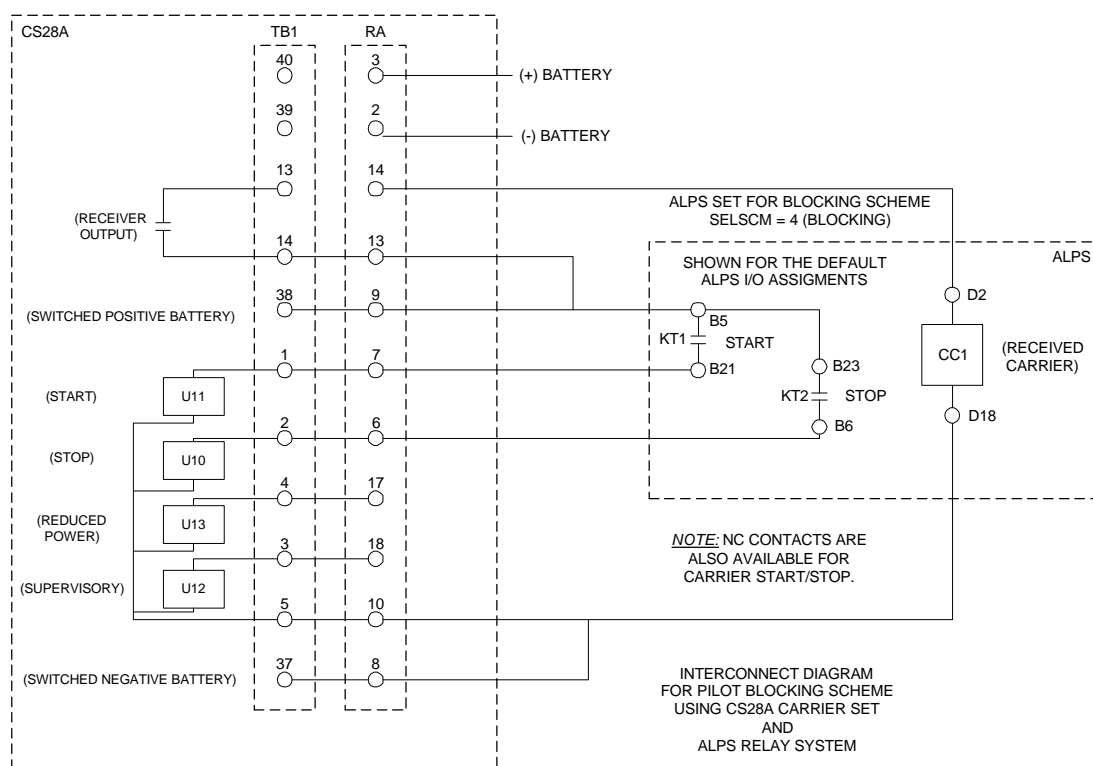


Figure 1-13 Interconnection Diagram for Blocking Scheme with CS28A

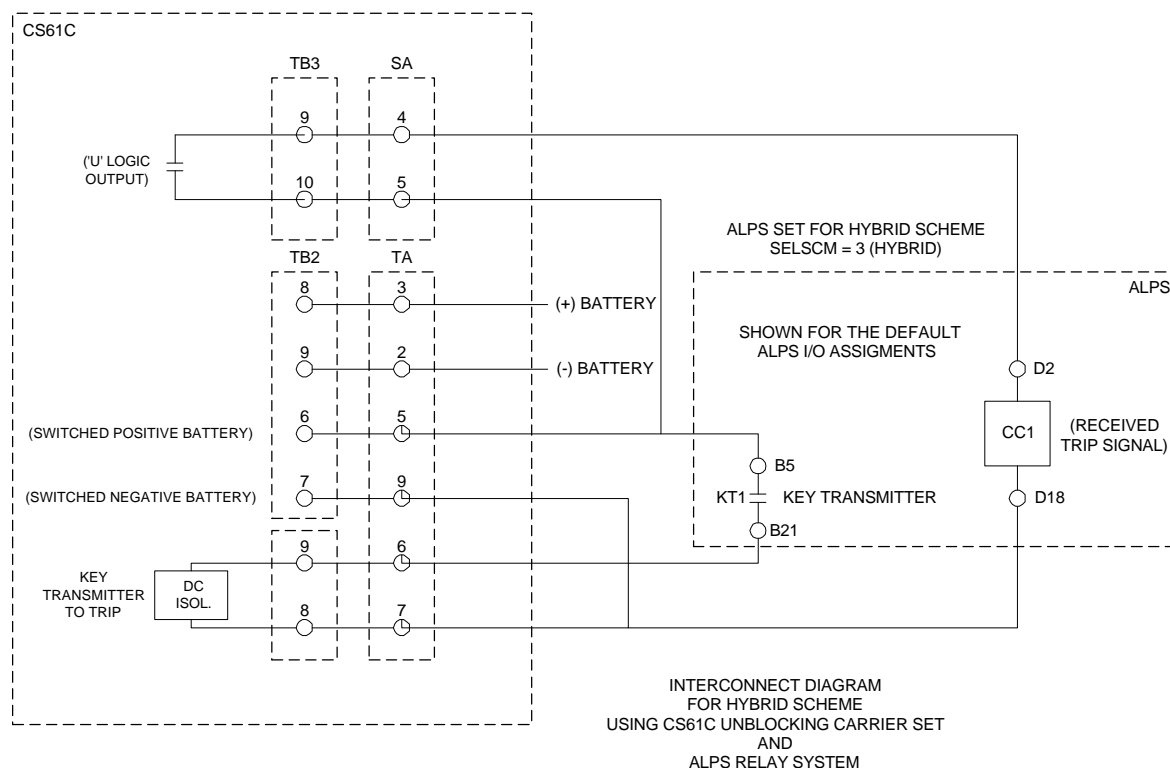


Figure 1-14 Interconnection Diagram for Blocking Scheme with CS61C

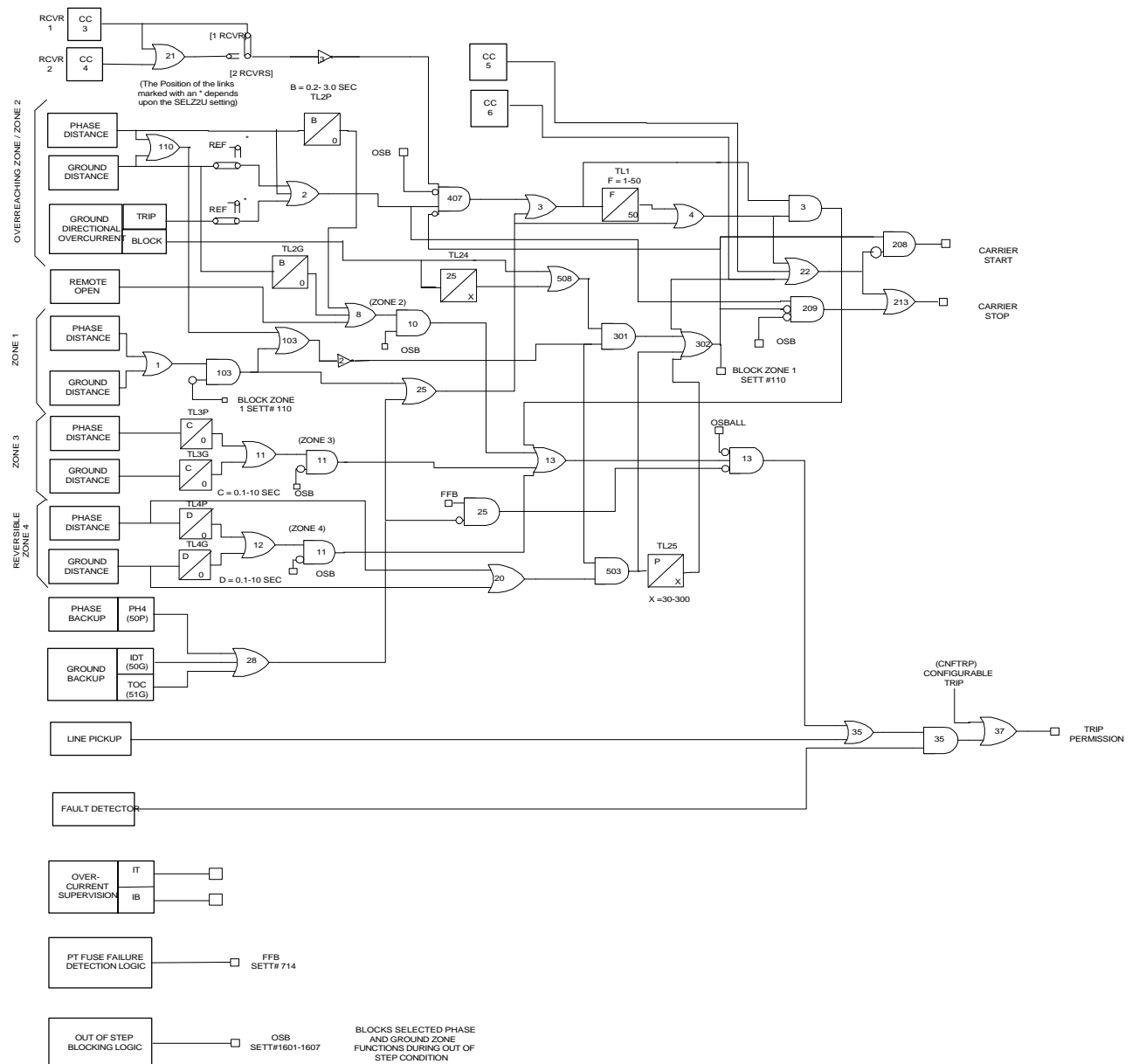


Figure 1-12 Blocking Scheme Logic Diagram

For remote external faults within the reach of the local overreaching zone tripping functions, one of the remote blocking functions operates to key the transmitter ON, sending a blocking signal to the local end. The receiver output is supplied to the ALPS via one of the contact converter inputs. The default, or As Shipped, contact converter assigned to the Receiver is CC1. An input from the receiver blocks tripping at the local end by removing the upper input to AND407 via CC1 and NOT3. At the remote end, the output of the blocking

functions is applied to the lower NOT input of AND407 to block tripping there. This lower NOT input to AND407 forms part of the transient blocking logic that blocks tripping when clearing external faults or during current reversals that occur when clearing faults on a parallel line.

The ground-directional overcurrent (GDOC) transient blocking logic consists of TL24, OR508, AND301, and OR302. After an external fault, the GDOC blocking function starts the

carrier and applies a blocking input to the comparer. If the external fault persists for 25 ms, TL24 produces an output. At this point the GDOC blocking function is set up with an extended dropout time so that the carrier is maintained and tripping is blocked at the comparer for at least 30 ms following the clearing of the external fault.

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

In a typical application with ON-OFF carrier sets, only one receiver is used at each terminal of the line, regardless of the number of line terminals. The contact converter (RCVR 1 in Figure 1-12) converts the receiver output into a blocking signal usable by the ALPS.

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

External contacts may be used to supervise the relay-channel interface. The EXTERNAL

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

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

Hybrid Scheme

Figure 1-15 is the logic diagram for the Hybrid scheme. A Hybrid scheme combines aspects of a tripping scheme with aspects of a blocking scheme, but it is perhaps easiest to explain as an enhanced POTT scheme.

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

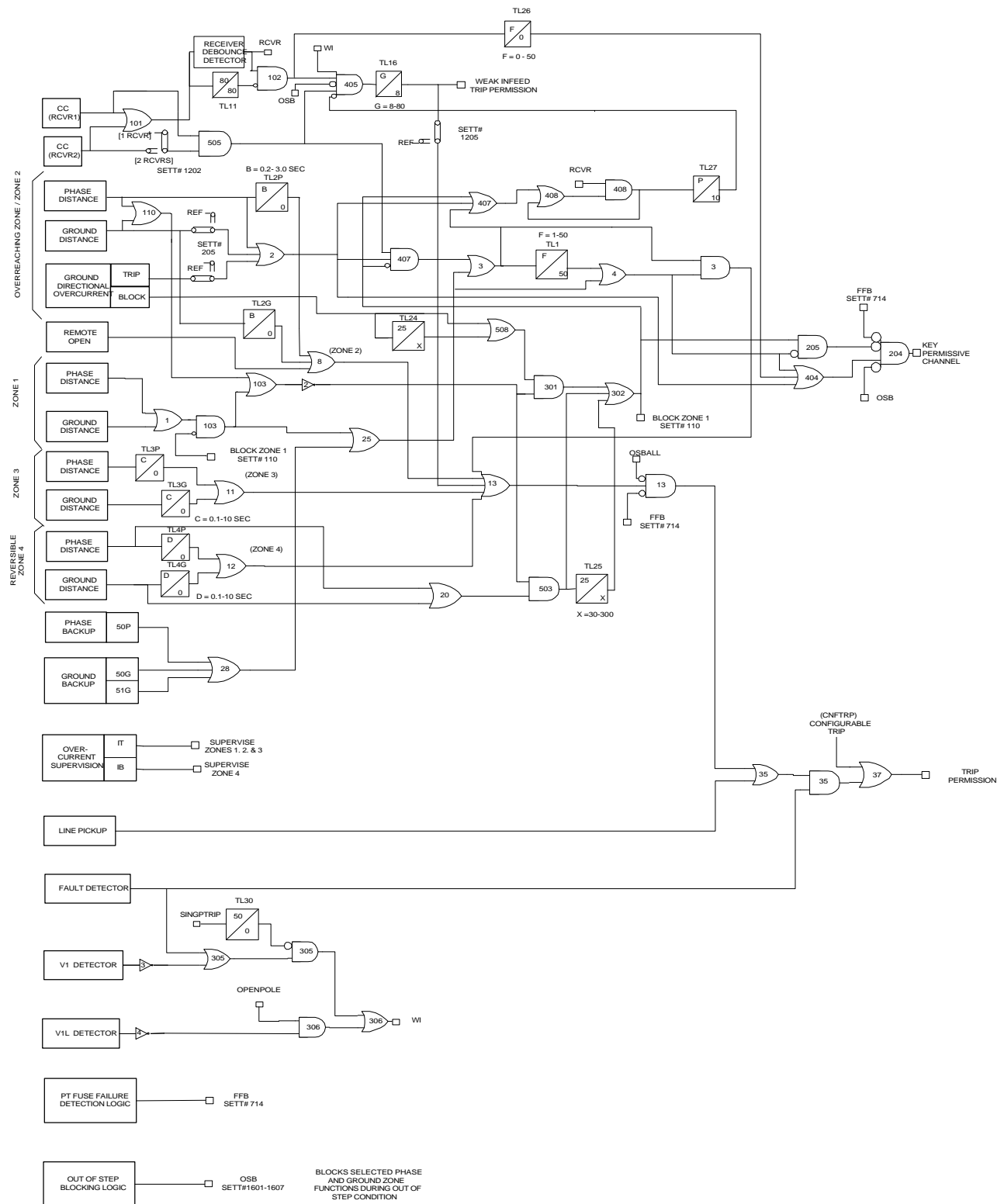


Figure 1-15 Hybrid Logic Diagram

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

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

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

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 for HYBRID.

The echo circuit plus OR305, OR306, AND305, AND306, TL17, AND405, and TL16 comprise the weak in-feed tripping circuit. For the same internal fault condition outlined in the previous paragraph, AND405 produces an output because of the following:

- The NOT input to AND405 is satisfied because there is no output from the blocking functions.
- There is an output from OR306, since either
 - FD has operated,
 - V1 has dropped out.
- The other two inputs to AND405 are satisfied, since a trip signal is being received and timer TL11 has not timed out yet.

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

Single-Phase Tripping

Phase Selection

The ALPS is designed such that, when it is used in a single phase tripping application, only the faulted phase will be tripped for a single line to ground fault, but all phases will be tripped for any multi-phase fault. In order to accomplish this goal, the ALPS relay includes a faulted phase determination algorithm. The faulted phase determination algorithm uses a combination of distance measuring functions and current only faulted phase selection algorithms to select the fault type. The output of this algorithm, along with other logic, is used to determine which trip outputs should be energized for each fault. The Trip Output logic for the ALPS relay is shown in Figure 1-16 for all logic scheme except the Hybrid; the trip Output logic for the Hybrid scheme is shown in Figure 1-17.

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

Open Pole Determination

The ALPS includes logic to detect when one or more poles of the circuit breaker is open. This logic is depicted in Figure 1-18. The logic uses a combination of current and voltage detectors and breaker auxiliary contacts. The breaker auxiliary contacts (52/b) are not required for

the relay to function correctly. The Open Pole logic detects when any pole is open, when only one pole is open, and when all three poles are open.

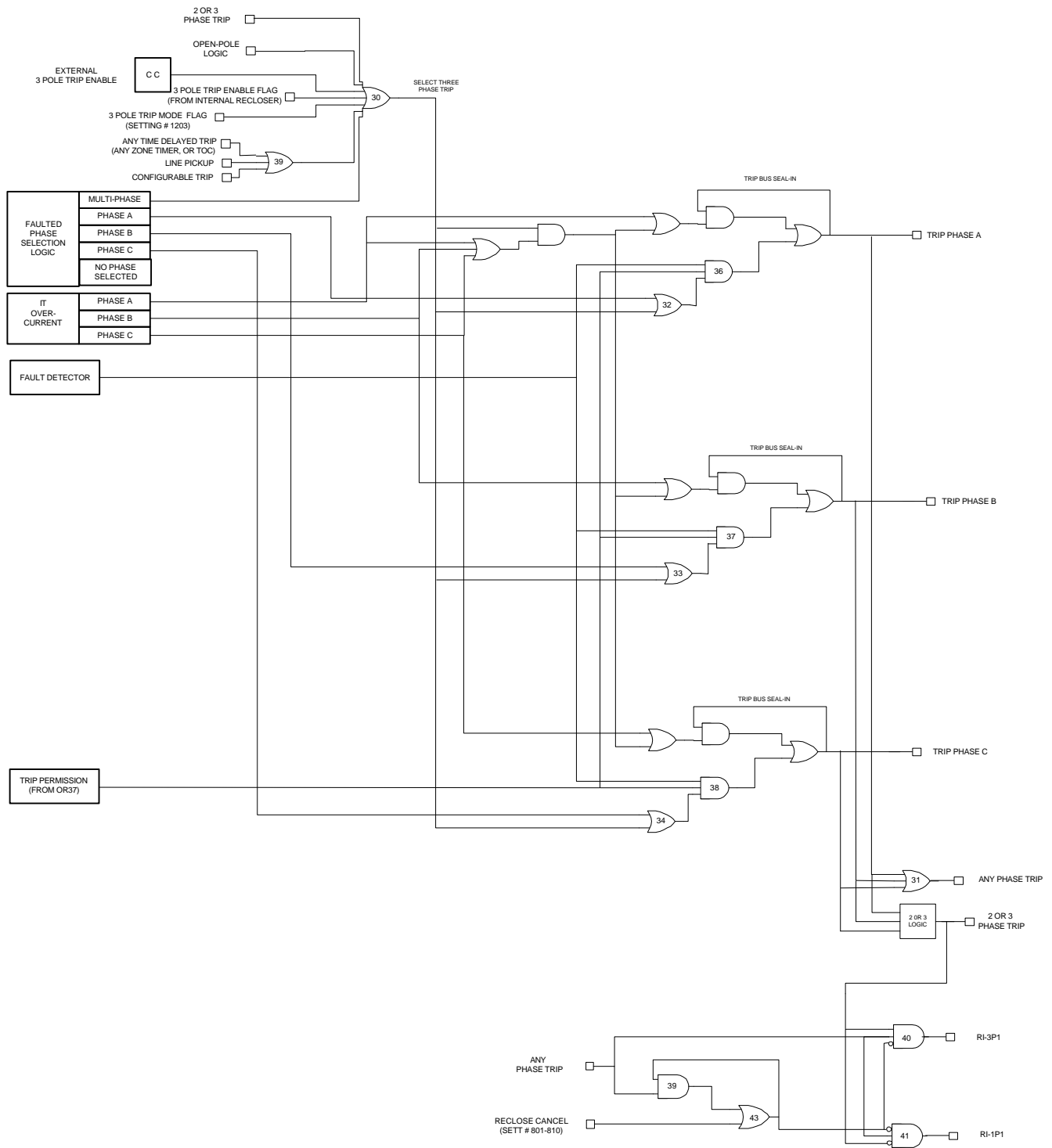


Figure 1-16 Tripping Logic - except for Hybrid Scheme

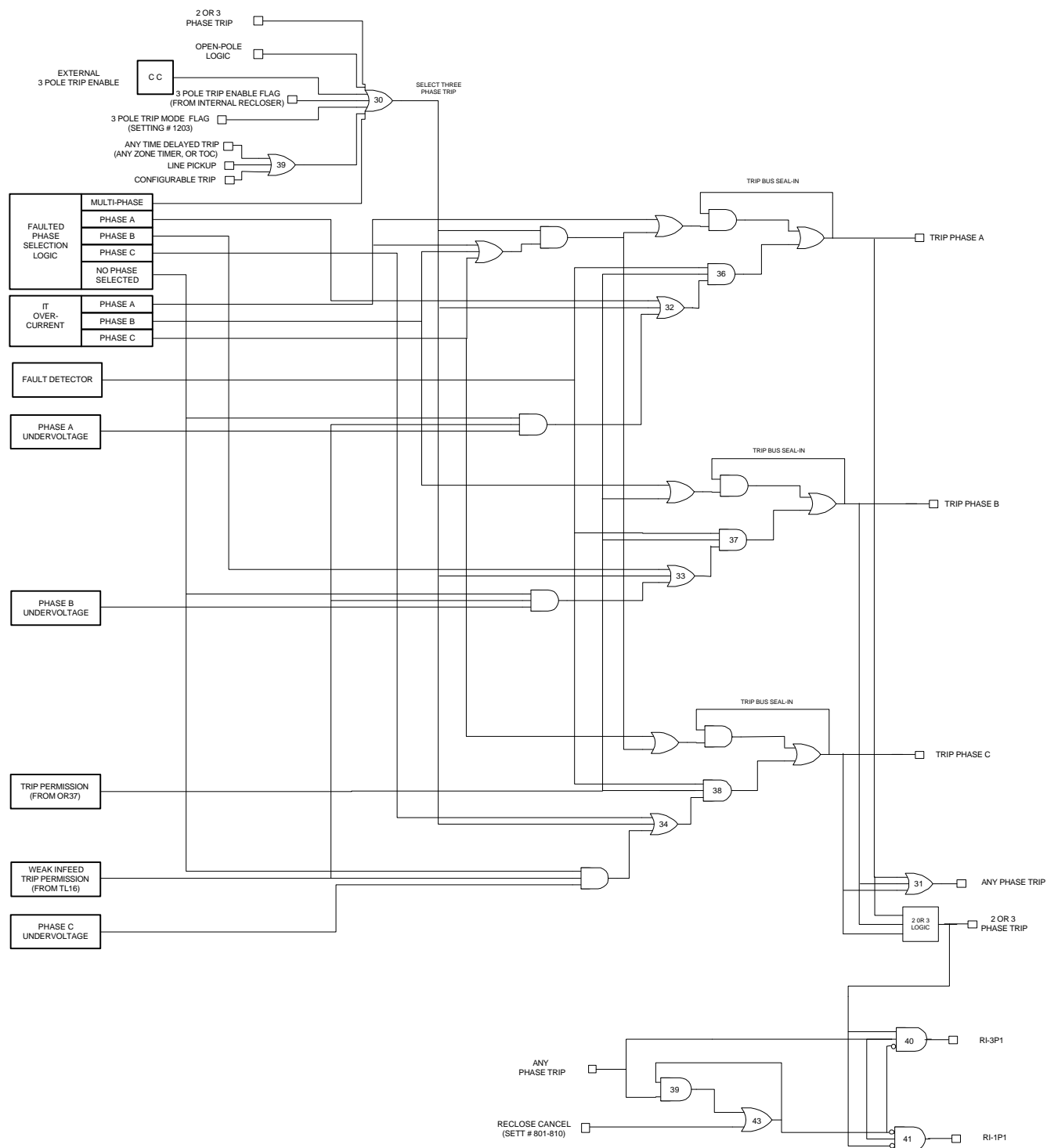


Figure 1-17 Tripping Logic for Hybrid Scheme

OUTPUT OF UV UNITS IS HIGH WHEN
VOLTAGE IS LOW

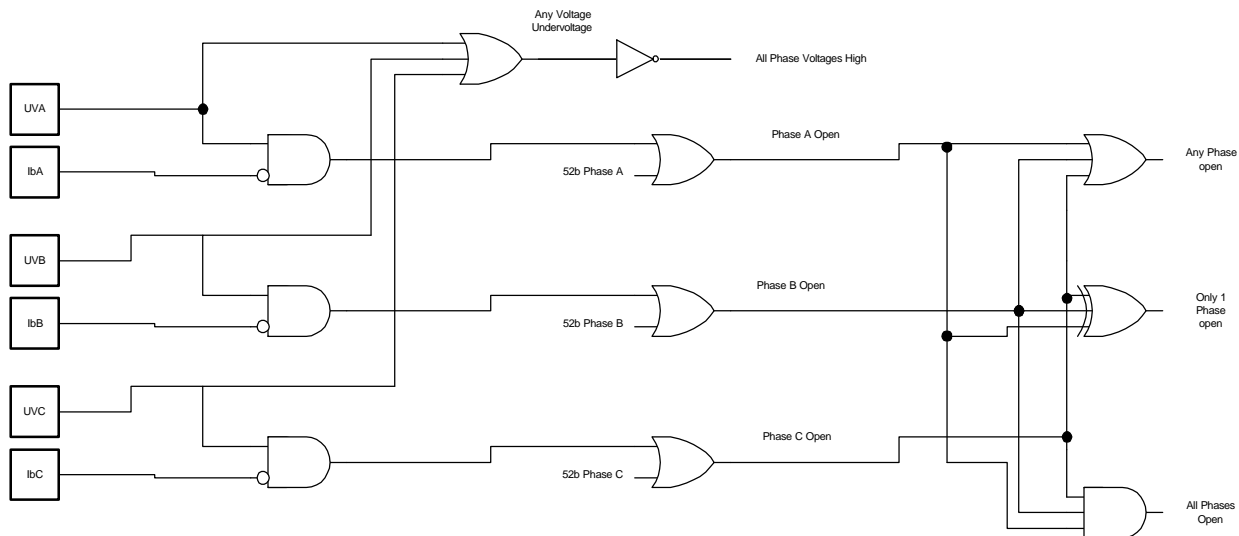


Figure 1-18 Open Pole Detection Logic

Open Pole Operation

The functional logic diagrams in Figures 1–1 through 1–5 do not depict all the logical interactions that occur in the software algorithms during the period that one pole is open. Two software flags and two associated masks control the operation during an open-pole period. The single-phase-trip flag, SINGPTRIP, is set when the ALPS issues a single-phase trip. The open-pole flag, OPENPOLE, is set when the pole-disagreement logic detects that one pole is open.

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

The OPENPOLE flag is shown on all the functional logic diagrams as one input to OR30. This indicates that once the OPENPOLE flag is set, any subsequent fault will cause a three-phase trip regardless of the fault type. The Fault Detector (FD) measurement is modified when the OPENPOLE flag is set. With all poles closed, FD operates on the magnitude of I2 and I0, as well as the change in I1, I2, and I0. When the OPENPOLE flag is set, FD operates on the change in the three sequence currents but does not operate on the magnitude of I2 and I0, since an open pole will produce some steady-state level of I2 and I0.

The Potential Transformer Fuse Failure Detection function (FFB on the logic diagrams). For a Hybrid scheme, the weak-infeed logic is modified as shown on Figure 1–5 and described above. The operation of the Out-of-Step Blocking logic is modified as explained below. If the ground directional overcurrent functions are used as part of a pilot scheme, they are disabled. The ground backup overcurrent functions, 50G and 51G, are disabled.

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

Reclose Control

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

As shown on Figures 1-19 and 1-20, the Reclose Initiation outputs of the ALPS may be blocked by the Reclose Cancel logic. The Reclose Cancel options are discussed in *Chapter 2 - Calculation of settings*

Out of Step Tripping (optional)

Description

The Out of Step Tripping (OST) option is a positive-sequence static distance relay designed to provide out-of-step tripping protection. It uses three modified mho characteristics, all with the same forward and reverse reach along a common maximum reach angle, but each having a different shape (such as lens, circle or tomato). It includes logic and time delay circuits that work with the modified-mho characteristics to detect an out-of-step condition.

The OST function does not have a dedicated output relay, nor does it automatically initiate tripping via the ALPS trip output relays. Rather, the output of the OST logic must be assigned by the user to an output relay, or to the configurable trip bus input (CNFTRP, Index # 122) if it is desired to trip the same circuit breaker as for a line fault.

Loss of synchronism or a power swing between two areas of a power system is detected by measuring the positive sequence impedance seen by the relay over a period of time as the power swing develops. Since the OST option measures positive sequence impedance as seen at the relay location, there is less chance of setting up blocking for non-swing conditions (such as close in single phase to ground faults on series compensated lines where gap flashing and capacitor reinsertion can cause the fault impedance to vary greatly) than there is for a relay that measures phase impedance.

The OST option includes three positive sequence offset mho distance relay characteristics. These characteristics have the same reach along a common angle of maximum reach, but have different reaches along the R axis. An out-of-step condition is detected by measuring the time it takes for the apparent impedance seen by the OST to travel from a load impedance value to a point along the protected line. A fault on the line will cause this impedance change to occur immediately and will not set up out-of-step tripping. For a swing condition the impedance will change slowly. If the impedance passes through the three characteristics in the proper sequence, an out-of-step trip output is produced.

The basic mode of operation is with all three characteristics (OUTER, MIDDLE, INNER). However, by setting number 1702, NUMBRCHAR, the MIDDLE characteristic can be bypassed, thereby using only the OUTER and INNER characteristics for out-of-step detection. The decision whether to use two or three characteristics depends largely on the maximum slip frequency expected during a swing condition. Three characteristics are preferred if the slip frequency is low enough to permit making the minimum recommended settings on TLOS1, TLOS2 and TLOS3. In some applications only two characteristics may be necessary, because the combination of a fast-moving swing locus (high-slip frequency) and a restricted OUTER characteristic (due to heavy

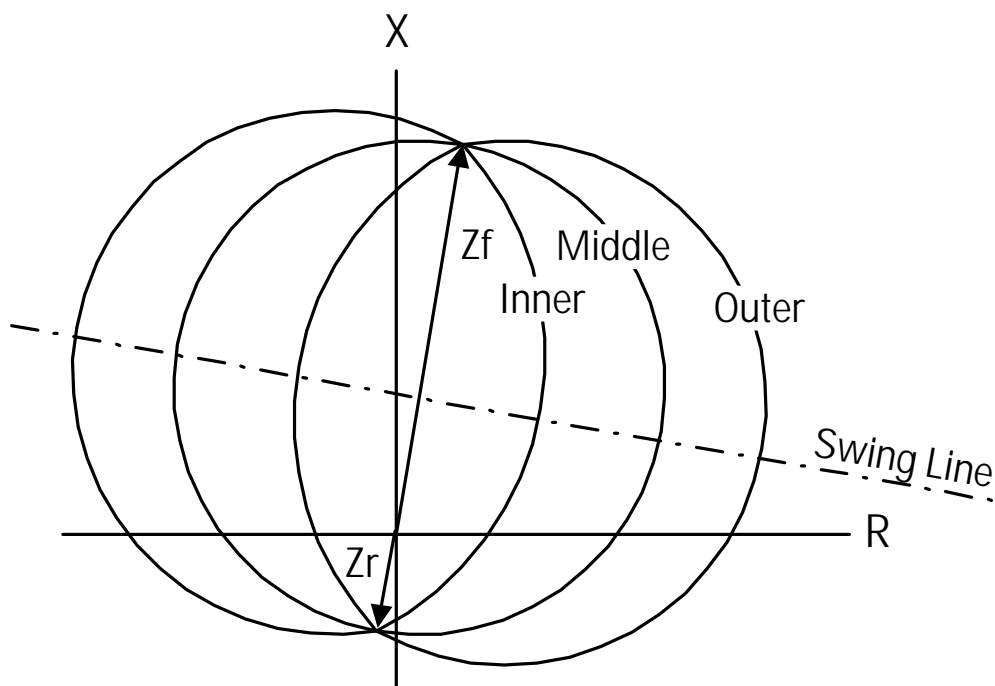


Figure 1-19 OST MHO Characteristic

load transfer) prevents setting up the proper logic sequence.

There is another setting option that provides a choice between tripping as soon as the out-of-step condition is confirmed; that is, on entering the INNER characteristic (Setting 1703, TRIPIN_OUT = IN) or delaying tripping until the two system voltages are more nearly in phase; that is, on leaving the OUTER characteristic (Setting 1703, TRIPIN_OUT = OUT). Some users prefer this delayed tripping to reduce the risk of damage to the circuit breaker that does the tripping.

OST Characteristic Shape

The shape of the offset mho characteristic may be expanded or restricted by changing

the characteristic timer setting. Figure 1-19 shows three mho characteristics used in the OST function. All three have the same forward and reverse reach along the maximum reach angle, but the OUTER characteristic is an expanded mho (tomato-shaped) while the INNER characteristic is a restricted mho (lens shaped). The angle of maximum reach of the three characteristics is determined by the positive sequence impedance angle of the protected line, Setting number 1401, POSSEQANG.

In Figure 1-19, the dotted line, SWING LOCUS, represents one possible path that would be followed by

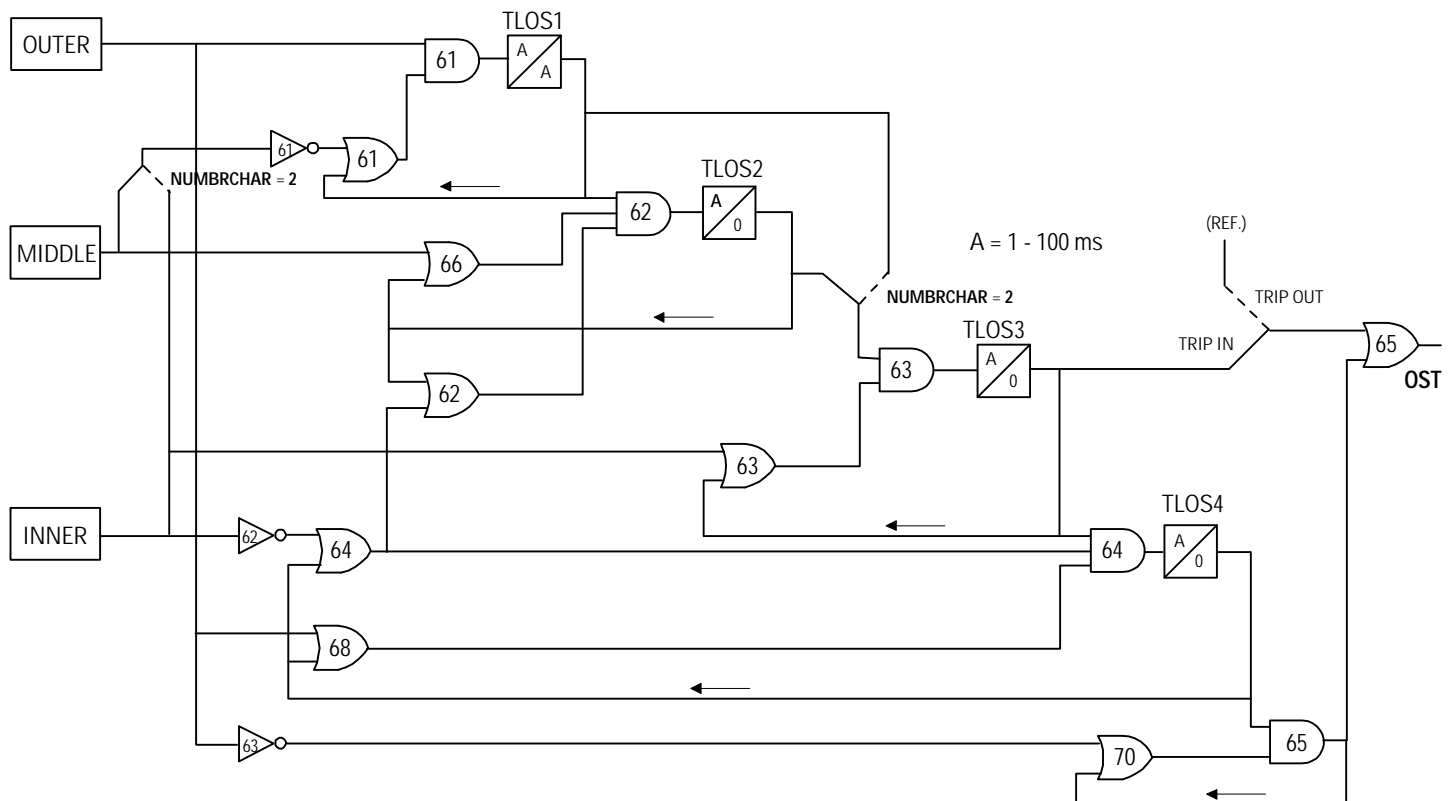


Figure 1-20 Out-of-Step Tripping Logic Diagram

the apparent impedance resulting from a swing, and it may travel either from left to right, or from right to left. Also, the SWING LOCUS may be above the location shown, depending on the relationship between the relay location and the electrical center of the power system.

The discrimination between a fault condition and a system swing is accomplished by checking the time that it takes for the apparent impedance to move from the load condition (far outside the OUTER characteristic) to a point within the INNER characteristic. This change occurs immediately for a fault condition, but occurs at a much slower rate for a swing.

Out-Of-Step Detection

The actual out-of-step detection in the OST option is accomplished by a software algorithm. This algorithm is represented by the logic diagram shown in Figure 1-20.

The operation of the logic diagram in Figure 1-20 is explained below; this discussion assumes that NUMBRCHAR=3 and all three OST mho characteristics are used.

STEP 1

The power swing enters the OUTER characteristic. Thus AND61 will have one input from the OUTER and a second input from OR61 since NOT61 has no input. If the swing impedance remains between the OUTER and MIDDLE characteristics for the pickup setting of TLOS1, TLOS1 operates, seals in one input of AND61.

When a fault occurs, the OUTER and MIDDLE characteristics operate almost simultaneously, and the MIDDLE blocks AND61 through NOT61 thus preventing TLOS1 from operating.

STEP 2

The swing now enters the MIDDLE characteristic but remains outside the INNER characteristic. One input of AND62 is energized by TLOS1, a second input is proved by the MIDDLE, and the last is supplied by NOT62. If the swing impedance remains between the MIDDLE and INNER characteristics long enough for TLOS2 to pick up, TLOS2 seals in the lower two inputs to AND62. AND62 is therefore controlled by TLOS1, which, in turn is controlled by the OUTER characteristic.

STEP 3

The swing now enters the INNER characteristic. One input to AND63 is provided by TLOS2, the second by the INNER. If the swing impedance remains inside the INNER characteristic for the pickup setting of TLOS3, TLOS3 provides one input to AND64. At this point the decision to trip has been made and sealed-in. The out-of-step tripping output will be provided immediately if TRIPIN_OUT=IN.

STEP 4

The swing now leaves the INNER characteristic (traveling in either direction), but remains inside the OUTER characteristic. One input to AND64 is provided by TLOS3, a second input is supplied by the OUTER, the third input is energized by NOT62 through OR64. If the output from AND64 lasts for the pickup setting of TLOS4, TLOS4 operates and seals in. The output of TLOS4 also provides one input of AND65.

STEP 5

If TRIPIN_OUT=OUT, tripping is not initiated until the swing has passed through the OUTER characteristic for the second time. When the OUTER resets, the second input of AND65 is supplied by NOT63. AND65, through OR65, picks up the out-of-step tripping relay, OST. This output lasts for 50 milliseconds (three

cycles at 60 hertz) after the OUTER resets, which is the dropout time of TLOS1.

Two-Characteristic Operation

Operation with two characteristics instead of three (NUMBRCHAR=2) is essentially the same as described above, except that the MIDDLE characteristic and TLOS2 are taken out of the circuit. Only the OUTER and INNER characteristics are involved in the two-characteristic mode of operation.

Out of Step Oscillography Capture

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

Compensated Positive Sequence Over Voltage (optional)

Description

The positive-sequence overvoltage option includes four separately-adjustable overvoltage functions: an instantaneous unit and a definite-time overvoltage unit that responds to V_{A1} , and an instantaneous unit and a definite-time overvoltage unit that responds to $V_{A1} - I_{A1}Z_R$. The compensated voltage, $V_{A1} - I_{A1}Z_R$, is intended to reproduce the positive-sequence voltage present on the line Z_R ohms from the relay location. Refer to Figure 1-21.

Application

The compensated positive-sequence overvoltage function is intended to provide tripping of transmission lines when the line voltage becomes so high as to endanger system operation. The series-compensated overvoltage function provides an instantaneous and a time-delayed trip on either the local positive-sequence voltage (V_{A1}) or on the compensated positive-sequence voltage ($V_{A1} - I_{A1}Z_R$). The positive-sequence voltage, V_{A1} , is intended to measure the voltage at the relay location, while the compensated positive-sequence voltage ($V_{A1} - I_{A1}Z_R$) is intended to approximate the voltage at the far end of the line when Z_R is set to reflect the rise in the line due to capacitance charging.

These functions can provide the following advantages:

- A local measurement of the balanced voltage.
- A remote measurement of the voltage at the far end of the line, which can:

a) Detect high voltage due to an open line, and trip the energized end. This is especially important, because, with high voltage, more corona may exist on the line and inhibit the proper reception of a carrier-transfer-trip signal.

b) Detect the line that is open, creating the bus high voltage, and provide a selective tripping of the proper line.

This function must be set high enough to allow safe normal operation while tripping for high voltages. Because of transients involved in line energization, the instantaneous function should be set at least 15% higher than the voltage obtained or calculated for a steady-state line energization.

If the relay reach, Z_R , is set equal to one-half of the line impedance, the compensated voltage ($V_{A1} - I_{A1}Z_R$) will be approximately equal to the positive-sequence voltage at the remote end of the line, due to the Ferranti effect when the remote terminal is open. A more accurate setting of Z_R may be made if the positive-sequence charging current (I_C) and the voltages

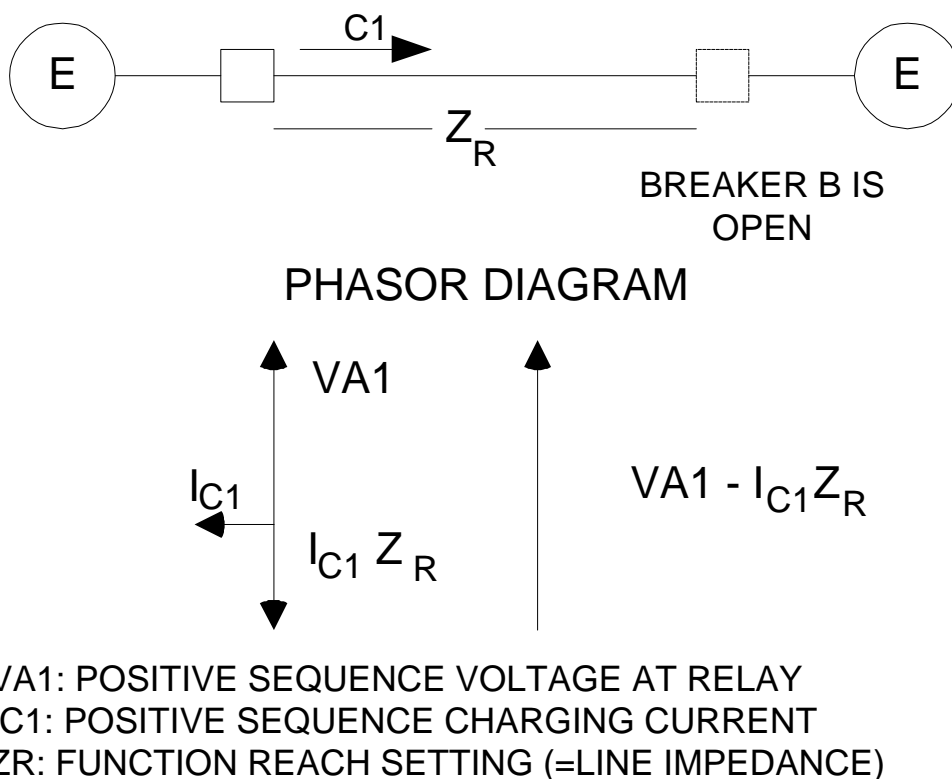


Figure 1-21 Compensated Positive Sequence Overvoltage Phasor Diagram

at both the near and remote line ends (V_N and V_R) resulting from an open breaker are known. The desired reach setting would be:

$$Z_R = (V_R - V_N) / I_C$$

RECLOSER (optional)

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

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

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

Reclosing Mode

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

1. **NONE** - No reclosing is selected. The three-pole trip enable signal (see outputs) will not be set up at this time. This mode should be selected when the ALPS recloser is not used.
2. **INTERNAL** - Reclosing will be controlled by the ALPS relay only. No external inputs will be recognized.

3. **EXTERNAL** - Reclosing will be controlled by external inputs (from other relays/systems) only. Inputs from the ALPS system will be ignored.
4. **BOTH** - Reclosing will be controlled by signals from the ALPS system as well as from external inputs (other relays/systems).
5. **OFF** - No reclosing, either by internal or external control, is allowed. The three-pole trip enable output (see outputs) will be set up at this time. This mode should be selected when automatic reclosing is disabled.

Reclosing Programs

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

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

phase tripping (SETT # 1802 (TRIPMODE) = 1POL or 1POLZ2).

- II. **3POLE** - In this mode of operation, up to four reclosing attempts (all three-pole) can be made following an initial three phase trip; there will be no reclosing following an initial single phase trip. Each reclosing attempt requires a **3PRI** signal thus indicating that three-pole tripping was initiated. In this mode, the three-pole trip enable signal will be issued at all times, so that the relays will issue a three-pole trip signal to trip all three poles of the breaker regardless of the fault type. This three-pole trip enable signal is issued internally to the ALPS system, but it must be programmed to drive one of the output relays for use with an external relay system, if such a relay system is used with the recloser. Four separate timers are provided so that each of the four reclosing attempts can be set with a different time if required. For proper operation of the recloser in the **3POLE** program, the ALPS relay must be programmed for three phase tripping (SETT # 1802 (TRIPMODE) = 3POL).
- III. **1POLE3POLE** - If this mode of operation is selected, the recloser will operate as follows:
 - A. The program described under the **1POLE** mode of operation will be followed if a single-pole reclose initiate (**1PRI**) signal is received by the recloser thus indicating that a single-pole trip occurred.
 - B. The program described under the **3POLE** mode of operation will be followed if a three-pole reclose initiate (**3PRI**) signal is received by the recloser thus indicating that a three-pole trip has occurred.

Note: The recloser settings (**RECLTYPE**) and the relay settings (**TRIPMODE** in the **ALPS**) must be compatible. Thus if the ALPS system is

set for single-pole tripping, then the recloser must be set to **1POLE** if single-pole reclosing only is to be used, or it must be set to **1POLE3POLE** if both modes of reclosing are to be used. If the ALPS is set for single-pole tripping and the recloser is set to **3POLE**, then the recloser will issue the three-pole trip enable signal to tell the ALPS to trip three-pole regardless of the fault type, and the recloser will be immediately sent to lockout following any trip. If the ALPS system is set for three-pole tripping and the recloser is set to the **1POLE** type, then the recloser will go to lockout following any trip, regardless of the fault type.

From 1 to 4 reclose attempts may be selected for each of the reclosing programs. For the **1POLE3POLE** program, the number of **1POLE** and **3POLE** reclose attempts may be set independently. Each of the reclose attempts has an independent time delay setting with a range of 0.1 to 300.0 seconds. The reclose delay time begins when the recloser receives either a single pole reclose initiate signal (**1PRI**), or a three pole reclose initiate signal (**3PRI**).

The reset time setting (**RESETTIME** - RANGE: 0.1 - 300 seconds) establishes the time that the recloser will wait before going to reset following:

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

therefore, If a fault is closed into or occurs during the reset time, then the recloser will remain in the lockout state. If there are no faults, then the recloser will go to the reset state at the end of the reset time delay.

The dwell time setting (**DWELLTIME** - RANGE: 0.1 - 2.0 seconds) establishes the time that the close contacts will remain closed when a reclose is called for by the recloser.

RECLOSER INPUTS

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

Single-pole Reclose Initiate (1PRI) - The **1PRI** input starts the single-pole reclosing mode of operation. The ALPS system will provide this input directly to the recloser. If the recloser is set to operate for **EXTERNAL** or **BOTH**, then one of the contact converter inputs must be programmed to accept this 1PRI input, and the external relaying system must be capable of supplying it.

Three-pole Reclose Initiate (3PRI) - The **3PRI** input starts the three-pole reclosing mode of operation. The ALPS system will provide this input directly to the recloser. If the recloser is set to operate for **EXTERNAL** or **BOTH**, then one of the contact converter inputs must be programmed to accept this 3PRI input, and the

external relay system must be capable of supplying it.

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

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

- In Reset, the recloser disregards any reclose initiate received while Reclose Cancel is ON and stays in Reset.
- During a reclose cycle, Reclose Cancel sends the recloser to Lockout.

- During the DWELL TIME, Reclose Cancel waits until the dwell time has elapsed and the close relay has reset and then sends the recloser to Lockout.
- In Lockout, the Reclose Cancel signal has no effect.

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

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

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

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

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

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

RECLOSER OUTPUTS

All of the outputs provided by the recloser are programmable, therefore, if any of these outputs are to be used externally, it must be insured that an appropriate output relay is assigned to each of the outputs that are to be used. Assignment can be made through the ALPSLINK setting program, through the Xpression builder program, or through the keyboard. The following outputs are provided:

Close - The close output is used to control reclosing of the breaker. The dwell time setting (**DWELLTIME**, 1814) controls the time that the output contacts will remain closed following a close command from the recloser.

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

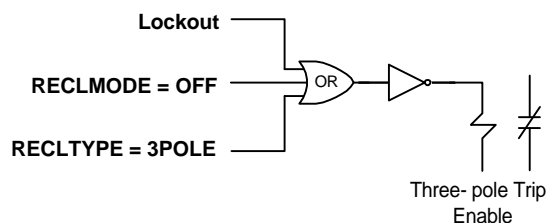


Figure 1-22 Three-pole Trip Enable Output

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

This output is internally routed to the ALPS system and is used to insure that three-pole tripping will be initiated for all faults (regardless of fault type) as long as the three-pole trip enable output is maintained. If the recloser is used externally with another relay system, then the NOT of the three-pole trip enable output must be programmed (as shown in Figure 1-22) to drive a form “b” contact, so that the contact will be closed whenever the three-pole trip enable output is produced, and will otherwise remain open.

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

Reclose in Progress (RIP) - This output is produced whenever a reclosing cycle is started and it will reset when the recloser goes to reset if reclosing is successful, or to lockout if reclosing is unsuccessful.

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

SYNCHRONISM CHECK (optional)

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

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

The **BUSLINE** setting (**RANGE: BUS or LINE**) tells the recloser where the three-phase voltage used by the relay system is located, bus or line.

The **SYNCPHASE** setting (**RANGE: VA, VB, VC, VAB, VBC or VCA**) establishes which phase or phase pair is used to make the angle and voltage check measurements.

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

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

Four voltage settings (**VBUSLIVE, VBUSDEAD, VLINELIVE, and VLINEDeAD**) are required for the synchronism check function to establish live and dead voltage levels for the bus and line potential. Each of these levels has a range 0.1 - 130 volts. The live voltage setting for the line and bus also establish the minimum voltage that must be present before the synchronism check functions are allowed to operate.

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

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

SYNCHRONISM CHECK INPUTS - The only additional input required to run the synchronism check function is the single-phase voltage input. No contact inputs are required.

SYNCHRONISM CHECK OUTPUTS - The only output produced by the synch check function is the synchronism check/voltage check permission output. This output is run directly to the internal recloser to supervise reclosing. The output is also programmable,

therefore, if an external synch check signal is required. It may be programmed to drive one (or more) of the output contacts in the ALPS system either through the ALPSLINK or Xpression Builder programs or through the keypad.

Alps Reclosing Program Summary

ALPSTRIPMODE (SETT #1203)	RECLTYPE (SETT#1802)	INITIAL TRIP TYPE	PROGRAM
1POL/1POLZ2	1POLE	Single phase	Up to 4 reclose attempts using 1P delays
		Three phase	Lockout
3POL	1POLE	Any trip	Lockout
3POL	3POLE	Any- trip	Up to 4 reclose attempts using 3P delays
1POL/1POLZ2	3POLE	Any trip	Lockout
1POL/1POLZ2	1POLE3POLE	Single phase	Up to 4 reclose attempts using 1P delays
		Three-phase	Up to 4 reclose attempts using 3P delays
3POL	1POLE3POLE	Single phase	Up to 4 reclose attempts using 3P delays
		Three-phase	Up to 4 reclose attempts using 3P delays



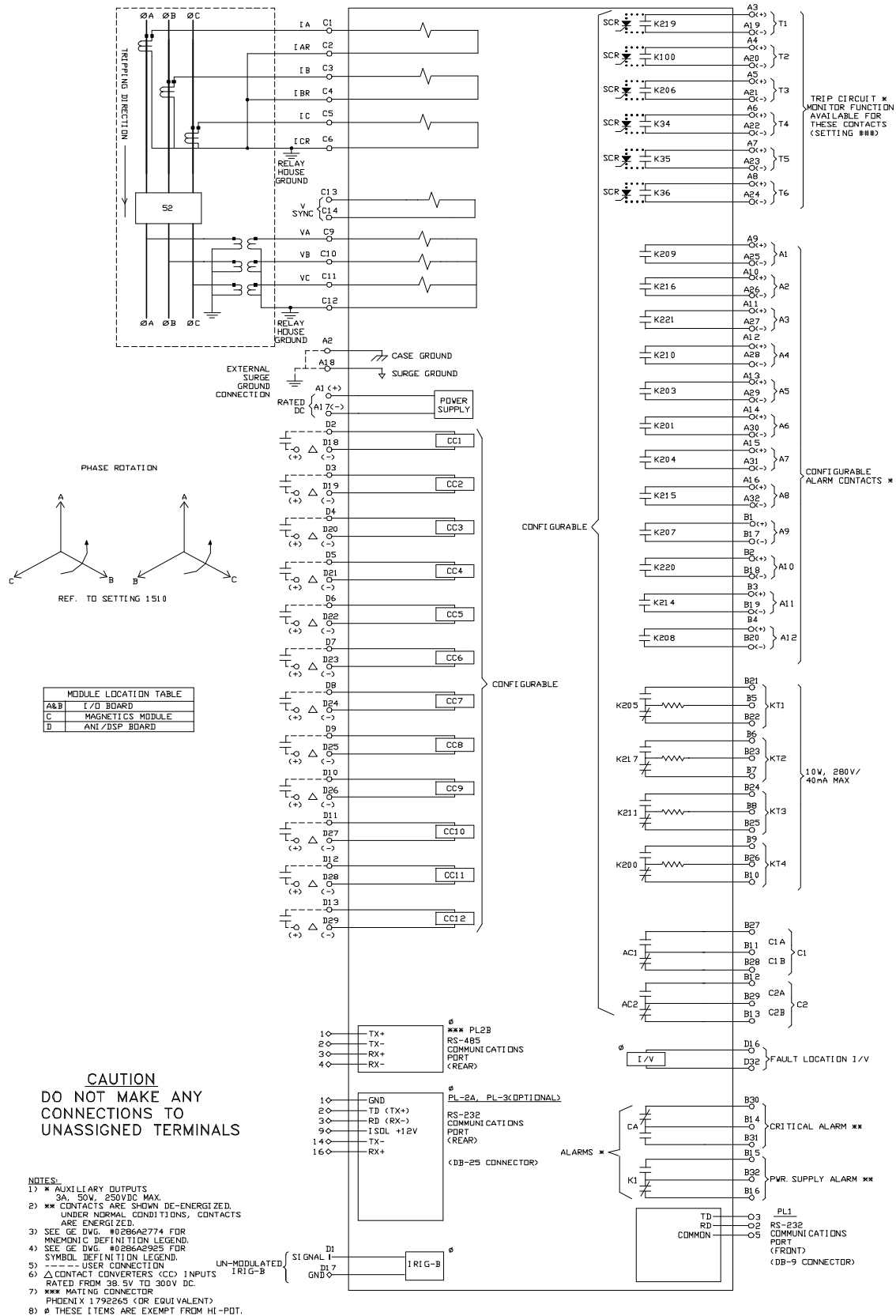


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CALCULATION OF SETTINGS

INTRODUCTION

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

1) General Settings

- Configuration
- Communications
- Oscillography
- Equipment Duty
- Programmable Inputs

2) Protection Settings

- Z1DIST
- Z2DIST
- Z3DIST
- Z4DIST
- CURSUPVIS
- OVERCUR
- VOLTAGE
- BLK RECLOS
- LINEPU
- REMOTEOPEN
- LINE OVERLOAD
- SCHEME
- SCHEMETIM
- LINE QTY.
- SCADA DTA
- OS TRIPPING optional)
- RECLOSER
- NON CRITICAL ALARM
- PROGRAMMABLE OUTPUTS

The sub-groups (defined by their mnemonic) are given in the order that they appear when scrolled in the display provided on the front of the **ALPS** system.

Up to four separate and distinct **Protection Settings** Groups can be programmed and stored

in the **ALPS** relaying system. Selection of the settings group to be used can be made via the keypad, through the communications link or through external contacts applied to selected programmable inputs.

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

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

All of the settings used in the **ALPS** system are listed in Table 2-1 which also shows setting ranges for 5 ampere and 1 ampere rated systems. Note that each specific setting in a subgroup has a distinctly assigned number in addition to a unique mnemonic. These identification numbers can be used to facilitate entering or changing a setting via the keypad or through the **ALPSLINK** communications program provided with this book.

Note that all settings must be entered in secondary values (ohms, amperes, volts) unless per unit (pu) or other values are called for.

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

1. Go through this section setting by setting and manually record each setting in the blank form provided. Once the form is completed, enter the settings individually via the keypad located on the front of the

ALPS system or through the ASCII communications port (a long and laborious process and not recommended). Alternatively, use the **ALPSLINK** communications program to access and modify an existing settings file (a sample settings file is included on the program disk). This file can then be downloaded to the **ALPS** system and saved for possible modification in the future.

2. Use the **ALPSSET** setting program provided with this book (the easiest

method when first starting). This program goes through each category setting by setting and allows specific settings to be determined and stored into a file which may then be saved and downloaded into the **ALPS** system via the **ALPSLINK** program. This file will then be readily available for future modification if required.

General Settings

CONFIGURATION

101: UNITID - Unit ID Number

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

102: SYSFREQ - System Frequency

SYSFREQ establishes the frequency at which the **ALPS** system will operate and can be set to either 50 Hz or 60 Hz. When this setting is changed it will only be implemented by turning the DC power off and then on to re-initialize the **ALPS** system.

103: PHASRRotate - Phase Rotation

PHASRRotate can be set to either A-B-C or A-C-B to match the positive-sequence phase rotation for the power system where the **ALPS**

system is installed. This setting permits the **ALPS** system to properly report the faulted phase or phase pair.

104: TIMESYNCH - Select Time Synchronization

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

105: NUM_BKR - Number of Breakers

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

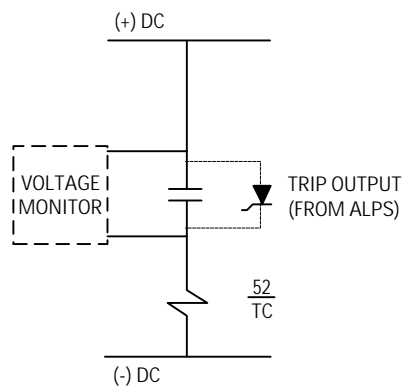


Figure 2-1 Trip Circuit Monitor

106: NUM_TC - Number of Trip Circuits

The number of trip outputs available in the **ALPS** system is made by assignment of the trip outputs via the **NUM_TC** setting and is directly coupled to the **NUM_BKR** setting.

The **ALPS** system is provided with the capability (when enabled) to trip the breaker(s) locally through the keypad, or remotely via the **ALPSLINK** program or the ASCII commands. In order for the **ALPS** system to recognize which breaker should be tripped, the **NUM_TC** setting must be made as given in table 2-i or 2-ii and the trip outputs must be connected to the appropriate trip coils as assigned in table 2-1 or 2-ii. For example, if a three-pole tripping scheme is employed and if **NUM_TC** = 2, then trip output T1 must be connected to the trip coil TC-1 of breaker no.1 and the output T2 must be connected to the trip coil TC-1 of breaker no. 2.

107: NUM_MON - Trip Outputs To Be Monitored

Trip circuit monitoring can be used to check the integrity of the trip circuit to which the selected trip output is connected. It does this

Table 2-II										
Single-Phase Tripping Schemes										
		Trip Output Assignments								
		Breaker No. 1						Breaker No. 2		
Number of Breakers NUM_BKR =	Number of Trip Circuits NUM_TC =	Trip Circuit 1			Trip Circuit 2			Trip Circuit 1		
		ΦA TC1-1	ΦB TC1-2	ΦC TC1-3	ΦA TC2-1	ΦB TC2-2	ΦC TC2-3	ΦA TC1-1	ΦB TC1-2	ΦC TC1-3
1	1	T1	T2	T3	-	-	-	-	-	-
1	2	T1	T2	T3	T4	T5	T6	-	-	-
2	1	T1	T2	T3	-	-	-	T4	T5	T6

TC1, TC2 = Trip Coils T1 - T6 = **ALPS** Trip Outputs

With the Single-phase tripping model, six outputs (T1 - T6) are available, and are assigned per the **NUM_TC** setting as shown in Table 2-II. In this case, outputs T4 - T6 are available for assignment through *Xpression Builder* only when one breaker with one set of trip coils is being controlled. (**NUM_TC** = 1)

by sensing the voltage across the trip output as shown in Figure 2-1. If the trip circuit is intact, almost full DC voltage will be detected across the trip output. If the trip circuit is open for some reason, there will be no voltage, or very little voltage, across the trip output. The monitoring circuit will detect this condition, store an event and can be

programmed to close an alarm contact if so desired.

The trip contacts are also monitored when a trip is initiated by the **ALPS** system. If the voltage across the contacts does not drop when the trip is initiated, then it is assumed that the trip circuit is not intact and an alarm is issued. If the voltage does drop concurrently with the trip initiation, then the trip circuit is considered to have been activated and no alarm is issued.

Table 2-IV

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

Any or all of the outputs can be monitored regardless of whether or not they are used in a trip circuit.

For single-pole tripping schemes, the setting format for **NUM_MON** is abcdef, where any position can be a zero (0) or a one (1) as shown in Table 2-IV.

To monitor outputs T1-T3 and not T4-T6, make the following setting:

NUM-MON = 000111

This setting is entered in to the relay from the LUI in decimal format, (NUM-MON=7).

108: DISPLAYVAL - Present Value Display Mode

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

109: LANGUAGE

Two settings are possible: **ENGLISH** or **SPANISH**.

COMMUNICATIONS

201: COMPORT1 - Communications Port 1

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

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

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

202: COMPORT2 - Communications Port 2

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

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

The baud rate setting of 300, 1200, 2400, 4800, or 9600, must be set to match the baud rate of the modem or serial device connected to the serial port of the **ALPS** relay system. The parity and stop bits must match those selected for the serial port of the remote PC. Normally 1 stop bit is selected. However, certain

modems or other communications hardware might dictate using 2 stop bits. **ALPSLINK** communications software can be configured to match this **ALPS** setting for baud rate, parity, and stop bits.

203: COMPORT3 - Communications Port 3

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

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

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

204: PROTOCOL1 - Comm Port No. 1 Protocol

Two settings are possible:

1. **GE-MODEM** - use this setting to communicate with the **ALPS** system via the **ALPSLINK** communications program as described in Chapter 11 (**ALPSLINK** Users Guide).
2. **ASCII** - use this setting to communication with the **ALPS** system via the ASCII commands provided in Chapter 12 (ASCII Communications).

205: PROTOCOL2 - Comm Port No. 2 Protocol

Two settings are possible:

1. **GE-MODEM** - use this setting to communicate with the **ALPS** system via the **ALPSLINK** communications program.
2. **ASCII** - use this setting to communicate with the **ALPS** system via the ASCII commands provided in Chapter 12 - ASCII Communications.

206: PROTOCOL3 - Comm Port No. 3 Protocol

Two settings are possible:

1. **GE-MODEM** - use this setting to communicate with the **ALPS** system via the **ALPSLINK** communications program.
2. **ASCII** - use this setting to communication with the **ALPS** system via the ASCII commands provided in Chapter 12 - ASCII Communications.

OSCILLOGRAPHY

301: NUMFAULTS - Number Of Faults To Be Captured

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

This setting allows the user to apportion a fixed amount of memory into different sized blocks for oscillography storage. The following tabulation (based on standard memory configuration) shows the total number of oscillography cycles allowed per storage event as a function of the **NUMFAULTS** setting.

NUMFAULTS	<u>STORAGE CYCLES</u>
2	72
4	36
8	18
12	12

If the expanded memory configuration is ordered, the total number of oscillography cycles allowed per storage event as a function of the **NUMFAULTS** setting is:

NUMFAULTS	<u>STORAGE CYCLES</u>
6	72
12	36
24	18
36	12

302: PREFault - Number Of Pre-Fault Cycles To Capture In Each Oscillography Record.

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

303: SPLITREC - Split Oscillography Record For Long Duration Faults

The **ALPS** system allows a pre-defined number of oscillographic records to be captured per the **NUMFAULTS** setting described above. Each record is a specific number of cycles long as determined by this setting. If a fault occurs that is greater in length than the number of cycles set to be captured, the **SPLITREC** setting will allow the record to be split so that the beginning and the end of the fault can be captured. Note that **SPLITREC** does not affect the number of prefault cycles that are

captured as determined by the **PREFault** setting. **SPLITREC** applies only the fault record exclusive of the prefault cycles. **SPLITREC** is set as a percentage with a range of 0 to 100 percent, and splits the record so that the end of the record is equal to the **SPLITREC** percentage and the beginning of the record is equal to (1 - **SPLITREC**). For example, assume that **NUMFAULTS** is set to 4 and **PREFault** is set to 4. This means that the record will capture 4 cycles of prefault data and 28 cycles of fault data. The **ALPS** system samples at 64 times per cycle, therefore, 2048 samples (64*32) of fault data will be captured. Further assume that **SPLITREC** is set to 30 percent. If the fault lasts longer than 32 cycles (2048) samples, then 28 cycles (1792 samples) of the oscillographic record will be split and the display will show 8.4 cycles (538 samples) at the end and 23.6 cycles (1510 samples) at the beginning. If the fault is less than the set number of cycles then **SPLITREC** has no effect and the total fault record will be displayed.

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

EQUIPMENT DUTY

The **ALPS** system will count the total number of breaker operations and furthermore will calculate and accumulate the total breaker duty on a per phase basis according to the following equation:

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

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

The number of operations and accumulated duty will be compared to set values (entered by user), and when the respective value is reached, an event will be recorded, and the

non-critical alarm will be initiated if programmed to do so. The number of operations and the total duty can start from zero, or if the existing number of operations or total duty is known, those values can be entered into the **ALPS** system which will then use them as the starting point. The following settings need to be made.

401: EXPONENT - Exponent To Use In Ixt Calculation

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

402: MAX_OP - Maximum Number Of Breaker Operations That Will Be Permitted

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

403: MAX_IXT - Maximum Breaker Duty

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

404: IXTPHASEA - Accumulated Duty, Breaker Phase A

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

405: IXTPHASEB - Accumulated Duty, Breaker Phase B

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

406: IXTPHASEC - Accumulated Duty, Breaker Phase C

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

408: NUM_OP_A - Present Number Of Breaker Operations, Phase A

NUM_OP _A can be set over the range of 0-9999 with a step of 1. If the number of operations to that point in time is known, enter that value, otherwise, enter an estimated value or use the default value of zero (0).

409: NUM_OP_B - Present Number Of Breaker Operations, Phase B

NUM_OP _B can be set over the range of 0-9999 with a step of 1. If the number of operations to that point in time is known, enter that value, otherwise, enter an estimated value or use the default value of zero (0).

410: NUM_OP_C - Present Number Of Breaker Operations, Phase C

NUM_OP _C can be set over the range of 0-9999 with a step of 1. If the number of operations to that point in time is known, enter that value, otherwise, enter an estimated value or use the default value of zero (0).

Protection Settings

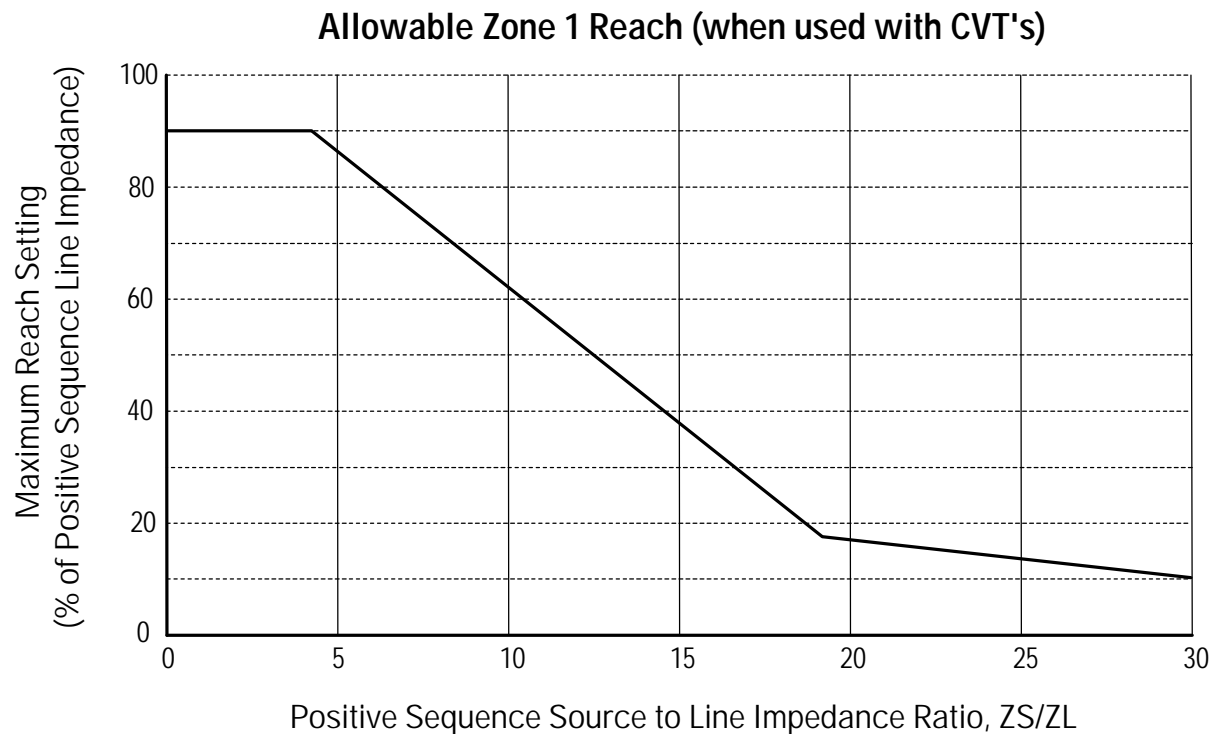


Figure 2 - 2

Z1DIST

101: Z1PHASE - Zone 1 Phase Distance Functions

PUTT Scheme

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

Z1PHASE = YES

All Other Schemes

Set **Z1PHASE** equal to **YES** if zone 1 protection for phase faults is desired. Otherwise set **Z1PHASE** equal to **NO**. It is highly desirable to use zone 1 protection in all schemes because

it provides independent, high speed direct tripping for all phase faults within the reach setting.

102: Z1PREACH - Zone 1 Phase Reach Setting

If potential transformers (PT's) are used, use a reach setting that is no greater than 90 percent of the positive sequence impedance of the line to be protected. If capacitor voltage transformers are used, refer to Figure 2 - 2.

103: Z1PLEVDET - Zone 1 Phase Level Detector Setting (Series Capacitor Model Only)

The distance functions in the **ALPS** system make their measurement by comparing the phase relationship of an operate signal ($I_Z - V$) to a polarizing signal (V); where, Z is the set

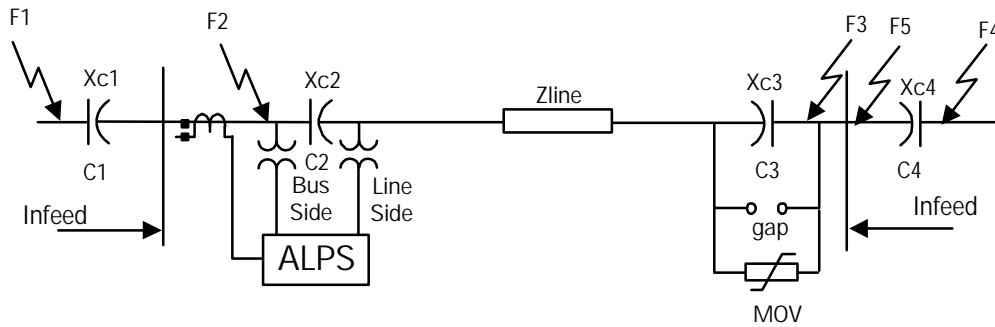


Figure 2 - 3 Power System One line Diagram with Series Capacitors

reach of the function and I and V are the current and voltage seen by the function. While this measurement alone is sufficient to provide secure and dependable performance on uncompensated lines, it is not suitable for application on lines with series capacitors. For example, consider the system shown in Figure 2 - 3 and assume that the potential source for the **ALPS** system is located on the line side of the series capacitor ($C2$). For a fault at $F3$, the impedance seen by a distance function is equal to the line impedance minus the impedance of capacitor $C3$ ($Z_{line} - X_{c3}$). It might then be assumed that a zone 1 function could be set to reach 90 percent of this compensated impedance to provide high speed direct tripping for the uncompensated portion of the transmission line. However, the function may overreach on the low frequency transients that could occur for faults beyond the capacitor if the fault current level is insufficient to cause gap flashing or significant conduction in the MOV's. To overcome this limitation, the operating signal ($I Z - V$) in the zone 1 functions in the **ALPS** system must be greater than a set level in addition to meeting the phase angle requirement mentioned earlier. The set level is directly related to the amount of compensation and the type of protection used around the capacitor. For the fault at $F3$, the voltage at the relay is:

$$V = I * (Z_{line} - X_t)$$

where,

$X_t = X_{c3}$ if gaps are used

X_t = parallel combination of X_{c3} and the MOV impedance when MOV's are used

If the zone 1 function is set with a reach equal to Z_{line} , then the operating signal for the fault at $F3$ is:

$$I Z - V = I \times Z_{line} - I \times (Z_{line} - X_t) = I \times X_t$$

If gap flashing does not occur, or if there is not significant conduction in the MOV, then the operate signal, $I Z - V$, is equal to $I * X_c$, the voltage drop across the capacitor. If the gaps flash, the operate signal will be very small, or if the MOV'S conduct, the voltage will be less than or equal to the MOV protective level. The level detector in the operate circuit of the zone 1 functions is set greater than the gap flashing level or the MOV protective level, so that the functions cannot operate for faults beyond the zone of protection even in the presence of low frequency transients.

Now consider a fault at $F5$ directly in front of the zone 1 functions. For this fault, $V = 0$, and the operate signal, $I Z - V$, will therefore equal $I Z$. If the source behind the function is very strong and the line is very long (Z is big), the operate signal will be very large and fast operation will result.

To simplify the explanation, the above discussion was predicated on $C3$ being the only capacitor located between the relay potential source and the fault. In determining the level detector setting, it is necessary to

consider external faults beyond any capacitor located at the remote bus in adjacent/parallel line sections. All of the capacitors that appear between the source of the relay potential and those external faults must then be taken into consideration. Consider the forward fault at location F4 in Figure 2 - 3:

1. Capacitors C3 and C4 need only be considered if line side potential is used.
2. If bus side potential is used then capacitor C2, C3 and C4 must be taken into consideration.

Capacitor C4 should be treated as follows when determining the level detector setting:

1. With gaps - If the minimum fault current for a fault at F5 (including infeed) is above the gap flashing level, then exclude C4 from the calculation. If the gaps do not flash then use the gap flashing level in making the calculations.
2. With MOV's - If the MOV's are protected with gaps, and if the minimum fault current (including infeed) for a fault at F5 is above the gap flashing level, then exclude C4 from the calculation. If there are no gaps around the MOV's or if the gaps do not flash then use the protective level of the MOV's in making the calculations.

Please note that only one capacitor is shown in location C4 where in actuality there may be more than on line containing capacitors that emanates from the remote bus. Each capacitor must be evaluated individually in determining whether it should be used in calculating the level detector setting. Use the highest protective/gap flashing level so obtained in calculating the setting.

After it has been decided which capacitors are involved, sum the protective levels of those capacitors as follows:

$$PLt = \frac{\sum_{n=1}^n PLn}{95}$$

Where:

n = number of capacitors involved

PLn = the gap flashing level in peak volts if gaps are used to protect the capacitors, or,

PLn = the protective level in peak volts if MOV's are used to protect the capacitors.

Once PLt has been determined, **Z1PLEVDET** can be calculated as follows:

$$Z1PLEVDET = \sqrt{0.15 + 1.3 \times PLt^2}$$

104: Z1GROUND - Zone 1 Ground Distance Functions

PUTT Scheme

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

Z1GROUND = YES

Blocking, Hybrid, POTT1 and POTT2 Schemes

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

105: Z1GRDREACH - Zone 1 Ground Reach Setting

If potential transformers (PT's) are used, use a reach setting that is no greater than 90 percent of the positive sequence impedance of the line to be protected. If capacitor voltage transformers (CVT's) are used, refer to Figure 2 - 2.

If single-pole tripping is employed, and if the application involves a parallel line (bussed at both ends) where single-pole tripping is also employed, the zone 1 ground distance functions should not be set greater than 80 percent of the line impedance, or greater than 80 percent of the setting determined using Figure 2-2.

106: Z1GRDCHAR - Zone 1 Ground Characteristic

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

107: Z1SUREACH - Mho Supervision Of Ground Reactance Function (When Used)

This setting is relevant only when the zone 1 ground-distance functions have been set to be reactance functions (see **Z1GRDCHAR** above). Since the reactance function is non-directional, it must be supervised by a

Mho function, as shown in Figure 2 - 4. This supervision is automatically implemented whenever the reactance function is selected via the **Z1GRDCHAR** setting described above.

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

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

108: Z1GROUNDK0 - Zone 1 Ground Distance Functions Zero Sequence Compensation Factor

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

$$\mathbf{Z1GROUNDK0} = 0.95 \times (\mathbf{Z0L} / \mathbf{Z1L})$$

where:

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

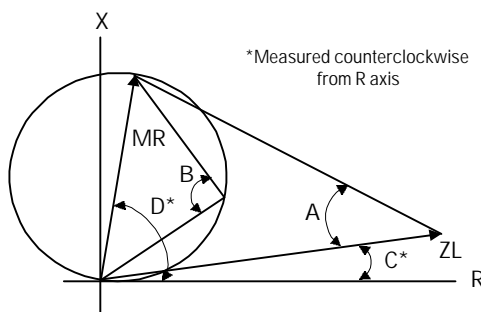
109: Z1GLEVDET - Zone 1 Ground Level Detector (Series Compensated Line)

Use the total protective level PLt determined under the **Z1PLEVDET** setting and calculate **Z1GLEVDET** as follows:

$$Z1GLEVDET = \sqrt{0.15 + \times PLt^2}$$

110: Z1BLOCK - Supervise Zone 1 Functions By Blocking Functions

This setting prevents the zone 1 functions from producing an output if the respective blocking functions have operated. This type of operation is required when series capacitors are located behind the **ALPS** system as shown in Figure 2 - 3. For this situation, the voltage applied to the system would reverse for a fault beyond the capacitors if gap flashing were not to occur or if the MOV protection did not conduct significantly. **Z1BLOCK** can be set to either YES or NO. Set **Z1BLOCK** to YES if



MR = Maximum Allowable Reach

ZL = Load Impedance

D = Angle of Maximum Reach

B = Characteristic Angle; < 90 = Lens

C = Load Impedance Angle

Figure 2 - 4 Maximum Allowable Reach

there are series capacitors located behind the **ALPS** system as shown in Figure 2 - 3.

Zone 2, Zone 3 and Zone 4 Distance Functions

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

1. the shape of the characteristic - circle or lens,
2. the angle of maximum reach, and
3. the maximum amount of load flow transferred across the transmission line.

The maximum allowable reach (**MR**) is based on the criteria shown in Figure 2 - 4 and can be calculated as follows:

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

Where,

ZL = minimum load impedance (Ohms)

B = Characteristic angle

90° = circle

>90° = lens

C = angle of minimum load impedance (degrees)

D = angle of maximum reach (degrees)

E = |D - C|

Note that this is the maximum reach that can be safely made based on the given parameters. It is based on maintaining a 40° margin between the angle B and the angle A shown in Figure 2 - 4. A circular mho characteristic (B = 90°) should be used when possible. However, for larger load flows (smaller load impedance's) and for longer reaches, it may be necessary to resort to a lenticular

characteristic ($B > 90^\circ$) to remain within the allowable limit. Lenticular settings greater than 120° should never be used. Similarly, the characteristic angle should never be set less than 90° except in the case of the zone 4 functions when they are applied as blocking functions in certain of the available schemes. In those applications, it is permissible to set the characteristic angle for zone 4 down to a minimum of 80° .

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

Z2DISTANCE

201: Z2PHASE - Z2 Phase Distance Function

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

202: Z2PHREACH - Z2 Phase Distance Reach

Stepped Distance Scheme

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

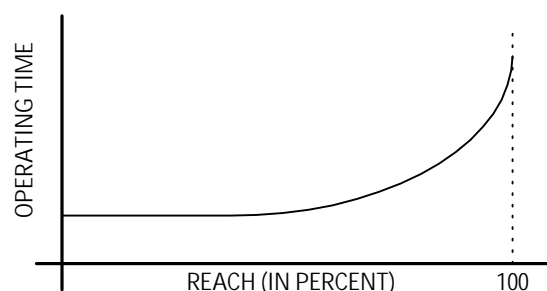


Figure 2 - 5 Operating time characteristic

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

Blocking, Hybrid PUTT, POTT1, and POTT2 Schemes

The primary purpose of the zone 2 functions in any of the pilot relaying schemes is to detect a fault anywhere on the transmission line and to work with the pilot channel to provide fast and secure tripping. To this end, the functions must be set to reach beyond the remote terminal of the transmission line and this requirement may be met by setting the functions with a reach of 125 to 200 percent of the transmission line. Although the reach requirement would be met with such settings, the operating time might not be at the optimum when taking into account the operating characteristics of the distance functions as shown in Figure 2 - 5.

For example if the reach of the zone 2 functions is set to 125 percent of the line impedance, then the operating time for remote faults would fall in the area of the upturn of the operating time characteristic,

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

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

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

203: **Z2PCHARANG** - Z2 Phase Characteristic Angle

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

the formula associated with the "Maximum Allowable Reach" method of Figure 2 - 4

204: **Z2G** - Z2 Ground Distance Function

The choice of settings is **YES** or **NO**. Set **Z2G** = **YES** if the zone 2 ground distance functions are to be used, otherwise set **Z2G** = **NO**.

205: **Z2GRDCHAR** - Zone 2 Ground Function Characteristic

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

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

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

Stepped Distance Scheme

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

PUTT Scheme

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

Z2GRDCHAR = MHO

Blocking, Hybrid, POTT1 and POTT2 Schemes

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

Z2GRDCHAR = MHOGDOC

206: Z2GR - Z2 Ground Distance Function Reach

See discussion for Z2PR phase distance function reach setting. Same philosophy applies.

207: Z2GCHARANG - Z2 Ground Distance Function Characteristic Angle

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

208: Z2TIMERS - Z2 Timers

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

209: Z2P_TIME - Z2 Phase Timer

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

209: Z2G_TIME - Z2 Ground Timer

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

Z3DISTANCE**301: Z3PHASE - Select Zone 3 Phase**

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

302: Z3PHREACH - Zone 3 Phase Reach

In a Step Distance scheme zone 3 provides backup protection for adjoining line sections out of the remote bus, and **Z3PHREACH**

should be set to see a multi-phase fault at the end of the longest adjoining line section out of the remote bus, considering such factors as arc resistance and underreach caused by intermediate fault current sources. **Z3PHREACH** should never be set so large as to:

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

303: Z3PCHARANG - Zone 3 Phase Characteristic Angle

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

304: Z3GRND - Select Zone 3 Ground

Z3GRND can be set to either **YES** or **NO**. When zone 3 is used as part of a Step Distance scheme, and zone 3 ground distance functions are required then set **Z3GRND** = **YES**. If zone 3 is not used required, set **Z3GRND** = **NO**.

305: Z3GRDREACH - Zone 3 Ground Reach

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

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

306: Z3GCHARANG - Zone 3 Ground Characteristic Angle

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

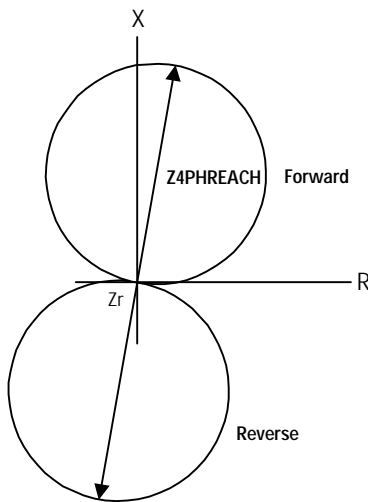


Figure 2 - 6

307: Z3P_TIME - Z3 Phase Timer

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

308: Z3G_TIME - Z3 Phase Timer

Z3G_TIME can be set over the range of 0.10 -

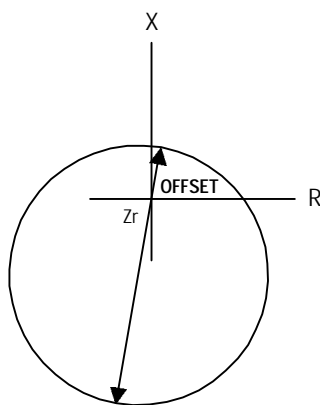


Figure 2 - 7

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

Z4DISTANCE

The settings to be used on the zone 4 distance functions in the **ALPS** system depend on the application and the scheme selected.

Both the phase and ground distance functions can be set to look in the reverse direction relative to the zone 1, zone 2 and zone 3 phase and ground distance functions (Figure 2 - 6). The reverse direction is required in certain applications and/or schemes as described below.

Historically, zone 4 distance functions have been provided with offset to include the origin of the R-X diagram within their characteristics (see Figure 2 - 7). Without the offset, memory would have to be relied on to provide an output for a zero voltage fault right at the relay location, and the output would last only as long as the memory lasted. With the offset, the function will operate on current alone and thus provide a continuous output for a zero voltage fault right at the relay location. A continuous output is required from the zone 4 functions in some schemes to insure that incorrect tripping does not occur for certain fault conditions. For example, consider the fault at F1 in Figure 2 - 8 and assume that a blocking scheme is being used in the protected line. A continuous blocking signal must be sent to the remote terminal to block tripping there until the fault is cleared. Offset in the zone 4 functions will assure this condition. Offset will also assure that zone 4 time-delayed backup (when used) will also be provided for zero voltage faults.

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

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

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

401: Z4PHASE - Z4 Phase Distance

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

Blocking, Hybrid and POTT2 Schemes

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

Z4PHASE = YES

Stepped Distance and POTT1 Schemes

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

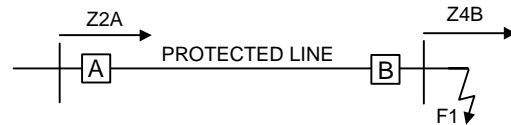


Figure 2 - 8

402: Z4PHREACH - Z4 Phase Distance Reach

Blocking, Hybrid and POTT2 Schemes

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

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

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

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

If the reach of the zone 2 phase distance function (**Z2PHREACH_R**) at the remote end of the line is less than twice the positive-sequence impedance of the line, then the proposed setting is:

Z4PHREACH 0.85 (Z2PHREACH_R)

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

$$Z4PHREACH = 1.7 \times (\quad \quad \quad R \quad Z1L)$$

Z2PHREACH_R

functions at remote
line terminal

protected line

With these proposed settings, proper tripping and blocking functions at the remote terminal of the line. It may be possible to use a proposed, but,

1. reach should be checked per the maximum allowable reach procedure **Zone 2, Zone 3 and Zone 4 Distance Functions** 18.
2. the reach should be checked to assure that the function will operate for all can operate for.

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

$$Z4PHREACH \quad Z2PHREACH$$

Where, **Z2PHREACH** is the reach of the pilot tripping functions (zone 2 in this example) at

Stepped Distance and POTT2 Schemes

In all other schemes, the zone 4 phase distance zone of time-delayed backup protection. They protection in a straight stepped distance scheme, or they can be reversed in direction to -called "reversed third zone" of protection.

should be set with a considering underreach caused by intermediate fault current sources. should never be set so large as to:

exceed the maximum allowable reach (), or,

to cause loss of selectivity with phase distance functions providing -delayed backup on any adjoining line section. If this requirement

then it may be necessary to get this selectivity by setting timer with additional time delay.

403: Z4PCHARANG - Z4 Phase Characteristic

Blocking, Hybrid and POTT2 Schemes:

Set the zone 4 characteristic angle setting to 10 setting (**Z2PCHARANG**) of the zone 2 functions at the remote terminal of the line;

$$Z4PCHARANG = (\quad \quad \quad R - 10)$$

This setting determines the characteristic shape and, consequently, the area of resistance

distance functions. **Z4PCHARANG** can be set to 80° to 120° in 5° steps. A 90° setting is recommended and lower than 90 degrees should not be used except in blocking, hybrid and POTT2 types of schemes. If the desired reach, **Z4PHREACH**, with a 90° characteristic and with maximum load flow does not allow the maximum allowable reach criteria to be met, then a "lens-shaped" characteristic must be used. The settings of both **Z4PHREACH** and **Z4PCHARANG** may be evaluated by using the formula associated with the "Maximum Allowable Reach" method of Figure 2 - 4.

404: Z4GRND - Z4 Ground Distance

Z4GRND can be set to **YES** or **NO** and determines whether or not the functions are to be used in the application.

Blocking, Hybrid and POTT2 schemes

The zone 4 ground distance functions are always required in these schemes, therefore, set:

$$\mathbf{Z4GRND = YES}$$

Stepped Distance and POTT1 Schemes

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

405: Z4GRDREACH - Z4 Ground Reach

Blocking Hybrid and POTT2 Schemes

In a blocking scheme, the zone 4 functions key the transmitter to send a blocking signal to the remote terminal of the line to block tripping for an external fault (F1 for example) within reach of the zone 2 functions located at the remote terminal (see Figure 2 - 8).

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

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

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

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

$$\mathbf{Z4GRDREACH = 0.85 \times (Z2GRDREACH_R)}$$

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

$$\mathbf{Z4GRDREACH = 1.7 \times (Z2GRDREACH_R - Z1L)}$$

where,

Z2GRDREACH_R = reach of phase zone 2 functions at remote line terminal

Z1L = positive sequence impedance of protected line

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

1. If a longer settings is used, then the reach should be checked per the maximum allowable reach procedure given under **Zone 2, Zone 3 and Zone 4 Distance Functions** found on page 2-10.
2. If a shorter reach setting is used, then the reach should be checked to assure that the function will operate for all faults that the remote zone 2 function can operate for.

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

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

Where, **Z2GRDREACH_R** is the reach of the ground distance pilot tripping functions (zone 2 in this example) at the remote end of the line.

Stepped Distance and POTT1 Schemes

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

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

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

406: Z4GCHARANG - Z4 Ground Characteristic Angle

Blocking and Hybrid Schemes:

Set the zone 4 characteristic angle setting to 10 degrees less than the characteristic angle setting (**Z2GCHARANG_R**) of the zone 2 functions at the remote terminal of the line; i.e.,

$$\mathbf{Z4GCHARANG} = (\mathbf{Z2GCHARANG_R} - 10)$$

Stepped Distance, POTT1 and POTT2 Schemes:

This setting determines the characteristic shape and, consequently, the area of resistance coverage provided by the zone 4 phase distance functions. **Z4PCHARANG** can be set to 80° to 120° in 5° steps. A 90° setting is recommended and lower than 90 degrees should not be used except in blocking, hybrid and POTT2 types of schemes. If the desired reach, **Z4GHREACH**, with a 90° characteristic and with maximum load flow does not allow the maximum allowable reach criteria to be met, then a "lens-shaped" characteristic must be used. The settings of both **Z4GRDREACH** and **Z4GCHARANG** may be evaluated by using the formula associated with the "Maximum Allowable Reach" method of Figure 2 - 4.

407: Z4DIRECTN: Z4 Direction

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

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

Z4DIRECTN = REVERS

All other schemes

Z4DIRECTN = FORWRD

408: Z4_TIMERS - Z4 Timers

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

409: Z4P_TIME - Z4 phase timer

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

410: Z4G_TIME - Z4 Ground Timer

If **Z4_TIMERS = YES** and if the zone 4 ground distance functions are to provide time-delayed backup protection, then the **Z4G_TIME** time delay should be set long enough to coordinate with the time-delayed operation of the appropriate zone of ground-distance relays in adjacent line sections. If **Z4_TIMERS = NO**

then the **Z4G_TIME** can be set to any value within its range with no affect on scheme operation.

CURSUPVISN

501: IT_PICKUP - Trip Supervision Current

502: IB_PICKUP - Block Supervision Current

Stepped Distance, PUTT, POTT1 and POTT2 Schemes

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

IT_PICKUP = minimum

IB_PICKUP = minimum

Blocking and Hybrid Schemes

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

IB_PICKUP = minimum

IT_PICKUP = 1.3*IB_PICKUP_R + I_c

where,

IB_PICKUP_R = pickup setting of **IB**
function at remote
terminal of line

I_c = positive sequence line charging current (include effect of any non-switched shunt reactors)

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

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

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

Stepped Distance Scheme

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

PUTT Scheme

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

POTT1 Scheme

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

$$IPT_{op} = 3I_0$$

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

IPB is not used therefore any setting that is made is irrelevant.

Hybrid and POTT2 Schemes

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

$$3I_0 - 0.3I_1$$

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

$$3I_0 - IPBKFACTOR \times 3I_1$$

The _____ controls the amount of _____ with the _____ function. _____ can be proposed for these schemes.

both the tripping and blocking functions to unbalance that may occur during load flow or

IPT **IPB**
proper coordination. This is done by setting
IPB **IPT**

IPB_PICKUP

IPT_PICKUP **IPB_PICKUP**
Ioc

IPB_PICKUP = setting of **IPB**
remote terminal
line.

I_{oc} = zero sequence line charging current (include effect of any non-switched shunt reactors)

Blocking Scheme

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

$$3I_0 - (0.3)I_1$$

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

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

1. logically AND'ed with the negative sequence blocking function **NB** to form the pilot tripping function.
2. used alone to form the carrier start function.
3. not be used at all in the carrier start circuit.

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

$$3I_0 - \text{IPBKFACTOR} \times 3I_1$$

The **IPBKFACTOR** controls the amount of

Table 2-V

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

positive sequence current restraint that is used with the **IPB** function. **IPBKFACTOR** can be set equal to 0 or 0.066. The proposed settings

for a blocking scheme are dependent on the **CARRSTART** setting and are given in Table 2-V.

505: IPBKFACTOR - IPB I1 Restraint

The **IPB** operating quantity is:

$$3I_0 - \text{IPBKFACTOR} \times 3I_1$$

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

506: NT_OFFSET: NT/NB Offset

The NT/NB functions use an offset to provide a reliable polarizing quantity for the conditions shown in Figure 2 - 9. Shown in this Figure are the negative sequence networks and corresponding voltage profiles for an uncompensated system and a system using series capacitors.

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

In the system with series capacitors, and with line-side potential as shown in Figure 2 - 9, the effect of the capacitor is to cause the voltage to reverse as shown. This will lead to incorrect directional sensing unless something is done to overcome the reversal. The offset in this

case provides a compensating voltage that is opposite to and larger than the drop in the capacitor so that when it is added to the actual voltage a signal is produced that is in the proper direction to provide correct directional sensing.

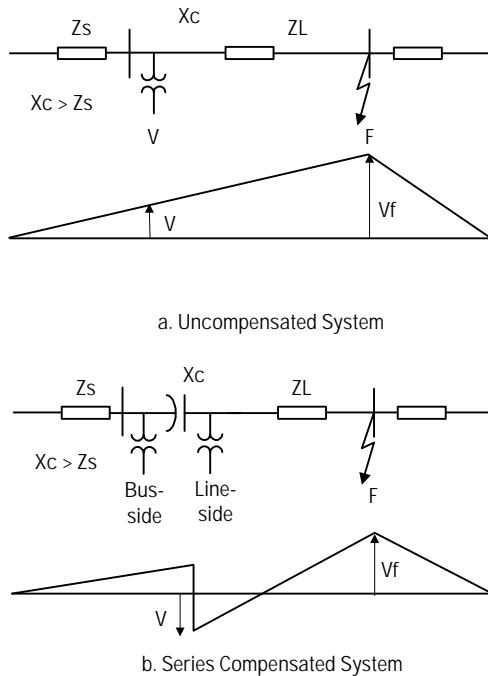


Figure 2 - 9

If bus-side potential is used, the voltage will never reverse and, as is done for an uncompensated line, it is only necessary to use an offset setting that is sufficient to cause a reliable polarizing source.

Use the following settings:

1. Uncompensated Lines

NT_OFFSET can be determined as follows:

$$\mathbf{NT_OFFSET} = (0.05)(Z_1)(I_n)$$

Where,

Z_1 = positive sequence impedance of protected line (in secondary ohms)

I_n = Magnetics Module CT rating (1A or 5A)

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

1. Series compensated line, Bus-side Potential

$$\mathbf{NT_OFFSET} = (0.022)(Z_1 - X_t)(I_n)$$

2. Series compensated line, Line-side potential

$$\mathbf{NT_OFFSET} = (0.022)(X_c)(I_n)$$

Where,

Z_1 = positive sequence impedance of protected line (in secondary ohms)

X_t = total series capacitive reactance connected between the bus-side source of potential and the source of potential of the relays located at the remote end of the line (in secondary ohms)

X_c = series capacitive reactance (in secondary ohms) of capacitor located between line-side potential source and bus directly behind relay (X_c in Figure 2 - 9)

I_n = Magnetics Module CT rating (1A or 5A)

507: UNBALALARM - Unbalanced Current Alarm

The **ALPS** system is supervised by a fault detector (FD) that uses the following operating quantity:

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

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

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

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

OVERCURRENT

601: 50 - Phase Instantaneous Overcurrent

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

602: 50_DIRCNL - Directional Control Of 50

The **50** function can be set to be either directional or non-directional. Directionality is obtained through the use of the Zone 2 phase distance functions.

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

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

603: 50PICKUP - 50 Pickup Setting

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

604: 50PICKUPFF - 50 Pickup During Fuse Failure

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

605: 50G - Ground Instantaneous Overcurrent

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

606: 50G_DIRDNL - Directional Control Of 50G

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

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

607: 50GPICKUP - 50G Pickup Setting

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

the operating current for a fault at the remote end of the line.

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

$$50G_{op} = 3x|I_0| - 50GRESTNT \times 3x|I_1|$$

where:

$$50GRESTNT = 0 \text{ or } 0.3$$

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

$$50GPICKUP = 3x|I_0| - 50GRESTNT \times 3x|I_1| + 0.25 \times 3x|I_0|$$

608: 50GPCKUPFF - Pickup During Fuse Failure

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

609: 50GRESTNT - 50G Restraint Setting

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

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

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

611: 51G_DIRCNL - Select Directional Control of TOC

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

612: 51GPICKUP - Ground Time Overcurrent Setting

The **51G** function provides time-delayed backup tripping for single-line-to-ground faults, and its operating quantity is:

$$3x|I_0|$$

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

613: 51GPCKUPFF - 51G Pickup During Fuse Failure

If **51G** is made directional and potential is lost to the relay, then directional control will be lost and the **51G** function will not be able to

provide any protection. To overcome this drawback, a second setting (**51GPCKUPFF**) can be made on the **51G** function to provide some backup during a loss of potential. A **51GPCKUPFF** setting must always be made and it must always be set as given above and based on the maximum operating quantity that can be obtained for a fault at either end of the.

614: 51GCURVE - Select 51G Characteristic Curve

51GCURVE determines the characteristic curve shape for the **51G** function. The choices are (**INV**, Figure 2 - 19) inverse curve, (**V-INV**, Figure 2 - 20) very inverse curve, (**E-INV**, Figure 2 - 21) extremely inverse, (**CUSTOM**) user-defined custom curve, and (**DEFT**) definite time.

615: 51GTIMDIAL - Ground Time Overcurrent Time Dial

51GTIMDIAL selects the time-dial setting for the **51G** function. **51GTIMDIAL** 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.

616: DEFTIMDELY - Definite Time Delay

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

617: 51G_RESET - Select Time Overcurrent Reset Characteristic

The **51G** function can be set to have a very fast reset (approximately 50 milliseconds for the definite time curve and 4 milliseconds for the variable time curves) following its pickup, or it can be set to have a reset characteristic that

emulates the reset time of an electro-mechanical device with a similar time curve. Select **FAST** for the fast reset or **EM** to emulate an electro-mechanical function.

VOLTAGE

701: RATEDVOLTS - Rated Per Unit Voltage

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

702: PHASEOVER - Select Phase Overvoltage

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

703: PHOVPICKUP - Phase Overvoltage Pickup

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

704: PHOVTMDLY - Phase Overvoltage Time Delay

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

Positive Sequence Voltage Functions

The **ALPS** system can be supplied with positive sequence overvoltage functions if desired. Two types of functions are provided:

1. An uncompensated overvoltage function (**V1OVER**) that operates on positive sequence voltage alone:

$$\mathbf{V1OVER} = \mathbf{V1}$$

2. A compensated overvoltage function (**V1COMP**) that operates on positive sequence voltage and a compensating voltage that is related to the positive sequence current and a compensating impedance:

$$\mathbf{V1COMP} = \mathbf{V1} - \mathbf{I1} \times \mathbf{Z1c}$$

where,

V1 = positive sequence voltage at the relay

I1 = positive sequence current at the relay

Z1c = compensating positive sequence impedance

The uncompensated function is meant to respond to the positive sequence voltage developed directly at the relay location. The compensated function is meant to respond to the positive sequence voltage at some point (**Z1c** ohms) in front of the relay location. For example, if **Z1c** is set equal to the positive sequence impedance of the protected line, then **V1COMP** will measure the positive sequence voltage developed at the end of the line remote from the relay location.

705: V1OVER - Select Positive Sequence Overvoltage (Overvoltage Models Only)

If the uncompensated positive sequence voltage function is to be used, set **V1OVER** = **YES** otherwise, set **V1OVER** = **NO**.

706: V1OVINSTPU - Instantaneous Positive Sequence Overvoltage Pickup

V1OVINSTPU establishes the pickup setting of the instantaneous **V1OVER** function and can be set from **1.0** to **1.4** per unit based on the **RATEDVOLTS** setting. If **V1OVER** is selected, make a **V1OVINSTPU** setting that is suitable to the particular application.

707: V1OVTIMPU- Time Positive Sequence Overvoltage Pickup

V1OVTIMPU establishes the pickup setting of the time delayed **V1OVER** function and can be set from **1.0** to **1.4** per unit based on the **RATEDVOLTS** setting. If **V1OVER** is selected, make a **V1OVTIMPU** setting that is suitable to the particular application.

708: V1OVTIMDLY - Positive Sequence Overvoltage Time Delay

V1OVTIMDLY establishes the time delay to be used with the time delayed positive sequence overvoltage function and can be set from **0** to **10.0** seconds. If **V1OVER** is selected, make a **V1OVTIMDLY** setting that is suitable to the particular application.

709: V1COMP - Compensated Positive Sequence Overvoltage Function

If the compensated positive sequence voltage function is to be used, set **V1COMP** = **YES** otherwise, set **V1COMP** = **NO**.

710: V1COMPRCH - Compensated Positive Sequence Overvoltage Function Impedance

V1COMPRCH establishes the point (in positive sequence ohms) in front of the relay at which the positive sequence voltage will be measured. If **V1COMP** is selected, make a **V1COMPRCH** setting that is suitable to the particular application.

711: V1COMPINPU - Compensated Positive Sequence Voltage Instantaneous Pickup

V1COMPINPU establishes the pickup setting of the instantaneous **V1COMP** function and can be set from **1.0** to **1.4** per unit based on the **RATEDVOLTS** setting. If **V1COMP** is selected, make a **V1COMPINPU** setting that is suitable to the particular application.

712: V1COMPTDPU - Compensated Positive Sequence Overvoltage Time Delayed Pickup

V1COMPTDPU establishes the pickup setting of the time delayed **V1COMP** function and can be set from **1.0** to **1.4** per unit based on the **RATEDVOLTS** setting. If **V1COMP** is selected, make a **V1COMPTDPU** setting that is suitable to the particular application.

713: V1COMPTDLY - Compensated Positive Sequence Overvoltage Time Delay

V1COMPTDLY establishes the time delay to be used with the time delayed positive sequence overvoltage function and can be set from **0** to **10.0** seconds. If **V1COMP** is selected, make a **V1COMPTDLY** setting that is suitable to the particular application.

714: FUSEFAIL - Potential Fuse Failure Blocking

Since a distance or directional function may operate for a full or partial loss of ac potential caused by one or more blown fuses, **FUSEFAIL** is provided to block distance and directional function tripping when a fuse failure is detected. If the backup overcurrent functions **50**, **50G**, and **51G** are non-directional they will be allowed to trip. If **50**, **50G** or **51G** are non-directional, then they will not be allowed to trip. Figure 2 - 10 shows the functional logic for the **FUSEFAIL** function.

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

circuit breaker(s) are open, **FUSEFAIL** is disabled.

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

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

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

BLK RECLOS

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

801: ALL_BELOW - Block Reclosing For All Selectable Functions/Logic Points

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

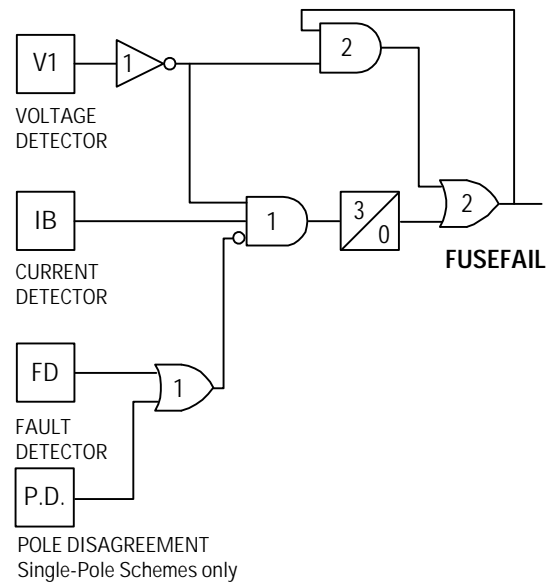


Figure 2 - 10

802: OUTOFSTEP - Block For Out Of Step

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

803: ALL_3_Z2PH - Block For Three-Phase Faults

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

804: 50G_BLOCK - Block For 50G

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

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

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

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

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

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

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

808: Z1PHASRIP - Block For Zone 1 Phase Trip

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

809: ANYZ2PHASE - Block For Any Zone 2 Phase Fault

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

810: CONFGTRIP - Block For Configurable Trip Logic

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

LINEPICKUP

Line Pickup provides tripping in the event that the breaker is closed into a zero-voltage bolted three-phase fault, such as occurs if the grounding chains were left on the line

following maintenance. Figure 2 - 11 shows the functional logic for Line Pickup.

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

If the line is energized and no fault exists, V1 picks up and timer TL1 will begin timing; 25 ms later the output of TL1 resets timer TL2 via the fast reset input. AND1 and AND2 have the lower inputs removed at that time to take Line Pickup out of service.

If the line is energized and a fault exists, current detector I1 or one of the ZONE 2 distance functions will operate and AND1 and/or AND2 will produce an output.

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

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

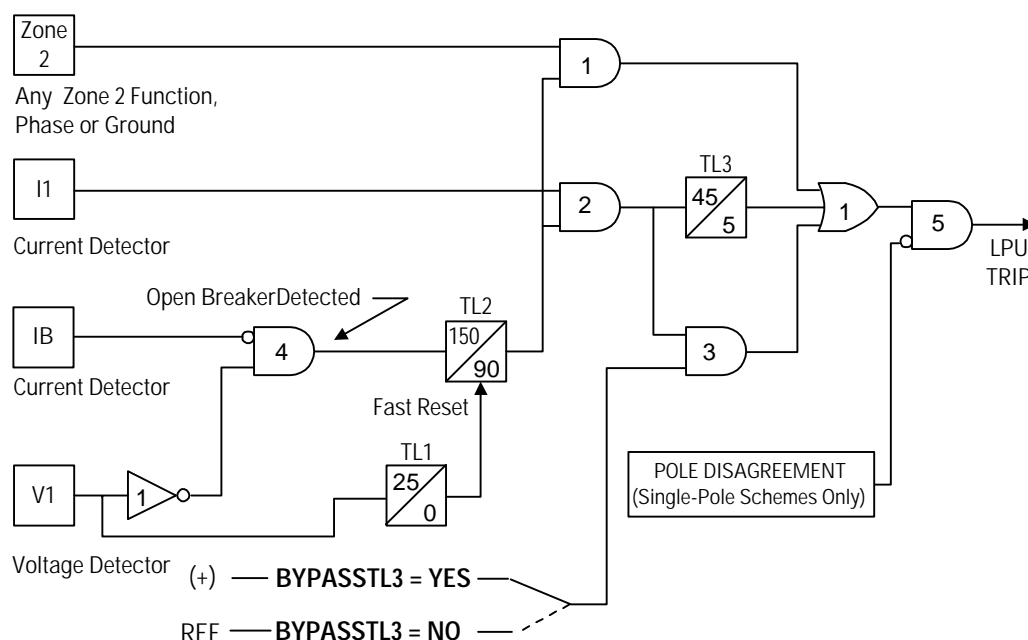


Figure 2 - 11

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

901: LINEPICKUP - Select Line Pickup

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

902: BYPASSTL3 - Bypass Line Pickup Time Delay

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

903: I1PICKUP - I1 Pickup Setting

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

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

REMOTEOPEN

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

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

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

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

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

If sufficient load current is flowing prior to the fault, there is no output from OR1, indicating that no charging current is detected, and AND3 is not blocked, since there is no output from AND2. If an unbalanced fault

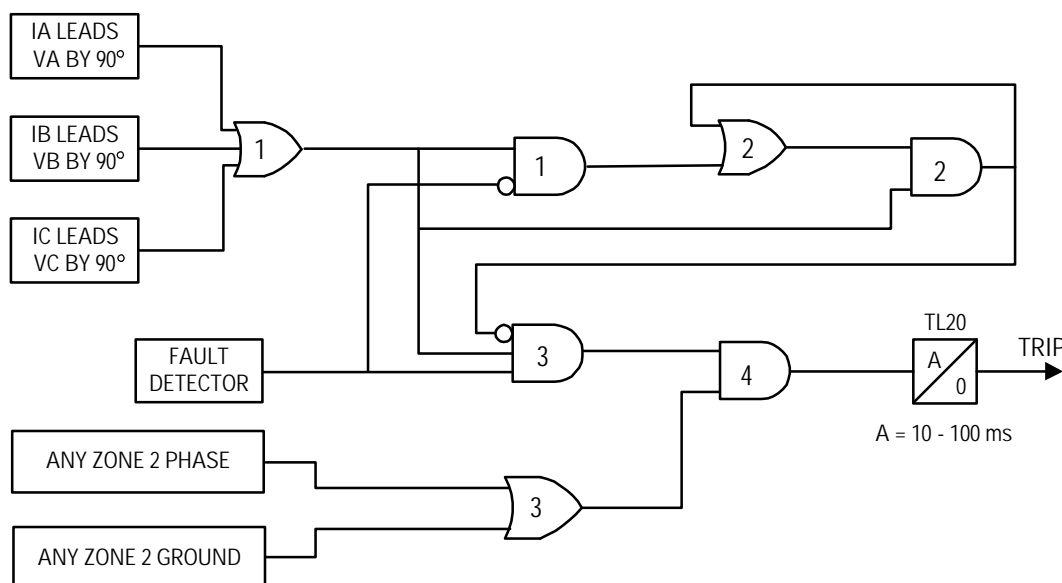


Figure 2 - 12

subsequently occurs, **FD** blocks **AND1** to prevent an **AND2** output. **AND3** is allowed to produce an output when the remote breaker opens, provided there is sufficient charging current to operate one or more of the three charging-current-detectors that are the inputs to **OR1**. The capacitive charging current must be 60 milliamperes or more (secondary phase current) to assure operation of **ROD**. If the fault is still present, as indicated by an output from **OR3**, a **ROD** trip is initiated following **TL20** security time delay setting.

1001: REMOTEOPEN - Select Remote Open Detector

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

1002: TL20PICKUP - Remote Open Detector Time Delay

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

LINEOVRD

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

1101: LINEOVERLD - Select Line Overload Protection

Set **LINEOVERLD** = **YES** if line overload protection is to be used, otherwise set

LINEOVERLD = **NO**. If **LINEOVERLD** = **NO**, ignore settings **1102** - **1105**.

1102: LEVEL1PU - Level 1 Pickup Current

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

1102: LEVEL2PU - Level 2 Pickup Current

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

1103: LEVEL1TDLY - Level 1 Time Delay

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

1104: LEVEL2TDLY - Level 2 Time Delay

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

SCHEME

1201: PICKSCHEME - Select Scheme Logic

Any one of the following schemes can be selected:

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

Set **PICKHEME** to the desired scheme.

1202: NUMRCVR - Select Number Of Receivers

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

1203: TRIPMODE - Select 1-Phase/3-Phase Trip Mode

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

1. **3POLE** - with this selection, three-pole tripping will be initiated for all faults regardless of the fault type.
2. **1pole** - with this selection, single-pole tripping will be initiated for single line to ground faults and three-pole tripping will be initiated for all multi-phase faults.
3. **1poleZ2** - with this selection, tripping will be the same as with the **1pole** setting with the additional feature that single-pole tripping will also be initiated for zone 2 time-delayed single-line-to-ground faults.

1204: CARRSTART - Select Function To Use To Start Carrier In BLOCKING Scheme

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

1. **DIR** - with this selection, carrier will be started by the operation of the **NB** and **IPB** functions.
2. **IPB** - with this selection carrier will be started by the operation of the **IPB** function.

3. **FD** - with this selection will be started by the operation of the fault detector (**FD**) function.

SCHMTIMERS

1301: TL1PICKUP - Trip Integrator

Stepped Distance Scheme

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

Blocking Scheme

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

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

Based on the above, use the following setting:

$$\text{TL1PICKUP} = 2 + \text{channel time} + \text{propagation time}$$

Where, channel time and propagation time are entered in milliseconds.

PUTT, POTT1, POTT2 and HYBRID Schemes

For a these schemes, timer TL1 provides security against spurious channel output during external faults within the reach of the overreaching trip functions. **TL1PICKUP**

should be based on the maximum output, if any, expected from the channel under these conditions.

1302: TL4PICKUP - Pott1 Coord Timer Pu

POTT1 Scheme

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

$$\text{TL1PICKUP} = 4 \text{ ms}$$

$$\text{TL4PICKUP} = 13 \text{ ms} + \text{channel release time}$$

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

PUTT Scheme

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

1303: TL4DROPOUT - Pott1 Coord Timer Do

PUTT and POTT1 Schemes

Set **TL4DROPOUT** to 0.

Stepped Distance, POTT2, Blocking and Hybrid Schemes

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

1304: TL5PICKUP - BKR1 b sw COORD TIMER PU

POTT1 ,POTT2 and PUTT Schemes

For these schemes, the breaker 52/b contacts are required to key the local transmitter to the TRIP frequency when all three poles of the breaker(s) are open. TL5 and TL6 provide coordinating times to synchronize the breaker 52/b switch contact operation with the opening and closing of the breaker's main interrupting contacts. The pickup times (**TL5PICKUP** and **TL6PICKUP**) should be set so that an output will be produced just after the main contacts of the breaker open. The dropout times (**TL5DROPOUT** and **TL6DROPOUT**) should be set so that the timer output resets just before the main contacts of the breaker close. The outputs of the timers are AND'ed together when two breakers are used. The switch shown in Figures 2-12 and 2-13 is not a physical switch but is just a logical representation that is digitally by the **NUM_BKR** setting (105) described in the GENERAL SETTINGS section of this book.

Figure 2 - 13 shows the connections for a three-pole tripping scheme. The 52/b contacts are wired from breaker 1 to CC5 and from breaker 2 to CC6.

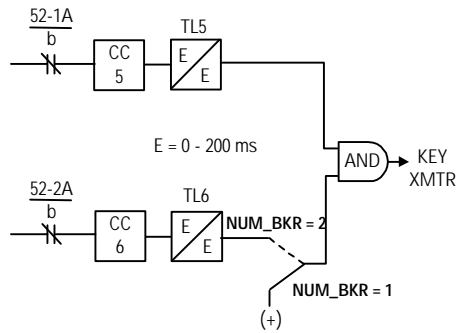


Figure 2 - 13

Figure 2 - 14 shows the connections for a single-pole tripping scheme. The 52/b contacts are wired from breaker 1 to CC8 (phase A), CC9 (phase B), and CC10 (phase C), as shown in the Figure.

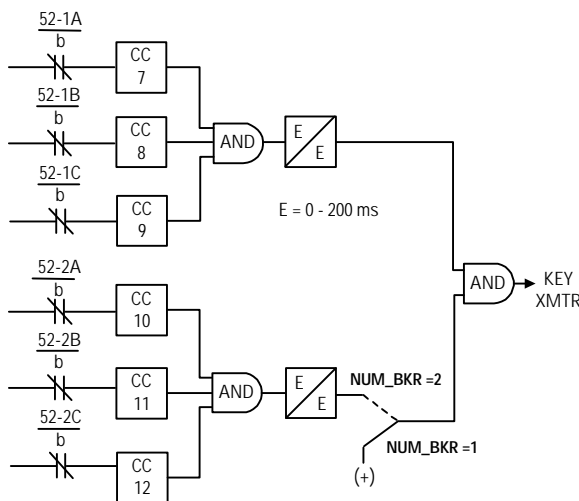


Figure 2 - 14

In either type of scheme (single-pole or three-pole), the output of TL5 and TL6 are also used by the **ALPS** system to provide a time-tagged event to indicate that the breaker is either open or closed.

Blocking and Hybrid Schemes

Keying of the transmitter is not required in these schemes, however, the **ALPS** system uses these timer outputs to provide a time-tagged event to indicate that the breaker is either open or closed. If these events are required,

then wire the 52/b contacts as shown in Figures 2-12 and 2-13. The setting requirements for TL5 and TL6 are the same as described above.

1305: TL5DROPOUT - Bkr1 b sw Coord Timer DO

See description for **TL5PICKUP**.

1306: TL6PICKUP - Bkr2 b sw Coord Timer Pu

See description for **TL5PICKUP**.

1307: TL6 DROPOUT - Bkr2 b sw Coord Timer DO

See description for **TL5PICKUP**.

1308: TL16PICKUP - Weak Infeed Trip Timer

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

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

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

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

1309: TL24DRPOUT - Gdoc Blocking TimerStepped Distance and POTT1 Schemes

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

Blocking, Hybrid and POTT2 Schemes

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

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

The following settings are proposed:

1. Uncompensated Lines
TL24DRPOUT = 30 ms
2. Series Compensated Lines or Lines Adjacent to a Series Compensated Line
TL24DRPOUT = 125 ms

1310: TL25DRPOUT - Distance Blocking Timer

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

Blocking, Hybrid and POTT2 Schemes

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

1. current reversals that can occur as a result of sequential clearing of faults on a parallel line

2. voltage reversals that can occur for faults near capacitors on series compensated lines.
3. transients that can occur for external fault clearing

The following settings are proposed:

1. Uncompensated Lines
Three-pole tripping schemes:
TL25DRPOUT = 30 ms
Single-pole tripping schemes:
TL25DRPOUT = 50 ms
2. Series Compensated Lines or Lines Adjacent to a Series Compensated Line
TL25DRPOUT = 125 ms

1311: TL26PICKUP - Repeat Delay TimerStepped Distance, Blocking, POTT1 and POTT2 Schemes

This timer is not used in these schemes, therefore it will be ignored, and any setting that is made is irrelevant.

Hybrid Scheme

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

The following settings are proposed:

With an **ALPS** system at the remote terminal of the line:

TL26PICKUP = 0 ms

With other than an **ALPS** system at the remote terminal of the line:

TL26PICKUP = $|Z_{Blocal} - Z_{Tremote}| + P + C$

Where,

$|Z_{Blocal} - Z_{Tremote}|$ is the maximum difference in operating time between the blocking functions in the **ALPS** system and the tripping functions in the system at the remote end of the line. if Z_{Blocal} is less than $Z_{Tremote}$, ignore this term in the calculation.

C is the channel time of the communications channel.

P is the channel propagation time from the remote terminal to the local terminal.

LINE INFO

1401: POSSEQANG - Positive Sequence Impedance Angle

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

1402: ZERSEQANG - Zero Sequence Impedance Angle

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

1403: ZLINE - Positive Sequence Line Impedance

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

1404: ZEROSEQKO - Zero Sequence Current Compensation

ZEROSEQKO establishes the amount of zero-sequence current that is used in all of the ground-distance functions (except zone 1) to provide "self-compensation." This permits the

reach setting for the ground-distance functions to be based on the positive-sequence impedance of the protected line. Use the following setting:

$$\text{ZEROSEQKO} = Z_{0L} / Z_{1L}$$

where:

Z_{0L} = zero-sequence impedance of line

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

1405: LINELENGTH - Line Length

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

1406: LINEUNIT - Unit Of Length

The **ALPS** system will report the distance to the fault relative to the relay location. Set **LINEUNIT** equal to miles if location in miles is required, otherwise set **LINEUNIT** equal to kilometers.

1407: CTRATIO - Current Transformer Ratio

The **ALPS** system will report present values in terms of secondary values or primary values as set by the **DISPLAYVAL** setting (**108**) under General Settings. The ratio of the of the current transformers used to supply the system is used in this procedure. Set **CTRATIO** equal to the CT ratio used with the **ALPS** system.

1408: PTRATIO - Potential Transformer Ratio

The **ALPS** system will report present values in terms of secondary values or primary values as set by the **DISPLAYVAL** setting (**108**) under General Settings. The ratio of the of the potential transformers used to supply the

system is used in this procedure. Set **PTRATIO** equal to the PT ratio used with the **ALPS** system.

SCADA DATA

An internal DTA (digital to analog) function, standard on the **ALPS** system, provides the following:

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

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

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

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

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

1501: FLTLOCK - Hold Time

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

1502: FLTRESET - Fault Location Reset Time

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

Example:

FLTLOCK = 10 seconds

FLTRESET = 5 minutes

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

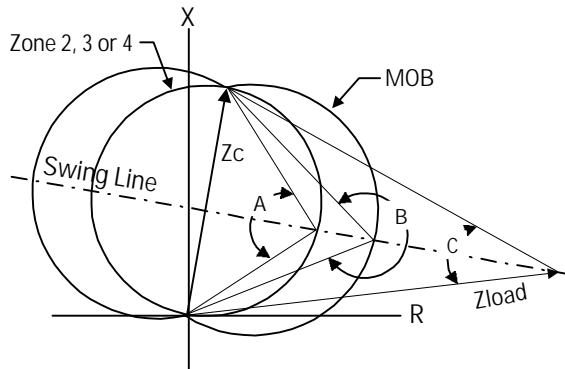


Figure 2 - 15

OS BLOCKING

Out-of-step blocking (OSB) is offered as a standard feature in the **ALPS** system. Refer to the product description section of this book for a complete description of the OSB logic. The OSB function is implemented through the distance functions in the **ALPS** system as shown in Figure 2 - 15. For an out-of-step condition, the apparent impedance seen by the relay will follow a typical swing line as shown in Figure 2 - 15. The **ALPS** system recognizes an out-of-step condition by sensing that the MOB function operates first, and that the coordinating function (zone 2, 3 or 4) operates a short time later. The **MOBZONE** setting is used to select which of the zones (2, 3 or 4) is used as the coordinating zone. Note that zone 4 can only be used as the coordinating zone when it is set to look in the forward direction (**Z4DIRECTN** = **FORWRD**).

The angles A, B and C are determined as a function of the reach (Z_c) of the coordinating zone, the maximum load flow (minimum Z_{load}) and the fastest swing (first slip cycle). The angle A in the figure is selected via the **ZxPCHARANG** ($x = 2, 3$ or 4) and determines the shape of the coordinating zone characteristic. The angle B is selected via the **MOBCHARANG** setting and determines the shape of the MOB characteristic. The angle B should be set so that the time for the fastest swing to traverse from angle B to angle A is not

less than 30 milliseconds. In addition, the A and B angle settings must be selected so that the difference between angle B and angle C is never less than 20 degrees. Note that angle C is determined as a function of the minimum load impedance (Z_{load}) and the reach (Z_c) of the coordinating zone. Load flow and stability studies may have to be run to determine the settings necessary to establish out-of-step blocking.

1601: MOBZONE - Coordinating Zone

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

1602: MOBCHARANG - MOB Characteristic Angle

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

1603: BLOCKWHAT - Functions To Block During OS

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

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

1604: BLOCKZ1 - Block All Zone 1 Functions

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

1605: BLOCKZ2 - Block All Zone 2 Functions

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

1606: BLOCKZ3 - Block All Zone 3 Functions

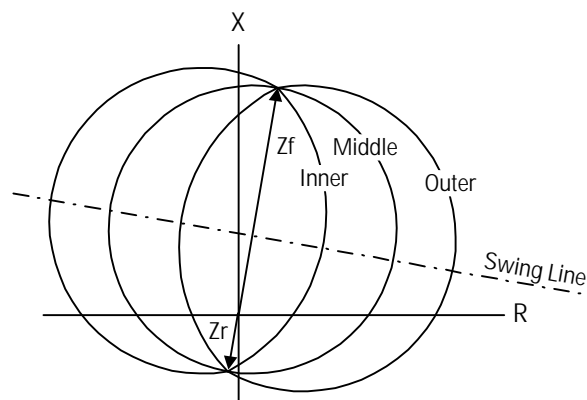
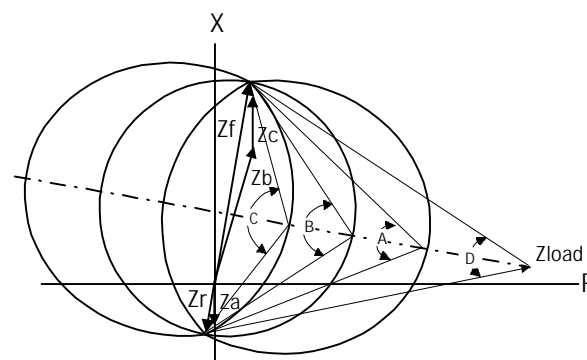
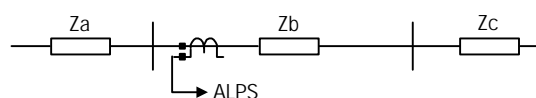
Set **BLOCKZ3 = YES** to block tripping by any of the zone 3 distance functions, otherwise set **BLOCKZ3 = NO**.

1607: BLOCKZ4 - Block All Zone 4 Functions

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

OST TRIPPING

The **ALPS** system can be supplied with out-of-step tripping (optional) in addition to the out-of-step blocking described earlier. For a complete description of the operation of the Out-of-step tripping logic see the **Product Description** section of this book. Out-of-step tripping is implemented using positive sequence distance functions (separate from the regular **ALPS** distance functions) as shown in Figure 2 - 16. Briefly, for an out-of-step condition, the apparent impedance seen by the relay will follow a typical swing line as shown in Figure 2 - 16. An out-of-step condition is recognized by sensing that the apparent impedance seen by the system first enters the outer characteristic, then the middle characteristic and finally the inner characteristic. The traversal from characteristic to characteristic occurs in a finite time that is directly related to the slip frequency of the power system during an out-of-step condition.

**Figure 2 - 16****Figure 2 - 17**

The following settings must be made (refer to Figures 2-15 and 2-16). It will most likely be necessary to run load flow and system swing studies to determine the settings that must be made in any given application. The example used below is provided only for use as a guide in describing each of the settings.

1701: USE_OST - Select OST

Set **USE_OST = YES** if out-of-step tripping is to be used, otherwise set **USE_OST = NO**.

1702: NUMBRCHAR - Select Number Of Characteristics

Depending on the application, it may not be possible to use all three of the characteristics, and the **MIDDLE** characteristic must be bypassed. If only two characteristics are to be used (**MIDDLE** characteristic bypassed), set **NUMBRCHAR** = 2, otherwise set **NUMBRCHAR** = 3.

1703: TRIPIN_OUT - Trip Enter Or Leaving Inner

The **OST** function can be set so that tripping will be initiated shortly after the impedance enters the inner characteristic (pickup time of **TLOS3**), or it can be set to trip shortly after the swing leaves the outer characteristic (dropout time of **TLOS1**). Which setting to use is determined by the capability of the breakers used in the power system:

1. If the circuit breaker is capable of

interrupting when the systems are approximately 180° apart (around twice voltage across the breaker contacts) set **TRIPIN_OUT** = **IN**.

2. If the circuit breaker is not capable of interrupting when the systems are nearly 180° apart, set **TRIPIN_OUT** = **OUT**.

1704: FWDREACH - OST Forward Reach

For the simple system shown in Figure 2 - 17, set the forward reach long enough to include the line plus the source at the remote end of the line; i.e.,

$$\text{FWDREACH} > Z_b + Z_c$$

1705: REVREACH: - OST Reverse Reach

For the system shown in Figure 2 - 17, set the reverse reach to include the source behind the **ALPS** system; i.e.,

$$\text{REVREACH} > Z_a$$

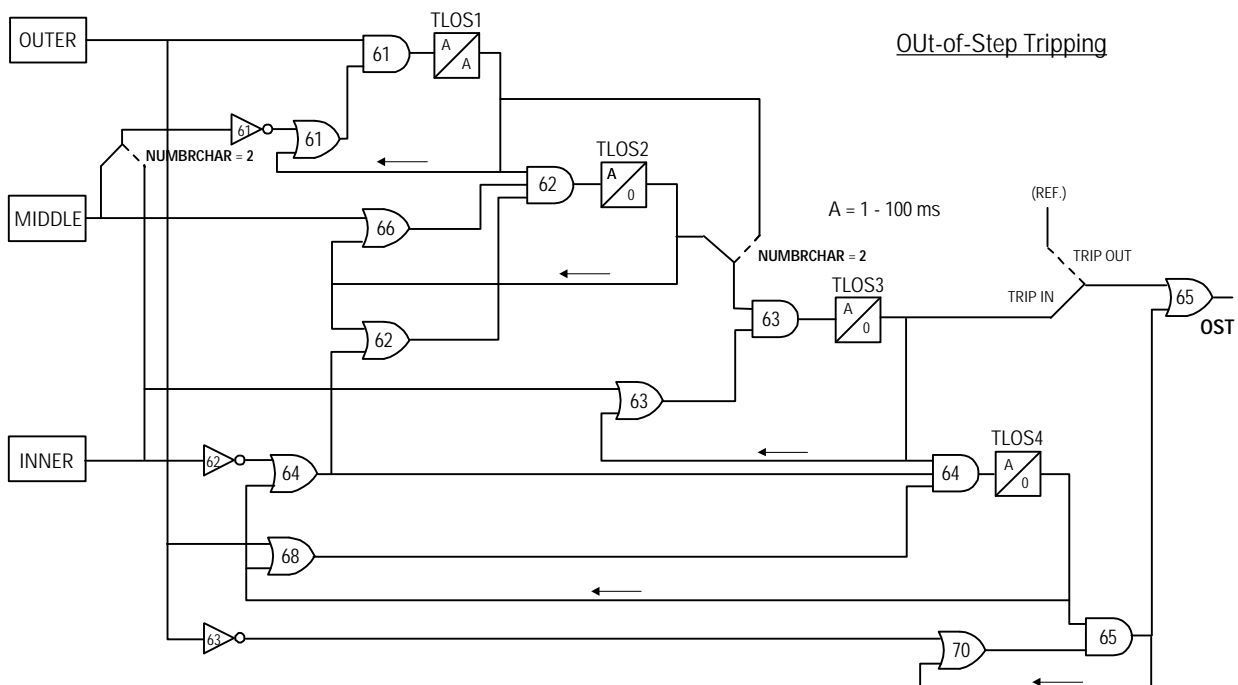


Figure 2 - 18

1706: OUTER: Outer Characteristic Angle

1707: MIDDLE - Middle Characteristic Angle

1708: INNER - Inner Characteristic Angle

These three settings are related and the object is to obtain the maximum difference in angle between the inner and outer settings. This provides the best opportunity of detecting the fastest possible powers swings. Two factors are used in determining the outer and inner settings:

1. the maximum load flow across the line which determines the minimum load impedance seen by the relay.
2. the maximum swing angle that the power system can tolerate and beyond which the system cannot recover; i.e., the system becomes unstable.

The **OUTER** characteristic angle setting (angle A in Figure 2 - 17) is based on the maximum load flow across the system and should be selected so that angle A is always greater than angle D by at least 20 degrees. For example if angle D = 50°, then set **OUTER** = 70°.

The **INNER** characteristic angle (angle C in Figure C-16) sets the point at which an out-of-step trip will be initiated and is dependent on the angle beyond which the system cannot recover. Select an **INNER** setting such that the system is beyond recovering once the inner characteristic is entered. Typical settings for **INNER** would be in the 120° to 150° range.

The **MIDDLE** characteristic angle setting is dependent on the **OUTER** setting and the **INNER** setting, and should be set approximately halfway between the two. For example if **OUTER** = 70° and **INNER** = 150°, then set **MIDDLE** = 110°.

1709: TLOS1PU - Coordinating Timer 1 Pickup

1710: TLOS1DO - Coordinating Timer 1 Dropout

1712: TLOS3PU - Coordinating Timer 3 Pickup

1713: TLOS4PU - Coordinating Timer 4 Pickup

1711: TLOS2PU - Coordinating Timer 2 Pickup

These five settings are related to each other with the object being to detect the fastest possible swing and to produce an **OST** output in a secure manner.

The pickup time of **TLOS1** establishes the first step in the out-of-step process and sets the time that the swing must remain between the outer and middle characteristics for the first step to be completed. **TLOS1PU** must be set less than the time that it takes for the *fastest* swing to travel from the outer to the middle characteristic. If **TRIPIN_OUT** is set to **OUT**, the dropout time of **TLOS1** sets the duration of time that and out-of-step trip output will be produced. A minimum setting for **TLOS1DO** of 50 milliseconds is proposed. If **TRIPIN_OUT** is set to **IN**, then **TLOS1DO** can be set to any setting within its' range.

The pickup time of **TLOS2** establishes the second step in the out-of-step process and sets the time that the swing must remain between the middle and inner characteristics for this step to be completed. **TLOS2PU** must be set less than the time that it takes for the *fastest* swing to travel from the outer to the middle characteristic.

The pickup time of **TLOS3** establishes the final step in the out-of-step process and determines the time that the swing must remain inside of the inner characteristic before the final decision is made to produce an out-of-step trip. It provides added security

to the logic. A minimum setting for **TLOS3PU** of **20** milliseconds is proposed .

If **TRIPIN_OUT** is set to **OUT**, then the output of timer **TLOS4** is used to seal in the logic used to provide a trip output once the swing leaves the outer characteristic. Timer **TLOS4** is started when the swing exits the inner characteristic (NOT62 produces an output). The pickup time of **TLOS4** provides added security to the system. A minimum setting for **TLOS4PU** of **20** milliseconds is proposed.

RECLOSER

The **ALPS** system can be supplied with an optional recloser, a complete description of which can be found in the **Product Description** section of this book. Note that if another relaying system is going to be used with or without the **ALPS** system to control the recloser, then that relaying system must be capable of supplying a 1PRI (one pole reclose) and a 3PRI (three-pole reclose) input to the recloser. The following settings must be made when the recloser is supplied.

1801: RECLMODE - Select Reclosing Option

Set one of the following reclosing options:

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

OFF - no internal or external reclosing allowed. The three-pole trip enable output (see outputs for details) will be enabled at this time.

INTERNAL - controlled by **ALPS** only.

EXTERNAL - controlled by external relays only.

BOTH - controlled by **ALPS** or external relays.

1802: RECLOSETYPE - Select Reclosing Type

Set one of the following reclosing types:

1POLE - With this type of reclosing selected, the first trip must be single-pole so that a 1PRI signal is supplied to the recloser to start the

first reclose. If the first trip is three-pole, then the 3PRI signal will cause the recloser to go to lockout. When 1POLE reclosing is used, the three-pole trip enable signal (see recloser outputs in product description section) will be set after the first reclose signal is issued, but not until at least 30 milliseconds after the 1PRI signal is removed from the recloser. The three-pole trip enable signal will be maintained until the recloser resets or goes to lockout. This will insure that three-pole tripping will be initiated for any subsequent faults that may occur during the remainder of the reclosing cycle. Up to three subsequent three-pole reclosures with independent time delays can be selected (Setting **1803, NUM1P**). These subsequent reclosures will be started by an input from the three-pole reclose initiate (3PRI) signal. This mode of operation requires four independent timers which hereafter will be referred to as **1PDELAY1, 1PDELAY2, 1PDELAY3 AND 1PDELAY4** (settings **1804 - 1807**).

3POLE - With this type of reclosing selected, the first trip must be three-pole so that a 3PRI signal is supplied to the recloser to start the first reclose. If the first trip is single-pole, then the 1PRI signal will cause the recloser to go to lockout. All reclosures will be started by an input from the three-pole reclose initiate (3PRI) signal. Up to four reclosures with independent time delays can be selected (Setting **1808, NUM3P**). In this mode of operation, the three-pole trip enable signal will be set at all times. This mode of operation requires four independent timers which hereafter will be referred to as **3PDELAY1, 3PDELAY2, 3PDELAY3 AND 3PDELAY4** (settings **1809 - 1812**).

1POLE/3POLE - This mode of operation is a combination of modes 1 and 2 above. If a 1PRI input is first applied to the recloser, then the program by the **1POLE** setting will be followed. On the other hand, if a 3PRI input is first applied to the recloser then the program described by the **3POLE** setting will be followed. This mode of operation uses the same timers described by the **1POLE** and **3POLE** settings respectively. The number of reclose attempts for the **1POLE** and **3POLE**

programs are set independently by **NUM1P** and **NUM3P** (Settings **1803** and **1808**).

1803: NUM1P - Number Of Attempts Following Single-pole Trip

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

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

Select a setting suitable for the application.

1804: 1PDELAY1 - Single Pole First Reclose Delay

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

1805: 1PDELAY2 - Single Pole Second Reclose Delay

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

1806: 1PDELAY3 - Single Pole Third Reclose Delay

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

1807: 1PDELAY4 - Single Pole Fourth Reclose Delay

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

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

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

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

Select a setting suitable for the application.

1809: 3PDELAY1 - Three Pole First Reclose Delay

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

1810: 3PDELAY2 - Three Pole Second Reclose Delay

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

1811: 3PDELAY3 - Three Pole Third Reclose Delay

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

300.0 seconds. Select a setting suitable for the application.

1812: 3PDELAY4 - Three Pole Fourth Reclose Delay

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

1813: RESETTIME - Reset Time

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

1814: DWELLTIME - Contact Dwell Time

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

1815: HOLD: Inhibit Hold Select

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

1816 HOLDDTIME - Inhibit Hold Time

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

1817 HOLDSENSE - Contact Input Status

HOLDSENSE can be set to:

CC - contact closed

CO - contact open

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

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

1818: SYNCHECK - Synch Check Supervision Select

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

1819: CLOSEANG - Closing Angle

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

1820: SLIPFREQ - Slip Frequency

SLIPFREQ establishes the slip frequency for which the synchronism check function will

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

1821: BUSLINE - Bus or Line Voltage

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

1822: SYNCPHASE - Voltage used by SYNCHECK

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

1823: SYNCHOLD - SYNCHECK Hold Time

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

1824: SP1PDELAY2 - Supervise Second Reclose Following Initial Single-pole Reclose

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

1825: SP1PDELAY3 - Supervise Third Reclose Following Initial Single-pole Reclose

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

1826: SP1PDELAY4 - Supervise Fourth Reclose Following Initial Single-pole Reclose

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

1827: SP3PDELAY1 - Supervise First Three-pole Reclose

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

1828: SP3PDELAY2 - Supervise Second Three-pole Reclose

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

1829: SP3PDELAY3 - Supervise Third Three-pole reclose

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

1830: SP3PDELAY4 - Supervise Fourth Three-pole reclose

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

1831: SYNCMANCLS - Supervise Manual Close

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

1832: VBUSLIVE - Live Bus Voltage

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

1833: VBUSDEAD - Dead Bus Voltage

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

1834: VLINELIVE - Live Line Voltage

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

1835: VLINEDeAD - Dead Line Voltage

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

1836: LBUStLINE: - Live Bus Dead Line

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

1837: DBUSLLINE - Dead Bus Live Line

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

1838: DBUSDLINe - Dead Bus Dead Line

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

1839: DELTAV - Voltage Difference

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

1840: DELTAVBLK - Block Synch Check by DELTAV

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

NONCRIT_AL

Up to eight of the signals listed in the Index Tables given at the end of this section can be used to produce a non-critical alarm signal (Index No. 52). This signal, when produced, will always be reported as an event and it can also be programmed to drive one of the output relays if an external alarm is required.

1901: NCAIN1 - Non-Critical Alarm Input #1

Set **NCAIN1** to one of the available Index numbers given in the Tables at the end of this section.

1902: NCAIN2 - Non-Critical Alarm Input #2

Set **NCAIN2** to one of the available Index numbers given in the Tables at the end of this section.

1903: NCAIN3 - Non-Critical Alarm Input #4

Set **NCAIN3** to one of the available Index numbers given in the Tables at the end of this section.

1904: NCAIN4 - Non-Critical Alarm Input #4

Set **NCAIN4** to one of the available Index numbers given in the Tables at the end of this section.

1905: NCAIN5 - Non-Critical Alarm Input #5

Set **NCAIN5** to one of the available Index numbers given in the Tables at the end of this section.

1906: NCAIN6 - Non-Critical Alarm Input #6

Set **NCAIN6** to one of the available Index numbers given in the Tables at the end of this section.

1907: NCAIN7 - Non-Critical Alarm Input #7

Set **NCAIN7** to one of the available Index numbers given in the Tables at the end of this section.

1908: NCAIN8 - Non-Critical Alarm Input #8

Set **NCAIN8** to one of the available Index numbers given in the Tables at the end of this section.

OUTPUTS

All 24 of the output contacts (settings **2001-2024**) in the **ALPS** system are configurable. They can be driven by any one of the functions as described by an index number provided in the Tables at the end of this section. Each of the contacts has a default setting as listed in the Protection Settings listed at the end of this section. The default settings are established through an *Xpression builder* file that is downloaded in the **ALPS** system in the factory. Any of the settings can be changed by modifying this logic via the *Xpression Builder* program, by settings change through

the **Alpslink** program, or by settings change through the keypad. Note that any index number settings that are changed through the keypad or Alpslink will be reflected in the configurable logic file, while any settings that are changed through the configurable logic will be reflected in the settings file.

2001: T1 - T1 Contact

If other than the default setting is to be used, change the configurable logic or select an index number reflecting the function by which the contact is to be driven.

2002: T2 - T2 contact

See setting **2001**.

2003: T3 - T3 Contact

See setting **2001**.

2004: T4 - T4 Contact

See setting **2001**.

2005: T5 - T5 Contact

See setting **2001**.

2006: T6 - T6 Contact

See setting **2001**.

2007: A1 - A1 Contact

See setting **2001**.

2008: A2 - A2 Contact

See setting **2001**.

2009: A3 - A3 Contact**2010: A4 - A4 Contact**

See setting **2001**.

2011: A5 - A5 Contact

See setting 2001.

2012: A6 - A6 Contact

See setting 2001.

2013: A7 - A7 Contact

See setting 2001.

2014: A8 - A8 Contact

See setting 2001.

2015: A9 - A9 Contact

See setting 2001.

2016: A10 - A10 Contact

See setting 2001.

2017: A11 - A11 Contact

See setting 2001.

2018: A12 - A12 Contact

See setting 2001.

2019: C1 - C1 Contact

See setting 2001.

2020: C2 - C2 Contact

See setting 2001.

2021: KT1 - KT1 Contact

See setting 2001.

2022: KT2 - KT2 Contact

See setting 2001.

2023: KT3 - KT3 Contact

See setting 2001.

2024: KT4 - KT4 Contact

See setting 2001.

2025: CNFTRIP - Initiate Three Pole Trip

The **CNFTRIP** setting allows tripping to be initiated through the trip output contacts that are used by the scheme logic. **CNFTRIP** can be driven by any one of the functions as described by an index number provided in the Tables at the end of this section, or separate logic can be designed using the *Xpression Builder* program.

2026: CONFOSC - Trigger Oscillography

The CONFOSC setting allows oscillography data capture to be initiated by the operation of selected signals within the ALPS logic, or via external input through a contact converter. Regardless of the setting of CONFOSC, oscillography data capture will always occur when the ALPS issues a trip output. Care should be taken to ensure that the signals chosen; if one of the selected triggers can operate frequently, trip oscillography data may be overwritten and lost. CONFOSC can be driven by any one of the functions as described by an index number provided in the Tables at the end of this section, or separate logic can be designed using the *Xpression Builder* program.

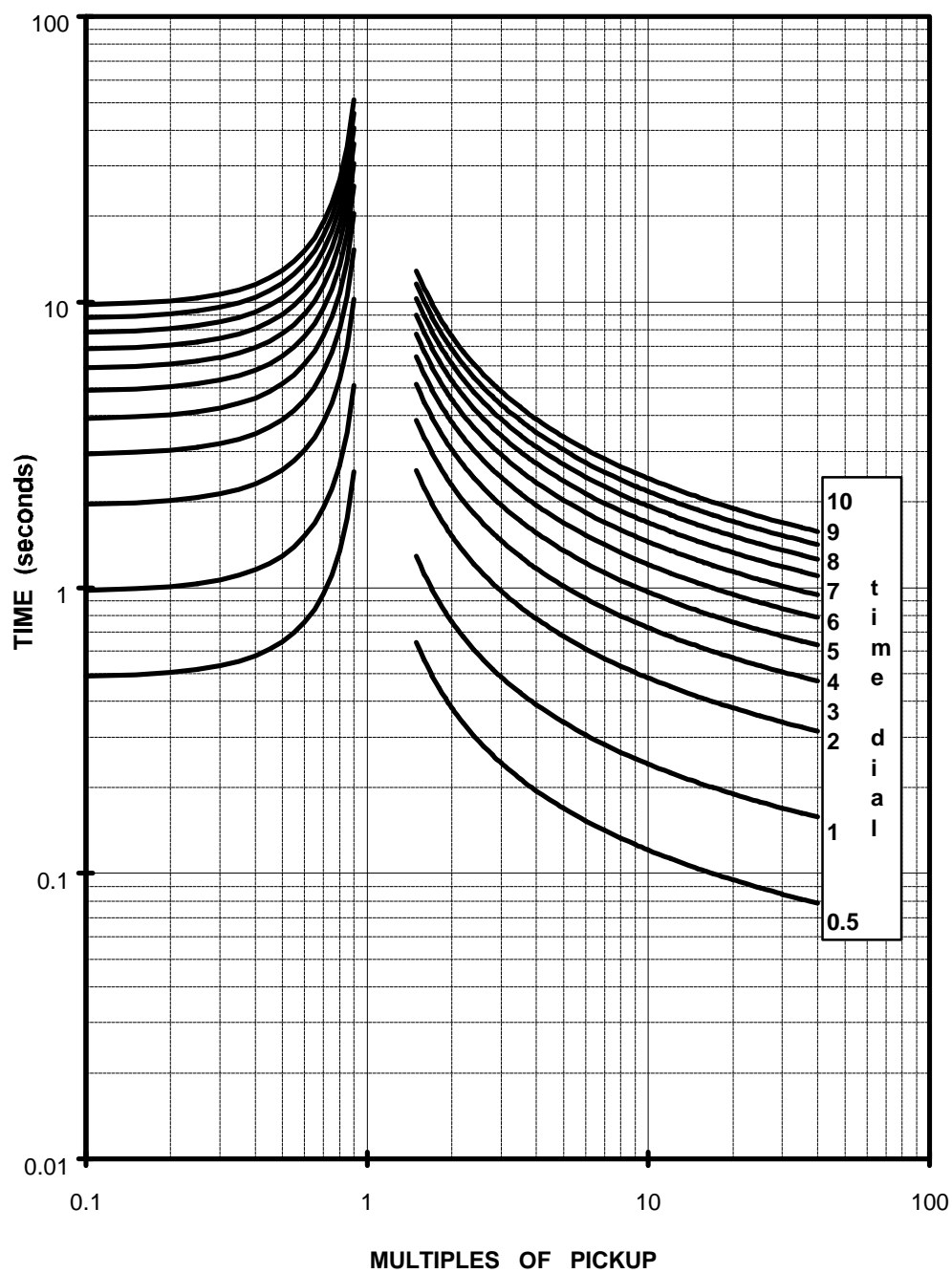
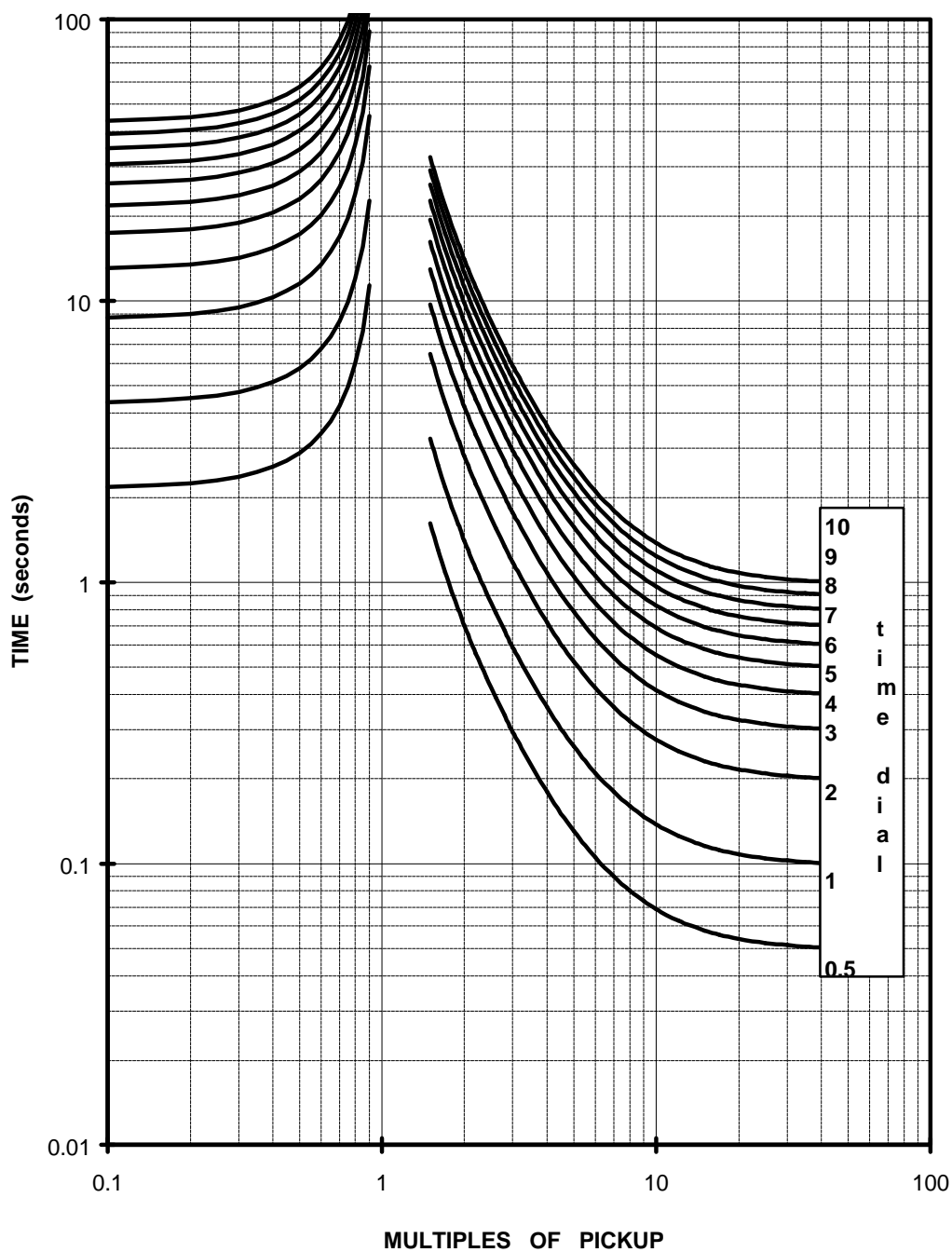
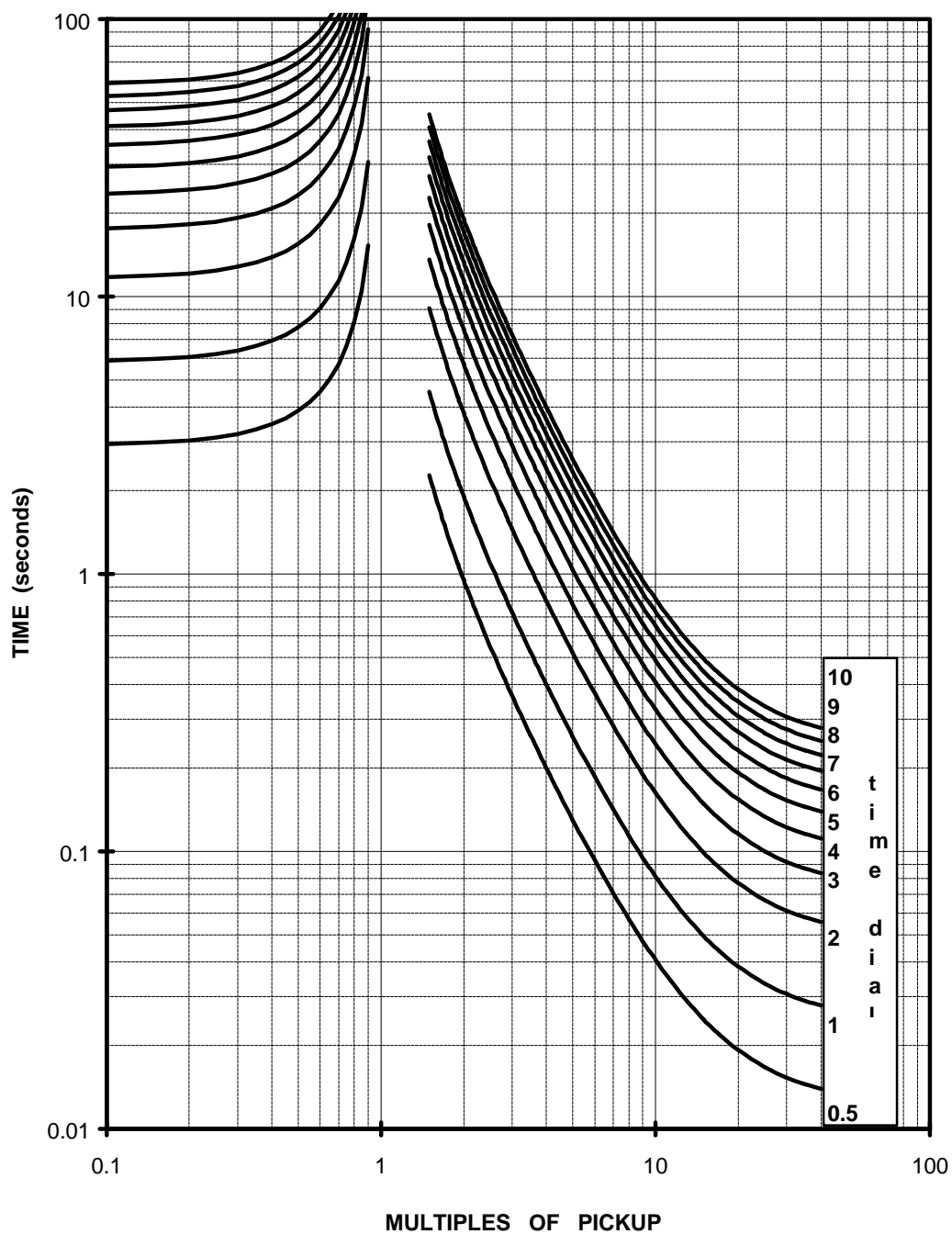


Figure 2 - 19, Inverse Curve



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

Figure 2 - 20, Very Inverse Curve



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

Figure 2 - 21, Extremely Inverse Curve

**INDEX NUMBERS FOR CONFIGURABLE LOGIC
AND PROGRAMMABLE OUTPUT FLAGS**

TABLE 2-VI

Contact Converter Input Assignment

Index	Description	Mnemonic
1	Breaker #1 52b Contact Input Phase A	52B_1A
2^	Breaker #1 52b Contact Input Phase B	52B_1B
3^	Breaker #1 52b Contact Input Phase C	52B_1C
4	Breaker #2 52b Contact Input Phase A	52B_2A
5^	Breaker #2 52b Contact Input Phase B	52B_2B
6^	Breaker #2 52b Contact Input Phase C	52B_2C
7^	Enable 3 Phase Tripping	EXTRP3P
8	Change Setting Group Input (BIT0)	CGST1
9	Change Setting Group Input (BIT1)	CGST2
10	External Contact Input to Stop Carrier*	STCR
11	External Contact Input to Block Pilot Tripping*	BPLTRP
12	Receiver 1 Input	RCVR1
13	Receiver 2 Input	RCVR2
14	External Reclose Initiate 1Pole	EXRI1P
15	External Reclose Initiate 3 Pole	EXRI3P
16	External Reclose Inhibit	EXRINH
17	External Reclose Cancel	EXRCNL
18	Reclose Reset	RCLRST
19	Enable 3 Phase Reclose	CLOS3P
20	External Contact Input to Reset ALPS Trip Target Display	RESET
21	External Contact Input to Disable Protection	DISPRT
22	External Contact Input to Disable Outputs	DISOUT
23	External Contact Input to Trigger Oscillography Capture	OSCTRG
24	Manual Lockout	MANLKT
25	CONFIGURABLE INPUT1	CNFDI1
26	CONFIGURABLE INPUT2	CNFDI2
27	CONFIGURABLE INPUT3	CNFDI3
28	CONFIGURABLE INPUT4	CNFDI4
29	CONFIGURABLE INPUT5	CNFDI5
30	CONFIGURABLE INPUT6	CNFDI6
31	CONFIGURABLE INPUT7	CNFDI7
32	CONFIGURABLE INPUT8	CNFDI8

NOTE: Any of the above signals (1-32) may be assigned to the 8 available ALPS Contact Converter Inputs (CC1 - CC8). Those 8 signals will also be available for use for the Programmable Outputs and/or the Configurable Logic. Unassigned signals will NOT be available.

* Applies to Blocking Scheme only.

**Index Numbers for Configurable Logic
and Programmable Output
Table 2-vi (cont'd)**

Scheme Logic, Recloser Logic, Programmable Logic Signals

Index	Description	Mnemonic
33	Trip Bus Phase A	TRIPA
34	Trip Bus Phase B	TRIPB
35	Trip Bus Phase C	TRIPC
36	1P Reclose Initiate	RI-IP
37	3P Reclose Initiate	RI-3P
38	Reclose Cancel Output from Scheme Logic	CANCL
39	KEY XMTR1/CARR START Output from Scheme Logic	KEY1
40	KEY XMTR2/CARR STOP Output from Scheme Logic	KEY2
41 [^]	3 Phase Trip Enable	TRIP3P
42	spare	
43	spare	
44	Reclose In Progress	RIP
45	Line Over Load Alarm Output	LNOVLD
46	Critical Alarm Output	CRTALM
47	Recloser Lockout Alarm	LORCL
48	Trip Circuit Alarm	TCMALM
49	Zone Flags On Alarm	ZNALM
50	Overcurrent Alarm	OVRALM
51	Unbalanced Current Detector Alarm Output	UNBAL
52	Non-Critical Alarm Output	NCALM
53	spare	
54	spare	
55	spare	
56	MANUAL OPEN BRK1	MNOPN1
57	MANUAL OPEN BRK2	MNOPN2
58	MANUAL CLOSE BRK1	MNCLS1
59	MANUAL CLOSE BRK2	MNCLS2
60	Fault ID: Phase A Involved	DAFLTA
61	Fault ID: Phase B Involved	DAFLTB
62	Fault ID: Phase C Involved	DAFLTC
63	Fault ID: Neutral Involved	DAFLTN
64	DMA Overrun	DMAOVR
65	Zone 1 AB Distance Function	Z1AB
66	Zone 1 BC Distance Function	Z1BC
67	Zone 1 CA Distance Function	Z1CA
68	Zone 2 AB Distance Function	Z2AB
69	Zone 2 BC Distance Function	Z2BC
70	Zone 2 CA Distance Function	Z2CA
71	Zone 3 AB Distance Function	Z3AB
72	Zone 3 BC Distance Function	Z3BC
73	Zone 3 CA Distance Function	Z3CA
74	Zone 4 AB Distance Function	Z4AB
75	Zone 4 BC Distance Function	Z4BC
76	Zone 4 CA Distance Function	Z4CA

77	Any Z1 Phase Distance Function	Z1PH
78	Any Z2 Phase Distance Function	Z2PH
79	Any Z3 Phase Distance Function	Z3PH
80	Any Z4 Phase Distance Function	Z4PH
81	Zone 1 AG Distance Function	Z1AG
82	Zone 1 BG Distance Function	Z1BG
83	Zone 1 CG Distance Function	Z1CG
84	Zone 2 AG Distance Function	Z2AG
85	Zone 2 BG Distance Function	Z2BG
86	Zone 2 CG Distance Function	Z2CG
87	Zone 3 AG Distance Function	Z3AG
88	Zone 3 BG Distance Function	Z3BG
89	Zone 3 CG Distance Function	Z3CG
90	Zone 4 AG Distance Function	Z4AG
91	Zone 4 BG Distance Function	Z4BG
92	Zone 4 CG Distance Function	Z4CG
93	Any Z1 Ground Distance Function	Z1GRD
94	Any Z2 Ground Distance Function	Z2GRD
95	Any Z3 Ground Distance Function	Z3GRD
96	Any Z4 Ground Distance Function	Z4GRD
97	Phase A Open	AOPEN
98	Phase B Open	BOPEN
99	Phase C Open	COPEN
100	All Phases Open	3OPEN
101	Any Phase Open	ANYOPN
102	1 Pole open	1OPEN
103	Any Phase Undervoltage	ANYUVT
104	All Voltages High (No Phase Undervoltage)	ALLVLT_
105	Fault Detector (FD)	FLTDET
106	TL1 Timer Output	TL1
107	IT Detector	IT
108	IB Detector	IB
109	IPT Detector	IPT
110	IPB Detector	IPB
111	Remote Breaker Open Detector	REMOPN
112	Ground Directional Trip (Nt • Ipt)	GRDTRP
113	Ground Directional Block (Nb • Ipb)	GRDBLK
114	Line Pickup	LPU
115	Fuse Failure Alarm	FF
116	Instantaneous Phase Overcurrent (50p/Ph4)	PH4
117	Instantaneous Ground Overcurrent (50g/Idt)	IDT
118	Ground Time Overcurrent Pick Up	TOCACT
119	Ground Time Overcurrent Trip (51g/Toc)	TOCTRP
120	Out Of Step Blocking	OSB
121	Out Of Step Trip	OST
122	Configurable Trip Bus Input	CNFTRP
123	Configurable Oscillography Trigger	CNFOSC
124	TL16 Timer Output	TL16
125	TL24 Timer Output	TL24
126	Ground forward flag (nt)	GRDFWD

127	Ground Reverse Flag (NB)	GRDREV
128	TI25 Timer Output	TL25
129	Z2 Ground Timer	Z2GTMR
130	Z3 Ground Timer	Z3GTMR
131	Z4 Ground Timer	Z4GTMR
132	Z2 Phase Timer	Z2PTMR
133	Z3 Phase Timer	Z3PTMR
134	Z4 Phase Timer	Z4PTMR
135	Any Trip Bus	TRPBUS
136	Weak Infeed Trip	WITRIP
137	Sync Check	SYNC
138	Number of Breaker Operation Alarm	BRMNOP
139	Breaker Equipment Duty Alarm	BRMNDT
140	Any Phase Over Voltage Pickup	OVVRPU
141	Positive Sequence Over Voltage Pickup	V1TPU
142	Compensated Positive Sequence Over Voltage Pickup	V1CPU
143	I1 line Pickup	I1LPU
144	Block Reclose Initiate	BLOCKRI
145	Inhibit Reclose Initiate	INH-RI
146	Breaker Close	BKRCLS
147	Trip Circuit #1 Voltage Monitor Status	T1TC
148	Trip Circuit #2 Voltage Monitor Status	T2TC
149	Trip Circuit #3 Voltage Monitor Status	T3TC
150	Trip Circuit #4 Voltage Monitor Status	T4TC
151	Trip Circuit #5 Voltage Monitor Status	T5TC
152	Trip Circuit #6 Voltage Monitor Status	T6TC
153	PHASE A OVERVOLTAGE	AVOVR
154	PHASE B OVERVOLTAGE	BVOVR
155	PHASE C OVERVOLTAGE	CVOVR
156	Instantaneous Positive Sequence Overvoltage	V1IOVR
157	Time Delayed Positive Sequence Overvoltage	V1TOVR
158	Instantaneous Compensated Positive Sequence Overvoltage	V1CIOV
159	Time Delayed Compensated Positive Sequence Overvoltage	V1CTOV
160	Any Phase Overvoltage	OVVRLT
161	Programmable Logic Gate # 1 Output	G1
162	Programmable Logic Gate # 2 Output	G2
163	Programmable Logic Gate # 3 Output	G3
164	Programmable Logic Gate # 4 Output	G4
165	Programmable Logic Gate # 5 Output	G5
166	Programmable Logic Gate # 6 Output	G6
167	Programmable Logic Gate # 7 Output	G7
168	Programmable Logic Gate # 8 Output	G8
169	Programmable Logic Gate # 9 Output	G9
170	Programmable Logic Gate # 10 Output	G10
171	Programmable Logic Gate # 11 Output	G11
172	Programmable Logic Gate # 12 Output	G12
173	Programmable Logic Gate # 13 Output	G13
174	Programmable Logic Gate # 14 Output	G14
175	Programmable Logic Gate # 15 Output	G15
176	Programmable Logic Gate # 16 Output	G16

177	Programmable Logic Gate # 17 Output	G17
178	Programmable Logic Gate # 18 Output	G18
179	Programmable Logic Gate # 19 Output	G19
180	Programmable Logic Gate # 20 Output	G20
181	Programmable Logic Gate # 21 Output	G21
182	Programmable Logic Gate # 22 Output	G22
183	Programmable Logic Gate # 23 Output	G23
184	Programmable Logic Gate # 24 Output	G24
185	Programmable Logic Gate # 25 Output	G25
186	Programmable Logic Gate # 26 Output	G26
187	Programmable Logic Gate # 27 Output	G27
188	Programmable Logic Gate # 28 Output	G28
189	Programmable Logic Gate # 29 Output	G29
190	Programmable Logic Gate # 30 Output	G30
191	Programmable Logic Gate # 31 Output	G31
192	Programmable Logic Gate # 32 Output	G32
193	Programmable Logic Gate # 33 Output	G33
194	Programmable Logic Gate # 34 Output	G34
195	Programmable Logic Gate # 35 Output	G35
196	Programmable Logic Gate # 36 Output	G36
197	Programmable Logic Gate # 37 Output	G37
198	Programmable Logic Gate # 38 Output	G38
199	Programmable Logic Gate # 39 Output	G39
200	Programmable Logic Gate # 40 Output	G40
201-224	spare	
225	Programmable Logic TIMER 1 Output	TM1
226	Programmable Logic TIMER 1 RESET	TM1RST
227	Programmable Logic TIMER 2 Output	TM2
228	Programmable Logic TIMER 2 RESET	TM2RST
229	Programmable Logic TIMER 3 Output	TM3
230	Programmable Logic TIMER 3 RESET	TM3RST
231	Programmable Logic TIMER 4 Output	TM4
232	Programmable Logic TIMER 4 RESET	TM4RST
233	Programmable Logic TIMER 5 Output	TM5
234	Programmable Logic TIMER 5 RESET	TM5RST
235	Programmable Logic TIMER 6 Output	TM6
236	Programmable Logic TIMER 6 RESET	TM6RST
237	Programmable Logic TIMER 7 Output	TM7
238	Programmable Logic TIMER 7 RESET	TM7RST
239	Programmable Logic TIMER 8 Output	TM8
240	Programmable Logic TIMER 8 RESET	TM8RST
241	Programmable Logic COUNTER 1	CNTR1
242	Programmable Logic COUNTER 2	CNTR2
243	Programmable Logic COUNTER 3	CNTR3
244	Programmable Logic COUNTER 4	CNTR4
245	Programmable Logic COUNTER 5	CNTR5
246	Programmable Logic COUNTER 6	CNTR6
247	Programmable Logic COUNTER 7	CNTR7
248	Programmable Logic COUNTER 8	CNTR8

249	Programmable Logic LATCH 1	LATCH1
250	Programmable Logic LATCH 2	LATCH2
251	Programmable Logic LATCH 3	LATCH3
252	Programmable Logic LATCH 4	LATCH4
253	Programmable Logic LATCH 5	LATCH5
254	Programmable Logic LATCH 6	LATCH6
255	Programmable Logic LATCH 7	LATCH7
256	Programmable Logic LATCH 8	LATCH8

PROTECTION SETTINGS GUIDE

Table 2-viii
Range (5A)

No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step	Default 5A	1A	
Z1DISTANCE									
101	Z1PHASE	Z1 Phase Distance	NO, YES		NO, YES		NA	YES	YES
102	Z1PREACH	Z1 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	5.40	27.0
103	Z1PLEVDET	Z1 Phase Level Detector (Series Capacitor Model Only)	0.0 - 9.9	0.1	0.0-9.9	0.1	pu volts	0	0
104	Z1GROUND	Z1 Ground Distance	NO, YES		NO, YES		NA	YES	YES
105	Z1GRDREACH	Z1 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	5.40	27.0
106	Z1GRDCHAR	Z1 Ground Characteristic	MHO, REACT		MHO, REACT		NA	MHO	MHO
107	Z1SUREACH	Z1 Grd React. Mho Sup'v'n Reach	0.01-50.0	0.01	0.05-250	0.05	ohms	20.0	100.0
108	Z1GROUNDK0	Z1 Ground K0	1.0 - 7.0	0.01	1.0-7.0	0.01	NA	2.7	2.7
109	Z1GLEVDET	Z1 Ground Level Detector (Series Capacitor Model Only)	0.0 - 9.9	0.1	0.0-9.9	0.1	pu volts	0	0
110	Z1BLOCK	Blocking Sup'v'n of Z1	NO, YES				NA	NO	NO
Z2DISTANCE									
201	Z2PHASE	Z2 Phase Distance	NO, YES		NO, YES		NA	YES	YES
202	Z2PHREACH	Z2 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	9.0	45.0
203	Z2PCHARANG	Z2 Phase Characteristic Angle	90-120	5	90-120	5	deg.	90	90
204	Z2GROUND	Z2 Ground Distance	NO, YES		NO, YES		NA	YES	YES
205	Z2GRDCHAR	Z2 Ground Characteristic	MHO, GDOC, MHO GDOC		MHO, GDOC MHO GDOC		NA	MHO	MHO
206	Z2GRDREACH	Z2 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	9.0	45.0
207	Z2GCHARANG	Z2 Ground Characteristic Angle	90-120	5	90-120	5	deg.	90	90
208	Z2TIMERS	Z2 Timers	NO, YES		NO, YES		NA	YES	YES
209	Z2P_TIME	Z2 Phase Timer	0.10 - 3.0	0.01	0.1-3.0	0.01	sec.	1.0	1.0
210	Z2G_TIME	Z2 Ground Timer	0.10 - 3.0	0.01	0.1-3.0	0.01	sec.	1.0	1.0

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Table 2-viii
Range (5A) Step Range (1A)

No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step	Default 5A	1A
Z3DISTANCE								
301	Z3PHASE	Z3 Phase Distance	NO, YES		NO, YES		NA	YES
302	Z3PHREACH	Z3 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	12.0
303	Z3PCHARANG	Z3 Phase Characteristic Angle	90-120	5	90-120	5	deg.	90
304	Z3GRND	Z3 Ground Distance	NO, YES		NO, YES		NA	YES
305	Z3GRDREACH	Z3 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	12.0
306	Z3GCHARANG	Z3 Ground Characteristic Angle	90-120	5	90-120	5	deg.	90
307	Z3P_TIME	Z3 Phase Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.	2.0
308	Z3G_TIME	Z3 Ground Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.	2.0
Z4DISTANCE								
401	Z4PHASE	Z4 Phase Distance	NO, YES		NO, YES		NA	YES
402	Z4PHREACH	Z4 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	18.0
403	Z4PCHARANG	Z4 Phase Char. Angle	80-120	5	80-120	5	deg.	90
404	Not Used							
405	Z4GRND	Z4 Ground Distance	NO, YES		NO, YES		NA	YES
406	Z4GRDREACH	Z4 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	18.0
407	Z4GCHARANG	Z4 Ground Char. Angle	80-120	5	80-120	5	deg.	90
408	Z4DIRECTN	Z4 Direction	FORWRD, REVERS		FORWRD, REVERS		NA	FORWRD
409	Z4_TIMERS	Z4 Timers	NO, YES		NO, YES		NA	YES
410	Z4P_TIME	Z4 Phase Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.	3.0
411	Z4G_TIME	Z4 Ground Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.	3.0
CURSUPVISN								
501	IT_PICKUP	Trip Sup'v'n Current	0.20-4.0	0.01	0.04-0.8	0.01	amps	0.20
502	IB_PICKUP	Block Sup'v'n Current	0.20-4.0	0.01	0.04-0.8	0.01	amps	0.20
503	IPT_PICKUP	GDOC Trip Current	0.50-5.0	0.01	0.1-1.0	0.01	amps	0.75
504	IPB_PICKUP	GDOC Block Current	0.25-3.75	0.01	0.05-0.75	0.01	amps	0.25
505	IPBKFACTOR	IPB I1 Restraint	0.0, 0.066		0.0, 0.066		NA	0.066
506	NT_OFFSET	NT/NB Offset	0.0-20.0	0.01	0.0-100	0.01	ohms	.05
507	UNBALALARM	Unbalanced Current Alarm	NO, YES		NO, YES		NA	YES

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No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step	Default 5A	1A
OVERCURRENT								
601	50	Phase Inst. Overcurrent	NO, YES		NO, YES		NA	NO
602	50_DIRCNL	Directional Control 50	NO, YES		NO, YES		NA	YES
603	50PICKUP	50 Pickup Setting	2.0-160.0	0.1	0.4-32.0	0.1	amps	20.0
604	50PICKUPFF	50 Pickup during fuse failure	2.0-160.0	0.1	0.4-32.0	0.1	amps	30.0
605	50G	Ground Inst. Overcurrent	NO, YES		NO, YES		NA	YES
606	50G_DIRCNL	Directional Control of 50G	NO, YES		NO, YES		NA	YES
607	50GPICKUP	50G Pickup Setting	0.5-80.0	0.1	0.1-16.0	0.1	amps	10.0
608	50GPCKUPFF	50G Pickup during fuse failure	0.5-80.0	0.1	0.1-16.0	0.1	amps	15.0
609	50GRESTNT	50G Restraint Setting	0.0, 0.3		0.0, 0.3		NA	0.3
610	51G	Ground Time Overcurrent	NO, YES		NO, YES		NA	YES
611	51G_DIRCNL	Directional Control 51G	NO, YES		NO, YES		NA	YES
612	51GPICKUP	51G Pickup Setting	0.20 - 15.0	0.01	0.04-3.0	0.01	amps	1.0
613	51GPCKUPFF	51G Pickup during fuse failure	0.20 - 15.0	0.01	0.04-3.0	0.01	amps	2.0
614	51GCURVE	51G Curve	INV, V-INV, E-INV, CUSTOM, DEFT		INV, V-INV, E-INV, CUSTOM, DEFT		NA	V-INV
615	51GTIMDIAL	51G Time Dial	0.5 - 10.0	0.1	0.5-10.0	0.1	NA	5
616	DEFTIMDELY	Definite Time Delay	0.5 - 30.0	0.1	0.5-30		sec.	1.0
617	51G_RESET	51G Reset Characteristic	FAST, EM		FAST, EM		NA.	FAST
VOLTAGE								
701	RATEDVOLTS	Rated Per Unit Voltage	100,105,110, 115,120		100,105,110, 115,120		volts	115
702	PHASEOVER	Select Phase Overvoltage	NO, YES		NO, YES		NA	NO
703	PHOV PICKUP	Phase Overvoltage Pickup	0.0 - 1.4	0.01	0.0-1.4	0.01	pu volts	1.4
704	PHOV TMDLY	Phase Overvoltage Time Delay	0.0 - 10.0	0.01	0.0 - 10.0	0.01	sec.	0.50
705	V1OVER	Select Pos. Seq. Overvoltage *	NO, YES		NO, YES		NA	NO
706	V1OV INSTPU	Inst. Pos. Seq. Overvoltage Pickup*	1.0 - 1.4	0.01	1.0-1.4	0.01	pu volts	1.25
707	V1OVTIMPU	TOV Pos. Seq. Overvoltage Pickup*	1.0 - 1.4	0.01	1.0 - 1.4	0.01	pu volts	1.25

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No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step		Default 5A	1A
708	V1OVTIMDLY	Pos. Seq. Overvoltage Time Delay*	0.0 - 10.0	0.01	0.0-10.0	0.01	sec.	0.25	0.25
709	V1COMP	Compensated Pos. Seq. OV*	NO, YES		NO, YES		NA	NO	NO
710	V1COMPRCH	Comp. Pos. Seq. OV Impedance*	0.01 - 50.0	0.01	0.05 - 250.0	0.05	ohms	6.0	30.0
711	V1COMPINPU	INST Comp. Pos. Seq. OV Pickup*	1.0 - 1.4	0.01	1.0-1.4	0.01	pu volts	1.4	1.4
712	V1COMPTDPU	TOVComp. Pos. Seq. OV Pickup*	1.0 - 1.4	0.01	1.0-1.4	0.01	pu volts	1.4	1.4
713	V1COMPTDLY	Comp. Pos. Seq. OV Time Delay*	0.0 - 10.0	0.01	0.0-10.0	0.01	sec.	0.30	1.5
714	FUSEFAIL	PTFF Blocking	NO, YES		NO, YES		NA	YES	YES

*Overvoltage Model Only

BLK RECLOS

801	ALL_BELOW	Block reclosing for any function	NO, YES		NO, YES		NA	NO	NO
802	OUTOFSTEP	Block for Out of Step	NO, YES		NO, YES		NA	NO	NO
803	ALL_3_Z2PH	Block for 3 phase faults	NO, YES		NO, YES		NA	NO	NO
804	50G_BLOCK	Block for 50G trip	NO, YES		NO, YES		NA	NO	NO
805	Z2TIMETRIP	Block for Z2 Time Delayed Trip	NO, YES		NO, YES		NA	NO	NO
806	Z3TIMETRIP	Block for Z3 Time Delayed Trip	NO, YES		NO, YES		NA	NO	NO
807	Z4TIMETRIP	Block for Z4 Time Delayed Trip	NO, YES		NO, YES		NA	NO	NO
808	Z1PHASTRIP	Block for any Z1 phase fault	NO, YES		NO, YES		NA	NO	NO
809	ANYZ2PHASE	Block for any Z2 phase fault	NO, YES		NO, YES		NA	NO	NO
810	CONFGTRIP	Block for Configurable triplogic	NO, YES		NO, YES		NA	NO	NO

LINEPICKUP

901	LINEPICKUP	Select Line Pickup	NO, YES		NO, YES		NA	YES	YES
902	BYPASSTL3	Bypass Line pickup time delay	NO, YES		NO, YES		NA	NO	NO
903	I1PICKUP	I1 pickup	1.0-15.0	0.1	0.2-3.0	0.1	amps	3.0	0.6

REMOTEOPEN (Not useable in single-phase systems)

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<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>Default 5A</i>	<i>1A</i>
1001	REMOTEOPEN	Select remote open detector	NO, YES		NO, YES		NA	NO
1002	TL20PICKUP	Remote open detector time delay	10 - 100	1	10-100	1	msec. 100	100
LINE OVRLD								
1101	LINEOVERLD	Select line overload protection	NO, YES		NO, YES		NA	NO
1102	LEVEL1PU	Level 1 pickup current	2.5-20.0	0.1	0.5-4.0	0.1	amps 10	2
1103	LEVEL2PU	Level 2 pickup current	5.0-40.0	0.1	1.0-8.0	0.1	amps 20	4
1104	LEVEL1TDLY	Level 1 time delay	10-200	1	10-200	1	sec. 50	50
1105	LEVEL2TDLY	Level 2 time delay	10-99	1	10-99	1	sec. 25	25
SCHEME								
1201	PICKSCHEME	Select scheme logic	STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK	NA	STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK		NA	STEPDST
1202	NUMRCVR	Select number of receivers	0, 1, 2	NA	0, 1, 2		NA	0
1203	TRIPMODE	1-Phase/3-Phase trip mode	3POLE, 1POLE 1POLEZ2	NA	3POLE, 1POLE 1POLEZ2		NA	3POLE
1204	CARRSTART	Select function to use to start carrier in BLOCKING scheme	DIR, IPB, FD	NA	DIR, IPB, FD		NA	IPB
1205	WKINFTRIP	Select Weak Infeed tripping for Hybrid scheme	NO, YES	NA	NO, YES		NA	NO
SCHMTIMERS								
1301	TL1PICKUP	Trip Integrator	1 - 200	1	1 - 200	1	msec. 5	5
1302	TL4PICKUP	POTT Coord Timer PU	0 - 50	1	0 - 50	1	msec. 0	0
1303	TL4DROPOUT	POTT Coord Timer DO	0 - 50	1	0 - 50	1	msec. 0	0
1304	TL5PICKUP	BKR1 b sw Coord Timer PU	0 - 200	1	0 - 200	1	msec. 50	50
1305	TL5DROPOUT	BKR1 b sw Coord Timer DO	0 - 200	1	0 - 200	1	msec. 50	50
1306	TL6PICKUP	BKR2 b sw Coord Timer PU	0 - 200	1	0 - 200	1	msec. 50	50
1307	TL6DROPOUT	BKR2 b sw Coord Timer DO	0 - 200	1	0 - 200	1	msec. 50	50
1308	TL16PICKUP	Weak Infeed Trip Timer	8 - 99	1	8 - 99	1	msec. 8	8

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Table 2-viii
Range (5A)

No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step		Default 5A	1A
1309	TL24DRPPOUT	GDOC Blocking Timer	30 - 500	1	30 - 500	1	msec.	30	30
1310	TL25DRPOUT	Distance Blocking Timer	30 - 500	1	30 - 500	1	msec.	30	30
1311	TL26PICKUP	Repeat Delay Timer	0-50	1	0-50	1	msec.	0	0

LINE INFO

1401	POSSEQANG	Pos. Seq. Impedance Angle	25-90	1	25-90	1	deg.	85	85
1402	ZERSEQANG	Zero Seq. Impedance Angle	25-90	1	25-90	1	deg.	75	75
1403	ZLINE	Positive Sequence Line Impedance in sec. ohms	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms	6	30
1404	ZEROSEQK0	Z0 / Z1 ratio	1.0 - 7.0	0.01	1.0-7.0	0.01	NA	3.0	3.0
1405	LINELENGTH	Line Length	0.0 - 500.0	0.1	0.0-500.0	0.1	NA	100.0	100.0
1406	LINEUNIT	Units of Length	miles, km		miles, km			miles	miles
1407	CTRATIO	CT Ratio	1 - 5000	1	1-5000	1	NA	400	2000
1408	PTRATIO	PT Ratio	1 - 7000	1	1-7000	1	NA	3000	3000

SCADA_DATA

1501	FLTLOCK	Hold Time	0 - 99.9	0.1	0-99.9	0.1	sec.	0	0
1502	FLTRESET	Fault Location Reset Time	0 - 999	1	0-999	1	minutes	0	0

OS BLOCKING

1601	MOBZONE	Coordinating Zone	ZONE 2, ZONE 3, ZONE 4		ZONE 2, ZONE 3, ZONE 4		NA	ZONE3	ZONE3
1602	MOBCHARANG	MOB characteristic Angle	30 - 130	1	30-130	1	deg.	70	70
1603	BLOCKWHAT	Block during OS	BLKALL, BLKDIST, BLKPHAS, BLKNONE		BLKALL, BLKDIST, BLKPHAS, BLKNONE		NA	BLKALL	BLKALL
1604	BLOCKZ1	Block all zone 1 functions	NO, YES		NO, YES		NA	YES	YES
1605	BLOCKZ2	Block all zone 2 functions	NO, YES		NO, YES		NA	YES	YES
1606	BLOCKZ3	Block all zone 3 functions	NO, YES		NO, YES		NA	YES	YES
1607	BLOCKZ4	Block all zone 4 functions	NO, YES		NO, YES		NA	YES	YES

OS TRIPPING (Out-of-Step Trip Model Only)

1701	USE_OST	Select OST	NO, YES		NO, YES		NA	NO	NO
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<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>Default 5A</i>	<i>1A</i>
1702	NUMBRCHAR	Select Number of Characteristics	2, 3		2, 3		NA	3
1703	TRIPIN_OUT	Trip Entering or Leaving Inner	IN, OUT		IN OUT		NA	OUT
1704	FWDREACH	OST Forward Reach	0.1 - 75.0	0.1	0.5 - 375.0	0.5	ohms	15.0
1705	REVREACH	OST Reverse Reach	0.1 - 75.0	0.1	0.5 - 375.0	0.5	ohms	5.0
1706	OUTER	Outer Characteristic Angle	40 - 165	1	40-165	1	deg	90
1707	MIDDLE	Middle Characteristic Angle	40 - 165	1	40-165	1	deg	105
1708	INNER	Inner Characteristic Angle	40 - 165	1	40-165	1	deg	120
1709	TLOS1PU	Coordinating Timer 1 Pick-up	1 - 100	1	1-100	1	msec.	40
1710	TLOS1DO	Coordinating Timer 1 Drop-out	1 - 100	1	1-100	1	msec.	40
1711	TLOS2PU	Coordinating Timer 2 Pick up	1 - 100	1	1-100	1	msec.	40
1712	TLOS3PU	Coordinating Timer 3 Pick up	1 - 100	1	1-100	1	msec.	40
1713	TLOS4PU	Coordinating Timer 4 Pick up	1 - 100	1	1-100	1	msec.	40
RECLOSER								
1801	RECLMODE	Select Reclosing Option	OFF , NONE, INTERNAL, EXTERNAL, BOTH		OFF , NONE, INTERNAL, EXTERNAL, BOTH,		NONE	
1802	RECTYPE	Select Reclosing Type	1POLE, 3POLE, 1POLE/3POLE		1POLE, 3POLE, 1POLE/3POLE		3POLE	
1803	NUM1P	Number of attempts following 1P Trip	1 - 4	1	1		1	
1804	1PDELAY1	1 Pole First Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1805	1PDELAY2	1 Pole Second Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1806	1PDELAY3	1 Pole Third Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1807	1PDELAY4	1 Pole Fourth Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1808	NUM3P	Number of attempts following 3P Trip	1 - 4	1	1 - 4	1	1	

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No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step	Default 5A	1A
1809	3PDELAY1	3 Pole First Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1810	3PDELAY2	3 Pole Second Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1811	3PDELAY3	3 Pole Third Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1812	3PDELAY4	3 Pole Fourth Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	0.1 Sec	
1813	RESETTIME	Reset Time	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	1 Sec	
1814	DWELLTIME	Contact Dwell Time	0.1 - 2 Sec	0.1 sec	0.1 - 2 Sec	0.1 sec	0.1 Sec	
1815	HOLD	Inhibit Hold Select	YES, NO		YES, NO		NO	
1816	HOLDTIME	Inhibit Hold Time	1-1000 Sec	1	1-1000 Sec		1 Sec	
1817	HOLDSENSE	Contact Input Status	CC, CO		CC, CO		CC	
1818	SYNCCHECK	Synch Check Supervision	YES, NO		YES, NO		NO	
1819	CLOSEANG	Closing Angle	0 -75 degrees	1	0 -75 degrees	1	30 degrees	
1820	SLIPFREQ	Slip Frequency	0.1 - 5Hz	.1Hz	0.1 - 5Hz	.1Hz	1Hz	
1821	BUSLINE	Bus or Line Voltage	BUS, LINE		BUS, LINE		LINE	
1822	SYNCPHASE	Voltage used by SYNCCHECK	VA, VB, VC, VAB,VBC,VCA		VA, VB, VC, VAB,VBC,VCA		VA	
1823	SYNCHOLD	SYNCCHECK Hold Time	1 -100 Sec	1Sec	1 -100 Sec	1Sec	1 Sec	
1824	SP1PDELAY2	Supervise 2 nd 3P Reclose after 1P trip	YES, NO		YES, NO		NO	
1825	SP1PDELAY3	Supervise 3 rd 3P Reclose after 1P trip	YES, NO		YES, NO		NO	
1826	SP1PDELAY4	Supervise 4 th 3P Reclose after 1P trip	YES, NO		YES, NO		NO	
1827	SP3PDELAY1	Supervise 1 st 3P Reclose after 3P trip	YES, NO		YES, NO		NO	
1828	SP3PDELAY2	Supervise 2 nd 3P Reclose after 3P trip	YES, NO		YES, NO		NO	
1829	SP3PDELAY3	Supervise 3 rd 3P Reclose after 3P trip	YES, NO		YES, NO		NO	
1830	SP3PDELAY4	Supervise 4 th 3P Reclose after 3P trip	YES, NO		YES, NO		NO	
1831	SYNCMANCLS	Supervise Manual Close	YES, NO		YES, NO		NO	
1832	VBUSLIVE	Live Bus Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	50	
1833	VBUSDEAD	Dead Bus Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	50	
1834	VLINELIVE	Live Line Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	50	
1835	VLINDEAD	Dead Line Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	50	
1836	LBUSDLINE	Live Bus Dead Line	YES, NO		YES, NO		NO	
1837	DBUSLLINE	Dead Bus Live Line	YES, NO		YES, NO		NO	

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No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step	Default 5A	1A
1838	DBUSDLINE	Dead Bus Dead Line	YES, NO		YES, NO		NO	
1839	DELTA V	Voltage Difference	0.1 - 30V	0.1V	0.1 - 130V	0.1V	10	
1840	DELTA VBLK	Block Synch Check by DELTA V	YES, NO		YES, NO		NO	

NONCRIT_AL

1901	NCAIN1	Non-Critical Alarm Input # 1 These eight inputs are 'OR'ed together and then output to the contact assigned to the Non-Critical Alarm.	0 - 256 depending on the choice of input assignment	1	0 - 256 depending on the choice of input assignment	1	NA	48	48
1902	NCAIN2	Non-Critical Alarm Input # 2	0 - 256	1	0 - 256	1	NA	49	49
1903	NCAIN3	Non-Critical Alarm Input # 3	0 - 256	1	0 - 256	1	NA	50	50
1904	NCAIN4	Non-Critical Alarm Input # 4	0 - 256	1	0 - 256	1	NA	51	51
1905	NCAIN5	Non-Critical Alarm Input # 5	0 - 256	1	0 - 256	1	NA	0	0
1906	NCAIN6	Non-Critical Alarm Input # 6	0 - 256	1	0 - 256	1	NA	0	0
1907	NCAIN7	Non-Critical Alarm Input # 7	0 - 256	1	0 - 256	1	NA	0	0
1908	NCAIN8	Non-Critical Alarm Input # 8	0 - 256	1	0 - 256	1	NA	0	0

OUTPUTS

							Single Phase	Three Phase
2001	T1*	T1 Contact	0 - 256*	1	0 - 256*	1	33**	33**
2002	T2*	T2 Contact	0 - 256*		0 - 256*		34**	33**
2003	T3*	T3 Contact	0 - 256*	1	0 - 256*	1	35**	33**
2004	T4*	T4 Contact	0 - 256*	1	0 - 256*	1	33**	33**
2005	T5*	T5 Contact	0 - 256*	1	0 - 256*	1	34**	
2006	T6*	T6 Contact	0 - 256*	1	0 - 256*	1	35**	
2007	A1 *	A1 Contact	0 - 256*	1	0 - 256*	1	58**	58**
2008	A2 *	A2 Contact	0 - 256*	1	0 - 256*	1	59**	59**
2009	A3 *	A3 Contact	0 - 256*	1	0 - 256*	1	33**	33**
2010	A4 *	A4 Contact	0 - 256*	1	0 - 256*	1	33**	33**
2011	A5 *	A5 Contact	0 - 256*	1	0 - 256*	1	34**	37**

OUTPUTS

							Single Phase	Three Phase
2012	A6 *	A6 Contact	0 - 256*	1	0 - 256*	1	34**	37**

PROTECTION SETTINGS GUIDE

Table 2-viii
Range (5A)

No	Mnemonic	Description	Step	Range (1A)	Step	Default	
2013	A7 *	A7 Contact	1	0 - 256*	1	35**	38**
2014	A8 *	A8 Contact	1	0 - 256*	1	35**	45**
2015	A9 *	A9 Contact	1	0 - 256*	1	36**	
2016	A10 *	A10 Contact	1	0 - 256*	1	37**	
2017	A11 *	A11 Contact	1	0 - 256*	1	38**	
2018	A12 *	A12 Contact	1	0 - 256*	1	45**	
2019	C1 *	C1 Contact	1	0 - 256*	1	52**	52**
2020	C2 *	C2 Contact	1	0 - 256*	1	115**	115**
2021	KT1 *	KT1 Contact	1	0 - 256*	1	39**	39**
2022	KT2 *	KT2 Contact	1	0 - 256*	1	40**	40**
2023	KT3 *	KT3 Contact	1	0 - 256*	1	39**	39**
2024	KT4 *	KT4 Contact	1	0 - 256*	1	40**	40**
2025	CONFTRIP	Initiate three-phase trip with input from <i>Xpression Builder</i>	1	0 - 256	1	0	0
2026	CONFOSC	Initiate oscillography capture with <i>Xpression builder input</i>	1	0 - 256	1	0	0

* Contact configurable, and is normally open; add 1000 to number to close contact under normal conditions

** See attached list for index assignment

GENERAL SETTINGS GUIDE

Table 2-viii
Range (5A) Step

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>			<i>Units</i>	<i>Default</i>
CONFIGURE						
101	UNITID	Unit ID	0000-9999		NA	0000
102	SYSFREQ	System Frequency	50, 60		Hz	60
103	PHASROTATE	Phase Rotation	ABC, ACB		NA	ABC
104	TIMESYNCH	Time sych source	INTERNAL, IRIG-B		NA	INTERNAL
105	NUM_BKR	Number of Breakers	1,2		NA	1
106	NUM_TC	Number of trip circuits	1 - 2	1		1
107	NUM_MON	Number of trip Circuit Monitors	(T6→T1) Format = abcdef a-f = 0(OFF) or 1(ON)		NA	000111 (7) T1, T2 and T3 OFF
108	DISPLAYVAL	Value Display Mode	PRI, SEC		NA	SEC
109	LANGUAGE	Language Option	ENGLISH, SPANISH		NA	ENGLISH
COMMPORTS						
201	COMPORT1	Comm Port #1 Settings	Baud Rate: Parity Stop Bits xxyz	xx = 03, 12, 24, 48, 96 y = 0(none), 1(odd), 2(even) x = 1, 2 9601		9601
202	COMPORT2	Comm Port #2 Settings	Interface Baud Rate: Parity Stop Bits ixxyz	i=0(RS232), 1(RS485) xx = 03, 12, 24, 48, 96 y = 0(none), 1(odd), 2(even) x = 1, 2 09601		09601
203	COMPORT3	Comm Port #3 Settings	Interface Baud Rate: Parity Stop Bits ixxyz	i=0(RS232), 1(RS485) xx = 03, 12, 24, 48, 96 y = 0(none), 1(odd), 2(even) x = 1, 2		09601

GENERAL SETTINGS GUIDE

Table 2-viii

<i>No.</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range</i>	<i>Step</i>	<i>Units</i>	<i>Default</i>
				09601		
204	PROTOCOL1	Comm Port #1 Protocol	GE-MODEM, ASCII		NA	GE-MODEM
205	PROTOCOL2	Comm Port #2 Protocol (One Rear Port Model)	GE-MODEM, ASCII		NA	ASCII
206	PROTOCOL3	Comm Port #3 Protocol (Two Rear Port Model)	GE-MODEM, ASCII		NA	GE-MODEM
OSC_GRAPHY						
301	NUMFAULTS	Number of fault records (with standard memory)	2, 4, 8, 12		NA	12
301^	NUMFAULTS	Number of fault records (with expanded memory)	6,12, 24, 36		NA	12
302	PREFault	Number of prefault cycles	1 - 8		NA	5
303	SPLITREC	Splits fault record and captures this percentage at end, with (1-SPLITREC) captured at beginning	0 - 100	1	percent	0
BRKR DUTY						
401	EXPONENT	Exponent in I ^x t calculation	1.0 - 2.0	0.1	NA	2.0
402	MAX_OP	Maximum number of Breaker Operations for a breaker	0000-9999	1	NA	0
403	MAX_IXT	Maximum Breaker Duty for a breaker	0 - 9999999	0.1 K	A ^x sec	0
404	IXTPHASEA	Accumulated Breaker Duty, Phase A	0 - 9999999	0.1 K	A ^x sec	0
405	IXTPHASEB	Accumulated Breaker Duty, Phase B	0 - 9999999	0.1 K	A ^x sec	0
406	IXTPHASEC	Accumulated Breaker Duty, Phase C	0 - 9999999	0.1 K	A ^x sec	0
407	NUM_OP_A	Present number of Breaker Operations for Phase A	0000-9999	1	NA	0
408	NUM_OP_B	Present number of Breaker	0000-9999	1	NA	0

GENERAL SETTINGS GUIDE

Table 2-viii

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Units</i>	<i>Default</i>
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409	NUM_OP_C	Operations for Phase B	0000-9999	1	NA	0
		Present number of Breaker				
		Operations for Phase C				

INPUTS

501	CC1	CONTACT CONVERTER 1	0 - 32*	1	12	12
502	CC2	CONTACT CONVERTER 2	0 - 32*	1	13	13
503	CC3	CONTACT CONVERTER 3	0 - 32*	1	10	10
504	CC4	CONTACT CONVERTER 4	0 - 32*	1	11	11
505	CC5	CONTACT CONVERTER 5	0 - 32*	1	7	1
506	CC6	CONTACT CONVERTER 6	0 - 32*	1	20	4***
507	CC7	CONTACT CONVERTER 7	0 - 32*	1	1	20
508	CC8	CONTACT CONVERTER 8	0 - 32*	1	2	0
509	CC9	CONTACT CONVERTER 9	0 - 32*	1	3	
510	CC10	CONTACT CONVERTER 10	0 - 32*	1	4***	
511	CC11	CONTACT CONVERTER 11	0 - 32*	1	5***	
512	CC12	CONTACT CONVERTER 12	0 - 32*	1	6***	

* Contact Converter output normally appears as a Logic 1 with normally open contact connected, to invert output to Logic 0, add 1000 to number.

** See table 2-vii for index assignments

*** Only used if NUM_BKR setting is equal to 2

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
Z1DISTANCE							
101	Z1PHASE	Z1 Phase Distance	NO, YES		NO, YES		NA
102	Z1PREACH	Z1 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
103	Z1PLEVDET	Z1 Phase Level Detector (Series Capacitor Model Only)	0.0 - 9.9	0.1	0.0-9.9	0.1	pu volts
104	Z1GROUND	Z1 Ground Distance	NO, YES		NO, YES		NA
105	Z1GRDREACH	Z1 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
106	Z1GRDCHAR	Z1 Ground Characteristic	MHO, REACT		MHO, REACT		NA
107	Z1SUREACH	Z1 Grd React. Mho Sup'v'n Reach	0.01-50.0	0.01	0.05-250	0.05	ohms
108	Z1GROUNDK0	Z1 Ground K0	1.0 - 7.0	0.01	1.0-7.0	0.01	NA
109	Z1GLEVDET	Z1 Ground Level Detector (Series Capacitor Model Only)	0.0 - 9.9	0.1	0.0-9.9	0.1	pu volts
110	Z1BLOCK	Blocking Sup'v'n of Z1	NO, YES				NA
Z2DISTANCE							
201	Z2PHASE	Z2 Phase Distance	NO, YES		NO, YES		NA
202	Z2PHREACH	Z2 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
203	Z2PCHARANG	Z2 Phase Characteristic Angle	90-120	5	90-120	5	deg.
204	Z2GROUND	Z2 Ground Distance	NO, YES		NO, YES		NA
205	Z2GRDCHAR	Z2 Ground Characteristic	MHO, GDOC, MHOGDOC		MHO, GDOC MHOGDOC		NA
206	Z2GRDREACH	Z2 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
207	Z2GCHARANG	Z2 Ground Characteristic Angle	90-120	5	90-120	5	deg.
208	Z2TIMERS	Z2 Timers	NO, YES		NO, YES		NA
209	Z2P_TIME	Z2 Phase Timer	0.10 - 3.0	0.01	0.1-3.0	0.01	sec.
210	Z2G_TIME	Z2 Ground Timer	0.10 - 3.0	0.01	0.1-3.0	0.01	sec.

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
Z3DISTANCE							
301	Z3PHASE	Z3 Phase Distance	NO, YES		NO, YES		NA
302	Z3PHREACH	Z3 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
303	Z3PCHARANG	Z3 Phase Characteristic Angle	90-120	5	90-120	5	deg.
304	Z3GRND	Z3 Ground Distance	NO, YES		NO, YES		NA
305	Z3GRDREACH	Z3 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
306	Z3GCHARANG	Z3 Ground Characteristic Angle	90-120	5	90-120	5	deg.
307	Z3P_TIME	Z3 Phase Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.
308	Z3G_TIME	Z3 Ground Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.
Z4DISTANCE							
401	Z4PHASE	Z4 Phase Distance	NO, YES		NO, YES		NA
402	Z4PHREACH	Z4 Phase Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
403	Z4PCHARANG	Z4 Phase Characteristic Angle	80-120	5	80-120	5	deg.
404	Not Used						
405	Z4GRND	Z4 Ground Distance	NO, YES		NO, YES		NA
406	Z4GRDREACH	Z4 Ground Reach	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
407	Z4GCHARANG	Z4 Ground Characteristic Angle	80-120	5	80-120	5	deg.
408	Z4DIRECTN	Z4 Direction	FORWRD, REVERS		FORWRD, REVERS		NA
409	Z4_TIMERS	Z4 Timers	NO, YES		NO, YES		NA
410	Z4P_TIME	Z4 Phase Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.
411	Z4G_TIME	Z4 Ground Timer	0.10 - 10.0	0.01	0.10-10.0	0.01	sec.
CURSUPVISN							
501	IT_PICKUP	Trip Sup'v'n Current	0.20-4.0	0.01	0.04-0.8	0.01	amps
502	IB_PICKUP	Block Sup'v'n Current	0.20-4.0	0.01	0.04-0.8	0.01	amps
503	IPT_PICKUP	GDOC Trip Current	0.50-5.0	0.01	0.1-1.0	0.01	amps
504	IPB_PICKUP	GDOC Block Current	0.25-3.75	0.01	0.05-0.75	0.01	amps
505	IPBKFACTOR	IPB I1 Restraint	0.0, 0.066		0.0, 0.066		NA
506	NT_OFFSET	NT/NB Offset	0.0-20.0	0.01	0.0-100	0.01	ohms
507	UNBALALARM	Unbalanced Current Alarm	NO, YES		NO, YES		NA

OVERCURRNT

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
601	50	Phase Inst. Overcurrent	NO, YES		NO, YES		NA
602	50_DIRCNL	Directional Control 50	NO, YES		NO, YES		NA
603	50PICKUP	50 Pickup Setting	2.0-160.0	0.1	0.4-32.0	0.1	amps
604	50PICKUPFF	50 Pickup during fuse failure	2.0-160.0	0.1	0.4-32.0	0.1	amps
605	50G	Ground Inst. Overcurrent	NO, YES		NO, YES		NA
606	50G_DIRCNL	Directional Control of 50G	NO, YES		NO, YES		NA
607	50GPICKUP	50G Pickup Setting	0.5-80.0	0.1	0.1-16.0	0.1	amps
608	50GPCKUPFF	50G Pickup during fuse failure	0.5-80.0	0.1	0.1-16.0	0.1	amps
609	50GRESENT	50G Restraint Setting	0.0, 0.3		0.0, 0.3		NA
610	51G	Ground Time Overcurrent	NO, YES		NO, YES		NA
611	51G_DIRCNL	Directional Control 51G	NO, YES		NO, YES		NA
612	51GPICKUP	51G Pickup Setting	0.20 - 15.0	0.01	0.04-3.0	0.01	amps
613	51GPCKUPFF	51G Pickup during fuse failure	0.20 - 15.0	0.01	0.04-3.0	0.01	amps
614	51GCURVE	51G Curve	INV, V-INV, E-INV, CUSTOM, DEFT		INV, V-INV, E-INV, CUSTOM, DEFT		NA
615	51GTIMDIAL	51G Time Dial	0.5 - 10.0	0.1	0.5-10.0	0.1	NA
616	DEFTIMDELY	Definite Time Delay	0.5 - 30.0	0.1	0.5-30		sec.
617	51G_RESET	51G Reset Characteristic	FAST, EM		FAST, EM		NA.

VOLTAGE

701	RATEDVOLTS	Rated Per Unit Voltage	100,105,110, 115,120		100,105,110, 115,120		volts
702	PHASEOVER	Select Phase Overvoltage	NO, YES		NO, YES		NA
703	PHOVPIKUP	Phase Overvoltage Pickup	0.0 - 1.4	0.01	0.0-1.4	0.01	pu volts
704	PHOVTMDLY	Phase Overvoltage Time Delay	0.0 - 10.0	0.01	0.0 - 10.0	0.01	sec.
705	V1OVER	Select Pos. Seq. Overvoltage *	NO, YES		NO, YES		NA
706	V1OVINSTPU	Inst. Pos. Seq. Overvoltage Pickup*	1.0 - 1.4	0.01	1.0 - 1.4	0.01	pu volts
707	V1OVTIMPU	TOV Pos. Seq. Overvoltage Pickup*	1.0 - 1.4	0.01	1.0 - 1.4	0.01	pu volts
708	V1OVTIMDLY	Pos. Seq. Overvoltage Time Delay*	0.0 - 10.0	0.01	0.0-10.0	0.01	sec.

PROTECTION SETTINGS DATA SHEET

<i>Table 2-ix</i>							
<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
709	V1COMP	Compensated Pos. Seq. OV*	NO, YES		NO, YES		NA
710	V1COMPRCH	Comp. Pos. Seq. OV Impedance*	0.01 - 50.0	0.01	0.05 - 250.0	0.05	ohms
711	V1COMPINPU	INST Comp. Pos. Seq. OV Pickup (Overvoltage Model Only)	1.0 - 1.4	0.01	1.0-1.4	0.01	pu volts
712	V1COMPTDPU	TOVComp. Pos. Seq. OV Pickup*	1.0 - 1.4	0.01	1.0-1.4	0.01	pu volts
713	V1COMPTDLY	Comp. Pos. Seq. OV Time Delay*	0.0 - 10.0	0.01	0.0-10.0	0.01	sec.
714	FUSEFAIL	Potential Fuse Failure Blocking	NO, YES		NO, YES		NA

* Overvoltage Model Only

BLK RECLOS

801	ALL_BELOW	Block reclosing for any function	NO, YES		NO, YES		NA
802	OUTOFSTEP	Block for Out of Step	NO, YES		NO, YES		NA
803	ALL_3_Z2PH	Block for 3 phase faults	NO, YES		NO, YES		NA
804	50G_BLOCK	Block for 50G trip	NO, YES		NO, YES		NA
805	Z2TIMETRIP	Block for Z2 Time Delayed Trip	NO, YES		NO, YES		NA
806	Z3TIMETRIP	Block for Z3 Time Delayed Trip	NO, YES		NO, YES		NA
807	Z4TIMETRIP	Block for Z4 Time Delayed Trip	NO, YES		NO, YES		NA
808	Z1PHASTRIP	Block for any Z1 phase fault	NO, YES		NO, YES		NA
809	ANYZ2PHASE	Block for any Z2 phase fault	NO, YES		NO, YES		NA
810	CONFGTRIP	Block for Configurable triplogic	NO, YES		NO, YES		NA

LINEPICKUP

901	LINEPICKUP	Select Line Pickup	NO, YES		NO, YES		NA
902	BYPASSTL3f	Bypass Line pickup time delay	NO, YES		NO, YES		NA
903	I1PICKUP	I1 pickup	1.0-15.0	0.1	0.2-3.0	0.1	amps

REMOTEOPEN (Not useable in single-phase systems)

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
1001	REMOTEOPEN	Select remote open detector	NO, YES		NO, YES		NA
1002*	TL20PICKUP	Remote open detector time delay	10 - 100	1	10-100	1	msec.
LINE OVRLD							
1101	LINEOVERLD	Select line overload protection	NO, YES		NO, YES		NA
1102	LEVEL1PU	Level 1 pickup current	2.5-20.0	0.1	0.5-4.0	0.1	amps
1103	LEVEL2PU	Level 2 pickup current	5.0-40.0	0.1	1.0-8.0	0.1	amps
1104	LEVEL1TDLY	Level 1 time delay	10-200	1	10-200	1	sec.
1105	LEVEL2TDLY	Level 2 time delay	10-99	1	10-99	1	sec.
SCHEME							
1201	PICKSCHEME	Select scheme logic	STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK	NA	STEPDST, PUTT, POTT1, POTT2, HYBRID, BLOCK		NA
1202	NUMRCVR	Select number of receivers	0, 1, 2	NA	0, 1, 2		NA
1203	TRIPMODE	1-Phase/3-Phase trip mode	3POLE, 1POLE, 1POLEZ2	NA	3POLE, 1POLE, 1POLEZ2		NA
1204	CARRSTART	Select function to use to start carrier in BLOCKING scheme	DIR, IPB, FD	NA	DIR, IPB, FD		NA
1205	WKINFTRIP	Select Weak Infeed tripping for Hybrid scheme	NO, YES	NA	NO, YES		NA
SCHMTIMERS							
1301	TL1PICKUP	Trip Integrator	1 - 200	1	1 - 200	1	msec.
1302	TL4PICKUP	POTT Coord Timer PU	0 - 50	1	0 - 50	1	msec.
1303	TL4DROPOUT	POTT Coord Timer DO	0 - 50	1	0 - 50	1	msec.
1304	TL5PICKUP	BKR1 b sw Coord Timer PU	0 - 200	1	0 - 200	1	msec.
1305	TL5DROPOUT	BKR1 b sw Coord Timer DO	0 - 200	1	0 - 200	1	msec.
1306	TL6PICKUP	BKR2 b sw Coord Timer PU	0 - 200	1	0 - 200	1	msec.
1307	TL6DROPOUT	BKR2 b sw Coord Timer DO	0 - 200	1	0 - 200	1	msec.

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
1308	TL16PICKUP	Weak Infeed Trip Timer	8 - 99	1	8 - 99	1	msec.
1309	TL24DRPPOUT	GDOC Blocking Timer	30 - 500	1	30 - 500	1	msec.
1310	TL25DRPPOUT	Distance Blocking Timer	30 - 500	1	30 - 500	1	msec.
1311	TL26PICKUP	Repeat Delay Timer	0-50	1	0-50	1	msec.

LINE INFO

1401	POSSEQANG	Pos. Seq. Impedance Angle	25-90	1	25-90	1	deg.
1402	ZERSEQANG	Zero Seq. Impedance Angle	25-90	1	25-90	1	deg.
1403	ZLINE	Positive Sequence Line Impedance in sec. ohms	0.01-50.0	0.01	0.05 - 250.0	0.05	ohms
1404	ZEROSEQK0	Z0 / Z1 ratio	1.0 - 7.0	0.01	1.0-7.0	0.01	NA
1405	LINELENGTH	Line Length	0.0 - 500.0	0.1	0.0-500.0	0.1	NA
1406	LINEUNIT	Units of Length	miles, km		miles, km		
1407	CTRATIO	CT Ratio	1 - 5000	1	1-5000	1	NA
1408	PTRATIO	PT Ratio	1 - 7000	1	1-7000	1	NA

SCADA_DATA

1501	FLTLOCK	Hold Time	0 - 99.9	0.1	0-99.9	0.1	sec.
1502	FLTRESET	Fault Location Reset Time	0 - 999	1	0-999	1	minute s

OS BLOCKING

1601	MOBZONE	Coordinating Zone	ZONE 2, ZONE 3, ZONE 4		ZONE 2, ZONE 3, ZONE 4		NA
1602	MOBCHARANG	MOB characteristic Angle	30 - 130	1	30-130	1	deg.
1603	BLOCKWHAT	Block during OS	BLKALL, BLKDIST, BLKPHAS, BLKNONE		BLKALL, BLKDIST, BLKPHAS, BLKNONE		NA
1604	BLOCKZ1	Block all zone 1 functions	NO, YES		NO, YES		NA
1605	BLOCKZ2	Block all zone 2 functions	NO, YES		NO, YES		NA
1606	BLOCKZ3	Block all zone 3 functions	NO, YES		NO, YES		NA
1607	BLOCKZ4	Block all zone 4 functions	NO, YES		NO, YES		NA

OS TRIPPING (Out-of-Step Trip Model Only)

1701	USE_OST	Select OST	NO, YES		NO, YES		NA
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PROTECTION SETTINGS DATA SHEET

<i>Table 2-ix</i>							
<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
1702	NUMBRCHAR	Select Number of Characteristics	2, 3		2, 3		NA
1703	TRIPIN_OUT	Trip Entering or Leaving Inner	IN, OUT		IN OUT		NA
1704	FWDREACH	OST Forward Reach	0.1 - 75.0	0.1	0.5 - 375.0	0.5	ohms
1705	REVREACH	OST Reverse Reach	0.1 - 75.0	0.1	0.5 - 375.0	0.5	ohms
1706	OUTER	Outer Characteristic Angle	40 - 165	1	40-165	1	deg
1707	MIDDLE	Middle Characteristic Angle	40 - 165	1	40-165	1	deg
1708	INNER	Inner Characteristic Angle	40 - 165	1	40-165	1	deg
1709	TLOS1PU	Coordinating Timer 1 Pick-up	1 - 100	1	1-100	1	msec.
1710	TLOS1DO	Coordinating Timer 1 Drop-out	1 - 100	1	1-100	1	msec.
1711	TLOS2PU	Coordinating Timer 2 Pick up	1 - 100	1	1-100	1	msec.
1712	TLOS3PU	Coordinating Timer 3 Pick up	1 - 100	1	1-100	1	msec.
1713	TLOS4PU	Coordinating Timer 4 Pick up	1 - 100	1	1-100	1	msec.

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
RECLOSER							
1801	RECLMODE	Select Reclosing Option	OFF , NONE, INTERNAL, EXTERNAL, BOTH		OFF , NONE, INTERNAL, EXTERNAL, BOTH		
1802	RECTYPE	Select Reclosing Type	1POLE, 3POLE, 1POLE/3POLE		1POLE, 3POLE, 1POLE/3POLE		
1803	NUM1P	Number of attempts following 1P Trip	1 - 4	1	1	1	
1804	1PDELAY1	1 Pole First Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1805	1PDELAY2	1 Pole Second Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1806	1PDELAY3	1 Pole Third Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1807	1PDELAY4	1 Pole Fourth Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1808	NUM3P	Number of attempts following 3P Trip	1 - 4	1	1		
1809	3PDELAY1	3 Pole First Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1810	3PDELAY2	3 Pole Second Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1811	3PDELAY3	3 Pole Third Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1812	3PDELAY4	3 Pole Fourth Delay	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1813	RESETTIME	Reset Time	0.1 - 300 Sec	0.1 sec	0.1 - 300 Sec	0.1 sec	
1814	DWELLTIME	Contact Dwell Time	0.1 - 2 Sec	0.1 sec	0.1 - 2 Sec	0.1 sec	
1815	HOLD	Inhibit Hold Select	YES, NO		YES, NO		
1816	HOLDTIME	Inhibit Hold Time	1-1000 Sec	1	1-1000 Sec		
1817	HOLDSENSE	Contact Input Status	CC, CO		CC, CO		
1818	SYNCCHECK	Synch Check Supervision	YES, NO		YES, NO		
1819	CLOSEANG	Closing Angle	0 -75 degrees	1	0 -75 degrees	1	
1820	SLIPFREQ	Slip Frequency	0.1 - 5Hz	.1Hz	0.1 - 5Hz	.1Hz	
1821	BUSLINE	Bus or Line Voltage	BUS, LINE		BUS, LINE		
1822	SYNCPHASE	Voltage used by SYNCCHECK	VA, VB, VC, VAB,VBC,VCA		VA, VB, VC, VAB,VBC,VCA		
1823	SYNHOLD	SYNCCHECK Hold Time	1 -100 Sec	1Sec	1 -100 Sec	1Sec	
1824	SP1PDELAY2	Supervise 2 nd 3P Reclose after 1P trip	YES, NO		YES, NO		
1825	SP1PDELAY3	Supervise 3 rd 3P Reclose after 1P trip	YES, NO		YES, NO		
1826	SP1PDELAY4	Supervise 4th 3P Reclose after 1P trip	YES, NO		YES, NO		

PROTECTION SETTINGS DATA SHEET

Table 2-ix

<i>No</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range (5A)</i>	<i>Step</i>	<i>Range (1A)</i>	<i>Step</i>	<i>USER SETTING</i>
1827	SP3PDELAY1	Supervise 1 st 3P Reclose after 3P trip	YES, NO		YES, NO		
1828	SP3PDELAY2	Supervise 2 nd 3P Reclose after 3P trip	YES, NO		YES, NO		
1829	SP3PDELAY3	Supervise 3 rd 3P Reclose after 3P trip	YES, NO		YES, NO		
1830	SP3PDELAY4	Supervise 4th 3P Reclose after 3P trip	YES, NO		YES, NO		
1831	SYNCMANCLS	Supervise Manual Close	YES, NO		YES, NO		
1832	VBUSLIVE	Live Bus Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	
1833	VBUSDEAD	Dead Bus Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	
1834	VLINELIVE	Live Line Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	
1835	VLINEDeAD	Dead Line Voltage	0.1 - 130V	0.1V	0.1 - 130V	0.1V	
1836	LBUSDLINe	Live Bus Dead Line	YES, NO		YES, NO		
1837	DBUSLLINe	Dead Bus Live Line	YES, NO		YES, NO		
1838	DBUSDLINe	Dead Bus Dead Line	YES, NO		YES, NO		
1839	DELTAV	Voltage Difference	0.1 - 30V	0.1V	0.1 - 30V	0.1V	
1840	DELTAVBLK	Block Synch Check by DELTAV	YES, NO		YES, NO		

NONCRIT_AL

1901	NCAIN1	Non-Critical Alarm Input # 1 These eight inputs are 'OR'ed together and then output to the contact assigned to the Non-Critical Alarm.	0 - 256 depending on the choice of input assignment	1	0 - 256 depending on the choice of input assignment	1	
1902	NCAIN2	Non-Critical Alarm Input # 2	0 - 256	1	0 - 256	1	
1903	NCAIN3	Non-Critical Alarm Input # 3	0 - 256	1	0 - 256	1	
1904	NCAIN4	Non-Critical Alarm Input # 4	0 - 256	1	0 - 256	1	
1905	NCAIN5	Non-Critical Alarm Input # 5	0 - 256	1	0 - 256	1	
1906	NCAIN6	Non-Critical Alarm Input # 6	0 - 256	1	0 - 256	1	
1907	NCAIN7	Non-Critical Alarm Input # 7	0 - 256	1	0 - 256	1	
1908	NCAIN8	Non-Critical Alarm Input # 8	0 - 256	1	0 - 256	1	

PROTECTION SETTINGS DATA SHEET

Table 2-ix

No	Mnemonic	Description	Range (5A)	Step	Range (1A)	Step	USER SETTING
OUTPUTS							
2001	T1*	T1 Contact	0 - 256*	1	0 - 256*	1	
2002	T2*	T2 Contact	0 - 256*		0 - 256*		
2003	T3*	T3 Contact	0 - 256*	1	0 - 256*	1	
2004	T4*	T4 Contact	0 - 256*	1	0 - 256*	1	
2005^	T5*	T5 Contact	0 - 256*	1	0 - 256*	1	
2006^	T6*	T6 Contact	0 - 256*	1	0 - 256*	1	
2007	A1 *	A1 Contact	0 - 256*	1	0 - 256*	1	
2008	A2 *	A2 Contact	0 - 256*	1	0 - 256*	1	
2009	A3 *	A3 Contact	0 - 256*	1	0 - 256*	1	
2010	A4 *	A4 Contact	0 - 256*	1	0 - 256*	1	
2011	A5 *	A5 Contact	0 - 256*	1	0 - 256*	1	
2012	A6 *	A6 Contact	0 - 256*	1	0 - 256*	1	
2013	A7 *	A7 Contact	0 - 256*	1	0 - 256*	1	
2014	A8 *	A8 Contact	0 - 256*	1	0 - 256*	1	
2015^	A9 *	A9 Contact	0 - 256*	1	0 - 256*	1	
2016^	A10 *	A10 Contact	0 - 256*	1	0 - 256*	1	
2017^	A11 *	A11 Contact	0 - 256*	1	0 - 256*	1	
2018^	A12 *	A12 Contact	0 - 256*	1	0 - 256*	1	
2019	C1 *	C1 Contact	0 - 256*	1	0 - 256*	1	
2020	C2 *	C2 Contact	0 - 256*	1	0 - 256*	1	
2021	KT1 *	KT1 Contact	0 - 256*	1	0 - 256*	1	
2022	KT2 *	KT2 Contact	0 - 256*	1	0 - 256*	1	
2023	KT3 *	KT3 Contact	0 - 256*	1	0 - 256*	1	
2024	KT4 *	KT4 Contact	0 - 256*	1	0 - 256*	1	
2025	CONFTRIP	Initiate three-phase trip with input from <i>Xpression Builder</i>	0 - 256	1	0 - 256	1	
2026	CONFOSC	Initiate oscillography capture with input from <i>Xpression builder</i>	0 - 256	1	0 - 256	1	

* Contacts are configurable, and are normally open; add 1000 to number to close contact under normal conditions

** See attached list for index assignment

GENERAL SETTINGS
Table 2-ix

<i>No.</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range</i>	<i>Step</i>	<i>USER Setting</i>
CONFIGURE					
101	UNITID	Unit ID	0000-9999		
102	SYSFREQ	System Frequency	50, 60		
103	PHASROTATE	Phase Rotation	ABC, ACB		
104	TIMESYNCH	Time sych source	INTERNAL, IRIG-B		
105	NUM_BKR	Number of Breakers	1,2		
106	NUM_TC	Number of trip circuits	1 - 2	1	
107	NUM_MON	Number of trip Circuit Monitors	(T6→T1) Format = abcdef a-f = 0(OFF) or 1(ON)		
108	DISPLAYVAL	Value Display Mode	PRI, SEC		
109	LANGUAGE	Language Option	ENGLISH, SPANISH		
COMMPORTS					
201	COMPORT1	Comm Port #1 Settings	Baud Rate: Parity Stop Bits xxyz	xx = 03, 12, 24, 48, 96 y = 0(none), 1(odd), 2(even) x = 1, 2 9601	
202	COMPORT2	Comm Port #2 Settings	Interface Baud Rate: Parity Stop Bits ixxyz	I=0(RS232), 1(RS485) xx = 03, 12, 24, 48, 96 y = 0(none), 1(odd), 2(even) x = 1, 2 09601	
203	COMPORT3	Comm Port #3 Settings	Interface Baud Rate: Parity Stop Bits ixxyz	I=0(RS232), 1(RS485) xx = 03, 12, 24, 48, 96 y = 0(none), 1(odd), 2(even) x = 1, 2 09601	
204	PROTOCOL1	Comm Port #1 Protocol	GE-MODEM, ASCII		
205	PROTOCOL2	Comm Port #2 Protocol (One Rear Port Model)	GE-MODEM, ASCII		

GENERAL SETTINGS
Table 2-ix

No.	Mnemonic	Description	Range	Step	USER Setting
206	PROTOCOL3	Comm Port #3 Protocol (Two Rear Port Model)	GE-MODEM, ASCII		
OSC_GRAPHY					
301	NUMFAULTS	Number of fault records (with standard memory)	2, 4, 8, 12		
301^	NUMFAULTS	Number of fault records (with expanded memory)	6,12, 24, 36		
302	PREFault	Number of prefault cycles	1 - 8		
303	SPLITREC	Splits fault record and captures this percentage at end, with (1-SPLITREC) captured at beginning	0 - 100	1 percent	
BRKR DUTY					
401	EXPONENT	Exponent in I ^x t calculation	1.0 - 2.0	0.1	
402	MAX_OP	Maximum number of Breaker Operations for a breaker	0000-9999	1	
403	MAX_IXT	Maximum Breaker Duty for a breaker	0 - 9999999	0.1 K	A ^x sec
404	IXTPHASEA	Accumulated Breaker Duty, Phase A	0 - 9999999	0.1 K	A ^x sec
405	IXTPHASEB	Accumulated Breaker Duty, Phase B	0 - 9999999	0.1 K	A ^x sec
406	IXTPHASEC	Accumulated Breaker Duty, Phase C	0 - 9999999	0.1 K	A ^x sec
407	NUM_OP_A	Present number of Breaker Operations for Phase A	0000-9999	1	
408	NUM_OP_B	Present number of Breaker Operations for Phase B	0000-9999	1	
409	NUM_OP_C	Present number of Breaker Operations for Phase C	0000-9999	1	
INPUTS					
501	CC1	CONTACT CONVERTER 1	0 - 32*	1	
502	CC2	CONTACT CONVERTER 2	0 - 32*	1	
503	CC3	CONTACT CONVERTER 3	0 - 32*	1	
504	CC4	CONTACT CONVERTER 4	0 - 32*	1	

GENERAL SETTINGS
Table 2-ix

<i>No.</i>	<i>Mnemonic</i>	<i>Description</i>	<i>Range</i>	<i>Step</i>	<i>USER Setting</i>
505	CC5	CONTACT CONVERTER 5	0 - 32*	1	
506	CC6	CONTACT CONVERTER 6	0 - 32*	1	
507	CC7	CONTACT CONVERTER 7	0 - 32*	1	
508	CC8	CONTACT CONVERTER 8	0 - 32*	1	
509	CC9	CONTACT CONVERTER 9	0 - 32*	1	
510	CC10	CONTACT CONVERTER 10	0 - 32*	1	
511	CC11	CONTACT CONVERTER 11	0 - 32*	1	
512	CC12	CONTACT CONVERTER 12	0 - 32*	1	

* Contact Converter output normally appears as a Logic 1 with normally open contact connected, to invert output to Logic 0, add 1000 to number.

** See table 2-vii for index assignments

*** Only used if NUM_BKR setting is equal to 2

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DSP / ANI / COMM / LUI.....	13
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CAUTION: Power down the relay by turning off the front panel power switch and disconnecting power from the rear connector (A1-A17) before disassembling the unit. Failure to do so can permanently damage the relay.

3-1 Case Assembly

Construction

The relay case is constructed from an aluminum alloy. It consists of a main frame with mounting brackets and a front, top and rear cover. The relay may be mounted either vertically or horizontally. The mounting ears may be placed in 6 positions. (See Figure 3-2)

An outline drawing is shown in figure 3-2, presenting the front and rear views of the horizontal mount ALPS. The figure provides a panel cutout and drill pattern for mounting the ALPS.

The front cover attaches with four thumb screws. A hole in each of the screws permits a

tamper proof installation when a sealing wire is passed through two or four thumbscrews. The Target reset/Metering button is accessible via a hole in the front cover.

The rear of the case, shown in Figure 3-1, supports terminal blocks for external connections to the case. The printed circuit boards are mounted horizontally inside the case. The boards are connected via a bus card behind the front panel. The printed circuit boards have rear edge connectors that electrically connect with the rear terminal blocks. The boards are firmly held in place by restraining screws on the front of the module trays.

Each board is mounted on an aluminum plate. Proper alignment of the boards to their sockets is maintained by card guides. The aluminum plate supporting each board fits into these guides. The magnetics module, due to its weight, is rigidly mounted to the bottom of the case.

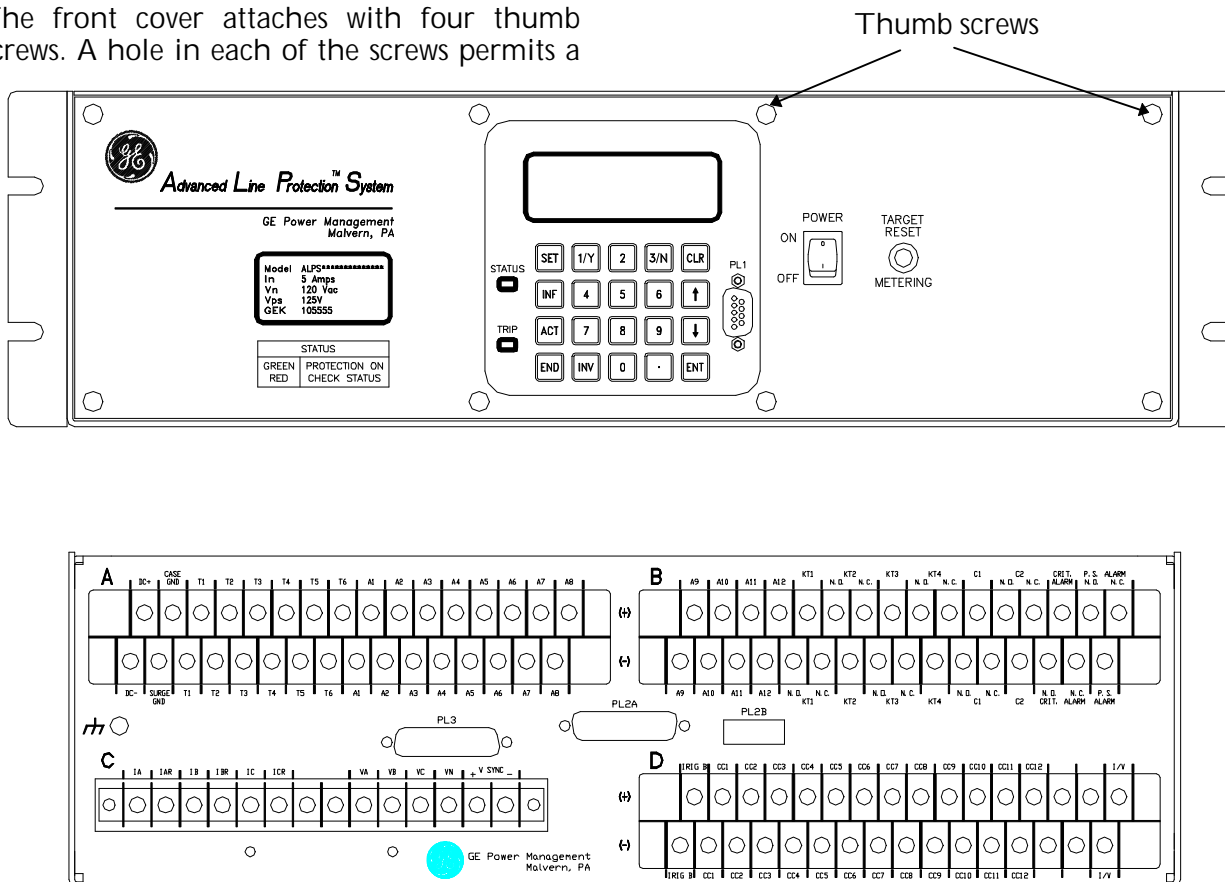


Figure 3-1. Front and Rear views of the ALPS.

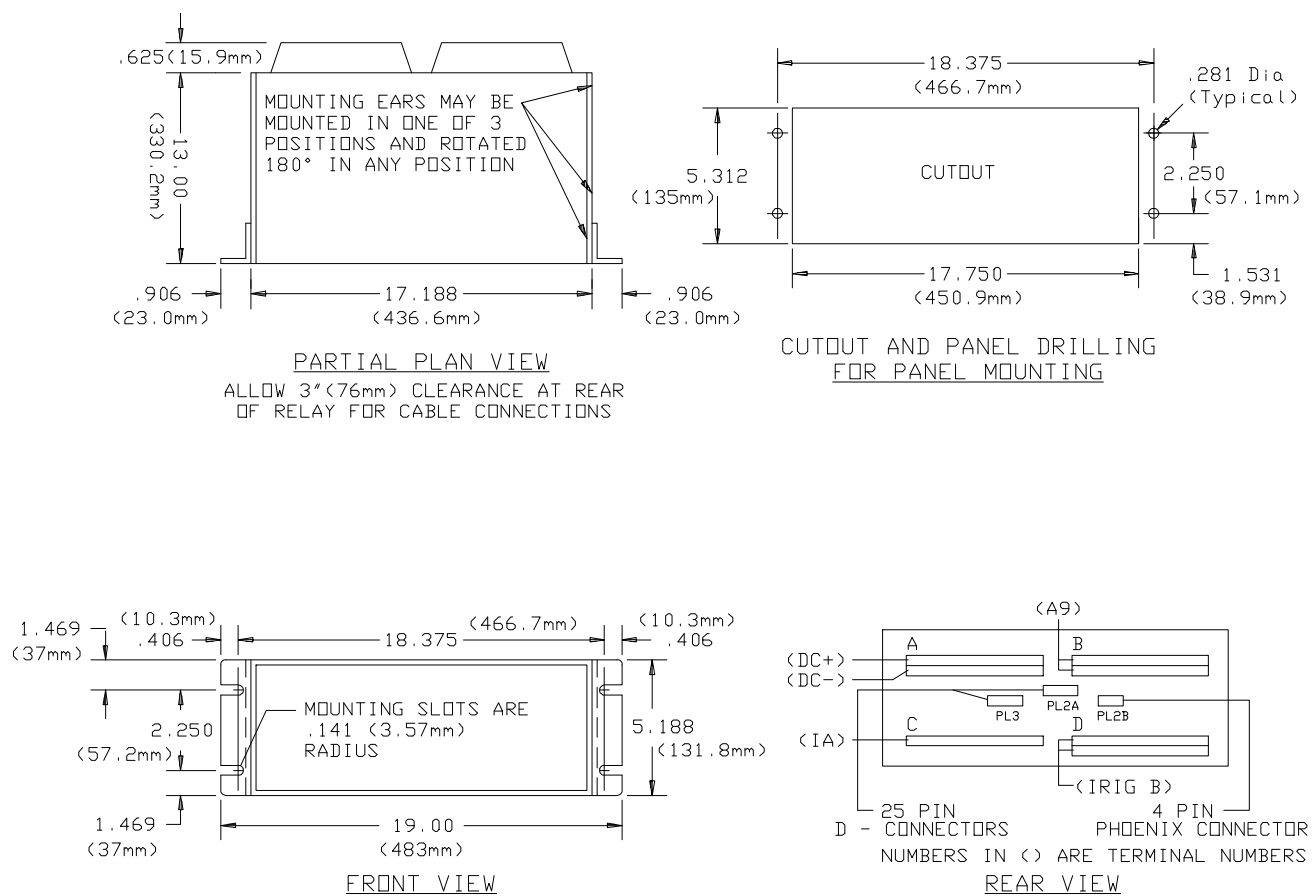


Figure 3-2.ALPS OUTLINE HORIZONTAL.

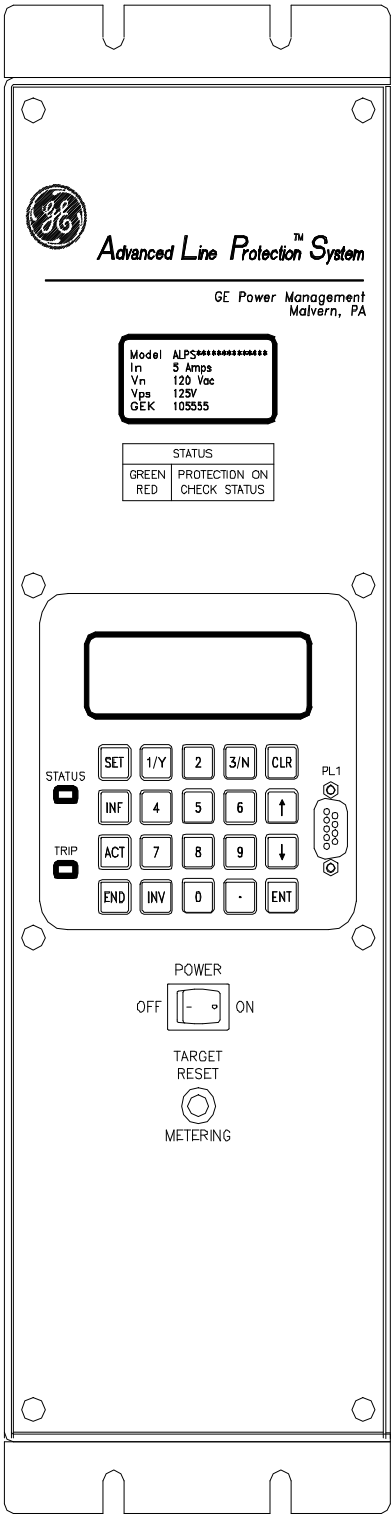


Figure 3-3 ALPS OUTLINE VERTICAL (1)

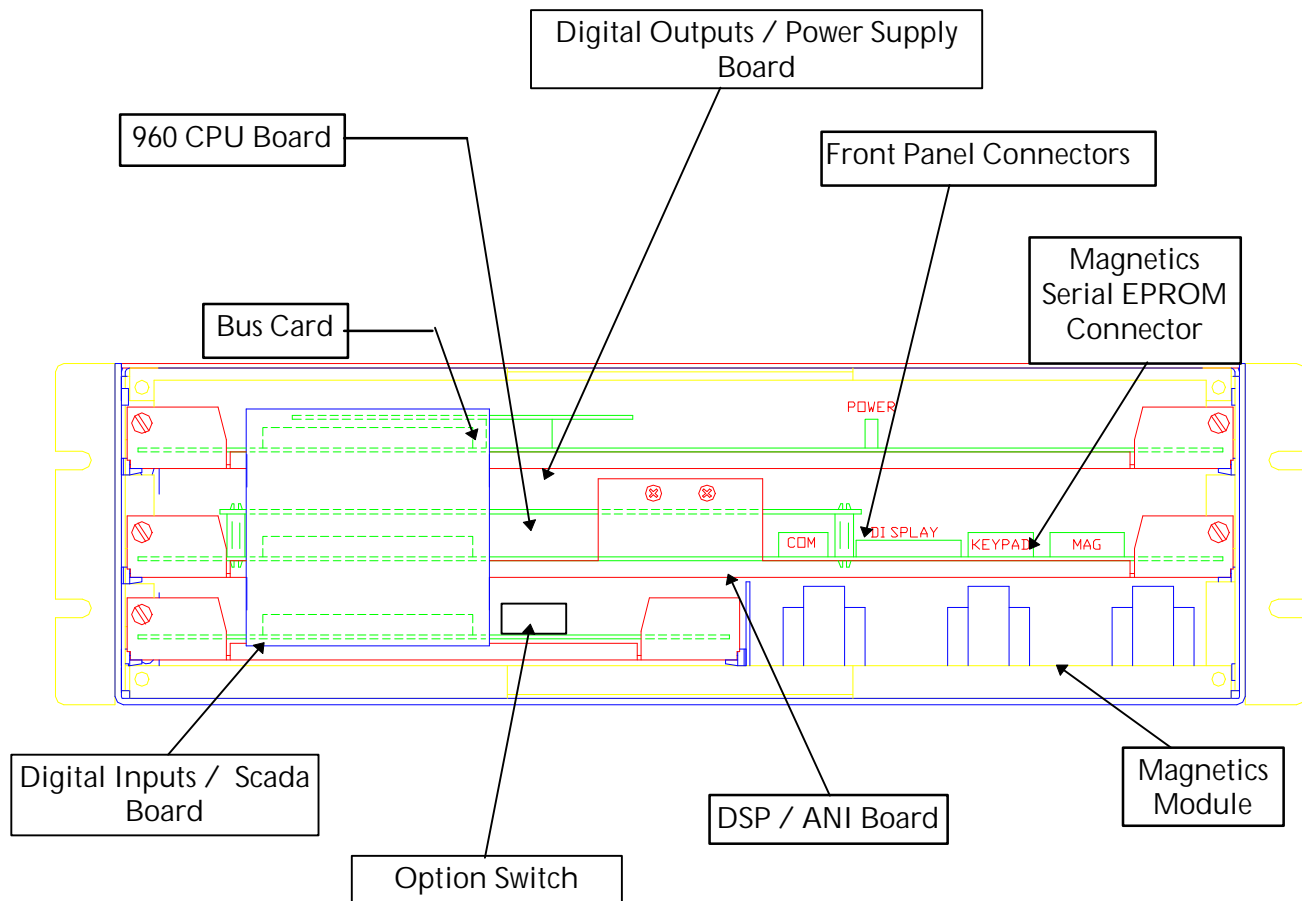


Figure 3-4. Circuit boards location.

Electrical Connections and Internal Wiring

Electrical connections are made to the case through four terminal blocks (A, B, C, D) mounted on the rear cover plate. Terminal blocks A, B and C contain 32 terminal points, which consist of a #6 screw threaded into a flat contact plate. Terminal D contains 14 terminal points, which consist of a #6 screw threaded into a flat contact plate.

The top and bottom printed circuit boards connect directly to terminal blocks A, B and C via edge connectors along the rear of the boards. The magnetics module is wired directly to terminal block D.

The middle printed circuit board is connected to the the top and bottom circuit boards via the Bus Card connected on the front side of the circuit boards. The magnetics module is connected via a card edge connector to the bottom circuit board (input board). The current block contacts are rated to handle current transformer (CT) secondary currents.

Identification

The ALPS system model number label is located on the front cover.

The terminal blocks located on the rear cover plate are uniquely identified by a label that is found along the side of each terminal block. Each terminal is also identified.

Four connectors, PL1, PL2 (A &B), and PL3 are used for serial communication between the ALPS and a PC or modem. PL3 is an optional communications port. All three communications ports work independently.

System Block Diagram

Figure 3-5 is the ALPS system block diagram, illustrating the external connections and the interconnections between the system modules.

3-2 Receiving, Handling, and Storage

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

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

3-3 Installation

Environment

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

Mounting

The ALPS case has been designed for standard rack mounting. The case is three rack units (3 RU) high. Figure 3-2 shows the outline and mounting dimensions.

External Connections

External connections are made according to the elementary diagram, Figure 1-6. This is a default diagram incorporating all of the available options. Since the relay is programmable, some outputs and inputs may need to be re-programmed. Refer to Chapter-2 Calculation of Settings for more details.

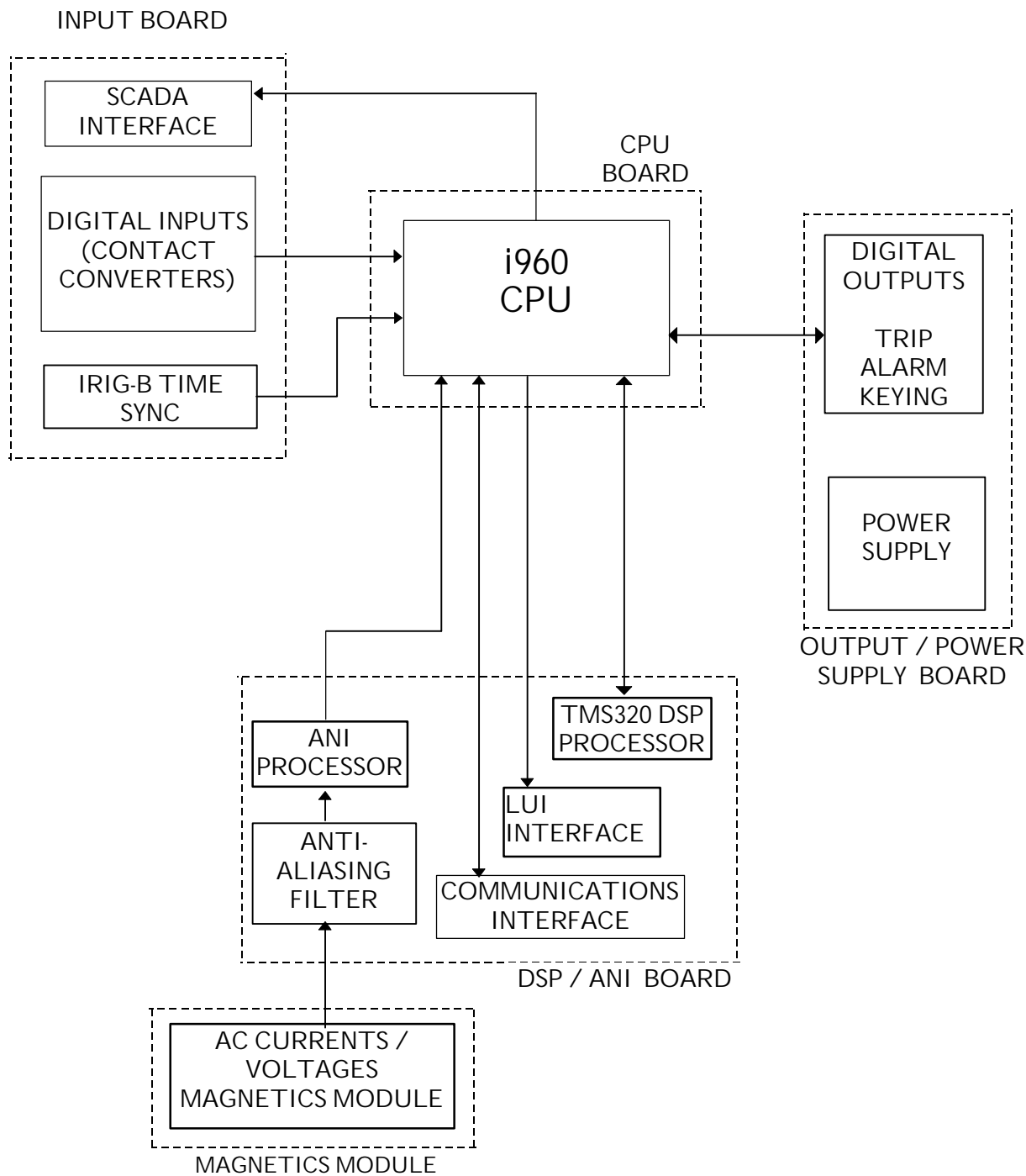


Figure 3-5. ALPS SYSTEM BLOCK DIAGRAM.

3-4 Surge Ground Connections

CAUTION: ALPS Terminals A2 (case ground) and A18 (surge ground) must be tied together, with terminal A18 tied to station ground, as shown in the elementary diagram, Figure 1-6. The connection to the ground bus must be made as short as possible, using #12 wire or larger.

3-5 Printed-Circuit Board Modules

CAUTION: This relay contains electronic components that can be damaged by electrostatic discharge currents. The main source of electrostatic discharge currents is the human body, and low humidity, carpeted floors, and isolating shoes are conducive to the generation of electrostatic discharge currents. Care should be exercised when removing and handling the modules. Each person handling the printed circuit boards must ensure that their body through a grounding wrist strap or similar apparatus tied to ground potential *before* touching any of the components on the boards or the boards themselves.

The printed-circuit boards are located inside the case in the positions shown in Figure 3-3.

Basic Construction

Each module consists of a printed-circuit board and aluminum plate. The printed circuit board is securely mounted to five stand offs on the plate with five screws. There are two tabs on the front of the aluminum plate for removing and inserting the module. Electrical connection is made by an edge connector on the rear of the input and output

boards and ribbon cables and the bus card connector on the front of the boards.

Module Identification

Each module is identified by silk screen description on the printed circuit board.

CAUTION: Power down the relay by removing any DC voltage to the relay before removing or inserting modules. Failure to do so can permanently damage the relay.

Local User Interface (LUI)

The Keypad/Display Interface contains a 4-line, 20-character LED display, a green/red status LED, a red trip LED, a 9-pin RS-232 port, and the 20-character keypad. The interface logic is contained on two printed circuit boards (DSP/ANI and LUI).

- The LUI module board contains all of the items listed above except the keyboard decoding logic which is on the DSP/ANI board.
- The Output board contains the ALPS communications interface (RS-232 / ASCII), a Critical Alarm Timer, various output relay drivers, and user-selectable switches to enable remote functions.

Input Board

The input board contains the input logic which includes the programmable contact converter opto-couplers. The SCADA I/V (current/voltage) selection switch, SW1, is in the left corner on this board, near the edge connector. The IRIG-B input is also on this board. Figure 3-6 is the block diagram of the input board.

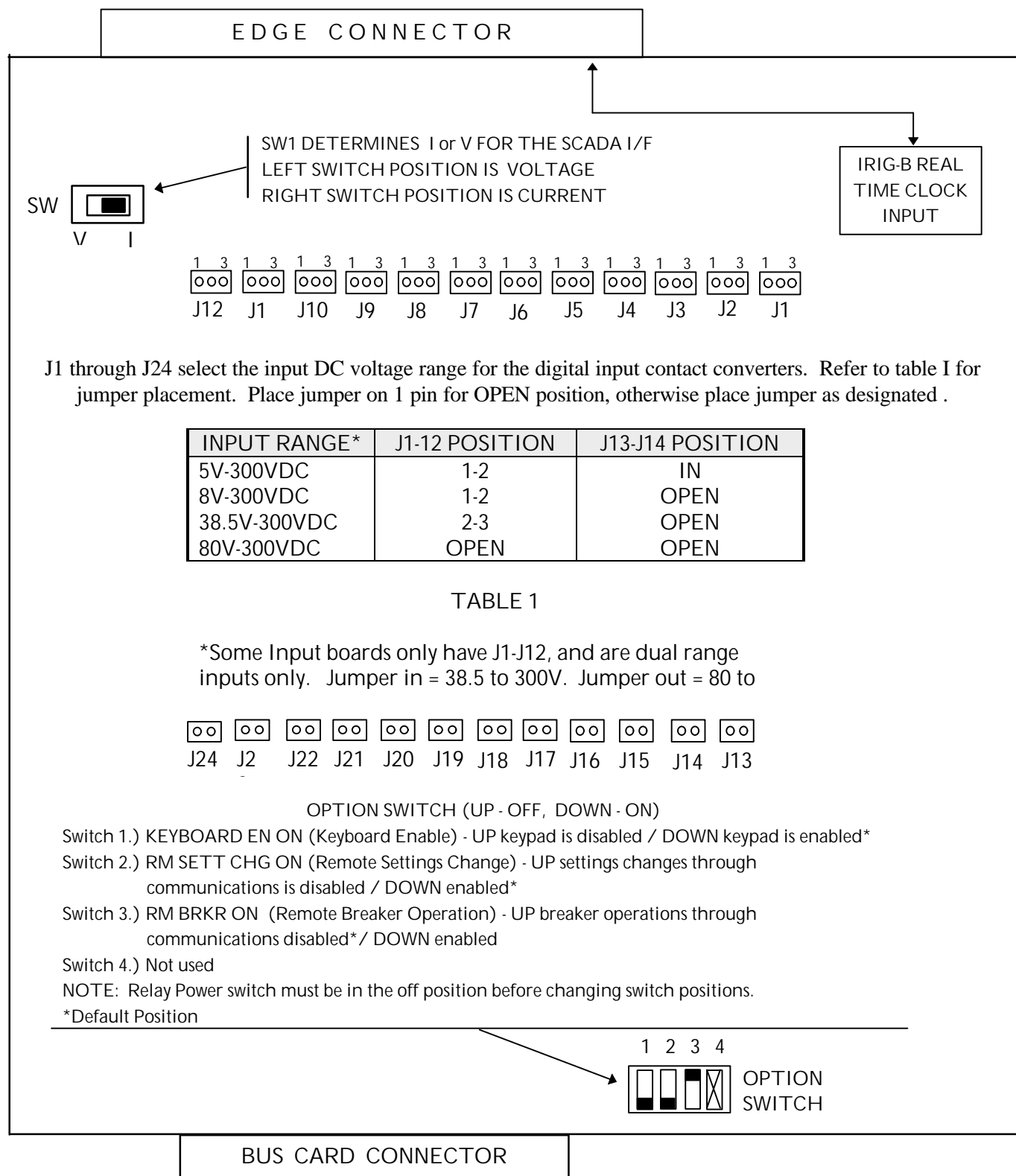
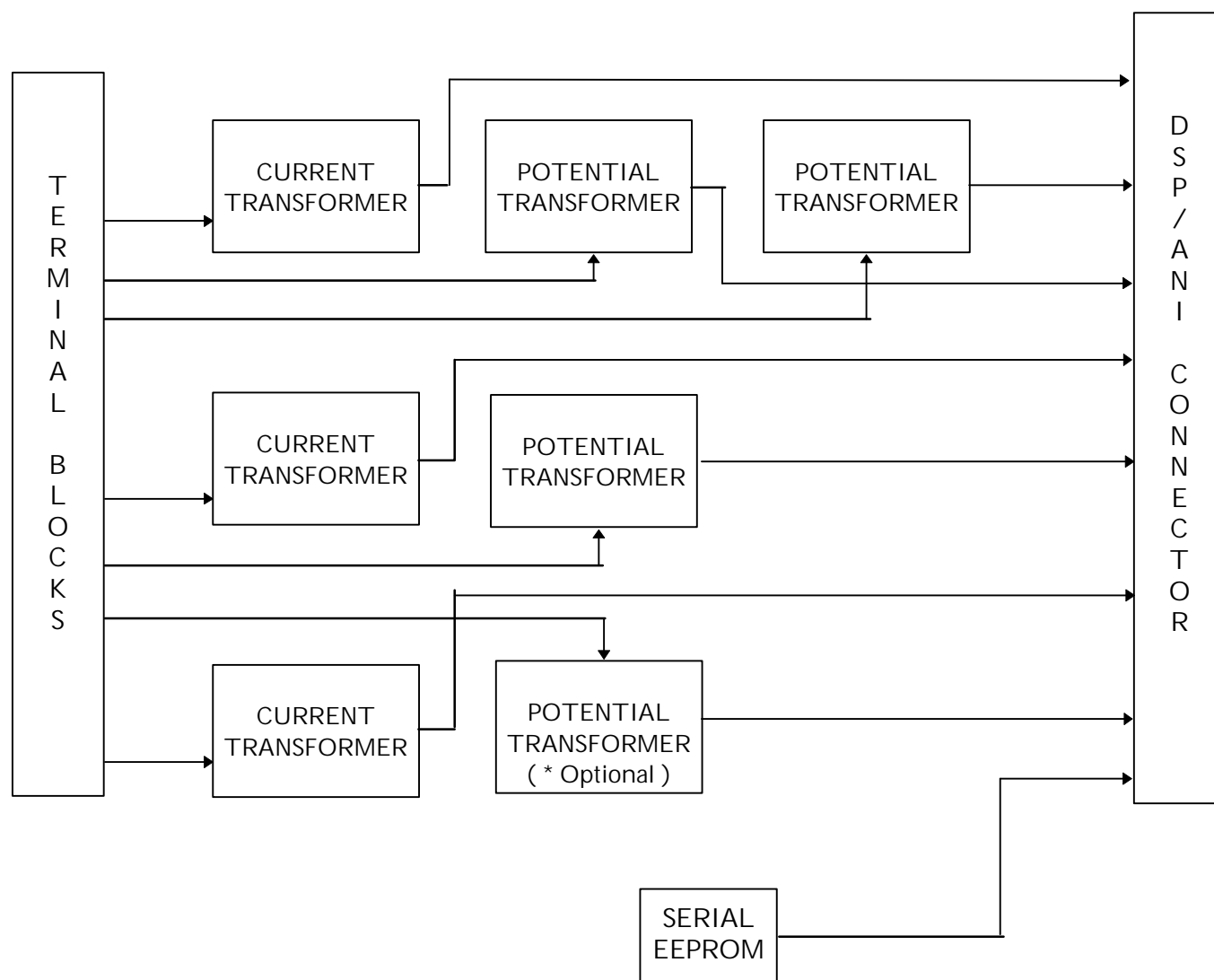


Figure 3-6 INPUT Board Diagram

Magnetics Module

The magnetics module (MGM) contains the input current transformers and voltage transformers. The MGM also contains an EEPROM with factory-stored ALPS model information (dc voltage rating, ac current rating) and gain-calibration information for the analog channels

The relay driver logic located on the output board contains the alarm, BFI, RI, RC, breaker close, key transmitter, and phase A tripping contacts (or SCRs).. Figure 3–7 is a block diagram of the magnetics module and the relay driver.



(FACTORY PROGRAMMED VALUES
NOT FIELD SERVICABLE)

Figure 3–7. Block diagram of the magnetics module (MGM).

Communications Interface

The communications interface resides on plug-in modules with user selectable jumpers to configure the interface for the communications application. The two

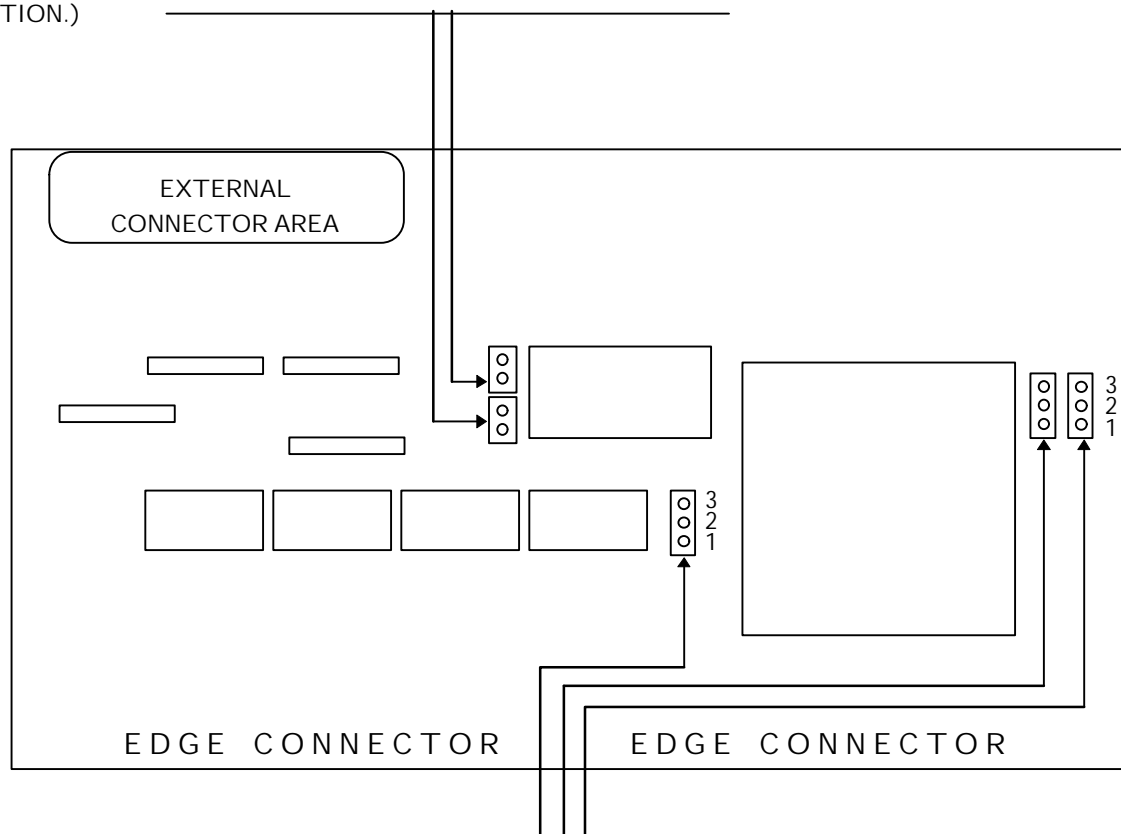
communications types that can be chosen are RS-232 and RS-485. See the description below for details. Figure 3–8 is the block diagram of the PC card for the communications interface.

JP4 and JP5 SELECT THE RS-485 TYPE WHEN RS-485 COMMUNICATIONS IS SELECTED (2 wire/4 wire)

BOTH JUMPERS INSTALLED - 2 WIRE TYPE RS-485

BOTH JUMPERS UNINSTALLED - 4 WIRE RS-485

(UNINSTALLED MEANS THE JUMPERS INSTALLED ON ONE POST, THE OUTSIDE ONE, TO STORE THE JUMPER. THERE WILL BE NO ELECTRICAL CONNECTION WITH JUMPERS IN THIS POSITION.)



Jumpers JP1, JP2 AND JP3 are used to determine the type of communications

JP1	JP2	JP3	TYPE OF COMMUNICATIONS
OPEN	2 - 3	OPEN	RS-232
2 - 3	OPEN	2 - 3	RS-485
1 - 2	1 - 2	1 - 2	PROGRAMMABLE FROM KEYPAD OR COMMUNICATIONS (REFER TO THE CALCULATION OF SETTINGS AND COMMUNICATIONS CHAPTERS IN THIS BOOK.)

Figure 3–8. Block diagram of the Communications Module.

Digital Output / Power Supply

The Digital Outputs, which are programmable are located on this board. The logic to select and write a digital output is located on this board. The power supply circuitry is also contained on this board.

Board

Figure 3-9 is a block diagram of the Digital Output/Power Supply board.

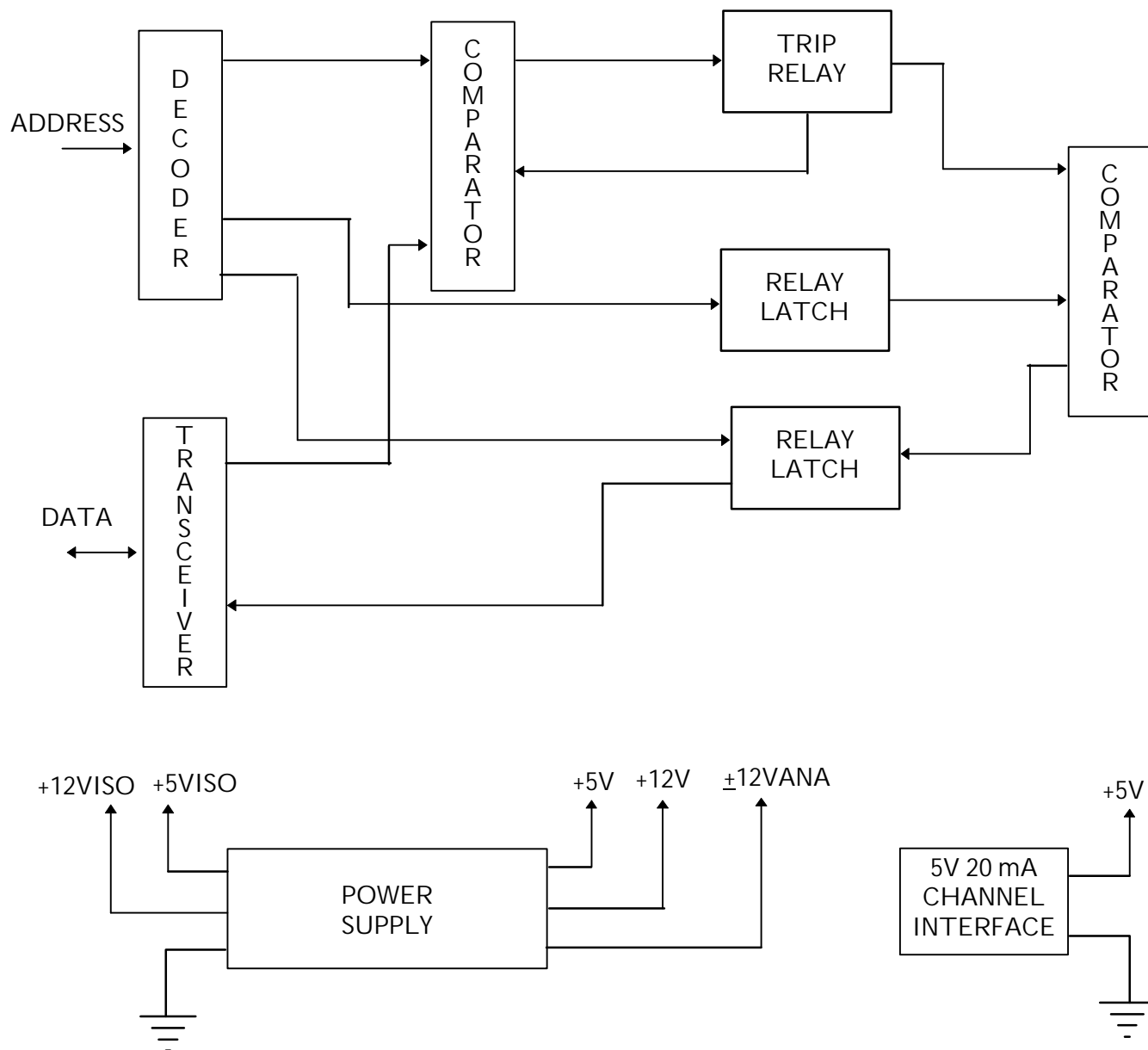


Figure 3-9. Block diagram of the Digital Output/Power Supply.

DSP / ANI / COMM / LUI

The digital signal processor (DSP), located on the DSP/ANI board, contains the TMS320C52 digital signal processor chip and its required memory. The DSP is responsible for most of the numerical calculations in the ALPS. It performs a recursive Fourier transform calculation to transform the digitized

waveforms into phasor quantities. It also handles the data acquisition through the ANI section of the board. The keypad, display and communications interfaces are all on the DSP/ANI Board, as well. Figure 3-10 is the block diagram of the DSP/ANI Board.

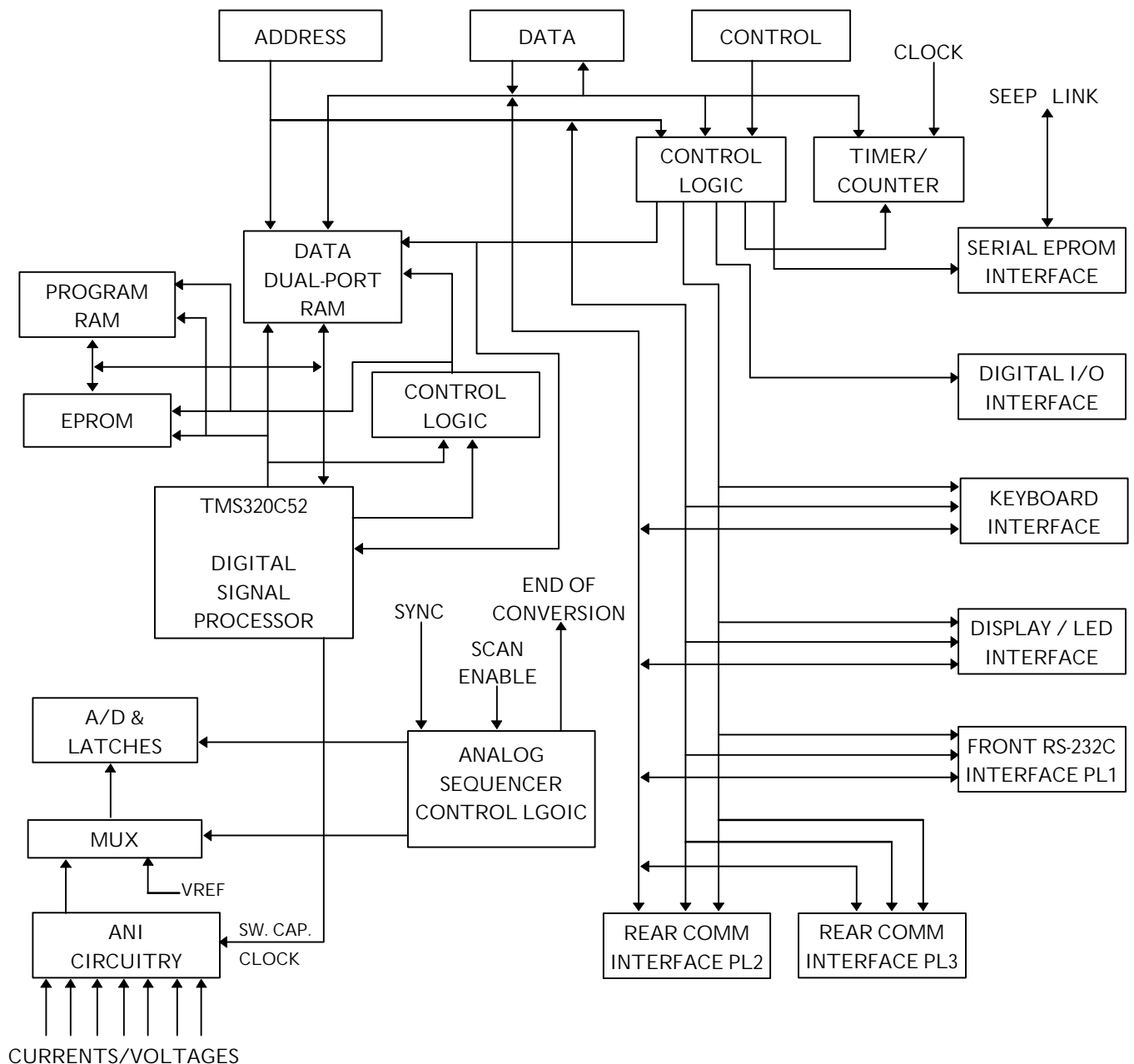


Figure 3-10. Block diagram of the DSP/COMM/LUI Module.

960 CPU Board

The 960 CPU board contains the 960 processor used in the ALPS, EEPROM for storage of user settings, CAPRAM for storage of fault data and oscillography, and controls data transfer to other modules. The following functions are performed by the 960 CPU board:

- Scheme Logic
- Test Mode

- Peripheral Protection Trip Logic
- Digital Output Logic
- Fault Reporting
- Power System Alarming
- Communications and Printer Control

Figure 3–11 contains the block diagram of the CPU logic.

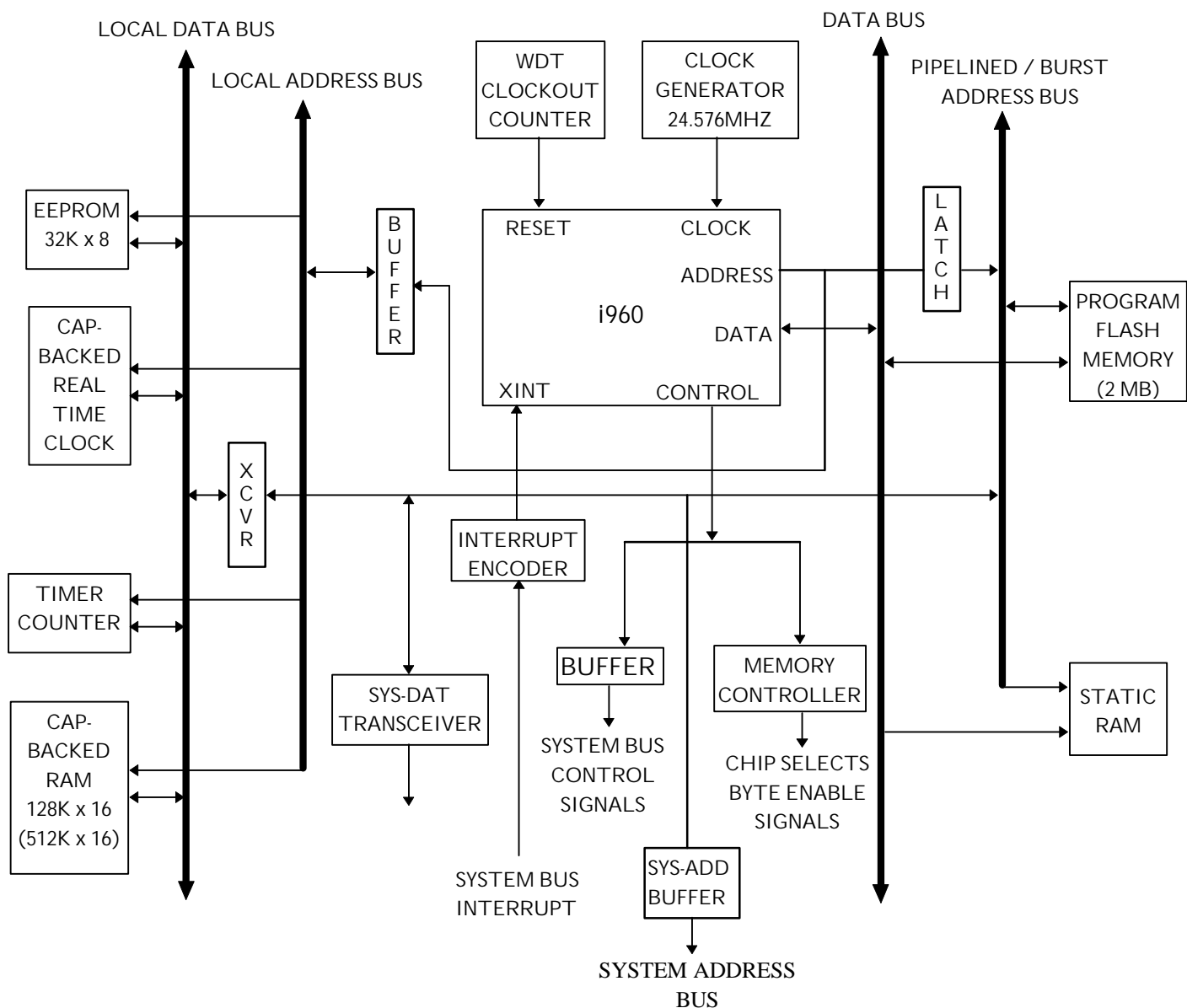


Figure 3–11. Block diagram of the system processor (960 CPU).

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Display and Keypad Tests	8
T2 – Digital Output Test	9
T3 – Configurable Input and Output Test	11
T4 – AC System Input Test	11
Figure 4-2. Configurable input and output test connections	13
Figure 4-3. Phase-to-ground test connections	14

Warning: Remove all power from the relay by disconnecting the dc control power and removing all voltage inputs to the rear terminals prior to opening the unit. Dangerous or lethal voltages may be present inside the unit even if the power switch is OFF.

4-1 Overview

This section is a guide for testing the ALPS. These tests are not necessary for incoming inspection. The relay was tested at the factory with automated test equipment. The ALPS is controlled by self-checking software. If a system failure is detected, it is reported through the display and STATUS LED.

The tests in this section include self-tests of the relay status, display, and Keypad/Display Interface. Tests of backup protection functions, measuring units, and zone timers are also included, and can be performed at the customer's discretion.

General Relay Tests

- T1 – Relay Status and Display Tests (Self Tests)
- T2 – Digital Output Tests
- T3 – Configurable Input and Output Tests
- T4 – AC System Input Test

Test Equipment

- A three-phase source of voltage and current at rated frequency.
- A DC Control voltage source.
- Three ac voltmeters.
- Three ac ammeters.
- A continuity tester or ohmmeter.
- An IBM PC-compatible computer with a serial port and mouse.
- An RS232 null modem cable to connect the PC to the ALPS.
- A precision timer for testing timed events.

The specific equipment requirements are listed in the instructions for each test and in the associated circuit diagrams.

The three-phase ac sinusoidal voltage must be balanced and undistorted. Similarly, the dc power should come from a "good" source with less than 5% ripple. A good source is within the voltage range listed in *Chapter 7 – Specifications*.

Alternatively, a three-phase electronic test source may be used. In many cases, these devices allow simplification of the test circuits.

Drawings and References

The following drawings should be used for reference during testing.

Drawings

- Elementary Diagrams, Figure 1-23, 1-24
- Logic Diagrams, Figures 1-1, 1-2, 1-3, 1-5, 1-7, 1-8, 1-9, 1-10
- 51G curves, Figures 2-2, 2-3, 2-4

References

- Chapter 11- ALPS-link
- Chapter 12- ASCII Communications

Equipment Grounding

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

The ground connection on the ALPS is terminal A2. The common for surge protection is terminal A18.

NOTE: A2 should be connected to A18 with #12 wire or larger during test as well as operation. (The separate surge ground is for High Pot testing purposes.)

Required Settings

Most tests use the default settings. Any required setting changes are listed with the test procedure.

For details on performing the relay test with user-specific settings during periodic testing, see *Chapter 6 - Functional Tests (User Settings)*

General Instructions

1. Tests are performed using the relay's test mode, which allows viewing of the internal measuring units and functions. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

The test mode selects and isolates various relaying functions and measuring units, then routes their status to the A1 (programmable alarm 1) contact. When the particular function under test has picked up, the A1 contact closes. Target information is displayed for tests that cause tripping.

Testing can be performed with outputs disabled. The A1 contact still closes whenever a trip condition exists, however the tripping contacts do not operate. Disabling outputs can be accomplished from the ACTIONS menu or at the start of Relay Test mode.

CAUTION: Contact A1 will chatter when the unit under test is near its threshold. *Do not let it continue to chatter.* Remove the test current. A single contact closure is enough to determine that the unit picked up.

In tests that cause tripping, the trip target type may not match the unit being tested in the procedure. For example, if a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. Keep this in mind during the tests.

Use a continuity tester with high-input impedance, ohmmeter, to monitor such as a digital the A1 contact during relay testing.

NOTE: Tripping contacts will operate while the relay is in test mode unless the outputs are disabled.

2. Where appropriate, current levels are defined with two numbers as xx(yy); xx is the value to be used for relays rated at 5 amperes and (yy) is the value to be used for 1-ampere relays.
3. One or more of the electronic current sources may not be used during a test. If the source is not used, it must be set to zero, in addition to being disabled. Also, the currents should always be set at or near zero whenever a current source is powered on or off.
4. The phase angles of the test sources are shown relative to phase A voltage. A positive phase angle indicates the referenced quantity is leading phase A voltage. A negative phase angle indicates the referenced quantity is lagging phase A voltage.
5. All test voltages are phase-to-ground measurements unless otherwise specified.
6. Entries at the keypad are shown as KEY, with the label of the key to be pressed. For tests that require a setting change, the setting number is shown in parentheses next to the setting. This is performed by pressing the SET key, choosing the setting type (Protection or General), the group (if necessary), the setting number (nnnn), and ENT. The new setting may then be entered.

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

7. When testing the relay using the ALPS-LINK software, the only time that information will automatically appear on the display is after the relay has tripped or to report a detected error. Relay status and test mode information will not appear.

8. At the end of testing, make sure that all settings are returned to their initial values. This can be done through the ALPS-LINK by uploading the settings to the PC before testing begins and then downloading them back to the relay when testing has been completed. If a PC is not available, scroll through all settings using the keypad and verify each one with the table in the Calculation of Settings section of this book..

Setting Changes

Setting changes required for a particular test are listed before the test. A sample setting change is shown below. Refer to *Chapter 8 – Interface* for further details on making setting changes.

Example Setting Change

This example illustrates changing the reach of the Zone 1 Ground Unit to 5.6 Ohms.

1. Apply rated dc and wait for relay initialization to complete, indicated by a solid green status LED on the front of the relay.
2. Press the SET key:
Enter Password:
is displayed.
If this is the first time the Settings Level functions are used, the password has the factory value "123.". This password must be changed before any setting functions can be accessed. See *Chapter 8 – Interface* for details on changing the password.
3. Enter the current settings level password. If the password is not known, see *Chapter 9 – Communications* for details on viewing the password. When the correct password is entered, the settings menu is displayed.
4. Press the 1/Y and ENT keys to select Protection settings.
5. Scroll with the ARROW key until the cursor is on,
1. Z1DISTANCE
then press the ENT key.
6. Scroll through the Z1DISTANCE menu until
Z1GRDREACH = #.#
appears on the display.
7. Press the ENT key and then press 5.6 on the keypad. The inputs appear on the display and the "=" changes to a blinking colon (:) to indicate that a change has been made but not yet entered.
8. When the correct reach is entered, press the ENT key. The blinking colon (:) will change back to a "=". This indicates that the change is entered into the settings buffer, but not permanently changed in the relay.
9. To complete the setting change, press the END key followed by the ENT key. If these keys are not pressed after setting changes, the settings are not stored in memory.
10. Restore the Z1GR setting to its original value before beginning the test. You will have to enter the settings level password again.

Entering Test Mode

Before a test can be performed, the ALPS must be put in test mode and select the function to be tested. The test mode is set as follows:

1. Apply rated dc and wait for relay initialization to complete (if this has not already been done), indicated by the green status LED on the front of the relay.
2. Press the ACT key and
Enter Password:
is displayed.
If this is the first time the Actions Level functions are used, the password has the factory value "456.". This password must be changed before any Control functions can be accessed. See *Chapter 8 – Interface* for details on changing the password.
3. If using remote communications, enter the current Control Level password. If the password is not known, see *Chapter 11 – ALPS-link* or *Chapter 12 – ASCII*

Communications for details on viewing the password. When the correct password is entered, the actions menu is displayed.

4. Scroll with the ARROW keys until
 5. Relay Test
 is displayed, then press the ENT key.
5. Scroll through the different test mode functions or enter the number of the desired test, such as 38 for the Fault Detector. Press ENT and the cursor will be placed on the fault detector test. Press ENT again and the test is started. When the ALPS picks up for the selected function it closes the A1 contacts.
6. To exit test mode, press the ACT key. Scroll with an arrow key until
 5. Relay Test
 is displayed, then press the ENT key. Scroll until the display indicates
 1. END TEST MODE
 and press the ENT key. The user will be prompted to Enable Outputs. Press 1/Y and ENT. The status LED should return to green, indicating that normal operation has resumed.

Using Communications (Optional)

The relay can be tested without using the keypad. A PC and a communications program, either ALPS-LINK or an ASCII terminal emulator, are required to establish communications, change the passwords, change settings for the tests, and place the unit into test mode. The example used here is for ALPS-LINK. Refer to *Chapter 11 – ALPS-link* or *Chapter 12 - ASCII Communications* for details on using a terminal emulator. All the functions available at the keypad are also available through communications.

This section contains a step-by-step procedure to test the relay, from setting up communications to the application of the voltage and current inputs. You must be familiar with the ALPS-LINK software. Refer to *Chapter 11 – ALPS-Link* or *Chapter 12 - ASCII*

Communications for more details on using ALPS-LINK.

Hardware Setup

The appropriate cable to connect the PC to the relay depends on the connections the PC and The ALPS require. The ALPS front port PL-1 accepts a 9-pin male D-connector. Port PL-2 and the optional PL-3 accept a 25-pin male D-connector. The PC used may require a 9- or 25-pin connector. A null modem cable is used to connect two communications ports without a modem. Null modem cables are shown in *Chapter 8 – Interface* for connecting to The ALPS to a PC.

PC Software Setup

The software setup consists of starting Windows, loading the software into the PC, starting the program, and configuring the program to the port and baud rate of the PC and ALPS. ALPS-LINK is a Windows program. Refer to *Chapter 11 – AALPS-link* or *Chapter 12 - ASCII Communications* or the manuals that came with your computer for directions on using a mouse, menu bars, dialog boxes and windows.

Load & Start ALPS-LINK

1. Use the installation guide in *Chapter 11 – ALPS-link* or *Chapter 12 - ASCII Communications* for directions for loading ALPS-LINK into the PC.
2. Double-click on the group icon that contains ALPS-LINK to open the window.
3. Start the program by double-clicking the ALPS-LINK icon.

Set the Local PC configuration.

1. When you start ALPS-LINK the main menu bar is displayed.
2. Click on the Device... menu item. Then click on the Local Settings... menu item..
3. Enter the communications port number that you are using on your PC by clicking

in the box and typing the number. Do not hit the ENTER key yet.

4. Type in the port number that matches the PC port connected to the ALPS. If port 3 or 4 is selected, the IRQ number must also be selected.
5. Select OK when the port is configured.

Set Up a Test Unit Description

The next step is to create a new Unit Description that matches the ALPS's baud rate, phone number, and switch code. Usually, the ALPS is accessed locally during testing; therefore, the PHONE NUMBER and SWITCH CODE are left blank. The BAUD RATE is set to the factory setting of 2400 with one stop bit and no parity.

1. Select the ADD RELAY TO LIST heading from the SETUP menu.
2. When prompted for the UNIT DESCRIPTION, type TEST and select OK. A new unit description called TEST is created and must now have parameters set for it. The RELAY PARAMETERS menu appears with spaces for PHONE NUMBER, SWITCH CODE, BAUD RATE, STOP BITS, and PARITY.
3. At the PHONE NUMBER prompt, type in 10 zeros and press TAB. (This is the default used when there is no phone.)
4. At the SWITCH CODE prompt, press TAB.
5. At the BAUD RATE prompt, select 2400 and press TAB.
6. At the STOP BITS prompt, select 1 and press TAB.
7. At the PARITY prompt, select None and press TAB.
8. The Unit Description for TEST is complete. Enter OK to return to the SETUP MENU.

Relay Setup

Before shipment, the relay is set with factory default settings. These include the Unit ID,

the Baud Rate, and the Factory Passwords. The default communications parameters are listed in Table 4-1.

Parameter	Setting
Unit ID	0
View Password	VIEW!
Control Password	CONTROL!
Settings Password	SETTING!
Master Password	MASTER!
Baud Rate	9600

Table 4-1. Factory-default communication parameters.

Logging Into the Relay

1. Select LOGIN from the RELAY FUNCTIONS menu.
2. Select the test device just created. ALPS-LINK will prompt for a password. If this is the relay login, the passwords listed in Table 4-1 must be changed before any relay functions except CHANGE PASSWORD and LOGOUT will operate. See *Chapter 11 – ALPS-link* or *Chapter 12 – ASCII Communications* for details on changing a password.
3. Type in the current password and press TAB. If the password is not known, refer to *Chapter 8 – Interface* for details on displaying the current password.
4. ALPS-LINK prompts for the unit ID. Type 0 and press TAB.
5. Select OK. ALPS-LINK responds with the message,

SUCCESSFUL LOGIN

If this was an initial login, you must log out at this point and log in again, in order to get a complete display of all the ALPS menus.

6. Select LOGOUT from the RELAY FUNCTIONS menu and select OK.

Setting Changes

Setting changes required for a particular test are listed before the test. A setting can be changed either by category or individually, by

selecting either VIEW/CHANGE CATEGORY OF SETTINGS or VIEW/CHANGE INDIVIDUAL SETTINGS from the ALPS SETTINGS menu. A procedure for and example of how to change settings is provided in *Chapter 11 – ALPS-link* or *Chapter 12 - ASCII Communications*.

It is important to remember to select END SETTING CHANGES from the ALPS SETTINGS menu after all settings changes for a particular test are complete. This is necessary because settings are stored in a buffer so that they can all be downloaded at once. Selecting END SETTINGS CHANGES the settings in the relay itself.

Entering the Test Mode

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

1. Select CHANGE ACCESS LEVEL from the RELAY FUNCTIONS menu.
2. Enter the Control Level password. If the password is not known, see *Chapter 8 – Interface* for details on viewing the current password.
3. When the password is accepted,
CONTROL LEVEL
appears at the bottom of the screen.
4. Select RELAY TEST MODE from the ALPS ACTIONS menu. The RELAY TEST list box appears.
5. Select the test you wish to enter from the menu and then select OK.
6. The STATUS LED changes from green to red when the ALPS is in test mode.

Exiting the Test Mode

To end test mode and turn relay protection on, select END TEST MODE from the RELAY TEST list box and then select OK. The STATUS LED changes from red to green, indicating that normal operation has resumed.

Initial Test Setup

Before beginning a test, the relay settings should be checked for reference and verification. The factory settings are listed in *Chapter 2 – Calculation of Settings*. You may use either the communications ports or scroll through the settings to ensure they all match the defaults.

For testing with ALPS-LINK, the relay settings should be uploaded from the ALPS and printed for reference and verification. Verify that each ALPS 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 ALPS settings can be saved to a disk file so that they can be downloaded to the ALPS when testing is completed. Use the SAVEALPS SETTINGS TO FILE command in the ALPS SETTINGS menu. ALPS-LINK prompts for a name for the file, after which you should enter a valid MS-DOS filename. More information on how to use this command can be found in *Chapter 11 – ALPS-link* or *Chapter 12 - ASCII Communications*.

4-2 General Relay Tests

T1 – Relay Status and Display Testing

The ALPS's Status is reported through the Keypad/Display Interface, the noncritical alarm contact, and the critical alarm contact. If a system error causes relaying functions to cease, the status LED turns red and the critical alarm contact closes. A failure that does not interrupt relaying is indicated by closing the noncritical alarm contact and displaying a WARN message.

Status Check

This test demonstrates the use of the Keypad/Display Interface to check relay status. See

Chapter 11 – ALPS-link or *Chapter 12 - ASCII Communications* for further details.

1. Only the dc power supply voltage is required for this test. Apply the rated dc power and wait for initialization to complete (if this has not been done already), as indicated by the green LED.

2. Press the INF key, then use the ARROW keys to scroll until the cursor is on

1.ALPS STATUS

3. Press the ENT key. The display should contain

STATUS: OK

which means that the relay is operational and there are no errors.

4. Verify the setting of the trip circuit monitor (#107 in General Settings) is:

NUM_MON = 0011 (000111)

Be sure to press the END and ENT keys after the setting is changed. When this is done, the relay expects wetting voltage across the trip contacts.

5. Press the INF key and scroll with ARROW keys until the display contains

1.ALPS STATUS

6. Press the ENT key. The display should contain

STATUS: FAIL

FAIL: TRIP CKT #1 CONTINUITY
ERROR

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

8. Change the setting of the trip circuit monitor to

NUM_MON = 0000 (000000)

re-check the status. It should be

STATUS: OK

change the setting of the trip circuit monitor back to NUM_MON = 0011 (000111) before starting the next test.

Display and Keypad Tests

The Keypad/Display Interface (LUI) Test is built into the software and allows testing the keypad and the display.

1. Apply rated dc power and wait for initialization to complete, as indicated by the green LED, if necessary.

2. Press the ACT key, then scroll with the arrow keys until the display contains the heading,

7. LUI TEST

3. Press the ENT key. The display should contain three choices to test the display, LEDs and keyboard.

4. Select 1. Display and press the ENT key.

5. Check that the display has two rows filled completely with rectangles and press the ENT key. The display changes to the last two rows filled with rectangles. When the display has been checked press the ACT key. If any other key is pressed the display will not return to the LUI Test menu.

6. Use the ARROW keys to select

2. LEDs

and press the ENT key. The selected LED will change. Press ENT after verifying each LED state. When the test is finished the LUI Test menu will be displayed.

7. Use the ARROW keys to select

3. Keyboard

and press ENT. A map of the key board will be displayed on the screen.

8. At this point the relay is in the keyboard test. Press every key on the keypad, except for the CLR key. As you press each key, verify that the display indicates the key that was pressed. For example, pressing the up arrow is indicated on the displayed by the up arrow flashing. The display corresponding to the other keys is the legend that is on printed the key itself.

9. When all the keys have been checked, press the CLR key.

10. When the test is completed, press the END followed by the ENT key. Press the CLR key to clear the message. This ends the Keypad/Display Interface Test.

T2 – Digital Output Test

This test checks all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults. Protection can be enabled or disabled, as deemed necessary.

Note: If this test is run remotely through ALPS-LINK, then switch RM BRKR must be in the down position to allow the outputs to operate. Refer to section 8-3 for details on changing the switch position. Note that the relay is shipped from the factory with the switch in the down position allowing the outputs to operate.

1. Connect the relay as shown in Figure 4–1.
2. Press the ACT key and enter the control level password.
3. Use the ARROW key to select

8. Digital Output Test

Press the ENT key. Before a contact is allowed to be tested, the display prompts

DISABLE PROTECT?

Press the 1/Y key followed by the ENT key to turn protection off. Protection remains off until the test mode is ended. (If desired, protection can be left enabled during the test.)

4. Select the output to test by using the ARROW keys to scroll to the desired output, such as T1, and press the ENT key.
When the digital output is chosen, the selected relay output closes. Verify that the output under test has closed, using an ohmmeter or other suitable device.
5. After the output is tested, scroll to the next output to test, then press the ENT key. This output closes and the previously

selected output opens. Continue in this fashion until all outputs are tested.

6. End the test mode by scrolling to the

END TEST MODE

selection, then press the ENT key. Alternatively, press END followed by the ENT key to end the test and re-enable protection.

PWR = Power Supply Alarm

DIGITAL OUTPUT	X	Y
T1	A3	A19
T2	A4	A20
T3	A5	A21
T4	A6	A22
T5	A7	A23
T6	A8	A24
A1	A9	A25
A2	A10	A26
A3	A11	A27
A4	A12	A28
A5	A13	A29
A6	A14	A30
A7	A15	A31
A8	A16	A32
A9	B1	B17
A10	B2	B18
A11	B3	B19
A12	B4	B20
KT1 (no)	B5	B21
KT1 (nc)	B5	B22
KT2 (no)	B23	B6
KT2 (nc)	B23	B7
KT3 (no)	B8	B24
KT3 (nc)	B8	B25
KT4 (no)	B26	B9
KT4 (nc)	B26	B10
C1A (no)	B11	B27
C1B (nc)	B11	B28
C2A (no)	B29	B12
C2B (nc)	B29	B13
CA (nc)	B14	B30
CA (no)	B14	B31
PWR (nc)	B32	B15
PWR(no)	B32	B16

(no) - normally open contact
(nc) - normally closed contact

Tx - TRIPPING contacts (programmable)
Ax - Alarm contacts (programmable)
KTx - Key Transmitter contacts (programmable)
Cxy - C Form contacts with one no/nc contact pair (programmable)
CA - Critical Alarm

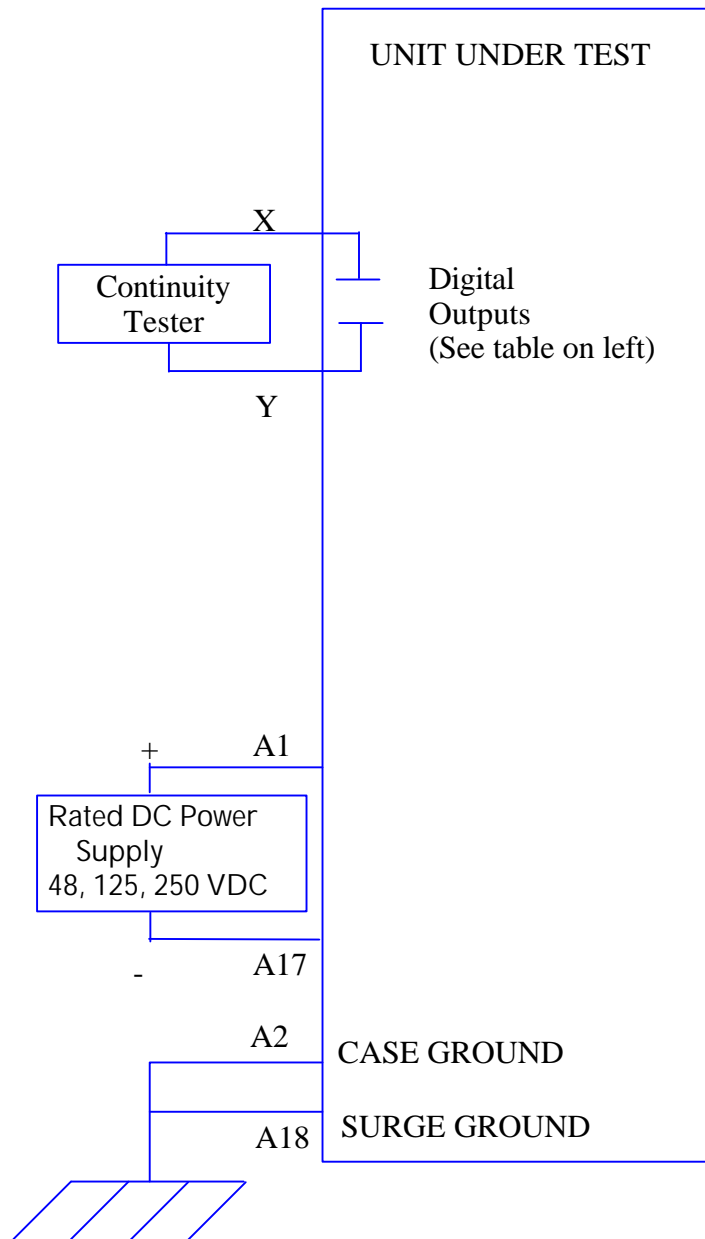


Figure 4-1 Digital Output test connection diagram

T3 – Configurable Input and Output Test

The ALPS includes eight configurable inputs and eighteen configurable outputs, which provide great flexibility in applying and testing the relay.

The configurable inputs are programmed to determine how they will be used. For example, one input could be used to trigger oscillography, while another could be used to select a settings group.

The configurable outputs are set in a similar manner. Each output can be set as one of the 217 different flags available in the relay of the relay.

In the test case below, the digital inputs are used to control the settings group, disable protection and send inputs to outputs. The configurable output contacts will echo inputs, monitor internal units and respond to user actions.

Test T3 Procedure

The steps of test T3 are as follows. Some tests will test inputs as well as outputs at the same time. Some will be tested separately.

1. Apply rated DC across CC1 (D2-D18). Using the keypad and the INFORMATION: "CC status" command, verify that CC1 is ON. Remove the DC from CC1.
2. Apply rated DC across CC2 (D3-D19). Using the keypad and the INFORMATION: "CC status" command, verify that CC2 is ON. Remove the DC from CC2.
3. Apply rated DC across CC3 (D4-D20). Using the keypad and the INFORMATION: "CC status" command, verify that CC3 is ON. Remove the DC from CC3.
4. Apply rated DC across CC4 (D5-D21). Using the keypad and the INFORMATION: "CC status"

command, verify that CC4 is ON. Remove the DC from CC4.

5. Apply rated DC across CC5 (D6-D22). Using the keypad and the INFORMATION: "CC status" command, verify that CC5 is ON. Remove the DC from CC5.
6. Apply rated DC across CC6 (D7-D23). Using the keypad and the INFORMATION: "CC status" command, verify that CC6 is ON. Remove the DC from CC6.
7. Apply rated DC across CC7 (D8-D24). Using the keypad and the INFORMATION: "CC status" command, verify that CC7 is ON. Remove the DC from CC7.
8. Apply rated DC across CC8 (D9-D25). Using the keypad and the INFORMATION: "CC status" command, verify that CC8 is ON. Remove the DC5. Apply rated DC across CC5 (D6-D22). Using the keypad and the INFORMATION: "CC status" command, verify that CC5 is ON. Remove the DC from CC5.
9. Apply rated DC across CC9 (D10-D26). Using the keypad and the INFORMATION: "CC status" command, verify that CC9 is ON. Remove the DC from CC9.
10. Apply rated DC across CC10 (D11-D27). Using the keypad and the INFORMATION: "CC status" command, verify that CC10 is ON. Remove the DC from CC10.
11. Apply rated DC across CC11 (D12-D28). Using the keypad and the INFORMATION: "CC status" command, verify that CC11 is ON. Remove the DC from CC8 from CC11.
12. Apply rated DC across CC12 (D13-D29). Using the keypad and the INFORMATION: "CC status" command, verify that CC12 is ON. Remove the DC from CC8 from CC12.

T4 – AC System Input Test

This test uses the Present Values to determine that the voltages and currents are connected

properly to the terminal strip. The VALUES function can be used at any time during the test to verify that the relay voltages and currents.

1. Connect the relay as shown in Figure 4-3.
2. Set VA to 67 Vrms 0°, VB to 57 Vrms – 120°, and VC to 47 Vrms 120°.

3. Press the INF key on the keypad. Scroll, using the ARROW keys, to the heading,

1. Present values

and press the ENT key. The present values are now displayed.

4. Scroll to the values of VA, VB, and VC and verify that the voltages are within ± 2 volts of the voltage source setting. This verifies the connections of the voltage sources.

Note: Alternately, whenever the display is blank, press the CLR key to have the relay automatically scroll through the present values.

5. Set Iop to 1.0 amp rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4-3.
6. Verify the value of IA, IB, or IC depending on connection Y. Verify that the current reading is between 0.9 and 1.1 amps rms.
7. Reduce the test current to zero amps.

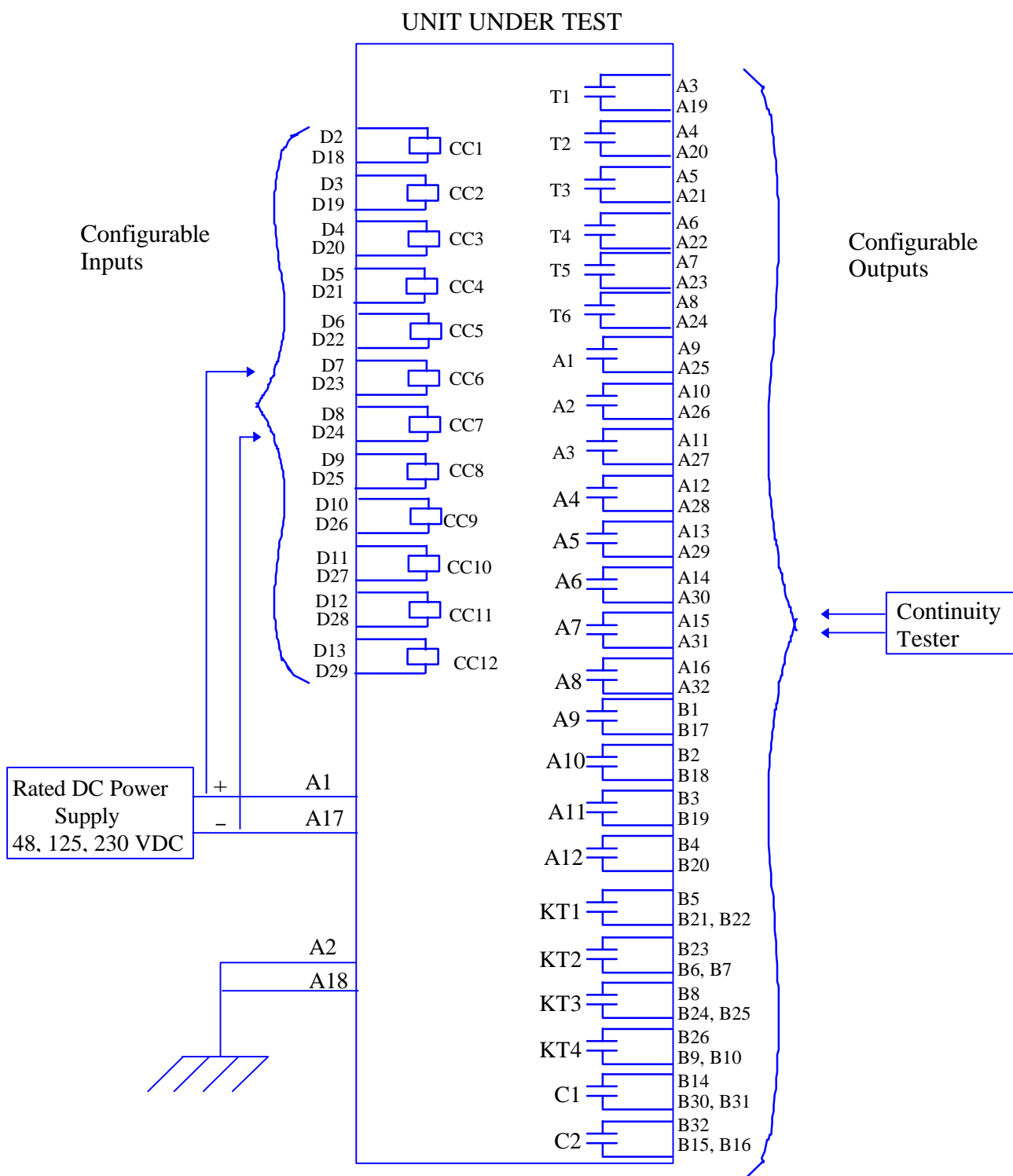


Figure 4-2. Configurable input and output test connections.

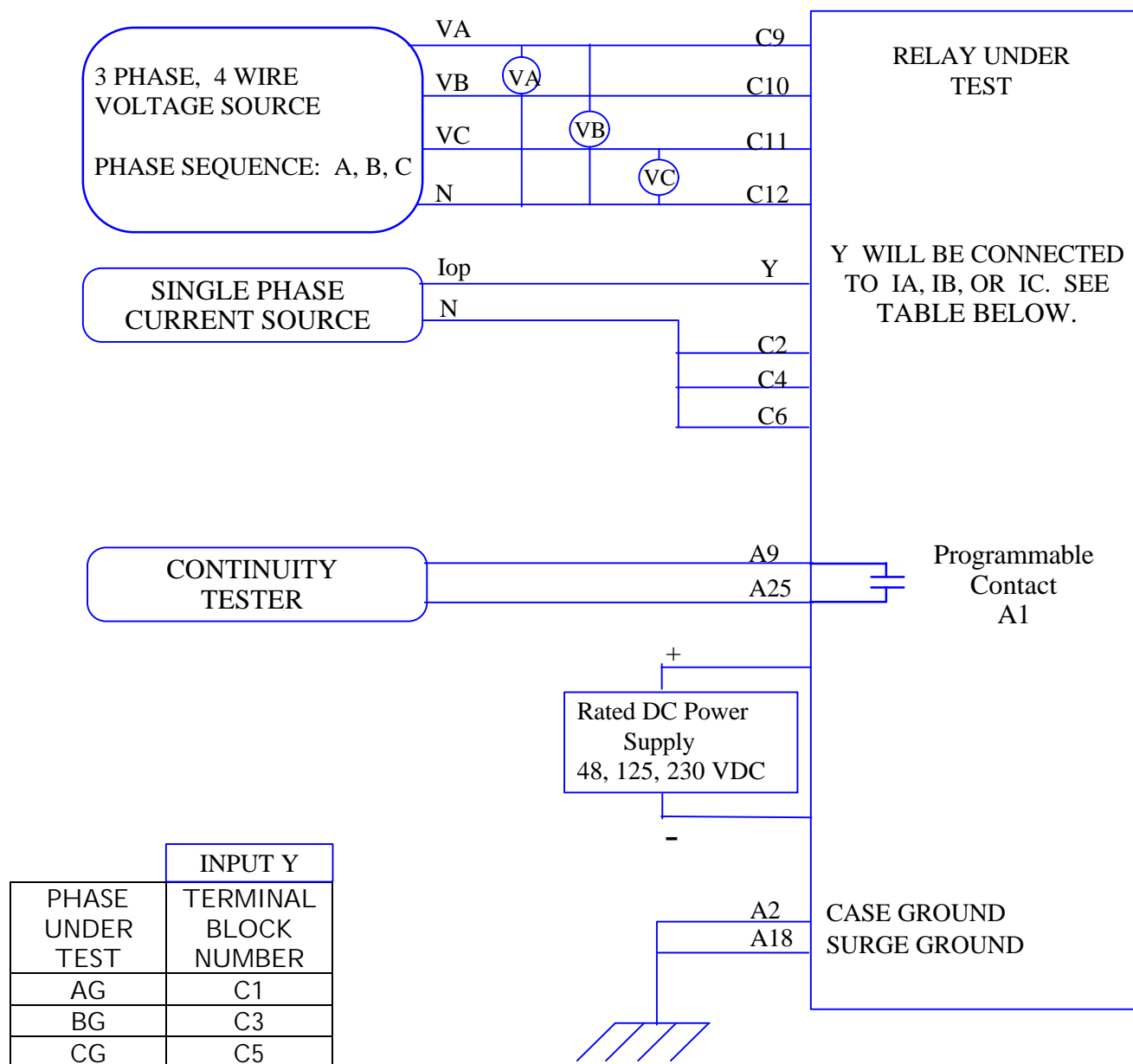


Figure 4-3. Phase-to-ground test connections

5-1 MEASURING UNIT TESTS	2
T1 – FAULT DETECTOR TEST.....	2
T2 – IT TRIP SUPERVISION TEST.....	2
T3 – IB BLOCKING SUPERVISION TEST	3
T4 – GROUND DIRECTIONAL TRIP TEST, IPT + NT.....	3
T5 – GROUND DIRECTIONAL BLOCK TEST, IPB + NB	3
T6 – PHASE INSTANTANEOUS OVERCURRENT 50	3
T7 – GROUND INSTANTANEOUS OVERCURRENT 50G	4
T8 – GROUND TIME OVERCURRENT 51G	4
T9 – UNDERVOLTAGE TEST	7
T10 – OVERVOLTAGE TEST	7
5-2 ZONE REACH AND TIMER TESTS.....	7
T11 – ZONE 1 GROUND REACH TEST, M1G GROUND FAULTS (AG, BG, AND CG).....	8
T12 – ZONE 2 GROUND REACH, MTG GROUND FAULTS (AG, BG, AND CG)	8
T13 – ZONE 3 GROUND REACH, M3G GROUND FAULTS (AG, BG, AND CG).....	9
T14 - ZONE 4 GROUND REACH, M4G GROUND FAULTS (AG, BG, AND CG)	9
T15 – GROUND (ZONE BACKUP) TIMER TESTS	10
5-3 PHASE-TO PHASE ZONE REACH TESTING.....	11
T16 – ZONE1 PHASE REACH, M1 FAULTS (AB, BC, AND CA)	11
T17 – ZONE 2 PHASE REACH, MT FAULTS (AB, BC, AND CA).....	12
T19 – ZONE 4 PHASE REACH, M4 FAULTS (AB, BC, AND CA)	13
T20 – PHASE (ZONE BACK-UP) TIMER TESTS	14
5-4 MOB TESTING	16
T21 – OUT OF STEP REACH, MOB.....	16
5-5 END OF TEST WITH FACTORY SETTINGS	16

5-1 Measuring Unit Tests

Measuring Unit Tests

T1: FD Fault Detector

T2: IT Trip Supervision Test

T3: IB Blocking Supervision Test

T4: Ground Directional Trip Test, IPT & NT

T5: Ground Directional Block Test, IPB & NB

Backup Protection Tests

T10: Phase Instantaneous Overcurrent 50

T11: Ground Instantaneous Overcurrent 50G

T12 – Ground Time Over-current 51G

T13 – Undervoltage

T14 – Overvoltage

Zone Ground / Phase Reach and Timers Tests

T15 – Zone1 Ground Reach M1G

T16 – Zone2 Ground Reach MTG

T17 – Zone3 Ground Reach M3G

T18 – Zone4 Ground Reach M4G

T19 – Zone Ground Timer Tests

T20 – Zone1 Phase Reach M1

T21 – Zone2 Phase Reach MT

T22 – Zone3 Phase Reach M3

T23 – Zone4 Phase Reach M4

T24 – Zone Phase Timer Tests

T25 – Out of Step MOB

CAUTION: Contact A1 will chatter when the unit under test is near the threshold. **Do not allow this to continue.** Remove the test current. A single contact closure is enough to determine that the unit picked up.

T1 – Fault Detector Test

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

1. Connect the relay as shown in Figure 4–3.
2. Set the relay into test mode 38 (the fault detector). The relay displays

FAULT DETECTOR ON

Settings:

Z1DISTANCE

(101) Z1PHASE= NO

(104) Z1GROUND- NO

Z2DISTANCE

(201) Z2PHASE= NO

(204) Z2GROUND- NO

Z3DISTANCE

(301) Z3PHASE= NO

(304) Z3GROUND- NO

Z4DISTANCE

(401) Z4PHASE= NO

(404) Z4GROUND- NO

OVERCURRENT

(605) 50G= NO

(610) 51G= NO

Set the voltages as follows:

VA = 67 V rms 0°

VB = 67 V rms –120°

VC = 67 V rms +120°.

3. Slowly increase Iop to 1.2 (0.4) A rms, at approximately 0.1 (0.01) A per second. Slowly decrease the current to 0 A. The A1 contact should not close.
4. Immediately increase Iop to 1.5 (0.3) A rms. The A1 contact should close momentarily.
5. Immediately increase Iop to 2.5 (0.5) A rms. The A1 contact should close until current is removed.
6. Reduce Iop to 0.

T2 – IT Trip Supervision Test

1. Protection Setting:
CURSUPVIS
(501) IT_PICKUP = 0.25(0.05) AMP
2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 34 (IT Detector). The LUI should display
IT DETECTOR ON

Set the voltages as follows:

VA = 67 V rms 0°

VB = 67 V rms –120°

VC = 67 V rms +120°.

4. Set Iop to .40 (.08) A rms and apply to the relay. The A1 contact should close. Lower Iop to .15 (.03) amp rms, at which point the A1 contact should open.
5. Reduce Iop to 0.

T3 – IB Blocking Supervision Test

1. Setting:
CURSUPVIS
(502) IB_PICKUP = 0.2(0.04) AMP
2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 35 (IB Detector). The LUI should display
IB DETECTOR ON
Set the voltages as follows:
VA = 67 V rms 0°
VB = 67 V rms –120°
VC = 67 V rms +120°.
4. Set Iop to .30 (.06) A rms and apply to the relay. The A1 contact should close. Lower Iop to .10 (.02) A rms, at which point the A1 contact should open.
5. Reduce Iop to 0.

T4 – Ground Directional Trip Test, IPT + NT

1. Setting:
Z2DISTANCE
(204) Z2GROUND= YES
(205) Z2GRDCHAR GDOC
CURSUPVIS
(503) IPT_PICKUP = 0.5(0.1) AMP
2. Connect the relay as shown in Figure 4–3.
 3. Set the voltages as follows:
VA = 55 V rms 0°
VB = 67 V rms –120°
VC = 67 V rms +120°.
4. Set the relay into test mode 36 (Ground Directional Trip). The LUI should display

GRD DIR TRIP ON

5. Set IA, the current of Iop, to .70 (.14) A rms –85°, and apply to the relay. The A1 contact should close. Lower Iop to .40 (.08) A rms, at which point the A1 contact should open.
6. Reduce Iop to 0.

T5 – Ground Directional Block Test, IPB + NB

1. Setting:
CURSUPVIS
(504) IPB_PICKUP = 0.25(0.05) AMP
2. Connect the relay as shown in Figure 4–3.
3. Set VA to 55 V rms 0°, VB to 67 V rms –120°, and VC to 67 V rms 120°.
4. Set the relay into test mode 37 (Ground Directional Block). The LUI should display
GRD DIR BLK ON
5. Set IA, the current of Iop, to .40 (.08) A rms –265° and apply to the relay. The A1 contact should close. Lower Iop to .15 (.03) A rms, and the A1 contact should open.
6. Reduce Iop to 0.

T6 – Phase Instantaneous Overcurrent 50

1. Protection settings:
OVERCURRNT
(601) 50 = YES
(602) 50_DIRCNL = NO
(603) 50PICKUP = 5.0 (1.0)
2. Connect the relay as shown in Figure 5-2 for a phase AB, BC, or CA fault. Note that the leading phase is 180 deg. out of Phase with the line to which it is shorted.
3. Set the relay into test mode 43 (Phase Overcurrent). The LUI should display

INST PHS OVRC ON

4. Set Iop to 2.8 (.6) A rms and apply to the relay. The A1 contact should close. Lower Iop to 2.0 (.4) A rms, at which point the A1 contact should open.
5. Reduce Iop to 0.
6. Restore the following Protection settings
OVERCUR
(602) 50_DIRCNL = YES
(603) 50PICKUP = 20.0 (4.0) AMPS

T7 – Ground Instantaneous Overcurrent 50G

1. Protection settings:
OVERCURRNT
(605) 50G = YES
(606) 50G_DIRCNL=NO(Directnl ctrl off)
(607) 50GPICKUP = 2.5 (0.5) AMPS
2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 44 (Ground Overcurrent). The LUI displays

INST GND OVRC ON

4. Set Iop to 4.0 (.80) A rms and apply to the relay. The A1 contact should close. Lower Iop to 2.4 (.40) A rms, at which point the A1 contact should open.
5. Reduce Iop to zero.
6. Restore the following settings
OVERCURRNT
(605) 50G_DIRCNL = YES
(605) 50GPICKUP = 10 (2.0) AMPS

T8 – Ground Time Overcurrent 51G

1. Setting:
OVERCURRNT
(610) 51G = YES
(611) 51G_DIRCNL = NO (Direct. ctrl off.)
(612) 51GPICKUP = 1.0 (0.2) AMPS
(614) 51GCURVE = V-INV
(615) 51GTIMDIAL = 5.0
2. Connect the relay as shown in Figure 5-1.

NOTE: Start the timer when Iop is applied, and stop the timer when A1 closes (the relay trips).

3. For this test remove the relay from test mode.

(2007) A1 = index 119; TOCTRP

4. Apply Iop at 3.0 (0.6) A rms and start the timer. Leave the current on until the A1 contact close and stop the timer. The 51G should time out in 2.8 to 3.2 seconds.
5. Reduce Iop to zero.
6. Repeat steps 3 and 4 with the values for Iop from Table 5-1. Verify that the 51G times out within the specified time.

Iop, A rms	51G time out, s
3	2.8–3.2
6	0.9–1.1
10	.6–.8

Table 5-1. Time-out values while repeating T8

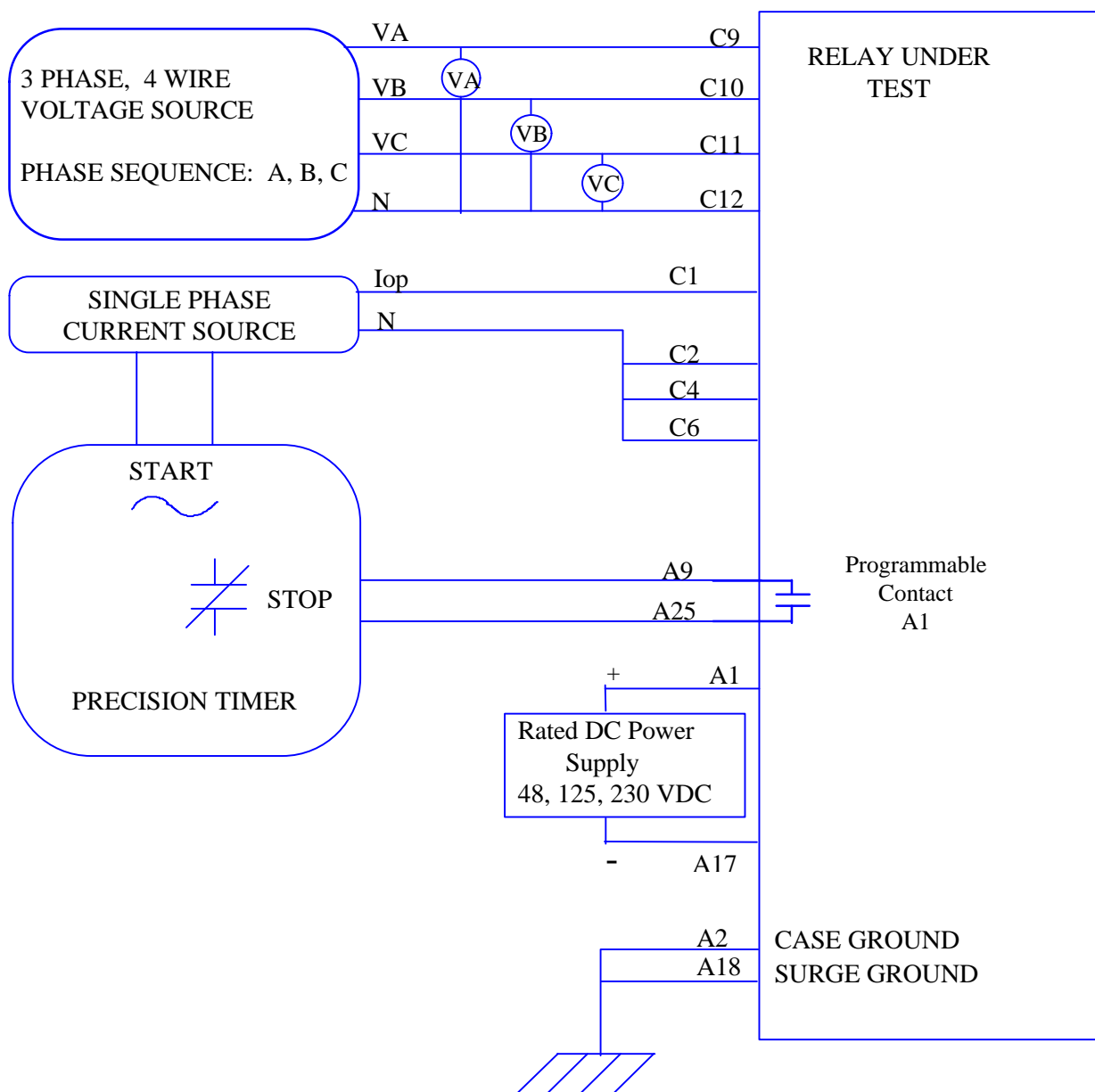


Figure 5-1. Ground Reach Timer Test Connections.

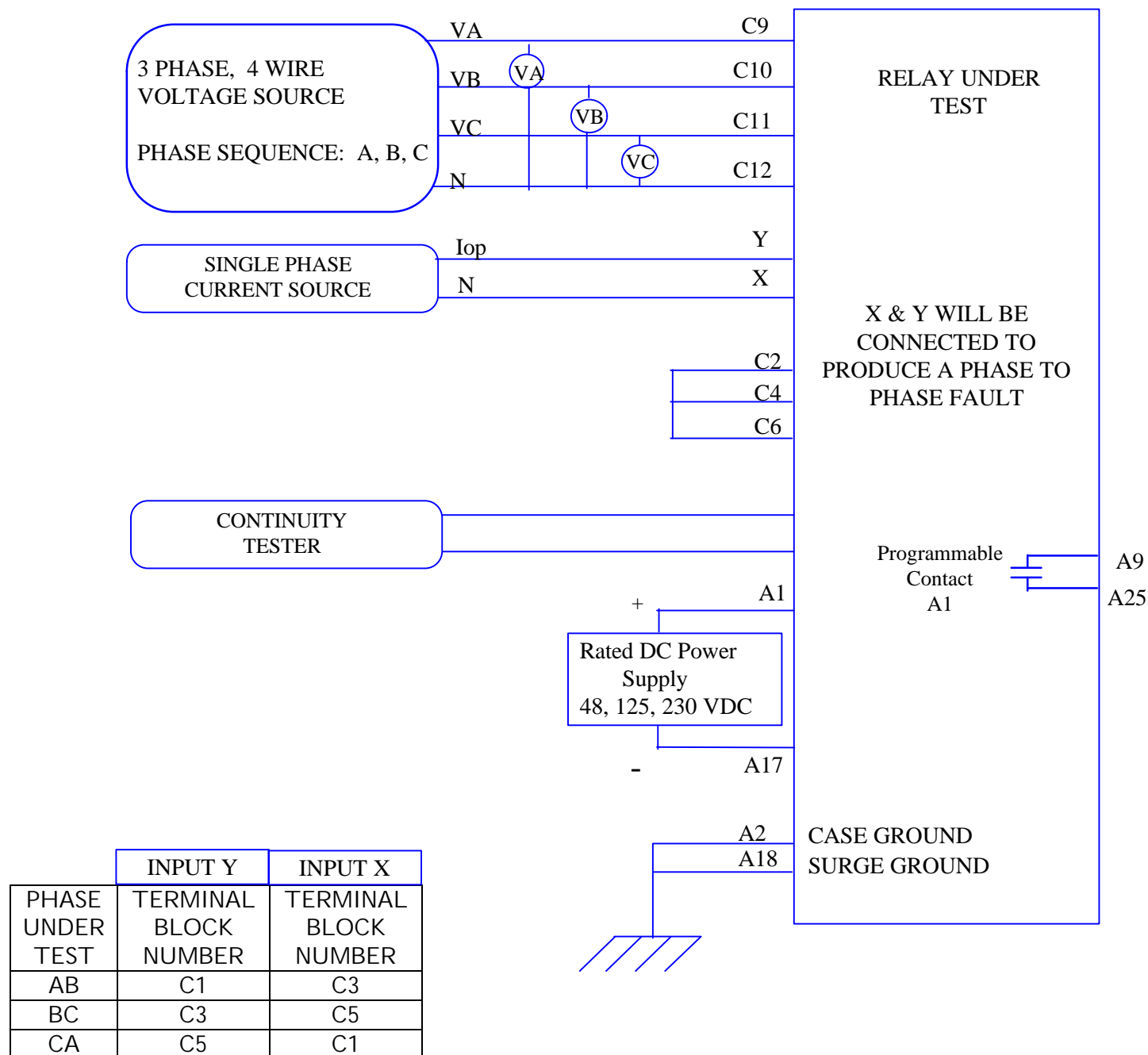


Figure 5-2. Phase-to-phase test connections.

7. Restore these Protection settings

OVERCURRENT

- (610) 51G = Pretest setting
- (611) 51G DIRCNL = Pretest setting
- (612) 51G Pickup = Pretest setting
- (615) 51G Timedial = Pretest setting

OUTPUTS

- (2007) A1 = Pretest setting

T9 – Undervoltage Test

1. Connect the relay as shown in Figure 5-2.
2. Set the relay into test mode 48 The LUI displays

UNDERVOLTAGE ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°

VB: 67 volts rms –120°

VC: 67 volts rms –240°.

Set Iop to zero Amps.

5. Set phase A voltage to 35 V and check that contact A1 closed. Set phase A voltage back to 67 V and check that contact A1 opens. Repeat for phase B and C.

T10 – Overvoltage Test

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

VOLTAGE

- (701) RATEDVOLTS = 115 (rms)
- (702) PHASEOVER= YES
- (703) PHOVPICKUP=1.10(pu Volts)
- (704) PHOVTMDLY = 0.5
- (705) V1OVER = NO

3. Set the relay into test mode 47. The LUI displays

OVERVOLTAGE ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°

VB: 67 volts rms –120°

VC: 67 volts rms –240°.

Set Iop to zero Amps.

5. Set phase A voltage to 74 V and check that contact A1 closed. Set phase A voltage back to 67 V and check that contact A1 opens. Repeat for phase B and C.

5-2 Zone Reach and Timer Tests**General Zone Reach Testing Considerations**

1. The Zone measuring units are checked in the test mode of operation. The A1 (programmable alarm) contact indicates when the unit has operated. It is the *only* measure of whether the test passes or fails. The displayed target information is for reference only. Different test equipment methods can alter the output from what is shown.

The display output is shown for reference only; it is not part of the test. The display includes the target information.

2. When a particular zone is under test, the other protection zones are disabled so that they do not time out and distort the results of the zone under test.

The backup protection functions will cause the relay to trip during zone testing, as they should. They must be disabled to isolate the zone reach unit under test. Before doing any of the reach tests make the following protection settings changes:

OVERCUR

(601) 50 = NO

(605) 50G = NO

(610) 51G = NO

OS BLOCKING

(1603) BLOCKWHAT=3
(BLKNONE)

NOTE: After the zone reach testing is completed, restore these settings to their pretest values.

T11 – Zone 1 Ground Reach Test, M1G Ground Faults (AG, BG, and CG)

- Protection settings:
 Z1DISTANCE
 (101) Z1PHASE= NO
 (104) Z1GROUND = YES
 Z2DISTANCE
 (201) Z2PHASE = NO
 (204) Z2GROUND= NO
 Z3DISTANCE
 (301) Z3PHASE = NO
 (304) Z3GROUND = NO
 Z4DISTANCE
 (401) Z4PHASE = NO
 (404) Z4GROUND = NO
- Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
- Set the relay into test mode 14 (Any Zone1 Ground). The LUI displays
 ANY Z1 GRND ON
- Set the voltage inputs to the following values:
 VA: 67 volts rms 0°
 VB: 67 volts rms –120°
 VC: 67 volts rms –240°.

Set the fault current, I_{op} , to the phase angle listed in Table 5-2. (Increase VA, VB, and VC to 75 V when $I_{op} = -79^\circ$)

I Degrees	Volts rms	DIST*
–49	56–63	—
–79	65–73	82–88
–109	56–63	—

* Reference only.

Table 5-2. Fault current phase settings for test T11.

- Set the fault current, I_{op} , to 8.2 (1.6) A rms. Reduce the voltage of the faulted phase and check that the A1 contact

closes when the voltage is within the limits shown in Table 5-2

- Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as

TRIP: AG Z1 "DIST"

- Repeat the test for phase BG and CG faults.

T12 – Zone 2 Ground Reach, MTG Ground Faults (AG, BG, and CG)

- Protection settings:
 Z1DISTANCE
 (101) Z1PHASE= NO
 (104) Z1GROUND = NO
 Z2DISTANCE
 (201) Z2PHASE = NO
 (204) Z2GROUND= YES
 Z3DISTANCE
 (301) Z3PHASE = NO
 (304) Z3GROUND = NO
 Z4DISTANCE
 (401) Z4PHASE = NO
 (404) Z4GROUND = NO
- Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
- Set the relay to the ZONE 2 ground test mode for the appropriate phase under test. The LUI displays, for instance,
 AG Test: ZONE 2 AG ON
 BG Test: ZONE 2 BG ON
 CG Test: ZONE 2 CG ON
- Set the voltage inputs to the following values:
 VA: 67 volts rms 0°,
 VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.

Set the fault current, I_{op} , to the phase-angle value listed in Table 5-3. (Increase VA, VB, and VC to 75 V when $I_{op} = -79^\circ$)

I Degrees	Volts rms	DIST*
-49	56-63	—
-79	65-72	146-154
-109	56-63	—

* Reference only.

Table 5-3. Fault current phase settings for test T10.

- Set the fault current to 4.6 (0.9) amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within the limits in Table 5-3.
- Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault is displayed as
TRIP: AG Z2 "DIST"
- Repeat the test for phase BG and CG faults.

T13 – Zone 3 Ground Reach, M3G Ground Faults (AG, BG, and CG)

- Setting:
Z1DISTANCE
(101) Z1PHASE= NO
(104) Z1GROUND = NO
Z2DISTANCE
(201) Z2PHASE = NO
(204) Z2GROUND= NO
Z3DISTANCE
(301) Z3PHASE = NO
(304) Z3GROUND = YES
Z4DISTANCE
(401) Z4PHASE = NO
(404) Z4GROUND = NO
- Connect the relay as shown in Figure 4-3 for the appropriate phase under test.
- Set the relay to the ZONE 3 ground test mode for the appropriate phase under test. The LUI displays, for instance:
ZONE 3 AG ON
- Set the voltage inputs to the following values:
VA: 67 volts rms 0°,

VB: 67 volts rms -120°,

VC: 67 volts rms -240°.

Set the fault current, I_{op} , to the phase-angle value listed in Table 5-4. (Increase VA, VB, and VC to 75V when $I_{op} = -79^\circ$.)

I Degrees	Volts rms	DIST*
-49	57-64	—
-79	66-73	195-205
-109	57-64	—

* Reference only.

Table 5-4. Fault current phase settings for test T11.

- Set the fault current to 3.5 (0.7) amperes rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within the limits in Table 4-5.
- Reduce the fault current to zero. Note that the trip target indication concurs with the fault. An AG fault will be displayed as follows:
TRIP: AG Z3 "DIST"
- Repeat the test for phase BG and CG faults.

T14 - Zone 4 Ground Reach, M4G Ground Faults (AG, BG, and CG)

- Setting:
Z1DISTANCE
(101) Z1PHASE= NO
(104) Z1GROUND = NO
Z2DISTANCE
(201) Z2PHASE = NO
(204) Z2GROUND= NO
Z3DISTANCE
(301) Z3PHASE = NO
(304) Z3GROUND = NO
Z4DISTANCE
(401) Z4PHASE = NO
(404) Z4GROUND = YES
- Connect the relay as shown in Figure 4-3 for the appropriate phase under test.

- Set the relay to the ZONE 4 ground test mode for the appropriate phase under test. The LUI displays, for phase A:

ZONE 4 AG ON

- Set the voltage inputs to the following values:
 VA: 67 volts rms 0°,
 VB: 67 volts rms -120°,
 VC: 67 volts rms -240°.

Set the fault current, I_{op}, to the phase-angle value listed in Table 5-5. (Increase VA, VB, VC to 75V when I_{op} = -79°.)

I Degrees	Volts rms	DIST*
-49	56-63	—
-79	62-72	290-310
-109	56-63	—

* Reference only.

Table 5-5. Fault current settings for test T14.

- Set the fault current to 2.3 (0.5) amperes rms. Reduce the faulted phase voltage and check that the A1 contact closes when the voltage is within the limits shown in Table 5-5.
- Reduce the fault current to zero.
- Repeat the test for phase BG and CG faults.

T15 – Ground (Zone Backup) Timer Tests

1. For this test, remove the relay from test mode.

2. Protection settings:

LINEPICKUP

(901) LINEPICKUP = NO

Z1DISTANCE

(101) Z1PHASE = NO

(104) Z1GROUND = NO

Z2DISTANCE

(201) Z2PHASE = NO

(204) Z2GROUND = YES

(209) Z2P_TIME = 1.0

(210) Z2G_TIME = 1.0

Z3DISTANCE

(301) Z3PHASE = NO

(304) Z3GROUND = YES

(307) Z3P_TIME = 3.0

(308) Z3G_TIME = 3.0

Z4DISTANCE

(401) Z4PHASE = NO

(404) Z4GROUND = YES

(409) Z4P_TIME = 5.0

(410) Z4G_TIME = 5.0

OUTPUTS

(2007) A1 = Z2GTMR; Index 129

ZONE 2 Timer

- Connect the relay as shown in Figure 5-1 for the appropriate phase under test.
- Set the voltage inputs to the following values:
 VA: 55 volts rms 0°,
 VB: 67 volts rms -120°,
 VC: 67 volts rms -240°.

Set the fault current, I_{op}, to -55°.

- Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps, but should be applied at that level.) This is an AG fault that is within pickup of all four zones.
- Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE2 trip, such as: AG Z2. This verifies that the second zone tripped. The time for the trip should be in the range 0.9–1.1 seconds.

- Leave the voltages at the values of step 4.

ZONE3 Timer

- Setting:

Z2DISTANCE

(201) Z2PHASE = NO

(204) Z2GROUND = NO

OUTPUTS

(2007) A1 = Z3GTMR; Index 130

- Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be

ramped to 8.2 amps, but should be applied at that level.) This is an AG fault that is within pickup of all four zones.

10. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE3 trip, such as: AG Z3. This verifies that the third zone tripped. The time for the trip should be in the range 2.9–3.1 seconds.
12. Leave the voltages at the values of step 4.

ZONE4 Timer

13. Setting:
 Z3DISTANCE
 (301) Z3PHASE = NO
 (304) Z3GROUND = NO
 OUTPUTS
 (2007) A1 = Z4GTMR; Index 131
14. Apply the fault current at 8.2 (1.6) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 8.2 amps, but should be applied at that level.) This is an AG fault that is within pickup of all four zones.
15. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE4 trip, such as: AG Z4. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8–5.2 seconds.
16. If not continuing with Phase Reach testing, return all settings to their pretest values:
 Z1DISTANCE
 (101) Z1PHASE= YES
 (104) Z1GROUND = YES
 Z2DISTANCE
 (201) Z2PHASE = YES
 (204) Z2GROUND= YES
 Z3DISTANCE
 (301) Z3PHASE = YES
 (304) Z3GROUND = YES

Z4DISTANCE

- (401) Z4PHASE = YES
 (404) Z4GROUND = YES

5-3 Phase-to Phase Zone Reach Testing

The following setting changes apply to all Phase-to-Phase tests:

OVERCUR

- (601) 50 = NO
 (605) 50G = NO
 (610) 51G = NO

OS BLOCKING

- (1603) BLOCKWHAT = 3
 (BLKNONE)

T16 – Zone1 Phase Reach, M1 Faults (AB, BC, and CA)

1. Setting:
 Z1DISTANCE
 (101) Z1PHASE= YES
 (104) Z1GROUND = NO
 Z2DISTANCE
 (201) Z2PHASE = NO
 (204) Z2GROUND= NO
 Z3DISTANCE
 (301) Z3PHASE = NO
 (304) Z3GROUND = NO
 Z4DISTANCE
 (401) Z4PHASE = NO
 (404) Z4GROUND = NO
 2. Connect the relay as shown in Figure 5-2 for the appropriate phases under test. Set the relay to test mode 30 (ANY ZONE 1 Phase). The LUI displays:
 ANY Z1 PHASE ON
 3. Set the voltage inputs to the following values:
 VA: 67 volts rms 0°,
 VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.
- Set the fault current, I_{op}, to the phase-angle value listed in Table 5-6. Note that

the leading phase angle is 180° out of phase with the line to which it is shorted.

I Degrees	Volts rms	DIST*
-25	51-57	—
-55	59-66	82-88
-85	51-57	—

* Reference only.

Table 5-6. Fault current phase settings for test T16.

- Set the fault current to 10.0 (2.0) amps rms. Simultaneously reduce the voltage of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in Table 5-6.
- Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

TRIP: AB Z1 DIST

- Repeat the test for phase BC and CA faults.

T17 – Zone 2 Phase Reach, MT Faults (AB, BC, and CA)

- Setting:
 Z1DISTANCE
 (101) Z1PHASE= NO
 (104) Z1GROUND = NO
 Z2DISTANCE
 (201) Z2PHASE = YES
 (204) Z2GROUND= NO
 (209) Z2P_TIME = 0.1
 (210) Z2G_TIME = 0.1
 Z3DISTANCE
 (301) Z3PHASE = NO
 (304) Z3GROUND = NO
 Z4DISTANCE
 (401) Z4PHASE = NO
 (404) Z4GROUND = NO
- Connect the relay as shown in Figure 5-2 for the appropriate phases under test. Set the relay to the ZONE 2 Phase test mode (31) for the appropriate phase under test. The LUI displays, for instance:

ZONE 2 AB ON

- Set the voltage inputs to the following values:

VA: 67 volts rms 0°,

VB: 67 volts rms -120°,

VC: 67 volts rms -240°.

Set the fault current, I_{op}, to the phase-angle value listed in Table 5-7. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.

I Degrees	Volts rms	DIST*
-25	57-64	—
-55	65-73	146-154
-85	57-64	—

* Reference only.

Table 5-7. Fault current phase settings for test T17.

- Set the fault current to 6.7 (1.4) amps rms. Simultaneously reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in Table 5-7.
- Reduce I_{op} of the faulted phase to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as follows:

TRIP: AB Z2 "DIST"

- Repeat the test for phase BC and CA faults.

T18 – Zone 3 Phase Reach, M3 Faults (AB, BC, and CA)

- Setting:
 Z1DISTANCE
 (101) Z1PHASE= NO
 (104) Z1GROUND = NO
 Z2DISTANCE
 (201) Z2PHASE = NO
 (204) Z2GROUND=NO
 Z3DISTANCE
 (301) Z3PHASE = YES
 (304) Z3GROUND = NO
 Z4DISTANCE
 (401) Z4PHASE = NO

(404) Z4GROUND = NO

2. Connect the relay as shown in Figure 5-2 for the appropriate phase under test. Set the relay to the ZONE 3 (32) Phase test mode for the appropriate phase under test. The LUI displays, for instance:

ZONE 3 AB ON

3. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,

VB: 67 volts rms -120°,

VC: 67 volts rms -240°.

Set the fault current, I_{op} , to the phase-angle value listed in Table 5-8. Note that the leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, and VC to 75 V when $I_{op} = -55^\circ$)

I Degrees	Volts rms	DIST*
-25	56-63	—
-55	65-73	195-205
-85	56-63	—

* Reference only.

Table 5-8. Fault current phase settings for test T18.

4. Set the fault current to 5.0 (1.0) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in Table 5-8.
5. Reduce the fault current to zero. Note that the trip target indication concurs with the fault. For example, an AB fault is displayed as:

TRIP: AB Z3 "DIST"

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

T19 – Zone 4 Phase Reach, M4 Faults (AB, BC, and CA)

1. Setting:

Z1DISTANCE

(101) Z1PHASE= NO

(104) Z1GROUND = NO

Z2DISTANCE

(201) Z2PHASE = NO

(204) Z2GROUND=NO

Z3DISTANCE

(301) Z3PHASE = NO

(304) Z3GROUND = NO

Z4DISTANCE

(401) Z4PHASE = YES

(404) Z4GROUND = NO

(409) Z4P_TIME = 0.1

(410) Z4G_TIME = 0.1

2. Connect the relay as shown in Figure 5-2 for the appropriate phase under test. Set the relay into the ZONE 4 Phase test mode (33) for the appropriate phase under test. The LUI displays, for instance:

ZONE 4 AB ON

3. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,

VB: 67 volts rms -120°,

VC: 67 volts rms -240°.

Set the fault current, I_{op} , to the phase-angle value listed in Table 5-9. Note that the leading phase angle is 180° out of phase with the line to which it is shorted. (Increase VA, VB, and VC to 75 V when $I_{op} = -55^\circ$)

I Degrees	Volts rms	DIST*
-25	56-63	—
-55	64-72	290-310
-85	56-63	—

* Reference only.

Table 5-9. Fault current phase settings for test T19.

4. Set the fault current to 3.3 (0.7) amperes rms. Simultaneously reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in Table 5-9.
5. Reduce the fault current to zero.
6. Repeat the test for phase BC and CA faults.

T20 – Phase (Zone Back-up) Timer Tests

1. For this test remove the relay from test mode.
2. Setting:
 - Z1DISTANCE
 - (101) Z1PHASE= NO
 - (104) Z1GROUND = NO
 - Z2DISTANCE
 - (201) Z2PHASE = YES
 - (204) Z2GROUND= NO
 - (209) Z2P_TIME = 1.0
 - (210) Z2G_TIME = 1.0
 - Z3DISTANCE
 - (301) Z3PHASE = YES
 - (304) Z3GROUND = NO
 - (307) Z3P_TIME = 3.0
 - (308) Z3G_TIME = 3.0
 - Z4DISTANCE
 - (401) Z4PHASE = YES
 - (404) Z4GROUND = NO
 - (409) Z4P_TIME = 5.0
 - (410) Z4G_TIME = 5.0
 - OUTPUTS
 - (2007) A1= Z2PTMR; Index 132

ZONE2 Timer

3. Connect the relay as shown in Figure 5-3 for an AB fault.
4. Set the voltage inputs to the following values:
 - VA: 55 volts rms 0°,
 - VB: 55 volts rms –120°,
 - VC: 67 volts rms –240°.
 Set the fault current, Iop, to –55°.
5. Apply the fault current at 6.7 (1.4) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps, but should be applied at that level.) This is an AB fault that is within pickup of all four zones.
6. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE2 trip, such as: AB Z2. This verifies that the second zone tripped. The

time for the trip should be in the range 0.9–1.1 seconds.

7. Leave the voltages at the values of step 4.

ZONE3 Timer

8. Setting:
 - Z2DISTANCE
 - (201) Z2PHASE = NO
 - (204) Z2GROUND= NO
 - OUTPUTS
 - (2007) A1= Z3PTMR; Index 133
9. Apply the fault current at 5.0 (1.0) amps rms to the relay and start the Precision Timer. (The fault current should not be ramped to 10.0 amps, but should be applied at that level.) This is an AB fault that is within pickup of all four zones.
10. Stop the timer when the A1 contact closes, and reduce the fault current to zero. 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 2.9–3.1 seconds.
11. Leave the voltages at the values in step 4.

ZONE4 Timer

12. Setting:
 - Z3DISTANCE
 - (301) Z3PHASE = NO
 - (304) Z3GROUND= NO
 - OUTPUTS
 - (2007) A1= Z4PTMR; Index 134
13. Apply a fault current of 3.3 (0.7) amps rms to the relay and start the Precision Timer. The fault current should not be ramped to 10.0 amps, but should be applied at that level. This is an AG fault within pickup of all four zones.
14. Stop the timer when the A1 contact closes, and reduce the fault current to zero. Verify that the trip target indication shows a ZONE4 trip, such as: AB Z4. This verifies that the fourth zone tripped. The time for the trip should be in the range 4.8–5.2 seconds.

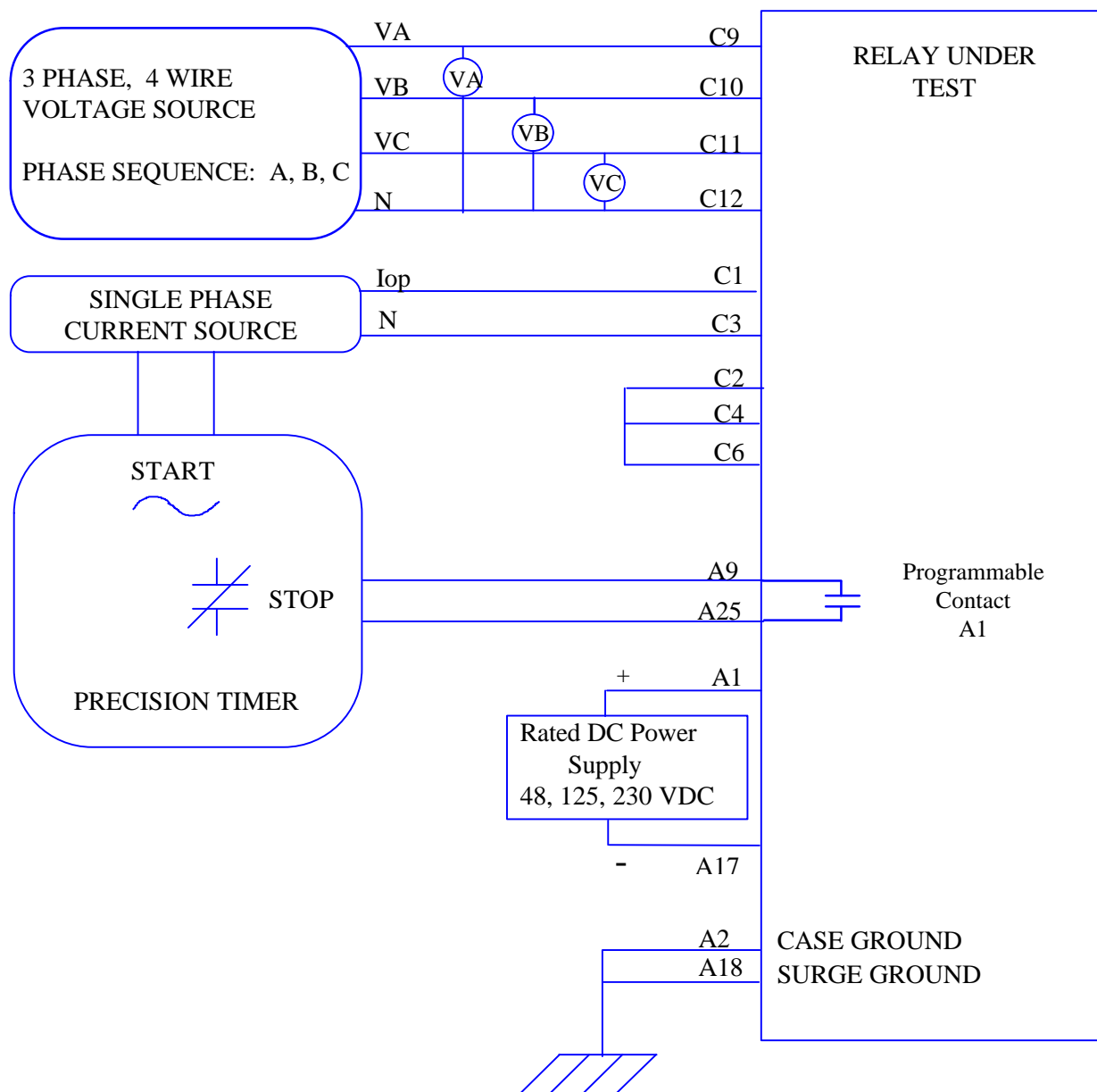


Figure 5-3. Phase-reach timer test connections.

15. If not continuing with MOB testing, return all settings to their pretest values:

Z1DISTANCE

(101) Z1PHASE= YES

(104) Z1GROUND = YES

Z2DISTANCE

(201) Z2PHASE = YES

(204) Z2GROUND= YES

Z3DISTANCE

(301) Z3PHASE = YES

(304) Z3GROUND = YES

Z4DISTANCE

- (401) Z4PHASE = YES
- (404) Z4GROUND = YES

5-4 MOB Testing

T21 – Out of Step Reach, MOB

1. Setting:
 - OS BLOCKING
 - (1601) MOBZONE = 0 (ZONE2)
 - (1603) BLOCKWHAT = 0 (BLKALL)
 - Z1DISTANCE
 - (101) Z1PHASE= NO
 - (104) Z1GROUND = NO
 - Z2DISTANCE
 - (201) Z2PHASE = YES
 - (204) Z2GROUND= NO
 - Z3DISTANCE
 - (301) Z3PHASE = NO
 - (304) Z3GROUND = NO
 - Z4DISTANCE
 - (401) Z4PHASE = NO
 - (404) Z4GROUND = NO
2. Connect the relay as shown in Figure 5-1 for the appropriate phase under test.
3. Set the relay to test mode 40 (OUT OF STEP). The LUI displays the following:
 - OUT OF STEP ON
4. Set the voltage inputs to the following values:
 - VA: 75 volts rms 0° ,
 - VB: 75 volts rms –120° ,
 - VC: 75 volts rms –240° .

Set the fault current, I_{op} , to the phase-angle value listed in Table 5-10. Note that the leading phase angle is 180° out of phase with the line to which it is shorted.

I Degrees	Volts rms
–85	62–72
–25	62–72

Table 5-10. Fault current phase settings for test T21.

5. Set the currents in the faulted phases to 6.3 (1.3) amperes rms. Reduce the voltages of the faulted phases and check that the A1 contact closes when the voltages are within the limits shown in Table 5-10.
6. Reduce the current in the faulted phase to zero.
7. Repeat the test for phases BC and CA
8. Return settings to their pretest values:
 - LINEPICKUP
 - (901) LINEPICKUP = YES
 - Z1DISTANCE
 - (101) Z1PHASE= YES
 - (104) Z1GROUND = YES
 - Z2DISTANCE
 - (201) Z2PHASE = YES
 - (204) Z2GROUND= YES
 - Z3DISTANCE
 - (301) Z3PHASE = YES
 - (304) Z3GROUND = YES
 - Z4DISTANCE
 - (401) Z4PHASE = YES
 - (404) Z4GROUND = YES

5-5 End of Test with Factory Settings

Make sure that the relay is no longer in test mode; select END TEST MODE from the test mode menu. Print out or scroll through all of the settings. Compare them with the initial settings of the relay, and change to initial values. If the initial settings were saved to a disk file with ALPS-LINK before testing, download the file to the relay.

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6–1 ALPS Functional Tests (User Settings)

This chapter contains formulas for the calculation of pickup currents and voltages for testing the ALPS with settings specific to a particular application. The test circuits and procedures are the same as used and illustrated in *Chapter 4 – Acceptance Tests*.

The customer must determine the extent of the testing to be performed. These tests are intended as guides; they are not required for every periodic test of the relay. The desired test procedures can be incorporated into the standard test procedures. However, it is suggested that the relay's built-in self tests be incorporated into the test procedures, since they test the operational status of the unit.

It is assumed in what follows that you are familiar with ALPS testing. If not, refer to *Chapter 4 – Acceptance Test* for details.

General Tests

- T1 – LUI Status Test (Built-In Self Tests)
- T2 – LUI Display Test (Built-In Self Tests)
- T3 – Digital Output Test
- T4 – AC System Input Test

Measuring Unit Tests

- T5 – IT Detector Test
- T6 – IB Detector Test
- T7 – Ground Directional Trip Test, IPT + NT
- T8 – Ground Directional Block Test, IPB + NB

Backup Protection Tests

- T9 – Phase Instantaneous Overcurrent 50
- T10 – Ground Instantaneous Over-current 50G
- T11 – Ground Time Over-current 51G
- Zone Ground/Phase Reach Measuring Units**
- T12 – Zone1 Ground Reach M1G
- T13 – Zone2 Ground Reach MTG
- T14 – Zone3 Ground Reach M3G
- T15 – Zone4 Ground Reach M4G

- T16 – Zone1 Phase Reach M1
- T17 – Zone2 Phase Reach MT
- T18 – Zone3 Phase Reach M3
- T19 – Zone4 Phase Reach M4

Drawings and References

The following drawings should be used for reference during testing.

Drawings

- Elementary Diagram, Figures 1–23, 1-24
- Logic Diagrams, Figures 1–1, 1–2, 1–3, 1–5, 1–7, 1-8, 1-9, 1-10
- 51G curves, Figures 2–2, 2–3, 2–4

Reference

- Chapter 11 - ALPS - Link
- Chapter 12 - ASCII Communications

General Instructions

Tests are performed in test mode, which allows viewing of the internal measuring units and functions. The measuring units and functions are actually internal to the software. There are no individual hardware modules that are responsible for the specific measuring functions.

The test mode selects and isolates various test functions and measuring units, then routes their status to the A1 (A9-A25) contact. When the particular function under test has picked up, the A1 contact closes. Target information is displayed for tests that cause tripping.

Testing can be performed with outputs disabled. The A1 contact still closes whenever a trip condition exists, however the tripping contacts do not operate. Disabling outputs can be accomplished when test mode is entered.

CAUTION: The A1 contact will chatter when the unit under test is near its threshold. *Do not let it continue to chatter.* Remove the test current. A single contact closure is enough to determine that the unit picked up.

In tests that cause tripping, the trip target type may not match the unit under test. For example, if a Zone 1 ground fault is being tested, Zone 2 may pick up and trip the relay before the fault is in Zone 1's characteristic. The target information will reflect the Zone 2 trip, not Zone 1. It is important to remember this during the tests.

Use a continuity tester with high-input impedance, such as a digital ohmmeter, to monitor the A1 contact during relay testing.

NOTE: Tripping contacts will operate while the ALPS is in test mode unless the outputs were disabled by the user.

Entering Test Mode

Before a test can be performed, the ALPS must be put in test mode and select the function to be tested. The test mode is set as follows:

1. Apply rated dc and wait for relay initialization to complete (if this has not already been done), indicated by the green status LED on the front of the relay.
2. Press the ACT key and
Enter Password:
is displayed.

If this is the first time the Control Level functions are used, the password has the factory value "5678.". This password must be changed before any Control functions can be accessed. See *Chapter 8 – Interface* for details on changing the password.
3. Enter the current Control Level password. If the password is not known, see *Chapter 11 –ALPS - Link* or *Chapter 12 - ASCII Communications* for details on viewing the password. When the correct password is entered, the actions menu is displayed.
4. Scroll with the ARROW keys until

5. Relay Test

is displayed, then press the ENT key.

5. Scroll through the different test mode functions or enter the number of the desired test, such as 38 for the Fault Detector. Press ENT and the cursor will be placed on the fault detector test. Press ENT again and the test is started. When the ALPS picks up for the selected function it closes the A1 contacts.

6. To exit test mode, press the ACT key. Scroll with an arrow key until

5. Relay Test

is displayed, then press the ENT key. Scroll until the display indicates

1. END TEST MODE

and press the **ENT** key. The user will be prompted to Enable Outputs. Press 1/Y and ENT. The status LED should return to green, indicating that normal operation has resumed.

Using ALPS-LINK (Optional)

The relay can be tested without using the keypad. A PC and communications program are required to establish communications, change the password, change settings for the tests, and place the unit into test mode. Follow the procedure in *Chapter 4 – Acceptance Tests* to test the relay with ALPS-LINK or ASCII.

6-2 General Relay Tests

T1 – LUI Relay Status

The ALPS Status is reported through the LUI, the non-critical alarm contact, and the critical alarm contact. If a system error causes relaying functions to cease, the status LED turns red and the critical alarm contact closes. A failure that does not interrupt relaying closes the non-critical alarm and displays a FAIL or WARN message on the LUI.

If a STATUS error is detected, see *Chapter 11 – ALPS - Link* or *Chapter 12 - ASCII Communications* for further information.

1. Apply rated dc power and wait for initialization to complete, as indicated by a green status LED.
2. Press the INF key, then scroll with the ARROW keys until the following item is displayed.

1. STATUS

3. Press the ENT key. The display should contain

STATUS OK

which means that the relay is operational and there all self test pass.

T2 – LUI Display Test

The LUI Test is built into the software and allows testing the keypad and the display.

1. Apply rated dc power and wait for initialization to complete, indicated by the green STATUS LED.
2. Press the ACT key, then scroll with the arrow keys until the display contains the heading,

7. LUI TEST

3. Press the ENT key.
4. Select 1. Display and press the ENT key.
5. Check that the display has two rows filled completely with rectangles and press the ENT key. The display changes to the last two rows filled with rectangles. When the display has been checked press the ACT key. If any other key is pressed the display will not return to the LUI Test menu.

6. Use the ARROW keys to select

2. LEDs

and press the ENT key. Each LED will change. Press ENT after verifying each LED state. When the test is finished the LUI Test menu will be displayed.

7. Use the ARROW keys to select

3. Keyboard

and press ENT. A map of the key board will be displayed on the screen.

8. At this point the LUI is in the keyboard test. Press every key on the keypad, except for the CLR key. As you press each key, verify that the display indicates the key that was pressed. For example, pressing the up arrow is indicated on the displayed by the up arrow flashing. The display corresponding to the other keys is the legend that is on printed the key itself.
9. When all the keys have been checked, press the CLR key.
10. When the test is completed, press the END followed by the ENT key. Press the CLR key to clear the message. This ends the LUI Test.

T3 – Digital Output Test

This test checks all outputs of the relay. It is a convenient way to determine proper system connections and verify the operation of all relay contacts, without having to apply currents and voltages to simulate faults. Protection can be enabled or disabled, as deemed necessary.

Note: If this test is run remotely through ALPS-LINK, then switch RM BRKR must be in the down position to allow the outputs to operate. Refer to section 8-3 for details on changing the switch position. Note that the relay is shipped from the factory with the switch in the down position allowing the outputs to operate.

1. Connect the relay as shown in Figure 4–1.
2. Press the ACT key and enter the control level password.
3. Use the ARROW key to select

8. Digital Output Test

Press the ENT key. Before a contact is allowed to be tested, the display prompts

DISABLE PROTECT?

Press the 1/Y key followed by the ENT key to turn protection off. Protection remains off until the test mode is ended. (If

desired, protection can be left enabled during the test.)

4. Select the output to test by using the ARROW keys to scroll to the desired output, such as T1, and press the ENT key. When the digital output is chosen, the selected relay output closes. Verify that the output under test has closed, using an ohmmeter or other suitable device.
5. After the output is tested, scroll to the next output to test, then press the ENT key. This output closes and the previously selected output opens. Continue in this fashion until all outputs are tested.
6. End the test mode by scrolling to the

END TEST MODE

selection, then press the ENT key. Alternatively, press END followed by the ENT key to end the test and re-enable protection.

T4 – AC System Input Test

This test uses the Present Values to determine that the voltages and currents are connected properly to the terminal strip. The VALUES function can be used at any time during the test to verify that the relay voltages and currents.

1. Connect the relay as shown in Figure 4-3.
2. Set VA to 67 Vrms 0°, VB to 57 Vrms -120°, and VC to 47 Vrms 120°.
3. Press the INF key on the keypad. Scroll, using the ARROW keys, to the heading,
 1. Present values
 and press the ENT key. The present values are now displayed.
4. Scroll to the values of VA, VB, and VC and verify that the voltages are within ± 2 volts of the voltage source setting. This verifies the connections of the voltage sources.

Note: Alternately, whenever the display is blank, press the CLR key to have the relay automatically scroll through the present values.

5. Set Iop to 1.0 amp rms for phases IA, IB, or IC, as shown by the Y connection point in Figure 4-3.
6. Verify the value of IA, IB, or IC depending on connection Y. Verify that the current reading is 5% of the input current.
7. Reduce the test current to zero amps.

6-3 Measuring Unit Tests

CAUTION: The A1 contact will chatter when the unit under test is near its threshold. *Do not allow this to continue.* Remove the test current. A single contact closure is enough to determine that the unit has picked up.

At the start of each test is an area to record your specific setting for the function under test.

T5 – IT Trip Supervision Test

1. Setting:

CURSUPVISN
(0501)IT_PICKUP = [_____] amps,
where I_T is set as follows:

$$I_T = IA, IB, \text{ or } IC. \quad (1)$$

The test current, Iop, is single-phase and is applied to IA. Thus, the ALPS should pick up when Iop is equal to I_T .
2. Connect the relay as shown in Figure 4-3.
3. Set the relay into test mode 34 (I_T Detector). The LUI display contains

IT DETECTOR ON
4. Set the level of Iop to $I_T + 0.1 =$ [_____] amps rms and apply to the relay. The A1 contact should close. Lower Iop to $I_T - 0.1 =$ [_____] amps rms; the A1 contact should open.
5. Reduce Iop to zero.

T6 – IB Blocking Supervision Test**(Blocking Schemes Only)**

1. Setting:

CURSUPVIS

(0205) Z2GRDCHAR = G00?

(1201) PICKSCHEME = BLOCK

(0502) IB_PICKUP = []
amps,

where IT is set as follows:

$$IT = IA, IB, \text{ or } IC. \quad (2)$$

The test current, I_{op} , is single-phase and is applied to IA. Thus, the ALPS should pick up when I_{op} is equal to IB.

2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 35 (IB Detector). The LUI display contains
IB DETECTOR ON
4. Set the level of I_{op} to $IB + 0.1 = []$ amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $IB - 0.1 = []$ amps rms; the A1 contact should open.
5. Reduce I_{op} to zero.

T7 – Ground Directional Trip Test, IPT + NT**(Blocking Schemes Only)**

1. Setting:

CURSUPVISN

(0205) Z2GRDCHAR = GDOC

(1201) PICKSCHEME = BLOCK

(0503) IPT_PICKUP = []
amps,

The IPT operating quantity is given by

$$3 \cdot |I_0| - 3 \cdot K_T \cdot |I_1|, \quad (3)$$

where I_0 is equal to the Zero-Sequence Current; I_1 is equal to the Positive-Sequence Current; and K_T is equal to

0.3 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes.

Since the test current, I_{op} , is single-phase, I_0 and I_1 are given by

$$I_0 = I_{op}/3, \quad (4)$$

$$I_1 = I_{op}/3. \quad (5)$$

Substituting Equations 4 and 5 into Equation 3 and assuming a Blocking or Hybrid scheme yields

$$\begin{aligned} PUIPT &= I_{op} - 0.1 I_{op} \\ &= 0.9 I_{op}. \end{aligned} \quad (6)$$

Therefore IPT will pick up when $I_{op} \geq PUIPT/0.9$.

2. Connect the relay as shown in Figure 4–3.
3. Set the voltage inputs to the following values:
VA: 55 V rms 0°
VB: 67 V rms -120°
VC: 67 V rms 120°
4. Set the relay into test mode 36 (Ground Directional Trip). The LUI should display
GRD DIR TRIP ON
5. Set the current of I_{op} to $(PUIPT/0.9) + 0.10 = []$ amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $(PUIPT/0.9) - 0.1 = []$ amps rms; the A1 contact should open.
6. Reduce I_{op} to zero.

T8 – Ground Directional Block Test, IPB + NB (Blocking Schemes Only)

1. Setting:

CURSUPVISN

(0205) Z2GRDCHAR = G00?

(1201) PICKSCHEME = BLOCK

(0504) IPB_PICKUP = []
amps,

The IPT operating quantity is given by

$$3 \cdot |I_0| - 3 \cdot K_B \cdot |I_1|, \quad (7)$$

where I_0 is equal to the zero-sequence current; I_1 is equal to the positive-sequence current; and K_B is equal to 0.066 for Blocking and Hybrid schemes or 0 for POTT and PUTT schemes.

Since the test current, I_{op} , is single-phase, I_0 and I_1 are given by

$$I_0 = I_{op}/3 \quad (8)$$

and

$$I_1 = I_{op}/3 \quad (9)$$

Substituting Equations 8 and 9 into Equation 7 and assuming a Blocking or Hybrid scheme yields

$$\begin{aligned} PUIPT &= I_{op} \div 0.066 \cdot I_{op} \quad (10) \\ &= 0.934 I_{op}. \end{aligned}$$

Therefore IPT will pick up when $I_{op} \geq PUIPT/0.934$.

2. Connect the relay as shown in Figure 4–1.
3. Set the voltage inputs to the following values:
 - VA: 55 V rms 0°
 - VB: 67 V rms -120°
 - VC: 67 V rms 120° .
4. Set the relay into test mode 37 (Ground Directional Block). The LUI should display

GRD DIR BLK ON

5. Set the current of I_{op} to $(PUIPB/0.934) + 0.1 = \underline{\hspace{2cm}}$ amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $(PUIPB/0.934) - 0.1 = \underline{\hspace{2cm}}$ amps rms; the A1 contact should open.
6. Reduce I_{op} to zero.

6–4 Backup Protection Tests

T9 – Phase Instantaneous Overcurrent 50

1. Setting:

OVERCURRENT

(0601) 50 = YES

(0602) 50_DIRCNL = NO

(0603) 50PICKUP = $\underline{\hspace{2cm}}$
amps,

50 is calculated with the following equation:

$$50 = (I_A - I_B) \text{ or } (I_B - I_C) \text{ or } (I_C - I_A), \quad (11)$$

where 50 is the difference in phase-to-phase current.

The test current, I_{op} , is connected to one phase and returned through another to simulate a phase-to-phase fault. When an AB fault is applied, the difference $(I_A - I_B)$ equals $(I_{op} - (-I_{op})) = 2 I_{op}$. Therefore 50 will pick up when $I_{op} = .5 \cdot 50$

2. Connect the relay as shown in Figure 5-2, for a phase AB, BC, or CA fault.
3. Set the relay into test mode 43 (Phase Overcurrent). The LUI should display

INST PHS OVRC ON
4. Set $I_{op} = .5 \cdot 50 + 0.05 \cdot 50 = \underline{\hspace{2cm}}$ amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $.5 \cdot 50 - (0.05 \cdot 50) = \underline{\hspace{2cm}}$ amps rms; the A1 contact should open.
5. Reduce I_{op} to zero.

T10 – Ground Instantaneous Overcurrent 50G

1. Setting:

OVERCURRENT

(0605) 50G = YES

(0606) 50G_DIRCNL = NO

(0607) 50GPICKUP = $\underline{\hspace{2cm}}$
amps,

50G is given by

$$50G = 3 \cdot I_0 - 0.9 \cdot I_1, \quad (12)$$

where I_0 is the zero-sequence current and I_1 is the positive-sequence current. Since the test current, I_{op} , is single-phase, I_0 and I_1 are given by

$$I_0 = I_{op}/3 \quad (13)$$

and

$$I_1 = I_{op}/3 \quad (14)$$

Substituting Equations 13 and 14 into Equation 12 yields

$$50G = I_{op} - 0.3 I_{op} \quad (15)$$

$$= 0.7 I_{op}.$$

Therefore IPT will pick up when $I_{op} = 50G/0.7$.

2. Connect the relay as shown in Figure 4–3.
3. Set the relay into test mode 44 (Ground Overcurrent). The LUI displays

INST GND OVRC ON

4. Set I_{op} to $(50G/0.7) + 0.5 = [\quad]$ amps rms and apply to the relay. The A1 contact should close. Lower I_{op} to $(50G/0.7) - 0.5 = [\quad]$ amps rms; the A1 contact should open.
5. Reduce I_{op} to zero.
6. Change the setting of SELD50G back to YES to restore directional control, if required.

T11 – Ground Time Overcurrent 51G

1. Setting:

OVERCURRNT

(0610) 51G = YES

(0611) 51G_DIRCNL = NO

(0612) 51GPICKUP = $[\quad]$ amps,

(0615) 51GTIMDIAL = $[\quad]$ Time dial,

(0614) 51GCURVE = $[\quad]$ Curve,

51G is calculated with the equation

$$51G = 3 \cdot I_0, \quad (16)$$

where I_0 is equal to the zero-sequence current. Since I_{op} is single-phase, I_0 is given by

$$I_{op}/3 = I_0. \quad (17)$$

Substituting Equation 17 into Equation 16 yields

$$I_{op} = 51G. \quad (18)$$

Therefore, 51G will pick up when $I_{op} \geq 51G$. The time it takes for 51G to pick up is determined by the time-dial curve in Chapter 2 – Calculation of Settings.

CAUTION: If the test current exceeds $2 I_n$ (I_n is the rated current), then the current test should be applied with a 50% duty cycle. For instance, if current is applied for 5 minutes, it should be left off for 5 minutes before it is reapplied.

2. Connect the relay as shown in Figure 6--2.

NOTE: Start the timer when I_{op} is applied and stop the timer when the A1 closes (the relay trips).

3. Set the relay into test mode 45 (51G). The LUI displays

TIM DLY GD OC ON

4. Apply I_{op} at $2 \cdot 51G = [\quad]$ amps rms and start the timer. Leave the current on until the A1 contact closes, then stop the timer. The time should be within $\pm 7\%$ of the value found on the ALPS time-dial curve in use.
5. Reduce I_{op} to zero.
6. Repeat steps 4 and 5 for I_{op} at $6 \cdot 51G = [\quad]$ and $10 \cdot 51G = [\quad]$.
7. Change the setting of SELD51G back to YES if directional control of 51G is required.

6–5 Zone Reach Tests

General Considerations

Testing the reach of the relay requires a few organized steps, as follows:

1. Choosing a test current (I_T) for the impedance of the reach.
2. Calculating the voltage range in which the unit will pick up.
3. Applying the test voltage and currents in accordance with the test procedure.

Equations are given for calculating the pickup voltage for a chosen current magnitude and phase. If you wish to test the complete characteristic, the software program, ALPSTEST, can be used to generate test currents and voltage pickups for the complete characteristic. ALPSTEST is included in the plastic pocket at the back of this book.

Zone 1-4 Phase-to-Ground Calculations

This section describes how to determine the test currents and voltages for Z1G, Z2G, Z3G and Z4G. The same procedure is used for each zone to determine the test values. The procedure is as follows:

- Choose a test current.
- Calculate the impedance of the zone.
- Calculate the operate voltage at the test current and impedance.

The test current, I_T , is determined from Table 6-1. The value of I_T is chosen according to the reach of the zone. The nominal pickup voltage, V_{NOM} , is calculated with respect to I_T and to several settings of the relay.

NOTE: The pickup voltage calculations at a particular magnitude and phase of I_T are referenced to the faulted phase under test. For instance, if a BG Fault was applied, the current angles would be with respect to the phase angle of VB.

The nominal pickup voltage is given by

$$V_{NOM} = [Z \cdot ZR \cdot I_T / \cos(90 - \theta_T)] \cdot \cos(\theta_l - \theta_Z - \theta_T + 90) \quad (19)$$

for $(\theta_Z + \theta_T - 180) < \theta_l < \theta_Z$, or

$$V_{NOM} = [Z \cdot ZR \cdot I_T / \cos(90 - \theta_T)] \cdot \cos(\theta_l - \theta_Z + \theta_T - 90) \quad (20)$$

for $\theta_Z < \theta_l < (\theta_Z - \theta_T + 180)$.

Definitions

- Z = Calculated Impedance
 ZR = Relay reach for Z1G, Z2G, Z3G, or Z4G.
 θ_Z = Angle of maximum reach.

- I_T = Test current for I_{op} , chosen for the zone.
 θ_T = Characteristic timer of the zone.
 θ_l = Test current angle with respect to the faulted phase.
 K0 = Zero-sequence compensation factor of the zone.
 POSSEQANG = Positive-sequence angle of maximum reach.
 ZERSEQANG = Zero-sequence angle of maximum reach.

Settings and Calculations

1. Record the following relay settings:

(1401), POSSEQANG = []

(1402), ZERSEQANG = []

(0105), Z1GRDREACH = []
(Zone 1)

(0206), Z2GRDREACH = []
(Zone 2)

(0305), Z3GRDREACH = []
(Zone 3)

(0405), Z4GRDREACH = []
(Zone 4)

Z1GANG = 90 (fixed for Zone1)

(0207), Z2GCHARANG = []
(Zone 2)

(0306), Z3GCHARANG = []
(Zone 3)

(0406), Z4GCHARANG = []
(Zone 4)

(0108), Z1GROUNDK0 = [] (Zn 1 only)

(1404), ZEROSEQK0 = []
(Zones 2-4)

2. Determine the test current, I_T , for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 5-1.

• $I_T(Z1GR) = []$ Amps rms

• $I_T(Z2GR) = []$ Amps rms

• $I_T(Z3GR) = []$ Amps rms

• $I_T(Z4GR) = []$ Amps rms

ZR Reach (In = 5 A)	I _T , A	ZR Reach (In = 1 A)	I _T , A
0.1 – 2.5	10	0.5 – 12.5	2
2.5 – 6.0	7	12.5 – 30.0	1.4
6.0 – 12.0	3.5	30.0 – 60.0	0.7
12.0 – 20.0	2.1	60.0 – 100.0	0.4
20.0 – 30.0	1.4	100.0 – 150.0	0.3
30.0 – 40.0	0.8	150.0 – 200.0	0.2
40.0 – 50.0	1.0	200.0 – 250.0	0.2

Table 6–1. Test current ranges for phase-to-ground reach.

3. Calculate the impedance, Z , for each zone, where Z equals the magnitude of the expression,

$$(2/3)/(\text{POSSEQANG}) + (K0/3)/(\text{ZERSEQANG})$$

The real and imaginary components of Z are given by

$$\begin{aligned} Z(\text{real}) &= (2/3) \cos(\text{POSSEQANG}) \\ &+ (K0/3) \cos(\text{ZERSEQANG}) \quad (21) \\ &= [\text{_____}] \end{aligned}$$

and

$$\begin{aligned} Z(\text{imag}) &= (2/3) \sin(\text{POSSEQANG}) \\ &+ (K0/3) \sin(\text{ZERSEQANG}) \quad (22) \\ &= [\text{_____}] . \end{aligned}$$

The magnitude is then given by

$$Z = \sqrt{[Z(\text{real})]^2 + [Z(\text{imag})]^2} \quad (23)$$

the settings are

- $Z1 = [\text{_____}]$ (Zone magnitude)
- $Zn = [\text{_____}]$ (magnitude of Zones 2, 3, and 4)

4. Calculate the impedance angle, ϕZ , for each zone, where ϕZ is the phase angle of the expression,

$$(2/3)/\text{POSSEQANG} + (K0/3)/\text{ZERSEQANG}$$

and is given by

$$\phi Z = \arctan [Z(\text{imag})/Z(\text{real})]. \quad (24)$$

The settings are

- $\phi Z1 = [\text{_____}]^\circ$ (impedance angle of Zone 1)

- $\phi Zn = [\text{_____}]^\circ$ (impedance angle of Zones 2, 3, and 4)

5. Choose the I_T test angle (ϕI) for the zone:

- $\phi I1 = [\text{_____}]^\circ$ (Zone 1)
- $\phi I2 = [\text{_____}]^\circ$ (Zone 2)
- $\phi I3 = [\text{_____}]^\circ$ (Zone 3)
- $\phi I4 = [\text{_____}]^\circ$ (Zone 4)

6. Calculate V_{NOM} for each zone by substituting the values of ZR , Z , ϕZ , and ϕI into Equation 19 or 20.

- $V_{NOM1} = [\text{_____}]$ Volts rms (nominal test voltage Zone 1)
- $V_{NOM2} = [\text{_____}]$ Volts rms (nominal test voltage Zone 2)
- $V_{NOM3} = [\text{_____}]$ Volts rms (nominal test voltage Zone 3)
- $V_{NOM4} = [\text{_____}]$ Volts rms (nominal test voltage Zone 4)

NOTE: If Zone 4 is reversed, #0411 SEL4ZD = 1, remember to add 180° to both the test angle, $\phi I4$, and the impedance angle, $\phi Z4$.

T12 – Zone 1 Ground Reach Test, M1G Ground Faults (AG, BG, and CG)

1. Setting:

Z1DISTANCE

(0101) Z1PHASE = NO

(0104) Z1GROUND = YES

(0105) Z1GRDREACH = $[\text{_____}]$ ohms,

$V_{NOM1} = [\text{_____}]$ V,

$I_T = [\text{_____}]$ A,

$\phi I1 = [\text{_____}]^\circ$,

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

3. Set the relay into test mode 14 (Any Zone1 Ground). The LUI displays

ANY Z1 GRND ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°

VB: 67 volts rms –120°

VC: 67 volts rms –240°.

Set the fault current, I_{op}, phase angle to $\phi I = []$, lagging.

- Set the fault current, I_{op}, to I_T = [] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of VNOM.
- Reduce the fault current to zero.
- Return the Zone 1 phase, Z1PHASE, to your specific setting.

T13 – Zone 2 Ground Reach, MTG Ground Faults (AG, BG, and CG)

- Setting:

Z2DISTANCE

(0201) Z2PAHSE = NO
 (0204) Z2GROUND = YES
 (0206) Z2GRDREACH=[] ohms,
 VNOM2 = [] V,
 I_T = [] A,
 $\phi I2 = []^\circ$,

- Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
- Set the relay to the Zone 2 ground test mode for the appropriate phase under test. The LUI displays, for instance,

ZONE 2 AG ON

- Set the voltage inputs to the following values:

VA: 67 volts rms 0°,
 VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.

Set the fault current, I_{op}, phase angle to $\phi I = []$, lagging.

- Set the fault current to I_T = [] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of VNOM.
- Reduce the fault current to zero.
- Return Zone 2 phase, Z2PHASE, to your specific setting.

T14 – Zone 3 Ground Reach, M3G Ground Faults (AG, BG, and CG)

- Setting:

Z3DISTANCE

(0301) Z3PHASE = NO
 (0304) Z3GRND = YES
 (0305) Z3GRDREACH=[] ohms,
 VNOM3 = [] V,
 I_T = [] A,
 $\phi I3 = []^\circ$,

- Connect the relay as shown in Figure 4–3 for the appropriate phase under test.

- Set the relay to the Zone 3 ground test mode for the appropriate phase under test. The LUI displays, for instance:

ZONE 3 AG ON

- Set the voltage inputs to the following values:

VA: 67 volts rms 0°,
 VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.

Set the fault current, I_{op}, phase angle to $\phi I = []$, lagging.

- Set the fault current to I_T = [] amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of VNOM.

- Reduce the fault current to zero.

- Return Zone 3 phase, Z3PHASE, to your specific setting.

T15 – Zone 4 Ground Reach, M4G Ground Faults (AG, BG, and CG)

- Setting:

Z4DISTANCE

(0401) Z4PHASE = NO
 (0404) Z4GRND = YES
 (0405) Z4GRDREACH=[] ohms,
 VNOM4 = [] V,

$$I_T = \text{[]} \text{ A,}$$

$$\phi I_4 = \text{[]}^\circ,$$

2. Connect the relay as shown in Figure 4–3 for the appropriate phase under test.
3. Set the relay to the Zone 4 ground test mode for the appropriate phase under test. The LUI displays, for instance:

ZONE 4 AG ON

4. Set the voltage inputs to the following values:
 VA: 67 volts rms 0° ,
 VB: 67 volts rms -120° ,
 VC: 67 volts rms -240° .
 Set the fault current, I_{op} , phase angle to $\phi I = \text{[]}$, lagging.
5. Set the fault current to $I_T = \text{[]}$ amps rms. Reduce the voltage of the faulted phase and check that the A1 contact closes when the voltage is within 7% of VNOM.
6. Reduce the fault current to zero.
7. Return Zone 4 phase, Z4PHASE, to your specific setting.

Zone 1–4 Phase-to-Phase Reach Calculations

This section describes how to determine the test currents and voltages for Z1P, Z2P, Z3P, and Z4P. The same procedure is used for each zone to determine the test values.

The test current, I_T , is determined from Table 6–2. The value of I_T is chosen according to the value of the reach of the zone. The nominal pickup voltage, VNOM, is calculated with respect to I_T and to several settings of the relay.

VNOM calculations are referenced to the leading phase-to-ground faulted voltage. When an AB fault is applied, the current angle is with respect to the phase angle of VA, not the phase-to-phase voltage. That is why the 1.732 (square root of three) factor and the added angle of 30° are included in Equations 25 and 26.

The nominal pickup voltage is given by

$$VNOM = [(2/1.732) \cdot ZR \cdot I_T / \cos(90 - \phi T)] \cdot \cos((\phi I + 30) - \phi Z - \phi T + 90) \quad (25)$$

for $(\phi Z + \phi T - 180) < \phi I < \phi Z$, or

$$VNOM = [(2/1.732) \cdot ZR \cdot I_T / \cos(90 - \phi T)] \cdot \cos((\phi I + 30) - \phi Z + \phi T - 90) \quad (26)$$

for $\phi Z < \phi I < (\phi Z - \phi T + 180)$.

Definitions

ZR = relay reach for Z1P, Z2P, Z3P, or Z4P.

ϕZ = Angle of maximum reach.

I_T = Test current for I_{op} , chosen for the zone.

ϕT = Characteristic timer of the zone.

ϕI = Test current angle with respect to the faulted phase.

POSSEQANG = Positive-sequence angle of maximum reach.

Settings and Calculations

1. Record the following relay settings:
 (1401), POSSEQANG = []
 (0102), Z1PRREACH = [] (Zone 1)
 (0202), Z2PHREACH = [] (Zone 2)
 (0302), Z3PHREACH = [] (Zone 3)
 (0402), Z4PHREACH = [] (Zone 4)
 Z1PANG = 90 (fixed for Zone 1)
 (0203), Z2PCHARANG = [] (Zone 2)
 (0303), Z3PCHARANG = [] (Zone 3)
 (0403), Z4PCHARANG = [] (Zone 4)
2. Determine the test current, I_T , for Zone 1, Zone 2, Zone 3, and Zone 4 from Table 6–2.
 - $I_T(Z1R) = \text{[]}$ Amps rms
 - $I_T(Z2R) = \text{[]}$ Amps rms
 - $I_T(Z3R) = \text{[]}$ Amps rms
 - $I_T(Z4R) = \text{[]}$ Amps rms

ZG Reach (In = 5 A)	I _T , A	ZG Reach (In = 1 A)	I _T , A
0.1 – 2.5	10	0.5 – 12.5	2
2.5 – 6.0	8	12.5 – 30.0	2
6.0 – 12.0	5	30.0 – 60.0	1
12.0 – 20.0	3	60.0 – 100.0	0.6
20.0 – 30.0	2	100.0 – 150.0	0.4
30.0 – 40.0	1.5	150.0 – 200.0	0.3
40.0 – 50.0	1.0	200.0 – 250.0	0.2

Table 6-2. Test current ranges for phase-to-phase reach.

3. Choose ϕI (the I_T angle). VNOM is at maximum when $\phi I = \phi Z - 30$.

- $\phi I1 = []^\circ$ (Zone 1)
- $\phi I2 = []^\circ$ (Zone 2)
- $\phi I3 = []^\circ$ (Zone 3)
- $\phi I4 = []^\circ$ (Zone 4)

4. Calculate VNOM for each zone by substituting the values of ZR, ϕZ (POSSEQANG), I_T, and ϕI into Equations 25 and 26 for VNOM according to zone.

- VNOM1 = [] Volts rms
(nominal test voltage for Z1P)
- VNOM2 = [] Volts rms
(nominal test voltage for Z2P)
- VNOM3 = [] Volts rms
(nominal test voltage for Z3P)
- VNOM4 = [] Volts rms
(nominal test voltage for Z4P)

NOTE: If Zone 4 is reversed, #0411 SEL4ZD = 1, remember to add 180° to both the test current angle, $\phi I4$, and the impedance angle, $\phi Z4$. If Zone 4 has a nonzero offset, use the ALPSTEST software to calculate VNOM4.

5. Record VNOM_n, I_T, and ϕI_n in the space provided in the appropriate Zone reach test.

T16 – Zone 1 Phase Reach, M1 Faults (AB, BC, and CA)

1. Setting:

Z1DISTANCE

(0101) Z1PHASE = YES

(0104) Z1GROUND = NO

(0102) Z1PREACH = [] ohms,

VNOM1 = [] V,

I_T = [] A,

$\phi I1 = []^\circ$,

2. Connect the relay as shown in Figure 4-4 for the appropriate phases under test.

3. Set the relay to test mode 30 (ANY ZONE 1 Phase). The LUI displays:

ANY Z1 PHASE ON

4. Set the voltage inputs to the following values:

VA: 67 volts rms 0°,

VB: 67 volts rms -120°,

VC: 67 volts rms -240°.

Set the fault current, I_{op}, phase angle to $\phi I = []$, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

5. Set the fault current to I_T = [] amps rms. Simultaneously reduce the voltage of the faulted phases and check that the A1 contact closes when the voltages are within 7% of VNOM.

6. Reduce the fault current to zero.

7. Return Zone 1 ground Z1GROUND to your specific setting.

T17 – Zone 2 Phase Reach, MT Faults (AB, BC, and CA)

1. Setting:

Z2DISTANCE

(0201) Z2PHASE = YES

(0204) Z2GROUND = NO

(0202) Z2PHREACH = [] ohms,

VNOM2 = [] V,

I_T = [] A,

$\phi I2 = []^\circ$,

2. Connect the relay as shown in Figure 5-1 for the appropriate phases under test.

- Set the relay to the Zone 2 Phase test mode for the appropriate phase under test. The LUI displays, for instance:

ZONE 2 AB ON

- Set the voltage inputs to the following values:
 VA: 67 volts rms 0°,
 VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.

Set the fault current, I_T , phase angle to $\phi I = []$, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

- Set the fault current to $I_T = []$ amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the A1 contact closes when the voltages are within 7% of VNOM.
- Reduce the current in the faulted phase to zero.
- Return Zone 2 ground Z2GROUND to your specific setting.

T18 – Zone 3 Phase Reach, M3 Faults (AB, BC, and CA)

- Setting:

Z3DISTANCE

(0301) Z3PHASE = YES
 (0304) Z3GRND = NO
 (0302) Z3PHREACH=[]
 ohms,
 VNOM3 = [] V,
 $I_T = []$ A,
 $\phi I3 = []^\circ$,

- Connect the relay as shown in Figure 5-1 for the appropriate phase under test.
- Set the relay to the Zone 3 Phase test mode for the appropriate phase under test. The LUI displays, for instance:

ZONE 3 AB ON

- Set the voltage inputs to the following values:
 VA: 67 volts rms 0°,

VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.

Set the fault current, I_T , phase angle to $\phi I = []$, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.

- Set the fault current to $I_T = []$ amps rms. Simultaneously reduce the voltages of the faulted phases, and check that the A1 contact closes when the voltages are within 7% of VNOM.
- Reduce the fault current to zero.
- Return Zone 3 ground Z3GROUND to your specific setting.

T19 – Zone 4 Phase Reach, M4 Faults (AB, BC, and CA)

- Setting:

Z4DISTANCE

(0401) Z4PHASE = YES
 (0404) Z4GRND = NO
 (0402) Z4PHREACH=[]
 ohms,
 VNOM4 = [] V,
 $I_T = []$ A,
 $\phi I4 = []^\circ$,

- Connect the relay as shown in Figure 5-1 for the appropriate phase under test.
- Set the relay into the Zone 4 Phase test mode for the appropriate phase under test. The LUI displays, for instance:

ZONE 4 AB ON

- Set the voltage inputs to the following values:
 VA: 67 volts rms 0°,
 VB: 67 volts rms –120°,
 VC: 67 volts rms –240°.
- Set the fault current, I_T , phase angle to $\phi I = []$, lagging. Note that the leading phase angle is 180° out of phase with the line it is shorted to.
- Set the fault current to $I_T = []$ amps rms. Simultaneously reduce the

voltages of the faulted phases, and check that the A1 contact closes when the voltages are within 7% of VNOM.

6. Reduce the fault current to zero.
7. Return Zone 4 ground Z4GROUND to your specific setting.

CAUTION: When testing is completed, verify that all settings are returned to your specified values. It may be helpful to print out the settings and check them one by one.

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7-1 Ratings

Table 7-1 contains the electrical and environmental ratings of the ALPS, Table 7-2 contains the burden ratings, and Table 7-3 contains the contact ratings.

Electrical Ratings	Value
Rated frequency	50–60 Hz
Rated voltage (phase to phase)	100–120 Vac
Rated current	$I_n = 1$ or 5 A
DC control voltage, operating range	48 VDC 110/125 VDC 220/250 VDC
Maximum permissible current	$3 \times I_n$ Continuous 3 seconds 1 seconds
Maximum Permissible AC Voltage	138 VAC (ph-n) 208 VAC (ph-n)
Sample Rate	64 per cycle
Hi-Pot (DC Test) (Refer to Elementary diagram for connections)	ANSI C37.90 IEC 255-5
Surge Withstand Capability (SWC)	ANSI C37.90.1 IEC 255-22-1
Impulse Voltage Withstand Fast Transient	5 kV peak, 1.2/50 ms, 0.5 joules ANSI c37.90.1 IEC 255-4
Radio Frequency Interference Withstand	ANSI C37.90.1 IEC 255-22-3
Electrostatic Discharge (ESD)	IEC 255-22-2
Humidity	95% without condensation
Ambient temperature range Storage Operation	–30° to 75° C –20° to 65° C

Table 7-1. Electrical ratings of the ALPS.

Burdens	Value
Current circuits	0.022 Ω , @ 5 deg, $I_n = 5$ A 0.12 Ω , @ 30 deg, $I_n = 1$ A
Voltage circuits	0.15 VA, @ 60 Hz 0.20 VA, @ 50 Hz
DC battery (for contact converters)	2.5 mA at rated dc input V
DC battery (power supply)	Less Than 20 W
Trip-circuit monitor	150 mA for current-flow sensor

Table 7-2. Burden ratings of the ALPS.

Contacts	Ratings
Fault Location I / V	0–1 mA, 10 V load or 0–5 V output (4 V = full scale, 5 V = error)
Trip outputs (T1 - T6)	Continuous rating = 5 A, Make and carry = 30 A (per ANSI C37.90) Interrupting = 25 VA Pickup < 4 ms
SCR outputs	Same as trip contacts
Auxiliary outputs A1 - A12 C1 & C2	Continuous rating = 5 A, Make and carry = 30 A (per ANSI C37.90) Interrupting = 25 VA Pickup < 8 ms
High Speed KT1 - KT4	Continuous = 0.5 A Maximum Voltage = 280 VDC Pickup < 0.5 ms
Contact Converter Inputs	38.5–300 VDC

Table 7-3. Contact ratings of the ALPS.

7-2 Protection Scheme Selection

The seven available protection schemes are:

- Stepped distance
- POTT1 & POTT2
- PUTT
- Blocking
- Hybrid
- Programmable Logic

Reach Setting

Reach setting ranges are listed in Table 7-4.

Directional Control

Directional control is forward or reverse.

Time Synchronization

The time-synchronization input is by demodulated IRIG B signal (5 VDC).

Out-of-Step Blocking

The reach of MOB is that of the zone it is coordinated with—Zone 2, Zone 3, or Zone 4.

The characteristic angle is 30°–130°.

Setting	Measuring Unit	Range, Ω		Resolution, Ω	
		$I_n = 5 \text{ A}$	$I_n = 1 \text{ A}$	$I_n = 5 \text{ A}$	$I_n = 1 \text{ A}$
Z1DISTANCE	M1G (Ground Reach)	0.01–50	0.05–250	0.01	0.01
	M1 (Phase Reach)	0.01–50	0.05–250	0.01	0.01
Z2DISTANCE	MTG (Ground Reach)	0.01–50	0.05–250	0.01	0.01
	MT (Phase Reach)	0.01–50	0.05–250	0.01	0.01
Z3DISTANCE	M3G (Ground Reach)	0.01–50	0.05–250	0.01	0.01
	M3 (Phase Reach)	0.01–50	0.05–250	0.01	0.01
Z4DISTANCE	M4G (Ground Reach)	0.01–50	0.05–250	0.01	0.01
	M4 (Phase Reach)	0.01–50	0.05–250	0.01	0.01

Table 7-4. Reach setting ranges of the protection schemes.

7-3 Protection Function Settings**Current Supervision Function**

The current supervision function settings are listed in Table 7-5.

Function	Range, A		Resolution, A	
	$I_n = 5 \text{ A}$	$I_n = 1 \text{ A}$	$I_n = 5 \text{ A}$	$I_n = 1 \text{ A}$
IPT	0.50–5.00	0.10–1.00	0.01	0.01
IPB	0.25–3.75	0.05–0.75	0.01	0.01
IT	0.20–4.00	0.04–0.80	0.01	0.01
IB	0.20–4.00	0.04–0.40	0.01	0.01

Table 7-5. Current supervision function pickup settings.

Overcurrent Backup

The overcurrent backup settings are listed in Table 7-6.

Function	Range, A		Resolution, A	
	$I_n = 5 \text{ A}$	$I_n = 1 \text{ A}$	$I_n = 5 \text{ A}$	$I_n = 1 \text{ A}$
50	2.0–160.0	0.4–32.0	0.1	0.1
50G	0.5–80.0	0.1–16.0	0.1	0.1
51G	0.2–15.0	0.04–3.0	0.01	0.01

Table 7-6. Overcurrent backup pickup settings.

TOC Time Dial

The TOC time dial is set as follows:

- Range: 0.5–10 × the pickup setting.
- Steps: 0.1.

Line Pickup

The line pickup settings are listed in Table 7–7.

Function	Range, A		Resolution, A	
	I _n = 5 A	I _n = 1 A	I _n = 5 A	I _n = 1 A
I1	1.0–15.0	0.2–3.0	0.1	0.1

Table 7–7. Line pickup settings.

Remote Open Detector Timer

The remote open detector timer (TL20) is set as follows:

- Range: 10–100 ms
- Steps: 1 ms

Line Overload

The line overload overcurrent and timer settings are listed in Tables 7–8 and 7–9, respectively.

Function	Range, A		Resolution, A	
	I _n = 5 A	I _n = 1 A	I _n = 5 A	I _n = 1 A
Level 1 PU	2.5–20.0	0.5–4.0	0.1	0.1
Level 2 PU	5.0–40.0	1.0–8.0	0.1	0.1

Table 7–8. Line overload overcurrent settings.

Function	Range, s	Resolution, s
LV1 timer LEVEL1TDLY	10–99	0.1
LV2 timer LEVEL2TDLY	10–99	0.1

Table 7–9. Line overload timer settings.

Compensation Factor

The compensation factor, K0 (zero-sequence compensation for Z2, Z3, and Z4 ground-distance units), is set as follows:

- Range: 1.0–7.0
- Resolution: 0.01

K0 compensation for Z1G is a separate setting in the Z1DIST category, with the same range and resolution as above.

Protection Scheme Logic Timers

The protection scheme logic timer settings are listed in Table 7–10.

Timer	Description	Range	Resolution
TL1PICKUP	Trip integrator pickup	1–50 ms	1 ms
Z2P_TIME Z2G_TIME	Zone 2 timer	0.1–3.0 s	0.01 s
Z3P_TIME Z3G_TIME	Zone 3 timer	0.1–10.0 s	0.01 s
Z4P_TIME Z4G_TIME	Zone 4 timer	0.1–10.0 s	0.01 s
TL4	POTT/PUTT coordination	0.1–50 s	0.01 s
(TL5) TL5PICKUP TL5DRPOUT	b contact coordination for breaker 1 (pickup and dropout timers)	0–200 ms	1 ms
(TL6) TL6PICKUP TL6DRPOUT	b contact coordination for breaker 2 (pickup and dropout timers)	0–200 ms	1 ms
(TL16) TL16PICKUP	Weak infeed trip pickup	8–99 ms	1 ms
(TL24) TL24DRPOUT	GDOC Blocking Timer	30–500 ms	1 ms
(TL25) TL25DRPOUT	Distance Blocking Timer	30–500 ms	1 ms
(TL26) TL26PICKUP	Repeat Delay Timer	0–50 ms	1 ms

Table 7–10. Protection scheme logic timer settings.

System Configuration

The system configuration settings are listed in Table 7-11.

Parameter	Settings Range
Communications baud rate	300, 1200, 2400, 4800, 9600, 19200
Number of breakers	1–2
CT ratios	1–5000
PT ratios	1–7000
Units of distance for reports	Miles or kilometers

Table 7-11. System configuration settings.

7-4 Accuracies

The accuracies of various ALPS parameters are listed in Table 7-12.

Parameter	Accuracy
Distance measuring units	Reach: $\pm 5\%$ of setting at angle of maximum reach and rated current.
Zone timers	± 2 ms
Fault locator	$\pm 3\%$ (typical)
RMS Values	$\pm 1\%$ of reading
Watts & Vars	$\pm 3\%$ of Full Scale from 1A to MAX rated current
Data sample time tag resolution	± 1 ms

Table 7-12. Accuracies of ALPS measurements and settings.

7-5 Dimensions and Weight

The dimensions of the ALPS case are listed in Table 7-13.

Parameter	Dimension
Height	5.31" [135mm] 3 standard rack units
Width	19.00" w/ ears (3 std. rack units) 16.90" w/o ears [430mm]
Depth	13.63" [347mm]

Table 7-13. Dimensions of the ALPS case.

The standard rack-mounted unit weighs approximately 23 pounds.

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8-1 INTRODUCTION

The Local User Interface (LUI) for the Advanced Line Protection System (LPS) consists of a 4-line liquid crystal display (LCD), a keypad and trip and status LEDs.

There are a few conventions used with the keypad and display that will be mentioned periodically in this section. However, to aid the user in using this section more effectively, they will be described briefly here.

When a command key is pressed a menu will be displayed. There are several levels of choices and menus which will be needed to perform a certain task. If the user wishes to go back up through the different levels they just went down, that command key is used. For example, in ACTIONS, the ACT key will go back up through the levels needed to perform that action. The SET and INF keys work the same way.

If you make a mistake when you are entering data, just press the CLR key once, verify what you just typed is gone and start re-typing the data or answer.

Messages will be displayed at times. There may have been a mistake made in entering data or the relay may be simply informing the user of a state they have just put the relay in. These messages must be cleared before any other keypad input can be accepted. The CLR key will remove these messages but leave the user at the same level. Pressing the ACT, SET or INF keys will let the user continue.

If a message box or list of items is similar to one preceding it, the new one will not be shown.

There are lists of items that have numbers next to them that appear on the display. If the number of an item is known the number can be pressed followed by the ENT key. This will position the cursor on the item. The user must press the ENT key one more time to actually enter the item the cursor is on.

Display, Keypad and LEDs

Display

The LCD display consists of four, 20 character lines. The LCD character contrast can be adjusted through the Actions key on the keypad. For more information see Actions Key in this section.

Keypad

The keypad consists of twenty keys: 10 numeric keys, a decimal point, eight function keys and an INV key (as shown below).

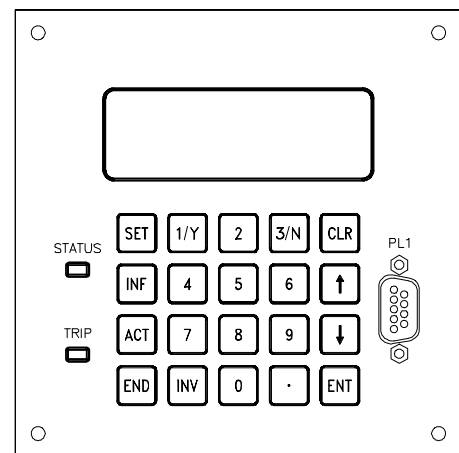


Figure 8-1 LPS Keypad

The keys are divided into three groups:

The **Command keys**: SETTINGS (SET), INFORMATION (INF), ACTIONS (ACT) and END, begin or end a command sequence. These keys will be discussed in detail in this section.

The **Control keys**: ENTER (ENT), UP-ARROW, DOWN-ARROW AND CLEAR (CLR) may cause the relay to take some action.

The **Data Entry keys**: all the numeric keys, the decimal point and the INV key enter data into the relay or answer prompts.

The keypad can be enabled or disabled by SW2 on the input board. If the switch is in the

“ON” position, the keypad is enabled and if the switch is in the “OFF” position, the keypad is disabled. Only the CLR key functions when the keypad is disabled.

Control Keys

METERING/CLEAR Key (CLR)

Depending on the current state of the display, the CLR key has the following uses: abort a key sequence in progress, clear an error message, activate scrolling of metering and display recorded TRIP data.

If the CLR key is pressed while entering data, all or part of the display will be blanked. If there is user-entered data on the display, only the data will be blanked. For example, if the user is entering a Setting value or responding to an Action prompt when the CLR key is pressed, only the user's input will be blanked; the name of the setting or the prompt will remain on the display. If there is no user-entered data on the display when CLR key is pressed, the entire display will be blanked and the relay screen will be displayed.

When a keypad error message is displayed, the user must press the CLR key to remove the error message (all other keys will be ignored). When the error message is removed, the user will be returned to the current operation being performed.

Pressing the CLR key while a TRIP message is displayed will produce the TRIP information on the LCD. Only the target information (TRIP message) and date/time of the trip for each of the accumulated faults are displayed, starting from the most recent fault (i.e., the one whose TRIP message was on display before pressing the CLR key). The trip time resolution is one millisecond as shown below:

#1
19:10:01.259
06/29/95
TRIP AB Z2 145.0MI

If the user presses the CLR key again, the target information and trip time and date for

the next most recent fault is shown on the display. The user can scroll through all the accumulated TRIP information using the CLR key. The most recent TRIP message will flash. Pressing the CLR key after the last trip will display the relay screen. Scrolling through the TRIP information using ARROW keys is not possible which means the trip information may only be viewed from the most recent to the oldest when using the CLR key.

Pressing the CLR key when the screen is blank or when the relay screen is displayed, causes the Present Values/Metering to be displayed. Each screen of values is displayed for 4 seconds before proceeding to the next screen. Screens containing breaker health present values are not displayed. After automatically scrolling through all the screens, the display returns to the relay screen. The items displayed are described later in this section (see “Request Present Values”). The user cannot use the ARROW keys to scroll through the present values.

Both the fault data display and the Present Value display are stopped by one of the following: TRIP, FAIL/WARN message or a key being pressed.

ARROW Keys

The ARROW keys are used to scroll through the lists of commands and categories and adjust the contrast of the LCD display. By pressing the UP-ARROW and DOWN-ARROW keys, the user can select any item in the menu displayed. The LCD scrolls upward or downward when there are more items than can be displayed on three lines.

When the user reaches the desired category, pressing the ENTER key will then produce the name of the category on the top line and the first three items in that category on the remaining three lines. The user can use UP-ARROW or DOWN-ARROW keys to scroll through the items.

The UP-ARROW key scrolls in a “backward” direction through a list of categories or items and the DOWN-ARROW key scrolls “forward” through a list. The UP-ARROW will select the

item before it in a list (for example, from item 5 to item 4). The DOWN-ARROW will select the item after it in a list (for example, from item 5 to item 6).

Both the UP-ARROW and DOWN-ARROW keys wrap. Wrapping happens when the top or bottom of a list are reached. The last item becomes the first and the first item becomes the last.

ENTER Key (ENT)

The ENTER key is used to enter data or to enter a choice. When a category name or command is selected on the display and the ENTER key is pressed, the user is "choosing" to scroll through that category. After the user selects an item to be edited using the ENT key, the numeric keys and decimal point are used to enter the value. When the correct value has been entered, the ENT key is used to accept the new value for the selected item.

Data Entry Keys

The numeric keys 1 and 3 have two meanings, depending on the context. If the user is entering numeric values, the 1/Y and 3/N keys are used as the numbers 1 and 3. If the user is responding to a YES/NO prompt, the 1/Y key is used and displayed as YES and the 3/N key is used and displayed as NO.

The INV (!) key is used to invert the values of logic signals used with the programmable outputs. For example, if the user needs to invert the value of the ZONE 1 AG logic signal (signal number 81) for input into programmable output A1, "!" followed by "81" (ex: !81) is entered.

MESSAGES

All messages on the display are the result of some keypad action, with four exceptions: the Trip message when the relay has caused a protective trip, the Fail message when the relay has discovered a critical self-test failure, the Warning message when the relay has discovered a non-critical self-test failure, and the Initialization messages when the relay is initializing during a power up.

If a protective trip occurs when there is no self-test message (Self-test Failure or Warning) on the display, the TRIP message will be displayed on four lines of the display. An example is shown below :

TRIP
AG
Z1
50.5 MI

The TRIP message will be displayed with the background flashing to indicate that the relay has caused a protective trip. The red TRIP LED will also be flashing to indicate the trip, and that the trip has not been acknowledged. Three fields of information form the TRIP message on display. They are : a three character fault type (e.g. ABG), a three character trip type (see "Request Fault Information" in this section for a list of the trip types), and distance to the fault (in the user-specified units). The message will remain on the display until removed by a keypad operation or by the remote communications Target Reset command. If the relay restarts or is powered down and up, the trip indicator will be remembered and redisplayed. In either case, as soon as any key on the keypad is pressed or remote communications resets the target, the LED indicating protective tripping by the relay will stop flashing and the Trip message will be removed from display. The Trip information will be stored for later use.

When a system failure occurs, the Fail message is always shown on the bottom two lines of the display and has the following format:

```
BBB FAIL-XXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXX
```

Where BBB stands for the sub-system name issuing the message, and XXX...XXX is the text which describes the critical self-test failure. The Fail message remains on the display until a key is pressed or until the relay restarts successfully (with no self-test failures).

If a TRIP message is already on display when a failure occurs, the TRIP message is displayed on a single line (top line) instead of on all the four lines. The fail message is still shown on

the bottom two lines of the display, as shown below :

TRIP AG Z1 50.5MI
BBB FAIL-XXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXX

Since a trip has occurred, the LCD background for all four lines will be flashing.

The Warn message is also always shown on the bottom two lines of the display using the same format as the failure message. The Warning message remains on the display until a key is pressed or until the relay restarts successfully (with no self-test warnings). If a TRIP message is already on display when a warning occurs, the display format will be the same as the fail message. Since a trip has occurred the LCD background will be flashing.

The Initialization messages are displayed while the relay is initializing itself during a power up (and not during a warm restart).

All other messages, which are the result of keypad operations, remain on the display until another key is pressed, or until no keys have been pressed for a period of 15 minutes; at the end of this time-out interval, the display is blanked.

Though there are some exceptions, like the display of present values and events, for any user initiated interaction, the following applies:

The top line of the display shows the current category. For example, if the user is editing a setting item, the top line shows the name of the current category, the setting group number and the setting item number. If the user is viewing the status of the Contact Converters, the top line shows "CC STATUS".

The fourth line usually displays the response to the actions initiated by the user. The response will be either a success or error message.

When the user ends a session by pressing the END ENT sequence of keys, the display is cleared after 10 seconds. The

KEYPAD/DISPLAY INTERFACE access privilege is then set to View Level.

SETTINGS

The user can view or edit protection and general settings, change the active settings group and modify the date and time with the SET command key.

Pressing the SET key prompts the user for the Settings level password. If the password is not valid, PASSWORD INVALID will be displayed on the bottom line of the display. The user has to press the CLR key to clear this error message and then is again prompted to enter the password.

If the password is valid, the user's privilege level is set to the one associated with the entered password.

NOTE :

(1) The user is asked to key in a password only when the user does not have Setting or Master level access privilege at the time of pressing the SET key.

(2) When the relay is first shipped, CONTROL, SETTING and MASTER passwords are loaded with factory values. The factory values for the passwords are: Settings (123.), Actions (456.) and Master (789.). Selecting these passwords doesn't increase the user's privilege level. All three passwords must be changed to user-defined passwords. It is important to understand that the user will not obtain higher privilege levels until the passwords have been changed. See the servicing section of this instruction book for details.

1. EDIT PROTECTION SETTINGS

EDIT PROT GROUP (1-4) : 4 Lose Chgs to Gn? Act Grp= #
--

This option allows the user to modify the protection settings. Four different groups of settings are provided. SETTING or MASTER

privilege level must be selected in order to change settings. The user may only view settings with Control or default privilege level.

The **Edit Protection Settings** command is used to display or change protection settings. Each of the four groups contain the same list of settings but they may have different values. Only one group of settings can be used at a time, however, any of the four groups may be viewed or changed at any time. Settings are divided into categories. By using the ARROW keys, the user can scroll through the categories and the settings within each category. Each setting within a category has been assigned a number so that the user may go directly to the setting to view or change it.

If the user selects **Edit Protection Settings** by positioning the cursor on that line and pressing the ENT key, the display will change to allow the user to select a group of settings.

The cursor will be positioned after the colon (see figure above). If a group was previously edited but not saved then its number will be displayed after the colon and blink. If no group has been previously selected, there will be no number after the cursor. A number must be entered after the colon of an error message will displayed which must be cleared by the CLR key. The ACT GRP= at the bottom of the display indicates which group of settings is being used for protection. This group number is only informational. You must enter a number for the group.

After the group to be edited has been selected, press the ENT key. If the blinking digit (indicating that there are settings changes that have not been saved for that group) is changed, the display changes to indicate the changed settings will be lost if the new group selection is confirmed. ***Unless the settings changes are saved using the END key, the changes are not permanent and can be lost.***

In the above figure, n is the settings group which was modified but not saved. The user presses 1/Y (YES) to indicate that changes to previously selected group should be dropped, or 3/N (NO) to keep the changes and select another group. If the user has pressed NO, the

group selection prompt is redisplayed. It is recommended the settings changes be saved by pressing the END key to save the modified settings group in EEPROM. It is still possible to re-select a group number which is blinking, by just pressing the ENTER key.

When a group is finally selected, the display will have SETTINGS on the first line and the first three categories on the next three lines. The cursor is positioned on the second line.

A couple things should be noted at this point. First, the user now has the ability to type a setting number in directly. If this is done, the setting number will be displayed in the upper right-hand corner. To select the setting after typing the setting number the ENT key must be pressed. If the number is valid, the setting is selected. The ENT key must be pressed again to change the setting. If the setting number is invalid, an error message will be displayed, which will appear on the bottom line of the display and must be cleared with the CLR key.

Second, there is a blinking square cursor on the left side of the display. This is the current selected item. To move the cursor to select a different item, use the UP-ARROW and DOWN-ARROW keys. Pressing the ENT key will activate the item in the current cursor position.

The SET key now also has a new function. The SET key will now return to the level above the current menu level each time it is pressed until the top SETTINGS menu is reached. For example, if the user is currently entering a new setting value, pressing the SET key will return to the list of settings in the current category. Pressing it again will return to the list of settings categories. Then to the group

selection screen and finally to the original SET key menu.

Once a category is selected and the ENT key is pressed, the first three items in that category are displayed as 10-character mnemonics of the settings and their values. For example, if the ENT key was pressed when the cursor is

positioned on the line displaying "Z3DIST", the following will be displayed:

```
Z3DISTANCE Gn S0301
Z3PHASE   = YES
Z3PHREACH = 20.32
Z3PCHARANG = 105
```

with the cursor positioned on the second line from the top. 'Gn' indicates the group number currently being edited and 'S####' indicates the setting number on which the cursor is currently placed.

Whether the user is in the setting category display or in the setting item display, he can specify the number of the setting item to be edited by entering that number and pressing ENT key. The number being entered is echoed at the same place (right corner of top line) where the current setting item number is displayed. After the ENT key is pressed, the number is checked for validity. If the number is valid, the cursor will be positioned on the setting corresponding to the number entered. If the setting number is invalid, an error message is displayed.

If the user wants to edit a setting, first the item should be selected by moving the cursor to that item and then pressing the ENT key. The information related to the current setting being edited is displayed as follows :

The cursor is positioned on the second line, at the beginning digit of the displayed value.

When the first data entry key is pressed, the setting mnemonic will remain on the display but the "=" will be replaced by a blinking ":". Each data entry key will be displayed as it is pressed, and the ":" symbol will continue to blink. Remember that the 1/Y key is also the YES key and the 3/N is also the NO key. After the last digit of the new value is entered, the user presses the ENT key. If the new value is valid, then the ":" will be replaced by the "=" and the relay will store and display the new setting value. If the value is not valid, an error message will be displayed on the fourth line and the old setting value will be retained.

```
Z3DISTANCE Gn S0302
Z3PHREACH : 51.37
Zone 3 Ph reach(Ohm)
VALUE OUT OF RANGE
```

Two checks are made before accepting the user-entered value. When it is valid, the privilege level will be checked for either Setting or Master level and Communications must not be in the process of changing settings. If the check fails then an error message is displayed and the setting is not changed.

After changing the value of a setting, the setting name and the new value will remain on the display. The user may press one of the ARROW keys to edit the next setting in the category. The user may also press any Command key to begin performing other operations. If the user presses the SET key, the next higher level menu consisting of the settings items in the present category is displayed with the cursor positioned on the last item edited. The user may then use the ARROW keys to go to another setting item.

If the user presses SET key again, the user will be taken to the setting category display with the cursor positioned on the latest edited category. If the user presses the SET key for the third time, the group selection display, with the current group number blinking, will appear. If the user presses any of the other Command keys, the command menu associated with that Command key will be displayed.

It is important to note that while values are being entered for any settings, the relay will not stop its Protection activities. Entered Settings are stored in a temporary buffer until the user presses END and selects one of the save settings item. This will cause a transfer of settings from the buffer to EEPROM and the protection to re-initialize, if there is not a fault in progress at that time. If the settings are not saved and the relay is allowed to time out (15 minutes), after the last key entry, all of the settings in the temporary storage will be lost.

As soon as the user has made the first valid setting change, the LED which indicates ALPS status starts blinking, to remind the user to

save the settings after editing them. It continues to blink until the user saves the settings by pressing END and makes the choice to save settings or the relay times out (15 minutes). In order to safeguard changed settings the following message will be displayed whenever ACT or INF keys are pressed after changing but not saving settings.

To Save Settings
Press END key

At this point the user can press the END key to save the changed settings in EEPROM. The user may also press the ACT or INF keys and proceed with the other operations. The setting changes will continue to reside in temporary memory until the user later presses the END key or the relay times out.

END key

END
1.Save settings & quit
2.Save settings
3.Quit

The END key has two purposes. The first is to transfer settings changes from the temporary area into the correct group. The other is to return the user to the VIEW or default privilege level. One of these functions may be accomplished without the other.

If no settings changes have been made, the option the user has when pressing END is Quit. This is the option to return to the default privilege level. If settings changes were made, then the user has three choices which are a combination of the two functions.

The user may enter the number of one of the choices or use arrow keys followed by the ENT key. Once the ENT key is pressed, the action is taken. There are no more prompts.

If the user chooses "Save set & quit" the edited settings are saved in the relay group they were edited from and the privilege level is returned

to default. The messages "SETTINGS SAVED." and "SESSION ENDED." Appear on the display reporting the action taken.

If the user chooses "Save settings", the edited settings are saved in the proper group and the current privilege level is retained. For this choice only "SETTINGS SAVED." is displayed.

END
Settings changed.
SETTINGS SAVED.
SESSION ENDED.

If only "Quit" is selected and the settings are not saved, the user is prompted to save them. If the user 1/Y (YES) and ENT, the settings are saved and the privilege level returns to default. Both "SETTINGS SAVED." and "SESSION ENDED." are displayed. If the user responds 3/N (NO) and ENT, the settings are **not** saved and the privilege level returns to default.

After the session is ended, the display is cleared after 10 seconds and the user's privilege level is reset to the default level, i.e., view level.

If no setting changes are made prior to pressing the END key, the only choice will be "Quit". If the user presses the ENT key, "SESSION ENDED." is displayed and the user is returned to the default privilege level.

NOTE:

1. If the Digital Output Test was started, it will be terminated when a choice containing Quit is selected.
2. If the user chooses to save the settings, they will be copied to EEPROM. If the saved settings affect protection and no fault is currently in progress the settings change is completed. Otherwise, an error message is issued to the user.

When settings are saved, protection is turned ON if it is currently OFF. The status LED turns

GREEN if disabling protection was the only reason to turn it RED.

If the settings saved are from the active settings group, a “Trip Bus Check” is made to ensure that the new settings are “legitimate”. If the check fails, the protection is turned off and the status LED turns RED indicating that the relay is no longer protecting the line.

EDIT GENERAL SETTINGS

```
EDIT GEN
1.CONFIGURE
2.COMMPORTS
3.OSC_GRAPHY
```

Using this option, the user can display or change settings other than protection settings, for example, Configuration, Communications, Oscillography, etc. Unlike the protection settings, there is only one group of general settings. SETTING or MASTER privilege level must be active in order to change general settings. It is possible, however, to view settings with Control or default privilege level.

Viewing/Editing of General Settings and the relay's response to key selection is similar to those described under the protection settings.

SELECT ACTIVE SETT GRP

```
SELECT ACT SETT GRP
Act Grp= n

Range: 0 - 4
```

This command allows selection of setting group to be used by protection functions. When this command is selected, the currently active group is displayed as follows:

The cursor is positioned on the second line. 'n' indicates the group number currently active. If group number selection is currently controlled by Contact Converter inputs, the display will contain the word EXTERNAL.

When the user changes the active group number, the '=' will be replaced by a blinking ':' symbol until the user presses the ENT key. The user can enter a value between 0 - 4. Entering 1 - 4 followed by ENT key selects setting group 1 - 4 for use by protection. Entering the group number '0' tells the relay that the active group number should now be read from Contact Converter inputs. If any number other than 0 - 4 is entered, an error message is displayed on the second line until the CLR key is pressed.

MODIFY DATE/TIME

This command is used to display or change the current date and/or time stored in the relay. SETTING or MASTER privilege level is required to change the date or the time. Users with any privilege level can view the date and time. When this item is selected, the display looks as shown below :

```
MODIFY DATE/TIME
Date   = 12/10/95
Time   = 10:00:00
```

The cursor will be located on the second line. To change the date or the time, place the cursor on the line with the desired item and press the ENT key.

```
MODIFY DATE/TIME
Date   = 12/13/95

FORMAT: MM/DD/YY
```

Enter the 6 digits corresponding to the correct date or time from the numeric keypad and press the ENT key.

When the first digit is entered, the 6 digits on the display are blanked and the '=' symbol is replaced by a blinking ':' symbol until the ENT key is pressed. If the entered digits do not compose a valid date or time, the old date or time is retained (new date or time is not stored) and an error message is displayed.

In both cases, two checks are performed: privilege level must be Setting or Master the process of manipulating time or date. If the checks fail then an error message is displayed and the change is not performed.

ACTIONS

ACTIONS
1.Disable outputs
2.Enable outputs
3.Trip breaker

The ACT key is used to select Action Commands. All Action Commands except LUI Test require either CONTROL or MASTER privilege level. The KEYPAD/DISPLAY INTERFACE Test can be performed with any privilege level. The PASSWORD ENABLE/DISABLE command and all relay tests require MASTER privilege level.

ACTIONS
Enter Password :

After the user presses the ACT key, the relay requests a password. The cursor is located at the beginning of the third line. The user may enter a password or just press the ENT key. If the ENT key is pressed without entering a password the current privilege level is retained and the ACT command category menu is displayed. If the user starts entering the password, each digit of the password is echoed on the screen as a '*'. When the user presses the ENT key, the entered password is checked for validity. If the password is not valid, an error message is displayed which must be cleared with the CLR key. When the error message has been cleared, the user may re-enter the password. If the password is valid, the user's privilege level is set to the one associated with the entered password.

NOTE :

(1) The user is asked to key in a password only when the privilege level is not Control or Master at the time the ACT key is pressed.

(2) When the relay is shipped from the factory, the CONTROL, SETTING and MASTER passwords are loaded with factory values. Selecting these passwords will not increase the user's privilege level; it only allows the user to change them to private passwords. The user will have access to higher privilege levels, only after the passwords have been changed.

The following list describes the available ALPS actions:

1.Disable outputs	8.Enable outputs
2.Trip breaker	9.Close breaker
3.Relay test	10.Channel test
4.LUI test	11.Digital output test
5.Playback	12.Change password
6.Enable/Disable passwords	13.Reset data
7.	14.Adjust contrast

The display will be similar to the settings display. The first line will display ACTIONS when the user is in the Actions menu. The next three lines will contain the ACTIONS commands. Other menu items can be seen and selected by pressing the UP-ARROW and DOWN-ARROW keys. To go directly to a menu item, type the menu item number. The menu number item will appear in the right corner of the top line. If the number is valid, when the ENT key is pressed the cursor will be positioned on that action category. If the number is invalid, when the ENT key is pressed an error message will be displayed which must be cleared by the CLR key.

When an action category has been selected, press the ENT key. The first item or prompt in the selected category is displayed. If the category contains a list of items, the user may scroll through the items using the ARROW keys, as described above. To select another actions category, press the ACT key and repeat the previous steps.

DISABLE OUTPUTS

This command is used to inhibit the relay from energizing any of the Digital Output contacts except for the critical alarm and power supply alarm outputs.

The relay will ask the user whether to disable the outputs. Press a 3/N (NO) or a 1/Y for YES followed by the ENT key. If the user responds NO, "CANCELED" is displayed, and no ALPS action occurs. If the user responds YES, two tests are performed. Control or Master privilege level is verified and Communication must not be in the process of performing an ACTION. If the test fails then an error message is displayed and the action is not performed. If the test passes, the action is performed, "OUTPUTS DISABLED" is displayed and the status LED on the front of the relay will turn RED. If the user responds with a key other than a 1/Y or 3/N, an error message is displayed and the outputs are not disabled. If the user selects this category when outputs are already disabled, the following message is displayed and must be cleared with the CLR key.

DISABLE OUTPUTS
OUTPUTS CURRENTLY
DISABLED.

ENABLE OUTPUTS

This command is used to permit the relay to enable the digital outputs of the relay.

The relay will ask the user whether to enable the outputs. Press 3/N (NO) or 1/Y for YES and press the ENT key. If the user responded NO, the message "CANCELED" is displayed, and no ALPS action occurs. If the user responded YES, two checks are performed. The Control or Master privilege level is verified and Communication must not be in the process of performing an ACTION. If the test fails then an error message is displayed and the action is not performed. If the test passes, the action is performed and "OUTPUTS ENABLED" is displayed. The

status LED on the front of the relay will turn GREEN if there are no status problems with the relay. If the user responds with a Data Entry key other than a 1/Y or 3/N, an error message is displayed and the outputs are not enabled.

If the user selects this category when outputs are already enabled, the relay will display a message which must be cleared with the CLR key.

TRIP BREAKER

This command is used to manually trip a breaker. Each breaker controlled by the relay must be tripped individually.

When this category is selected, if the relay is controlling two breakers, the relay will request which breaker to trip.

The user presses a 1 or 2 (any other Data Entry key will cause an error message to be displayed) to indicate which breaker and then presses the ENTER key. If the relay is set to control one breaker, the relay will skip this question.

The user will be asked whether to trip the selected breaker. The user presses 3/N (NO) or a 1/Y (YES) and then followed by the ENT key. If the user responded with NO, "CANCELED" appears on the display, and no ALPS action occurs. If the user responded YES, the checks are performed for the control or master privilege level and whether Communication is in the process of performing an action. If the checks fail then an error message is displayed and the action is not performed. If the checks pass then the action is performed and either "BREAKER x TRIPPED" or "NOT TRIPPED" appears on the bottom line of display depending on the status of the breaker. If the user responds with a Data Entry key other than a 3/N or 1/Y, an error message is displayed and the breaker is not tripped. Note that in a single pole system all three poles of the breaker are tripped.

The breakers are tripped as follows:

- For one breaker and one trip circuit, output contact T1 is energized.
- For one breaker and two trip circuits, output contact T1 and T2 are energized.
- For two breakers with one trip circuit each, output contacts T1 and T2 are energized.
- For two breakers with two trip circuits each, output contacts T1, T2, T3 and T4 are energized.

TRIP BREAKER
 Trip Breaker 1/2?

CLOSE BREAKER

This command is used to manually close the breaker; if two breakers are being controlled by the relay, each breaker must be closed individually.

When this category is selected, if the relay is controlling two breakers, the relay will request which breaker to close.

The user presses a 1 or 2 (any other Data Entry key will cause an error message to be displayed) to indicate which breaker and then presses the ENTER key. If the relay is controlling only one breaker, the above message is skipped.

The user will be asked whether to close the selected breaker. The user presses 3/N (NO) or 1/Y (YES) and then presses the ENT key. If the user responds NO, "CANCELED" appears on the display, and no ALPS action occurs. If the user responds YES, the checks are performed for the control or master privilege level and whether Communication is in the process of performing an action. If the checks fail then an error message is displayed and the action is not performed. If the checks pass then the action is performed and either "BREAKER x CLOSED" or "NOT CLOSED" is displayed depending on breaker status. If the user responds with a key other than 3/N or 1/Y, an error message is displayed and the breaker is not closed. Note that in a single pole system all three poles of the breaker are closed.

RELAY TEST

This command is used to test the protection functions of the relay. Master level privilege is required to perform relay test and Protection must be enabled. If protection has been turned off before entering this test, the relay will prompt the user to enable it. If the user enters 3/N (NO) and presses the ENT key, "CANCELED" is displayed and the test is CANCELED. If the user enters 1/Y (YES) and presses the ENT key, the user will be asked whether the digital outputs should be disabled.

RELAY TEST
 1.End Test Mode
 2.Zone 1 AG
 3.Zone 1 BG

Whether protection was just turned on or was already on when this test was selected, the relay prompts the user to decide whether to disable the digital outputs. If the user answers YES, all outputs except contact A1 will be disabled and the status LED turns RED to indicate the digital outputs have been disabled. The user has an option to enable them when End Test Mode is selected. If the user answers NO, all the digital outputs will stay active during the test.

Note: During relay test, all results from the tests will be output to contact A1 whether the digital outputs are enabled or disabled.

RELAY TEST
 1.End Test Mode
 2.Zone 1 AG
 3.Zone 1 BG

When the relay test items are displayed, the cursor will be positioned on the second line. The user may then display additional tests either by using the ARROW keys or entering the number corresponding to the test followed by the ENT key. The entered digits are echoed in the top right corner of the display. If the user presses the ENT key and if the entered number is valid, the test item corresponding to that number is displayed. A test item can also be selected by moving the cursor to the test item and pressing the ENT

key. At this point a check is performed to make sure that Communication is not in the process of performing an action. If the check fails then an error message is displayed and the test is not selected. When the test is selected, the word "ON" will be displayed to the right of the unit under test.

```
RELAY TEST
15.ANY Z2 GRND  ON
16.ANY Z3 GRND
17.ANY Z4 GRND
```

Performing the "Zone 2" test.

The user will be able to perform one test at a time. Each time a new test is selected, the previously selected test will be deselected.

During the relay test, the user may perform other activities using the SET, ACT or INF keys. When the user returns to the relay test category, the test started earlier will only be remembered if the END key has not been used. If the digital outputs were enabled, the user will be asked again to decide if they should be disabled. If protection was disabled, the user will be asked to enable it before proceeding with the tests again.

NOTE: The Disable Output? screen may appear first.

To remove the relay from test mode, the user moves the cursor to the item "End Test Mode" and presses ENT key in order to select it. The cursor can be moved to the item in two ways : (i) using ARROW keys, or (ii) entering "1" followed by ENT key. If "End Test Mode" is selected, the letters "ON" will be removed from the display line of the test item which is currently under test and the relay test is terminated.

If the user has disabled outputs before starting the relay test, a prompt appears after the selection of "End Test Mode" option, as shown below:

```
RELAY TEST
Enable outputs?
```

If the user replies 'YES' followed by ENT key, the outputs are enabled, the status LED may turn GREEN(if disabling outputs or relay test was the cause to turn it RED) and the user is taken to the ACT command menu. If the user replies 'NO' followed by ENT key, the outputs remain disabled, the status LED still stays RED and the user will be taken to the ACT command menu. If the user enters any other key, an error message is generated and CLR key is to be pressed to clear the error message.

The available tests and their corresponding numbers are:

- | | |
|------------------|---------------------|
| 1: End Test Mode | 25: ZONE 3 BC |
| 2: ZONE 1 AG | 26: ZONE 3 CA |
| 3: ZONE 1 BG | 27: ZONE 4 AB |
| 4: ZONE 1 CG | 28: ZONE 4 BC |
| 5: ZONE 2 AG | 29: ZONE 4 CA |
| 6: ZONE 2 BG | 30: ANY Z1 PHASE |
| 7: ZONE 2 CG | 31: ANY Z2 PHASE |
| 8: ZONE 3 AG | 32: ANY Z3 PHASE |
| 9: ZONE 3 BG | 33: ANY Z4 PHASE |
| 10: ZONE 3 CG | 34: IT DETECTOR |
| 11: ZONE 4 AG | 35: IB DETECTOR |
| 12: ZONE 4 BG | 36: GRD DIR TRIP |
| 13: ZONE 4 CG | 37: GRD DIR BLOCK |
| 14: ANY Z1 GND | 38: FAULT DETECTOR |
| 15: ANY Z2 GND | 39: REM OP DETCT |
| 16: ANY Z3 GND | 40: OUT OF STEP BLK |
| 17: ANY Z4 GND | 41: V1 DETECTOR |
| 18: ZONE 1 AB | 42: LINE OVERLOAD |
| 19: ZONE 1 BC | 43: INST PHS OVRC |
| 20: ZONE 1 CA | 44: INST GND OVRC |
| 21: ZONE 2 AB | 45: LINE PICKUP |
| 22: ZONE 2 BC | 46: OVER VOLTAGE |
| 23: ZONE 2 CA | 47: UNDER VOLTAGE |
| 24: ZONE 3 AB | 48:OUT OF STEP TRIP |

CHANNEL TEST

This command is used to allow the user to key (turn on) the local transmitter when a

channel scheme (POTT1, POTT2, PUTT, BLOCKING or HYBRID) is used.

Protection must be enabled to perform a channel test. If protection is disabled when channel test is selected, the relay will prompt the user to enable protection.

```
CHANNEL TEST
Enable Protection?
```

If the user responds with 3/N (NO), "CANCELED." is displayed and the test is CANCELED. If the user responds 1/Y (YES), the relay checks the outputs. If they are enabled, the test item is displayed. If the outputs are disabled, the user is prompted, as above, to enable them. If the user responds with 3/N (NO), "CANCELED." is displayed and the test is CANCELED.

If the user responds 1/Y (YES), the outputs are enabled and the test item is displayed.

```
CHANNEL TEST
1.End Chnl Test
2.Channel Test
```

If the user selects "Channel test", the privilege level must be Control or Master and Communications must not be performing an action. If either check fails, an error message is displayed and the test is not performed. The error message must be cleared by pressing the CLR key. When the checks pass and the test is started, the word "ON" will be displayed to the right of the item.

```
CHANNEL TEST
1.End Chnl Test
2.Channel Test  ON
```

When the user selects **End channel test**, the test is terminated the user is returned to the Actions menu.

KEYPAD/DISPLAY INTERFACE TEST

This command will test the display, keypad, and LEDs. This test does not require a specific privilege level. The user will be able to choose any of the three tests.

```
LUI TEST
1.Display
2.LEDs
3.Keypad
```

The user can select an item by using the ARROW keys followed by the ENT key.

If the Display test is chosen, the top two lines of the display will be filled to verify that all LCD dots are working. The display will prompt the user to press the ENT key. The bottom two lines of the display will now be filled. This is the end of the test. If the CLR key is pressed the user will leave Actions and return to the relay screen. If the ACT key is pressed, the LUI TEST choices will be displayed.

If the user chooses the LED test, both the STATUS and TRIP LEDs will be tested. The STATUS LED is tested first followed by the TRIP LED. The display will indicate the correct state of the LED. After each LED state the user will be prompted to press the ENT key and move to the next test.

When the user presses the ENT key after the last test, the LEDs return to their pre-test state and the KEYPAD/DISPLAY INTERFACE test item menu is displayed.

If the user chooses keypad test, the following screen appears:

```
SET 1/Y 2 3/N CLR
INF 4 5 6 UP
ACT 7 8 9 DN
END INV 0 . ENT
```

When any key is pressed, the key label will blink on the display. If another key is pressed, the new key label will blink. Pressing the CLR key will terminate the keypad test and the test item menu is displayed.

DIGITAL OUTPUT TEST

This command is used to test the digital outputs of the relay. If the digital outputs are not enabled, the user is prompted to enable them. If the user enters 1/Y (YES) and presses ENT, the outputs are enabled. If the user presses 3/N (NO), "CANCELED." is displayed and the test is terminated.

When the outputs are enabled the user must disable protection if it is currently enabled. If the user responds 'NO', "CANCELED." is displayed and the test is CANCELED. If user responds 'YES', protection is turned OFF, the status LED turns RED and the list of available tests is displayed.

The user can scroll through the list using arrow keys or enter the test number followed by the ENT key, to select a test item. If the prerequisites to perform the test are satisfied, the word "ON" will be displayed to the right of test item. If the privilege level is not MASTER or communications is performing an action, an error message is displayed and the test is not performed.

The contact being tested will close if it is normally open and it will open if it is normally closed. The user will be able to monitor only one output at a time. When a new output is tested, the old output will be reset and the new output will either open or close.

The user may perform other activities using the SET, ACT or INF keys at any time. When the user returns to the Digital Output tests again, the user is asked questions about Protection enable and then the test started by him and its following tests are displayed, starting from the second line.

To stop the digital output test, the user presses the ARROW keys until "End Test Mode" is displayed or enters "1" followed by the ENT key. The user then presses ENT. Then, the digital output test is terminated and the following message is displayed:

DO TEST
Enable Protection?

The cursor will be stationed at the beginning of the third line. If the user enters 1/y ('YES') followed by the ENT key, protection is turned ON. The LED indicating ALPS status turns GREEN(if performing digital output test was the only cause for turning it RED) and the user is taken to the ACT command menu with the cursor positioned on the item "Dig output test". The above prompt will be displayed also for the case where the user tries to exit the digital output test category without ending the test.

If the user enters 3/n ('NO') followed by ENT key, protection is not enabled and the status LED remains RED. The user is taken to the ACT

command menu with the cursor positioned on the item "Dig output test".

The user can also stop the test by pressing END ENT key sequence which ends the relay session with protection turned ON.

The available tests and their corresponding numbers are listed in the table below. The digital outputs with asterisks (*) refer to additional outputs that are available on single pole models.

1: End Test Mode	14: A7
2: T1	15: A8
3: T2	16: A9
4: T3	17: A10
5: T4	18: A11
6: T5	19: A12
7: T6	20: C1A/C1B
8: A1	21: C2A/C2B
9: A2	22: KT1
10: A3	23: KT2
11: A4	24: KT3
12: A5	25: KT4
13: A6	26:CA-A/B (Critical Alarm)

PLAYBACK

This category is used to check the relay logic as well as outputs by replaying oscillography data. The oscillography data can be the embedded factory test case, uploaded oscillography data or oscillography data stored in the relay.

After this command is selected, the following message appears on the display if protection is currently disabled:

PLAYBACK
 Enable Protection?

The cursor is positioned at the beginning of the third line. If the user responds 'NO', "CANCELED." is displayed and the test is canceled. If the user presses any keys other than 1/y or 3/n and presses the ENT key, an error message is displayed. It can be cleared and a valid input can be entered using the CLR key.

If the user responds 'YES', protection is enabled and the user is asked whether to disable the outputs, if they are currently enabled. The display looks as follows :

The user presses 1/Y or 3/N followed by ENT key. These keys are echoed on the display as 'YES' or 'NO' respectively. If the user has pressed 1/Y, the outputs are disabled and then the playback mode is continued. The user has the option to enable the outputs after the playback is complete. If the user has pressed 3/n, the outputs remain enabled. Any control actions issued by the relay do take place in this case.

If the outputs are disabled, the status LED turns RED since the relay is currently not protecting the line. If they remain enabled during playback, the status LED turns RED only for the duration of the playback. In that case, after the playback is complete, the status LED turns GREEN again.

The cursor will be located on the second line. If the option "Factory test case" is chosen by moving the cursor to that line and pressing the ENT key.

The user is asked here to select the settings which are used during playback. If the user presses 1/Y followed by ENT key, the settings that are currently in effect in the relay will be used during playback. If the user presses '2' followed by ENT, the settings stored along with the oscillography data will be used.

The factory test case is an A phase to ground fault at 50% of the line determined by the default factory settings, except for the configurable outputs which are all assigned a value of 0 (no assignment). The contact converters will respond to the levels in the uploaded file. After the user's response as described above, playback is started and the word "ON" will be displayed on the top line.

The cursor will be positioned on the top line. After the playback is over, the word "ON" is removed from the top line.

If the second choice, i.e., "Uploaded data" is selected, a check is made to verify whether any uploaded oscillography data exists in the relay. If the data does not exist, an error message is displayed. If the data exists, the user is asked to select the settings to be used during playback, as explained for the item "Factory test". An oscillography file may be uploaded by using ALPS-Link refer to chapter 11 for The playback is started after the user responds to all the prompts and the word "ON" will be displayed as shown above, as long as the playback lasts.

The only data files that can be uploaded to the relay are .OSC files downloaded from another ALPS or ALPS relay, or a Binary or ASCII Commtrade file from another source (see below for Commtrade details). These files contain the Analog data, flags and settings to be uploaded to the relay.

Any file that meets the Commtrade format may be downloaded to the ALPS after it has been converted to a .OSC format using the CTRD2OSC.exe program provided in the rear

pocket of this manual on the ALPS-LINK software disk and will be installed into the same directory that ALPS-LINK is installed into. This utility converts only the Analog data from the file, all flag values are set to 0, and default settings will be added to the file. View the CTRD2OSC.TXT text file for complete instructions on using the conversion utility. The only data used from a COMMTRADE file is the analog channel data. All other data will be discarded and replaced with dummy values. The data must be sampled at a rate of 64 samples per power cycle or 3840 samples/second at 60 Hz.

The values of the oscillography setting are obtained from the current settings and not the ones in the playback fault. Therefore, the new fault report will correspond to the current settings. For example, if the playback fault has 36 cycles of data, but the current NUMFAULT is set to 8 only 18 cycles of data will appear in the new fault report. Conversely, if the playback fault has only 12 cycles of data and the current setting will generate 36 cycles, then 24 cycles of zero data will be processed at the end of playback.

If the third choice, i.e., "Data in relay" is selected, the user is asked to select the settings(current/fault) for playback. After the user responds, the summary of faults stored in the relay is displayed and one must be selected. If fault settings is selected, the settings active at the time of the fault will be used. The settings file is attached to the oscillography and is always saved with the oscillography data.

The cursor will be located on the second line. In order to move cursor to an item, the user can scroll through the list of faults using the arrow keys or enter the fault number followed by the ENT key. If the user is entering a number, the digits pressed are echoed at the top right corner of the display. If the user presses ENT key after moving the cursor to the desired item, playback is started and the top line changes to indicate to the user that playback has started.

The word "ON" will be removed from the display as soon as the playback is complete.

Two checks are made before starting playback: the privilege level must be Master and communications must not be in the process of performing an action. If either of these checks fails, an error message is displayed to the user and the test is CANCELED.

If the user chooses the first choice, i.e., "End Playback" and if the outputs are disabled, the user is prompted with the dialogue:

If the user enters 'YES', the outputs are enabled, the status LED turns GREEN(if playback test was the only reason to turn it RED) and the user is taken to the ACT command category selection display. If the user enters 'NO', the outputs remain disabled, the status LED remains RED and the user is taken to the ACT command category selection display.

CHANGE PASSWORD

This category is used to change the Settings, Control and Master passwords. The user can use ARROW keys to select the desired item. To select an item press the ENT key. Once a password has been selected to be changed, only the number keys can be used to enter the old password. The digits are echoed with "*" for privacy. When the ENT key is pressed, the old password is checked for validity. If the password is valid, the user will be asked to enter the new password.

Only the number keys can be used to enter the new password as well. Once the new password has been entered followed by the ENT key, the user will be asked to re-enter the new password to ensure no mistakes were made while typing.

If the last two password entries are exactly the same then the message "PASSWD CHANGED." is displayed and the new password replaces the old one. If they are not the same then "PASSWD NOT CHANGED." is displayed and the password is not changed.

No privilege level is needed to use this command and communications is not checked.

ENABLE/DISABLE PASSWORDS

This category is used to enable/disable KEYPAD/DISPLAY INTERFACE passwords. Master privilege level must be used to enable or disable passwords.

If passwords are currently enabled the user will be prompted to disable the passwords. If passwords are currently disabled the user will be prompted to enable the passwords.

In either case, if the user responds 3/N (NO), "CANCELED." is displayed and the command is terminated.

The user presses 1/Y (YES) the current state for the operation of the passwords will be changed. If the current state is disabled, when the user executes this command, the user will be asked for the MASTER password followed by the ENT key, "PASSWORDS ENABLED." is displayed and passwords will be required to perform most of the commands for the relay with the keypad. When the passwords are enabled, the same passwords which were in effect before disabling the passwords are restored. If the current state is enabled, when the user executes this command, "PASSWORDS DISABLED." is displayed and no passwords will be required to perform most, if not all list Functions still requiring p/w's. Remember, a MASTER level password is required to perform this command whether or not passwords are enabled.

RESET DATA

This command is used to reset the fault, event, Oscillography and breaker health data.

Use the ARROW keys or press the item number followed by the ENT key to select an item to be reset. Once an item has been selected, press the ENT key again. The user is prompted to reset the data. If the

user responds 3/N (NO) followed by the ENT key, "CANCELED." is displayed and the data is not reset. If the user responds 1/Y (YES) followed by the ENT key, the data is reset and

a message is displayed which must be cleared with the CLR key.

If a fault is in progress while attempting to reset fault data or equipment duty data, an error message is displayed and the data is not reset.

An event is logged for each successful reset operation. Control or Master privilege is needed to perform this command and Communications must not be executing an action command.

ADJUST CONTRAST

The contrast level of the LCD display can be adjusted using this command. The UP-ARROW or DOWN-ARROW keys are used to increase or decrease the contrast of the display, respectively. As the user presses the ARROW keys, the contrast change will be visible on the display. Increasing the contrast will make the characters appear darker on the display. Decreasing the contrast will make the characters lighter on the display.

If the user has reached the minimum or maximum contrast limit, the relay will change the prompt to INCREASE only or DECREASE only, depending on the limit reached. Pressing the other ARROW will not produce any contrast change.

An error message will be displayed if the data entry keys are used. CONTROL or MASTER privilege is required to use this command.

8-2 INFORMATION

The INF key is used to view information stored in the relay and can be used with any privilege level. Pressing the INF key on the keypad allows the user access to the following information in the relay.

- 1.LPS status information
- 2.Fault information
- 3.Present values
- 4.Contact Converter status
- 5.Digital output status
- 6.Events information

- 7.Communication Passwords
- 8.Station/Line ID
- 9.LPS Model/Version
- 10.snaps hot oscillography

INFORMATION

- 1.LPS status
- 2.Faults
- 3.Present values

Use the ARROW keys to select the desired category. The user may also select a category by entering the category number followed by the ENT key.

The user can scroll through the list of categories by pressing the UP-ARROW or DOWN-ARROW keys. The user can select a category by entering its number as well. If the user enters a category number, it is echoed in the upper right-hand corner. When the user presses the ENT key after selecting a category, the first three items of information of the selected category are displayed. Use the ARROW keys to display information that is not currently display. The cursor will be visible only when the user is making a choice to view information. It is not visible while the user is viewing the information. The user may return to the category list by pressing the INF key at any time. Another category can be selected by using the ARROW keys or entering a new category number and pressing the ENT key as above. If the text on a line is longer than 20 characters (the maximum number per line), the text continues on the next line with the first character blank, as shown below.

**REQUEST
INFORMATION**

```
LPS STATUS
Trip Bus Check Fail
Setting changes
started
```

When the user requests the relay status, the overall relay status is displayed on the second line. If the relay is working properly and

protecting the line, the rely will display "STATUS: OK". If there is a critical failure detected by self-test, the display will be "STATUS: FAIL". If there are no critical failures but there is a non-critical failure, the display will be "STATUS: WARN". Even if there are no hardware failures, there may still be miscellaneous status in which case the display will be "STATUS: MISC".

The detailed status information is presented starting from the third line. The user may use the arrow keys to scroll through the information. Each time the ARROW key is pressed, a full screen of detailed status information is displayed. Status information is presented in the following order : critical failure information, non-critical failure information and miscellaneous status information.

REQUEST FAULT INFORMATION

This category is used to display fault information.

When this category is selected, a summary of the fault information for the stored faults is displayed to facilitate the user choose a fault for viewing more information about it. An example is shown below:

```
SELECT FAULT #1
XXX YY MM/DD HH:MM
XXX YY MM/DD HH:MM
XXX YY MM/DD HH:MM
```

where:

XXX: Fault type

YYY: Trip type

MM/DD HH:MM: Date and time of occurrence

The number in the top right-hand corner indicates the selected fault. When the category is entered, the number is #1 and the cursor is on the first fault. The arrow keys may be used to scroll through the list of accumulated faults. The number on the top line will change to match the currently selected fault. The user can also enter the fault number to view. If the number is valid when

the user presses ENT key, the cursor will be placed on the selected fault description. An error message is displayed if the user enters an invalid number.

The user has to press ENT key to view all the fault information. An example is shown below :

FAULT #1 Time : HH:MM:SS.XXX Date : MM/DD/YY

Explanation of the information displayed for each fault is given below :

Time: HH:MM:SS.XXX (XXX = msec)
(time of fault occurrence)

Date: MM/DD/YY
(date of fault occurrence)

Fault Type: XXX
(see the list below)

Trip Type: YYY
(see the list below)

Distance: zzz.z MI/KM
(distance to fault occurrence)

Relay Op Time: xxxxxx
(relay operating time in msec)

Brkr Op Time: xxxxxx
(breaker opening time in msec)

Fault Types:

AG	(phase A to ground)
BG	(phase B to ground)
CG	(phase C to ground)
ABG	(phases A-B to ground)
BCG	(phases B-C to ground)
CAG	(phases C-A to ground)
AB	(phases A-B)
BC	(phases B-C)
CA	(phases C-A)
3PH	(3-phase)

Trip Types:

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 pick up)
REM	(Remote open)
WI	(Weak Infeed)
OSC	(Oscillography Trigger)
SZ1	(Single Pole Zone 1 Trip)
SZ2	(Single Pole Zone 2 Trip)
SPI	(Single Pole Pilot Trip)
SWI	(Single Pole Weak Infeed)
CTB	(configurable trip bus trip)

REQUEST PRESENT VALUES

This category is used to display the present analog values. They are updated every 4 seconds while being displayed.

The present values information is displayed in six different screens. Each time the user presses the DOWN-ARROW key, the next screen of information will be displayed. Using the UP-ARROW key will display the information screens in reverse order.

The forward order of the information screens is: 1) RMS Values, 2) Power Factor, Frequency and Watts Vars, 3) Analog Values for Voltage, 4) Analog Values for Current, 5) Breaker Duty and 6) Breaker Operations.

NOTE :

Currents and voltages are displayed in primary or secondary values depending on the value of General Setting 108. For secondary side values, the units of voltages will be "V" and the current units will be "A". For primary side values, the voltage units will be "KV" and the current units will still be "A". The RMS present values are always displayed in primary units. The symbol '*' used for Watts and Vars can be: blank or 'K' (for 1000) or 'M' (for 1,000,000). The breaker duty is calculated according to the values in the BRKR DUTY General Settings. In general, the units of breaker duty are (Amps)^x(Seconds) where ^x is setting 401 in BRKR DUTY in General Settings. The breaker duty values are displayed with the units 'A' (AxSec), 'K' (KAxSec, Thousands) or

'M' (MAxSec, Millions). In the ALPS-Link program, the voltages will be shown in secondary values only.

CONTACT CONVERTER STATUS

This category is used to display the state of each digital input monitored by the relay. They are updated every 4 seconds while they are displayed.

The number of the contact converter, the name of the digital input assigned to the contact converter and the status of the converter are displayed on the same line. Three contact converter status are displayed at a time.

CC STATUS
1.52B_1A : 0
2.52B_1B : 1
3.52B_1C : 0

NOTE:

1. The ALPS has 12 contact converters.
2. The contact converter is OPEN if the status is a '0'. The contact converter is CLOSED if the status is a '1'.
3. If no digital input is assigned to a contact converter, its status information will still be displayed along with the contact converter number but the name will be blank.

DIGITAL OUTPUT STATUS

This command displays the definition and the state of each digital output in the relay. The information is displayed three lines at a time.

Use the ARROW keys to scroll through the digital outputs. The outputs are displayed in groups. For example, the first four trip outputs are on one line followed by the last two if the relay is a single pole version.

The Trip Outputs have the letter T in front of the output contact number. Alarm Contacts have the letter A in front of the output contact number. The two Form C output contacts have the letter C in front of the number. The Critical Alarm is just labeled CA.

DO STATUS
T1 - T4 : 1 0 1 1
T5 - T6 : 0 0
A1 - A4 : 0 1 0 0

NOTE:

If the DO status is shown as '0' it means it is OPEN. If it is '1', it is 'CLOSED'.

EVENT INFORMATION

This category can be used to view event information logged when certain functions are performed by the relay. Information displayed for each event consists of: Event number and its time of occurrence on the top line. Date of occurrence of event on the second line. Detailed event description on the third and fourth lines. The user may use the ARROW keys to view the event information. The user can also enter an event number followed by the ENT key to display the information for a specific event. An error message is displayed if the user enters an invalid event number. Listed below is a list of the possible event messages available:

EVENT LIST

Fail: CPU board SRAM	Fail: More than 4 warm restarts occurred in an hour
Fail: 960 access to DPRAM	Fail: i960 DSP interface
Fail: EEPROM	Fail: Runtime flash test CRC check
Fail: Digital output test	i960 Instruction fault
Fail: Interrupt test	i960 Arithmetic fault
Fail: ANI ADC Control logic	Too many bogus interrupts
Fail: ANI ref. channel test	Warning: CPU board timer test
Fail: DMA interrupt failure	Warning: Zero crossing logic
Fail: ANI board timer	Warning: CAPRAM failure
Fail: ANI board serial EEPROM test	Warning: RTC test failure
Fail: MAG module serial EEPROM test	Warning: Comm front port failure
Fail: Digital output serial EEPROM test	Warning: Comm rear port 1 failure
Fail: DTA serial EEPROM test	Warning: Comm rear port 2 failure
Fail: DSP PROM failure	Warning: Watch dog timer failure
Fail: DSP internal RAM	Warning: LCD display failure
Fail: DSP internal RAM checksum error	Warning: IRIGB failure
Fail: DSP access to DPRAM	Warning: Rear port 2 absent
Fail: DSP interrupt	Warning: Non critical field in model number
Fail: Digital input test	Warning: CAPRAM size mismatch
Fail: Model number - critical in nature	Warning: Frequency error
Fail: MAG module configuration mismatch	Warm restart
Fail: ANI module configuration mismatch	ANI reference corrected
Fail: Digital input module config mismatch	Digital input error corrected
Fail: Digital output module config mismatch	MAG module error corrected
Fail: Trip circuit continuity monitor #1	ANI module error corrected
Fail: Trip circuit continuity monitor #2	LCD display error corrected
Fail: Trip circuit continuity monitor #3	Remote communication login failure
Fail: Trip circuit continuity monitor #4	Passwords changed
Fail: Trip circuit continuity monitor #5	Outputs enabled
Fail: Trip circuit continuity monitor #6	Outputs disabled
Fail: Software version error	Manual trip
Fail: DSP software version error	Manual close

Manual trip failed	Receive carrier OFF
Manual close failed	Key transmitter ON
Setting changes started	Key transmitter OFF
Setting changes completed	Trip circuit #1 energized
Protection OFF	Trip circuit #2 energized
Protection ON	Trip circuit #3 energized
Fault queue in CAPRAM re-initialized	Trip circuit #4 energized
Event queue in CAPRAM re-Initialized	Trip circuit #5 energized
OST oscillography data area re-initialized	Trip circuit #6 energized
Equipment duty is reset	Line overload alarm ON
Active setting group changed	Line overload alarm OFF
Protection re-initialized	Trip circuit #1 monitor alarm ON
Request for protection re-initialization not serviced	Trip circuit #1 monitor alarm OFF
Factory settings done	Trip circuit #2 monitor alarm ON
Error in constants used by protection	Trip circuit #2 monitor alarm OFF
Error in code area of configurable logic	Trip circuit #3 monitor alarm ON
LPS Initialized	Trip circuit #3 monitor alarm OFF
Trip signals ON	Trip circuit #4 monitor alarm ON
Trip signals reset	Trip circuit #4 monitor alarm OFF
Trip A signal ON	Trip circuit #5 monitor alarm ON
Trip A signal reset	Trip circuit #5 monitor alarm OFF
Trip B signal ON	Trip circuit #6 monitor alarm ON
Trip B signal reset	Trip circuit #6 monitor alarm OFF
Trip C signal ON	Pilot protection ON
Trip C signal reset	Pilot protection OFF
Out of step block ON	Oscillography trigger
Out of step block OFF	Fail: Trip bus check
Breaker #1 open	Unbalanced system detection alarm ON
Breaker #1 closed	Unbalanced system detection alarm OFF
Breaker #2 open	Zone measurement units alarm ON
Breaker #2 closed	Zone measurement units alarm OFF
Fuse failure alarm ON	Overcurrent monitor alarm ON
Fuse failure alarm OFF	Overcurrent monitor alarm OFF
Receive carrier ON	Trip circuit #1 not energized

Trip circuit #2 not energized
 Trip circuit #3 not energized
 Trip circuit #4 not energized
 Trip circuit #5 not energized
 Trip circuit #6 not energized
 Ext reclose initiate - 1P
 Ext reclose initiate - 3P
 Run time ANI controller error
 Run time ANI reference error
 Run time DSP H/W fail
 Run time DSP settings error
 Run time DSP table corrupted
 TOC curve changed
 Runtime NO DMA interrupt
 Recloser in reset
 Recloser in progress start
 Recloser in progress end
 Recloser Single Pole Cycle 1
 Recloser Single Pole Cycle 2
 Recloser Single Pole Cycle 3
 Recloser Single Pole Cycle 4
 Recloser Three Pole Cycle 1
 Recloser Three Pole Cycle 2
 Recloser Three Pole Cycle 3
 Recloser Three Pole Cycle 4
 RECL in Lockout No Sync Check
 RECL in Lockout No Inhibit Input
 RECL in Lockout Breaker Open
 RECL in Lockout REC Unsuccessful
 RECL in Lockout Reclose Cancel
 RECL in Lockout BRK Fail to Open
 RECL in Lockout Maximum Shots
 RECL in Lockout Invalid REC Type
 RECLOSE Output Issued

RECL in Lockout Manual Lockout

An example of event information display is shown below :

13:45:21.240 Evt#100 09/12/88 LUI:MANUAL CLOSE
--

COMMUNICATION PASSWORDS

This category is used to view the communications passwords in encrypted form.

The user will be able to view only those encrypted passwords as permitted by his current privilege level. With a default or factory password privilege level, the user will only see the VIEW password for communications. With settings privilege level, only the SETTINGS and VIEW passwords are displayed. With control privilege level, only the CONTROL and VIEW passwords are displayed. All passwords can be viewed with master privilege level.

If the relay is set for MASTER privilege level, use the ARROW keys to view the second pair of passwords.

To change the privilege level in the relay, enter either the SETTINGS or ACTIONS categories and enter the password there. The SET key and the ACT key are the only two keys that allow you to set your privilege level. If only the SETTINGS privilege level is desired, the SET key must be used. The ACT key must be used if only the CONTROL privilege level is desired. Either can be used for the MASTER privilege level. See the following table for decoding information.

Displayed	Decoded	Displayed	Decoded
(space)	P	@	0
!	T	A	4
"	X	B	8
\$	Q	D	1
%	U	E	5
&	Y	F	9
(R	H	2
)	V	I	6
*	Z	L	3
,	S	M	7
-	W	P	(space)
1	D	Q	\$
2	H	R	(
3	L	S	,
4	A	T	!
5	E	U	%
6	I	V)
7	M	W	-
8	B	X	"
9	F	Y	&
:	J	Z	*
;	N	[.
<	C	\	#
=	G]	'
>	K	^	+
?	O	_	/

Password encryption key table.

REQUEST STATION/LINE ID

This category is used to view the Station and Line ID strings which are set by the remote communications. These IDs allow the user to easily identify each relay by name while logged in through communications. Use the ARROW keys to display the ID not currently on the screen.

NOTE:

If the station/line ID string is of more than 20 characters, a check is made to see if the string can be smoothly separated to fit on two lines. If it is not possible, the first 20 characters of the station ID are displayed on the third line and the rest of the characters are displayed on the fourth line.

REQUEST ALPS MODEL/VERSION

This category is used to display the Model and Version numbers for the relay.

OSCILLOGRAPHY SNAPSHOT

OSC SNAPSHOT
 Trigger Osc?

This command can be used to trigger the immediate collection of oscillography data. Oscillography can be triggered without at any privilege level. The user will be prompted to start the trigger.

Error Message	Cause of Error
VAL OUT OF RANGE	The setting value is either greater than the upper limit or less than the lower limit.
SETT NUM INVALID	The setting number is not valid.
Y/N NOT ENTERED	A YES or NO response key was required, but the 1/Y or 3/N key was not pressed.
REQUEST INVALID	A key was pressed that is not valid for a sequence; for example: The ENT key is pressed to view events. The _ key is pressed during entry of a settings value.
CATEGORY INVALID	An incorrect category number was entered for an action or information item.
BKR NUM INVALID	A breaker number other than 1 or 2 was entered.
DATE INVALID	The day, month, or year entry is invalid.
TIME INVALID	The hour, minute, or seconds entry is invalid.
FAULT # INVALID	An out of range fault number was entered.
REMOTE LINK ACT	The remote communication link is in use for actions or settings; local settings or changes can't be done.
LUI KEY ERROR	The LUI received an invalid key code from the keyboard (hardware error).
ACT INVALID NOW	The current action is invalid because the setting's CRC code is in error.

Table 8-1. KEYPAD/DISPLAY INTERFACE error messages.

8–3 ASCII Interface

The pin-to-pin connections for the cable connecting the ASCII port to plug PL2 on the back of the ALPS are shown in Figure 8–2. Virtually any standard communications package on a PC with a serial interface may be used. The ASCII serial interface must be programmed to the same parameters as the remote communications ports. The ASCII port's handshaking mode must be set to either XON/XOFF or DTR Ready. ALPS The ALPS setting COMMPORT affects both the baud rate of the RS232 port (plug PL1) and the ASCII port PL2. Figure 8-3 shows a Null modem cable for the 9 Pin front port PC-1.

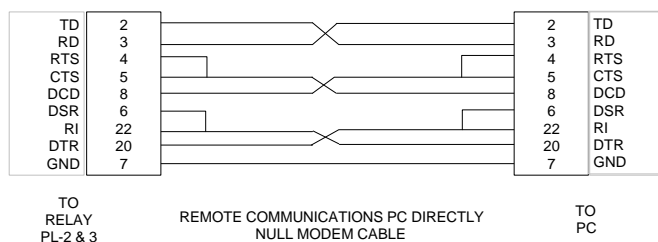


Figure 8-2 25 Pin Null Modem Cable

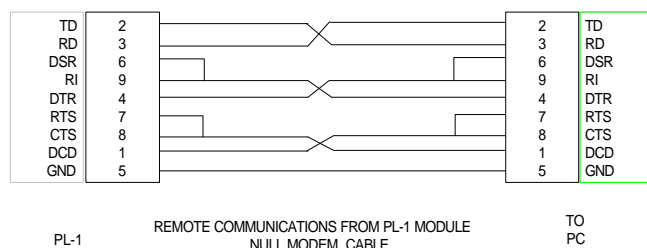


Figure 8-3 Null Modem Cable for Port PL1

Recommended Remote Communications Package

The following programs have been tested and known to support the ASCII interface on the ALPS. Note that most any communications package that emulates a TTY type terminal should communicate successfully. ALPS.

Description	Vendor
Procomm Plus	Datastorm
Windows Terminal Program	Microsoft

Table 8–2. Recommended terminal emulation programs.

8–4 Remote Communication Interface

Hardware Switches

There are hardware switches on the Input Board (see *Chapter 3 – Hardware Description*) that inhibit the Remote Breaker Operations, the Remote Settings Change and the Remote Enable/Disable Outputs functions. Please note that these switches are

shipped from the factory in the down position and these functions are enabled.

The proper sequence for setting these switches is::

1. Remove four thumbscrews holding the plastic cover in place and lay aside with plastic cover.
2. Turn the power switch off on the front panel.
3. Remove dc power from the ALPS.

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

4. Remove the four 1/4" hex nuts at the four corners of the front panel and carefully remove the front panel.
5. Disconnect the power and the ribbon cables from the front panel and lay the panel aside
6. The Switches are located in the middle on the front edge of the board. Move the switches up to turn a function off. Figure 3-

- 6 indicates the location of the jumpers on the board.
7. Reinstall the PC board retainers with the four phillips head screws.
8. Reinstall the power cable and the bus card on the PC boards.
9. Reconnect the LUI ribbon cable and the power cable to the front panel and install the front panel with the four 1/4" hex nuts.
10. Turn on the front panel power switch.
11. Restore dc power to the relay.
12. Reinstall the plastic cover with the four thumbscrews.

The hardware switches are defined below in Table 8–3.

Switch	Function
KBD EN ON	Down position enables keyboard operations. Up position disables.
RM CHG SET ON	Down position enables remote settings changes. Up disables.
RM BRKR ON	Down position enables remote breaker operations. Up disables.

Table 8–3. Hardware switch descriptions.

Modem Connections and Settings

When establishing communication between the relay and a remote PC, Two modems connected by a phone line are required to establish a connection between the relay and a remote PC. One modem is located at the relay and the other modem at the PC. The pin connections for the cable that connects the modem with either the relay or the PC is shown in Figure 8–4. Both modems must be "Hayes-compatible," which means that they accept configuration commands first developed by Hayes. This is necessary since the relay-LINK communications software that runs on the PC sends a Hayes-compatible command string to the modem located at the PC. The ALPS does not send any configuration commands to its modem. *Both the relay modem and the PC modem must be uniquely configured to permit logging into and communicating with the relay using ALPS-LINK software.*

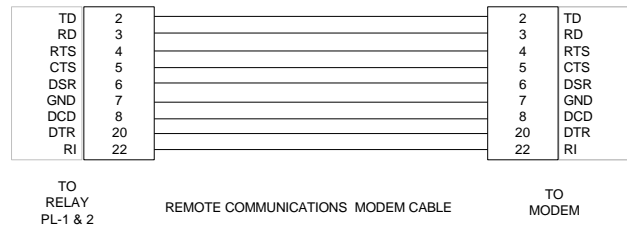


Figure 8-4 Modem Cable

The required configuration settings are presented as changes to the factory-default configuration settings for a Hayes V-Series 2400 SmartModem. The default settings are listed in Table 8–4.

B1	Y0	&S0	S12=50
E1	&C0	&T4	S18=0
L2	&D0	&X0	S25=5
M1	&G0	S0=0	S26=1
N1	&J0	S6=2	S36=1
P	&K3	S7=30	S37=0
Q0	&L0	S8=2	S38=20
V1	&P0	S9=6	
W0	&Q5	S10=14	
X4	&R0	S11=95	

Table 8–4. Modem configuration settings required for ALPS communications.

Other "Hayes-compatible" modems may implement a subset of the full Hayes command set. *It is the responsibility of the customer to determine the exact commands accepted by a particular modem.* The proper syntax for entering the Hayes-compatible commands (sometimes referred to as the "AT" command set) is not described here. Refer to the manual of your modem for an explanation of this syntax.

PC Modem

The PC modem must be configured for "intelligent" (command recognition enabled) operation. For the Hayes V-Series 2400 SmartModem, this setting is made with an internal jumper. The default settings listed in Table 8–4 are valid for ALPS-LINK. The

configuration settings critical to the operation of ALPS-LINK are sent to the modem from ALPS-LINK:

```
+++
      (delay 2 seconds)
ATE0L0Q0S7=60V0X4Y0
```

These commands are explained in Table 8–5.

Command	Meaning
+++	Set modem to command mode
AT	Modem attention command
E0	disable command state echo
L0	Low speaker volume (desirable, not required)
Q0	Modem returns result codes
V0	Result codes returned in numeric form
X4	Enables result code features
Y0	Disable long-space disconnect
S7=60	Modem hangs up if no connection within 60 sec.

Table 8–5. Explanation of command sequence sent by ALPS-LINK to the modem.

The S7=60 command is present starting with version 1.05 of ALPS-LINK. Earlier versions of ALPS-LINK do not send this command, leaving the time out at the default value, which is typically 30 seconds.

If any of the above commands are not recognized by the modem, then the modem will not operate properly. In addition to the required configuration settings listed in Table 8–4, it is suggested that the following two settings also be made:

&D3 – the modem resets on the ON-to-OFF transition of DTR (Data Terminal Ready).

&C1 – DCD (Data Carrier Detect) tracks the received carrier signal.

The modem will operate properly without these two settings, but it will not hang up if the appropriate handshaking signal is lost.

A ALPS-LINK setting establishes the baud rate, which must match the baud-rate setting of the ALPS. ALPS-LINK will then set the specified PC serial port (COM1, COM2) to the proper

baud rate, parity, data bits, and stop bits. If the PC modem is capable of operating at more than one baud rate, then it must be able to automatically configure its baud rate, character length, and parity setting by examining the "AT" command prefix.

LPS Modem

The ALPS modem must be configured for "dumb" (command recognition disabled) operation. On the Hayes V-Series 2400 SmartModem, this setting is made with an internal jumper. Since the relay sends no configuration commands to its modem, the required configuration settings must be made before connecting the modem to the relay. Additionally, the modem must be initialized to the required configuration settings each time modem power is turned OFF and then ON. Depending on the design of the modem this is accomplished with switch settings via switches or by saving the settings in nonvolatile memory.

The required configuration settings are listed in Table 8–6.

Command	Description
E0	Disable command state echo
L0	Low speaker volume (desirable, not required)
Q1	Disable result code display
&C1	DCD (Data Carrier Detect) tracks the received carrier signal
&D0	Modem resets on the ON-OFF transition of DTR (Data Terminal Ready)
&Q0	Asynchronous mode
S0=1	Enable auto-answer

Table 8–6. Configuration settings for the modem connected to the relay.

If any of the settings in Table 8–6 cannot be implemented, the modem may not answer, the relay may not connect properly, or you may not be able to log into the relay. With a Hayes V-Series 2400 SmartModem or equivalent, the relay modem performs a modulation handshake with the PC modem to set the baud

rate of the relay modem. The default setting of N1 permits handshaking to occur at any baud rate supported by both modems. This is one reason why it is better to use identical modems at each end.

Note that auto-answering is controlled by register S0:

- S0=0 – disables auto-answer.
- S0=1 – the relay modem answers incoming calls after one ring. S0 can be set for any value between 1 and 255, if it is desirable to delay modem answering. Note that ALPS-LINK (version 1.05 or higher) configures the PC modem to wait 60 seconds for the relay modem to answer. If the relay modem register S0 is set higher than 12 (answer after 12 rings), the PC modem may time out and hang up before the relay modem can answer. S0=12 corresponds approximately to the 60 second

delay (S7=60) at the PC modem; however, you should verify the number of rings that correspond to 60 seconds for a particular application.

Table 8–7 lists the modem command set required to communicate to the relay from a remote PC.

Null-Modem Connections

A PC can be connected directly to the relay without a modem through a null-modem cable. The required pin-to-pin connections for the PC null-modem cable are shown in Figure 8–2. The pin-to-pin connections for a null-modem cable to the 9-pin connector on the KEYPAD/DISPLAY INTERFACE are shown in Figure 8–3. The null modem cable should be no more than 50 feet long.

Function	LPS Modem (remote)	PC Modem (local)
DTR Status	Follow DTR (&D3)	Follow DTR (&D3)
Result Code Format	Numeric (V0)	Numeric (V0)
Result Code Display	Disable (Q1)	Disable (Q1)
Command State Echo	Disable (E0)	Disable (E0)
Auto-Answer	Enable (S0=1)	Disable (S0=0)
Carrier Detect	Follow CD (&C1)	Follow CD (&C1)
Jack Type	RJ-11, etc. (&J0)	RJ-11, etc. (&J0)
Command Recognition	Disable (Dumb)	Enable (Smart)
Comm. Std. (@1200 bps)	Bell 212A (B1)	Bell 212A (B1)
Response to DTR	Ignore DTR (&D0)	Ignore DTR (&D0)
Fall Back to 4800Bd	AT#F1	
Pulse Dial Ratio	39%Mk/61%Bk (&P0)	39%Mk/61%Bk (&P0)

Table 8–7.

Modem commands required for communication between the relay and a PC.

9-1 SPARES.....	2
9-2 SERVICING WITH THE RELAY SELF-TEST	2
9-3 TROUBLE-SHOOTING.....	3
THE INFORMATION STATUS COMMAND	4
SERVICING A CRITICAL FAILURE	4
LOCATING THE DEFECTIVE BOARD	4
SERVICING A NONCRITICAL FAILURE	7
LOCATING THE DEFECTIVE BOARD	7
SERVICING SYSTEM STATUS FAILURES	7

9-1 Spares

There are two servicing methods for the ALPS:

- Spare board replacement.
- Component level repair.

The preferred method is board replacement using the ALPS automatic self-tests to isolate failed boards. When the defective board is found, it can be replaced with a spare, and the system can be returned to service. This method typically yields the shortest system down time. To further reduce down time, we recommend keeping a complete set of spare boards at the maintenance center.

We do not recommend servicing the relay at the component level. This requires a substantial investment in test and repair equipment and in technical expertise, and usually results in longer down time than board replacement. For those who do wish to troubleshoot to the component level, drawings can be requested from the factory. When you request drawings, you must supply the following information:

- The name of the board. This is found on the component side of the printed circuit board with the assembly number and revision.
- The assembly number of the board is an eight-digit number with a letter inserted between the fourth and fifth digit and with a group-identification suffix, such as 0215B8011G001.
- The revision number is found adjacent to the assembly number of the board.

CAUTION: Power down the relay by turning off the front panel power switch and disconnecting power from the rear connector before disassembling the unit. High Voltage levels can be accessed at the Power supply inputs.

9-2 Servicing with the Relay Self-Test

The ALPS automatically performs tests of major functions and critical hardware components and reports their status via the LUI Display, status LED and the non-critical and critical alarm contacts. The failure report is dependent on the type or level of the failure. Some failures operate the critical alarm contact and the status LED, while others only operate the non-critical alarm contact.

There are three levels of self-test performed by the ALPS:

1. The first level indicates severe relaying failures, indicated by a FAIL message on the display, the critical alarm contact opening, and the status LED turning red. These failures indicate that the relay is not providing protection.
2. The second level displays warning messages. They are indicated by a WARN message on the display and closure of the non-critical alarm contact. These failures indicate that the relay is still providing some degree of protection.
3. The third level indicates system status errors that are due to power system errors (Trip Circuit Open) or are caused by a ALPS command that disables the relay (Disable Outputs). They are indicated by the closing of the non-critical alarm contact, a red LED, or by the opening of the critical alarm contact. However, nothing is displayed until the Information Status command is issued.

The types of self-tests performed are described in the *Chapter 1 – Product Description*. The components tested during the start-up self-tests are listed in Table 9-1. The components tested during run-time background and foreground self-tests are listed in tables 9-2 and 9-3, respectively.

Component	Method	Processor	Nature
Flash Memory (PROM)	CRC-type check	960 CPU	Critical
EPROM	Checksum on DSP board.	DSP	Critical
Local RAM	Patterns to check for stuck bits, stuck address lines, cross-talk between adjacent bits	960 CPU DSP	Critical
Shared RAM	Same as Local RAM	Both	Critical
Nonvolatile RAM CAPRAM Serial Ram	CRC-type check on settings area; checksum on fault storage area; duplicate locations on serial NVRAM	960 CPU	Critical if settings area or serial NVRAM
Timer Chip	Test all processor timers and their interrupts	960 CPU	Critical if ANI logic, non-critical if 960
Interrupt Controller	Test all 960 internal interrupts	960 CPU	Critical
Serial Chips	Wraparound and interrupt tests for serial interface	960 CPU	Non-critical
A/D Controller	DMA interface	960 CPU	Critical
Digital Output Circuitry	Loop-back test	960 CPU	Critical
Digital Input Circuitry	Comparison of bits read via two separate optocouplers	960 CPU	Non-critical, turn off pilot protection
Real-Time Clock	Test of real-time clock operation and interrupts	960 CPU	Non-critical

Table 9-1. Components tested during start-up self-tests.

Component	Method	Processor	Nature
Flash Memory (PROM)	CRC-type check	906 CPU	Critical, restart
EPROM	Checksum type check	DSP	Critical, restart
RAM	Protection values checked for correctness, Configurable logic checked for validity	960 CPU	Critical, restart
Nonvolatile RAM	CRC-type check on settings area;	960 CPU	Non-critical
CAPRAM	checksum on fault storage area	960 CPU	

Table 9-2. Run-time background self-tests.

Component	Method	Processor	Nature
A/D Controller	DMA interface	960 CPU	Critical
Digital Input Circuitry	Comparison of bits read via two separate optocouplers	960 CPU	Non-critical, turn off pilot protection
Digital Output Circuitry	Loop-back test	960 CPU	Critical; restart
Trip Circuit Continuity	Bit read via bus	960 CPU	Non-critical
LUI	Operator initiated, visual feedback	960 CPU	Non-critical

Table 9-3. Run-time foreground self-tests.

9-3 Trouble-Shooting

Troubleshooting the ALPS comprises three steps, as follows:

1. Determine the relay status as either critical, non-critical, or miscellaneous.
2. Use the list of failure codes and warning codes or the Information Status command to determine the defective board(s).
3. Replace the defective board(s) in accordance with safety and static-discharge precautions.

NOTE: Refer to *Chapter 4 – Acceptance Testing* for tests of the Local User Interface (LUI) display, and keypad and of the measuring units.

The Information Status Command

Tables 9-5 and 9-6 contain the failure and warning codes that appear on the LCD display. The Information Status command should be used to obtain complete data about the relay status. The Information Status command can be used at the relay or remotely over a modem link.

The Information Status command is invoked as follows:

1. Apply rated dc power to the relay and wait for initialization to complete (if necessary).
2. Press the INF key, then scroll with the ↑ and ↓ keys until the LCD display indicates
 1. ALPS status
3. Press the ENT key. The display indicates a failure with the words

STATUS: FAIL
4. Press the ↑ key to get a detailed report of all the failures. A complete list of the possible errors is found in Tables 9-4, 9-5, and 9-6. The FAIL and WARN messages are also included. Their descriptions may

also be displayed on the LCD Display, with the Information Status command.

NOTE: After initial power up or a loss of power exceeding 24 hours, the time and date reset to 00:00:00 01/01/96. All event and fault data are reset.

Error	Indication	Description
WARN	NCA	Warn condition
FAIL	CA/LED	Fail condition
MISC	LED	Miscellaneous condition

LED: Red Status LED .

CA: Critical alarm contacts close.

NCA: Non-critical alarm contacts close.

Table 9-4. System status error messages.

Servicing a Critical Failure

A critical failure indicates total interruption of protection. When a failure occurs on one of the boards (excluding the power supply), the critical alarm contact opens and the status LED turns red. Remove and reapply dc power to try to bring up the fail message on the display. If the ALPS successfully restarts, the status LED turns green.

If the failure still exists, the status LED will be red and the critical alarm contact will be open. A FAIL message may also be on the display. The Fail message indicates the nature of the critical failure. The Fail message remains on the display until a key is pressed or until the ALPS restarts successfully with no self-test failures. See Table 5-5 for the list of codes or mnemonic failure codes and their meanings.

If the fail message is not associated with a printed circuit board, then check all external connections to the ALPS.

NOTE: The Information-ALPS Status command can be used to display all the current failures.

Locating the Defective Board

Use Table 9-5 or the Information Status command to isolate the cause of the failure. Then refer to figure 3-4, (ALPS System Block Diagram), to determine which board contains the defective logic module. When the suspected board is found, power down the ALPS and replace the board.

The proper sequence for replacing a board is as follows:

1. Remove four thumbscrews holding the plastic cover in place and lay aside with the plastic cover.
2. Turn the power switch off on the front panel.
3. Remove dc power from the ALPS.

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

4. Remove the four 3/16" hex nuts at the four corners of the front panel and carefully remove the front panel.
5. Disconnect the power and the ribbon cables from the front panel and lay the panel aside.
6. Remove the two ribbon cables and power cables from the front of the PC boards and lay aside.
7. Remove the PC board that connects the other PC board and lay aside in a anti-static bag.
8. Remove the defective PC board, place into an anti-static bag for storage or shipment.
9. Remove the replacement board from its anti-static container and insert it into the ALPS case.
10. Reinstall the connecting PC board.

11. Reinstall the ON/OFF switch cable and the two ribbon cables.
12. Reconnect the LCD display ribbon cable and the RESET/METERING cable to the front panel and install the front panel with the four 3/16" hex nuts.
13. Restore dc power to the ALPS.
14. Turn on the front panel power switch.
15. Reinstall the plastic cover with the four thumbscrews.

If the FAIL message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that another board requires replacement.

Servicing a Non-critical Failure

A non-critical failure indicates an interruption potential in the ALPS protection, but not a total loss. When a non-critical failure occurs, the ALPS non-critical alarm contact closes, but the LED remains green. Turn off the dc input power, then reapply it. The WARN xxx message reappears if the failure still exists.

The non-critical failure message has the format WARN xxx. The xxx field is the numeric code that indicates the nature of the failure. The WARN message remains on the display until a key is pressed or until the ALPS restarts successfully with no self-test failures. See Table 6-6 for the list of Warning codes or mnemonic codes and their meanings.

NOTE: As an alternative, the Information Status command can be used to display the warning type directly on the LCD Display.

Locating the Defective Board

Use Table 9-6 or the Information Status command to isolate the cause of the failure. Power down the ALPS and replace the suspected board, if appropriate. Reapply power; if the WARN message is gone, then the unit has been successfully repaired. If the message has changed, it is possible that another board requires replacement.

Servicing System Status Failures

A system failure indicates a failure of a power system input or that the relay has been disabled by a user command. It is indicated by the closing of the non-critical alarm contact, by a red LED, or by the closing of the critical alarm contact. However, no LCD display is provided until the Information Status command is invoked.

Turn off and reapply the dc input power. The non-critical alarm contact is closed if the failure still exists. Use the Information Status command to determine the cause of the trouble.

960 CPU Board

FAIL-FLASH MEMORY
 FAIL-STATIC RAM
 FAIL-STATIC RAM CRC
 FAIL-DPRAM 960 ACCESS
 FAIL-I960 INTRPT CONTROLLER
 FAIL-CPU TIMER
 FAIL-CPU EEPROM
 FAIL-CPU CAPRAM
 FAIL-CPU RTC
 FAIL-CPU WATCHDOG TIMER
 FAIL-S/W PROT CONSTANTS
 FAIL-S/W CONFIG. LOGIC
 FAIL-CONFIG S/W VERSION ERROR
 FAIL-CPU SYSTEM IN RESET
 FAIL-CPU SYSTEM SHUTDOWN
 FAIL-DO FEED BACK
 FAIL-LUI LCD DISPLAY
 FAIL-IRIGB
 FAIL-TRIP CKT #1 CONTINUITY ERROR
 FAIL-TRIP CKT #2 CONTINUITY ERROR
 FAIL-TRIP CKT #3 CONTINUITY ERROR
 FAIL-TRIP CKT #4 CONTINUITY ERROR
 FAIL-TRIP CKT #5 CONTINUITY ERROR*
 FAIL-TRIP CKT #6 CONTINUITY ERROR*
 FAIL-CONFIG H/W MISMATCH
 FAIL-NO DMA INTERRUPT
 FAIL-RUNTIME SETTINGS AREA
 FAIL-EEP CONTENTS ERROR
 STAT-DO DISABLED HARDWARE

Magnetics Module

FAIL-MAG SEEPROM

Communications Warnings

FRONT PORT LOGIN FAILURE
 REAR PORT #1 LOGIN FAILURE
 REAR PORT #2 LOGIN FAILURE
 WARN-FRONT PORT FAIL
 WARN-REAR PORT #1 FAIL
 WARN-REAR PORT #2 FAIL
 WARN-REAR PORT 1 ABSENT
 WARN-REAR PORT 2 ABSENT

Miscellaneous Failures

CON MONITOR ALARM
 UNBALANCED SYS ALARM
 FUSE FAILURE
 TRIP BUS CHK FAIL
 TIME STROBE FAIL

Miscellaneous Messages

WARN-LUI KEYPAD ERROR
 WARN-RTC
 WARN-DIGITAL INPUT LOGIC
 WARN-LCD DISPLAY
 ACTIVE GROUP SWITCH THROUGH CCs
 LUI PASSWORDS DISABLED
 DISABLED OUTPUTS
 DO DISABLED-SOFTWARE
 DO DISABLED-HARDWARE
 RELAY TEST
 DIGITAL OUTPUT TEST
 CHANNEL TEST
 PLAYBACK

ANI / DSP Board
FAIL-ANI ADC CONTROLLER
FAIL-ANI ADC SEEPROM
FAIL-ANI REF. VOLTAGE
FAIL-ANI ZERO CROSSING LOGIC
FAIL-DMA NO INTERRUPT
FAIL-DI INPUT LOGIC
FAIL-SERIAL EEP READ
FAIL-FREQUENCY OUT OF RANGE
FAIL-DSP PROGRAM ROM
FAIL-DSP INTERNAL RAM
FAIL-DSP INTERNAL RAM CRC
FAIL-DSP DPRAM DSP ACCESS
FAIL-DSP 960-DSP INTERRUPT
FAIL-RUN TIME DPRAM CHECKSUM
FAIL-DI SERIAL EEPROM
FAIL-DO SERIAL EEPROM
FAIL-DSP SETTINGS
FAIL-DSP TABLES
FAIL DSP I960 HANDSHAKE
FAIL-DSP IN RESET
FAIL-DSP S/W VERSION
FAIL-DSP IN SHUTDOWN
FAIL - ANI VREF1
FAIL - ANI VREF2
FAIL - ANI VREF3
WARN-COMM FRONT PORT FAIL
WARN-COMM REAR PORT #1 FAIL
WARN-COMM REAR PORT #2 FAIL
WARN-COMM LUI KEYPAD ERROR
STAT-DI ERROR CORRECTED

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10-1 INTRODUCTION

ALPS Test is used to generate test data for the measuring units in the ALPS relay for the settings specified by the user. This data can be used to validate your test data.

In order to run the program, the following files need to be installed in a directory of the tester's choice.

ALPS_TST.EXE
ALPS_TST.INI
ALPS_TST.HLP
PUSHHELP.VBX

10-2 STARTING PROGRAM THE FIRST TIME

- Install the program from the floppy disk provided in the instruction book.

When the program is started, the following screen is displayed.

The menu items are listed below.

File
 New Test File Ctrl+N
 Open Test File... Ctrl+O
 Open Setting File...
 Close Test File

 Save Input Quantities Ctrl+S
 Save Input Quantities As...
 Save Output As...

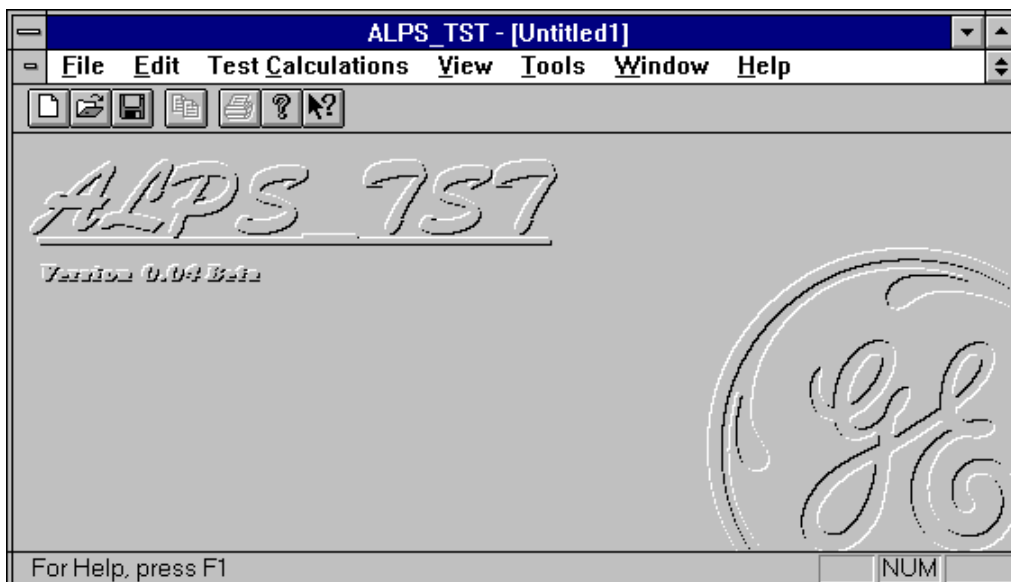
 Print... Ctrl+P
 Print Setup...

 Recent File

 Exit

Edit
 Copy Output Ctrl+C
 Copy Text Only
 Copy Mho Circle Only

Test Calculations
 M1 Phase Units - Zone 1
 MT Phase Units - Zone 2
 M3 Phase Units - Zone 3
 M4 Phase Units - Zone 4
 MOB Phase Unit



M1G Ground Units - Zone 1
 MTG Ground Units - Zone 2
 M3G Ground Units - Zone 3
 M4G Ground Units - Zone 4

View
Toolbar
Status Bar

Tools
 Setup

Window
Cascade
Tile
Arrange Icons

Help
Contents
Using Help

About ALPS_TST...

The following menu items are disabled.

File menu
 Save Output As...
 Print...
 Recent File
 Edit menu
 Copy
 Copy Text Only
 Copy Mho Circle Only

10-3 STARTING PROGRAM AFTER THE FIRST TIME

Start the program as in the previous section. When the program is started, the opening screen is displayed as in section 2 above.

- The title bar of the main window has the currently opened file name which is the file name the user selected in section 2 above.
- Pull down the "File" menu. The most recent file is this same file name.

10-4 TEST CALCULATIONS

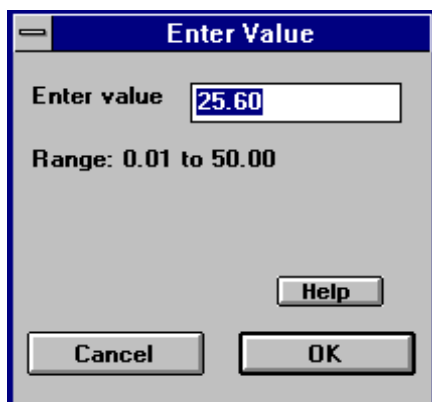
The following is the user input quantities and their ranges. Each test does not use all the quantities. The default values are used for only the first test dialog box displayed for each new test.

INPUT QUANTITY	RANGE	DEFAULT VALUES
Rated current	1 or 5 amp	1 amp
Reach	1 amp: .01 to 250.00	.01
(Reach in forward/reverse direction)	5 amp: .01 to 50.00	
Positive Sequence Reach Angle	45 to 90 degrees	45 degrees
Characteristic Timer	M1: 90 degrees MT: 90 to 120 degrees in steps of 5 M3: 90 to 120 degrees in steps of 5 M4: 80 to 120 degrees in steps of 5 MOB: 30 to 130 degrees M1G: 90 degrees MTG: 90 to 120 degrees in steps of 5 M3G: 90 to 120 degrees in steps of 5 M4G: 80 to 120 degrees in steps of 5	90 degrees for all
Test Current	calculated	high limit of range
Degrees to increment angle	5,10, 15	5
Phase angle reference	V[øG], V[øø]	V[øø]
Zero Sequence Reach Angle	45 to 90 degrees	45
I0 Compensation Factor, K0	1.0 to 7.0	1.0
Direction	forward, reverse	reverse
Offset Reach (times main reach)	0 to 0.4	0
Replica Impedance Angle	Calculated for output only	N/A
Effective Test Reach	Calculated for output only	N/A

Select the "Help" button from the "Enter value" dialog box. A help screen is displayed describing how to use this dialog box.

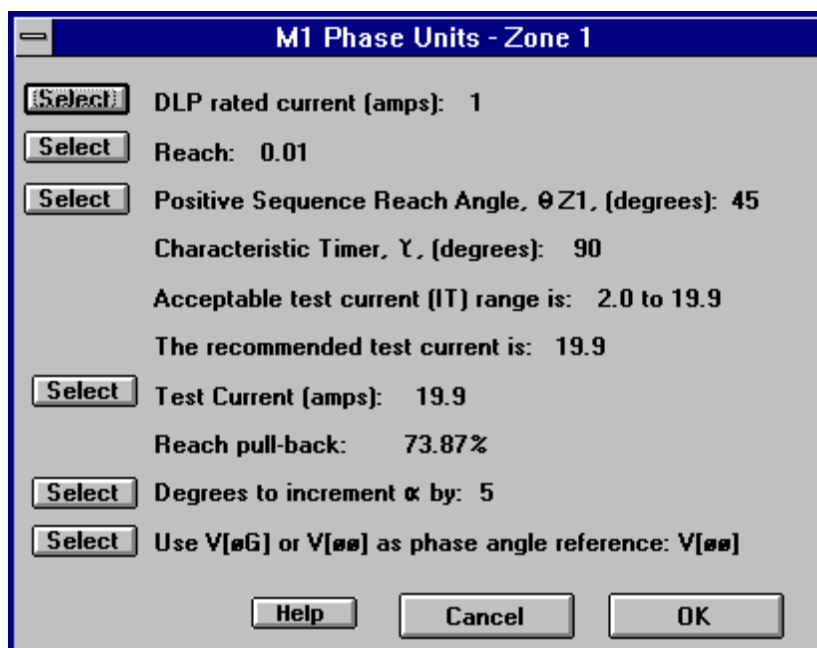
Entering Input Quantities

When the user clicks on a "Select" button, the "Enter value" dialog box is displayed. This dialog box has two modes, one is to enter a value for a continuous range of values and the other is to select a value from a list of values.



Entering a value

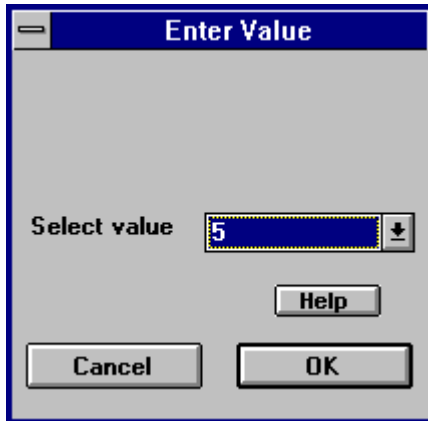
Click on a "Select" button from one of the test dialog boxes below for an input quantity that has a continuous range. For a Reach value where the rated current is 5 amps, the following dialog box is displayed:



Enter a valid new value and click on "OK". The dialog box clears from the screen and the value in the test dialog box is changed to the value just entered.

Selecting a value

Click on a "Select" button from one of the test dialog boxes below for an input quantity that has a list of values. For "Rated current", the following dialog box is displayed:



Select a new value and click on "Cancel". The dialog box clears from the screen and the value in the test dialog box remains unchanged.

Select a new value and click on "OK". The dialog box clears from the screen and the value in the test dialog box is changed to the value just entered.

M1 Phase Units - Zone 1

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

MT Phase Units - Zone 2**10-5 FILE MENU****New Test File**

Select "New Test File" from the "File" menu. This will create a new test which is indicated by the GE logo being displayed and the test name of "Untitledx" in the title bar. The 'x' is a digit which indicates the number of new documents created.

Open Test File

This menu item results in a dialog box supplied by Microsoft. Therefore only the "OK" button of the dialog box is tested to make sure the file was properly opened.

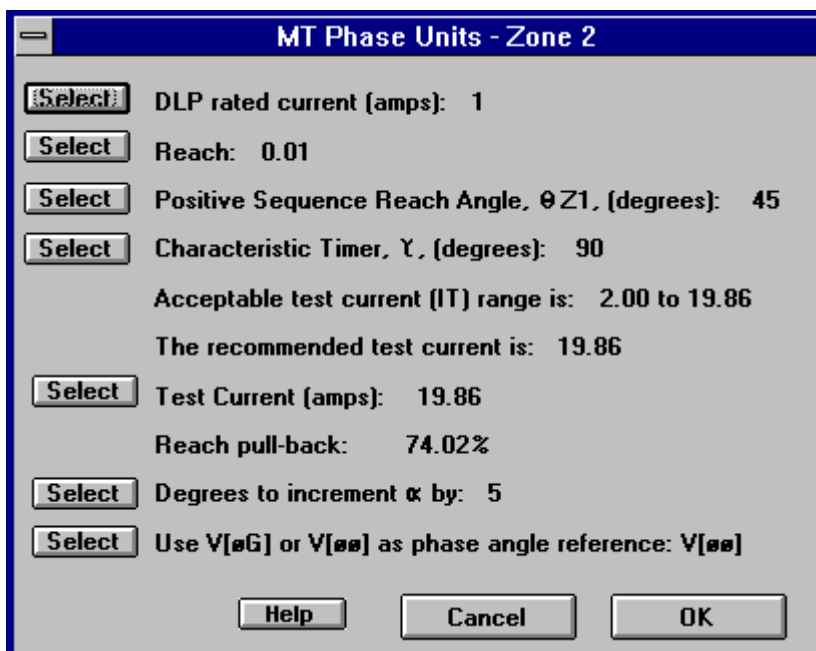
Select "Open test File" from the "File" menu. Select a file that is not a test file and not a setting file. A message box is displayed that explains the error. Verify that the currently active test has not changed from before the open command.

Edit an existing test file using a text editor. Add a line to the file. Select "Open test File" from the "File" menu. Select the edited file. A message box is displayed that explains the error. Verify that the currently active test has not changed from before the open command.

Edit an existing test file using a text editor. Remove a line which contains a user entered value that is not a default value. Select "Open test File" from the "File" menu. Select the edited file. A message box is displayed explaining the error. Verify that the test file is still loaded and that the missing value has its default value.

Select "Open Test File" from the "File" menu. Select a test file containing no errors and click the "OK" button to open it. Select a test. Verify that the values in the dialog box are the same as those in the file (see the "Save Input Quantities" section).

wing dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.



MT Phase Units - Zone 2

DLP rated current (amps): 1

Reach: 0.01

Positive Sequence Reach Angle, $\theta Z1$, (degrees): 45

Characteristic Timer, γ , (degrees): 90

Acceptable test current (IT) range is: 2.00 to 19.86

The recommended test current is: 19.86

Test Current (amps): 19.86

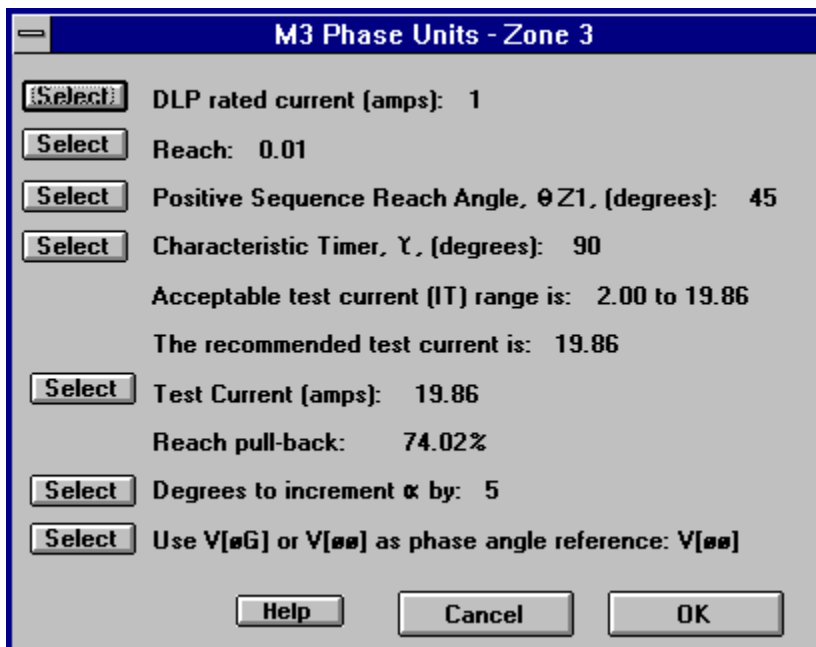
Reach pull-back: 74.02%

Degrees to increment α by: 5

Use V[0G] or V[00] as phase angle reference: V[00]

M3 Phase Units - Zone 3

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.



M3 Phase Units - Zone 3

DLP rated current (amps): 1

Reach: 0.01

Positive Sequence Reach Angle, $\theta Z1$, (degrees): 45

Characteristic Timer, γ , (degrees): 90

Acceptable test current (IT) range is: 2.00 to 19.86

The recommended test current is: 19.86

Test Current (amps): 19.86

Reach pull-back: 74.02%

Degrees to increment α by: 5

Use V[0G] or V[00] as phase angle reference: V[00]

M4 Phase Units - Zone 4

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

M4 Phase Units - Zone 4

DLP rated current (amps): 1

Direction: Reverse

Reach in reverse direction: 0.01

Offset Reach (times main reach): 0.00

Positive Sequence Reach Angle, $\theta Z1$, (degrees): 45

Characteristic Timer, γ , (degrees): 90

Acceptable test current (IT) range is: 2.0 to 19.9

The recommended test current is: 19.9

Test Current (amps): 19.9

Reach pull-back: 73.87%

Degrees to increment α by: 5

Use V[0G] or V[00] as phase angle reference: V[00]

MOB Phase Unit

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

MOB Phase Unit

DLP rated current (amps): 1

Reach: 0.01

Positive Sequence Reach Angle, $\theta Z1$, (degrees): 45

Characteristic Timer, γ , (degrees): 30

Acceptable test current (IT) range is: 2.0 to 19.9

The recommended test current is: 19.9

Test Current (amps): 19.9

Reach pull-back: 73.87%

Degrees to increment α by: 5

Use V[0G] or V[00] as phase angle reference: V[00]

M1G Ground Units - Zone 1

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

The screenshot shows a dialog box titled "M1G Ground Units - Zone 1". It contains several parameters, each with a "Select" button to its left. The parameters and their values are: DLP rated current (amps): 1; Reach: 0.01; Positive Sequence Reach Angle, θ_{Z1} , (degrees): 45; Zero Sequence Reach Angle, θ_{Z1} , (degrees): 45; IO Compensation Factor, K0: 1.0; Characteristic Timer, γ , (degrees): 90; Acceptable test current (IT) range is: 2.0 to 27.5; The recommended test current is: 27.5; Test Current (amps): 19.9; Reach pull-back: 110.55%; and Degrees to increment α by: 5. At the bottom of the dialog are three buttons: "Help", "Cancel", and "OK".

Parameter	Value
DLP rated current (amps)	1
Reach	0.01
Positive Sequence Reach Angle, θ_{Z1} , (degrees)	45
Zero Sequence Reach Angle, θ_{Z1} , (degrees)	45
IO Compensation Factor, K0	1.0
Characteristic Timer, γ , (degrees)	90
Acceptable test current (IT) range is	2.0 to 27.5
The recommended test current is	27.5
Test Current (amps)	19.9
Reach pull-back	110.55%
Degrees to increment α by	5

MTG Ground Units - Zone 2

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

The screenshot shows a dialog box titled "MTG Ground Units - Zone 2". It contains several parameters, each with a "Select" button to its left. The parameters and their values are: DLP rated current (amps): 1; Reach: 0.01; Positive Sequence Reach Angle, θ_{Z1} , (degrees): 45; Zero Sequence Reach Angle, θ_{Z1} , (degrees): 45; IO Compensation Factor, K0: 1.0; Characteristic Timer, γ , (degrees): 90; Acceptable test current (IT) range is: 2.00 to 27.50; The recommended test current is: 27.50; Test Current (amps): 19.86; Reach pull-back: 110.78%; and Degrees to increment α by: 5. At the bottom of the dialog are three buttons: "Help", "Cancel", and "OK".

Parameter	Value
DLP rated current (amps)	1
Reach	0.01
Positive Sequence Reach Angle, θ_{Z1} , (degrees)	45
Zero Sequence Reach Angle, θ_{Z1} , (degrees)	45
IO Compensation Factor, K0	1.0
Characteristic Timer, γ , (degrees)	90
Acceptable test current (IT) range is	2.00 to 27.50
The recommended test current is	27.50
Test Current (amps)	19.86
Reach pull-back	110.78%
Degrees to increment α by	5

M3G Ground Units - Zone 3

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

The screenshot shows a dialog box titled "M3G Ground Units - Zone 3". It contains several parameters, each with a "Select" button to its left. The parameters and their values are: DLP rated current (amps): 1; Reach: 0.01; Positive Sequence Reach Angle, θ_{Z1} , (degrees): 45; Zero Sequence Reach Angle, θ_{Z1} , (degrees): 45; IO Compensation Factor, K0: 1.0; Characteristic Timer, γ , (degrees): 90; Acceptable test current (IT) range is: 2.00 to 27.50; The recommended test current is: 27.50; Test Current (amps): 19.86; Reach pull-back: 110.78%; and Degrees to increment α by: 5. At the bottom of the dialog are three buttons: "Help", "Cancel", and "OK".

Parameter	Value
DLP rated current (amps)	1
Reach	0.01
Positive Sequence Reach Angle, θ_{Z1} , (degrees)	45
Zero Sequence Reach Angle, θ_{Z1} , (degrees)	45
IO Compensation Factor, K0	1.0
Characteristic Timer, γ , (degrees)	90
Acceptable test current (IT) range is	2.00 to 27.50
The recommended test current is	27.50
Test Current (amps)	19.86
Reach pull-back	110.78%
Degrees to increment α by	5

M4G Ground Units - Zone 4

The following dialog box is displayed for this test. The values are the default values used when the user selects "New Test File" from the "File" menu.

The screenshot shows a dialog box titled "M4G Ground Units - Zone 4". It contains several parameters, each with a "Select" button to its left. The parameters and their values are: DLP rated current (amps): 1; Direction: Reverse; Reach in reverse direction: 0.01; Positive Sequence Reach Angle, θ_{Z1} , (degrees): 45; Zero Sequence Reach Angle, θ_{Z1} , (degrees): 45; IO Compensation Factor, K0: 1.0; Characteristic Timer, γ , (degrees): 90; Acceptable test current (IT) range is: 2.0 to 27.5; The recommended test current is: 27.5; Test Current (amps): 19.9; Reach pull-back: 110.55%; and Degrees to increment α by: 5. At the bottom of the dialog are three buttons: "Help", "Cancel", and "OK".

Parameter	Value
DLP rated current (amps)	1
Direction	Reverse
Reach in reverse direction	0.01
Positive Sequence Reach Angle, θ_{Z1} , (degrees)	45
Zero Sequence Reach Angle, θ_{Z1} , (degrees)	45
IO Compensation Factor, K0	1.0
Characteristic Timer, γ , (degrees)	90
Acceptable test current (IT) range is	2.0 to 27.5
The recommended test current is	27.5
Test Current (amps)	19.9
Reach pull-back	110.55%
Degrees to increment α by	5

Open Setting File

The following is a list of setting numbers whose values are used by this test program.

102	Z1PREACH	Z1 Phase Reach
105	Z1GRDREACH	Z1 Ground Reach
108	Z1GROUNDK0	Z1 Ground K0
202	Z2PHREACH	Z2 Phase Reach
203	Z2PCHARANG	Z2 Phase Characteristic
Angle		
206	Z2GRDREACH	Z2 Ground Reach
207	Z2GCHARANG	Z2 Ground Characteristic
Angle		
302	Z3PHREACH	Z3 Phase Reach
303	Z3PCHARANG	Z3 Phase Characteristic
Angle		
305	Z3GRDREACH	Z3 Ground Reach
306	Z3GCHARANG	Z3 Ground Characteristic
Angle		
402	Z4PHREACH	Z4 Phase Reach
403	Z4PCHARANG	Z4 Phase Characteristic
Angle		
404	Z4PHOFFSET	Z4 Phase Offset
406	Z4GRDREACH	Z4 Ground Reach
407	Z4GCHARANG	Z4 Ground Characteristic
Angle		
408	Z4DIRECTN	Z4 Direction
1401	POSSEQANG	Pos. Seq. Angle
Impedance		
1402	ZERSEQANG	Zero Seq. Impedance
Angle		
1404	ZEROSEQK0	Z0 / Z1 ratio
1601	MOBZONE	Coordinating Zone
1602	MOBCHARANG	MOB characteristic Angle

This menu item results in a dialog box supplied by Microsoft. Therefore only the "OK" button of the dialog box is tested to make sure the file was properly opened.

Select "Open Setting File" from the "File" menu. Select a file that is not a setting file and not a test file.

Verify the following:

- A message box is displayed that explains the error.
- The currently active test has not changed from before the open command.

Select "Open Setting File" from the "File" menu. Select a setting file containing no errors and click the "OK" button to open it. Select each test.

- Verify that the values in each dialog box which correspond to settings are the same as those in the setting file.

Edit an existing setting file using a text editor. Remove a setting line which contains a user entered value. Select "Open Setting File" from the "File" menu. Select the edited setting file. Select a test that uses the setting value that was deleted.

Verify the following:

- No error message is displayed.
- The corresponding test value is the default value.

Close Test File

Save the currently active test file. Select "Close Test File" from the "File" menu. Window is cleared from the screen thus closing the test.

Modify the currently active test file. Select "Close Test File" from the "File" menu. A message box will be displayed asking if you want to save the file. Click the "OK" button. The file is saved under the current name. The window is cleared from the screen thus closing the test.

- Verify that the file contains the modified values by looking at the file with a text editor.

Modify the currently active test file. Select "Close Test File" from the "File" menu. A message box will be displayed asking if you want to save the file. Click the "Cancel" button. The file is not closed.

- Verify the window is not cleared from the screen and that the test file contains the modified inputs.

Modify the currently active test file. Select "Close Test File" from the "File" menu. A message box will be displayed asking if you want to save the file. Click the "No" button. The file is not saved. The window is cleared from the screen thus closing the test.

- Verify that the file does not contain the modified values by looking at the file with a text editor.

Open a new test file. Select "Close Test File" from the "File" menu. A message box will be displayed asking if you want to save the file. Click the "OK" button. The "Save Input Quantities As" dialog box will be displayed. Enter a name for the test and select the "OK" button. The test is saved. The window is cleared from the screen thus closing the test.

- Verify that the file contains the values displayed in the test dialog boxes by looking at the file with a text editor.

Save Input Quantities

Select a test where the input quantities have been changed and not saved. Select "Save Input Quantities" from the "File" menu. The test is saved.

Verify the file format:

- Read the file using any text editor. The saved file is in ASCII format.
- There is a line for each input quantity listed in Table 1 regardless of whether a

particular input quantity was used for the test.

- Each line contains the value's ID number, the value, and a brief description of the quantity. Each item on the line is separated by spaces.
- There is one section for each test.

Verify file can be re-opened:

- Close the test file that was just saved.
- Open the saved test file.
- Select the menu item for the test.
- Verify that the quantities in the dialog box are the same as in the test just saved.

Create a new test. Select "Save Input Quantities" from the "File" menu. The "Save Input Quantities As" dialog box will be displayed. Enter a name for the test and select the "OK" button. The test is saved.

- Verify the saved test as above.

Save Input Quantities As

This menu item results in a dialog box supplied by Microsoft. Therefore only the "OK" button of the dialog box is tested.

Select "Save Input Quantities As" from the "File" menu. Select a drive, path, and file name to save the input quantities of test.

Verify that this item worked by following the same procedure as for the "Save Input Quantities" menu item.

Save Output As

This menu item results in a dialog box supplied by Microsoft. Therefore only the "OK" button of the dialog box is tested.

Select "Save Output As" from the "File" menu. Select a drive, path, and file name from the dialog box to save the test output. Click on "OK" and the file is saved.

Print

This menu item results in a dialog box supplied by Microsoft. Therefore only the "OK" button of the dialog box is tested.

Select "Print" from the "File" menu. This is a standard MS-WINDOWS dialog box. It behaves however Microsoft and MS-WINDOWS determines it should behave. There is one exception, both the "Selection" and "Pages" buttons are disabled. Click on "OK". The output is printed as it appears on the screen.

Print Setup

This menu item results in a dialog box supplied by Microsoft. It can be tested only to the extent that it does get displayed and that it behaves in the same manner as other similar dialog boxes in other programs.

Select "Print Setup" from the "File" menu. This is a standard MS-WINDOWS dialog box. It behaves however Microsoft and MS-WINDOWS determines it should behave.

last 4 opened settings files

The last 4 opened settings files are displayed in the File menu, and may be selected here.

Exit

Save all open test files (windows). Select "Exit" from the "File" menu. The program exits.

If you have not saved the current file, select "Exit" from the "File" menu. A message box is displayed asking if you want to save the modified test. Click on "OK". The program saves the file and exits.

10-6 Edit menu**Copy**

Select a test, set the input quantities to the desired values, and click the "OK" button.

Select "Copy" from the "Edit" menu.

Copy Text Only

Select a test, set the input quantities to the desired values, and click the "OK" button.

Select "Copy Text Only" from the "Edit" menu.

Copy Mho Circle Only

Select a test, set the input quantities to the desired values, and click the "OK" button.

Select "Copy Mho Circle Only" from the "Edit" menu.

To use the output that is on the clipboard:

- Start Windows Application.
- Select "Paste Special" from the "Edit" menu. There is one item on the clipboard, a bitmap.
- Select the bitmap and paste into the current document.

10-7 View menu

These menu items are supplied and manipulated by Microsoft. Therefore the testing will be brief as these items behave however Microsoft and MS-WINDOWS

determines they should behave. The one exception is the items on the toolbar.

Toolbar

The items on the toolbar are (from left to right):

- Create a new test file.
- Open an existing test file.
- Save the current test file.
- Copy the current test output to the clipboard
- Print the current test output.
- Display the "About" dialog box.
- Context Help command.

Select the "Toolbar" menu item. The toolbar is removed from the display.

Select the "Toolbar" menu item again. The toolbar is displayed.

Status Bar

Verify the items on the status bar:

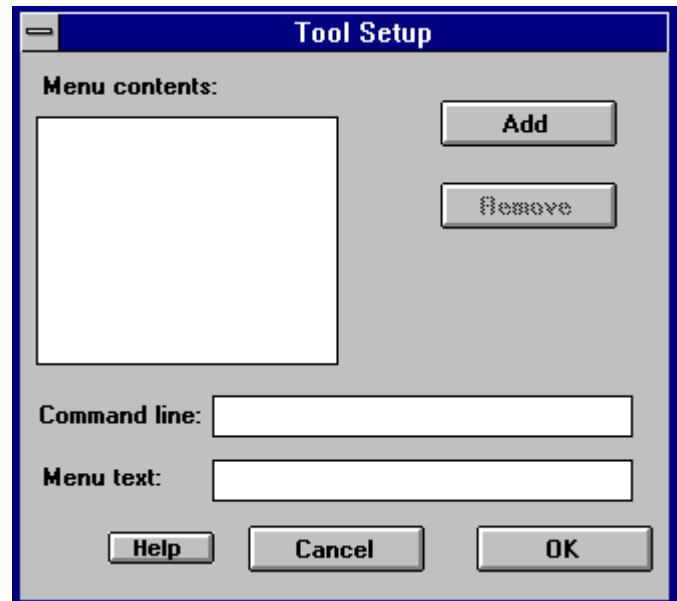
- The left portion displays a short description of each menu item.
- The right most area displays "SCRL" if the scroll lock key has been selected and displays nothing if the scroll lock key has been de-selected.
- The area to the left of the scroll lock area displays "CAP" if the caps lock key has been selected and displays nothing if the caps lock key has been de-selected.
- The area to the left of the caps lock area displays "NUM" if the num lock key has been selected and displays nothing if the num lock key has been de-selected.

Select the "Status Bar" menu item. The status bar is removed from the display.

Select the "Status Bar" menu item again. The status bar is displayed.

10-8 Tools menu

There is one menu item, "Setup". Click on "Setup" and the following dialog box is displayed.



The Remove button and the Command line and Menu text boxes are disabled, and that the focus is set to the Add button.

Type the Enter key or click on the Add button. The Add Tool dialog box is displayed. This is a standard MS-Windows dialog box. Select an executable windows program and click on the OK button.

- The full path and name is in the Command line text box
- The program name less the extension is in the Menu text box
- The program name less the extension is the Menu contents list box
- The Remove button is enabled
- The focus is set to the Menu text box.

Change the text in the Menu text box to text suitable for the tools menu. Click anywhere in the Command line text box.

- Verify that the new menu name is displayed in the Menu contents list box.

Change the command line so that it is invalid (e.g. remove a character from the program name). Click on the OK button. Pull down the "Tools" menu.

Verify the following:

- There is one tool followed by a separator bar and the "Setup" menu item.
- The tool's name is correct.

Click on the tool.

- Verify that an error message is displayed indicating that the program couldn't be started.

Select the "Setup" menu item again.

- The focus is set to the first item in the Menu contents list box.
- The menu text is in the Menu text box.
- The Command line text box has the invalid path name.

Change the path name to the correct path. Click on the OK button. Pull down the "Tools" menu and click on the tool.

- Verify that the program started.

Select the "Setup" menu item again. Add a second tool.

- Verify that the tool gets added after the first tool.

Click on the OK button. Pull down the "Tools" menu.

Verify the following:

- There are two tools and they are in the correct order.
- The two tools are followed by a separator bar and the "Setup" menu item.

Select the "Setup" menu item again. Leave the first item in the Menu contents list box selected. Add a third tool.

- Verify that the tool gets added after the first tool and before the second tool.

Click on the OK button. Pull down the "Tools" menu.

- There are three tools and they are in the correct order.

- The three tools are followed by a separator bar and the "Setup" menu item.

To Remove a tool, select the "Setup" menu item again. Select the second item in the Menu contents list box. Click on the Remove button.

- Verify that the selected item gets removed from the Menu contents list box and that the item immediately below the one removed is selected.

Click on the OK button. Pull down the "Tools" menu.

- Verify that there are two tools and they are in the correct order.
- The two tools are followed by a separator bar and the "Setup" menu item.

10-9 Window menu

These menu items are supplied and manipulated by Microsoft. Therefore the testing will be brief as these items behave however Microsoft and MS-WINDOWS determines they should behave.

Cascade

Have more than one test file active in the program. Select the "Cascade" menu item. The windows are displayed in a cascaded style.

Tile

Have more than one test file active in the program. Select the "Tile" menu item. The windows are displayed in a tiled style.

Arrange Icons

Select a test and click on its icon button (upper right corner of window). The window

is reduced to an icon with its test name under it. Perform this action on several tests.

Click on "OK". The dialog box is cleared from the screen.

Move the icons around on the screen.

Select the "Arrange Icons" menu item. The icons are rearranged across the bottom of the screen.

Viewing multiple tests

When more than one test file active in the program. Pull down the "Window" menu. The menu shows all the active test windows.

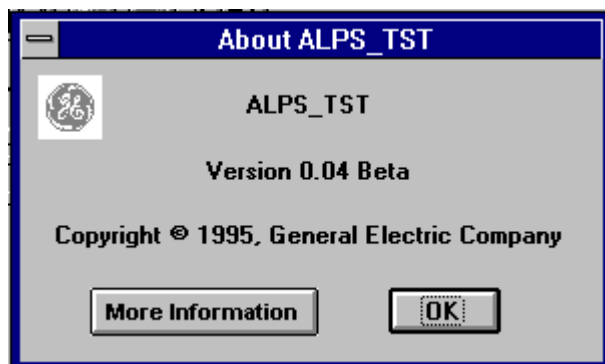
10-10 Help menu

Contents

Select "Contents" from the "Help" menu. A help screen is displayed that lists the contents of the help system. Any item that is green can be clicked on to view that topic.

About ALPS_TST

Select "About ALPS_TST" from the "Help" menu. The following dialog box is displayed:



Click on "More Information". Information about who to contact is displayed.

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11-1 ALPS-LINK USERS GUIDE

OVERVIEW

The Advanced Line Protection System Link (ALPS-Link) User's Guide contains detailed information about using ALPS-Link.

The ALPS-Link software facilitates various operations with the data from the relay formatted for easy viewing.. The link software has the capability of opening a dialog session for a remote device through a dial-up modem or directly over a serial link. The software uses the GEMODEM communications protocol to operate the relay remotely. All the operations performed on a device will be initiated by a user command. The responses from the relay will be formatted for easy viewing.

WHAT'S INCLUDED IN YOUR ALPS-LINK USER'S GUIDE

This guide is organized as a comprehensive reference. In addition to the information needed to help you use the ALPS-Link to interact with the relay, this manual also includes some basic information for those users with little experience of working with Windows applications

USING ON-LINE HELP

ALPS-Link software comes with on-line help for quick reference. It includes step-by-step procedures that you can follow as you work. You can view the ALPS-Link Contents window by choosing Contents from the Help menu. From this window, you can jump to more specific information. You can also press the F1 key on the keyboard to get the Help contents. Help information on any dialog box could be obtained by clicking the Help button in that dialog box.

ALPS-Link Installation

This section describes the required system hardware and software needed for installing ALPS-Link software on your machine.

SUPPORTED ARCHITECTURE

The minimum system configuration required to run ALPS-Link software is:

1. Personal Computer(PC) with an 80386/80486 processor with:
 - 8 MB RAM
 - 200 MB Hard Disk Drive
 - 3.5", 1.44 MB Floppy Disk drive
 - VGA / EGA display card and monitor
 - PC/AT keyboard
 - One or more RS-232 serial ports
 - One parallel port for printer
 - Mouse
 - Any printer supported by MS-Windows
 - MS-Windows, version 3.1 or 3.11 (Windows NT is not supported)

The ALPS relays can be connected to the host machine directly or through a dial-up modem. The ALPS may be connected directly to the host's RS232 port; for connection via the ALPS's RS485 port, an RS485/RS232 converter is required. If you wish to connect to your ALPS over a dial-up modem, the relays should be connected as follows:

Each device must have its own modem.

A Code Operated Switch (COS) is attached to the modem and a number of devices are connected to the multiplexor. If a device is on an RS-485 line, a converter can be used between the device and the COS.

The printer is connected on the parallel port of the PC.

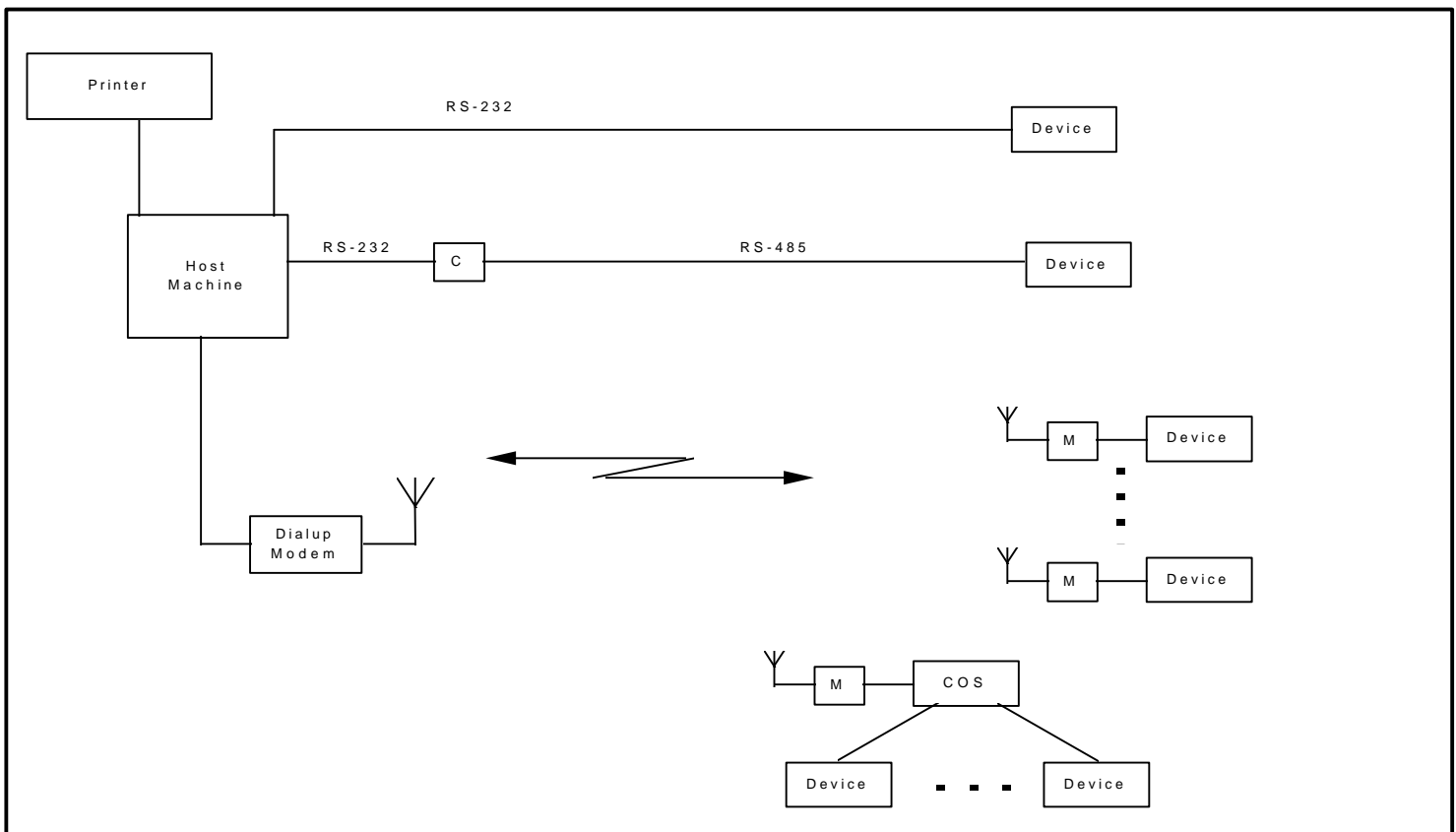


Figure 11- 1. Supported Architecture

HARDWARE INSTALLATION

Before proceeding verify that your computer is working well and meets the requirements above.

Connect the printer to the parallel port of the PC. You may have to choose an appropriate printer driver using the Windows Print Manager. For more details refer to the printer's installation manual.

It is assumed that the relay is installed and configured according to the Interface section of this instruction book.

SOFTWARE INSTALLATION

Microsoft Windows 3.1 or 3.11 must be installed on your PC before proceeding with ALPS-Link installation.

To install ALPS-Link:

1. Start Windows
2. Insert the first Setup disk in drive A or drive B.
3. From Windows Program Manager, choose the Run command from the File Menu.
4. In the Command Line box, type `a:install` if you put the Setup disk in drive A or `b:install` if you put the Setup disk in drive B, then click OK.
5. You will be prompted to enter the directory and path where you wish to install the software. If the directory does not exist, the install will create it for you.

Once the ALPS-Link software is installed, set-up must be chosen from the Device menu to set-up to communicate to the relay.

Note: ALPS-Link may have difficulty operating with some WINDOWS applications running; therefore, it is recommended that

before starting the application make sure there are no other programs or TSRs loaded on the system as this might affect the performance of ALPS-Link and related applications.

STARTUP

This section describes the Startup procedure and explains the main screen details.

After a successful installation of ALPS-Link, the group window appears on the screen. This

window consists of the ALPS-Link icon and the Help icon. Choose the ALPS-Link icon to start the ALPS-Link.

The ALPS-Link application starts and the ALPS-Link application window appears. The main window has a title bar with ALPS-Link, a menu bar, a tool bar and a status bar.

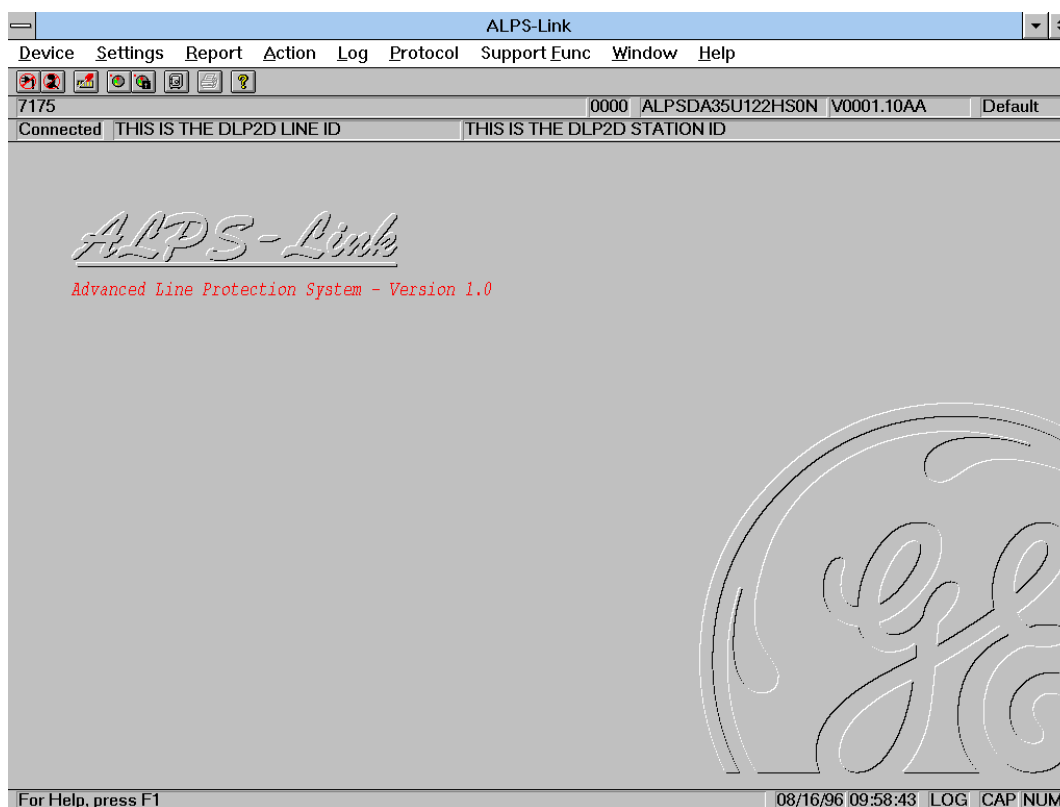


Figure 11- 2. ALPS-Link Application Window

MENU BAR

The items in the ALPS-Link application window menu bar are:

Device, Log, Support Func, Window and Help. The items in each menu change when a device is connected. ex. Log will not have the current item now but will display it when the device is connected.

TOOL BAR

The tool bar consists of icons which help choose some of the ALPS-Link activities quickly. The active icons at this time in the tool bar are Connect, Hang-up(if a telephone line is used), Device Setup, Local Settings, archive, printer, Help and Contest Sensitive Help.

STATUS BAR

The status bar is divided in six parts. It is the bottom most row in the picture as shown in the ALPS-Link application window. Starting from the left, part one displays the information regarding any command selected, part two and three display the date and time respectively, part four indicates if Log is on or off, part five and six indicate the Caps Lock and Num Lock respectively.

SETUP YOUR HOST MACHINE

This is the preparation of the ALPS-Link software and the host machine for a trouble free and satisfactory operation with the ALPS devices. Certain parameters of the serial (COM) port to which you wish to connect the device, the modem used for communication and the printer connected to the host machine are to be configured for ALPS-Link. ALPS-Link provides all the necessary user interface to set these parameters.

Keep the User's manuals for the serial port of your host machine, the modem and the printer handy for a quick reference.

COM PORT SETUP

For any operation with the ALPS device, it is essential that the PC and the device have a physical link established between them. This physical link could be an RS-232 line or an RS-485 line. If required, dial-up modems can be used for this connection. On the host side, this can be connected to any of the serial (COM) ports of the host machine. To do the serial (COM) port setup

From the Support Functions menu click on the host setup.

A pop up menu with Ports/Modem/Printer will be displayed. Choose the Ports item.

Change the Base port address only if the device connected to your serial is not Com1 or Com2. Open the list to select an address.

Before assigning IRQ numbers to serial ports, determine which interrupts are used by the devices connected to the serial ports and

which ones are not being used by other cards or boards installed in your computer. You may need to adjust your serial card to use available interrupts. For information, see your serial-card documentation.

If you change the parameters of any port in this dialog box, these changes take effect only when you restart Windows. Choose the OK button to proceed with the selection or Cancel to quit without updating the selection.

MODEM SETUP

When the device is connected to ALPS-Link through a dial-up modem, it is essential that ALPS-Link is supplied with information about the modem characteristics. This can be done using the Modem setup.

To do the Modem setup,

From the Support Functions menu, Choose the host setup item.

A pop up menu with Ports/Modem/Printer will be displayed. Choose the Modem item.

- The modem setup dialog box appears.

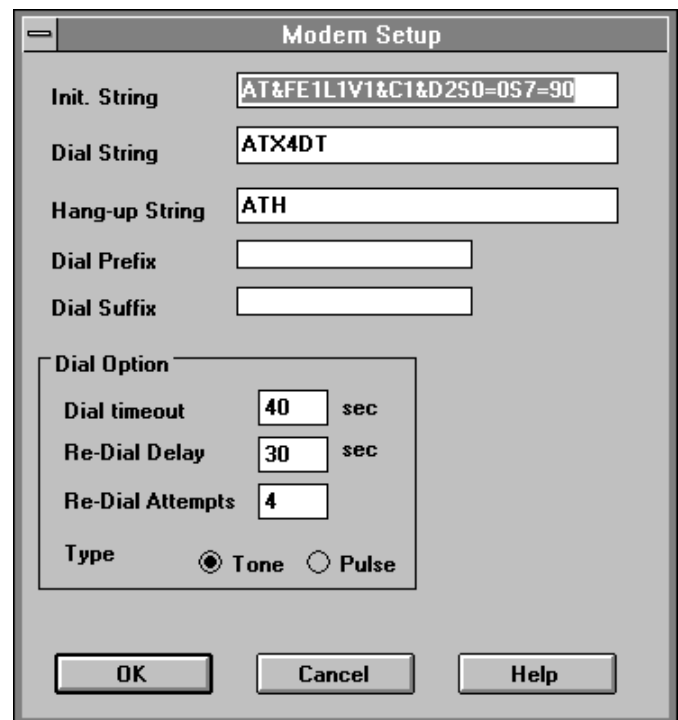


Figure 11- 3: Modem Setup

The init string, dial string and the hang-up string are all modem dependent. Refer to your modem manual for the suitable strings. Up to 40 characters are accepted for each of these fields.

If any number or string is to be dialed or sent on the port before dialing the phone number, specify it as the dial prefix. Similarly any strings to be appended at the end of the phone number are to be entered in the dial suffix field. These are modem independent and can be left blank if not needed.

The amount of time for which the system has to wait before deciding the non-availability of the telephone line is the dial time-out. A maximum of 99 seconds can be specified here. The host will re-dial if the maximum number of valid re-dials are not yet completed.

The redial-delay is in addition to the time-out delay. This is the amount of time the host machine waits before a re-dial. A maximum of 99 seconds can be specified here.

Specify the number of re-dials the host machine has to do before declaring the dialing operation a failure. A maximum of 9 re-dials can be specified.

Any modifications done in the modem setup actually take effect the next time you make a connection request with a device.

PRINTER SETUP

The hard copies for reports, logs and settings are made through the printer connected to the host machine. The host machine need to be configured with the printer setup.

The Printer setup is performed from the Support Function menu. Choose the Host Setup item from the Support Func pull down menu in the menu bar. A pop up menu with Ports/Modem/Printer will be displayed. Choose the Printer item.

Select the printer you want to use. You can select the Default Printer by clicking that radio button or choose the Specific Printer option by

clicking on that radio button and select one of the current installed printers shown in the box.

click on the Options button to get additional choices about printing, specific to the type of printer you have selected.

DEVICE SETUP

More than one ALPS device could be connected to the host machine on the physical link. But, at any given time, ALPS-Link can communicate with a single device. It is possible that each of these devices are configured with various communication parameters. e.g. telephone number, baud rate etc. ALPS-Link should be setup with these details so that it can make proper connections with the devices. The Device Setup facilitates updating ALPS-Link with this information. If you need to add a device or modify the existing communication parameters of a device, Device Setup provides you the necessary interface.

HOW TO ADD A DEVICE

You can introduce a new device to ALPS-Link system or modify the setup of an existing device using the device setup.

Choose the Device Setup item in the Device menu. A Device directory dialog box appears. This has the list of the devices already known to ALPS-Link. Click on the scroll button of the device name field to see this list.

To add a new device, Choose the Add button. The device setup dialog box appears with the default parameters.

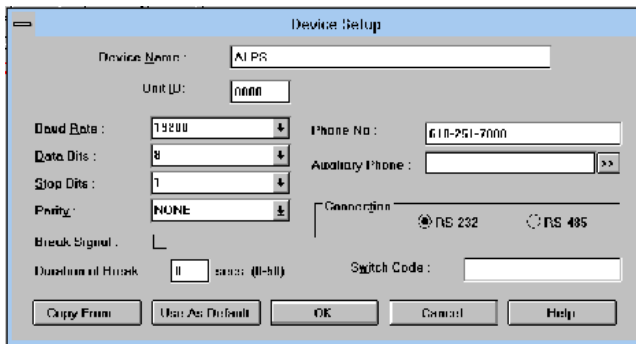


Figure 11- 4. Device Setup

Click in the Device Name box and enter the name for the relay. Do the same for the Unit ID.

From the baud rate list, select the communication speed that matches the relay Name (Device Name).

Specify the number of data bits, stop bits and the parity in the specified fields for communication with this device.

The break signal is needed for communication with certain Code Operated Switch(COS) used on the other side of the communication line. Click this if the COS you are using needs this.

Duration of the break is the amount of time gap needed to specify a certain message is for the COS. This may be needed with or without the break signal.

The phone number the host machine has to dial to get connected to this device is specified in the phone number field. A maximum of 60 characters can be entered in this field.

The auxiliary phone number specified is dialed before dialing the actual phone number. The Browse button (>>) will display a dialog box with a list of the existing auxiliary phone numbers.

In this dialog box, you can add, delete and modify auxiliary phone numbers. For Modify and Delete, first select a number from the list and then choose the appropriate button. When you select Add and Modify, a dialog box appears with fields for the number and description. If no auxiliary phone number is

necessary, leave this field blank.

A maximum of 60 characters can be entered in each of these field.

In the Device Setup dialog box, click on one of the radio buttons to indicate the mode of communication as the RS-232 or the RS-484.

Switch code is a string of characters sent to the code operated switch. It accepts a maximum of six characters in Hexadecimal format.

These parameters take effect from the next time you make a connect request to the device specified.

Choose the OK button to save these parameters for the specified device. Choose the Cancel button to quit the dialog box without updating the Device Setup.

Use As Default

Clicking on this button will save the parameters for the device and also makes them as the default values. By selecting the most common device parameters as default will simplify the addition of a device to the system. So, next time you want to add a device, the device setup dialog box appears with these default parameters.

Copy From

If you want to setup a new device by copying information from an existing device setup to a new one, you can use the Copy From option. Choose this button to display a list box with the existing devices. Select a device and choose the OK button to proceed. All the device setup parameters of that device are displayed under the device currently being edited. If any modifications are required, you can do them. You can save the new device with these parameters or Cancel to quit without saving.

To Modify the parameters for an already existing device, select the device from the device directory, and choose the Modify button. The device setup dialog box appears with all the parameters of that device. Do the necessary modifications and save or quit.

To delete a device from the system, select the device from the device directory and choose the Delete button. A message box requesting the confirmation for the deletion appears. Choose the Yes button to proceed with the deletion. Choose the No button to quit deleting the device from the list.

CONNECTING TO AND LOGGING OUT OF A DEVICE

Once the host setup and device setup is completed, operations with the device may be performed. To start with, a connection has to be established with a device to perform any kind of operation on that device. Select the device you want to connect to from the user interface provided and ALPS-Link will provide the connection for you, taking care of all the parameters like the phone number, speed of communication etc.

CONNECT TO A DEVICE

To connect to a device, choose the connect field in the device menu.

A connect device dialog box appears. If there are more than one device configured in the ALPS-Link, the Device Name field will appear with a scroll button. Click this button to get the list of configured devices. From the list, select the device you desire a connection with and choose OK to proceed with the connection. Choose the Cancel button to quit the connection process.

Once the connection is established with the device, you are requested to enter a password to the device. The password determines the level of your privilege with the device. Enter password to the privilege at which you wish to interact with the device. Choose the OK button to proceed with the password entered or choose the Cancel button to quit the connection process.

The password you enter is sent to the device and if the login is successful, the menu bar and the tool bar change to incorporate the additional functions. Reports, Settings and

Actions items will be added to the existing items in the menu bar.

Logging into the device is the start of a session. A session log starts and logs all the operations performed. The current item in the log menu is enabled and can be used to view the current session log. The tool bar also changes to display the Logout symbol in place of the connect symbol.

Logout from a Device

If the communication line is using a dial-up modem, the logout option will not hang-up the communication line.

To logout from a device, choose the Logout item in the device menu. After a confirmation from the user, the device will be logged out. From the tool bar, the Logout icon also can be used.

The following conditions will be checked before the request for logout confirmation.

- If any settings were downloaded, was an END message sent ?
- Are the outputs in disabled condition ?
- Is the device in Test mode ?

If any of the above conditions are true, ALPS-Link will display an appropriate message in the confirmation box. If you still want to proceed with the logout, choose the Yes button in the message box, or, if the END message is not sent, choose No, get back to the settings, send the END message. There is no need to download the settings again.

If the outputs are left in the disabled condition, choose the Enable outputs item in the actions menu.

If the device is in the Test mode, choose the End Test item in the actions menu.

If you logout from a device when a dial-up modem is being used, a hang-up request need to be explicitly made. In fact, you can directly ask for hang-up without logging out of a device. ALPS-Link will do the necessary logout before hang-up.

Why this explicit hang-up ?

When you have more than one device connected to the other end of the telephone

line using a code operated switch, you need not hang-up the line to logout from one device and login to another on the same line.

ALPS-Link - [ALPS_SIM]

Device Settings Report Action Log Support Func Window Help

ALPS_SIM

0000 ALPSDA35U122HS0N V0001.10AA Default

Connected THIS IS THE DLP2D LINE ID

THIS IS THE DLP2D STATION ID

Group : 1

Model No : ALPSDA35U122HS0N

01 Z1DISTANCE

02 Z2DISTANCE

03 Z3DISTANCE

04 Z4DISTANCE

05 CURSUPVISN

06 OVERCURRNT

07 VOLTAGE

0701 RATEDVOLTS 100 volts

0702 PHASEOVER NO

0703 PHOV PICKUP 1.50 pu volts

0704 PHOVTMDLY 00.50 sec.

0705 V1OVER YES

1.50

?

Setting Details

Description: Phase Overvoltage Pickup

Save

Load

Print...

Download...

End

Close

Help

For Help, press F1

08/16/96 15:25:00 LOG CAP NUM

Even if the other device is not on the same line, ALPS-Link will automatically hang-up this line and dial the new number to connect to the new device you selected.

SETTINGS

The ALPS device performs protection functions in a power system according to the device settings values. The settings are grouped into categories. The ALPS has 4 settings groups. ALPS-Link provides for uploading the settings from the device, modifying and these modified settings can

either be downloaded to the device or stored in a local file. The settings can also be loaded from these local files for download etc.

Upload Settings

The settings can be uploaded from a connected device for viewing and modifying. An upload command will get all the settings of all the categories from the connected device.

To Upload Settings
Connect to the desired device. From the device menu, choose the Settings item. From the drop down menu, choose the Get Settings

item. Choose the Upload item in the pop up menu. The settings dialog box with the uploaded settings will appear.

For an upload command, the device sends the latest settings available with it. That means, if you download settings to the device and request an upload before sending the END message, the device will send those downloaded settings.

In the Settings dialog box, you can modify the settings of a category you desire, save them locally, print them and/or download them to the device.

From the Category field, you can select a particular category. Click the scroll button to see the list of available categories. Selecting a particular category will display only the settings of that category. You can view and modify the values of the settings in that category only. If you want to view and modify all the settings of all the categories, select All in the category field.

The dialog box has two parts, one has the list of all the settings selected in a category. This is more like a table with the setting number, setting name, the setting value, the units of that setting and the new value if entered.

Once a setting is selected from the list, the second part of the dialog box displays the description of the setting and the value(s) in that setting. You can change the value of a setting by entering the new value in the Change to field. For some settings you can only choose one of the available values. If the text box is a combo box, select the value from the list.

If the (?) button is displayed next to the field, the value is to be entered by you. Clicking on this button will display the valid ranges for that setting. You can download the settings to the device by clicking the Download button. It is possible to download either all the settings of all categories or only the Changed Values. When you choose the Download button, a dialog box appears so that you can select between All and Changed values only. Choose the Cancel button to quit the download

operation. You can also download Protection Settings, General Settings, or both categories.

After a successful download, a dialog box displaying the download status of the settings and requesting confirmation for sending an END message will appear. If you want to send the END message immediately, choose the Yes Button. If you do not want to send the END message immediately, choose the No button.

The END message can be sent explicitly by clicking on the END button in the settings dialog box.

The settings can be saved locally in a file. Choose the Save Locally button in the Settings dialog box. A File Save dialog box appears where you can select the name and location of the file in which you want the settings to be saved.

The Close button will close the dialog box. Any modifications to the settings (downloaded or not) will be lost if not saved explicitly using the Save Locally button. If the settings are changed, a message box appears asking if you wish to save the changes. Choose Yes to save the changes and a File Save dialog box appears. You can choose No to quit without saving or choose Cancel to get back to the settings dialog box.

A hard copy of the settings can be obtained by choosing the Print button in the settings dialog box.

While you are working on a set of settings uploaded from the device, if you wish to load the settings from a file and use them for modifications and download, choose the Load file button. A File Open dialog box appears for you to choose the file.

NOTE: If more than one user is logged in to the relay, it may be possible to have more than one set of settings group being edited locally. However, only one user may download and end settings changes at a time.

LOAD LOCAL SETTINGS

You can view, modify and print settings loaded from a local file. It is not essential to connect

to the device for loading local settings. The file from which the settings are to be loaded is user selectable. A file open dialog box helps in locating the necessary file.

The download and END options in the settings dialog box will be disabled in this option.

To load local settings when not connected to a device,

From the Device menu, choose the Local Settings item.

If you are already connected to a device,

From the Device menu, choose Settings.

From the drop down menu, choose Get Settings

Choose Load Local settings from the pop up menu.

In both cases, a file open dialog box appears where you can select the file to load from, and the settings dialog box with the settings will appear. Multiple files can be opened simultaneously for viewing, modifying and printing.

Refer to Upload Settings for explanation on the settings dialog box features.

GET LOGIC

This command allows you to get configurable logic from the relay. This command automatically runs the Xpression Builder program installed on your hard drive from the Xpression Builder install disk located in this instruction book. See *Chapter 13 - Xpression Builder*.

After configurable logic is downloaded from Xpression Builder, the program returns to ALPS-Link, but does not close Xpression Builder. Since Xpression Builder is still open, ALPS-Link will not let the user upload the configurable logic again. The uploaded logic window in Xpression Builder should be closed after the download by switching to the Xpression Builder application and closing the

window corresponding to the uploaded logic. The same is true between any two consecutive logic upload operations.

SET DATE AND TIME

This feature helps you update the date and time in the device. Choose the Set Date/Time item from the settings menu. The Set Date/Time dialog box will appear with the date and time of the host computer.

Modify the date and time as required. Choose OK to proceed with the downloading to the device.

The Cancel button ignores the modifications done and quits the dialog box. Any modification done here is only downloaded to the device and is not updated in the host computer.

CHANGE BUS/STATION ID

You can change the Bus and Station Id of a device. Choose the Change Bus/Station Id item from the settings menu. A Change Bus/Station Id dialog box will appear.

This dialog box will display the current identifiers of the device. You can modify these strings. A maximum of 32 characters are accepted for each of them.

Choose OK to proceed with the download of these strings to the device or choose Cancel to quit.

TOC CURVES

ALPS-Link will facilitate uploading/downloading the TOC curves to/from the device. A separate software package will be used to view and edit the TOC curves. This package will not be a part of ALPS-Link. The interface between this package and ALPS-Link will be TOC curve files stored on the disk.

CALIBRATION

ALPS-Link will provide a facility to view the Calibration parameters in the device. User will also be able to modify these parameters and download them to the device. Selecting Calibrate item from the Settings menu will post the following dialog box.

ACTIONS

ALPS-Link provides a mechanism to perform certain actions on a connected device. When necessary, the commands sent to a device to carry out these actions will follow 'Arm' and 'Execute' sequence defined in GEMODEM protocol. After a user confirmation for an action request, Arm and Execute sequence will be transparent to the user. You can not perform any of the actions before logging in to a device. It is also essential that you are logged in to the device with the appropriate privilege for performing actions.

ENABLE OUTPUTS

You can Enable the device outputs by sending this request. This is an action that follows the Arm and Execute scheme. This scheme needs a user confirmation before executing the command.

To Enable Device Outputs, click the *Enable Output* item in the *Actions* menu. A message box will be posted for your confirmation. Choose OK to proceed with enabling the outputs of the device. Choose Cancel if you wish to quit from enabling the outputs of the device.

Before logging out of the device, make sure the outputs are enabled.

DISABLE OUTPUTS

You can disable the outputs of a device by sending this request. This action follows the Arm and Execute Scheme. This needs a user confirmation before executing the command.

To Disable Device Outputs, click the *Disable Output* item in the *Actions* menu. A message box will be posted for your confirmation. Choose OK to proceed with disabling the outputs of the device. Choose the Cancel button if you wish to quit from disabling the outputs of the device.

If the outputs are in disabled position, the ALPS-Link will inform you during logout.

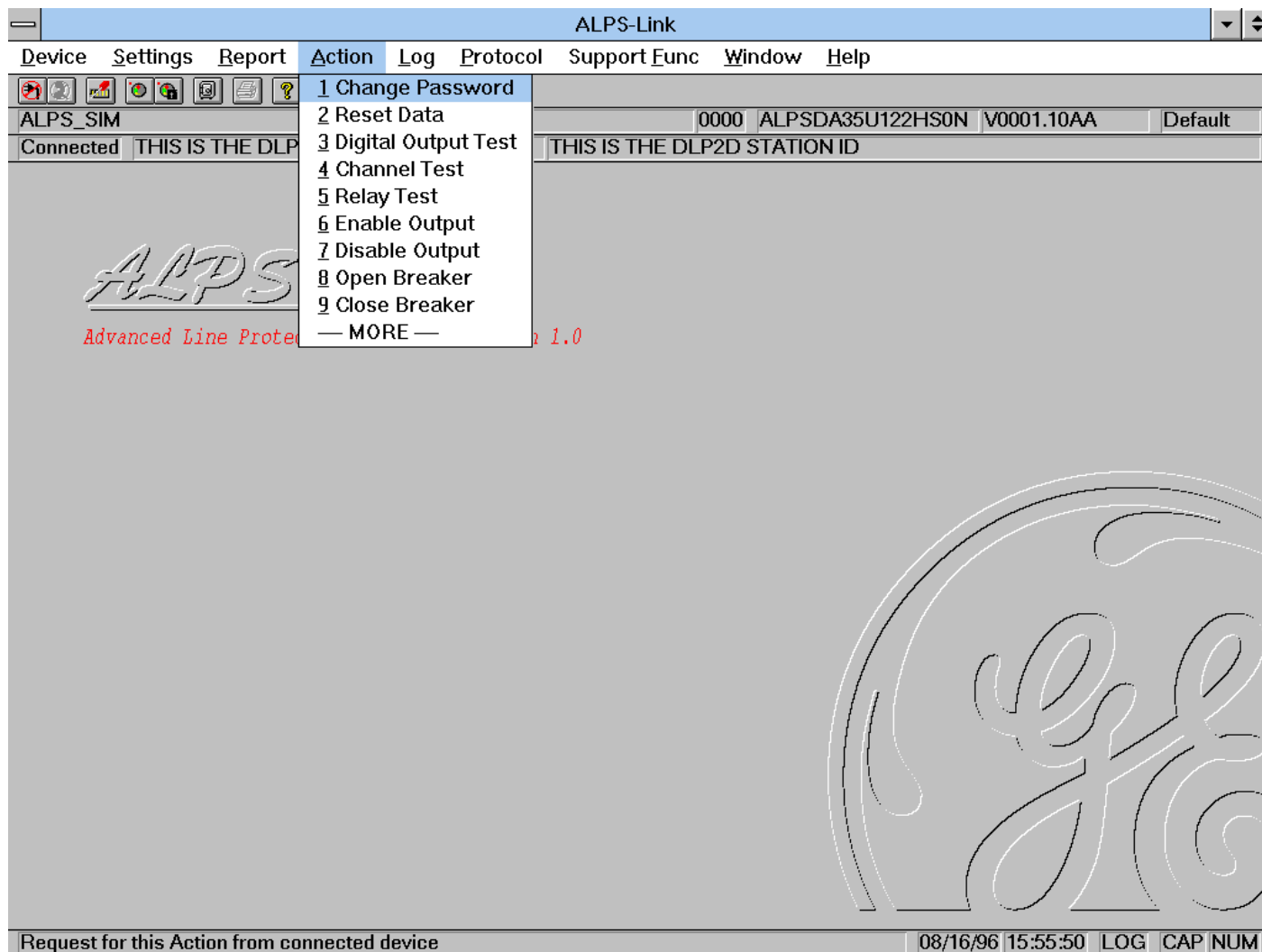


Figure 11- 5. Action Menu

CHANGE PASSWORD

You can change the password you use to log in to a device from ALPS-Link. Choose the *Change Password* item in the *Actions* menu. A change password dialog box appears.

Changing the password happens in three steps.

First you are asked to enter the old password. That is the password you are currently logged with. Enter the password and Choose the OK button. Choose the Cancel button to quit the Change Password operation.

When you choose OK to proceed with changing password, ALPS-Link will post another dialog box asking you to enter the new password. Enter the new password and choose the OK button. Only alphanumeric characters are accepted for the password. Since the device accepts only upper case letters, all the characters are changed to upper case before sending to the device. The maximum length of the acceptable password is 16 characters.

For validation purpose, you are prompted to re-enter the new password. This is to take care of any typographical errors in your entering the password. Enter the new password again and choose the OK button.

The passwords are downloaded to the device for change. Any error from the device will be notified to you.

RESET DATA

This item helps you to reset specific data in a ALPS device.

To reset any of the data, choose the *Reset Data* item in the *Actions* menu. A dialog box will appear with various data items which can be reset. Check the associated check boxes, for all the data items which you want to reset. Choose OK to proceed with resetting of selected items or choose Cancel to abort the reset operation. While you choose OK if the *Breaker Health Data* item is checked, another dialog box appears asking you to enter new breaker health values. This Reset Breaker Health dialog box is shown below.

If you choose OK, the ALPS-Link will send an appropriate message to the device. If you choose Cancel then ALPS-Link will uncheck the *Breaker Health Data* item and brings you back to the Reset Data dialog box.

DIGITAL OUTPUT TEST

When you choose this item from the *Actions* menu, a dialog box appears with the list of output types.

Select an output test from the list and choose OK to proceed or choose Cancel to quit. If you choose OK, ALPS-Link will send an appropriate command to the device.

RELAY TEST

When you choose *Relay Test* item from the *Actions* menu, a dialog box with a list of available test modes will appear. Select a test mode you want and choose OK to proceed with the test. Choose the Cancel button to quit the testing.

Select the *End Of Relay Test* item from the list to bring the device out of the test mode. If you leave the device in a test mode, during the

logout from the device, ALPS-Link will remind you that you have left the device in the test mode. NOTE: An error message: OTHER USER IS ACCESSING THIS RESOURCE will appear if the relay is in test mode from another port, or the keypad.

OPEN BREAKER

Choose this menu item to open the Breaker, this will prompt you with the confirmation message box. Click Yes to open the breaker. The ALPS will send command to the device to open the Breaker.

CLOSE BREAKER

Choose this menu item to close the Breaker. This will prompt you with the confirmation message box. Click Yes to close breaker. The ALPS will send command to the device to close the Breaker.

INFORMATION

Different types of information stored in a ALPS device can be fetched and viewed in a desired report format. ALPS-Link facilitates the acquisition of the information and presents it to you. You have the facility to view the reports, print the reports, or to store them for viewing or printing later. You can select the report you want from the *Reports* menu. A list of available reports will be displayed when you choose the reports item. You can also view an existing report from a local file. You ought to have logged into a device before you deal with any of the information.

OPEN REPORT

The reports item is not visible in the menu bar till you are logged in to a device. ALPS-Link provides you with facilities to fetch a new report from the device, store the report, view a report acquired earlier and stored in a file and print the reports.

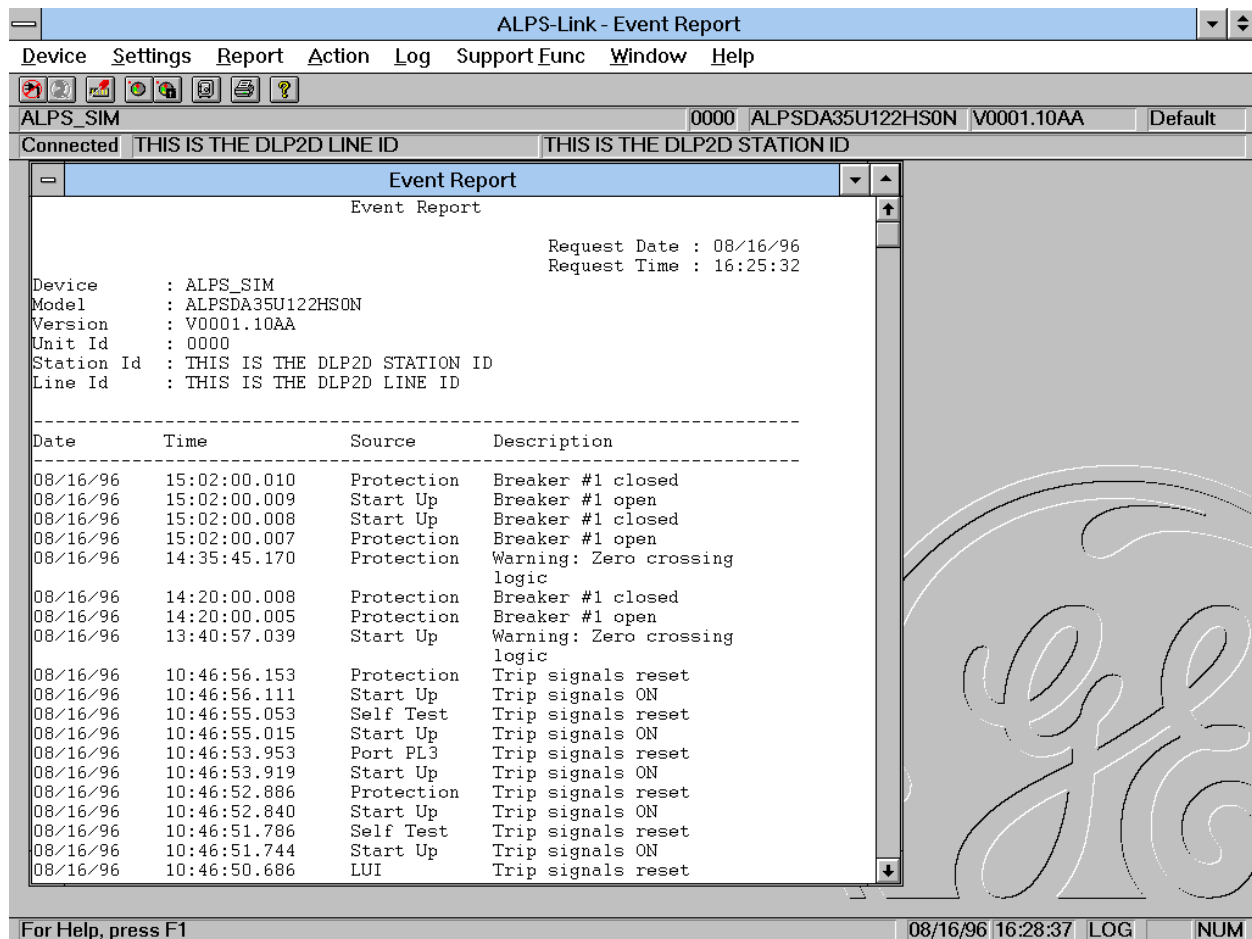


Figure 11- 6: Report Menu

NEW REPORT

Reports are the means of acquiring the current data from the device. For easy comprehensibility, the data is made available in various reports. The list of reports you can fetch from the device are displayed in the menu. Selecting *MORE* in the menu will post a dialog box from which you can select your choice including those which are not displayed in the above report menu.

When you select the *New* item in the *Reports* menu, this list will be displayed. Select the report you want and ALPS-Link will get that report data from the device and display it for you. You can view the sample reports in Appendix A.

You can not modify the contents of a report. You can save the report acquired from the device in a local file for viewing or printing later. To save a report, choose the *Save As* item in the *Reports* menu. A File Save dialog box appears where you can select the name and destination of the file in which you want to store the report.

You can also print the report by choosing the *Print* item in the *Reports* menu.

You can acquire and view more than one report at a time. To do this, go through the same steps of getting a new report. You can also view some stored report by selecting the *Open* item. These multiple reports are displayed to you in multiple windows.

If you wish to print or save a report when multiple reports are in view, ALPS-Link will save or print the report in the active window. So, make sure that the report you want to print or save is in the active window before choosing the item.

Some reports need further input from the user. In all such cases data is acquired from user through a dialog and ALPS-Link validates this data wherever it is possible, before it proceed with the report. Each one of the reports with its associated dialog box(if any) is explained below.

FAULT REPORT

When you choose the *Faults* report, a dialog box with the list of faults available with the device is displayed.

Select the fault for which you want the report and choose OK. ALPS-Link will fetch relevant data from the device.

OSCILLOGRAPHY REPORT

To retrieve an oscillography report from the relay, select REPORT from the menu bar. Then select REGULAR OSCILLOGRAPHY. A list of available faults will appear. Select the fault to be downloaded. Enter the starting cycle and number of cycles required to be downloaded in the next window. A choice of DAF or COMTRADE formats is available.

The .DAF file is formatted for use with the GE-DATA oscillography program. The .OSC format creates a binary COMTRADE file that can be viewed with any binary COMTRADE reader. You will be prompted for a name of this report when you close the fault report window, or, choose REPORT from the menu bar and select SAVE or SAVE AS. Type in a descriptive file name, but do not add an extension. 5 files will be saved 3 files will be created to fit the COMTRADE standard. They are *.hdr (contains fault settings, fault report, and events), *.cfg (ASCII file containing definition of the data channels), *.dat (contains binary data). A *.OSC file is also created that can be used for playback. See

Chapter 8 PLAYBACK for complete description of the PLAYBACK function.

A *.rep is also created, the user may delete this file as it does not contain any useful information for the user. It is used by the LINK program during generation of the oscillography file.

BREAKER HEALTH REPORT

Select *Breaker Health* from report menu to see the current breaker health values. User input is not required for this report.

DEMAND REPORT

In *Demand* Report, you have to select the demand number(or range) for which you want demand data. Normally the allowed range is 1-192. If extended demand option is set, then the valid range is 1-3360. If you want to see the report for a particular number and not the range, enter the same value in both Start Interval and End Interval entries.

DIAGNOSTICS REPORT

Select *Diagnostics* from the reports menu to see a listing of all the diagnostic events occurred at the device.

EVENT REPORT

Select *Event* from the reports menu to see the events data fetched from a connected device.

PRESENT VALUES REPORT

When you select *Present Values* from the reports menu, ALPS-Link will pop-up a dialog box asking you to enter the period value in seconds. ALPS-Link will monitor the present values and update these values at the end of specified period continuously. These updated values are displayed through a special dialog box where you can monitor these as long as you want. You can get a report of these values at any moment by selecting the Generate Report or stop monitoring by selecting Close on the special dialog box monitoring these values. NOTE: When General setting 108 is

set to Primary, the Current values are in amps, the voltage values are in KV. The ALPS-Link Present Value display will show the units as V.

STATUS REPORT

Select *Status* from the *Report* menu to get the status report of various system components.

CONTACT STATUS REPORT

Select *Contact Status* from the *Report* menu to get the status of various contacts associated with the device. The status is conveyed in the On/Off or Open/Close terminology.

LUI PASSWORD REPORT

Select *LUI Password* to get a report on passwords of all the three levels namely settings level, control level and master level.

OPEN REPORT

This helps you view and/or print a report stored in a file. The report must have been fetched earlier from the device and stored in the file. When you choose the *Open* item in the *Reports* menu, a File Open dialog box appears.

In the File Open dialog box, the File header part displays some information about the report file you are opening. This helps you in picking the right report file.

Select the file name, directory and the source from where you want to read the report. The report will be displayed and you can print the report.

You can open multiple reports from multiple files and also can get new reports from the device for viewing simultaneously.

SAVE REPORT

Any report fetched from the device can be saved in a file. You can choose the name and location of the file in which you want to store the report. When you are in the report view, choose the *Save As* item from the *Report* menu. A File Save dialog box appears for the selection of the file name and path. If you wish

to save a report when multiple reports are in view, ALPS-Link will save the report in the active window. So, make sure that the report you want to save is in the active window before choosing the item.

PRINT REPORT

You can take a hard copy of any of the report fetched from the device. You can do this before storing the report in a file or a report read from a file. When you are viewing multiple reports and choose the print item, ALPS-Link will print the report in the active window. So, make sure the report you want a hard copy of is in the active window.

SESSION LOG

ALPS-Link logs all the transactions done with a device. These logs are stored in disk files so that you can view them later. All the transactions in a session are stored in one log file. A session is defined as the time between logging into a device and logging out of a device. Up to 100 logs are stored in a cyclic manner. i.e. after the 100th, the overwriting starts from the first.

Each session log is stored in a different file. The log item is displayed in the menu bar before and after you are logged in to a device. To view the logs from the disk, you need not be logged in to a device. The current session log in the log menu is visible only when you are logged into a device. The LOG field in the status bar displays if the session log is on or off.

TURN OFF

By default, ALPS-Link has the session log on. If you wish to turn the log off, choose the Turn Off item in the Log menu. You can do this before and after logging in to a device. From the moment you turn the log off, ALPS-Link will not create any session log for any device until you turn it on.

If you choose Turn off, a select mark will be displayed with that item in the menu. The LOG field in the Status bar will be empty.

When you wish to turn the log on again, all you need to do is to choose this item again.

CURRENT SESSION LOG

This can be viewed only when you are connected to a device. This log contains all the transactions you have had with the device till this moment. You can add comments about your operations in the current log. This feature is only limited to the current log and you can not add comments to any previous logs.

As soon as you log out of a device, ALPS-Link automatically closes the log and stores it in the appropriate file.

You can print the current session log by choosing the print item in the Log menu.

To close the current log, choose the Close item in the Log menu. This will appear in the Log menu when you are in an active log window.

OPEN SESSION LOG

You can open a previous log for viewing and printing. You need not be logged into a device to invoke this option. Choose the Open item in the Log menu and a list box with all the available logs will appear.

The display consists of the log name, the date and time of occurrence and the device logged in during that session. You can scroll through the window and see the entire list. Select the log you wish to open and choose the OK button to view it. The session log will be displayed. Choose Cancel to quit the selection.

You can not add comments in any log opened from the list, but you can take a hard copy of the log by choosing the Print item in the Log menu.

You can view as many logs as you want using the Open option. If you choose the print item when you are viewing multiple logs, ALPS-Link will print the log that is in the active window.

To close a log, make sure that window is active and choose the Close item in the Log menu.

ARCHIVAL

Reports and Settings can be stored on the secondary storage by you, where as up to 100 log files are stored by ALPS-Link. It might be necessary to make an archival of some of these files. ALPS-Link supports this through the Archival option. The same option can be used to retrieve these backups.

ARCHIVE

When you want to take a backup of one of the Report, Settings or log files stored on the disk, use this option. Choose the Archive item in the Support Functions menu. An archives dialog box appears.

Enter the name of the source file along with the path and the destination file. Choose OK to proceed with the archival. You can also click the browse(>>) button to get a file common dialog box where you can select the file name. This browse button is available for both the source and destination.

RETRIEVE

You can retrieve the archived files using the same dialog box. If you wish to retrieve any of the files, choose the Archive item in the support functions menu. The same archive menu will appear. You can select the source from where you want to retrieve e.g. floppy disk etc. and give the destination name and path.

If you are retrieving any of the log files, make sure you copy the file in to the directory c:\ge_relay\ALPS\link\data\log. Since you would not want to destroy the log existing with the same name, you can give a name of your choice, but with an extension of .log i.e., you can name it test.log.

For Report and Settings, you can select the directory and name of your choice.

ASCII COMMUNICATIONS 2

ASCII INTERFACE 2

TABLE 12-1 ASCII PROMPTS 2

TABLE 12-2. OSCILLOGRAPHY DATA STRUCTURE 3

ASCII COMMUNICATIONS

The ALPS has a built-in ASCII interface which will communicate using any terminal emulator, such as, Procomm Plus, Terminal from inside windows, etc. The user must initiate all commands by typing them. Some of the commands have abbreviations which are represented by the capital letters in a command. If there are no lower case letters in a command, the command does not have an abbreviation and the whole command must be typed.

Any operation that can be performed at the Keypad, can be performed through the ASCII communications interface. The communications passwords apply to the ASCII interface and must be used to gain the necessary privilege level. If the passwords are not known or forgotten, they are available from the Keypad using the INF key.

Once the terminal emulator has been started, the PC COMM port the relay or modem is connected to, must be setup to match the relay for bits (8), parity (none), stop bits (1) and XON/XOFF.

Once the terminal emulator is ready and the relay is connected, press the ENTER key. The standard error message should appear. If it does not check the connections and settings. All the commands that follow can then be used. Use the save to file command from your ASCII communications program to save relay responses in a file.

ASCII INTERFACE

1) When a prompt says "Press", this indicates that as soon as that key is pressed the relay will respond without the user pressing the ENTER key. When a prompt says "Enter", the entered keystrokes will not be processed until the ENTER key is pressed.

2) The CAPITAL letters in a command name must be typed to execute the command. The lowercase letters that continue the command are optional. For any command to be executed the ENTER must be pressed.

3) If a mistake is made while entering commands, a message will be displayed and the correct information can be entered after the prompt at the end of the error message. No action that will cause the relay to change settings, operate a breaker, or change the relay operation in any way will be done without user verification (i.e.: TRIP BREAKER 1, are you sure (Y/N):?).

4) The relay responses below are in order of appearance. Where there is a user choice, all possible responses may not be listed. However, any unlisted responses will be similar to others listed.

5) Help is available before typing a command by typing HELP at the ALPS_XXX> prompt and pressing the ENTER key. Some commands have built-in help as well.

6) There are two kinds of command prompts. The colon (:) is used to indicate the relay is not logged in and is waiting for the LOGIN command. After a successful login, the prompt changes to:

Privilege Level	Prompt
VIEW	ALPS_INF>
ACTIONS	ALPS_ACT>
SETTINGS	ALPS_SET>
MASTER	ALPS_MST>

Table 12-1 ASCII Prompts

Communication using ASCII protocol presents oscillography data as directly readable ASCII characters. Oscillography data may contain 12 to 72 power cycles of data. Each power cycle contains 64 samples of data. The data structure of a sample is as shown in Table 12-2. Each sample appears on a separate line.

Table 12-3 ASCII Command List

Item	Data Format (ASCII characters)	Description
Sample No	decimal integer	Sample number within the cycle
Ia	signed decimal (resolution of .01 units)	Inst. current in Phase A
Ib	signed decimal	Inst. current in Phase B
Ic	signed decimal	Inst. current in Phase C
Va	signed decimal (resolution of 0.1 units)	Inst. voltage in Phase A
Vb	signed decimal	Inst. voltage in Phase B
Vc	signed decimal	Inst. voltage in Phase C
Digital Flags	Eight 4 byte hexadecimal integers	The 252 digital flags represent system status

Table 12-2. Oscillography Data structure

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
LOGIn	Login to the relay	NONE	Unit ID? Password? Reports the access level granted OR that the password entered is INVALID	Relay ID number Up to ten character password
QUIT	Logs out from the relay, displays the relay status and returns the privilege level to VIEW for the relay port used.	VIEW	Press ENTER to continue Do you want to logout? You have logged out from the relay	Press the ENTER key Y or N
PASSword	Change the passwords used by ALPS-Link and ASCII; MMI passwords are not affected by this command	Level equal to the password being changed	Enter Current password Enter New password Re-enter New password Password Changed OR Invalid, password not changed	Old password New password New password
VALues	Display the present values of voltages, currents, watts, VARS, etc, including Breaker Health in the second screen. Press ENTER to see the second screen.	VIEW	Present Values VArms V IArms A VBrms V IBrms A VCrms V ICrms A Inrms A VA V DEGS IA A DEGS VB V DEGS IB A DEGS VC V DEGS IC A DEGS IN A DEGS WATTS KW Vars KVAR Power Factor Frequency Hz Setting Group Number: 1 Number Of Breakers: 2 Breaker 1 Closed Breaker 2 NA BREAKER HEALTH Phase A Accumulated Amps 45.2A Breaker Operations 129 Phase B Accumulated Amps 11.1A Phase C Accumulated Amps 25.7A	None
READings	Display the present values of voltages, currents, watts, VARS, etc, and update them once per second; The ESC key stops the update. No breaker health is displayed.			

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
FAUIts	Display fault reports. The list of available faults is displayed first then a number is chosen to view a particular fault.	VIEW	<pre> FLTNO DATE TIME TRIP FAULT DISTANCE TYPE TYPE 1 07/03/96 16:32:23.6833 EXT AG 0.2MI Enter Fault Number (press 'ESC' to quit): 1 Report for Fault No: 1 TRIP DATE: 07/03/96 TRIP TIME: 16:32:23.6833 Trip type(s): Z1 Fault type: ABG Relay Operating Time: 488mS Breaker Operating Time: 1152mS Distance: 9999 miles ITEM A B C N Prefault Current (A) 0.00 0.00 0.00 0.00 Fault Current (A) 0.00 0.00 0.00 0.00 Fault Voltage (kV) 0.0 0.0 0.0 --- Press ENTER to continue List of Fault events : TIME EVENT 16:32:23.7025 Oscillography Capture 16:32:23.7041 RMS Oscillography Capture Press 'Y' to get oscillography data Press 'ESC' to quit Press Any Key to continue </pre>	<p>Press 'E' for expanded mode, ESC to end</p> <p>Two digit number, 1-16</p>

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
EVENTs	Display events	VIEW	List of events with date and time; example: 06/30/96 16:26:29.7562 Host Logoff on MMI 06/30/96 16:24:37.5944 Host Logon OK on Port2 06/30/96 16:10:45.6505 Recloser in RESET state 06/30/96 16:10:40.0000 Settings File 0 In Use 06/30/96 16:10:40.0000 System Booted Press Enter to continue, 'B' to go back a screen or ESC to quit.	
TRIP	Open Breaker command; issues the command to open breaker; breaker will be determined by settings NUM_BRKR and NUM_TC.	CONTROL	Enter Breaker No (1 / 2 / BOTH) TRIP BREAKER 1,! Are you sure? (Y/N) Breaker open command sent	1, 2 or BOTH Y to trip, N to cancel
CLOSE	Close Breaker command; issues the command to close breaker; breaker will be determined by settings NUM_BRKR and NUM_TC.	CONTROL	Enter Breaker No (1 / 2 / BOTH) CLOSE BREAKER 1,! Are you sure? (Y/N) Breaker close command sent	1, 2 or BOTH Y to trip, N to cancel
ENOUT	Enable outputs	CONTROL	Enable Outputs, Are you sure? (Y/N) Outputs are enabled OR Outputs cannot be enabled	Y for OK, N to cancel command
DISABLE outputs	Disable outputs	CONTROL	Disable Outputs, Are you sure? (Y/N) Outputs are disabled OR Outputs cannot be disabled	Y for OK, N to cancel command
STATUS	Display status of the relay	VIEW	RELAY STATUS Refer to the serviceing section for staus messages for the ALPS. Press ENTER to continue	

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
DATAReset	Clear various data logs maintained in the relay	SETTING	<p>To clear FAULT REPORT and OSCILLOGRAPHY enter 'F'</p> <p>To clear OST REPORT enter 'S'</p> <p>To clear EVENT DATA enter 'E'</p> <p>To reset target LED and clear warn, failure and trip messages enter 'L'</p> <p>To clear BREAKER HEALTH enter 'B'</p> <p>To quit press 'ESC'</p> <p>Enter your choice :</p>	Enter letter, press ENTER
DIGTest	Perform Digital Output tests; the test energizes the selected output until END is chosen or another output is tested.	MASTER	<p>Turn Protection off (Y/N):</p> <p>Enter the number of the Digital Ouput to be tested (1 to 18)</p> <p>Enter END to end test</p> <p>To see the list of Digital Outputs enter 'H'</p> <p>To quit press 'ESC'</p> <p>Enter your choice : 4</p> <p>Digital Ouput # 4 is Activated</p> <p>Turn Protection on (Y/N): ?</p>	Enter digit from 1 to 18
GROUP		SETTING	<p>The active Protectiong Setting Group number is 1</p> <p>To select a Setting Group enter Setting Group Number ('1'-'4')</p> <p>To select acive setting group through Contact Converter Inputs enter '0'</p> <p>To quit press 'ESC'</p> <p>Enter your choice : 3</p> <p>Are you sure (Y/N): ? y</p> <p>New Active Group = 3</p>	Enter digit from 0 to 8

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
INPutS	Request contact converter status	VIEW	Contact Converter #0 = 0 (SETTING GROUP BIT 0) Contact Converter #1 = 1 (SETTING GROUP BIT 1) Contact Converter #2 = 1 (not assigned) Contact Converter #3 = 0 (not assigned) Contact Converter #4 = 0 (not assigned) Contact Converter #5 = 1 (not assigned) Contact Converter #6 = 0 (not assigned) Contact Converter #7 = 1 (not assigned)	
MODEL	Retrieve the model number, serial number and version of the relay	VIEW	MODEL :ALPSDA35U143VE3S VERSION :V0001.11	
CRCcalc	Recalculates the CRC of various settings groups (this is primarily a troubleshooting command - it is used in those instances where a relay may have gone through a loss of power during a settings change, and the settings are corrupted beyond the ability of the relay to correct.)	SETTINGS	CRCs are recalculated	
STLINID	Allows the station and line IDs to be changed	SETTINGS	Station ID : Current Station ID Line ID : Current Line ID Do you want to change Station and/or Line Id ? (y/n) : y Enter new station ID (max. 32 characters) :NEW STATION ID Enter new line ID (max. 32 characters) :NEW FEEDER ID Are you sure ? (y/n) : y	Displays current IDs Y to change or N to exit New Station ID or ENTER to keep current ID New Feeder ID or ENTER to keep ID

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
RELTest	Selects and runs a given relay test. Puts the relay in test mode (Contact A! Reports test function operation).	MASTER	Disable Outputs? (Y/N): Select the function to be tested (2 to 49) To stop the test in progress enter '1' To see the list of functions enter 'H' To quit without suspending the test enter 'Q' To quit press 'ESC' Enter your choice : 2 Z1 AG test function is routed to contact A!	One or two digit number, 1 to 49, 'H' or 'Q'.
ACCESS	Allows the user to change privilege level	VIEW	Enter Password: ?	User-defined password
OSCtrg	Start oscillography recording	VIEW	Are you sure (Y/N): ? y Oscillography is triggered	
CHNLtest	Test PLC channel. The test starts when a B is entered and ends only when an E is entered.	MASTER	To begin Channel Test enter 'B', To end channel test enter 'E'	B to begin testing the channel, E to quit
PLAYBack	Re-run a fault that was produced earlier or a test case for the relay. There are three choices for running a fault. The first is to re-run a fault the has been saved in the relay. The second is with the factory test data. The last is to download oscillography into the relay and run that fault.	ACTION	To run the relay on Fault Data enter Fault Number To run the relay on factory test case enter 'F' To run the relay on the downloaded test data enter 'D' To quit press 'ESC' Enter your choice : 5 This fault is absent There is no factory test data in the relay There is no downloaded data in the relay	

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
LUIPass	Displays coded LUI passwords. See decoding table in Chapter 8 - Interface.	VIEW	MMI PASSWORDS Settings Password : [DHLPPPPPPPPPPPP Control Password : [AEIPPPPPPPPPPP Master Password : [MBFPPPPPPPPPPPP	
HELP	Displays the ASCII command mnemonics as well as descriptions of each command.	VIEW		
OUTPuts	Displays the current state of the digital outputs	VIEW	Output Contact# 1, T1 =0 Output Contact# 2, T2 =0 Output Contact# 3, T3 =0 Output Contact# 4, T4 =0 Output Contact# 5, A1 =0 Output Contact# 6, A2 =0 Output Contact# 7, A3 =0 Output Contact# 8, A4 =0 Output Contact# 9, A5 =0 Output Contact# 10, A6 =0 Output Contact# 11, A7 =0 Output Contact# 12, A8 =0 Output Contact# 13, KT1=0 Output Contact# 14, KT2 =0 Output Contact# 15, KT3=0 Output Contact# 16, KT4 =0 Output Contact# 17, C1 =0 Output Contact# 18, C2 =0	
DATE	Displays the current ALPS date.	SETTINGS	DO you want to change date (Y/N): Enter new date (mm/dd/yy): Command is executed	
TIME	Displays the current ALPS time.	SETTINGS	DO you want to change time (Y/N): Enter new time (hh:mm:ss): Command is executed	
LINES	Changes the number of lines the relay will display before pausing for the user to read.	VIEW	Enter the number of LINES PER PAGE (24/25/48/50):	
GEModem	Changes communications type to GE-Modem after user has logged out.	SETTINGS		
ECHo	Toggles the echo state and reports its status	VIEW	Echo is turned ON (OFF)	

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
PORTparam	Changes and displays the current port parameters on the ALPS port communicating with this terminal emulator. Changes do not effect port until user logs out.	SETTINGS	<p>DO you want to change communication port parameters (Y/N):</p> <p>Interface is (0 - RS232, 1 -RS485): 0</p> <p>Enter interface type (0 - RS232, 1 -RS485):</p> <p>Baud rate is 9600</p> <p>Enter Baud rate (19200, 9600, 4800, 2400, 1200, 300):</p> <p>Parity check type is (0 - none, 1 - odd, 2- -even): 0</p> <p>Enter Parity check type (0 - none, 1 - odd, 2- -even):</p> <p>Number of stop bits is 1</p> <p>Enter number of stop bits ('1' or '2'):</p> <p>Save changes (Y/N):</p>	<p>Y displays each parameter to be changed, N exits</p> <p>0 for RS232 / 1 for RS485</p> <p>ENTER key for no change</p> <p>(applies to each prompt)</p> <p>Pick the baud rate that matches the PC to be used</p> <p>Currently is 0 for the ALPS</p> <p>Currently is 1 for the ALPS</p> <p>Y changes will be saved after logout.</p>
END	Ends the session	VIEW		

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
SHOWSET	Displays the current values of selected settings.	VIEW	<p>To see PROTECTION GROUP Settings press Setting Group no '1' to '4' To see GENERAL Settings press 'G' To quit press 'ESC'</p> <p>Enter your choice : 2</p> <p>To View Category of Settings press 'C' To View ALL Settings press 'A' To go back to previous menu press 'B' To quit press 'ESC'</p> <p>Enter your choice : C</p> <p>To view protection SETTINGS in a category enter ctageory number '1' - '20' To view protection settings CATEGORY names enter 'C' To go back to previous menu press 'B' To quit press 'ESC'</p> <p>Enter your choice : 5</p> <p>Press 'ENTER' to continue or 'ESC' to quit</p>	

Table 12-3 ASCII Command List

ASCII Command Mnemonic	Command Description	Lowest Level Password Needed	Relay Prompt	User Response
SET	Allows the user to change settings	SETTINGS	<p>To View/Change PROTECTION GROUP Settings press Setting Group No. '1' to '4'</p> <p>To View/Change GENERAL Settings press 'G'</p> <p>To quit press 'ESC'</p> <p>Enter your choice : 2</p> <p>To View/Change Category of Settings press 'C'</p> <p>To View/Change ALL Settings press 'A'</p> <p>To go back to previous menu press 'B'</p> <p>To quit press 'ESC'</p> <p>Enter your choice : C</p> <p>To view protection SETTINGS in a category enter ctageory number '1' - '20'</p> <p>To view protection settings CATEGORY names enter 'C'</p> <p>To go back to previous menu press 'B'</p> <p>To quit press 'ESC'</p> <p>Enter your choice : 1</p> <p>Do you want to save the changes ? (y/n) : y</p>	<p>Select one of the four settings groups or General settings</p> <p>Listing of the settings categories to choose from</p> <p>Select one of the categories</p> <p>Presents a list of the settings in this category</p> <p>Change entered Y to enter change, N to cancel</p>

Table 12-3 ASCII Command List